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OF THE
JURASSIC AMMONITE FAUNA
OF
MOUNT HERMON, SYRIA

OTTO HAAS

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INTRODUCTION

MATERIAL

When Dr. Harold E. Vokes (then at the American Museum of Natural History, now at Johns Hopkins University) visited Syria and Lebanon for geological and stratigraphic researches in 1940, he was entrusted by Dr. Bayard Dodge, then President of the American University of Beirut, with the rich collections of Jurassic invertebrates from Mount Hermon and of other fossils from that area belonging to the university for study at the American Museum of Natural History.

The present report, prepared in the years 1951–1954, deals with only a part of the material from the Jurassic of Mount Hermon, namely, with the ammonites from Noetling's (1887, pp. 7, 10) "Lower Syrian Jurassic." According to the attached labels, all were collected at or near the village of Majdal Shams,[1] situated at an elevation of 1340 meters above sea level, at the southern end of Mount Hermon, of Biblical fame, near the Lebanon-Syrian boundary, but still on Syrian territory. Only three comparatively large ammonites [A.M.N.H. Nos. 27335:4, 27369:4, and 27840:15, here identified as *Phylloceras plicatum*, *Lissoceras erato*, and *Perisphinctes* (*Properisphinctes*) *trapezoidalis*, respectively] carried slips, obviously all written at the same time by the same hand, that read: "Majdal Shams. Mu'. Isk. Haddad. Said to be from E. of Tell 'Ain al Kasab." These special labels may be interpreted to the effect that Mu'. Isk.[2] Haddad, who was possibly one of the students participating in the collecting, reported finding these particular ammonites east of Tell 'Ain al Kasab, a basalt hill about three-fourths of a kilometer northeast of the village. This may have struck the person who supervised the collecting as extraordinary, because, according to Noetling (1887, p. 4), most of the fossils of this horizon are found southwest of that basalt hill, and induced him to note it on special labels which he attached to the specimens concerned. However, because all three are referable to species represented at the main localities also, there can be no doubt but that they came from the same horizon as the bulk of the material, perhaps exposed in some small patch northeast of the Tell.

The main collection includes, in addition to the ammonites dealt with here, many other invertebrates, chiefly pelecypods and brachiopods, a considerable number of specimens of *Hibolites hastatus* and perhaps still other belemnitid species, about a dozen nautilids, some crinoid stem fragments and echinoid spines, and rare gastropods.

The ammonites in this material number roughly 7600; the over-all total of specimens from this horizon contained in the collection may conservatively be estimated at about 12,000. The accumulation of such abundant material is probably due to collecting through several decades by successive generations of students. Hamlin's (1884, p. 10) following remark points in this direction: "It is known that the pupils of the mission stations established at Mejdel esh Shems and Abeth are encouraged by their teachers to gather up the fossils which abound in both districts, and that by them has been brought together a large part of the fine collection now exhibited in the college at Beirut. It was probably from the station at Mejdel esh Shems that these Jurassic Ammonites were procured." Much more material is likely to have been added in the almost 60 years between the time about which this remark was made (about 1880) and 1940 when the collection was handed over to Vokes.

Certain differences in lithologic facies within this material are pointed out below. A single piece of limestone should, however, here be mentioned as standing entirely apart. It carries fragments and imprints, some of

[1] The spelling of this Arabic name, translated "Tower of the Sun" by Fraas (1878) but "Glory of the Sun" by Dr. George Gaylord Simpson, varies greatly in literature, primarily with the language of the respective papers. It is Medjdel esch Schems (Fraas, 1877, 1878) or Medschel esch Schems (Diener, 1886a, 1886b; Noetling, 1887; Frebold, 1928) in German papers, Mejdel esh Shems in Hamlin's (1884) English paper, and Medjel Chems in Vautrin's French one. In the labels of the Protestant Syrian College, now the American University of Beirut, it is spelled Majdal Shams. After consultation with Dr. Simpson, who masters the Arabic language as he does many others, this spelling has been adopted throughout the present report.

[2] These two abbreviated names cannot be deciphered with certainty.

the latter rather indistinct, of eight ammonites, all but one of which are very probably referable to *Hecticoceras* (*Putealiceras*) *schumacheri* and one probably to *H.* (*Sublunuloceras*) *guthei*. In a slip attached to this sample the locality is given as "Majdal Shams, E. side of Kuneid al M'aaz,"[1] which is obviously the gully about 1.5 kilometers southwest of the village the name of which is spelled "Kuneid el-Ma'ānse" by Noetling (1887, p. 4 and map, pl. 1). Although the locality marked "1" in Brotzen's sketch map (Frebold, 1928, p. 184) seems to be situated to the south rather than to the southwest of the village, there is good reason to believe that we are dealing here with a sample of the "Mergelkalke" (marly limestones) visited by Brotzen and mentioned, especially for the abundance of *H. schumacheri* in them, by Frebold (1928, p. 187), though not by Noetling.

Most of the fossils examined are marked as part of the Day collection and a few of the rare labels of the "Syrian Protestant College, Geological Collection" accompanying the material list "Day" as the collector. I have not been able to find this name mentioned in the literature, but it may be assumed to have been that of one of the missionaries at the Protestant Syrian College of Beirut who was in charge of its geological collection. A minority of the ammonites, mostly choice specimens, are marked, with labels of a different kind, "Collection of Rev. William Bird."[2] From the evidence available it cannot be stated with any certainty whether Bird preceded or succeeded Day in the care of the Beirut fossil collections, nor if he was the successor of the Rev. E. R. Lewis, M.D., mentioned in that capacity by Fraas (1877, p. 29; 1878, pp. 13, 20). Be that as it may, it seems only appropriate here to renew the tribute paid by Fraas (1877, p. 30) to the missionaries of the Syrian Protestant College for having aroused in their students an interest in the fossils at Majdal Shams and thus accumulated the most complete collection of these fossils in existence. It provided the present author with material which, if not fully representative[3] of the Mount Hermon ammonite fauna, certainly represents it much more completely than that on which Noetling based his monograph.[4] Noetling (1887, p. 9) gives the number of Phylloceratidae in his material as 12 and of the "Harpoceratidae" (=Oppelidae) as 92; the number of Perisphinctidae is not given by him, but from the number of individuals given for his several species it may be estimated at 50 at the most. Thus a total of a little more than 150 individuals is arrived at, as compared to about 7600 dealt with in the present report.

Most of the ammonites studied are embedded in a light gray marl and are pyritized; their surfaces are black or dark brown with a bronzy luster. The preservation of a minority, most of them belonging to *Hecticoceras* (*Putealiceras*) *caelatum* and to the two closely related species *H.* (*P.*) *solare* and *H.* (*P.*) *separandum*, is, however, somewhat different.[5] Owing to oxidation of the pyrite on the surfaces to limonite, they are ochreous in color, and the pyritization is further advanced in some specimens on the surface of which pyrite crystals have formed. The question of whether this deviating mode of preservation indicates only another facies or that and also a slightly different age is discussed below (p. 201).

As stated by Noetling (1887, p. 4), the body chambers are crushed in most of these ammonites, "with the exception of quite small individuals,"[6] and "only the part of the

[1] Transliteration of this name uncertain.

[2] Mentioned by Hamlin (1884, p. 1) as the husband of Mrs. Bird who collected the second of the two collections of Syrian fossil mollusks presented to the Museum of Comparative Zoölogy.

[3] The presence of two species represented by a single specimen each [*?Quenstedtoceras ?mariae*, *Peltoceras annulare* (Reinecke *in* Quenstedt)] and of four others represented by only a few specimens each (*Lissoceras erato*, *Taramelliceras* cf. *langi*, *Aspidoceras douvillei*, and *Peltoceras* cf. *arduennense*) suggests some caution in this respect.

[4] Frebold (1928) does not give precise counts of the specimens examined, but from scattered data the total number of ammonites in Brotzen's collection can be inferred to be much smaller than in Noetling's.

[5] Some individuals belonging to other species show, however, the same peculiar mode of preservation, among them one probably belonging to *H.* (*Sublunuloceras*) *guthei*, two probably belonging to *H.* (*Brightia*) *kautzschi*, and the large whorl fragment A.M.N.H. No. 27765: 76 referred to *Perisphinctes* (*Alligaticeras*) *?paneaticus* Noetling (pl. 19, fig. 12).

[6] *Scaphitodites scaphitoides* is another remarkable exception (p. 117).

conch reenforced by the septa" is intact.

The preservation of the few ammonites present in the sample of "Mergelkalk" from the east side of Kuneid el-Ma'ānse, mentioned above (pp. 9, 10), is entirely different from that of the pyritized ones; that limestone shows no indications of iron content.[1]

PREVIOUS LITERATURE

For Lartet's exploration of the area in the 1860's and his reports thereon, reference is made to Noetling (1887, p. 1).

The first explicit description of the topography and geology of Majdal Shams (there spelled "Medjdel esch Schems") and the first faunal list of that locality with brief discussions (but unfortunately without illustrations) of the species listed are found in Fraas (1877, pp. 21–30; 1878, pp. 13–20). Fraas distinguished at Majdal Shams two horizons. The lower horizon he assigned to the "Upper Brown Jura" and the upper to the "Lower White Jura"; it is the lower one in which the ammonites here dealt with are found.

Fraas's results are referred to in Hamlin's report of 1884; here the occurrence of Jurassic ammonites at Majdal Shams is repeatedly mentioned (pp. 2, 6, 9–10), and three species are briefly described (pp. 10, 11) under the names *Ammonites convolutus*, *A. hecticus*, and *A. fuscus* but not figured. To judge by Quenstedt's illustrations quoted by Hamlin, the first of these species seems to be a *Properisphinctes*, the second a *Brightia*, and the third a *Proscaphites*.

Quenstedt's brief discussion of this fauna, in the "Schlussworte" of his "Ammoniten des schwäbischen Jura" (1888, p. 1110), relies on Fraas's reports, although Noetling's (1887) much more exhaustive monograph had just appeared, for the old master resented the "obscuration" of his "good old species" by Noetling's "meaningless new names."

A year before Noetling's monograph appeared, my late teacher, Carl Diener, then a young geologist, dealt in both a preliminary paper (1886a, pp. 633, 634) and in his "Libanon" book (1886b, pp. 25–27) with the section exposed at Majdal Shams and with the fossils found at this locality. Essentially, he confirmed Fraas's results, although he did not share that author's belief in a full agreement of the Syrian with the Swabian fauna. However, some of Diener's remarks were considered unreliable by Noetling (1887, p. 2).

The latter's paper "Der Jura am Hermon," published in 1887, has remained the standard work on the subject to this day. For this reason the synonymies in the Systematics section of the present report are as a rule not traced back beyond Noetling's monograph and with few exceptions omit the names under which ammonites from Majdal Shams are recorded in the earlier papers of Fraas and Hamlin. However, by the addition of "*cum synon.*" to the references to Noetling, 1887, they are in most cases[2] implicitly included in our synonymies. For the same reason, the earlier work is not taken into consideration in the Conclusions of the present report.

About 40 years after the publication of Noetling's paper, Frebold, then in Greifswald, now in Ottawa, studied collections made in 1922 near Majdal Shams by Brotzen (now in Stockholm) and published a report (1928) in which he described (but, unfortunately, did not illustrate) some ammonite forms not previously recorded from Mount Hermon, one of them new, and revised those described by Noetling. Frebold arrived at an interpretation of the stratigraphy and at a correlation somewhat different from Noetling's.

In the recent French literature on the geology of Syria and Lebanon the ammonite-bearing beds of the Jurassic, as exposed at

[1] Still another ammonite found in the collection studied shows a quite different lithology. It can be recognized as that characteristic of the famous *subbullatus* beds of the Hallstatt limestones of the Austrian Alps, and the ammonite itself as a small arcestid, with some suture lines exposed. It can be identified as the inner whorls of *Arcestes ciceronis* Mojsisovics (1873, p. 103, pl. 51, fig. 2, pl. 54, figs. 4–7), of Triassic (Carnian) age.

[2] "*Ammonites fuscus* Quenstedt" *in* Hamlin, synonymized with *Taramelliceras* (*Proscaphites*) *hermonis* here but not by Noetling, is an exception.

Majdal Shams, are repeatedly mentioned, e.g., by Dubertret (1933, pp. 288, 289; 1948, p. 213; 1950, pp. 12, 13; 1951, p. 107), Geze 1951, p. 94), and Renouard (1951, p. 993). However, Vautrin's paper of 1934 is particularly important for the present study, for it contains (p. 1439) a detailed section of the Jurassic of the Anti-Lebanon which, according to Vautrin, can be closely correlated with the section at Majdal Shams studied by Noetling.

VARIOUS PRELIMINARY REMARKS

Arkell's (1950) sequence of superfamilies, families, and subfamilies has been adopted in the following systematic part of the present report.

The same terminology is used herein as in previous ammonitological papers of the author. In particular, a purely morphological rather than a genetic designation of sutural elements has been adhered to in this paper also; the term "suspensive lobe" has been used between quotation marks only to comprehend several auxiliary lobes strongly inclined dorsad. Although, or perhaps because, I have strongly emphasized the study of the ontogeny throughout my paleontological work, I am inclined to share Schmidt's (1952, p. 209) doubts concerning "a procedure by which the designation of [elements of] the adult suture line is, from the outset, made dependent on ontogenetic evidence which is in part not yet uncovered or cannot even be expected, because ontogeny skips relevant stages." In thus quoting Schmidt, I do not in any way intend to indicate full agreement with him in his recent discussion with Schindewolf (1951, 1954) on morphologic versus genetic nomenclature of ammonite sutures. I may even quote Schindewolf's (1951, p. 26) statement that "great and, for the time being, insurmountable difficulties preclude, for reasons following from the nature of things, application of the genetic nomenclature to Jurassic and Cretaceous ammonites" in support of my attitude.

For the convenience of readers not familiar with the author's previous ammonitological papers the explanation of the symbols used in the sections on dimensions is here repeated: D indicates, unless otherwise noted, the greatest diameter that could be measured and is expressed in millimeters (down to two decimals). H indicates the height of the last whorl from the umbilical seam to the periphery, H′ its height from the dorsum to the periphery, W the width of the whorl section, and U that of the umbilicus, all these dimensions measured at the anterior end, unless otherwise noted. H, H′, W, and U are expressed in per cent of D, decimals having been reduced or increased, respectively, to full or half per cent. Throughout the descriptive part, sculptural elements on both sides and venter are included in the measurements of H, H′, and W. In the table of dimensions of the geniculate specimens of *Hecticoceras* (*Lunuloceras*) *kersteni* and in that of *Scaphitodites scaphitoides* the relative height of the whorls is measured not only at the anterior end (H) but also at the geniculation point,[1] thus introducing a sixth dimensional symbol (HG).

With the exception of the photomicrographs on plate 14, all photographs accompanying this report, most of them enlarged, some up to 20 times, were made by Mr. Robert Adlington of the Department of Geology and Paleontology. Although suture lines can be seen clearly in many photographs of ammonites published in previous literature, it is believed that in the present paper the first attempt is made purposely to illustrate suture lines solely by photography without having (with the following exception) recourse to drawings. I trust that especially the suture-line photographs will bear witness to the high skill and great devotion applied by Mr. Adlington to his task. Attempts to illustrate some minute nuclei of *Ochetoceras* (*Campylites*) *freboldi* by photomicrographs succeeded, chiefly thanks to the cooperation of Mr. Chester Tarka, of the Department of Art and Exhibition of the American Museum, only after special equipment adequate for the purpose had been secured. Credit is due to Mr. Tarka also for the very accurate drawings of the prosutures

[1] In *Scaphitodites scaphitoides* at the point of the second geniculation, to be precise.

and earliest sutures of some of these nuclei (text figs. 1–4) and the painstaking preparation of these nuclei, the greatest dimensions of which are in the order of magnitude of 0.5 mm., for illustration. The greatest success of these endeavors was the baring of the caecum of specimen A.M.N.H. No. 27909:98 which is shown in three dimensions in plate 14, figures 4 and 5.

According to an agreement reached in 1940 between President Dodge of the American University of Beirut and Dr. Vokes, all type specimens, figured specimens, and specimens otherwise referred to, that is, all those listed under American Museum catalogue numbers in the following text, are being retained in the collections of the American Museum of Natural History; the rest of the material has been returned to the American University of Beirut.

The author is responsible for the translations of passages from works in foreign languages which are quoted in English.

ACKNOWLEDGMENTS

First and foremost, the American Museum of Natural History and the author owe a debt of gratitude to the authorities of the American University of Beirut, primarily to its former president, Dr. Bayard Dodge, for entrusting to us their rich fossil collections for study, for permission to publish its results, and for the generous agreement quoted above.

The author feels greatly indebted to Dr. William Joscelyn Arkell, F.R.S., of Cambridge, England, for repeated consultations on taxonomic problems, for information on the literature, and for the loan of his personal copy of Noetling's 1887 Hermon monograph, which was not available in the United States until a microfilm of the copy belonging to the British Museum could be made.

I also wish to express my thanks to Dr. Hans Frebold of Ottawa, Dr. Fritz Brotzen of Stockholm, and to Prof. Dr. Serge von Bubnoff, formerly at Greifswald, now at Berlin, for their willingness to assist me in my futile attempts to trace the material published in 1928 by Frebold, to Dr. George Gaylord Simpson, Chairman of the Department of Geology and Paleontology of the American Museum, for putting his knowledge of Arabic at my disposal, and to Dr. Brian H. Mason, Curator of Mineralogy in the Department of Geology and Paleontology, for assistance with regard to the lithology of the material.

Last but not least, I wish gratefully to acknowledge a grant from the Council of the Scientific Staff of the American Museum by which considerable acceleration of the photographic work was made possible.

PHYLLOCERATACEAE Hyatt, 1900

With only about 180 individuals, this superfamily is by far the least abundant of the three superfamilies that compose the ammonite fauna of Mount Hermon (Phylloceratacea, Oppeliaceae, and Perisphinctaceae, if the single fragment referable to the Stephanocerataceae is left out of account).

PHYLLOCERATIDAE Zittel, 1884

This family is represented in our assemblage by two subgenera of the genus *Phylloceras* and by the genus *Sowerbyceras*.

PHYLLOCERAS Suess, 1865, sensu lato

Subgenus PHYLLOCERAS, sensu stricto

Phylloceras (Phylloceras) plicatum Neumayr

Plate 1, figures 1–13

Phylloceras plicatum nov. sp.; Neumayr, 1871, p. 313, pl. 12, fig. 7, pl. 13, fig. 2.

Phylloceras plicatum Neumayr; Noetling, 1887, p. 14, pl. 2, fig. 2.

Phylloceras cfr. *plicatum* Neum.; Choffat, 1893, p. 10, *pro parte*, pl. 16, fig. 2 only.

Non Phylloceras plicatum Neum.; von Lóczy, 1915, pp. 283, 435, text figs. 6–8.

?*Phylloceras* cf. *plicatum* Neumayr; de Grossouvre, 1922, p. 314, pl. 15, fig. 11.

Dimensions

A.M.N.H. No. 27335	D	H	H′	W	U
1 (innermost whorls)	7.10 mm.	40½	37	44	34½
1 (full disk)	35.6 mm.	55	35	34½	12
2	52.2 mm.	55½	35	33	8
3	58.4 mm.	57	?	38	10½
4	62.7 mm.	57½	*ca.* 35½	34	9½
5	66.1 mm.	55½	?	*ca.* 28	9
6	80.5 mm.	56	*ca.* 38½	*ca.* 31	8½

The dimensions of the innermost whorls of specimen number 1 prove that the shell is much more evolute and thicker in early youth than later in development. If, however, the full disks are compared, only slight variation in dimensions can be found, except for trends of the whorl height to decrease somewhat and of the umbilicus to become somewhat narrower, from a diameter of about 60 mm. on.

In specimen number 4 the last septum can be located immediately behind the anterior end, whereas all others are septate throughout. Thus no inferences are possible as to the size actually reached by this species in the present assemblage. The incomplete shell illustrated in Neumayr (1871, pl. 12, fig. 7), here designated lectotype of this species, is septate to the anterior end, that is, to a diameter of nearly 11 cm., and must therefore, when complete, have measured between 15 and 20 cm. across.

Description: The innermost whorls of specimen number 1 exhibit an inverted-oval whorl profile (fig. 2) and, from a diameter of about 6 mm., a faint indication of radial ornamentation. Only in the anteriormost part, corresponding to a diameter of about 7 mm., can this ornamentation be recognized to consist of slightly rursiradiate and gently recurved delicate folds of which seven or eight can be counted to 1 mm. They are overgrown, as it were, by even finer striae which parallel them in course and of which about three or four can be counted to each of the aforementioned folds (fig. 1).

At the anterior end of specimen number 1 the whorl profile (fig. 5) has become markedly narrower; it is now nearly lanceolate. The venter is narrow (fig. 3). Nearly 20 blunt, slightly recurved folds can be counted around the outer volution; they are most distinct around the umbilicus but vanish on the venter. Superimposed on these folds is the delicate radial striation which, in turn, becomes most distinct towards the venter and can be seen to cross it in almost straight lines; at this stage the number of such striae on the outer whorl may be estimated at about 200 (fig. 4).

Except for being a little stouter in some shells, e.g., number 4 (fig. 10), the whorl section remains the same throughout further development; that of the largest shell present is shown in figure 13. The ornamentation, however, becomes more pronounced. The density of the folds varies, there being 16, 13, and 18 on the last half-whorls of specimens 4, 5, and 6, respectively. They are only slightly rursiradiate and only gently recurved and have a somewhat sigmoidal aspect in numbers 4 and 5 (figs. 8, 11), but those of the largest shell present (no. 6, fig. 12) are somewhat stiffer and more pronouncedly recurved, thus resembling those of the holotype. In all shells these folds vanish at the lateroventral shoulder, so that they can never be followed across the venter, but the striae cross the venter, without losing strength, horizontally or in a gently forward convex sinus. On the sides they share the course of the folds and are therefore slightly sigmoidal in specimens 3, 4, and 5 (figs. 6, 8, 11) but stiffer and more distinctly recurved in specimen 6 (fig. 12). Their number increases from about 60 on the last quarter whorl of number 4 to about 75 on that of number 6; this gives a ratio of approximately four striae to one fold.

No constrictions can be recognized on any of the specimens examined.

Suture lines cannot be studied in the early juvenile stage of this species, as represented by whorls of specimen number 1, but they are well observable at later stages, corresponding to diameters of from 15 to 80 mm., in all specimens and fragments present, best in number 3 (figs. 6, 7). They are typically phylloceratid in every respect. The indentation is extremely rich. All lobes are greatly narrowed and all saddles deeply pinched, with prongs from the adjacent lobes almost cutting off their main stems at or near the base. The siphonal lobe is only a little more than half as deep as the first lateral one, whereas the second is not so much shorter than the first. The long and sharp main points of the siphonal lobe are strictly parallel or even slightly converge apicad; they are separated by an extremely slender and high, arrowpoint-shaped median knob. The external saddles diverge in the shape of a V from the median line and end in two main leaves each. The first lateral lobe spreads out widely in its lower part and is clearly trifid, whereas the second is bifid, as are all auxiliary lobes that could be examined in this respect. At least six of them which gradually decrease in size can be counted between second lateral saddle and umbilical seam. The first lateral saddle carries three terminal leaves, the outer of which is markedly stronger than the inner, but all following saddles end in two leaves only. The middle terminal leaf of the first lateral saddle and both leaves of the second are about equally high and mark the culminating portion of the gentle, forward convex arc that connects the tops of all saddles. The leaves separating the main branches of the first lateral lobe equal the smaller ones of those auxiliary saddles in size and even exceed them in the degree of indentation. The internal suture line could not be studied without the sacrifice of a specimen.

Remarks: The perfect agreement of our form with Neumayr's puts their conspecificity beyond doubt, and although the figures of the single specimen given by Noetling are rather poor, his description seems to establish the correctness of his identification.

The individual from Portugal illustrated in Choffat's figure 2 can be safely referred to Neumayr's species, whereas the one shown in his figure 1 differs by its broader venter and by being altogether stouter for that stage. The same holds true for Quenstedt's (1887, p. 901, pl. 97, fig. 7) *Ammonites heterophyllus*, listed in Choffat's synonymy; furthermore, the sutures, well seen in Quenstedt's drawing, seem to refer his specimen to a quite different group of the Phylloceratidae. The conspecificity of de Grossouvre's fragment from Niort, which does not show any indication of plications at a diameter of about 22 mm., is also open to question, as is that of Lóczy's Hungarian form which agrees, except for the narrower umbilicus, with ours in dimensions but in which the whorl section hardly tapers ventrad. To judge by Lóczy's extremely poor drawings, the suture lines do not agree either. Thus Spath's (1927, p. 40) exclusion of Lóczy's form from the synonymy of the true *P. plicatum* appears to be well founded.

For the relations of this form to some closely related ones, among them the one designated by Spath (*loc. cit.*) "*Phylloceras* sp. nov. ? cf. *plicatum* auct. non Neumayr," reference may be made to Spath's discussion.

The only other *Phylloceras* (*sensu stricto*) species of the present assemblage and the only *Calliphylloceras* are compared below (pp. 19, 22) with the present form.

Material Studied: Altogether 11 specimens (including fragments).

Phylloceras (Phylloceras) riazi de Loriol

Plate 1, figures 14–21; plate 2, figures 1–36

Phylloceras sp.; Pompeckj, 1893, p. 246, pl. 4, fig. 9.

Phylloceras riazi DE LORIOL, 1898, p. 110, pl. 8 (1899), figs. 8–12.

Phylloceras Riazi, P. de Loriol; DE LORIOL, 1900, pp. 14, 136, pl. 1, figs. 3, 4.

Phylloceras Riazi Lor.; NEUMANN, 1907, p. 10.

?*Phylloceras* sp.; FREBOLD, 1928, p. 185.

Calliphylloceras sp., probably *C. schems* (Noetling); HAAS, 1952, p. 858, figs. 1, 2.

DIMENSIONS

A.M.N.H. No. 27336	D	H	H′	W	U
46	3.91 mm.	49	31	51	24½
1	4.77 mm.	53	36½	47	18½
2	5.55 mm.	52½	35	38½	14
45	5.94 mm.	54	35	34½	19½
3	6.13 mm.	54½	37½	42	12½
4	6.13 mm.	53	37½	43½	14
5	6.31 mm.	54½	*ca.* 36½	*ca.* 42½	12
6	6.91 mm.	53½	38½	38½	14
7	7.10 mm.	55	37	35½	12½
8	7.10 mm.	57½	*ca.* 39½	38½	11
9	7.39 mm.	55½	39½	37	13
10	8.66 mm.	56	*ca.* 46	45	7½
11	9.05 mm.	55	37½	43	9½
12	9.34 mm.	60½	42½	45	5
13	9.58 mm.	60	40½	41½	6
14	9.58 mm.	57	37	35½	10
15	9.73 mm.	56	43	36	8½
16	9.73 mm.	57	40	36	8
17	9.83 mm.	59½	42½	41½	7
18	9.83 mm.	59½	44½	47	7
19	10.22 mm.	57	38	33½	9½
20	10.61 mm.	59½	38½	42	4½
21	10.90 mm.	60½	45½	44	6½
22	11.19 mm.	61	42½	43½	4½
23	11.68 mm.	60	43½	42½	5
24	11.97 mm.	60	40	44	5
25	11.97 mm.	62	?	44	7½
26	12.07 mm.	60½	41	42	6½
27	12.84 mm.	59	39½	33½	7
47	13.03 mm.	60	42	42½	5½
28	13.23 mm.	59	38	35½	6½
29	14.01 mm.	62	41½	42½	5
30	14.21 mm.	59½	40½	35½	6
31	14.3 mm.	57½	40½	35½	7
32	14.6 mm.	57	42	35	6
33	14.7 mm.	60½	39½	34½	7½
39	14.9 mm.	62½	43½	43	6½
34	15.1 mm.	60½	43½	35	7½
35	16.0 mm.	61	43	37½	6
36	16.1 mm.	59½	41	35½	6
37	16.4 mm.	61	42	36	7½
38	17.7 mm.	62	45½	42	6
40	*ca.* 19.5 mm.	*ca.* 59	*ca.* 38½	*ca.* 41½	*ca.* 7½

Specimen number 41, otherwise not fit for measuring exact dimensions, attains about 20 mm. in diameter; number 12 is a fragment of a disk the diameter of which may be estimated at about 22 mm., which is the largest occurring in the present material, as compared to 28 mm. recorded by de Loriol (1900, p. 14) for his material from the Jura Mountains. Apart from this largest of his individuals, he gives the size range as from 9 to 24 mm. (1898, p. 110; as corrected, 1900, p. 14). The specimen illustrated by Pompeckj, with a diameter of not quite 15 mm., fits well into this range. The absence of disks exceeding 22 mm. and 28 mm., respectively, in diameter in the Syrian and Swiss materials does not, however, permit any inference as to the actual size attained by this species, because all previously recorded individuals as well as all those examined in the course of the present study are septate throughout. It is, however, more likely than not that we are here dealing with a miniature species. As pointed out in the remarks below, the form is definitely not the juvenile of *P. plicatum*, nor is it that of *Calliphylloceras schems*.

The above table shows clear trends of the whorl height to increase, and of the umbilical width to decrease, with growth. The lowest values for H, ranging from 49 to 55, are found concentrated in the nine smallest individuals, and the highest, ranging from 59 to 62½, in the eight largest, but the value of 62, which comes closest to the maximum, occurs at diameters of about 12 mm., about 14 mm., and at 17.7 mm. Similarly, none of the 10 smallest measured individuals yielded a value for U lower than 11, with the maximum of 24½ found in the very smallest and the values coming closest to this maximum (18½ and 19½) in two others of the four smallest. Above the diameter of 10.5 mm. U never exceeds 7½; the minimum of 4½ and the near-minimum of 5 occur at diameters between 10.6 mm. and 14 mm. rather than at the bottom of the table. For all practical purposes both the increase of H and the decrease of U seem to come to a standstill at diameters around 10 mm. Beyond the diameter of 9.75 mm. H varies only between 57 and 62½, and beyond that of 10.5 mm. U varies only between 4½ and 7½.

The smallest juvenile exhibits, in addition to the widest umbilicus (24½), also the greatest width (51). The value closest to this maximum (47) is encountered in the smallest juvenile but one, but also in the medium-sized shell 18, whereas number 19, only slightly larger, shares the minimum of W (33½) with the somewhat larger number 27. If the extremes for W of 51 and 47 on the one hand and of $33\frac{1}{2}$ and $34\frac{1}{2}$ on the other be left out of account, the thickness is found throughout the table to vary between 35 and 45 only, without being determined in any pronounced way by size, except in the two smallest juveniles.

As would be expected, H′ in general follows H, but in some cases two individuals with approximately the same whorl height exhibit markedly different degrees of involution. Thus numbers 20 and 21, of nearly the same size, differ by one unit only in the values for H but by seven units in those for H′.

Designation of Type: The shell illustrated in de Loriol (1899, pl. 8, figs. 10, 10a) is hereby selected as lectotype of *P. riazi*.

Description: In the juvenile number 45 the protoconch was recognizable in side view in the shape of a comparatively flat bubble of about 0.5 mm. in diameter, but unfortunately it broke out in the course of preparation and could not be recovered.

Most distinctive of this species are the narrow umbilicus and the fast increase in whorl height. At the earliest stage studied (no. 46, D = *ca.* 4 mm.) the whorl profile is subcircular (pl. 2, fig. 3). In the further course of development it varies. It shows flat, parallel flanks and an only gently arched, not so narrow venter in some shells, e.g., numbers 2, 45, 6, 15, 19, 47, and 42 (pl. 1, figs. 15, 18, 21; pl. 2, figs. 6, 9, 10, 22), but gently or even decidedly convex flanks and a rather narrowly rounded venter in others, e.g., numbers 10, 13, 22, and 24 (pl. 2, figs, 7, 14, 19, 21). In the second group the whorl profile tends to assume a more or less slender elliptic shape. In the best preserved among the larger individuals (nos. 30, 35, and 37, pl. 2, figs. 26, 29, 30), however, the flanks are flat or only gently convex, and the venter is rounded. Among them, number 35 is somewhat exceptional in that the flanks run not parallel in sectional view but converge slightly ventrad from the point of greatest width which is, in this individual, immediately above the umbilical shoulder (pl. 2, fig. 30). The comparatively stout specimen number 39, with elliptical whorl profile, deserves special mention for exhibiting a shallow circumumbilical depression which is bounded, at about the second fifth of the flanks, by a blunt spiral ridge, similar to the one seen in Pompeckj's drawing but nearer to the umbilical shoulder (pl. 2, fig. 34). In specimen number 17, which has a similar circumumbilical depression, the spiral ridge bounding it is found at about the third fifth of the flanks, still somewhat farther from the lateroventral shoulder than in Pompeckj's figure. Indications of constrictions are extremely rare. Two very shallow ones which run straight across the venter can be recognized in the smallest juvenile (no. 46) at diameters of about 3.5 mm. and about 3.75 mm. (pl. 2, fig. 1), two similarly shallow ones in the juvenile 5, where they describe gently backward concave arcs over most of the flanks, at diameters of about 5 mm. and about 6 mm. (pl. 2, fig. 23), and one in specimen number 31 at a diameter of about 14 mm. (pl. 2, fig. 31). The last describes, in the outer half of the side only, a shallow forward concave arc of which the chord runs in a rursiradiate direction.

Traces of a radial ornamentation, recorded by de Loriol (1900) in a single specimen as "stries transverses d'une extrême délicatesse," are present in two of ours. Extremely fine, slightly sigmoidal radial striae can just be perceived under the microscope in specimen 39 at a diameter of about 13 mm., and two much more distinct radii, also sigmoidal, on the left flank of specimen 40 immediately behind the anterior end (pl. 2, fig. 36).

Suture lines can be well observed in nearly all individuals from the smallest to the largest, thus permitting a study of their ontogeny. Even at the earliest observable stages, e.g., in specimens numbers 46 (pl. 2, figs. 1–3), 1, and 45, at diameters of from 1.75 mm. to 6 mm., the sutures are markedly crowded and indentation is comparatively rich, but the phylloceratid character is not yet so far developed as it is later in ontogeny (compare pl. 1, figs, 17, 20, and pl. 2, figs. 2, 33, with pl. 2, figs. 15, 28, and 31). At an early stage the last endings of the saddles just begin to assume the characteristic phylloid shape, the saddles are not yet so pinched at their bases and the lobes not so narrowed, and the external saddles still stand upright on the whole, with only their inner stem just beginning to lean a little dorsad. The tips of the siphonal and second lateral lobes reach about the same radius, while the first lateral lobe is markedly deeper. A line connecting the tops of the saddles forms a forward convex arc which culminates in the first lateral saddle. Only the external saddle and the first lateral one are bifid, but all the others are still simple at this stage, and both lateral lobes and the first auxiliary are trifid, but the following auxiliaries are not yet clearly subdivided. Four auxiliary lobes are present. At the somewhat later stage represented by the juvenile 1, corresponding to diameters up to 4.5 mm., some increase in indentation can be noted; the second lateral saddle, too, is now clearly divided into two leaves, the inner one of which marks the highest point of the saddle curve (pl. 2, fig. 33).

Suture lines of a medium growth stage are well exemplified by the last line in specimen number 17 (pl. 2, figs. 15, 16). The lobes are now more narrowed, and the saddles more straitened, than at earlier stages, the degree of indentation is greatly increased, and the terminal leaves of the saddles are clearly phylloid. The three main saddles still end in two leaves each, but in all three a lateral leaflet on the inner side of the inner terminal leaf is so strongly developed as to make the saddle appear almost triphyllous. The same development causes the inner stem of the external saddle to lean dorsad more decidedly. The first lateral lobe is still the deepest of the main lobes, but the siphonal one is a little deeper than the second lateral. In addition to the lateral lobes, the three first of the seven auxiliary lobes are also trifid. The gentle, forward convex arc connecting the tops of the saddles culminates in the inner terminal leaf of the first rather than the second lateral saddle.

Elaboration of the sutures has further progressed in specimen number 30 (pl. 2, figs. 24, 25), of about one and a half times the size of number 17, and in the incomplete shell number 44, of about the same diameter as 30, but it reaches an even higher degree in the largest shells, of which numbers 37 and 31 (pl. 2, figs. 27, 28, 31, 32) serve as the best examples. The phylloid character of the terminal leaves has become even more pronounced. Both saddles and lobes are in the usual places pinched to the extreme, and the inner main stem of the external saddle is even more inclined dorsad, so that both external saddles form a V enclosing the siphonal lobe, which is here shorter than at the previous stage. The second lateral lobe almost equals the first in depth, and the inner terminal leaf of the first lateral saddle and both terminal leaves of the second are now equally high, marking the culmination of the curve connecting the saddle tops. Both terminal leaves of the external saddle are now symmetrically subdivided. Altogether nine auxiliary lobes can be counted; the first three are distinctly bifid, the last four crowd together on the umbilical wall. Altogether this suture line exhibits phylloceratid character and elaboration to almost the same degree as the one described above in *P. plicatum*.

REMARKS: This species, although not named until 1898, was illustrated earlier in a specimen from Majdal Shams, not by Noetling, it is true, but several years later by Pompeckj (*loc. cit. in syn.*) in a place where one would least expect it, namely, in a revision of the ammonites of the Jurassic of Swabia (southern Germany). It may be startling to read in Pompeckj's explanation of his plate 4[1] that this form from "Djebel el chems," Lebanon, is repeatedly encountered in Swabian collections (probably meaning chiefly those of Stuttgart and Tübingen). The obvious explanation is that the first German student who collected on Mount Hermon, O. Fraas, brought specimens of this form, among others, home to Stuttgart whence they must have found their way into the collections mentioned by Pompeckj.

The single small specimen of a form "hitherto unknown from Hermon," of which Frebold (1928, p. 185) says only that it is "certainly not a juvenile of the Syrian phylloceratids," may or may not be referable to the present species. If it is, then Frebold must have overlooked both its presence in several Swabian collections and its illustration by Pompeckj; otherwise he would not have called it a hitherto unknown form.

De Loriol (1898, p. 112) questions the con-

[1] I have not succeeded in tracing any mention of this form in his text.

specificity of Pompeckj's specimen, "très aplatie au pourtour de l'ombilic avec une région siphonale plus élargie." However, one of the two specimens depicted by de Loriol himself in 1900 (pl. 1, fig. 3) exhibits these same characters almost as distinctly as Pompeckj's, and our own material also includes individuals with flat and parallel flanks as well as some with more convex, ventrad converging flanks, as seen in the lectotype designated above or in the other of the two specimens illustrated by de Loriol in 1900 (pl. 1, fig. 4). Thus, all these shells from both the Jura Mountains and Mount Hermon may well be referred to *P. riazi.*

The correct subgeneric reference of this species is rendered difficult by the complete absence of body chambers in an estimated total of more than 100 specimens on record (including those here dealt with). Pompeckj included it in the "Formenreihe" of *P. partschi* Stur which now constitutes the subgenus *Partschiceras* Fucini of *Phylloceras*, as restricted by modern authors. Spath (1927, p. 40), however, refers his geologically somewhat older but closely related, though not conspecific (see below), "*Ph.* sp. juv. ind. cf. *kunthi* Neumayr" to *Phylloceras, sensu stricto.* With the uncertainty imposed by the absence of mature individuals, this procedure is here followed with regard to the present species. My reference in a previous paper (1952), of an individual to the genus *Calliphylloceras*[1] was based on my former belief that the shells now referred to *P. riazi* were the juveniles of *C. schems* Noetling and cannot be maintained, once this belief has turned out to be erroneous. As is shown below (p. 22) in the discussion of *Calliphylloceras schems*, that species is readily distinguishable from the present one even at small diameters up to 22 mm., the maximum attained by *P. riazi.*

Nor can the form under discussion be the juvenile of *P. plicatum* (an opinion that might gain some appeal from the fact that the largest individual of *P. riazi* measures 22 mm. in diameter, but the smallest of *P. plicatum* 35.6 mm.), for individuals of *riazi* of the same size are quite different from the nucleus of specimen number 1 of *plicatum* both in dimensions and whorl section and also by lacking the radial ornamentation already well developed in that nucleus at a diameter of 7 mm. Furthermore, the suture lines of the present species seem to attain a high degree of elaboration at a much earlier stage than those of *P. plicatum.*

Phylloceras esulcatum Pompeckj (1893, p. 189, pl. 4, fig. 8, = *Ammonites heterophyllus esulcatus* Quenstedt, 1887, p. 761, pl. 86, fig. 28) from the Callovian of Oeschingen resembles the present species in its narrow umbilicus, but has a stouter, more rounded whorl section and an early appearing radial ornamentation.

Another narrowly umbilicate species, *P. kunthi* Neumayr (1871, p. 312, pl. 12, fig. 6, pl. 13, fig. 1), can be readily distinguished by the pronouncedly truncate venter and by suture lines much less elaborate even at a size that may be estimated at more than six times that of our specimen number 37.

The richer indentation and more phylloceratid character of the sutures readily distinguishes *P. riazi* also from the juvenile illustrated by Waagen (1875, p. 25, pl. 5, fig. 2; see also Spath, 1927, p. 40, *cum. syn.*) under the designation *P.* cf. *kunthi* Neumayr, which resembles the present species in shell shape and whorl profile to the extent that Lóczy (1915, p. 287) considered them probably conspecific.

The homeomorphy prevailing between *P. riazi* and the similarly small *Taramelliceras* (*Richeiceras*) *richei* (de Loriol) (p. 108, pl. 16, figs. 36–52, pl. 17, figs. 1–17) has been dealt with in a previous article (Haas, 1952) to which reference is made for the essential differences in sutures and minor differences in shell shape that serve to "unmask" that homeomorphy.

MATERIAL STUDIED: Altogether 61 specimens.

SUBGENUS **CALLIPHYLLOCERAS** SPATH, 1927

Arkell's (1939, p. 141) example is followed here in granting only subgeneric rank to Spath's name *Calliphylloceras.*

Phylloceras (Calliphylloceras) schems Noetling

Plate 2, figures 37–44; plate 3, figures 1–6

Phylloceras Schems sp. nov.; NOETLING, 1887, p. 13, pl. 2, fig. 1.

[1] Relegated to subgeneric rank in the present report.

Phylloceras Schems Noetl.; FREBOLD, 1928, p. 192.

DIMENSIONS

A.M.N.H. No. 27337	D	H	H′	W	U
9	4.77 mm.	51	36½	51	22½
10	6.13 mm.	47½	35	43	28½
11	7.20 mm.	44½	35	42	29
12	7.59 mm.	45½	34½	41½	25½
2	8.37 mm.	46½	34½	39½	25
13	8.37 mm.	47½	37	42	23
1	8.66 mm.	47	39½	37	23½
3	9.05 mm.	54	41	*ca.* 28[1]	21½
4	10.31 mm.	47	32½	37	22½
5	12.94 mm.	51	34	36½	19
6	14.11 mm.	44	*ca.* 33	*ca.* 30½	28½
7	21.9 mm.	55	31½	35½	13
8	59.3 mm.	55	*ca.* 32	35	9½

The above sample is interrupted by a wide gap between the diameters of about 22 mm. and nearly 60 mm. Thus it cannot be expected to be very conclusive as to growth trends. A value for H (54) almost as high as in the two largest shells is encountered among the juveniles also. The smallest shell (no. 9) is by far the thickest, but otherwise W varies, if the crushed specimen number 3 is left out of account, only within the range of from 30½ to 43, with values around 35 found almost anywhere beyond the diameter of 8.5 mm. Up to a diameter of about 14 mm. the range of variation for U is even narrower (between 19 and 29), but the umbilicus definitely tends to become narrower in maturity, as pointed out by Lóczy (1915, p. 293) for the closely related *C. demidoffi*. Thus its width decreases from the range given above to 13 at a diameter of about 22 mm. and to 9½ at a diameter of almost 60 mm. It is, then, not surprising that the highest degree of involution (with H = 55) is found in the same two individuals.

The juvenile number 3 has the last septum at a diameter of about 4.5 mm.; two-thirds of the outer volution belong to the body chamber which is, however, not preserved to the aperture. All the other individuals present are septate throughout, as are the two examined by Noetling. Thus no inference is permissible as to the size reached by this comparatively rare species. The largest disk present (no. 8) measures in diameter only about 5 mm. more than the one chosen by Lóczy (1915, p. 293) as an example of a "small specimen" of *P. demidoffi*, and Arkell (1939, p. 141) estimates the full diameter of the single specimen from the Woodham pit referred by him to that species (with which the present one is, at least, closely related) at "nearly 2 feet."

DESIGNATION OF TYPE: The larger of the two specimens that constituted Noetling's hypodigm, and the only specimen figured, must be considered the holotype of this species.

DESCRIPTION: Three of the specimens present (nos. 2, 4, and 6) show the protoconch in side view (pl. 3, figs. 3, 4); it appears as a flat bubble, measuring a little less than 0.3 mm. in diameter.

The shell is slender, only moderately involute in youth but quite involute in maturity. The whorl section is oval throughout development, with the greatest width at about the inner third of the sides whence the gently convex flanks converge to the rather narrowly rounded venter (nos. 12, 4, 7, 8; pl. 2, figs. 42, 44; pl. 3, figs. 2, 5).

The juveniles numbers 9 and 3 do not yet show any constrictions but in those numbered 10 and 2 their first indications appear at diameters of about 5 mm. and less than 4.5 mm.[2] Including the first, only faint constriction, five can be counted on two-thirds of the outer volution of specimen number 2. They are shallow and rather broad and run in a gentle, forward convex arc, the chord of which is radial in direction, across the flanks; only in the anteriormost quarter of this whorl can they be recognized to cross the venter in a straight line. In the juvenile number 4, however, the first and only constriction corresponds to a diameter of almost 10 mm.; it resembles the constrictions just described in number 2, except that the chord of the arc runs here in a clearly prorsiradiate direction. In the juvenile number 5 the constrictions, of about the same density as in number 2, are restricted to, or at least well visible in, the circumumbilical zone only, but they are distinct all over the flanks and also on the venter in the only slightly larger shell number 6 where six are present on three-quarters of

[1] Crushed.

[2] According to Noetling's description, constrictions would appear only beyond the diameter of 15 mm.

the outer volution. Here they are at first nearly straight and radial but tend to assume a slightly sigmoidal course near the anterior end; they indent the venter quite markedly (pl. 3, fig. 4). The second largest shell (no. 7, pl. 2, fig. 43) resembles number 5 in that the constrictions are well developed in the inner zone of the flank, but gradually vanish before reaching the venter. The largest cast (no. 8, pl. 3, fig. 6), representing a much more advanced stage, has rather deep and wide constrictions on three-quarters of the outer whorl; they run nearly straight and in a slightly prorsiradiate direction across the flanks and form a narrow, forward-pointing tongue on the venter.

On the venter and the flanks of the juvenile number 10 a delicate radial striation, which runs in a rursiradiate direction across the sides, can be recognized, in oblique illumination only, from a diameter of about 4.5 mm. There are six or seven thread-like striae to 1 mm.; they are separated by intervals of two or three times their own width. The same striation is seen, from a diameter of about 10 mm., on the venters only of specimens 5 and 6 (pl. 3, fig. 4). Here the striae, five of which are counted to 1 mm., are worn and therefore appear wider than their intervals. In the juvenile number 3 (pl. 2, fig. 37), however, which is smaller than specimens 5 and 6 but has the test preserved in part, this radial ornamentation can be seen from the same diameter of about 10 mm. on, that is, on nearly all the unseptate part of the outer whorl, to extend all over the flanks where the striae are slightly rursiradiate and recurved. They increase ventrad in width and distinctness. In the outer zone of the sides their density is the same as above (five to 1 mm.). The incomplete test number 7 shows, on the venter of its posteriormost quarter-whorl only, the same striae as numbers 5 and 6, but here they extend from the venter, gradually vanishing, almost to the middle of the flank. The largest individual (no. 8) shows a similarly fine striation (six to 2 mm.) only where its test is preserved, that is, on the venter of the posteriormost part of the outer whorl. The thread-like striae, here only about half as wide as the intervals between them, form a shallow, forward convex sinus. They can be followed into the outermost zone of the left flank but soon disappear, which may be owing to preservation only.

Suture lines are well observable in all individuals present, so that their development can be followed from the diameter of 2 mm. in the smallest juvenile (no. 9) to that of 59 mm. in the largest disk (no. 8). In the former specimen (pl. 2, figs. 38, 39) all saddles stand upright and are hardly pinched near their bases; only the external and the first lateral are clearly diphyllous. The siphonal lobe is comparatively narrow and divided by an arrowpoint-shaped knob carrying a sharp median point. The first lateral lobe, which begins to spread out rather widely in its lower part, exceeds the siphonal lobe and the second lateral only slightly in depth. The two lateral lobes and the first of the auxiliaries (of which there are not yet more than three or four) are trifid. Up to a diameter of about 4 mm. the sutural characters of the juvenile number 2 are the same as just described, except that the sharp point of the median knob increases in length and the first lateral saddle begins to be pinched near its base. Only three-quarters of a whorl later, near the anterior end of this shell, however, the degree of indentation has increased, the external saddle begins to lean dorsad, and both lateral saddles are now markedly straitened near their bases. Otherwise the sutural characters are unchanged. The number of auxiliary lobes has increased to six. The sutures of the juvenile number 4, well seen in plate 3, figures 1, 2, in general agree with those of number 2 but are more elaborate and the dorsad inclination of the external saddle becomes more manifest. Simultaneously, the difference in depth between siphonal and first lateral lobes increases. Specimens numbers 5 and 6 show further progress along all these lines. The latter individual is noteworthy for the rapid development the suture lines undergo on its outer volution. They show rather sturdy, upright, parallel, only moderately indented saddles and comparatively primitive lobes in the posterior portion of this whorl, but quite elaborate, richly indented sutures, with both lateral saddles considerably pinched and the external one leaning distinctly dorsad, near the anterior end. The siphonal lobe now attains only about two-thirds of the depth of the first lateral, whereas the second is only a little shorter than the first. Seven auxiliaries can now be counted. Thus in this shell the sutures may well be said to change, within a single volution, from a *Sowerbyceras* style to a *Phylloceras* style.

The character of the suture lines is still essentially the same in the much larger shell number 7 (pl. 2, fig. 43), if allowance is made for increasing indentation. The number of auxiliary lobes has increased to eight.

In all suture lines of this species hitherto dealt with, the tip of the inner terminal leaf of the first lateral saddle marks the culmination point of the gentle, forward convex arc that connects all saddle tops. As far as the main saddles are concerned, this arc is still very shallow at an early stage and becomes pronounced only later in ontogeny, but all suture lines examined slope increasingly steeply dorsad from the first auxiliary saddle, thus uniting all auxiliaries but the first in a "suspensive lobe."

The largest shell (no. 8, pl. 3, fig. 6) is the only one that exhibits mature sutures, but they differ from those of earlier stages merely in the now nearly phylloid character of the terminal leaves of the main saddles, in that the inner terminal leaf of the first lateral saddle and the outer one of the second are now equally high and form together the culminating portion of the curve of the saddle tops and in the number of auxiliaries, of which there are now nine.

REMARKS: This species is very closely related to *P.* (*C.*) *demidoffi* (Rousseau) (Lóczy, 1915, p. 291, *cum synon.*,[1] text figs. 18–21, pl. 1, fig. 2, pl. 2, figs. 3–5, pl. 3, fig. 1; Spath, 1927, p. 52; Arkell, 1939, p. 141; Jeannet, 1951, p. 27, text figs. 56–58, pl. 5, fig. 5; synonym: *P. lajouxense* de Loriol, 1900, p. 11, pl. 1, figs. 1, 2, pl. 2, fig. 1). Because of the vast difference in sizes, even the largest of our specimens cannot well be compared with the shell illustrated by d'Orbigny (1849, pl. 180) under the name *Ammonites tatricus* and designated by Spath (*loc. cit.*) lectotype of *P.* (*C.*) *demidoffi*, or with the even much larger disk of "*P. lajouxense*" shown in de Loriol (1900, pl. 1, fig. 1, pl. 2, fig. 1). However, the dimensions given by Lóczy (p. 293) for what is to him a small individual come fairly close to those of our largest, and the smaller shells illustrated by Spath (as *C.* aff. *demidoffi*, pl. 7, fig. 8) from India and by Jeannet from Herznach are extremely similar to those from Mount Hermon figured by Noetling and in the present report. Were *demidoffi* to be circumscribed as widely as it was by Lóczy, then *P. schems* would certainly have to be added to its long list of synonyms. Accepting, however, Arkell's less wide circumscription of Rousseau's species, I believe that Noetling's can just be distinguished from it on the strength of the following characters: A greater number of constrictions appears at an earlier stage, and the narrowing of the umbilicus sets in earlier in *schems* than in *demidoffi*. Also the latter species seems at all stages to be somewhat thinner than the former. I have been unable to find essential sutural differences between the two species; however, Lóczy's drawings are too poor for comparison and both d'Orbigny's and Jeannet's (which considerably differ from each other) represent far more advanced stages.

The type species, *P.* (*C.*) *disputabile*, seems to be more slender than *P.* (*C.*) *schems* and to have more sinuous and less deep constrictions.

Within the present material this species is readily distinguished from the two referred above to *Phylloceras*, *sensu stricto*. *Phylloceras plicatum* lacks the constrictions so characteristic of *P.* (*C.*) *schems*, and *P. riazi* has at all comparable sizes a considerably narrower umbilicus. Both those species have, furthermore, at the same diameter more crowded, more elaborate, and more typically phylloceratid suture lines; compared with them, those of *schems* differ by having lower and somewhat sturdier saddles.

For comparison with *Sowerbyceras helios*, see the discussion of that species (p. 26).

Because the present species is more widely umbilicate than *P. riazi*, those juveniles of *Taramelliceras* (*Richeiceras*) *richei* (p. 108, pl. 16, figs. 36–52, pl. 17, figs. 1–17) that stand out by having unusually wide umbilici appear to be homeomorphic to juveniles of *P.* (*C.*) *schems* rather than to those of *P. riazi*. One of them resembles the juvenile number 1 of the present species so closely in shell shape and whorld profile that it was referred to

[1] Lóczy obviously extends his synonymy too far; at least *P. disputabile* (Zittel) Waagen (1875, p. 31, pl. 6, figs. 1–3), type species of *Calliphylloceras*, should be excluded from it.

P. (*C.*) *schems* until closer examination of the suture lines revealed it to be oppelid instead.

MATERIAL STUDIED: Fourteen specimens.

SOWERBYCERAS PARONA AND BONARELLI, 1895

Sowerbyceras helios (Noetling)

Plate 3, figures 7–34; plate 4, figures 1–5

Phylloceras Helios sp. nov.; NOETLING, 1887, p. 14, pl. 2, figs. 3, 4.

Phylloceras helios Nötl.; POMPECKJ, 1893, pp. 190, 192, 202.

Phylloceras Helios Noetling; FREBOLD, 1928, p. 192.

DIMENSIONS

A.M.N.H. No. 27338	D	H	H′	W	U
1	3.70 mm.	47½	33	50	25
2	4.57 mm.	38½	27½	49	38½
3	4.67 mm.	35½	29	49	41½
4	4.96 mm.	47	37	?	38
5	5.35 mm.	38	29	?	38
6	5.59 mm.	45	29½	48	22½
7	5.74 mm.	46	32	49	23
8	6.03 mm.	47	34	47	22½
10	6.23 mm.	47	30	45½	22
12	6.81 mm.	48	33	44½	21½
13	7.20 mm.	42	*ca.* 27	46	24½
14	7.39 mm.	46	31½	44½	22½
15	7.59 mm.	45	34½	47½	22
16	7.88 mm.	43	*ca.* 32	43	24½
17	7.98 mm.	44	30½	45	24½
18	8.17 mm.	44	28½	45	25
19	8.95 mm.	42½	29½	44½	25
20	9.15 mm.	46	26½	43½	24½
21	9.24 mm.	43	?	*ca.* 42	21
22	9.54 mm.	44	29½	44	24½
23	9.73 mm.	45	29	44½	25
24	10.12 mm.	48	31½	47	24½
25	10.31 mm.	42½	27½	43½	25½
26	10.90 mm.	43	28½	44½	23
27	10.99 mm.	44	29	42½	25½
28	11.19 mm.	42½	30½	44½	25
29	11.77 mm.	41½	27½	43	25½
30	12.55 mm.	44	28½	43½	24
31	13.3 mm.	42½	30	39	26½
32	13.7 mm.	44	30	41	27
33	14.3 mm.	45	?	43½	30
35	16.8 mm.	44	30	41	25
36	17.4 mm.	43	27½	43	26½
37	20.0 mm.	*ca.* 45	27½	41½	27
38	22.2 mm.	43	30½	42½	29½
34	23.6 mm.	46½[1]	*ca.* 28½[1]	39[1]	28[1]
39	24.6 mm.	42½	?	*ca.* 40½[2]	28½[2]
40	24.8 mm.	45	?	*ca.* 42½	28½
41	25.8 mm.	46	?	*ca.* 41	27
42	27.1 mm.	47	31½	39	27½
43	36.8 mm.	44½	?	?[3]	28½
44	44.7 mm.[4]	*ca.* 46½	*ca.* 33½	?[4]	*ca.* 27

[1] Measured at D=21.0 mm.

[2] Measured at D=22.8 mm.

[3] Crushed.

[4] Body chamber crushed and deformed.

In general this species tends to become somewhat more slender with growth. In the six smallest juveniles of which the width could be measured it varies from 47 to 50 (maximum), but in the 12 largest individuals from 39 (minimum) to 43½. However, in the intermediate group, the range of variation of W is narrow, from 42 to 47½. There is no such clear trend in the degree of involution. H rapidly decreases in early youth (from 47½ to 35½), reaches the maximum (48) at diameters of a little less than 7 mm. and then again of a little more than 10 mm., and seems to increase a third time between the diameters of 25 and 30 mm. If the unusually evolute juvenile number 3 is left out of consideration, H also varies within a narrow range only (38–48). U, however, exhibits much wider variation, from 21 to 38½; the widest umbilici are found in small juveniles (except the smallest) and the narrowest between the diameters of 5.59 mm. and 12.55 mm. From a diameter of 13 mm. on, the umbilici tend to be wider again.

The smallest juvenile present (no. 1) exhibits the last septum at a diameter of about 2.5 mm., two other juveniles (nos. 3 and 4) at diameters of about 3 mm., the medium-sized shell number 39 at a little less than 20 mm., and the two largest individuals present (nos. 43, 44) at diameters of about 30 mm. In number 43 about one-third, and in number 44 more than one-half, of the last volution belongs to the body chamber, but it is not entire in either. If its beginning at about the same diameter in both these shells is not mere coincidence then this species may be estimated to have reached a size of only about 50 mm.,[5] in contrast to the closely related type species of *Sowerbyceras*, *S. tortisulcatum*, which attains a considerably larger size, e.g., in the specimen figured by d'Orbigny (1849, pl. 189), almost 90 mm.

DESIGNATION OF TYPE: The smaller but better preserved of the two specimens figured by Noetling, namely, the one illustrated in figure 4 of his plate 2, is here designated lectotype of *S. helios*.

DESCRIPTION: Shell comparatively stout, especially in early youth (no. 1, pl. 3, figs. 7, 9). Throughout development the whorl pro-

[5] Noetling gives the diameter of his largest specimen, which he assumes to include the body chamber, as 42 mm.

file is characterized by pronounced, though well-rounded umbilical and lateroventral shoulders, by a nearly or fully perpendicular umbilical wall which becomes concave at later stages (no. 39), by rather flat flanks converging only slightly ventrad from the point of maximum width, just above the umbilical shoulder, and by a broad, only gently arched venter which becomes increasingly truncate with growth (specimens nos. 1, 14, 19, 27, 30, 38, 40, 9; pl. 3, figs. 9, 18, 10, 19, 24, 28, 30; pl. 4, fig. 3). Thus the whorl profile appears, as a rule, to be roughly subquadratic or, at later stages, rectangular. The steepness of its walls causes the umbilicus to appear deep. A few individuals only (nos. 25,[1] 34, pl. 3, figs. 21, 33) exhibit more decidedly ventrad-converging flanks and a more narrowly rounded venter so that the whorl section approaches an oval shape.

Most characteristic of this species, although hardly recognizable in some of its individuals (e.g., no. 12), are the constrictions the course of which is alluded to in the trivial name of the type species of *Sowerbyceras*, *S. tortisulcatum*. In the small juveniles numbers 2 and 4 (pl. 3, figs. 11, 12) they can be recognized from a diameter of about 2 mm. on. There are four sharply engraved constrictions per volution, which run straight in a prorsiradiate direction across the sides and cross the venter, without losing depth, in a shallow forward convex arc. Constrictions are considerably shallower and much less distinct in the juvenile number 14 (pl. 3, figs. 17, 18), but here they begin to assume a reversed S shape on the flanks. Their peculiar course, carefully described by Noetling,[2] can be recognized more distinctly in specimens numbers 21 and 24 (pl. 3, fig. 25). Here they can be seen to rise in a prorsiradiate direction on the umbilical wall, then to run sharply obliquely forward across the flank, to turn back just before reaching the outer shoulder, and to form a shallow, forward concave sinus on that shoulder and a flat, forward convex tongue on the venter. As keenly observed by Noetling, the first turn coincides with the first lateral saddle and the second with the first lateral lobe. At this stage the constrictions are deepest and widest in the inner zone of the sides and shallowest on the venter; they all but vanish at the median line. The constrictions of specimens 20 and 25, although at about the same ontogenetic stage as in 21 and 24, deviate by lacking the sinuosities just described. They run straight or in an extremely shallow forward concave arc across the flanks, in a radial direction in number 20 and in a prorsiradiate one in number 25 (pl. 3, fig. 20). In both shells they cross the venter uninterruptedly in a very flat forward convex arc.

The curves, or hooks, described by the constrictions near and on the outer shoulder and the tongue they form on the venter become more pronounced with development, as seen best in specimen number 39 (pl. 3, fig. 31); here the constrictions narrow considerably but remain quite distinct in crossing the venter. They are bounded by pronounced edges. The first constriction on the body chamber of the largest shell present (no. 44) also shows the characters just mentioned, except that here only the anterior edge can be followed across the venter whereas the posterior one is flattened out; the ventral tongue assumes a trapezoidal shape (pl. 4, fig. 5). Only in this specimen can five constrictions, as stated by Noetling, be counted on the outer whorl, while in all smaller shells their number does not exceed four. None among about 80 specimens examined is covered to any larger extent with the test. Thus I am in no better position than was Pompeckj (1893, p. 192) to verify Noetling's observation that hardly perceptible varices correspond on shelled surfaces to the constrictions just described.

However, the "very fine, parallel but often interrupted transverse wrinkles running straight across the test" recorded by Noetling (1887, p. 14, pl. 2, fig. 4b) can be recognized on a portion of the septate part of specimen number 43 which has the test preserved. They seem to be just growth striae which in some places assume the irregular aspect seen in Noetling's figure, whereas elsewhere they are quite regular; from 10 to 12 are counted to 1 mm.

[1] This individual seems to be somewhat transitional to *Sowerbyceras*, indeterminate juvenile form (p. 26).

[2] However, his statement that they "überschreiten die Externseite in der Höhe des Externsattels [cross the venter at the height of the external saddle]" is difficult to understand.

In some individuals, e.g., number 38 (pl. 4, fig. 1), the middle of the venter is marked, on the septate part of the cast, by an almost continuous, neatly engraved line, interrupted only in the top portions of the median knobs. On the body chamber of specimen number 39, however, a low ridge, flanked by two hardly perceptible furrows, marks the median line for about one-sixth of a volution.

Suture lines are well visible in most of the specimens present, from a diameter of about 2 mm. (no. 1) to one of nearly 30 mm. (nos. 43, 44). Whereas there is considerable progress in indentation from the diameter of 2 mm. to that of 6.5 mm. and the number of auxiliary lobes increases from two (or possibly three) to five between these diameters, the sutural characters remain essentially unchanged from the latter stage on. It is well exemplified by specimen number 12 (pl. 3, figs. 13, 14). All the saddles on the flanks stand upright, parallel to one another. Only the second auxiliary saddle, just outside the umbilical shoulder, and two more that follow on the umbilical wall are inclined dorsad. The saddles are comparatively slender but hardly pinched near their bases. The three main saddles are more or less symmetrically diphyllous, the following ones monophyllous. The tops of all saddles are connected by a shallow forward convex arc culminating in the first lateral saddle. The trifid first lateral lobe is by far the widest but only somewhat exceeds its two neighbors in depth. The siphonal lobe is divided by a slender knob, which carries a median point, into two parallel, rather blunt main points. The second lateral lobe repeats the first at a somewhat reduced scale. As are the lateral lobes, the first two auxiliaries are trifid; in the third, riding on the umbilical shoulder, trifidity is just indicated, but the fourth and fifth, situated on the umbilical wall, are simple. They may be considered to form a short "suspensive lobe." The excellently preserved suture lines of specimen number 22 (pl. 3, figs. 15, 16) differ from those just described only in that the three main lobes equal one another in depth and that now four minute auxiliary lobes, constituting a steeply sloping "suspensive lobe," are present on the umbilical wall, increasing their total to seven. The sutures of specimens numbers 26 (pl. 3, figs. 26, 27), 28, and 30 (pl. 3, figs. 22–24) exhibit about the same characters as those just discussed. As seen in the shells numbers 37, 38 (pl. 4, figs. 1–3), and 39, elaboration hardly progresses with size beyond the last stage described, so that at greater diameters the sutures appear to be comparatively less elaborate than at smaller ones; nor does the number of auxiliary lobes increase beyond seven. The last six or seven sutures of number 39 (pl. 3, fig. 31) are remarkably crowded, thus indicating that this is a full grown (though not complete) shell. Those of the latest stages, as observable best in specimens numbers 42 (pl. 3, fig. 34) and 44, are characterized by low and sturdy main saddles and wide and shallow main lobes rather than by a high degree of indentation. Nowhere do the terminal leaves of the saddles assume a truly phylloid character.

Altogether the external suture lines described so far agree well with Noetling's drawings 3b and 3c and with d'Orbigny's (1849, pl. 189) figure 3 of a suture line of *S. tortisulcatum*, but none of those three drawings extends beyond the third auxiliary saddle so that hardly any of the auxiliary elements situated on the umbilical wall are shown. Thus no correct idea of the "suspensive lobe" can be gained from them.

The internal suture line is observable in several specimens, best in number 45 at a diameter of about 13 mm. (pl. 3, fig. 29). The antisiphonal lobe ends in two narrow, sharp points; the internal saddle is typically monophyllous, bounded by a nearly straight line on its dorsal side but indented by two prongs on the opposite side. Between this saddle and the umbilical seam there follow three more saddles of a similar shape but gradually decreasing in size and height. Between these four saddles are three trifid lobes, with a fourth, dorsad oblique lobe near the umbilical seam. Of those three lobes the middle one is shorter than the two adjacent ones, and the antisiphonal lobe is markedly shorter, but neither so shallow nor so wide as shown in Noetling's drawing (fig. 4c) which otherwise, as far as it extends, agrees with our figure.

REMARKS: This species undoubtedly belongs to the group of *S. tortisulcatum*, thoroughly studied by Pompeckj (1893, pp. 190–205), even before that species was made the genotype of *Sowerbyceras* by Parona and Bonarelli. It is particularly interesting to note that his studies led Pompeckj to consider decrease of sutural indentation as one of the features characteristic of the evolution of this group. This is the more interesting because a relative, if not absolute, decrease of sutural elaboration is recorded above within the ontogeny of the present species also. If Pompeckj's concept is correct, then we are dealing here with a case of retrogressive evolution, and the change of the sutures from a *Sowerbyceras* to a *Phylloceras* style, followed within the ontogeny of two of the preceding species (pp. 17–18, 22) would call for a proterogenetic rather than a palingenetic interpretation.

Noetling bases the distinction of the present species from *S. tortisulcatum* on the lack of varices crossing the venter in front of the constrictions and on the fact that the latter become extremely shallow or vanish entirely on the venter. However, in not a few specimens in our material the constrictions do not lose much depth in crossing the venter. At any rate, *S. helios*, aside from being a smaller form, seems to be altogether sturdier than *S. tortisulcatum.*

Noetling's identification of the form from Mount Hermon with one occurring in Swabia in the zone of *Aspidoceras perarmatum* and later included by Pompeckj (1893, p. 202, pl. 2, fig. 9) in his *Phylloceras subtortisulcatum* is questioned by Pompeckj. However, *P. subtortisulcatum* comes very close to the present species and differs from it merely in that its whorl section has the maximum width at the middle rather than immediately above the umbilical shoulder and by the greater sharpness of that shoulder.

Among the other phylloceratids of the present assemblage the juveniles of *P.* (*Calliphylloceras*) *schems* resemble, up to a diameter of about 15 mm., those of *S. helios* in dimensions, except for being more slender. Even at that early stage, however, those of the present species are readily distinguished by their angular whorl profile and by their sutures which retain their *Sowerbyceras* style throughout development. Larger shells of the two species are even easier to distinguish on the strength of these two criteria; in addition, the umbilicus narrows considerably in maturity in *P.* (*C*). *schems* but much less so in *S. helios.*

Whereas juveniles of *P. riazi* and *P.* (*C.*) *schems* are homeomorphic with *Taramelliceras richei* (see pp. 19, 22), juveniles of *Perisphinctes* (*Properisphinctes*) *delicatulus* (below, p. 149; pl. 23, figs. 43–60, pl. 24, figs. 1–18) are, before costation appears, sometimes indistinguishable from those of the present species in shell shape, whorl profile, and number and course of the constrictions. It will be seen in the section on the subgenus *Properisphinctes* that of all its species *delicatulus* remains smooth until a comparatively late juvenile stage and has the greatest number of constrictions. These two features are responsible for the homeomorphy here dealt with. It can, however, readily be revealed by examination of the suture lines which are, of course, thoroughly different in these two species.

MATERIAL STUDIED: Altogether 95 specimens, including a few fragments.

Sowerbyceras, indeterminate juvenile form

Plate 4, figures 6–14

DIMENSIONS

A.M.N.H. No. 27339	D	H	H′	W	U
1	6.08 mm.	38½	29	37	35
2	6.23 mm.	37½	33	*ca.* 38	37½
3	7.59 mm.	37	31	*ca.* 36	37
4	9.91 mm.	42	32½	33½	31½
5	11.48 mm.	42½	30	33	30

Within the above small sample the degree of involution tends to increase and the thickness of the shells to decrease with growth.

Both specimens numbers 2 and 3 have their last septum at a diameter of less than 4.5 mm., with the anterior halves of their outer whorls belonging to the body chamber. Because, however, no crowding of the septa preceding the last is noticeable, these individuals must still be considered juveniles.

DESCRIPTION: Five small specimens clearly referable to *Sowerbyceras* differ too much from *S. helios* to be considered conspecific.

In shell shape they are considerably more slender and less involute than equally small juveniles of *S. helios*. In two of five shells U exactly equals H, and in a third it does so approximately.

The whorl profile is not angular as it is in *S. helios*, but oval, with the maximum width at about the inner third of the sides (nos. 1, 2, 5, figs. 11, 7, 14).

In both the smallest and the largest shells the protoconch is visible in side view; it resembles that observed in *Calliphylloceras schems* but measures only 0.2 mm. in diameter.

Only one shallow and sinuous constriction is barely perceptible in specimen number 1, at a diameter of about 5 mm., but in numbers 2 and 3 constrictions appear as early as at diameters of about 3 mm. and 4 mm., respectively. In both these juveniles and in number 4 there are four constrictions per whorl. They describe a forward convex arc on the sides and a forward concave arc across the venter where they are as deep as on the sides but narrower (figs. 6, 8). In the half-disk number 5, however, four rather closely set constrictions cross the venter in a straight line and are accompanied anteriorly and posteriorly, or posteriorly only, by indistinct varices. Constrictions are more distinct on the venter than on the flanks on which they describe forward convex arcs the chords of which run in a radial direction (figs. 12, 13).

The suture lines of the three small juveniles (nos. 1–3, figs. 8–10) differ from those of *S. helios* at the same stage by much poorer indentation and by having fewer lobes and saddles on the flanks (which, it is true, are narrower as a greater portion of the diameter is claimed by the umbilicus). Whereas the third auxiliary lobe rides on the umbilical shoulder in *S. helios* (e.g., number 12), the first is found in that site in the juveniles here dealt with, with two more auxiliaries between that shoulder and the umbilical seam; thus there are only three auxiliary lobes, as compared to five in *S. helios* at the same size. The sutures of specimens numbers 4 and 5 (figs. 12, 13), however, are as elaborate as those of *S. helios* at about the same size and have nearly as many auxiliary lobes (six), the last four of which form in their entirety a steeply sloping "suspensive lobe" as in *S. helios*. The only important difference between these suture lines and those of *S. helios* at a comparable size is in the siphonal lobe, which attains only about two-thirds of the depth of the first lateral. In specimen number 5 the external saddles are furthermore markedly lower than they are in *S. helios*.

REMARKS: Although the differences pointed out above prevent referring the few individuals here dealt with to *S. helios*, the material available, which contains no individual that might be considered adult, is too scanty to justify the establishment of a new species.

The half-disk number 5 differs in shell shape from similarly small individuals of *P.* (*Calliphylloceras*) *schems* only by being more evolute. However, this similarity is merely a case of homeomorphy within the family Phylloceratidae, as disclosed by comparison of the sutures: Whereas those of *P.* (*C.*) *schems* have assumed a typically phylloceratid character at a diameter of about 11.5 mm., those of that half-disk strictly maintain their *Sowerbyceras* style to the anterior end and do not nearly reach the same degree of elaboration.

MATERIAL STUDIED: Five specimens.

OPPELIACEAE BUCKMAN, 1924

This superfamily is represented in our material by four haploceratids on the one hand, and by almost 5000 oppelids on the other.

HAPLOCERATIDAE ZITTEL, 1884

LISSOCERAS BAYLE, 1879

Considerable confusion has been caused by Bayle's (1879, p. 34) proposal to replace Zittel's generic name *Haploceras* [which Bayle considered preoccuppied by *Aploceras* d'Orbigny, 1847 (see d'Orbigny, 1850, p. 112)] by *Lissoceras*. Spath (1921, p. 14, footnote 6) rejected for good reasons Bayle's proposal[1] but also discards his generic name *Lissoceras*, proposing instead *Lissoceratoides*, type species *Ammonites erato* d'Orbigny, 1847. Simultaneously, Spath restricted the genus *Haploceras* "to the Tithonian *H. elimatum* (Op.) Zittel." Because Zittel had not, in establishing the genus (1870, p. 48) or in his "Handbuch" (1885, pp. 464–465), formally designated a type, Spath's restriction of the genus implies selection of *H. elimatum* as its lectotype. On the other hand, as Bayle had formally designated *Ammonites psilodiscus* as the type species of *Lissoceras*, the two genera appear to be based on different type species and may therefore coexist. If *Lissoceras* is thus considered a valid genus including *Ammonites erato*, listed by Zittel

[1] As does Arkell, who otherwise could not maintain (1950, p. 363) Haploceratidae as the family name.

(1870, p. 49) among the species of his genus *Haploceras*, there is no need for the genus *Lissoceratoides*, which was proposed by Spath obviously because he considered *Lissoceras* a synonym of *Haploceras*. Therefore, Roman's (1938, p. 173) opinion that *Lissoceratoides* should be reunited with *Lissoceras* is here acceded to and *Lissoceras erato*, although designated the type species of *Lissoceratoides* by Spath, is left with the genus *Lissoceras* Bayle to which it was by implication referred by the restriction of *Haploceras* to *H. elimatum*.

Lissoceras erato (d'Orbigny)

Plate 4, figures 15–19

Ammonites Erato D'ORBIGNY, 1847, p. 531, pl. 201, figs. 3, 4 (*non* figs. 5, 6).

Ammonites Erato, d'Orbigny; FAVRE, 1875, p. 28, pl. 1, fig. 15.

Haploceras Erato d'Orb.; ZITTEL, 1885, p. 465.

Haploceras Erato d'Orbigny; DE RIAZ, 1898, p. 50, pl. 16, fig. 5.

Haploceras Erato, d'Orbigny; DE LORIOL, 1900, p. 39, *cum synon.*, text fig. 7, pl. 3, fig. 16.[1]

"*Haploceras*" (*Lissoceras*) *erato* d'Orbigny, SPATH, 1923, p. 14, footnote 6.

Lissoceras erato d'Orbigny; MAIRE, 1928, p. 50, pl. 3, figs. 20–23.

Lissoceratoides erato, d'Orbigny sp.; SPATH, 1933, p. 673, pl. 127, fig. 9.

DIMENSIONS

A.M.N.H. No. 27369	D	H	H′	W	U
1	9.56 mm.	*ca.* 47½	*ca.* 35½	32½	27½
2	18.7 mm.	45½	37	28	29½
4	52.0 mm.	46½	40½	28	24

A certain trend towards increase of involution with growth may be found in the above small sample.

All three measured specimens are septate throughout, as is a whorl fragment (no. 3) that represents about the same growth stage as specimen 4.

DESCRIPTION: The whorl section (figs. 16, 19) attains the maximum width at about the inner third of the flanks; from there it tapers more distinctly ventrad than dorsad. The venter is broadly rounded and even slightly truncate in the small specimen 1 and in the medium-sized shell 2 but narrowly rounded in the two largest specimens (nos. 3, 4, figs. 18, 19), thus causing the whorl profile to become slender-lanceolate. Throughout development the umbilical shoulder is pronounced, though rounded, and the umbilical wall is perpendicular and comparatively high. The venter carries no keel but, in specimen 2, just an indication of a siphuncular band.

Faint indications of falciform costae which stand far apart are recognizable in the same individual, whereas all the others appear to be completely smooth, as do those figured by d'Orbigny and Favre. The two large shells (nos. 3, 4), the surfaces of which are somewhat corroded, show no traces of the fine costation reported and illustrated by Maire for "exemplaires bien frais."

Mature suture lines are, or have been made, well visible in these two individuals at diameters of from 45 mm. to 52 mm. (fig. 17). They agree in general plan and in the high degree of ramification and indentation with de Loriol's (1900) text figure 7 or, for that matter, with his drawing (1898, p. 65, text fig. 21) of the suture lines of his *Oppelia rollieri* which for all practical purposes are indistinguishable from those of *L. erato*. Our specimens exhibit the same remarkably shallow siphonal lobe, divided by a low and sturdy, trapezoidal median knob which is richly indented on both its top and its sides. There are, furthermore, the same strongly inclined external saddles jutting out from the base of the median knob as they do in some phylloceratids, and the same widely spread first lateral lobe, divided into four unequal points by three leaflets, the outermost of which is by far the largest and duplicates, as it were, the external saddle at a reduced scale. There is also the same slender first lateral saddle which is divided by a deep, trifid lobule into two divergent main stems the inner of which is stronger and much higher than the outer and markedly exceeds the external sadddle in height. The second lateral lobe is very slender and deep and asymmetrically trifid. It is followed by the slender and bifid second lateral saddle which attains only a little more than half of the height of the first. A line connecting the tops

[1] This specimen is united by Jeannet (1951, p. 104) with *Oppelia rollieri* de Loriol (1898, p. 64, pl. 4, fig. 24; Jeannet, 1951, p. 104, text figs. 235, 236, pl. 31, figs. 3–6), but that species seems to differ from *L. erato* by slower increase in whorl height and by a less pronounced umbilical shoulder.

of the second lateral saddle and of the three auxiliary saddles, which imitate it in shape but rapidly decrease in size, slopes steadily to the umbilical seam. These auxiliary saddles separate four auxiliary lobes; all but the last of these are trifid; the third just rides on the umbilical shoulder.

The sutures of specimen 2 (fig. 15) are less elaborate, as would be expected considering the difference in size, but they essentially agree with those just described, except that here the line connecting the tops of the second lateral saddle and of the auxiliary saddles follows a radial direction, as it does in the smallest specimen (no. 1) also. The sutures of this individual, although less richly indented than those of number 2, otherwise approach the mature sutural characters observable in numbers 3 and 4 even more closely, especially in the way the first lateral saddle is pinched near its base. The second lateral lobe is bifid rather than asymmetrically trifid in this shell, but even at this early stage it is remarkably slender and not so much shorter than the first.

REMARKS: It is the sutural characters here described, chiefly the widespread and rich ramification of the first lateral lobe and the much higher degree of elaboration at any stage, that serve to distinguish this species readily from all the *Hecticoceras* and *Ochetoceras* species of this assemblage, some of which indeed closely resemble it in shell shape and dimensions.

This holds especially true of *H.* (*Sublunuloceras*) aff. *H.* (*S.*) *guthei* which has a similarly narrow umbilicus and which is also almost smooth (compare pl. 4, figs. 17, 18, with pl. 6, figs. 23, 24). It is, however, even more slender than the present form and has more distinct lateroventral shoulders and a truncate venter which sometimes carries a keel. The true *H.* (*S.*) *guthei* differs in maturity from *L. erato*, in addition, by the quite heavy costation of the outer zones of the sides.

Our form agrees so perfectly in shell shape, whorl profile, and smoothness with d'Orbigny's, de Loriol's, and Favre's illustrations and in the suture lines with de Loriol's drawing that its conspecificity cannot seriously be doubted.

Application of Arkell's (1950) classification places this genus and species in this report between the genera *Sowerbyceras* and *Hecticoceras*, *sensu lato*, thus bringing to mind Spath's (1928, p. 153) derivation of the Haploceratidae from the Phylloceratidae and, in particular, of the sutures of the former from those of *Sowerbyceras*.

MATERIAL STUDIED: Four specimens, including one fragment.

OPPELIDAE BONARELLI, 1893

With almost 5000 individuals, this family is by far the most abundant on Mount Hermon. It is represented by the genera *Hecticoceras*, *sensu lato*, the commonest of all, *Ochetoceras*, *sensu lato*, *Taramelliceras*, *sensu lato*, *Creniceras*, and *Scaphitodites*. Use of the subfamily names created by Spath (1928, p. 77) and accepted (with the exception of the Phlycticeratinae) by Arkell (1950, p. 363) can here be dispensed with, as three of these subfamilies (Hecticoceratinae, Ochetoceratinae, and Taramelliceratinae) are each represented by their type genus only and it is uncertain to which subfamilies the two remaining genera (*Creniceras* and *Scaphitodites*) should be referred, although it cannot be doubted that they are oppelids.

Study of the Oppelidae from Mount Hermon is likely to raise still other taxonomic issues. There are few groups in the Ammonoidea in which the splitting off of subgenera which soon turned into genera has reached such proportions. Within the genus *Hecticoceras*, in particular, de Tsytovitch (1911, p. 7) considered even the division into the two subgenera *Hecticoceras*, *sensu stricto*, and *Lunuloceras*, proposed by Bonarelli (1893, p. 77) simultaneously with the creation of the genus, "pour le moins inutile." E. Lemoine (1932, p. 20) accepts these two subgenera but otherwise strongly objects (1932, p. 28) to the "pulvérisation" of the genus, especially by Spath. Even since that author's Kachh monograph a considerable number of new generic names have been proposed, not a few quite recently by Jeannet (1951). Careful study of the Mount Hermon assemblage reveals, however, extremely close similarities and often transitions between forms that would under such a taxonomic conception belong to different subgenera or genera. Under this impression I believe that all those subgeneric and generic names serve only to cover one good species each, plus a few very closely related forms, and that they do not deserve the subgeneric or even generic rank claimed for them by their authors. None the less, for the sake of expediency they are used throughout this paper in the manner of subgeneric names to indicate the relationships of the forms concerned, because there exists no other technical way to designate units that are supraspecific but infrageneric. This applies to *Lunuloceras*, *Sublunuloceras*, *Brightia*, and *Putealiceras* within the genus *Hecticoceras*, *sensu lato*; to *Campylites* within the genus *Ochetoceras*, *sensu lato*; and to *Proscaphites* and *Richeiceras* within the genus *Taramelliceras*, *sensu lato*.

Still another vexing problem arises in the course of the study of this family from the fact that certain forms of the subgenus *Campylites* of *Ochetoceras* can be paired, as to ornamentation and dimensions, with certain forms of the genus *Hecticoceras*, *sensu lato*, so that some differ from others essentially only by the presence on the periphery of the three keels distinctive of *Ochetoceras*. That this last peculiarity may be a secondary sexual character only too readily comes to mind. The hypothesis that forms known under two different taxonomic names represent the males and females of a single species have been voiced twice before for this very group of ammonites. Both Munier Chalmas (1892) and Rollier (1913) devoted a paper to the problem of sexual dimorphism in ammonites. The former considered certain "formes scaphitoides," all of them small, more or less geniculate, with lateral lappets, and with the sutural development coming to an early standstill, as the males. He paired them with certain much larger forms, lacking those distinctive characters but agreeing in others with their counterparts, which he considered the corresponding females. Munier Chalmas' hypothesis was accepted and supported by Rollier, who did not hesitate to interpret lateral lappets and similar outgrowths of the shell of the supposed males as organs of copulation (1913, p. 269). This hypothesis, especially in the keener form given it by Rollier, differs from my above-mentioned suspicion not only in being less reserved and more comprehensive and in definitely designating the males but also in considering size and the presence or absence of lateral lappets the distinctive sexual characters. The idea tentatively brought forward above was suggested merely by my observations on otherwise similar forms which, however, differ from one another in the characters of the venter which carries no keel or one weak keel in some but three keels in others. Because this idea cannot be substantiated, let alone proved to the extent that the taxonomy of the forms concerned could reliably be based on it, the conventional taxonomic evaluation of *Hecticoceras* and *Ochetoceras* is maintained in the present report. Where the similarity, in characters other than those of the periphery, between corresponding species of these two genera is particularly noticeable, it is pointed out in the discussions of the species concerned.

Noetling (1887, p. 17) states for all the forms included by him in the genus *Harpoceras* Waagen, that is, for those here referred to *Hecticoceras*, *sensu lato*, and *Ochetoceras*, *sensu lato*, that "the embryonic volutions, as far as observable, are alike in all of them." From other passages in Noetling's paper it is apparent that he includes in the term "embryonic volutions" juveniles up to 5, and even 10 mm., in diameter. Now on cursory examination the early juvenile stages of all these forms appear indeed to be indistinguishable. If, however, ontogenetic series are formed and carefully examined under the microscope, the distinctive characters of each can be distinctly traced back to a very early stage. Only for the truly embryonic volutions, that is, up to a diameter of 1 mm. or less, does Noetling's statement quoted above hold true.

HECTICOCERAS Bonarelli, 1893, sensu lato

This genus, with about 3700 individuals, is the most abundant in the Mount Hermon ammonite fauna. It is here represented by the "subgenera" *Lunuloceras*, *Sublunuloceras*, *Brightia*, and *Putealiceras*. For the taxonomic evaluation of these subgenera, reference is made to the section on the family Oppelidae.

In addition to nearly 3300 specimens and fragments referred to the 12 species here distinguished within this genus, there are some 400 more which are too poorly preserved even for subgeneric determination and which have, therefore, been labeled merely "*Hecticoceras*, *sensu lato*, sp. indet."

Three of these specimens are geniculate, but poor preservation precludes a decision as to whether this geniculation is caused merely by crushing or is organic, as it is assumed to be in three individuals referred below (p. 34) to *H.* (*Lunuloceras*) *kersteni* (Noetling).

Of the 12 species just mentioned five have been previously described by Noetling from Mount Hermon. A sixth, "*Harpoceras excavatum*," is based by Noetling solely on the presence of a siphonal furrow which has, however, been found to occur in various species of different "subgenera." Therefore, "*Harpoceras excavatum*" cannot be accepted as a good species.

SUBGENUS **LUNULOCERAS** BONARELLI, 1893

This subgenus is represented in our material by the following rare species only.

Hecticoceras (Lunuloceras) kersteni (Noetling)

Plate 4, figures 20–37; plate 5, figures 1–5

Harpoceras Kersteni sp. n.; NOETLING, 1887, p. 19, pl. 2, figs. 5–5c.

Hecticoceras (*Lunuloceras*) *Kersteni* Nötl. f.; BONARELLI, 1893, p. 95.

H(*ecticoceras*) *Kersteni* Noetl.; FREBOLD, 1928, p. 186.

DIMENSIONS

A.M.N.H. No. 27370	D	H	H′	W	U
1	5.91 mm.	41	37	22[1]	32½
2	10.51 mm.	43	?	*ca.* 30½	27
3	11.47 mm.	41½	*ca.* 38	29½	31
4	11.73 mm.	42½	?	28½	33½
6	14.3 mm.	45[2]	?	*ca.* 23[2]	32½[2]
7	17.8 mm.	45½	41	*ca.* 23	31½
8	17.8 mm.	46½	?	25½	29
9	17.8 mm.	44½	?	25½	31½
10	22.6 mm.	44½	36	28½	33½
11	24.1 mm.	44	?	28	33½
12	40.7 mm.	51½	*ca.* 37	24½	20

The largest measured specimen is exceeded in size by the incomplete and poorly preserved disk number 13 which attains 48 mm. in diameter.

Noetling's measurements of the holotype, namely,

D	H	W	U
32 mm.	50	*ca.* 22	25

fit well into our table above.

It clearly shows a trend of the whorl height steadily to increase with growth, whereas the corresponding trend of the umbilicus to become narrower is manifested only above the diameter of 25 mm. W varies throughout development between 22 and 30½; no growth trend is recognizable in this respect.

[1] Crushed.

[2] Measured at D = 13.8 mm.

The two largest shells present (nos. 12 and 13) are septate throughout, as Noetling's type seems to be, to judge by his figure 5b which, as it is said to be enlarged three times, must be taken from the anteriormost part of the outer whorl. Thus shells with complete body chamber may well have reached 80 to 90 mm. in diameter.

DESIGNATION OF TYPE: Noetling's only specimen must be considered the holotype of this species.

DESCRIPTION: Shell discoidal, moderately involute, with comparatively narrow and shallow umbilicus. Whorl profile lanceolate throughout development, with the maximum width at about the inner third of the height, whence it tapers gently dorsad but more decidedly ventrad. Venter sharpened, crowned by a strong keel which at earlier stages may better be compared to the ridge of a roof and only from a diameter of about 15 mm. begins to be separated from the venter by steeply oblique, gently concave bands. Umbilical shoulder pronounced, almost sharp in maturity (pl. 4, fig. 29), umbilical wall perpendicular. Whorl profiles of successive ontogenetic stages are best illustrated by the frontal views of specimens numbers 10 and 12 (pl. 4, figs. 35, 30) and by the natural cross sections at both ends of the whorl fragment number 5 (pl. 4, figs. 24, 25), whereas venter and keel can be seen in the ventral views of various shells (pl. 4, figs. 21, 28, 31, 34).

From a diameter of about 12 mm. a concentric ridge develops a little dorsad of the middle of the flanks in some individuals (nos. 5, 7, 10, 12), but it is less distinct in others (e.g., no. 9) and absent in the otherwise well-preserved shell number 11. This concentric ridge, where present, connects the angulation points of the ribs. The "hardly perceptible furrow" said by Noetling to accompany this ridge is just recognizable, dorsad of it, in specimen number 12 (pl. 4, fig. 29); this furrow is rather wide and extremely shallow.

The innermost whorls are smooth. Ornamentation appears in the juvenile number 3 at a diameter of a little more than 5 mm. in the form of drop-shaped, quite heavy but blunt tubercles in the outer zone of the sides; five can be counted on the first ornamented half-whorl. They are followed, in the anteriormost portion of this shell, by less heavy tubercles which gradually come to resemble the outer portions of the ribs of later stages (pl. 4, fig. 20). The only slightly larger juvenile number 4, however, shows no trace of such tubercles. It appears almost smooth at first sight, although delicate falciform ribs can be recognized from a diameter of about 9 mm. in the outer half of the flanks. These ribs become distinct only on the lateroventral shoulders where they form blunt tubercles. Eight can be counted in the anteriormost quarter-whorl (pl. 4, fig. 22).

In the anterior half of the outer whorl of specimen number 6 the ornamentation just described can be seen to change into the mature one. There are, in this half-whorl, 16 slightly rursiradiate and gently forward concave ribs, mostly restricted to the outer half of the flanks. They markedly thicken towards the outer ends, then on the venter gradually vanish towards the keel (pl. 4, fig. 33). The same style of costation is only feebly developed, and in fact hardly perceptible, in the somewhat larger specimen number 7 (pl. 4, fig. 27), whereas the ornamentation of specimens 8 and 9, both equaling number 7 in diameter, fully agrees with that of specimen number 10, considered characteristic of the ornamentation at a medium growth stage. Here 29 rather stiff, rursiradiate ribs, which become a little club-shaped ventrad, are present in the outer zone of the last volution; especially in its posterior half they form distinct tubercles accentuating the lateroventral edge, then they turn sharply forward towards the keel which they do not quite reach. As a rule, only every other one of these ribs continues across the aforementioned concentric ridge into the inner zone of the flanks. The prorsiradiate ribs of the latter are, however, markedly weaker than those in the outer zone and recognizable in the anterior third of this whorl only, where six are present. They form a distinct angulation where they connect, across that concentric ridge, with an outer rib and hardly perceptible swellings where crossed by a second, very weak concentric ridge, situated about halfway between the first and the umbilical shoulder (pl. 4, fig. 36).

The somewhat larger individual number 11 exhibits, of all those measured, the most pronounced ornamentation (pl. 4, figs. 31, 32). Here the ribs of the inner zone can be followed back almost to the beginning of the last volution, but they are distinct only in its anteriormost portion and become more and more fold-like and indistinct apicad. The inner zones of earlier whorls, as seen in the umbilical opening, are entirely smooth. Nine inner ribs, or folds, for that matter, can be counted on the last half-whorl. They are more or less prorsiradiate and mostly split into two outer ribs at the angulation point; here and there outer ribs are intercalated that do not originate from an inner one. Here, too, the outer ribs, 17 of which are present in the anterior half of the outer volution, are rursiradiate, crescent-shaped, and thickened on the lateroventral shoulder. Beyond it, they become much thinner and continue in a decidedly forward direction as far as the base of the keel. The latter shows in the anteriormost third of the outer volution gentle undulations corresponding in site to those external ends of the ribs. The ornamentation of the much larger shell number 12 (pl. 4, fig. 29) is essentially the same as the one just described, but much less pronounced. In the inner zone of the flanks ribs are discernible only from a diameter of about 28 mm. An inner concentric ridge and slight swellings produced by it on the inner ribs at the crossing points, as described above in specimen 10, are barely visible in this shell also. The ribs of the outer zone become stiffer in the anterior half of the last whorl, gradually losing their crescent aspect, and end bluntly at some distance from the base of the keel. All these characters can also be recognized in Noetling's figure 5. Thirty-four such ribs are counted on the last volution, as compared to the 38 tentatively given by Noetling for the type, which is smaller by about one-fifth. Where the sculpture is preserved in the largest individual present (no. 13), that is, between the diameters of 33 and 38 mm., it agrees much better with that of specimen 11, which attains only half of its diameter, than with that of number 12, which is next to it in size, or with that of the type. Here the ribs are quite robust, even in the inner zone of the flanks, and still distinctly crescent-shaped in the outer. Four inner and seven outer costae are counted on about a sixth of the last whorl, corresponding to 42 outer ribs per volution (pl. 4, fig. 26).

The earliest stage at which the suture lines of this species can be examined is represented by the smallest specimen (no. 1) in which the sutures are bared and somewhat coarsened by corrosion at diameters from less than 3 mm. to nearly 6 mm. (pl. 4, fig. 23). The rather narrow siphonal lobe is divided by a low trapezoidal median knob which rides on the sharp keel. The first lateral lobe is as deep as, or only slightly deeper than, the siphonal one and ends in three blunt prongs. The following lobes, i.e., the second lateral, a first auxiliary and a second, cut off by the umbilical seam, decrease rapidly in depth and, perhaps owing to corrosion only, show no indentations. As is characteristic for all *Hecticoceras* sutures, both lateral saddles clearly exceed the external saddle in height, though not to the extent found in some of the following species. Thus the suture on the whole rises quite markedly from the periphery towards the umbilicus. The external saddle shows one indentation at about its middle, and the first lateral saddle two.

Better preserved sutures can be studied in specimens 3, 4, and 7 at diameters of about 10 mm. or a little less. One from specimen number 3 is illustrated (pl. 4, figs. 20, 21). At this stage the siphonal lobe is markedly wide and shallow and the median knob is low and unusually wide, with a wide and shallow depression between its two hornlets. The first lateral lobe does not quite reach the depth of the siphonal one. It ends in three blunt prongs, of which the middle prong hardly exceeds the others in length. The second lateral lobe attains only two-thirds of the depth of the first and shows just an indication of trifidity. Two auxiliary lobes are present in the inner zone of the flanks and a third occurs on the umbilical wall; it is separated from the second by a broad and low auxiliary saddle with distinctly indented top. Here, too, the external saddle is markedly lower than the lateral saddles. Both external and first lateral saddles are indented by short lobules, the former almost symmetrically, the latter asymmetrically, the inner stem being about twice as wide as, and also considerably higher than, the outer and subdivided by a secondary lobule. The second lateral saddle may be characterized as a reduced repetition of the first; the first auxiliary saddle shows no indentation. In specimens 4 and 7 the siphonal lobe is shifted to the right of the median line, with its left hornlet riding on the keel.

The sutures of specimens 8, 9, and 11 show, at diameters of about 15 mm., the same general plan as those just described but an increased degree of indentation and are thus ontogenetically transitional to the much more elaborate suture line of specimen number 10, corresponding to a diameter of 21.5 mm. (pl. 4, figs. 36, 37). The siphonal lobe is divided into two comparatively short main points by a median knob which is subquadratic in shape and sunk in at the top. From the tips of its hornlets undulant lines, each consisting of a little knob between two rounded notches, descend towards the middle which is occupied by a semicircular tongue. This central tongue attains, however, only about one-eighth of the depth of the siphonal lobe, as measured from the top of the adjacent saddles down to its bottom, and it indents the median knob only for about one-fourth of its total height. Noetling's drawing (fig. 5c), which shows a narrow triangular notch indenting the median knob even beyond the depth of the terminal points of the siphonal lobe and which misled Bonarelli (*loc. cit. in synon.*) into considering this an important peculiarity of this species, is obviously due to faulty observation. At this stage the middle point of the trifid lateral lobe has developed two secondary prongs and markedly exceeds in length both the lateral points of this lobe and the terminal ones of the siphonal lobe. Both second lateral and first auxiliary lobes are asymmetrically trifid. The external saddle is divided by a rather deep, three-pronged lobule into two main stems, the inner of which is somewhat higher and much wider than the outer. Both lateral saddles are also richly indented. The relation in height between the saddles and the number and configuration of auxiliary elements are still the same as described for earlier growth stages. The sutural characters are about the same, and the degree of indentation has not progressed much in specimen number 12 at a diameter of about 30 mm. (pl. 4, fig. 29), but in this suture both lobes and saddles appear to be somewhat plumper, and shallower and lower, respectively, and the points of the lobes somewhat shorter and blunter than in specimen number 10, which thus seems to exhibit at a considerably smaller diameter a more advanced sutural development than number 12.

It is worth noting that the sutures stand rather far apart in this species. In specimen number 10, for example, there are, at diameters between 18 and 22 mm., four sutures to a quarter whorl.

By way of appendix to this species three geniculate individuals are here dealt with which, on the strength of their sharpened venter and the character of their ornamentation, are believed to be referable to this species despite their irregular coiling.

To obtain a correct picture of their dimensions, the relative height of the last whorl was measured not only at the anterior end (H) but also at the break where the regular coiling changes to an irregular one (HG). As a consequence of the geniculation, HG is greater than H, in the smallest shell considerably so.

DIMENSIONS

A.M.N.H. No. 27371	D	H	HG	H′	W	U
1	18.0 mm.	40½	48	?	17	34
2	24.0 mm.	40	44	30	24½	33
3	26.4 mm.	42	46	?	24½	33

Except for the extraordinary thinness of the smallest shell, there is a remarkable agreement in proportions between all three. This is not surprising in view of the narrow size range of the sample.

It is important to note that in all three individuals the break in coiling occurs near the beginning of the body chamber, namely, in numbers 1 and 2 about one-sixth of a volution ahead of the last septum and in number 3 at about the same distance behind it.

If the geniculation is left out of consideration the individuals here discussed agree well with the others referred above to this species, except that the sharpness of the periphery is lost anterior to the geniculation point. Furthermore, specimen number 2 (pl. 5, fig. 2) shows, at and near the geniculation point, clearly a serration of the keel, with its teeth corresponding roughly to the thickened outer ends of the ribs. Faint indications of such a serration, comparable to the undulations reported above for the normally coiled specimen No. 27370:11, can be recognized in the two other specimens also.

The sutures of these geniculate shells, best observed in specimen number 2 at a diameter of about 12 mm. (pl. 5, fig. 4), agree in their general plan with those described above for *H.* (*L.*) *kersteni* but appear somewhat retarded in development, especially as to degree of indentation.

All told, these three shells are tentatively considered aberrant and somewhat stunted individuals of this species. Their peculiarities seem to be due to the irregularity of their coiling. The causes of such irregularity are unknown; if Munier-Chalmas' and Rollier's ideas (see above, p. 30) were followed, it would represent a sexual character.

REMARKS: It is true that Bonarelli (1893, pp. 92, 93, 95, 102), depending solely on Noetling's descriptions and drawings, referred all the latter's *Harpoceras*" species that come within *Hecticoceras*, *sensu lato* (with the exception of *Harpoceras excavatum* Noetling which he excluded from the genus), to his subgenus *Lunuloceras*. However, the present species is the only one among them that, with its sharp venter and strong keel, comes under Bonarelli's diagnosis of *Lunuloceras* and is thus really referable to this subgenus.

Vautrin (1934, p. 1439) records from the *Creniceras renggeri* horizon of the Anti-Lebanon (which can safely be correlated with Noetling's blue clays with *H. socini* on Mount Hermon) still another *Lunuloceras* species, namely, *L. nisoides* Spath. According to the latter author (1928, p. 120, pl. 13, fig. 8b, pl. 14, fig. 11, pl. 15, fig. 5), however, this species has a periphery like that of *Hecticoceras bonarellii* de Loriol (1898, p. 36, pl. 3, figs. 19–21) which shows a somewhat truncate venter, bounded by distinct, though rounded shoulders and, in my classification as well as that of Arkell (1939, p. 146), comes under *Sublunuloceras* rather than *Lunuloceras*, as, on the strength of Spath's description, would *L.*

nisoides also. Thus the form quoted by Vautrin must be assumed to lack the sharpened venter of *H.* (*L.*) *kersteni* and can therefore not be referred to this species. It may belong to *H.* (*Sublunuloceras*) *guthei* (see below).

From all the other *Hecticoceras* forms of the assemblage under study the present species is readily distinguished by its sharply fastigate, keel-bearing venter, even from those which approach it in shell shape in having a similarly narrow umbilicus, as do *H.* (*Sublunuloceras*) *guthei* (below) and *Ochetoceras* (*Campylites*) *delmontanum* (p. 80). In the former the venter is somewhat truncate and blunt, as in *H.* (*S.*) *bonarellii* (see above). In the latter the venter is narrow, it is true, but it carries three keels, the middle one of which is not so much higher than the others, which are separated from it by distinct furrows, whereas the smooth bands which in maturity bound the keel of *H.* (*L.*) *kersteni* slope steeply from it. There is no space whatever for lateral keels or furrows on the sharpened venter of the present species, and they are never present or even indicated.

MATERIAL STUDIED: Twenty-five specimens (including two incomplete or fragmentary and three geniculate ones).

SUBGENUS **SUBLUNULOCERAS** SPATH, 1928

When establishing his genus *Sublunuloceras*, here relegated to quasi-subgeneric rank (see p. 30), Spath (1928, p. 102) characterized it by ribs straighter than in *Brightia* and by "discoidal shells [which] have slight tubercles" and designated *Harpoceras lairense* Waagen (1875, pl. 13, fig. 3) as the genotype.

It is true that "obtuse" or "low obtuse" tubercles, both at the point where the ribs of the inner zone connect with those of the outer one and on the lateroventral shoulder, are mentioned in Waagen's (1875, p. 65) description of the type species, as they are in passing in Spath's (1928, p. 123) discussion of the typical form of *S. lairense*, but no tubercles deserving that name can be recognized in Waagen's figure (quoted above) of the lectotype nor, for that matter, in Spath's figure 1 of plate 14 or in figures 5 and 6 of his plate 17. If they are present in the illustrated specimens, they are certainly not conspicuous.

Thus it would seem that the lesser degree of sinuosity of the ribs (as compared to those of *Brightia*) should be relied upon as a group character for the forms under discussion rather than the "slight tubercles" mentioned by Spath. Still another character, which we consider a diagnostic one, can well be seen in Waagen's figure 3b. The venter is somewhat truncate and separated by rounded but distinct shoulders from the flanks. This same character shows well in de Loriol's (1898, pl. 3) figure 19c of the lectotype (here designated) of *Hecticoceras bonarellii* and Arkell's (1939, pl. 8) figures 22b and 24a of the same species, which is here referred to *Sublunuloceras*, as it is by Arkell (1939, p. 146), rather than to *Lunuloceras*, as it is by Spath (1928, p. 120).

This subgenus, so understood, is represented at Majdal Shams by *H.* (*S.*) *guthei*, by a closely related form, and by a new species, *H.* (*S.*) *socium*.

Hecticoceras (Sublunuloceras) guthei (Noetling)

Plate 5, figures 6–47; plate 6, figures 1–19

Harpoceras Guthei sp. n.; NOETLING, 1887, p. 20, *cum synon.*, text fig. 5, pl. 2, figs. 6–8.

Harpoceras excavatum sp. n.; NOETLING, 1887, p. 24, *pro parte*, ?pl. 4, fig. 1.

Hecticoceras (*Lunuloceras*) *Guthei* Nötl. f.; BONARELLI, 1893, p. 95.

Hecticoceras Guthei Noetl.; FREBOLD, 1928, p. 187.

H. Guthei Noetling; LEMOINE, 1932, p. 471.

?*Lunuloceras nisoides* Spath; VAUTRIN, 1934, p. 1439.

DIMENSIONS

A.M.N.H. No. 27372	D	H	H′	W	U
1	4.95 mm.	42	37	35	35
2	5.12 mm.	41½	35	31½	33½
3	6.26 mm.	40½	34½	33½	34½
4	6.60 mm.	42	*ca.* 39½	35½	33
5	6.87 mm.	38	?	31½	33
6	6.95 mm.	42½	39	32½	31
7	7.65 mm.	40	33	32	34
8	7.73 mm.	42	36	35	32½
9	8.17 mm.	42½	35	32	32
10	8.26 mm.	41	36	35	35
11	8.69 mm.	43	33	32	32
12	9.56 mm.	38	32½	31	33
15	10.86 mm.	40	?	*ca.* 28	31
20	10.95 mm.	44½	35	31½	29½
17	11.12 mm.	40	34½	28	32½
19	11.56 mm.	43	33	28½	31
22	11.56 mm.	41½	37	29½	32½
25	11.7 mm.	43	33½	31	32

A.M.N.H. No. 27372	D	H	H′	W	U
21	12.1 mm.	43	35½	29	31
24	12.1 mm.	44	39	?	32
26	12.3 mm.	44½	?	31½	28½
27	12.5 mm.	42½	37½	25½	33
29	12.8 mm.	45½	40	28	28
31	13.1 mm.	41	33	27½	35
32	13.2 mm.	41½	?	29	34
38	13.7 mm.	46	?	28½	31½
33	14.2 mm.	42½	?	29	31½
34	14.2 mm.	41½	?	28	35
35	14.3 mm.	43½	?	27½	32
36	14.6 mm.	43	35	27½	35½
37	14.6 mm.	44½	36½	29½	33
39	14.6 mm.	42½	?	29	34½
47	15.0 mm.	44	34½	27½	36½
41	15.2 mm.	42	31½	28½	35
42	15.2 mm.	41½[1]	?	29[1]	34½[1]
43	15.3 mm.	47½	?	27	29½
114	15.3 mm.	42	?	27	39
46	16.2 mm.	44½	33½	28½	35
115	16.3 mm.	42½	?	30½	37½
49	16.6 mm.	43½	?	26½	37½
50	17.0 mm.	41	34	27	34½
52	17.1 mm.	45½	?	25	30½
53	17.2 mm.	45½	33½	27	32
113	17.4 mm.	40	31	28	37½
60	17.7 mm.	42	?	25½	34
62	18.0 mm.	46	36	27	28
63	18.1 mm.	41½	31½	28½	35½
64	18.1 mm.	42½	35½	28½	34½
112	18.2 mm.	40	?	28	39
66	18.2 mm.	42	?	31	35
67	18.5 mm.	41½	?	25½[2]	37½
68	18.8 mm.	42½	34	29	35
69	19.1 mm.	41	*ca.* 36	22½	33½
71	19.5 mm.	46½	?	26½	28½
78	20.0 mm.	43	?	26½	34½
74	20.2 mm.	46½	?	28	30½
75	20.3 mm.	47	?	26	30½
76	20.5 mm.	41½	?	27	35½
77	21.2 mm.	43	?	?	32½
83	21.2 mm.	46½[3]	?	31½[3]	31[3]
116	21.2 mm.	40½	32	22½	36½
84	21.3 mm.	42	?	28	33½
79	21.4 mm.	43	?	29	34½
81	21.8 mm.	45½	36½	27	33½
82	22.0 mm.	44	*ca.* 32½	26½	32½
85	22.0 mm.	42½	?	26½	33
80	22.4 mm.	42	32½	28½	36
86	22.8 mm.	48	?	*ca.* 24	29
87	22.8 mm.	42½	?	24½	35½
88	22.8 mm.	45½	34	26½	32½
89	23.2 mm.	46	?	30½	31½
111	23.2 mm.	43	?	29	37½
90	23.7 mm.	43½	35½	*ca.* 23½	35½
73	23.8 mm.	42½	?	27½	35
91	24.0 mm.	43½	?	*ca.* 27½	33½
92	24.3 mm.	43½	*ca.* 35	*ca.* 23	33½
93	24.5 mm.	45½	?	?	32
94	25.5 mm.	50	37	28	27
96	26.0 mm.	44	?	25½	36½
97	26.0 mm.	47½	?	25	33
98	26.9 mm.	47	35½	29	29½
99	27.6 mm.	46½	*ca.* 37½	?[2]	33
100	28.0 mm.	47	?	*ca.* 23½[2]	32½
110	28.1 mm.	39	*ca.* 31½	26	37
101	28.8 mm.	40½	*ca.* 38	31	29
102	31.3 mm.	48	?	*ca.* 24[2]	27
103	32.3 mm.	49	34½	26½	24½
104	33.4 mm.	46½	?	27	28
105	35.4 mm.	48[4]	?	*ca.* 20[2,4]	25[4]
106[5]	45.1 mm.	47½	31½	*ca.* 20[2]	28
107[5]	47.7 mm.	45½	35	*ca.* 23[2]	25½

[1] Measured at D=14.2 mm.
[2] Crushed.
[3] Measured at D=19.8 mm.
[4] Measured at D=32.2 mm.
[5] Half-disks.

The last two specimens of the table are exceeded in size by specimen number 95 which attains about 51 mm. in diameter but is too badly deformed to be measured.

On the whole the degree of involution increases with growth; if number 110, one of the more evolute shells to be mentioned below, is left out of account, the highest values for H and the lowest for U are found near the bottom of the table. The shell also tends to become more slender with growth; although the maximum (35½) and near maximum (35) for W are found within the 10 smallest measured specimens, but the minimum (22½) and near minimum (*ca.* 23) in three medium-sized ones,[6] large disks are, on an average, thinner than small ones.

The outer whorls of the half-disks 106 and 107 belong to the body chamber, as does the anterior half of that of the largest shell (no. 95) which is, however, not preserved to the aperture. It has the last septum at a diameter of about 32 mm. If the length of the body chamber is assumed to have been somewhat more than half of a volution, this species may, from the present material, be estimated to have reached a diameter of from 55 to 70 mm. As is the rule in this assemblage, the body chambers are mostly crushed.

Designation of Type: The specimen illustrated in Noetling's figures 6–6c is selected as lectotype of this species.

Description: Shell discoidal and as a rule comparatively involute. In some speci-

[6] Crushed specimens left out of consideration.

mens (e.g., nos. 49, 80, 110–116), however, the umbilicus is quite wide, U amounting to from 36 to 39 but never exceeding H. These shells become thereby difficult to distinguish from *H.* (*Brightia*) *syriacum*, especially at earlier stages when the ornamentation characteristic of the present species has not yet developed. Throughout development the whorl profile, which has its maximum width at about the first third of the height, is characterized by only gently convex or, exceptionally, even flat flanks, distinct, though well-rounded lateroventral shoulders, and a truncate venter (pl. 5, figs. 7–9, 15, 16, 33, 37, 40, 46). The umbilical shoulder is mostly rounded but quite marked in some specimens (e.g., no. 15, pl. 5, fig. 14), and the umbilical wall is steep to perpendicular. The median line begins to be slightly raised as early as at a diameter of about 5 mm. in some juveniles (no. 3). At a diameter of about 7 mm. the first indication of a thread-like median keel can be recognized, under the microscope only, in the juvenile number 7. This thread-like keel becomes more readily recognizable at diameters of from 8 mm. to 9 mm. but in some individuals only considerably later in development. Still, it remains extremely delicate and becomes more pronounced even in those specimens that carry a distinct keel (e.g., nos. 76, 85, 87, 73, 93, 106; pl. 5, figs. 22, 38, 19, 26, 25; pl. 6, fig. 2), only from diameters of from 17.5 mm. to 20 mm., whereas it remains rudimentary or is entirely lacking, even on the body chamber, in as many equally well-preserved individuals (e.g., nos. 88, 99, 103, 107; pl. 5, figs. 30, 44, pl. 6, figs. 4, 6). About a dozen shells (among them nos. 36, 41, 66, 89, and 14) carry a median groove instead. This groove is, however, mostly restricted to a half, a third, or an even smaller part, of the outer volution, the rest of it being smooth or (nos. 66, 89) exhibiting the keel. Such a median groove is shown in the ventral view of specimen number 41 (pl. 5, fig. 12). These individuals would come, as would many more in the following species, under *Harpoceras excavatum* Noetling, if that species were to be accepted (see pp. 31, 48, 54, 58). But on the strength of their other characters they are referred without hesitation to the present species. The larger of the two specimens depicted by Noetling (pl. 4, fig. 1) as "*Harpoceras excavatum*" may well belong to the present species.

Three juveniles (nos. 3, 21, 50) show faint indications of spiral ornamentation. In the anteriormost third of the outer whorl of number 3 two extremely delicate concentric ridges, separated by an equally narrow, shallow furrow and followed dorsad by another, can be recognized between the middle and the outer third of the flanks (pl. 5, fig. 6). In number 21 that outer third is marked by a fine ridge, accompanied on its inner side by a hardly perceptible furrow (pl. 5, fig. 23). In number 50 the angulation points of the ribs, situated at the inner third of the flanks, are connected by a blunt ridge. In the same zone the somewhat larger shell number 84 exhibits only an engraved spiral line (pl. 5, fig. 39).

The inner whorls of the small juvenile number 3 are smooth up to a diameter of about 5 mm. Then ornamentation appears in the form of indistinct, fold-like ribs, three or four per quarter whorl, which form forward convex arcs on the inner half of the flanks, then continue indistinctly into the outer zone where they assume a sickle shape. They vanish before reaching the outer shoulder (pl. 5, fig. 6). In the only slightly larger juvenile number 8 the situation is nearly reversed. Here 13 falciform ribs are present on the outer half of the last quarter whorl, whereas the inner zone is almost smooth (pl. 5, fig. 10). The outer ends of these ribs turn sharply forward on the lateroventral shoulder. The venter of this specimen is corroded, but on that of the juvenile number 7 of the same size the continuations of these ribs (here much less developed) can be seen to unite across the venter, forming narrow, parabolic, forward-pointing tongues, or chevrons. Similar, somewhat less pointed tongues are also present in the juvenile number 10, at a stage when there is not yet any trace of the median keel (pl. 5, fig. 13), and, at about the same ontogenetic stage, in number 21 where, however, an incipient keel is crossed by these tongues (pl. 5, fig. 24). The juvenile number 17, attaining a diameter of about 11 mm., exhibits a costation somewhat different from that of number 8, described above. On the anteriormost quarter of the outer volution altogether 15 weak, falciform, rursiradiate ribs can be counted in the outer zone. Only about every third of these can be seen to continue beyond the middle of the flanks, to form a distinct but rounded hook at their inner third, and to continue as a hardly perceptible, strongly prorsiradiate fold into the circumumbilical zone, where it soon vanishes. The other ribs are restricted to the outer zone (pl. 6, fig. 14). The costation on the whole is similar in specimen number 32, but the circumumbilical ribs are more distinct and can be followed right to the umbilical shoulder, whereas those of the outer zone are even less developed than in number 17 and maintain a more radial direction. They can well be seen to cross the venter in parabolic tongues, as mentioned above (pl. 5, figs. 31, 32). The character of the ornamentation is the same in specimen number 35, except that here the innermost parts of the outer ribs and the hooks by which they are connected with the inner ones stand out most strongly (pl. 6, fig. 12). In specimens numbers 47 (pl. 6, fig. 19), 42, and 43 the same course of the ribs can be recognized as in those just described, but they are reduced to mere growth folds and growth striae so that the surface appears almost smooth to the naked eye. The ornamentation is similar but somewhat less delicate in the slightly larger shell number 52 (pl. 6, fig. 16), but here the strongly prorsiradiate and slightly orad concave inner ribs, which run from the umbilical shoulder across the inner third of the flanks to the angulation point and of which nine can be counted in the anteriormost quarter whorl, stand out much more than those of the outer zone. In specimen number 66, although it represents the same ontogenetic stage, the aspect of the ornamentation is again somewhat different (pl. 5, fig. 27). Here, too, the circumumbilical ribs stand out most strongly, except in the anteriormost portion of the outer whorl, but they are shorter and markedly stronger than in number 52 and much less closely set, there being only 10 on one-half of the outer volution. In its anteriormost portion these inner ribs lose their strength rather abruptly, but the falciform costae become in turn more distinct and better individualized. Twelve are present on the last quarter-whorl. The chords of the forward concave arcs described by these ribs are distinctly rursiradiate at the posterior end of, but gradually assume an almost radial direction within, this quarter-whorl. The outer extensions of these ribs form the usual parabolic tongues across the venter, which shows a shallow median furrow at the beginning and develops a blunt keel only at the end of this whorl. Specimen number 68 should be mentioned for the fact that in its anteriormost part these tongues produce a faint denticulation of the median keel.

The ornamentation of the excellently preserved shell number 76 essentially agrees with that of number 66, but number 78, only slightly smaller than 76, exhibits further progress in the transition to mature ornamentation. Whereas the costation is weak and hardly perceptible in the posterior half of the outer whorl, and like that of number 66 in the third quarter, the ribs of the outer zone assume strength and a clearly radial direction and move farther apart in the anteriormost quarter on which nine of them are present. About 12 strongly prorsiradiate but much less pronounced ribs correspond to them in the inner zone, with the angulation zone between them almost smooth (pl. 6, fig. 17). The trend just recognized in number 78 is even more clearly manifest in the comparatively stout shell number 83; here the outer zone carries comparatively few (13 on the anterior half whorl) heavy ribs which widen but stop abruptly at the lateroventral shoulder. The circumumbilical ribs are also quite strong and are continuous with the outer ones in the posterior part of the outer volution, but they become fold-like and tend to change into bundles of growth striae in the anterior part (pl. 5, fig. 34). On the venter also the ribs tend to dissolve into growth striae which locally produce in this shell also a fine denticulation on the median keel (pl. 5, fig. 35). Four other individuals (nos. 56–59), measuring from 21.5 to 26.5 mm. in diameter, exhibit a similarly robust costation.

In this group (nos. 83, 56–59) the sculptural development seems, however, somewhat accelerated, for in number 84, of about the same size as 83 and mentioned above for the presence of an engraved spiral line (pl. 5, fig. 39), and in the even larger individual number 92 the costation is still very delicate, whereas number 87, only 1.5 mm. larger, agrees in the character of ornamentation with number 78, described above. Numbers 88 and 91, of the same size as 87 and a little larger, respectively, may be considered intermediate in this respect between 87 and 83. The shells 87 and 88 are figured side by side (pl. 6, figs. 15, 13) to illustrate the extreme variability in the ornamentation of this species. The outer costation is heavier and less dense in number 88 than in number 87, but even more striking is the contrast in the circumumbilical costation which consists of 13 flat and delicate ribs in the anteriormost quarter-whorl of number 87 but of only five quite heavy ones in that of number 88. Specimen 87 is shown in ventral view also (pl. 5, fig. 19) to illustrate the tongues formed by delicate growth striae across the keel.

About 20 shells in addition to those already mentioned (nos. 47, 42, 43, 84, 92) are characterized by extremely delicate ornamentation which might be termed, at least in some places, a mere growth striation rather than a costation. Specimens numbers 44 (pl. 5, fig. 21) and 65, the latter with a diameter of about 30 mm. one of the largest in this group, illustrate this feature best. Some of these individuals (nos. 48, 51, 54, 55, 117) differ in having many (up to 20 or even more per quarter-whorl) fine but well-individualized outer costae, whereas in the other shells of this group the ribs are not so well defined but rather resemble growth striae or bundles thereof. Number 48 is a good example of the first group (pl. 5, fig. 28). Shell 72 (pl. 5, fig. 17) with low and sinuous, well-defined ribs, which tend, however, to dissolve into bundles of growth folds here and there, is intermediate in ornamentational character between those with robust and those with delicate costation.

In the majority of the medium- and large-sized individuals, the trend reported above for number 78 and exaggerated, as it were, in numbers 83 and 56–59 continues. The inner ribs tend to disappear so that the circumumbilical zone becomes eventually smooth except for growth striae, and the outer ribs become stronger, stiffer, and gradually less rursiradiate. Specimens 98, 99, 105, and 106 (pl. 5, fig. 45; pl. 6, figs. 3, 5, 1), the last representing best the mature sculpture of this species among the large individuals, illustrate this trend. From 16 to 19 outer ribs are counted on the anterior half-whorls of these four specimens.

Shell number 110, attaining about 28 mm. in diameter, deserves special mention for the following peculiarities of its ornamentation: It is quite inconspicuous in the posterior half of the outer volution, making the surface appear smooth for all practical purposes, thus strongly reminiscent of the holotype of *H.* (*Brightia*) *syriacum* (pl. 8, fig. 45). On the anterior half of this whorl, however, both inner and outer ribs become quite pronounced and the inner ones can be seen to continue or to bifurcate into outer ones, in a way strongly reminiscent of *H.* (*Puteaoliceras*) *schumacheri* (pl. 9, figs. 36, 39), while other outer ribs are intercalated independently. Twenty-four outer ribs and 11 inner ones are counted on this half-whorl (pl. 6, fig. 10).

For the sake of completeness it is here mentioned that the ribs seem to cross the venter uninterruptedly in the poorly preserved specimen number 45 (of about the same size as number 105). This may be an original malformation of the shell or this aspect may merely be produced by crushing.

The juvenile number 2 exhibits excellently preserved suture lines at diameters of from 3.3 mm. to 5.1 mm. (pl. 5, fig. 11). The siphonal lobe (which shifts increasingly to the left of the median line between those two diameters) is moderately wide and shallow; the median knob is low, broadly trapezoidal, and slightly sunk in the middle of its top, but no hornlets are yet developed. The trifid first lateral lobe is only somewhat deeper than the siphonal one, the second lateral is rounded-triangular, with just an indication of an outer point, and attains only about two-thirds of the depth of the first. Two increasingly shallow auxiliaries are present. The two main saddles are rather sturdy. The external one is subsymmetrically divided by a short lobule, the first lateral one asymmetrically, with the inner stem much higher and wider than the outer. The following saddles show no indentations. As is characteristic in this genus, the first lateral saddle exceeds the external one in height, and quite considerably so. The line connecting the tops of the first lateral saddle and the following saddles rises slightly above the radius.

The last suture lines of juvenile number 6 correspond to the same ontogenetic stage but show somewhat shallower lobes and plumper saddles. A somewhat later stage is observable, at a diameter of about 7 mm., in juvenile number 17; here the siphonal lobe is remarkably shallow, and the sides of the first lateral show some indentation (pl. 6, fig. 14).

The sutures are more elaborate and more richly indented in juveniles numbers 22 (pl. 6, fig. 11), 24, and 32 at diameters of up to 12 and 10 mm., respectively. The siphonal lobe attains here only about half of the depth of the first lateral which is remarkably broad; its middle point exceeds the lateral ones only slightly in length. The inner terminal point of the second lateral lobe tends to occupy a lower site and to reach farther down than the outer. Beyond this lobe follow a symmetrically bifid second lateral saddle, an indistinctly trifid first auxiliary lobe, a low, trapezoidal first auxiliary saddle with an incipient indentation of its top, and two more auxiliary lobes with an inconspicuous saddle between them. The second auxiliary lobe rides on the umbilical shoulder. The tops of all the saddles from the first lateral dorsad hit the same radius. Hornlets just begin to develop on the median knob.

In the small shell number 108 (pl. 6, fig. 18) the development of the suture lines, corresponding to diameters of from 6 mm. to 14 mm., appears to be accelerated, to judge by the degree of elaboration, which is very high for this growth stage, and by their crowding, no fewer than 13 being present on the last half-whorl.

Specimen number 40 (pl. 5, fig. 36; pl. 6, fig. 7), on the other hand, shows at diameters of from 13 to 15 mm. normal progress in sutural development. The hornlets of the median knob are here well developed, and both lateral lobes are more slender than at earlier stages and have long middle points with a small secondary point on their outer sides. The lobules intersecting the two principal saddles have become deeper. The first lateral saddle considerably overtops both its neighbors and especially the radius connecting the top of the following saddles. An even higher degree of sutural indentation is encountered in the anterior half of the outer whorl of specimen number 62 at diameters of from 13 to 18 mm. (pl. 5, fig. 29). Here the middle point of the first lateral lobe carries secondary points on either side, with the outer stronger and in a higher position than the inner, and the first auxiliary lobe has become symmetrically bifid. This shell is remarkable for the crowding of the sutures in its anterior part, seven being present in the last quarter of the outer whorl. Here, however, this crowding seems merely to foreshadow the vicinity of the last septum, for only four sutures can be counted in the second quarter of the same volution. At the same ontogenetic stage specimen number 69 shows about the same degree of sutural elaboration, whereas the sutures of specimen number 67 exhibit, at diameters up to 15 mm., rather the characters of an earlier stage and are not crowded at all; even the last four are spread over as much as a quarter-whorl (pl. 6, fig. 8).

At the next stage, around the diameter of 20 mm., the general plan of the suture line and the degree of indentation remain about the same, but there is a truly bewildering variability in details, especially as far as the two lateral lobes are concerned. Thus the second lateral lobe is more or less symmetrically bifid throughout the half-disk number 16 (pl. 5, fig. 47) and in specimen number 55, but asymmetrically trifid in specimens numbers 86 and 18, with the three prongs, the innermost of which is the strongest, aligned along the steeply dorsad sloping bottom of this lobe. Specimen number 18 is, in addition, remarkable for the density of its sutures (six to a quarter-whorl) and for a strong shift of the siphonal lobe to the right (pl. 5, fig. 41). In the shell number 48 the three terminal points of the first lateral lobe and the middle one of the second become very long and narrow, assuming a dagger shape, and the former diverge but little (pl. 5, fig. 28). The well-preserved sutures of specimens numbers 28, 30, 75, 76, 13, 14, 109 (pl. 6, fig. 9), and 110 exhibit about the same characteristics as those of number 62, described above, but indentation, of course, increases with growth and is manifested by the addition of secondary prongs. In specimen number 13 the siphonal lobe is markedly shifted to the left. As seen in plate 5, figure

20, this asymmetry greatly affects the aspect of the left suture line. Not only the external saddle, which altogether seems a little stunted, but even the first lateral saddle are markedly reduced in width, as compared to their counterparts on the right side of the shell. In this suture line the extent to which the first lateral saddle overtops both neighbors seems to reach a maximum.

In addition to the individuals already mentioned for sutural asymmetry, many more, e.g., number 99 (pl. 6, fig. 4), exhibit this feature which is quite common in the genus *Hecticoceras* (see Noetling, 1887, p. 17).

The latest sutural stage observable in this species is found in a short whorl fragment (no. 61) the anterior end of which may be estimated to correspond to a diameter of about 31 mm. It is illustrated (pl. 5, figs. 42, 43) as representing the highest degree of sutural elaboration encountered in this species within our material. It is worth noting that the hornlets of the median knob are separated from its main body by short notches but that otherwise the top of the latter is horizontal or gently convex but not indented. There is no indication of the deep and wide median indentation described above (p. 33) in *H.* (*Lunuloceras*) *kersteni*.

REMARKS: The ammonites listed by Fraas (1877, 1878) from Mount Hermon under Quenstedt's name *Ammonites hecticus compressus* may well belong to the present species, as Noetling states, but whether the Syrian form is indeed, as that author and Frebold (1928, p. 187) assume, conspecific with that from Thalheim illustrated by Quenstedt (1858, p. 546, pl. 72, fig. 8) cannot be decided without knowing the whorl profile of the latter. Even if there were conspecificity, it would not affect the validity of Noetling's name, because, as Noetling points out, the Thalheim form is specifically different from that from Jungingen to which Quenstedt (1849, pl. 8, fig. 3) first applied the trivial name *hecticus compressus*. To the differences mentioned by Noetling may be added the fact that the Jungingen form has a fastigate venter, whereas that of *guthei* is truncate.

It may have been an almost smooth shell of this species that Vautrin (1934, p. 1439) identified from the same horizon on the Anti-Lebanon as *Lunuloceras nisoides* which, according to Spath, has also a truncate venter (for reference, see p. 34). Even if the Syrian form were conspecific with *nisoides*, as Vautrin believed, the fact would not affect the validity of Noetling's (1887) name which antedates Spath's (1928).

Certain characters (the predominantly higher degree of involution; the truncate, though narrow venter bounded by distinct, though rounded shoulders; the trend of the ornamentation to withdraw, after a passing stage with well-developed circumumbilical ribs, into the outer two-thirds of the flanks, leaving the circumumbilical zone all but smooth; the gradual change of the ribs of the outer zone from a rursiradiate to a radial direction along with their gradual decrease in sinuosity; and certain sutural peculiarities, as pointed out in the above description) distinguish this species among the oppelids from Mount Hermon. It must be admitted, though, with Noetling that earlier stages at which the above-mentioned trends of the ornamentation are not yet realized are sometimes difficult to distinguish from individuals of the same size belonging to the subgenera *Brightia* and *Putealiceras* and sometimes even from those belonging to *Ochetoceras* (*Campylites*). The close resemblance of more evolute shells of this species, especially at earlier growth stages, with those of the same size of *H.* (*Brightia*) *syriacum*, is mentioned above.

More detailed comparisons are made, where warranted, in the discussions of the following species.

MATERIAL STUDIED: In addition to about 725 individuals, including incomplete ones and fragments, among the pyritized ammonites from Majdal Shams, a single half-disk embedded in the piece of "Mergelkalk" (pp. 9–10), numbered A.M.N.H. No. 27379/1, is probably also referable to this species.

Hecticoceras (Sublunuloceras) aff. H. (S.) guthei (Noetling)

Plate 6, figures 20–25

DIMENSIONS

A.M.N.H. No. 27374	D	H	H′	W	U
1	23.6 mm.	46½	*ca.* 34½	*ca.* 21	26
2	25.8 mm.	48[1]	?	26[1]	27[1]
3	31.6 mm.	48	*ca.* 38	*ca.* 23	24
4	32.0 mm.	48½	39	*ca.* 24½	26½

[1] Measured at D = 22.1 mm.

In these four shells the last septum can be located between the diameters of 13 and 21 mm. The anterior half of the outer whorl belongs to the body chamber in numbers 1, 3, and 4, but none of them is preserved to the aperture. The whorl fragment number 5, which stands out by extreme slenderness and which corresponds at the anterior end to a diameter of about 25 mm., is also unseptate.

DESCRIPTION: The five individuals comprised under the above designation deviate from *H.* (*S.*) *guthei* by a higher degree of involution and correspondingly narrower umbilici and by the delicacy of the ornamentation. A few weak outer ribs show in specimen number 1 and five quite distinct ones in the fragment number 5 (fig. 22), and there is a remarkably dense (seven strongly prorsiradiate ribs on a quarter-whorl) circumumbilical costation in specimen number 2 (fig. 20), but otherwise the ornamentation is reduced to a faint growth striation (no. 3, fig. 25) or, although agreeing with that of the typical *H.* (*S.*) *guthei*, it is so delicate as to be perceived only in oblique illumination (no. 4, fig. 23). Except in specimen number 2, a fine median keel is recognizable all around the periphery or in parts of it. In specimens 4 and 5 (figs. 24, 21) this keel assumes rather the aspect of a ridge, with the venter on both sides sloping from it more decidedly than in the typical *H.* (*S.*) *guthei.*

The suture lines seem to be the same as in that species.

REMARKS: This form may be considered a mere morphological variety of *H.* (*S.*) *guthei* to which it is therefore here appended. The differences from the typical form are pointed out in the above description. The narrow umbilicus also serves to distinguish this form from all other forms of *Hecticoceras, sensu lato*, of the present assemblage.

The dimensions of this form and the absence of a pronounced ornamentation account for its superficial resemblance to *Lissoceras erato* which is, however, not quite so slender, lacks a median keel, is entirely smooth, and above all has quite different, much more elaborate sutures. This similarity is best seen if the right side views of the specimens A.M.N.H. No. 27369:4 (*Lissoceras erato*, pl. 4, fig. 17) and A.M.N.H. No. 27374:4 [*H.* (*S.*) aff. *guthei*, pl. 6, fig. 23] are compared.

MATERIAL STUDIED: Five specimens, including one whorl fragment.

Hecticoceras (Sublunuloceras) socium, new species

Plate 6, figures 26–38; plate 7, figures 1–19

DIMENSIONS

A.M.N.H. No. 27377	D	H	H′	W	U
1	5.30 mm.	37½	33	36	36
2	7.21 mm.	41	33½	35	32
3	7.65 mm.	40	34	33½	34
4	7.82 mm.	38½	32	32	34½
5	8.26 mm.	40	36	29½	36
6	9.04 mm.	37½	?	31½	37½
7	9.47 mm.	40½	?	33	35
8	9.56 mm.	40	32	32	34½
10	10.08 mm.	42½	?	32	32
12	10.51 mm.	39½	34½	27½	34
13	10.95 mm.	41½	31½	28½	38
14	11.12 mm.	39	*ca.* 33	30½	37½
15	11.12 mm.	41½	*ca.* 36	*ca.* 30½	33
9	11.30 mm.	40	32½	32½	35½
16	11.30 mm.	38½	?	31½	37½
17	12.25 mm.	40½	*ca.* 34½	29½	33½
18	12.25 mm.	39	?	30	35
39	12.60 mm.	42	35	*ca.* 31½	33
19	12.69 mm.	41	?	30	33
20	13.03 mm.	43½	35½	31½	29½
21	13.03 mm.	42½	?	31½	30½
22	13.03 mm.	40	32	30½	34
25	13.30 mm.	44	*ca.* 37½	*ca.* 27[1]	29½
23	13.64 mm.	45	36	30	29½
37	13.64 mm.	42½	?	*ca.* 28	30
24	13.90 mm.	42	33	30	33½
26	14.60 mm.	41½	?	*ca.* 30	31
44	14.95 mm.	38	32½	28½	33½
27	16.16 mm.	38	34	25½	35
38	18.5 mm.	46	?	?27[2]	33½
40	19.1 mm.	38	32	25½	38
28	19.9 mm.	45½	35	27	32
41	20.0 mm.	37½	32	28½	39
29	20.0 mm.	45	?	27	33½
30	24.0 mm.	40½	?	27	38½
31	27.4 mm.	46	?	27½	29
32 (holotype)	28.2 mm.	41	31	27	36
33	29.1 mm.	40	?	28	37½
34	31.5 mm.	38½[3]	?	27[3]	39[3]
35	54.0 mm.	44	32	26	31½

The only trend that can be safely deduced from the table is that the shells decrease in thickness with growth; the two smallest measured (nos. 1, 2) are also the thickest,

[1] Somewhat crushed.
[2] Crushed anteriorly.
[3] Measured at D=28.1 mm.

and the largest (no. 35) is only slightly exceeded in slenderness by the medium-sized paratype 40.

It is true that larger shells as a rule are more involute than small ones, the minimum of H (37½) being found in two small juveniles (nos. 1, 6) and the maximum (46) and near maximum (45½) in three medium-sized shells (nos. 38, 28, 31); in the largest measured paratype (no. 35) H comes, with 44, fairly close to the maximum. However, this general trend is obscured by the fact that the shell combining the minimum of H with the maximum of U (no. 41) and the one combining the maximum of H with the minimum of U (no. 31) differ by only about 7.5 mm. in diameter and thus occupy positions fairly close to each other in the table. The former and paratype 34 are the only shells in which U exceeds H, while both these values are equal in paratypes 6 and 40. As a rule, however, H exceeds U, sometimes quite considerably (e.g., no. 31).

In the paratypes 33 and 34 the last spetum can be located at diameters of about 21 and 26 mm., respectively, but the even larger paratype 35 [which, among the oppelids from Mount Hermon, is surpassed in size only by the largest individuals of *H.* (*Putealiceras*) *schumacheri* and *H.* (*P.*) *douvillei*] is septate throughout, as is the holotype. Thus this species may be inferred to have reached at least 85 to 90 mm. in diameter.

DESIGNATION OF TYPE: Specimen A.M.N.H. No. 27377:32 is designated holotype of this species.

DESCRIPTION: The protoconch which measures less than 0.1 mm. in diameter and does not overtop the first volution can be seen, in side view, in only a few juveniles (nos. 1, 3, 6).

At an early stage the whorl profile is broad-elliptic, with both flanks and venter gently convex and with distinct, though well-rounded lateroventral shoulders (nos. 1, 2; pl. 6, figs. 37, 28; no. 4). Later in development the whorl section becomes more slender, the flanks become flatter, the lateroventral shoulders more pronounced, and the venter is accordingly more distinctly truncate, but it still can be seen to slope gently from the median keel towards the outer shoulders. Simultaneously the umbilical shoulders also become more distinct and the umbilical wall becomes steeper or even perpendicular (nos. 12, 9, 22, 32; pl. 6, figs. 29, 32, 33; pl. 7, figs. 3, 8, 9). In the short whorl fragment 11, corresponding to a size only a little smaller than the holotype, the whorl profile is somewhat stouter than in the latter (pl. 7, fig. 18).

Ornamentation sets in at an unusually early stage in this species. First indications are recognizable even in the smallest juvenile (no. 1), as early as at a diameter of a little more than 2.5 mm., as indistinct nodes occupying the middle of the flanks. On the last volution these nodes soon turn into blunt ribs extending over most of the flanks in a strongly sigmoidal course, with the outer sickles decidedly recurved (pl. 6, fig. 36). Thus the mature costation of this species is clearly foreshadowed at this very early stage, corresponding to a diameter of about 5 mm. These ribs are better observed in the anteriormost portions of paratypes 2 and 3, at diameters of about 7 mm. and 7.5 mm., respectively (pl. 6, fig. 27). Here bifurcation just begins to take place and six outer sickles can be counted on an eighth of the whorl. This ornamentational stage may be said to extend up to a diameter of about 11 mm. In the juvenile 5 differentiation between the inner primary and outer secondary ribs has become more distinct. Paratype 8 is illustrated (pl. 6, fig. 26) for excellently exhibiting a strongly sigmoidal course in its anteriormost rib, with a sharp, though rounded, hook or tongue connecting the strongly prorsiradiate inner portion with the deeply forward concave and strongly recurved outer sickle. In paratypes 3 and 14 the costation is distinct in the outer zone only; 13 sickles are counted in the last quarter-whorl of number 13.

In the anteriormost portion of paratype 9 (pl. 7, fig. 2) the short inner ribs, which run in a strongly prorsiradiate direction up the steep umbilical wall and culminate on the umbilical shoulder, also become distinct, as do the rather sharp angulations connecting them with the outer sickles. By these characters this individual, as well as the only slightly larger paratype 18, proves to be transitional to the next ornamentational stage, best represented by numbers 19, 20, 22, 25, 37, and 24 and eight somewhat smaller disks and fragments; of these, paratypes 20 and 37 are illustrated (pl. 7, figs. 4, 5) as the most characteristic. Both exhibit a dense costation, consisting of strongly prorsiradiate inner ribs which are connected at the second fifth of the flanks by a sharp angulation with some of the equally well-developed, moderately recurved outer sickles, the protracted outer ends of which almost reach the median line; others are added by intercalation rather than bifurcation. In paratype 20, 16 such sickles correspond to 11 inner ribs, and in paratype 37, 14 of the former to nine of the latter; thus the number of the outer ribs is not fully twice that of the inner ones. Paratype number 44, somewhat larger than those just mentioned, deserves special mention for having broader, less numerous (12 on the last quarter-whorl), strongly recurved outer costae; inner costae are present but are hardly perceptible. Here, too, the angulation is quite sharp (pl. 7, fig. 13).

The ornamentation remains essentially the same through the following ontogenetic stage, that is, up to a diameter of about 30 mm. (e.g., no. 33; pl. 7, fig. 15), with the modification, however, that in almost half of the shells of this size group (paratypes 38, 40, 41 and the holotype; pl. 7, figs. 10, 6, 8) the inner zones of the flanks remain practically smooth up to diameters of from 16 to 21 mm. and the angulation between inner and outer costae, where it can be observed, is less pronounced than even at the earlier stage represented by paratypes 20 and 37.

The fully mature ornamentation of this species can be studied, even better than in the holotype, in paratypes 34 and 35, although it is here preserved only up to diameters of 28.5 and 34 mm., respectively, and, best of all, in the whorl fragment 36, the anterior end of which corresponds to a diameter of about 36 mm. Paratype 34 exhibits six strong, rather sharp, decidedly prorsiradiate inner ribs per quarter-whorl which split somewhat ventrad of the second fifth of the flanks into two moderately rursiradiate, somewhat less strong sickles each (pl. 7, fig. 16). In paratype 36, consisting of about one-sixth of a whorl, four high and strong inner ribs and eight almost equally strong outer ones are counted. Some of the latter are intercalated, while others originate by bifurcation (pl. 7, fig. 12). In both these shells the angulation between inner and outer costae is quite pronounced.

A fine, thread-like keel appears at a diameter of about 6 mm. in paratype 6, and of about 10 mm. in paratype 44 (pl. 7, fig. 14). Both these appearances must be considered premature, for in most shells the keel appears only at diameters of from 17 to 20 mm., e.g., at 17-mm. diameter in the holotype (pl. 7, fig. 7). The keel remains low and inconspicuous to the end. In some of the larger paratypes (nos. 33, 35) and in six whorl fragments it is accompanied, from a diameter of about 25 mm. on, by two even lower keels which are separated from it by extremely shallow grooves. This triple keel, best observed in the whorl fragments 11 and 36 (pl. 7, figs. 17, 11), is, however, readily distinguishable from the three much sharper and higher keels on the markedly narrower venters of the subgenus *Campylites* of the genus *Ochetoceras*. No median grooves have been observed in this species.

Rather closely set (five per quarter-whorl), not so primitive suture lines can be seen in the five smallest measured juveniles (nos. 1–5; pl. 6, figs. 27, 28, 35, 36). At a diameter of about 5 mm. the first, and at one of about 6.5 mm. both, lateral lobes can be recognized to be trifid. One auxiliary lobe and one such saddle are present at the former diameter, and a second such lobe appears at the latter. At a diameter of about 7.5 mm. the wide median knob already carries two distinct hornlets (no. 3, pl. 6, fig. 38). The sutures are slightly less indented in paratypes 4 and 5.

In the somewhat larger juveniles 8 (pl. 6, fig. 26) and 16 the density of the suture lines is still the same, but they show a rather more primitive character, with low saddles and short lobes with stubby points, somewhat reminiscent of *H.* (*Putealiceras*) *schumacheri* (see pp. 64, 65). In contrast, the sutures of paratypes 10, 13 (pl. 7, fig. 19), 14, and 15 show richer indentation and higher density (six or even seven per quarter-whorl). The number of auxiliary lobes has increased to three. In paratype 14 the siphonal knobs exhibit median swellings in addition to the outer hornlets. Paratype 42 deserves special mention for the exceptionally high density (nine per quarter-whorl) of the sutures (pl. 6, fig. 30). In the larger paratype 26, however, such crowding of even more elaborate sutures is restricted to a portion of the shell about a quarter-whorl from the anterior end, indicating a temporary slowing down in growth rather than the vicinity of the body chamber.

As seen in paratypes 45, 43, 40, and 29, indentation becomes ever richer with growth, with the density still five per quarter-whorl. In the two last-named shells the median points of the first lateral lobes carry two secondary prongs from a diameter of about 14 mm., and even the first auxiliary lobes are now trifid (pl. 7, fig. 10).

The suture lines just discussed may thus be considered transitional to the last four of the holotype, corresponding to diameters of from 24 to 28 mm. and representing the most mature sutural stage known in this species (pl. 7, figs. 7, 8). Both terminal points of the siphonal lobe are now three-pronged, as are the middle points of both lateral lobes. The median knobs are clearly three-cusped. The first auxiliary lobe is now distinctly trifid, and the second bifid; only the third, which now occupies the middle of the umbilical wall and is followed by a trapezoidal auxiliary saddle, is simple.

REMARKS: The presence of distinct lateroventral shoulders and the character of the costation seem to refer this species, within *Hecticoceras*, *sensu lato*, to the "subgenus" *Sublunuloceras*.

Indeed it resembles the most abundant representative of this subgenus at Majdal Shams, *H.* (*S.*) *guthei*, more closely than any other form of this assemblage. It differs from Noetling's species by being less involute and more slender, by the less pronounced truncation and lesser width of the venter, and by the more regular and uniform and, in maturity, finer costation, with the inner ribs persisting throughout the later ontogenetic stages, whereas they disappear in maturity in *H.* (*S.*) *guthei*.

This species seems to resemble *H.* (*S.*) *bonarellii* de Loriol (1898, p. 36, pl. 3, figs. 19–21; 1900, p. 36, pl. 3, fig. 14; Arkell, 1939, p. 146, *cum synon.*, pl. 8, figs. 22–35) even more closely than *H.* (*S.*) *guthei*. It differs from de Loriol's species only by the greater density and somewhat sharper angulation of the costation.

Beyond the limits of the "subgenus" *Sublunuloceras*, *H.* (*S.*) *socium* shows similarities with some species of *H.* (*Brightia*), particularly with *H.* (*B.*) *socini* and *H.* (*B.*) *syriacum*, and it approaches also, by the sharp angulation of its ribs, the subgenus *Campylites* of *Ochetoceras*, chiefly the similarly evolute *O.* (*C.*) *evolutum*. All these forms are compared with the present species in more detail elsewhere (pp. 50, 61, 96).

MATERIAL STUDIED: Eighty-eight specimens, including incomplete specimens and fragments.

SUBGENUS **BRIGHTIA** ROLLIER, 1922, EMEND. SPATH, 1928

Rollier (1922, p. 360) proposed this name as a generic one "pour l' *Hecticoceras nodosum* Bonarelli i.f. Quenst. (*Am. hecticus nodosus*) ou l'*Am. Brighti* auctor. (non Pratt), qui a . . . un canal avec nodosités au milieu des flancs, mais pas de nodosités périphériques."

It seems that of the few characters here given the presence of a lateral spiral groove, although included by Bonarelli (1893, p. 94) in the diagnosis of the type species (verb.: "*canaliculatis*"), cannot be maintained as a distinctive feature of this subgenus. Spath (1928, p. 102) says that it *may*[1] be present. Anyway, the profile of the single fragment from Kachh he refers to this "genus" (p. 121, pl. 18, fig. 7) shows no trace of it. Gérard and Contaut (1936, p. 41) mention, in their excellent diagnosis of this "genus," merely "l'impression [d'] une légère et étroite bande" separating the inner ribs from the outer ones but no spiral groove. Of the species from Woodham Pit illustrated by Arkell (1939, pp. 144–146, pl. 8, figs. 10–14, 20, 21) only one, namely, *H.* (*B.*) *glyptum*, shows this character (fig. 20a).

Thus we do not hesitate to assign Noetling's species *socini* and *kautzschi* (both referred to *Lunuloceras* by Bonarelli, 1893, pp.

[1] Italics added.

92, 93) to *Brightia* despite the absence of a "canal."

Notwithstanding the tautonomy *brighti-Brightia*, *Ammonites hecticus nodosus* Quenstedt (1849, pl. 8, fig. 4), as the species named by Rollier in the first place, must be considered the type species of this subgenus, as it is by Arkell (1939, p. 144). Gérard and Contaut's designation of "*Brightia Quenstedti* de Tsytovitch" as the type species is refuted by the very fact that de Tsytovitch (1911, p. 47) considers this form as varietally different, and Gérard and Contaut consider it even specifically different, from the typical *Ammonites hecticus nodosus* Quenstedt, quoted by Rollier.

Thus interpreted, the subgenus (see p. 30) *Brightia* is, with nearly 1650 individuals, by far the most abundant among the *Hecticoceras* at Majdal Shams. Most of these individuals can be referred to the two abovenamed species established by Noetling, but a third species must be proposed for others that cannot.

Hecticoceras (Brightia) socini (Noetling)

Plate 7, figures 20–47; plate 8, figures 1, 2

Harpoceras Socini sp. n.; NOETLING, 1887, p. 22, *cum synon.*, pl. 3, figs. 5–7.

Harpoceras excavatum sp. n.; NOETLING, 1887, p. 24, *pro parte*, ?pl. 4, fig. 2.

Hecticoceras (*Lunuloceras*) *Socini* Nöt. f.; BONARELLI, 1893, p. 92, *?cum synon.*

H. Socini Noetl.; DE TSYTOVITCH, 1911, p. 52.

H. Socini Noetl.; FREBOLD, 1928, p. 188.

Harpoceras (*Hecticoceras*) *Socini* Noetling; LEMOINE, 1932, pp. 235, 480.

P[*utealiceras*] *socini* (Noetling); SPATH, 1933, p. 670.

DIMENSIONS

A.M.N.H. No. 27373	D	H	H′	W	U
17 (nucleus)	0.62 mm.	40	33½	86½	26½
1	2.78 mm.	40½	34½	44	31½
2	3.82 mm.	39	34	36½	32
3	4.00 mm.	41½	35	37	30½
4	4.26 mm.	41	34½	41	32½
6	4.52 mm.	43½	38½	38½	31
7	4.69 mm.	39	35	32½	35
8	4.78 mm.	40	34½	36½	34½
9	4.95 mm.	40½	35	35	35
10	5.13 mm.	42½	39	34	34
11	5.21 mm.	43½	38½	38½	33½
12	5.30 mm.	42½	36	33	33
13	5.47 mm.	41½	*ca.* 35	33½	32
14	5.74 mm.	47	?	38	29½
15	5.82 mm.	40½	36	33	36
16	5.82 mm.	43½	37½	36	31½
18	5.91 mm.	42½	37	35½	31
19	6.00 mm.	40½	35	32	32
20	6.26 mm.	43	37½	36	33½
21	6.34 mm.	41	34½	34½	31½
22	6.43 mm.	42	36½	34	32½
23	6.60 mm.	41	36	37	34½
24	6.95 mm.	41	35	31	32½
25	7.30 mm.	40½	34½	33½	34½
26	7.39 mm.	42½	36	34	34
27	7.39 mm.	42	37½	33	33
28	7.73 mm.	41½	37½	31½	33½
29	7.91 mm.	39½	33½	31½	34
30	7.99 mm.	42½	35	32	32½
31	8.17 mm.	41½	?	36	33
32	8.26 mm.	42	38	32½	30½
33	8.34 mm.	41½	35½	33½	31
34	8.52 mm.	42	35½	34½	31½
36	8.60 mm.	45	36½	32½	30
37	9.39 mm.	41	34½	32	33½
38	9.56 mm.	40	?	*ca.* 33	33½
39	9.73 mm.	42	37½	31½	34
41	10.08 mm.	42½	34½	30	33
42	10.08 mm.	43	39½	32	30
43	10.60 mm.	41	?	30½	33½
44	10.95 mm.	43	?	31	30
45	11.30 mm.	40	33½	28½	35½
46	11.38 mm.	39	?	30	36½
47	11.47 mm.	41½	36½	29½	32
93	11.56 mm.	37½	32½	28½	36
48	12.17 mm.	43	*ca.* 38	29	29
49	12.34 mm.	43	?	31½	30½
108	12.60 mm.	36½	31	31	36
50	12.60 mm.	40½	*ca.* 33	31	38
51	12.60 mm.	45	?	*ca.* 29	32½
52	13.03 mm.	38½	?	*ca.* 26½	32½
53	13.12 mm.	42½	35	30½	31
54	13.47 mm.	38	?	31	35
55	13.56 mm.	40	35½	31	37
56	13.73 mm.	42½	*ca.* 35	31	35
57	13.82 mm.	39½	36½	29	35½
58	13.90 mm.	37½	35½	29½	38
92	13.90 mm.	41	33	27	34½
59	14.25 mm.	39	?	*ca.* 30½	37
60	14.34 mm.	42	?	29	33½
61	14.77 mm.	42	?	29½	32
62	15.0 mm.	42½	?	26½	30½
63	15.5 mm.	39½	?	29	42
90	15.5 mm.	38½	?	30½	36½
64	15.6 mm.	43½	?	29	38
66	16.1 mm.	41	35	28	37
67	16.6 mm.	44½	*ca.* 36½	29	39
68	17.5 mm.	42½	?	26½	32½
69	17.9 mm.	44[1]	?	27[1]	31½[1]
70	18.1 mm.	46	?	*ca.* 27½	41
72	18.9 mm.	43½	?	26	37½
73	19.3 mm.	47	?	31	33½
74	20.0 mm.	44	35	28½	37½
77	21.0 mm.	42½	*ca.* 35	26	34½

[1] Measured at D=17 mm.

A.M.N.H. No. 27373	D	H	H′	W	U
78	21.6 mm.	47	?	27	31½
79	22.8 mm.	40	?	27½	35½
91	22.8 mm.	42	?	28½	37
80	24.4 mm.	44	?	25½	34½
81	27.8 mm.	43½	?	27½	31½
82	31.5 mm.	40[1]	?	?[2]	39[1]
83	33.2 mm.	39½	?	24½	37
84	36.4 mm.	39	*ca.* 34	*ca.* 24½	39½
85	37.3 mm.	37½	30	30	40
86	37.5 mm.	35	?	?	43½
87	40.0 mm.	40	?	*ca.* 26	37
88	42.4 mm.	35	?	*ca.* 28	43
89	42.5 mm.	38½	?	?23½	39

As seen in the above table, H oscillates between the values of 36½ and 45 during most of the ontogeny, that is, from the smallest measured individuals up to a diameter of 17.5 mm., then attains its highest values (46 and 47) between the diameters of 18 and 22 mm. but drops to, or mostly beneath, 40 above the diameter of 30 mm., with the minimum of 35 encountered in the fourth and second largest shells. Accordingly, the umbilical width, which varies between the values of 29[3] and 39 up to the 18-mm. mark, increases rather rapidly in the last growth stage, with the highest values of 43½ and 43 encountered in the same shells that exhibit the minimum of H. Below the diameter of 35 mm. H exceeds U, mostly quite considerably; only quite exceptionally U approaches H (nos. 93, 108) or even slightly exceeds it (nos. 58, 63) in shells that must be considered transitional to *H.* (*B.*) *kautzschi*. The values given by Noetling, namely, 39 for both H and U, are approximated in two (nos. 84, 89) of our six largest shells. Of these, number 84 approaches and number 89 slightly exceeds the maximum diameter measured by Noetling.

Only our largest shell, which exhibits the minimum of W (?23½) is almost as thin as Noetling reports the holotype to be (W = 23), but both these disks appear to be somewhat crushed. Specimens numbers 83 and 84, smaller by only 9 mm. and 6 mm., respectively, than the holotype, are nearly as thin, their width amounting to 24½. Up to a diameter of 25 mm., however, W varies between 25½ and 44.[4] Values below 30 appear only from a diameter of about 11.5 mm. up, at first sporadically, then with increasing frequency.

Thus decrease in both degree of involution and thickness are the foremost growth trends inferable from the above table.

In four of the six largest shells the last septum can be located at diameters of from 25 to 36 mm. (at the latter in no. 88). If at least half a whorl is allowed for the body chamber, the diameter actually reached by this species may conservatively be estimated at about 50 mm.

Designation of Type: The largest of the three individuals depicted by Noetling (his figs. 5, 5a, and 5b) is here designated lectotype of *H.* (*B.*) *socini*.

Description: Shell moderately involute in the young, becoming more evolute in maturity. In a few individuals (e.g., nos. 6, 12, 13, 108; pl. 7, figs. 21, 29, 22) the protoconch can well be seen in side view; it measures not quite 0.1 mm. in diameter and does not project above the following volutions. The nucleus of specimen number 17 (pl. 7, fig. 20) is barrel-shaped and shows an extremely broad and low whorl profile.

In the course of development the profile, which attains the maximum width at or somewhat below the inner third of the flanks, becomes elliptic (nos. 18, 45; pl. 7, figs. 23, 35) or, where the sides converge faster ventrad than dorsad, rather oval (nos. 13, 37, 35; pl. 7, figs. 24, 25, 30). Only in maturity, when, with the degree of involution, the whorl height decreases, the profile becomes wider but still remains oval (nos. 88, 85; pl. 7, figs. 31, 39). At this late stage the umbilical shoulder can be seen to be quite pronounced, though well rounded, and the umbilical wall to be steep and rather high. No pronounced lateroventral shoulders can be recognized at any stage and the venter as a rule is well rounded. Only exceptionally, as in the juveniles numbers 4 and 8, the venter is fastigate at a very early stage but only up to diameters of 2.6 mm. and 3.1 mm., respectively. In a few shells (e.g., nos. 20, 25) the site of the siphuncle is indicated by a flat band, which in number 25 is bounded by

[1] Measured at D = 30.6.

[2] Crushed.

[3] An even narrower umbilicus (U = 26½) has been measured in the embryonic nucleus of number 17.

[4] If the much greater thickness (86½) of the embryonic nucleus of number 17 is left out of account.

two fine engraved lines (pl. 7, fig. 27), but much more frequently there is a distinct median groove of varying depth. Such median grooves are present, mostly on a portion of the periphery only, between the diameters of 6 mm. and 16 mm. in at least 30 individuals, which would thus come under Noetling's "*Harpoceras excavatum*," if that were a usable species. However, as is shown above and is stated often below in the present report, this median groove occurs occasionally in almost all the *Hecticoceras* species of the present assemblage and cannot be considered a specific character. The smaller individual depicted by Noetling (pl. 4, fig. 2) under the name "*Harpoceras excavatum*" may belong to this species or to the following one.

On the other hand, a median keel appears at diameters of from 17 mm. to 25 mm. (not only at 30 mm., as Noetling claims in the original description of this species). This keel is sometimes broader, sometimes more delicate, as in specimen number 85 (pl. 7, fig. 37), but always quite low. The sharpening of the venter on both sides of this keel, as observed in some of our shells (nos. 86, 87, 89) as well as in the holotype (see Noetling's fig. 5a), seems, however, to be caused by crushing that affects the body chambers of most of the Mount Hermon ammonites. I never found it where the venter is quite intact.

Ornamentation appears first, in the juvenile number 7, at a diameter of about 2.4 mm. in the form of indistinct, forward convex, recurved folds which are restricted to the inner half of the flanks and so delicate that even under the microscope they can be recognized in oblique illumination only. About six can be counted per quarter whorl. Another juvenile (no. 14) exhibits, at a diameter of not quite 4 mm., mere indications of two folds in the middle of its left flank. In addition, there are distinct, sickle-shaped growth striae on the outer shoulders which continue onto the venter on which they form forward-directed tongues. Similar indications of folds are recognizable in number 23 and, more distinctly, at a diameter of about 5 mm. in number 25 (pl. 7, fig. 28). Here there are five strongly forward convex folds on the inner half of the flanks of the last quarter-whorl which continue into sickle-shaped, forward concave, even more delicate outer ribs. In some other juveniles (nos. 27, 37, 42–44), measuring between 7 and 11 mm. in diameter, the ornamentation of later ontogenetic stages is just foreshadowed. Only at a somewhat larger size, at diameters from 9.5 to 18 mm., circumumbilical folds, which are strongly prorsiradiate and of which there are five to a quarter-whorl, become more distinct (no. 53) or even quite pronounced (nos. 108, 59, 66). These folds are mostly short and node-like but somewhat longer and rather sharp in specimen 108 where each is indistinctly connected with two much weaker outer sickles (pl. 7, fig. 22). The circumumbilical folds are even longer in specimens 62 (pl. 7, fig. 32) and 69 where they extend to the middle of the flanks.

It must be mentioned, however, that in other individuals even the circumumbilical ornamentation is still hardly indicated at the stage just dealt with, so that for all practical purposes some appear smooth. Even in those that clearly show circumumbilical nodes hardly any ornamentation is recognizable in the outer zone of the flanks. Indistinct sickles appear there first at a diameter of about 13.5 mm. in specimen 80, where, however, they soon disappear again, and at a diameter of about 17 mm. in specimen 70 (pl. 7, fig. 42).

Specimen 82, attaining 31.5 mm. in diameter, deserves special mention for being practically smooth from a diameter of 17.5 mm. on. The mature ornamentation of this species can be observed best in specimen number 85 (pl. 7, fig. 38) and on unworn surfaces of the other large shells present (nos. 86, 88, 89). As far as the poor quality of Noetling's drawing permits comparison, this ornamentation seems to agree fairly well with that of the holotype. In the aforementioned specimen 85 there are 10 short, quite sharp, strongly prorsiradiate umbilical ribs on the anterior half of the outer whorl. They extend hardly beyond the umbilical shoulder and are but indistinctly connected with the much less distinct, sickle-shaped, strongly recurved outer ribs which extend from there to the lateroventral shoulder. About 20 of these outer ribs can be counted on the same portion of the whorl, so that there are two outer ones to every inner one.

Where the connection between both kinds of costae can be traced, it is seen to be in the shape of an obtuse, well-rounded angle. There is never such an acute angulation as in *H.* (*Sublunuloceras*) *socium* or as in the subgenus *Campylites* of *Ochetoceras*.

The earliest stage at which suture lines can well be studied is found between the diameters of about 3.5 mm. and 4.75 mm. in the juvenile number 5 (pl. 7, fig. 36). They are of almost goniatitic simplicity. The first lateral lobe can be recognized to be triangular and to end in a point, but otherwise neither lobes nor saddles show any indentations. As is characteristic in this group, the first lateral saddle markedly overtops the external one. Four sutures are present on the last quarter-whorl of this juvenile but only three on that of the even smaller juvenile 109 of which the excellently preserved sutures (pl. 7, fig. 40) differ from those just described merely by showing tiny notches in the tops of both main saddles. The suture lines are similarly far apart in the somewhat larger juvenile 65 but here the first lateral lobe is already clearly trifid and the external saddle carries a notch on its top. Further progress in indentation can be recognized in the juveniles 71 and 75 and even more in numbers 12 (pl. 7, fig. 29), 22, and 76. At this stage the lobes and saddles are longer and more slender, the second lateral lobe gradually becomes trifid, and there are two auxiliary lobes, the second on the umbilical wall. In the juveniles 76 (D about 6 mm.) and 28 and 30 (D in both nearly 8 mm.) the density of the sutures increases to five, and in the juvenile 94, of about the same size as 76, even to six per quarter-whorl. Specimen number 40, measuring about 9 mm. in diameter and having five suture lines per quarter-whorl and comparatively wide and shallow first lateral lobes, is illustrated (pl. 7, fig. 44) as an example of the high density of the sutures even at this early stage. In this shell, as in so many others, the siphonal lobe is shifted markedly to the right, thus causing the left external saddle considerably to expand at the expense of its opposite number. The median knob is sunk at the top and raised at the corners which thus foreshadow the hornlets. The latter are well developed in the juvenile 43 (D = 10.6 mm., pl. 7, fig. 43) in which further progress in indentation is noticeable in other respects as well. Thus the middle point of the first lateral lobe carries two secondary prongs, the inner of which appears earlier and is stronger than the outer. The second lateral lobe becomes asymmetrically trifid, its inner point occupying a markedly lower position than the outer. The density of the sutures is the same as in number 40. Similarly crowded and elaborate sutures are found in the somewhat larger shells 49, 95, and 53 (pl. 7, figs. 46, 47) also, but in number 53 a secondary prong develops only on the outer side of the middle point of the first lateral lobe and the siphonal knob forms a median dome which overtops the hornlets, and the sutures of number 95 are altogether somewhat irregular. An even higher degree of crowding of the sutures on the last quarter-whorl of specimen number 96, where seven can be counted, seems, however, to be caused by nearness to the living chamber, for in the posterior part of this volution there are only four per quarter-whorl.

In specimen number 63, which is transitional in shell shape to *H.* (*B.*) *kautzschi*, the suture lines are also closely set (six on the last quarter-whorl) but less elaborate than in the shells just dealt with, whereas those of specimen number 64, of about the same size, are richly indented (pl. 7, fig. 45). As a correction for Noetling's description which allows for only one auxiliary lobe, said to be situated "on the umbilical edge," it should be pointed out that, in addition to that first lobe, which is bifid and rides indeed on the umbilical shoulder, two other markedly shorter and simple ones are present on the umbilical wall. The degree of indentation is about the same in specimen number 69, measuring about 18 mm. across. Here there are five sutures on the last quarter-whorl, but in most shells above the diameter of 15 mm. this number is six. The sutures of specimen 97 are illustrated (pl. 8, fig. 1) as characteristic of this size group in both density and elaboration.

From a diameter of 20 mm. up, the density of the sutures increases even further, e.g., in specimen 74 to eight on the last quarter-whorl, but it seems that in some of the largest shells it decreases again towards the last septum. The highest degree of indentation is found in the whorl fragment 98, corresponding to a diameter of about 23 mm. (pl. 8, fig. 2), and in two of the largest shells present (no. 85, pl. 7, figs. 37–39; no. 88). As seen in the illustration of the siphonal lobe of number 85 (pl. 7, figs. 37, 39), the median knob occupies an exactly median position which is the exception rather than the rule in *Hecticoceras, sensu lato.*

Other anomalous developments seem to occur quite frequently in the suture lines of this species. While both first and second lateral lobes are trifid as a rule, both may become bifid in some individuals. Thus the juvenile 99, measuring only 8 mm. in diameter, has bifid first laterals throughout (pl. 7, fig. 41), while in the whorl fragment 100, corresponding to a diameter of about 12.5 mm., these lobes can be seen to change within three consecutive suture lines from trifid to bifid. In the disk number 101, which attains a diameter of 22 mm., the first lateral lobes are trifid but have a distinctly two-pronged middle point, whereas the second laterals are asymmetrically bifid rather than trifid, because the outer lateral point has far outgrown the inner.[1] The middle points of these lobes also are two-pronged. In the medium-sized specimen 102 the second lateral lobes maintain their symmetrically trifid shape, but the middle point is, here too, two-pronged and rectangular in shape. In some other shells (nos. 103–106), however, these lobes themselves become bifid, assuming the shape of a two-pronged fork.

In summary, the close spacing of the lines in most of its individuals may be considered the outstanding sutural character of this species, recognized as such by Noetling. It must be added that Noetling's figure 8, showing all three main saddles as being equally high, is certainly misdrawn, as has already been pointed out by Bonarelli (*loc. cit. in synon.*).

REMARKS: Noetling's synonymy, comprising two names mentioned by Fraas in 1877 and again in 1878, all without illustrations, cannot be checked but need not be questioned. However, Quenstedt's (1887, p. 705, pl. 82, figs. 29, 30) *Ammonites hecticus*, included by Bonarelli in the synonymy of Noetling's species but referred by de Tsytovitch (1911, p. 51) to *H. svevum* Bonarelli, in addition to the differences pointed out by de Tsytovitch (p. 52), is much more evolute and has far more pronounced outer ribs than *H.* (*B.*) *socini.*

The smaller of the two specimens referred by Noetling to his *Harpoceras excavatum* is possibly a juvenile of *socini.* In addition, there is good reason to assume that Noetling included many juveniles of other *Hecticoceras* species, especially *guthei, socium,* and *schumacheri,* and probably also of *Ochetoceras* (*Campylites*), in this species, thus arriving at his erroneous assumption that it is the most common species at Majdal Shams (see pp. 41, 51, 56).

However, *H.* (*B.*) *socini* is perhaps the least characteristic among the Oppelidae from Mount Hermon. All the species just mentioned resemble it in one way or another, especially in youth, so that it might be called the central species of this group. At early and medium stages it resembles *H.* (*Sublunuloceras*) *guthei* in dimensions and sutures and can be distinguished only by the lack of pronounced lateroventral shoulders and by its rounded, not truncate venter. In maturity, however, the present species becomes more evolute than *guthei* and its circumumbilical nodes or ribs are much more pronounced than the ribs of the outer zone, whereas in *guthei* it is the latter that become strong and the circumumbilical zone becomes smooth in maturity. Also the outer ribs then assume a radial direction in *guthei,* whereas they remain, where observable, always recurved in *socini.* These differences in the characters of the costation of the outer zone and, in addition, the presence of a rather sharp angulation at the connection of inner and outer ribs in *H.* (*S.*) *socium* serve to distinguish that species from the present one.

The two other *Brightia* species of the present assemblage (*kautzschi* and *syriaca*) are compared below with *socini* (pp. 56, 60). The possibility of distinguishing juveniles of this species from those of *H.* (*Putealiceras*) *schumacheri* and of two of the *Campylites* species recognized in our material also is pointed out below in this report (pp. 65, 85, 93).

[1] This development is exaggerated, as it were, in the juvenile 107 (D = *ca.* 12 mm.) in which the inner lateral point of these lobes has entirely disappeared, and both the outer and the middle points are two-pronged.

Noetling (p. 22) notes a striking resemblance between juveniles of this species and those of "a form from the Oxfordian of the Mont Terrible near Porrentruy [Switzerland], designated as *Ammonites fonticula* Menke and coming from the von Buch collection." This statement of Noetling's misled Frebold (1928, p. 189) so that he reached the conclusion that "*H. Socini* Noetl. is probably identical with *fonticula* Menke from the Swiss Jura."

Frebold's conclusion necessitated an investigation into "*Ammonites fonticula* Menke" which showed that Noetling's statement is obviously based on a label found with the specimens in the von Buch collection. The contents of that label are, of course, scientifically irrelevant. What counts is only what is published on the species in literature. As far as I could ascertain, it was published only once, namely, by Leopold von Buch in 1831 (pl. 2, figs. 4–6) under the name *Ammonites fonticola*[1] Mencke. The figures illustrate a form with decidedly fastigate whorl profile and an ornamentation very different from that of *H.* (*B.*) *socini* and leave no doubt but that the two forms cannot be conspecific. In the text von Buch says that the ammonite is named *lunula* by Zieten (referring to Zieten, 1830, pl. 10, fig. 12), whereas in his "Jura in Deutschland" (1837, p. 115) von Buch adds the trivial name *fonticola* in parentheses to the heading of his paragraph on *Ammonites hecticus* (Zieten, 1830, pl. 10, fig. 11).[2]

Hence it follows that to von Buch himself "*Ammonites fonticola* Mencke" was a synonym of either *A. lunula* or *A. hecticus*. As both these names date back to Reinecke, 1818, *A. fonticola* was still-born from the outset as a junior synonym of one or the other. The fact that this name cannot be found in the Swiss and French literature on Callovian and Oxfordian ammonites, including the great work of de Loriol, de Tsytovitch's (1911) and Lemoine's (1932) monographs, and Jeannet's (1951) Herznach volume, and that it is not mentioned in Bonarelli's *Hecticoceras* paper of 1893 seems to prove that, except for wholly undocumented mention by Noetling and Frebold, it has fallen into well-deserved oblivion.

[1] I.e., the inhabitant of springs, not "*fonticula*" (the little spring), as misspelled by both Noetling and Frebold.

[2] See also Quenstedt (1887, p. 698).

MATERIAL STUDIED: Altogether 633 specimens, including incomplete ones and fragments. Thus this species, considered the most abundant and selected as index fossil for the horizon in which most of the ammonites occur at Majdal Shams by Noetling, is, in our material, considerably outnumbered within the subgenus *Brightia* by *H.* (*B.*) *kautzschi* and within the genus *Hecticoceras*, *sensu lato*, by *H.* (*S.*) *guthei*, which happens to be almost exactly as abundant as ***kautzschi.***

Hecticoceras (Brightia) kautzschi (Noetling)
Plate 8, figures 3–35

Harpoceras Kautzschi sp. n.; NOETLING, 1887, p. 23, *cum synon.*, pl. 3, figs. 9, ?10, not 8.

Harpoceras excavatum sp. n.; NOETLING, 1887, p. 24, *pro parte*, ?pl. 4, fig. 2.

Hecticoceras (*Lunuloceras*) *Kautzschi* Nötl. f.; BONARELLI, 1893, p. 93.

H. Kautzschi Noetl.; FREBOLD, 1928, p. 188.

?*Hecticoceras Kautzschi* Noetling sp.; LEMOINE, 1932, p. 403, text fig. 57, pl. 12, fig. 19.

P[*utealiceras*] *kautzschi* (Noetling); SPATH, 1933, p. 670.

DIMENSIONS

A.M.N.H. No. 27375	D	H	H′	W	U
90 (nucleus)	1.78 mm.	37	30	51	*ca.* 46½
2	3.82 mm.	38½	*ca.* 34	41	38½
3	4.00 mm.	37	30½	39	39
4	4.26 mm.	39	32½	41	37
91 (nucleus)	4.35 mm.	38	32	39	38
5	4.52 mm.	38½	?	*ca.* 37½	39½
6	4.78 mm.	36½	31	38	36½
7	4.87 mm.	39½	31	37½	39½
8	5.04 mm.	38	32½	38	38
9	5.30 mm.	39½	33	36	36
92	5.56 mm.	35	30½	36½	39
93	5.56 mm.	39	34½	35	37½
1	5.65 mm.	38½	32½	34	36
10	5.75 mm.	36½	32	35½	39½
11	5.95 mm.	35	30½	33½	39½
12	6.08 mm.	38½	34½	33	34½
13	6.26 mm.	39	32	32	36
14	6.52 mm.	37½	33½	34½	41½
94	6.52 mm.	38½	34½	32½	37½
15	6.69 mm.	38½	34	32½	34½
16	6.95 mm.	35½	31	30	41
17	7.04 mm.	39½	35½	34½	35½
18	7.39 mm.	39	33	34	41

A.M.N.H. No. 27375	D	H	H′	W	U
19	7.82 mm.	38	34½	33½	40
20	8.34 mm.	34½	30	30	38½
21	8.52 mm.	32½	*ca.* 29½	*ca.* 29½	43
22	8.52 mm.	35½	30	28½	42
23	8.60 mm.	33½	?	?29	39½
95	8.86 mm.	37½	33½	29½	40
24	8.95 mm.	39	35	34	35
25	8.95 mm.	34	?	31	42
26	8.95 mm.	38	*ca.* 33	*ca.* 37	37
27	9.12 mm.	36	30½	37	43
28	9.21 mm.	33	?	*ca.* 28½	42½
29	9.39 mm.	35	29	28	44½
30	9.47 mm.	38[1]	?	*ca.* 33[1]	39[1]
31	9.56 mm.	37½	32	33½	43½
32	9.99 mm.	37½	*ca.* 32	28½[2]	36½
33	10.30 mm.	38	32½	32½	40½
34	10.34 mm.	33	28½	28	47
89	10.51 mm.	38	?	30	35½
96	10.60 mm.	39	33½	30½	36½
35	10.60 mm.	36	*ca.* 32	31	40
36	10.78 mm.	38	?	30½	38½
42	10.78 mm.	35½	?	30½	42
37	10.82 mm.	37½	?	29	39½
41	10.86 mm.	32	?	28	44
38	10.95 mm.	35	*ca.* 31½	28½	39½
39	11.12 mm.	38½	32	30½	38½
97	11.56 mm.	37	*ca.* 31½	28	38
43	11.64 mm.	37	?	28½	38
40	11.73 mm.	36½	*ca.* 33½	*ca.* 29½	38½
87	11.73 mm.	32½	29	27½	45
44	11.91 mm.	38	?	26½	41
98	12.08 mm.	33	29	27½	42½
111	12.08 mm.	36	31	26½	39
45	12.17 mm.	37	*ca.* 32	27	41½
46	12.17 mm.	35½	?	30½	39½
88	12.17 mm.	32	28	30	45
47	12.34 mm.	31½	24½	27	44½
48	12.34 mm.	35	?	30½	42½
99	12.60 mm.	35	?	*ca.* 27½	40½
112	12.60 mm.	37	28½	25½[3]	38½
49	12.69 mm.	37	?	28	37½
50	12.77 mm.	33½	?	30	42
51	12.86 mm.	36	?	27	37
52	12.86 mm.	37	?	*ca.* 30½	40
53	13.03 mm.	34	?	30½	41½
54	13.03 mm.	33½	29½	28½	40
55	13.12 mm.	33	?	29	41½
56	13.38 mm.	37½	?	*ca.* 30	39
100	13.64 mm.	36½	?	28½	41
57	13.73 mm.	38	?	27	39½
58	13.90 mm.	32	?	27	45
59	13.99 mm.	38½	?	30½	38½
60	13.99 mm.	35½	30	25	39
61	14.25 mm.	36½	?	*ca.* 30½	42
101	14.69 mm.	38	32½	27	39½
62	14.77 mm.	35½	?	*ca.* 29	40
63	15.12 mm.	33½	?	26½	42½
64	15.21 mm.	38½	?	*ca.* 29	39
65	15.21 mm.	37	?	*ca.* 30	38½
102	15.29 mm.	35	?	30	41½
66	15.99 mm.	36½	?	*ca.* 28½	36½
67	16.25 mm.	37½	*ca.* 33½	31	43
68	16.34 mm.	40	35½	32½	41½
103	16.60 mm.	37½	?	27½	38
69	17.0 mm.	34	?	24½	47½
70	17.5 mm.	35½	?	25	49
104	17.7 mm.	38½	31½	27	40
71	18.0 mm.	39½	?	28½	42
72	18.1 mm.	40½	?	28½	41
73[4]	18.3 mm.	38½	?	31½	44½
74	19.0 mm.	36	*ca.* 31½	27	44
75	19.5 mm.	38	?	31½	44
76	20.3 mm.	39½	?	28	41
121	20.4 mm.	34	?	29½	48½
105	21.3 mm.	35	*ca.* 30½	28½	45
77	21.5 mm.	36½	?	27½	42½
78	21.7 mm.	38½	*ca.* 32½	28	42
79	22.7 mm.	38½	*ca.* 35	*ca.* 26½	39½
80	23.5 mm.	37	?	26½	42½
106	24.6 mm.	34	?	28	42½
124	24.6 mm.	37½	?	*ca.* 26½	41½
81	27.1 mm.	36½	?	27½	40½
107	27.5 mm.	35½	?	28	43½
122	27.6 mm.	35	?	28½	46
110	28.0 mm.	37	27½	27½	41½
108	28.6 mm.	37½	?	28½	43½
82	29.0 mm.	34½	31½	27	39
83	32.6 mm.	36[5]	?	29½[5]	43½[5]
84	33.7 mm.	34	?	25	47½
109	34.8 mm.	35	*ca.* 29½	26	41½
85	37.3 mm.	35½	?	26½	43
86	*ca.* 39.9 mm.	*ca.* 36½	?	*ca.* 25	*ca.* 41½
120	46.8 mm.	35	?	?	43

[1] Measured at D=8.69 mm.
[2] Crushed.
[3] Deformed.
[4] Transitional in whorl profile to *H.* (*B.*) *syriacum*.
[5] Measured at D=26.5 mm.

As in *H.* (*B.*) *socini*, the shells tend to become more evolute with growth. It is true that H attains the very maximum of 40½ (as compared to 47 in the preceding species), not among the smallest sizes measured but in a shell of about 18 mm. diameter (no. 72), with values for H close to this maximum occurring among individuals of similar size (nos. 68, 71, 76) as well as in some of the smallest (nos. 7, 8, 17), and that the minimum of 31½ (as compared to 35 in *socini*) is not found among the largest shells, as might be expected, but in a shell only 12.33 mm. in diameter (no. 47), with other individuals in the same size group (nos. 87, 88, 58) fairly close to this minimum. If these extremes are left out of account, H varies within the range of from 33 to 39. Similarly, the maximum (49,[1] as compared to 43½ in *socini*) and minimum (34½, as compared to 29 in *socini*) for U are not, as might be expected, encountered at the bottom and top, respectively, of the table, but the maximum in the medium-size specimen number 70 and the minimum in specimen number 15 which is quite small but not among the smallest. The same holds true for specimens numbers 17, 24, and 89 in which the umbilicus is nearly as narrow as that of number 15. On the other hand, umbilici almost reaching the maximum in width are found in specimens number 34, markedly smaller than number 70, and number 69, of about the same size, but also in the fourth largest shell (no. 84).

The highest values for W[2] (51 for the nucleus number 90, measuring only about 1.75 mm. in diameter, and 41 and 39 for the four smallest shells beside that nucleus) are, according to expectation, encountered at the very top of the table, but the minimum for W (24½) occurs in a shell only 17 mm. across (no. 69). However, two[3] shells in the same size group (nos. 60, 70) and two of the largest (nos. 84, 86) are, with W equal to 25, almost as slender as number 69.

On the whole, it can be seen from the table that no values above 37½ for H are found beyond the diameter of 23 mm., no values below 39 for U beyond that of 17 mm., and no values of 30 or more for W beyond that of 20 mm. Thus this species, too, is seen to become more evolute and more slender with growth, although the decrease in maturity in the degree of involution is not so abrupt as it is in *H.* (*B.*) *socini*.

Only in some small individuals (nos. 4, 9, 93, 1, 12, 13, 94, 15, 17, 24, 26, 32, 89, 96), the largest of which attains 10.6 mm. in diameter, does H somewhat exceed U. In a few others (nos. 2, 91, 6, 7, 8, 39, 59, 66), the largest of which measures about 16 mm. in diameter, the two values are equal. In all the other measured specimens U exceeds H, often quite considerably; no exception from this rule is found from the diameter of 16 mm. up.

Among the six largest shells, numbers 84 and 109, measuring in diameter 33.7 mm. and 34.8 mm., respectively, are septate throughout; in the four others the last septa can be located at diameters of from 27 to 33 mm. The last figure applies to the largest individual present (no. 120), the last half whorl of which belongs to the (crushed) body chamber. All these facts lead to the assumption of a maximum size of from 50 to 55 mm. attained by entire shells of this species, contrary to the impression caused by Noetling's plate 3 that *socini* grows considerably larger than *kautzschi.*

DESIGNATION OF TYPE: Lemoine's (*loc. cit. in synon.*) words "Si l'on prend pour type les figures 9 (T. III) de Noetling," plus his doubts, fully corroborated in the present report (pp. 56, 60), about the conspecificity of Noetling's figure 10, must be interpreted as his designation of the specimen depicted in Noetling's figures 9 and 9a–c as lectotype of *H.* (*B.*) *kautzschi.*

DESCRIPTION: Shell disk-shaped, increasingly evolute with growth. The protoconch, which does not fully attain 0.1 mm. in diameter and does not project above the first volution, is clearly visible in side view in specimen number 1 (fig. 4) and in two other small juveniles (no. 113, fig. 14; no. 114). Throughout development the whorl profile is subcircular (no. 3, nucleus of no. 91, no. 27; figs. 6–8) or more or less broadly oval (nos. 7, 1, 67, 82; figs. 9, 5, 21, 10). As the shells become more slender with growth, oval profiles are dominant among medium-sized and large shells. The maximum width of the whorls is found at or near the inner third of the height. The venter is well rounded (quite exceptionally, as in the juvenile number 1, fig. 3, somewhat fastigate at a very early stage) and not bounded by distinct shoulders.

In specimen 91 three fine keels, separated by very shallow grooves, can be seen on the venter for the length of a quarter-whorl, but they disappear at a diameter of about 8 mm.; this feature is certainly quite exceptional.

[1] It must be emphasized that the value of U given by Noetling (55) is inconsistent with his figure 9, which indicates a value of only 43½, and is obviously wrong. Not even in *H.* (*B.*) *syriacum*, which is somewhat more evolute than *kautzschi*, does U ever reach 55.

[2] Here again, Noetling's figure of 60 for W is obviously quite erroneous. From his figure 9a W is found to amount to 34. In the material under examination, W varies at diameters between 29 and 40 mm., that is, in the size group to which the only specimen measured by Noetling (D=31 mm.) belongs, between 25 and 27.

[3] Omitting the deformed specimen number 112.

A true median keel appears only at a much later stage, in some individuals (nos. 67, 75) as early as at a diameter of 15 mm., but mostly only at a diameter of about 20 mm. Where present, it is low and in most shells fine (e.g., no. 82, fig. 11); in only a few (nos. 85, 86) is it somewhat more massive. In other individuals it seems to be absent, even in some large ones (e.g., nos. 110, 83, 84; fig. 12). Some 50 juveniles, among them nos. 16, 25, 31, 112, and 115 (fig. 19), exhibit instead the median groove, encountered in nearly all oppelid species of this assemblage, that misled Noetling to establish his species "*Harpoceras excavatum*." Such a median groove is, however, not found beyond a diameter of about 15 mm.

In the small juvenile 113 a blunt concentric ridge can be seen to continue the spiral of involution on the last whorl (fig. 14). A similar ridge can be recognized in specimen 22, but in most, if not all, other individuals examined the flanks are gently and uniformly convex.

The umbilical shoulder is pronounced and mostly well rounded and the umbilical wall steep and comparatively high. Some juveniles (nos. 92, 93, 16, 111; fig. 16) stand out by exhibiting a sharp umbilical edge from which a gently concave umbilical wall slopes at an angle of about 60 degrees. In the largest of these individuals (no. 111) this peculiar feature disappears at a diameter of about 10 mm. and in specimen number 58, where it is restricted to the penultimate whorl, at about 7 mm.

No trace of ornamentation can be recognized up to a diameter of about 7 mm. Then indistinct folds appear on the inner half of the flanks (nos. 20, 21). In the juvenile 22, of the same size as 21, seven short, forward-convex folds, which culminate at the inner third of the flanks, can be counted on the last quarter-whorl; only one of them continues, as an indistinct sickle, into the outer zone (fig. 17). The somewhat larger juvenile 26 shows only three or four well-defined ribs, standing far apart and not agreeing in their courses, in the anteriormost quarter. The circumumbilical folds described above in number 22 can be seen in oblique illumination only in the well-preserved juvenile 33 but more readily in number 38 where they become, however, indistinct again, so that the anteriormost portion of this shell appears almost smooth, as do many other individuals of this size group. Only in the somewhat larger juvenile 46 are eight node-like, quite robust, hook-like circumumbilical folds present on the anterior half of the outer volution; they vanish at about the middle of the flanks, the outer zone of which remains smooth (fig. 15). In the anterior half of the last volution of number 48, however, distinct, strongly recurved ribs can be recognized in that outer zone. Two correspond to every one of the short, decidedly prorsiradiate inner folds. Eight such outer ribs are counted on the last quarter-whorl (fig. 18). They are, however, hardly recognizable in the slightly larger juvenile 99 and still rather weak in number 58, of which the ornamentation is otherwise characteristic of this stage. The umbilical shoulder is studded with 17 nodes which only in the anterior half of the last whorl turn into strong, short, prorsiradiate inner ribs, simultaneously with the first appearance of ribs in the outer zone (fig. 22). In contrast, in specimen 63 these circumumbilical elements retain the character of plump nodes (16 on the outer whorl) beyond the diameter of 15 mm. (fig. 23). In the excellently preserved shell number 102 (fig. 28) the ornamentation resembles more that described above for number 58 but is markedly weaker.

Between the diameters of 15 and 28 mm. the ornamentation of some shells gradually approaches that of the mature stage in that the outer ribs catch up in strength with the inner ones. Even in this group, however, there are wide differences in the strength of the costation. It is rather delicate in some individuals, e.g., number 67 (fig. 20), but strong and conspicuous in others, e.g., numbers 121, 122 (figs. 24, 26), and quite sharp and prominent in the otherwise poorly preserved disk number 123 (fig. 25). Depending on size, from 14 to 18 outer ribs correspond to about half that number of inner ones, but only in some shells, best in numbers 121 and 123, can two of the former be seen clearly to originate from one of the latter, thus causing a striking similarity with the costation of *H.* (*Putealiceras*) *schumacheri* where the outer ribs are, however, less recurved.

In other individuals of the same size group, e.g., number 70 (fig. 29) there are well-developed, closely set (nine per half-whorl) circumumbilical nodes, but the outer ribs are still recognizable in oblique illumination only.

The fully mature ornamentation of this species is best exemplified by number 84 (fig. 13) which carries on the anteriormost quarter-whorl six strong, but not high, short, prorsiradiate inner ribs which do not extend far beyond the umbilical shoulder. At their outer ends they are only indistinctly and without sharp angulation connected with nine decidedly recurved outer ribs; the latter do not extend to the venter. The costation is similar but somewhat more pronounced in the two largest shells (nos. 85, 86), but others which are not so much smaller, e.g., numbers 107 and 110 (fig. 31), are almost smooth, except for feeble, node-like, circumumbilical ribs.

At the earliest stage at which suture lines can be studied, namely, between the diameters of 2.6 mm. and 5.6 mm. (juveniles nos. 6, 8, 1; fig. 4), they are just developing the first indentations. At the anterior end of number 1 the first lateral lobe is clearly trifid and the second is about to become so. The median knob is low and trapezoidal, with its top slightly sunk. The first lateral saddle decidedly exceeds the external one in height; both carry only two indentations each. Altogether the saddles are rather plump and the lobes not so deep. Two auxiliaries are present. There are, as a rule, only three sutures per quarter-whol at this stage.

It is at this growth stage that internal suture lines are well exposed in the whorl fragment number 119 (fig. 30) the anterior end of which corresponds to a diameter of about 6 mm. The antisiphonal lobe is extremely deep and slender; its middle point attains about half of the total length, but the two lateral points are much shorter. They point more outward than downward. This lobe is flanked on either side by a slender saddle without indentations. These saddles are followed by simple lobes less than half as deep as the antisiphonal lobe. Between these lobes and the umbilical seam there are still another diminutive saddle and a shallow lobe on either side.

At a diameter of about 9 mm. (no. 28, fig. 32) the indentation is only slightly richer than in specimen 1 and the density of the sutures has increased to four per quarter-whorl. It must be noted that not a few individuals, most of them measuring from 10 to 15 mm. in diameter, are characterized by remarkably primitive and reduced sutures with strikingly plump lobes and saddles (e.g., nos. 117, 50, 88; fig. 33). In those in which the main elements are more normal the middle point of the first lateral lobe is only a little longer than the lateral ones (nos. 33, 58; figs. 34, 22; no. 47). The features just described are also found, and in greater abundance, in *H.* (*Putealiceras*) *schumacheri*. The sutures of a few of the shells here discussed, e.g., number 88, remain primitive also in this respect, that there are only three to a quarter-whorl. In others the density remains at four, but in one (no. 96) there are six sutures in the last quarter-whorl. This specimen, as well as another of the same size (no. 116) with seven sutures (which are, however, neither primitive nor reduced) per quarter-whorl, must be considered transitional in density to *H.* (*B.*) *socini*. Still other shells within this size range, e.g., numbers 96, 111, 49, occupy, with five sutures on the last quarter-whorl, an intermediate position.

A somewhat later stage is well represented by the sutures of number 102 of which there are also five to a quarter-whorl. The degree of indentation has increased; hornlets are now clearly recognizable on the median knob; the first auxiliary lobe, too, becomes trifid, and two more can be seen on the umbilical wall (figs. 27, 28). However, the indentation is even richer in the juvenile 118 (fig. 35) of about the same diameter; here, for the first time in the ontogeny, the median point of the first lateral lobe carries two secondary points, and that of the second is clearly two-pronged, as it is in specimen number 103.

From a diameter of 17 mm. up, both elaboration and density of the suture continue to increase, but at various rates. Thus, no secondary points can be seen in the rather closely set (six per quarter-whorl) suture lines of specimen 69, and those of number 77 are even less elaborate and farther apart, whereas those of numbers 80, 106, 107, 110, 108, and 82 are transitional to those of specimen 84 which are, as seen in figures 12 and 13, the most elaborate sutures lines found in our material of *H.* (*B.*) *kautzschi* and which somewhat resemble Noetling's inaccurate drawing 9c. Here the indentation is just as rich as at the latest sutural stages observable in *H.* (*B.*) *socini*, but the density (six per quarter-whorl) is less than in mature individuals of that species.

REMARKS: This is the only oppelid species established by Noetling on forms from Mount Hermon that has been recorded from another locality, namely, by Lemoine in a single specimen from the Callovian of Monthou, France. However, it is difficult to decide from the only figure of this rather poor specimen if it really belongs to Noetling's geologically younger species.

With Lemoine we doubt the conspecificity of the shell illustrated in Noetling's figure 10, which we are inclined to refer to our *H.* (*B.*) *syriacum*.[1]

As mentioned above, the smaller of the two specimens illustrated by Noetling under the name "*Harpoceras excavatum*" (pl. 4, fig. 2) may well belong to *H.* (*B.*) *kautzschi*.

Within the "subgenus" *Brightia* this species requires first comparison with *H.* (*B.*) *socini* from which it can be distinguished by being more evolute at all growth stages, by having, as a rule, distinct outer ribs in maturity, and by its less crowded and, at early stages, less elaborate suture lines. The following species, *H.* (*B.*) *syriacum*, resembles the present one even more closely than *H.* (*B.*) *socini;* it is compared below (p. 60).

Among species of other "subgenera" *H.* (*Putealiceras*) *schumacheri* may sometimes resemble the present species in the character of ornamentation.The differences making distinction possible are pointed out in the discussion of *schumacheri* (pp. 65, 66). The same applies to comparison with *Ochetoceras* (*Campylites*) *evolutum*.

MATERIAL STUDIED: Altogether 727 individuals, including incomplete specimens and fragments.

[1] Noetling's figure 8, meant to illustrate a suture line of *H.* (*B.*) *socini*, is erroneously listed in the text, though not in the explanation of plate 3, as belonging to this species.

Hecticoceras (Brightia) syriacum, new species

Plate 8, figures 36–54; plate 9, figures 1–14

?Harpoceras Kautzschi sp. n.; NOETLING, 1887, p. 23, *pro parte*, pl. 3, fig. 10 only.

DIMENSIONS

A.M.N.H. No. 27378	D	H	H′	W	U
13	3.39 mm.	38½	34½	41	38½
1	5.04 mm.	38	32½	32½	35½
2	5.47 mm.	37½	32	36½	36½
3	5.91 mm.	39½	33	36½	34½
4	6.00 mm.	33½	30	34½	42
5	6.26 mm.	39	?	37½	37½
6	7.47 mm.	40½	?	34½	32½
7	7.56 mm.	37	?	32	40
8	7.65 mm.	41	36	33	33
9	8.08 mm.	36½	?	27	39
10	8.34 mm.	34½	28	30	41½
11	8.43 mm.	33	?	32	43½
12	8.69 mm.	35	?	32	42½
14	8.69 mm.	36	?	32	40
15	9.04 mm.	36½	?	29	38½
16	9.12 mm.	37	?	29½	40
17	9.30 mm.	32	28	32½	43½
18	9.39 mm.	36	?	29	42½
19	9.65 mm.	29½	27	28	45
20	9.99 mm.	35½	30½	29½	41
21	9.99 mm.	33	29½	30½	44½
22	10.17 mm.	31½	27½	30	43½
23	10.17 mm.	32½	29	28	44½
85	10.25 mm.	40	35½	29	36½
24	11.12 mm.	36	30½	28	39½
25	11.47 mm.	33½	29½	27½	44½
86	11.47 mm.	39½	?	30½	34
26	11.64 mm.	36½	?	27½	42
27	11.64 mm.	33½	30	28½	44½
28	11.73 mm.	31	26½	30½	41½
29	11.99 mm.	35½	31½	26½	42
30	12.17 mm.	34½	30	26½	40
31	12.34 mm.	34½	29	28	41½
32	12.43 mm.	35½	?	26	38½
33	12.60 mm.	34½	31	25½	40
34	12.60 mm.	33	29	27½	43½
35	12.95 mm.	33½	?	29½	43½
36	13.12 mm.	36	?	*ca.* 33	39½
37	13.21 mm.	33½	?	26½	44
38	13.47 mm.	37	32	28½	40½
39	13.47 mm.	36	?	28½	38½
40	13.64 mm.	35	?	28½	41½
41	14.08 mm.	32[2]	?	*ca.* 25½[2]	43½[2]
42	14.16 mm.	39	34½	30	38
43	14.34 mm.	31	?	*ca.* 30½	41
44	14.34 mm.	32	27	28	43½
81	14.5 mm.	40½	?	27½	47
45	14.95 mm.	33½	29½	28½	41½
46	15.12 mm.	36	?	27	38
47	15.9 mm.	31½	?	28½	48½
48	16.1 mm.	37	30½	28½	39½
49	16.1 mm.	31	?	25	51½
50	16.4 mm.	39	?	29	41½
51	16.4 mm.	35	29	25½	48

[2] Measured at D = 13.64 mm.

A.M.N.H. No. 27378	D	H	H′	W	U
52	16.5 mm.	34	?	25	49½
53	17.0 mm.	29½	?	26½	52½
54	17.2 mm.	34½	?	24	45½
55	17.2 mm.	40	?	27	41½
73	17.3 mm.	37	29½	27	42
56	17.6 mm.	34½	?	27½	49
57	17.6 mm.	39½	32	31½	45
58	18.1 mm.	40	?	*ca.* 27½	44
59	18.4 mm.	42	32	30½	43½
60	18.5 mm.	29½	25	27½	52
61	19.0 mm.	31½	?	27½	50
62	19.0 mm.	34	?	26	49
63	19.5 mm.	34½	?	24½	51
64	20.4 mm.	33	?	29½	49
65	20.5 mm.	37½	?	28	40
66	21.8 mm.	36	?	?[1]	48
82	22.1 mm.	37	31	26	43½
67	23.7 mm.	39	33	27	42
68	23.7 mm.	34	?	30	46
69	24.4 mm.	35½	?	24	39½
70	25.1 mm.	32½	27½	27½	46½
71	26.0 mm.	34	?	25½	49½
72 (holotype)	27.8 mm.	38½	29	24	39½

The proportions of this species and the trends recognizable in their development are quite similar to those of *H.* (*B.*) *kautzschi*. The range of variation is almost exactly the same in W (24–41 in the present species, 24½–41 in *kautzschi*), but it is wider in both H (29½–42 in *syriacum*, as compared to 31½–40½ in *kautzschi*) and U (32½–52½, as compared to 34½–49).

As in the two preceding species, the shells tend to decrease with growth in both thickness and degree of involution. As far as W is concerned the table bears this out very clearly. The smallest measured specimen (no. 13) is also the thickest. The largest, the holotype, shares the minimum of W (24) with the only somewhat smaller paratype 69 but also with paratype 54 which is more than 10 mm. smaller. The values for W that come closest to the maximum are found near the top of the table, as would be expected, but those coming closest to the minimum are found not at the end but between the diameters of 16 and 19.5 mm. (nos. 49, 52, 63).

The situation is not quite so clear with regard to the degree of involution. The smallest shells measured conform to expectations; in the very smallest, H equals U and even exceeds it in six others of the nine smallest. Above the diameter of 8 mm., however, H exceeds U in only three individuals (nos. 85, 86, 42). It is remarkable that in medium-sized and large individuals H and U differ sometimes only slightly, as in the holotype (38½/39½) or in paratype 59 (42/43½), sometimes very considerably, as in paratypes 53 and 60 (pl. 8, fig. 52) in both of which the minimum of H (29½) meets the maximum (52½, in no. 53) or the value next to the maximum (52, in no. 60) of U. It is particularly striking that one of these two paratypes (no. 60) is of almost exactly the same size as paratype 59 which exhibits the maximum of H. This arouses suspicion that two morphologically different forms may have been united within this species, as here circumscribed, but because all the individuals included in it agree well in other characters and because even in dimensions there is a steady transition between those two extremes, taxonomic separation of these two forms does not seem to be warranted.

At any rate, the present species, in which U attains a maximum of 52½, exhibits the widest umbilici, and the only ones that occupy more than half of the diameter, among all the oppelids from Mount Hermon.[2]

Whereas in three of the five largest measured shells (paratypes 69 and 70 and the holotype) the last septa can be located at diameters around 20 mm., two others (paratypes 68 and 71), attaining diameters of 23.7 and 26 mm., respectively, are septate throughout. Hence, it must be inferred that complete shells of this species reached at least a diameter of about 40 mm. Still, it seems to have been somewhat smaller than the two other species of this subgenus occurring at Majdal Shams.

Designation of Type: The largest measured specimen (A.M.N.H. No. 27378:72), which, though less evolute than most shells of the same size, is characteristic in whorl profile and ornamentation, is designated holotype of *H.* (*B.*) *syriacum*.

Description: Shell slender, mostly evolute. A few specimens are slightly geniculate. The protoconch, which is exactly as in *H.* (*B.*) *kautzschi*, can be seen in the juvenile 1.

[1] Crushed.

[2] It is pointed out above (p. 53) that Noetling's value of 55 for U in the holotype of *H.* (*B.*) *kautzschi* must be wide of the mark.

The whorl profile is throughout development characterized by flat flanks, well-developed lateroventral shoulders, and, from a medium size, by truncate venters; thus its shape is subquadratic at early stages, later mostly subrectangular (nos. 13, 2, 8, 10, 19, 34, 74, 44, 75, 70, 72; pl. 8, figs. 41, 43, 38, 40, 54, 48, 46; pl. 9, fig. 2). The umbilical shoulder is pronounced, but as a rule more or less rounded, the umbilical wall steep to perpendicular (holotype, pl. 8, figs. 45, 46). Only a few juveniles (e.g., nos. 4, 85, 24; pl. 9, fig. 14) exhibit the sharp umbilical edge and inverted-conical, sometimes slightly concave umbilical wall mentioned in the description of *H.* (*B.*) *kautzschi;* in the juvenile 24 this peculiarity disappears at a diameter of a little more than 9 mm.

In two mature individuals (nos. 82, 67) a median keel appears at or near the beginning of the living chamber, i.e., at a diameter of about 17 mm., but only a rudimentary keel is recognizable, at diameters of from 15 to 20 mm., in other medium-sized shells (nos. 73, 59, 64, 65). On the other hand, some 15 juveniles, among them paratypes 4, 18, 22, 24, 27, 40, show the median groove on which Noetling based his "*Harpoceras excavatum,*" but it is not found beyond a diameter of 10 mm. Paratype 27, which shows a fine median ridge within this groove, is illustrated as an example (pl. 9, fig. 9). However, just a faint indication of such a median groove can be recognized in the anteriormost part of the holotype (pl. 8, fig. 44) and in paratype 80.

A blunt concentric ridge, similar to the one reported above in specimen 113 of *H.* (*B.*) *kautzschi*, is seen, on the outer whorl of the juvenile 5, to continue the spiral of involution, but spiral keels of a different character are present in the juvenile 85 and the nearly mature paratype 82. In the anteriormost portion of the former a concentric ridge is recognizable, on the left side only, at about the third fifth of the flanks, with another, finer one running between it and the outer shoulder, while on the left side of paratype 82 a thread-like keel runs parallel to the umbilical shoulder only a little ventrad of it, encircling a smooth innermost zone (pl. 8, fig. 49).

In the afore-mentioned juvenile 5 forward convex hooks appear, as the earliest elements of ornamentation, at the inner third of the flanks at a diameter of about 3 mm., but they disappear towards the anterior end of this shell. Short, prorsiradiate, node-like circumumbilical folds can be recognized from a diameter of about 7 mm. in the juvenile 10 (pl. 8, fig. 42). In the anteriormost portion of the juvenile 16 elements of ornamentation better characterized as growth folds than ribs show a typical *Hecticoceras* course. Forward convex arcs on the inner third of the sides continue, without any pronounced angulation, into even weaker sickles on their outer zone. At first glance, however, this shell appears to be smooth (pl. 8, fig. 47). About the same character of ornamentation is recognizable at the anterior end of the juvenile 24 (pl. 9, fig. 14), but here the outer sickles are even fainter. The contrast between inner and outer zones is even more pronounced in the somewhat larger paratype 27; nine quite prominent nodes per half whorl ride on the umbilical shoulder but in the outer zone delicate sickles can be recognized in oblique illumination only (pl. 9, fig. 10). The style of ornamentation remains the same in the characteristic medium-sized shells 43, 44 (pl. 9, fig. 3), and 45, except that the inner hooks extend somewhat higher up the flanks, but at a size only a little larger even the circumumbilical ornamentation becomes so faint in some shells that it is difficult to perceive (nos. 49, 75; pl. 8, fig. 53; pl. 9, fig. 5; no. 57). In others, e.g., no. 54 (pl. 9, fig. 4), the inner hooks, here rather closely set, are barely visible, but the outer sickles, which become more and more recurved, are very delicate and must be called growth striae rather than true ribs. In contrast, paratype 73, of the same size, carries near its anterior end six well-developed and not so strongly recurved sickles, and a few individuals measuring from 14.5 to 16.5 mm. in diameter (nos. 81, 83, 84) exhibit, as do some of the preceding species, an ornamentation reminiscent of that of *H.* (*Putealiceras*) *schumacheri*, with a clear connection between inner and outer ribs and two of the latter more or less distinctly originating from one of the former. The half-disk number 84 is illustrated as an example (pl. 9, fig. 1). In the somewhat larger shell 64, however, the outer ribs are less pronounced than in paratype 73 and decidedly recurved, whereas the circumumbilical zone is nearly smooth. In other individuals of the same size group (nos. 59; 62, pl. 8, fig. 50; 63), on the other hand, this zone is studded with short, strongly prorsiradiate ribs which tend, however, to vanish towards the anterior end; eight are present on half a whorl. In contrast, these circumumbilical nodes persist or at least remain clearly visible in paratypes 65 (pl. 8, fig. 51) and 70 and in the whorl fragment 76 up to diameters of 20.5, 25, and 27 mm., respectively. It is worth noting that, especially in paratype 65, the outer ribs almost equal the inner ones in distinctness and, being decidedly recurved, form an acute angle with the latter with which they are, however, but indistinctly connected. Still, the costation is altogether faint as compared to that of paratypes 81, 83, and 84, mentioned above.

The mature ornamentation of this species, best observable in paratype 69 and in the holotype (pl. 8, fig. 44), shows again a somewhat different aspect: At first glance even these shells appear smooth, or nearly so, especially around the umbilicus. On closer examination straight, only moderately prorsiradiate inner "ribs," which are so delicate as hardly to deserve the name, can be seen to extend from the umbilical edge over the inner third of the flanks. Only a few are at their outer ends indistinctly connected with the sickles of the outer zone which are now markedly more distinct (or less indistinct) than the circumumbilical costae, whereas the opposite relation prevailed earlier in the ontogeny. These outer ribs end rather abruptly at the lateroventral shoulder; only here and there can tongues formed by faint growth folds be perceived on the venter (pl. 8, fig. 44). At this last stage the ornamentation of the sides is rather dense; 15 inner and 17 outer "ribs" are counted on a quarter-whorl; both kinds decrease in both density and distinctness, almost to the vanishing point, towards the anterior end.

Suture lines can excellently be observed as early as at diameters of from 2 to 3.33 mm. in the smallest measured juvenile (no. 13, pl. 8, fig. 39). In addition to the siphonal and two lateral lobes and to the external and two lateral saddles there are a shallow auxiliary lobe and, on the umbilical wall, a low auxiliary saddle. The first lateral lobe is only a little deeper than the siphonal one, but the first lateral saddle already markedly overtops the external one. The first lateral lobe is neatly trifid, but no indentations are yet present in any of the other lobes and saddles, nor in the trapezoidal median knob. Even the main saddles and lobes are rather plump. There are three sutures to a quarter-whorl. In the juvenile 3 (pl. 8, figs. 36, 37), exceeding number 13 by about 2.5 mm. in diameter, one more auxiliary lobe and one more such saddle are present on the umbilical wall. Both main saddles are asymmetrically divided, with their wider, inner stems carrying a secondary indentation, and the first lateral lobe is less symmetrically trifid than in number 13, as its outer lateral point far exceeds the inner in strength. Here that lobe is considerably deeper than the siphonal one, but otherwise the general plan and style of the suture are still the same as in the smaller shell. The indentation is much richer, the second lateral lobe is clearly trifid, and hornlets begin to develop on the median knob at diameters up to 8.5 mm. in the juveniles 12 (pl. 9, fig. 13) and 85; both saddles and lobes have become more slender and taller and deeper, respectively. In contrast, paratype 34 has again rather plump lobes and saddles and, although almost one and a half times as large as number 12, shows only a little, if any, progress in indentation over it. The sutures of paratype 44 are similarly primitive at the same growth stage. In both shells (34 and 44) the density of the sutures amounts still to four per quarter-whorl, as it does in number 12 and even in the much smaller juvenile 3. In specimen 39 it has increased to five per quarter-whorl; the suture lines of this shell, with slender lobes and saddles, resemble those of number 12 much more than those of number 34 but are markedly more elaborate than the former, as would be expected on account of the difference in size. Now the first auxiliary lobe is trifid also, and a third has appeared on the umbilical wall. In the anteriormost quarter-whorl the middle points of the first lateral lobes carry secondary prongs on either side, and the hornlets of the median knob are now clearly differentiated. The only slightly larger paratype 77 shows similarly crowded and elaborate suture lines but with somewhat plumper lobes and saddles, whereas those of the equally crowded and even more elaborate four last sutures of paratype 78 (pl. 9, fig. 12), again only a little larger, are particularly slender. Here the second lateral lobe is asymmetrically trifid, with the inner lateral point occupying a markedly lower position than the outer, and the first auxiliary, bifid in three earlier lines, turns similarly asymmetrically trifid in the last two.

In the latest stage observable, corresponding to diameters from about 17 mm. to about 27 mm., closely set, richly indented sutures with comparatively slender main elements are found in some shells but sutures that stand farther apart and show a lower degree of indentation and plumper main elements in others. The first group is represented by the holotype (pl. 9, fig. 7) and the suturally similar paratype 68. In the former the density of the suture lines reaches the maximum (six per quarter-whorl) of this species but obviously only owing to the crowding of the last sutures. In the latter the density is five per quarter-whorl. A typically hecticoceratid median knob from paratype 68 (at D = 20 mm.) is illustrated in plate 9, figure 11. In paratype 79 (pl. 9, fig. 8) the density is only four per quarter-whorl, but, except for somewhat shallower main lobes, style and elaboration resemble those of the holotype and number 68. In the quarter-whorl number 80 five sutures can be counted, it is true, but, in view of the diameter of about 27 mm. at the anterior end, this count does not indicate a density any higher than in number 79. Lobes and saddles are rather plump and the degree of indentation is low, with the middle points of the first lateral lobes lacking secondary prongs throughout this whorl fragment (pl. 9, fig. 6).

REMARKS: Unfortunately Noetling gives only a side view of the smaller of the two specimens figured as "*Harpoceras Kautzschi*" (fig. 10), excluded by Lemoine and myself from the synonymy of that species, so that the whorl profile is not known. However, there is good reason to assume that Noetling's "kleineres, schwächer skulpturiertes" specimen (so characterized in his explanation of pl. 3) belongs to *H.* (*B.*) *syriacum*.

Hecticoceras (*B.*) *kautzschi* is indeed the species to which the present one is most closely related. Still, the following differences seem to justify specific separation: The flat flanks, the pronounced lateroventral shoulders, the somewhat truncate venter, and the mostly more pronounced umbilical edge, all producing a subquadratic to subrectangular profile in *syriacum*, the even greater umbilical width attained in some of its individuals, and the altogether less distinct ornamentation which makes many shells of all sizes appear almost smooth. In particular, the circumumbilical nodes which persist into the latest ontogenetic stages in *kautzschi* tend to disappear in *syriacum*, and the outer sickles are here much more delicate, more closely set, and not quite so strongly recurved. Furthermore, a keel appears only occasionally in the present species and, when it does, it never attains the same strength as in some mature individuals of *kautzschi*. Also, the suture lines of *syriacum* do not quite attain the density and elaboration of those of *kautzschi*, and their lobes and saddles are often somewhat plumper.

By these same sutural characters, chiefly by the far lesser density of the sutures, and, in addition, by the angular whorl profile and by the much lower degree of involution, the present species is readily distinguished from *H.* (*B.*) *socini*.

Hecticoceras (*B.*) *syriacum* requries, however, comparison also with some oppelids outside the "subgenus" *Brightia*, especially with *H.* (*Sublunuloceras*) *guthei* and *H.* (*S.*) *socium*. With the former, *syriacum* has the pronounced lateroventral shoulders and the slightly truncate venter in common, and it therefore resembles it in whorl profile. One distinctive character is provided by the keel, regularly present in *guthei*, but only rarely in *syriacum* and even then rather rudimentary. As a rule *guthei* is much more involute, but that species includes also some rather evolute individuals which can then be distinguished from the comparatively widely umbilicate *syriacum* specimens only by their ornamentation. In this respect a further difficulty arises from the fact that in *H.* (*S.*) *guthei*, too, the innermost zone of the flanks tends to become smooth in maturity. However, the sickles of the outer zone then become mostly robust and always radial in direction in *guthei*, whereas they are always decidedly recurved and delicate, and tend to vanish in the latest stages observable, in *syriacum*. From *H.* (*S.*) *socium*, on the other hand, the present species can be distinguished by the much more angular whorl profile and by the wider umbilici. The ornamentation of the outer zone of the flanks is somewhat similar in both forms, but the sickles of *socium* are at the same size (compare the side views of the holotypes) definitely stronger and less recurved and connected in a sharp angulation with quite pronounced inner ribs, which are strongest on the umbilical shoulder, at a stage at which these ribs have withdrawn higher up into the flanks and almost reached the vanishing point in *syriacum*. Also there is never such a clear connection between inner and outer ribs in the present species as is the rule in *socium*. In sutural characters *H.* (*B.*) *syriacum* differs from these two species of the "subgenus" *Sublunuloceras* in the same direction and in similar respects as it does from *H.* (*B.*) *socini*.

Some specimens of *H.* (*Putealiceras*) *schumacheri* also may, at certain stages, resemble some of the present species, as may, in side view only, some of *Ochetoceras* (*Campylites*) *evolutum*. Both these species are compared below (pp. 65, 96) with the present one.

MATERIAL STUDIED: Altogether 276 specimens, including incomplete ones and fragments.

SUBGENUS **PUTEALICERAS** BUCKMAN, 1922[1]

This "subgenus" is represented on Mount Hermon by *H.* (*P.*) *schumacheri*, one of Noetling's species, by a closely related but much rarer species of the group of *H.* (*P.*) *punctatum*, believed to be conspecific with Douvillé's "*punctatum*" from Normandy, only recently renamed *douvillei* by Jeannet, and by three more that may be comprised in a "group of *H.* (*P.*) *caelatum* (Coquand) de Loriol." This group is characterized by the feature that the ribs from both sides meet on the venter or even cross it uninterruptedly. I realize that by modern taxonomic standards that feature might be used as a diagnostic subgeneric, or even generic character (by Jeannet probably as the latter), but in line with the attitude expressed above (pp. 29, 30) under the heading on the family Oppelidae, I would not consider such a procedure justified.[2] Thus I include all three of the Mount Hermon species referable to this group, namely, *H.* (*P.*) *caelatum*, *H.* (*P.*) *solare*, and *H.* (*P.*) *separandum*, in this subgenus.

[1] Plate 297.

Hecticoceras (Putealiceras) schumacheri (Noetling)

Plate 9, figures 15–44; plate 10, figures 1–7

Harpoceras Schumacheri sp. n.; NOETLING, 1887, p. 21, *cum synon.*, pl. 3, figs. 1–4.

Hecticoceras (*Lunuloceras*) *Schumacheri* Nötl. f.; BONARELLI, 1893, p. 93.

H. Schumacheri Noetl.; FREBOLD, 1928, p. 187.

Putealiceras schumacheri [Noetling]; SPATH, 1928, p. 107.

P[*utealiceras*] *schumacheri* (Noetling); SPATH, 1933, p. 670.

DIMENSIONS

A.M.N.H. No. 27379	D	H	H′	W	U
12 (nucleus)	1.79 mm.	42	34	50	35
1	2.08 mm.	38	34	46	34
2	3.30 mm.	41	37	42	35½
70	3.48 mm.	40	35	37½	33½
3	4.26 mm.	43	?	41	30½
4	4.87 mm.	39½	35½	38½	32
5	5.13 mm.	39	33	35½	34
11	5.47 mm.	38	35	33½	33½
6	5.56 mm.	37½	34½	36	34½
7	6.78 mm.	38½	32	33½	37
8	7.21 mm.	42	?	35	30
9	7.73 mm.	40½	?	32½	32½
10	7.73 mm.	38	?	36	35
13	7.99 mm.	39	?	33½	35
14	8.43 mm.	39	34	32	36
15	8.52 mm.	41	*ca.* 36½	*ca.* 33½	33½
16	9.30 mm.	43½	36½	35½	33½
17	9.39 mm.	39	?	35	35
18	9.56 mm.	41	35½	33½	34½
19	9.65 mm.	42	37	35½	37
20	10.51 mm.	38½	33	33	39
21	10.69 mm.	36½	30	32½	37
22	10.69 mm.	40½	?	30	35
23	11.12 mm.	39	*ca.* 35	*ca.* 35	36½
24	11.56 mm.	38½	?	29½	36
40	11.56 mm.	40	34	31	34
75	11.91 mm.	41½	35	30	31½
25	12.34 mm.	38½	?	29½	35
26	12.51 mm.	35½	28½	30	39
28	12.69 mm.	39	29	31½	37
29	13.03 mm.	32	?	32	44½
30	13.30 mm.	32½	29½	30½	42½

[2] Even Spath (1928, p. 109) left his fragment named *Kheraites? varicosus* (which exhibits the same peculiarity of the costation), though doubtfully, with his genus *Kheraites*, although the ribs do not unite on the venter in the type species, nor in other known forms, of that genus.

A.M.N.H. No. 27379	D	H	H′	W	U
31	13.38 mm.	36½	30½	30	38½
27	13.73 mm.	35	?	30	41
32	14.16 mm.	38	?	30½	38
33	14.69 mm.	33½	29	29½	37½
34	14.77 mm.	37	33	29½	31
35	14.86 mm.	38½	32	29	32
36	15.29 mm.	40	33	28½	34½
37	15.4 mm.	45½	37	31½	36½
38	15.5 mm.	38½	?	32½	38½
39	15.6 mm.	36	?	28	45½
41	16.1 mm.	40½	?	*ca.* 30	39
42	17.0 mm.	39	?	29½	39
43	17.2 mm.	40	31½	*ca.* 28	39½
73	17.2 mm.	45	33	25½	32½
44	17.5 mm.	37	?	28½	41
45	18.0 mm.	36½	?	32	43½
46	18.2 mm.	37	31	31½	42
47	18.4 mm.	41½	32	31	41
48	18.7 mm.	37½	?	29	41½
49	19.5 mm.	36½	?	28	41½
51	20.1 mm.	37	?	29	40½
52	20.4 mm.	35	?	31½	44
53	21.1 mm.[1]	35½	31½	32	42
55	22.1 mm.	44½	?	27	36
56	24.1 mm.	38½	?	*ca.* 28	38½
57	24.7 mm.	39	*ca.* 32½	*ca.* 28½	39
58	25.0 mm.	39	?	?[2]	39
59[3]	28.1 mm.	45	34	*ca.* 25	31
60	28.6 mm.	39	29½	29½	39
61	31.1 mm.	41½	?	29	36½
62	31.5 mm.	41½	?	29½	35½
63	33.7 mm.	44	*ca.* 33	23½[4]	31½
64	35.0 mm.[5]	38[5]	?	26½[5]	37[5]
65	37.2 mm.	46½[6]	?	19[6]	29½[6]
66	47.2 mm.	42[7]	?	28[7]	34½[7]
67	72.8 mm.	40½[8]	?	*ca.* 27½[8]	36[8]

While in the above table the lowest values for H and the highest for U are encountered at diameters between 13 mm. and 20.5 mm. (nos. 29, 30, 33, 39, 52), and the highest for H above that of 17 mm.[9] (nos. 73, 55, 59, 63, 65[10]), the lowest values for U (29½–31) occur not only near the bottom of the table, as expected, but also near the top (nos. 3, 8). Thus the whorl height seems somewhat to decrease in the earlier part of the ontogeny, although quite involute shells, e.g., number 34 with U close to the minimum, occur in the afore-mentioned 13–20.5-mm. size group also. Beyond a diameter of 22 mm. the shells tend in general to be more involute.

The picture is, however, somewhat obscured by the fact that, as in *H.* (*Brightia*) *syriacum* (p. 57) and throughout the subgenus *Putealiceras* (see pp. 66, 70, 74), for the three following species), more and less involute shells of the same size occur side by side, sharing all other specific characters to such an extent that taxonomic separation based solely on the degree of involution is out of the question.

The trend of the shells to decrease in thickness with growth is, however, quite unequivocal; W declines more or less steadily from its maximum, attained by the nucleus of specimen 12 at a diameter of less than 2 mm., to the lowest values of from 23½[11] to 27½, encountered at diameters of from 17.2 mm. to 60.6 mm. (nos. 73, 59, 63, 64, 67).

The largest specimen (no. 67) is septate up to a diameter of 68 mm. Allowing about two-thirds of the last volution for the body chamber, a diameter of about 120 mm. is arrived at for this individual when entire. This estimate far exceeds Noetling's tentative one of "at least 75 mm." but fully confirms his statement that this species produces the largest individuals among the *Hecticoceras* from Mount Hermon. Within this genus and within the oppelids at large, it leaves *H.* (*Sublunuloceras*) *socium*, with an estimated maximum diameter of 85–90 mm., far behind. (For comparatively great sizes attained by ammonites of other groups represented at Majdal Shams, see p. 199).

Designation of Type: The largest of the specimens figured by Noetling (1887, pl. 3, figs. 1, 1a–c) is hereby selected as lectotype of *H.* (*P.*) *schumacheri*.

Description: The protoconch, measuring a little more than 0.1 mm. in diameter, is in-

[1] Slightly geniculate and deformed.

[2] Crushed.

[3] Transitional to *H.* (*Sublunuloceras*) *guthei* in shell shape and ornamentation.

[4] Crushed.

[5] Deformed anteriorly; measured at D = 29.6 mm.

[6] Measurements not reliable because body chamber is crushed.

[7] Body chamber crushed; measured at D = 32.3 mm.

[8] Body chamber crushed; measured at D = 60.6 mm.

[9] If specimen 37, measuring only 15.4 mm. in diameter but prematurely exhibiting a value for H close to the maximum, be left out of account.

[10] The body chamber of this shell being crushed, the measurements may not be reliable.

[11] The absolute minimum for W of 19, measured in specimen 65, is deliberately omitted as it may be accounted for by crushing.

distinctly visible in the side view of the juvenile 3 (pl. 9, fig. 17).

The whorl profile is subcircular, with slightly flattened flanks, in early youth (no. 1, pl. 9, fig. 15), then gradually turns elliptic (no. 72, pl. 9, fig. 18) and becomes increasingly slender in some shells (nos. 75, 73, pl. 9, fig. 29), less so in the more evolute ones (e.g., no. 53, pl. 9, fig. 26). In both groups it tends later to become inverted-oval rather than elliptic, with the maximum width at the inner third of the flanks. At this growth stage (about 20 mm. in diameter) distinct, though rounded shoulders bound the slightly truncate venter which slopes gently from the median keel towards the outer shoulders (pl. 9, fig. 24). In the somewhat smaller shells 73 and 68 the shoulders are even more pronounced and the venter accordingly is more distinctly truncate (pl. 9, figs. 27, 29, 20). The median keel appears at diameters between 7 mm. (nos. 17, 73) and 12 mm. (no. 53). In the afore-mentioned individual 68 only, it dissolves into teeth formed by the apices of triangular chevrons which the ribs produce on the venter (pl. 9, fig. 20). The keel remains rather fine (nos. 59, 64; pl. 9, figs. 31, 34) or is even inconspicuous (e.g., no. 60, pl. 9, fig. 44) even at later ontogenetic stages. The whorl profile does not change much in the further course of development. The latest stage at which it can be seen undistorted is represented by specimen 62, which is septate throughout and therefore uncrushed, whereas the anteriormost portions of all shells larger than number 62 belong to the body chamber and are crushed or otherwise deformed. As seen in the ventral view of number 62 the keel is rather broad but particularly low (pl. 9, fig. 38). Throughout development the umbilical shoulder is distinct, though rounded, and the umbilical wall steep but low (e.g., no. 62, pl. 9, fig. 40).

Median grooves, which would refer the shells carrying them to Noetling's "*Harpoceras excavatum*," occur less frequently in the present species than in the subgenus *Brightia;* they can be observed in seven specimens only, among them numbers 23, 26, 27 and 34, all measuring between 11 and 14 mm. in diameter. This median groove is restricted to less than half of a volution, but it can be followed from one end to the other of the half-disk number 69. It disappears at diameters from 8 to 14.5 mm. before the median keel appears. That of specimen 23 is illustrated as an example (pl. 9, fig. 23).

The earliest elements of ornamentation are blunt folds, only occasionally assuming the shape of ribs, which appear in specimen 9 at a diameter of about 4.5 mm. They are most distinct in the inner half of the flanks and extend only indistinctly into the outer zone; five are counted on the last half-whorl of this juvenile (pl. 9, fig. 19). In number 15, only a little larger than number 9, the folds of the inner zone are joined by about twice as many indistinct sickles in the outer one. Only here and there can the latter be seen to originate by bifurcation from the former, but in contrast to other *Hecticoceras* of the present assemblage there is no break between inner and outer costae, and both are about equally strong or at this stage rather equally weak (pl. 9, fig. 30). Thus the mature ornamentation characteristic of this species is foreshadowed, as it is in the larger specimen number 23 (pl. 9, fig. 22).

It may be said to be fully present on the anteriormost portion of the juvenile 71 (pl. 9, fig. 21). In the last quarter-whorl four rather high, strongly prorsiradiate inner ribs form, a little dorsad of the middle of the flanks, a pronounced, though rounded hook and bifurcate more or less distinctly into two recurved, forward concave, outer sickles each; another such sickle is intercalated so that altogether nine are counted on this quarter-whorl. However, ornamentational development must be accelerated in this juvenile, for at an even somewhat larger size number 16 is still almost smooth. In numbers 17, 22, and 24 the same sculptural elements can be recognized as in number 71, but they are less distinct and stand farther apart; in particular, there are fewer outer sickles, an inner rib often continuing in only one of them.

In the evolute specimens 29, 30, and 33, on the other hand, the costation is fully developed again, but the inner ribs are sharper and shorter, as the bifurcation point is shifted dorsad to the inner third of the flanks, and the outer sickles are more uniform. They originate mostly by bifurcation, with additional ones occasionally intercalated. There are differences in the strength of this costation; it is most pronounced in number 29 where the outer sickles are comparatively sharp and where 10 sickles and five inner ribs are counted on the last quarter-whorl (pl. 9, fig. 41). It is evolute shells such as these that are not so readily distinguished from equally strongly ornamented ones of *H.* (*Brightia*) *kautzschi;* however, on the latter the inner ribs seem to be more node-like, more closely set, so as almost to merge with one another, and the outer sickles are more recurved.

The character of the costation remains essentially the same, as described above in number 29, at diameters from 15 to 25 mm., with only minor individual variations. Thus the costation is pronounced in some individuals (nos. 47, 52; pl. 9, figs. 36, 35) but more subdued in others (nos. 41, 53; pl. 10, fig. 1, pl. 9, fig. 25). The shell 73, among the smallest of this size group, occupies an intermediate position in that the primary ribs of the inner zone of the flanks are well developed but the secondary ribs of the outer zone are much less so. The former move markedly farther apart on the outer volution; the latter originate, at least in its anterior portion, by intercalation rather than bifurcation (pl. 9, fig. 28). Altogether the ornamentation of this shell is reminiscent of that of a somewhat earlier ontogenetic stage. In this group the outer sickles are decidedly recurved in some individuals (nos. 49, 53; pl. 9, figs. 37, 25; no. 58) but considerably less so in others (nos. 38, 73; pl. 9, figs. 42, 28). At this stage eight or nine outer sickles are counted along the periphery of the last quarter-whorl, with about half as many inner ribs present.

It is worth noting that throughout this stage the outer costae turn slightly forward and gradually vanish, without thickening, on reaching the outer shoulder. In some shells, e.g., numbers 68 and 53 (pl. 9, figs. 20, 24) they continue on the venter as fine growth folds which form triangular chevrons, culminating on the keel or, where the latter is not present, on the median line. From a diameter of about 25 mm., however, the outer ends of the ribs can be seen to form on the lateroventral shoulder blunt tubercles which appear in ventral view to point obliquely forward. This feature is best illustrated by specimens 60, 62 (pl. 9, figs. 44, 38), 64, and 65. Otherwise the character of the costation is still about the same as in earlier stages, with minor variations. Thus the sickles are less recurved in some shells (no. 60, pl. 9, fig. 43) than in others (no. 62, pl. 9, fig. 39); also the inner ribs are less closely set in the latter individual than in the former and carry indications of tubercles at the bifurcation points. As seen in the four largest shells, in all of which approximately one-half of the outer whorl is unseptate, the ribs remain sinuous on the septate part of the shell, regardless of diameter, but become stiffer, and in the largest shell also markedly broader on the body chamber (nos. 64–66, 67; pl. 9, figs. 33, 32; pl. 10, fig. 6). On the septate portions of the shells bifurcation prevails, but on the body chambers of the largest shells the ribs tend to become single; in both cases a shorter rib is occasionally intercalated between two longer ones.

With the density of costation, the number of inner ribs varies at this ontogenetic stage from four to six per quarter-whorl and that of the outer sickles from eight to 12. Where single ribs predominate, as they do on the body chambers of numbers 65, 66, and 67, the total number of ribs per quarter-whorl is eight or nine.

The earliest stage at which suture lines can well be studied in this species is represented by the juvenile 2. At this stage, corresponding to diameters of from 1.75 to 3.33 mm., there are only three to a quarter-whorl, and they are extremely primitive, almost goniatitic; both lobes and saddles are plump and remarkably shallow and low, respectively, with the trifidity of the first lateral lobe only very faintly indicated and other indentations entirely absent. There is just one auxiliary lobe on the umbilical wall (pl. 9, fig. 16). In the juveniles 3, 5, 11, and 7–9, although they are markedly larger, the sutures stand just as far apart and are almost as primitive as in juvenile 2, except that the first lateral lobe is now clearly trifid, the tops of the main saddles are shallowly indented, and the auxiliary lobe is followed by an auxiliary saddle (pl. 9, figs. 17, 19; pl. 10, fig. 2). In specimen 9 only the unusually short interval between two lines raises the number of sutures on the last quarter-whorl from three to four. Even five per quarter-whorl are counted in the juvenile 15 (pl. 9, fig. 30) owing to the usual crowding of the last sutures. Even at this early stage, corresponding to diameters of from 7 to 8.5 mm., the middle point of the broad first lateral lobe can be seen to exceed the lateral ones but very little in length; this feature, particularly marked in specimen 18 (pl. 10, fig. 3), must be considered distinctive of the present species. A second auxiliary lobe appears at the umbilical seam in this stage.

The juvenile 26, transitional to *H.* (*Brightia*) *kautzschi* also in shell shape, deviates from the usual sutural characters of this species in exhibiting rather closely set (five per quarter-whorl) sutures with comparatively slender and elaborate lobes and saddles (pl. 10, fig. 4), whereas those of numbers 32 (pl. 10, fig. 5) and 36, though also rather closely set, show the plumpness and low degree of indentation characteristic of *H.* (*P.*) *schumacheri*. The number of auxiliary lobes has now increased to three.

The same sutural characters persist through the next ontogenetic stage, extending up to a diameter of about 20 mm., as exemplified by specimens numbers 48 and 52 (pl. 9, fig. 35), and even beyond (no. 60, pl. 9, fig. 43). In other individuals, however, the sutures become more elaborate. Thus in number 51 the middle point of the first lateral lobe begins as early as at a diameter of 14 mm. to develop two secondary prongs, as do all three points of this lobe and the middle one of the second lateral at a diameter of about 27 mm. in specimen 61. Not only the second lateral lobe, but also the first and second auxiliaries, are now trifid; on the right side only of this shell the middle points of the first lateral lobes are distinctly bifid (pl. 10, fig. 7), as they are also in specimen 63.

At about the same diameters (30–35 mm.) as number 61, specimen 62 (pl. 9, fig. 39) exhibits similar but somewhat less richly indented sutures, and those of specimen 66 (pl. 9, fig. 32) are remarkable for maintaining, along with a rather high degree of indentation, the comparatively sturdy shape of the main lobes and saddles and the peculiarity that the middle point of the first lateral lobe exceeds the lateral ones only a little in length. This last feature is still recognizable in two first lateral lobes which show in the largest shell (no. 67, pl. 10, fig. 6), and at a diameter of about 50 mm. represent the latest ontogenetic stage at which these lobes can be studied; their points show plenty of secondary prongs.

Some individuals show sutural asymmetry and anomalies, as they are quite common in *Hecticoceras, sensu lato*. Thus the sutures of the juvenile 50 are stunted on the left side only, where the main lobes are rounded and hardly show any indentations. On the left side of the even smaller juvenile 54 the middle points of the first lateral lobes are asymmetrically bifid rather than trifid. The same abnormality is observable at a much larger scale in specimen 74, also on the left side only; here it can be seen to have been brought about by a considerable shift dorsad of the middle points of these lobes.

REMARKS: This is the only species of the "subgenus" *Putealiceras* recorded by Noetling from Mount Hermon. It has therefore here been dealt with first among the forms referred to this "subgenus."

This species differs from all those of *Hecticoceras, sensu lato,* hitherto dealt with in the present report in its ornamentation and suture lines. The former from a comparatively early stage is continuous all over the flanks, whereas in those other forms it concentrates at given stages either in the inner zone or in the outer. Also inner and outer ribs are in the present species connected in a smooth curve, without sharp angulation. This gives the costation on the whole a gently sigmoidal appearance not found in the preceding "subgenera." The sutures of *H.* (*P.*) *schumacheri* are characterized by the fact that they stand far apart, especially in early stages, and throughout development by the plumpness and comparatively low degree of indentation of their lobes and saddles and, in particular, by the fact that the middle point of the first lateral lobe is not so much longer than the lateral ones.

It is true that these sutural characters are sometimes encountered in *H.* (*Brightia*) *kautzschi* also, and some individuals of that species resemble evolute ones of the present species in shell shape and ornamentation also. However, even where the costation is just as strong in some *kautzschi* specimens as it is in *schumacheri*, the outer ribs are more recurved than they ever are in the present species.

For its distinction from *H.* (*Sublunuloceras*) *guthei* the ornamentational character, mentioned above, and the more truncate venter of *guthei* can be relied upon. Also the outer ends of the ribs are never thickened, as they are in later stages of the present species, in either *kautzschi* or *guthei*, and the latter is, on an average, somewhat more involute than *schumacheri*.[1]

Within the subgenus *Putealiceras*, *H.* (*P.*) *schumacheri* differs from the type species, *Ammonites putealis* Leckenby (Buckman, 1922, pl. 297), by more sinuous costae and plumper suture lines, which are also more distant from one another, and from the true *Ammonites punctatus* Stahl (1824, p. 48, fig. 8), as refigured by Zieten (1830, p. 13, pl. 10, fig. 4) and by Douvillé (1914, p. 6, fig. 1), by less recurved outer ribs and by the much less massive keel. *Hecticoceras* (*P.*) *douvillei*, which is closely related to *H.* (*P.*) *punctatum*, is compared below (p. 68) with the present species, as is the first of the three species of this subgenus occurring on Mount Hermon in which the ribs meet at the median line or even cross the venter uninterruptedly (p. 73).

Finally, some forms of *Ochetoceras* (*Campylites*) also resemble at early stages *H.* (*P.*) *schumacheri* to an extent warranting comparison, for which reference is made to pages 85 and 93.

MATERIAL STUDIED: Two hundred and twenty specimens, including incomplete specimens and fragments, among the pyritized ammonites from Majdal Shams. In addition, seven fragments, and imprints thereof recognizable on a piece of limestone, believed to represent a sample of Frebold's "Mergelkalke" (pp. 9, 10) and numbered A.M.N.H. No. 27379/1, are, to judge by their costation, most probably referable to this species. This identification is, however, not quite certain, because the venter is not visible and, as futile attempts at preparation proved, not even preserved in any of these fragments. The possibility that they may belong to *H.* (*P.*) *caelatum* instead cannot fully be excluded. However, the sinuosity of the ribs, which become club-shaped in their outer portions only at a rather large size, makes reference to *H.* (*P.*) *schumacheri* more likely. The relative abundance of this species in the "Mergelkalke" is emphasized by Frebold (1928, p. 187).

[1] Noetling's figures are misleading inasmuch as he gives higher values for both H and U in *guthei* than in *schumacheri*. Measurements of his drawings give a range for U of from 22½ to 29½ in *guthei* but of from 31½ to 40 in *schumacheri*, so that the latter species appears to have a much wider umbilicus. In our own material U varies between 24½ and 39 in *guthei* and between 30 and 45½ in *schumacheri*; thus the latter species is less involute and more widely umbilicate than the former.

Hecticoceras (Putealiceras) douvillei Jeannet

Plate 10, figures 8–26

?*Hecticoceras punctatum* Stahl, "var. type"[1]; DE TSYTOVITCH, 1911, p. 22, pl. 1, fig. 6.

Hecticoceras punctatum Stahl; DOUVILLÉ, 1914, p. 6, pl. 1, figs. 1–6.

?*Hecticoceras punctatum* Stahl sp.; LEMOINE, 1932, p. 68, *pro parte*, pl. 3, fig. 10.

Hecticoceras punctatum Stahl, var. *Douvillei* JEANNET, 1951, p. 55.

Hecticoceras punctatum Stahl sp. var.; JEANNET, p. 54, *pro parte*, text figs. 121b, d, 122b, *non cet.*, pl. 12, figs. 5, 7, 8, *non* fig. 6, *non* pl. 16, fig. 6.

DIMENSIONS

A.M.N.H. No. 27900	D	H	H′	W	U
1	ca. 15.7 mm.	ca. 39	ca. 32½	ca. 36½	ca. 43½
2	19.0 mm.	41	?	33	39
9	19.5 mm.	41½	?	31½	36
3	19.6 mm.[2]	38½[2]	?	37[2]	45½[2]
4	20.3 mm.	41½	?	31½	42
10	21.7 mm.	41	?	31½	38
5	22.0 mm.	44	?	35	37½
6	27.0 mm.	40	32	ca. 34	38
7	27.8 mm.	36½	?	34½	42
8	32.6 mm.[3]	48[3]	?	ca. 29[3]	30[3]
11	48.2 mm.[4]	42[4]	?	31[4]	35[4]
12	66.0 mm.	46	33½	ca. 26	30½

Even if the somewhat deformed specimen 3, in which the umbilicus is unusually wide, be left out of account, more and less widely umbilicate shells can be found in the above sample at approximately the same sizes (nos. 9 and 3, 4 and 5, 6 and 7). Still, over-all increase in the degree of involution as noted by both de Tsytovitch and Douvillé (*loc. cit. in synon.*), and decrease in thickness, as also observed by de Tsytovitch, are clearly recognizable.

[2] Somewhat geniculate; measured at D = 18.5 mm.

[3] Deformed anteriorly; measured at D = 31.6 mm.

[4] Body chamber crushed; measured at D = 29 mm.

In the largest specimen but one (no. 11) the last septum is located at a diameter of about 31 mm., but the largest, the half disk number 12, is septate throughout. This would suggest a maximum diameter of the entire shell and a size attained by this form at Majdal Shams of about 110 mm., as compared to a diameter of about 160 mm. that the largest individual from Villers-sur-Mer (illustrated in Douvillé's fig. 1) may have reached when complete.

DESIGNATION OF TYPE: The specimen illustrated in Douvillé's figure 2 (the measurements of which are given by Jeannet) is hereby selected as lectotype of *H.* (*P.*) *douvillei* Jeannet.

DESCRIPTION: The whorl profile is subcircular in early youth and broad-elliptic in adolescence and then becomes oval, with the maximum width somewhat beneath the inner third of the flanks. Later in development it becomes considerably more slender (nos. 1, 2, 5, 12; figs. 14, 8, 11, 25). The flanks are more or less gently convex. Lateroventral shoulders and a slight truncation of the venter become distinct from a diameter of 17.5 mm. (no. 3, fig. 20) or 19 mm. (no. 5, fig. 9) and apparently earlier in the more evolute shells than in others. The umbilical shoulder is more pronounced, and the umbilical wall, which is steep but far from perpendicular, is higher in some individuals (e.g., nos. 3, 6, figs. 19, 21) than in others (e.g., nos. 5, 8, figs. 10, 11, 16).

The only juvenile present (no. 1) is smooth up to a diameter of 4.5 mm. and probably 7.5 mm., but on the preserved half of the outer whorl it carries altogether 12 quite strong ribs. Up to a diameter of about 14 mm. two outer ribs originate by bifurcation from each of the prorsiradiate inner ones, then in the anterior third of this half-whorl longer and shorter ribs alternate. The latter originate at about the middle of the flanks. The outer sickles are gently concave forward and a little recurved in the posterior quarter of this whorl but hardly so in the anterior one (fig. 13). Throughout development, the costation remains strong and rather sparse, the number of ribs on the last half-whorl, counted along the periphery, varying from 11 (in nos. 3, 6, 11) to 14 (in nos. 2, 10, 7, 14) and, in specimen 9 only, to 15. However, there is considerable variation in strength, sharpness, course, and density of the costation. Up to a diameter of 30 mm. it seems to be most robust and least dense in the evolute specimens 3 and 6 (figs. 19, 21), less strong and more dense in the more involute shells 9 (fig. 26) and 10, with specimen 5 (figs. 9, 10) exhibiting average density and strength. In the three largest individuals (nos. 8, 11, 12; figs. 16, 17, 23, 24) the ribs are altogether heavy. As in *H.* (*P.*) *schumacheri*, they tend to stiffen on the (crushed) body chambers while maintaining an elegantly sigmoidal course up to the anterior end of the largest shell, the half-disk 12, which is septate throughout. At this stage the chords of the sickles follow an essentially radial direction. Bifurcation disappears at diameters of from about 14 mm. (nos. 1, 2, 9) to about 28 mm. (no. 7); earlier, short or long ribs are repeatedly intercalated between the bifurcating ones. In specimens 9 and 5 (figs. 26, 10), on the other hand, all ribs become single and more or less uniform from diameters of 17 and 19 mm., as they are also in the septate portion of specimen 11 (fig. 17), and alternation of longer and shorter ones becomes indistinct on the body chamber of number 8 and in the anteriormost portion of the half-disk 12. The more robust the ribs the more pronounced are the blunt tubercles which are formed by their outer ends on the lateroventral shoulders from about a diameter of 15 mm. on (figs. 12, 20, 9, 15, 22).

In most of the shells a median keel appears at diameters of from 15 to 16 mm. but it remains low and inconspicuous until full maturity is reached. Only in the anterior portion of the half-disk 12 (fig. 23) has this keel become quite strong.

Suture lines can well be studied, first, at diameters of from 11.5 to 19 mm. in specimens 1–6, 9, and 10 (figs. 13, 19, 10, 21, 26). All resemble those of *H.* (*P.*) *schumacheri* in their comparatively broad and short lobes and saddles, but this resemblance goes farther in the more sturdy and evolute specimens 3, 4, and 6 than in the others. In the former individuals there are only four sutures to a quarter-whorl, the degree of indentation is low, and in particular the middle point of the first lateral lobe exceeds the lateral ones only slightly in length. In specimens 1, 2, 5, 9, and 10, on the other hand, the sutures are more closely set (five or even six to a quarter-whorl), the indentation is markedly richer, and the middle point of the first lateral lobe is considerably longer, especially in specimen 9 where it develops two secondary prongs as early as at a diameter of 15.5 mm. In these individuals the siphonal lobe is broad and rather shallow and the median knob trapezoidal and three-cusped, with the middle cusp subdivided, in number 1 only, by a tiny median notch. Both lateral lobes are trifid and the first auxiliary is asymmetrically bifid; there are two more auxiliaries which are simple. In the afore-mentioned shells with coarser sutures, however, the first also is still simple, with merely indications of notches foreshadowing later trifidity.

A similar dimorphism is observable in the next sutural stage, represented by specimens 7, 8, and 11 (figs. 18, 16, 17) and corresponding to diameters up to 28 mm. While the sutures of number 7, an evolute, rather coarsely ribbed shell, are of the sturdy type reminiscent of *H.* (*P.*) *schumacheri* and exhibit particularly stubby points of the first lateral lobe and a bifid, W-shaped first auxiliary, those of the other two individuals are much more elaborate and the middle points of the first lateral lobes are long and slender, especially in number 11, and carry one or two lateral prongs. The number of auxiliary lobes has increased to four in this specimen; the first is asymmetrically trifid, the third bifid. Here there are six septa to a quarter-whorl, and even seven in number 8, but only five in number 7, the sutures counted being the last in all three shells.

At the latest sutural stage, as represented by the half-disk 12, at a diameter of a little more than 60 mm. only some details of the first lateral lobe can be observed, but they are quite characteristic. A long, dagger-shaped middle point, barbed on either side by three secondary prongs, can be seen, in contrast to what is recorded above (p. 65) for about the same stage of *H.* (*P.*) *schumacheri*, far to exceed the lateral points of this lobe in length (fig. 24).

REMARKS: Douvillé (*loc. cit. in synon.*) considered his form from Villers-sur-Mer conspecific with the original *Ammonites punctatus* Stahl (1824, p. 48, fig. 8; Zieten, 1830, p. 13, pl. 10, fig. 4)[1] from Württemberg and even claimed that the series of specimens illustrated by him be considered the "figuration typique" of Stahl's species. Lemoine (1932, p. 69), however, questions Douvillé's point of view. Spath (1933, p. 669), speaking of "*P. punctatum* Stahl sp. auct.," Arkell (1939 p. 143), and Jeannet (1951, p. 55) do not seem to consider Douvillé's form fully conspecific with the true *Ammonites punctatus*. These students' example is here followed, and the varietal name "*douvillei*" proposed by Jeannet for Douvillé's form is here raised to specific rank. In addition to Douvillé's type series, the Callovian form considered by de Tsytovitch (*loc. cit. in synon.*) as the "var. type" of *H. punctatum* and the form here under discussion are believed to be referable to *H.* (*P.*) *douvillei*. Some of our specimens indeed resemble strikingly those of these two authors. This holds true especially for our numbers 8, 11, and 12 (figs. 16, 17, 23, 24), which are closely comparable to Douvillé's figures 4, 3, and 2, and for our number 7, which is very similar to de Tsytovitch's figure 6. The more densely costate specimens among those measured and figured by Jeannet have, however, been excluded from the synonymy of this species.

The true *H.* (*P.*) *punctatum* seems to differ from the present species chiefly by its massive keel and strongly recurved ribs.

Within the Mount Hermon fauna *H.* (*P.*) *douvillei* is most closely related to *H.* (*P.*) *schumacheri*, but it is readily distinguished by its heavier and less dense costation, by the earlier appearance of alternating longer and shorter ribs and of single ones, and by its more closely set, more elaborate sutures with, as a rule, less stubby points of the first lateral lobes. Some individuals of the present species, especially the more evolute and coarsely sculptured ones of medium size, share, however, almost fully the sutural characters of *H.* (*P.*) *schumacheri*.

Distinction of the three following species from the present species is much easier because their common characteristic, the meeting of the ribs from either side at the median

[1] For more complete synonymies, see Bonarelli (1893, pp. 85, 86), de Loriol (1898, p. 32; 1900, p. 34), Lóczy (1915, pp. 320, 321), and Lemoine (1932, p. 68).

line or their uninterrupted crossing of the venter, never occurs in *H.* (*P.*) *douvillei.*

MATERIAL STUDIED: Fourteen specimens, including two half-disks and two whorl fragments.

Hecticoceras (Putealiceras) caelatum ([Coquand] de Loriol)

Plate 10, figures 27–36; plate 11, figures 1–32

Hecticoceras caelatum, Coquand; DE LORIOL, 1898, p. 38, *cum synon.*, text fig. 11, pl. 3, figs. 13–15.

?Hecticoceras bernense DE LORIOL, 1898, p. 42, pl. 3, fig. 23.

Hecticoceras coelatum Coquand; MAIRE, 1928, p. 8, pl. 1, fig. 2.

?H[*ecticoceras*] *Schumacheri* Noetl.; FREBOLD, 1928, p. 187, *pro parte.*

Putealiceras caelatum, Coquand sp.; SPATH, 1928, p. 102.

H[*ecticoceras*] *coelatum* Coquand *in* de Lor.; LEMOINE, 1932, p. 493.

?Hecticoceras rossiense Tiess. [*recte:* Teiss.); VAUTRIN, 1934, p. 1439.

DIMENSIONS

A.M.N.H. No. 27901	D	H	H′	W	U
1 (nucleus)	2.09 mm.	46	39½	50	35½
2	4.26 mm.	39	?	39	*ca.* 37
3	4.61 mm.	39½	34	38	36
4	4.87 mm.	39½	?	?	37½
6	5.13 mm.	40½	?	*ca.* 35½	30½
8	5.47 mm.	43	*ca.* 38	36½	32
9	5.47 mm.	39½	33½	37½	33½
10	5.65 mm.	40	*ca.* 35½	*ca.* 34	34
11	5.65 mm.	38½	*ca.* 34	38½	37
12	5.82 mm.	41½	*ca.* 36	*ca.* 34½	31½
13	5.82 mm.	37½	?	?34½	37½
15	6.08 mm.	38½	*ca.* 33	32	37
17	6.26 mm.	37½	32	34½	36
18	6.52 mm.	41½	?	36½	34
19	6.78 mm.	41	36	32	36
20	6.87 mm.	43	36½	34	31½
21	6.95 mm.	40	31	?[1]	33½
22	7.21 mm.	41	35	35	35
23	7.30 mm.	41½	*ca.* 35½	34½	33½
24	7.30 mm.	41½	?	33½	33½
25	7.56 mm.	41½	*ca.* 35½	34½	34½
26	7.73 mm.	44	35	36½	31½
27	7.82 mm.	42	?	31½	34½
28	7.82 mm.	41	35½	33½	34½
29[2]	8.08 mm.	39	35	37½	36½
30	8.26 mm.	41	36	30½	35
5	8.26 mm.	43	?	31½	31½
7	8.26 mm.	41	35	35	33½
14	8.69 mm.	43	35	33	33½
16	8.69 mm.	44	?	*ca.* 40	32
31	9.12 mm.	41	?	*ca.* 33½	35
32	9.47 mm.	41½	35	37	35
33	9.73 mm.	44½	39½	35½	30½
34	9.99 mm.	42½	35½	*ca.* 31½	33
35	10.34 mm.	42	?	34½	33½
36	10.34 mm.	41	37	35½	34½
37	10.43 mm.	46½	38½	34	30
38	10.60 mm.	40	34½	29½	33
39	11.21 mm.	39	?	*ca.* 31	36½
40	11.73 mm.	45	?	34	32½
42	12.34 mm.	41½	35	35	38
43	13.12 mm.	45½	41½	*ca.* 30½	36½
44	13.56 mm.	41½	36½	*ca.* 30	32½
45	13.64 mm.	42	?	35	34½
46	14.08 mm.	40	34	30	32
47	14.77 mm.	45½	?	31[3]	30½
48	15.7 mm.	45	?	*ca.* 30½	32½
49	15.9 mm.	44	34½	32	35
50	16.3 mm.[4]	41[4]	?	32[4]	38[4]
51	16.6 mm.	47	?	32	30
52	16.7 mm.	46	36	31½	31½
53	17.2 mm.	45	?	31½	31½
54	18.6 mm.	46	?	28½	32½
55	19.0 mm.[5]	49[5]	?	*ca.* 29½[5]	30[5]
56	19.7 mm.	48	?	32½	26½
57	24.0 mm.	46	?	28½[6]	26½

[1] Distorted.

[2] Transitional in shell shape and ornamentation to *H.* (*P.*) *solare.*

Specimen 57 is the largest measurable, though incomplete disk present, but the whorl fragments numbers 41, 58, and 59, the latter two badly crushed, correspond at their anterior ends to diameters of about 25 mm., 35 mm., and 37 mm., respectively.

The above table clearly shows that the shells tend to become more involute with growth. The lowest values for H are found below the diameter of 6.5 mm. (nos. 11, 13, 15, 17) and the highest above that of 16.5 mm. (nos. 47, 48, 49). Similarly, some of the widest umbilici are encountered among the smallest shells (nos. 2, 4, 11, 13, 15) and all the narrowest umbilici among the largest (nos. 51, 54–57). This increase in the degree of involution is, however, not general. It will be noted in the table that, whereas as a rule H exceeds U, sometimes quite considerably, this difference is greatly reduced in several specimens (nos. 2–4, 15, 17, 29, 39) and that U even equals H in one (no. 13), although it

[3] At D=13.5 mm.

[4] Deformed anteriorly; measured at D=15.7 mm.

[5] Deformed anteriorly; measured at D=18.1 mm.

[6] Slightly crushed.

never exceeds it. As in *H.* (*P.*) *schumacheri* and in the following species, more and less involute shells occur side by side in the present species, as exemplified by the pairs numbers 10 and 11, 12 and 13, 17 and 18, 50 and 51, each of which consists of one more and one less involute shell, both of the same, or approximately the same, size. This accounts for the fact, surprising at first sight, that the very widest umbilici occur not among the smallest juveniles but in two medium-sized shells (nos. 42, 50). Both these individuals thus become transitional in shell shape to *H.* (*P.*) *solare*, but as distinction between that species and the present one is based chiefly on the whorl section, these individuals have been left with *caelatum*.[1]

Another growth trend that can be deduced from the above table is that towards decreasing thickness of the disks. The nucleus of number 1 exhibits, as might be expected, a value of W (50) far exceeding that of any later ontogenetic stage. Beyond the earliest stage, values for W from 36½ to 40 are found only below the diameter of 9.5 mm. (in nos. 2, 3, 8, 9, 11, 18, 26, 29, 16, 32), and values of 30 and less only above the diameter of 10.5 mm. (in nos. 38, 44, 46, 54, 55, 57), with the very lowest (28½ and 29½) present in three among the four largest measured specimens.

In one of the largest complete disks (no. 56) the last septum can be located at a diameter of somewhat more than 15 mm., but the whorl fragment 41 is septate up to the anterior end which corresponds to a diameter of about 25 mm. The two crushed fragments 58 and 59, corresponding to diameters of about 35 mm. and 37 mm., appear to be unseptate. From these data the maximum diameter attained by complete disks of this species at Majdal Shams may be estimated at about 45 to 50 mm., as compared to a maximum diameter of 31 mm. actually measured by de Loriol among the specimens from Authoison and to a diameter of 36 mm. attained by the single, entirely septate individual from Chatillon on which that author based his species *H. bernense*, which is probably synonymous with the present one.

DESIGNATION OF TYPE: The specimen from Authoison (Haute-Saône) illustrated in de Loriol (1898, pl. 3, figs. 14 and 14a), which resembles most closely the largest well-preserved specimen from Majdal Shams (no. 41) is hereby designated lectotype of *H.* (*P.*) *caelatum*.

DESCRIPTION: The protoconch can be seen in side view in the juvenile 24; it does not differ in any way from that of other *Hecticoceras* species that can be examined in the present material.

On the other hand, the juvenile 21 is the only one among about 7600 ammonites examined in the present report that has the apertural margin preserved, though not completely. The lateral lappet is entire on the left side and almost so on the right (pl. 10, figs. 27, 29). On the right side it has its apex at about the inner third of the flank, on the left a little farther dorsad. This difference is due to the fact that the body chamber is crushed, as usual, but it is difficult to decide which side is more affected by the ensuing distortion. However, the aspect of the left side seems to agree well, as to the site of the lappet, with d'Orbigny's figure 3 of his plate 157 ["*Ammonites lunula*, Zieten" = *H.* (*P.*) *punctatum* (Stahl)]. The median rostrum is unfortunately not fully preserved, but its base can be recognized in both ventral view and right side view (pl. 10, figs. 27, 28). In this juvenile the body chamber occupies about two-thirds of the last volution.

At the earliest stage observable (nucleus of specimen 1, diameter about 2 mm.) the whorl profile is subcircular and somewhat wider than high (pl. 10, fig. 30). This ratio is reversed in the whorl profile of the juveniles 9 (pl. 10, fig. 34) and 11, but there it can clearly be seen to taper more decidedly ventrad than dorsad and should therefore be termed broad-oval rather than subcircular. In further development the whorl section soon becomes more slender, more so in some individuals (no. 28, pl. 11, fig. 1) than in others (nos. 32, 45; pl. 11, figs. 14, 9) where the ventrad tapering of the profile is less distinct so that it might be called broad-elliptic as well as oval. Despite variation in width it remains essentially the same up to the greatest diameters at which uncrushed disks or fragments are available; the fragments 42, 52, 60, 61, and 41 are illustrated as examples

[1] Both these individuals and, in addition, numbers 14, 29, 43, 45, 51, 53, and 56 also approach *H.* (*P.*) *solare* in having a slightly truncate, though narrow venter.

(pl. 11, figs. 7, 11, 19, 23, 22). However, a group of other shells (nos. 14, 43, 45, 50, 51, 53, 56), which range in diameter from 8.69 mm. to 19.7 mm., deviate from the normal by having a distinctly truncate venter (pl. 11, figs. 6, 9, 17); in this character they are transitional to *H.* (*P.*) *solare*, but the venter, though truncate, is not so wide as it is in typical individuals of that species. Because the specimens here dealt with otherwise agree better in shell shape and ornamentation with the present species they have been left with it.

Ornamentation appears in this species (as in the following one) earlier than in any species hitherto discussed in the present report. In the juvenile 2 indications of blunt nodes, four to a quarter-whorl, can be recognized a little dorsad of the middle of the flanks as early as from a diameter of about 3.5 mm. In the juveniles 4 and 6 these tubercles, of which five are here counted on one half-whorl, can be seen gradually to extend in a radial direction so that in the anteriormost quarter they have changed into short, heavy ribs which are, however, still restricted to the inner zone of the flanks (pl. 10, fig. 31). In the juveniles 8 and 9 the tubercles persist longer; they are particularly pronounced in number 9 (pl. 10, fig. 33). They are somewhat reminiscent of those encountered at the same early stage in *Aspidoceras* (*Euaspidoceras*), except that there they are more closely set and situated on the lateroventral shoulder.

At this early stage there is much variation in the development of the ornamentation. Thus only four indistinct short ribs per half-whorl can be counted in the juvenile 10, but seven and nine, respectively, in the juveniles 13 (pl. 10, fig. 35) and 18, while in number 11, of exactly the same size as number 10, the ornamentation, of the same density as in number 13, changes within half a whorl from bullate nodes to nearly straight, radial ribs which extend well over the inner two-thirds of the sides (pl. 10, fig. 32). In the juveniles 13 and 15, exhibiting the same change, these ribs, in contrast, are strongly recurved from the outset (pl. 10, figs. 35, 36), and in number 18 they even begin to form sickles which extend as far as the lateroventral shoulder. However, in the juvenile 17, intermediate in size between 15 and 18, the ornamentation is still restricted to faint nodes.

The juvenile 25, although attaining only about 7.5 mm. in diameter, exhibits already the characteristic costation of later stages of this species. Eight primary ribs are present on the anterior half of the outer volution; three of these bifurcate at the inner fourth of the sides; farther orad, two short ribs are intercalated between two primary ones. All these add up to 13 ribs, as counted around the periphery. From a diameter of about 6 mm. these ribs form tongue-shaped chevrons on the venter; these chevrons cross it without being disturbed by the median keel which has appeared, indistinctly, only a little later (pl. 11, figs. 4, 5). The same character of ornamentation, which is essentially that of the mature stage, prevails also in the somewhat larger, particularly fine specimen 32 (pl. 11, figs. 12, 13). Here there are simple hooks up to a diameter of about 6 mm., then follow, first, a single bifurcating rib and, from a diameter of 7 mm., regular alternation of long and short ribs. The former are elegantly sigmoidal, the latter sickle-shaped, and all are essentially radial in direction. A total of 14 costae is counted along the periphery of the anterior half-whorl. They cross the venter and the median keel, appearing at a diameter of 7 mm., in a forward convex sinus.

In contradistinction to these shells and others with the same or a closely similar ornamentation (nos. 33–37), number 29, somewhat transitional to *H.* (*P.*) *solare*, carries only single, robust, sigmoidal ribs up to a diameter of 8 mm., and those of number 39, of medium size, stand markedly farther apart (10 per half-whorl); only in the anteriormost portion of this shell are one or two secondary costae intercalated between two primary ones.

On the whole, however, the kind of ornamentation exhibited by the afore-mentioned shells 25 and 32 persists up to a diameter of 25 mm. (nos. 43, 56, 41; pl. 11, figs. 15, 17, 18, 20, 21); on the anteriormost portion of the first individual the ribs are so strong in crossing the venter that it begins to assume a cockscomb-like aspect in side view; on the two others bifurcation can be found side by side with intercalation of secondary ribs. There are, as could be expected, minor variations. Thus the costation is more dense than usual, with 16 and 17 ribs, respectively, to a half-whorl, and bifurcation persists longer, in specimens 42 and 48 (pl. 11, fig. 10); the ribs do not cross the venter in full strength, and the keel is somewhat stronger there than the costae, in number 40; and the ribs are a little recurved in specimen 44 (pl. 11, fig. 16) and in the evolute fragment 62.

In the latest ontogenetic stage observable, as represented by the crushed whorl fragments 58 and 59 (pl. 11, fig. 24) the ribs, the number of which may now be estimated at 16 per half-whorl, become as broad as the intercostals and, at least in number 59, markedly less sigmoidal than they were at earlier stages. In this fragment they cross the venter in an almost horizontal line, and the keel becomes more ridge-like (pl. 11, fig. 25).

Suture lines can well be studied from a diameter of less than 3.5 mm. in the small juvenile 3 (pl. 11, fig. 28). They stand almost as far apart as in *H.* (*P.*) *schumacheri* at the same stage (three per quarter-whorl), but they are not so primitive and their saddles and lobes are not so plump. The first lateral lobe is slender and trifid, and both main saddles are indented by little lobules. At a diameter of about 5 mm. the sutures are rather less indented but more closely set (five per quarter-whorl) in the juvenile 11. The density is only four per quarter-whorl in number 17 at diameters between 5 and 6 mm. but the indentation is richer again; the second lateral lobe shows an indication of trifidity, and there are two auxiliaries, each followed by a small auxiliary saddle (pl. 11, fig. 3).

With increasing size the degree of indentation also gradually increases (nos. 24, 7, 32, 33, 36, 40; pl. 11, figs. 8, 13, 29), with the density remaining at four per quarter-whorl. Of the specimens just mentioned, number 32 is remarkable for suture lines which recall those of *H.* (*P.*) *schumacheri* both in the plumpness of their main elements and in the stubbiness of the points of the first lateral lobe, with the middle point exceeding the lateral points only slightly in length. These same characters are in another group of individuals, ranging in size from 6.5 to 13.5 mm., combined with increased density of the sutures of which there are at least five per quarter-whorl; specimens 63 and 64 are illustrated as examples (pl. 11, figs. 31, 30).

Other individuals, however, approach *H.* (*P.*) *separandum*, both in degree of indentation and in density of the sutures. In these, too, there are at least five sutures to a quarter-whorl as early as at diameters of from 5 to 7.5 mm., but both saddles and lobes are markedly more slender and more elaborate than in the preceding group. The second lateral lobes are particularly long and slender and tend to become asymmetrically trifid, with the inner lateral point at a considerably lower site than the outer and somewhat stunted. Despite its smallness, the juvenile 65 (pl. 11, figs. 26, 27) serves as an excellent example of this group, to which numbers 40 and 44 also belong.

Still a third group, including numbers 66 and 48 (pl. 11, figs. 32, 10), is, at the same density of the sutures, intermediate between the two groups just discussed, both in the degree of indentation and in the slenderness of the main lobes.

The latest suture lines observable in this species, those of the whorl fragment 41 (pl. 11, fig. 21), show richly elaborate first and second lateral lobes, with the middle points far exceeding the lateral ones in length and carrying two or even four secondary prongs each, but rather sturdy main saddles. The density has increased to six sutures per quarter-whorl.

The juvenile 67 may be mentioned for having, on the right side only, two-pronged middle points of the first lateral lobes.

REMARKS: This diminutive species, named earlier by Coquand but published only in 1898 by de Loriol, is here recorded from Mount Hermon for the first time.

The possibility that some of the whorl fragments recognizable on the piece of limestone A.M.N.H. No. 27379/1 may belong to this species rather than to *H.* (*P.*) *schumacheri* is mentioned, although it is considered unlikely, at the end of the section on the latter species. However, so long as the behavior of the ribs on the venter cannot be examined, the question cannot be safely decided.

Similarly, the *H. rossiense* recorded by Vautrin from the Anti-Lebanon and assigned by that author to the late Callovian may rather belong to the present species. A comparison of figures 14 (*caelatum*) and 16 (*rossiense*) of de Loriol's (1898) plate 3 proves best that these two species cannot really be distinguished in side view.

As far as I could ascertain, the only other *Hecticoceras* (*sensu lato*) species in which the ribs from either side meet on or cross the venter is *Kheraites? varicosus*[1] Spath (1928, p. 109, pl. 11, fig. 8) which is, however, more evolute and has a much wider, almost reniform whorl section.

The form from Majdal Shams agrees so well with the forms from the Jura and from the Franche-Comté that there can be no doubt about their conspecificity. This is best documented by the almost perfect agreement of our whorl fragment 41 (pl. 11, figs. 20–22) with the lectotype from Authoison (de Loriol, 1898, pl. 3, figs. 14, 14a) and with the typical specimen from the same locality illustrated in Maire's figures 2, 2a. However, it is difficult to understand how the close similarity to *H.* (*P.*) *caelatum* of the single specimen from Chatillon named *H. bernense* by de Loriol could escape that author to the extent that, without even mentioning *caelatum* as a related form, he stated: " . . . je n'en connais aucune [espèce] avec laquelle elle pourrait être confondu." On the contrary, comparison of figures 24 and 25 of our fragment 59 with de Loriol's figures 23 and 23a shows that "*Hecticoceras bernense*" most probably is a crushed large specimen of *caelatum*. The narrowness of the umbilicus (U=22), emphasized by de Loriol, is quite in line with our table of dimensions in which U comes at the diameter of 24 mm., amounting to only two-thirds of the maximum diameter, as far down as 26½.

Within the present assemblage this species is most closely related to *H.* (*P.*) *schumacheri* on the one hand and to *H.* (*P.*) *solare* and *H.* (*P.*) *separandum* on the other. The last two species are compared below (pp. 76, 79) with the present form. From *H.* (*P.*) *schumacheri* it differs, in addition to its markedly smaller size, in the fact that its ribs meet on or cross the venter, in the regular alternation of longer and shorter ribs which dominates the ornamentation, in the stiffening and broadening of the costae at a smaller size, and in its suture lines which, except in the very earliest stages, are more closely set and always more elaborate, although some resemble those of *schumacheri* in certain features.

Even in side view *Hecticoceras* (*P.*) *douvillei* is readily distinguishable from *H.* (*P.*) *caelatum* by its heavier and less dense costation; it also has stouter whorls.

MATERIAL STUDIED: Three hundred and forty-one specimens, including incomplete specimens and fragments.

Hecticoceras (Putealiceras) solare, new species
Plate 11, figures 33–57; plate 12, figures 1–12

DIMENSIONS

A.M.N.H. No. 27902	D	H	H′	W	U
1 (nucleus)	1.41 mm.	38½	32½	59	37
2	3.39 mm.	40	33½	43½	36
3	4.08 mm.	40½	36	40½	32
4	4.08 mm.	38	34	44½	34
5	4.30 mm.	38½	32½	40½	32½
6	4.35 mm.	40	35	40	34
8	4.69 mm.	39	?	41	35
9	5.13 mm.	37½	?	39	37½
11	5.30 mm.	39½	ca. 36	37½	36
12	5.82 mm.	36	31½	37½	39
13	5.91 mm.	39½	36½	38½	35½
14	6.17 mm.	38	34	36½	36½
15	6.52 mm.	41½	34½	40	33½
16	6.52 mm.	38½	33½	38½	36
17	6.78 mm.	40	32	38½	34½
18	6.95 mm.	36	31	36	39
19	6.95 mm.	41	?	39	34
20	7.21 mm.	43½	35	42	32½
21	7.21 mm.	38½	?	42	42
22	7.21 mm.	35	29	41	38½
23	7.30 mm.	40½	34½	38	33½
24	7.39 mm.	35½	31½	39	39
25	7.86 mm.	37½	ca. 31	36½	40
26	7.91 mm.	42	ca. 35	39½	34
27	8.08 mm.	40	32	37½	34½
28	8.69 mm.	40	33	37	35
29	8.69 mm.	45	?	46	31
30	8.91 mm.	40	35	36	30
31	9.12 mm.	38	32½	36	37
32	9.12 mm.	41	33½	36	34½
33	9.21 mm.	35	31	34	40½
34	9.82 mm.	35½	ca. 31	34½	40
35	9.91 mm.	43	ca. 36	ca. 39½	33½
36	9.91 mm.	39½	?	38½	37

[1] In choosing the specific name, Spath alluded to the similarity of his species in ventral ornamentation with *Hysteroceras varicosum* (Sowerby). Similarly, I was struck, long before knowing of the existence of Spath's species, by this similarity to the extent that I originally used "*varicosum*" as a working name for this, then not identified, species.

A.M.N.H. No. 27902	D	H	H′	W	U
37	9.99 mm.	40½	?	40	34
38	11.30 mm.	45½	37	35½	30
39	11.39 mm.	39½	?	36	36½
41	11.39 mm.	36½	?	34½	40½
42	11.73 mm.	45	ca. 35½	40½	29½
43	11.99 mm.	39	32½	32	36
44	12.77 mm.	40	ca. 33½	32½	37
45	13.56 mm.	40	ca. 33½	32½	36
46	14.08 mm.	40½	33½	36	32
47	15.2 mm.	37½	33	33½	30½
48 (syntype A)	15.5 mm.	35	29½	33½	41½
49	17.0 mm.	40½	36½	36½	ca. 37½
50	19.4 mm.	45½	?	31	33
51	21.0 mm.	36½	?	28	37
52	21.7 mm.	44	?	ca. 32½	33
53	25.4 mm.	40	34	ca. 27	39½

Paratype 53, a half-whorl septate in the posterior quarter only, is the largest specimen that can properly be measured. The whorl fragment 54 (syntype B) seems to be from a disk of about the same diameter as number 53, but the fragments 55, 56, and 57 correspond to greater diameters, viz., of about 28, 32, and 35 mm., respectively.

Even if the barrel-shaped nucleus of paratype 1, in which W exceeds H by more than one-half, be left out of account, a trend of the conchs to become thinner with growth is clearly recognizable. The two thinnest shells (nos. 51, 53) are among the three largest measured, and two of the thickest ones (nos. 2, 4), aside from the afore-mentioned nucleus, among the three smallest, but paratype 29, more than twice as large, is even thicker (W=46).

A trend towards increasing involution, if present, is not clearly recognizable. As in other species of this subgenus, more and less involute shells occur at the same, or nearly the same, sizes. Specimens 18 and 19, 20 and 21, 23 and 24, 25 and 26, 32 and 33, 34 and 35, 39 and 41, 47 and 48, have deliberately been paired in the table to demonstrate this. Whereas in one member of every one of these pairs H exceeds U, sometimes quite considerably, the opposite ratio prevails in the other member. Thus it is not surprising that the highest values for H and the lowest for U are scattered all over the lower half of the table (nos. 29, 30, 38, 42, 43, 47, 50) and that the lowest values for H and the highest for U are found repeatedly between the diameters of 7.21 mm. and 15.5 mm. (nos. 21, 22, 24, 33, 34, 48). Because this species tends on the whole to be more evolute, or less involute, than its two closets relatives, *H.* (*P.*) *caelatum* and *H.* (*P.*) *separandum*, individuals with comparatively wide umbilici have been chosen for types (see below).

The last septa can be located at diameters of from 16 mm. to 21 mm. in the four largest paratypes, whereas the whorl fragments nos. 54–57, corresponding to diameters of up to about 35 mm., appear to be unseptate. From these observations the maximum size attained by this species may tentatively be estimated at from 40 mm. to 45 mm.

Designation of Types: The medium-sized specimen A.M.N.H. No. 27902:48 is considered the most characteristic complete disk and is therefore selected as syntype A. In addition, the whorl fragment A.M.N.H. No. 27902:54, believed to illustrate best the mature whorl profile and ornamentation, is designated syntype B.

Description: The protoconch, measuring about 0.1 mm. in diameter, can well be recognized in the side view of paratype 1 (pl. 11, fig. 36).

In early youth the whorl profile is circular (no. 3, pl. 11, fig. 34), transverse-elliptic (nos. 58, 22, pl. 11, figs. 38, 49), or subquadratic with rounded lateroventral and umbilical shoulders (no. 10, pl. 11, fig. 37; no. 15). In the further course of development the venter tends to become wider and more and more truncate (nos. 32, 37, 43; pl. 11, figs. 41; pl. 12, figs. 1, 9). In most individuals the whorl section is about as wide as high, but in others (e.g., no. 43) it is more slender. The flanks tend to flatten in some shells (nos. 46, 50; pl. 11, fig. 56, pl. 12, fig. 6) but are quite convex in others, e.g., in syntype A (pl. 11, fig. 52). The mature whorl profile, with the costal section almost as wide as high, gently convex flanks, and a wide, decidedly truncate venter, is best exemplified by syntype B (pl. 11, fig. 43).

A median keel appears at a diameter of about 7.5 mm. (paratype 34) but it remains distinct only exceptionally (no. 40, pl. 11, fig. 53); in most individuals, however, it is exceeded in strength and, later in the ontogeny, all but obliterated by the ribs crossing the venter.

The ornamentation of this species develops in the same way and is essentially the same as that of *H.* (*P.*) *caelatum*. Here, too, the first faint indications of tubercles are recognizable at a very early stage, namely, from a diameter of 2.75 mm., in the juvenile 3 (pl. 11, fig. 35). They are more distinct but still blunt in paratype 6 where four are counted per half-whorl, whereas they are quite sharp and reminiscent of those described above in specimen 9 of *caelatum* and begin to elongate radially in paratype 7 (pl. 11, fig. 33). At diameters between 4 and 6 mm. these nodes gradually change into short ribs which are at first restricted to the middle zone of the flanks and keep a node- or hook-like appearance in some juveniles (e.g., no. 14, pl. 12, fig. 3; no. 9) but become more linear and more closely set (four to a quarter-whorl) in others (e.g., nos. 8, 11). In the slightly larger paratype 17 (pl. 11, fig. 39), however, true, still hook-shaped, rather heavy ribs extend well into the outer zone of the sides; they, too, number four per quarter-whorl. Soon the ribs, assuming a more or less distinctly sigmoidal course, extend all the way to the periphery, and secondary ribs begin to be intercalated in the outer third of the flanks (nos. 20–23, pl. 11, figs. 46, 48). Including these secondary ones, the total number of ribs is 11 on the anterior half-whorl of paratype 22. Towards the anterior end of this paratype the ribs tend to continue on the venter, and some of them cross it (pl. 11, fig. 47). They do so more distinctly and regularly in a forward convex tongue in the somewhat larger paratype 28 from a diameter of about 6 mm. on (pl. 11, fig. 40).

The character of the costation does not change much in the next stage, corresponding to diameters from 9 to 12 mm. Paratype 32 (pl. 11, fig. 42), in which two bifurcating ribs precede the regular alternation of long and short ones, serves as a typical representative of this stage, whereas the ribs are more sharp, sigmoidal, and closely set (14 per half-whorl) in paratypes 33 and 37 (pl. 11, fig. 57; pl. 12, fig. 2). In paratype 33 they are, in addition, decidedly recurved. Paratype 43 stands out by having on the posterior half of the outer whorl only a weak costation which then changes rather abruptly to one normal for this size (pl. 12, fig. 8).

The ornamentation of medium-sized shells is best exemplified by paratype 46 (pl. 11, figs. 54, 55) and syntype A (pl. 11, figs. 50, 51). In both, 14 ribs are counted along the periphery of the last half-whorl, and bifurcation gives way, at diameters of 10 and 14 mm., respectively, to alternation of long and short ribs. The same change occurs at a diameter of about 21 mm. only in the half-whorl 53 which carries 16 decidedly recurved ribs. Only alternation is found, however, in the three large whorl fragments numbers 54–56, among which syntype B (pl. 11, figs. 44, 45) seems to represent best the fully mature sculpture of this species. It differs from that of earlier stages only by the strong development of the ribs on the venter which they now cross in a straight line, with node-like swellings on the shoulders. Between these nodes the ribs appear markedly lower in the median zone, and the keel, now far exceeded in strength by the costae, remains visible in the intercostals only. In the six shells discussed in this paragraph the ribs appear to be more recurved than at earlier stages.

The earliest good suture lines can be studied in paratype 8 at diameters from 3.5 to 4.5 mm. (pl. 12, fig. 10). They are less primitive than would be expected, showing clearly trifid first lateral lobes and distinctly indented main saddles. Four are counted on the last quarter-whorl.

The density has increased (to five per quarter-whorl) in the juvenile 18 but not the indentation. Rather, the points of the first lateral lobe appear blunter than in the smaller shell. The sutures of paratypes 19 and 21 are more elaborate. Here the second lateral lobes, too, are distinctly trifid, but the points of the first are stubby, especially so in number 21 (pl. 12, fig. 11). The suture lines of paratype 32 (pl. 11, fig. 42), well exposed up to a diameter of 6.7 mm., are remarkable for combining a long and slender second lateral lobe with a first of which the three points are uniformly short and blunt. In contrast, the middle points of these lobes are long, and the sutures altogether more richly indented in paratype 3 at a diameter of about 9 mm., whereas those of paratype 33 (pl. 11, fig. 57) are less elaborate but crowded towards the last (six per quarter whorl) and those of paratype 36 are particularly plump, reminiscent of those of *H.* (*P.*) *schumacheri* at the same stage. Paratype 59 may be said to be intermediate between numbers 36 and 3, inasmuch as its saddles are low and both lateral lobes short but also pronouncedly trifid, with middle points markedly longer than the lateral ones (pl. 12, fig. 12).

The same wide range of variation and especially the same occurrence of more and less elaborate suture lines side by side are encountered up to the greatest diameters at which sutures can be studied in this species. Thus they are rather closely set (five per quarter-whorl) and elaborate in paratypes 38 and 40, with the second lateral lobes becoming asymmetrically trifid in the latter to the extent that they might be called irregularly bifid as well, but the sutures remain rather plump and farther apart in paratype 43 (pl. 12, fig. 8). The four largest individuals that exhibit sutures (though imperfectly), namely, syntype A and paratypes 50, 52, and 53, seem to be intermediate with regard to both spacing and elaboration.

REMARKS: The trivial name of this species is derived from "Shams" (the sun) in the locality name Majdal Shams.

Hecticoceras (*P.*) *solare*, an even more diminutive species than *H.* (*P.*) *caelatum*, is most closely related to the latter. It differs in the stouter whorl profile which tends to become quadratic in maturity, especially in the wide and truncate venter, and in being somewhat more evolute on an average. In ornamentation the two species resemble each other closely, except that on the broad venters of *solare* the ribs can develop to such strength as they never attain in *caelatum*, and even tend to form nodes on the shoulders. The suture lines, which are, like those of *caelatum*, intermediate in both density and elaboration between those of *schumacheri* and those of the following species, cannot be considered distinctive of this species.

The question may arise whether *solare* should not be considered merely a morphologic variety of *caelatum*. The fact that the latter differs from the former in more than one essential feature and that these distinctive characters, especially of the whorl section, can be followed throughout development seems to call for specific rank for the form under discussion.

Maire (1928, pp. 8, 9, pl. 1, figs. 3, 4) splits from *H.* (*P.*) *caelatum* two varieties, *inflata* and *perinflata*, which, as does the present species, differ from the typical *caelatum* in being stouter and more evolute; the var. *perinflata* has, in addition, a pronouncedly truncate venter in common with *solare*. However, Maire points out in his descriptions that the ribs stiffen with growth on the flanks of his var. *inflata* and that they are straight "dès leur naissance" in the var. *perinflata*, whereas in *solare* they are, if anything, rather more sinuous than in the true *caelatum*. Despite some striking similarities the present species can therefore not be considered conspecific with either of Maire's varieties.

Hecticoceras (*P.*) *caelatum* resembles in side view also some evolute individuals of *H.* (*P.*) *douvillei*, as enountered on Mount Hermon, but the ribs never meet on the venter in the latter species, let alone cross it.

Hecticoceras (*P.*) *separandum* is compared below (p. 79) with the present species.

Occasional convergence between the present species and forms of *Ochetoceras* (*Campylites*) is mentioned in the discussion of *O.* (*C.*) *evolutum* (p. 96).

MATERIAL STUDIED: Ninety-five individuals, including incomplete specimens and fragments.

Hecticoceras (Putealiceras) separandum,
new species
Plate 12, figures 13–48

DIMENSIONS

A.M.N.H. No. 27903	D	H	H′	W	U
60	5.04 mm.	?46½	?38	*ca.* 34½	29½
1	5.21 mm.	37½	?	39	37½
2	5.39 mm.	42	*ca.* 35½	35½	30½
3	5.74 mm.	44	?	33½	32
4	5.91 mm.	39½	36½	35½	36½
5	5.91 mm.	41	*ca.* 35½	36½	34
61	6.06 mm.	41½	35½	32	33
6	6.17 mm.	41	35	35	35
7	6.26 mm.	39	34	30½	36
62	6.48 mm.	40	34½	31	33
63	6.60 mm.	42	38	29	31½
8	6.73 mm.	41½	35½	33½	36
9	6.95 mm.	43½	37	37½	33½
10	7.13 mm.	42½	36½	35½	33
11	7.21 mm.	42	*ca.* 37½	36	35½
12	7.30 mm.	43	35½	*ca.* 35½	33½
57	7.39 mm.	41	34½	33	34½
13	7.48 mm.	45½	?	32½	31½
14	7.73 mm.	44	?	33½	31½
15	7.82 mm.	44½	*ca.* 35½	35½	31
16	7.82 mm.	38½	32	31	37
17	7.91 mm.	43	?	?	34

A.M.N.H. No. 27903	D	H	H′	W	U
18	7.99 mm.	43½	38	30½	30½
19	8.08 mm.	42	36½	35½	33½
20	8.26 mm.	44	*ca.* 36	34	29½
64	8.26 mm.	43	37	29½	31½
21	8.52 mm.	44	36½	33	30½
22	8.69 mm.	44½	*ca.* 37	34	31½
23	8.78 mm.	47½	?	35½	29½
24	9.12 mm.	45	38	37	31
25	9.39 mm.	46½	38	35	28½
26	9.56 mm.	42½	36½	32	32½
27	9.65 mm.	44	?	*ca.* 34½	30½
28	9.73 mm.	47½	?	*ca.* 36½	27½
29	9.73 mm.	39½	35	33	38
30	9.99 mm.	47	?	35½	28½
59	9.99 mm.	45	?	31	28
66	10.17 mm.	43	37	30	31
31	10.43 mm.	43	36	30	31
32	10.43 mm.	43	38	34	29
55	10.69 mm.	46½	?	*ca.* 31½	27
34	10.78 mm.	46	?	*ca.* 33	29
65	10.95 mm.	43	36½	29½	31½
35	11.21 mm.	42½	?	29½	35½
56	11.47 mm.	47	38½	?	29
36	11.56 mm.	47½	?	34	37
37	11.73 mm.	46	?	30½	28½
38	11.99 mm.	46½	37	32½	27½
39	12.08 mm.	46	?	31½	29
40	12.51 mm.	45	?	28½	28
41	12.60 mm.	44	?	31½	29½
42 (syntype A)	13.03 mm.	44½	*ca.* 38½	30½	30
43	13.21 mm.	47½	37½	27	26½
44	13.38 mm.	46	38½	30	28
45	13.99 mm.	44	38½	29	30½
46	14.51 mm.	*ca.* 49	?	*ca.* 33	*ca.* 24
47	15.38 mm.	43½	36	30½	30
48	15.99 mm.	48½[1]	?	?[1]	26½
49 (syntype B)	17.47 mm.	49½	44	29	24½

None of the fragments referable to this species indicates a greater diameter than the one measured in syntype B.

This species tends to be rather involute; only in the most evolute shells does U equal (no. 1) or closely approach (nos. 16, 29[2]) H. As is manifested by the fact that the minimum for H and the near maximum for U are found in the smallest measured shell but one (no. 1) and the maximum for H and the near minimum for U in the largest (syntype B), the degree of involution increases with growth. The thickness, on the other hand, decreases with growth. The second smallest measured paratype is also the thickest, and the largest shell (syntype B) and the fifth in size (no. 45) are among the thinnest (W=29) and are exceeded in thinness only by the seventh in size (no. 43, W=27), though equaled in this respect by the small juvenile 63.

In the largest paratype (no. 48) and in syntype B the last septum is found around a diameter of 10 mm., but the second largest paratype, which attains a diameter of 15.38 mm., is septate throughout. At any rate, from our hypodigm the maximum diameter reached by this species cannot be estimated at more than 25 mm. to 30 mm. It is thus the smallest among the many *Hecticoceras* species of the Mount Hermon fauna.

Designation of Types: In addition to the largest specimen, A.M.N.H. No. 27903: 49, which exhibits the shell shape and ornamentation characteristic of this species and is designated syntype B, the medium-sized shell A.M.N.H. No. 27903:42 is selected as syntype A for showing best the suture lines distinctive of *H.* (*P.*) *separandum*.

Description: Shell comparatively involute and slender. The elliptic whorl profile tends to decrease in width even in the early stages of the ontogeny (nos. 7, 8, 58, 26; figs. 15, 13, 18, 24). In some of these shells the venter tends to become slightly truncate, as in paratype 8; in others the flanks converge somewhat more decidedly ventrad than dorsad, thus rendering the section transitional between an elliptic and an inverted-oval one (paratypes 58, 15, 26; figs. 18, 44, 24). In shells that appear to be somewhat transitional in shape and costation to *H.* (*P.*) *solare* (e.g., no. 32), the section may be wider and the truncation of the venter more pronounced (fig. 16). As best demonstrated by specimens 59, 56, 38, 42 (syntype A), 47, and 49 (syntype B), the flanks tend to flatten in the course of further development and the venter, though still narrow, becomes more distinctly truncate, with a median prominence caused by the keel where the latter is strong enough to affect the profile. Accordingly, both lateroventral and umbilical shoulders become more pronounced and the umbilical wall becomes steeper and higher (figs. 35, 21, 32, 39, 25, 26).

As in the two preceding species, the ornamentation develops early. In the two smallest measured paratypes blunt nodes change

[1] Body chamber crushed.

[2] Both these specimens are somewhat aberrant, especially paratype 16, which must be considered transitional to *H.* (*P.*) *solare*.

as early as at a diameter of not fully 3 mm. into gently forward convex, radial folds or ribs which in paratype 1 run from the umbilical almost to the outer shoulder. As many as six are counted on the last quarter-whorl (fig. 20). Thus a density of costation higher than in either *caelatum* or *solare* is indicated even at this early stage. This density is increased to seven costae per quarter-whorl in the slightly larger paratypes 5 and 6, while there are only five shorter ones in the somewhat larger paratype 8 (fig. 14). Where preserved, the costation is seen to be particularly delicate and closely set (seven per quarter-whorl) in paratypes 10 and 11 (fig. 27). In both these juveniles the ribs begin to assume a sigmoidal course and to unite on the venter in a forward convex tongue (fig. 17). The juvenile 13 is remarkable for showing on the right side short, hook-like ribs in the posterior portion of the outer whorl, while its anterior third appears smooth. On the left side of this shell, however, thin, strongly sigmoidal ribs, 10 of which can be counted per half-whorl, persist to the anterior end. Ten elegantly sigmoidal, still weak single ribs are counted on the last half-whorls of paratypes 15 (fig. 45) and 59. The costation of paratype 16 is retarded in development and remains restricted, in the form of short hooks, to the middle zone of the flanks and that of the juvenile 23 is somewhat subdued; it consists of very low, fold-like, sigmoidal ribs which extend over most of the flanks and of which only eight are counted on the anterior half-whorl (fig. 22).

Similarly feeble ornamentation is encountered in some larger shells also, up to diameters of 12.6 mm. (nos. 24–26, 30, 55, 56, 36, 39, 41). Of these, paratypes 25, 26 (fig. 23), 55, and 41 appear smooth, or nearly so, but all except number 55 show from two to four strongly sigmoidal ribs in their anteriormost portions. The sigmoidal ribs are very delicate in paratype 56 and just perceptible in paratype 36, which might be taken for individuals of *Campylites* were it not for the fact that the costae rise up to the venter and form chevrons there. In the second largest shell of this group (no. 39, fig. 37) the costation is still very delicate in the posterior part of the last whorl, but it gathers strength in its anterior half where 13 quite strong ribs are present, but indistinct in the circumumbilical zone so that primary and secondary ribs can hardly be distinguished. However, bifurcation of costae at first, then intercalation of secondary ribs are well observable in the last quarter-whorl of paratype 24, the only part of this shell with a true costation, consisting of 11 ribs.

In other individuals of this size group (paratypes 27, 29, 31–33, and 40 and syntype A) the ornamentation approaches that of the mature stage. It is of average fineness and density (nine or 10 costae on the last quarter-whorl) in paratypes 27, 31, and 40 and in syntype A (figs. 42, 28, 34, 31), somewhat coarser in paratype 32, one of those transitional to *H.* (*P.*) *solare*, but unusually fine and dense (20 per half-whorl) in paratype 33 (fig. 19). The most evolute specimen (no. 29) deviates in having similarly closely set but decidedly recurved costae. In this size group differentiation between primary and secondary ribs, the latter originating first by bifurcation and soon afterward by intercalation, becomes manifest only at diameters of about 8 mm., but this is largely due to the fact that ornamentation is, up to that diameter, distinct only in the outer zone of the flanks. In most of these individuals a median keel appears at about the same diameter. It is mostly still weak at this stage, but in paratype 40 it exceeds the costae markedly in strength (fig. 33); it is rather blunt in syntype A (fig. 30). The ribs now cross the venter quite regularly in a rather blunt chevron.

Among the seven largest disks, paratypes 43, 44, 47, and 48 agree essentially in ornamentation with paratype 40 and syntype A, the costation of which is described above, but paratypes 45 and 46 are aberrant, representing opposite extremes. In the former the ribs of the inner zone (five to a quarter-whorl) are much more pronounced than in any other individual of this size but those of the outer zone, originating by bifurcation of the former, are comparatively weak. In contrast, paratype 46, even at this comparatively late stage, is smooth except for crowded (about eight per quarter-whorl), fine sickles restricted to the outermost zones of the flanks.

Only syntype B can be said to exhibit the fully mature ornamentation of this species (figs. 25, 26). Only single costae show in the posterior part of the outer volution but altogether 18 primary and secondary ribs are counted on its unseptate anterior half; almost all the latter originate by bifurcation, but one or two primaries remain single. The ribs are elegantly sigmoidal and radial in direction. They are markedly stronger than the fine median keel which they cross in a flat, forward-pointing tongue.

The smallest paratype (no. 1) exhibits at diameters of from 3 to 4 mm. suture lines characterized by slender, clearly trifid first lateral lobes with a comparatively long and sharp middle point. Even at this early stage five sutures are present on a quarter-whorl. The sutures show similarly slender and indented main elements and are equally or even more closely set (five to six per quarter-whorl) in the small juveniles 8, 9, and 10. They stand farther apart in paratypes 61 and 62 (only three per quarter-whorl) and 63 and 12 (four per quarter-whorl), all of the same size group. Whereas in number 61 (fig. 43) the two lateral lobes are trifid but rather plump and short, they are much more slender and longer in the three other paratypes just mentioned; especially in numbers 62 (fig. 46) and 12 do the second lateral lobes nearly equal the first in length.

Paratype 14 gives an excellent example of the crowding and elaboration of the suture lines of this species as early as at diameters between 5 and 7.5 mm. (fig. 38). There are six sutures per quarter-whorl. Both lateral lobes are slender and trifid, with the middle points considerably exceeding the lateral ones in length; two, if not three, auxiliary lobes are present; both external and first lateral saddles are rather deeply indented by lobules. In paratype 15, of about the same size, and in the somewhat larger paratype 59 the sutures are less crowded (five per quarter-whorl), and lobes are deeper and saddles taller than in number 14, but the degree of indentation is about the same (figs. 44, 45, 35, 36). Wide and shallow siphonal lobes, with their broad median knobs just beginning to develop hornlets, are excellently exposed in the even smaller juvenile 50 (no. 41). The sutures of paratypes 19, 20, 22, 27, 29, and 64–66 (figs. 42, 47) agree fully, except for somewhat increased indentation, with those of the juvenile 14, but in the anterior portions of paratypes 18, 51 (fig. 48), and 52 the sutures are even more crowded (eight and 11, respectively, per quarter-whorl), perhaps only because the last is near. Those of paratype 30 (fig. 29), distinguished by particularly long and slender second lateral lobes with stunted inner lateral points, stand much farther apart (only five per quarter-whorl). Three auxiliary lobes are here clearly recognizable.

Most characteristic of the sutures of this species is, however, syntype A (figs. 30, 31) with eight richly elaborate lines on the anteriormost quarter-whorl. The long and slender middle points of the first lateral lobes now carry two secondary prongs each, and an outer such prong also appears in the middle points of the slender, asymmetrically trifid second lateral lobes. The first of the three auxiliaries is asymmetrically trifid, and also the second lateral saddle is now indented by a short lobule. The siphonal lobe is no longer so shallow and the three-cusped median knob is subquadratic in shape.

The sutures observable in paratypes 43, 44, and 46 and in syntype B agree more or less closely with those of syntype A, just described, but those of paratypes 45, 47, and 48 have sturdier saddles and lobes, the latter ending in shorter and blunter points, and thus somewhat resemble the suture lines of *H.* (*P.*) *solare* to which the first of these specimens (no. 45) appears to be transitional in other respects also.

Finally, minor sutural abnormalities occur in this species as well as in others of this genus. Thus the middle points of the first lateral lobes become two-pronged in specimen 53 and show a trend towards becoming so in specimen 54.

REMARKS: This species, smallest of the group of *H.* (*P.*) *caelatum*, differs from both that species and its closest relative, *H.* (*P.*) *solare*, not only by being more involute and slender and by the flatness of its flanks in maturity, but also in its ornamentation, which remains feeble until a late ontogenetic stage and is more dense and finer throughout development, and in its suture lines, which as a rule are much more elaborate and crowded than in the two other species of this group. As indicated in the trivial name, it must, therefore, be separated specifically from them. The fact that the venter becomes truncate from a medium growth stage provides still another difference from *caelatum* but not from *solare*, in which the venter is truncate, too, but always considerably wider than in the present species.

The distinctive character of this group, namely, the continuation of the ribs onto the venter on which they meet from both sides or which they even cross, dispenses with comparisons of this species with other Oppelidae, except certain juveniles of *Ochetoceras* (*Campylites*) at a stage at which the triple keel of that subgenus is not yet present. Being thinner, *H.* (*P.*) *separandum* may resemble them even more closely than the other two species of the *caelatum* group. Still, the behavior of the costae in approaching the venter and on it makes distinction possible.

Material Studied: One hundred and fifty-three specimens, including a few incomplete specimens and fragments.

OCHETOCERAS Haug, 1885

This genus is represented at Majdal Shams only by the following subgenus.

Subgenus CAMPYLITES Rollier, 1922

In maturity this subgenus is characterized by a sharpened venter which carries three sharp but comparatively low keels. There is, however, considerable variation, both interspecific and intraspecific, with regard to the ontogenetic stage at which these distinctive characters become manifest.

The slenderness of the shells and the shallowness of the umbilici expose the protoconch much more frequently in this group than in related ones. Moreover, they facilitate separation, by breakage or preparation or both, of inner nuclei so that their characters can be studied better than in other groups. One character observable in such nuclei, namely, the presence of one constriction or even two, seems to be peculiar to this subgenus among the oppelids of this assemblage. These constrictions are described in detail and illustrated below (pp. 89, 94, pl. 14, figs. 8, 9, 49, 50).

One species, *O.* (*C.*) *delmontanum*, has been recorded from Mount Hermon by Noetling under two trivial names (*delmontanum* and *rauracum*), now considered synonymous. A second, which is by far the most common, has been added by Frebold, also under two names, namely, *Ammonites arolicus* and *Hecticoceras brotzeni*, the latter here replaced by *O.* (*C.*) *freboldi*. A third species, *O.* (*C.*) *evolutum*, is new.

Ochetoceras (Campylites) delmontanum (Oppel)
Plate 13, figures 1–43

Ammonites Delmontanus Oppel, 1863, p. 194, pl. 54, fig. 3.

Ammonites rauracus Mayer, 1864, vol. 12, p. 376; 1865, vol. 13, pl. 7, fig. 4.

Harpoceras Rauracum Ch. Mayer; Noetling, 1887, p. 23, pl. 3, fig. 11.

Harpoceras Delmontanum Oppel; Noetling, 1887, p. 24, pl. 3, fig. 12.

Harpoceras rauracum, Ch. Mayer; de Loriol, 1898, p. 9, *cum synon.*, pl. 1, fig. 6.

Harpoceras rauracum, Ch. Mayer; de Loriol, 1900, p. 22, *cum synon.*, pl. 2, figs. 15–18.

Harpoceras delmontanum, Oppel; de Loriol, 1901, p. 8, *cum synon.*, pl. 1, fig. 3.

H. Rauracum Ch. Mayer; Frebold, 1928, p. 189.

H. Delmontanum Oppel; Frebold, 1928, p. 189.

Hecticoceras tauracum Mayer; Vautrin, 1934, p. 1439.

Ochetoceras (*Campylites*) *delmontanum* Oppel; Arkell, 1943, p. lxxxiv; 1947, p. 349, pl. 72, figs. 5, 8.

Campylites delmontanus Oppel sp.; Jeannet, 1951, p. 70, *cum synon.*, text figs. 161–166, pl. 17, figs. 1–10, pl. 19, figs. 1, 2.

Dimensions

A.M.N.H. No. 27908	D	H	H′	W	U
1	5.30 mm.	41	35	35	33½
2	5.61 mm.	40½	*ca.* 35	34	32½
3	5.69 mm	40½	35	33½	33½
4	5.90 mm.	41	36½	32½	34
5	6.13 mm.	42½	*ca.* 37	32½	31
6	6.21 mm.	40½	?	33½	32
7	6.43 mm.	40½	35	31	35
8	6.43 mm.	42	36½	*ca.* 28½	34
80	6.52 mm.	41½	34½	30½	32
9	6.69 mm.	43	37	32½	32½
10	6.78 mm.	41	34½	29½	33½
81	7.21 mm.	39½	33½	29	35
11	7.47 mm.	40½	?	29	33
12	7.56 mm.	41½	?	30	32
13	7.65 mm.	42	33	30½	33
14	7.91 mm.	43	*ca.* 38½	29½	30
15	7.91 mm.	42	37½	30	31
16	7.99 mm.	42½	35	28	32½
17	8.26 mm.	45½	39	26½[1]	28½
18	8.26 mm.	41	34½	22[2]	32½
82	8.43 mm.	43½	35	31	30

[1] Slightly crushed.
[2] Crushed.

A.M.N.H. No. 27908	D	H	H′	W	U
19	8.69 mm.	42	37	27½	30½
20	8.69 mm.	42	37	27	32
21	8.86 mm.	42	36½	28½	32½
22	8.95 mm.	42½	37	33	31
78	8.95 mm.	42	*ca.* 37	30	30
23	9.12 mm.	45	39	*ca.* 26½	30½
24	9.30 mm.	46	39½	26	31
25	9.30 mm.	43	36½	29	31
26	9.30 mm.	43	*ca.* 37½	29	33
27	9.56 mm.	46	*ca.* 39	28½	27½
28	9.56 mm.	42½	?	26½	30
79	9.65 mm.	43½	?	27	30½
29	9.91 mm.	44	37½	29	32½
30	9.99 mm.	41½	34	30½	32
31	10.17 mm.	45½	39	28	27
32	10.34 mm.	46	*ca.* 38	*ca.* 33½	28
33	10.34 mm.	43½	38	26	31
34	10.70 mm.	41½	35½	27	32½
83	10.86 mm.	43	37	31	32
35	11.04 mm.	42½	37	27	29
36	11.04 mm.	44	38½	27	29½
37	11.12 mm.	43	39	26½	31
38	11.64 mm.	40	34½	26½	35
39	11.91 mm.	45	41½	*ca.* 29	28½
40	12.17 mm.	44½	*ca.* 34½	28½	28½
41	12.25 mm.	41	35½	*ca.* 27	31
84	12.43 mm.	44	35	27½	31
42	12.95 mm.	41	35	25½	31½
43	13.12 mm.	41½	37	*ca.* 28	34
44	13.12 mm.	39½	?	27	33
45	13.21 mm.	44	35½	26½	30½
85	13.21 mm.	44	37	29½	29½
46	13.38 mm.	41	35½	*ca.* 24½	33
47	13.51 mm.	44	38	25	26½
86	13.56 mm.	43½	?	26½	31½
48	13.90 mm.	43½	35½	25½	30
49	14.25 mm.	41½	36	26	31½
50	14.43 mm.	48	*ca.* 41½	*ca.* 26	26½
51	14.50 mm.	46½	38½	26½	27
52	14.50 mm.	40	33½	26½	32½
53	15.38 mm.	43½	34	25½	29
87	15.38 mm.	43	38½	28½	33
54	15.64 mm.	46	?	25½	29
55	15.90 mm.	42½	?	28	32
56	16.2 mm.	45	?	*ca.* 24½	34
57	16.3 mm.	46	39	24½	31½
88	16.3 mm.	43	?	25	35½
58	16.4 mm.	46½	?	22½	28
59	16.7 mm.	46½	?	*ca.* 26½	33½
89	16.7 mm.	48½	?	21½	27½
90	16.9 mm.	45	?	26½	35½
60	16.9 mm.	48½	?	?[1]	32
61	17.0 mm.	48	36½	23	30½
62	17.1 mm.	48½	*ca.* 38	28	33
91	17.1 mm.	43½	?	27	35
63	17.4 mm.	46½	36	25½	30½
64	17.7 mm.	47½	*ca.* 37½	23	28
65	17.8 mm.	42½	?	23½	33½
66	18.0 mm.	45½	37	23½	31
92	18.0 mm.	44½	*ca.* 36½	24	36½
67	18.6 mm.	47½	?	22½	31
93	18.7 mm.	41	?	22	35
94	18.8 mm.	45	?	27½	30½
68	19.2 mm.	47	?	23½	32½
69	19.8 mm.	48½	*ca.* 39	?[1]	29
70	20.0 mm.	47½	*ca.* 38	22½	29
95	21.0 mm.	42	33½	25	33
71	21.7 mm.	48½	?	?[1]	27½
72	22.0 mm.	45½	39	*ca.* 22	31½
73	22.0 mm.	43	?	22½	34
74	23.3 mm.	42	*ca.* 36½	*ca.* 20	31
75	30.0 mm.	48½	?	?[1]	27
76	31.1 mm.	45½	*ca.* 32	*ca.* 25	31
77	34.5 mm.	51	40½	?[1]	25½

[1] Crushed.

The table clearly shows increase of whorl height, narrowing of the umbilicus, and thinning of the disks with growth. With some remarkable exceptions (nos. 90–93), the highest values for H and the lowest for W and U are found amont the largest shells, and the lowest for H and the highest for W and U among the smallest.

The largest measured shell (no. 77) has the last septum located at a diameter of 28.5 mm., and a disk attaining about the same diameter is septate to the anterior end. Hence the maximum size reached by this species in our assemblage may be estimated at from 50 to 60 mm., roughly corresponding to that of the holotype which, according to Oppel, attains a diameter of 47 mm. but has the body chamber only partly preserved. The largest individual recorded by Jeannet (1951, p. 72, pl. 17, fig. 3 [slightly reduced]) attains, however, twice that diameter (110 mm.).

TYPE: The single specimen illustrated by Oppel and refigured by Jeannet (1951, pl. 17, fig. 1) is by monotypy the holotype of *Ammonites delmontanus* which is, in turn, the type species by monotypy of *Campylites*.

DESCRIPTION: The protoconch can well be seen in side view in specimens 1, 8, 80 (fig. 8), 52, and in two others. It measures about 0.08 mm. in diameter and does not project above the surrounding innermost whorls, except in the smallest juvenile (no. 1) in which the latter are corroded. No nuclei of this species are present that would permit observation of constrictions, as recognizable in the two following species of this subgenus.

The whorl profile considerably increases in height and decreases in width in the course of development but remains throughout characterized by attaining the maximum width at about the inner third of the height and tapering decidedly towards the venter. These features lend a more and more lanceolate shape to the whorl section (nos. 7, 16, 33, 42, 45, 53, 63; figs. 5, 11, 25, 17, 30, 22, 33). The flanks are only gently convex or almost flat, the umbilical shoulder is pronounced, though rounded, and the umbilical wall steep to nearly perpendicular (best seen in the profiles of nos. 7, 33, 53; figs. 5, 25, 22). Exceptionally, as in the medium-sized shell 87, which by its wide umbilicus approaches *O.* (*C.*) *evolutum*, the umbilical edge is quite sharp and the umbilical wall strictly perpendicular, if not overhanging (fig. 34). The venter is narrow and sharpened from a medium stage on. This character is further accentuated by a median keel which, from a diameter of about 10 mm., is joined by two more on either side. However, these three keels are, preservation permitting, seen to be foreshadowed by three extremely fine threads of about equal distinctness as early as at a diameter of less than 4 mm., for instance, in the smallest juvenile (no. 1, fig. 1). A blunt median ridge can be recognized at about the same diameter in the second smallest juvenile (no. 2) and a true keel, still thin and low but quite sharp, from a diameter of about 7 mm., e.g., in the juveniles 21 (fig. 9) and 24. Simultaneously, pronounced edges develop at the boundaries of the flanks and the narrow venter. As long as the median keel has not developed or remains inconspicuous, these edges cause in some individuals (nos. 20, 28) the venter to appear truncate despite its narrowness. In the further course of development these edges become accentuated by keels of their own which appear, indistinctly at first, at a diameter of from 8.5 mm. to 10 mm. (nos. 29, 40) and are fully developed at a diameter of about 11 mm. (no. 45, fig. 28). They are separated from the median keel by shallow furrows of about their own or a slightly greater width. From this stage on these three keels persist throughout the further ontogeny, as seen in all ventral views of individuals beyond that size (e.g., figs. 20, 31, 43). Throughout development, the median keel is stronger than, and overtops, the lateral ones, sometimes considerably so, as in the largest shell (no. 77, fig. 37). Although the venter is badly damaged and deformed in fragment 76, the furrows separating the lateral keels from the median keel can be seen in its anteriormost portion (fig. 41) to have increased in both width and depth and to have assumed a rounded profile.

A single juvenile (no. 96) shows a siphonal groove which, however, disappears at a diameter of 7 mm. ("*Harpoceras excavatum*" Noetling).

Even in the smallest juvenile (no. 1) three indistinct folds can be seen on the anteriormost quarter-whorl, that is, from a diameter of about 4.33 mm. In the anterior portions of juveniles 2, 3, 4, and 6, which are only slightly larger, these folds change into more closely set, faint ribs which run in a sigmoidal course all over the flanks. In the juvenile 7, however, the circumumbilical zone appears smooth and the outer one carries distinct sickles which start from blunt nodes in the middle of the flanks (fig. 4). The juvenile 17 is remarkable for exhibiting only a few but comparatively high ribs in its anteriormost part only, while the afore-mentioned sickles are markedly recurved, as in *O.* (*C.*) *evolutum*, in the juvenile 82 (fig. 19). The costation of specimens 21 (fig. 10) and 23, although still delicate, otherwise approaches that of later ontogenetic stages, except that here the rounded hooks, situated at the inner third of the flanks and connecting inner and outer ribs, stand out most clearly, whereas the sickles gradually vanish ventrad. In the juvenile 27, on the other hand, it is the sickles, eight of which are counted on the last quarter whorl, which are most distinct but the costation is still altogether subdued (fig. 18).

Costation is still delicate in the juveniles 37, 39, 84, 42 (fig. 16), 46, and 48 but more pronounced in numbers 43 and 44 (fig. 27). In the last quarter-whorl of the latter, eight straight, decidedly prorsiradiate circumumbilical ribs are connected with 10 outer sickles by an angulation which becomes more and more pronounced, with only two of the inner ribs bifurcating at the angulation points. In specimen 50, although somewhat larger, the costation is again more delicate and also more dense, there being 10 inner ribs and 12 outer ones on the last quarter-whorl (fig. 26); the angulation is quite pronounced in this shell also. The ornamentation is similarly delicate, if not more so, in the medium-sized shells 89 (fig. 12) and 70. On the last quarter-whorl of the former seven inner ribs meet 12 outer sickles in a marked angulation. Some of the latter continue an inner costa, others are intercalated. Although this shell appears almost smooth at first glance, the fact that the inner ribs are nearly as well developed as the sickles serves to distinguish it from disks of the same size of *O.* (*C.*) *freboldi*. Specimens 58 and 61, of about the same diameter as 89, differ from it only by a slightly more distinct costation, but other individuals of the same size exhibit a more mature ornamentation, e.g., the half-disk 63 of which the last quarter-whorl carries five inner ribs and 10 outer sickles which meet in a quite sharp angulation (fig. 32).

In the nearly mature stage, as represented by numbers 69 and 95 (fig. 13), the individual ribs have become better defined and stronger. Their number, however, has decreased rather than increased, there being in the last half-whorl of specimen 95, 12 inner and 18 outer ribs, connected by a sharp angulation. Outer ribs are added by intercalation rather than bifurcation. In specimen 72 (fig. 35), on the other hand, the costation is somewhat finer and denser (15 inner, 19 outer ribs per half-whorl).

In no individual referred to the present species does the costation show so clearly as in number 73 (fig. 42). Whereas it is subdued on the inner volutions to the extent that they appear almost smooth, it is well developed on the outer whorl on the anterior half of which 12 inner ribs and 19 outer sickles are counted. The former are decidedly prorsiradiate, the latter clearly rursiradiate. About half of the additional outer ribs originate by bifurcation, which occurs near the anterior end within the inner zone of the flanks. The others are intercalated. An indistinct spiral ridge connects the points at which both kinds of ribs meet in a sharp angulation. The inner zone of the flanks between that ridge and the umbilical shoulder appears slightly concave, making the strong inner ribs stand out even more distinctly. In the badly damaged half-disk 76 (fig. 40) the outer ribs are particularly heavy and are thus reminiscent of those seen in Noetling's figure 12. The costation of the largest disk (no. 77, fig. 37) agrees in both strength and density with that of number 73, described above, except that the chords of the outer sickles run in a radial rather than in a rursiradiate direction. The spiral ridge accentuating the angulation points is present in the posterior half of the outer whorl but disappears, or is worn off, in the anterior one.

Whereas in all other shells studied the outer ends of the sickles extend to, but end at, the lateral keels, they continue beyond and unite across the median keel in an obtuse tongue in the juvenile 97, measuring about 13 mm. in diameter. This juvenile is also noteworthy for its particularly heavy, swollen and radial, not prorsiradiate ribs of which only five are counted on a quarter-whorl (figs. 38, 39).

Suture lines are well seen in the smallest juvenile (no. 1) at diameters of from 2.6 to 5.3 mm. (fig. 2). They are highly developed for this early stage, exhibiting a rather wide siphonal lobe with a broad-trapezoidal median knob, which in the anteriormost suture line just beings to develop hornlets and a median swelling; trifid lateral lobes, the first with a long middle point; distinctly indented main saddles, and a well-developed auxiliary lobe with indications of two more. The suture lines of the juveniles 3 and 4, corresponding to diameters up to 4 mm., and even those of number 21 (fig. 10), corresponding to diameters up to 7.5 mm., are, however, much more primitive than those of number 1, whereas those of juveniles 6, 7 (figs. 6, 4), and 8 are intermediate in degree of indentation. Only in specimen 80 (fig. 8) at diameters of from 4.5 to 6.5 mm. does it equal that found in juvenile 1. All the juveniles hitherto mentioned have four suture lines to a quarter-whorl but this rate increases to five in number 82 (fig. 19), to six in number 81 and 14, and decreases to three in number 12 (fig. 14).

At a somewhat later stage (at diameters of from 6.5 to 10 mm.) two characters appear for the first time in the sutures of specimens 27 (fig. 18) and 31 that may be considered distinctive of the subgenus *Campylites* in the sense that they are not encountered in other groups of oppelids, though not in the sense that they are found in all individuals of this subgenus. One of these characters is the comparative shallowness of lobules and minor indentations which makes for a softer and rounder aspect of the saddles. The other distinctive character is provided by the fact that the middle points of the first lateral lobes and thus the lobes as a whole point clearly ventrad. Otherwise these sutures are fairly elaborate and closely set (five per quarter-whorl). The same characters are present in the sutures of specimen 33 which stand, however, farther apart (four per quarter-whorl). They are also a good example of lateral shift of the siphonal lobe, so common in oppelids, in this case to the right, and of the ensuing asymmetry between the two external saddles (figs. 23, 24). In this individual the middle points of the first lateral lobes of the last sutures show just an indication of an inner secondary prong. Secondary prongs are present, at an only slightly larger diameter, on both sides of this point in specimen 36.

Specimen 101 deserves special mention for exhibiting, at a diameter of 10.5 mm., extremely crowded sutures (nine on the last quarter-whorl), although the last septum is not yet in sight.

The well-preserved suture lines of specimens 42 (figs. 15, 16), 47, and 86 are closely set (six per quarter-whorl), though less so than those of the much smaller shell 29 (seven). Those of number 49 are peculiarly reduced, with stubby, rounded middle points in the first lateral lobes and with the second ones also rounded and hardly indented.

Specimens 52, 53 (fig. 21), and 57 exemplify the increased degree of indentation and the density (six per quarter-whorl) of the sutures at the next stage (diameter about 15 mm.). Elaboration is further increased but the density still the same at diameters of from 17 to 17.5 mm. in specimens 61 and 63 (figs. 31, 32). Now the median knobs carry pronounced hornlets with a median swelling between them, and the main points of the siphonal lobes and the middle points of the second lateral lobes also carry secondary prongs.

Specimens 70 and 72 (fig. 35) represent the highest degree of indentation, and the latter simultaneously exhibits the greatest density (nine per quarter-whorl) attained by this species in the present material.

Shifting of the siphonal lobe to either side seems to occur particularly frequently in this species (nos. 100, 79, 33, 98, 42, and several others). The whorl fragment 100, in which all of the siphonal lobe is on the left side of the shell, is illustrated as another example (fig. 36), also to show how the left external saddle is pinched at the base as a consequence of this sutural asymmetry. In other individuals the first (nos. 28, 99) or the second (no. 44) lateral lobes become, on one side only, bifid instead of trifid.

REMARKS: This species has been recorded from Mount Hermon by Noetling under two names, as *Harpoceras rauracum* and as *H. delmontanum*. The fragment figured by him under the latter name agrees well with the form here dealt with, especially with our half-disk 76, but it must be kept in mind that Noetling's figures 11 and 11a–c depict, under the name *H. rauracum*, a specimen not from Mount Hermon but from Swabia. This is the first of several cases (cf. pp. 145, 148) in which Noetling illustrated in the plates of his Hermon paper ammonites from other localities without any warning to that effect in the explanations. Only a careful scrutiny of his text will enable the reader to realize their true origin. Aside from the fact that Noetling's procedure is dangerous *per se*, his motivation in this particular case is even more astonishing. For, after reporting how much he rejoiced at finding in the Berlin collection a Swabian form indistinguishable from his specimen from Mount Hermon, he illustrates the former to prove the correctness of his claim. It is, however, difficult to understand how the figures of the Swabian form alone can document its full agreement with the Syrian one.

Be that as it may, de Loriol (1901, p. 9) declared *Ammonites rauracus* Mayer a synonym of *A. delmontanus* and has been followed in this by both Arkell (1943) and Jeannet (1951). Thus there is a good probability that Noetling's "*Harpoceras rauracum*" also belongs to the present species, although his drawings of a Swabian specimen said to resemble it perfectly are rather poor. Certainly the venter seen in his figure 11a is not at all as sharp as it is in our largest disks which do not even reach that size. They agree, however, quite well with Oppel's type.

In side view juveniles of *O.* (*C.*) *delmontanum* closely resemble those of almost every other *Hecticoceras* species from Mount Hermon, except the most evolute ones (*Brightia kautzschi*, *B. syriaca*), especially *Lunuloceras kersteni*, *Sublunuloceras guthei*, *Brightia socini*, *Putealiceras schumacheri*, and *P. separandum*. The similarity with *H.* (*S.*) *guthei* persists considerably beyond the juvenile stage, chiefly owing to a sometimes quite surprising analogy in ornamentation. However, from all these forms the present species is distinguishable through all ontogenetic stages by the slenderness of the disks, by the graceful lanceolate whorl section, and by the narrow, sharpened venter which, from a diameter of 10 mm. or even less, is crowned by three keels.

The two other species of *Campylites* are compared below (pp. 93, 96) with the present species.

MATERIAL STUDIED: Two hundred and twenty individuals, including incomplete specimens and fragments. The fact that Noetling recorded only one specimen plus one whorl fragment may be accounted for by the possibility that he may have mixed the juveniles of this as well as of the following species with those of *Hecticoceras* (*Brightia*) *socini* and perhaps also of other *Hecticoceras*.

Ochetoceras (Campylites) freboldi, new species

Plate 14, figures 1–47; text figures 1–4

?*Amm. Arolicus* Oppel; FREBOLD, 1928, p. 185.

?*Hecticoceras Brotzeni* sp. nov.; FREBOLD, 1928, p. 185.

DIMENSIONS

A.M.N.H. No. 27909	D	H	H′	W	U
1 (nucleus)	0.728 mm.	40	28½	74½	?40
2 (nucleus)	1.123 mm.	41	30	59½	30
3 (nucleus)	2.142 mm.	41	33	44½	33
4 (nucleus)	2.246 mm.	40	32½	35½	34
5	3.454 mm.	44	36	38½	31½
6	4.06 mm.	43½	37½	37½	31½
7	5.09 mm.	43	?	31	32
8	5.33 mm.	43	37½	28½	29½
9	5.33 mm.	42	35	33	32
10	5.45 mm.	43½	35½	36	31
87	5.45 mm.	43½	39	36½	30
11	5.82 mm.	41½	36½	31	31½
12	5.88 mm.	43½	38	32	31
13	6.42 mm.	41½	35	32	32
14	6.78 mm.	43½	37	29½	30
15	6.95 mm.	41	35½	27½	31½
16	7.13 mm.	42½	?	34	33
17	7.13 mm.	44	36½	28	30½
18	7.21 mm.	41	33½	29½	31½
19	7.21 mm.	41	35	29	34½
20	7.30 mm.	41½	*ca.* 35½	29½	31
21	7.30 mm.	42½	35½	28½	31
22	7.56 mm.	43½	37	30	30
23	7.56 mm.	45	?	28½	28½
24	7.65 mm.	44½	38½	28½	30½
25	7.82 mm.	42	35½	31	31
26	7.82 mm.	44½	36½	30	29
27	7.99 mm.	43½	36	32½	30½
28	7.99 mm.	41½	36	28	32½
29	7.99 mm.	45½	37	30½	28
30	8.08 mm.	43	36½	28½	31
31	8.08 mm.	44	37½	32	30
32	8.26 mm.	43	37	27½	28½
33	8.34 mm.	43½	37½	27	29
34	8.60 mm.	41½	34½	29	32½
35	8.60 mm.	45½	37½	?[1]	29½
36	8.69 mm.	43	36	28	30
37	8.78 mm.	43½	?	28½	30
38	8.86 mm.	43	36½	27½	29½
39	9.12 mm.	43	36	27½	30½
40	9.21 mm.	41½	?	28½	31
41	9.47 mm.	42	35	27½	31
42	9.47 mm.	43	?	*ca.* 27½	29½
43	9.47 mm.	46	37½	32	27½
44	9.65 mm.	43½	*ca.* 37	?[1]	30½
45	9.99 mm.	41½	36½	24½	33
46	9.99 mm.	44½	37½	28	27½
47	10.08 mm.	43	36	27½	28½
48	10.08 mm.	44	38	27½	28½
49	10.25 mm.	41½	*ca.* 36½	*ca.* 29	33
50	10.17 mm.	43½	36	27½	29
51	10.34 mm.	42	36	26	30½
52	10.34 mm.	43½	?	22½	29½
53	10.43 mm.	43½	36	26½	30
54	10.60 mm.	45	?	28	27
55	10.60 mm.	47	?	28½	27½
56	10.86 mm.	43	*ca.* 35	25½	29
57	11.12 mm.	44½	38½	26	29
58	11.12 mm.	43	36	26½	31
59	11.47 mm.	43	35½	27½	29
60	11.64 mm.	42	?	25½	30
61	11.82 mm.	45	36½	27	27
62	11.99 mm.	44	36	26	27½
64	12.17 mm.	42	35½	25	33½
65	12.17 mm.	44½	35½	28	30
66	12.34 mm.	44½	?	26	29½
67	12.51 mm.	44½	39	25	30
68	12.77 mm.	44	37½	24½	29½
69	12.95 mm.	43	?	26	30
70	12.95 mm.	46½	38½	27	25½
71	13.03 mm.	45½	38	24½	29½
72	13.12 mm.	43	36	26	31
73	13.47 mm.	43	36	24½	28½
74	13.47 mm.	45	35½	25	25

[1] Crushed.

A.M.N.H. No. 27909	D	H	H′	W	U
75	13.99 mm.	45½	38½	26½	28
76	14.51 mm.	43	?	*ca.* 25½	27½
77	14.60 mm.	44½	*ca.* 37½	*ca.* 25	28½
78	14.77 mm.	43½	37	*ca.* 23½	27½
79	14.95 mm.	45	?	24	28½
89	15.3 mm.	45½	33½	27	33½
80 (syntype A)	15.47 mm.	47	?	25½	26
81	16.0 mm.	47½	?	25½	25
90	16.8 mm.	44½	34½	26	32½
82	17.2 mm.	47	?	21½[1]	30
88	18.0 mm.	45	36	25	32½
83	21.2 mm.	47	38	24½	29
84	22.4 mm.	45½	?	22½	31
85	26.9 mm.	*ca.* 45½	?	*ca.* 22½	*ca.* 26½
86 (syntype B)	26.9 mm.	48	?	24½	28½

It is interesting to compare the ranges of variation for H, W, and U found in the present species with those encountered in the preceding one. Because the smallest measured specimen of *O.* (*C.*) *delmontanum* has a diameter of 5.3 mm., the size group of *O.* (*C.*) *freboldi* below the diameter of 5 mm., consisting mostly of nuclei, must be left out of consideration for the purpose of this comparison. Then H is found to vary from 40 to 48 in the present species and from 39½ to 51 in *delmontanum*, the higher maximum in that species being probably due to the fact that it reaches a greater diameter than *freboldi* (34.5 mm. as compared to not quite 27 mm.). The range of variation in W, amounting to from 20 to 35 in *delmontanum* and to from 22½ to 36½ in *freboldi*, is about the same in both species, but the average is somewhat higher in the present one (29½, as compared to 27½ in *delmontanum*). Below the diameter of 5 mm. however, W varies in *O.* (*C.*) *freboldi* from 37½ to 74½, with the maximum reached in the smallest nucleus, attaining not quite 0.75 mm. in diameter. If the doubtful value of U (40) in the same nucleus is left out of account, the range in variation of umbilical width is nearly the same as in *delmontanum*, namely, from 25 to 34½ as compared to from 25½ to 36½ in that species. Altogether, the two species may be said to exhibit essentially the same dimensions, and the general growth trends stated above for *delmontanum* hold true for *freboldi* also, with comparatively wide umbilici encountered in the present species occasionally still at medium diameters (nos. 63, 89).

The last septum is located at a diameter of 18 mm. in the largest measured shell (syntype B) and at diameters of from 21 to about 24 mm. in paratypes 83–85 and in an (unnumbered) whorl fragment. Complete shells may have attained diameters of about 40 mm. Thus this species appears to be somewhat smaller than *O.* (*C.*) *delmontanum.*

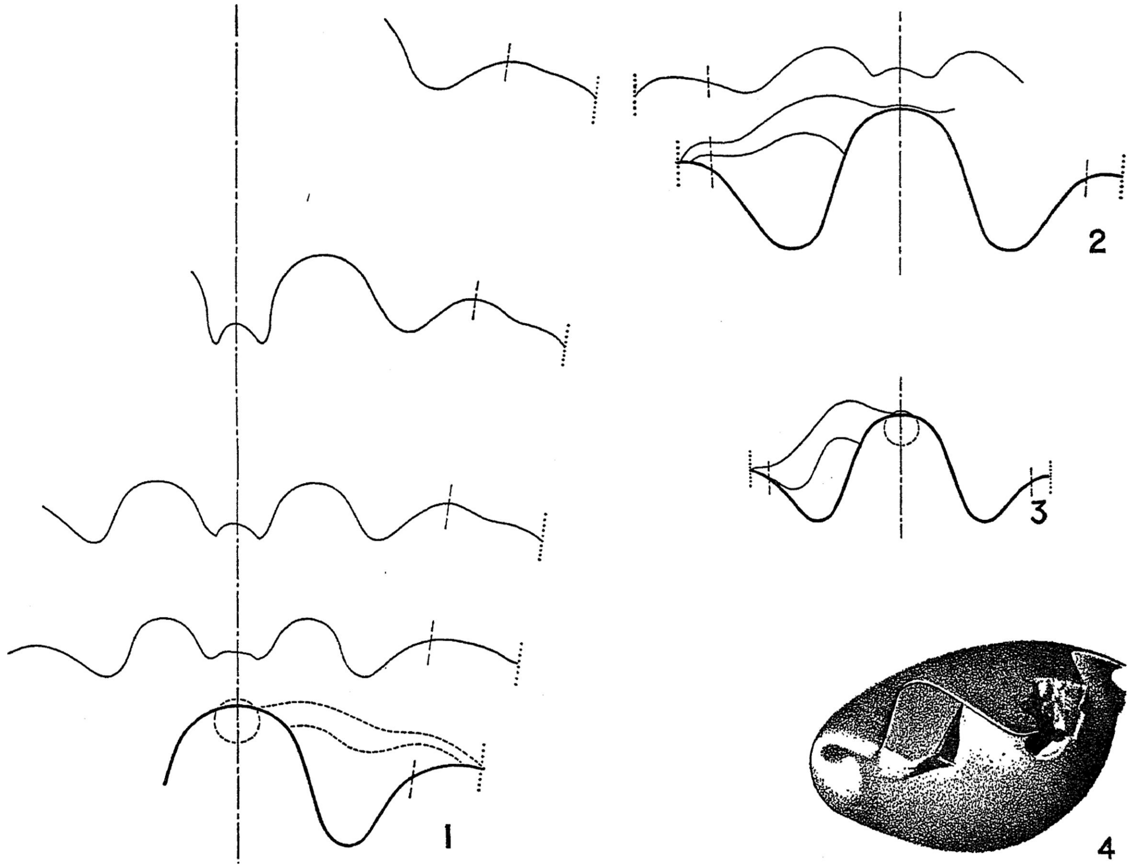
Designation of Types: Specimen A.M.N.H. No. 27909:80, considered most characteristic of medium-sized, nearly smooth disks of this species, is selected as syntype A, and the largest specimen, A.M.N.H. No. 27909:86, which shows the mature costation, as syntype B.

Description: The opportunities for investigation of the very earliest ontogenetic stages offered by the shell shape of this subgenus (p. 80) can best be utilized in this species, the most abundant of *Campylites* in the present assemblage. Not only does the protoconch, as seen in side view, as in not a few other species of this fauna, project as a little bubble, which measures a little more than 0.1 mm. in diameter, from the embracing whorls in many individuals (nos. 1–4, 9, 10, 16, 23, 94; figs. 6, 9, 19), but it has been possible (in this species only) to prepare tiny innermost nuclei of 15 individuals (nos. 1, 2, 91–103; pl. 14, figs. 1–5, 8–12; text fig. 4) which consist of the protoconch only (no. 103; pl. 14, figs. 1, 2) or of the protoconch with from one to six of the following chambers attached to it. However, in all these nuclei the protoconch[2] can be viewed and studied in three dimensions.

As seen best in plate 14, figures 1 and 2, and in text figure 4, the protoconch as a rule is spindle- or roller-shaped even in the present species which assumes the shape of very slender disks in maturity; in paratype 103 the ratio of W to D is 29:19 or 29:17, corresponding to values of 153 and 170, respectively, for W, depending on whether or not the forward-projecting tongue is in-

[1] Crushed.

[2] This term seems to be preferable to "ovisac" (Munier-Chalmas, 1873, p. 1559), "Anfangskammer" (initial chamber, Branco, 1879, *passim;* Zittel, 1885, p. 346), "Anfangsblase" (initial bubble), or just "nucleus" (Zittel, 1885, pp. 346, 347), used in the earlier literature.



FIGS. 1–4. *Ochetoceras* (*Campylites*) *freboldi* Haas. 1–3. Prosutures (heavy lines) and earliest suture lines (short-dashed lines, where indistinct) of three nuclei. Long-dashed lines indicate ventrolateral shoulder; dotted lines, umbilical seam. Abrupt line endings indicate the boundaries of the specimens or the limit of legibility. 1. A.M.N.H. No. 27909:91. 2. A.M.N.H. No. 27909:94. 3. A.M.N.H. No. 27909:99. 4. Perspective drawing of nucleus, A.M.N.H. No. 27909:92. All figures × *ca.* 100.

cluded in D. The absolute width of all these protoconchs is about 0.5 mm.[1] Exceptionally, as in paratypes 100 (pl. 14, fig. 3) and 101, the protoconch is not quite so wide, so as to appear barrel- rather than spindle-shaped, with W amounting, in number 100, to about 136 only. As seen best in one of the oblique side views of the nucleus of paratype 91 (fig. 10), the protoconch occupies somewhat more than a full volution, but, owing to deep indentation by the lateral lobes of the proseptum,[2] the embrace by the following chambers begins about a quarter-whorl earlier. As seen in this oblique side view and, better still, in a less enlarged one of the same nucleus (pl. 14, fig. 12) and also in the perspective drawing of paratype 92 (text fig. 4), the protoconch is markedly flattened in its posterior half-whorl so as to be somewhat depressed on the whole. Its lateral faces are somewhat convex and pro-

[1] About the same width of the protoconch is given by Currie or can be inferred from her diagrams (1942, figs. 1, 8; 1943, fig. 4; 1944, p. 191) for other Jurassic ammonite genera.

[2] Schindewolf's (1951, p. 12, and his earlier papers quoted there) terminology, accepted by Schmidt (1952, p. 206), is here adopted. Accordingly, the septum separating the protoconch from the first chamber is here called proseptum, and its margin appearing on the surface prosuture, the septum separating the first chamber from the second primary septum, and its margin appearing on the surface primary suture. The following sutures are numbered the second, third, and so forth. Branco (1879, 1880), on the other hand, starts numbering the sutures at the prosuture which to him is the first.

ject as little buttons from the surrounding whorl (pl. 14, fig. 10; text fig. 4).

Orad the protoconch projects about a quarter of a whorl in a median tongue which is bounded ventrally by the outer surface, dorsally by the proseptum. The prosuture in which these two meet is clearly seen in figures 1, 3, 4, 10, 11 of plate 14 and in text figures 1–4. It will be noted that the anteriormost part of this tongue is broken off in paratype 103 (pl. 14, fig. 1). The shape of this tongue, which occupies only about one-third (somewhat more in paratype 100, pl. 14, fig. 3) of the total width of the protoconch, clearly refers our species, as all oppelids (see, e.g., Branco, 1879, pl. 11, figs. 2–4) and all post-Triassic ammonites for that matter, to Branco's (1879, p. 27) Angustisellati. The prosuture and the following sutures, along with the corresponding septa, are described in more detail in the section on suture lines (pp. 90, 91).

It is in the anteriormost part of the aforementioned tongue and thus still within the protoconch that the initial bubble is situated from which the siphuncle originates. In the present material this caecum,[1] as this initial bubble hereinafter is called for the sake of brevity, can be recognized in three different ways:

1. In most nuclei (e.g., nos. 91, 94, 99, 100; pl. 14, figs. 3, 10; text figs. 1, 3) it shines through to the surface, filling the tip of the tongue and in most cases slightly projecting orad beyond it. This is readily explained by the fact that it lies so close under the surface that the latter becomes here so thin as to be easily corroded.

2. In the nuclei 92 and 103 (text fig. 4; pl. 14, figs. 1, 2) the caecum is broken out, leaving behind an incompletely spherical pit.

3. Most interesting, however, is the nucleus of paratype 98: The protoconch is broken out, but the spherical caecum projects into the cavity left behind by the missing protoconch (pl. 14, figs. 4, 5). It is believed that, thanks to patient and skillful preparation by Mr. Tarka, the caecum can for the first time be shown in three dimensions in the photomicrographs depicting this nucleus in inverted-frontal and ventral views, whereas both Branco's (1879, pl. 13) figure 7 and Munier-Chalmas' drawing, as reproduced in Zittel's (1885) figure 490, show it in median section only.

In addition to the circular pit left behind by the caecum, the protoconch 103 (pl. 14, fig. 2) exhibits still another cavity, namely, a median groove which begins right under the tip of the tongue (360° apicad of it) and runs from there orad for a distance about equaling the diameter of the caecum. This groove, the strictly median position and the shape and course of which strongly plead for its organic character, may well have been left behind by the prosiphon of Munier-Chalmas (1873, p. 1559).[2] However, it should not be overlooked that, according to Munier-Chalmas' original description and his drawing, the prosiphon is a tube extending apicad from the caecum across the interior of the protoconch, whereas the groove under discussion is found in a position almost 360 degrees apicad of the caecum. To reach the caecum, as it would have to do according to Munier-Chalmas, it would have to run internally all around the protoconch. This is possible, although the alleged prosiphon cannot be seen on the side of protoconch 103 opposite to that seen in our figure 2 (pl. 14), as it could only if it were eroded there, too. However, the fact that indications

[1] This term seems to have been first used, in the rendition "*coecum*," by Munier-Chalmas (1873, p. 1559), which explains the abbreviation "c" used for this structure in his drawing, reproduced in Zittel (1885, fig. 490). Zittel (1885, p. 347) himself uses the German equivalent of caecum, "Blindsack," alternately with the rather clumsy term "Kugelige Anschwellung des Siphoanfangs" (spherical swelling of the beginning of the siphuncle). Similarly, Branco (1879, explanation of pl. 13, fig. 7; 1880, p. 60) calls the caecum the "Kugel, mit welcher der Sipho beginnt" (ball with which the siphuncle begins).

[2] Branco (1880, p. 65) questions Munier-Chalmas' description of the prosiphon and regrets the absence of illustrations in his article. On the other hand, the drawing reproduced by Zittel (1885, p. 347) as figure 490 only a few years later, the first and only one that gives an indication of the prosiphon, is credited to Munier-Chalmas (whose article is there, in a footnote preceded by two asterisks not found anywhere in the text, dated, obviously owing to a typographical error, from 1378, instead of 1873). However, despite a painstaking search I have not been able to trace any paper of Munier-Chalmas himself containing that drawing. I am thus led to believe that the latter author permitted Zittel the use of a drawing, which he had prepared for publication, for his handbook but that his own paper for which the drawing was made has never been published. From Zittel's "Handbuch" it then found its way into his "Grundzüge" and all the later editions and translations of that text book.

of a quiver-like structure can indistinctly be seen under the surfaces of paratype 101 (and perhaps also of paratype 94) just apicad of the caecum, seems to enhance that possibility.

The constrictions mentioned in the heading on this subgenus can be seen indistinctly in the nucleus of paratype 1 but much better in that of paratype 2 (fig. 8) and in the nuclei 92–94 (fig. 9). They run straight and about radially across the sides (fig. 9) and cross the venter in a straight, horizontal line (fig. 8).

The four nuclei of which the measurements are entered at the top of the table of dimensions and the last of which attains more than three times the diameter of the first constitute a series illustrating the fast decrease of the conch in width. Compared with the values for W of from 136 to 170 in protoconchs, given above, even the smallest of these nuclei, with W equal to 74½, appears to be slender, and W continues steadily to decrease within the series, down to 35½ in the nucleus of paratype 4.

As seen in frontal view (pl. 14, fig. 7), the whorl profile is still subcircular, with somewhat flattened flanks, at this stage but it soon stretches in a dorsoventrad direction, gradually to assume the lanceolate shape characteristic of this species as well as of the preceding one (nos. 9, 10, 14, 21, 29, 45, 50, 80, 83; figs. 13–16, 18, 23, 24, 33, 45). Here, too, the flanks are only gently convex or somewhat flattened and the section tapers more decidedly ventrad than dorsad. As seen, e.g., in paratypes 21, 29, and 50 (figs. 15, 24, 33), the developing median keel shows with increasing distinctness in the whorl section. In some shells a strong and high median keel lends an ogival aspect to the upper part of the whorl section (no. 45, fig. 16; no. 49). The umbilical wall tends to become fully or nearly perpendicular, the umbilical shoulder is pronounced but, as a rule, rounded, only exceptionally quite sharp, as in paratypes 24, 29, 50 (figs. 24, 33; in both figured specimens more decidedly so on the right side of the shell than on the left), and 81 (fig. 43) and in syntype B (fig. 41).

Three fine threads foreshadowing the three keels of later stages can be recognized, at diameters of from 2.5 mm. to 7 mm., on the venters of the juveniles 10 (fig. 20), 87, 95, and 27. A true median keel appears as early as at a diameter of not quite 6 mm. in paratype 23 (fig. 17). Almost simultaneously the lateroventral shoulders become pronounced edges, separated by mere indications of shallow furrows from the median keel. At an only slightly greater diameter a median keel appears in paratype 29 also, but it immediately dissolves into four teeth (fig. 26). The triple keel characteristic of this subgenus can be seen at a diameter of a little more than 8 mm. in the excellently preserved paratype 48; extremely shallow furrows separate the lateral keels, which are just indicated, from the median one (fig. 27). As seen in paratypes 52, 56, and 57 and best in syntype A (fig. 21), this triple keel becomes quite pronounced even at a medium shell size. The mature stage of this triple keel is best seen in syntype B (fig. 40); all three keels are now sharper and the furrows between them deeper and narrower; the middle keel overtops the two others.

Paratype 96 may be mentioned for exhibiting a blunt spiral ridge at the second third of the flanks, with a faint indication of another at the first third.

The flanks remain smooth in all specimens up to a diameter of from 7.5 mm. to 9 mm., and in some considerably longer. Then faint sickles appear which are restricted to the outer two-thirds of the flanks. In paratype 48 (fig. 28) they can be perceived in oblique illumination only but are rather regularly spaced (four on the last quarter-whorl), whereas they are spaced sporadically but are slightly more distinct in paratypes 50 (fig. 32), of about the same size, and 57. In paratypes 64 and 67 the costation is just as faint as, though somewhat denser than, in number 48 but slightly better defined. It is still delicate but clearly sigmoidal in paratypes 65 (fig. 30) and 68. Nine ribs to an eighth of a whorl are counted in the anteriormost part of the former but only six to a quarter-whorl in that of the latter. In both they seem to extend farther dorsad than in the shells mentioned earlier, but the circumumbilical zone still remains smooth.

In the next size group, that is, up to a diameter of 16 mm., the ornamentation remains mostly restricted to faint sickles, often perceptible in oblique illumination only, in the outer zone of the flanks, as in paratypes

71, 76, 78 (fig. 39), 79, and in syntype A (fig. 22), or the shells remain smooth for all practical purposes (nos. 74, 77). There are a few exceptions. Thus the anterior half-whorl of paratype 72 exhibits rather widely spaced and low but quite strong sickles, and even, prematurely, some prorsiradiate circumumbilical folds. Paratype 89, transitional to *O.* (*C.*) *evolutum* also in umbilical width, carries delicate sickles which extend comparatively far dorsad and are decidedly recurved, as they are in that species (fig. 42). Paratype 81, mentioned above for its remarkably sharp umbilical shoulder, has in the anteriormost quarter-whorl comparatively robust sickles which are, however, restricted to the outer third of the flanks (fig. 43).

The mature ornamentation appears first at a diameter of about 14.5 mm. in paratype 82 (fig. 47). Here it consists of well-defined, radial or slightly rursiradiate sickles, 10 on the last quarter-whorl, in the outer two-thirds of the flanks and of much weaker, prorsiradiate folds in their circumumbilical zone. Paratype 90, however, of about the same size as 82, shows similar, weak, circumumbilical folds but even more subdued outer sickles. The boundary between both is marked by a faint spiral ridge, comparable to the one recorded above for specimen 73 of *O.* (*C.*) *delmontanum;* there are two or three more spiral striae between that ridge and the outer shoulder. The costation of paratype 88 is similar to that of 90. In paratype 83, on the other hand, inner and outer ribs are about equally delicate in the first quarter of the outer whorl, but later the former vanish and the costation is reduced to short sickles, 14 of which are counted in the last quarter, in the outer half of the flanks (fig. 44). Paratypes 84 and 85 (fig. 46) recall by their subdued ornamentation earlier ontogenetic stages, but in the latter crowded prorsiradiate inner folds are almost as strong as the outer sickles. The fully mature costation of this species is believed to be present only in syntype B which carries on the anterior half of the outer whorl about 25 sickles, split in two here and there, and 12 or 13 not much weaker inner ribs. Both kinds of costae become well defined on the body chamber only which occupies the anterior third of this whorl (fig. 41).

As indicated in the section on the very earliest ontogenetic stages (p. 88), the sutural development, thanks to the availability of so many extremely small nuclei, can be traced farther back in this species than in any other of the assemblage under study.

The prosuture, forming on the surface the anterior boundary of the protoconch, is well seen in all these nuclei, best in paratypes 91, 92, 94, 99, 100, and 103 (text figs. 1–4; pl. 14, figs. 10, 11, 3, 1). It consists of a high, well-arched median saddle, flanked by two rather deep lateral lobes of rounded-triangular shape. Dorsad of these, there is one more saddle on either side, culminating at the umbilical seam which appears as a continuation of the prosuture. The more or less arbitrary boundary between prosuture and umbilical seam is at the point where the second suture meets both; this point is sometimes marked by a little pit or scar (pl. 14, fig. 10; text figs. 1–3).

It is fascinating to follow the ontogenetic development in the course of which the pronounced median saddle of the prosuture is gradually replaced by the siphonal lobes of later sutures. Observation of this process is, however, rendered difficult by the peculiar fact that, whereas the prosuture is always deeply engraved and thus quite conspicuous and the third suture also shows distinctly, the first (or primary) suture and, even more, the second are only shallowly engraved and difficult to trace.[1] This is best illustrated by figure 11 of plate 14 in which both prosuture and third suture stand out most distinctly, but no trace of the two sutures in between can be perceived. Accordingly, these only in-

[1] This seems to account for the fact that suture lines comparable to the first and second (in our terminology) are only rarely encountered in Branco's (1879) otherwise excellent drawings of early sutures. Only figure 3k of his plate 8 shows both the first and second, but here Branco did not quite trust his eyes and therefore dotted the left half of the second suture. (What he considered the third in his terminology, namely, the one marked 1 in figure 3, is actually the fourth.) In Branco's drawings 1m and 3f of plate 9 and 6h of plate 10 only the primary suture shows, and in his drawings 5h of plate 9, 4h of plate 10, and 5i of plate 12 only the second. In many more drawings, however (pl. 11, fig. 3, pl. 12, fig. 3, and pl. 13, fig. 6), both these suture lines are missing, and the line called the second (corresponding to our first, or primary, suture) in the explanation of plates is actually the third in our terminology (or the fourth in Branco's) or an even later one.

distinctly visible suture lines are indicated only by dotted lines in the diagrammatic drawing (text fig. 1).

In contrast to the prosuture, the primary, or first, suture has a shallow median lobe of which, however, only the outer parts, dipping more or less decidedly towards the median line, are visible, whereas the central portion is hidden beneath the median saddle of the prosuture (text figs. 1–3). This is merely the two-dimensional expression of the fact that the primary septum does not reach the outer surface with its median portion but plunges under the tongue of the protoconch, resting on the proseptum just apicad of the caecum. This is well seen in the perspective drawing (text fig. 4) of the protoconch of specimen number 92, to which just a portion of the first chamber, sticking in the right lateral lobe of the proseptum, is attached. The caecum is broken out, with some damage done to the tip of the tongue also. The aforementioned fragment of the first chamber is bounded orad by a triangular part of the primary septum, appearing in deep shadow. The side of this triangle that appears on the right is a part of the contact line along which the primary septum clings to the proseptum. The dorsal ends of the primary septum do not reach the umbilical seam either, but rest on the proseptum a short way before it changes into the seam. The latter phenomenon, well seen (in two dimensions) in text figures 1–3, was previously observed, and called "Reiten" ([horseback] riding) "of the second suture on the first" by Branco (1879, p. 31). Otherwise this primary suture consists of two external saddles flanking the median lobe, followed by more or less shallow lateral lobes, and forms one more low saddle immediately before it meets the prosuture. This last saddle, however, can be recognized in paratypes 91 and 94 (text figs. 1 and 2) only but not in paratype 99 (text fig. 3) nor in paratype 92 (text fig. 4), in which the external saddle appears to be markedly shifted dorsad. The primary suture of paratype 99 deviates altogether from the sutures of 91 and 94 by rising much more decidedly from the dorsal ends towards the middle. It is thus the only one of those studied that resembles in its trapezoidal aspect Branco's drawings of this suture (1879, pl. 8, fig. 3k; pl. 9, figs. 1m, 3f; pl. 10, fig. 6h), none of which, however, shows its disappearance under the prosuture found in all our nuclei. The two other primary sutures, namely, those of paratypes 91 and 94 (text figs. 1, 3), exhibit much shallower inflections and rise much more gently towards the middle.

In these two individuals the second suture shows the same lobes and saddles as the first but even gentler curvatures. In paratype 99, too, the second suture repeats the first in that it rises much more steeply than in paratypes 91 and 94 towards the middle but it differs from it in having shallower "lobes" and lower "saddles." In all three of these second suture lines the wide and shallow median lobe just touches with its median portion the top of the median saddle of the prosuture. Their dorsal ends meet the prosuture exactly where the latter turns into the umbilical seam.

In contradistinction from the first and second sutures, the third, fourth, and fifth, well visible in paratype 91 only (text fig. 1; pl. 14, figs. 10, 11) exhibit the usual characters of oppelid sutures, though at a still very primitive stage. The moderately shallow, wide siphonal lobe is already bifid, with its two "points" separated by a very low and wide median knob, in the third suture. This lobe is flanked by well-rounded, broad, external saddles which are followed by quite deep but still rather wide lateral lobes; the last elements of the external suture line are wide and low umbilical saddles. The fourth and fifth suture lines show the same general plan as the third, but the lobes become steadily deeper, and the saddles, including the median knob, higher. This is particularly well seen in the "W" formed by the siphonal lobe which becomes gradually deeper and narrower, the points of which become more pronounced, and the margins steeper, from the third suture to the fifth. It may be added that all three of these lines can be seen to hit the umbilical seam in the oblique side view of paratype 91 (fig. 10).

A suture line well visible in paratype 4 at a diameter of 1.6 mm. (fig. 6) shows still the same general character and in particular the same absence of secondary indentations as those just described, but the number of elements has increased to six (three saddles and three lobes) on either side. The first lateral lobe, which rides on the ventrolateral shoulder, is only half as deep as the siphonal one, and the two following lobes are increasingly shallower than the first lateral. The first lateral saddle markedly overtops not only the second but also the external saddle, thus exhibiting a distinctive family character of the Oppelidae even at this early stage.

The further development of the sutures in this species parallels so closely that in *O.* (*C.*) *delmontanum* that describing it at length would amount to sheer repetition. Instead, sutures representative of various stages are illustrated in figures 34 (no. 7, D = 5.09 mm.), 19 (no. 10, with only three sutures per quarter-whorl, D = 5.45 mm.), 29 (no. 22, D = 7.56 mm.), 35 (no. 24, with secondary prongs of the long middle points of both lateral lobes appearing unusually early, i.e., at D = 7.65 mm.), 36 (no. 37, with middle points of first lateral lobes deflected ventrad to the extent that these lobes assume a bifid rather than trifid aspect anteriorly, D = 8.78 mm.), 28 (no. 48, D = 10.08 mm.), 37 (no. 96, D = 12 mm., with strong shift of the siphonal lobe to the left and the left external saddle reduced in width accordingly), 38 (no. 71, D = 13.03 mm.), 31 and 39 (nos. 76 and 78, both remarkable for having only four sutures to the quarter-whorl, D = 14.51 mm. and 14.77 mm., respectively), 22 (syntype A, D = 15.47 mm.), and 47 (no. 82, D = 17.2 mm., remarkable for crowding of sutures first one quarter-whorl behind, then again towards the last). In addition to paratype 37, mentioned above for this character, paratypes 96, 71, 76, and 78 and syntype A (figs. 37, 38, 31, 39, 22) also show the deflection ventrad of the middle points of the first lateral lobes and thus of these lobes themselves, and also the comparative shallowness of the indentations of the saddles, both features considered distinctive sutural characters of *Campylites* in the section on the sutures of *O.* (*C.*) *delmontanum.*

In addition to number 96 mentioned above, paratypes 56 and 76 (fig. 31) also have siphonal lobes shifted far to the right and left, respectively, of the median line.

In this species the internal sutures also can be examined, namely, in paratype 91 at a diameter of about 4 mm. and in paratype 97 at diameters of from 4.33 mm. to 8.5 mm. At the latter diameter a deep, trifid antisiphonal lobe with a long and strong middle point and much shorter lateral points occupies the middle of the impressed zone. It is flanked by two tall and slender saddles, each of which is separated by a narrow, trifid lobe, attaining less than half of the depth of the antisiphonal one, from still another plain saddle which stands as high as the internal and which is in turn separated by a shallow, simple lobe from a low trapezoidal saddle astride of the umbilical seam. The same elements are recognizable at a considerably smaller scale in paratype 97.

REMARKS: There is good reason to assume that this is the species named *Hecticoceras brotzeni* (*nomen invalidum*, see below) by Frebold. It is true that he gives considerably greater diameters for the appearance of (a) the middle keel, (b) the lateral keels, and (c) the sickles (15–17 mm., 20 mm., and 17 mm., respectively), as compared to about 6 mm., about 8 mm., and 14.5 mm., respectively, according to my description above. These discrepancies may, however, be caused by the scarcity of Frebold's material which did not permit observations as accurate as mine. However, his description of *H. brotzeni* is not quite complete and unfortunately not accompanied by any illustration. Therefore, I attempted[1] to locate the specimens collected by Brotzen and studied by Frebold with a view to borrowing them for comparison, but these attempts failed. Thus the conspecificity of Frebold's form and the one here described cannot for the time being safely be established, and the former is therefore included in the synonymy of the latter only with a question mark. Should such conspecificity be established at some later date, the specific name here given this species in honor of the man I believe to be its describer must still be maintained, although Frebold's name "*brotzeni*" antedates it. The earlier name lacks validity under the ruling of the Second International Geological Congress of Bologna, 1882, which denies nomenclatorial standing to paleontological specific names published without illustration (Richter, 1952).

It seems that Frebold recorded this species

[1] By correspondence with Dr. Frebold, now at Ottawa, Dr. Brotzen, now at Stockholm, and Prof. Serge von Bubnoff, now at Berlin.

from Mount Hermon under still another name, "*Amm. arolicus* Oppel."[1] Juveniles figured by Quenstedt (1887, 1888, pl. 91, figs. 32, 35, 36), to which Frebold refers, very much resemble shells of this species at the same size, except for their smaller umbilici. This makes it probable—though not certain—that Frebold's "*Amm. arolicus*" also belongs in the synonymy of the present species.

As mentioned in the above discussion of the dimensions, it hardly differs in shell shape and whorl profile from *O.* (*C.*) *delmontanum*, nor is there any important difference in sutural characters. It is, however, readily distinguished from the preceding species by the later appearance and delicacy of the ornamentation and by its restriction, except for the very latest ontogenetic stages, to the outer zone of the flanks. Inner ribs, when present, are as a rule markedly finer and weaker than in *O.* (*C.*) *delmontanum.*

The present species of *Campylites* also can be distinguished from various species of *Hecticoceras* (*sensu lato*) only by the lanceolate whorl section, and in particular by the sharpened venter which, from a comparatively early stage, carries a triple keel. These distinctive characters are particularly needed to separate specimens of *O.* (*C.*) *freboldi* from those of *H.* (*Sublunuloceras*) *guthei* of the same size, as they sometimes agree so perfectly in ornamentation (e.g., specimen 52 of *guthei*, pl. 6, fig. 16, and paratype 85 of this species, pl. 14, fig. 46) that they are indistinguishable in side view.

Ochetoceras (*Campylites*) *freboldi* is compared with *O.* (*C.*) *evolutum* below (p. 96).

MATERIAL STUDIED: With 400 individuals (including incomplete specimens and fragments), this species is by far the most common species of *Campylites* at Majdal Shams.

Ochetoceras (Campylites) evolutum, new species

Plate 14, figures 48–51; plate 15, figures 1–29

DIMENSIONS

A.M.N.H. No. 27910	D	H	H′	W	U
1 (nucleus)	1.206 mm.	41½	31	65½	29½
2	6.17 mm.	41	35	34	34½
3	6.26 mm.	37½	?	37½	36
4	6.26 mm.	39	?	?[2]	36
5	6.34 mm.	40	34½	33	34½
6	6.34 mm.	38½	33	35½	37
7	6.43 mm.	38	32	31	36
8	6.60 mm.	39½	33½	34½	34½
9	6.69 mm.	37½	32½	29½	37½
10	6.87 mm.	39½	ca. 34	31½	35½
11	7.21 mm.	39½	33½	30	36
12	7.21 mm.	38½	32½	31½	33½
13	7.39 mm.	40	ca. 34	33½	33
14	7.56 mm.	38	32	30	33½
15	7.56 mm.	40	34½	30	34½
16	7.65 mm.	37½	30½	29½	34½
17	7.73 mm.	41	35	31½	33
18	8.08 mm.	37½	32	31	36½
19	8.26 mm.	39	33½	31½	37
20	8.34 mm.	40½	?	31	34
21	8.43 mm.	40	35	28	35
22	8.78 mm.	38½	32½	28½	35½
23	8.86 mm.	38	32½	28	36½
24	9.04 mm.	41½	33½	30	32
25	9.12 mm.	40	35	28½	33½
26	9.21 mm.	39½	?	27½	33
27	9.30 mm.	41	36½	30	33
29	9.56 mm.	39	?	ca. 32½	35½
30	9.56 mm.	37	32½	30	36½
31	9.73 mm.	39½	34	29½	34
32	9.91 mm.	39½	?	31½	35
33	10.08 mm.	39½	ca. 35½	30	36
34	10.08 mm.	40½	ca. 35½	26	33½
35	10.25 mm.	40	ca. 34	32	36½
36	10.43 mm.	41½	ca. 36	30	32½
37	10.51 mm.	40½	?	ca. 28	34
38	10.69 mm.	41½	ca. 36½	31½	35
39	11.04 mm.	38½	ca. 34	28½	36
40	11.12 mm.	41½	ca. 33½	26	33½
41	11.38 mm.	38	?	ca. 30½	36½
42	11.82 mm.	39	33	28½	36½
43	12.08 mm.	42½	?	28	32½
44	12.51 mm.	41	34½	38	37½
45	12.51 mm.	41	ca. 37	28½	32½
46	13.47 mm.	39½	32½	26	34
47	13.56 mm.	40½	34	24½	32½
48	13.90 mm.	42	34	ca. 37½	31½
49	14.77 mm.	40½	?	ca. 27	33½
50	14.86 mm.	37½	32	29	39
51	14.95 mm.	41½	ca. 34½	ca. 31½	32
61	15.5 mm.	42½	37	26	35½
52	16.4 mm.	39½	ca. 34	27½	42
53	16.5 mm.	40	ca. 31½	31½	39
54	16.5 mm.	37	?	ca. 25½	39½
55 (syntype A)	16.8 mm.	38½	32	ca. 31	40
56	17.1 mm.	42	?	24	37
57	17.4 mm.	42	?	26½	37½
58	17.8 mm.	34½	?	26	45
59	19.0 mm.	41	?	25½	37
60 (syntype B)	21.0 mm.	40	ca. 29	25	39½

[1] Referred by Rollier (1909, p. 622) to his genus *Trimarginites* which is, however, granted only subgeneric rank under *Ochetoceras* by Arkell (1943, p. lxxxiii).

[2] Crushed.

This species also exhibits the usual trend towards increase of whorl height with growth, but it is obscured by the fact that the absolute minimum of H (34½) is found not in a small juvenile but in the third largest paratype (no. 58) and that the values of 37 and 37½, coming closest to that minimum, occur not only between diameters of 6 and 10 mm. but at those of 14.86 and 16.5 mm. as well. The lowest values of W (24–25½) are found in five out of the 15 largest measured specimens, thus indicating that this species also decreases, as a rule, in thickness with growth, but the second highest (37½) occurs in the same size group (no. 48) as well as in one of the smallest juveniles (no. 3), and the highest (38)[1] in paratype 44, the diameter of which is only about 1 mm. less than the lower limit of that size group. The table is least conclusive with regard to umbilical width. Between the extreme limits of 29½, measured in the nucleus of paratype 1, and 45, encountered in the unusually evolute large paratype 58 (which also exhibits the minimum of H), the lowest values amount to from 31½ to 32½ and the highest to 40 and 42. All these values appear to be concentrated between the diameters of 12 and 16.8 mm., with the values close to the maximum occurring in paratype 52 and syntype A, and those close to the minimum in syntypes 43, 45, 47, 48, and 51. Outside this size group, those low values are encountered only in two individuals (nos. 24, 36) at diameters of about 9 mm. and about 10.5 mm.

The range of dimensions in our three species of *Ochetoceras* (*Campylites*) is as follows:

	H	W	U
delmontanum	39½–51	30 –35	25½ –36½
freboldi	40 –48	22½–36½[2]	25 –34½[2]
evolutum	34½–42½	24 –38[2]	31½[2]–45

From the above tabulation it can be clearly seen that the present species grows somewhat thicker and is decidedly more evolute than the two preceding species; the specific name alludes to the latter difference.

The largest individual present (syntype B) shows the last septum at a diameter of about 16 mm., but syntype A and paratypes 57 and 59 are septate throughout, that is, up to diameters of from 16.8 to 19 mm. If it be assumed that the body chamber begins in adults at a diameter of about 20 mm., a diameter not exceeding 30 mm. is arrived at for entire, full-grown shells of this species. It thus appears to have been markedly smaller than both *delmontanum* and *freboldi* and may be considered a diminutive member of the subgenus *Campylites*.

DESIGNATION OF TYPES: The wholly septate specimen A.M.N.H. No. 27910:55 is selected syntype A for best representing the early and medium growth stages of this species, and specimen A.M.N.H. No. 27910: 60, with one-third of the outer whorl belonging to the body chamber, is selected syntype B as a mature individual.

DESCRIPTION: The protoconch, well visible in paratypes 15 and 39, has a diameter of the order of magnitude of 0.1 mm. Otherwise it does not differ from those observed in related species. The nucleus of paratype 1 (pl. 14, figs. 49–51) clearly shows, at diameters of 0.71 mm. and 0.92 mm., two constrictions which stand a little more than a quarter of a whorl apart and which run more or less straight across the flanks; they cannot be recognized on the venter.[3]

In frontal view this nucleus (pl. 14, fig. 49) exhibits, at a diameter of 1.2 mm., a whorl profile which is still reniform. In the further course of development it turns first elliptic, then inverted-oval (nos. 5, 11, 22; pl. 15, figs. 2, 3, 13) and in some of the sturdier shells (e.g., no. 16, pl. 15, fig. 4) broad-oval. The width of the whorl is also responsible for the difference, at medium sizes, between the ogival whorl profiles of some specimens (e.g., paratype 46, pl. 15, fig. 16) and the inverted heart-shaped ones of others (e.g., syntype A, pl. 15, fig. 24; as the lower left corner of this profile is badly deformed, only the right side of this figure gives a correct profile). A profile similar to this one, but much less wide at the umbilical shoulder, is found in syntype B (pl. 15, fig. 27). With

[1] If the absolute maximum of 65½ reached by the nucleus of paratype 1 at a diameter of 1.2 mm. is left out of account.

[2] Excluding nuclei and disks measuring less than 5 mm. in diameter.

[3] Another constriction has been observed on the venter of another nucleus of about the same size, which was, however, lost in the course of preparation and could not be recovered.

growth the median keel and later all three keels show increasingly in the whorl section. Where the lateroventral shoulders develop before the median keel becomes conspicuous, the venter assumes, for a passing stage, a slightly truncate aspect, e.g., in paratype 35 (pl. 15, fig. 6). The maximum width is at, or somewhat dorsad of, the inner third of the flanks or in some shells (syntype A) even at the inner fourth. The greater the width and the nearer its maximum to the umbilical shoulder, the higher becomes the umbilical wall which is in some specimens steep or even perpendicular (nos. 17, 22, 46, 55; pl. 15, figs. 9, 13, 16, 24).

The three fine threads on the venter foreshadowing the triple keel, as recorded in the two preceding species, are encountered rather frequently in the present one, too, at diameters of from 3 to 8.5 mm. (paratypes 4, 7, 12, 14, 28; pl. 15, fig. 11). A pronounced median ridge is present as early as at a diameter of 5 mm. in the small juvenile 3; in paratype 34 it has developed into a true keel at a diameter of 8.7 mm. The triple keel characteristic of this subgenus appears at diameters of from 10.5 to 12.5 mm. (nos. 42, 50, 51, 52, 56, 60; pl. 15, figs. 19, 21, 25). Two juveniles only (nos. 6, 25) exhibit a siphuncular groove; it disappears in number 6 at a diameter of 5.2 mm. but persists in number 25 to the anterior end, corresponding to one of 9.12 mm.

The first indications of ornamentation are forward convex, node-like folds restricted to the inner half of the flanks in the small juveniles 4 and 6; about 10 are counted on the anterior half-whorl of the latter specimen (pl. 15, fig. 1), where they set in at a diameter of a little more than 4 mm. These folds increase in number to seven per quarter-whorl in paratype 8 and spread in its anterior portion, at diameters from 6 to 6.5 mm., as true, distinctly sigmoidal, radial ribs all over the flanks (pl. 15, fig. 8). The ornamentation of the not so much larger juvenile 20 (pl. 15, fig. 5), on the other hand, foreshadows that of later stages. In the anterior third of the outer whorl nine strongly recurved sickles are present which are restricted to the outer two-thirds of the flanks. The same style of ornamentation is recognizable, though less distinctly, in paratypes 24, 26, and 27 also. The last two also begin to show indications of the "handles of the sickles," i.e., straight, prorsiradiate inner ribs. The costation is much better developed in paratype 30 (pl. 15, fig. 7); here it comprises, in the anteriormost quarter of the outer whorl, six inner ribs and 10 quite robust sickles. The somewhat larger paratype 41 (pl. 15, fig. 17) carries eight strongly prorsiradiate, fold-like inner ribs which in a sharp angulation give rise to two equally strongly recurved outer ribs each. Thus this shell approaches the mature ornamentation even more closely than paratype 30. This style of costation prevails in the size group of from 11.5 mm. to nearly 15 mm., quite pronounced in some shells, e.g., 42–44, 48, 49, less so in others (no. 46, pl. 15, fig. 15), and rather subdued in a few (nos. 45, 47). The ornamentation of paratype 50 (pl. 15, fig. 20), consisting on the anterior half of the outer volution of 11 prorsiradiate, slightly forward concave inner ribs and 16 comparatively sharp sickles, is, on the other hand, quite robust and remarkable for two more features: The inner ribs extend forward at the angulation points, thus merging into a spiral ridge separating the circumumbilical zone from the outer one, which is more than twice as wide, and the outer sickles, which originate at this spiral ridge either by bifurcation of inner ribs or by intercalation, become less recurved towards the anterior end. Paratype 61, slightly larger than 50, is remarkable in contrast for its utterly subdued costation; it appears smooth at first glance. The excellently preserved ornamentation of syntype A (pl. 15, fig. 23), on the other hand, agrees with that of paratype 50, just described, except for having slightly fewer (eight) inner and a few more (18) outer ribs and for the fact that the sickles remain recurved to the anterior end. They are even more recurved and the costation is a little denser in the most evolute paratype (58) which, though deformed, is very distinctive of this species in its ornamentation (pl. 15, fig. 28). Paratype 56 and syntype B (pl. 15, fig. 26), the latter with 12 "handles" and 17 sickles, resemble syntype A in costation, without, however, developing the spiral ridge there connecting the angulation points.

The septal margin at the anterior end of the nucleus of paratype 1, well seen in figure 51 of plate 14, represents the earliest sutural stage observable in this species, corresponding to, and agreeing with, the one described in paratypes 92, 93, and 4 of the preceding species. At about three times the size of that nucleus the first lateral lobe has become clearly trifid and the main saddles are indented by shallow notches in paratype 2. Sutures are still rather primitive and widely spaced (three per quarter-whorl) in paratypes 3, 4, and 19, but comparatively advanced in indentation and more closely set (four or five per quarter-whorl) in paratype 5 (pl. 14, fig. 48). In paratype 8, again, they are nearly goniatitic and the last six crowded (pl. 15, fig. 8), whereas for that stage they show an average degree of indentation and are rather closely set (five per quarter-whorl) in paratypes 11 and 17 (pl. 15, fig. 9). At the same density the sutures are surprisingly primitive in paratype 20 (pl. 15, fig. 5), with both lateral lobes very plump and only the first divided into three extremely short and rounded "points," moderately elaborate in paratype 28 (pl. 15, fig. 12), but somewhat reduced in paratype 32 (pl. 15, fig. 10). In paratypes 30 (pl. 15, fig. 7) and 36, on the other hand, only four quite elaborate suture lines are counted to a quarter-whorl. The sutures of paratype 40 show the same density and are remarkable for their plump lateral lobes, the first of which ends in unusually stubby points.

Even through medium sizes the saddles are sturdier and the lobes plumper and shorter in the sutures of this species than in those of the two preceding ones, although the degree of indentation is about the same (nos. 42, 46, 50, 55; pl. 15, figs. 18, 15, 20, 23). Some individuals, however, e.g., paratypes 47 and 56, exhibit more slender saddles and lobes, such as are found in those species. Secondary prongs appear first on the outer sides of the middle points of the first lateral lobes at a diameter of 11 mm. in paratype 46 and on both sides of those points at a diameter of about 14 mm. in syntype A. In both these shells these middle points are deflected ventrad, as is characteristic of this subgenus, thus causing the first lateral lobes themselves to point in the same direction (pl. 15, figs. 15, 23).

The abnormalities so common in oppelid suture lines occur in the present species also. Thus the siphonal lobes are shifted far to the right in paratypes 21 and 62 (pl. 15, fig. 29), the first lateral lobes are symmetrically bifid on the left side of paratype 63 and asymmetrically so on the right side of paratype 37, and the second lateral lobes are, on the left side only, symmetrically bifid rather than trifid throughout the penultimate whorl and the preserved half of the outer one in syntype A (pl. 15, fig. 23).

REMARKS: For differences in shell shape of this species from its closest relatives, *O. (C.) delmontanum* and *O. (C.) freboldi*, reference is made to the above discussion of the dimensions, and for a basic difference in the suture lines to the preceding description. The greater width attained by the whorl section of this species lends it an inverted heart-shape rather than the lanceolate one characteristic of the two preceding species.

In ornamentation *O. (C.) evolutum* differs from *O. (C.) freboldi* by the much earlier appearance and stronger development of the ribs, in which respect it agrees much better with *O. (C.) delmontanum*. From the latter it can still readily be distinguished by the heavier, sharper, and more decidedly recurved ribs. Comparison of our side views of specimen 63 of *delmontanum* (pl. 13, fig. 32), on the one hand, and of syntype A of the present species (pl. 15, fig. 23), on the other, bears this out best.

As do other species of this subgenus, *O. (C.) evolutum* closely resembles in side view certain forms of *Hecticoceras* (*sensu lato*), especially *H.* (*Sublunuloceras*) *socium*, the ornamentation of which is sometimes indistinguishable from that of this species, and *H.* (*Putealiceras*) *solare*, in which the ribs are similarly pronounced, bifurcating, and strongly recurved. From both the present species is readily distinguished by the marked ventrad tapering of the whorl section and the narrowness of the venter, on which three sharp keels appear at a comparatively early stage, whereas the venter is somewhat truncate and carries only one rather delicate keel in *socium*, and is crossed by heavy ribs which all but obliterate the median keel in *solare*. These are two more of the cases of striking similarities in characters other than those of the periphery alluded to in the introductory section on the Oppelidae.

MATERIAL STUDIED: One hundred and two specimens, including incomplete specimens and fragments.

TARAMELLICERAS DEL CAMPANA, 1904

The forms of our assemblage referable to this genus would come all under the subgenus *Proscaphites*, as understood by Spath (1928, pp. 131, 134)[1] and Arkell (1939, p. 147), were it not for Jeannet's (1951, p. 95) recent creation of a separate "genus" *Richeiceras* for *Ammonites pichleri* Oppel, *Oppelia richei* de Loriol, and some closely related forms.

Thus, although subgeneric rank at the most can here be granted to Jeannet's new group, the *Taramelliceras* from Mount Hermon must now be divided between the "subgenera" *Proscaphites* and *Richeiceras*.

With altogether about 400 individuals, this genus, among the Oppelidae of the present fauna, is vastly outnumbered by *Hecticoceras* and, to a lesser degree, by *Ochetoceras*, but it is much more abundant than *Scaphitodites*, not to mention the rarest of all these genera, *Creniceras*.

SUBGENUS PROSCAPHITES ROLLIER, 1909[2]

Following Spath (1928, pp. 131, 134) and Arkell (1939, pp. 147–150) and notwithstanding Jeannet's (1951, p. 90) view to the contrary, this subgenus is here not restricted to forms in which the median portion of the venter is raised and laterally compressed as it is in *Ammonites anar* Oppel (1863, p. 207, pl. 55, fig. 1), the type species, but is understood to include the group of *Oppelia episcopalis* de Loriol, here considered a synonym of *Oppelia hermonis* Noetling, and its close allies.

In addition to *T.* (*P.*) *hermonis* [=*T.* (*P.*) *episcopalis*], *T.* (*P.*) *globosum* (de Loriol), treated by that author as a variety of *episcopalis* but here raised to specific rank, and three shells comparable to *T.* (*P.*) *langi* de Loriol are referred to *Proscaphites* in the present report.

Taramelliceras (Proscaphites) hermonis (Noetling)

Plate 15, figures 30–59; plate 16, figures 1–5

Oppelia hermonis NOETLING, 1887, p. 26, pl. 4, fig. 4.

Oppelia episcopalis DE LORIOL, 1898, p. 45, text fig. 14, pl. 4, figs. 1–6.

Oppelia episcopalis, P. de Loriol; DE LORIOL, 1900 (exclusive of var. *globosa*), p. 41, pl. 3, fig. 17, *non* figs. 18, ?21, 22, 23.

Proscaphites cf. *hermonis* (Noetling); SPATH, 1928, p. 134, *cum synon.*, pl. 13, fig. 4.

Oppelia hermonis Noetl.; FREBOLD, 1928, p. 191.

Taramelliceras episcopale de Loriol (var. *cincta* nov.); MAIRE, 1928, p. 18, pl. 2, figs. 1, 1a, 3b.

Taramelliceras (*Proscaphites*) *episcopale* (de Loriol); ARKELL, 1929, p. 149, *cum synon.*, pl. 8, figs. 5, 7.

Taramelliceras (*Proscaphites*) *episcopale* (de Loriol); ARKELL AND HOLT, 1952, p. 18.

DIMENSIONS

A.M.N.H. No. 27921	D	H	H′	W	U
1	4.69 mm.	46½	?	*ca.* 41	26
2	4.69 mm.	44½	35	*ca.* 39	27
3	4.78 mm.	47	36½	43½	27
4	5.13 mm.	49	39	39	26½
5	5.21 mm.	53½	37½	40	20
6	5.56 mm.	48½	37½	36	22
7	5.61 mm.	50½	39	39	22½
8	5.65 mm.	49	*ca.* 40	37	23
9	5.65 mm.	47	37	38½	25½
10	5.95 mm.	48	36	41	25
11	6.00 mm.	50½	37½	39	19
12	6.26 mm.	47½	37½	38	23½
13	6.26 mm.	53	37½	47½	16
14	6.26 mm.	55½	37½	39	15½
15	6.60 mm.	51½	39½	39½	21
16	6.69 mm.	50½	36½	36½	21½
17	6.78 mm.	52½	?	42½	19½
18	7.04 mm.	52	*ca.* 39½	38	19½
19	7.30 mm.	57	?	*ca.* 45	13
20	7.47 mm.	51½	37½	37	21
21	7.82 mm.	54½	38	39	16½
22	7.82 mm.	51	38	36½	21
23	7.82 mm.	56½	*ca.* 40	36½	14½
24	7.82 mm.	55½	35½	36½	10½
25	7.99 mm.	53	*ca.* 40	38	18½
26	7.99 mm.	54½	41½	42½	15
27	8.26 mm.	52½	39½	34	17
28	8.43 mm.	55	?	44½	15½
29	8.43 mm.	51½	?	*ca.* 38	19½
30	8.78 mm.	53½	38½	36½	15
31	8.78 mm.	51½	*ca.* 39½	34½	15½
32	8.86 mm.	54	?	37½	15½
33	8.86 mm.	56½	?	36½	13½
34	9.12 mm.	52½	36	39	17

[1] However, Spath treats *Proscaphites* as an independent genus, not as a subgenus of *Taramelliceras*.

[2] My attempts to secure a copy of a paper by H. Tintant and J. M. Étienne, "Sur quelques *Proscaphites* de l'Oxfordien du Jura" (1950, Bull. Sci. Bourgogne, vol. 13) failed, so that I do not know whether it has any bearing on the present report or not.

A.M.N.H. No. 27921	D	H	H′	W	U
35	9.34 mm.	56	38	40	15
36	9.65 mm.	54	38½	38	16
37	9.91 mm.	56	42	37	13
38	10.08 mm.	56	*ca.* 37	43	13
39	10.25 mm.	54½	38	38	15½
40	10.25 mm.	55	*ca.* 40½	37½	13½
41	10.78 mm.	55	38	41	10½
42	10.86 mm.	55	40	41	13½
43	11.21 mm.	56½	?43½	41	12½
44	11.30 mm.	56	37	42½	9
45	11.30 mm.	53	37½	33	12½
46	11.47 mm.	54	39	32½	14½
47	11.56 mm.	55	39	40	14½
48	11.64 mm.	55	37½	41	12
49	11.73 mm.	57	38	38	11
50	11.82 mm.	56	40½	*ca.* 37½	12½
51	12.17 mm.	53½	37	39½	14½
52	12.60 mm.	55	36	42	10½
53	13.04 mm.	57½[1]	?43½	40	13½
54	13.38 mm.	55	38½	37½	8½
55	13.82 mm.	55½	39	41	12
56	13.82 mm.	55½	38	44½	12
57	13.82 mm.	56	?	36	11½
58	14.43 mm.	56½	?	36	12½
59	15.03 mm.	56½	36½	41½	9
60	15.29 mm.	57	38½	37	11
61	15.56 mm.	57	40	38	10
62	16.51 mm.	55½	39½	39	9
63	17.38 mm.	58½	42½	*ca.* 39	10
64	17.4 mm.	57	35½	41	9½
65	18.3 mm.	57½	36	38½	13
66	19.0 mm.	53½	*ca.* 35½	*ca.* 37	11
67	19.2 mm.	57	34½	38	11½
68	19.4 mm.	56½	36	39½	9½
69	21.3 mm.	58	34	41	11
70	22.3 mm.	57	37½	47½	*ca.* 10
71	22.9 mm.	60	37½	38	9½
72	32.7 mm.	56½	37	41½	9
73	33.0 mm.	54	*ca.* 34½	41	11½
74	39.6 mm.	59½	*ca.* 38½	*ca.* 43	8½

The table clearly shows trends towards increase in whorl height and decrease in umbilical width with growth. The lowest values for H and the highest for U are found in the four smallest juveniles, and the highest for H and the lowest for U among the seven largest individuals; however, extremely narrow umbilici also occur in two medium-sized shells (nos. 54, 59). It is interesting to note that, with the exception only of specimen 12, H always exceeds 50 from the diameter of 6 mm. and that U never reaches 20 beyond the diameter of 8 mm.

With the exception of a few particularly stout individuals (nos. 13, 19, 28, 56, 70), to be dealt with presently, the width varies only between 32½ and 43, with the minimum (32½) and the value closest to it (33) encountered at diameters between 11.25 mm. and 11.5 mm. and values from 41 to 43 scattered all over the table. Thus no growth trend with regard to the width of the shell is recognizable.

The five specimens enumerated above which stand out by widths of from 44½ to 47½ are too close in width to the stoutest of the others to be considered a morphological variety. They certainly are not referable to de Loriol's var. *globosa* [of *T.* (*P.*) *episcopale*], raised below to specific rank (p. 102), for not only is W still markedly below the minimum width of *globosum* (52) in the stoutest of those five individuals (47½), but, what seems more important, they have the whorl profile characterized by gently convex flanks and a rather broad, slightly truncate venter in common with the rest of this population, whereas it tapers very decidedly towards the narrow, sometimes somewhat sharpened venter in *T.* (*P.*) *globosum*.

The dimensions given by Noetling for his largest (and only figured) specimen roughly agree with those of similar size in our material, except for his value of 15 for U, which, as his figure 4 shows, must be reduced to 12½.

De Loriol's (1898) dimensions, as given for his *Oppelia episcopalis* in the size range from 11 mm. to 33 mm., also agree well with those in our table, except for a somewhat lower mean value of H.

The shell figured by Noetling seems to be septate up to its largest diameter of 26 mm. Some shells illustrated by de Loriol in 1898 show the last septa at diameters of a little more than 20 mm., 26 mm., and 32 mm., respectively, but all those described by him in 1900 are said to be septate throughout, as are all our largest shells, except specimens 70 and 74, in both of which the last septa can be located immediately behind the anterior ends, at diameters of about 22 mm. and 39 mm., respectively. If the latter specimen be considered to have reached maturity and the length of the body chamber be estimated at only half a volution, then this species may be assumed to have attained a diameter of about 60 mm.

DESIGNATION OF TYPE: The largest, and

[1] Outer whorl abruptly increases in height anteriorly.

only figured (see synonymy) specimen of Noetling's must be considered the holotype of this species.

DESCRIPTION: The protoconch as such is not recognizable in any individual present, but from the hole the lost protoconch left behind in the juvenile 5 its diameter can be estimated at a little less than 0.1 mm.

A shallow but wide constriction crosses the venter of the smallest juvenile (no. 1) at a diameter of 2.6 mm.; this is the only constriction observed in any individual of this genus.

The whorl profile is slender-elliptic in the young (e.g., no. 7, pl. 15, fig. 35), with the maximum width at about the inner third of the gently convex flanks, which pass without any distinct shoulder into the rather broad, gently rounded venter, and with a pronounced, though rounded, umbilical shoulder and a high and steep umbilical wall. The whorl section is essentially the same in the slightly larger juvenile 12 (pl. 15, fig. 32), except for the fact that the inner two-thirds of the flanks are almost flat and the umbilical wall is almost perpendicular. With increasing involution the whorl profile becomes higher and thus appears more slender (no. 16, pl. 15, fig. 33). The juvenile 24 is remarkable for having a slightly truncate venter (pl. 15, fig. 54).

At a somewhat later ontogenetic stage, as represented by specimen 45 (pl. 15, fig. 49), the whorl section is still the same, except for the now even more pronounced rectangular umbilical shoulder and the strictly perpendicular umbilical wall. A few medium-sized individuals, namely, numbers 55 (pl. 15, fig. 59), 59, and 61, stand out by flat and parallel flanks, a feature otherwise distinctive of *T.* (*Richeiceras*) *richei* which is, however, much more slender. In the two first-mentioned specimens, both rather on the stout side, the venter is, in addition, unusually wide and only very gently convex. As a rule, however, both flanks and venter remain gently rounded, regardless of whorl width (nos. 60, 67, 69, 74; pl. 15, figs. 41, 42, 53; pl. 16, fig. 1). This holds true even for the very stoutest shell (no. 70, pl. 15, fig. 40).

In specimens numbers 25, 30, and 56 a continuous, low, and comparatively broad "keel," which seems to be nothing other than the outer side of the siphuncular tube, develops between the diameters of 6 and 9 mm.; it is flanked by two extremely shallow furrows, thus simulating the embryonic "three keels" repeatedly noted in juveniles of *Ochetoceras* (*Campylites*).

Faint indications of median nodes appear as early as at a diameter of 6 mm. in the juvenile 18. They are more distinct, from about the same diameter, in the juvenile 30 (pl. 15, fig. 34), where they can be recognized as the continuations of the still indistinct outer sickles across the venter. Accordingly these median nodes are low and transversely elongated. There are from 15 to 20 such median nodes on a quarter-whorl. They are finer, more closely set (more than 25 on the last quarter-whorl), and more distinctly connected with the outer sickles in the juvenile 33 (pl. 15, fig. 44), of which the anterior half of the outer whorl belongs to the body chamber. This shell is remarkable for forming a rather sharp, continuous median ridge in the anteriormost quarter-whorl, accompanied on either side by two or three delicate longitudinal striae. A similar striation is seen on the venter of the somewhat larger juvenile 40 (pl. 16, fig. 4) which seems to be septate throughout and lacks the median ridge.

The median nodes recognizable in the juveniles 37 and 41 are no more distinct than those of number 30 described above. The same holds true for the slightly larger shell 45, except for its anteriormost quarter-whorl, where a shallow siphonal groove splits the row of median nodes into two parallel, gently undulating keels (pl. 15, fig. 46).

Only the medium-sized shell 66 develops, in its unseptate anteriormost portion corresponding to diameters of from about 16 mm. to 19 mm., the true "quille perlée" (Rollier, 1909, p. 623) characteristic of this genus (pl. 16, fig. 3); the number of beads is 20 to the quarter-whorl, equaling that of the outer sickles. Unfortunately the median zone of the venter is worn in all individuals ranging in size between number 66 and the largest (no. 74), except for specimen 71 which carries, still in its septate part, beads somewhat coarser and blunter than those of number 66. Only the largest individual (no. 74) exhibits, in the posterior half of the outer whorl, which is still provided with the test, at diameters of from 19 mm. to 25 mm. beads as fine and distinct as those described in specimen 66; here 17 are counted per quarter-whorl (pl. 16, fig. 1).

Indistinct and irregularly spaced, forward concave folds can be recognized in the inner zone of the flanks of even the smallest juvenile (no. 1) and even faint indications of sickles in the outer zone. Similar early traces or ornamentation are recognizable under the microscope in some similarly small juveniles, but most of them appear smooth at first glance. Only in the juvenile 11 do the first true circumumbilical folds appear, three to a quarter-whorl, at a diameter of about 3.5 mm. (pl. 15, fig. 31). Somewhat coarser ones are seen in the last quarter-whorls of the juveniles 13 and 16 at slightly larger diameters. In the anterior portion of specimen 17 these circumumbilical folds begin to resemble those of later stages, are rather heavy and gently forward concave and extend over the inner half of the flanks, exceptionally somewhat beyond, and still number three to a quarter-whorl (pl. 15, fig. 39). In the slightly larger specimen 23 these folds are more node-like and less well defined (pl. 15, fig. 37), but they are well developed and continue far into the outer zone of the flanks in specimen 25 (pl. 15, fig. 38).

The excellently preserved juvenile 33 (pl. 15, fig. 45) is remarkable for exhibiting, from a diameter of 6.5 mm., fine outer sickles, 13 of which can be counted on the last quarter-whorl and which cross the venter in an obtuse, forward-pointing tongue, but no circumumbilical folds. In numbers 37 and 39 (pl. 15, fig. 51), however, these folds and the outer sickles combine to foreshadow the mature ornamentation of this species. Ten of the former and 20 of the latter are counted on the anterior half of the outer whorl of number 39, with each inner fold bifurcating, seemingly, into two outer sickles. The costation is similarly dense and even more delicate in specimen 45, but much less so in numbers 42, 43, and 44. In the last, only three circumumbilical folds but 13 outer sickles are counted on the last quarter-whorl. Thus here four rather than two of the latter correspond to each of the former (pl. 15, fig. 50). This coexistence of shells with few and strong circumumbilical folds on the one hand and of others with more and weaker such folds on the other seems to continue throughout the further development. Specimens 53, 56, 70, and 72 (pl. 15, fig. 57) serve as examples of the first type; specimens 59, 63, 65 (pl. 15, fig. 55), 67, 68, 71, and the holotype as examples of the second. This dimorphism might be considered a minor detail, were it not for the fact that this very coexistence disposes of the first and, apparently, most important difference of several on which de Loriol (1898, p. 48) based his separation of *episcopalis* from *hermonis*. A third group of shells, represented by numbers 64, 69 (pl. 15, fig. 52), and 73, occupies an intermediate position, in that two circumumbilical ribs each are paired, with occasionally a single, weaker one in the interval between the pairs. In the last half-whorl of specimen 69 nine inner ribs correspond to 28 outer ones, the latter originating by bifurcation, trifurcation, or intercalation. Exactly the same features are observable in some specimens illustrated by de Loriol (1898, pl. 4, figs. 2, 3; 1900, fig. 17).

In the largest individual present (no. 74), which represents the fully mature ornamentation of this species, the corresponding numbers are 14 inner and 42 outer ribs, thus again yielding a ratio of three outer to one inner. Here, too, both bifurcation and trifurcation occur as well as intercalation. The circumumbilical costae tend here to unite in bundles of three, separated by wider intervals, rather than in pairs (pl. 16, fig. 2).

In passing it may be added that some of our shells, e.g., numbers 63 and 65 (pl. 15, fig. 55), are indeed, as indicated in the subgeneric name, strongly reminiscent in ornamentation of the early, still tightly coiled stage of some Cretaceous *Scaphites*.

So many shells of this species (indeed, most of those present) exhibit the suture lines so well that it is difficult to select those with the very best sutures. Throughout development, in this species as well as in its congeners, they are much more richly indented and elaborate than in all other oppelids hitherto dealt with. Thus, even at the earliest juvenile stages, corresponding to diameters of from 2.5 mm. to 3.5 mm. and best exemplified by specimen 3 (pl. 15, fig. 30), both lateral lobes are clearly trifid, even the first auxiliary is just developing an outer lateral point in addition to the terminal one, and, what may be considered the best scale for the degree of indentation, the middle point of the first lateral lobe shows indications of two secondary points. The second auxiliary lobe rides just on the umbilical shoulder, and there is a third on the umbilical wall.[1] Both external and first lateral saddles are divided by lobules into two leaves each, with the inner leaf of the latter saddle subdivided by a tiny secondary lobule. It is amazing how closely this suture line resembles in degree of indentation and especially in regular alignment of the slender, upright-standing saddles, that of *Sowerbyceras helios*, a species belonging to a different suborder, at the same stage (compare pl. 15, fig. 30, with pl. 3, fig. 20).[2] This confirms Spath's (1928, p. 153) derivation of the Oppeliaceae from the Phylloceratidae, especially on the strength of sutural homologies. The only difference that can be found on the flanks between these early sutures of *Sowerbyceras* and those of *Taramelliceras* is the somewhat higher degree to which the first lateral saddle overtops the external one in the latter genus, this being perhaps the most distinctive feature of oppelid sutures throughout the family.

At a slightly more advanced stage, corresponding to diameters of from 5.5 mm. to about 7.5 mm. and best exemplified by the juveniles 7 and 20 (pl. 15, fig. 36; pl. 16, fig. 5), the elaboration of the sutures can be seen to increase rather rapidly beyond that of the earliest stage studied. Now the second auxiliary lobe becomes trifid and the inner lateral point of the first lateral lobe and the middle point of the second also acquire secondary prongs. The inner lateral point of the second lateral lobe outgrows the outer and occupies a markedly lower site, thus gradually causing this lobe to change from a trifid to an irregularly bifid one. In the larger of these two shells (no. 20, pl. 16, fig. 5) the number of auxiliary lobes has increased to at least five, three of which are on the side, followed by a fourth which rides on the umbilical wall. It is worth noting that, despite the high degree of elaboration of the suture lines, their density amounts to only three per quarter-whorl in the smaller of the two specimens and does not yet reach four in the larger. The height of the saddles and depth of the lobes seem to account for this comparatively wide spacing.

More progress in indentation is recognizable in specimens 24, 25 (pl. 15, fig. 38), and 30, in all of which the first lateral lobe spreads rather widely into three points, all distinctly three-pronged. The ramification and indentation of the saddles increase *pari passu* with those of the lobes.

Specimens 36, 43, and 45 (pl. 15, fig. 48) are good examples of the steady further advance in sutural elaboration. In the last of these shells the first auxiliary lobe imitates the second lateral in changing from trifidity to bifidity, and the third auxiliary has become symmetrically trifid and thus a somewhat reduced repetition of the second. The number of auxiliaries is still five, three on the flank and the fourth and fifth on the umbilical wall, the sharp umbilical edge now being occupied by the third auxiliary saddle which is divided into two leaves, as are the first and the second.

The maximum of floridity of the sutures in this species is observed, at diameters up to 16.5 mm. and 32.5 mm., respectively, in specimens 62 and 72 (pl. 15, figs. 43, 56, 57), whereas the largest shell present (no. 74), covered with the test, does not lend itself well to a study of the sutures. The rich indentation of the two high leaflets bounding the middle point (now asymmetrically bifid rather than trifid) of the first lateral lobe in specimen 72 (pl. 15, figs. 56, 57) deserves special mention. This shell exhibits six auxiliary lobes, four, all richly indented, on the flank and two simple and short ones on the high umbilical wall. With this extreme elaboration, the density of the sutures still amounts to only from three to four per quarter-whorl.

REMARKS: De Loriol, when creating his *Oppelia episcopalis* in 1898, was well aware of its close relationship to *O. hermonis* Noetling. He found, however, three differences, or groups thereof, on which he relied for sepa-

[1] Its presence at this very early stage best refutes de Loriol's (1898, p. 48) belief, caused by Noetling's incomplete drawing (fig. 4c), that *T.* (*P.*) *hermonis* has only two auxiliary lobes.

[2] This applies primarily to the sutures on the flanks. On the venter the median knob, which has the shape of an arrowhead in *Sowerbyceras* but is trapezoidal in *Taramelliceras*, as in other oppelids, provides a safe criterion for distinction.

ration of the two species. The last of these are sutural differences of which, however, de Loriol specifies only one: He assumes, obviously on the strength of Noetling's incomplete drawing, that that author's species has only two auxiliary lobes, whereas he records three in *episcopalis*. Now the preceding section proves that the Mount Hermon form carries three auxiliaries as early as at a diameter of about 3 mm. and that their number gradually increases to six in maturity (as it probably does also in the Jura form). This disposes of the third difference. The second is based on a somewhat greater umbilical width in *hermonis*. However, U, incorrectly given as 15 in Noetling's text, actually amounts to only 12½ in the holotype, and, according to de Loriol, to 10–12 in his hypodigm. No real difference can be found here either. The first group of differences, as listed by de Loriol, concerns the ornamentation. The inner ribs of *hermonis* are said to be more numerous and less prominent around the umbilicus, and almost all are said to bifurcate regularly, whereas these details are considered to be different in *episcopalis*. Now such differences may be found, if one tries hard enough, between de Loriol's material and the single individual illustrated by Noetling, but they vanish completely once the former author's array of specimens is compared with our population, comprising some 150 individuals, from Mount Hermon. All the features attributed by de Loriol to *episcopalis* and seen in his illustrations, even such peculiarities as the arrangement of the inner ribs in pairs, can be just as readily recognized in some of our specimens (see the above section on ornamentation). Thus not the slightest doubt remains but that the Mount Hermon and the Jura forms are conspecific and that *O. episcopalis* de Loriol is a junior synonym of *O. hermonis* Noetling.

This statement includes the forms referred to the typical *episcopalis* by Maire, Arkell, and Arkell and Holt but not de Loriol's var. *globosa* of *episcopalis*, to which Arkell refers a specimen from Woodham Pit also and which is raised below to the rank of an independent species. On the other hand, Maire's var. *cincta* is believed not to deserve taxonomic separation, even as a variety, as flat or even slightly depressed spiral bands occasionally occur in the Mount Hermon population also. Nor would I hesitate to include Spath's (*loc. cit. in synon.*) Indian specimen in *T.* (*P.*) *hermonis* proper.

Taramelliceras (*Proscaphites*) *hermonis* is compared below with two other forms of the subgenus *Proscaphites* (pp. 105, 107), with *T.* (*Richeiceras*) *richei* (p. 111), and with *Scaphitodites scaphitoides* (p. 120).

The high degree of sutural indentation and elaboration make distinction of this species from all other Oppelidae of the present assemblage easy. The only species of Oppeliaceae with similarly elaborate, but in other respects quite different, suture lines, *Lissoceras erato*, can readily be distinguished from the present one by its much wider umbilicus.

MATERIAL STUDIED: One hundred and fifty-two specimens, including a few incomplete specimens and fragments.

Taramelliceras (Proscaphites) globosum (de Loriol)

Plate 16, figures 6–27

Oppelia episcopalis, P. de Loriol, var. *Globosa*; DE LORIOL, 1900, p. 41, pl. 3, figs. 19, 20, 24.

Oppelia episcopalis, P. de Loriol; DE LORIOL, 1900, p. 41, *pro parte*, pl. 3, figs. 18, ?21, 22, 23, *non* 17.

?*Oppelia* sp. (*globula* Qu.?); FREBOLD, 1928, p. 185 (*non: Ammonites flexuosus globulus;* Quenstedt, 1849, p. 127, pl. 9, fig. 6).

Taramelliceras (*Proscaphites*) *episcopale* (de Loriol), var. *globosa;* ARKELL, 1939, p. 149, pl. 8, fig. 6.

DIMENSIONS

A.M.N.H. No. 27922	D	H	H′	W	U
1	5.65 mm.	47½	34	60	21½
2	6.08 mm.	53	*ca.* 38½	54½	18½
3	6.17 mm.	55	35	52	12½
4	6.34 mm.	52	*ca.* 34½	63	19
5	6.43 mm.	58	*ca.* 38	59½	16½
6	6.52 mm.	53½	*ca.* 30½	60	14½
7	6.52 mm.	53½	34½	59½	16
8	6.87 mm.	52	31½	61	15
9	6.87 mm.	53	31½	62	14
10	6.95 mm.	53½	31	71	13½
12	7.30 mm.	58½	37	53½	12
13	7.30 mm.	55	34½	60½	15½
14	7.39 mm.	56½	37½	52	11½
15	7.73 mm.	53	37	54	13½
16	7.82 mm.	54½	39	52	11
17	7.82 mm.	55½	34½	61	14½
18	7.82 mm.	54½	43½	59	13½

A.M.N.H. No. 27922	D	H	H′	W	U
19	8.17 mm.	53½	38½	57½	15
20	8.17 mm.	53	?	59½	14
21	8.43 mm.	54½	ca. 36	66	15½
22	8.95 mm.	54½	ca. 37	57½	9½
23	9.04 mm.	52	33½	59½	14½
24	9.39 mm.	54½	?	63	13
25	9.47 mm.	55	35	66	13
26	9.65 mm.	56	37	58	12½
27	10.43 mm.	56	36	58½	10
28	10.60 mm.	53	34½	59	13
29	12.86 mm.	56	ca. 37	55½	13
30	13.73 mm.	57	40½	66½	10
31	14.34 mm.	62	38	65½	?11
32	17.12 mm.	52½	ca. 35½	52	10½

The minimum of H (47½) is found in the smallest juvenile (no. 1) and the maximum in the largest individual but one (no. 31). Similarly, the widest umbilici, with U ranging from 18½ to 21½, are encountered in three of the four smallest shells, and some of the narrowest, with U ranging from 10 to 13, in the nine largest. Thus the degree of involution may well be said to increase with growth, despite the fact that the values for H coming closest to the maximum occur in two small individuals (nos. 5, 12) and that the very minimum of U (9½) occurs in specimen 22, not attaining 9 mm. in diameter, and similarly low values occur in the even smaller individuals 16 and 14.

The maximum of W, amounting to 71 and thus exceeding that of 67, given by de Loriol (1900), occurs in a small shell (no. 10), but the minimum of 52 is encountered at diameters of 6.17 mm. and 7.39 mm. (nos. 14, 16) as well as in the largest shell present (no. 32) the diameter of which exceeds 17 mm. The values of W most closely approaching the above minimum occur around the diameter of 7.5 mm., whereas those that come closest to the afore-mentioned maximum are found in the lower half of the table at diameters of about 8.5 mm., 9.5 mm., and 13.75 mm. (nos. 21, 25, 30). Thus a definite growth trend as to the width of the conch seems to be no more discernible in this species than in the preceding one. It is worth noting, however, that in most of the measured specimens W exceeds H, sometimes quite considerably, whereas the opposite ratio occurs in only six out of 31 (nos. 3, 12, 14, 16, 29 and 32). As these are scattered all over the table, they do not help to show any growth trend of W either.

All de Loriol's specimens here referred to this species, including the two largest, depicted in his figures 18 and 19, are septate throughout, that is, up to diameters of about 22 mm. and about 20.5 mm., respectively; the same holds true for the markedly smaller shell illustrated by Arkell. In the two largest individuals from Majdal Shams (nos. 31, 32), however, the last septa can be located at diameters of a little more than 13 mm.; especially in specimen 32 are the last septa markedly crowded. This fact would indicate that the present species is a micromorphous one, at least on Mount Hermon. The somewhat larger sizes reached by still entirely septate individuals in the Jura Lédonien do not necessarily preclude such an assumption for this species, but they prevent any estimate of the full size that it reaches.

Designation of Type: The specimen from Arinthod illustrated in de Loriol (1900, figs. 19, 19a) is here selected as lectotype of *T.* (*P.*) *globosum* (de Loriol).

Description: Throughout development the whorl profile is inflated and attains the maximum width immediately above the umbilical shoulder or, exceptionally, at the inner third of the height; hence, it tapers decidedly ventrad. The venter is more or less broadly rounded but never truncate, the umbilical shoulder is pronounced though well rounded, the umbilical wall is always high and perpendicular. All this makes for an inverted heart-shaped whorl section varying in width (nos. 3, 7, 12, 13, 19, 11; figs. 6, 11, 12, 13, 21, 18).

An indication of a continuous, extremely low and rather broad median keel can be recognized in the juveniles 6 and 19 from diameters of about 4.5 mm. and 6 mm., respectively. A beaded keel appears at diameters of about 6 mm., 7 mm., and 9 mm., in specimens 17, 20, and 23, respectively, but is much better developed, between the diameters of 7.5 mm. and 9 mm., in the half-disk 11 (fig. 16), and between the diameters of about 9 mm. and about 12 mm. in the largest specimen (no. 32). This beaded keel is more or less distinct in most of the larger individuals (nos. 25–30). However, in specimen 30 the beads nearly vanish a little beyond the diameter of 12 mm., and in the two largest shells (nos. 31, 32) the beaded keel changes, at diameters of 10 mm. and 12 mm., respectively, rather abruptly into a strong and continuous one which is soon joined by rather wide and deep furrows on either side and rapidly gains in both strength and height (figs. 22, 27), just as shown in de Loriol (1900, pl. 3, figs. 22a and 23a). Whereas de Loriol observed this in shells still entirely septate, in these two specimens from Mount Hermon the change takes place at the penultimate and antepenultimate septum, respectively. This aberrant configuration of the venter affects, of course, the whorl profile also (fig. 22). It almost seems as if the allomorphous growth of the shell in width would crack up the conch ventrally and as if it would then patch up the crack and reënforce it by a surprisingly strong keel.

Strong, markedly prorsiradiate circumumbilical folds appear as early as at a diameter of about 4.5 mm. in the juvenile 2 (fig. 9), but they are less well defined in the juvenile 5 at about the same size. In another individual of this size group (no. 4, fig. 8), however, they split about mid flank into outer sickles which continue in a gently forward convex tongue across the broad venter, slightly rising in the middle and thus foreshadowing the median beads of a later stage. The juveniles 6 and 12, on the other hand, remain smooth up to diameters of 6.5 mm. and 7.3 mm., respectively.

At a somewhat later stage, the ornamentation of juveniles 17 and 19 (fig. 20) agrees, except for being more delicate, with that of number 4, described above. It is more robust in specimens 18, 20, and 21. Six strong circumumbilical folds and about twice as many outer sickles are counted on the anterior half of the outer whorl of the last specimen. The costation is much more dense, with four strong circumumbilical folds and 13 outer ribs on the last quarter-whorl, in the juvenile 23 (fig. 25); the outer costae originate here, with a rather sharp angulation, at the inner third of the flanks. The ornamentation of specimens 24–29 and of the half-disk 11 may be considered transitional to that of the mature stage. In number 11 (fig. 17) five inner and 14 outer costae are counted on the anterior quarter-whorl. The inner ones are no longer so much stronger than the outer ones, most of which originate from the former by bifurcation, with others intercalated. They continue, though markedly weakened, across the venter, culminating in the median beads characterized above (fig. 16). Although a count proves the density of costation to be about the same (eight inner and 28 outer ribs on the last half-whorl) in specimen 30 (fig. 19), it gives the impression of being more dense, probably because the individual ribs are somewhat finer than in specimen 11.

The latest ornamentational stage observable in this form on Mount Hermon is represented by specimen 32 (figs. 26, 27). It is characterized by a certain increase in number and fading in strength of the inner folds on the unseptate anterior third of the outer whorl. With nine inner ribs and 26 outer ones, two of which originate by bifurcation of a secondary rib, the density of the costation is still essentially the same as in specimens 11 and 30. In the present individual the deep furrows accompanying the median keel prevent the costae from crossing the venter. They stop abruptly at the ridges bounding these furrows on the outside. The largest shell but one (no. 31) exhibits on the venter the "lignes granuleuses épidermiques" recorded and figured by de Loriol (1900, p. 42, pl. 3, fig. 24) in a specimen of his var. *globosa.* They are crossed by equally fine growth striae which produce a reticulate pattern (fig. 23).

Suture lines can clearly be observed from a diameter of about 3 mm., e.g., in juvenile 3 (fig. 7). Although the lobes and saddles, including the auxiliaries, are the same in number as in *T.* (*P.*) *hermonis* at the same stage, they are strikingly sturdier and decidedly plump. The second lateral and first auxiliary saddles especially are surprisingly low and broad; both carry shallow notches on their tops (compare pl. 16, fig. 7, with pl. 15, fig. 30). There is less indentation in this sample than even at earlier juvenile stages of *hermonis.* Both lateral lobes and the first auxiliary are clearly trifid, it is true, but no secondary points are yet present in this shell. However, there are two distinct prongs on the middle point, and one each is just developing in the lateral points, of the first lateral lobe of the juvenile 1 at a diameter of about 5.2 mm. The same specimen is remarkable for the fact that the second lateral lobe becomes bifid rather than trifid anteriorly, a feature repeatedly encountered in *T.* (*P.*) *hermonis* also.

The character of the sutures remains essentially the same up to a diameter of about 8 mm.; this stage is best exemplified by the juveniles 7, 13, 15, 18, and 19 (figs. 10, 14, 20). As seen in the second of these illustrations, it is the lobes, chiefly the first lateral, rather than the saddles that are wide in specimen 15. It has altogether four auxiliary lobes, the first, symmetrically trifid, on the flank; the second, asymmetrically bifid, on the umbilical shoulder; and two on the umbilical wall. At about the same size the number of auxiliaries has increased to five in *hermonis* (A.M.N.H. No. 27921:20, pl. 16, fig. 5). The same number and distribution of auxiliaries prevail in specimen 19 also, in which all three points of the first lateral lobes have become clearly three-pronged (fig. 20).

Elaboration of the sutures gradually increases in the further course of development, as exemplified by the ventral view of the last suture lines of specimen 25, which exhibits among other features a median knob with two quite sharp hornlets (fig. 15), and by the side view of those of specimen 27 (fig. 24), just four of which are counted to a quarter-whorl. The saddles in this specimen are not much sturdier than in one of *hermonis* of the same size (A.M.N.H. No. 27921:43). The outer and middle points of the second lateral lobe, too, carry a secondary prong each. Only the first auxiliary lobe is on the flank, and the second, which is now also symmetrically trifid, rides on the umbilical shoulder. As seen at about the same diameter in specimen 29, there are still not more than two auxiliary lobes, the first now also trifid, on the umbilical wall.

None of the shells just dealt with exhibits suture lines beyond a diameter of about 10.5 mm. Only the two largest (nos. 31, 32) show sutures up to one of about 13 mm. The last suture lines of the latter specimen, seen in figures 26, 27, are distinguished by short, though quite richly indented lobes and by low saddles. This applies particularly to the second lateral and first auxiliary saddles which are not only very low but extremely wide, a feature causing the sutures to resemble those of *Scaphitodites scaphitoides*. In that species it extends, however, to the main saddles. It is this hypertrophic width of the smaller saddles which seems to preclude the addition of more auxiliary lobes; the second still rides on the shoulder and certainly not more than two are present on the umbilical wall. This adds up to a total of four, as compared to at least five at the same size in *T.* (*P.*) *hermonis* (A.M.N.H. No. 27921:62).

REMARKS: In establishing this variety, de Loriol (1900) denied that he could find any difference between it and his *Oppelia episcopalis*, here considered synonymous with *T.* (*P.*) *hermonis*, other than one in degree, namely, in the width of the conch, and he also stated that "des passages permettent de relier entre elles les formes extrêmes." Both these statements must here be contradicted. To begin with the second, there is no gradual transition in width between the two forms but, as noted above (p. 98), the maximum value of W in *hermonis* ($47\frac{1}{2}$) is still separated by a distinct gap from the minimum in *globosum* (52), and the mean values of 40 in the former and $61\frac{1}{2}$ in the latter are quite far apart. Furthermore, the whorl profile of the present species, attaining its maximum width near the umbilical shoulder or slightly above and decidedly converging ventrad, is essentially different from that of *T.* (*P.*) *hermonis* in which the flanks, although more or less convex, converge towards the venter no more pronouncedly than they do towards the umbilical shoulder. There are also sutural differences of more than merely varietal significance. Of these, de Loriol mentions only the smaller number of auxiliaries on the flanks due, in his opinion, only to the fact that the second and third "s'enfoncent dans l'ombilic." However, it is the greater width of the sutural main elements (mostly the saddles, sometimes the lobes, and sometimes both) rather than the greater convexity of the flanks that does not permit more than one auxiliary lobe to establish itself on the flanks, as compared to up to three in *hermonis*. It is true that two can be counted on the umbilical wall of this species at a comparatively early stage but, contrary to de

Loriol's assumption, quoted above, their number there does not increase beyond that even at the greatest diameter of about 13 mm. at which suture lines can be studied in this species, despite the much greater height of the umbilical wall in this inflated form. The altogether plumper habitus of the sutures and their somewhat lesser degree of indentation cannot be considered to be controlled by the shell shape. The greater width of their main elements could be explained by the high convexity of the flanks which thus allow for more space, but it must not be forgotten that they expand at the expense of the auxiliary elements, displacing all auxiliary lobes but one from the flanks. The unusual width and lowness of the second lateral and first auxiliary saddles in particular, encountered at the earliest stage (no. 3) as well as at the latest (no. 32), are a further peculiarity which cannot be derived from the shape of the shell. Thus both sutural characters and the distinctive whorl profile justify the granting of specific rather than varietal rank to this form.

The very small specimen listed by Frebold (1928, p. 185) as "*Oppelia* sp. (*globula* Qu.?)" may well belong to the present species, but *Ammonites flexuosus globulus* Quenstedt (*loc. cit. in synon.*), to which Frebold doubtfully refers it, clearly differs from *T.* (*P.*) *globosum* by much stronger median nodes and by the presence of lateroventral ones.

The extreme width and lowness of some saddles constitute a sutural peculiarity shared by this species with *Scaphitodites scaphitoides*. As long as the juveniles of the latter species are not geniculate, they closely resemble equally small juveniles of the present species in shell shape also. For the differences that serve to distinguish them, reference is made to the discussion of *scaphitoides* (p. 120).

MATERIAL STUDIED: Thirty-five specimens (including one incomplete specimen).

Taramelliceras (Proscaphites) cf. langi
(de Loriol)
Plate 16, figures 28–35

Cf.:

Oppelia Langi, DE LORIOL, 1898, p. 56, pl. 4, figs. 18–20.

Oppelia Langi, P. de Loriol; DE LORIOL, 1900, p. 47, *cum synon.*, pl. 4, figs. 2–7.

Taramelliceras (*Proscaphites*) *langi* (de Loriol); ARKELL, 1939, p. 149, pl. 8, figs. 8, 9.

DIMENSIONS

A.M.N.H. No. 27923	D	H	H′	W	U
1	14.16 mm.	53	*ca.* 37	*ca.* 37	12
2	22.5 mm.	59½	?	*ca.* 35½	13½
3	34.0 mm.	58	*ca.* 33	44	14½

Because H, W, and U on the whole all seem to increase with growth, the above small sample must be considered inconclusive with regard to growth trends.

This form considerably surpasses the true *T.* (*P.*) *langi* in size. No specimen of the latter species exceeding 20 mm. in diameter is recorded, although most of those figured by de Loriol (e.g., 1898, figs. 18–20), include part of the body chamber and one (1900, p. 47, fig. 2) even includes all of it. In the material from Mount Hermon the last septa are found in specimens 2 and 3 at diameters of not quite 15 mm. and about 28.5 mm., respectively. If the length of the body chamber is estimated at half of a volution, the largest shell from Majdal Shams, when entire, should have attained a diameter of at least 55 m., that is, should approximately have equaled *T.* (*P.*) *hermonis* [=*episcopalis* (de Loriol)] in size.

DESIGNATION OF TYPE: The specimen illustrated by de Loriol (1898) in plate 4, figure 20, is selected as lectotype of *T.* (*P.*) *langi* (de Loriol).

DESCRIPTION: This form, represented only by the three measured specimens listed above, is clearly distinct in some characters from *T.* (*P.*) *hermonis* which it otherwise closely resembles. Thus it may be described best by pointing out these distinctive characters.

The whorl profile differs from that of *hermonis* by distinct lateroventral shoulders which become even more pronounced in maturity, when accentuated by rows of tubercles or "ears" (figs. 28, 30, 31, 33, 35).

The costation of the sides differs from that of *hermonis* in that the inner ribs, even at a comparatively early stage, are more pronounced, more sinuous, and extend farther ventrad, viz., to the middle of the flanks, and that the outer sickles are markedly finer and more closely set; there are 18 in the last quarter-whorl of the smallest specimen (no. 1), corresponding to only five circumumbilical costae. The latter bifurcate regularly, with from one to two secondary ribs intercalated between those originating from the bifurcation of primary ones. These secondary ribs cross the venter in a forward convex arc which, in the anterior third of the last whorl, carries a tiny median bead. Altogether the ornamentation of this shell is markedly finer and more regular than that of specimens of *hermonis* of the same size (figs. 28, 29).

The number of ribs is only slightly increased (to six inner and 19 outer ones on the last quarter-whorl) in the medium-sized shell number 2, the greater size being counteracted by the fact that all ribs gain in strength and keep somewhat wider intervals from one another. In crossing the lateroventral shoulders the ribs, especially those that are the continuation of a primary rib, form small tubercles which are at this stage mostly elongated in the direction of the rib that carries them but not in the spiral sense. The median beads are now more pronounced than at an earlier stage, forming in their entirety the beaded keel characteristic of this subgenus (figs. 31, 32).

In the posterior half of the outer whorl of the largest individual (no. 3) the ornamentation is the same as in specimen 2, with about 40 secondary ribs counted along the periphery of this half-whorl, but in the anterior half the character of the ornamentation begins to change rather abruptly about a quarter-whorl apicad of the last septum, this change becoming most pronounced on the body chamber. The costae become much stronger and move farther apart, there being, despite the fact that the diameter has increased to from 26 to 34 mm., only five inner and 19 outer ones on the last quarter-whorl, and strong tubercles, which become increasingly elongated in the spiral sense, develop along the lateroventral shoulders as well as along the median line. The median tubercles alternate quite regularly in site with those on the shoulders. The latter are each touched by two or three secondary ribs, which in the anteriormost part of this shell split, more often than not, on the venter into from two to four fine tertiary ribs each (figs. 33–35).

The suture lines of the smallest shell (no. 1, fig. 29), best observable at diameters of from 10 to 14 mm., exhibit about the same degree of elaboration as those of *T.* (*P.*) *hermonis* at the same size. Three auxiliary lobes can be recognized on the flanks, a fourth rides on the umbilical shoulder, and at least one more follows on the umbilical wall. Only the last is simple, while the first four are more or less symmetrically trifid. In specimen 2 the high degree of sutural indentation can be seen even better at the same diameters. Most remarkable is the length of the dagger-shaped middle point of the first lateral lobe. It is clearly trifid, as usual in this genus, but not only are there two more lateral prongs above the terminal ones, but the middle terminal prong itself carries two secondary prongs on the sides (fig. 32). To judge by some details, barely visible, of the last three suture lines of the largest specimen (no. 3, figs. 33, 34), corresponding to diameters up to 28.5 mm., they seem to be just as florid as those of *T.* (*P.*) *hermonis* at the same size.

REMARKS: Some of the differences distinguishing this form from *T.* (*P.*) *hermonis* are explicitly pointed out in the above description. Others, especially the spectacular development of both lateroventral and median nodes elongated in the spiral sense, are so obvious from that description and our figures that they need not be repeated here. Altogether, they clearly prove this form to be specifically distinct from *hermonis*.

It seems to come closest to a species associated with "*Oppelia episcopalis*" [= *T.* (*P.*) *hermonis*] in both the Jura Bernois and the Jura Lédonien, and at Woodham Pit, England, namely, *T.* (*P.*) *langi* (de Loriol), which develops both lateroventral and median nodes, as does the present form, on the body chamber but at an even smaller size. However, there are considerable differences. In the first place, the Mount Hermon form is not so micromorphous as *T.* (*P.*) *langi*, and therefore both lateroventral and median nodes appear later. Also they are less closely set and show a much more pronounced trend to become spirally elongated, whereas in de Loriol's (1898, pl. 4, figs. 18, 20) species the shoulder tubercles tend to become horn-shaped and considerably to overtop the median ones, which is not so in the form here described. Thus the latter cannot be considered fully conspecific with *T.* (*P.*) *langi*. However, a hypodigm of just three specimens is hardly sufficient for the creation of a new species. Therefore this form is here determined by merely comparing it with *langi* as the most similar contemporary. However, the close resemblance of its mature ornamentation to that of the geologically younger *T. trachinotum* (Oppel, 1863, p. 214, pl. 56, fig. 4), the type species of *Taramelliceras, sensu stricto*, at the same diameter should not be overlooked.

From the only form other than *T.* (*P.*) *hermonis* in the present assemblage that might call for comparison, namely, *T.* (*P.*) *globosum*, this form can readily be distinguished, even up to the comparatively small size attained by *globosum*, by being much thinner and by the pronounced lateroventral shoulders.

MATERIAL STUDIED: Three specimens.

SUBGENUS RICHEICERAS JEANNET, 1951

Jeannet, when establishing this subgenus, took its name from *Oppelia richei* de Loriol; nonetheless he selected as the type not that species but *Ammonites pichleri* Oppel (1863, p. 112, pl. 51, fig. 4).

Of all the new supraspecific names created in the last half century and questioned above (pp. 29, 30), *Richeiceras*, even if relegated to subgeneric rank, seems to be one of the most readily dispensable.

The group so named is represented in our material only by the following species.

Taramelliceras (Richeiceras) richei (de Loriol)

Plate 16, figures 36–52; plate 17, figures 1–17

Oppelia Richei DE LORIOL, 1898, p. 52, text fig. 17, pl. 4, figs. 13–16.

Oppelia Richei, P. de Loriol; DE LORIOL, 1900, p. 46, *cum synon.*, pl. 3, fig. 26.

Taramelliceras Richei de Loriol; MAIRE, 1928, p. 20.

Taramelliceras (*Proscaphites*) *richei* (de Loriol); ARKELL, 1939, p. 147, *cum synon.*, pl. 8, figs. 1–4.

Cf. *Richeiceras* cf. *Richei* de Lor. sp.; JEANNET, 1951, p. 95, pl. 21, fig. 6, pl. 30, fig. 3.

Taramelliceras (*Proscaphites*) *richei* (de Loriol); ARKELL AND HOLT, 1952, p. 18.

Taramelliceras (*Proscaphites*) *richei* (de Loriol); HAAS, 1952, p. 857, text figs. 3, 4.

DIMENSIONS

A.M.N.H. No. 27924	D	H	H′	W	U
1	5.04 mm.	46½	?	*ca.* 38	26
2	5.08 mm.	47	36	36	27½
3	5.21 mm.	49	?	*ca.* 36½	23½
4	5.30 mm.	47½	36	39½	27
5	5.39 mm.	45	37	35½	26½
6	5.74 mm.	51½	39½	?33½[1]	23
7	5.82 mm.	48½	37½	37½	24
8	5.91 mm.	50½	36½	36½	22
9	6.00 mm.	55	37½	37½	13
10	6.17 mm.	53½	38	38	14
11	6.52 mm.	53½	?	35	17½
12	6.52 mm.	49½	38½	36	24
13	6.60 mm.	50	37	37	21
14	6.95 mm.	50	37½	35	18½
15	7.13 mm.	50½	36½	36½	19½
16	7.13 mm.	55	38	34	12
17	7.39 mm.	54	37½	35½	21
18	7.39 mm.	54	?	35½	16½
19	7.56 mm.	56½	?	34½	16
20	7.73 mm.	55	38	33½	15½
21	7.73 mm.	48	37	35	23½
22	7.82 mm.	52	?	*ca.* 36½	19
23	8.08 mm.	52½	37½	35½	17
24	8.17 mm.	54	?	35	16½
25	8.43 mm.	54½	36	35	15½
26	8.60 mm.	52½	37½	34½	16
27	8.69 mm.	50	38	35	20
28	8.86 mm.	55	36½	33½	12½
29	9.12 mm.	56	39½	33	12½
30	9.12 mm.	52½	*ca.* 36	34½	15
31	9.39 mm.	55½	40	32½	14
32	9.47 mm.	57	37½	28½	7½
33	9.56 mm.	56½	38	32½	12½
34	9.73 mm.	55½	?	32	15
35	9.82 mm.	56½	*ca.* 40½	32	11½
36	9.91 mm.	52	39½	31½	17½
37	10.17 mm.	55½	37½	31½	12
38	10.17 mm.	53	37	33½	15½
39	10.25 mm.	54½	36½	31½	14½
40	10.25 mm.	55	37½	31½	12
41	10.34 mm.	55½	?	31	11
42	10.43 mm.	55	36	31	9
43	10.43 mm.	56	39	32½	11½
44	10.51 mm.	57	40½	30½	12½
45	10.60 mm.	53	38½	33	14½
46	10.78 mm.	56½	40½	32	11½
47	10.86 mm.	56	38½	36	12½
48	11.04 mm.	56	39½	34	13½
49	11.12 mm.	54½	38½	36½	14
50	11.12 mm.	53½	40	39	16½
51	11.30 mm.	54	?	31	13
52	11.47 mm.	55½	35	34	7½
53	11.56 mm.	54	39	30[2]	13½
54	11.56 mm.	55½	37½	32½	11½
55	11.82 mm.	57½	38	27½	11
56	11.82 mm.	54½	*ca.* 40½	32	11
57	11.91 mm.	54½	38½	33½	11½
58	11.99 mm.	54½	40	*ca.* 35	14

[1] Deformed.
[2] Crushed.

A.M.N.H. No. 27924	D	H	H′	W	U
59	12.17 mm.	55½	39½	30	9½
60	12.35 mm.	55½	37½	27½	10
61	12.86 mm.	57	39	28½	11
62	13.03 mm.	56	38	34	10
63	13.12 mm.	55	*ca.* 38½	30	11½
64	13.47 mm.	55½	37½	29	11
65	13.56 mm.	54½	38½	32	11½
66	13.73 mm.	56½	38	27	10
67	13.90 mm.	56	?	31	9
68	13.95 mm.	55	?	30	12
69	14.08 mm.	56	40	31	10½
70	14.25 mm.	55½	?	28	9
71	14.43 mm.	54	?	26½	10
72	14.51 mm.	53½	34½	31	12
73	14.77 mm.	58	40½	*ca.* 34	9½
74	15.21 mm.	55	*ca.* 43	43½	11
75	15.73 mm.	52½	37	27½	14½

The lowest values for H and the highest for U are found among the four smallest juveniles. No value of H below 50 and only a single one of U as high as 20 are encountered beyond a diameter of 7.75 mm. These facts sufficiently prove the tendency of the degree of involution to increase with growth, although the highest values for H (57–58) are encountered not only in specimen 73, the third largest, but, occasionally, also down to a diameter of less than 9.5 mm. (no. 32), and the lowest values for U (7½–10½) not only in nine out of the 17 largest shells, but also in three others which come down to the same diameter of less than 9.5 mm., with the absolute minimum of U (7½) represented by two medium-sized individuals (nos. 32, 52).

In contrast to the three species of the subgenus *Proscaphites* dealt with above, the present species shows a clear trend of W to decrease with growth; with only rare exceptions, the widest shells are concentrated at the top of the table and the most slender ones at the bottom. Throughout development, H exceeds W in this species by up to 100 per cent (nos. 32, 61) or even more (nos. 60, 66, 71).

The seven largest measured shells are septate throughout, as are the unmeasured ones of approximately the same size. This is not surprising in view of the fact that in de Loriol's (1898) hypodigm, although reaching diameters up to 24 mm., not a single individual had the body chamber preserved and that it is generally missing at the Woodham Pit also (Arkell, 1939, p. 148). De Loriol (1900) records a shell septate up to its anterior end which corresponds to a diameter of 30 mm. The only specimen with part of the living chamber preserved figured by that author (1900, pl. 3, fig. 26) has the last septum at a diameter of about 18 mm., as also seems to be the case in the specimen illustrated by Arkell (1939) in figure 4. In the population from Mount Hermon, on the other hand, the only larger individual with part of the body chamber preserved (no. 68) has the last septum at a diameter of about 13 mm.

Thus our material does not seem to be indicative of the size actually reached by this species. If de Loriol's shell, mentioned above, which is septate up to 30 mm., and the specimens of a closely related Herznach form (see Jeannet, *in synon.*) which attain diameters of 32 and 32.5 mm., respectively, are taken into consideration, *T.* (*R.*) *richei* may well be estimated to have reached a size of 45 mm. or more, but it seems to have been smaller than *T.* (*P.*) *hermonis* [=*episcopalis* (de Loriol)].

Designation of Type: The specimen illustrated by de Loriol (1898) in figures 15 and 15a is selected as lectotype of *T.* (*R.*) *richei* (de Loriol), as it is one of the larger specimens originally figured by that author and shows well the delicate ornamentation. It should, however, be kept in mind that the small shell illustrated by de Loriol (1898) in figures 16, 16a, and 16b gives a better idea of the usual aspect of this species which, as pointed out by de Loriol,[1] mostly appears smooth at first glance.

Description: The characteristic shell shape of this species is best exemplified by specimens 59 and 71 (pl. 16, figs. 50–52; pl. 17, figs. 6–8). The whorl profile seen in the frontal views of these two individuals (pl. 16, fig. 52; pl. 17, fig. 8), characterized by flat, parallel flanks, by a rounded venter which becomes ever narrower with growth, and by marked, though well-rounded shoulders which connect the flanks with the perpendicular umbilical wall, can be traced back to the earliest ontogenetic stages (nos. 4, 7, 40, 48; pl. 16, figs. 36, 38, 43, 46). Only a few

[1] "Cette ornamentation est, en somme, peu accentuée et, en bonne partie, effacée dans la majorité des exemplaires."

shells show a somewhat different whorl profile, either with flanks that are gently convex rather than flat, as found in the largest specimen (no. 75, pl. 17, fig. 17), or with flanks slightly converging ventrad, as found in specimen 72 (pl. 17, fig. 10).

Some specimens exhibit a smooth siphuncular band (e.g., no. 26) or a groove left by the weathering out of the siphuncle (no. 44). A somewhat different kind of siphuncular groove appears at a much later stage in the anteriormost portions of specimens 66 and 72, corresponding to diameters of from 11.5 mm. to 14.5 mm., where it splits the median beads in two (pl. 17, fig. 12). In specimen 49 (pl. 16, fig. 48), on the other hand, the upper surface of the siphuncular tube shows on the cast, from a diameter of about 7.5 mm., as a very low, continuous keel, distinct from the beaded one appearing later in the ontogeny. In specimen 59, however, an indistinctly beaded keel passes gradually into an almost continuous one.

Two circumumbilical folds extending from the umbilical edge well beyond the middle of the flanks are seen in the juvenile 11 between diameters of less than 6 mm. and 6.5 mm. (pl. 16, fig. 45). Faint indications of such folds can be recognized at about the same growth stage in the juveniles 14, 27, 29, and 35–37; of these, number 29 deserves special mention for the peculiarity that the inner half of the flanks, to which these folds are restricted, is slightly depressed and encircled by a blunt, hardly perceptible spiral ridge (pl. 17, fig. 14).

Outer sickles can first be seen, though indistinctly, in the juvenile 21 from a diameter of about 6.5 mm. and, somewhat better, in specimens 47, 48, and 57 from diameters of 8 mm. and 9 mm., respectively. In specimen 48, six straight, blunt ribs, which are restricted to the outer third of the flanks, are counted on the last sixth of the outer whorl (pl. 16, fig. 47). They are less blunt, finer, and more numerous (eight on the unseptate anteriormost sixth of the outer whorl), but are also restricted to the outer third of the flanks in specimen 58 (pl. 16, fig. 49). The only shell of this species in the Mount Hermon material in which both umbilical folds and outer sickles are clearly recognizable, the former being quite pronounced, the latter less distinct, is number 68 (pl. 16, fig. 40). The largest specimen but one (no. 74, pl. 17, fig. 9), on the other hand, shows distinct sickles, about 16 of which are counted on the last quarter-whorl and which can be seen to cross the venter near the anterior end only, but no circumumbilical folds. Most shells of this species, however, appear, for all practical purposes, smooth in side view up to the greatest size attained in our material. Numbers 56, 59, 71, and 75 (pl. 16, fig. 51; pl. 17, figs. 2, 7, 16) bear this out.

It is important to note that the median nodes develop in this species independently of the outer sickles; they also appear earlier, e.g., in specimen 42 as early as at a diameter of 7.8 mm. (pl. 16, fig. 44). They are also, as a rule, comparatively heavier than the beads of *T.* (*P.*) *hermonis* and *T.* (*P.*) *globosum*, and they are by no means restricted to the body chamber, as Arkell's (1939, p. 148) remark to this effect and comparison of his figure 4 with his figures 1–3 might induce one to assume. As a rule, they appear at a somewhat later stage than in number 42, for instance, at diameters between 9.5 mm. and 11.5 mm. in specimens 51, 52, 60, 63, and 67. They are best developed, from a diameter of 12.5 mm., in four of the six largest shells (nos. 70, 71, 72, and 75; pl. 17, figs. 7, 8, 10, 11, 12, 16). As seen in these figures, these median nodes (for which the term "beads" would be hardly appropriate) are heaviest and approach the teeth of *Creniceras renggeri* (p. 113, pl. 17, figs. 18–37) in shape in specimens 72 and 75.

All the four smallest juveniles show, from a diameter of 2.33 mm., the same surprisingly elaborate, *Sowerbyceras*-like suture lines as *T.* (*P.*) *hermonis* at the same early stage (A.M.N.H. No. 27921:3, pl. 15, fig. 30). The sutures of the juvenile 4 (pl. 16, fig. 37) exemplify this early stage best. From a diameter of as little as 4 mm. the middle point of the first lateral lobe clearly shows two secondary prongs. The second lateral lobe is asymmetrically trifid, tending to turn bifid. The first auxiliary is asymmetrically trifid. The second, which is here situated slightly ventrad of the umbilical shoulder, is asymmetrically bifid, and the third, which is on the umbilical wall, simple. Specimens 7, 9, and 12 (pl. 16, figs. 39, 41, 42) illustrate well the rapid progress in sutural elaboration, with the middle point of the first lateral lobe elongating apicad and with two (in the juvenile 8 even three) auxiliary lobes on the flanks, one riding on the umbilical shoulder, and one on the umbilical wall. As seen in specimens 27, 29 (pl. 17, fig. 14), 32 (pl. 17, fig. 1), and 62 (pl. 17, figs. 4, 5), the degree of indentation further increases with growth, and quite markedly so. In number 29 three, and in number 32 even four, auxiliary lobes, all but the last trifid, are counted on the flanks, with two more following on umbilical shoulder and wall. Thus the maximum number of auxiliaries (six) is attained by the last-mentioned specimen at a diameter of about 9 mm., that is, less than a third of that at which six auxiliaries can first be counted in *hermonis*. This extraordinary increase in the number of auxiliaries at such an early stage represents, however, an individual feature, for specimen 49, although larger than 32, shows only two on the flank, and specimens 37, 62, and 76 (pl. 17, figs. 4, 5, 13), the first only slightly, the two others markedly, larger than 32, show only three. It is worth noting that in all three of these shells the third auxiliary saddle considerably widens and becomes indented by a shallow lobule at its top. Finally, in specimen 56 (pl. 17, fig. 3), which is septate up to a diameter of about 11 mm., there are four auxiliary lobes on the flanks. They are separated by the wide and low fourth auxiliary saddle, which is on the shoulder, from two more such lobes on the umbilical wall. Thus here, too, the maximum of six auxiliaries is reached at about a third of the diameter at which it is attained in *hermonis*. Although the sutures of shells 56 and 62 are the most florid ones studied in this species, only four are counted in the last quarter-whorl of the former and only three in that of the latter.

REMARKS: The conspecificity of this form, which is by far the most abundant *Taramelliceras* on Mount Hermon, with de Loriol's species, as recorded by that author from various localities of the Jura Mountains and by Arkell from Buckinghamshire, appears to be beyond any doubt. The more distinct ornamentation on the sides of the lectotype and of the other shells of about the same size illustrated by de Loriol is fully accounted for by the fact that they are considerably larger and accordingly further advanced in development than even the largest individual from Mount Hermon.

This species is readily distinguished from *T.* (*P.*) *hermonis* and even more readily from *T.* (*P.*) *globosum* and *T.* (*P.*) cf. *langi* by its slenderness, by the flat and parallel flanks, by the late appearance and weakness of the costation, and by the comparatively heavier median nodes which are not just a projection of the secondary ribs, as are the median beads of *hermonis* and *globosum*. Furthermore, the sutures of the present species tend to become more and more richly indented and elaborate at an even earlier stage than those of *hermonis*.

The above-mentioned strength of the median nodes and the slenderness of the conch make some juveniles and medium-sized specimens of *T.* (*R.*) *richei* difficult to distinguish from equally small individuals of *Creniceras renggeri* with still narrow umbilici. The differences that make separation possible are pointed out in the discussion of the latter species (p. 114).

The striking homeomorphy between this form and *Phylloceras riazi* (above, p. 15, pl. 1, figs. 14–21, pl. 2, figs. 1–36) has been discussed in a preliminary paper (Haas, 1952).

MATERIAL STUDIED: Two hundred and sixty-five individuals, including fragments.

CRENICERAS MUNIER-CHALMAS, 1892[1]

Creniceras renggeri (Oppel)

Plate 17, figures 18–37

Ammonites cristatus, Defrance, MSS.; J. DE C. SOWERBY, 1825, p. 24, pl. 421, fig. 3.

Ammonites Renggeri Opp.; OPPEL, 1863, p. 203, *cum synon.*

Oppelia (*Oekotraustes*) *Renggeri* Oppel; NOETLING, 1887, p. 26, *cum synon.*, pl. 4, fig. 3.

Creniceras Renggeri, Oppel; DE LORIOL, 1898, p. 65, *cum synon.*, text fig. 24, pl. 5, figs. 3–9.

Creniceras Renggeri, Oppel; DE LORIOL, 1900, p. 53, *cum synon.*, pl. 4, figs. 10, 11.

Creniceras Renggeri Oppel; DOUVILLÉ, 1914, p. 20, *cum synon.*, pl. 1, figs. 17–21.

Creniceras crenatum Bruguière; DOUVILLÉ, 1914, p. 21, pl. 1, fig. 16.

Oecotr. Renggeri Oppel; FREBOLD, 1928, p. 192.

[1] Page clxxi.

Creniceras Renggeri Oppel; Vautrin, 1934, p. 1439.

Creniceras Renggeri Opp.; Roman, 1938, p. 169, pl. 15, fig. 161.

Creniceras renggeri (Oppel); Arkell, 1939, p. 150, pl. 9, figs. 15–27.

?*Creniceras Renggeri* (?) Oppel sp.; Jeannet, 1951, p. 101, pl. 31, fig. 16.

Creniceras renggeri (Oppel); Arkell and Holt, 1952, p. 18.

Dimensions

A.M.N.H. No. 27925	D[1]	H[1]	H'[1]	W	U
1	9.91 mm.	56	39½	30	10½
2	11.64 mm.	58	*ca.* 38	31½	*ca.* 8
3	12.08 mm.	55½	38	32½	12
4	12.69 mm.	53½	38½	25½	13½
5	13.64 mm.	50½	39½	31	16
6	13.64 mm.	51	40	32½	16
7	15.38 mm.	44	34	28	22½
8	15.7 mm.	55½	?	28	16
9	17.3 mm.	48½	?	*ca.* 30½	22
10	18.9 mm.	42½	?	30½	33
11	19.2 mm.	39½	*ca.* 28	*ca.* 21	31½
12	19.6 mm.	36½	*ca.* 30½	24	*ca.* 30½
13	20.4 mm.	*ca.* 38	?	*ca.* 23½	32
14	21.3 mm.	37½	*ca.* 29½	*ca.* 21½	28

The posterior part of a body chamber (no. 15),[2] representing about one-third of a whorl, corresponds at its anterior end to a diameter of about 26.5 mm., which is the largest actually encountered in this species at Majdal Shams (see below).

The above table clearly shows the trend of the umbilicus greatly to increase, and of the whorl height to decrease accordingly, with growth. This trend was recognized by Oppel when he established this species and well documented and described by Noetling (1887) and de Loriol (1898). On the whole, the width of the whorls also tends to decrease with growth.

This is an essentially micromorphous species. Sowerby's figure of the holotype, if true to size, indicates a diameter of 17 mm. Noetling and de Loriol (1898) list 19 mm. and 23 mm., respectively, as maximal diameters, and even the largest among the shells from the Woodham Pit illustrated by Arkell (1939) do not fully match the holotype in size. However, our above-mentioned fragment 15, consisting of only one-third of an unseptate whorl, exceeds the above maxima, especially if reconstructed to full size. Estimating the length of the body chamber at two-thirds of a whorl, as we may well do,[3] we get a diameter of at least 36 mm. for the entire disk.

Designation of Type: The specimen from near Weymouth, England, erroneously referred to *Ammonites cristatus* and figured by Sowerby and apparently refigured by Roman (*locis cit. in synon.*), must be considered the holotype of this species, as it is by both Roman and Arkell.

Description: Shell disk-shaped, quite slender in some medium-sized and in all three of the largest individuals present. The rapid increase in umbilical width, as seen in the table of dimensions, is well visible in side view as a rather abrupt "egression" of the inner spiral of involution, occurring at diameters of from about 10 mm. to about 15 mm. (nos. 6, 9, 11, 12; figs. 24, 26, 29, 36). Similarly, the decrease in whorl height manifests itself in the side views of individuals which have part of the body chamber preserved, but only in a few shells (nos. 10, 11, fig. 36) to the extent that they appear geniculate. In both these individuals the geniculation appears to be accentuated by particularly strong median teeth at or near the beginning of the living chamber. The umbilicus is markedly deep, as long as it remains narrow; in widening it becomes much shallower.

In the smallest shell (no. 1) the whorl profile is slender-elliptic, with flattened flanks and a gently rounded venter, up to a diameter of about 7.5 mm., that is, until the median nodes appear. Then the profile becomes, within a quarter of a whorl, fastigate and slender-ogival, as seen at the anterior end of this juvenile which is septate throughout (fig. 22). At the front end of the somewhat larger juvenile 4, of which only the anteriormost portion belongs to the body chamber, this slender-ogival shape of the whorl profile is even more pronounced, owing to the

[1] Including height of median teeth.

[2] To judge by the color of both pieces, this fragment may well be from the same individual as the disk 7, measured above; if so, an intermediate fragment is missing. Therefore, the present fragment has been numbered separately.

[3] Noetling's claim that it measures "exactly half a volution" is not corroborated by our observations.

presence of a particularly high and sharp tooth at the anterior end, and the flanks are almost entirely flat (fig. 20). They are gently convex in the markedly thicker juvenile 6 (fig. 27) and converge even more decidedly ventrad in the entirely septate specimen 7. At the anterior end of the latter shell the median nodes are still low and therefore do not yet affect the whorl profile (fig. 32) to the same extent as in numbers 1 and 4. With the decrease in whorl height, the profile as a rule becomes stouter and less fastigate in the body chambers of the larger shells, but at the posterior end of the whorl fragment 15, formed by the last septum and corresponding to a diameter of about 20 mm., it is essentially still the same as at the anterior end of the smallest juvenile (no. 1), although one and a half times as high (fig. 34). At the earliest stages the umbilical shoulder is pronounced, though rounded, and the umbilical wall comparatively steep and high. However, as the umbilicus widens and becomes shallower in the course of development, both its shoulder and its wall become inconspicuous and the slope of the wall becomes much more gentle.

From this description of the whorl section it can be seen how thoroughly it is influenced from a very early stage by the laterally compressed, strong and high median teeth which are the distinctive feature of this genus. They constitute the foremost sculptural element of this species. They mostly but by no means always appear, or become pronounced, in the vicinity of the last septum, as in specimens 4 (fig. 19), 8, 10, 11 (fig. 36), and 12 (fig. 29). In the juveniles 1 (fig. 21), 3, 5, and 6 (fig. 26), of which the first three are septate throughout, and in the medium-sized shell 9 (fig. 24) the last quarter-whorl or even a somewhat larger portion of the outer volution carries already well-developed teeth. The latter vary greatly, not only with regard to the ontogenetic stage at which they appear but also, as pointed out by Arkell (1939), in density, shape, and coarseness. Thus the teeth are fine and accordingly closely set in specimens 3 and 6 (fig. 26), which carry 24 and 20, respectively, on the last half-whorl, stronger, longer, and standing farther apart in the juveniles 1, 4, and 5 (figs. 21, 19, 28) and in the whorl fragments 15 and 16 (fig. 31), with seven to a quarter-whorl in specimens 5 and 15, and coarsest and farthest apart in the adults 11, 12, and 14, with 12, 10, and 11, respectively, to a half-whorl. The last three individuals, especially number 14 (fig. 35), approach in the coarseness and small number of teeth Arkell's (1939, p. 150, pl. 9, figs. 20, 27) var. *woodhamensis*, if they are not outright referable to it. Because there is full intergradation between the sculptural extremes, as stated by Arkell himself and de Loriol (1898, p. 67), the establishment of that separate variety for shells with particularly coarse crenulation does not seem warranted. As a rule, the teeth are strongly compressed laterally. Only quite exceptionally, as in the juvenile 5 (fig. 28), are they rather bullate, thus approaching those observed in *Taramelliceras* (*Richeiceras*) *richei*. They are triangular and appear almost pointed only where the crenulation is very dense (no. 6, fig. 26), but as a rule they appear trapezoidal or nearly semicircular in side view (nos. 9, 11, 12, 14, figs. 24, 36, 29, 35). In addition to these adults, the small whorl fragment 16 is also illustrated (fig. 31) because it shows the shape of the teeth particularly well. Here they slope more steeply apicad than orad, so that they appear to point slightly backward. The first teeth are preceded by a shallow median groove in the juvenile 4 for about half of a whorl, and in specimen 12 for about a quarter-whorl. Segments of such a siphonal groove are well visible between the teeth of the body chamber of the juvenile 6 (fig. 25) and, changed into two sharply engraved grooves with an equally pronounced ridge between them and two ridges flanking them on the outside, between those of specimen 11 (fig. 37). The same feature is noticeable in the medium-sized shell 9, with another faint furrow added beyond both of the two outer ridges.

At first glance the sides of even adults of this species appear smooth, but some lateral ornamentation can be recognized in some individuals. Thus fine outer sickles are well visible in the anteriormost portion of the juvenile 3, and both inner folds and outer sickles (six of the former and 11 of the latter to one-sixth of a volution) on the body chamber of the juvenile 6 (fig. 26) and, less distinctly, in specimens 7 and 9 (figs. 33, 24). In specimen 12 (fig. 29), on the other hand, straight, prorsiradiate folds alone are present, whereas the outer sickles have dissolved into delicate, barely perceptible growth striae.

Suture lines are more or less distinctly exposed in most of the examined individuals. Even at the earliest stages at which they can be studied, that is, from a diameter of about 5 mm. and best in the juvenile 4 (fig. 19), these sutures exhibit a typically oppelid character and rich elaboration. Even at this early stage the middle point of the trifid first lateral lobe, which is markedly shorter and plumper than in the preceding oppelid species, is clearly three-pronged. The second lateral lobe is asymmetrically trifid and tends to become bifid. Three auxiliary lobes are present on the flanks and at least one more on the umbilical wall, which is still comparatively high at this early stage. The main saddles are deeply divided by lobules and also otherwise richly indented. The siphonal lobe is comparatively shallow, and the median knob is slender and trapezoidal and just beginning to develop hornlets. In the anteriormost sutures of the same juvenile, the last of which corresponds to a diameter of about 11 mm., a low median leaf is present between these hornlets, the inner main point of the first lateral lobe shows a secondary prong on its outer side, and the fourth auxiliary has moved up to the umbilical edge, with a fifth on the umbilical wall. The sutures of the juvenile 5, observable to the anterior end which corresponds to a diameter of a little more than 13.5 mm., agree in all essentials with those just described, whereas those of specimen 7 (fig. 33), observable up to a diameter of about 15.33 mm., show somewhat increased indentation. Both main points of the siphonal lobe and all three of the first lateral one can now be recognized to be clearly three-pronged, and the median knob has become more clearly three-cusped. About the same degree of elaboration is exhibited by the main elements of the anteriormost sutures of specimen 12 (fig. 29), the last of which corresponds to a diameter of about 12 mm., but on the left side the auxiliary elements of these sutures, obviously owing to some lesion of the shell and the septa, are merged into a broad, low, and only shallowly indented saddle, a rather deep, simple, triangular lobe, and still another, much more slender saddle which seems to ride on the umbilical shoulder.

All the suture lines studied are remarkable for the comparative shallowness and plumpness of the first lateral lobe, noted above among the sutural characters of the juvenile 4 and well noticeable also in the suture line drawings of both Noetling (1887, fig. 3b) and de Loriol (1898, fig. 24) with which the sutures of our specimens agree well in other respects also.

Remarks: For distinction of the present species from its congeners, *C. crenatum* (Bruguière) and *C. dentatum* (Reinecke), reference may be made to Oppel, Noetling (*locis cit. in synon.*), and de Loriol (1898, p. 68). The characteristic considered distinctive of *C. renggeri* by both Oppel and de Loriol, viz., the narrowness of the umbilicus at an early stage and its widening at a medium diameter, is well borne out by our table of dimensions and by the side views of some of the shells from Mount Hermon (figs. 24, 26, 29, 36).

Munier-Chalmas' (1892, p. clxxiii) tentative interpretation of *Creniceras* as the male of "*Neumayria*" (= *Taramelliceras*), alluded to in the introductory section on the Oppelidae of the present report, has been considered plausible by Douvillé (1914, p. 20) but questioned, apparently with good reason, by both Rollier (1913, p. 272) and Roman (1938, pp. 167, 169), although the former author supported Munier-Chalmas' hypothesis on sexual dimorphism in general and tried to substantiate it.

Within the present material, juveniles of this species with umbilici still narrow and deep may in side view quite closely resemble individuals of *Taramelliceras* (*Richeiceras*) *richei* of the same size group, but they can be distinguished by their ogival, sometimes pointed, nodal whorl profile, by the absence of pronounced circumumbilical folds, and by their wider and shallower first lateral lobes.

The geniculate shells resemble in their dimensions and in the decrease, or lack of increase, of the whorl height in the body chamber those referred above (p. 34, pl. 5, figs. 2, 5) to *Hecticoceras* (*Lunuloceras*) *kersteni*, but they can readily be distinguished from the latter by their robust median teeth and by the absence of the heavy, rursiradiate costation found in *H.* (*L.*) *kersteni*.

MATERIAL STUDIED: With only 20 individuals (including two whorl fragments) this species is, by the standards of this report, rare in the collections of the American University of Beirut. This seems striking in view of the fact that Noetling lists it as "nicht selten" (not rare) and that Frebold (1928) counted about 15 individuals in Brotzen's collection, and is in contrast to its abundance, according to de Loriol (1898, 1900), in both the Jura Bernois and the Jura Lédonien, where it is used as the index fossil of the zone, and at Woodham Pit, according to Arkell (1939).

SCAPHITODITES BUCKMAN, 1924

Buckman, when establishing this genus (1924, vol. 5, pt. 44, pl. 459), based it on a specimen from St. Ives, Huntingdonshire, England, which he designated as the holotype of a new species, *S. navicula*, thus making the latter the type species of *Scaphitodites*. *Scaphitodites navicula* is, however, relegated below to a subjective synonym of *Ammonites scaphitoides* Coquand. Thus to us *S. navicula* Buckman [=*S. scaphitoides* (Coquand)] is the genotype of *Scaphitodites*.

Scaphitodites scaphitoides (Coquand)

Plate 17, figures 38–47; plate 18, figures 1–21

Ammonites scaphitoïdes (COQUAND), 1853, p. 442, pl. 14, figs. 9, 10.

Ammonites scaphitoïdes (COQUAND), 1855, p. 48, pl. 5, figs. 9, 10 [essentially a repetition of Coquand, 1853].

?Oppelia paucirugata n.f.; BUKOWSKI, 1887, p. 117, pl. 26, fig. 3.

Oekotraustes scaphitoïdes Coquand; DE LORIOL, 1898, p. 68, *cum synon.*, text fig. 25, pl. 5, figs. 14, 14A.

Oekotraustes scaphitoïdes, Coquand; DE LORIOL, 1900, p. 54, *cum synon.*, pl. 4, figs. 12–15.

Scaphitoidites navicula, nov.; BUCKMAN, 1924, vol. 5, pt. 44, pl. 459.

Oecotraustes scaphitoides Coquand; FREBOLD, 1928, p. 185.

Scaphitodites scaphitoides (Coquand); ARKELL AND HOLT, 1952, p. 18.

DIMENSIONS

A.M.N.H. No. 27926	D	H	HG[1]	H′	W	U
1	5.47 mm.	52½	—	30	52½	15
2	5.56 mm.	51½	—	29½	51	12½
3	6.08 mm.	53	—	*ca.* 28½	47	11½
4	6.78 mm.	51½	—	31	50	14
5	7.13 mm.	55	—	34	46½	11
6	7.13 mm.	55	—	*ca.* 38	48½	12
7	7.30 mm.	54½	—	33½	47½	10½
8	7.56 mm.	54	—	32	45	9
9	7.82 mm.	36½	50	28	42	26½
10	7.99 mm.	52	53	*ca.* 36	42½	14
11	8.08 mm.	37½	41	28	37½	26
12	8.17 mm.	41½	43½	29½	42½	24½
13	8.26 mm.	54½	—	36	47½	11½
14	8.52 mm.	44	49	34	38	20½
15	8.86 mm.	52½	—	35½	*ca.* 44	12
16	8.86 mm.	54	—	?	46	10
17	8.95 mm.	53½	—	34	46½	14½
18	9.12 mm.	55½	—	36	*ca.* 52½	8½
19	9.21 mm.	52	—	33	44½	11½
20	9.30 mm.	54	—	33	50½	10½
21	9.91 mm.	55	—	35	50	9
22	9.99 mm.	*ca.* 39	42	*ca.* 30½	35	22½
23	10.25 mm.	57½	—	34	46½	9½
24	10.60 mm.	42½	46	*ca.* 28	37½	19
25	10.69 mm.	42	50½	29	41	18
26	10.95 mm.	51	—	*ca.* 31½	*ca.* 39½	16½
27	10.95 mm.	48½	51	31	41	16
28	11.04 mm.	53	—	*ca.* 30	*ca.* 45	12½
29	11.04 mm.	43½	50½	31½	41	18½
30	11.30 mm.	44	48½	31½	38½	19
31	11.30 mm.	37½	44	26	35½	27
32	11.56 mm.	41½	46½	31	38	20½
33	11.82 mm.	43½	49½	37	38	21½
34	11.99 mm.	43½	49½	32½	42½	17½
35	12.34 mm.	42½	50½	*ca.* 28	*ca.* 39½	21
36	12.69 mm.	35	41	30	32	26½
37	13.03 mm.	41½	47½	*ca.* 33½	39	24
38	14.12 mm.	42	*ca.* 49	30	41	21½
39	14.60 mm.	35½	42	28½	*ca.* 28½	27½

An evaluation of the data of the above table must take into consideration the peculiar shell shape of this species, namely, its truly scaphitoid way of coiling, as best illustrated by specimens 9, 30, 32, 37 (pl. 17, figs. 38, 39, 44; pl. 18, fig. 8) and others. It is surprising that not a single shell with a similarly pronounced scaphitoid coiling has been figured, or even mentioned, by Coquand, de Loriol, or Buckman (*locis cit. in synon.*), by the first author despite the fact that he so

[1] As in the table of dimensions of the geniculate specimens referred to *Hecticoceras* (*Lunuloceras*) *kersteni*, the relative height of the whorls in the present species was measured not only at the anterior end (H) but also at the point of the second geniculation (HG), to insure a correct picture of the dimensions.

clearly recognized the peculiarity that he based the specific name on it. This scaphitoid coiling is brought about by two geniculations, the first occurring, at various diameters, in the septate part of the shell, the second decisive one (hereinafter called, for the sake of brevity, the "hump") in the body chamber, mostly one-quarter to one-third of a volution beyond the last septum. Specimens 40 and 39 are illustrated (pl. 17, figs. 41, 42) as examples of particularly pronounced humps. It seems that two groups can be distinguished as to the diameter at which the hump occurs. In the first group, represented within the measured series by specimens 9–12, 14, and 22, this diameter measures between 7 and 8 mm., in the second group, represented in the measured series by specimens 24, 25, 27, and 29–39,[1] between 9.5 and 13.2 mm. The occurrence in some individuals, all below the diameter of 10 mm., of this important change at a size much smaller than in others is striking indeed and strongly recalls the hypotheses of sexual dimorphism repeatedly proposed for this group of ammonites. Should the individuals reaching maturity so much earlier (e.g., no. 9) than the full grown ones (e.g., nos. 29–39) be the males and the latter the females, or vice versa?

The second geniculation is called decisive because the proportions of the shell change thoroughly at the hump. The outer volution decreases in height, not only relatively but absolutely, as proved by the fact that HG, wherever it appears in the above table, always exceeds H. In some shells the amount of this decrease is quite considerable, e.g., 27 per cent and 17 per cent, respectively, in the last sixth of the outer volution in numbers 9 (pl. 17, fig. 38) and 25. Simultaneously with the height of the whorl its width also decreases, though less markedly, and the umbilicus widens to from two to three times its original diameter, thus contributing from the inside to the reduction of the whorl height. Under these circumstances shells without hump, that is, those that have not yet reached the stage of the second geniculation, cannot reasonably be compared in dimensions with those beyond that stage. Both groups must be considered separately. In the following tabulation the ranges are given in per cent of D:

	H	HG	W	U
Shells without hump	51–57½	—	*ca.* 39½–*ca.* 52½	8½–16½
Shells with hump	35–48½	42–53	28½–42½	14–27½

These figures clearly show that, between the two above groups, the range of W and that of U overlap only slightly and that of H not at all, and further that the mean of HG markedly exceeds that of H. For comparison, the dimensions of the holotype, as measured on Coquand's drawings (1853, 1855), are given:

D	H	HG	W	U
18.4 mm.[2]	37	38	27	25

Dimensions recorded by de Loriol for *S. scaphitoides* and those given by Buckman for his *S. "navicula"* are:

Author	D	H	W	U
De Loriol (1898)	8–13 mm.	38	29[3]–35	23 (body chamber)
De Loriol (1900)	9–18 mm.	?	27 –38[4]	
Buckman (1924)	9.4–18 mm.	42–51.5	36–54	14–30.5

If all these figures are weighed together, it will be found that our shells with hump, but not those without, compare well in their dimensions with the holotype as well as with de Loriol's material, except for being slightly thicker on an average, and with Buckman's hypodigm, except for being, on an average, somewhat thinner and exhibiting a somewhat lower whorl height at the anterior end. In width, our shells without hump come closer to Buckman's range than do those with hump, but, as must be kept in mind, Buckman's range is reduced to 36–42, once his smallest specimen, measuring only 9.4 mm. in diameter and probably not having reached the stage of the second geniculation, is excluded. For as in most ammonites, W tends to decrease with growth in the present species, as seen in our table in which the two smallest shells register the highest values for W[5] and

[1] Blanks in the above table indicate shells that are not preserved up to the hump.

[2] Only 17 mm. according to Coquand (1855).

[3] Actually 26½ (see below).

[4] Actually 45½ (see below).

[5] The maximum of *ca.* 52½ recurs, however, in specimen 18, measuring 9.12 mm. in diameter.

as explicitly stated by de Loriol (1900, p. 55), whose smallest shell, illustrated in his figure 15, is also the thickest.[1] From the preceding it may be concluded that, if *Ammonites scaphitoides* Coquand and *Scaphitodites navicula* Buckman were to be considered separate species, the Mount Hermon form might have to be referred to the latter rather than to the former. However, the splitting off of *S. navicula* from Coquand's species, as proposed by Buckman, is here considered entirely unwarranted.[2] As seen from his inclusion of the shell depicted in de Loriol (1898, figs. 14A, 14Aa) in *S. navicula*, Buckman bases the separation of his species solely on its somewhat greater thickness. Now W, as measured on those drawings, amounts to 31, as compared to 26½ in the shell illustrated in de Loriol's (1898) figures 14, 14a, and 14b, which Buckman leaves with *S. scaphitoides*. The difference of 4½ points is certainly slight. If the values for W in the holotypes of Coquand (27) on the one hand and of Buckman (36) on the other are compared, the difference is 9, that is, exactly twice as wide. But even this difference appears negligible, if compared with the ranges of W in de Loriol's material (26½–45½, as emended), and in our own (28½–52½, if shells with and without hump are here lumped together).

Because all the other, very distinctive characteristics of Coquand's species can well be recognized in Buckman's "holotype" and in the specimen from Chatillon referred by him to "*navicula*" as well as in the Mount Hermon population, Buckman's procedure can by no means be justified,[3] less so if it be considered that de Loriol records more than 500 individuals from La Billode (Jura Lédonien) alone and that those recorded from Mount Hermon by Frebold (1928) and in the present report add up to 85, whereas Buckman seems to have dealt with three or four specimens only.

Nearly half of the measured specimens below, and all those above, the diameter of 10.5 mm. are in part unseptate, the last septum being located at diameters of from 5 mm. to 7 mm. in those said above to mature early and at diameters of from 7.5 mm. to 10 mm. in full-grown shells, most frequently at diameters of from 8 mm. to 9.5 mm. The portion of the body chamber that is present depends on preservation and varies from a small part only to fully two-thirds of the outer volution, this maximum being nearly attained in specimen 31 and fully only in the largest measured shell (no. 39, pl. 17, fig. 42). As a rule, somewhat more than one-half of the outer volution belongs to the body chamber, but in no specimen is it preserved to the apertural margin.

The above observation that it occupies in most cases more than half of the outer whorl fully agrees with that of Coquand (1853) and of de Loriol (1898, 1900). Beyond that, both in the materials studied by de Loriol and in the population from Mount Hermon the body chamber is preserved and, it should be added, is intact in most individuals. This provokes some thinking in view of the fact that in almost all other species represented at Majdal Shams, as in other assemblages of pyritized ammonites, the body chamber is missing or, if present, crushed in most cases. It seems that a mechanical explanation offers itself for this exception, namely, that the body chamber is protected from being broken off or crushed by a decrease in both height and width of the whorl and by nestling up, as it were, to the inner whorls rather than flaring, as in most ammonite forms.

The diameter of the holotype (18.4 mm.) is not fully reached by the greatest diameters of 18 mm. recorded by both de Loriol (1900) and Buckman, and even less so by the largest shell from Mount Hermon (no. 39) which, although nearly complete, attains only 14.6 mm. in diameter. Thus Coquand's holotype may be assumed to come close to the maximum size reached by this micromorphic species, which certainly does not exceed 20 mm.

DESIGNATION OF TYPE: The specimen from

[1] W, as measured on that drawing, amounts to 45½, that is, far above the maximum of the range (27–38) given by the author, but almost exactly the mean of both our range for shells without hump and Buckman's.

[2] This attitude of ours seems to be supported by the use of Coquand's but not Buckman's specific name by Arkell and Holt (1952) for their form from Stangate Hill, near Huntingdon, which may almost be considered a topotype of Buckman's "holotype."

[3] Despite the fact that he designated "*navicula*" as genotype of *Scaphitodites*.

the French Jura mountains described and illustrated by Coquand in 1853 and again in 1885 (*locis cit. in synon.*) must be considered the holotype of this species.

DESCRIPTION: The peculiar shell shape of this species is fully discussed above. The whorl profile is inverted heart-shaped and quite wide in early youth (nos. 2, 4, 5, 7; pl. 17, figs. 45, 47). It remains essentially the same up to a diameter of about 10 mm., as long as the shell is septate and has not yet undergone the decisive second geniculation. Some shells remain stout (e.g., no. 20; pl. 18, fig. 1), whereas others become more slender and the sides converge more decidedly ventrad, so that the whorl section approaches a lanceolate shape (nos. 8, 23; pl. 17, fig. 40; pl. 18, fig. 3). In all these individuals the umbilical shoulder is very pronounced, though rounded, and the umbilical wall high and perpendicular (nos. 5, 23; pl. 17, fig. 45; pl. 18, fig. 3), the umbilici being quite deep in this species as long as they are narrow (see above). As do the proportions of the shell, the whorl profile thoroughly changes at the second geniculation, regardless of the diameter at which it occurs. The venter becomes truncate, the flanks become less convex, and the cross section loses the more in height the farther ahead of the point of this geniculation it is, thus becoming first subrectangular (nos. 10, 36; pl. 17, fig. 46; pl. 18, fig. 9), then subquadratic (no. 33, pl. 18, fig. 5) in outline, always with gently rounded corners. As the umbilicus widens, it becomes shallower, its shoulder becomes less pronounced, and its wall slopes more gently.

On the venter of the septate portions of casts a siphuncular groove appears at diameters of from 4.5 mm. to 7 mm. It soon becomes quite wide and deep (nos. 13, 21; pl. 18, figs. 10, 11), but shallower in the early part of the body chamber; then it gradually disappears (nos. 12, 25, 33; pl. 18, figs. 4, 6). In specimen 42, belonging to the same size group as the five individuals just mentioned, a low keel appears in the middle of this vanishing groove (pl. 18, fig. 7). A similar but even finer keel is recognizable at the same stage in specimens 40, 26, 28, 32, 35, and 39. In specimen 35 the aspect of this groove with its median keel soon changes into that of an extremely fine triple keel. In the juvenile 16 (pl. 18, fig. 17), however, the groove, at the end of the septate portion and in the early part of the body chamber, is replaced by a quite strong keel, which is flanked by shallow furrows, and there is an even higher and sharper keel (without furrows) in the somewhat larger, crushed specimen 41.

The two last-mentioned shells are the only ones of which the sides show an ornamentation deserving the name of true costation.[1] It is most distinct in the otherwise poorly preserved specimen 41 (pl. 18, fig. 15), which exhibits on the last quarter of the outer whorl four faint prorsiradiate inner ribs and eight much more distinct, recurved outer sickles. In specimen 16 (pl. 18, fig. 16) only the latter are visible, here restricted to the outer third of the flanks. However, indications of lateral ornamentation are recognizable, though less distinctly, in other individuals, namely, occasional circumumbilical folds in numbers 2, 3, 4, and, more clearly and regularly, in numbers 6 (pl. 18, fig. 12) and 28. In the latter individual they are quite robust but stand far apart, whereas in the two smallest juveniles here mentioned (nos. 2, 3) some approach each other so closely as to simulate constrictions between them. In some other shells, namely, 15, 40, 43 (pl. 17, fig. 41; pl. 18, figs. 14, 20), 44, and 45, these folds, though mostly distributed in a somewhat sporadic way, tend to continue in a sigmoidal course across most of the flanks, whereas specimens 32 and 34 exhibit only faint indications of the costation described above and illustrated in number 16. In specimen 33 these rudimentary costae are so fine that they should rather be termed growth striae; this shell shows, in addition, two blunt spiral ridges, with a shallow groove between them, in the inner half of the flanks.

Suture lines can well be studied in many shells of this species at diameters of from less than 3 mm. to about 10 mm. Those of specimens 2 and 15 are illustrated (pl. 18, figs. 19, 13, 14) as the best examples of, so to speak, normal suture lines of this species, i.e., lines not yet affected by the degeneration fre-

[1] Both Coquand and de Loriol (1898) described this species as smooth, but in 1900 de Loriol recorded some "exemplaires costulés."

quently occurring in the last septa, which is dealt with presently. Although unmistakably oppelid in character, the sutures of this species exhibit peculiarities, just as does the shell shape. Both lateral saddles and the first auxiliary are markedly wider than in other species of this family, so as to allow for only one auxiliary lobe on the flanks of both shells here selected as examples. Two more, separated by a second auxiliary saddle, not so wide, follow on the umbilical wall which, as noted above, is comparatively high in the septate portion of shells of this species. The siphonal lobe is rather shallow and divided by a median knob which carries distinct hornlets as early as at a diameter of about 3.5 mm.; at a diameter of about 6 mm. a median swelling appears between them. At an early stage, as exemplified by specimen 2, the lateral lobes are shallow and sturdy, but they become comparatively slender in the last sutures of specimen 15, corresponding to diameters of up to 8 mm. Both these lobes are symmetrically trifid in both shells,[1] whereas the first auxiliary lobe shows no subdivision in the smaller and is asymmetrically bifid in the larger. In both individuals the three corresponding saddles not only are unusually wide but markedly low. All three are divided by lobules, the first lateral saddle asymmetrically, with the inner branch both wider and higher than the outer and itself subdivided by a shallow lobule, the two others symmetrically, as is the external saddle. It is worth noting that the progress in indentation is slower in this species than in others. Thus in specimen 15 the middle points of the first lateral lobes begin to acquire secondary prongs at a diameter of about 6 mm. only, with no such prongs discernible elsewhere. As a unique feature of this individual it should be mentioned that the saddles, especially of the last suture lines, are surrounded by grooves which in turn are accompanied on the orad side by ridges of the same shape (pl. 18, fig. 14).

As pointed out in the preceding paragraphs, the sutures of this species are distinct from those of related species by a reduced number of elements. Furthermore, the height of the saddles and the depth of the lobes often suffer reduction in the course of the ontogeny. In many, though not all, shells in which crowding of the last sutures indicates that growth has come to a standstill all lobes become very short and all saddles extremely low and both lose almost all indentations, especially dorsad of the first lateral lobe. Once that ontogenetic stage is reached, this degeneration of the sutures occurs, regardless of size, in the small juvenile 3 (pl. 18, fig. 21) at a diameter of less than 6 mm. as well as in the largest specimens (nos. 39, 40; pl. 17, figs. 42, 41) at a diameter of about 10 mm., but it seems to be most conspicuous at diameters of between 6 and 8 mm., especially in specimens 43 (pl. 18, fig. 20) and 14, whereas it is less pronounced in other shells, e.g., number 15 (pl. 18, figs. 13, 14), and hardly noticeable in number 35.

As long as the sutures are not crowded towards the last, they stand rather far apart, there being as a rule only three to a quarter-whorl. Only exceptionally are they more closely set, e.g., in specimen 20, where four, more richly indented than in other individuals, are counted on the last quarter-whorl (pl. 18, fig. 2).

Remarks: As pointed out in the above discussion of the dimensions, there is no sufficient reason for splitting *S. navicula* Buckman or the form from Mount Hermon from Coquand's species. Therefore both are here included in the synonymy of the latter, as are all the shells referred by de Loriol to *S. scaphitoides*.

The situation is, however, doubtful with regard to *Oppelia paucirugata* Bukowski (*loc. cit. in synon.*), which de Loriol (1900, p. 55) considers also a synonym of *scaphitoides*, claiming that circumumbilical folds, believed by Bukowski to distinguish his species from Coquand's, occur in the latter as well. De Loriol's claim is fully verified by the Syrian material. However, Bukowski's measurements of his specimen, which are more precise than any given for any *Scaphitodites*, prove that the width of the whorl increases from the point of the second geniculation to

[1] In the seven last sutures of the left side only of specimen 26, however, both these lobes are symmetrically bifid. In these sutures a second auxiliary lobe is present just ventrad of the umbilical edge (pl. 18, fig. 18).

the anterior end, whereas the opposite change takes place in the body chambers of the Syrian specimens. This difference imposes some reservation in referring Bukowski's form to *scaphitoides*.

Another species of this genus, *Ammonites polonicus* Oppel (*in* Oppel and Waagen, 1866, p. 216; Bukowski, 1887, p. 118), seems never to have been figured, and Oppel's remarks on it are rather incomplete. The more inflated whorl section and the more convex flanks mentioned by him need not exclude it from the present species, as these features occur in English and Syrian shells here included without hesitation in *scaphitoides*. However, Oppel noted that the umbilicus is still "narrowly closed" at a diameter of 17 mm. and that the body chamber occupies almost an entire volution. These two characters, should they prove correct, may well supply a sufficient cause for specific separation, if "*polonicus*" be granted any standing under the Rules. To us it seems rather to be a *nomen dubium*.

Within the Majdal Shams assemblage the present species requires comparison with both *Taramelliceras* (*Proscaphites*) *hermonis* and *T.* (*P.*) *globosum*. On the one hand, septate shells of *S. scaphitoides* with only indistinct first geniculation may closely resemble in whorl profile and dimensions the stouter ones among equally small juveniles of *hermonis* in which the characteristic costation of that species has not yet developed. However, the latter can readily be distinguished by their somewhat flatter flanks, the lack of a siphuncular groove, and chiefly by the more elaborate and more closely set sutures which have up to three auxiliary lobes on the sides, as compared to only one in the present species. On the other hand, it is only certain sutural characters, namely, the presence of only one auxiliary lobe on the flanks and the extreme width and lowness of some saddles, especially in maturity, which *S. scaphitoides* has in common with *T.* (*P.*) *globosum*. However, juveniles of the latter can be distinguished from those of the present species, even as long as there is no distinct geniculation, by their much stouter whorl profile, which tapers decidedly ventrad, and by their much more distinct and regular ornamentation.

MATERIAL STUDIED: Eighty specimens, including two fragments.

STEPHANOCERATACEAE WEDEKIND, 1917

CARDIOCERATIDAE HYATT, 1892

QUENSTEDTOCERAS HYATT, 1877

SUBGENUS PAVLOVICERAS BUCKMAN, 1920

?Quenstedtoceras (Pavloviceras) ?mariae (d'Orbigny)

Plate 18, figures 22–25

?Ammonites Mariae D'ORBIGNY, 1848, p. 486, pl. 179, figs. 1–6, *non caet.*[1]

?Quenstedticeras Mariae, d'Orbigny; DE LORIOL, 1898, p. 25, *cum synon.*, pl. 3, fig. 1, *non caet.*[2]

?Quenstedticeras Mariae d'Orbigny; R. DOUVILLÉ, 1912, p. 67, pl. 5, figs. 1, 5, *non caet.*[2]

?Quenstedtoceras (*Pavloviceras*) *mariae* (d'Orbigny); ARKELL, 1939, p. 152, *cum synon.*, pl. 10, figs. 6–8, pl. 11, figs. 3, 4.

?Quenstedtoceras (*Pavloviceras*) *mariae* (d'Orb.); ARKELL AND HOLT, 1952, p. 18.

DIMENSIONS

A.M.N.H.	D	H	H′	W	U
No. 27927	84.4 mm.	41	*ca.* 32	*ca.* 40	*ca.* 34

These dimensions differ from those of the lectotype, as given by Arkell, by a lesser degree of involution and by lesser whorl thickness at the anterior end. Both these differences are, however, in line with the growth trends recognizable in the lectotype, if the much greater diameter (84.4 mm., as compared to 62 mm.) of our specimen is taken into consideration. In the lectotype, too, U increases with growth (from 25 to 28 within a quarter-whorl) and W decreases (from 48 to 46 within a quarter-whorl). The decrease in width is even much faster in the present specimen, the width of which at the posterior end, measured over the circumumbilical nodes, amounts to 56½ per cent of the corresponding diameter of 59 mm.

DESCRIPTION: The above designation is applied to an incomplete cast, consisting of somewhat more than half of a disk, and apparently entirely unseptate. It is very large by the standards of the present assemblage[3] but badly worn.

[1] See R. Douvillé (1912, p. 68).

[2] *Fide* Arkell (1939, p. 152).

[3] It is exceeded in diameter only by a whorl fragment of *Perisphinctes* (*Alligaticeras*) *?paneaticus* (A.M.N.H. No. 27765:76), estimated to correspond to a diameter of about 110 mm.

The whorl section (fig. 24) is semicircular at the posterior end but inverted heart-shaped, with just an indication of fastigation, at the anterior one. The ornamentation consists of heavy inner ribs, which swell in the circumumbilical zone to form radially elongated tubercles, and rather blunt outer ribs which originate in part by bifurcation of the inner ones, in part by intercalation between those so produced, run in a nearly radial direction across the outer two-thirds of the flanks, and cross the venter straight or in an extremely obtuse forward sinus. Four inner and 11 outer ribs are counted on the posterior quarter-whorl; the anterior one is too much corroded for such a count.

REMARKS: This poorly preserved specimen can be referred to *Quenstedtoceras* (*Pavloviceras*) only with a question mark. In the absence of inner whorls and suture lines its reference to *Q.* (*P.*) *mariae* is based on resemblance to the lectotype, as figured by Arkell (1939), with allowance made for the considerably larger size of the Syrian specimen, and is bound to be even more doubtful.

The only other species in more or less contemporary faunas which this single shell resembles to a certain extent is "*Macrocephalites*" *kobyi* de Loriol (1896, p. 20, pl. 4, fig. 1, pl. 5, fig. 1), referred by Arkell (1940, p. 215, text fig. 75) to *Pachyceras* (*Tornquistes*). However, de Loriol's species, even if its younger geological age be left out of the question, does not show any indication of fastigation, the inner ribs do not swell to form nodes at a diameter at which the latter are strongly developed in the specimen under discussion, and the whorl thickness tends to increase rather than to decrease with growth.

Thus the tentative identification ventured above still seems to be the better, if not the best, guess. Should it prove to be correct, it would refute Roman's (1938, p. 228) claim that *Quenstedtoceras* "n'a pas pénétré en Syrie."

MATERIAL STUDIED: The measured and figured specimen only.

PERISPHINCTACEAE WEDEKIND, 1917

This superfamily is represented in our material by the Perisphinctidae and Aspidoceratidae, by the former much more abundantly than by the latter.

PERISPHINCTIDAE HYATT, 1900

With close to 2000 individuals, this family is second in abundance on Mount Hermon only to the Oppelidae. Two genera, *Perisphinctes*, *sensu lato*, and *Mirosphinctes*, are referable to it.

PERISPHINCTES WAAGEN, 1869, SENSU LATO

This extremely large genus is represented in the assemblage under study by the subgenera *Alligaticeras*, *Dichotomosphinctes*, and *Properisphinctes*. The last is by far the most abundant group within not only the genus but the family and superfamily.

SUBGENUS ALLIGATICERAS BUCKMAN, 1923

Perisphinctes (Alligaticeras) ?paneaticus Noetling

Plate 18, figures 26–36; plate 19, figures 1–12

?Perisphinctes Paneaticus sp. n.; NOETLING, 1887, p. 27, pl. 4, fig. 5.

DIMENSIONS

A.M.N.H. No. 27765	D	H	H′	W	U
1	4.1 mm.	35	?	59½	38
2	4.8 mm.	37	30	58	35
3	5.0 mm.	40	?	58	32
4	5.3 mm.	40½	34	55½	32
5	5.3 mm.	37	30	56	32
8	5.5 mm.	39	32½	57	30½
6	5.6 mm.	46[1]	40[1]	64	28
7	5.6 mm.	40	36	64	28
10	5.7 mm.	41	33½	59	35½
11	5.7 mm.	35½	29½	61	37
12	5.8 mm.	40½	34½	60½	31½
13	5.8 mm.	38½	32½	57½	34½
18	5.9 mm.	34	28½	56½	38½
20	6.0 mm.	33½	?	55½	37
19	6.4 mm.	40½	35	54½	35
21	6.4 mm.	35	28	56	35
22	6.8 mm.	36	29½	55½	37½
35	6.8 mm.	38	*ca.* 30	46½	34½
28	6.9 mm.	35	31	53	38
23	7.1 mm.	33½	30	52½	35½
29	7.1 mm.	38	32	57	32
24	7.2 mm.	35	29½	54½	35
27	7.2 mm.	39	?	61	35
30	7.2 mm.	35	?	47	36½
16	7.4 mm.	44	36½	59	30½
37	7.5 mm.	37½	31½	52½	36
38	7.7 mm.	39	?	53½	33½
39	8.1 mm.	37½	30½	54	34½
40	8.5 mm.	42	33	58	30½
41	8.5 mm.	38	*ca.* 33	60½	35½
42	8.7 mm.	38½	?	56½	32
9	9.0 mm.	40	?	51	32½
44	9.3 mm.	40	*ca.* 31½	53	32½

[1] Egression of spiral, flaring outer whorl.

A.M.N.H. No. 27765	D	H	H′	W	U
45	9.4 mm.	33½	?	46½	39½
48	9.7 mm.	39	33½	50½	34½
15	9.7 mm.	41½	32	53	31
49	9.8 mm.	38½	35	57	34
50	9.8 mm.	35	32	*ca.* 57	36½
26	9.9 mm.	36½	?	45½	29½
31	10.1 mm.	38	34½	47	34½
54	10.3 mm.	41	33	52½	35
51	10.7 mm.	39½	33½	45	33½
55	10.9 mm.	41½	?	39½	38½
52	11.5 mm.	37	32½	48½	38
59	11.6 mm.	39½	?	64½	36
56	11.7 mm.	42½	35	50	34
57	11.8 mm.	45	37	50	31½
58	12.2 mm.	40	?	47	32
60	12.2 mm.	41	33½	49	38
61	12.8 mm.	37½	?	47	40½
33	12.9 mm.	37	31	47½	35
62	13.1 mm.	39	?	46	39
66	15.9 mm.	43	?	?[1]	34
67	16.3 mm.	41½	34½	*ca.* 45	39
68	16.7 mm.	38	?	43½	38
69	16.7 mm.	45	36½	?	*ca.* 36½
77	17.1 mm.	45	36	47	34½
70	18.3 mm.	40	?	46	34½
34	23.9 mm.	41	35	44½	36½
46[2]	61.6 mm.	*ca.* 34	?	*ca.* 24	*ca.* 46½

To supplement the above table, the following should be pointed out:

1. The gap between specimens 34 and 46 is by no means so wide as it appears from the table. If only more or less complete disks are counted, there are two (nos. 65, 71) measuring 25 mm. and 27 mm., respectively, two (nos. 72, 73) measuring about 35 mm., and one (no. 74) measuring about 50 mm. in diameter. All these disks are, however, so badly crushed that no useful purpose could be served by an attempt at measuring their proportions.

2. Two whorl fragments obviously belong to the same subgenus and are tentatively referred to the present species, but their conspecificity cannot safely be established, because the difference in growth stage, as compared to the largest measured specimen (no. 46), is much too wide and not bridged by any intermediate specimens. The diameter of the shell to which the smaller fragment (no. 75) belongs is difficult to estimate; the larger one (no. 76) corresponds to a diameter of at least 110 mm.

[1] Deformed.

[2] Crushed; H, H′, W, and U measured at D=50.5 mm.

In an attempt at evaluating the above table, the largest measured specimen (no. 46) must be left out of consideration, as it is so badly crushed that the measurements taken do not reliably render the dimensions of the uncrushed shell.

As in other species of this group, W decreases with growth, with the maximum of 64 represented by two small juveniles (nos. 6 and 7) and the minimum of 39½ by a larger one (no. 55). Above the diameter of 12 mm. W varies between 43½ and 49. The abnormal thinness (24) of the largest measured specimen (no. 46) is due to crushing, but in the largest whorl fragment present (no. 76), corresponding to a diameter about four and one-half times that of specimen number 34, the second largest in the table, W may be estimated at a little more than 60 per cent of H, whereas W more or less considerably exceeds H in all measured specimens except numbers 55 and 46. This observation confirms the growth trend mentioned above. No pronounced trends can be found in H and U; if the deformed specimen 46 is left out of account, the former varies, throughout the table, between 33½ and 46, and the latter between 27 and 40½.

Some shells measuring 30 mm. and more in diameter are still septate throughout, but the largest measured specimen (no. 46) is not. Its preservation is, however, so poor that the last septum cannot be located. Nor can the total length of the body chamber be estimated in any other individual. The largest whorl fragment (no. 76) seems to belong to the body chamber but not necessarily to its anterior part. Thus the maximum size reached by this, or a closely related, species at Majdal Shams may considerably exceed the diameter of 110 mm., as estimated above for that fragment.

Designation of Type: Noetling's (*loc. cit. in synon.*) only specimen is, by monotypy, the holotype of *P.* (*A.*) *paneaticus* Noetling.

Description: Shell comparatively involute. Whorl section first transversely rectangular (pl. 18, figs. 28, 33, 36), then subquadratic (pl. 19, fig. 6) and at the latest stage (no. 76) subrectangular with flanks and venter always flattened, the umbilical wall nearly perpendicular and rather high, and both umbilical and lateroventral shoulders pronounced, though well rounded. No constrictions can safely be recognized in juveniles; they can only occasionally be observed in medium-sized (nos. 65, 72) and large (no. 46) specimens.

This species is characterized throughout ontogeny by its dense costation. It appears at a diameter of about 2.5 mm. and consists first of single ribs which gradually extend all over the width of the flanks and soon become slightly sigmoidal, changing from a radial to a slightly prorsiradiate direction. From a diameter of about 6 mm. they bifurcate at about the inner third of the flanks and occasionally form a parabolic node that may be connected with a "lacet" (de Loriol, 1900, p. 81). At this early stage the ribs continue across the venter only as indistinct folds. To the naked eye the venter appears smooth, or nearly so (no. 28; pl. 18, figs. 26–28). Thirty-five ribs are counted along the lateroventral shoulder of the outer whorl of this specimen. The character of the costation is still the same in the somewhat larger juvenile number 38 (pl. 18, figs. 31, 32), except that the ribs (now 38) assume a decidedly prorsiradiate course and in the anteriormost part of the outer whorl continue in a shallow, forward convex arc across the venter. The costation is markedly less dense (27 ribs on outer whorl), but otherwise quite similar in specimen number 42 (pl. 18, fig. 30), which exceeds number 38 by only 1 mm. in diameter. In the larger juvenile number 57 a "lacet" can be seen here and there, and the point of bifurcation gradually shifts to the lateroventral shoulder. About 45 ribs can here be counted along the periphery (pl. 19, figs. 4, 5). The costation is equally dense but more homogeneous and somewhat stiffer in specimen number 58 of about the same size (pl. 19, fig. 3) and in the considerably larger specimen number 70 (pl. 19, figs. 1, 2). In the anteriormost quarter whorl of the latter specimen, belonging to the body chamber, single primary or secondary costae are occasionally intercalated between the bifurcating ones. Nearly 70 ribs can here be counted along the periphery. The medium-sized shell number 34 shows the transition to mature ornamentation; the ribs become more radial in direction and rather stiff and are quite well developed also on the venter where about 20 are counted on the last quarter-whorl (pl. 18, figs. 34, 35).

At a more advanced stage the costation is characterized by its density and by the straightness and generally radial direction of the primary ribs which bifurcate quite regularly on, or slightly inward of, the lateroventral shoulder; 20 or more secondary ribs per quarter-whorl are counted on the venter which they cross quite straight at this stage. All specimens showing this ornamentational character are badly crushed or otherwise poorly preserved, but a portion of number 46 is illustrated in figure 7 of plate 19. This individual and the much smaller number 73 seem to come closest in the character of ornamentation to the specimen seen in Noetling's side view, but specimen number 73 has somewhat sinuous ribs which bifurcate farther inward than those of number 46.

Essentially the character of ornamentation is still the same at the latest stage observable, represented by the afore-mentioned whorl fragment number 76 (pl. 19, fig. 12), which can only doubtfully be referred to this species. The primary ribs are quite straight and somewhat prorsiradiate and birfurcate or trifurcate quite regularly a little below the lateroventral shoulder. In a sixth of a whorl 12 primary ribs are present on the flanks. The number of secondary ribs on the venter, which they cross in a gentle, forward convex arc, is estimated at 27 or 28.

The earliest stage at which suture lines can be studied is found in the juvenile number 12 at a diameter of a little more than 3 mm. The penultimate suture line of this individual (pl. 18, fig. 29) shows a rather deep siphonal lobe, divided by a trapezoidal median knob which is shallowly notched on its top into two almost parallel terminal points; a moderately wide, asymmetrically divided external saddle; a rather wide, three-pronged lateral lobe which attains only a little more than half of the depth of the siphonal one; a wide lateral saddle which is nearly symmetrically divided by a short lobule; and a short, triangular auxiliary lobe, riding on the umbilical shoulder and followed by an auxiliary saddle on the umbilical wall. A line connecting the tops of the main saddles coincides with, or only slightly rises over, the radius.

The antepenultimate suture line of the juvenile number 7, corresponding to a diameter of about 4.5 mm. (pl. 19, fig. 8), agrees with the one just described, as do the sutures of specimens numbers 22 and 28 (pl. 18, figs. 26, 28) at diameters of 5.5 mm. and somewhat more than 6 mm., respectively. The last three sutures of specimen number 19, corresponding to a diameter of about 3.5 mm., differ by having much wider external saddles and extremely shallow lateral lobes, but this peculiarity may well be individual. As seen in specimen number 39 (pl. 19, fig. 11), the suture has become more elaborate at a diameter of 7.5 mm., and the external saddle is here somewhat wider than it was at the earliest stages studied. At the next stage, however, best represented by sutures of specimen number 68 corresponding to a diameter of about 15 mm. (pl. 19, figs. 9, 10) and by the last sutures of specimen number 70 corresponding to an only slightly smaller diameter, the external saddle is only moderately wide. It is divided by a sturdy lobule into two main stems, the outer of which is markedly higher and wider than the inner. The lateral lobe is slender and attains not quite three-fifths of the depth of the siphonal one. The triangular lobe following the lateral saddle has moved up on the flank, now deserving the designation of a second lateral, and points ventrad. On the umbilical wall there follow a triangular auxiliary saddle and a slender auxiliary lobe. The tops of all saddles hit the same radius. There is no pronounced "suspensive lobe." This is the last stage at which a complete external suture line can be studied in this species. Of all the larger individuals, all of which are more or less crushed, only number 72 at a diameter of about 20 mm. shows details of a suture line which seem to agree with that last described. Throughout development the sutures of this species are characterized by a moderately wide external saddle, a short lateral lobe which never reaches even two-thirds of the depth of the siphonal one, and the absence of a true "suspensive lobe."

REMARKS: *Perisphinctes paneaticus* is one of three *Perisphinctes* species from Mount Hermon created or identified by Noetling on the strength of a single specimen each. Frebold's (1928, p. 190) statement that not much can be done with them, since "Positives kommt dabei nicht heraus," is certainly true. In our particular case Noetling's drawing shows a poorly preserved and badly crushed specimen,[1] and not much additional information can be gained from his description. However, his specimen is the only hitherto published perisphinctid from Mount Hermon that suggests the subgenus *Alligaticeras* to which I am inclined to refer the form here described. Furthermore, our larger specimens agree in character of ornamentation quite well with Noetling's, and they are connected by transitions, although not without gaps, with the many juveniles in our material, some of which are excellently preserved. Thus reference of the form here dealt with to *P. paneaticus* Noetling may be justified, but the fact that the species is based on a single individual poorly qualified for a holotype imposes caution, as expressed by the question mark before the trivial name.

Siemiradzki (1898, p. 181) treats Noetling's name as a synonym of *P. mazuricus* Bukowski (1887, p. 157, pl. 30, figs. 7–9), but as both names were proposed in 1887[2] it remains doubtful which would be entitled to priority even if they were synonymous. In my opinion, however, they are not, because *mazuricus* has a finer and denser costation than *paneaticus* and a whorl section that decidedly tapers towards the narrow venter, as pointed out in Bukowski's description and seen in figure 9b of his plate 30, whereas the flanks are parallel both in Noetling's figure 5a and throughout development in the form here described.

Perisphinctus mazuricus has been selected by Schindewolf (1925, p. 325) as the type species of his genus *Prososphinctes*, relegated to subgeneric rank by Arkell (1937, p. 1, pl. E, figs. 2–4), but the characters of the present form pointed out in the above description seem rather to warrant its reference to the

[1] It is interesting to note that our fragment number 76 shows at its posterior, crushed end the same distorted whorl section as Noetling's figure 5a.

[2] I for one have been unable to ascertain the exact publication date of Noetling's Hermon monograph within the year 1887. Bukowski's paper was published on July 20, 1887.

subgenus *Alligaticeras* Buckman, as characterized by Arkell (1936, p. xlii, pl. C, fig. 4), the fact that constrictions are not clearly recognizable in the juveniles notwithstanding.

Within this subgenus *P.* (*A.*) *noetlingi* de Loriol (1898, p. 83, pl. 6, figs. 7, 8; 1900, p. 70, text fig. 13, pl. 6, figs. 1–5; 1902, p. 64; Maire, 1932, p. 29), based on the specimen from Besançon illustrated by Noetling (1887, p. 29, pl. 4, fig. 8), resembles the present species in costation, but it has more rounded shoulders and is more slender even at an early stage. Also its suture line shows a lateral lobe equaling the siphonal one in depth and a pronounced "suspensive lobe."

Of forms outside this subgenus, *?Dichotomosphinctes orthocyma*, *Properisphinctes bernensis*, *P. latilinguatus*, *P. hermonis*, and *Mirosphinctes regularis* call for comparison with the present species; it is made in the remarks on these species.

Material Studied: Altogether 129 specimens, including fragments.

Subgenus DICHOTOMOSPHINCTES Buckman, 1926

Perisphinctes (?Dichotomosphinctes) ?orthocyma Noetling

Plate 19, figures 13–21

?Perisphinctes orthocyma Noetling, 1887, p. 29, *cum synon.*, pl. 4, fig. 9.

?Perisphinctes orthocyma Noetling; Siemiradzki, 1898, p. 284.

Dimensions

A.M.N.H. No. 27835	D	H	H′	W	U
1	9.3 mm.	32½	27	44	41
2	17.1 mm.	37	*ca.* 31½	48	39
3	22.8 mm.	35	?	38½	43
4	49.4 mm.	30½	?	*ca.* 32	46

Small as the above sample is, it shows, especially above a diameter of 17 mm., trends of H and even more of W to decrease, and of U to increase, with growth.

The last septum is found in the juveniles numbers 2 and 3 at diameters of 14 and 17 mm., respectively. In the largest specimen (no. 4) no sutures can be traced beyond a diameter of 21 mm. Thus the last quarter of the penultimate volution and all the last belong to the body chamber, although the latter is not completely preserved.

Designation of Type: The only specimen described and figured by Noetling (*loc. cit. in synon.*) is the holotype of *P.* (*?D.*) *orthocyma* Noetling.

Description: Whorl section transversely elliptical at the earliest stage, later approaching subquadrate shape. Flanks flattened, the venter less so, umbilical wall comparatively high, but both umbilical and lateroventral shoulders well rounded (figs. 17, 20). Up to three deep constrictions per half-whorl, which run in an orad concave, prorsiradiate arc across the flanks and form a blunt tongue on the venter (figs. 13–20).

Fourteen primary ribs are present on the last half-whorls of specimens 1 and 2 (figs. 13, 16); and 15 and 18, respectively, on those of specimens 3 and 4 (figs. 19, 21). Even at an early stage they are more prominent than in the other perisphinctids present and become high and sharp in the largest individual. They are separated by increasingly deep intercostals from two to three times as wide as the costae. They are markedly prorsiradiate in youth, become radial on the last quarter-whorl of specimen number 3, but are prorsiradiate on the outer volution of the largest individual (no. 4), except in its anteriormost part where they fall back behind the radius. Except in the last quarter-whorl of specimen number 3, they describe an orad concave arc. From a diameter of 8 mm. on these primary ribs split on or somewhat inside the lateroventral shoulder quite regularly in two secondary ribs, with an additional secondary occasionally intercalated. Thus 38 secondary ribs can be counted around the periphery of the largest individual. They cross the venter straight or in a shallow, forward convex arc.

The last suture line of the juvenile number 2 exhibits a moderately wide siphonal lobe with perpendicular terminal points and a rather long lateral point above either of them, a sturdy external saddle extending slightly beyond the outer shoulder, the outer main stem of which exceeds the inner in both height and width, a slender first lateral lobe with three long points, the middle of which almost attains the depth of the siphonal lobe, a sturdy first lateral saddle, a trifid second lateral lobe which points ventrad and is only about half as deep as the first, a low second lateral saddle, and just beneath the umbilical shoulder a narrow and long auxiliary lobe, more inclined than the second lateral.

The last suture lines of specimen number 3 are crowded, thus indicating that growth had come to a standstill, and the middle line of the siphonal lobes is shifted markedly to the left of the median line of the venter (figs. 18, 19). These siphonal lobes are divided by a high, arrowpoint-shaped median knob into two long terminal points. Otherwise these suture lines agree with the one described above. In both, the tops of the main saddles hit the same radius. The slope of the suture in the inner part of the flank is only moderately steep, much less so than in Noetling's figure 9c which, however, depicts a suture of a considerably later stage. Otherwise there is good agreement between the suture lines here described and the suture drawn by Noetling, except that in his drawing the first lateral lobe appears to be markedly shorter than the siphonal one, whereas in his text they are said to be equally deep.

REMARKS: The sharp, prominent ribs which stand rather far apart and the numerous constrictions seem to refer the present form to the subgenus *Dichotomosphinctes*, as characterized by Arkell (1936, p. xlv, pl. D, fig. 3) and represented by the type species *D. antecedens* Salfeld (see Arkell, 1938, p. 83, text figs. 19–21, pl. 14, fig. 6, pl. 15, figs. 1–6, pl. 16, fig. 8). That the ribs are stiff in all these illustrations of the type species but mostly describe a forward concave arc in the present form imposes some caution as to the subgeneric affinities of the latter which is therefore only tentatively assigned to *Dichotomosphinctes*.

This subgenus seems to be represented in Noetling's monograph by *P. orthocyma*, which according to both his description and figures also has sharp, rather widely set ribs and the same general plan of suture line. Now *orthocyma* is the second of the three *Perisphinctes* species from Mount Hermon which are based on one specimen only, and it is a badly crushed one at that. In this particular case the wide difference in size (12 cm. as compared to 5 cm.) renders identification of our material with Noetling's species even more difficult, especially as the earliest growth stages, so well represented by our specimens 1 and 2, are missing or damaged beyond recognition in Noetling's. However, in the stage that corresponds to the outer whorl of our largest specimen the costation of Noetling's specimen is fairly similar and at least here and there shows the curvature of the ribs described above. Thus the form here described is tentatively identified with Noetling's species.

The sharp and less dense costation characterizes this form well within the present material and distinguishes it readily even from those forms which resemble it in dimensions, especially from *Properisphinctes vicinus* (p. 130).

MATERIAL STUDIED: Five specimens.

SUBGENUS **PROPERISPHINCTES** SPATH, 1931[1]

Most of the Perisphinctidae of the Mount Hermon assemblage (about 1325 individuals, chiefly juveniles) belong to this subgenus.

Altogether eight species are distinguished. The distinction is often rendered difficult by the fact that it leads to different results depending on whether shell shape, whorl profile, and ornamentation, or sutural characters are depended on most for classification, sutural characters distinctive of one group repeatedly spilling over, as it were, into neighboring groups. It would seem that speciation proceeded at unequal rates with regard to shell shape, whorl section, and ornamentation on the one hand and sutural characters on the other. After careful consideration the former characters have been given preference over the sutural ones, although the latter, too, are distinctive of the bulk of the individuals of a given species, the extremes being represented by the reduced sutures with sometimes extremely low saddles and shallow lobes of young *P.* (*P.*) *bernensis* on the one hand and by the surprisingly florid sutures of *P.* (*P.*) *delicatulus* on the other.

Because the juveniles of each species resemble those of almost every other, sometimes so as to make distinction quite difficult, the sequence of species followed below must be admitted to be more or less arbitrary.

[1] Page 398; Arkell (1936, p. xli, pl. C, figs. 2, 3).

Perisphinctes (Properisphinctes) vicinus, new species

Plate 19, figures 22–33; plate 20, figures 1–18

DIMENSIONS

A.M.N.H. No. 27836	D	H	H′	W	U
1	4.41 mm.	35	*ca.* 24½	67½	37
2	4.82 mm.	32	27½	57½	40½
3	4.92 mm.	34½	25½	*ca.* 65½	39
47	5.33 mm.	37½	29	54	35½
4	5.53 mm.	34½	25½	58	39
48	5.64 mm.	36½	25½	64½	36½
49	6.05 mm.	31½	20½	59½	40½
5	6.15 mm.	35	26½	52½	36½
6	6.66 mm.	35	26	54	32½
50	6.66 mm.	32½	20	58½	43
51	6.66 mm.	31	24½	61½	38½
7	6.66 mm.	40	31	?	32½
8	6.87 mm.	33	24	53½	38½
13	7.18 mm.	34½	23	54½	38½
9	7.28 mm.	38	?	56½	31
10	7.69 mm.	38½	33½	42½	33½
14	7.79 mm.	38	27	47½	38
11	7.89 mm.	36½	22	*ca.* 52	34
12	7.89 mm.	32½	22	49½	39½
52	8.10 mm.	34	24	57	38
15	8.20 mm.	36	29	47½	37½
53	8.20 mm.	35	25	53½	37½
16	8.30 mm.	32	?	50½	38
54	8.30 mm.	29½	?	47	39½
17	8.81 mm.	32½	?	51	38½
18	8.92 mm.	33½	24	47	42½
19	9.02 mm.	35	?	42	36½
20	9.12 mm.	33½	25½	49	38
21	9.22 mm.	39	25½	45½	35½
22	9.33 mm.	36½	?	47½	35
23	9.94 mm.	35	?	*ca.* 49½	37
24	10.04 mm.	35½	26½	49	39
25	10.04 mm.	32½	?	42½	41
26	10.15 mm.	37½	?	42½	34½
27	10.15 mm.	38½	?	45½	32½
46	10.45 mm.	37½	23½	49	37½
28	11.17 mm.	36	31	39½	43
29	11.86 mm.	32½	*ca.* 23½	?37[1]	41
30	12.2 mm.	32	?	*ca.* 37	41
31	12.4 mm.	39½	*ca.* 26	*ca.* 38½	42
45	12.5 mm.	29½	24½	44	49
32	14.5 mm.	36	28½	40	47
33	14.9 mm.	32	?	*ca.* 41	47½
34	15.5 mm.	40	*ca.* 28½	*ca.* 35[1]	33
35	15.5 mm.	33	?	*ca.* 33	51
36	16.0 mm.	36	?	36	44½
37	19.4 mm.	39½	*ca.* 32	39	41½
38	20.1 mm.	38½	28	30½	52
55	20.6 mm.	29	?	38	52
39	21.0 mm.	29½	?	38½	53½
40	29.0 mm.	29½	*ca.* 23	*ca.* 26½	51
41	29.6 mm.	27½	?	32	54½
42 (syntype A)	32.5 mm.	32	*ca.* 27½	33	50
44 (syntype B)	50.7 mm.	27½	*ca.* 24½	*ca.* 32½	51

[1] Crushed.

The incomplete disk number 43, with a diameter of about 40 mm., is intermediate in size between syntypes A and B.

The above table clearly shows how H and W tend to decrease, while U tends to increase, with growth, although, owing to differences in speed of development, these changes are not steady throughout the table. Thus the maximum of 40 for H can be found in both a shell of only 6.66 mm. and one of 15.5 mm. in diameter.

Syntype A is septate to the anterior end. In syntype B, the largest specimen present, although it is not preserved to the aperture, almost one whorl and a quarter belong to the body chamber. The full size of this species may therefore be inferred from the present material to have been at least 70 mm.

DESIGNATION OF TYPES: Specimens A.M.N.H Nos. 27836:42 and 27836:44, the former with inner volutions completely preserved but septate throughout, the latter with innermost volutions destroyed but with most of the body chamber preserved, are designated syntypes A and B, respectively.

DESCRIPTION: Shell early in development moderately, in maturity quite, evolute, with the umbilicus attaining half the diameter, or a little more, of the disk. Whorl profile at first reniform (no. 48; pl. 19, fig. 25), later becoming transversely elliptic (no. 51; pl. 19, fig. 23), then gradually changing to subcircular (no. 55; pl. 20, fig. 3), subquadratic (syntype A; pl. 20, fig. 11), and finally elliptic (syntype B; pl. 20, fig. 7), but always more or less distinctly tapering ventrad. Flanks and venter gently convex, the latter imperceptibly truncate in some individuals only. The umbilicus is rather deep and surrounded by a pronounced ridge in the young (nos. 48, 51; pl. 19, figs. 24, 22) but flattens in maturity, and simultaneously the umbilical wall loses its original height.

The first, still indistinct constrictions appear at a diameter of about 4 mm. in paratype number 48 (pl. 19, fig. 25). At a somewhat later stage, as represented by paratype number 51 (pl. 19, fig. 22), as many as five decidedly prorsiradiate constrictions are present per whorl; they cross the venter in a gently forward convex arc. In some individuals these constrictions, by deeply indenting the umbilical wall and shoulder, disturb the inner spiral of involution, though not to the same extent as in juveniles of *P.* (*P.*) *bernensis* (see p. 134), and thus lend a pentagonal outline to the umbilicus, as in paratype number 51 (pl. 19, fig. 22), or, more frequently, a triangular one, as seen best in paratypes numbers 56 and 57 (pl. 19, figs. 26, 30). On the later volutions there are fewer constrictions, for example, only three per whorl in paratype number 55 (pl. 20, fig. 2) and only two in syntype A (pl. 20, fig. 10), whereas none is recognizable on the preserved two-thirds of the outer whorl of syntype B. Where present, their course parallels that of the ribs.

As in other forms, the earliest volutions are smooth (pl. 19, figs. 24, 25). Costation sets in at a diameter of a little more than 6 mm. (no. 51; pl. 19, fig. 22). At this earliest stage, well represented by paratype number 11 (pl. 19, fig. 27), the ribs are still restricted to the nner two-thirds of the flanks, inconspicuous, prorsiradiate, and form an extremely shallow forward concave arc. About 10 are counted on the anteriormost quarter of the outer whorl. They gradually increase in strength and height and extend into the venter, simultaneously beginning, at a diameter of about 10 mm., to bifurcate quite regularly at the outer third of the sides, but they are at this stage still weak on the venter, at any rate weaker than on the flanks (paratype no. 30; pl. 20, fig. 6). A markedly more evolute disk, representing about the same size and stage of ornamentation (paratype no. 45), is shown in figure 5 of plate 20. Thirty-eight primary ribs are counted on the outer volution of paratype number 30 and about 42 on that of paratype number 45. The costation shows about the same density (44 primary ribs on the outer whorl) in the somewhat larger paratype number 32 which is remarkable for occasional bifurcation of ribs already at the inner third of the sides and for the fact that the secondary ribs, in the anteriormost quarter of the outer whorl, originate by intercalation rather than bifurcation (pl. 20, fig. 4). Except for the median zone, at this stage the ribs are almost as strong on the venter as on the flanks. The costation of paratype number 55, with 45 primary ribs around the outer whorl (pl. 20, fig. 2), approaches the mature style of that of syntype A, whereas in the rather poorly preserved paratype number 39, of about the same size, the primary ribs stand markedly farther apart and are much stronger. The afore-mentioned paratype number 55 carries a smooth siphuncular band which here and there becomes a shallow groove (pl. 20, figs. 1, 3). The same holds true for syntype A (pl. 20, figs. 9, 11) in which the costation becomes less dense in the anteriormost part of the outer whorl; only 40 primary ribs are counted on this whorl. This trend towards more widely spaced and coarser ribs is much more conspicuous in the incomplete and deformed paratype number 43 where the heavy and rare costae of the anterior portion of the outer volution contrast strongly with the regular and dense ribbing of the posterior part, which agrees with that of syntype A at the same diameter. The latter shows, in one place only, faint parabolic nodes, as are found at a somewhat earlier stage in paratype number 38. The degree of prorsiradiateness of the ribs decreases at the latest ontogenetic stage, thus causing those of the last volution of syntype B, the largest specimen, somewhat to fall back behind those of the penultimate whorl (pl. 20, fig. 8). The density of the costation is undiminished in this individual, as compared to earlier growth stages, 28 primary ribs being present on the anterior half of its outer volution.

At an early stage, as represented by paratype number 58 (pl. 19, figs. 28, 29) at a diameter of about 5.2 mm., the suture lines of this species are characterized by a broad and rather shallow siphonal lobe, divided by a low and wide, trapezoidal median knob; a wide external saddle, divided by a rather deep triangular lobule into two main stems which are themselves subdivided by shorter lobules and of which the outer is both higher and wider than the inner; a trifid lateral lobe which in this individual is not so much shorter than the siphonal one; a rather slender, bifid lateral saddle somewhat exceeding the external one in height and thus representing the peak of a line connecting the saddle tops. From here this line slopes towards the umbilicus, thus foreshadowing the "suspensive lobe" of later ontogenetic stages. Accordingly, the following lobe (at this stage still to be qualified as the first auxiliary) points decidedly ventrad. If this suture line is viewed towards the middle of the siphonal lobe (which in this individual does not exactly coincide with the median line of the conch, as indicated by two fine grooves separated by an equally fine ridge, but is shifted markedly to the right), the lateral lobes are barely but not entirely visible.

The suture lines of paratypes numbers 52 (pl. 19, figs. 32, 33) and 59 (pl. 20, fig. 13), at diameters of about 7.75 mm. and 8.75 mm., respectively, generally agree with the suture just described, but the indentation is richer and the elements following the lateral saddle can now be seen more distinctly. There is a trifid second lateral lobe, only about half as deep as the first and pointing ventrad, a wide and low, bipartite saddle, and a narrow auxiliary lobe which tends to exceed the second lateral in length and to descend obliquely beneath the saddle between these two lobes. It is followed by a low auxiliary saddle beyond which a second auxiliary lobe is just visible at the umbilical seam. In a ventral view of the suture line of paratype number 52, which is stouter than average, the first lateral lobes are entirely visible (pl. 19, fig. 33), as they are quite regularly in *P.* (*P.*) *hermonis*.

On the other hand, the suture lines of paratypes numbers 11 and particularly 54 and 60 at diameters of from 6 to 7.5 mm., exhibit the shallow lobes and low saddles and the somewhat reduced degree of indentation characteristic of *P.* (*P.*) *bernensis* at the same size (pl. 19, figs. 27, 31).

The excellently preserved suture lines of paratypes numbers 28 and 33 agree with those of number 59, described above, and illustrated, at about 8 mm. in diameter.

A considerable increase in the degree of indentation is found in paratype number 38 at a diameter of about 15 mm. (pl. 20, figs. 14, 15). Thus the median knob, which is also higher and more slender, has become three-cusped, and the terminal points of the siphonal lobe and the middle point of the first lateral lobe carry secondary points on either side. Furthermore, the first lateral saddle rises markedly higher than at earlier stages above a line connecting the tops of the two adjacent saddles, thus making the slope of the suture line towards the umbilical seam more conspicuous, and the saddle between the second lateral and first auxiliary lobes is more slender than described above. In all these respects this suture line approaches that of *P.* (*P.*) *delicatulus* (p. 151). All this also holds true for the suture line of paratype number 55 at a diameter of about 20 mm., except that its broader venter allows for a somewhat greater width of the siphonal lobe and that this line is a little more elaborate than the last.

Further progress in this respect is found in the whorl fragment number 61 which, at diameters of from 22 to 25 mm., shows the best and most completely preserved suture lines encountered in any individual of this species (pl. 20, figs. 16–18). That the first lateral lobe is unusually wide and shows a smaller than usual difference in length between middle and lateral points in the second and third of the lines depicted in plate 20, figure 17, seems to be merely a peculiarity of these individual lines. The inclination of the second lateral and first auxiliary lobes and the length and narrowness of the latter have markedly increased. The internal suture line also is fully exposed in this fragment (pl. 20, fig. 18). A low trapezoidal saddle rides on the umbilical seam. It is followed dorsad by two narrow, pointed, and strongly reclining lobes with a slender saddle between them, all three elements corresponding more or less symmetrically to the three last of the external suture line. There follow a rather florid saddle, inclined towards the seam, a rather sturdy, trifid lobe, and beyond it the slender internal saddle, about one and a half times as high as its neighbor. The extremely long and narrow, richly indented antisiphonal lobe ends in three points, the middle of which is the longest but is comparatively blunt.

About the same degree of elaboration is found at about the same diameter in the last suture lines of paratype number 43. Although syntype A is septate throughout, it exhibits well-preserved suture lines only up to a diameter of 27 mm. As would be expected, these suture lines are even more elaborate than the last discussed, the "suspensive lobe" is more conspicuous, the second lateral lobe longer, more slender, and more inclined, and the first auxiliary, which carries now three lateral prongs on either side, approaches a horizontal position (pl. 20, fig. 12).

REMARKS: The trivial name of this species was suggested by its close similarity to several other forms of the present assemblage; it can, however, readily be distinguished from all of them.

On the one hand, it resembles the form doubtfully referred above to *P.* (?*Dichotomosphinctes*) *orthocyma* Noetling in shell shape and dimensions, but the latter can readily be distinguished not only by its sharp, high, more widely spaced and more curved ribs but also by keeping up to three constrictions per half-whorl to a diameter of nearly 50 mm. and by its less elaborate suture lines.

The distinction of this species from others of the present subgenus, especially from *filocostatus*, *bernensis*, and *latilinguatus*, but also from *hermonis* and *delicatulus*, is sometimes not easy at early stages, but the largest individuals of all these species are readily distinguished from one another. For detailed comparisons, see pages 131, 137, 145, 149.

Perisphinctes greppini de Loriol (1896, p. 30, pl. 3, fig. 4), *non* Oppel *in* Neumayr (1870a, p. 249; see Spath, 1928, p. 268), somewhat resembles our syntype B of the present species but, in addition to growing much larger, is altogether thinner and has somewhat stiffer ribs which trifurcate rather than bifurcate.

MATERIAL STUDIED: Altogether 238 individuals, including incomplete and poor specimens and fragments.

Perisphinctes (Properisphinctes) filocostatus,
new species

Plate 20, figures 19–36

DIMENSIONS

A.M.N.H. No. 27837	D	H	H′	W	U
1	5.73 mm.	39½	23	62½	32
2	6.25 mm.	37	?	49	36
3	6.46 mm.	35	27	57	36½
4	6.66 mm.	37	*ca.* 27½	54	34
5	7.28 mm.	34½	22½	50½	34
19	7.38 mm.	37½	*ca.* 28	*ca.* 50	33½
6	7.58 mm.	39	?	52½	34
7	7.58 mm.	34½	23	48½	34
8	7.69 mm.	33½	23½	53½	36
9	8.20 mm.	40	?	51	31½
20	8.51 mm.	36	25½	47	30
10	8.81 mm.	38½	31½	*ca.* 43	32½
18	9.22 mm.	38	22	50	35½
11	9.43 mm.	41½	31½	46½	36
21	10.45 mm.	35½	28½	44	41
12	11.58 mm.	38	28½	*ca.* 56½	35½
13	11.79 mm.	35½	*ca.* 26	50½	39
14	11.98 mm.	38½	?	43½	36
15	12.81 mm.	40	?	49½	38½
16	14.86 mm.	36	26	40½	33
17 (holotype)	15.1 mm.	40½	?	47	37

In this species, too, general trends of H and W to decrease, and of U to increase, with growth can be recognized. Because the sample does not represent so wide a range in size as that in congeneric species, the ranges of variation are, except in W, comparatively narrow, and the maxima or minima of a given dimension, or values close to them, are sometimes found near the middle of the table rather than at its top or bottom.

The last septum can be located in the holotype at a diameter of about 9 mm., but specimen number 16, measuring almost 15 mm. in diameter, is septate throughout. Adding, for the living chamber, even a whorl and a half would yield a disk of only about 25 mm. in diameter. Thus, if the material examined may be considered representative of *P.* (*P.*) *filocostatus*, it must have been a miniature perisphinctid.

DESIGNATION OF TYPE: The largest specimen present (A.M.N.H. No. 27837:17) is designated holotype.

DESCRIPTION: This form was originally believed to be a mere variety of *P.* (*P.*) *vicinus*, with which it has the reniform whorl profile of the earliest stages (fig. 20) and the oval, ventrad tapering one of the later growth stages (figs. 25, 34) in common. Closer examination, however, proved the differences between both forms to be of higher than varietal rank. These differences affect the shell shape on the one hand and the ornamentation on the other.

In the former respect the shells of this species on an average are markedly thicker and more involute (or less evolute) than those of *P.* (*P.*) *vicinus*. Constrictions appear as early as at a diameter of 3.5 mm. (paratype no. 1, fig. 19) at the rate of five or six per volution. Eight can be counted around the periphery of paratype number 14 (fig. 35) and three in the anterior half of the outer whorl of the largest shell (holotype, fig. 33). They are deepest and broadest around the umbilicus, thus lending it in some individuals (e.g., paratype no. 10, fig. 22) a triangular shape.

Most characteristic of this species is the costation, which has suggested the trivial name (*filocostatus* = thread-ribbed). Ribs appear in paratype number 19 at a diameter of a little more than 6 mm.; at this stage they are rather stiff, prorsiradiate, and restricted to the flanks. With growth they become more delicate, slightly sinuous, and rather closely set; 16 are counted on the anteriormost half whorl of paratype number 10 (fig. 22), including two which originate by bifurcation at the inner third of the sides. In paratype number 11, illustrated as a characteristic medium-sized shell (figs. 23–25), on the other hand, there are only 14 ribs on the anteriormost half whorl; here they are more widely spaced and rather fold-like and become decidedly sigmoidal anteriorly. Only from a diameter of 8.7 mm. can the characteristic ornamentation of this species be seen to develop in paratype number 12. The ribs are slightly sigmoidal, thin, and rather high; they bifurcate, somewhat ventrad of the middle of the flanks or at their outer third, into fine secondary ribs which, with intercalation of more, cross the venter in a gently forward convex arc. Thus about 30 thread-like ribs can be counted around the periphery in the anteriormost quarter whorl (figs. 26, 27). The ribs are even thinner and sharper in the characteristic paratypes numbers 14 (figs. 35, 36) and 15, where 28 per half whorl are present on the flanks. The latest ornamentational stage of this species is represented by the holotype (figs. 32, 33). The costae are irregularly prorsiradiate and sinuous on its anteriormost quarter whorl. Here secondary ribs are added, by bifurcation or intercalation, to the primary ones on the lateroventral shoulder only. Thus 15 ribs can be counted on the flanks and 29 on the venter of this quarter-whorl. The thread-like appearance, especially of the secondary ribs, is quite conspicuous in the holotype.

The suture line, which in its earlier stages can best be studied in paratypes numbers 2, 6, and 7 (figs. 28, 29), agrees in general with that of *P.* (*P.*) *vicinus*, but there are minor differences. For example, the top of the first lateral saddle does not rise so high above the base line as it does at the same stage in *vicinus*. Nevertheless, the "suspensive lobe" is quite conspicuous as early as at a diameter of 8.25 mm. (paratype no. 18). The last five suture lines of paratype number 13, the last corresponding to a diameter of 7 mm., are markedly crowded, thus indicating that this individual had reached maturity despite its smallness. These sutures (figs. 30, 31) show a somewhat higher degree of elaboration than that observed in paratype number 18. What little is visible of the last suture line of the holotype, corresponding to a diameter of only about 9 mm., seems to exhibit about the same degree of indentation as observed in paratype 13 or a slightly higher one.

Remarks: This comparatively rare species comes closest to *P.* (*P.*) *vicinus*, with which it is compared in the above description. In its rounded, ventrad-tapering whorl profile it resembles also *P.* (*P.*) *bernensis* but, even though its smallness precludes comparison above the diameter of 15 mm., it can be recognized to be always more slender at the same size. It differs from *bernensis* even more distinctly by its peculiar costation, described above.

The striking resemblance of the holotype of this species to that of *Ammonites bakeriae* Sowerby (1829, p. 134, pl. 570, figs. 1, 2), as refigured by Spath (1931, pl. 59, fig. 8), is believed to be due to homeomorphy. According to Sowerby's description, his specimen shows parabolic nodes and resorbed old apertural margins, not found in the present species, and has a much higher whorl profile and, as preserved, no constrictions. Spath (1931, p. 326) assigns Sowerby's species tentatively to the genus *Grossouvria*.

Material Studied: Altogether 30 specimens.

Perisphinctes (Properisphinctes) bernensis de Loriol

Plate 20, figures 37–58; plate 21, figures 1–31

Perisphinctes latilinguatus sp. n.; Noetling, 1887, p. 28, *pro parte, non* pl. 4, figs. 7, 8.

Perisphinctes bernensis, P. de Loriol, 1898, p. 76, pl. 5, figs. 18–24.

Perisphinctes bernensis, P. de Loriol; de

LORIOL, 1900, p. 62, *pro parte*, pl. 4, figs. 27–32, *non* figs. 23–26.

Perisphinctes bernensis, P. de Loriol; DE LORIOL, 1902, p. 63.

Perisphinctes bernensis P. de Loriol; DE GROSSOUVRE, 1922, p. 313.

Properisphinctes bernensis (P. de Loriol); SPATH, 1931, p. 404, pl. 54, figs. 3, 9, pl. 58, fig. 8, pl. 59, fig. 7.

Perisphinctes bernensis de Loriol; MAIRE, 1932, p. 21.

Perisphinctes bernensis de Loriol; VAUTRIN, 1934, p. 1439.

Perisphinctes bernensis de Loriol; ARKELL, 1936, p. xli, pl. C, figs. 2, 3.

Perisphinctes (*Properisphinctes*) *bernensis* de Loriol; ARKELL, 1939, p. 159, *cum synon.*, pl. 9, figs. 10, 11.

DIMENSIONS

A.M.N.H. No. 27843	D	H	H′	W	U
1 (nucleus)	1.10 mm.	33½	24	66½	36½
2	2.66 mm.	38½	25	71	27
3	2.92 mm.	35	21	80½	31½
4	3.48 mm.	35½	22	72	32½
5	3.48 mm.	38	20½	73½	29½
6	3.79 mm.	39	25½	73	34
7	3.89 mm.	37	26½	71	31½
8	4.10 mm.	40	25	*ca.* 70	30
9	4.20 mm.	39	19½	80½	31½
10	4.41 mm.	39½	21	*ca.* 74½	32½
11	4.61 mm.	40	20	69	33½
12	4.61 mm.	35½	?	75½	33½
13	4.71 mm.	43	?	65	28
14	4.82 mm.	44½	25½	64	23½
15	4.82 mm.	40½	32	55½	30
16	4.82 mm.	47	26½	?	23½
17	4.92 mm.	39½	18½	75	31
18	4.92 mm.	36½	23	*ca.* 75	27
19	5.02 mm.	35½	?	*ca.* 61	35½
20	5.02 mm.	41	28½	57	32½
21	5.12 mm.	42	24	70	34
22	5.33 mm.	38½	21	69	29
23	5.43 mm.	41½	21	69	30
24	5.84 mm.	45½	?	66½	28
25	5.94 mm.	41½	*ca.* 20½	?77½	22½
26[1]	5.94 mm.	36	24	65½	39½
27	6.05 mm.	40½	22	69½	30
28	6.15 mm.	35	20	56½[2]	30
29	6.15 mm.	41½	26½	65	28½
30	6.25 mm.	36	26	59	31
31	6.35 mm.	40½	24	59½	26
32	6.35 mm.	37	26	63	32½
33	6.35 mm.	47	?	64½	24
34	6.46 mm.	36½	22	58½	31½
35	6.46 mm.	39½	?	57	27
41	6.46 mm.	36½	24	71½	22
36	6.66 mm.	38½	21½	56	31
37	6.76 mm.	35	26	59	38
38	6.87 mm.	43½	25½	60	27
45	6.87 mm.	43½	19½	70	33
39	7.17 mm.	35½	22	60	30
42	7.17 mm.	41½	20	65½	25½
43	7.28 mm.	34	21	53½	35
46	7.28 mm.	35	22½	57½	35
44	7.48 mm.	37	?	55	30
40	7.58 mm.	34	19½	52	28½
47	7.58 mm.	36½	24½	55½	38
48	7.58 mm.	34	20½	58	39
49	7.58 mm.	43	21½	67½	21½
50	7.99 mm.	39½	28½	54	28½
51[3]	8.10 mm.	38	29	61	35½
56	8.20 mm.	36	20	56	32½
52	8.30 mm.	39	20	60½	33½
53	8.40 mm.	36½	27	61	35½
54[4]	8.51 mm.	41	?	49½	27½
55	8.71 mm.	41	28	52	29½
57	8.81 mm.	35	?	*ca.* 56	35
58	9.12 mm.	40½	24½	57½	29
59	9.12 mm.	31½	?	56½	36
60	9.22 mm.	44½	*ca.* 30	65½	25½
61	9.33 mm.	35	27½	58	32
62	9.43 mm.	35	21½	56½	37
63	9.53 mm.	37½	22½	57	29
64	9.74 mm.	34½	20	57	36
65	9.74 mm.	36	19	58	34½
66	9.74 mm.	37	23½	49½	34½
67	9.84 mm.	32½	20	*ca.* 52	36½
68	10.15 mm.	31½	22	*ca.* 45½	40½
69	10.25 mm.	35	21	56	36
70	10.45 mm.	34½	*ca.* 19½	*ca.* 59	35½
71	10.86 mm.	31	21½	55½	37
72	11.07 mm.	36	23	52	34½
73	11.27 mm.	32½	23½	*ca.* 59	32½
74	11.27 mm.	29	?	54½	43½
75	11.99 mm.	32½	?	52	45½
76	11.99 mm.	38½	24	59	35
77	13.12 mm.	33½	24	51	40½
78[5]	13.73 mm.	40½	?	55	32
79	13.84 mm.	35½	26	52	44½
80	14.35 mm.	32	24½	51½	45½
81	14.96 mm.	31½	19	55	39
82	16.1 mm.	28½	24	50½	46
83	17.2 mm.	27½	20	43½	52½
84[6]	25.7 mm.	29	23½	*ca.* 33½	50½
86	40.9 mm.	26½	*ca.* 22½	33½	48½

[1] Transitional to *P.* (*P.*) *vicinus* in shell shape.
[2] Deformed.

The wide gap in size between numbers 83 and 86 is bridged by the badly corroded shell number 93, attaining about 21 mm. in diameter, and by two incomplete disks, numbers 84 (of which the measurements of only

[3] Transitional to *P.* (*P.*) *delicatulus* in both ornamentational and sutural characters.
[4] Sutures transitional to *P.* (*P.*) *vicinus*.
[5] Transitional to *P.* (*P.*) *delicatulus* in costation.
[6] Penultimate whorl.

the penultimate volution are given above) and 85, the diameters of which are estimated at about 40 mm.

The growth trends recognizable in the above table are those common in *Properisphinctes:* H and W tend to decrease and U tends to increase. Accordingly, the minima and near minima for H and W and the maximum and near maximum for U are found in the three largest measured shells, and the maximum and near maximum for W among small individuals, measuring between 2.92 mm. and 4.61 mm. in diameter. However, the maximum and near maximum for H occur not among the very smallest individuals but at diameters from 4.82 mm. to 6.35 mm., and the near minimum and minimum for U even later in development, namely, at diameters of 6.46 mm. and 7.58 mm., respectively. The break in coiling frequently occurring in this species and the distortion of the inner spiral of involution by deep and broad constrictions apparently make in some cases for a lower value for U but in others for a higher one. Also otherwise the growth trends mentioned above manifest themselves in a way which is far from steady. However, it must be considered that increases in size between neighboring specimens are of the order of tenths of millimeters only up to number 74 and of the order of half to full millimeters from number 75 to number 83, whereas the largest measured specimen is more than twice as large as number 83 and still more than one and a half times as large as the measured penultimate whorl of number 84.

It will be noted from the table that the whorls of this species remain at all stages wider than high. In contradistinction from *P.* (*P.*) *latilinguatus* W here never comes down to the value of H.

The last septum is situated in specimen number 84 at a diameter of about 22.5 mm., about one volution behind the anterior end, and in the largest complete shell (no. 86) at a diameter of about 30 mm., about half a volution behind the anterior end, but the incomplete disk number 85 is septate up to the anterior end which corresponds to a diameter of about 40 mm. If about a whorl and a quarter is allowed for the body chamber, this shell (no. 85), when complete, must have measured at least 50 mm. across. Thus the three largest known individuals of this species, namely, the two figured by de Loriol (1898, pl. 5, fig. 24; 1900, pl. 4, fig. 29) and number 86 from Mt. Hermon, all measuring around 40 mm. in diameter, do not yet represent the maximum size attained by this species.

Designation of Type: The specimen illustrated by de Loriol (1898) in figures 18 and 18a was designated lectotype of *P. bernensis* de Loriol by Arkell (1936, p. xli, explanation of pl. C).

Description: The shell shape of this species undergoes through ontogeny truly amazing changes from almost spherical, comparatively narrow-umbilicated juveniles (nos. 3, 4, 5; pl. 20, figs. 37, 41–44) to decidedly evolute disks, in which the width of the umbilicus is one-half, and the thickness one-third, of the diameter (no. 84; pl. 21, figs. 22–24). Accordingly the whorl profile changes from reniform or crescent-shaped (pl. 20, figs. 37, 44, 46, 49) over semicircular (nos. 14, 24, 65; pl. 20, figs. 39, 53; pl. 21, fig. 11) to depressed rectangular (no. 81; pl. 21, fig. 18), and finally subquadratic with well-rounded lateroventral and umbilical shoulders, as the section appears in specimens numbers 84, 85, and 86 (pl. 21, figs. 24, 29, 31). The early development of the whorl profile is well illustrated by the natural cross section of the juvenile number 92, which measures about 5.5 mm. in diameter (pl. 20, fig. 56). Even at the latest stages the flanks remain distinctly convex and the whorl section attains maximum width somewhat below the middle, tending to taper towards the venter, and the latter remains convex between the lateroventral shoulders, all in contradistinction from the parallel flanks, truncate venter, and altogether more angular whorl profile of *P.* (*P.*) *latilinguatus* (pl. 22, fig. 46; pl. 23, fig. 10).

No less characteristic of this species than the development of the whorl section are particularly deep and wide constrictions. They appear, in specimen number 5 (pl. 20, fig. 43), as early as at a diameter of not quite 3 mm. Three are here present on a half whorl, and they are deepest and widest on the umbilical shoulder and in the inner zone of the flanks but gradually vanish towards the periphery. At the somewhat later stage represented by specimen number 24 the constrictions continue in full depth and width across the venter (pl. 20, figs. 50, 51, 53), as they do throughout further development. One constriction each in specimens 24 (pl. 20, fig. 51) and 73 is remarkable for being subdivided by a high and sharp ridge. In several other individuals constrictions are accompanied along their anterior margins by a particularly strong, almost varix-like rib (e.g., no. 84; pl. 21, figs. 22, 24); in specimen number 73 one of the constrictions is bounded by a true, high and sharp varix (pl. 21, fig. 13). More frequently and more intensively than in any of the closely related species the constrictions disturb the inner spiral of involution so as to lend an irregular shape to the umbilicus. Thus it assumes rarely, as in the juvenile number 5 (fig. 43), a pentagonal outline, more often a subquadratic, as in specimens numbers 30, 90 (pl. 21, fig. 5), 38, and 70, and in about 70 of the individuals present a triangular one. Specimens numbers 17, 80, 87, 88, and 89 (pl. 20, fig. 48; pl. 21, figs. 2–4, 12) serve to exemplify the last group. Specimen number 65 is remarkable for exhibiting such a triangular umbilicus within a subquadratic one (pl. 21, fig. 10). As in other species of *Properisphinctes* the number of constrictions per volution decreases with growth; on the largest shells present (nos. 84, 86) the penultimate and last whorls carry only one or two each (pl. 21, figs. 23, 30).

The same individuals exhibit slightly deepened siphonal bands (pl. 21, figs. 24, 31), as do some smaller ones, whereas a pronounced siphonal groove, somewhat displaced to the right, is developed in specimen number 85 (pl. 21, fig. 27).

In a few individuals, for instance in the juvenile number 18 (pl. 20, fig. 54), the body chamber appears to be bent down, seemingly not by external pressure, and the whorl height decreases rather than increases from the deformation point to the anterior end. A similar phenomenon, namely, a slowdown, if not a standstill, in the increase of the whorl height, is recognizable in specimen number 81 also, here within the septate part of the conch (pl. 21, fig. 17).

Juveniles remain smooth to a diameter of about 4 mm. or 5 mm. (specimens nos. 4, 17; pl. 20, figs. 41, 42, 47–49), exceptionally even to one of about 9 mm. (specimen no. 60). In specimen number 12 the first indications of ribs can be recognized on the umbilical shoulder at a diameter of 4.4 mm., and in the juveniles numbers 25 and 28, from a diameter of a little more than 5 mm.; they extend over the inner half of the flanks. In the somewhat larger juvenile number 37 the costation begins at a diameter of only about 6 mm. Now the ribs, which are still blunt and inconspicuous and markedly prorsiradiate, extend from the umbilical to the lateroventral shoulder. Eight are present on one-sixth of the outer whorl. The costae assume a radial direction near the anterior end of the juvenile number 91, of about the same size as 37, but here they are much stronger and more widely spaced (five to one-sixth of a volution, pl. 20, fig. 55). Costation is remarkably fine and radial rather than prorsiradiate in specimen number 52 where, owing to bifurcation occurring on, or slightly dorsad of, the lateroventral shoulder, delicate secondary ribs cross the venter straight, at the number of about 24 per quarter whorl (pl. 21, figs. 6, 7). However, the costation of specimen number 65 (pl. 21, figs. 9, 10), with 18 moderately strong and decidedly prorsiradiate primary ribs and about 35 only slightly weaker secondary ones in the anterior half of the outer whorl, is more characteristic of the present species at this stage (D = 9.74 mm.). Here the primary ribs bifurcate, as a rule, at the outer, but for the length of about a quarter-whorl at the inner, third of the sides. The shells numbers 75 and 77 (pl. 21, figs. 19, 21) serve as good examples of the character of ornamentation at a somewhat later stage. The ribs are strongly prorsiradiate, describe a forward concave arc on the flanks and a shallowly forward convex one across the venter, and as a rule bifurcate on or somewhat inward of the lateroventral shoulder; 24 primary ribs are counted on the anterior half-whorls of both shells. The costation is somewhat finer, though not denser, in number 77 than in number 75. The degree of prorsiradiateness of the costae increases in the last quarter-whorl of specimen number 81, but it decreases in that of the somewhat larger specimen number 82. In both 22 ribs are counted on the flanks of the anteriormost half whorls. The same trend towards a less prorsiradiate direction of the ribs is observable in specimen number 83 which is transitional in character of ornamentation to the two much larger disks numbers 84 and 85 (pl. 21, figs. 23, 28). The ribs of their penultimate whorls are still prorsiradiate, though much less so than at earlier stages, but those of the outer volutions run in a radial or, in number 85, even slightly rursiradiate direction. This contrast causes the ribs of two consecutive whorls to form a very obtuse angle which opens apicad where they meet at the umbilical seam. This angulation, believed to be a characteristic of mature shells of *Properisphinctes*, is particularly noticeable in de Loriol's (1898) figure 24a and is found also in *P.* (*P.*) *latilinguatus* and *P.* (*P.*) *trapezoidalis* (compare pl. 23, fig. 4; pl. 22, fig. 19). Forty-one primary ribs are counted on the penultimate volution of number 84 and 11 on the preserved quarter of its outer whorl, as compared to 13 on that of number 85.

A count of the ribs of the largest shell (no. 86, pl. 21, fig. 30) yields about the same result (42 primary costae each in both penultimate and last whorls) as in number 84, but the ribs run here more nearly radially in both volutions. In this respect as in others, this shell (which I originally hesitated to refer to the present species) closely resembles the two largest individuals referred to it by de Loriol after careful examination and illustrated by him in 1898 (pl. 5, fig. 24) and 1900 (pl. 4, fig. 29), respectively.

Here it should be pointed out that a few specimens, although exhibiting shell shape and whorl profile of the present species, approach *P.* (*P.*) *delicatulus* in the character of ornamentation. Thus costation appears in specimens numbers 51, 60, and 78 not until diameters between 8 and 9 mm. are reached, that is, considerably later than is normal in the present species, so that the two first-mentioned shells for all practical purposes remain smooth to the end, except for a few scattered, hardly perceptible ribs. The costation which sets in in specimen number 78 at a diameter of a little more than 8 mm., is, for about half a volution, fine, as it usually is in *delicatulus*.

The sutural changes taking place in the course of the ontogeny of this species are as surprising in magnitude as those affecting its whorl profile and shell shape. In early stages the suture lines are characterized, and distinguished from those of related species, by wide and shallow lobes and even wider, low saddles, both with an unusually low degree of indentation, and they do not slope markedly towards the umbilicus (pl. 20, figs. 57, 58; pl. 21, figs. 14, 20), whereas in the latest stages observable they become as elaborate and indented and exhibit as long and slender main lobes and saddles and as pronounced a "suspensive lobe" as in any other species of *Properisphinctes* in maturity (pl. 21, fig. 26). There seems to exist an intrinsic connection between the width of the whorl profile and the character of the sutures in juveniles and even medium-sized individuals of this species, inasmuch as the amount of shell substance available for the construction of septa is limited. Therefore if more is needed to build a wide whorl profile, less is left for extension of the septa in the direction of the spiral of involution, as expressed in higher saddles and deeper lobes.

The sutural characters ascribed above to the juveniles of this species are well seen in specimen 7 (pl. 20, fig. 40) at a diameter of 3.6 mm. and, better still, in specimen 94 (pl. 20, figs. 57, 58) at a diameter of 4.3 mm. The latter exhibits best the low saddles, shallow lobes, and poor indentation mentioned above. Otherwise the sutures show the characters common in this subgenus, as more explicitly described above (pp. 128–130) in *P.* (*P.*) *vicinus*. In both these individuals the trapezoidal median knobs are remarkably wide and low, as in *P.* (*P.*) *hermonis* (see p. 148, pl. 23, figs. 18, 19). Comparison of the two suture lines just discussed shows a much greater difference in depth between siphonal and first lateral lobes in number 94 than in number 7, an unusually shallow first lateral lobe being one of the characteristics of typical juvenile suture lines of *bernensis*. Those of specimens numbers 96 and 40, both corresponding to diameters of about 6 mm. (pl. 21, figs. 1, 8), agree better with that of number 7 than with that of number 94. In number 40 the first lateral saddle begins to rise above the line connecting the other saddle tops. The suture lines of specimen number

52, seen in plate 21, figures 6 and 7, and corresponding to diameters of around 6.5 mm., on the other hand, are more like those of specimen number 94, if allowance is made for the difference in size. The lobes, especially the first lateral one, are even shallower in the four last sutures of specimen number 57 (pl. 21, fig. 20), corresponding to an only slightly smaller diameter.

The same holds true for the very characteristic last two sutures visible in specimen number 95 (diameter *ca.* 6.66 mm., pl. 21, fig. 14). At the somewhat later ontogenetic stage represented by specimens numbers 63 (pl. 20, figs. 45, 46) and 65 (pl. 21, figs. 9–11) the character of the suture lines is still essentially the same, with hardly any progress in indentation, although there are individual differences. For example, the median knob is already three-cusped in number 63, but still extremely low and absolutely straight and horizontal at the top in number 65. Only in specimen number 74 is some increase in the degree of indentation of the suture lines (pl. 21, fig. 15) noticeable. This shell is less stout than the smaller ones hitherto dealt with, and the main lobes and saddles are accordingly more slender. The sutures of specimen number 81, seen in plate 21, figures 16 and 17, although on an average corresponding to a diameter of about 12 mm., as compared to about 10 mm. for the preceding suture line, are, with their comparatively low and broad saddles and shallow lobes, both but little indented, again more like those characteristic of much earlier stages. Those of specimen number 85 (pl. 21, fig. 26), however, corresponding to diameters of from 35 to 40 mm. and thus separated by an extremely wide gap in size and ontogenetic stage from those just discussed, are as elaborate and florid as any in the other species of this subgenus studied in the present report and are distinguished by extremely long and slender lobes. Their saddles are also much less wide than at earlier stages. The terminal points of the siphonal lobe are very long and narrow and carry at least four secondary prongs on either side. The median knob, somewhat distorted by the slightly eccentric siphonal groove, is high, strongly compressed, and deeply intersected to form three extremely slender cusps. The first lateral lobe reaches even a little farther down than the siphonal one and is characterized by an unusually long and slender middle point, almost as long as the stem of this lobe before it divides into three main points. Second lateral and first and second auxiliary lobes are, in this order, increasingly reclined, with the second auxiliary nearly horizontal, and both auxiliaries come to be situated far below the lower end of the second lateral lobe. Thus there is a pronounced "suspensive lobe." In all these characters these suture lines agree perfectly with those depicted in de Loriol (1898, fig. 26), drawn after his specimen from Gempen which, according to figure 23 of his plate 5, attains a diameter of about 30 mm. only and thus represents a slightly earlier stage than our specimen number 85.

The juvenile number 97 is here mentioned for having, at a diameter of about 5 mm., the siphonal lobes of his two last suture lines shifted considerably to the right, with the left external saddles widened accordingly. This phenomenon is quite common among the Oppelidae but extremely rare among the Perisphinctidae of the present assemblage.

This section has been devoted to the description of suture lines considered more or less characteristic of this species. However, a few among its specimens are in sutural characters transitional to other species of this subgenus. Thus the suture lines of specimen number 51, mentioned above as remaining smooth to an unusually late stage, definitely approach the style of those of *P.* (*P.*) *delicatulus*, and the suture lines of specimen number 54 are like those of *P.* (*P.*) *vicinus*. On account of shell shape and whorl section, however, both these shells are left with *P.* (*P.*) *bernensis*.

REMARKS: This species, established by de Loriol only 11 years after the publication of Noetling's Hermon monograph, is here for the first time recorded under this name from Majdal Shams, but the juveniles measuring about 5 mm. in diameter and having a "nahezu kugeliges, tief genabeltes Gehäuse" (a nearly spherical, deeply umbilicate shell) mentioned by Noetling (1887, p. 29) are undoubtedly referable to this species but not to *latilinguatus*, the juveniles of which at the same stage appear quite different (see p. 142, pl. 22, figs. 25–27). Thus there are certainly individuals of this species, as there may be some of other species dealt with in this report, among those included by Noetling in his *P. latilinguatus*.

Arkell (1939, p. 159), although recording from the Woodham Pit of Buckinghamshire, England, "many minute nuclei, 5 to 7 mm. in diameter, exactly like de Loriol's (1900) plate IV, figures 32, 32a," still includes the latter's three nuclei (1900, pl. 4, figs. 30–32) only with a question mark in his synonymy. However, their conspecificity with the larger of de Loriol's originals, among them the lectotype (see above), is put beyond any doubt by the complete and continuous series studied in the present report.

At the other end of this series stands our largest individual (no. 86) which agrees in almost every respect with the two large specimens figured by de Loriol (1898, pl. 5, fig. 24; 1900, pl. 4, fig. 29). After some hesitation I no longer question the conspecificity of these three specimens either.

I follow Arkell in referring the more slender forms with flat flanks, a truncate venter, and parabolic nodes, included in *P. bernensis* by de Loriol (1900, pl. 4, figs. 23–26), to *latilinguatus* rather than to the present species.

The positive part of our synonymy, however, is fully supported by the excellent agreement of the Syrian specimens with those described and illustrated by de Loriol, Spath, Maire, and Arkell (1939) in appearance, dimensions, when given (de Loriol, 1898, 1900; Maire, 1932, p. 22), and suture lines, when shown (de Loriol, 1898, text fig. 24; Spath, 1931, pl. 54, figs. 3, 9; Arkell, 1936, pl. 9, fig. 10).

Within the Mount Hermon fauna *P.* (*P.*) *vicinus*, *P.* (*P.*) *filocostatus*, *P.* (*P.*) *trapezoidalis*, and *P.* (*P.*) *latilinguatus* come closest to the present species. With *vicinus* and *filocostatus* it has in common the rounded whorl profile with convex flanks, slightly converging ventrad, and convex venter, but it differs from both species by being stouter and having more prorsiradiate ribs which appear somewhat earlier, and, except at the latest growth stages, more primitive suture lines with low saddles and shallow lobes. *Perisphinctes* (*P.*) *trapezoidalis* and *P.* (*P.*) *latilinguatus* are compared below (pp. 141, 145) with *bernensis*, as is *P.* (*P.*) *delicatulus* (p. 152), which also has a rounded whorl profile and to which some shells of the present species show transitions in ornamentational or sutural characters or both.

MATERIAL STUDIED: Three hundred and forty-five disks, 98.6 per cent of which do not attain 20 mm. in diameter, plus about 60 whorl fragments; altogether about 400 specimens. Thus this species is by far the most abundant of *Properisphinctes* at Majdal Shams.

Perisphinctes (Properisphinctes) radiocostatus, new species

Plate 21, figures 32–46

DIMENSIONS

A.M.N.H. No. 27841	D	H	H′	W	U
1	12.81 mm.	30½	?	44	39
2	15.27 mm.	25½	?	*ca.* 40½	58½
3	19.1 mm.	26½	?	37½	56
(syntype A)					
4	22.2 mm.	26	20½	34	52
5	*ca.* 23 mm.	30½[1]	?	34½[1]	52½[1]
6	30.0 mm.[2]	23½[2]	?	27	54½
(syntype B)					
7	30.4 mm.	31	*ca.* 22½	*ca.* 33	48
8	32.1 mm.	*ca.* 30	?	*ca.* 31½	*ca.* 54
9	36.0 mm.	33½	?	30	45½

In an evaluation of the above table the two last specimens must be excluded because both are too distorted to yield reliable measurements. The remaining sample is extremely small and covers only a limited size range.[3] At any rate, a decrease in W is clearly recognizable. The umbilicus tends to become wider in maturity, as in other species of this subgenus; specimens numbers 2 and 3 seem to represent cases of accelerated development in this respect.

Both specimens numbers 9 and 10, the latter attaining 33 m. in diameter but not included in the above table, are septate throughout. Thus this form may well have reached a diameter of about 60 mm. All the outer whorl of specimen number 5, and about

[1] Measured at D = 21.2 mm.

[2] Exclusive of varix at anterior end.

[3] The absence of juveniles between the diameters of 3 mm. and 12 mm., so abundant in other species of this subgenus, may be due to the fact that they are still indistinguishable from those of *P.* (*P.*) *latilinguatus*.

two-thirds of that of specimen number 6, belong to the body chamber.

DESIGNATION OF TYPES: A.M.N.H. No. 27841:6 appears to be the best example of a mature individual and is therefore designated syntype B. Because its inner whorls are not well preserved, the juvenile A.M.N.H. No. 27841:3 is, in addition, designated syntype A.

DESCRIPTION: Shell moderately evolute, least in the smallest juvenile. Whorl profile, except in the largest measured shell, decreasingly wider than high, transversely rectangular, though with well-rounded ventrolateral shoulders, in the young (paratype no. 1, fig. 33, and syntype A), later subquadratic, and finally elliptical (syntype B, fig. 40). There are from two to three, mostly deep and wide constrictions per whorl, at later stages only one. They run straight and radially across the flanks and form a forward tongue, the convexity of which decreases with growth, on the venter. In syntype B the anteriormost constriction is bounded orally by a strong varix (fig. 39). In about half of the shells present a median groove, rather deep in syntype A and paratype 4 (figs. 37, 46) but only delicately engraved in paratype number 5 (fig. 35), or at least a smooth median band interrupts the costation on the venter. This groove is mostly restricted to two-thirds or one-half of the outer whorl or to an even shorter part of it. It is worth noting that in both paratype number 4 and syntype B the groove does not coincide with the middle axis of the siphonal lobe but is markedly shifted to the left in the former shell and to the right in the latter (figs. 46, 41).

At the earliest observable stage, that is, at a diameter of 8.7 mm. in paratype number 1, costation is already fully developed. It is in most shells very regular. The ribs are straight, stiff, and as a rule radial in direction, but in paratype number 2 they are slightly prorsiradiate in the posterior and anteriormost parts of the outer volution, and in syntype B they are rursiradiate and recurved, *Mirosphinctes* style, in about the middle third of this volution (fig. 39). The primary ribs bifurcate quite regularly on, or a little inward of, the lateroventral shoulder, so that secondary ribs twice their number cross the venter, in an extremely shallow forward convex arc at early stages but straight later. Only exceptionally (paratype no. 8) does intercalation of secondary ribs occur instead of bifurcation. The density of the costation varies from 19 primary ribs per half, i.e., 38 per full whorl in paratype number 7 to 56 per whorl in paratype number 5, and decreases with growth, as seen best by comparison of the side views of paratype 1, syntype A, and paratype 5 (figs. 32, 36, 34) with that of syntype B (fig. 39). Only the posteriormost quarter of the outer whorl of syntype B shows in two or three places faint indications of parabolic nodes.

As a rule the suture lines of this species show only a moderate degree of indentation, an external saddle which is less wide than in other forms of this subgenus, a strikingly wide and shallow first lateral lobe which, up to a diameter of about 20 mm., is considerably shorter than the siphonal one,[1] and from the earliest stage examined (paratype no. 1, fig. 32) a more or less steeply sloping "suspensive lobe." However, in paratypes numbers 13 and 10 suture lines corresponding to diameters of about 19 and about 30 mm., respectively, are much more elaborate than in other individuals of this species, and the first lateral lobes are less wide than stated above and deeper than the siphonal ones, as they are in syntype B. In the fragment number 13, the sutural development of which seems to be accelerated as compared to syntype B at about the same size, the external saddle is definitely wide. The suture line of paratype 10 is particularly richly indented, with the external and lateral saddles narrowing the upper portion of the first lateral lobe, of which the lower portion spreads widely, deeply indenting the trunks of the adjacent saddles. Suture lines of syntype B and of paratypes 1, 4, 13, and 10 are illustrated (figs. 32, 41–46).

REMARKS: This form could be considered a variety of *P.* (*P.*) *latilinguatus* with which it more or less agrees in dimensions. Closer study reveals, however, that, in addition to the straightness, stiffness, and radial direction (indicated in the trivial name) of the ribs and on an average the greater density of the

[1] In the asymmetrical sutures of paratype number 4 this difference in length is much greater on the left side than on the right.

costation, other differences exist between both forms, namely, in whorl profile and suture lines; both are described above. Therefore this form is granted species rank.

From other *Properisphinctes* species in this assemblage the present species can readily be distinguished by its peculiar ornamentation.

MATERIAL STUDIED: With only 12 specimens, this is the rarest among the *Properisphinctes* species of Mount Hermon.

Perisphinctes (Properisphinctes) trapezoidalis, new species

Plate 22, figures 1–20

DIMENSIONS

A.M.N.H. No. 27840	D	H	H′	W	U
1	6.25 mm.	29	24	67½	46½
2	6.25 mm.	32	23	61½	42½
3	6.46 mm.	31½	20½	60½	48
4 (syntype A)	6.66 mm.	32½	21½	80	40
5	6.66 mm.	34	23	61½	46
6	7.07 mm.	34	26	55½	42
7	7.79 mm.	30½	21	59	43½
8	8.20 mm.	32½	24½	53½	47½
9	8.40 mm.	34	19½	69½	38
10	8.50 mm.	33	ca. 23	71	40
11	10.25 mm.	35	27	64	39
12	12.40 mm.	29	23½	51	49
13	15.8 mm.	29½	25½	48½	55
14	25.8 mm.	27	ca. 24	35½	56
15 (syntype B)					
penultimate	36.8 mm.	28½	25½	37	48
last	55.2 mm.	29	27	ca. 32½	53

The usual trend of the conchs to become more evolute and thinner with growth can be recognized in the above table. Accordingly the minimum and near minimum for W appear at the bottom of the table and the maximum and near maximum for U somewhat above it. The maximum for W is found fairly near the top of the table, but the near maximum at a diameter of about 8.5 mm., as is the minimum for U, with the near minimum occurring at a somewhat greater diameter. H is even less conclusive, with values of and near 29 occurring at diameters of 12.4 mm. and 15.8 mm., and even in the largest shell (syntype B), as well as in one of the two smallest which measure only 6.25 mm. across. With regard to these inconsistencies the suspicion that heterogeneous individuals may have been comprised in this species cannot be excluded.

The last septa are found in specimens numbers 13, 14, and 15 at diameters of about 9 mm., 16 mm., and 32 mm., respectively. The outer whorl of the last specimen (syntype B) belongs to the body chamber which is, however, not entirely preserved. When complete, this shell may have measured close to 60 mm. in diameter, which may be considered the maximum reached by the species. As preserved, syntype B is the largest *Properisphinctes* in the present assemblage.

DESIGNATION OF TYPES: The juvenile A.M.N.H. No. 27840:4 is designated syntype A for exhibiting most distinctly the trapezoidal whorl section believed to be characteristic of this species, and the largest individual (A.M.N.H. No. 27840:15) is designated syntype B.

DESCRIPTION: The whorl profile peculiar to this species, which has suggested the trivial name, is most pronounced, not to say exaggerated, in syntype A (no. 4, fig. 4). The strongly developed ventrolateral shoulders jut far out and mark the maximum width of the whorl which is situated a little below the middle of its height. Between these shoulders the extremely wide venter is well arched and the flanks slope from them at an angle of about 45 degrees towards the umbilicus, changing before reaching the seam imperceptibly into the low, nearly perpendicular umbilical wall. The shoulders are less accentuated in other juveniles, for example, in paratypes 9, 10 (figs. 9, 5), and 11, but there are always the extreme width and steady curvature of the venter and the characteristic inward slope of the flanks. The whorl section of paratype 9 (fig. 9) is even more depressed than that of syntype A, although by no means so wide. The somewhat larger paratypes numbers 12 and 13 (figs. 8, 12) show how this characteristic whorl profile is maintained even as the width decreases with growth, although the sloping of the sides towards the umbilicus somewhat flattens in paratype 13. The same holds true for paratype 14, the only medium-sized shell of this species that serves to bridge the immense gap in size between paratype 13 and syntype B, that is, between diameters of not quite 16 mm. and of 55 mm. The whorl section of paratype 14 is clearly transitional from that of paratype 13 (fig. 12) to the profiles shown by syntype B at the anterior end of the penultimate volution and at about the first third of its outer whorl (fig. 20). In all three sections the ventrolateral shoulders are still well developed though rounded, and the sloping of the flanks towards the umbilicus is still recognizable, but the venter has become less convex and the shoulders have therefore moved higher up so that the maximum width, still marked by these shoulders, is at about three-quarters of the whorl height.

The changes in the whorl profile followed in the preceding paragraph cause the shell gradually to change from the shape of a barrel with a deep and rather narrow umbilicus to that of an evolute, shallowly umbilicate disk.

Constrictions are present in paratype number 3, from a diameter of a little more than 4 mm., at the rate of four to a volution. Their course, parallel to that of the ribs, is that common in this subgenus. They are strongly prorsiradiate and form a shallow forward concave arc on the sides and a blunt, forward-pointing tongue on the venter. With growth the constrictions become deeper and wider, as in *P.* (*P.*) *bernensis* (paratype 14, figs. 15, 16). There are still four on the outer whorl of this paratype but only one on the penultimate whorl and two on the outer whorl of syntype B.

A shallow siphonal groove can be recognized on these two volutions of syntype B (fig. 18). Among the smaller shells only paratype 13 shows the same character (figs. 10, 12).

The costation closely resembles that of *P.* (*P.*) *bernensis* throughout development. The ribs, appearing in paratype number 3 at a diameter of about 4 mm., are strongly prorsiradiate, fine, and closely set (21 per half-whorl). The costation is coarser and accordingly less dense in syntype A where only 14 ribs are counted on the anteriormost half-whorl (fig. 3). Thirty-seven ribs are present on the sides of the outer volution of paratype number 12 and extremely fine secondary ribs, originating on the shoulders by bifurcation of the primary ones, can be recognized from a diameter of about 8.75 mm. on the venter of this specimen (figs. 6, 7). The character of the ornamentation is the same in paratype number 13, except that here the 35 ribs of the outer whorl are a little heavier and tend to become less prorsiradiate or even radial towards the anterior end (fig. 11). The costation of the largest shell but one (no. 14, fig. 16) resembles more that of the smaller juveniles in being dense (24 ribs per half-whorl) and remaining prorsiradiate to the anterior end, whereas in syntype B the same changes in ornamentation are observable as described for the latest stages of *P.* (*P.*) *bernensis*. The costae become stronger, stiffer, more widely spaced (only 36 on the outer whorl), and radial in direction rather than prorsiradiate, thus giving rise to the peculiar angulation between those of the last and those of the penultimate volution recorded for *bernensis*. No parabolic nodes are encountered in this species.

Suture lines are observable in paratype 2 from a diameter of 3.75 mm. At a diameter of about 6.5 mm. they closely resemble those of *P.* (*P.*) *bernensis* at the same stage, especially in the shallowness of the first lateral lobe as compared with the siphonal one. The excellently preserved last sutures of paratype number 3, corresponding to a diameter of about 4.5 mm. (fig. 1), show the same difference in depth between the two lobes but the saddles are not so low, the lobes not so shallow, and the indentation is not so poor as in paratype 2. The same holds true for the suture lines of paratype 6 at a diameter of about 6 mm. The last suture lines of paratype number 13 (figs. 13, 14), corresponding to a diameter of about 9 mm., are clearly more elaborate. Siphonal and first lateral lobes are comparatively slender, the first lateral saddle raises its top above that of the neighboring saddles, and a "suspensive lobe" begins to develop, with the point of the strongly reclined first auxiliary lobe reaching deeper than the second lateral one. What little can be seen of the last suture of paratype number 14 (D = 16 mm.) indicates a somewhat higher degree of indentation. Unfortunately syntype B does not permit observation of good suture lines so that the mature, certainly much more elaborate, sutural stage cannot be studied in this species.

Remarks: Juveniles with the peculiar whorl profile of this species, such as syntype A, might be taken for an *Aspidoceras* rather than a *Perisphinctes*. They have the extreme width of the whorl in common with the stoutest of the aspidoceratids in the present assemblage, *Aspidoceras* (*Euaspidoceras*) *lyra* Spath (below, p. 184, pl. 29, figs. 17–31; pl. 30, figs. 1–4), and they even outdo it in the angularity of the lateroventral shoulder. However, the presence of several constrictions, always lacking in *Euaspidoceras*, in the early volutions, on the one hand, and the lack of tubercles on the ribs (although the costae become somewhat accentuated in crossing such a sharp edge as in our syntype A), on the other, clearly prove even the juveniles to be perisphinctids, not aspidoceratids. This becomes, of course, more evident in larger individuals such as paratype number 14 and syntype B.

Within the subgenus *Properisphinctes* this rare species occupies a position intermediate between *bernensis* and *latilinguatus*. With the former it has the great width particularly of the early volutions in common, W reaching 80 only in these two species, and, in addition, the character of the costation. However, throughout development *bernensis* is characterized by a well-rounded whorl profile, *trapezoidalis* by a more or less sharp lateroventral shoulder. The last character causes it to resemble *P.* (*P.*) *latilinguatus* to a certain extent, but in the latter species the flanks are more or less parallel, whereas in the present they converge markedly dorsad. Furthermore, in *latilinguatus* the whorls are not nearly so wide as in *trapezoidalis*, and the shell is considerably more evolute.

The characteristic whorl profile also serves readily to distinguish *P.* (*P.*) *trapezoidalis* from all other species of the subgenus in the present assemblage.

MATERIAL STUDIED: Altogether 18 specimens, of which 14 are juveniles.

Perisphinctes (Properisphinctes) latilinguatus Noetling

Plate 22, figures 21–52; plate 23, figures 1–15

Perisphinctes latilinguatus sp. n.; NOETLING, 1887, p. 28, *cum synon.*, *pro parte*, pl. 4, fig. 7, *non* fig. 8.

Perisphinctes latilinguatus Noetling; SIEMIRADZKI, 1898, p. 82.

Perisphinctes bernensis P. de Loriol; DE LORIOL, 1900, p. 62, *pro parte*, pl. 4, figs. 23–26 only.

Perisphinctes latilinguatus Noetl.; FREBOLD, 1928, p. 190.

Perisphinctes latilinguatus Noetling; MAIRE, 1932, p. 27, pl. 4, figs. 1–3.

Perisphinctes (*Properisphinctes*) *latilinguatus* Noetling; ARKELL, 1939, p. 160, pl. 9, figs. 2, 3; p. 195.

DIMENSIONS

A.M.N.H. No. 27839	D	H	H′	W	U
1	3.89 mm.	37	23½	59	41
3	4.30 mm.	35½	26	59½	43
4	4.41 mm.	30	23	56	44
5	4.61 mm.	29	22	53½	49
6	4.92 mm.	36½	25	54	37½
7	5.12 mm.	34	28	52	41
8	5.33 mm.	30	23	50	47
9	5.43 mm.	32	24½	58½	40
10	5.64 mm.	32½	?	48	42
11	5.89 mm.	30½	ca. 22½	43½	45
12	6.15 mm.	35	26½	50	41½
13	6.46 mm.	31½	24	57	42
14	6.66 mm.	35½	27½	?	41½
18	6.66 mm.	37	24½	57	41½
19	7.17 mm.	34½	24½	48½	43
20	7.28 mm.	32½	25½	48	45
22	7.38 mm.	32	25	50	41½
23	7.48 mm.	37	27½	46½	39½
24	7.58 mm.	31	25	47½	46
25	7.58 mm.	32½	?	48½	43
26	7.74 mm.	30½	25	51½	46½
27	7.79 mm.	35½	30½	39½	44½
28	7.89 mm.	31	24½	48½	45
29	7.99 mm.	29½	23	51½	45
88	7.99 mm.	31	24½	46	46
30	8.10 mm.	30½	24	48	43
31	8.20 mm.	28½	21	50	46
32	8.51 mm.	30	23½	52	43½
2	8.71 mm.	28	22½	50	48
33	8.71 mm.	30½	?	44½	43½
34	9.02 mm.	33	26	46½	43
89	9.02 mm.	29½	22½	41	48
36	9.22 mm.	30	25	42	43½
37	9.22 mm.	32	28	45½	44
98	9.22 mm.	29	22	47½	45½
38	9.33 mm.	29½	24	49½	44
39	9.48 mm.	32½	28	44½	43
40[1]	9.53 mm.	33½	24½	47½	42
41	9.63 mm.	30	23½	42	42½
42	9.84 mm.	29	24	43½	46
43	10.25 mm.	31	21	46	46
90	10.45 mm.	ca. 29½	?	39	50
45	10.56 mm.	30	20½	48½	44½
46	10.56 mm.	27	22	44½	51
47	10.86 mm.	31	20½	45½	45½
48	10.86 mm.	29½	24½	43½	49
15	10.97 mm.	33½	24½	51½	41
49	11.17 mm.	34	?	41½	43½
50	11.27 mm.	32½	22½	44½	44½
51	11.48 mm.	29½	23	44½	44½

[1] Sutures transitional to *P.* (*P.*) *delicatulus*.

A.M.N.H. No. 27839	D	H	H′	W	U
52	11.48 mm.	30½	*ca.* 21½	48	46½
53	11.58 mm.	32	23	49½	45
54	11.89 mm.	29½	22½	47½	45
58[1]	11.89 mm.	31	*ca.* 26	47½	45½
55	12.04 mm.	28	24	56	45
91[1]	12.20 mm.	32	25	45½	43
56	12.30 mm.	30	25	46	47½
57	12.50 mm.	27	22	37½	50
59	12.50 mm.	26	21½	43½	51
60	12.50 mm.	33	25½	48½	44½
92	12.61 mm.	29	?	40½	46½
61[1]	12.91 mm.	26	23	43	43½
93[1]	13.0 mm.	31½	?	*ca.* 35½	51½
62	13.12 mm.	31	23½	43	47
63	13.2 mm.	30½	23½	38½	50
84	13.2 mm.	28½	22	47	52½
65[2]	13.4 mm.	30	23	42½	48½
64	13.53 mm.	26½	21	43	54
94	13.63 mm.	32½	?	46	42
66	13.8 mm.	30	23	42½	51½
99	14.0 mm.	26½	22	44½	54½
67	15.1 mm.	*ca.* 32½	?	34½	50½
85	15.7 mm.	?25	?	35	51
95	15.7 mm.	29½	?	35	48½
82	16.2 mm.	33	29	36½	52
96[1]	16.4 mm.	28½	?	37	49
86	16.8 mm.	30	24½	40½	50
97	16.8 mm.	29	24½	40½	52½
68	17.0 mm.	29½	24½	39½	53½
83	17.7 mm.	27	?	39½	53½
69	19.3 mm.	30	24	37	59
70	20.2 mm.	27	24	33½	57½
71	20.7 mm.	29	?	28	55
72	21.1 mm.	30	?	33	55½
73[1]	21.6 mm.	30	26½	36½	54
74	22.0 mm.	27	?	28½	54
75	23.4 mm.	28	25½	31	51½
76	24.4 mm.	30	27	28½	49
77	24.8 mm.	31½	?	31½	50
87	*ca.* 28.0 mm.	25½	?	?[3]	53
78	29.9 mm.	28	?26	*ca.* 30	48½
79	32.8 mm.	24	21½	26	56
80	33.6 mm.	26½	24	25½	55½
81	*ca.* 35.0 mm.	26½[4]	23½[4]	29[4]	*ca.* 61½[4]

Throughout the above table distinct though not steady trends of H and W to decrease and of U to increase can be followed, but these trends, especially as far as W and U are concerned, assume momentum only after a diameter of about 15 mm. has been reached. Specimen number 69 stands out by being unusually evolute for its size. The minima for H and W and the maximum for U are encountered near or at the bottom, and the maximum and near maximum for W at the top of the table, as might be expected, but the maximum for H is found not only at the top but again at diameters of 6.66 mm. and about 7.5 mm., and the minimum for U at a diameter of almost 5 mm.

It can furthermore be seen from the table that the whorls are considerably wider than high in the young. This difference gradually diminishes in the course of development. Only beyond a diameter of 20 mm. does W come down to the value of H (specimen no. 77) or even, in specimens numbers 71, 76, and 80, one or at the most one and a half points below H. In this regard our measurements agree well with Noetling's (*loc. cit. in synon.*, p. 29) who gives the same value of 26 for both H and W at diameters of 22 and 23 mm. His statement refutes the sentence occurring later in his description that the 2:1 ratio of W:H in the embryonic volutions is reversed as the size increases.

In the largest measured specimen (no. 81) the last septum corresponds to a diameter of 16 mm., and the body chamber occupies more than one and one-half volutions. It cannot be safely decided whether or not the body chamber is entirely preserved; if so, the apertural margin cannot well be seen. The two shells next in size (nos. 79 and 80) are septate up to diameters of 24 and 25 mm., respectively,[5] with three-fourths and one-half, respectively, of the outer whorl belonging to the body chamber. If its full length is assumed to have measured more than one and one-half volutions in these individuals also, a diameter of the complete disks of from 45 to 50 mm. is arrived at, indicating the probable maximum size attained by this species.

DESIGNATION OF TYPE: The only specimen from Mount Hermon figured by Noetling (1887, pl. 4, fig. 7) constitutes the holotype of *P.* (*P.*) *latilinguatus* Noetling.

DESCRIPTION: Small juveniles, for example, number 6 (pl. 22, figs. 25–27), are

[1] Sutures transitional to *P.* (*P.*) *delicatulus*.

[2] Costation and sutures transitional to *P.* (*P.*) *delicatulus*.

[3] Crushed.

[4] Measured at D=30 mm.

[5] Noetling (*loc. cit. in synon.*) gives a diameter of 23 mm. for his largest, almost entirely septate specimen but an average diameter of only 22 mm. for specimens in which the body chamber is nearly complete.

rather stout and their umbilicus is only moderately wide, but in maturity this species becomes the most slender and most evolute of the Mount Hermon *Properisphinctes*. This is best seen in the largest shell present (no. 81, pl. 23, fig. 11); it is nearly matched in width of the umbilicus by a much smaller shell (no. 69, pl. 23, fig. 2), reminiscent of Maire's (1932, p. 29, pl. 4, fig. 4) var. *vesuntina* of this species but not quite so evolute.

The development of the whorl profile is best illustrated by the diametric fracture of the largest shell (no. 81, pl. 23, fig. 10), but the inner volutions of this specimen seem to be crushed and therefore do not give so good a picture of the juvenile whorl section as specimens numbers 6, 25, 28, 34, 41, and 64 (pl. 22, figs. 25, 32, 34, 37, 44, 43). From all these individuals and from specimen number 76 (pl. 22, fig. 46) the whorl profile of this species can be said to develop as follows. It is first transversely elliptical, then transversely rectangular in the young but changes to subquadratic or subrectangular in maturity. The flanks are gently convex and more or less parallel. There is always a distinct, though rounded, lateroventral shoulder. The venter is always somewhat truncate and less convex than the flanks.

Constrictions appear in the juveniles numbers 6 and 2 (pl. 22, figs. 26, 28) at diameters of about 4 and 4.75 mm., respectively. They are distinctly prorsiradiate, but both the forward concave arc they describe on the flank and the forward convex one on the venter are shallow. Four are present per whorl in specimen number 2. In the course of development this number increases to five (no. 41, pl. 22, fig. 45), then decreases again as a rule to three. The tongue they form on the venter becomes more convex with growth. In this species the constrictions attain only exceptionally (no. 69, pl. 23, figs. 1, 2) the depth and width of those of *P.* (*P.*) *bernensis*. This may account for the fact that triangular umbilici, so common in that species, occur only rarely (specimen no. 83, pl. 23, fig. 5). In the present species, too, the constrictions are often bounded on the orad side by a particularly strong rib (no. 75, pl. 23, fig. 8), but these ribs develop only exceptionally (nos. 73, 80, pl. 23, fig. 13) into varices.

In some medium-sized and large shells (nos. 69, 70, 72–74, 79, 80) a siphonal groove is present between diameters of 12 mm. and 24 mm. It is well developed in some shells (no. 69, pl. 23, fig. 1) but only narrow and shallowly engraved in others (no. 70, pl. 23, fig. 3). In specimen number 73 it is preceded for about a quarter-whorl by a smooth siphonal band. The groove mostly disappears again after a half or full whorl.

Costation of specimens numbers 7 and 25 (pl. 22, fig. 33) can be seen to set in at diameters of a little more than 4 mm. and about 5 mm., respectively. At first the ribs are restricted to the middle of the sides, but they soon expand to reach from the umbilical to the lateroventral shoulder. At this stage they are decidedly prorsiradiate and slightly sinuous. Nineteen ribs are counted on the anterior half of the outer whorl of specimen number 25, but 22 and 26, respectively, in specimens numbers 40 and 41 (pl. 22, figs. 35, 45) in which the costation, otherwise similar, is somewhat finer and denser. In specimens numbers 61 and 69 (pl. 22, fig. 40; pl. 23, fig. 2), on the other hand, where the ribs are stronger, higher, and also less prorsiradiate, there are only 34 and 35 primary ribs, respectively, on the outer volution. In most medium-sized shells, e.g., numbers 64 and 97 (pl. 22, figs. 42, 51), the corresponding number is 43 or 42, but it is smaller (38) in specimen 73 and much higher (54) in number 74 (pl. 23, fig. 7). In shells exceeding 23 mm. in diameter the number of primary ribs on the anterior half of the outer volution varies between 18 and 25 but is usually 22 or 23, thus agreeing fairly well with Noetling's figure of 46 per whorl.

Secondary ribs appear on the venter, at first only faintly, at a diameter of about 7.75 mm. (specimen no. 37). They originate on the lateroventral shoulder mostly by bifurcation of the primary ones, rarely, as in specimen number 97, by intercalation. Accordingly their number is about twice that of the primary ribs. The medium-sized shell number 67 (pl. 22, figs. 49, 50) deviates from the others in that bifurcation occurs frequently on the umbilical shoulder or between it and the middle of the flanks. The ribs produced by this bifurcation do not seem to bifurcate again before crossing the venter. This seems to be a case of accelerated development, for in the eight largest shells also the bifurcation point of the primary ribs is often shifted inward, though not beyond the middle of the flanks.

The afore-mentioned shell number 67 is remarkable also for exhibiting on the venter, for the length of half a whorl, a series of 15 consecutive old apertural margins, in the shape of high trapezoidal tongues, with parabolic nodes on either side (pl. 22, fig. 50). Fewer pairs of parabolic nodes than in this individual are found in specimen number 74 (pl. 23, fig. 6), where quite heavy tubercles are formed on each shoulder by the reunion of two primary ribs each, and in the incomplete outer whorl number 75 (pl. 23, figs. 8, 9), where three pairs of such nodes have indistinct tongues representing resorbed apertural margins between them. The last specimen agrees perfectly with the holotype in both size and ornamentation (compare our figures quoted above with Noetling's figs. 7 and 7a).

In the largest disks present the prorsiradiateness of the ribs diminishes on the last volutions. Thus in number 81 (pl. 23, fig. 11) the ribs can be seen to fall back in direction behind those of the penultimate whorl, though less conspicuously than in *bernensis* and *trapezoidalis* (pp. 135, 140). In specimen number 79 the ribs of the outer whorl become not only radial in direction in the last quarter but also clearly recurved, borrowing as it were a feature characteristic of *Mirosphinctes*.

Suture lines are well observable in a great many individuals; only the best are here described and figured. At the earliest stage (no. 8, pl. 22, fig. 21), corresponding to a diameter of about 3.5 mm., the indentation is still slight, the siphonal lobe and median knob are broad, the triangular first lateral lobe is markedly shorter than the siphonal one, and the tops of all saddles hit about the same radius. The sutures are still about the same at diameters of about 4.5 mm. and 5 mm. in the juveniles numbers 19 and 16 (pl. 22, figs. 22–24), but at about the same diameter the difference in depth between first lateral and siphonal lobes begins to diminish in the juvenile number 6 and the first lateral saddle begins to overtop its neighbors, thus preparing the way for the formation of a "suspensive lobe" (pl. 22, fig. 26). Except for a gradual increase in indentation, the sutural situation remains about the same in the juveniles numbers 22, 27, and 28. In the first, the first auxiliary lobe already reaches a little farther down than the second lateral (pl. 22, fig. 31). The "suspensive lobe" is markedly more pronounced in specimen number 42 at a diameter of nearly 10 mm. (pl. 22, fig. 38). At about the same diameter in specimen number 17 the indentation has become richer than in all suture lines of this species so far discussed, with the median knob now clearly three-cusped and lateral secondary prongs developed on the terminal points of the siphonal lobe. The degree of indentation is a little less, or the same at best, in the last suture lines of specimen number 64 which correspond to a diameter of about 13 mm. and the siphonal lobes of which are illustrated (pl. 22, fig. 41). At the somewhat greater diameter of 17 mm. specimen number 68 exhibits a comparatively steep "suspensive lobe," with the first of three parallel, reclined auxiliary lobes reaching far beneath the lowermost point of the trifid second lateral (pl. 23, fig. 15).

The last stage of what may be termed the typical suture lines of this species can be studied best in specimens numbers 100 and 80. In the last suture line observable in the former, an unusually evolute shell, at a diameter of 21 mm. the first lateral lobe is short and rather slender. The following part of the suture line slopes steadily but gently towards the umbilical seam, with strikingly low and sturdy saddles and shallow, increasingly reclined lobes (pl. 22, fig. 47). The sutural characters just described could be considered individual peculiarities were it not for the fact that they are encountered also in the seven last suture lines of specimen number 80 at diameters of from 21 to 25 mm. (pl. 23, fig. 13), where also the siphonal lobe can be seen to be comparatively short. Thus the rather surprising conclusion is warranted that, whereas in *vicinus*, *hermonis*, *delicatulus*, and *bernensis* the latest sutural stage is characterized by rich indentation and by slender, high saddles and narrow, long lobes, the development is rather retrogressive in the present species, with the latest sutural stage resembling earlier ones of *bernensis*, characterized by low, sturdy saddles and wide, shallow lobes which lend the suture an altogether reduced aspect. The seven sutures of specimen number 80 just described are furthermore interesting for their arrangement. There are normal intervals between the last four; then follow two pairs of sutures telescoped into one another, with about the same interval between them. Thus growth seems to have continued after a temporary standstill, only to reach a definite one soon afterward.

The suture lines hitherto discussed, found in the great majority of the individuals of this species, are normal or typical. In not a few individuals the suture lines are much more elaborate and more or less closely resemble those of *P.* (*P.*) *delicatulus*, distinguished by florid, crowded sutures with tall saddles and deep lobes, both slender even at early ontogenetic stages (see pp. 156, 157). Specimens numbers 40, 58, 91, 61, 93, 65, 96, and 73, plus five unnumbered, show such suture lines, although on the strength of their shell shape, whorl profile, and costation they belong to *latilinguatus* rather than to *delicatulus*. This character of the sutures can well be recognized in specimen number 40 (pl. 22, figs. 35, 36); in the first of these figures the middle point of the first lateral lobe is three-pronged as early as at a diameter of a little more than 9 mm. The ventral view of specimen number 58 and the side view of number 61 (pl. 22, figs. 39, 40) give other good examples of such elaborate suture lines. The latest stage at which they can be observed in this species, at a diameter of about 21 mm., is present in specimen number 73 (pl. 22, fig. 48).

On the other hand, suture lines closely resembling those of *P.* (*P.*) *bernensis* are found, at a diameter of about 6 mm., in the juvenile number 21 (pl. 22, fig. 29).

REMARKS: This is the only *Properisphinctes* species previously recorded from Mount Hermon and even based on a specimen from there (Noetling's fig. 7). It might be well to point out that the specimen illustrated in Noetling's figure 8 is not conspecific and not even from Majdal Shams but from the Oxfordian of Besançon, France; de Loriol (1898, p. 83, pl. 6, figs. 7, 8) established his *Perisphinctes noetlingi* on this specimen. The latter species appears not even to be referable to the same subgenus as the present one, but is referred by Arkell (1936, p. xliii) to *Alligaticeras*.[1] On the other hand, Mt. Hermon specimens of what are here considered different species seem to be included among the "rather many" referred to *latilinguatus* by Noetling. The "almost spherical, deeply umbilicate conchs" measuring about 5 mm. in diameter are certainly juveniles of *bernensis* but not of *latilinguatus;* those of the latter species are quite different at that size (see pl. 22, figs. 25–27). On the other hand, some of the specimens referred to *bernensis* by de Loriol (1900, pl. 4, figs. 23–26) seem to belong to *latilinguatus* (above, p. 137).

Within the present assemblage this species can readily be distinguished from *P.* (*P.*) *bernensis* by being never tumid in an early stage and by being less stout and more evolute throughout development. Its whorl profile is not so rounded as that of *bernensis* but has always pronounced lateroventral shoulders which separate a truncate venter from parallel, only gently convex flanks. The juveniles of *bernensis* in addition have a finer costation, with individual ribs more curved and more prorsiradiate. Also the constrictions as a rule are less deep and wide than in *bernensis* so that triangular (or otherwise deformed) umbilici occur only exceptionally in the present species. Up to a medium size its suture lines are not so reduced as those of *bernensis* and do not have such low saddles and shallow lobes. Later in ontogeny, however, this relation seems to be reversed.

Distinction of this species from *P.* (*P.*) *vicinus* is not so easy, especially in early stages. However, the latter is less evolute as early as at a diameter of 6 mm., and costation appears somewhat later than in *latilinguatus*. In maturity it remains more regular and dense in *vicinus*, and the individual ribs are more decidedly forward concave. Parabolic nodes are extremely rare in *vicinus*, but not in the present species. Finally, sutures tend

[1] Under these circumstances the inclusion by Arkell (1939, p. 160) of Noetling's figure 8 as well as his figure 7 in the synonymy of *P.* (*P.*) *latilinguatus* must be owing to an oversight.

to be more elaborate in *vicinus* than at a corresponding stage in *latilinguatus*.

Perisphinctes (*P.*) *latilinguatus* is compared above with *P.* (*P.*) *trapezoidalis* and *P.* (*P.*) *radiocostatus* (pp. 141, 138). For comparison with *P.* (*P.*) *hermonis* and *delicatulus*, see the discussions of those species.

MATERIAL STUDIED: About 265 specimens, including 15 that are poorly preserved and about 80 whorl fragments.

Perisphinctes (Properisphinctes) hermonis,
new species
Plate 23, figures 16–42

?*Perisphinctes curvicosta* Oppel sp.; NOETLING, 1887, p. 27, *non* pl. 4, fig. 6.

DIMENSIONS

A.M.N.H. No. 27838	D	H	H′	W	U
1	3.79 mm.	38	30	62	35
2	4.10 mm.	35	27½	60	43½
3	4.10 mm.	33½	ca. 25	57½	43½
4	4.36 mm.	36½	28	55½	39
29	4.71 mm.	34	24	58½	41½
5	4.82 mm.	34	30	61½	40½
6	4.82 mm.	38½	25½	64	38½
7	4.92 mm.	37½	29	58½	38½
8	5.02 mm.	36½	30½	57	39
9	5.12 mm.	36	30	60	40
10	5.33 mm.	37½	29	56½	38½
11	5.74 mm.	37½	27	53½	35½
12	6.04 mm.	32	22	54	40½
13	6.66 mm.	34	23	47½	40
14	6.66 mm.	37½	29	54	36
40	6.66 mm.	34	27½	63	37
15	6.66 mm.	37	22½	57	38½
16	6.87 mm.	38	27	61	39½
17	7.17 mm.	40	28½	61½	37
18	7.17 mm.	34½	27	50	40
41	7.38 mm.	33½	22	57½	40½
19	7.58 mm.	32½	27	52½	42
20	7.69 mm.	33½	26½	53½	38½
21	7.89 mm.	34	28½	49½	39
22	7.89 mm.	37½	30	53	37½
33	8.30 mm.	28	22	55½	42½
42	8.51 mm.	29	21½	57	42
23	8.81 mm.	33½	23	55	40½
24	9.22 mm.	33½	24½	56½	41
45	9.22 mm.	32	22	52	43½
43	9.33 mm.	37½	29½	59½	35
25	9.53 mm.	38½	27	55	34½
34	9.53 mm.	32½	23	50½	42
44	9.63 mm.	41½	23½	50	36
46	9.63 mm.	37	ca. 26½	55½	36
39	10.25 mm.	34	25	ca. 52	44
26	10.35 mm.	32½	25	52	40½
36	10.45 mm.	35½[1]	?	ca. 50[1]	40½[1]
47	11.07 mm.	33½	24	52	34½

[1] Measured at D=10.15 mm.

A.M.N.H. No. 27838	D	H	H′	W	U
35	11.17 mm.	34	27½	48	42½
48	12.25 mm.	33½	?	56	43½
27	12.61 mm.	31½	?	44	42½
28	12.81 mm.	36	ca. 30½	47	40
37[2]	19.4 mm.	32	?	40	55½
38	20.7 mm.	31½	ca. 28	42½	49
30 (holotype)	29.6 mm.	36	?	39	41

The gap appearing in the above table between numbers 28 and 37 is bridged by two specimens (nos. 31, 32), which measure in diameter about 17 mm. and 18.3 mm., respectively, but are unfit for accurate measurement.

The six largest measured specimens show a clear trend of W to decrease in maturity. Specimens numbers 37 and 38 also have much wider umbilici than those measured at earlier stages, reaching their maximum in specimen 37 which is somewhat transitional to *P.* (*P.*) *latilinguatus* in shell shape. Below the diameter of 11.25 mm., however, W does not fall below 47½ and U varies between 34½ and 44. Contrary to expectation, the lower of these limits for U is found among the largest of the individuals concerned (nos. 25, 47) and the upper among the smallest (nos. 2, 3). Similarly, values for W between 60 and 63 are found among the smallest individuals (nos. 12, 5, 9) as well as in markedly larger ones (nos. 40, 16, 17). H varies, within a similarly narrow range, from 28 to 41½, but the figures for H are inconclusive, as values between 31½ and 38½ are found in specimens of any size.

In the three largest specimens (nos. 30–32) the last septum is situated at diameters of from 10.5 mm. to 14 mm., in the holotype, in particular, at a diameter of about 12 mm. All the outer whorl (of which only the anterior half is preserved) of the holotype belongs to the body chamber which must have occupied at least a full volution. Thus the maximum size reached by this species within the present material may be estimated at from 35 mm. to 40 mm. It must be considered a small species, as are most *Properisphinctes*.

DESIGNATION OF TYPE: The largest specimen present (A.M.N.H. No. 27838:30) is designated holotype.

[2] Transitional to *P.* (*P.*) *latilinguatus*.

DESCRIPTION: Shell rather stout and as a rule only moderately evolute. The development of the whorl profile through earliest and early stages up to a diameter of 11.5 mm., from reniform through transversely elliptic to transversely subrectangular, is illustrated best by the natural cross sections of paratypes numbers 49 and 50 and by the frontal view of paratype number 8 (figs. 28, 36, 26). The last serves in other respects also as a good example of a still entirely smooth juvenile of this species (figs. 24–26). In the course of development the broad, gently arched venter, separated by distinct, though rounded shoulders from the low, parallel flanks, becomes more and more distinctive of the whorl profile (paratypes no. 24, fig. 32, and no. 28). These features persist into the latest stage, represented by the holotype in which the whorl profile, owing to the decrease of the relative whorl width, approaches a subquadratic shape (fig. 39).

The first constriction appears in paratype number 3 (fig. 16) as early as at a diameter of about 3.5 mm.; here it is still restricted to the sides. In paratype number 24, however, a deep and rather wide constriction, bounded by a varix on the orad side, crosses the venter at a diameter of about 5.5 mm. in a gentle, forward convex arc (fig. 32). In the holotype three constrictions each are present on the antepenultimate and penultimate volutions but only one on the preserved anterior half of the last, which belongs to the body chamber. In most of the smaller individuals the number of constrictions is also three per whorl, occasionally four (paratypes 35 and 31, figs. 27, 41).

No siphonal groove has been observed in this species, but there is sometimes an indication of a siphonal band, e.g., in paratypes 24 (fig. 30) and 28.

Costae appear in paratype 14 at a diameter of 5.75 mm. They are restricted to the sides, but here they are well developed and decidedly prorsiradiate from the outset. There are seven on one-sixth of a whorl (fig. 22). In the course of further development the ribs become rather coarse, markedly curved, and even more distinctly prorsiradiate. Paratypes 23, 24, and 39 (figs. 21, 31, 33), with diameters between 8.75 mm. and 10.25 mm., are good examples of this stage of ornamentation. The ribs number 18, 16, and 16, respectively, on the flanks of their last half-whorls. Only in the last-mentioned specimen do secondary ribs, at a diameter of about 9 mm., begin to show indistinctly on the venter. From a diameter of 7.5 mm. on, they are much better visible and very regular all around the periphery of paratype number 28, where they originate by bifurcation of the primary ribs on, or somewhat inside of, the outer shoulder. In crossing the venter they form an extremely shallow forward sinus. On the sides of this individual the costation, otherwise similar, is markedly denser and finer than just described, there being 24 ribs on the last half whorl (fig. 35). The latest ornamentational stage can best be studied in paratypes 31 and 38 and in the holotype (figs. 41, 42, 38). The ribs are still prorsiradiate but less coarse than at earlier stages. The point of bifurcation shifts somewhat dorsad so that the innermost portions of the secondary ribs are now visible in side view. In contradistinction from other species of this subgenus the absolute density of the costation does not diminish and the number of ribs therefore increases in maturity. Thirteen primary ribs per quarter whorl are counted in paratype 31, 22 per half-whorl in paratype 38, and 27 per half-whorl on the outer volution of the holotype (as compared to 20 on the penultimate one). This gives rib counts of 52, 44, and 54, respectively, for a full whorl, as compared to an average of 35 at earlier stages (if the exceptionally densely ribbed paratype 28 is left out of account). Whereas the absolute density of the costation thus does not diminish in the latest ontogenetic stage of this species, the degree of prorsiradiateness does, as seen from the fact that in the holotype (fig. 38) the ribs of the outer whorl fall slightly back in direction behind those of the penultimate one, though not to the same extent as in *bernensis* or *trapezoidalis*. No parabolic nodes have been recognized in this species.

The earliest sutures observable are present in paratype 3 at a diameter of about 2.5 mm. (fig. 17). They differ from similarly early sutures of related species chiefly in that the external saddle is not quite so wide. Division of this saddle by a tiny lobule is indicated, but the lateral saddle is still entire. Between these saddles is a comparatively deep first lateral lobe, with just an indication of being three-pronged. It is followed by a quite high lateral saddle, a triangular lobe riding on the umbilical shoulder and, after a low auxiliary saddle, a shallow auxiliary lobe right at the umbilical seam. Even at this early stage both first lateral lobes are entirely visible if the suture line is viewed ventrally. This holds true for the excellent suture lines, corresponding to diameters of about 4 mm., observable in both paratype 17 and the whorl fragment number 20 (figs. 19, 20, 18). Viewed the same way, they exhibit not only the first lateral lobes but beyond them the lateral saddles in their entirety. This unusual aspect is accounted for not only by the extraordinary width of the venter of this species, pointed out above in this description, but also by the fact that the external saddle is less wide than in related species. The latter feature is more noticeable in paratype 17 (fig. 19) than in paratype 20 (fig. 18). Other characteristics of these suture lines are the low and wide, rectangular median knob and the low degree of inclination of the first lateral lobe towards the median line. For this early stage the indentation is comparatively rich. The lobules dividing the external saddles are no longer so small and markedly deeper than those dividing the lateral saddles, and both first and second lateral lobes are now clearly trifid. The tops of both main saddles hit the same radius. A "suspensive lobe," if in the making, is not yet recognizable. The well-preserved suture lines of paratypes 29, 7, 12, 14, 15, 41, 48, and of nine others without numbers, corresponding to diameters of from about 3 mm. to nearly 9 mm., so closely resemble those just discussed, except for a slow and steady increase of indentation with growth, that they are not separately described or illustrated. Paratype number 40 (fig. 23), however, stands out by being unusually richly indented for its diameter of only 6.66 mm. Here a "suspensive lobe" begins to form, with the strongly reclined first auxiliary lobe reaching down to the same radius as the second lateral, if not beneath. In paratype 33, although it is septate throughout to its maximum diameter of 10.25 mm., the degree of indentation is not much higher, except that here the median knob has become more slender, trapezoidal, and deeply concave at the top. This suture line is further remarkable for a strong deflection ventrad of the first lateral lobe, and an even stronger one of the second (fig. 29). The suture lines of paratype 39 are very similar, as are those of paratype 28 at a diameter of only 7.5 mm. (fig. 34). The largest paratype (no. 38), however, exhibits in the suture line that is best visible, corresponding to a diameter of about 12 mm., a much higher degree of elaboration, reminiscent of the florid sutures of *P.* (*P.*) *delicatulus*. Especially noticeable are the depth and narrowness of the siphonal lobe, which is divided by a high and slender, three-cusped median knob, and the fact that the slender external saddle is further straitened somewhat below the middle of its height by the lowermost lateral point of the siphonal lobe from one side and by the outer main point of the first lateral lobe from the other. Both these features appear to be exaggerated, as it were, in the best suture line recognizable on the penultimate whorl of the holotype, although it corresponds to a diameter of only about 9.5 mm. (fig. 40). Here the first lateral lobe equals the siphonal one in depth, and the external saddle is reduced to a thin stalk[1] more than it ever is in *delicatulus;* the degree of indentation reached in the latter is fully matched by this suture line. In elaboration, it is inferior to no other *Properisphinctes* suture found in the present assemblage. As this happens at such an early stage, it may represent a case of accelerated sutural development. The "suspensive lobe" of this line slopes only gently towards the umbilical seam.

REMARKS: From Noetling's 1887 monograph no reliable picture of the single specimen described by him as *Perisphinctes curvicosta* Oppel can be gained. For it must be kept in mind that his figures 6, 6a–c, do not illustrate that specimen but one from the Brown Jura ζ of Lautlingen, Swabia. Oppel's species is nothing but a new name (1857, p. 555) proposed for Quenstedt's figure 2 of plate 13 (1849), which seems to suggest a

[1] A similar case, affecting the lateral saddle, can be seen in a *Cymatosphinctes* suture illustrated by Arkell (1935, pl. A, fig. 2), though at an incomparably larger scale.

Mirosphinctes rather than a *Properisphinctes*, whereas the Lautlingen specimen figured by Noetling, to judge by its costation and constrictions, may be a *Properisphinctes*. Under the circumstances guidance as to Noetling's Mount Hermon specimen can be expected solely from his description. Some of its passages, especially those concerned with costation and constrictions, seem to agree with our own observations on the present species; others do not but may be reconciled with them. Thus the whorls may become thinner than high only beyond the maximum diameter of about 30 mm. measured in our hypodigm, Noetling's specimen attaining one of 38 mm.; also the four pairs of parabolic nodes are stated to appear only on its last half-whorl which would just about correspond to the difference between those two diameters. For these reasons Noetling's specimen is doubtfully listed above as a synonym of the present species.

Perisphinctes (*P.*) *hermonis* differs from all the *Properisphinctes* species from Majdal Shams hitherto dealt with in the present report by the broad venter, the robust costation, of which the absolute density does not diminish in maturity, and by the peculiarities of the sutures, as pointed out above. It is compared with *P.* (*P.*) *delicatulus* below (p. 152).

MATERIAL STUDIED: Altogether 120 specimens, including fragments.

Perisphinctes (Properisphinctes) delicatulus,
new species

Plate 23, figures 43–60; plate 24, figures 1–18

DIMENSIONS

A.M.N.H. No. 27842	D	H	H′	W	U
1	4.20 mm.	35½	26	54½	43
70	4.30 mm.	30	21½	51	43
2	4.92 mm.	31½	23	58½	43½
3	5.02 mm.	36½	30½	59	36½
4	5.02 mm.	36½	27½	55	38½
5	5.12 mm.	37	29	53	38
6	5.33 mm.	35½	29	50	40½
7	5.64 mm.	40	27½	57½	34½
8	5.84 mm.	35	26½	54½	40½
9	5.84 mm.	37	30	44	38½
10	5.94 mm.	33	27½	57	40½
11	5.94 mm.	29½	22½	46½	43
12	6.25 mm.	37½	29½	53½	37½
13	6.56 mm.	33	25	50	40½
14	6.66 mm.	32½	24	51	41
15	6.76 mm.	38	30½	47	38
16	6.87 mm.	35	27	47½	40½
65	7.07 mm.	35	27½	46½	40
17	7.17 mm.	35½	28½	48½	39½
18	7.17 mm.	33	27	*ca.* 40	43
23	7.38 mm.	32	23½	47½	46
19	7.48 mm.	34	27½	48	40½
20	7.58 mm.	38	32½	44½	42
71	7.69 mm.	33½	26½	53½	38½
21	7.69 mm.	40	*ca.* 32	*ca.* 46½	36
25	7.69 mm.	37½	29½	46½	40
22	7.99 mm.	34½	28	45	41
24	7.99 mm.	34½	25½	39	41
26	7.99 mm.	34	22	47½	37
27	8.20 mm.	39	30½	50	37½
28	8.20 mm.	32½	?	43½	42½
29	8.20 mm.	30½	23½	47	42½
30	8.20 mm.	37½	29	45	38½
31	8.40 mm.	35½	?	?58½	39
32	8.51 mm.	35	26½	48	42½
33[1]	8.61 mm.	33½	26	46½	38
34	8.71 mm.	34	26½	44½	41
66	8.81 mm.	38½	23½	52½	33½
35	8.92 mm.	34½	29	51½	39
36	9.12 mm.	37	29	49½	37½
37	9.22 mm.	33	25	45½	43
38	9.33 mm.	33	27½	43	44
39	9.43 mm.	31½	?	39	43½
40[2]	9.63 mm.	36	28½	49	40½
44[2]	9.63 mm.	31	24½	48½	42½
67	9.63 mm.	36	?	53	38½
68	9.74 mm.	36	22	48½	33½
41	9.83 mm.	39½	32½	45	37½
42	10.15 mm.	34½	28½	37½	36½
43	10.25 mm.	32	26	37	44
45[3]	10.25 mm.	33	25	48	41
46	10.25 mm.	30	?	42	48
47	10.25 mm.	31	27	44	47
48	10.76 mm.	34½	25½	45	40
49	10.86 mm.	35	29½	42½	42½
50	10.97 mm.	33½	28	38½	45
69	11.07 mm.	41½	30½	53	31½
51	11.27 mm.	32	*ca.* 27½	46½	44½
52	11.79 mm.	34	26	45	42
53[1]	11.99 mm.	36	25½	35	46
54	12.40 mm.	33	29	38	42
55	12.61 mm.	33½	27	40½	40
56	12.91 mm.	31½	26	43	43
57	13.43 mm.	34½	30½	39	40½
58	14.04 mm.	31½	?	37	43
59	15.0 mm.	33½	28	41½	47½
60	15.1 mm.	34	26½	*ca.* 36	45½
61	15.4 mm.	30	?	40	44
62	18.4 mm.	32	24½	39	46
63 (holotype)	24.1 mm.	32	28	30½	45½

[1] Sutures transitional to *P.* (*P.*) *latilinguatus*.
[2] Transitional to *P.* (*P.*) *hermonis*.
[3] Sutures transitional to *P.* (*P.*) *hermonis*.

A single whorl fragment (no. 64) represents a somewhat larger size than the holotype; it may correspond to a diameter of nearly 30 mm.

This species exhibits the same growth trends as *P.* (*P.*) *latilinguatus;* H and W tend to decrease and U tends to increase in the course of development. Accordingly the greatest widths are found among the smallest measured shells and the largest (holotype) is also the thinnest. The narrowest umbilicus occurs in a medium-sized individual (no. 69) and the widest ones are found towards and at the bottom of the table, but the maximum for U is encountered also in a medium-sized shell (no. 46). H varies comparatively little, between 30 and 41½ only, with its minimum occurring at a diameter of about 6 mm. and its maximum at one of about 11 mm. However, no value for H higher than 34½ is encountered above the size of 12 mm.

In this species, too, the whorls are considerably wider than high at early and medium growth stages; in some of the largest individuals measured (nos. 57, 60) W approaches H but it becomes smaller than H only in the holotype.

Both the holotype and the fragment of a somewhat larger disk (no. 64) are septate throughout. Thus, if about one and one-quarter volutions are allowed for the body chamber, this species must have reached at least a full size of from 40 mm. to 45 mm. It may, therefore, be estimated to have been of nearly the same size as *P.* (*P.*) *latilinguatus.*

Designation of Type: The largest measured specimen (A.M.N.H. No. 27842:63) is designated holotype.

Description: Shell moderately evolute and comparatively slender except at the earliest stages. The whorl section changes in the course of development from reniform (paratype, 8, pl. 23, fig. 43) or transversely elliptic (paratype 12, pl. 23, fig. 44) to broad-oval (paratypes 22, 43; pl. 23, fig. 47; pl. 24, fig. 1) or subcircular (paratype 53, pl. 24, fig. 10) and eventually to oval (paratype 61 and holotype, pl. 24, figs. 15, 18). Some shells, such as paratypes 48 and 59 (pl. 24, figs. 5, 11), are somewhat wider in profile, thus approaching *P.* (*P.*) *latilinguatus* in this respect, but always the profile tapers ventrad; there are no distinct lateroventral shoulders, the venter is never truncate but always well rounded, widely in the young and in the thicker medium-sized shells but narrowly in maturity, and the flanks are flat or nearly so.

Constrictions appear as early as at a diameter of 3 mm. in paratype 2 (pl. 23, figs. 53, 54). They are prorsiradiate and almost straight on the sides but cross the venter in a gently forward convex arc. In the same paratype a varix, both preceded and followed by shallow constrictions, is present at a diameter of 4.5 mm. (pl. 23, fig. 54). Even at this extremely small size there are three constrictions per whorl, one of which is double. Their number increases rapidly with growth, up to as many as five (paratype 47, pl. 24, fig. 6), six (penultimate whorl of holotype; pl. 24, fig. 17), or even seven (paratypes 38, 42; pl. 23, figs. 60, 56) per whorl, until a medium size is reached, then rapidly decreases again; only three are counted in the outer volution of the holotype. They are, however, narrow and as a rule[1] shallow in this species, sometimes hardly perceptible. Their course exactly parallels that of the ribs.

In some specimens, e.g., in paratype 61 and in the holotype (pl. 24, figs. 13, 15, 16, 18), a smooth siphonal band is present; in the posteriormost quarter of the outer whorl of the holotype it changes to an extremely shallow groove.

One of the outstanding characteristics of this species is the comparatively late appearance of the costation. It is true that in a few individuals, e.g., paratype 20, delicate ribs can be recognized as early as at a diameter of somewhat less than 6 mm. and in a greater number of shells, as in paratypes 22 (pl. 23, fig. 46), 24, and 25, at diameters between 7 mm. and 7.5 mm., but many shells, e.g., paratypes 38 and 42 (pl. 23, figs. 60, 56), remain smooth until diameters of 9 mm. or even 10 mm. are reached. Even when finally appearing in such shells, the ornamentation consists at first of scattered, indistinct radial folds rather than being a continuous costation. Where the latter is present, it remains throughout development fine, dense, uniform, and decidedly prorsiradiate. The individual ribs are only gently curved at early and medium growth stages and become straight later. Simultaneously, the point of

[1] Paratypes 47, 48, and 53 (pl. 24, figs. 3–10) have exceptionally deep constrictions.

bifurcation of the primary ribs, situated at first on or near the outer shoulder, moves dorsad so that in the largest shells (e.g., paratype 61, pl. 24, fig. 14) the innermost parts of the secondary ribs become visible in side view. These secondary ribs appear only at a diameter of about 10 mm. or more and remain delicate to the end. From 48 to about 70 primary costae are counted per volution, the number increasing with growth, as the absolute density of the costation remains undimished in maturity. Paratype 59 (pl. 24, fig. 12), somewhat transitional to *P.* (*P.*) *latilinguatus* also in shell shape and whorl profile, stands out by having heavier and less dense costation, with only 42 ribs on the outer whorl.

The suture lines of this species are, as a rule, much more elaborate and also more closely set than those of other *Properisphinctes* species. Both these characters are already quite pronounced in the juvenile number 5 of which the suture lines are visible in side view (pl. 23, fig. 51) at diameters of from 2.5 mm. to a little more than 5 mm. and in ventral view (pl. 23, fig. 52) at diameters averaging 4 mm. Even at this early stage the main lobes are comparatively deep and narrow, and the main saddles slender and tall. The terminal points of the siphonal lobe are drawn out and tend to assume the shape of a club, the first lateral lobe equals the siphonal one in length, and a "suspensive lobe" begins to form. A higher degree of indentation can be recognized in paratypes 16 and 17 at diameters of about 7 mm. (pl. 23, figs. 55, 49, 50). In the former the terminal points of the siphonal lobe have acquired secondary prongs on the outer sides. In the latter the median knob separating these points has become quite tall and slender, secondary prongs appear on both sides of the middle points of the first lateral lobes also, and the "suspensive lobe" is now more distinct. The crowding of the sutures is particularly well seen in this individual. The sutures are again a little more florid at diameters of about 8 mm. in paratype 28 and in the whorl fragment number 72 (pl. 23, fig. 57), and in paratype 36 at a diameter of about 9 mm. (pl. 23, figs. 58, 59). In the latter individual the "suspensive lobe" appears fully developed, with both second lateral and first auxiliary lobes strongly reclined and the latter reaching markedly farther down than the former. The external saddle begins to be pinched at its lower third by the outer point of the first lateral lobe from one side and by the lowermost lateral point of the siphonal lobe from the other. It is seen to be straitened even more in specimen number 73 at about the same diameter (pl. 23, fig. 48). Paratypes 51, 54, and 60, attaining diameters of 11.25, 12.4, and 15 mm., respectively, exhibit further increases in the degree of indentation. An even higher one can be recognized in paratype 61 (pl. 24, figs. 13–15) where the afore-mentioned "lacing" of the main stem of the external saddle seems to attain its maximum within the present species, but not at all to the degree reported above (p. 148) for the penultimate whorl of the holotype of *P.* (*P.*) *hermonis* at only about half of the size. Floridity of the suture line on the whole reaches its peak in the holotype, as is to be expected as it is septate up to its maximum diameter of about 24 mm. Unfortunately the surface is somewhat corroded, but sutural details can well be seen in some places (pl. 24, figs. 16, 17). Only a few, all illustrating the high degree of elaboration, need be mentioned. The terminal points of the siphonal lobe and the middle point of the first lateral lobe now carry three, and the lateral points of the latter two, pairs of secondary prongs each, as does the extremely narrow main lobule of the external saddle which attains almost half of the depth of the siphonal lobe. The middle point of the first lateral lobe even exceeds its undivided stem in length (cf. *bernensis*, p. 136). The "suspensive lobe" slopes steadily, though not very steeply, to the umbilical seam, with the second lateral and three auxiliary lobes increasingly reclined and their points aligned one below the other. Altogether this suture line represents by far the highest degree of elaboration of any *Properisphinctes* in the Mount Hermon fauna, if not in the subgenus as such.

The sutures of specimen number 74 are worth mentioning for their asymmetry: Whereas the first lateral lobes are almost normal on the left side, they are badly stunted on the right to the extent that they hardly exceed the lobules of the external saddles in depth.

The sutural characters described above prevail in the vast majority of individuals of this species. Some, however, are transitional in their suture lines to related species, e.g. paratypes 33 and 53 (fig. 9) to *P.* (*P.*) *latilinguatus* and paratypes 40, 44, and 45 to *P.* (*P.*) *hermonis*, although their shell shape and ornamentation clearly refer them to *delicatulus*.

REMARKS: The whorl section, becoming slender, with a narrowly rounded venter, in maturity, the greater number of constrictions which are, however, neither deep nor wide, the late appearance, density, and delicacy of the costation, and the luxuriously indented and crowded suture lines clearly distinguish this species from the other *Properisphinctes* occurring at Majdal Shams, even from *latilinguatus* and *hermonis* which it otherwise resembles.

Perisphinctes (*Alligaticeras*) *pseudogracio-sus* Arkell (1939, p. 161, *cum synon.*, pl. 9, fig. 12) has similarly florid sutures at an early stage, but more robust ribbing and apparently fewer constrictions.

The homeomorphy that sometimes occurs between juveniles of this species and those of *Sowerbyceras helios* is discussed above (p. 26).

MATERIAL STUDIED: Altogether 244 specimens, including fragments.

MIROSPHINCTES SCHINDEWOLF, 1926

The distinctive characters of this genus can be deduced from Bukowski's (1887, p. 151, pl. 28, figs. 8, 9) description and illustrations of his *Perisphinctes mirus*,[1] designated its type species by Schindewolf (1926, p. 501). However, the present material, containing hundreds of individuals referable to *Mirosphinctes* and even larger numbers of other perisphinctids, offers an excellent opportunity for summarizing the following peculiar features that distinguish *Miroshinctes* from other perisphinctids, particularly of the subgenus *Properisphinctes* of *Perisphinctes, sensu lato:*

1. The rare occurrence of constrictions which are never so numerous and deep and, except for those occurring near the anterior end and believed to indicate the vicinity of the aperture, so wide as they are in *Properisphinctes*.

2. Except at the earliest stages, the peculiarly recurved ribs and the moving apart of the primary ribs in maturity, with frequent intercalation of more than one, and up to five or six, secondary ribs.

3. Certain peculiarities of the suture line, especially the development of the first lateral saddle which becomes very wide and symmetrically bifid but remains low at later stages of development, the more or less even ceiling of all saddles, and chiefly the fact that all lobes point backward in a spiral sense and that there is no "suspensive lobe."[2]

All these differences taken together seem to justify generic separation of *Mirosphinctes* from *Perisphinctes, sensu lato.*

In the sutural and some ornamentational characters, which are pointed out in the descriptions of the species that follow, *Mirosphinctes* is clearly transitional from the perisphinctids to certain *Aspidoceras*, mostly to the group of *Euaspidoceras perisphinctoides* (below, p. 165). Especially are the sutures of these two groups hardly distinguishable at corresponding sizes,[3] and juveniles are altogether indistinguishable, except for certain peculiarities of the whorl section. Only in maturity do considerable differences in both whorl profile and ornamentation widely separate these two groups.[4]

[1] The specimen illustrated in Bukowski's figure 8 is here designated lectotype of *M. mirus*.

[2] This last difference is pointed out by Maire (1932, p. 46) also with the words, "La ligne suturale des cloisons n'est pas récurrente dans sa partie ombilicale," relating to the suture line of *M. kobyi*. Maire thus attempted to prove that *kobyi* must be considered an aspidoceratid but not a perisphinctid. He was not aware of the existence of undoubted perisphinctids, namely, those of the genus *Mirosphinctes*, to which this negative character equally applies.

[3] Collot (1917, p. 7) states, with Maire's (1932, p. 41) approval, regarding the sutures of *A.* (*E.*) *perisphinctoides* and of closely related forms: "D'ailleurs la forme carrée de la première selle, la tendance de la ligne suturale à se porter en avant, en approchant de l'ombilic, au lieu d'être décurrente [this passage indicating the absence of a suspensive lobe], indique bien . . . , qu'il s'agit d'*Aspidoceras* et non de *Perisphinctes*." These sutural characters certainly help to distinguish the *Euaspidoceras* concerned from true *Perisphinctes, sensu lato*, but are of no value in separating *Euaspidoceras* from *Mirosphinctes*, of the existence of which Collot was no more aware than was Maire when he wrote the passage quoted in the preceding footnote.

[4] For a possible proterogenetic interpretation of the occurrence of a *perisphinctoides*-like ornamentation at certain stages of some *Mirosphinctes* species, followed by an abrupt change to a typical *Mirosphinctes* ornamentation on the body chambers of mature individuals, see page 196.

On cursory examination of the material from Majdal Shams, this genus appeared to be almost as abundant as *Properisphinctes*, but only owing to the much larger proportion of medium- and large-sized individuals in the *Mirosphinctes* populations, whereas small juveniles contribute by far the greatest number of individuals of *Properisphinctes*. As a matter of fact, the total of *Mirosphinctes* specimens is only about 475, as compared to about 1325 for the subgenus *Properisphinctes* and about 1460 for the whole genus *Perisphinctes, sensu lato.*

This genus is represented in the present assemblage by two closely related species already recorded by Noetling (the second as a variety only), *M. syriacus* and *M. regularis*, and in addition by the rare and small *M. kobyi* de Loriol.

Mirosphinctes syriacus (Noetling)

Plate 24, figures 19–45; plate 25, figures 1–13

Peltoceras syriacum sp. n.; NOETLING, 1887, p. 31, *cum synon.*, *pro parte*, pl. 5, figs. 3, 5, 8; *non* figs. 6, 7.

Peltoceras dubium sp. n.; NOETLING, 1887, p. 32, pl. 5, fig. 9.

Peltoceras syriacum Noetl.; FREBOLD, 1928, p. 191.

Peltoceras dubium Noetl.; FREBOLD, 1928, p. 191.

DIMENSIONS

A.M.N.H. No. 27760	D	H	H′	W	U
1	4.8 mm.	33½	32½	55	37
2	5.4 mm.	35½	29	54	37½
3	5.6 mm.	36	30	58	38
8	5.7 mm.	35½	27½	53	39
57	6.4 mm.	40½	30	59½	33½
70	6.6 mm.	35½	30½	57½	37½
96	6.7 mm.	38½	31½	53½	33½
72	7.0 mm.	33	29	53	39½
73	7.1 mm.	31½	?	47½	43
5[1]	7.1 mm.	31½	27	41½	47½
74	7.4 mm.	35	29	51½	38
78	7.4 mm.	35½	*ca.* 29½	56	39½
75	7.6 mm.	37	*ca.* 29½	57½	36
76	8.1 mm.	39	32½	58½	33½
77	8.1 mm.	34½	?	55½	39
11	8.3 mm.	39	?	47½	38
79	8.3 mm.	37	*ca.* 32½	52½	36½
81	8.4 mm.	40	*ca.* 32	54½	33½
82	8.4 mm.	37½	32	52	34
83	9.0 mm.	40	32½	47½	35
14	9.2 mm.	39	36½	53½	36½
84	9.4 mm.	40½	31	50	35½
89	9.4 mm.	37	?	53½	35½
15	9.5 mm.	35	32	44½	37½
85	9.6 mm.	42	?	58	33½
86	9.6 mm.	36	31½	53½	36
87	9.9 mm.	40	35	54½	34
88	9.9 mm.	34	29½	54½	41
90	9.9 mm.	37	31½	56	38
18	10.4 mm.	36½	?	54	41
25	10.8 mm.	40½	?	*ca.* 52	36½
68	11.2 mm.	36	?	51	39
26	11.6 mm.	34	?	*ca.* 43½	38½
91	11.6 mm.	38½	32	46½	43½
19	11.8 mm.	36	33½	50½	35
20	12.1 mm.	35	32½	48	33½
21	12.2 mm.	39½	35	49½	40½
27	13.1 mm.	37½	35	*ca.* 51½	33
22	13.2 mm.	35½	34	51	39
92	13.2 mm.	40	36½	*ca.* 51	37½
93	13.4 mm.	41	?	53	40½
28	13.7 mm.	36	?	*ca.* 45	39
31	14.0 mm.	36	?	51	40
29	14.2 mm.	36½	30	51	35½
95	14.5 mm.	39½	*ca.* 31½	51½	33
64	15.1 mm.	38½	*ca.* 33	*ca.* 39½	36
34	15.7 mm.	42	35	*ca.* 50	35½
69	15.8 mm.	37½	31½	49½	38½
46	18.0 mm.	40	33½	41½	36
37	20.0 mm.	36½	32½	42	35½
40	20.6 mm.	41½	34½	45	38½
4	21.6 mm.	*ca.* 30½	?	35½	42
41	23.1 mm.	42½	?	43	36
44	24.4 mm.	40	36½	39	39
6	25.0 mm.	43	32½	41	36½
48	25.2 mm.	40	?	35½	39½
51	25.9 mm.	39½	?	34½	40
9	27.6 mm.	*ca.* 34½	?	37	36½
53	29.0 mm.	34½	?	32½	43
56	30.0 mm.	43½	33½	37½	37½
60	34.4 mm.	38	?	27½	45
61	35.6 mm.	40	?	34	39½
62	36.3 mm.	36	*ca.* 25	32	45
63	39.1 mm.	34½	?	37	39
65	45.7 mm.	32	26½	25½[2]	44
66	47.2 mm.	37	?	29[3]	39½
67	48.6 mm.	34½	?	27½	41
68	48.7 mm.	37	?	26	*ca.* 42
59	49.4 mm.	38	?	*ca.* 30½	39½
50	54.3 mm.	36	?	?[4]	43½

[1] Conspecificity doubtful.

The last measured specimen is the largest of the species and of the genus *Mirosphinctes* but is not complete.

The only trend that can unequivocally be deduced from the above table is that the

[2] Slightly crushed.

[3] Measured about one-eighth of a whorl behind anterior end.

[4] Crushed.

width of the shells decreases with growth. Whereas values of from 53 to 59½ for W predominate up to a diameter of 10.4 mm., this dimension comes down to from 25½ to 30½ in five among the six largest disks in which W could be measured. The sixth is crushed. Between these extremes the decrease of W is more or less steady, but some shells (nos. 26, 64, 46, 4, 44, and 48) tend to be more slender than others representing the same growth stage. Specimen number 5, however, is not only unusually thin but also very evolute for its size so that its conspecificity becomes doubtful.

Another recognizable, though less pronounced trend is that of the umbilicus to become wider in maturity. If the doubtful specimen number 5, just mentioned, in which U attains 47½ is left out of consideration, the highest values for U, namely, 43½, 44, and 45, are found in four among the 10 largest measured shells. The minimum for U (33), however, is not encountered at the top of the table, as might be expected, but at about the middle at diameters of 13.1 mm. and 14.5 mm., respectively, and the near minimum (33½) five times at various diameters from 6.4 mm. to 12.1 mm.

H (and consequently H′) also tend to increase up to a diameter of about 30 mm. The lowest values for H are found in two specimens of only 7.1 mm. in diameter (nos. 73, 5), but also in one about three times as large (no. 4); the maximum of H (43½) occurs in specimen number 56 (diameter 30 mm.). Above this diameter, H tends to decrease.

Two of the five largest shells, namely, number 67 (pl. 24, fig. 40) and less conspicuously number 66, show a wide and deep constriction immediately behind their anterior ends, as does the lectotype of the type species, *M. mirus* (Bukowski, 1887, pl. 28, fig. 8).

In five of the six largest disks (nos. 65, 66, 68, 59, and 50) the last septa can be located at diameters of from 28 to 35 mm. In none, however, is the body chamber completely preserved. Should the above-mentioned constriction indicate the nearness of the apertural margin, which is possible, though by no means certain (Bukowski, 1887, p. 152), then the length of the body chamber may be estimated at about three-quarters of a volution. Under this assumption the largest shell (no. 50), in which about five-eighths of the outer whorl belongs to the body chamber, may have attained, when complete, about 60 mm. in diameter, as compared to the average size of about 29 mm. given by Noetling (1887, p. 31) and to the diameter of 36 mm. recorded by him (p. 32) for his largest specimen (pl. 5, fig. 9), separated by him as "*Peltoceras*" *dubium* but here included in the synonymy of *M. syriacus*.

Designation of Type: The specimen illustrated in Noetling's figures 5 and 5a is here designated the lectotype.

Description: The nucleus of specimen number 37, measuring slightly more than 1 mm. in diameter, serves as a good example of shell shape and whorl profile at a very early ontogenetic stage. The conch is nearly spherical in shape and quite involute, the outer whorl is almost twice as wide as high and its profile is reniform, with a widely arched, nearly semicircular venter and pronounced, though rounded, ventrolateral shoulders from which the flanks slope at an angle of about 45 degrees towards the umbilicus (pl. 25, fig. 4). There is a distinct constriction about three-quarters of a volution behind the septum which forms the anterior end of this nucleus.

At an early juvenile stage, as represented by numbers 70 and 78 (pl. 24, figs. 22–27), the conch has become moderately evolute and the whorl profile transversely rectangular with gently convex flanks and venter; both ventrolateral and umbilical shoulders are well rounded; the umbilicus is quite deep and its wall slopes at first steeply, then almost perpendicularly. Here and there an intercostal stands out by being wider than the others, but no true constrictions can be recognized.

Shell shape and whorl section are still the same in the somewhat larger juvenile number 90 (pl. 24, figs. 28, 29), but in the still larger specimens numbers 69 and 91 the whorl profile may be called subquadratic rather than transversely rectangular, in accordance with the trend of the ratio W:H to decrease with growth (pl. 24, figs. 33, 34). Flanks and venter are still gently convex in these individuals but less so in the larger shell number 37, in which the flanks appear somewhat flattened (pl. 25, fig. 3). In some shells, for example, in numbers 6 (pl. 24, fig. 19) and 60, the venter becomes quite high and rounded again and the whorl section altogether elliptic at diameters of about 25 mm. and 33 mm., respectively. As a rule, however, the profile remains subquadratic and the venter somewhat truncate in uncrushed specimens throughout further development (nos. 63, 67; pl. 24, figs. 41, 43, 39; no. 59).

Except for the nucleus mentioned at the beginning of this description no true constrictions are observable until the very latest stage, mentioned above in specimens numbers 66 and 67 (pl. 24, fig. 40), but wide intercostals somewhat reminiscent of constrictions occur throughout development.

No true median grooves are present, but specimen number 67, one of the largest present, shows a delicate median ridge (pl. 24, fig. 39). Five similar fine ridges, separated from one another by equally inconspicuous furrows, are recognizable on the venter of the juvenile number 91 at a diameter as small as about 5 mm. (pl. 24, fig. 34).

The nucleus of specimen number 37, described above as to shell shape and whorl section, is smooth, except for an extremely fine transverse striation recognizable on the venter only under the microscope. Ornamentation can be seen in specimen number 2 (pl. 24, fig. 21) to set in at a diameter of about 1.5 mm., at first in the form of blunt nodes which quickly develop into quite sharp, stiff, strongly prorsiradiate ribs. These ribs are restricted to the flanks which are still narrow at this early stage and end rather abruptly at both umbilical and lateroventral shoulders; there are 17 such nodes or ribs, respectively, on the first volution carrying ornamentation. Within the following half whorl, on which 15 ribs are counted, they change from a prorsiradiate to a radial direction. Only indistinct growth striae, sometimes assuming the shape of blunt folds, are recognizable on the venter at this stage. In specimen number 78, of which the diameter exceeds that of number 2 by 2 mm., the ribs become sinuous and slightly recurved on the flanks and from a diameter of about 4 mm. begin to bifurcate on or near the lateroventral shoulder, exceptionally at the inner third of the sides or even near the umbilical shoulder, and the secondary ribs thus produced cross the venter in a shallow forward convex arc. Simultaneously, the first indications of parabolic nodes appear. Twenty-five ribs per whorl are now counted on the sides and about twice as many on the venter (pl. 24, figs. 25–27). In specimen number 90, attaining almost 10 mm. in diameter, the ribs are stiffer than in the individual just described, not yet recurved, and change only at a diameter of about 8 mm. from the prorsiradiate to the radial direction, all these differences indicating retarded development. Twenty-nine ribs are here present on the outer volution (pl. 24, figs. 28, 29). Otherwise the character of ornamentation is the same as in number 78.

Specimen number 69 (pl. 24, figs. 31–33), which measures nearly 16 mm. in diameter, may be considered characteristic of the next ornamentational stage. Here 36 rather sharp and increasingly recurved ribs are counted on the flanks; those on the venter, which they cross almost horizontally, are less conspicuous than at earlier stages and there are no parabolic nodes. Specimen number 37 (pl. 25, figs. 1–3), at diameters between 15 and 20 mm., shows well the transition to mature ornamentation. The primary ribs move farther apart, so that they number only 27 on the last whorl, and the bifurcation point shifts from the periphery inward, sometimes as far as the middle of the flanks. Most of the stems of these primary ribs describe a forward concave arc on the inner zone of the flanks, thus assuming the characteristic comma shape often encountered in this genus as well as in some species of *Euaspidoceras* (see below). There are some quite pronounced parabolic nodes. The change from juvenile to mature costation takes place even more abruptly in specimen number 6 (pl. 24, fig. 20).

Specimen number 60 is remarkable for having far fewer primary ribs, only about 15 per whorl, on the last two volutions of its septate part, and these few primary ribs are extraordinarily reënforced and carry on the lateroventral shoulders particularly heavy parabolic nodes, the anteriormost two pairs of which are connected by forward-directed tongues believed to indicate resorbed apertural margins. Most of these features are strongly reminiscent of the "perisphinctoid" *Euaspidoceras* forms (see below, pp. 165–178), to which individuals of *Mirosphinctes*, such as the one here discussed, are indubitably transitional. However, soon after the beginning of the body chamber, corresponding in this individual to a diameter of about 23 mm., all these features disappear abruptly to give way to the normal mature ornamentation of this species (pl. 24, figs. 36, 37). They do not, therefore, in any way bring under question the reference of this particular individual to *Mirosphinctes*, but are believed rather to indicate the common ancestry of *Mirosphinctes* and that group of *Euaspidoceras* and their close relationship. These groups seem to have diverged, geologically speaking, not so long before the lifetime of the Mount Hermon ammonite fauna.

Finally, specimens numbers 59 and 65 are mentioned and illustrated (pl. 24, figs. 30, 44, 45) as examples of the fully mature ornamentation of this species. All the ribs are now strongly recurved. In both shells there is a remarkable contrast between the septate and the unseptate parts of the outer whorls. In the septate portion number 65, in particular, shows some reënforced "commas" among the primary ribs and widely apicad elongated parabolic nodes which are joined by two or three consecutive costae each. On the body chamber, however, the ornamentation is quite regular and uniform, with the primary ribs moving farther apart, especially in the anteriormost part of specimen number 59 where repeatedly two secondary ribs rather than one are intercalated between two primary ribs. At this late stage the secondary ribs also have become quite strong and cross the venter strictly horizontally. Rib counts yield totals of 35 and 30 primary ribs, and 62 and 68 secondary ones, for the outer volutions of specimens numbers 65 and 59, respectively.

The earliest stage at which suture lines can well be seen, corresponding to diameters of from about 3.5 mm. to about 5 mm., is best represented by the small juveniles numbers 1 and 2. In the former the sutures show a rather primitive condition, with wide and shallow main lobes and broad and low main saddles. Of the lobes, only the siphonal one is clearly divided by a low trapezoidal knob into two short and blunt terminal points. Of the saddles only the external one is clearly divided by a shallow lobule. The first lateral lobe is crudely triangular in shape and shows only in the last suture lines observable in this individual a faint indication of trifidity (pl. 25, fig. 5). In contrast, the first lateral lobe ends in three clearly differentiated points in specimen number 2. In this individual this lobe is only about half as deep as the siphonal one which is here not so shallow as in number 1, where it is only one and a half as long as the lateral lobe.

At a diameter of nearly 8 mm. the suture line has become more elaborate in the juvenile number 82 (pl. 25, figs. 6, 7). The main lobes are no longer so wide, and the first lateral lobe may almost be called slender and now nearly reaches the depth of the siphonal one. On the other hand, the external saddle is extremely wide and extends as far as the lateroventral shoulder. Whereas this suture line in general shows an increased degree of indentation, the lobule indenting the external saddle is still bag-shaped and rounded at the bottom, without any prongs. The first lateral saddle also is divided into two stems and quite wide, though only half as wide as the external one. It is followed by a triangular second lateral lobe, somewhat shorter than the first, by a rather low, trapezoidal second lateral saddle, and by an auxiliary lobe on the umbilical wall. The tops of all saddles hit about the same radius, and the axes of all lobes run in a spiral direction.

In specimen number 88, however, which is considerably more evolute than 82, both lateral lobes point somewhat ventrad. Otherwise this suture line at a slightly larger size is rather less indented than the preceding, but in all other respects quite similar (pl. 25, figs. 8, 9). The same is true for specimen number 90 (pl. 24, figs. 28, 29), which is a little less evolute and does not show the above-mentioned ventrad deflection of the lateral lobes.

Some progress in sutural development is shown by specimen number 69 at diameters between 12 and 15 mm. The median knob carries two horns at the corners, and the second lateral lobe, which rides just on the umbilical shoulder and is extraordinarily shallow, is distinctly trifid. Both lateral lobes are wider than they are even in smaller shells. In specimen number 4, however, these lobes are remarkably narrow and deep at a diameter of about 17.5 mm. (pl. 25, fig. 12). The suture line is somewhat more elaborate than at the stages just discussed, but the general plan is the same. It is worth noting that in this suture line the outer point of the first lateral lobe occupies a markedly deeper site than the inner, thus making this lobe somewhat intermediate between trifid and bifid. It now almost equals the siphonal lobe in depth.

The first lateral lobe is again symmetrically trifid in specimen number 41 at a diameter of about 22 mm. and even longer than the siphonal one. The external saddle is extremely wide. The now richly indented lobule dividing it rides just on the ventrolateral shoulder and is aligned with the parabolic nodes of this rather narrow-ventered shell (pl. 25, fig. 11). At about the same size specimen number 97 stands out by having unusually short, though richly indented first lateral lobes (pl. 25, fig. 10). A similar aspect develops gradually in the last five sutures of specimen number 56 (pl. 25, fig. 13) which, at diameters of from 24 to 29 mm., become increasingly crowded and irregular, especially as far as the prongs of the first lateral lobe are concerned.

The suture lines of specimen number 9, quite elaborate at a diameter of about 25 mm., and of specimens numbers 63 and 65, corresponding to diameters of up to 30 mm., may be considered representative of the penultimate sutural stage observable in this species, whereas the last stage, at diameters of from 28 to 35 mm., is well represented in the second largest shell present (no. 59, pl. 24, fig. 30). It is characterized by extremely wide external and first lateral saddles, both more or less symmetrically bifid, and equally narrow lateral lobes, both richly indented. The first, symmetrically trifid with a comparatively long middle point, clearly exceeds the siphonal lobe in depth. It is worth noting that in this stage also, as throughout development, the main saddles are sturdy and transversely rectangular in shape, their tops are connected by a nearly radial line, and the lobes point strictly in the spiral direction. Thus there is no trace whatever of a "suspensive lobe."

REMARKS: Frebold's (*loc. cit. in synon.*) view that "*Peltoceras*" *dubium* Noetling cannot correctly be separated from the present species is shared by the present writer. As a matter of fact, the single specimen for which Noetling established his "*P.*" *dubium* agrees perfectly with some individuals of about the same size in my material, e.g., number 62 (pl. 24, fig. 38). The differences which induced Noetling (1887, p. 32) to separate it specifically from *syriacus* come within the range of variation of this species. The umbilicus is even a little wider in our specimen 62, the costation just as coarse, and a subquadratic whorl section, considered by Noetling a characteristic of his "*P.*" *dubium,* is the rule rather than the exception in *M. syriacus* (see above, p. 155, and pl. 24, figs. 39, 41, 43).

On the other hand, the specimens illustrated in Noetling's figures 6 and 7, on account of their regular and denser costation, are here referred to Noetling's var. *regularis* of *syriacus*, raised below to species rank, rather than to the typical form.

Noetling wrote that he knew no previously described form comparable with the present species, except Quenstedt's *Ammonites convolutus parabolis* (1858, p. 542, pl. 71, figs. 10–12), which Noetling considered conspecific with his "*Peltoceras*" *dubium*, demonstrated above to be synonymous with *syriacus*. This is surprising in view of the fact that Moesch (1867, p. 292, pl. 1, fig. 2) had published 20 years earlier his *Ammonites frickensis* which is certainly a *Mirosphinctes* and one closely resembling the present species at that.[1] Moesch's protograph, it is true, shows this resemblance much less distinctly than de Loriol's (1901, p. 28, *cum synon.*, pl. 3, figs. 1, 3; 1902, p. 65, pl. 4, figs. 4–6) later figures, particularly those of 1901. Both Moesch's holotype and the specimens illustrated by de Loriol differ from those from Mount Hermon only by being somewhat stouter and less evolute at comparable sizes, by even more briskly recurved ribs, and by lacking parabolic nodes, differences that may justify specific separation. Bukowski's form from Czenstochau[1] also comes very close to

[1] It must, however, be noted that Bukowski (1887, pp. 150, 151), although he knew Moesch's species and even named a form from Czenstochau "*Perisphinctes* cfr. *Frickensis* Moesch," mentioned *Perisphinctes variabilis* as the only form resembling his *P. mirus*, the type species of *Mirosphinctes*, despite the fact that his *P.* cf. *frickensis* shows the same recurved ribs characteristic of *Mirosphinctes* as his *P. mirus*.

M. syriacus, from which, however, it seems to differ by having denser costation. The type species, *M. mirus* (Bukowski), is an altogether smaller form than *M. syriacus* and has an even heavier costation and a lower whorl section.

Mirosphinctes syriacus is compared below with *M. regularis* (p. 161).

Quenstedt's above-mentioned form, in my opinion, is not referable to *Mirosphinctes*, and even if it were, is certainly not conspecific with *syriacus*.

From all the forms of this assemblage referred above to *Perisphinctes*, *sensu lato*, *M. syriacus* can be readily distinguished on the strength of the generic differences pointed out in the section on the genus *Mirosphinctes*.

In earlier stages this species is not so easy to distinguish from some *Euaspidoceras*, especially from *E. perisphinctoides*. For comparison, reference is made to the discussion of the latter species.

MATERIAL STUDIED. Altogether 225 specimens, including fragments.

Mirosphinctes regularis (Noetling)

Plate 25, figures 14–40; plate 26, figures 1–19

Peltoceras syriacum sp. n., var. *regularis* NOETLING, 1887, p. 32, pl. 5, fig. 4.

Peltoceras syriacum sp. n., NOETLING, 1887, p. 31, *pro parte*, pl. 5, figs. 6, 7 only.

DIMENSIONS

A.M.N.H. No. 27761	D	H	H′	W	U
1	4.5 mm.	35	30	57½	35
5	5.5 mm.	32½	28½	59	39
8	5.6 mm.	37	31	53	38
2	5.9 mm.	36	*ca.* 30	56½	34
9	6.0 mm.	35	29½	57½	39
10	6.0 mm.	34½	27	52	38½
3	6.2 mm.	32½	*ca.* 27	54½	42
11	6.2 mm.	36½	27½	58	38
4	6.3 mm.	35½	27	52	40
15	6.3 mm.	37½	32	60½	35½
7	6.4 mm.	40½	31½	56	31½
13	6.6 mm.	39	30½	59½	32
101	6.6 mm.	34	29	*ca.* 51	40½
14	6.7 mm.	36½	30	53½	35
16	6.7 mm.	36½	29	53½	38½
19	6.9 mm.	32½	28	55	40½
26	6.9 mm.	32	27½	51½	40½
29	7.1 mm.	32½	28	54	39½
21	7.2 mm.	33	28	48½	42
22	7.2 mm.	36	30	56	33
30	7.3 mm.	32½	*ca.* 29	57	41½
106	7.3 mm.	34½	23	54½	37½
107	7.3 mm.	38½	24½	57	34
24	7.4 mm.	38	?	44	37
25	7.4 mm.	35	29	53	42½
31	7.4 mm.	32	27½	53	44
102	7.4 mm.	39	?	?[1]	38
32	7.6 mm.	38	32	56	34
116	7.6 mm.	38	*ca.* 29½	47	35½
105	7.7 mm.	35	29	50½	40½
41	7.8 mm.	35½	31½	54½	35½
108	7.8 mm.	34½	30½	54½	40
35	8.0 mm.	34	27	49½	37½
34	8.1 mm.	33½	28	46	41½
33	8.2 mm.	37	31	56	38½
141	8.3 mm.	32	27	46½	40½
36	8.4 mm.	36	32	50½	38½
45	8.4 mm.	38½	?	53½	40
110	8.4 mm.	38½	*ca.* 30½	54½	34½
43	8.5 mm.	38	?	51½	37
46	8.5 mm.	33	30½	48½	42
47	8.5 mm.	33½	28	48	42½
39	8.6 mm.	32½	27½	48	41½
111	8.6 mm.	37½	34	48	36½
113	8.6 mm.	40½	?	58½	34
112	8.7 mm.	37	*ca.* 29½	50	36
109	8.8 mm.	38	33½	50½	38
52	9.0 mm.	33½	27½	47½	40
117	9.0 mm.	35	30	53½	40
48	9.1 mm.	38½	31	49½	34½
50	9.2 mm.	34	?	*ca.* 44	39
114	9.2 mm.	41½	*ca.* 35½	*ca.* 44½	36
51	9.5 mm.	37½	*ca.* 33	53	33
123	9.6 mm.	34	29	50½	40
115	9.7 mm.	39	32	*ca.* 51½	32½
118	9.9 mm.	41	34	53½	33
53	10.0 mm.	33½	?	54	45
54	10.1 mm.	36½	?	46½	34½
55	10.1 mm.	31	?	?	44½
121	10.1 mm.	39	*ca.* 33½	?[1]	31
125	10.1 mm.	38	*ca.* 28	50	38
56	10.2 mm.	36½	33	49½	35
122	10.3 mm.	36	*ca.* 28	42½	38
120	10.4 mm.	42	*ca.* 37½	54	32
60	10.6 mm.	36	28½	44	41
124	10.6 mm.	39	*ca.* 31½	52½	33½
57	10.8 mm.	39½	31	*ca.* 41½	35
62	11.0 mm.	31½	*ca.* 27½	38	41½
58	11.1 mm.	33½	30½	45½	40½
61	11.1 mm.	35½	30½	50½	36½
59	11.2 mm.	36	?	43	*ca.* 40
63	11.2 mm.	40	*ca.* 35	50	34
142	11.2 mm.	37	*ca.* 25	*ca.* 39½	46½
128	11.4 mm.	38½	31½	45½	43
127	11.8 mm.	*ca.* 41	*ca.* 32½	51½	32½
133	12.0 mm.	38½	31½	45	46
65	12.1 mm.	35	27½	45½	41½
143	12.1 mm.	35½	?	42	54½
129	12.1 mm.	39	*ca.* 33	39½	39
130	12.3 mm.	42	39	50	39
132	12.4 mm.	37	*ca.* 33	47½	32
134	13.7 mm.	33	*ca.* 26½	41½	38
93	13.8 mm.	39	*ca.* 36	49½	35½

[1] Crushed.

A.M.N.H. No. 27761	D	H	H′	W	U
144	14.0 mm.	32	?	39½	45
137	14.3 mm.	41½	?	*ca.* 49	40
67	14.8 mm.	32	29	38	41½
135	14.9 mm.	39½	?	39	40½
68	15.7 mm.	34	27½	39½	39½
95	15.7 mm.	36½	?	*ca.* 46½	39
136	15.7 mm.	40	?	?[1]	35
69	16.2 mm.	35	*ca.* 30	38	40
138	16.2 mm.	40	?	*ca.* 49½	42
96	16.4 mm.	33	30	47	46½
70	17.6 mm.	37½	?	*ca.* 41	36
71	18.2 mm.	38½	27½	39½	42½
72	18.6 mm.	40	?	35	44½
74	19.1 mm.	38	32	43½	36½
75	19.5 mm.	42½	34	33½	37½
140	19.5 mm.	36	33	46½	36½
97	20.0 mm.	39	32	44	36
98	20.1 mm.	38½	?	45	39
145	21.3 mm.	41	?	45	44
77	21.9 mm.	42½	36	*ca.* 43	32½
146	22.0 mm.	35½	31½	48½	39
99	23.5 mm.	35½	*ca.* 33½	*ca.* 42	41½
78	24.0 mm.	33½	*ca.* 28½	*ca.* 34	41½
82	24.1 mm.	38½	*ca.* 35	*ca.* 37½	45
100	24.1 mm.	35½	32	39	35½
79	24.2 mm.	37½	35½	43½	36½
80	24.9 mm.	35½	?	35	43½
81	25.3 mm.	32	?	29½	46
83	29.7 mm.	38	31½	36½	38½
89	30.0 mm.	36½	30½	34½	42½
85	32.3 mm.	37	?	*ca.* 36	38½
86	34.5 mm.	36½	*ca.* 32	34½	42
92	39.2 mm.	31½	27½	*ca.* 31½	44½
87	44.4 mm.	*ca.* 37	?	?[2]	41

The last measured specimen is the largest present.

As in *M. syriacus*, in this species a trend of the width of the shell to decrease with growth is clearly recognizable. The maximum of W (60½) is found in a disk measuring only 6.3 mm. in diameter (no. 15), and its minimum (29½) in one of the larger shells measured (no. 81, D = 25.3 mm.). The largest individual of which the width could be measured (no. 92, D = 39.2 mm.), with W = *ca.* 31½, comes fairly close to the above minimum. Specimens numbers 140, 98, 145, and 146 are remarkable for retaining widths of 45 and more to a medium size. No equally obvious trends can be deduced from the table with regard to the other dimensions. H attains its minimum (31) in the small individual number 55 (diameter 10.1 mm.) and its maximum of 42½ in a medium-sized shell (no. 75) at a diameter of 19.5 mm., but similarly high values for H, from 40 to 42, are scattered over most of the table (specimens nos. 7, 113, 114, 118, 120, 63, 127, 130, 137, 136, 138, 72, ranging in diameter from 6.4 to 18.6 mm.), though not beyond the diameter of 19.5 mm. This last fact seems to be connected with the decreased degree of involution in maturity, noticeable in this as well as in the preceding species. Umbilical widths of 41 or more are encountered in nine of the 13 largest measured shells, but also, though less frequently, among the smaller ones. The maximum of U (54½) is attained in specimen number 143 at a diameter of only 12.1 mm. It surpasses by far the near maximum of 46½, encountered in specimens numbers 142 and 96 which measure 11.2 mm. and 16.4 mm., respectively, in diameter. The lowest value for U (31) is found in the rather small shell number 121 (D = 10.1 mm.). Thus no definite ontogenetic trend can be recognized in the width of the umbilicus, except for the afore-mentioned fact that it tends to become somewhat wider in maturity.

The last septa are markedly crowded in the largest shell (no. 87) which may thus be considered a mature individual and which seems to be not far from complete. Therefore, from the material under examination this species may be assumed to have reached from 45 mm. to 50 mm. in diameter.

The last septum can be located at a diameter of about 25 mm. in the third largest among the measured specimens (no. 86) and at diameters of about 30 mm. in the two largest (nos. 92 and 87). In all three the living chamber, as far as preserved, occupies somewhat more than half of a volution, but it cannot be said to be complete in any.

DESIGNATION OF TYPE: The only specimen of Noetling's var. *regularis* figured by him (pl. 5, fig. 4) under this designation must be considered the holotype of this species.

DESCRIPTION: This species is so closely related to *M. syriacus* that it can in some respects be described by way of reference to the latter.

The shell is rather evolute even at an early stage, the umbilicus of juveniles being slightly wider than in the preceding species. The whorl section is transversely elliptic in the young (nos. 19, 29; pl. 25, figs. 21, 24), with gently convex flanks and venter and

[1] Incomplete.
[2] Crushed.

both peripheral and umbilical shoulders well rounded. In some individuals (e.g., no. 28; pl. 25, fig. 22) the venter tends to become truncate even at this early stage. This trend becomes more manifest in a few somewhat larger juveniles, e.g., number 133 (pl. 26, fig. 6). Simultaneously the whorl profile tends to become subquadratic with decreasing width (nos. 93, 97; pl. 26, figs. 1, 12) or, in some individuals (no. 98, pl. 26, fig. 9), subcircular rather than transversely elliptical. The section is still subquadratic or, owing to some ventrad convergence of the flanks, rather trapezoidal, with the venter still truncate at the posterior end of the half-whorl number 79, believed to be the most characteristic representative of this species within our material, but at the anterior end of this same half-whorl the venter has become broadly arched and the whorl profile tapers markedly ventrad so that it might now be called broad-oval or heart-shaped (pl. 25, fig. 36). The same arched venter, crowning an oval or more or less elliptic whorl section, is found in all uncrushed shells measuring 25 mm. or more in diameter, as exemplified by numbers 86 and 89 (pl. 26, figs. 15, 19). Such a whorl section may thus be considered characteristic of mature individuals of *M. regularis*, as distinct from *M. syriacus* where the profile as a rule remains subquadratic in maturity.

More or less distinct but always shallow constrictions are found occasionally at various diameters, e.g., at 3.5 mm. in number 3, two around the diameter of 7 mm. in number 34, at about 8 mm. in number 46, at about 8.5 mm. in number 50, at about 9 mm. in number 53, at about 10 mm. in number 62, an unusually wide one at about 12 mm. in number 70, and one at 17 mm. in number 72; the last might just as well be characterized as an intercostal somewhat wider and deeper than the others. These constrictions show the same course as the ribs. However, none of the larger shells exhibits the deep and wide constrictions immediately behind the anterior end repeatedly found in *M. frickensis*, *M. mirus*, and *M. syriacus* where they may well indicate the vicinity of the aperture. The occasional presence of constrictions at smaller diameters and their entire absence from the anterior portions of the body chambers of adults constitute another difference of *M. regularis* from *M. syriacus*.

In some specimens faint median bands which, however, do not interrupt the costation, are just recognizable. In specimens numbers 121 and 72 five and seven spiral ridges, respectively, spread over the width of the venter where they produce a lattice pattern in crossing the secondary ribs (pl. 25, fig. 40; pl. 26, fig. 13; compare specimen no. 91 of *M. syriacus*, pl. 24, fig. 34).

In the juvenile number 19 ornamentation can be seen to appear first at a diameter of about 1.5 mm., just as in *M. syriacus*. In the present species also blunt tubercles appear first but change soon into strongly prorsiradiate ribs. They are straight and stiff for a little more than one volution, then become gently sigmoidal. As early as at a diameter of less than 4 mm. they begin to bifurcate at about the middle of the flanks and are at this early stage distinctly raised to form radially elongated tubercles in this zone, even before bifurcation actually sets in. Seventeen ribs are counted on the first costate volution and 25 primary ribs on the outer whorl. As soon as secondary ribs appear on the venter, their number about doubles that of the primary ones (pl. 25, figs. 19, 20). Bifurcation sets in markedly later, at a diameter of about 6 mm. only, in specimens numbers 26 and 29. The costation of the latter is also somewhat coarser and less dense (22 primary ribs on outer whorl; pl. 25, fig. 23). The costation of juveniles 106 (pl. 26, fig. 8) and 36, with 28 and 29 primary ribs, respectively, may be considered to be of average density for this stage, whereas that of some other juveniles of about the same size, namely, numbers 107, 102, 43, 46, and 47, consisting of from 30 to 34 primary ribs on the outer volution, is particularly dense and fine, thus exhibiting the main distinctive character of this species from *M. syriacus*. Numbers 107 and 43 are illustrated as examples (pl. 25, figs. 39, 30). Bifurcation occurs only occasionally in number 107 and for almost half a volution on, or somewhat inward of, the umbilical shoulder in number 106.

The juvenile number 39 deserves special mention for having an ornamentation which, with irregular bifurcations, "lacets" (loops), and parabolic nodes, a pair of which is connected by a tongue-like ridge across the venter, is in every way transitional to *Aspidoceras* (*Euaspidoceras*) *perisphinctoides* (pl. 25, figs. 27, 28). On the strength of the whorl profile which shows a gently arched, not truncate venter and well-rounded peripheral shoulders it is, however, left with the present species.

The juvenile number 117 (pl. 25, figs. 37, 38) is remarkable for exhibiting as early as at a diameter of only 9 mm. the costation characteristic of a much later stage, represented best by specimen number 79 (see below), with nearly sharp and narrow, elegantly recurved ribs which split sometimes on the outer, sometimes on the inner, shoulder or at the first third of the flanks. There are 30 on the outer whorl. Number 53 is here mentioned for carrying some pairs of apicad elongated parabolic nodes, and numbers 54 and 125 for the fact that their ribs hardly ever bifurcate but continue undivided across the venter (pl. 26, fig. 10). The somewhat larger, excellently preserved specimen number 133 is illustrated for its particularly regular, rather dense costation (39 primary ribs; pl. 26, figs. 4, 5). It is finer and more flexuous in the more involute shells numbers 132 and 93 (pl. 26, fig. 2), the latter remarkable also for a secondary bifurcation of the fifth rib from the anterior end. The specimens numbers 96, 97, and 72, measuring from 16.4 mm. to 20 mm. in diameter, are also shown in side views (pl. 26, figs. 3, 11, 14) for their excellently preserved ornamentation. That of the last is quite the same as that of the posterior part of number 79, mentioned above as the shell believed to be most characteristic of this species in our material, whereas the ribs become more briskly recurved in the anterior part; 18 primary ribs are counted on this half-whorl, and 39 very uniform secondary ones on its venter which they cross horizontally or in an extremely shallow, forward convex arc (pl. 25, figs. 34, 35).

The mature stage of ornamentation is best illustrated by the specimens numbers 89, 91, 86, and 87. At this latest stage a similar development occurs as reported above (p. 155) for *M. syriacus*. The primary ribs move farther apart on the body chamber so that their total for the outer volution decreases to from 27 (in no. 89) to 32 (in no. 87). In the last septate half-whorls of number 89 and, at a lesser degree, also of number 91 these primary ribs are sharply raised and comma-shaped (pl. 26, fig. 18), as in specimen number 60 of *M. syriacus* (above, p. 155). On the body chambers of all these shells, however, the costation becomes markedly weaker, chiefly in the largest present (no. 87, pl. 26, fig. 7). As noted in *M. syriacus* also, sometimes three rather than two secondary ribs which originate by either bifurcation or intercalation correspond to a primary rib at this stage. In most of these shells the ribs are decidedly recurved (pl. 26, figs. 7, 16) but much less so in number 89 (pl. 26, fig. 18). As seen when the rib counts given here and on page 156 are compared, the costation at this stage is no longer denser than in *M. syriacus* but altogether less robust and somewhat subdued.

By way of appendix to this section, four specimens in which the costation is locally badly distorted, owing obviously to some lesion of the shell, may be mentioned (nos. 147–150). Specimens 148 and 150, the latter with backward-pointing chevrons, which are, however, followed by ribs crossing the venter nearly normally, are illustrated as examples (pl. 25, figs. 31, 33).

As seen in figures 14–18, 23, 25, 26, 29, 30, and 32 of plate 25 and 14, 16, and 18 of plate 26, depicting suture lines at various growth stages, both the general plan and the development of the sutures are about the same as in *M. syriacus*, except for a tendency, manifest first at a diameter of about 6 mm., of the outer stem of the external saddle more and more to overtop the inner. The difference in height between these two stems is greatest in the last sutures of specimen 151 (pl. 25, fig. 18). In the last suture lines of specimen 152 (pl. 25, fig. 32), on the other hand, both these stems, although corresponding to a larger diameter, are equally high, as they are as a rule in *M. syriacus*. To judge by its costation, however, this shell belongs to the present species.

REMARKS: Noetling split this form as a variety from *M. syriacus* on account of "the very uniform strength of the dichotomizing ribs which can be followed back to the innermost volutions." The greater regularity, lesser strength, and, except for the very latest stage, higher density of the costation constitute indeed the most conspicuous difference between the two forms, but there are others which are pointed out in the above description. Taken together with the difference stated by Noetling, they are believed to justify specific rather than merely varietal separation.

As indicated in the synonymy, the individuals depicted in Noetling's figures 6 and 7 and referred by him to the typical *M. syriacus*, in addition to the holotype of his var. *regularis* (Noetling's fig. 4), are here also referred to the present species as they share its ornamentational characteristics.

From *M. mirus*, the type species, and *M. frickensis* the present species differs in a similar way as from *M. syriacus*.

Especially at a medium growth stage it resembles other perisphinctids with a similarly fine and dense costation even though they belong to other genera. Within the present assemblage this holds true for *Perisphinctes* (*Alligaticeras*) *?paneaticus* (p. 121) which can, however, readily be distinguished from the present form by having flatter flanks and more distinct lateroventral edges, by being somewhat more involute, and most of all, by the character of the costation which is stiffer, denser, and prorsiradiate, but not recurved. Finally *P.* (*A.*) *?paneaticus* does not exhibit the sutural characters of the genus *Mirosphinctes*.

Perisphinctes bonjouri de Loriol (1900, p. 76, *cum synon.*, text fig. 15, pl. 5, figs. 25–29), especially the shell shown in his figure 27, also resembles *M. regularis* in the fineness and elegant sinuosity of the costation, but the ribs of *P. bonjouri* are prorsiradiate rather than rursiradiate in direction and not recurved, the whorl section is strictly subquadratic, and there is a "suspensive lobe" which is entirely missing in the present species.

Some individuals in early or medium growth stages of *M. regularis* show a certain similarity, as does *M. syriacus*, to *Aspidoceras* (*Euaspidoceras*) *perisphinctoides* (see p. 165).

MATERIAL STUDIED: Altogether 239 specimens, including fragments.

Mirosphinctes kobyi (de Loriol)

Plate 26, figures 20–47

Perisphinctes Kobyi, DE LORIOL, 1898, p. 90, text fig. 27, pl. 6, fig. 14.

Perisphinctes Kobyi, P. de Loriol; DE LORIOL, 1900, p. 88, pl. 6, figs. 6–10.

Aspidoceras Kobyi de Loriol; MAIRE, 1932, p. 46, pl. 5, fig. 11.

Non Euaspidoceras Kobyi Rollier sp. (in fig. de Loriol); JEANNET, 1951, p. 207, text figs. 487–489, pl. 94, fig. 5, pl. 95, figs. 3, 4, pl. 96, figs. 2, 3, pl. 97, fig. 1.

DIMENSIONS

A.M.N.H. No. 27826	D	H	H′	W	U
1	5.04 mm.	35½	?	33½	36½
2	6.38 mm.	37½	28	42	37½
8	6.91 mm.	38	29½	45	36½
3	7.06 mm.	35½[1]	?	40½[1]	35½[1]
9	7.78 mm.	36	32½	43½	42½
4	7.84 mm.	37	33	33	37
10	8.66 mm.	*ca.* 39½	31½	*ca.* 45	32½
6	11.20 mm.	36[2]	?	34[2]	36[2]
7	13.44 mm.	38	*ca.* 34	32½	38
11	16.9 mm.	32½	*ca.* 30	30	46½

It will be noted that H equals U in five out of 10 measured specimens and that these two values differ only slightly in two others (nos. 1 and 8), but that U markedly exceeds H in specimen 9 and very much so in the largest shell present (no. 11). On the other hand, U is considerably smaller than H in specimen 10. In general, the width of the umbilicus is fairly constant between the diameters of 5 and 13.5 mm. (exception: no. 9), then increases quite decidedly, and the width decreases with growth (exception: the smallest measured shell).

The three largest specimens are septate throughout. Thus they do not give any indication of the full size reached by this species. To judge by the literature and by the absence of any disk exceeding 17 mm. in diameter in the present assemblage, it seems to be a micromorphic one (see also Maire, 1932, p. 46).

DESIGNATION OF TYPE: The single specimen from Chatillon published by de Loriol in 1898 (see synonymy), although smoother than average and lacking parabolic nodes as well as constrictions and therefore not really characteristic of this species, must be considered its holotype.

DESCRIPTION: Shell discoidal and slender. The umbilicus, quite deep in the young, becomes increasingly shallow with growth. In the smallest individual (no. 1) the whorl section is slender, elliptical, with parallel, flat flanks and an arched venter; the lateroventral shoulders are well rounded (fig. 28).

[1] Measured at D=6.61 mm.

[2] Measured at D=10.53 mm.

n the somewhat larger juvenile number 2 he whorl profile approaches a subquadratic hape; the flat flanks diverge a little from the ımbilical shoulder, which is quite proıounced, to the peripheral one (fig. 34). The vhorl section of specimen 9, which is again a ittle larger, agrees with that of number 2 exept that here the flanks are gently convex fig. 38), but in the slender juvenile number 4 hey are flat (fig. 22), as they are also in all ırger shells. In the largest shell but one (no.) the venter tends to become truncate in the nterior half of the outer whorl, and it is defiitely so in that of the largest individual (no. 1), with pronounced though rounded lateroentral shoulders (figs. 23, 25, 41, 43).

Six specimens show a more or less distinct onstriction either in their septate part (nos. , 9, 4, 6, 11) or on the body chamber (no.), and one (no. 10) shows two constrictions, oth on the body chamber. Some of these onstrictions are only narrow; others, mostly ituated behind the anterior end, as in specimens 8, 4, and 10, are rather broad but none ; deep. Their direction is mostly prorsiradite.

As among the specimens illustrated in the arlier literature (see synonymy), the ornamentation shows great variation within the resent material, to the extent that there are ardly two specimens with quite the same ype of ornamentation. In one individual no. 9) even the two sides differ in this repect. However, the ornamentation is always ıconspicuous and tends to become feeble or o vanish altogether at various sizes.

In the smallest juvenile (no. 1, fig. 27) lunt tubercles appear on the lateroventral houlder, which is, at this early stage, about alfway between the periphery and the umilical shoulder, at a diameter of about 2 mm. ıfter about half of a volution they change ıto short primary ribs, between each two of which one or two secondary ribs begin to be ıtercalated at a diameter of a little more han 4 mm. All these ribs are strongly reurved in typical *Mirosphinctes* style on the ides and in the anterior part of the outer whorl cross the venter in strongly forward onvex tongues. Thirteen primary ribs are ounted in the last half-whorl (figs. 26, 27). 'he ornamentation is similar but markedly ıore robust and less dense in the somewhat ırger juvenile number 2, there being only 10 primary and no secondary ribs. Here, too, the ribs can be followed across the venter, on which they form semicircular tongues while they assume a sigmoidal course on the sides (figs. 32, 33). The juvenile number 8, only about 0.5 mm. larger than number 2, also carries a few heavy tubercles, but they vanish almost entirely at a diameter of about 4.5 mm. Beyond it traces of ribs and extremely fine striae, perhaps homologous to the secondary ribs, can be seen only under the microscope, and the venter remains smooth or nearly so (fig. 31). In the juvenile number 3, of about the same size, coarse primary ribs, only eight per half-whorl, persist to the anterior end, with up to four secondaries, which are, however, restricted to the outermost zone of the sides, intercalated between them. Most of the primary ribs carry pronounced parabolic nodes (figs. 29, 30). Specimen number 5, although crushed, shows well a similar ornamentation. The outer whorl carries only 16 primary ribs which are at first coarse, sharp, and decidedly prorsiradiate but become weaker and recurved and move farther apart on the last quarter, allowing up to five, and probably even more, secondary ribs to be intercalated between them. The latter cross the venter in a gentle forward arc (fig. 46).

The juvenile number 9 has been mentioned above as exhibiting different ornamentation on either side. On its right side (fig. 36) it carries the normal ornamentation of a juvenile *Mirosphinctes*, consisting of primary ribs only and ending abruptly at a diameter between 7 and 7.5 mm., whereas the costation is more robust and less dense on the left side (fig. 37) but ends just as abruptly, though at an earlier stage (diameter less than 7 mm.). The rest of the outer volution is smooth, as is the venter.

The ornamentation of number 4 (figs. 20, 21) resembles that of number 3, described above, except for the fact that in the anterior half of the outer whorl, which is still septate, both primary and secondary costae are restricted to the outer zone of the sides and that the parabolic nodes, though present, are less conspicuous.

In specimen number 10, however, ornamentation appears only late, at a diameter of almost 5 mm., and the primary ribs extend all over the side only in the last quarter-whorl where there are six; they are rather robust and sharp and become strongly prorsiradiate towards the anterior end. Only the last crosses the venter. No secondary ribs can be recognized (fig. 45).

Under the assumption that this species attains only a small size, specimens 6 and 7 may be considered to represent a medium growth stage. In the former individual the costation, which consists of gently recurved primary ribs with some extremely delicate secondary ones between them, stops at a diameter of about 7.5 mm., beyond which only occasionally an indistinct primary rib and faint indications of secondary ones, restricted to the periphery, are recognizable (fig. 47). Distinct parabolic nodes appear in the last costate quarter-whorl, gradually assuming bead shape, as they do in the var. *margaritata* of *Aspidoceras* (*Euaspidoceras*) *perisphinctoides* (p. 169). Similar beads are present also throughout the anteriormost half-whorl of specimen number 7 (fig. 24) in which, however, a rather irregular and feeble costation resembling that seen in Maire (1932, pl. 5, fig. 11) persists to the end. In this shell ornamentation appears at a diameter of 3.5 mm. and can be followed over somewhat more than half a whorl where it is, however, very delicate; then it all but vanishes and reappears only on the aforementioned last half-whorl. The costation is even more feeble, still recognizable on the narrow, truncate venter which is crossed by the ribs in a shallow forward convex arc (figs. 23, 24).

The costation is similar but even weaker on the sides of the largest individual (no. 11). The venter is crossed, first in a very shallow forward convex arc, then in a nearly straight line by ribs which are fine and closely set over most of the outer whorl but become stronger and farther distant from one another in its anteriormost part. In this portion robust parabolic nodes appear rather abruptly; two pairs are present. Those of the posterior pair are peculiarly triplicated; those of the anterior one are connected across the venter by the semicircular remnant of what seems to have been an apertural margin (figs. 41–43).

Suture lines can well be studied in most of the specimens present at diameters ranging from 4 mm. to nearly 17 mm., best in numbers 2, 9, 4, 10, 7, and 11. Although there is some individual variation in the sutures also, they maintain their distinctive characters throughout development. The earliest stage, observable best in number 10, is illustrated in figure 44. The saddles, including the lateral one, are broad and low, and their tops all hit the same radius. The lobes are wide and shallow; the first lateral lobe equals the siphonal in depth. Indentation is still restricted to the main lobes and saddles. There is no "suspensive lobe." The suture lines of specimens numbers 2 (fig. 33) and 3 exhibit about the same characters, but those of numbers 8 and 9 differ by having first lateral lobes which are markedly shorter than the siphonal ones (figs. 31, 37). In the last individual (no. 9) the lateral saddle can be seen to have become remarkably wide and rather deeply bifid at diameters between 7.5 and 8 mm. (fig. 37).

The suture lines of specimen number 5 stand out by the plumpness of the lobes which, for the diameter of about 8.5 mm., show only a very low degree of indentation. The indentation is still comparatively poor in the sutures of the largest individual but one (no. 7, fig. 24), but the last of them show some progress beyond the earlier stages in that the first lateral lobe now somewhat exceeds the siphonal one in depth and the first lateral saddle, which is not so wide in this shell, somewhat rises with its inner stem above the radius connecting the neighboring saddles. That saddle is followed by a shallow, triangular second lateral lobe, a low second lateral saddle, a wide and short, indistinctly trifid auxiliary lobe, and an auxiliary saddle which is cut off by the umbilical seam. The suture lines visible on the outer volution of the largest individual (no. 11), on the contrary, gradually reassume the plump character of the earliest stages (?rejuvenation). All the lobes become increasingly shallow, with the first lateral somewhat shorter than the siphonal one at the beginning of this whorl, but equally long at its end. These two lobes exhibit only primitive denticulation, with short and blunt points, and the rounded-triangular second lateral lobe shows no denticulation at all. The saddles, on the other hand, become extremely wide and low. This is true not only for the external but especially for both lateral saddles. The first lateral saddle, near the anterior end of this shell, reaches more than one and one-half times the width of the preceding lobe. As is the external one, this saddle is subsymmetrically divided by a shallow lobule, with a comparatively pointed horn rising from the inner main stem just dorsad of the lobule. The horn is more pronounced in the posterior half of this whorl than in the anterior one. The trapezoidal median knob is lower and broader in the anteriormost suture lines than in the preceding ones and subdivided by a triangular notch. It should be pointed out that the suture lines shown in de Loriol's text figure 27 (1898) and in his figure 6b (1900) do not show the reduced character of those here described.

All the features recorded above characterize these lines as true *Mirosphinctes* sutures.

REMARKS: The generic affinities of this rare and interesting species have remained doubtful and controversial in previous literature. De Loriol refers it to *Perisphinctes*, Maire to *Aspidoceras*,[1] but both authors, when first dealing with this form, were somewhat puzzled as to what to do with it. In his paper of 1900, however, de Loriol clearly recognized its affinities to *P. mirus* (and "*P.*" *perisphinctoides*), thus referring it to the genus *Mirosphinctes*, based only 26 years later on the former species. This generic reference is here maintained; it is believed to be justified by the ornamentation and sutural characters pointed out in the above description.

The thinness of the disk and the peculiar trend of the ornamentation to vanish at a more or less early stage distinguish this species so readily from all other perisphinctids dealt with in the present report, including the two congeneric species, that more detailed comparisons can be dispensed with.

It may, however, be well to point out that in some ornamentational characters, for example, in the development of parabolic nodes into beads, this form approaches also *Aspidoceras* (*Euaspidoceras*) *perisphinctoides*, as recognized long ago by de Loriol.

Mirosphinctes kobyi is compared below with the equally slender *Aspidoceras* (*Euaspidoceras*) *douvillei* (p. 179).

From juveniles of some *Hecticoceras*, especially of the subgenus *Brightia*, nearly smooth shells of the present species can be distinguished only by their entirely different suture lines and by the parabolic nodes, where present. This is another interesting case of homeomorphy encountered in the present assemblage (cf. pp. 19, 22, 26).

MATERIAL STUDIED: Eleven specimens.

[1] Thereby making *Euaspidoceras Kobyi* (Rollier) Jeannet (*loc. cit. in synon.*) a possible junior homonym.

ASPIDOCERATIDAE ZITTEL, 1895

SUBFAMILY ASPIDOCERATINAE ZITTEL, 1895

ASPIDOCERAS ZITTEL, 1868, SENSU LATO

SUBGENUS EUASPIDOCERAS SPATH, 1931

Among the Perisphinctaceae of the Mount Hermon assemblage this subgenus is second in abundance only to the genus *Perisphinctes*, *sensu lato*, but it is closely matched in this respect by the genus *Mirosphinctes*.

Of altogether 486 specimens referable to *Aspidoceras* (*Euaspidoceras*), eight, mostly fragments, are too poorly preserved for specific determination. The remaining 478 individuals are referred to seven species of this subgenus, two of them with one variety each.

The fact that species first described from England, France, the Jura Mountains of Switzerland and Swabia, Russia, and India are recognizable in the present fauna proves once more the cosmopolitan character of these Oxfordian ammonites.

Aspidoceras (Euaspidoceras) perisphinctoides Sintzov

A. *Forma typica*

Plate 27, figures 1–23

Aspidoceras perisphinctoides n. sp., SINTZOV, 1888, p. 116, pl. 2, fig. 12.

Perisphinctes mirandus, P. DE LORIOL, 1898, p. 88, *pro parte*, pl. 6, figs. 16, 17, *non* 15.

Perisphinctes perisphinctoides, Sintzov; DE LORIOL, 1900, p. 81, *pro parte*, pl. 5, figs. 12–14, ?17, *non* 15, 16, 18–20.

Perisphinctes perisphinctoides, Sintzov; DE LORIOL, 1902, p. 64.

Aspidoceras perisphinctoides Sintzow; ROLLIER, 1909, p. 616.

?*Perisphinctes perisphinctoides* Sinzow et var. *armata* de Lor.; DE GROSSOUVRE, 1922, p. 313, *pro parte*.

?Klematosphinctes perisphinctoides (Sinzow); SPATH, 1931, p. 395, pl. 60, fig. 5.

Aspidoceras perisphinctoides Sintzow; MAIRE, 1932, p. 38.

DIMENSIONS

A.M.N.H. No. 27816	D	H	H′	W	U
63	4.10 mm.	37½	32½	62½	35
64	4.92 mm.	39½	32½	62½	31½
1	4.92 mm.	38½	34	54½	32
2	5.04 mm.	35½	31	60	33½
3	5.26 mm.	34	27½	53	38
4	5.60 mm.	40	*ca.* 32	56	36
5	5.82 mm.	34½	32½	57½	40½
6	6.16 mm.	36½	32	56½	38
7	6.27 mm.	35	?	55½	36
8	6.27 mm.	32	28½	50	46½
9	6.38 mm.	38½	33½	59½	35
10	6.38 mm.	37	31½	58	34
11	6.50 mm.	38	*ca.* 34½	60½	33
51	6.94 mm.	34	*ca.* 30½	55	35½
12	7.17 mm.	36	?	62½	33½
17	7.73 mm.	40½	35	56½	35
18	7.73 mm.	37	33	*ca.* 55	35½
13	7.73 mm.	39	32	56½	35
14	7.84 mm.	40	*ca.* 35½	60	33
52	7.84 mm.	35½	28½	55½	35½
15	7.95 mm.	36½	33	53½	34
16	8.18 mm.	33	30	55	38½
23	8.29 mm.	42	35	51½	34
20	8.40 mm.	37½	31½	50½	34
21	8.40 mm.	39½	33½	56	34½
22	8.62 mm.	35	32½	54½	37½
27	8.96 mm.	35	*ca.* 31	*ca.* 51	38½
62	8.96 mm.	37½	?	50	32½
61	9.07 mm.	39½	?	55½	32
24	9.18 mm.	40	35½	48	32
25	9.18 mm.	39	33	51	33
26	9.18 mm.	35½	?	57½	39
28	9.52 mm.	39	35½	48	32
29	9.52 mm.	40	34	53	35½
30	10.08 mm.	38	32	50	35
31	10.42 mm.	33½	?	55	33½
32	10.86 mm.	38	35	55½	34
33	11.20 mm.	40½	35	50	36
34	11.20 mm.	40	*ca.* 37	52	36
35	11.42 mm.	39	35	55[1]	34½
36	11.98 mm.	36½	32	53½	36½
38	14.1 mm.	41	35½	51½	39
39	14.6 mm.	39	34½	55½	38½
40	15.2 mm.	41	35	50	39
41	15.7 mm.	39½	37	56	39½
42	16.4 mW.	38	*ca.* 34½	49½	39½
43	18.0 mm.	40	36	45½	34
44	18.0 mm.	35	?	45	37
45	19.0 mm.	41	36½	53	35½
46	21.0 mm.	39½	33½	43½[2]	28
47	21.0 mm.	35	30½	44½	39
49	21.1 mm.	35½	*ca.* 33	45½	35½
50	21.1 mm.	38	32	43	39
56	24.9 mm.	37½	?	41	37½
55	26.0 mm.	38½	34½	45½	38½
53	26.1 mm.	40	32	50½	32
54	26.9 mm.	37	?	38½[3]	36½
57	28.0 mm.	40½	?	?[2]	34½
58	28.1 mm.	35½	?	?[4]	37½
59	30.0 mm.	?43½[4]	?	?[4]	32
60	31.0 mm.	35½	?	39½	42½

B. Var. **margaritata**, new name

Plate 27, figures 24–38

Cf. *Aspidoceras perarmatum* (Sow.) Neumayr; SINTZOV, 1888, p. 116, pl. 2, fig. 14.

Perisphinctes perisphinctoides, Sinzov; DE LORIOL, 1900, p. 81, *pro parte*, pl. 5, figs. 15, 16, 18–20 only.

DIMENSIONS

A.M.N.H. No. 27817	D	H	H′	W	U
1	6.83 mm.	33	29½	54	39½
2	8.51 mm.	37	?	*ca.* 52½	37
24	8.51 mm.	35½	33	55½	35½
21	8.74 mm.	38½	32	55	36
3	9.30 mm.	37½	30	50½	35½
4	10.08 mm.	39	?	55½	35½
5	10.08 mm.	38	*ca.* 32	50	36½
6	10.08 mm.	36½	?	45½	39
7	10.42 mm.	39	32	52½	33½
10	10.75 mm.	38½	35½	56	36½
8	11.54 mm.	38	32	56½	34
11	11.76 mm.	37½	33½	52½	33½
9	12.30 mm.	42	?	*ca.* 52½	40
25	12.43 mm.	40	?	50½	38
12	12.88 mm.	36½	33	57½	40
13	12.88 mm.	39	?	57½	35½
14	12.99 mm.	38	34½	51½	33½
15	13.10 mm.	37½	31	54½	38½
17	13.10 mm.	41	36	58	32½
16	13.66 mm.	38½	34½	56½	36
18 (holotype)	15.0 mm.	42½	36½	56½	34
19	16.1 mm.	38½	31½	43½	30
20	17.3 mm.	42	34	63[5]	35½

Two other specimens (A.M.N.H. Nos. 27817:22 and 23), which seem also to be referable to this variety, attain diameters of 18.5 and 33 mm., respectively, but they are not well enough preserved to be measured.

Because no essential differences between the typical form and the var. *margaritata* show in the above tables the dimensions of

[1] Slightly deformed.
[2] Crushed.
[3] Last quarter whorl does not increase in width.
[4] Crushed anteriorly.
[5] Owing to high circumumbilical tubercles

both forms may be discussed together. There is a general trend of the width to decrease with growth; the largest shell measured (A.M.N.H. No. 27816:60) is also the thinnest, if the somewhat abnormal specimen A.M.N.H. No. 27816:54, which ceases to increase in width about a quarter-whorl behind its anterior end, is here left out of account. On the other hand, the near maximum for W ($62\frac{1}{2}$) is found in the two smallest individuals measured (A.M.N.H. Nos. 27816:62, 63) and in another small one (A.M.N.H. No. 27816:12). It is true that an even slightly greater width (63) is encountered in the largest measured individual of the var. *margaritata* (A.M.N.H. No. 27817:20) which is of medium size, but here this is due to the height of the circumumbilical tubercles.

Although many small and medium-sized individuals have part of the living chamber preserved, the largest measured specimen (A.M.N.H. No. 27816:60) is still septate throughout. In the largest but one (A.M.N.H. No. 27816:59) the last septum corresponds to a diameter of 19 mm.; about half of a whorl belongs to the body chamber, but the latter is not completely preserved. Nor is it complete in the juvenile A.M.N.H. No. 27816:28, attaining less than 10 mm. in diameter, where, beginning at a diameter of about 5 mm., it occupies even two-thirds of the last volution. All that can be inferred from these data is that this species reached a diameter considerably beyond that of from 30 to 33 mm. found in its largest shells from both the Jura Mountains and Mount Hermon, and that the body chamber occupied more than half of a volution.

Designation of Type: The smaller of the two specimens figured by Sintzov (*loc. cit. in synon.*), which is a full disk, is selected as lectotype of *A.* (*E.*) *perisphinctoides* Sintzov. Should, however, both specimens figured by him belong to the same individual, then this individual would be the holotype of this species.

Description: This species is very variable, especially as far as the details of its ornamentation are concerned. Its whorl section, however, remains fairly constant, except for gradually decreasing in width with growth. Thus it is transversely oblong in early stages (figs. 6, 14) but becomes subquadratic in maturity (fig. 19). Throughout development, however, the flanks, as well as the venter, are flattened or only gently convex. This makes for comparatively high lateroventral shoulders. The umbilical shoulder is well rounded and the umbilical wall slopes at an angle of about 45 degrees.

In the smallest individual present of the typical form (A.M.N.H. No. 27816:63, fig. 2) ornamentation appears at a diameter of about 2 mm. in the form of tiny, at first not well-defined tubercles on about the middle of the flanks. Within half of a volution they change into fine, somewhat sinuous, prorsiradiate ribs which gradually become stronger and stiffer and at a diameter of about 3.5 mm. run all over the sides, though still culminating in their middle (A.M.N.H. No. 27816:64, fig. 4; A.M.N.H. No. 27816:3). At a diameter of about 4.5 mm. differentiation between primary and secondary ribs sets in. About every fourth rib is slightly stronger than the ribs between and carries an indication of a tubercle in the outer half of the flanks. Only a little later in ontogeny some ribs bifurcate at the same place. At diameters from less than 4 mm. to 4.5 mm. the venter carries only indistinct growth folds varying in strength, but later it is crossed by the secondary ribs in a shallow, forward convex arc. To the naked eye the venter at this stage appears almost smooth. On the outer volution of A.M.N.H. No. 27816:3 altogether 23 ribs (or, in its first quarter, tubercles) are present on the sides, whereas about 11 delicate ribs, varying in distinctness, can be counted on the venter in the anteriormost quarter of this volution. Another juvenile (A.M.N.H. No. 27816:6) is illustrated in figure 5 for its strongly prorsiradiate and slightly sigmoidal ribs, 21 of which are counted on the last volution. An only somewhat larger juvenile (A.M.N.H. No. 27816:16), with markedly depressed whorl section (H:W=3:5), deserves mention and illustration (figs. 9–11) for exhibiting the next stage in ornamentational development. In its outer volution the total number of ribs on the sides has increased to 34; in the anterior half of this volution only five primary ribs can be seen to bifurcate more or less distinctly at the middle of the flanks or, exceptionally, in their inner half. In three of these primary ribs, however, the two branches produced by bifurcation unite again on the lateroventral shoulder, thus forming a "lacet." Elsewhere in this half whorl, three secondary ribs are intercalated, without bifurcation, between two primary ones. The ribs, chiefly the primary ones, tend to assume a sigmoidal course. In this individual for the first time parabolic nodes appear on some primary ribs, from a diameter of about 5.4 mm. on, which become quite pronounced only a little later in ontogeny, at a diameter of 6.5 mm. (figs. 9, 10). On the venter the costae are still weak, occasionally hardly recognizable, and only quite shallowly arcuate forward. The juvenile A.M.N.H. No. 27816:17, however, representing about the same growth stage but exhibiting only faint indications of parabolic nodes, is remarkable for showing, especially on the venter, delicate, shallowly engraved growth striae which parallel the blunt ventral costae in their course and of which about 25 can be counted on the last quarter-whorl. A narrow siphuncular band is crossed by these fine growth striae (fig. 12). The same delicate growth striation is recognized on the venter and in the outer part of the sides of A.M.N.H. No. 27816:30, which otherwise, although somewhat larger than No. 27816:16, described above, exhibits about the same character of ornamentation. Here about 30 such growth striae are present on the last quarter-whorl (fig. 13).

A juvenile attaining a diameter of about 8 mm. (A.M.N.H. No. 27816:65) agrees in ornamentation best with No. 27816:6, described above, but in the first quarter of its outer whorl has the outer ends of the ribs raised to form distinct tubercles, a character that makes this specimen transitional to *A.* (*E.*) *subcostatum*. It is here mentioned also for exhibiting at a diameter of about 4.5 mm. an indication of a constriction that runs parallel to the ribs, a perisphinctid feature only rarely observed in the present genus.

At a medium size ornamention seems to become less regular and more diversified. Thus A.M.N.H. No. 27816:43 (fig. 22), in which the anterior half of the outer whorl belongs to the body chamber, is characterized by 15 sharp and high primary ribs on the outer volution. They are rather stiff and strongly prorsiradiate in its beginning but much less so in the middle of this whorl where they become distinctly forward concave on the flanks. On the lateroventral shoulder they form blunt parabolic nodes which assume the shape of trapezoidal or subquadratic tongues pointing backward. Secondary ribs are added by bifurcation or intercalation. The ribs can best be counted on the venter where they are now quite distinct and gradually become nearly uniform; they cross the venter in a straight or only gently forward arcuate line. They number 30 per half whorl, up to five connecting the parabolic nodes of each pair across the venter.

The same style of ornamentation prevails in A.M.N.H. No. 27816:46, only 3 mm. larger in diameter than the one just described, except that the ribs are less sinuous and the parabolic nodes not so flat and less extended backward. Here, too, 15 primary ribs can be counted on the last whorl. There are altogether 28 ribs on the venter in the posterior half of this volution, which are weaker than in A.M.N.H. No. 27816:43. A.M.N.H. No. 27816:47 (figs. 15, 16), of the same size as No. 27816:46 but septate throughout, is distinguished by 15 particularly strong primary ribs on its last whorl; they run sometimes nearly straight across the sides. In the anterior half of this whorl only one secondary rib or even none is seen in the intervals between the primary ones. More than 60 quite pronounced ribs are counted on the venter of this whorl. Whereas they run nearly straight across it, the strong nodes riding on the lateroventral shoulders are often connected by strongly parabolic ridges, perhaps indicating former apertural margins ("Reste resorbierter Mundränder," Noetling, 1887, p. 29). Except for the greater density of the ventral costation, this ornamentation greatly resembles that shown in de Loriol (1898, pl. 6, figs. 16, 16a).

The two largest shells of the typical form (A.M.N.H. Nos. 27816:59, 60) bring the ornamentational trends just described to even fuller realization. The former individual, with the anterior half of its last volution belonging to the body chamber, shows strong primary ribs which form large "lacets" on the flanks. One of these primary ribs, clearly seen on the left side of figure 20, assumes a complete S shape instead. In ventral view (fig. 21) strongly developed lateroventral nodes are seen on the primary ribs. They are connected, as in the last specimen described, by parabolic or broad-trapezoidal ridges, markedly contrasting in their course with that of the ribs which cross the venter straight. Most remarkable in this shell, however, is the abrupt change in the anteriormost sixth of the outer whorl to a strictly perisphinctoid ornamentation (?proterogenesis). Here the primary ribs are much more closely set, straight and stiff, and bifurcate quite regularly at the outer third of the sides. Of the 13 primary ribs counted on the outer whorl five are crowded together in its anteriormost sixth. On the venter 32 ribs are present in the anterior half of this volution. The largest measured shell (A.M.N.H. No. 27816:60, figs. 17–19), which is septate throughout, does not show any such sudden change in the character of ornamentation. Its primary ribs are more closely and more regularly set than in the preceding specimen. Fourteen are counted on the outer whorl; most carry parabolic nodes which here exhibit the shape of narrow drops strongly extended backward. No relics of old apertural margins are recognizable, but three intercostals in the anterior half of the outer whorl, wider and deeper than the others, appear, on the venter only, like constrictions.

In the var. *margaritata* the ornamentation seems to undergo ontogenetic changes similar to those in the typical form. Throughout development, however, the costation is finer and denser, and the parabolic nodes gradually assume the shape of more or less regular beads. This last character has suggested the varietal name. The following individuals have been selected to illustrate the peculiarities of this variety in ornamentation:

A.M.N.H. No. 27817:1 (figs. 24, 25), diameter 6.83 mm., altogether 42 ribs on last whorl; only in anterior half can four of these be recognized as primary ribs which at a diameter of 5.8 mm. begin to develop nodes.

A.M.N.H. No. 27817:21 (fig. 36), diameter 8.74 mm., altogether 34 ribs, which become sigmoidal towards anterior end, on last whorl. Nodes appear at a diameter of 6.7 mm. and are bead-shaped from the beginning.

A.M.N.H. No. 27817:3 (fig. 28), diameter 9.30 mm., with closely set. bead-shaped nodes.

A.M.N.H. No. 27817:4 (figs. 29, 30), diameter 10.08 mm., altogether 38 ribs on sides of outer whorl, of which 17, by their greater strength or by forming "lacets" or nodes, can be recognized as primary. The former appear at a diameter of 5.6 mm., the latter at a diameter of 9.5 mm. and are bead-shaped from the beginning. One pair is connected by a strongly convex parabolic ridge across the venter. Not only primary but secondary ribs bifurcate in anterior half of last volution. Ribs particularly fine on venter.

A.M.N.H. No. 27817:6 (figs. 26, 27), same diameter as, and quite similar in ornamentation to, preceding specimen, with altogether 46 ribs on last whorl, well-developed beads from a diameter of 7.3 mm., and parabolic connections across the venter between beads.

A.M.N.H. No. 27817:17 (figs. 34, 35), diameter 13.1 mm., with altogether 45 ribs on sides of last volution and strongly developed "lacets," referred to this variety on account of density and fineness of costation rather than of parabolic nodes of which the shape is more as in the typical form but not bead-like in any pronounced way.

A.M.N.H. No. 27817:18 (figs. 31–33), selected as holotype of this variety, diameter 15 mm., with altogether about 40 ribs, of which 10 are primary, on the sides of outer whorl. Throughout, the primary ribs first form "lacets," then nodes which soon assume bead shape.

A.M.N.H. No. 27817:20 (figs. 37, 38), diameter 17.3 mm., septate throughout, with altogether 45 ribs on sides of last whorl, remarkable for developing in anteriormost quarter high circumumbilical tubercles at about the inner third of the flanks in addition to the lateroventral beads, and for the great number of the latter (13 on the outer volution).

Even more of these beads (17 on the outer whorl) are counted in the largest specimen present (no. 23, diameter 33 mm.), which is too poorly preserved to be figured. Circumumbilical tubercles also seem to be present.

At a diameter of about 4 mm. the suture line of the typical form, as studied in specimen A.M.N.H. No. 27816:7 (figs. 7, 8), shows a rather deep and slender siphonal lobe ending in two parallel points which are separated by a low, almost quadratic median knob; a broad external saddle extending well into the flank and divided by a short lobule into two unequal stems, the outer of which is more than twice as wide as, and a little higher than, the inner; a trifid lateral lobe, which attains only a little more than half of the depth of the siphonal one; a broad lateral saddle, indented by a shallow lobule and slightly exceeding the external one in height; and on the umbilical wall a short and slender auxiliary lobe, followed by an auxiliary saddle. The same sutural characters are recognized at diameters up to 10 mm., in specimens A.M.N.H. Nos. 27816:10, 11, 17, (fig. 12), 19, 21, 22, 24, 30, (fig. 13), and 34 (fig. 23). The suture line of course becomes gradually more elaborate with increasing size, and the siphonal lobe is broader, the wider the venter in the individual specimen. In the larger specimens enumerated above, a second auxiliary lobe becomes half visible immediately above the umbilical seam. A later sutural stage can best be studied in A.M.N.H. Nos. 27816:46, 47 at diameters of about 13 mm. and about 17 mm., respectively. Suture lines of the latter specimen are well seen in figures 15 and 16. The general plan is still the same, but richer indentation is now observable all along the line. The median knob is higher, more slender, and ends in three tiny cusps; the slender siphonal lobe shows two lateral points above the terminal ones; the lobule of the external saddle is now deeper and bifid; the first lateral lobe now attains about three-fifths of the depth of the siphonal one; the lateral saddle is more deeply subdivided; both the second lateral lobe (which had to be termed the first auxiliary at an earlier stage), and the first auxiliary lobe are now quite slender and irregularly trifid; a new auxiliary saddle has appeared beyond the latter. This suture line agrees excellently with the one depicted by de Loriol (1900, pl. 5, fig. 12a). Except for some further progress in elaboration, the sutural pattern is still the same even in the largest shells of the typical form (A.M.N.H. Nos. 27816: 59, 60; figs. 17, 18, 20).

The var. *margaritata*, of which A.M.N.H. Nos. 27817:16, 17, and 20 (figs. 37, 38) show the suture lines best, does not seem essentially to differ in its sutural characters from the typical form, except that the first lateral lobe seems to be somewhat deeper. In paratype A.M.N.H. No. 27817:16 it attains about two-thirds, and in paratype No. 27817:20 about seven-tenths, of the depth of the siphonal lobe. The siphonal portion of the suture line of No. 27817:20, particularly elaborate for the diameter of less than 15 mm., can well be seen in figure 37.

REMARKS: Sintzov considered this species, as he indicated in its name, a *Perisphinctes*-like *Aspidoceras*, but de Loriol, after its identity with his *Perisphinctes mirandus*[1] had been brought to his attention, transferred it to the genus *Perisphinctes*. From de Loriol's (1900, p. 84) description of his var. *armata* of the present species it would seem that the presence of true parabolic nodes made him refer this form and related ones to *Perisphinctes* rather than to *Aspidoceras*. However, the study of the ontogeny of the present species leaves no doubt but that the tubercles and spines of some *Aspidoceras* also originate from parabolic nodes or are at least homologous.

In his reference of this form as well as of "*Perisphinctes billodensis*" to *Perisphinctes*, de Loriol was, however, not followed by later authors (except de Grossouvre, 1922, p. 313, and Frebold, 1928, p. 191). After Rollier (1909, p. 616) had pointed out the perisphinctid affinities of these forms but nonetheless included them in *Aspidoceras*, Collot (1917, p. 7) opposed de Loriol's views, and his attitude met with Maire's (1932, pp. 38, 41) full approval. Spath (1931, *passim*, especially p. 599) and Arkell (1939, p. 162) share the conception of the French authors.

All the students admit, however, that juveniles of the species concerned can only with great difficulty if at all be distinguished from certain perisphinctids of the same size. This holds true especially for the present species which, of all aspidoceratids of the subgenus *Euaspidoceras*, shows the greatest resemblance to perisphinctids, especially the genus *Mirosphinctes*. As the latter plays a dominant part in the Mount Hermon assemblage, separation of these two groups proved a particularly crucial task in the present study. Whereas the following *Euaspidoceras* forms become readily distinguishable from *Mirosphinctes* at medium growth stages and certainly seem quite different in ma-

[1] *Perisphinctes mirandus* is, however, maintained as an independent species for the form depicted in de Loriol's figure 15 by Spath (1931, p. 394, pl. 57, fig. 1, pl. 60, fig. 4) under the generic name *Klematosphinctes* and by Arkell (1939, p. 157, pl. 9, figs. 4, 5) under the generic name *Grossouvria*.

turity, the decision as to whether to assign the individuals eventually referred to this species to *Microsphinctes* or to *Euaspidoceras* remained a rather delicate one, except for the very largest shells. In particular, the following criteria were relied on for the separation of *A.* (*E.*) *perisphinctoides* from *Mirosphinctes*, especially from *M. syriacus* and, in some cases, also from *M. regularis*. The whorl section, at the earliest stages but even more so in maturity, shows a more truncate venter and flatter flanks and accordingly higher and less rounded lateroventral shoulders. Furthermore, the whorl section of *A.* (*E.*) *perisphinctoides* remains, at least in the present assemblage, wider than high throughout development, whereas this ratio is mostly reversed from a diameter of about 25 mm. on in both *M. syriacus* and *M. regularis*. Even more useful for the distinction under discussion are, however, ornamentational characters. In the present species blunt tubercles which soon change into short, strong, node-like ribs appear first. At later stages there is more differentiation among the ribs than in *Mirosphinctes*, both on the flanks where the primary ribs stand out more strongly[1] and between those on the flanks and those on the venter, the costae on the latter being much finer and much more numerous than those on the sides. Also in this species the ribs from an early stage tend to run radially or in a prorsiradiate sense and never assume the recurved aspect characteristic of the costae of *Mirosphinctes*. Sutural characters, however, are of no value for distinguishing the present species from those referable to *Mirosphinctes* (see above, p. 152, with footnotes 2 and 3).

Aspidoceras (*E.*) *perisphinctoides* is certainly transitional from the perisphinctids of the *Mirosphinctes* group to the more typical species of *Euaspidoceras*, dealt with below, especially to *A.* (*E.*) cf. *subbabeanum* and *A.* (*E.*) *subcostatum*. The other species of *Euaspidoceras*, described below in order of decreasing similarity with the perisphinctids, are compared with *A.* (*E.*) *perisphinctoides* on pages 175, 178, 179, and 184.

With regard to the synonymies preceding the tables of dimensions of both the typical form and the variety *margaritata* of the present species, reference is made to footnote 1 of page 170 with regard to *Perisphinctes mirandus* de Loriol. Of the forms included in "*P.*" *perisphinctoides* by de Loriol in 1900, only those depicted in his figures 12–14 are here without doubt referred to the *forma typica*, but those illustrated in his figures 15, 16, and 18–20, which clearly show the finer costation and the beads considered characteristic of the var. *margaritata* are referred to this variety. The specimen figured by Sintzov (1888, pl. 2, fig. 14) under the name *Aspidoceras perarmatum* (Sow.) Neumayr shows the same character of ornamentation as this variety but is more slender and has a more rounded internodal whorl profile. The specimen illustrated by de Loriol (1900) in figure 17, to judge by the character of the costation, may be a *Mirosphinctes* and is therefore only doubtfully listed in our synonymy, as is Spath's (1931) fragment which is believed to be too incomplete for precise identification.

Material Studied: Altogether 141 specimens, including fragments; of these 41 are referred to the variety *margaritata*.

Aspidoceras (Euaspidoceras) subcostatum Spath

Plate 28, figures 4–45

Aspidoceras babeanum d'Orbigny; de Loriol, 1898, p. 108, *pro parte*, text fig. 28; 1899, pl. 8, figs. 4, 5, ?2, *non* 1, 3.

Euaspidoceras babeanum (d'Orbigny), var. *subcostata*, nov.; Spath, 1931, p. 591, *cum synon.*, pl. 116, fig. 5, pl. 111, fig. 4.

Aspidoceras (*Euaspidoceras*) *babeanum* (d'Orbigny) var. *subcostata* Spath; Arkell, 1939, p. 162, *cum synon.*, pl. 9, figs. 7–9.

Dimensions

A.M.N.H. No. 27818	D	H	H′	W	U
1	4.37 mm.	36	28	60	38½
2	4.37 mm.	38½	31	59	33½
3	4.70 mm.	35½	28½	59½	35½
4	4.70 mm.	33½	26	52½	40½
5	4.70 mm.	39	28½	64	33½

[1] It should, however, be noted that a similar strong reënforcement of the primary ribs is also sometimes observed at diameters from about 10 mm. to about 25 mm., in *Mirosphinctes*, e.g., in specimen A.M.N.H. No. 27760:60 of *M. syriacus*, where this condition, however, then gives way rather abruptly to a typical *Mirosphinctes* ornamentation (p. 155, and pl. 24, fig. 37; see also p. 152, footnote 4, and p. 196).

A.M.N.H. No. 27818	D	H	H′	W	U
6	4.82 mm.	39½	28	63	32½
7	4.82 mm.	37	31½	60½	32½
11	4.93 mm.	36½	32	59	34
8	5.04 mm.	?44½	?40	66½	33½
14	5.04 mm.	40	33½	60	31
9	5.26 mm.	34	30	55½	38
10	5.26 mm.	36	30	59½	36
13	5.26 mm.	40½	34	59½	32
15	5.15 mm.	37	?28	58½	39
17	5.38 mm.	37½	29	53	37½
18	5.38 mm.	37½	29	60½	37½
19	5.49 mm.	39	30½	61	34½
22	5.60 mm.	40	28	60	34
23	5.60 mm.	40	32	62	30
24	5.60 mm.	34	29	60	38
77	5.60 mm.	38	*ca.* 32	68	32
25	5.60 mm.	40	34	53	30
26	5.71 mm.	37	32½	59	33½
20	5.77 mm.	41	35	66	29
21	5.77 mm.	42	35	58½	31½
27	6.16 mm.	38	32½	62	38
28	6.16 mm.	34½	27½	51	36½
29	6.38 mm.	40½	35	59½	35
37	6.50 mm.	38	31	58½	32½
38	6.50 mm.	39½	30	65½	31
30	6.61 mm.	35½	?	54	34
31	6.61 mm.	35½	29	54	37½
39	6.72 mm.	40	33½	60	36½
40	6.83 mm.	36	29½	60	36
42	7.50 mm.	37½	31½	59½	31½
35	7.60 mm.	37	29½	60½	35½
41	7.73 mm.	36	29½	53½	33½
44	8.62 mm.	35	31	52	36½
45	9.07 mm.	36	31	57	37
46	9.52 mm.	36½	30½	54	35½
51	9.52 mm.	39	30½	55½	35½
47	9.74 mm.	40	?	57½	37
53	10.08 mm.	38	32	59	35½
48	10.53 mm.	37½	34	57½	36
52	10.53 mm.	38½	32	53	36
49	10.64 mm.	41	35	52½	37
54	10.86 mm.	37	33	59	35
50	11.65 mm.	37½	31½	60½	38½
55	12.43 mm.	?42½	?36	56	37
56	12.77 mm.	36	?	52	37½
57	16.1 mm.	39[1]	?	55[1]	38[1]
58	16.1 mm.	39	*ca.* 33½	51	38
59	16.9 mm.	38	31½	*ca.* 49	36
60	17.9 mm.	38	*ca.* 34½	55½	36½
61	18.9 mm.	39½	34½	49	34½
62	19.0 mm.	40½	*ca.* 37	61½	39
63	19.5 mm.	41	?	50½	33½
64	19.6 mm.	43	35½	55	35
65	20.0 mm.	40½	?	58	34½
66	20.4 mm.	38½	?	50½	40½
67	*ca.* 24.0 mm.	41½[2]	?	61[2]	38½[2]
68	25.2 mm.	42	?	47½	37
69	25.5 mm.	39	?	54½	34½
71	26.1 mm.	38	*ca.* 34	52	39
72	27.4 mm.	41	?	56	38½
73	28.5 mm.	41	?	52	38
75	35.4 mm.	43	?	48	33
76	*ca.* 43.5 mm.	43[3]	?	?[4]	32½[3]

[1] Measured at D=13.4 mm.
[2] Measured at D=22.3 mm.
[3] Measured at D=42 mm.
[4] Crushed.

Within the above table the small specimen number 8 exhibits the absolute maxima for H and H′ and comes close to the maximum for W, but its measurements are not fully reliable. If it is left out of consideration, the next highest values for H are found among the largest shells (nos. 64, 75, 76) and the lowest among the small ones (nos. 9, 24). The maximum for W (68) is encountered in the small shell no. 77, the minimum for this value, 47½, in the comparatively large specimen number 68, and the near minimum of 48 in the largest but one (no. 75). Thus trends of the height of the whorls to increase and of their width to decrease with growth are recognizable.

In general, the umbilicus is wider in large shells (nos. 66, 67, 71–73) than in small ones but the maximum of 40½ for U is found in one of the smallest (no. 4) as well as in number 66; on the other hand, the narrowest umbilicus also is measured in a small shell (no. 20). Thus no definite trend can be deduced here.

Designation of Type: Damon's specimen from Weymouth, refigured by Spath (*loc. cit. in synon.*) is, on designation by Arkell (1939, p. 162), the holotype of the var. *subcostata* Spath of *A.* (*E.*) *babeanum* (d'Orbigny) and therefore also of *A.* (*E.*) *subcostatum* Spath.

Description: Early in development the whorl profile of this species is characterized by a highly arched venter which occupies about half of the total height of the whorl, by a pronounced ventrolateral shoulder which marks the point of maximum whorl width, and by narrow flanks which slope at an angle of about 45 degrees towards the umbilical shoulder. The latter is rounded, and the umbilical wall is comparatively high and almost perpendicular. All these characters combine to lend a reniform aspect to the whorl section (specimen no. 4, fig. 4).

As seen in this individual (figs. 4, 5) and in specimen number 13 (fig. 6), among many others, the lateroventral shoulder up to diameters from 2.5 mm. to 4 mm. forms a distinct edge which is even further accentuated by the tubercles riding on the shoulder at this early stage.

These tubercles, representing the first elements of ornamentation, appear in specimen number 4 at a diameter of about 2 mm. They are quite pronounced, not to say sharp, in specimen number 15 even at this early stage. After about a quarter of a whorl they change into short, coarse, prorsiradiate ribs which run across the narrow flanks. Twenty-two such tubercles and ribs are present on the outer volution of specimen number 4.

The whorl profile is still reniform at the somewhat later stage represented by specimen number 22 (fig. 7), but the flanks have become somewhat less, and more evenly, convex and no longer slope towards the umbilical shoulder. Some such sloping shows again, however, in the whorl section of the somewhat larger juvenile number 27 (fig. 10). That of number 39 (fig. 17) approaches a transverse-oblong shape, with the venter much less highly arched than at the earliest stages and the flanks beginning to flatten.

During the ontogenetic stage just dealt with the ribs become less coarse and extend all over the sides from the umbilical shoulder to somewhat beyond the lateroventral one; they are straight and more or less prorsiradiate as a rule (figs. 6, 9, 15), only exceptionally sinuous (anteriormost quarter-whorl of specimen number 39, fig. 16). In some individuals, as in number 27, the outer ends of these ribs begin to be slightly raised, thus giving in ventral view (fig. 8) the first indications of peripheral tubercles. In most cases the venter appears at this stage to be smooth, except for some faint indications of growth folds (fig. 8). Exceptionally, as in the anteriormost portion of specimen number 11, with proper illumination the ribs can be seen to continue, though indistinctly, straight across the venter. There are no secondary ribs at this stage, and the costation is comparatively dense, there being from 11 to 13 ribs on the last half-whorl.

The further development of ornamentation is marked by the differentiation between primary and secondary ribs, which sets in at a diameter of from 6 mm. to 7 mm., and by the simultaneous formation of parabolic nodes, which soon develop into horn-like outer tubercles. At diameters of 8 mm. and 10 mm. from three to seven secondary ribs can be counted between two primary ones. The former originate mostly by intercalation. Secondary ribs bifurcate occasionally, primary ones only rarely. In these cases the two branches thus formed often reunite, after forming a "lacet," in a parabolic node. All told, from 17 to 26 ribs can be counted at this stage on the last half-whorl. They now become quite distinct on the venter, which they cross in a shallow forward convex arc, but here they are much weaker than even the secondary ribs are on the sides, and nearly uniform. As soon as the outer tubercles have become horn-like, they strongly influence the nodal whorl profile, marking the site of the ventrolateral edge by a sharp corner. The developments described in this paragraph are illustrated best by specimens numbers 49 and 50, the former exhibiting a rather coarse, the latter a more delicate, ornamentation (figs. 26–28, 18–20).

Numbers 67, 68, and 71, all measuring about 25 mm. in diameter, serve to illustrate the next ontogenetic stage. The secondary ribs decrease in number in the anterior halves of the outer volutions of specimens 67 (fig. 36) and 71 (figs. 24, 25), only one such rib remaining in the intervals between the primary ones and thus making for an altogether less dense costation, and inner tubercles develop on the umbilical shoulder. By this style of ornamentation specimen 67 comes to agree perfectly with the holotype, whereas specimen 71 resembles most closely the one illustrated in Arkell's (*loc. cit. in synon.*) figure 8 which is, however, a little stouter. Reduction of the secondary ribs appears to be retarded in specimen number 68 (figs. 21, 22), in which the costation remains dense and comparatively fine up to a diameter of 22.5 mm. Then the inner portions of the primary ribs quite abruptly assume the shape of strongly raised, forward concave crescents, comparable to the inner part of the S-shaped rib noted and illustrated (pl. 27, fig. 20) above in specimen number 59 of *A.* (*E.*) *perisphinctoides*. These crescents seem to give rise to the inner tubercles. The whorl section of this individual, shown in frontal view (fig. 21) and agreeing well with Arkell's (*loc. cit. in synon.*) figure 8a, may be considered characteristic of this stage. With venter and flanks equally gently convex it approaches a subquadratic shape.

A similar but markedly wider whorl profile can be seen at the anterior end, corresponding to a diameter of about 27 mm., of the whorl fragment number 70 (fig. 13). This fragment is also remarkable for its regular ornamentation, consisting of 10 ribs on a quarter-whorl. They are rather stiff and straight and do not show much difference between primary and secondary ones, except that only the former on the anterior part of this fragment carry both inner and outer tubercles. Three ribs, the middle of which is a primary, originate from one of the inner tubercles. It is worth noting that these ribs continue in undiminished strength, here and there bifurcating at the outer tubercles, well into the venter; only its median zone remains smooth or nearly so (figs. 11, 12). Essentially the same character of ornamentation prevails in specimen number 72 (figs. 29–31), with 15 ribs in the anterior half of the outer whorl. Almost all these ribs carry sharp outer tubercles, but inner ones develop only in the anteriormost quarter-whorl. In this shell the ribs weaken but do not entirely disappear even in the median zone of the venter which they cross in a forward convex arc. The frontal view of this individual shows a characteristic nodal whorl section, deeply concave between the tubercles on the right. A similar, but altogether heavier costation, also consisting of 15 ribs in the anterior half of the outer whorl but with less pronounced tubercles, can be recognized in specimen 73 (figs. 32, 33); here the costae, without bifurcating, remain heavy all across the venter. The body chamber of specimen 74, although crushed, also exhibits well the ornamentation characteristic of this stage (figs. 40, 41).

Except that the inner tubercles become much heavier near the anterior end of the largest measured specimen (no. 76), the character of ornamentation remains the same as that just described even in the largest individuals. It should especially be noted that the ribs do not disappear even at this latest growth stage. As an example, the second largest specimen (no. 75) is illustrated (figs. 37–39).

Suture lines can be studied in the juvenile number 6 from a diameter of about 2 mm. on. The earliest sutural stage worthy of illustraton is represented by the last three sutures of the juvenile number 13, corresponding to a diameter of about 2.5 mm. They are characterized by a wide and shallow siphonal lobe and an even shallower lateral one (fig. 6). The siphonal lobe is less wide and not so shallow in the last suture of specimen number 6, corresponding to a diameter of about 3 mm., and in a suture, corresponding to a diameter of about 4.5 mm., of the juvenile number 11 (fig. 34). All these suture lines differ from the earliest illustrated in the preceding species (pl. 27, figs. 7, 8) only in the fact that here the outer stem of the external saddle is not so much wider than the inner, although the former is the higher of the two. The sutural characters are still the same in specimens numbers 16 and 30, the suture lines of which at diameters between 4.5 mm. and 5 mm. are shown in figures 42–45 to illustrate individual differences. All sutural elements can be seen to be stouter and lower, or shallower, respectively, in specimen number 30 (figs. 42, 43) than in specimen number 16 (figs. 44, 45). At a diameter of about 10 mm. the suture line has become more richly indented, and a second auxiliary saddle has appeared near the umbilical seam. This stage is represented best by specimens numbers 49, 50 (figs. 26–28, 18, 19), and 56.

Specimens numbers 68 and 71 show well the much greater elaboration the external suture lines have attained at a diameter of about 25 mm. and individual differences between them. In the former specimen (fig. 23) the siphonal lobe is quite deep. Above the two long, only slightly diverging, three-pronged terminal points it carries two strong lateral points, also three-pronged, and two minor ones on each side above them. The median knob is rectangular and slender with three little cusps on the top. A narrow, trifid lobule, attaining more than half of the depth of the siphonal lobe and pointing slightly ventrad, divides the external saddle into two main stems which are in turn symmetrically subdivided by shorter lobules. Both these main stems are about equally wide but the outer somewhat overtops the inner.

.e first lateral lobe is only a little deeper ın the siphonal one, slender, and asym-:trically trifid with a three-pronged middle ınt. The lateral saddle is somewhat lower ın the inner main stem of the external one, ›ad, and deeply and nearly symmetrically rided by the three-pronged lobule. This ldle is separated by the trifid second lateral ›e, which points decidedly ventrad, from : auxiliary saddle which is about as high the lateral one but only a little more than lf as wide and moderately indented at its ›. On the umbilical wall there follows a :her narrow, trifid auxiliary lobe, pointing ongly ventrad. Beyond it the outermost rtion of a saddle is just visible. Although : general plan of the suture line is the same specimen number 71 (figs. 24, 25), the ›es and lobules are wider and not quite so ep, and the saddles broader and lower in is individual which is markedly stouter an number 68, and this suture line is alto-ther less richly indented. Two minor dif-·ences may be mentioned: the first lateral ›e is here just as deep as, if not a little orter than, the siphonal one, and the :eral cusps of the median knob overtop its .ddle part in specimen 68, whereas this .ddle portion is slightly higher than these sps in number 71.

At the same diameter of about 25 mm. the ternal suture line is well visible in the whorl ıgment number 70 (fig. 14). Nearest to the ıbilical seam is a saddle of which the outer-›st part is just visible above the seam. It ·out equals in both height and width the xiliary saddle. It is separated by a deep .d narrow, three-pronged lobe from the gh and slender internal saddle. Between e two internal saddles the extremely nar-w, trifid antisiphonal lobe attains just about e depth of the siphonal one. In this frag-ent the first lateral lobe is decidedly orter than the siphonal one.

At the latest stage at which sutural de-ils can be examined in the present species, at is, at a diameter of about 30 mm. in ecimen 75, the degree of indentation is ›out the same as in specimen 68.

REMARKS: The good agreement of speci-ens from Majdal Shams representing about e same growth stage with both the holotype ıd Arkell's largest Woodham specimen ıves no doubt as to their conspecificity. De Loriol's largest specimens (1899, pl. 8, figs. 1, 2) are included by Arkell in his synonymy, but Jeannet (1951, p. 207) has since established the new species *Euaspidoceras kobyi* Rollier on the individual depicted in de Loriol's figure 1. His figure 2 also is difficult to compare with the much smaller specimens from Mount Hermon and is therefore only doubtfully listed in our synonymy.

Because this form remains throughout development clearly different from *A.* (*E.*) *hermonis*, which within the present assemblage comes closest to the true *A.* (*E.*) *babeanum*, it is here raised from a variety of the latter to species rank.

Within the Mount Hermon fauna *A.* (*E.*) *subcostatum* closely resembles *A.* (*E.*) *perisphinctoides* on the one hand and some of its following congeners on the other. From *perisphinctoides* it can be distinguished at early ontogenetic stages, though in some cases not easily, by the whorl section which is reniform rather than transversely oblong and by the early appearance of tubercles. At later stages the ornamentation of this species assumes a character quite different from that of *perisphinctoides*. The costation becomes less dense and more stiff and is gradually equaled, if not exceeded, in importance by true tubercles on the lateroventral shoulder, which develop from parabolic nodes but become horn- or spine-like from a medium growth stage on and at the latest stages observable are joined by similar circumumbilical tubercles. The whorl profile becomes similar to that of *perisphinctoides* in the course of development, but remains wider throughout. Minor differences in the suture lines are pointed out in the above description.

Aspidoceras (*E.*) *subcostatum* is compared below with *A.* (*E.*) *subbabeanum*, *A.* (*E.*) *douvillei*, and *A.* (*E.*) *hermonis* (pp. 178, 179, 184).

MATERIAL STUDIED: Altogether 148 specimens, including fragments.

Aspidoceras (Euaspidoceras) subbabeanum
Sintzov

A. *Forma typica*

Plate 27, figures 39–46; plate 28, figures 1, 2

Aspidoceras sub-Babeanum n. sp.; SINTZOV, 1888, p. 115, pl. 2, fig. 13.

Aspidoceras sub-Babeanum Sinz.; SINTZOV, 1899, pp. 5, 14, pl. 2, figs. 1–3.

Perisphinctes perisphinctoides Sinzov. Varietas *armata;* DE LORIOL, 1900, p. 84, *pro parte*, pl. 5, fig. 24 only.

?Perisphinctes perisphinctoides Sinzow et var. *armata* de Lor.; DE GROSSOUVRE, 1922, p. 313, *pro parte.*

Euaspidoceras subbabeanum Sintzov sp.; SPATH, 1931, p. 602.

Aspidoceras sub-Babeaui Sintzow; MAIRE, 1932, p. 40, *pro parte, non* pl. 5, fig. 2.

Cf. *Euaspidoceras* cf. *sub-Babeanum* Sinzow sp.; JEANNET, 1951, p. 206, text fig. 486, p. 93, fig. 4, pl. 94, fig. 2, pl. 95, fig. 2.

DIMENSIONS

A.M.N.H. No. 27820	D	H	H′	W	U
15	4.61 mm.	38	?	58	42
1	7.17 mm.	36	29½	53	37½
2	7.39 mm.	38	32	51	38
3	8.85 mm.	*ca.* 36½	31½	57	35½
5	16.6 mm.	40	*ca.* 36	55	40
6	18.8 mm.	40	32½	55½	36
8	20.1 mm.	42½	?	57	40
9	21.1 mm.	44	41½	54½	33
12	22.1 mm.	44	?	57½	32½

The largest measured specimen does not represent the maximum size attained by this species within the present material, for the fragments A.M.N.H. Nos. 27820:13, 14 correspond to diameters of approximately 35 mm. and 50 mm., respectively.

B. Var. **emaciata,** new name

Plate 28, figure 3

Perisphinctes perisphinctoides, Sinzov. Varietas *armata;* DE LORIOL, 1900, p. 84, *pro parte*, pl. 5, fig. 22 only.

Aspidoceras sub-Babeaui Sintzow; MAIRE, 1932, p. 40, *pro parte*, pl. 5, fig. 2.

DIMENSIONS

A.M.N.H. No. 27821	D	H	H′	W	U
1	14.7 mm.	36½[1]	28½	49[1]	42[1]
2	19.2 mm.	38½	?	46	38½

As indicated by its name, the var. *emaciata* is markedly more slender than the typical form.

In the *forma typica* U can be seen to decrease and H to increase with growth, but no definite growth trend is discernible with regard to W.

The extremely small sample of the var. *emaciata* conforms much better with the regularly observed trends, that is, H increases, and W and U decrease, with growth.

Because the largest specimen present, the fragment A.M.N.H. No. 27820:14, is still septate at a diameter of about 50 mm., this form must have attained at Majdal Shams at least a diameter of about 75 mm. This does not, however, convey a correct idea of the size attained by this species, for the large disk illustrated by Sintzov (1899, pl. 2) in figure 1 measures nearly 190 mm. across,[2] although still septate throughout.

DESIGNATION OF TYPES: The two fragments illustrated by Sintzov (1888), unless both should belong to the same shell, must be considered syntypes of *A.* (*E.*) *subbabeanum* Sintzov.[3] The specimen illustrated by de Loriol (1900) in figure 22 under the name *Perisphinctes perisphinctoides* Sintzov, var. *armata* is hereby designated the holotype of the new var. *emaciata* of *A.* (*E.*) *subbabeanum* Sintzov.

DESCRIPTION: This species, otherwise closely resembling *A.* (*E.*) *subcostatum*, clearly differs from it in its peculiar ornamentation. In specimen A.M.N.H. No. 27820:15 it can be observed to appear at a diameter of about 2.75 mm. and to consist for the next three-quarters of a volution of widely spaced, strongly prorsiradiate, and slightly sinuous ribs. These ribs, of which only seven or eight can be counted per half-whorl, seem to be accompanied by shallow furrows. From a diameter of a little more than 5 mm. two or three secondary ribs begin to appear between each two primary ribs. The latter soon become quite heavy and form parabolic nodes on the lateroventral shoulders, occasionally also "lacets" (A.M.N.H. No. 27820:1, pl. 27, fig. 40). With growth they tend to keep ever wider but irregular intervals between them; six and seven, respectively, per half-whorl are present on A.M.N.H. Nos. 27820:4 and 5 which attain diameters of about 13 and 16.5 mm., respectively. In No. 27820:5 two

[1] Measured at D=11.4 mm.

[2] The figures of 62 mm. and 72 mm. given in Sintzov's original description (1888, p. 115) for the height and width, respectively, of the "aperture" would indicate a diameter between 125 mm. and 145 mm.

[3] Jeannet (1951, p. 206, lower table of dimensions), unaware of the existence of Sintzov's earlier paper, erroneously considers the above-mentioned large disk (Sintzov, 1899, pl. 2, fig. 1) the type.

or three secondary ribs, which sometimes bifurcate, are intercalated between two primary ones. Simultaneously, bead-shaped tubercles develop on the peripheral shoulder; at the anterior end of this fragment they assume the shape of little horns (pl. 28, fig. 2). Their presence soon changes the shape of the whorl profile, which at the earliest stage observable (specimen no. 1, pl. 27, fig. 39) resembles that of juveniles of *A.* (*E.*) *subcostatum*, to that characteristic of the present species, as illustrated in Sintzov's (1888) figure 13 (pl. 28, fig. 1, corresponding to the smaller of Sintzov's two diagrams).

At a somewhat later stage, corresponding to a diameter of about 20 mm., the primary ribs tend to run a sigmoidal course, with their inner parts forming raised, sharp, forward concave crescents similar to those recorded above (p. 173) in specimen number 68 of *subcostatum*. This character is seen best in A.M.N.H. No. 27820:10 (pl. 27, fig. 46), in which the development otherwise appears to be retarded inasmuch as the peripheral shoulders still carry parabolic nodes but not tubercles. In the var. *emaciata* a somewhat similar ornamentational stage is represented by specimen 1, remarkable for its close resemblance to Maire's figure quoted in the synonymy of this variety. Here the parabolic nodes begin just at the anterior end to change into true tubercles. Up to six secondary ribs can be counted here between two primary ones (pl. 28, fig. 3).

The latest ornamentational stage that can be observed in the present material is represented by the two largest fragments (A.M.N.H. Nos. 27820:14, 15). The first (A.M.N.H. No. 27820:14, pl. 27, fig. 44) exhibits low, widely set ribs which carry radially elongated outer tubercles. Both these individuals, especially number 14, resemble Sintzov's (1888) larger fragment, less so the medium-sized shell illustrated by him in 1899 in plate 2, figure 3; the latter, however, cannot be granted type rank. The two primary ribs visible in A.M.N.H. No. 27820:10, which stand about one-eighth of a whorl apart, with only one sigmoidal secondary rib between, carry, in addition to the outer tubercles, heavy circumumbilical tubercles (pl. 27, fig. 46). That the latter are not present in Sintzov's (1888) larger figure appears to be owing to the fact that his figure represents a considerably earlier growth stage than our fragment. They can, however, be seen in Jeannet's (*loc. cit. in synon.*) text figure and plates.

Although even the two largest fragments, just mentioned, are septate throughout, or nearly so, suture lines of the typical form can be studied only in the smallest specimen and in three medium-sized ones. In the juvenile A.M.N.H. No. 27820:1 the external suture line is excellently visible at a diameter of about 6.5 mm. (pl. 27, figs. 41, 42). There is a moderately deep siphonal lobe ending in two short, only slightly diverging points, separated by a low, broad-trapezoidal median knob which already exhibits the first indications of three tiny cusps on its top. The external saddle is wide and divided at about its middle by a blunt lobule into two main stems, the outer of which is somewhat higher than the inner. The trifid lateral lobe attains only half of the depth of the siphonal one. The lateral saddle is markedly wide, equals the inner main stem of the external one in height, and is symmetrically divided by a shallow lobule. A little beneath the umbilical shoulder there is a triangular auxiliary lobe, and on the umbilical wall a low auxiliary saddle. The next stage of sutural development is represented by the whorl fragment number 10 at a diameter of somewhat more than 15 mm. (pl. 27, fig. 45). The indentation is much richer than at the earlier stage but the general plan is the same, except that the outer main stem of the external saddle is considerably wider than the inner and the inner stem of the lateral saddle here overtops the external one. The first lateral lobe now attains about three-fourths of the depth of the siphonal one and both second lateral (termed auxiliary above) and auxiliary lobes can be recognized to be three-pronged. In the impressed zone the outlines of the internal suture line, agreeing with the one described above (p. 175) in specimen number 70 of *A.* (*E.*) *subcostatum*, can just be made out. The suture line of A.M.N.H. No. 27820:9 at a diameter of 17.5 mm. shows an even higher degree of indentation than the one just described. The main lobes and saddles are somewhat more slender and the depth of the lateral lobe is about seven-tenths of that of the siphonal one. Otherwise the two suture lines are in good agreement.

In the var. *emaciata* the best suture lines are found in A.M.N.H. No. 27821:1 at a diameter of about 8 mm. Despite this somewhat greater size, they agree best with that of the smallest individual of the typical form, described above.

REMARKS: The peculiarities of the ornamentation and the resulting nodal whorl profile of this form clearly refer it to Sintzov's species, if judged by the syntypes. Comparison with the large disk which Sintzov figured in 1899 and the inner whorls of which are not preserved is frustrated by the vast difference in size. Maire's reference to the two specimens illustrated by de Loriol under the name *Perisphinctes perisphinctoides*, var. *armata*, in figures 22 and 24 of plate 5 to this species is here accepted, but only the original of de Loriol's figure 24 is referred to the typical form, whereas that of figure 22 as well as the small disk illustrated by Maire himself, on account of slenderness, is assigned to the new var. *emaciata*. Jeannet's much larger specimens are closely related to if not conspecific with *A.* (*E.*) *subbabeanum*.

The distinctive characters of the ornamentation, as pointed out in the description, serve to distinguish *A.* (*E.*) *subbabeanum* from both *perisphinctoides* and *subcostatum*. It is compared with *A.* (*E.*) *douvillei* and *A.* (*E.*) *hermonis* below (pp. 179, 184).

MATERIAL STUDIED: Altogether 21 specimens, including fragments; of the total, three are referred to the var. *emaciata*.

Aspidoceras (Euaspidoceras) douvillei Collot
Plate 28, figures 46–50

Aspidoceras perarmatum Sow. sp.; NEUMAYR, 1871, p. 371, *pro parte*, pl. 20, fig. 1.

?*Perisphinctes perisphinctoides* Sinzov. Varietas *armata;* DE LORIOL, 1900, p. 84, *pro parte*, pl. 5, fig. 23 only.

Aspidoceras Douvillei n. sp.; COLLOT, 1917, p. 9, pl. 1, fig. 3.

Euaspidoceras neumayri, *nom. nov.;* SPATH, 1931, p. 605, pl. 117, fig. 1.

Aspidoceras Douvillei Collot; MAIRE, 1932, p. 39, pl. 4, figs. 11, 12.

Aspidoceras (*Euaspidoceras*) *douvillei* Collot; ARKELL, 1944, p. 281, text figs. 96–98, pl. 63, figs. 3, 4.

Cf. *Euaspidoceras* cf. *Douvillei* Collot sp.; JEANNET, 1951, p. 211, text figs. 496–498, pl. 92, fig. 4, pl. 98, fig. 3, pl. 100, figs. 1, 2.

DIMENSIONS

A.M.N.H. No. 27822	D	H	H′	W	U
1	6.61 mm.	35½	30½	42½	35½
2	16.1 mm.	36½	31½	33½	39½

The sample, small as it is, shows the usual decrease of the whorl thickness with growth.

Both specimens are septate throughout.

DESIGNATION OF TYPE: Neumayr's (*loc. cit. in synon.*) specimen from Calvados was designated type of this species by Collot.

DESCRIPTION: This form is distinguished by its slenderness and by the flattening of its flanks and venter; thus the whorl profile becomes narrower and strictly rectangular with growth (figs. 50, 46, 48). At the early stage represented by specimen 1 the ornamentation resembles that of *A.* (*E.*) *subbabeanum*. There are 16 primary ribs on the outer volution; they are first strongly prorsiradiate, then less so, and in the anterior half of this whorl begin to form parabolic nodes and quite frequently also "lacets." One or two secondary ribs at this stage are intercalated between two primary ones, and the main ribs tend to move farther apart, but towards the anterior end three primary ribs follow one another in close succession, with no secondary ribs between them, and their peripheral nodes become quite strong (fig. 49). The same trend can be followed in the larger individual (no. 2, figs. 46, 47). In the anterior half of the outer whorl the peripheral tubercles, as far as preserved, become gradually more horn-like and quite sharp and move closer together, so that 10 can be counted on this half-whorl. Simultaneously the primary ribs become indistinct, and secondary ribs disappear altogether.

The suture lines in general agree with those of *A.* (*E.*) *subbabeanum*, except for a smaller difference in depth between lateral and siphonal lobes. In the small specimen (no. 1, figs. 49, 50) the lateral lobe, at a diameter of about 6 mm., attains about seven-tenths of the depth of the siphonal one, and it almost equals it in depth and comes down to the same radius in the larger specimen (no. 2, figs. 46, 47) at a diameter of about 14 mm.

REMARKS: The synonymy of this species,

as of the preceding one, is somewhat complicated by the fact that de Loriol (1900, p. 84, pl. 5, figs. 21–24) described and illustrated under the designation "*Perisphinctes perisphinctoides*, var. *armata*" three, if not four, different forms. Whereas Spath (1931, p. 598, pl. 109, fig. 12) maintains de Loriol's name, raising it to specific rank and excluding only de Loriol's figure 24 from his synonymy, Maire (1932, pp. 39, 40) refers de Loriol's specimens illustrated in figures 22 and 24 to *A.* (*E.*) *subbabeanum*,[1] the specimen illustrated in figure 23 to the present species, and considers the one illustrated in figure 21 to be intermediate between *A. douvillei* and *A. cailleti*, a species established (*fide* Maire) by Petitclerc in 1916–1917. Should all these identifications by Maire stand, they would invalidate both *A. douvillei* and *A. cailleti* as junior synonyms of *A. armatum*. Spath (1931, pp. 598, 605[2]), however, treats both these species as different from *A. armatum*, and they are therefore so considered in the present report.

It goes without saying that even our larger specimen (no. 2) is difficult to compare with the holotype, attaining about five and one-half times its diameter. Its reference to Collot's species is, however, based on its perfect agreement with Maire's (1932) figures 11 and 11a and on his assertion that the conspecificity of his specimens with the type is beyond any doubt. Our specimen number 1, in turn, agrees in its latest stages very well with the earliest stages observable in our specimen number 2.

As here conceived, this form can readily be distinguished from almost all its congeners in the Majdal Shams fauna by its slenderness, its flattened sides and venter, and its peculiar ornamentation, which is described above. *Mirosphinctes kobyi* (p. 162), the only other species of the Perisphinctaceae which is as slender, is readily distinguished by its quite different ornamentation.

MATERIAL STUDIED: Two specimens.

[1] The thinner of de Loriol's specimens, illustrated in his figure 22, is referred above to the var. *emaciata* of *A. subbabeanum*.

[2] There *A. douvillei* is named "*Euaspidoceras neumayri nom. nov.*" In the index of his Kachh monograph (1933, p. 941), however, Spath seems to admit that Collot's name "*douvillei*" antedates his "*neumayri*."

Aspidoceras (Euaspidoceras) hermonis,
new name

Plate 28, figures 50–58; plate 29, figures 1–16

Aspidoceras perarmatum Sow. sp.; NOETLING, 1887, p. 30, *cum synon.*, pl. 5, figs. 1, 2.

Aspidoceras perarmatum, Noetling, 1887; DE LORIOL, 1900, p. 78, 80.

Perisphinctes billodensis de Loriol; FREBOLD, 1928, p. 191.

Aspidoceras perarmatum, Noetling, 1887; SPATH, 1931, pp. 599, 601.

DIMENSIONS

A.M.N.H. No. 27823	D	H	H′	W	U
50	3.18 mm.	38½	29	64½	35½
49	4.26 mm.	38	27½	63	38
1	4.48 mm.	40	32½	57½	31
2	4.48 mm.	37½	30	62½	30
3	4.59 mm.	36½	29½	61	33
4	4.82 mm.	39½	32½	56	32½
5	5.04 mm.	38	33½	61	33½
6	5.04 mm.	39	31	60	33½
7	5.15 mm.	37	28	61	35
8	5.26 mm.	37	28½	61½	32½
9	5.60 mm.	*ca.* 39	*ca.* 33	62	*ca.* 34
10	5.60 mm.	37	30	56	37
11	5.71 mm.	39	*ca.* 29½	55	35½
12	5.82 mm.	36½	29	57½	34½
13	5.82 mm.	32½	29	56½	37½
14	6.05 mm.	37	?	55½	36
15	6.05 mm.	39	28½	56½	33½
16	6.33 mm.	40½	32	60	30
17	6.38 mm.	42	33½	57	28
18	6.72 mm.	40	?	57½[3]	33½
19	6.72 mm.	35	?	70[4]	38½
20	7.28 mm.	37½	32½	57½	35½
23	7.28 mm.	38½	?	?65½	37
21	7.34 mm.	36½	28	58	36½
22	7.62 mm.	41	?	54½	35½
24	7.84 mm.	35½	30	61½	34½
25	7.84 mm.	35½	31½	53	40
28	7.95 mm.	36½	31½	55½	35
26	8.06 mm.	39	*ca.* 34½	*ca.* 57	33½
27	8.06 mm.	40½	33½	57½	35½
29	8.79 mm.	39½	32	52	33
30	9.41 mm.	40½	33½	57	35½
31	9.69 mm.	40½	34½	58	37
32	10.75 mm.	35½	30	59½	34
33	11.09 mm.	40½	?	60½	42½
34[5]	13.6 mm.	35½	?	51½	38
35	14.7 mm.	39½	36	58	37½
36	20.8 mm.	38½	?	56	41½
37	22.1 mm.	40½[6]	33[6]	53½[6]	41[6]
38	22.1 mm.	*ca.* 40½	*ca.* 35	58½	*ca.* 36
39	23.3 mm.	41	35½	53	38
40	24.0 mm.	39½	33	52½	38

[3] Whorl section asymmetrical.

[4] Whorl section possibly depressed by crushing.

[5] Transitional to *A.* (*E.*) *perisphinctoides*.

[6] Measured at D = 20.1 mm.

A.M.N.H. No. 27823	D	H	H′	W	U
41	26.6 mm.	41½	?	60	36
42 (syntype A)	28.9 mm.	38[1]	?	*ca.* 56[1]	35½[1]
43	34.4 mm.	38	30	?[2]	40½
44	39.2 mm.	?29	?	*ca.* 49½	?34½
45	42.4 mm.	42	?	56	*ca.* 33½
46	55.2 mm.	45½	37	*ca.* 49	28
47	62.0 mm.	48	?	*ca.* 43½	*ca.* 38½

Among the individuals referred to this species without reservation, one that is badly crushed somewhat exceeds the largest measured specimen in diameter, thus approximating the maximum size of nearly 70 mm. reported by Noetling. However, an equally crushed fragment which can only tentatively be referred to this species (no. 48) corresponds to a diameter that must conservatively be estimated at about 115 mm.

The most striking growth trend discernible in the above table is the rather sudden increase in the height, and decrease in the width, of the last whorl beyond a diameter of about 40 mm. Accordingly, the maximum of H and the minimum of W are found in the largest measured specimen (no. 47) and the near minima for W in two among the four largest specimens measured (nos. 44, 46). The minimum of U is, however, associated not with the maximum of H, as would be expected, but with its second highest value, encountered in the largest measured individual but one (no. 46). It should be noted that the same minimal width of the umbilicus (28) has been measured also in specimen number 17 of which the diameter is only about one-ninth of that of number 46. The maximum of W (70) is measured in the small specimen number 19 but is here possibly owing to crushing. The next highest value for W (?65½) is found in specimen number 23 which is only 0.5 mm. larger. The maximum for U (42½) is measured in another rather small specimen (no. 33), and the minimum for H (?29), though doubtfully, in a specimen attaining almost 40 mm. in diameter (no. 44); nearest to this minimum comes the juvenile number 13, with H = 33½.

If all these extremes are left out of consideration, the range of variation is comparatively narrow for all three dimensions: 35–42 for H, 51½–63 for W, and 30–41½ for U. In general the small shells are somewhat stouter than medium-sized and large ones and have narrower umbilici, but otherwise values coming within the above ranges can be encountered at almost any size.

In the third largest measured specimen (no. 45) the last septum corresponds to a diameter of about 40 mm., but the above-mentioned fragment number 48, corresponding to a diameter of 11.5 cm., is still septate throughout. If about three-quarters of a volution is allowed for the living chamber, which is its length as observed in some small shells, the present species must have reached a diameter of almost 20 cm. in the fauna under study.

DESIGNATION OF TYPES: Our specimen number 42 and the larger of the two figured by Noetling (pl. 5, fig. 1) are designated syntypes A and B, respectively, of *A.* (*E.*) *hermonis.*

DESCRIPTION: As in *A.* (*E.*) *subcostatum,* the whorl section is reniform at the earliest stages (specimens nos. 2, 12; pl. 28, figs. 57, 52), then assumes a transverse-elliptic shape (specimen no. 27, pl. 29, fig. 10), later a transverse-rectangular one (specimen no. 37, pl. 29, fig. 3), and, as far as the internodal section is concerned, tends to become subquadratic at the latest growth stages examined (specimen no. 45, pl. 29, fig. 11). Except for the largest specimen measured (no. 47) and the even larger fragment number 48, which is badly crushed, the whorl profile remains wider than high throughout development.

The smallest shell present (no. 50) is still entirely smooth. The earliest ornamentation is observable in the small juvenile number 2 (pl. 28, figs. 56). Blunt tubercles appear at a diameter of less than 2 mm. and soon develop into short, strong, prorsiradiate ribs set rather wide apart; seven such sculptural elements are present on the last half-whorl. These tubercles appear at the same early stage in the somewhat larger juvenile number 11 where they show best in frontal view (pl. 29, figs. 4–6). The number of tubercles and ribs, which now extend all over the flanks, on the last volution is still 14 (pl. 29, fig. 5). In the anterior third of this volution, though much enfeebled, they cross the venter which

[1] Measured at D = 26.0 mm.; deformed beyond that diameter.
[2] Crushed.

before that is smooth; some equally weak ribs are intercalated between those that connect the ribs of the flanks (pl. 29, fig. 4). In the next stage, illustrated by specimen number 27 (pl. 29, fig. 9), the number of ribs on the last whorl has increased to 19. They carry an occasional "lacet" but no tubercles. Only at the anterior end does some bifurcation of ribs occur. Specimen number 34 (pl. 29, fig. 15), although transitional to *A.* (*E.*) *perisphinctoides*, illustrates well the first development of outer tubercles from parabolic nodes and of sharp crescents ("commas") in the inner half of the ribs, foreshadowing the inner tubercles.

A stage of ornamentation intermediate between juvenile and mature is represented by specimen number 38 (pl. 29, figs. 1, 2). Throughout its last volution the ribs carry pronounced, though rather small tubercles at the outer ends. Seventeen such tubercles can be counted around the periphery of this whorl. Secondary ribs are present in the posterior half, but disappear in the anterior one where the primary ribs assume a radial rather than prorsiradiate direction. Although deformed in the body chamber, specimen number 42 (pl. 29, figs. 12, 13) demonstrates excellently how in the further course of development the outer tubercles grow in strength and, along with inner tubercles which develop from the afore-mentioned "commas," gradually gain dominance over the ribs. That the tubercles are separated by such wide intervals in the anteriormost quarter-whorl of this individual must, however, be considered an individual feature, for in the badly crushed shell number 43, which is not so much larger, the tubercles are much more closely set, there being nine outer ones on the last half-whorl (pl. 29, fig. 16), as compared to only four or five in number 42. The latter individual shows on its venter (pl. 29, fig. 13) strongly arched old apertural margins which connect the outer tubercles of opposite sides. In figure 12 of plate 29 the outer tubercles appear to have moved somewhat inward from the periphery, and accordingly the distance between corresponding outer and inner tubercles appears to be reduced, but this seems to be caused merely by crushing. It can be seen in the same figure that at this stage the ribs tend to be reduced to inconspicuous folds connecting outer and inner tubercles or even entirely to disappear. In the anteriormost quarter-whorl of the somewhat larger shell number 45 the costae can be seen to vanish also on the venter, on which they have always been markedly weaker than on the flanks and which they cross at the latest stage observable in gentle forward convex arcs. These arcs are separated here and there from one another by shallow, furrow-like intercostals.

In the second largest measured specimen (no. 46) the venter becomes more convex in the body chamber to which about the anteriormost quarter-whorl belongs. Simultaneously the inner tubercles outgrow the outer ones, and all tubercles (of which six pairs per half-whorl are now present) become much stronger than in the preceding stage. Their strength, however, appears exaggerated in plate 29, figure 7, by the sediment encrusting the outer test. The ornamentation of the cast is not very different from that of the preceding stage. It proved, however, impossible in most cases to free the tubercles from that encrusting mass. Ornamentation is similarly coarse and shows the same degree of density in the largest individual measured (no. 47), but here the outer tubercles remain stronger than the inner. The venter of this specimen remains truncate to the anterior end (pl. 29, fig. 14).

The largest fragment present (no. 48), only tentatively referred to this species, is crushed to such a degree that the whorl profile cannot properly be studied but the sculpture can. Five outer and inner tubercles per quarter-whorl are connected by indistinct folds; in the posterior part of this fragment the inner tubercles are extended radially to the extent that they simulate rejuvenated ribs in the inner portion of the flanks. The outer tubercles, on the other hand, have become blunt [compare d'Orbigny, 1842–1849, pl. 181, fig. 1 of *A.* (*E.*) *babeanum*].

The earliest suture line studied is the last of specimen number 4, corresponding to a diameter of about 2.25 mm. (pl. 28, fig. 58). The lateral lobe does not even attain half of the depth of the siphonal one. The trapezoidal lateral saddle slightly exceeds the outer and higher stem of the external saddle in height. At a diameter of nearly 5 mm. the suture line agrees with that of *subcostatum* at the same stage, except that the lateral saddle appears to be not so wide (specimens nos.7, pl. 28, fig. 51, and 26). At a diameter of about 6.5 mm. the indentation of the suture line has somewhat increased, but it is otherwise unchanged (specimen no. 28, pl. 28, fig. 53).

At a diameter of 21 mm. the suture, well exposed in specimen number 42 (pl. 29, figs. 12, 13), has become much more elaborate. The siphonal lobe is comparatively slender and divided by a three-cusped, rather high median knob into two hardly diverging, three-pronged points. The wide external saddle is divided by a trifid lobule into two main stems, the outer of which is markedly wider and higher than the inner, both being in turn subdivided by smaller lobules. The trifid and slender lateral lobe reaches down to the same radius as the siphonal one. The lateral saddle even overtops the outer main stem of the external one slightly but does not fully attain its width; it is almost symmetrically divided by a short lobule. There follow a narrow and trifid second lateral lobe, only about half as deep as the first, and on the umbilical wall a slender auxiliary saddle which overtops the lateral one, a short, three-pronged auxiliary lobe, and a second auxiliary saddle. In this suture line, if projected into a plane, a line connecting the tops of the saddles slopes from the outer to the inner margin of the wide external saddle, then rises again towards the first auxiliary saddle.

The three last sutures of specimen number 46 (pl. 29, fig. 8), corresponding to diameters of between 35 and 45 mm., or to almost twice the size at which the suture lines of number 42 have been studied, show, of course, richer indentation, but the difference in this respect is less than might be expected. Otherwise these suture lines agree well with those just dealt with, except for certain distortions due to the strength of the tubercles at this stage, a phenomenon quite common in strongly sculptured ammonites. It is important to note that here the siphonal and lateral lobes reach down, and both main stems of the external saddle and the lateral one reach up, to about the same radii. The saddles do the same in Noetling's figure 26 and in de Loriol's (1900, p. 79) figure 16 of "*Perisphinctes*" *billodensis*. The first auxiliary saddle seems to rise even a little higher than the main saddles in specimen number 46 also.

Owing to poor preservation no comprehensive view of any suture lines of the largest fragment (no. 48) can be gained. What scattered portions are open to examination seem to agree with the sutures of the preceding growth stages except of course for being even more elaborate.

REMARKS: This is the only *Euaspidoceras* of the present assemblage that has been previously described and figured (Noetling, 1887) or at least discussed (Frebold, 1928).

The good agreement between our figures 15, 7, and 8 of plate 29 with Noetling's figures 2 and 1, 1a, respectively, leaves no doubt about the identity of our form with his.[1]

Only very reluctantly do I propose a new specific name for this form, because it is undoubtedly very closely related to three known species: *A.* (*E.*) *babeanum* d'Orbigny (1842–1849, p. 491, pl. 181, figs. 1–5; for synonymy, see Arkell, 1939, p. 162), "*Perisphinctes*" *billodensis* de Loriol (1900, p. 78, pl. 5, figs. 30–34; 1899, pl. 8, fig. 3, as *babeanum*), and *Euaspidoceras kobyi* Rollier[2] *in* Jeannet (1951, p. 207, text figs. 487–489, pl. 94, fig. 5, pl. 95, figs. 3, 4, pl. 96, figs. 2, 3, pl. 97, fig. 1), based on the specimen illustrated by de Loriol (1899) in figure 1 of plate 8 as *Aspidoceras babeanum*. Close relationship between these three species can be gathered even from the above references. Moreover, identities among them and between them and the present species have explicitly been established in the literature. De Loriol (*loc. cit. in synon.*) considered Noetling's form with "extreme probability" a synonym of his "*Perisphinctes*" *billodensis*, and Frebold (*loc. cit. in synon.*) accepted, without any reservation, not only de Loriol's identification but his reference of the forms concerned to *Perisphinctes* rather than *Aspidoceras*, rejected by almost all later authors (with special reference to Noetling's

[1] Noetling's value of 55 for H in his largest individual is incorrect. Measurements taken from his figure 1 of this specimen reduce it to 49, whereas for the smaller figured specimen H is given as 40 by Noetling. Thus there is good agreement also in dimensions.

[2] As distinct from *Perisphinctes kobyi* de Loriol (1898, p. 90, text fig. 27, pl. 6, fig. 14; 1900, p. 88, pl. 6, figs. 6–10), referred to *Aspidoceras* by Maire (1932, p. 46, pl. 5, fig. 11) but to *Mirosphinctes* in the present report (p. 162).

form by Spath, 1931, p. 599) and in the present report (p. 165). Maire (1932, p. 41) in turn includes "*Perisphinctes*" *billodensis* without reservation in the synonymy of *Aspidoceras babeanum*, chiefly on the strength of the identity of the specimen illustrated by de Loriol (1899) in figure 3 of plate 8 under the latter name with those illustrated in 1900 under the former name from the Jura Lédonien.

The three species concerned (*babeanum*, *billodense*, and *hermonis*) are here, however, not considered synonymous. It is true that there is considerable resemblance between d'Orbigny's figures 3 and 4 of a juvenile of *babeanum* and de Loriol's figures 30 and 31 of specimens of *billodense* of about the same size, but the agreement is far from perfect. The inner tubercles seem to appear earlier in *babeanum*, and the venter is more arched. From individuals of the same size of *hermonis* (e.g., no. 38, pl. 29, figs. 1, 2), on the other hand, de Loriol's differ by increasing more rapidly in width, by a less truncate venter, and by the earlier development and the more clavate shape of their outer tubercles. It is true that the aspect of juveniles measuring only about 6 mm. in diameter is quite similar but the costation of those from the Jura Lédonien is markedly more dense (compare de Loriol's fig. 33b with our pl. 29, fig. 5, of specimen no. 11). Furthermore, Spath (1931, p. 602) seems to be correct in considering *billodense* a micromorph form, an opinion supported by Maire's (1932, p. 41) statement that the species dealt with there under the designation "*Aspidoceras Babeaui* d'Orbigny," but considered by Maire identical with de Loriol's *billodense*, occurs in the Franche Comté "toujours en petits exemplaires."

These considerations seem to preclude identification of either *babeanum* or *hermonis* with *billodense*. However, the present species differs also from the true *babeanum* too much to be considered conspecific. In d'Orbigny's species the venter is markedly convex throughout development, whereas it soon becomes truncate in ours and remains so to the latest stage (as long as there is no deformation by crushing that very frequently affects the body chambers at Majdal Shams). Consequently, in *babeanum* the outer tubercles do not sit right on the periphery, as they do in the present species (compare d'Orbigny's fig. 3 with our pl. 29, fig. 1), and both outer and inner tubercles appear there earlier and grow faster. Should d'Orbigny's suture line drawing (fig. 5) be correct, then the steady and considerable slope of a line connecting the tops of the saddles would be another important difference from the present species in which this line at a comparable stage runs radially. (De Loriol's drawing of the suture line of *billodensis* agrees in this respect much better with that of *hermonis*, but it is obviously taken from a much smaller specimen.)

Finally, the present form cannot be referred to Rollier's *Euaspidoceras kobyi*. As pointed out by Jeannet (1951, p. 207), both rows of tubercles appear early in that species and its venter is also more convex than it is in *hermonis* so that the outer tubercles appear in side view to be situated a little inward from the periphery (e.g., pl. 95, fig. 3). Other sculptural characters considered distinctive of his species by Jeannet, such as the inward pointing of the inner tubercles, cannot be recognized in *A.* (*E.*) *hermonis* which is also on an average less evolute and somewhat stouter than *kobyi*. Finally, Jeannet's suture line drawing resembles d'Orbigny's of *babeanum*, but not Noetling's nor the suture lines described and illustrated in the present report.

Of other species recorded in previous literature *Euaspidoceras waageni* Spath, var. *robusta* Spath (1931, p. 600, pl. 115, fig. 3) comes fairly close to the Mount Hermon form but is less depressed (as stated by Spath, 1931, p. 601) and also more evolute at the same size, and its tubercles seem to be blunter. *Euaspidoceras obesum* Spath (1931, p. 601, *cum synon.*, pl. 116, figs. 2, 3) resembles the present species in ventral view (compare Spath's fig. 2 with our pl. 29, fig. 14) and in sutural design, but it is more evolute and its ribs remain distinct to a much greater diameter. *Euaspidoceras badiense* Spath (1931, p. 609, pl. 115, fig. 2, pl. 118, fig. 9) differs from *hermonis* in its whorl profile, which is much more depressed and increases only slowly in width, and by having less projecting tubercles.

Within the Mount Hermon assemblage

A. (*E.*) *subcostatum* and *A.* (*E.*) *lyra* most closely resemble *A.* (*E.*) *hermonis*. Comparison with *A.* (*E.*) *lyra* is given below (p. 186). *Aspidoceras* (*E.*) *subcostatum* differs from *hermonis* throughout development by having a denser and finer ornamentation, especially less heavy and more pointed tubercles. Also the ribs persist in *subcostatum* after the tubercles have fully developed, whereas at that stage they tend to become inconspicuous or to disappear altogether in the present species. *Aspidoceras* (*E.*) *perisphinctoides* deviates from *hermonis* in the same manner but more markedly than does *subcostatum*. *Aspidoceras* (*E.*) *subbabeanum* can readily be distinguished from *hermonis* by the peculiarities of ornamentation; *A.* (*E.*) *rotundatum*, by its whorl section.

MATERIAL STUDIED: Altogether 110 specimens, including fragments.

Aspidoceras (Euaspidoceras) lyra Spath

Plate 29, figures 17–31; plate 30, figures 1–4

Euaspidoceras lyra, sp. nov., SPATH, 1931, p. 591, pl. 109, fig. 7.

DIMENSIONS

A.M.N.H. No. 27824	D	H	H′	W	U
1	3.36 mm.	36½	?	83½	26½
2	3.81 mm.	41	32½	67½	29½
3	4.03 mm.	39	33½	64	33½
4	4.14 mm.	40½	28	62	38
5	4.37 mm.	41	?	59	28
6	4.37 mm.	38½	31	59	36
7	4.48 mm.	*ca.* 40	*ca.* 30	75	*ca.* 32½
8	4.70 mm.	?46[1]	?	67½[1]	?30[1]
9	4.70 mm.	35½	31	69	33½
10	4.82 mm.	42	?	65	30
11	4.82 mm.	39½	?	81½	30
12	4.93 mm.	36½	*ca.* 30	68	34
13	5.04 mm.	38	*ca.* 31	64½	35½
14	5.10 mm.	31	?	68	44
15	5.15 mm.	41½	33½	63	32½
16	5.38 mm.	37½	29	58½	35½
17	5.38 mm.	35½	?	64½	40
18	6.61 mm.	37½	*ca.* 30½	59½	35½
19	7.84 mm.	35½	30	61½	37
20	9.18 mm.	39	35½	64	36½
21	9.97 mm.	37	?	59	36
22	10.19 mm.	40½	30	57	30½
23	10.42 mm.	37½	31	63½	37½
24	13.1 mm.	40½	?	67	36
25	13.3 mm.	39	?	75	38½
26	13.6 mm.	40½	*ca.* 33	66	36
27	18.1 mm.	*ca.* 39	*ca.* 33½	*ca.* 63	39
30	21.8 mm.	*ca.* 43½	*ca.* 35	68½	37½
31	*ca.* 45 mm.	*ca.* 44½[2]	*ca.* 38[2]	63[2]	*ca.* 37½[2]

[1] Measured at D=4.14 mm.
[2] Measured at D=42.7 mm.

A badly deformed specimen (no. 32), before having been crushed, may have attained about the same diameter as the largest one measured. It is remarkable for the particularly fast increase in width of its outer whorl which thus attains a width of 31.5 mm. at a diameter of about 37 mm., at which W amounts to only about 24 mm. in specimen number 31 (pl. 30, fig. 1). The same rapid increase in width is also encountered at a much earlier stage in specimen number 11 (pl. 29, fig. 20).

It is important to note that in many of the larger individuals measured (from number 20 on) W is markedly increased by inclusion of the spine-like, outward-pointing tubercles. However, the highest amount for W (83½) is found in the very smallest specimen present (no. 1) and the second highest (81½) in another small specimen (no. 11). On the other hand, the minimum for W (57) is measured in a medium-sized shell (no. 22). It may be that the internodal width tends to decrease with growth but that in over-all width this decrease is partly compensated for by the development of ever higher tubercles. Altogether this species, within the present assemblage, is at all stages considerably stouter than the preceding.

As in *hermonis*, the height of the whorl grows rather rapidly towards the bottom of the table, here from a diameter of 20 mm. on. Until this stage is reached, H varies only within the narrow range from 35½ to 42, except for specimens number 14 in which it amounts to only 31, and number 8, in which it has, though doubtfully, been measured to be 46. If the last figure be neglected, the maximum for H (44½) is found in the largest measured specimen, and the near maximum (43½) in the largest but one.

The widest umbilicus (U=44) is measured in specimen number 14, just mentioned for exhibiting the minimum for H, and the narrowest (U=26½) in the smallest specimen present. If these extremes are left out of consideration, U varies between the values of 29½ and 40.

The largest measured specimen has its last septum at a diameter of 43.5 mm., slightly behind the anterior end, and may thus be estimated to have attained when complete a diameter of about 70 m.

DESIGNATION OF TYPE: The only specimen

figured by Spath (*loc. cit. in synon.*) was designated holotype of this species by that author (explanation of pl. 109).

DESCRIPTION: In shell shape the earliest stages of this species differ from those of the preceding only by greater width. There is the same reniform whorl profile as in *A.* (*E.*) *hermonis* (specimens nos. 2, 9; pl. 29, figs. 17, 19). The ornamentation, however, is a little different. The first tubercles appear slightly later and persist somewhat longer before changing into ribs; from six to eight are present on the last half-whorl (specimens nos. 9, 11, 12, pl. 29, figs. 18, 21). The first faint indications of ribs, from three to five to a pair of tubercles, appear on the venter which, however, still appears smooth to the naked eye (specimen no. 12, pl. 29, fig. 22).

The next ontogenetic stage is best represented by specimen number 20. The whorl profile is now inverted-trapezoidal with gently convex base line (pl. 29, fig. 30). There are altogether 25 ribs on the outer whorl which are first slightly sigmoidal and prorsiradiate but gradually become more or less straight and radial. Only in the anterior half of this whorl is one secondary rib intercalated here and there between two primary ribs. The latter carry at their peripheral ends tubercles which assume anteriorly the shape of tiny horns (pl. 29, figs. 28, 29). The venter is crossed, in a straight or only very gently forward convex line, by fine secondary ribs, five or more to every tubercle (pl. 29, fig. 28).

Development of ornamentation shows further progress in specimen number 25 (pl. 29, fig. 26) which, at a diameter of only about 13 mm., carries eight straight and somewhat rursiradiate ribs on the anterior half of its outer whorl. Each ends on the lateroventral shoulder in a quite heavy tubercle. The inner portions of these ribs are raised, thus foreshadowing inner tubercles. There are no secondary ribs in this individual, but up to three per intercostal are present in the fragment number 28 of a very much depressed whorl. These multiply by bifurcation on or somewhat beneath the shoulder, thus giving rise to a greater number of fine ribs on the venter where nine or 10 can be counted between two tubercles (pl. 29, fig. 27). Otherwise this fragment represents about the same stage of ornamentation as specimen number 25. In another, similarly depressed whorl fragment (no. 29, pl. 29, fig. 25) all ribs carry more or less pointed outer tubercles, and their innermost portions assume the shape of the "commas" (Spath, 1931, p. 609) from which the inner tubercles are to develop. The outer tubercles still predominate. Accordingly, the nodal section is still inverse-trapezoidal but its sides converge less downward than in plate 29, figure 30.

At the latest stage observable in this species, represented by specimen number 31 (pl. 30, figs. 1–4), the internodal whorl profile has become transversely rectangular, with a gently convex venter, and in nodal section the flanks are deeply concave between outer and inner tubercles, for in the outer whorl of this shell the afore-mentioned "commas" develop into true tubercles which equal the outer ones in height and strength.[1] The outer tubercles are slightly compressed in the spiral sense and clearly recurved (pl. 30, fig. 4). In the anterior half of this whorl, outer and inner tubercles are connected by much lower but distinct, broad ribs which are mostly somewhat prorsiradiate. Only six such ribs, with their pairs of tubercles, are present on this half-whorl, but there are no secondary ribs on its flanks. The venter, however, carries faint indications of fine transverse ribs. The umbilical wall is perpendicular, high, and smooth.

Suture lines are observable as early as at diameters of 2.25 mm. (in no. 1, pl. 29, fig. 23) and 3 mm. (in no. 13, pl. 29, fig. 24). They agree well with those of *hermonis* at corresponding stages, except that the extraordinary width of the venter of specimen number 1 makes for a particularly wide external saddle. One of the last suture lines of specimen number 20 (pl. 29, fig. 30), corresponding to a diameter of about 5.5 mm., shows somewhat richer indentation but otherwise still the same character. The lateral lobe is now about half as deep as the siphonal one, and the tops of the outer main stem of the external saddle and of the lateral and auxiliary saddles hit about the same radius, with only the inner main stem of the external saddle a little lower.

The latest sutural stage observable in this species, namely, in the two largest indi-

[1] That the inner tubercle appears to be even higher than the outer in plate 30, figure 3, is because the tip of the latter is broken off.

viduals (nos. 31, 32), shows much richer elaboration. The siphonal lobe with the adjacent parts of the external saddle, just recognizable in the ventral view of the former specimen (pl. 30, fig. 1), is seen much more clearly in the latter (pl. 29, fig. 31). The rather broad siphonal lobe is divided by a trapezoidal median knob, the top of which carries altogether six cusps, into two slightly diverging, three-pronged terminal points. Along the margins of this lobe are three more points, which decrease upward in length, on either side; the lowest are distinctly three-pronged. The trifid main lobule of the external saddle, with a three-pronged middle point, rides on, or slightly ventrad of, the ventrolateral shoulder. Thus the outer main stem is situated entirely on the venter, and the inner on the flank. The former is considerably wider and higher than the latter. The lobule subdividing the outer main stem points towards the median line and is three-pronged, as is that of the inner. From here on this description is taken from the penultimate suture line of specimen number 31 (pl. 30, fig. 2). The lateral lobe nearly equals the siphonal one in depth and is comparatively slender and trifid, with three-pronged terminal points and three lateral ones on either side. The markedly wide lateral saddle is nearly symmetrically subdivided by a short but broad lobule. There follow a slender, asymmetrically trifid second lateral lobe, which equals the main lobule of the external saddle in depth, a slender first auxiliary saddle, and two auxiliary lobes, both pointing obliquely outward, with a simple, low second auxiliary saddle between them. The outer half of a similar third saddle shows just above the umbilical seam. In this species, too, the tops of the outer main stem of the external saddle and of the lateral and first auxiliary saddles can be connected by a straight line which, however, rises considerably towards the center of the disk. The top of the inner main stem of the external saddle remains considerably below that connecting line. In its general plan this suture line agrees well with that of *Euaspidoceras obesum*, as delineated by Spath (1931, pl. 116, fig. 3) at a considerably greater diameter.

REMARKS: The early appearance and fast growth of the tubercles, the character of the costation, the markedly depressed whorl profile, and the rapid increase of the whorls in width clearly refer our form to *Euaspidoceras lyra* Spath, a species known hitherto only from England.

Both the var. *robusta* of *Euaspidoceras waageni* and *E. obesum* (see p. 183), despite their trivial names are by no means so stout as *E. lyra* and do not increase so rapidly in width. The same holds true for *E. badiense* (Spath, 1931, pl. 118, fig. 9), although it exhibits at a much larger size a very similar whorl profile (Spath, 1931, pl. 115, fig. 26). But the difference just mentioned precludes identification.

The rapid increase in width is, however, found in some forms of *E. billodense* (de Loriol), especially in that illustrated in figure 30a of plate 5 (1900), but de Loriol's species cannot match *lyra* either in stoutness or in development of tubercles.

Only *Ammonites corona* Quenstedt (1849, p. 178, pl. 14, fig. 3; 1858, p. 617, pl. 76, fig. 10; 1887, p. 878, pl. 99, figs. 48,?49[1]; Maire 1932, p. 43, pl. 5, figs. 3, 3a, 3b) is as sturdy as the present species and some of the figured specimens, namely, those shown in figure 48 of "Die Ammoniten" and in Maire's figure 3a, also increase rather rapidly in width. However, the even greater width and the transverse-elliptic shape of the internodal whorl section, the "forte inclinaison [of the nodal whorl profile] vers l'ombilic dès la partie la plus externe des flancs" (Maire), best seen in Quenstedt's figure 48, the evolute shell, and the absence of an inner row of tubercles keep that species clearly distinct from the present one.

Within the material under study *A.* (*E.*) *lyra* is readily distinguished from *hermonis* by the earlier appearance of both outer and inner tubercles and their greater strength, by the somewhat less closely set ribs which remain more distinct to the latest stage observable, by the wider umbilicus, and chiefly

[1] Maire (1932, p. 41) places figure 49 in the synonymy of *A. babeaui*, which is to him identical with *A. billodense*, but later (*ibid.*, p. 43) includes both figures 48 and 49 in the synonymy of *corona*. Quenstedt's figure 49 shows indeed a much less stout individual than this figure 48.

by the much wider and depressed whorl profile which, except in the latest ontogenetic stage, shows inverse-trapezoidal shape. These distinctive characters of the present species dispense with further comparisons with other congeners.

MATERIAL STUDIED: Forty-three specimens, including fragments.

Aspidoceras (?Euaspidoceras) rotundatum, new species

Plate 30, figures 5–16

DIMENSIONS

A.M.N.H. No. 27825	D	H	H′	W	U
1	8.85 mm.	30½	26½	?	43
2	8.85 mm.	36½	31½	50½	38
3	9.52 mm.	39	32	57½	36½
10	9.97 mm.	38	31½	57½	35
4	11.65 mm.	36½	?	48	37½
5	11.76 mm.	37½[1]	?	65½[1]	34½[1]
6	11.76 mm.	37½	31	59	35
7	16.02 mm.	41	?	*ca.* 43½	35
8 (holotype)	16.69 mm.	40½	33	49½	35
9	19.9 mm.	41	*ca.* 39	*ca.* 52½	34

As seen from the table, the whorl height tends to increase, and the umbilical width to decrease, with growth. No such clear trend can be recognized in W, but on an average the smaller shells are somewhat stouter than the larger ones.

Specimens numbers 10 and 5, both among the smaller shells, have their last septa at diameters of about 8.5 mm. and 10 mm., respectively, but almost all the others, including the two largest, are septate throughout. Thus no inferences can be drawn as to the full size reached by this species. It may be a micromorphic one, or it may just be represented by juveniles only.

DESIGNATION OF TYPE: The largest measured specimen but one (A.M.N.H. No. 27825:8) is designated the holotype of this species.

DESCRIPTION: The medium-sized paratype number 6 (figs. 5, 6) shows a transverse-elliptical whorl profile with broad, evenly rounded venter and 23 straight, radial, or slightly rursiradiate ribs on the flanks of its outer whorl. On reaching the lateroventral shoulder they form mere indications of tubercles; then they cross the venter, considerably weakened but without increase in number, in a straight or shallowly forward convex line.

[1] Measured at D=11.31 mm.

The somewhat smaller specimen number 10, except for its denser costation (27 ribs on last whorl), agrees in the character of ornamentation with number 6, but in the unseptate last portion of its outer whorl the outer tubercles gain in strength, and only one of them assumes the aspect of a parabolic node. This development produces a marked corner in the nodal whorl profile, somewhat disturbing the rounded shape considered distinctive of this species. The individual here dealt with (figs. 7, 8) is left with this species all the same; to a certain extent it may be considered transitional to *A.* (*E.*) *subcostatum*.

In the holotype (no. 8, figs. 12–14) the whorl profile is somewhat narrower than in the preceding specimens but equally well rounded. On the flanks of the outer volution altogether 28 ribs are counted, including three pairs which originate by bifurcation at the middle or at the outer third of the flanks, and one intercalated rib. The ribs become more distinctly rursiradiate and slightly recurved in the anterior half of this whorl, and the indications of outer tubercles, as observed in paratype number 6, have disappeared. There are about twice as many faint ribs on the venter which they cross in a nearly straight line.

The ribs are a little less closely set in the largest paratype (no. 9, fig. 11), with their total amounting to 27 on the last whorl, and the faint tubercles on the shoulder disappear somewhat later than in the holotype, but otherwise the character of the ornamentation is the same. In the anteriormost part of this whorl the costae become so faint on the venter that it appears nearly smooth. If deformation is corrected, the whorl profile appears to be nearly circular in this paratype.

The sutures are clearly visible in all four of the specimens discussed above and, except for the slowly increasing degree of indentation, show hardly any change from the diameters of about 8 mm. and 8.5 mm. (nos. 6 and 10, figs. 5, 6, 9, 10) to those of about

13.5 mm. (holotype, figs. 15, 16) and about 17 mm. (no. 9, fig. 11). The trifid lateral lobe attains mostly only half of the depth of the siphonal one, but in specimen number 10 only about one-third, and in the holotype a little more than half. The siphonal lobe is rather wide, its terminal points, separated by a low, tricuspidate median knob, diverge only slightly and in the largest paratype grow rather rapidly in length. The inner main stem of the external saddle is somewhat narrower but hardly lower than the outer. The wide lateral saddle is divided by a short lobule into two stems which in most of the suture lines examined are more or less equal in both height and width. Only in the holotype is the outer about twice as wide as the inner. Here the first auxiliary lobe is only about half as deep as the lateral one and asymmetrically trifid, points markedly ventrad and rides on the umbilical shoulder, as it does in specimen number 10, whereas it is only somewhat shorter than the lateral lobe in the two smaller paratypes 6 and 10 and situated somewhat beneath that shoulder in paratypes 6 and 9. There follows on the umbilical wall a low, trapezoidal auxiliary saddle; beyond it, the outer portion of a second auxiliary lobe shows only in the two largest specimens (nos. 8 and 9).

In all examined suture lines of this species the tops of all saddles and their main stems can be connected by a straight line which rises only slightly, if at all, towards the center. Altogether the suture line of this species is characterized by sturdy saddles and shallow lobes and by a lower degree of indentation than is found in other species of *Euaspidoceras* at the same ontogenetic stages.

REMARKS: The rounded whorl profile, which is indicated in the trivial name and approaches circular shape at the latest ontogenetic stages, and the strong, stiff, more or less radial costation, with outer tubercles mostly just indicated and disappearing later in development, characterize this form so well that proposal of a specific name appears justifiable despite the possibility that only juveniles may be present. Even so, they are clearly distinct from those of congeneric species at the same growth stages.

Although tubercles mostly do not fully develop and soon disappear, the width of the whorl profile and the marked contrast between the strongly ribbed flanks and the nearly smooth venter seem to refer this form to *Aspidoceras, sensu lato,* rather than to the true perisphinctids, as does the character of its suture line described above. Within the genus *Aspidoceras,* however, reference of this form to *Euaspidoceras* is not quite certain.

The peculiar characters mentioned above readily distinguish this form from hitherto known species of *Aspidoceras,* both within and without the fauna under study.

MATERIAL STUDIED: Thirteen specimens, five of which are incomplete or deformed.

SUBFAMILY PELTOCERATINAE SPATH, 1924

PELTOCERAS WAAGEN, 1871, SENSU LATO

This genus is represented in our material by three specimens only, but at the present status of subdivision they must be referred to two different subgenera.

Noetling's (1887) "*Peltoceras*" *syriacum,* with its var. *regularis,* and his "*P.*" *dubium,* although listed by Frebold (1928, p. 191) under the same generic name, are true perisphinctids and are referred above (pp. 153, 158) to the genus *Mirosphinctes.*

SUBGENUS PARAPELTOCERAS SCHINDEWOLF, 1925

This subgenus (Schindewolf, 1925, p. 321) is here understood as it is by Arkell (1940, p. lxix). Following this author, I consider Quenstedt's *Ammonites annularis* (see below) instead of the problematical *Nautilus annularis* Reinecke the type species of the subgenus.

Peltoceras (Parapeltoceras) annulare
(Reinecke *in* Quenstedt)
Plate 30, figures 20–22

Ammonites annularis Reinecke; QUENSTEDT, 1849, p. 191, pl. 16, fig. 6.

Ammonites annularis Reinecke; QUENSTEDT, 1858, p. 541, pl. 71, fig. 7, *non* figs. 6, 8.

Ammonites annularis Reinecke; QUENSTEDT, 1887, p. 782, pl. 88, figs. 9–11, ?14, 16–18.

Peltoceras annulare, Reinecke; DE LORIOL, 1898, p. 103, pl. 7, figs. 12, 13.

Peltoceras annulare Reinecke; DORN, 1931, p. 63, text fig. 156, pl. 18, figs. 4–6.

Peltoceras annulare; SPATH, 1931, p. 554.

Amm. annularis Quenstedt; PRIESER, 1937, p. 29.

DIMENSIONS

A.M.N.H. No. 27833	D	H	H′	W	U
	11.2 mm.	32[1]	?	38[1]	40[1]

The single specimen has the last septum at a diameter of a little more than 6 mm.; more than three-quarters of the outer whorl belong to the body chamber, but it is still not complete.

DESCRIPTION: Conch evolute. Whorl section subcircular, somewhat wider than high. The ornamentation consists of strong, straight, more or less radial ribs, 34 of which are present on the outer volution. Of these, 26 originate on or a little below the umbilical shoulder by bifurcation from a short stump which can be followed down the umbilical wall almost to the seam. As a rule, single and bifurcate ribs alternate, but in two portions of this volution three bifurcate ribs follow one another in a row. Only two such Y's can be recognized in the anterior half of the penultimate whorl; beyond, all costae seem to be single. All the ribs of the outer volution cross the venter in a straight line; here they are just as strong as, and even higher and sharper than, on the flanks.

The last suture line (fig. 20) consists of a rather broad and short siphonal lobe with parallel terminal points, separated by a rectangular median knob, a wide external saddle of which the outer main stem is more slender than the inner, a trifid lateral lobe equaling the siphonal one in length, and an asymmetrically divided lateral saddle which is as high as, and even wider than, the external one. In addition, there are two triangular auxiliary lobes, the second of which is deeper than the first, a trapezoidal auxiliary saddle between these two lobes, and still another auxiliary saddle just visible above the umbilical seam. The tops of the saddles hit the same radius.

REMARKS: Notwithstanding Spath's and Prieser's (*loc. cit. in synon.*) objections, this species, as described and illustrated by Quenstedt, is here considered valid, and it is believed that the single shell here dealt with can well be referred to it. Its main characteristics, namely, the site of the bifurcation point on or even beneath the umbilical shoulder, and the tendency of this point to shift markedly inward if the spiral is followed apicad, can be recognized at about the same sizes in Quenstedt's figures 6 (1849) and 10 (1887) and apparently also in de Loriol's figure 12. The same meaning seems to be implied in the sentence of Quenstedt's description (1887, p. 782), "dass die Gabelung noch über die Naht hinausgeht," if "shoulder" is substituted for "seam" ("Naht").[2]

Peltoceras athletoides Lahusen (*in* de Loriol, 1898, p. 101, pl. 7, figs. 10, 11) has similarly sharp and high but markedly less closely set ribs. In *Peltoceras athletulum* (Ch. Mayer, *in* de Loriol, 1900, p. 94, pl. 6, fig. 18), on the other hand, the density of the costation is about the same as in our form, but bifurcation occurs only exceptionally and not at all at the size of our individual.

The sharpness and height of the ribs on the venter characterize this form so well within the present assemblage that comparisons with any form of preceding genera are dispensed with. It is compared with *Peltoceras* (*Peltoceratoides*) *arduennense* below (p. 191).

MATERIAL STUDIED: One specimen.

SUBGENUS **PELTOCERATOIDES** SPATH, 1924

Although Schindewolf (1926, p. 516) himself conceded the synonymy of his name *Parawedekindia* with *Peltoceratoides* Spath, emend. Buckman, Arkell (1940, p. lxx) proposes to maintain both names, as they are based on different type species, the former on *Peltoceras arduennense* (d'Orbigny), the latter on *P. semirugosum* Waagen, and the latter species differs from the former "by retaining throughout the same typical ornamentation," a difference granted subgeneric value by Arkell. I believe, however, that the difference should be considered not more than specific. Diversity of type species alone does not suffice to keep two genera or subgenera separate as long as both species belong to the same group. Consistent adherence to the opposite principle would ultimately lead to re-

[1] Measured at D=9.97 mm.

[2] Waagen (1875, p. 83) mentions in the description of his *P. semirugosum* that "the ribs, which were on the former whorls divided in two on the middle of the sides, have now their dichotomism near the umbilical margin," but there this applies to a much later ontogenetic stage, persisting "up to a diameter of about 80–90 mm."

striction of the scope of genera or subgenera to their type species. Therefore, the group of *P. arduennense* to which the following form belongs is here included in *Peltoceratoides*.

Peltoceras (Peltoceratoides) cf. arduennense (d'Orbigny)

Plate 30, figures 17–19

Cf.:

Ammonites Arduennensis D'ORBIGNY, 1847, p. 500, pl. 185, figs. 4–7.

Peltoceras arduennense d'Orbigny; DE LORIOL, 1898, p. 91, *cum synon.*, pl. 7, figs. 1–3.

Peltoceras arduennense d'Orbigny; DE LORIOL, 1900, p. 90, *cum synon.*

Peltoceras Arduennense d'Orb.; DORN, 1931, p. 66, text fig. 158, pl. 17, fig. 9.

Peltoceras arduennense d'Orbigny, variétés; MAIRE, 1932, p. 47, pl. 5, figs. 12, 13.

Peltoceratoides arduennensis Orb.; PRIESER, 1937, p. 94, fig. 11A, b, pl. 8, fig. 10, pl. 9, fig. 5; p. 96, figs. 11A, a, C, pl. 9, fig. 12 (var. *schlosseri*); p. 97, figs. 11D, E, H, pl. 6, fig. 4, pl. 8, fig. 2 (var. *mairei*).

Peltoceras (Parawedekindia) arduennense (d'Orbigny); ARKELL, 1939, p. 183.

DIMENSIONS

A.M.N.H. No. 27834	D	H	H′	W	U
1	27.0 mm.	*ca.* 42	?	*ca.* 46[1]	38½

In specimen number 1 the last septum is found at a diameter of about 17 mm. and in the badly crushed, only slightly smaller specimen number 2 at a diameter of about 24 mm. In the former about half of the outer whorl belongs to the body chamber which is, however, not complete. The latter seems to be a mature, though incomplete, individual, to judge by the crowding of the last two septa.

DESCRIPTION: In specimen number 1, where not crushed, the whorl section can be recognized at a diameter of about 17.5 mm. to be subquadratic, with gently convex flanks and venter.

Along the periphery 37 rather heavy ribs are counted on the outer whorl of this individual. On the flanks they are straight and radial in its posterior half and bifurcate first on the lateroventral shoulder, then a little dorsad of it. In the anterior half the point of bifurcation, as far as bifurcation occurs, shifts gradually inward to the middle of the flanks or somewhat beyond the middle. Simultaneously the ribs become recurved and in places sinuous. For about a quarter-whorl there is no bifurcation, but secondary ribs, beginning at about the middle of the flanks, are intercalated between the primary ones (fig. 19). All these ribs cross the venter in a straight line without diminishing in strength; here they are separated by intercostals as wide as the ribs or slightly wider (fig. 18). About a quarter-whorl from the anterior end one rib carries a heavy parabolic node in the middle of the flank; continuing to the venter this node slants off three of the ribs. As far as can be observed, the costation shows the same character in specimen number 2, except that in this shell nearly all ribs bifurcate; here, too, there is a parabolic node quite similar to the one just described in the first specimen.

Suture lines can be studied at diameters from about 13 to about 24 mm. The comparatively broad siphonal lobe ends in two short points, separated by a slender, trapezoidal median knob. The wide external saddle is divided by a comparatively deep, ventrad-deflected, two-pronged lobule into two about equally wide stems, the outer of which is higher than the inner. The lateral lobe is comparatively slender and trifid and attains only about half of the depth of the siphonal one. The lateral saddle, which is nearly symmetrically divided by a short lobule, about equals the inner stem of the external one in both width and height. It is followed by a narrow auxiliary lobe which seems to be first two-pronged, but later in development asymmetrically three-pronged, and attains about two-thirds of the depth of the lateral lobe. A nearly straight line which rises slightly towards the center connects the tops of all saddles (fig. 17).

REMARKS: This form, so rare in the present assemblage, clearly belongs to the group of *P. arduennense*, but it cannot be fully identified with any of the forms described under that name. It is stouter and more involute, and the costation is particularly heavy for this early stage. Parabolic nodes, as described above, are not mentioned anywhere in the literature, as far as I could ascertain. Nor do any of the suture lines previously depicted (all of which correspond probably to a larger

[1] Measured at D=*ca.* 17.5 mm.

size than the one at which sutures can be studied in our material) show similarly short lateral lobes (see, e.g., de Loriol, 1898, fig. 2c; Prieser, 1937, fig. 11), but they can be seen in the last author's greatly enlarged figures 12B and 12D which illustrate sutures of the subgenus *Epipeltoceras*.

At any rate, the form from Majdal Shams at the same growth stage comes fairly close to the specimen from the Vaches Noires illustrated in Prieser's figures 10 of plate 8 and 5 of plate 9. It also resembles Maire's "variété à côtes rétroverses" (pl. 5, fig. 13), named var. *mairei* by Prieser (*loc. cit. in synon.*), which is, however, more densely ribbed.

From the only other *Peltoceras* of this assemblage, *P.* (*Parapeltoceras*) *annulare*, the present form is readily distinguished by being stouter and more involute and by having heavier, recurved ribs which bifurcate at a greater distance from the umbilicus.

MATERIAL STUDIED: Two specimens.

CONCLUSIONS

COMPOSITION OF THE MOUNT HERMON AMMONITE FAUNA

THE NUMBER OF INDIVIDUALS in each superfamily, family, genus, subgenus, and species represented in the present assemblage is given in table 1.[1]

As seen from table 1, the Oppelidae, with almost 5000 individuals, are by far the most abundant family in the fauna, contributing almost two-thirds to the total number of individuals.[2] Second in abundance among the families are the Perisphinctidae which, with 1936 individuals, do not quite attain 40 per cent of the number of the Oppelidae and contribute only about one-quarter to the total. The Aspidoceratidae, with 481 individuals, or 6.33 per cent of the total, rank third in abundance, and the Phylloceratidae, with 186 individuals, or not quite 2.5 per cent, are last among the major groups composing the present fauna. (The percentages of the Haploceratidae with four individuals and of the Cardioceratidae with only one are infinitesimal.)

The same sequence of abundance as in terms of individuals prevails in terms of species, there being 21 species of Oppelidae, 13 of Perisphinctidae, seven of Aspidoceratidae, five of Phylloceratidae, and one each of Haploceratidae and Cardioceratidae. It is worth noting that the average number of individuals per species decreases with the abundance; it amounts in the four families represented by more than one species to 238, 149, 69, and 37, respectively.

Among the 13 genera present *Hecticoceras, sensu lato*, with 3710 individuals, is by far the most abundant; it also boasts of the greatest number of species (12), distributed among four subgenera. *Perisphinctes, sensu lato*, with 1461 individuals, is second in abundance among the genera; also in number of species (10), eight of which belong to the subgenus *Properisphinctes*, it is second only to *Hecticoceras*. The third genus in number of individuals is *Ochetoceras (Campylites)*, with 722 specimens, whereas *Aspidoceras (Euaspidoceras)* and *Mirosphinctes*, with 478 and 475 individuals, respectively, are almost equal in abundance, and *Taramelliceras*, with 455 individuals, comes fairly close. It will, however, be noted that *Aspidoceras (Euaspidoceras)*, with seven species (two with a morphologic variety each), almost equals *Properisphinctes* in the number of species, while only four species are counted in *Taramelliceras* and three each in *Ochetoceras* and *Mirosphinctes*. The two remaining oppelid genera, *Creniceras* and *Scaphitoidites*, with one species each and only 20 and 80 individuals, respectively, are much less abundant than those just mentioned. Among the Phylloceratidae, *Sowerbyceras* (two forms, 100 individuals) somewhat outnumbers *Phylloceras, sensu lato* (three species, 86 individuals) in individuals, though not in species. Finally, the genera *Lissoceras*, *Peltoceras*, and *?Quenstedtoceras*, with only four and three specimens and one specimen, respectively, are extremely rare in the present assemblage.

Of the altogether 50 species dealt with in this report, the following 17 have been recorded by Noetling from Majdal Shams:

Phylloceras (Phylloceras) plicatum Neumayr
Phylloceras (Calliphylloceras) schems Noetling
Sowerbyceras helios (Noetling)
Hecticoceras (Lunuloceras) kersteni (Noetling)
Hecticoceras (Sublunuloceras) guthei (Noetling)
Hecticoceras (Brightia) socini (Noetling)
Hecticoceras (Brightia) kautzschi (Noetling)
Hecticoceras (Putealiceras) schumacheri (Noetling)
Ochetoceras (Campylites) delmontanum (Oppel)
Taramelliceras (Proscaphites) hermonis (Noetling)
Creniceras renggeri (Oppel)
Perisphinctes (Alligaticeras) paneaticus Noetling
Perisphinctes (Dichotomosphintes) orthocyma Noetling
Perisphinctes (Properisphinctes) latilinguatus Noetling
Mirosphinctes syriacus (Noetling)
Mirosphinctes regularis (Noetling)
Aspidoceras (Euaspidoceras) hermonis, new name (as *Aspidoceras perarmatum*)

Freebold added the following:

Scaphitodites scaphitoides (Coquand)

[1] About 70 specimens, mostly fragments, which are too poorly preserved for even generic determination, are omitted.

[2] Noetling (1887, p. 15) says that about one-half of the total are "*Harpoceras*." This, however, does not include the two species of Oppelidae listed by him as "*Oppelia (Oekotraustes)*" *renggeri* and "*Oppelia*" *hermonis*.

TABLE 1

SYNOPSIS OF THE JURASSIC MOUNT HERMON AMMONITES FROM THE COLLECTION OF THE AMERICAN UNIVERSITY OF BEIRUT

	Number of Individuals				
Phylloceratacea					186
Phylloceratidae				186	
Phylloceras			86		
Phylloceras		72			
plicatum	11				
riazi	61				
Calliphylloceras		14			
schems	14				
Sowerbyceras			100		
helios	95				
Indeterminate juvenile form	5				
Oppeliaceae					4991
Haploceratidae				4	
Lissoceras			4		
erato	4				
Oppelidae				4987	
Hecticoceras			3710		
Not subgenerically determined		400[a]			
Lunuloceras		25			
kersteni	25				
Sublunuloceras		819			
guthei	726				
aff. *guthei*	5				
socium	88				
Brightia		1636			
socini	633				
kautzschi	727				
syriacum	276				
Putealiceras		830			
schumacheri	227				
douvillei	14				
caelatum	341				
solare	95				
separandum	153				
Ochetoceras			722		
Campylites		722			
delmontanum	220				
freboldi	400				
evolutum	102				
Taramelliceras			455		
Proscaphites		190			
hermonis	152				
globosum	35				
cf. *langu*	3				
Reicheiceras		265			
richei	265				
Creniceras			20		
renggeri	20				
Scaphitodites			80		
scaphitoides	80				

[a] Approximate.

TABLE 1—(*continued*)

	Number of Individuals				
Stephanocerataceae					1
Cardioceratidae				1	
?Quenstedtoceras			1		
Pavloviceras		1			
?mariae	1				
Perisphinctaceae					2425
Perisphinctidae				1936	
Perisphinctes			1461		
Alligaticeras		129			
?paneaticus	129				
?Dichotomosphinctes		5			
?orthocyma	5				
Properisphinctes		1327			
vicinus	238				
filocostatus	30				
bernensis	400[a]				
radiocostatus	12				
trapezoidalis	18				
latilinguatus	265				
hermonis	120				
delicatulus	244				
Mirosphinctes			475		
syriacus	225				
regularis	239				
kobyi	11				
Aspidoceratidae				489	
Aspidoceras			486		
Euaspidoceras		486			
perisphinctoides	141				
subcostatum	148				
subbabeanum	21				
douvillei	2				
hermonis	110				
lyra	43				
rotundatum	13				
not specifically determined	8				
Peltoceras			3		
Parapeltoceras		1			
annulare	1				
Peltoceratoides		2			
cf. *arduennense*	2				
TOTAL					7603

Phylloceras (*Phylloceras*) *riazi* de Loriol (as *Phylloceras* sp.)
Ochetoceras (*Campylites*) *freboldi* Haas (as "*Hecticoceras Brotzeni*" and "*Amm. arolicus*")
Taramelliceras (*Proscaphites*) *globosum* (de Loriol) [as "*Oppelia* sp. (*globula* Qu.?)"]

Phylloceras riazi has been illustrated from the locality "Djebel el Chems" also by Pompeckj (1893).

Fifteen species previously described from other localities are here recorded for the first time from Majdal Shams, two [*Taramelliceras* (*Proscaphites*) *langi* and *Peltoceras* (*Peltoceratoides*) *arduennense*] with "cf.," and a third [*?Quenstedtoceras* (*Pavloviceras*) *?mariae*] with a "?" only:

Lissoceras erato (d'Orbigny)
Hecticoceras (*Putealiceras*) *douvillei* Jeannet

Hecticoceras (Putealiceras) caelatum ([Coquand] de Loriol)
Taramelliceras cf. *langi* (de Loriol)
Taramelliceras (Richeiceras) richei (de Loriol)
?*Quenstedtoceras (Pavloviceras)* ?*mariae* (d'Orbigny)
Perisphinctes (Properisphinctes) bernensis de Loriol
Mirosphinctes kobyi (de Loriol)
Aspidoceras (Euaspidoceras) perisphinctoides Sintzov
Aspidoceras (Euaspidoceras) subcostatum Spath
Aspidoceras (Euaspidoceras) subbabeanum Sintzov
Aspidoceras (Euaspidoceras) douvillei Collot
Aspidoceras (Euaspidoceras) lyra Spath
Peltoceras (Parapeltoceras) annulare (Reinecke *in* Quenstedt)
Peltoceras (Peltoceratoides) cf. *arduennense* (d'Orbigny)

Fourteen species, or a little more than one-fourth of the total, are new (it seemed inadvisable to propose new names for the first two):

Sowerbyceras, indeterminate juvenile form
Hecticoeras (Sublunuloceras) aff. *guthei* Noetling
Hecticoceras (Sublunuloceras) socium
Hecticoceras (Brightia) syriacum
Hecticoceras (Putealiceras) solare
Hecticoceras (Putealiceras) separandum
Ochetoceras (Campylites) evolutum
Perisphinctes (Properisphinctes) vicinus
Perisphinctes (Properisphinctes) filocostatus
Perisphinctes (Properisphinctes) radiocostatus
Perisphinctes (Properisphinctes) trapezoidalis
Perisphinctes (Properisphinctes) hermonis
Perisphinctes (Properisphinctes) delicatulus
Aspidoceras (Euaspidoceras) rotundatum

Thus the significance of the present revision may be sought not so much in the creation of new species as in the more thorough study of the ontogeny of, and the variation in, both previously known and new species, made possible by the wealth of the material available, which is more than 50 times as abundant as that on which Noetling based his monograph of 1887.

SUMMARY OF OBSERVATIONS BEARING ON ONTOGENY, PHYLOGENY, AND EVOLUTION

Earliest Ontogenetic Stages

Nuclei have been studied and protoconchs have been examined in side view in a considerable number of species (pp. 20, 47, 53, 62, 70, 74, 81, 94, 99; pl. 3, figs. 3, 4; pl. 7, figs. 21, 29, 40; pl. 8, figs. 4, 14, 16; pl. 9, fig. 17; pl. 11, fig. 36; pl. 13, fig. 8). By far the most significant observations on these earliest stages, namely, on a protoconch detached from the first chambers, on the caecum, the prosuture, and the primary and following sutures, have been made in a single species, *Ochetoceras (Campylites) freboldi* (pp. 86 ff., 90 ff.; text figs. 1–4; pl. 14, figs. 1–12).

Similarly, in only a single small, and perhaps crippled, juvenile belonging to *Hecticoceras (Putealiceras) caelatum* (p. 70, pl. 10, figs. 27–29) has the apertural margin, complete with median rostrum and lateral lappets, been observed.

Phylogenetic Conclusions; Palingenesis versus Proterogenesis[1]

Because the assemblage studied represents a cross section through the history of ammonite evolution in Jurassic time, it cannot be expected to yield important clues as to phylogenetic connections between the contemporary or almost contemporary, lineages caught in that cross section. However, there is strong evidence in support of derivation of the genus *Aspidoceras*, and more particularly its subgenus *Euaspidoceras*, from the Perisphinctidae by way of *Mirosphinctes* (p. 152), and the close similarity between the early suture lines on the flanks of *Taramelliceras (Proscaphites) hermonis* on the one hand and of *Sowerbyceras helios* on the other (p. 101) supports Spath's derivation, based on sutural homologies, of the Oppeliaceae (more particularly, of the Haploceratidae) from the Phylloceratidae.

Both these cases call for palingenetic interpretation, just as Noetling (1887, p. 17)

[1] Schindewolf's term proterogenesis is here given preference over the term caenogenesis (cenogenesis) used by Spath, because the latter is not only variously spelled (e.g., "Coenogenese" by Rensch, 1947, pp. 241, 248, 252) but is used with various meanings by different authors.

based his belief in the common origin of all Syrian "Harpoceratids" [roughly coextensive with the genera *Hecticoceras*, *sensu lato*, and *Ochetoceras* (*Campylites*), as understood in the present report] on his contention that the "embryonic volutions" are alike in all of them. It has been shown above (p. 30) that Noetling extends this connotation up to much too large a size. If it is cut down to proper size, then his contention may hold true, within certain limits. It is indeed supported by many observations on the ontogenies of the forms here studied. They all converge into the more or less commonplace conclusion that related forms resemble one another more closely the earlier are the ontogenetic stages compared, and become more differentiated the more advanced these stages are.

However, some of the observations made in the course of this study favor proterogenesis. Thus the relative if not absolute decrease of sutural elaboration observed in *Sowerbyceras helios* (p. 26) appears to be the ontogenetic equivalent of the same decrease observed by Pompeckj in the phylogeny of that genus, indicating retrogressive evolution. This in turn, as long as *Sowerbyceras* is considered an offshoot of *Phylloceras*, *sensu lato*, would call for a proterogenetic rather than palingenetic interpretation of the change of the sutures within the ontogenies of *Phylloceras riazi* and *P.* (*Calliphylloceras*) *schems* from *Sowerbyceras*- to *Phylloceras*-style (pp. 17, 22).

Furthermore, the character of the ornamentation of some individuals of *Mirosphinctes syriacus*, especially of specimen A.M.N.H. No. 27760:60, becomes at the medium growth stage strikingly like that of *Aspidoceras* (*Euaspidoceras*), especially that of *A.* (*E.*) *perisphinctoides*, but then gives way rather abruptly to a normal *Mirosphinctes* sculpture. As the present material strongly suggests derivation of *Euaspidoceras* from *Mirosphinctes*, this phenomenon would also seem to be a proterogenetic one.

HOMEOMORPHY, CONVERGENCE, "ANALOGOUS VARIATIONS"

The assemblage under study presents a considerable number of homeomorphies. Most striking are those leading to close similarity between members even of different suborders, viz., Phylloceratina and Ammonitina, as between *Phylloceras riazi* and *Taramelliceras* (*Richeiceras*) *richei* (Haas, 1952[1]; pp. 19, 111); between juveniles of the latter species with unusually wide umbilici and those of *P.* (*Calliphylloceras*) *schems* (p. 22); and between juveniles of *Sowerbyceras helios* and still smooth juveniles of *Perisphinctes* (*Properisphinctes*) *delicatulus* (pp. 26, 152).

One case of homeomorphy has been observed between the superfamilies Oppeliaceae and Perisphinctaceae, namely, between nearly smooth juveniles of *Mirosphinctes kobyi* and of some *Hecticoceras*, especially of the subgenus *Brightia* (p. 165), and one within the Oppeliaceae, namely, between the haploceratid *Lissoceras erato* and the oppelid *Hecticoceras* (*Sublunuloceras*) aff. *guthei* (p. 29).

Most of our cases of homeomorphy, however, are encountered within families. One has been noted in the Phylloceratidae, between one of the few specimens designated *Sowerbyceras* indeterminate juvenile form and similarly small juveniles of *Phylloceras* (*Calliphylloceras*) *schems* (p. 27).

In this case as well as in all other cases so far dealt with here the homeomorphy is unmasked by essential sutural differences (Haas and Simpson, 1946, p. 339).

As would be expected in view of the abundance and diversity of the Oppelidae in the present assemblage, many more cases of homeomorphy can be found within this family. The following six occur between different genera:

Hecticoceras (*Sublunuloceras*) *socium* and *Ochetoceras* (*Campylites*) *evolutum* (p. 96)

Ochetoceras (*Campylites*) *evolutum* and *Hecticoceras* (*Putealiceras*) *solare* (p. 96)

Heticoceras (*Putealiceras*) *separandum* and juveniles of *Ochetoceras* (*Campylites*) (p. 80)

Hecticoceras (*Sublunuloceras*) *guthei* and *Ochetoceras* (*Campylites*) *delmontanum* (p. 85) and *O.* (*C.*) *freboldi* (p. 93)

Juveniles of *Taramelliceras* (*Richeiceras*) *richei*

[1] The indication of a constriction, mentioned in that paper (footnote 1) as among the distinctive characters of *P. riazi* [then erroneously listed as "*Calliphylloceras*, probably *Calliphylloceras schems* (Noetling)"] has since been found to occur only quite rarely in that species.

and narrowly umbilicate juveniles of *Creniceras renggeri* (p. 114)

Juveniles of *Taramelliceras* (*Proscaphites*) *hermonis* and juveniles of *Scaphitodites scaphitoides* with only indistinct first geniculation and before the second occurs (p. 120)

Two cases of homeomorphy occur within the genus *Hecticoceras*, *sensu lato:* between evolute individuals of *Sublunuloceras guthei* and *Brightia syriaca* (pp. 41, 60) and between *Putealiceras schumacheri* and some individuals of *Brightia kautzschi* (pp. 56, 65).

In contrast to the homeomorphies discussed above, those occurring within the family Oppelidae as a rule can be unveiled by recourse to differences in whorl profile and in the configuration of the venter rather than to sutural differences.

In the last of the cases here quoted, the homeomorphy is brought about by a striking similarity in ornamentation. This case may be considered one of intrageneric convergence, comparable to cases repeatedly mentioned by Brinkmann (1929, *passim*, e.g., p. 149) within the genus *Cosmoceras*, as well as of homeomorphy. The acquisition at an early ontogenetic stage of an extremely wide whorl profile with pronounced peripheral shoulders in *Perisphinctes* (*Properisphinctes*) *trapezoidalis* and in some forms of *Aspidoceras* (*Euaspidoceras*) presents itself as a clear case of convergence between two families, viz., Perisphinctidae and Aspidoceratidae, of the Perisphinctaceae.

In two other cases of homeomorphy characters of the sutures themselves become closely similar. The first of these cases occurs between two members of the Oppelidae: *Taramelliceras* (*Proscaphites*) *globosum* and *Scaphitodites scaphitoides* exhibit similar reductions of the sutures (p. 120). The second case occurs within *Hecticoceras*, *sensu lato:* Sturdy main lobes with stubby points, distinctive of *Putealiceras schumacheri* (p. 65), occur occasionally also in *Sublunuloceras socium*. These two cases, as well as the similarity in ornamentation mentioned above between the last-named species and *Brightia kautzschi*, may be considered cases of Darwin's "analogous variations," i.e., of independent acquisition of the same, or at least similar, characters in different though related groups (see Haas and Simpson, 1946, p. 326, p. 337, footnote 53).

Other cases of such "analogous variations" in our material are the development of beads from parabolic nodes in both *Mirosphinctes kobyi* and *Aspidoceras* (*Euaspidoceras*) *perisphinctoides* (p. 164) and the even more striking "spilling over" of certain sutural peculiarities from some species of the subgenus *Properisphinctes* onto neighboring ones (pp. 129, 135, 145, 148). This phenomenon was observed by Lemoine (1932, p. 27) in the genus *Hecticoceras* and described, with special mention of the suture lines, as follows: "Mais s'il y a réellement communauté probable d'origine entre *Oppelia* et *Hecticoceras*, les deux séries doivent avoid conservé des caractères internes physico-chimiques communs, d'où la possibilité, dans des conditions identiques de milieu, d'oscillations réactionnelles dans le système des échanges, entraînant avec elles des phénomènes de convergence morphologique. C'est ce que l'observation confirme et, souvent, sans la ligne suturale, il est bien difficile de classer un individu dans un genre ou dans l'autre."

The gist of this paragraph seems to be what Simpson (1945, p. 9) expressed in terms of modern genetics much more briefly in one sentence, "Homologous genes tend to mutate the same way."

PALEOECOLOGICAL CONSIDERATIONS

Bathymetric Conditions

As did most ammonite faunas the present one must be considered to have inhabited a neritic environment. If Gayle Scott's (1940, text fig. 8, pp. 320–322) bathymetric scheme devised for the Cretaceous seas of Texas with special regard to their ammonite faunas be analogously applied to the one under discussion, all Perisphinctaceae and most of the Oppeliaceae would have to be assigned to his infraneritic zone, the rest of the Oppeliaceae probably in part to the epineritic[1] and in

[1] This would apply to particularly slender and smooth forms such as *Lissoceras erato*.

part to the epibathyal zones, and the Phyllocerataceae could be considered to have been washed in from the infrabathyal zone. The relative abundance of the groups concerned (see table 1) would agree well with the assumption of an infraneritic environment, with some admixture of forms from the adjacent epineritic, epibathyal, and infrabathyal zones, for the ammonites from Majdal Shams.

Environment of Pyritized Ammonite Faunas

This problem has been much discussed for almost half a century. Haug (1911, p. 938) considered the "marnes à Ammonites pyriteuses" (of which the Mount Hermon assemblage is a good example) to be "formations bathyales," that is, beds deposited at a depth exceeding 100 fathoms (=600 feet =180 meters; see Scott, *loc. cit.*). Corroy (1933, p. 224) assigns these marls to Fischer's "zones littorales et des Laminaires" of which the lower limit is placed at a depth of 28 meters, so that this author's opinion thus represents the opposite extreme. Henri and Geneviève Termier (1951, pp. 16, 24; 1954) place their "herbiers," that is, thickets of algae and other marine plants, considered by them the environment conducive to the pyritization of the shells buried in the ooze accumulating on the sea bottom under the thickets, in the bathymetric zone above the depth of 40 meters, explicitly stating: "Les faunes pyriteuses appartiennent à la branche supérieure de la zone néritique." They believe that pyritization takes place after instantaneous burial on the spot where the animal died, or at the most only a short distance away.

Rutten (1954), in his investigation into the genesis of the beds with pyritized ammonites of the "fosse vocontienne" of southern France, also reaches the conclusion, independently of the Termiers, that pyritized ammonites occur in deposits "que nous sommes amenés à considerer . . . comme littoraux ou néritiques."

Thus the results both of the Termiers and of Rutten agree fairly well with the conclusion reached above by analogous application of Gayle Scott's scheme, namely, that most of the ammonites of the present assemblage lived in the infraneritic zone, and they certainly corroborate the above assumption of a neritic environment.[1]

Size Problems

In their brief communication of 1954 the Termiers summarize their earlier studies to the effect that pyritized faunas consist in general of small shells, some (especially gastropods) probably dwarfs, some (especially cephalopods) juveniles, and that an important fraction of the spawn ("naissain") of cephalopods is encountered in the "herbiers." Similarly, Tasch (1953, p. 381) found that the populations of most of the species of the limonitic Pennsylvanian "Dry Shale fauna" consist predominantly of juveniles and that one of two goniatite species in that fauna appears to be dwarfed. Scott (1940, pp. 311, 312) reports that the pyritized ammonites from the Cretaceous of Texas "are all small" and many of them "obviously dwarfed."[2]

Study of the ammonite fauna under discussion in general yields similar results with regard to size. Small juveniles not exceeding 20 mm. in diameter predominate in this assemblage to such an extent that at first sight it might be taken for a "dwarfed fauna." This impression would, however, be misleading for the following reasons:

1. A considerable number of forms in the present fauna do not exceed a certain diameter, of the order of magnitude of about 20 mm., even in maturity. This holds true of the following species:

Phylloceras (*P.*) *riazi*
Hecticoceras (*Brightia*) *syriacum*

[1] After the present report had been submitted for publication, Goguel's (1954) article on this subject came to my attention. He is inclined to assign a somewhat wider bathymetric range to the marls with pyritized ammonites but seems otherwise to agree with Rutten and the Termiers, especially in excluding a bathyal environment.

[2] In an article published in a semi-popular magazine that came to my attention while I was writing this section of the Conclusions, Schuster-Dieterichs (1954) discusses the question of whether or not the iron content of sea water or of the sediments on the sea bottom could be responsible for the dwarfing of populations. As far as pyritized ammonite faunas are concerned, it must be kept in mind that pyritization occurs only in the process of fossilization of the shells under anerobiotic conditions (H. and G. Termier, 1951, p. 19). It seems unlikely that this process would require a concentration of iron in the sea water or in the sediments on the sea bottom sufficient to reduce the growth of the organisms living in that environment.

H. (*Putealiceras*) *caelatum*
H. (*P.*) *solare*
H. (*P.*) *separandum*
Ochetoceras (*Taramelliceras*) *evolutum*
Taramelliceras (*Proscaphites*) *globosum*
T. (*Richeiceras*) *richei*
Creniceras renggeri
Scaphitodites scaphitoides
Perisphinctes (*Properisphinctes*) *filocostatus*
Mirosphinctes kobyi
Peltoceras (*Parapeltoceras*) *annulatum*

As seen from the discussions of maximum size, which is found at the end of the sections on dimensions of each species in the systematic part of this report, the above holds true for all but one of the enumerated species which occur in other localities as well as on Mount Hermon, namely, for *P.* (*P.*) *riazi*, *H.* (*P.*) *caelatum*, *T.* (*P.*) *globosum*, *T.* (*R.*) *richei*, *C. renggeri*, *S. scaphitoides*, and *M. kobyi*. However, *P.* (*P.*) *annulatum*, which is represented at Majdal Shams by a single shell that measures only about 11 mm. in diameter, attains a larger size elsewhere. The seven other forms mentioned represent micromorphic species which just do not grow larger. Thus they cannot by any means be considered dwarfs. However, in these forms also, the smallest individuals, representing the juvenile stage, are much more numerous than larger ones.

2. It must be kept in mind that among 7600 ammonites examined, only a single, perhaps crippled, juvenile (pp. 70, 195) has been found preserved to the apertural margin and can thus be considered really complete. There are not a few nearly complete shells, but by far the majority of those examined are incomplete and many lack the body chamber. In this connection Scott (1940, p. 311) may again be quoted for his assumption that many of the small pyritized ammonites from Texas are probably "the preserved inner whorls of large[r] specimens." This incompleteness of many individuals is bound to increase greatly the apparent percentage of small specimens in the material studied. To correct this impression, an attempt has been made in the systematic part of this report to arrive at a correct estimate of the maximum size attained by each species.

3. In contradistinction to the species mentioned in paragraph 1 above, others present at Majdal Shams are found to have attained much larger diameters, estimated in the systematic part of this report at 85–90 mm. for *Hecticoceras* (*Sublunuloceras*) *socium*, 110 mm. for *H.* (*Putealiceras*) *douvillei*,[1] 120 mm. for *H.* (*P.*) *schumacheri*, 150–200 mm. for *Phylloceras* (*P.*) *plicatum*, and nearly 200 mm. for *Aspidoceras* (*Euaspidoceras*) *hermonis*. *Phylloceras* (*Calliphylloceras*) *schems*, ?*Quenstedtoceras* (*Pavloviceras*) ?*mariae*, and *Perisphinctes* (*Alligaticeras*) ?*paneaticus* must have grown even larger, but the maximum diameters reached by these species cannot reliably be estimated.[2]

4. All the other species present seem to have been intermediate in size between the micromorphic ones (1) and those just enumerated which grow quite large by the standards of pyritized ammonite faunas. In all these forms also, juveniles greatly predominate, perhaps more so in the subgenus *Properisphinctes* of *Perisphinctes* than in other groups, thus reënforcing the impression that this subgenus among the perisphinctids is a group of particularly small-sized forms.

In an attempt at evaluation of the size distribution just expounded, its analogy, though limited, with that encountered in the gastropod assemblages of the late Triassic light limestones of central Peru (Haas, 1953,[3] pp. 298–300) comes readily to mind. Both materials have the very great abundance of juveniles in common. Still neither can correctly be interpreted as a "dwarfed fauna." However, some remarkable differences prevail:

1. Except for broken-out nuclei and innermost whorls, no such extremely small sizes occur among the Mount Hermon ammonites as among the Peruvian gastropods.

2. Full-grown, or nearly full-grown, individuals are not so disproportionately rare as compared to small juveniles in the former material as they are in the latter.

[1] Attaining an estimated diameter of about 160 mm. at Villers-sur-Mer.

[2] *Phylloceras* (*Calliphylloceras*) *demidoffi*, closely related to *P.* (*C.*) *schems*, grows "nearly 2 feet" across at the Woodham Pit (p. 20).

[3] Unfortunately that paper went to the editor before the writer had seen the Termiers' article of 1951 and long before Dr. Tasch reported orally at the Boston meeting of the Geological Society of America, November, 1952, on his investigations, published in 1953. Thus, the writer could not refer in his 1953 paper to those authors whose results considerably support his own.

3. Furthermore the present material does not show such wide gaps in dimensions between mature individuals and juveniles as are found in the Peruvian faunules even in those few populations in which full-grown individuals do occur but of which juveniles still represent 98 per cent or even 99 per cent of the total. Accordingly the tables of dimensions in the present report do not exhibit, at least not to the same extent, the approach towards the maximum sizes "in leaps and bounds, as distinct from the steady increase in size recognizable in [their] earlier parts," noted for the Peruvian faunules (Haas, 1953, p. 299).

Following Fuch's (1871) interpretation of conditions in the algal thickets of the port of Messina, Sicily, I assumed that the Peruvian faunules represented the populations of a similar biotope especially suited for juveniles but unsuited for adults, which succeeded only occasionally in intruding into the algal thickets or the empty shells of which may have been washed into the sediment.

In view of the differences pointed out above, I feel that such an assumption in the case of the Mount Hermon assemblage is not warranted with the same degree of probability as it was for the gastropod faunules of the light limestones of central Peru. It may well be that the ammonites dealt with in the present report lived in "herbiers,"[1] thus confirming the Termiers' hypothesis with regard to habitat as well as bathymetric conditions and size distribution, but the material under examination yields no clues that would compel us to assume this. The apparent dominance of small specimens can be explained for the most part by their incompleteness. The still great abundance of juveniles among nearly complete shells can sufficiently be accounted for by heavy infantile and juvenile mortality (Deevey, 1947; Cloud, 1948; Haas, 1953, p. 300; Tasch, 1953, p. 388).

STRATIGRAPHIC CONCLUSIONS

One Horizon or More?

Without having had an opportunity to study the ammonite-bearing beds near Majdal Shams in the field, the present author depends, in regard to their stratigraphy, solely on the observations of Fraas (1877, 1878), Diener (1886a, 1886b), Noetling (1887), and Brotzen (Frebold, 1928). The labels with which the specimens were provided at Beirut do not in any way distinguish different horizons. As far as these labels indicate the horizon at all, without exception they read, "zone of *Harpoceras Socini.*" This situation leaves, in addition to purely paleontological inferences, only the lithology of the ammonites to be searched for stratigraphic clues.

Such an investigation, if carried out in the laboratory rather than in the field, cannot be expected to be anything better than guesswork. It must, however, be tried all the same, chiefly in an attempt to decide whether the material studied represents only one horizon or more than one. This problem is raised in particular by Frebold's (1928) interpretation of Brotzen's report on his visit to Majdal Shams and of Frebold's own identifications. For, while on the strength of Noetling's monograph of 1887 all the ammonites here dealt with appear to come from the lower division of his "zone of *Harpoceras Socini*,"[2] Frebold arrives at the two following conclusions:

1. His "Mergelkalke" are probably stratigraphically lower than the "zone of *Oecotraustes Renggeri*" (1928, p. 187).

2. His "new zone of *Oecotr. scaphitoides* and *Amm. Arolicus*"[3] is stratigraphically above the ammonitiferous lower division of

[1] The fact that the few ammonites found in a sample of "Mergelkalke" differ in lithological facies but not in other respects, especially not in size, from conspecific pyritized ones does not support the assumption that the pyritized preservation of the latter indicates some special biotope.

[2] No ammonites occur in the upper division. The "*Perisphinctes* sp. I" listed in Noetling's table (p. 8) as occurring in that division is actually from the zone of *Collyrites bicordata* (1887, p. 37).

[3] Considered in this report a probable synonym of *Ochetoceras* (*Campylites*) *freboldi*.

Noetling's "zone of *Harpoceras Socini*" and equivalent to the upper division of Noetling's zone (1928, pp. 193–195).

Now the only sample of what are probably Brotzen's and Frebold's "Mergelkalke" that could be examined by the present author contains, most probably, *Hecticoceras* (*Putealiceras*) *schumacheri* and *H.* (*Sublunuloceras*) *guthei* (pp. 10, 41, 66, 72), both species characteristic of the ammonitiferous lower division of Noetling's "zone of *Harpoceras Socini*." These marly limestones may thus be considered contemporaneous with and different only in facies from the marls of that division which have yielded the pyritized ammonites.

This result would be consistent with Frebold's first assumption as long as his second assumption stands. However, although *Scapitodites scaphitoides* occupies in England (Arkell and Holt, 1952, p. 19) a stratigraphic position somewhat above Beds B and A of the Woodham Pit section (Arkell, 1939, p. 137), the present material gives no faunistic indication for the presence of two or more horizons. Frebold's (1928, p. 194) comparison of Noetling's and Brotzen's collections does not really support the assumption of more than one horizon either, especially if the two following probabilities are considered: (1) Noetling seems to have lumped many juveniles of other species, including some of *Ochetoceras* (*Campylites*) *freboldi*, with his "*Harpoceras Socini*" (p. 50); (2) Frebold's "*Amm. arolicus* Oppel = *complanatus* Qu." seems to be synonymous with that same *O.* (*C.*) *freboldi*. To quote still another argument against age differentiation, *Scaphitodites scaphitoides* occurs in England (Arkell and Holt, 1952) in beds of the *mariae* zone in which *Creniceras renggeri* is less abundant than in the beds immediately below, designated Beds Band A at Woodham Pit. In Frebold's list of Brotzen's collection, however, the former species is listed as "ziemlich häufig" (rather abundant) but the latter as "sehr häufig" (very abundant).

As mentioned in the Introduction (p. 10), the three species belonging to the group of *Hecticoceras* (*Putealiceras*) *caelatum*, namely, this species, *H.* (*P.*) *solare*, and *H.* (*P.*) *separandum*, and some specimens belonging to other species somewhat differ in preservation from the bulk of the material, thus raising the question of whether or not this peculiar mode of preservation indicates a difference in age as well. That some individuals of other species, most of the specimens of which exhibit the dominant mode of preservation, share this peculiarity with the three abovenamed species seems to plead against the assumption of a difference in age. Furthermore, *H.* (*P.*) *caelatum*, the only species of the three that occurs elsewhere, as well as on Mount Hermon, is known from the "Zone à *Ammonites renggeri*" of the Jura Bernois, the Jura Lédonien,[1] and the Franche Comté and is associated in these three areas with 15, 17, and eight species, respectively, all of which also occur at Majdal Shams, without exhibiting the peculiar preservation of the *caelatum* group.[2] Thus the difference here discussed is also believed to be one of facies rather than of age.

It is concluded from the two preceding paragraphs that the assemblage dealt with here may be considered for stratigraphic purposes as representing one zone only, although intrazonal differences in the composition of the fauna may occur, such as those noted for the English *mariae* zone by Arkell (1939, p. 137) between Beds A and B at Woodham Pit and by Arkell and Holt (1952, p. 19) between the outcrops of Woodham Pit, Stangate Hill, and Purton Pit, or by Girardot (*in* de Loriol, 1900, p. 179) between the two divisions of the *renggeri* marls at La Billode. If so, in the present case they are not traceable because of lack of field data. In this connection it may be mentioned that Noetling (1887, p. 3) gives the thickness of his "zone of *Harpoceras Socini*" as 20 meters at the most. The thickness of its two divisions, only the lower of which has yielded the ammonites, is not indicated. If roughly one-half of

[1] It is worth noting that at La Billode, the most important fossil locality of the Jura Lédonien, this species occurs in both the lower and upper division of the "Marnes a *Ammonites Renggeri*" (Girardot *in* de Loriol, 1900, p. 179).

[2] Compared with this fact, the possibility that the *Hecticoceras rossiense* recorded by Vautrin (1934, p. 1439) from the upper Callovian of the Anti-Lebanon may be a *H.* (*P.*) *caelatum* instead (p. 72) is insignificant, especially as *rossiense* is recorded by de Loriol (1898, p. 41) from Châtillon, the most important fossil locality of the Jura Bernois, with *caelatum*.

TABLE 2

CORRELATION OF THE MOUNT HERMON AMMONITE FAUNA WITH SOME OTHER FAUNAS

Species	Oxfordian of England: Various Localities	Oxfordian of England: Woodham Pit	Oxfordian of England: Stangate Hill	"Divesian" of Normandy	*Ammonites renggeri* Zone: Jura Bernois	*Ammonites renggeri* Zone: Jura Lédonien	*Ammonites renggeri* Zone: Franche Comté	Oolite of Herznach, Switzerland: C	Oolite of Herznach, Switzerland: D	Oolite of Herznach, Switzerland: E	Oolite of Herznach, Switzerland: F	*Transversarius* Zone, Maruszina, Poland	"*Cordatum*" Zone, Saratov District, Russia	*Creniceras renggeri* Beds, Anti-Lebanon	"Divesian," Mostly *renggeri* Zone, India
	1	2[a]	3	4	5	6	7	8	9	10	11	12	13	14	15
Phylloceras (*Phylloceras*) *plicatum* Neumayr												=[b]			
Phylloceras (*Phylloceras*) *riazi* de Loriol					=	=									
Lissoceras erato (d'Orbigny)						=									
Hecticoceras (*Putealiceras*) *douvillei* Jeannet[c]				=				= (C–D)							
Hecticoceras (*Putealiceras*) *caelatum* ([Coquand] de Loriol)[d]					=	=	=								
Ochetoceras (*Campylites*) *delmontanum* (Oppel); syn.: *O.* (*C.*) *rauracum* (C. Mayer)					=[e]	=								=	
Taramelliceras (*Proscaphites*) *hermonis* (Noetling); syn.: *T.* (*P.*) *episcopalis* (de Loriol)		=	=		=	=	=								cf.[b]
Taramelliceras (*Proscaphites*) *globosum* (de Loriol)		=			=	=									
Taramelliceras (*Proscaphites*) cf. *langi* (de Loriol)		cf.			cf.	cf.									
Taramelliceras (*Richeiceras*) *richei* (de Loriol)		=	=		=	=	=				cf.				
Creniceras renggeri (Oppel)	=[f]	=	=	=	=[g]	=	=		?[b]					=	
Scaphitodites scaphitoides (Coquand)	=[h]			=	=	=[i]									
?*Quenstedtoceras* (*Pavloviceras*) ?*mariae* (d'Orbigny)		?	?	?[j]	?	?									
Perisphinctes (*Properisphinctes*) *bernensis* de Loriol	=	=			=	=								=	=
Perisphinctes (*Properisphinctes*) *latilinguatus* Noetling		=				=	=								
Mirosphinctes kobyi (de Loriol)					=	=	=								
Aspidoceras (*Euaspidoceras*) *perisphinctoides* Sintzov					=	=[k]							=		=
Aspidoceras (*Euaspidoceras*) *subcostatum* Spath	=[l]	=			=										
Aspidoceras (*Euaspidoceras*) *subbabeanum* Sintzov						=	=		cf. (D–E)						
Aspidoceras (*Euaspidoceras*) *douvillei* Collot	=[m]			=[n]		=	=[o]				cf.				
Aspidoceras (*Euaspidoceras*) *lyra* Spath	=[p]														
Peltoceras (*Parapeltoceras*) *annulare* (Reinecke *in* Quenstedt)					=[q]										
Peltoceras (*Peltoceratoides*) cf. *arduennense* (d'Orbigny)		cf.		cf.[r]			cf.								

the total thickness (10 meters) be assigned to the lower division, it would still be somewhat thicker than both Beds A and B of the *mariae* clays at Woodham Pit taken together, the total thickness of which is 29 feet, or 8.7 meters (Arkell, *loc. cit.*).

Correlation and Dating

The following 27 species have hitherto been recorded only from Majdal Shams and cannot therefore be used for purposes of correlation:

Phylloceras (*Calliphylloceras*) *schems* Noetling
Sowerbyceras helios (Noetling)
Sowerbyceras indeterminate juvenile form
Hecticoceras (*Lunuloceras*) *kersteni* (Noetling)
Hecticoceras (*Sublunuloceras*) *guthei* (Noetling)
Hecticoceras (*Sublunuloceras*) aff. *guthei* (Noetling)
Hecticoceras (*Sublunuloceras*) *socium* Haas
Hecticoceras (*Brightia*) *socini* (Noetling)
Hecticoceras (*Brightia*) *kautzschi* (Noetling)[1]
Hecticoeras (*Brightia*) *syriacum* Haas
Hecticoceras (*Putealiceras*) *schumacheri* (Noetling)
Hecticoceras (*Putealiceras*) *solare* Haas
Hecticoceras (*Putealiceras*) *separandum* Haas

[1] The conspecificity of the single specimen from the Callovian of Monthou referred by Lemoine (1932, p. 403, text fig. 57, pl. 12, fig. 19) to this species is doubtful.

Ochetoceras (*Campylites*) *freboldi* Haas
Ochetoceras (*Campylites*) *evolutum* Haas
Perisphinctes (*Alligaticeras*) ?*paneaticus* Noetling
Perisphinctes (?*Dichotomosphinctes*) ?*orthocyma* Noetling
Perisphinctes (*Properisphinctes*) *vicinus* Haas
Perisphinctes (*Properisphinctes*) *filocostatus* Haas
Perisphinctes (*Properisphinctes*) *radiocostatus* Haas
Perisphinctes (*Properisphinctes*) *trapezoidalis* Haas
Perisphinctes (*Properisphinctes*) *hermonis* Haas
Perisphinctes (*Properisphinctes*) *delicatulus* Haas
Microsphinctes syriacus (Noetling)
Microsphinctes regularis (Noetling)
Aspidoceras (*Euaspidoceras*) *hermonis* Haas
Aspidoceras (*Euaspidoceras*) *rotundatum* Haas

The remaining 23 species are used in table 2 for purposes of correlation. It cannot be claimed that this table is in any way complete, because for reasons of economy of space only the most important and best-studied contemporary faunas were entered. Such other references as may have some bearing on the subject were relegated to footnotes.

It follows conclusively from table 2 that the fauna from Mount Hermon can be correlated best with the faunas of the Oxfordian of England, especially with the *mariae* clays of Woodham Pit, and those of the "Marnes à *Ammonites renggeri*" of the Jura Mountains,

FOOTNOTES TO TABLE 2

[a] Unless otherwise noted, entries in vertical columns 2–15 are based on the following papers: 2, Arkell, 1939; 3, Arkell and Holt, 1952; 4, Douvillé, 1912, 1914; 5, de Loriol, 1898–1899; 6, de Loriol, 1900; 7, Maire, 1928; 8–11, Jeannet, 1951; 12, Neumayr, 1871; 13, Sintzov, 1888; 14, Vautrin, 1934; 15, Spath, 1927–1933. Species of other faunas are referred to as they are understood in the present report, regardless of the names applied in the respective papers.

[b] Symbols for correlation: =, same species as one listed at left of table; cf., comparable species; ?, conspecificity doubtful.

[c] Recorded also from the Callovian by de Tsytovitch (1911, p. 22) and Lemoine (1932, p. 68).

[d] Occurs possibly in the upper Callovian of the Anti-Lebanon (Vautrin, 1934, p. 1439).

[e] Oppel's (1863, p. 194) type is from (the "lower region" of) the "Terrain à Chailles" of Paturatte and other localities near Delémont, Jura Bernois (middle Oxfordian; see Koby *in* de Loriol, 1899, p. 204).

[f] At Weymouth (Oppel, 1863, p. 203).

[g] Recorded from Châtillon also by Oppel (1863, p. 204).

[h] At St. Yves (Buckman, 1924, vol. 5, pt. 44, pl. 459).

[i] Recorded from other localities of the French Jura by Coquand (1853, p. 443; 1855, p. 49).

[j] For precise zone at Dives, see Arkell (1939, p. 201).

[k] Recorded by de Loriol (1902, p. 64) from the middle Oxfordian also.

[l] At Weymouth, *renggeri* zone (Spath, 1933, p. 591).

[m] In the Ball Beds near Scarborough (Arkell, 1944, p. 283).

[n] Neumayr (1871, p. 371, pl. 19, fig. 1), Arkell (1944, p. 283).

[o] Recorded also from the ferruginous beds of the Côte d'Or (Collot, 1917, p. 9).

[p] At St. Yves (Spath, 1931, p. 591).

[q] Horizon of other references doubtful, except "Unterster Malm" = lower Oxfordian of the Frankenalb, Bavaria (Dorn, 1931, p. 63).

[r] *Fide* Prieser (1937, pp. 97, 98). Species recorded also from the "Unterster Malm" = lower Oxfordian of the Frankenalb, Bavaria (Dorn, 1931, p. 66).

both Jura Bernois and Jura Lédonien, and of the Franche Comté. Both zone fossils are represented at Majdal Shams, but *Quenstedtoceras mariae* by a single half disk only, probably washed in by some current and too incomplete to be identified with certainty, and *Creniceras renggeri* by 20 individuals, which means a rare species by standards of this report.

Thus the close agreement in faunal composition of our assemblage with the English and Swiss rather than the presence of the zone fossils makes it safe to place the Majdal Shams fauna in the *mariae* zone, the lowest of the Oxfordian stage (Arkell, 1946, pp. 8, 12), with which the *renggeri* zone of continental Europe is contemporaneous. It is felt that, in view of the lack of measured sections from the outcrop, no attempt at more precise dating than "lowermost Oxfordian" should be made and that intrazonal age differences, such as those recognizable between the various localities of the English *mariae* zone and between the lower and upper divisions of the *renggeri* marls of La Billode (see above, p. 201), should be left out of consideration in the present report.[1]

The entries in columns 4 and 8–15 of table 2 either confirm or are at least consistent with the result reached here, if it be considered that the *cordatum* zone of earlier Russian authors includes the *mariae* zone (Arkell, 1946, p. 25) at the bottom. It is true that some occurrences of the species recognized on Mount Hermon or of comparable species fall below or above the time limits of the *mariae* zone: those listed in the divisions C, D, and F at Herznach, where only division E corresponds to the *mariae* zone (Jeannet, 1951, p. 7, fig. 2); the occurrence of *Hecticoceras* (*Putealiceras*) *douvillei* Jeannet also in the upper Callovian of the southern Jura Mountains (de Tsytovitch, 1911) and of the Mont-du-Chat range (Lemoine, 1932); and the occurrence of *Ochetoceras* (*Campylites*) *delmontanum* and *Aspidoceras* (*Euaspidoceras*) *perisphinctoides* in the middle Oxfordian. All these occurrences, as well as the uncertainties prevailing with regard to "*Peltoceras annulare*," a doubtful species represented in our material by a single extremely small individual, may, however, be considered insignificant if compared with the excellent agreement of our fauna with the faunas so carefully studied by de Loriol (1898–1899, 1900) and Arkell (1939).

It is worth noting that all three of these faunas consist of pyritized ammonites, most of them small (Koby *in* de Loriol, 1899, p. 199; Girardot *in* de Loriol, 1900, p. 167; Arkell, 1939, p. 137), as does ours.

The result obtained above essentially confirms Frebold's (1928, p. 198) correlation of Noetling's *socini* zone with the middle portion of the *renggeri* marls of Switzerland. However, for the reasons pointed out above (p. 201) we cannot follow Frebold (*loc. cit.*) in his assumption of a separate "*scaphitoides-arolicus*" zone to which he assigns a higher stratigraphic position, possibly extending up into the *transversarius* zone which is the equivalent of the middle Oxfordian *plicatilis* zone of northwestern Europe (Arkell, 1946, pp. 12, 19). Noetling (1887, p. 10) correctly assigned a lower Oxfordian age to the Mount Hermon ammonites, but by equalizing his *socini* zone with that of *Aspidoceras perarmatum*, the latter also an equivalent of the *plicatilis* zone (see Arkell, 1940, p. 195), he also placed it two standard zones too high in the stratigraphic column.

Fraas (1877, 1878), on the other hand, in correlating the ammonitiferous beds on Mount Hermon with the "Ornatenton," which comprises the *jason* to *athleta* zones of the Callovian (Arkell, 1946, p. 19), erred in the opposite direction. Blanckenhorn (1914, p. 16) allowed those beds too wide a stratigraphic range, namely, from the *athleta* (=*ornatum*) up to the *perarmatum* (=*plicatilis*) zones; however, the middle of that range approximately coincides with the *mariae* zone.

[1] However, the relative scarcity of *Creniceras renggeri*, mentioned above, on the one hand and the presence of *Scaphitodites scaphitoides* on the other (compare Arkell and Holt, 1952, pp. 19, 5) may be quoted in favor of an agreement in age with Stangate Hill even closer than with Woodham Pit.

PALEOGEOGRAPHIC CONCLUSIONS

The correlations tabulated in table 2 again prove the wide extent of the Mesozoic Tethys with its surrounding neritic seas, inhabited by some species ranging as wide as from England to southern Russia, Syria, or India. The fact pointed out above that the ammonites of the most important of their deposits, formed at this particular moment of the history of the earth, are all pyritized seems to indicate that the particular sedimentary and ecologic conditions conducive to the production of pyritized ammonite faunas (p. 198) then prevailed over a large portion of, if not throughout, that vast range.

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PLATES 1–30

All specimens shown in the following plates are from the lower division of Noetling's "Zone of *Harpoceras Socini*," referrred in the present report to the lowermost Oxfordian, *mariae* zone, near Majdal Shams, Syria.

PLATE 1

PHYLLOCERATIDAE: *Phylloceras* (*Phylloceras*)

Phylloceras (*Phylloceras*) *plicatum* Neumayr: 1–13

1, 2. Innermost whorls of A.M.N.H. No. 27335:1, ×3; in 1 note radial striae on anteriormost quarter-whorl.

3–5. A.M.N.H. No. 27335:1, ×1; in 4 note radial ornamentation.

6, 7. A.M.N.H. No. 27335:3, ×1, note suture lines.

8–10. A.M.N.H. No. 27335:4, ×1.

11. A.M.N.H. No. 27335:5, ×1.

12, 13. A.M.N.H. No. 27335:6, ×1.

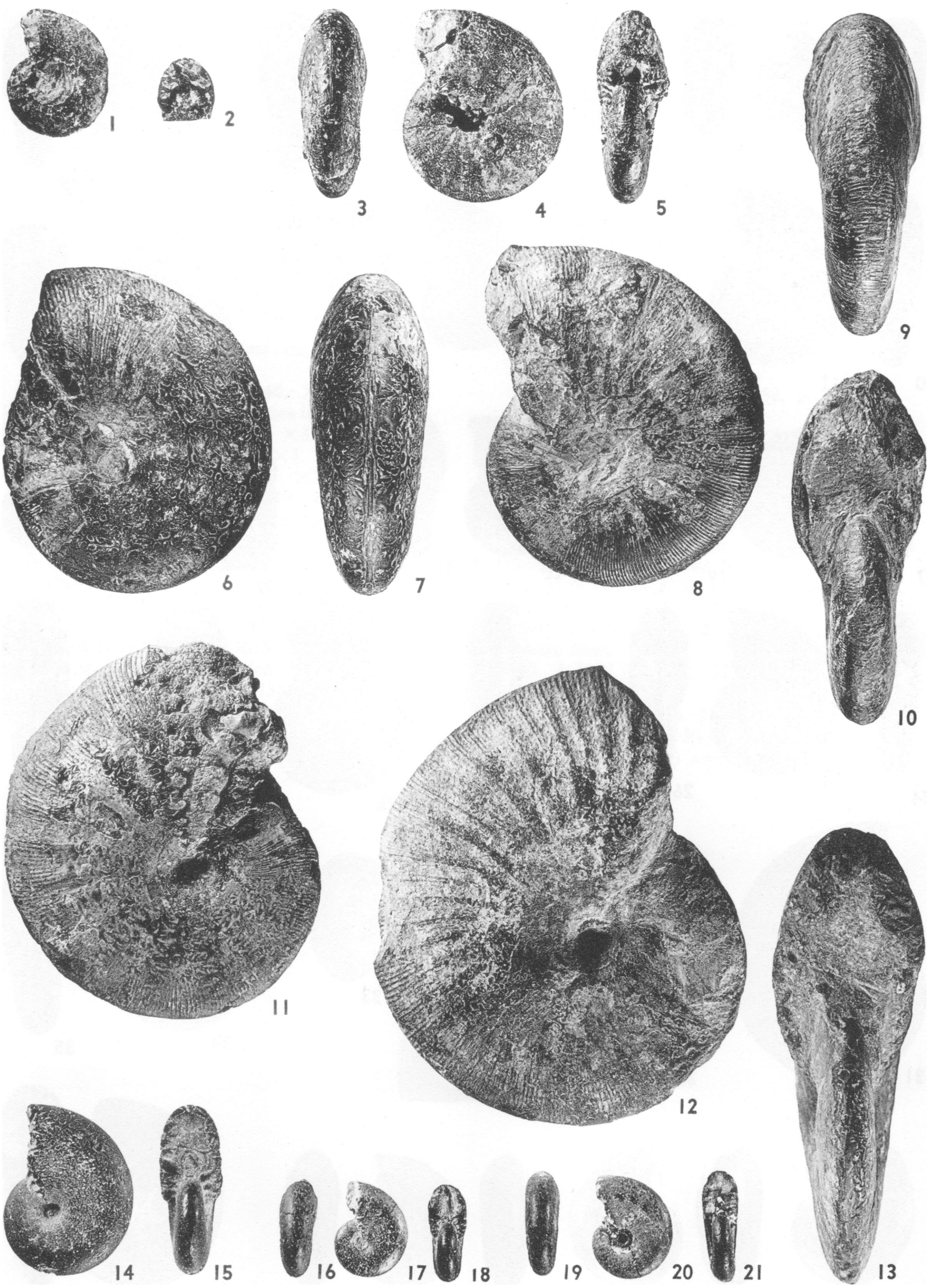
P. (*P.*) *riazi* de Loriol: 14–21

14, 15. A.M.N.H. No. 27336:15, ×3; note suture lines in 14.

16–18. A.M.N.H. No. 17336:2, ×3.

19–21. A.M.N.H. No. 27336:45, ×3.

The Phylloceratidae, *Phylloceras* (*Phylloceras*), and *P.* (*P.*) *riazi* are continued on plate 2.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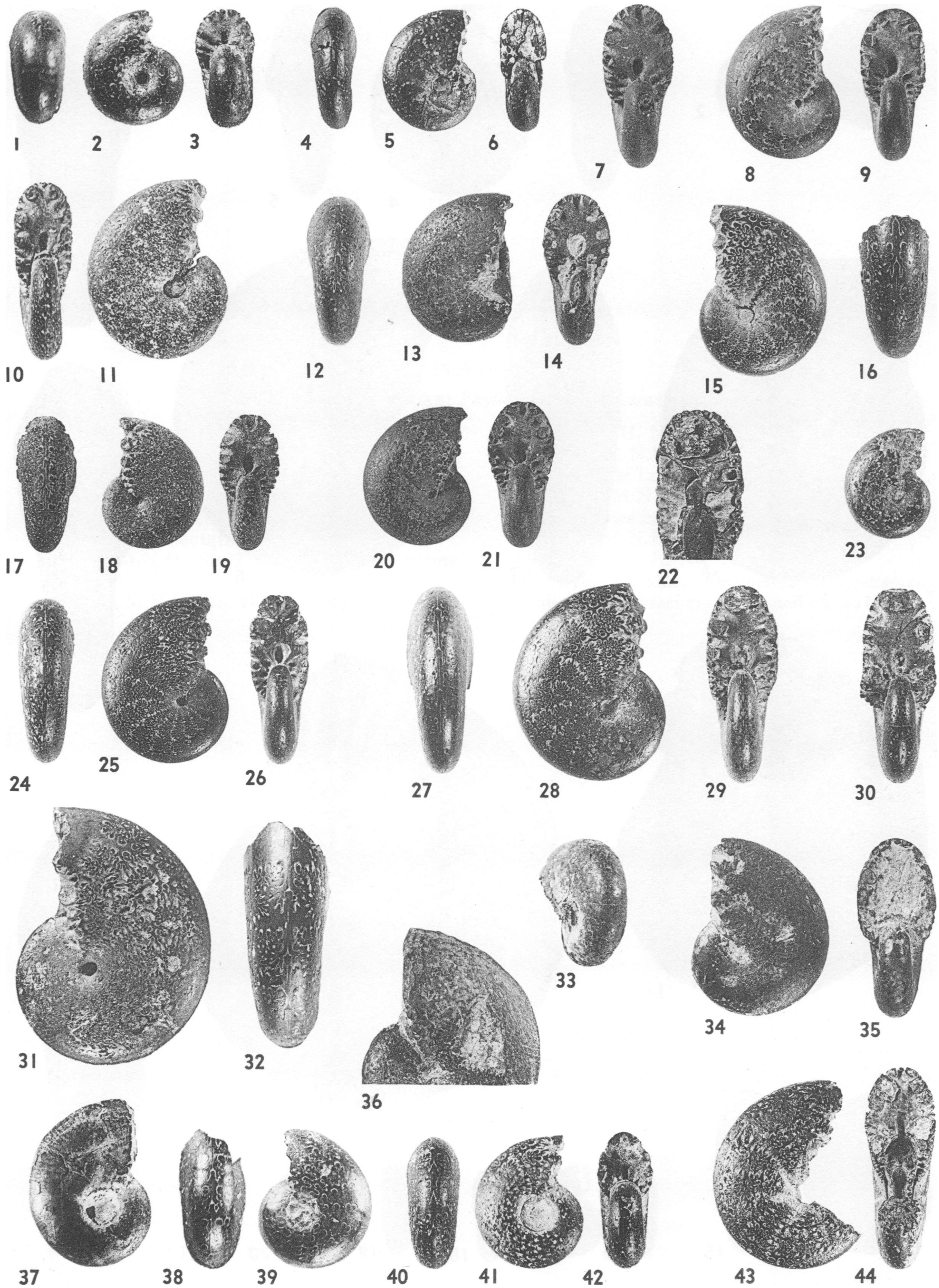
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PLATE 2

Phylloceratidae (*continued*): *Phylloceras* (*Phylloceras*), *Phylloceras* (*Calliphylloceras*)

Phylloceras (*Phylloceras*) *riazi* de Loriol (*continued*): 1–36

1–3. A.M.N.H. No. 27336:46, ×5; note constrictions in 1 and suture lines in 2 and 3.

4–6. A.M.N.H. No. 27336:6, ×3.

7. A.M.N.H. No. 27336:13, ×3.

8, 9. A.M.N.H. No. 27336:47, ×2.

10,11. A.M.N.H. No. 27336:19, ×3.

12–14. A.M.N.H. No. 27336:10, ×3.

15,16. A.M.N.H. No. 27336:17, ×3.

17–19. A.M.N.H. No. 27336:22, ×2; note suture lines, especially in 17.

20, 21. A.M.N.H. No. 27336:24, ×2.

22. A.M.N.H. No. 27336:42, ×2.

23. A.M.N.H. No. 27336:5, ×3; note constrictions in anterior third.

24–26. A.M.N.H. No. 27336:30, ×2, note suture lines in 24, 25.

27–29. A.M.N.H. No. 27336:37, ×2; note suture lines.

30. A.M.N.H. No. 27336:35, ×2.

31, 32. A.M.N.H. No. 27336:31, ×3; in 31 note constriction near anterior end. This specimen was illustrated in Haas (1952, p. 858, figs. 1, 2).

33. A.M.N.H. No. 27336:1, ×5, to show suture lines on side and venter.

34, 35. A.M.N.H. No. 27336:39, ×2; in 34 note blunt spiral ridge.

36. A.M.N.H. No. 27336:40, detail, to show two sigmoidal ribs near anterior end, ×2.

P. (*Calliphylloceras*) *schems* Noetling: 37–44

37. A.M.N.H. No. 27337:3, ×3; to show radial ornamentation.

38, 39. A.M.N.H. No. 27337:9, ×5; to show suture lines.

40–42. A.M.N.H. No. 27337:12, ×3; note suture lines.

43, 44. A.M.N.H. No. 27337:7, ×3/2.

The Phylloceratidae, *Phylloceras* (*Calliphyllocercas*), and *P.* (*C.*) *schems* are continued on plate 3.

PLATE 3

PHYLLOCERATIDAE (*continued*): *Phylloceras* (*Calliphylloceras*) (*continued*), *Sowerbyceras*

Phylloceras (*Calliphylloceras*) *schems* Noetling (*continued*): 1–6

1, 2. A.M.N.H. No. 27337:4; 1, ×5, to show suture lines; 2, ×3.

3. A.M.N.H. No. 27337:2; close-up of innermost whorls in left side view, ×8, to show protoconch.

4. A.M.N.H. No. 27337:6, ×5, to show suture lines and protoconch.

5, 6. A.M.N.H. No. 27337:8, ×1; note suture lines in 6.

Sowerbyceras helios (Noetling): 7–34

7–9. A.M.N.H. No. 27338:1, ×5.

10. A.M.N.H. No. 27338:19, ×3.

11, 12. A.M.N.H. No. 27338:4, ×5, to show constrictions.

13, 14. A.M.N.H. No. 27338:12, ×3, to show suture lines.

15, 16. A.M.N.H. No. 27338:22, ×3, to show suture lines.

17, 18. A.M.N.H. No. 27338:14, ×3; note constrictions in 17.

19. A.M.N.H. No. 27338:27, ×3.

20, 21. A.M.N.H. No. 27338:25, ×3.

22–24. A.M.N.H. No. 27338:30, ×3, to show suture lines.

25. A.M.N.H. No. 27338:24, ×3, to show constrictions.

26, 27. A.M.N.H. No. 27338:26, ×3, to show suture lines.

28. A.M.N.H. No. 27338:9, natural cross section, ×1.

29. A.M.N.H. No. 27338:45, ×4, to show internal suture lines.

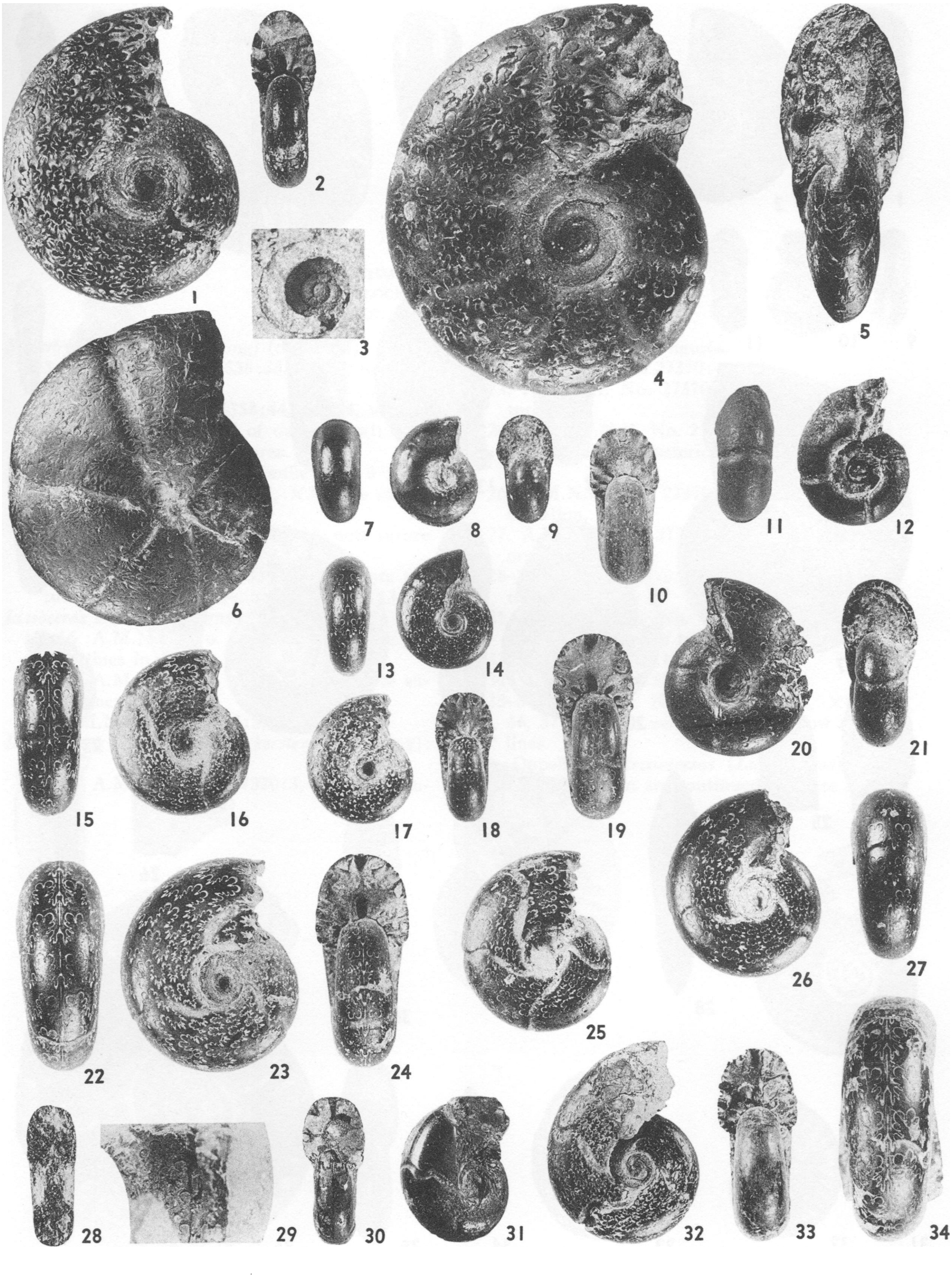
30. A.M.N.H. No. 27338:40, ×1.

31. A.M.N.H. No. 27338:39, ×1; note sinuosity of constrictions.

32, 33. A.M.N.H. No. 27338:34; 32, ×3/2; 33, frontal view at fracture about one-eighth of a whorl behind anterior end, ×2.

34. A.M.N.H. No. 27338:42, ×2, to show suture lines.

The Phylloceratidae, *Sowerbyceras*, and *S. helios* are continued on plate 4.



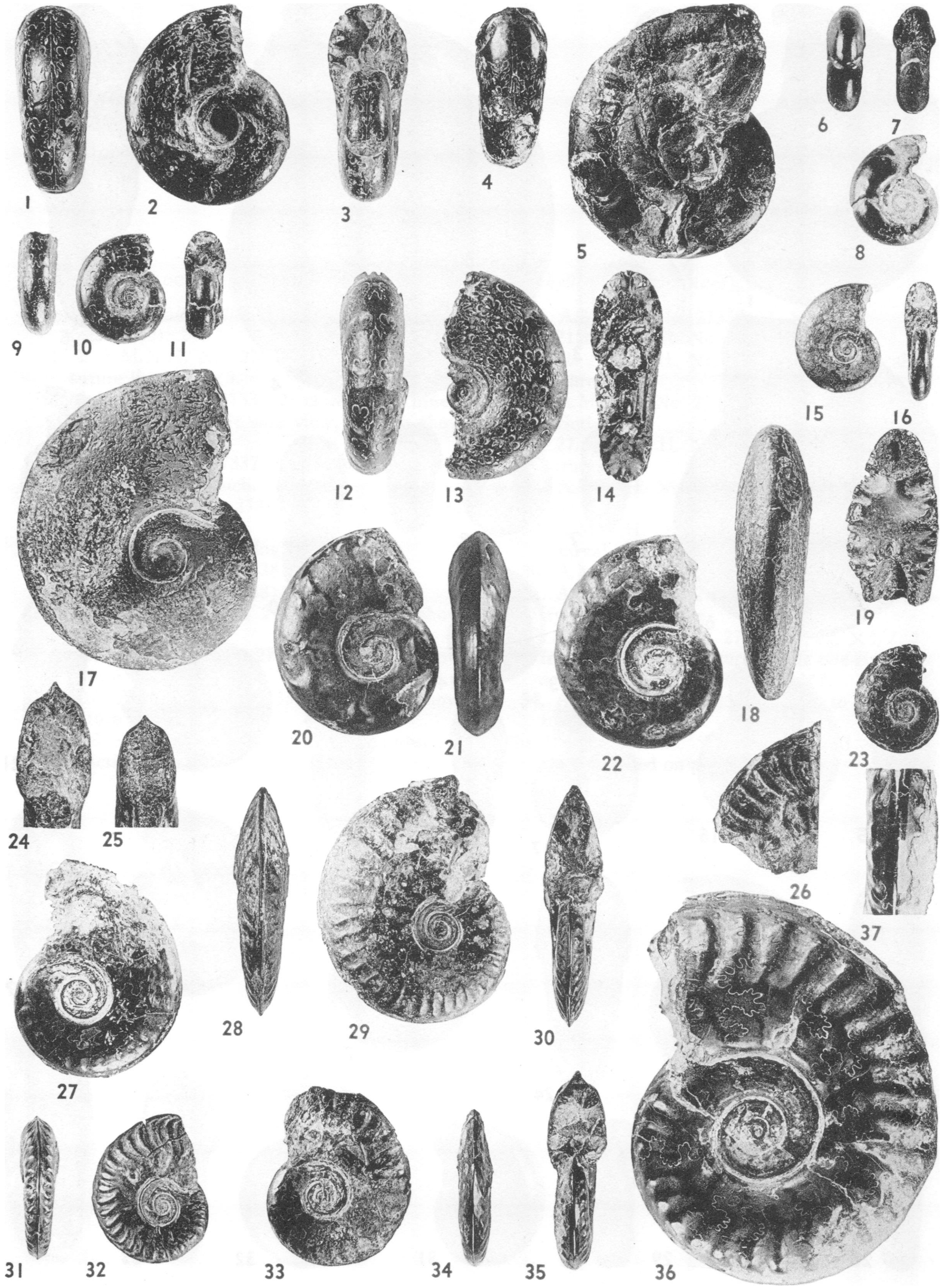

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PLATE 4

PHYLLOCERATIDAE (*continued*): *Sowerbyceras* (*continued*)
HAPLOCERATIDAE: *Lissoceras*
OPPELIDAE: *Hecticoceras* (*Lunuloceras*)

Sowerbyceras helios (Noetling) (*continued*): 1–5

1–3. A.M.N.H. No. 27338:38, ×3/2; note suture lines.

4, 5. A.M.N.H. No. 27338:44, ×1; 4, ventral view of posterior half of outer whorl; note constrictions in both figures.

Sowerbyceras indeterminate juvenile form: 6–14

6–8. A.M.N.H. No. 27339:2, ×3; note suture lines in 8.

9–11. A.M.N.H. No. 27339:1, ×3; note suture lines in 9 and 10.

12–14. A.M.N.H. No. 27339:5, ×3; note suture lines and constrictions in 12 and 13.

Lissoceras erato (d'Orbigny): 15–19

15, 16. A.M.N.H. No. 27369:2, ×1; note suture lines in 15.

17, 18. A.M.N.H. No. 27369:4, ×1; note suture lines in 17.

19. A.M.N.H. No. 27369:3, ×1.

Hecticoceras (*Lunuloceras*) *kersteni* (Noetling): 20–37

20, 21. A.M.N.H. No. 27370:3, ×3; note suture lines in both figures.

22. A.M.N.H. No. 27370:4, ×3.

23. A.M.N.H. No. 27370:1, ×3, to show suture lines.

24, 25. A.M.N.H. No. 27370:5, whorl sections at anterior and posterior ends of a fragment, ×2.

26. A.M.N.H. No. 27370:13, detail, to show costation, ×1.

27. A.M.N.H. No. 27370:7, ×2, to show faint ornamentation.

28–30. A.M.N.H. No. 27370:12, ×1; note suture lines in 29.

31, 32, A.M.N.H. No. 27370:11, ×1; in 32 note undulations of keel.

33. A.M.N.H. No. 27370:6, ×2.

34. A.M.N.H. No. 27370:14, ×3/2.

35–37. A.M.N.H. No. 27370:10; 35, × 3/2; 36, 37 (detail of venter), ×3, to show suture lines.

The Oppelidae, *Hecticoceras* (*Lunuloceras*), and *H.* (*L.*) *kersteni* are continued on plate 5.

PLATE 5

OPPELIDAE (*continued*): *Hecticoceras* (*Lunuloceras*) (*continued*), *Hecticoceras* (*Sublunuloceras*)

Hecticoceras (*Lunuloceras*) *kersteni* (Noetling) (*continued*), geniculate specimens: 1–5

1–4. A.M.N.H. No. 27371:2; 1–3, ×1; 4, detail, ×3, to show penultimate suture line.

5. A.M.N.H. No. 27371:3, ×1.

H. (*Sublunuloceras*) *guthei* (Noetling): 6–47

6. A.M.N.H. No. 27372:3, ×3; note ornamentation.

7. A.M.N.H. No. 27372:4, ×3.

8. A.M.N.H. No. 27372:6, ×3.

9. A.M.N.H. No. 27372:46, profile of outer whorl, ×2.

10. A.M.N.H. No. 27372:8, ×3.

11. A.M.N.H. No. 27372:2, ×5, to show suture lines.

12. A.M.N.H. No. 27372:41, ×2.

13. A.M.N.H. No. 27372:10, ×3; note tongues on venter.

14. A.M.N.H. No. 27372:15, ×2; note marked umbilical edge and high and steep umbilical wall.

15. A.M.N.H. No. 27372:70, ×1.

16. A.M.N.H. No. 27372:29, ×2.

17. A.M.N.H. No. 27372:72, ×1.

18. A.M.N.H. No. 27372:60, ×1.

19. A.M.N.H. No. 27372:87, ×1; note tongues on venter.

20. A.M.N.H. No. 27372:13, detail, to show suture lines, ×2.

21. A.M.N.H. No. 27372:44, detail, to show delicate ornamentation, ×2.

22. A.M.N.H. No. 27372:76, ×1.

23, 24. A.M.N.H. No. 27372:21, ×2; note indication of spiral furrow in 23, keel and tongues on venter in 24.

25. A.M.N.H. No. 27372:93, ×1; note tongues on venter.

26. A.M.N.H. No. 27372:73, ×1; note tongues on venter.

27. A.M.N.H. No. 27372:66, ×3/2.

28. A.M.N.H. No. 27372:48, ×2, to show ornamentation and suture lines.

29. A.M.N.H. No. 27372:62, ×3, to show suture lines.

30. A.M.N.H. No. 27372:88, ×1.

31, 32. A.M.N.H. No. 27372:32, × 2.

33. A.M.N.H. No. 27372:116, ×1.

34, 35. A.M.N.H. No. 27372:83, ×1; note denticulation of keel in 35.

36. A.M.N.H. No. 27372:40, ×3, to show suture lines; see also plate 6, figure 7.

37. A.M.N.H. No. 27372:37, ×2.

38. A.M.N.H. No. 27372:85, ×1.

39, 40. A.M.N.H. No. 27372:84, ×1; in 39 note delicate costation and engraved spiral line.

41. A.M.N.H. No. 27372:18, ×2, to show suture lines.

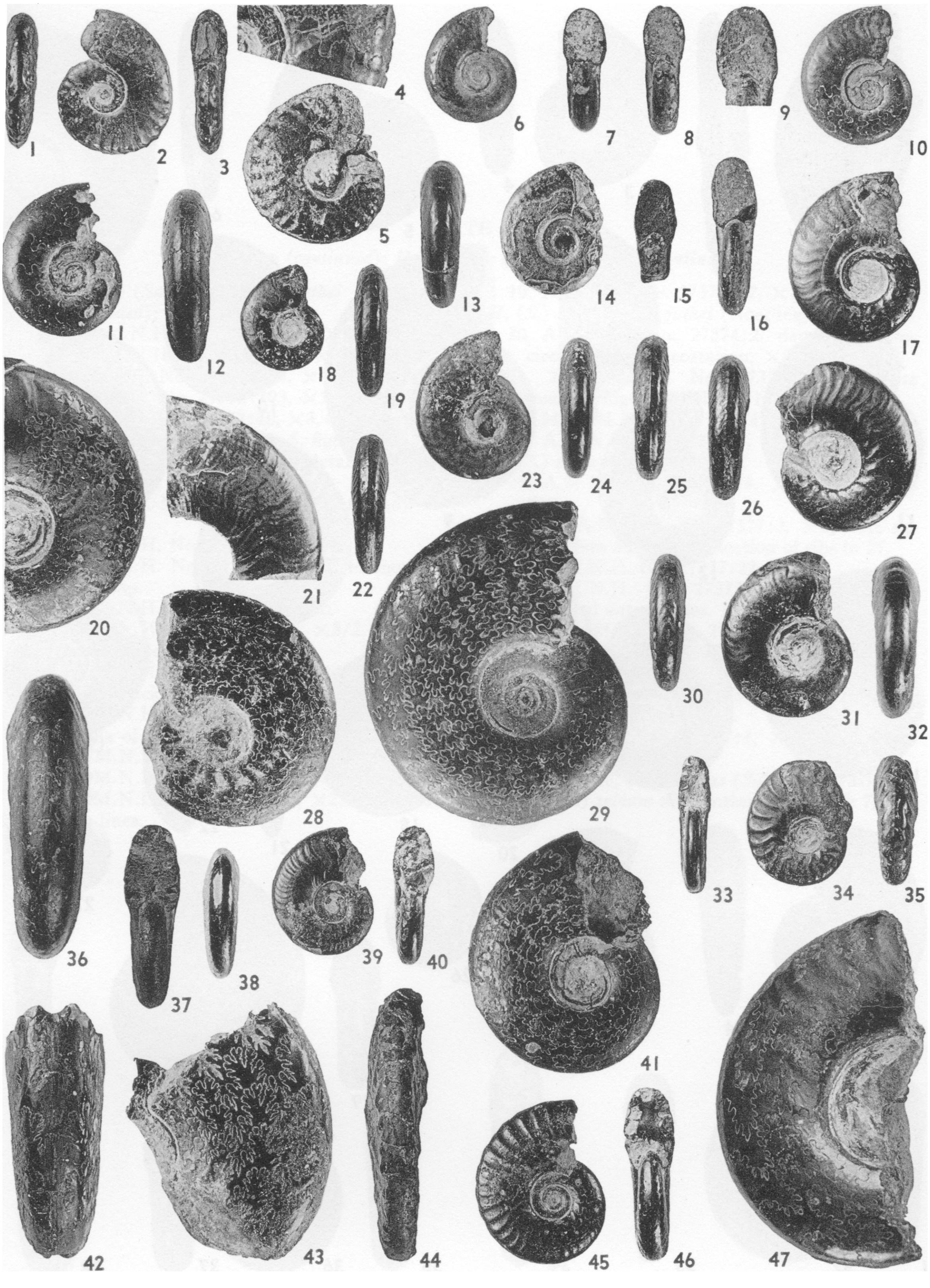
42, 43. A.M.N.H. No. 27372:61, ×2, to show suture lines.

44. A.M.N.H. No. 27372:107, ×1.

45, 46. A.M.N.H. No. 27372:98, ×1.

47. A.M.N.H. No. 27372:16, ×3, to show details of suture lines.

The Oppelidae, *Hecticoceras* (*Sublunuloceras*), and *H.* (*S.*) *guthei* are continued on plate 6.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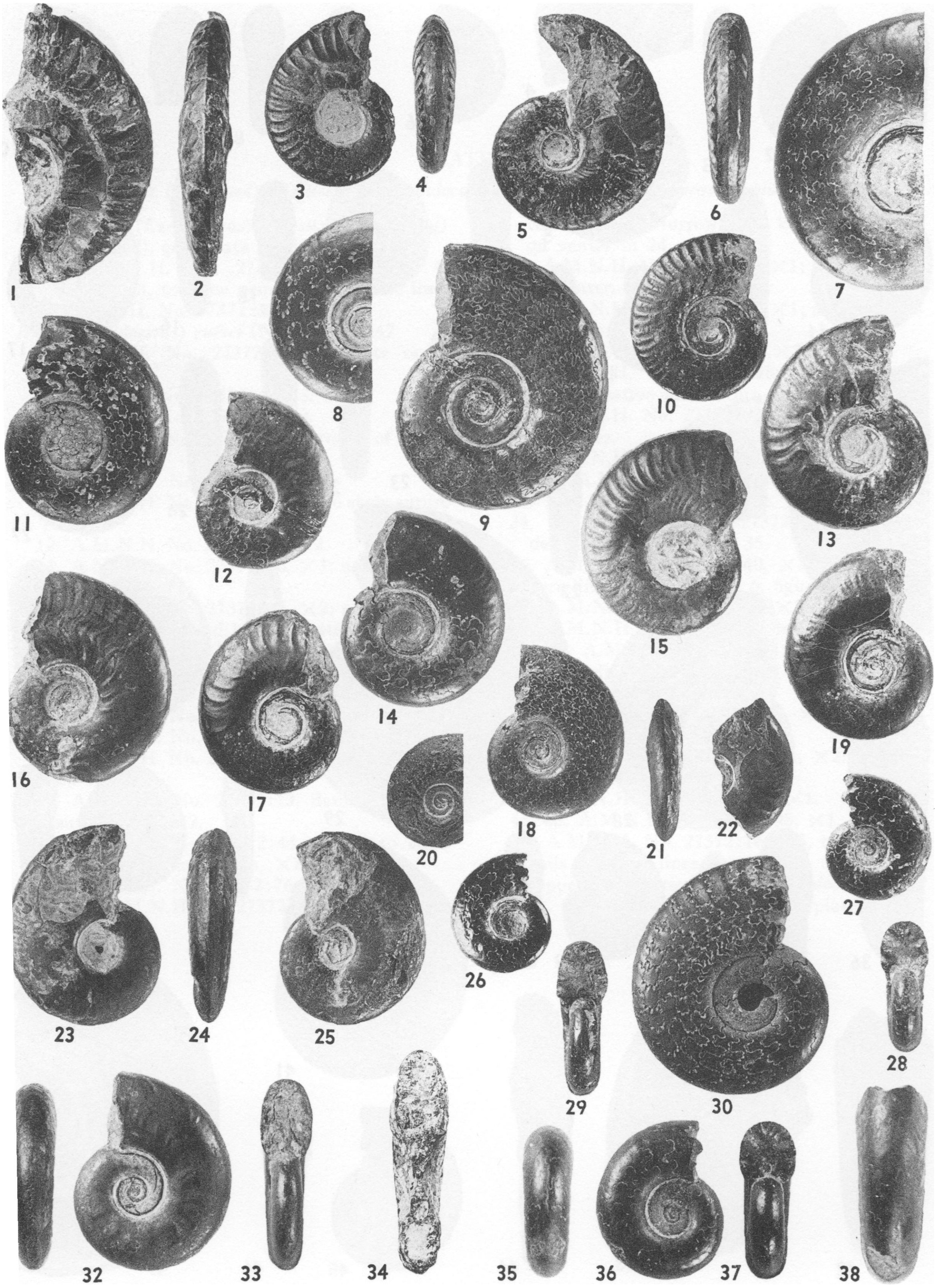
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PLATE 6

OPPELIDAE (*continued*): *Hecticoceras* (*Sublunuloceras*) (*continued*)

Hecticoceras (*Sublunuloceras*) *guthei* (Noetling) (*continued*): 1–19
1, 2. A.M.N.H. No. 27372:106, ×1.
3, 4. A.M.N.H. No. 27372:99, ×1.
5. A.M.N.H. No. 27372:105, ×1.
6. A.M.N.H. No. 27372:103, ×1.
7. A.M.N.H. No. 27372:40, ×3, detail, to show suture lines; see also plate 5, figure 36.
8. A.M.N.H. No. 27372:67, detail, to show suture lines, ×2.
9. A.M.N.H. No. 27372:109, ×2, to show suture lines.
10. A.M.N.H. No. 27372:110, ×1.
11. A.M.N.H. No. 27372:22, ×3, to show suture lines.
12. A.M.N.H. No. 27372:35, ×2.
13. A.M.N.H. No. 27372:88, ×3/2, to show details of costation.
14. A.M.N.H. No. 27372:17, ×3, to show delicate sickles and suture lines.
15. A.M.N.H. No. 27372:87, ×3/2, to show details of costation.
16. A.M.N.H. No. 27372:52, ×2,
17. A.M.N.H. No. 27372:78, ×3/2.
18. A.M.N.H. No. 27372:108, ×2, to show suture lines.
19. A.M.N.H. No. 27372:47, ×2.

H. (*S.*) aff. *H.* (*S.*) *guthei* (Noetling): 20–25
20. A.M.N.H. No. 27374:2, detail, to show circumumbilical costation, ×2.
21, 22. A.M.N.H. No. 27374:5, ×1; note median ridge in 21, sickles in 22.
23, 24. A.M.N.H. No. 27374:4, ×1.
25. A.M.N.H. No. 27374:3, ×1.

H. (*S.*) *socium* Haas: 26–38
26. A.M.N.H. No. 27377:8, ×2, note suture lines.
27. 28. A.M.N.H. No. 27377:2, ×3; note suture lines and first indication of ribs in 27.
29. A.M.N.H. No. 27377:22, ×2.
30. A.M.N.H. No. 27377:42, ×3, to show crowded suture lines.
31–33. A.M.N.H. No. 27377:12, ×3.
34. A.M.N.H. No. 27377:35, cross section at fracture, ×1.
35–37. A.M.N.H. No. 27377:1, ×5, to show suture lines in 35 and 36.
38. A.M.N.H. No. 27377:3, ×5. to show suture lines on venter.

The Oppelidae, *Hecticoceras* (*Sublunuloceras*), and *H.* (*S.*) *socium* are continued on plate 7.

PLATE 7

OPPELIDAE (*continued*): *Hecticoceras* (*Sublunuloceras*), (*continued*), *Hecticoceras* (*Brightia*)

Hecticoceras (*Sublunuloceras*) *socium* Haas (*continued*): 1–19

1–3. A.M.N.H. No. 27377:9, ×3, note suture lines in 1 and 2, sharp circumumbilical ribs in 2.

4. A.M.N.H. No. 27377:20, ×2, to show costation.

5. A.M.N.H. No. 27377:37, ×2, to show costation.

6. A.M.N.H. No. 27377:41, ×3/2, note suture lines.

7–9. A.M.N.H. No. 27377:32, holotype, ×1; note keel in 7, suture lines in 7 and 8.

10. A.M.N.H. No. 27377:40, ×2, to show suture lines.

11, 12. A.M.N.H. No. 27377:36, ×1.

13, 14. A.M.N.H. No. 27377:44, ×2; note details of costation in 13, delicate keel in 14.

15. A.M.N.H. No. 27377:33, ×1, to show costation.

16. A.M.N.H. No. 27377:34, ×1, to show costation.

17, 18. A.M.N.H. No. 27377:11, ×2; note triple keel in 17.

19. A.M.N.H No. 27377:13, ×3, to show outer sickles and suture lines.

H. (*Brightia*) *socini* (Noetling): 20–47

20. A.M.N.H. No. 27373:17, nucleus in front view, ×10.

21. A.M.N.H. No. 27373:6, ×5; note protoconch.

22. A.M.N.H. No. 27373:108, ×2; note contrast between strong inner ribs and weak sickles.

23. A.M.N.H. No. 27373:18, ×3.

24. A.M.N.H. No. 27373:13, detail, ×8.

25, 26. A.M.N.H. No. 27373:37, ×2.

27, 28. A.M.N.H. No. 27373:25, ×3; note two fine median grooves in 27.

29. A.M.N.H. No. 27373:12, ×5, to show suture lines and hole left by protoconch.

30. A.M.N.H. No. 27373:35, ×2.

31. A.M.N.H. No. 27373:88, fracture at posterior end, ×2.

32. A.M.N.H. No. 27373:62, ×2, to show circumumbilical ribs.

33–35. A.M.N.H. No. 27373:45, ×2; note suture lines in 34.

36. A.M.N.H. No. 27373:5, ×5, to show suture lines.

37–39. A.M.N.H. No. 27373:85, ×1; note suture lines on venter in figures 37 and 39.

40. A.M.N.H. No. 27373:109, ×5, to show suture lines and protoconch.

41. A.M.N.H. No. 27373:99, ×3, to show suture lines.

42. A.M.N.H. No. 27373:70, ×2, to show ornamentation.

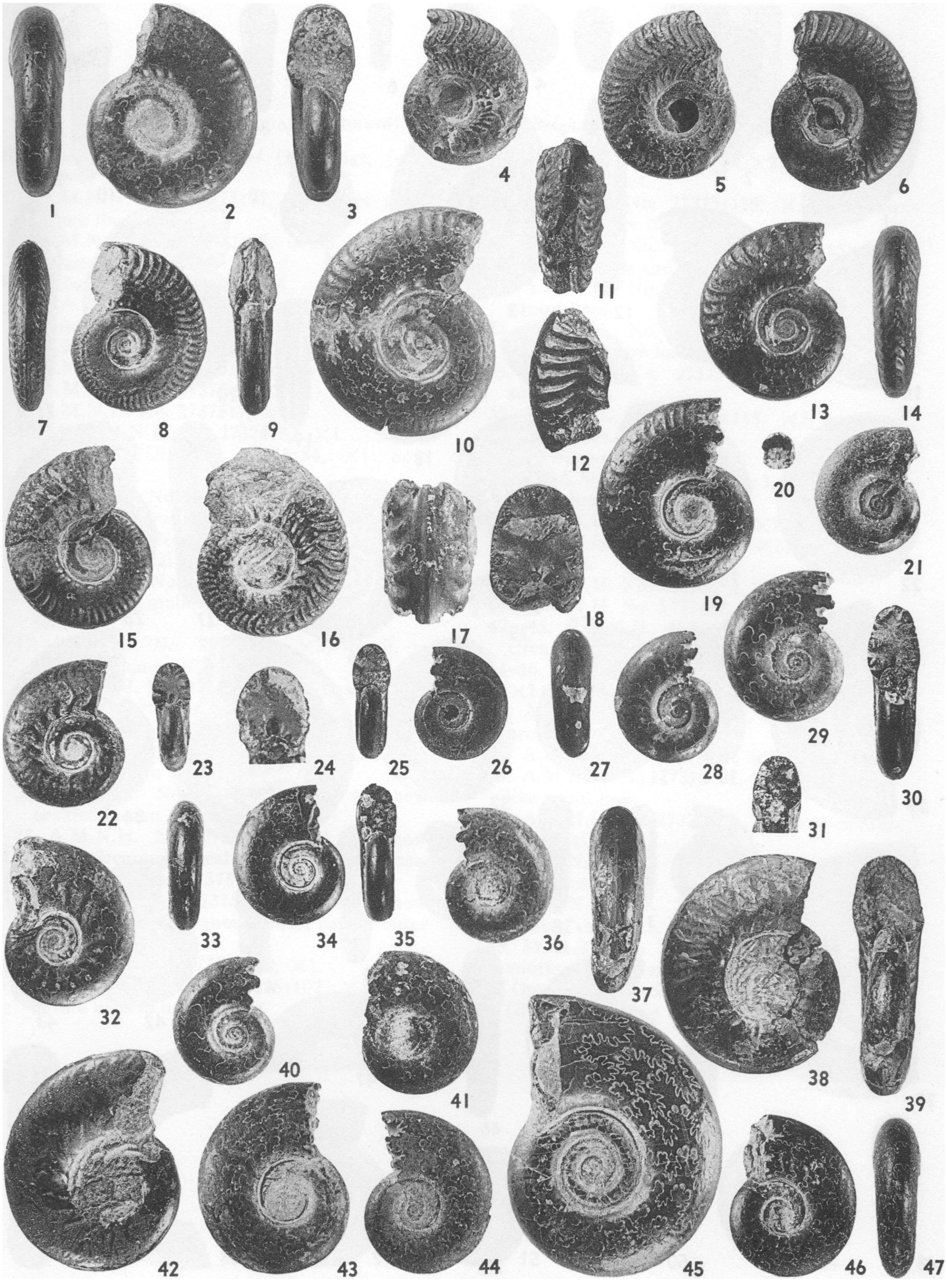
43. A.M.N.H. No. 27373:43, ×3, to show suture lines.

44. A.M.N.H. No. 27373:40, ×3, to show suture lines.

45. A.M.N.H. No. 27373:64, ×3, to show suture lines.

46, 47. A.M.N.H. 27373:53, ×2, to show circumumbilical folds and suture lines.

The Oppelidae, *Hecticoceras* (*Brightia*), and *H.* (*B.*) *socini* are continued on plate 8.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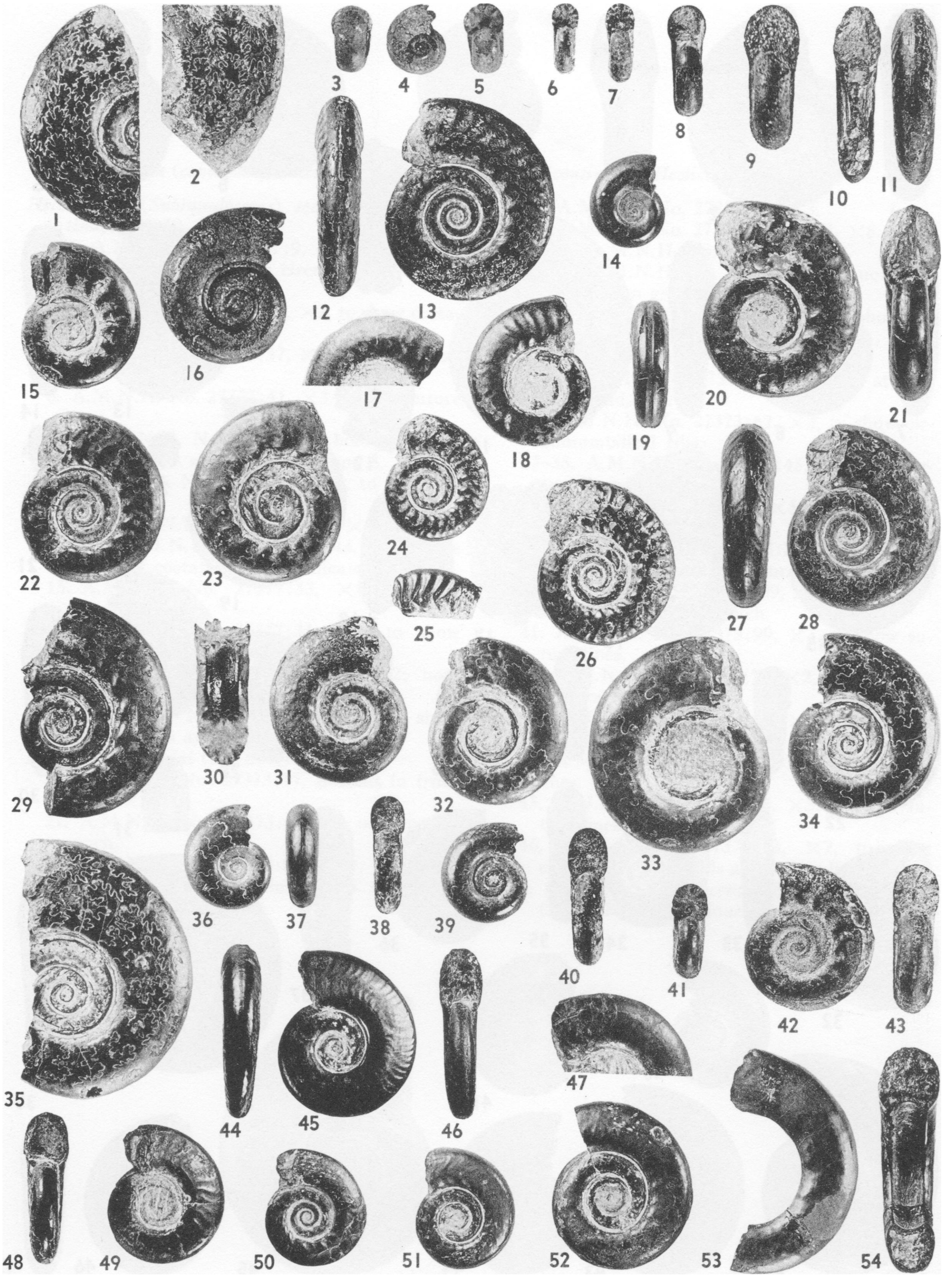
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PLATE 8

OPPELIDAE (*continued*): *Hecticoceras* (*Brightia*) (*continued*)

Hecticoceras (*Brightia*) *socini* (Noetling), (*continued:* 1, 2)

1. A.M.N.H. No. 27373:97, detail, to show suture lines, ×2.
2. A.M.N.H. No. 27373:98, detail, to show suture lines, ×2.

H. (*B.*) *kautzschi* (Noetling): 3–35

3–5. A.M.N.H. No. 27375:1, nucleus, ×8; note protoconch and suture lines in 4.
6. A.M.N.H. No. 27375:3, ×3.
7. A.M.N.H. No. 27375:91, nucleus, ×3.
8. A.M.N.H. No. 27375:27, ×2.
9. A.M.N.H. No. 27375:7, ×5.
10, 11. A.M.N.H. No. 27375:82, ×1.
12, 13. A.M.N.H. No. 27375:84, ×1; note suture lines.
14. A.M.N.H. No. 27375:113, ×3; note protoconch and spiral ridge.
15. A.M.N.H. No. 27375:46, ×2, to show circumumbilical nodes.
16. A.M.N.H. No. 27375:93, ×5; note protoconch, sharp umbilical edge, and concave umbilical wall.
17. A.M.N.H. No. 27375:22, ×3; detail, to show ornamentation.
18. A.M.N.H. No. 27375:48, ×2, to show costation.
19. A.M.N.H. No. 27375:115, ×2.
20, 21. A.M.N.H. No. 27375:67, ×2; note suture lines in 20.
22. A.M.N.H. No. 27375:58, ×2, to show ornamentation and suture lines.
23. A.M.N.H. No. 27375:63, ×2, to show heavy circumumbilical nodes and suture lines.
24. A.M.N.H. No. 27375:121, ×1.
25. A.M.N.H. No. 27375:123, detail, to show strong costation of anteriormost part of outer whorl, ×1.
26. A.M.N.H. No. 27375:122, ×1.
27, 28. A.M.N.H. No. 27375:102, ×2; note suture lines in both figures.
29. A.M.N.H. No. 27375:70, ×2; note circumumbilical nodes.
30. A.M.N.H. No. 27375:119, ×5, to show internal suture lines.
31. A.M.N.H. No. 27375:110, ×2, to show ornamentation and suture lines.
32. A.M.N.H. No. 27375:28, ×3, to show suture lines.
33. A.M.N.H. No. 27375:88, ×3, to show primitive suture lines.
34. A.M.N.H. No. 27375:33, ×3, to show suture lines.
35. A.M.N.H. No. 27375:118, ×3, to show suture lines.

H. (*B.*) *syriacum* Haas: 36–54

36, 37. A.M.N.H. No. 27378:3, ×5, to show suture lines.
38. A.M.N.H. No. 27378:19, ×2.
39. A.M.N.H. No. 27378:13, ×5, to show suture lines.
40. A.M.N.H. No. 27378:74, ×2.
41. A.M.N.H. No. 27378:2, ×3.
42, 43. A.M.N.H. No. 27378:10, ×3; note circumumbilical ribs in 42.
44–46. A.M.N.H. No. 27378:72, holotype, ×1; see also plate 9, figure 7.
47. A.M.N.H. No. 27378:16, detail, to show ornamentation, ×3.
48. A.M.N.H. No. 27378:70, ×1.
49. A.M.N.H. No. 27378:82, ×1; note thread-like spiral keel.
50. A.M.N.H. No. 27378:62, ×1; note circumumbilical nodes.
51. A.M.N.H. No. 27378:65, ×1, to show ornamentation.
52. A.M.N.H. No. 27378:60, a particularly evolute shell, ×1.
53, 54. A.M.N.H. No. 27378:75, fragment of another particularly evolute shell, ×2.

The Oppelidae, *Hecticoceras* (*Brightia*), and *H.* (*B.*) *syriacum* are continued on plate 9.

PLATE 9

OPPELIDAE (*continued*): *Hecticoceras* (*Brightia*) (*continued*), *Hecticoceras* (*Putealiceras*)

Hecticoceras (*Brightia*) *syriacum* Haas (*continued*): 1–14

1. A.M.N.H. No. 27378:84, ×3, to show costation.

2, 3. A.M.N.H. No. 27378:44, ×2.

4. A.M.N.H. No. 27378:54, ×2, to show delicate ornamentation.

5. A.M.N.H. No. 27378:49, ×2.

6. A.M.N.H. No. 27378:80, ×3, to show suture lines.

7. A.M.N.H. No. 27378:72, holotype, detail, ×3, to show last suture lines; see also plate 8, figures 44–46.

8. A.M.N.H. No. 27378:79, detail, to show suture lines, ×3.

9, 10. A.M.N.H. No. 27378:27; 9, ×2, to show median groove; 10, ×3, to show ornamentation.

11. A.M.N.H. No. 27378:68, detail, to show siphonal lobe and external saddles of a suture line, ×5.

12. A.M.N.H. No. 27378:78, detail, to show last four suture lines, ×3,

13. A.M.N.H. No. 27378:12, ×3, to show suture lines.

14. A.M.N.H. No. 27378:24, ×2; note sharp umbilical edge and delicate costation.

H. (*Putealiceras*) *schumacheri* (Noetling): 15–44

15. A.M.N.H. No. 27379:1, ×5.

16. A.M.N.H. No. 27379:2, ×5; note septal edge at anterior end.

17. A.M.N.H. No. 27379:3, ×5; note protoconch and primitive suture lines.

18. A.M.N.H. No. 27379:72, ×5, to show early development of whorl profile.

19. A.M.N.H. No. 27379:9, ×3; note primitive suture lines.

20. A.M.N.H. No. 27379:68, ×2; note distinct lateroventral shoulders and chevrons on venter.

21. A.M.N.H. No. 27379:71, ×3, to show robust costation.

22, 23. A.M.N.H. No. 27379:23, ×2; note suture lines in 22, median groove in 23.

24–26. A.M.N.H. No. 27379:53, ×1.

27–29. A.M.N.H. No. 27379:73, ×3/2.

30. A.M.N.H. No. 27379:15, ×3, to show early ornamentation and suture lines.

31. A.M.N.H. No. 27379:59, ×1; note fine median keel.

32. A.M.N.H. No. 27379:66, ×1; note suture lines.

33, 34. A.M.N.H. No. 27379:64, ×1; note fine median keel in 34.

35. A.M.N.H. No. 27379:52, ×1; note suture lines.

36. A.M.N.H. No. 27379:47, ×3/2.

37. A.M.N.H. No. 27379:49, ×3/2.

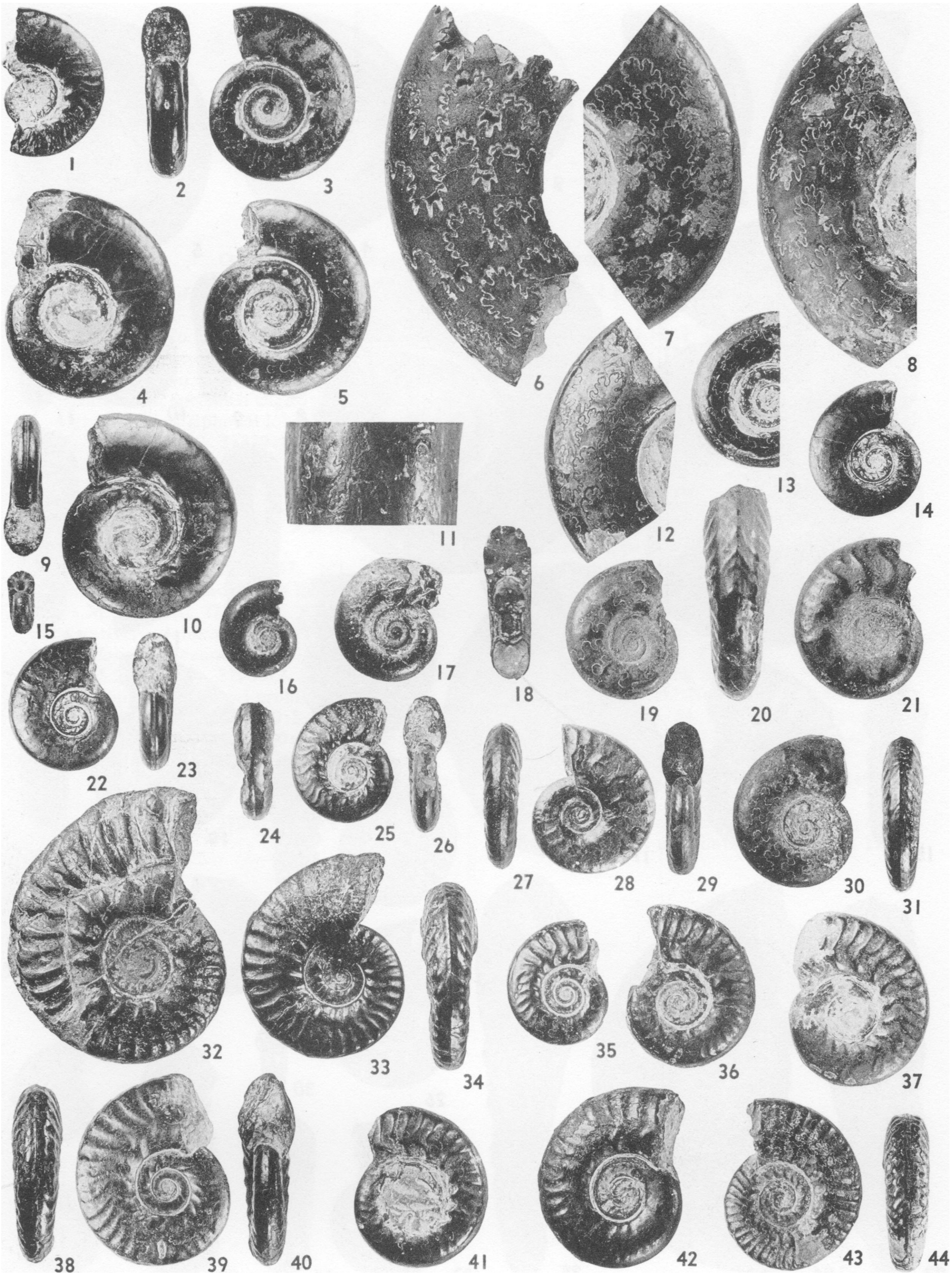
38–40. A.M.N.H. No. 27379:62, ×1; note sharp umbilical edge and suture lines in 39.

41. A.M.N.H. No. 27379:29, ×2; note costation and suture lines.

42. A.M.N.H. No. 27379:38, ×2.

43, 44. A.M.N.H. No. 27379:60, ×1; note tubercles on lateroventral shoulders in both figures and suture lines in 43.

The Oppelidae, *Hecticoceras* (*Putealiceras*), and *H.* (*P.*) *schumacheri* are continued on plate 10.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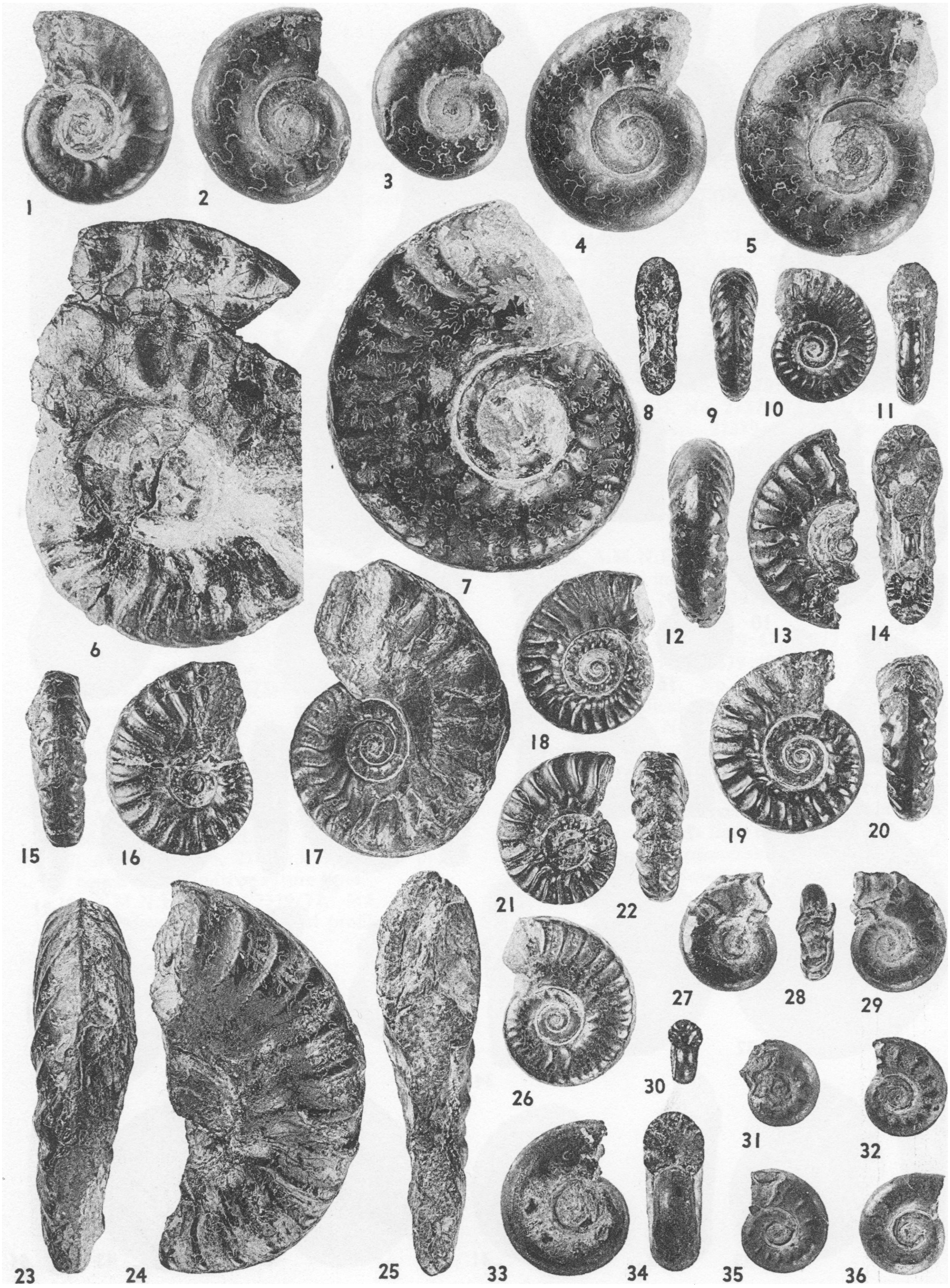
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PLATE 10

OPPELIDAE (*continued*): *Hecticoceras* (*Putealiceras*) (*continued*)

Hecticoceras (*Putealiceras*) *schumacheri* (Noetling) (*continued*): 1–7

1. A.M.N.H. No. 27379:41, ×2, to show ornamentation.
2. A.M.N.H. No. 27379:7, ×5, to show early suture lines; specimen slightly tilted, to show right halves of siphonal lobes.
3. A.M.N.H. No. 27379:18, ×3, to show plump first lateral lobes.
4. A.M.N.H. No. 27379:26, ×3, to show suture lines.
5. A.M.N.H. No. 27379:32, ×3, to show suture lines.
6. A.M.N.H. No. 27379:67, ×1, detail, to show costation and suture line.
7. A.M.N.H. No. 27379:61, ×2, to show comparatively elaborate suture lines.

H. (*P.*) *douvillei* Jeannet: 8–26

8. A.M.N.H. No. 27900:2, ×3/2, to show development of whorl profile.

9–11. A.M.N.H. No. 27900:5, ×1.

12–14. A.M.N.H. No. 27900:1, ×2; note suture lines in 12 and 13.

15, 16. A.M.N.H. No. 27900:8, ×1; note suture lines in 16.

17. A.M.N.H. No. 27900:11, ×1; note suture lines.

18. A.M.N.H. No. 27900:7, ×1; note suture lines.

19, 20. A.M.N.H. No. 27900:3, ×3/2; note suture lines in 19.

21, 22. A.M.N.H. No. 27900:6, ×1; note suture lines in 21.

23–25. A.M.N.H. No. 27900:12, ×1; in 24 note details of first lateral lobes.

26. A.M.N.H. No. 27900:9, ×3/2, to show suture lines.

H. (*P.*) *caelatum* ([Coquand] de Loriol): 27–36

27–29. A.M.N.H. No. 27901:21, ×3, to show lateral lappets and (incomplete) rostrum of apertural margin.

30. A.M.N.H. No. 27901:1, nucleus, ×5.

31. A.M.N.H. No. 27901:4, ×3; to show tubercles changing into heavy ribs.

32. A.M.N.H. No. 27901:11, ×3; to show tubercles changing into heavy ribs.

33, 34. A.M.N.H. No. 27901:9, ×5; 33, to show tubercles; 34, to show whorl profile.

35. A.M.N.H. No. 27901:13, ×3, to show hook-shaped inner ribs.

36. A.M.N.H. No. 27901:15, ×3; note strongly recurved ribs.

The Oppelidae, *Hecticoceras* (*Putealiceras*), and *H.* (*P.*) *caelatum* are continued on plate 11.

PLATE 11

OPPELIDAE (*continued*): *Hecticoceras* (*Putealiceras*) (*continued*)

Hecticoceras (*Putealiceras*) *caelatum* ([Coquand] de Loriol) (*continued*): 1–32

1, 2. A.M.N.H. No. 27901:28, ×3.

3. A.M.N.H. No. 27901:17, ×3, to show suture lines.

4, 5. A.M.N.H. No. 27901:25, ×3, to show characteristic ornamentation.

6. A.M.N.H. No. 27901:14, ×3.

7. A.M.N.H. No. 27901:42, natural cross section, ×2.

8. A.M.N.H. No. 27901:7, ×3; note suture lines.

9. A.M.N.H. No. 27901:45, ×2; note truncate venter.

10. A.M.N.H. No. 27901:48, ×2, to show characteristic costation.

11. A.M.N.H. No. 27901:52, natural cross section, ×2.

12–14. A.M.N.H. No. 27901:32, ×3; note crossing of venter by ribs in 12.

15. A.M.N.H. No. 27901:43, ×2, to show characteristic costation.

16. A.M.N.H. No. 27901:44, ×2, to show costation.

17, 18. A.M.N.H. No. 27901:56, ×3/2; note truncate venter in 17.

19. A.M.N.H. No. 27901:60, ×2, cross section at posterior end.

20–22. A.M.N.H. No. 27901:41, ×1; note suture lines in 21; 22, cross section at anterior end.

23. A.M.N.H. No. 27901:61, cross section at anterior end, ×3/2.

24, 25. A.M.N.H. No. 27901:59, largest fragment present (crushed), ×1.

26, 27. A.M.N.H. No. 27901:65, ×5, to show suture lines.

28. A.M.N.H. No. 27901:3, ×5, to show suture lines.

29. A.M.N.H. No. 27901:33, ×3, to show suture lines.

30. A.M.N.H. No. 27901:64, ×3, to show closely set suture lines.

31. A.M.N.H. No. 27901:63, ×3, to show closely set suture lines.

32. A.M.N.H. No. 27901:66, ×3, to show suture lines.

H. (*P.*) *solare* Haas: 33–57

33. A.M.N.H. No. 27902:7, ×5, to show tubercles.

34, 35. A.M.N.H. No. 27902:3, ×5, note first indications of tubercles in 35.

36. A.M.N.H. No. 27902:1, nucleus, ×10, to show protoconch.

37. A.M.N.H. No. 27902:10, ×3.

38. A.M.N.H. No. 27902:58, cross section at anterior end, ×3.

39. A.M.N.H. No. 27902:17, ×3, to show early costation.

40. A.M.N.H. No. 27902:28, ×3, to show ribs crossing venter.

41, 42. A.M.N.H. No. 27902:32, ×3; note suture lines in 42.

43–45. A.M.N.H. No. 27902:54, syntype B, ×1.

46. A.M.N.H. No. 27902:20, ×3, to show heavy ribs.

47–49. A.M.N.H. No. 27902:22, ×3, to show ornamentation.

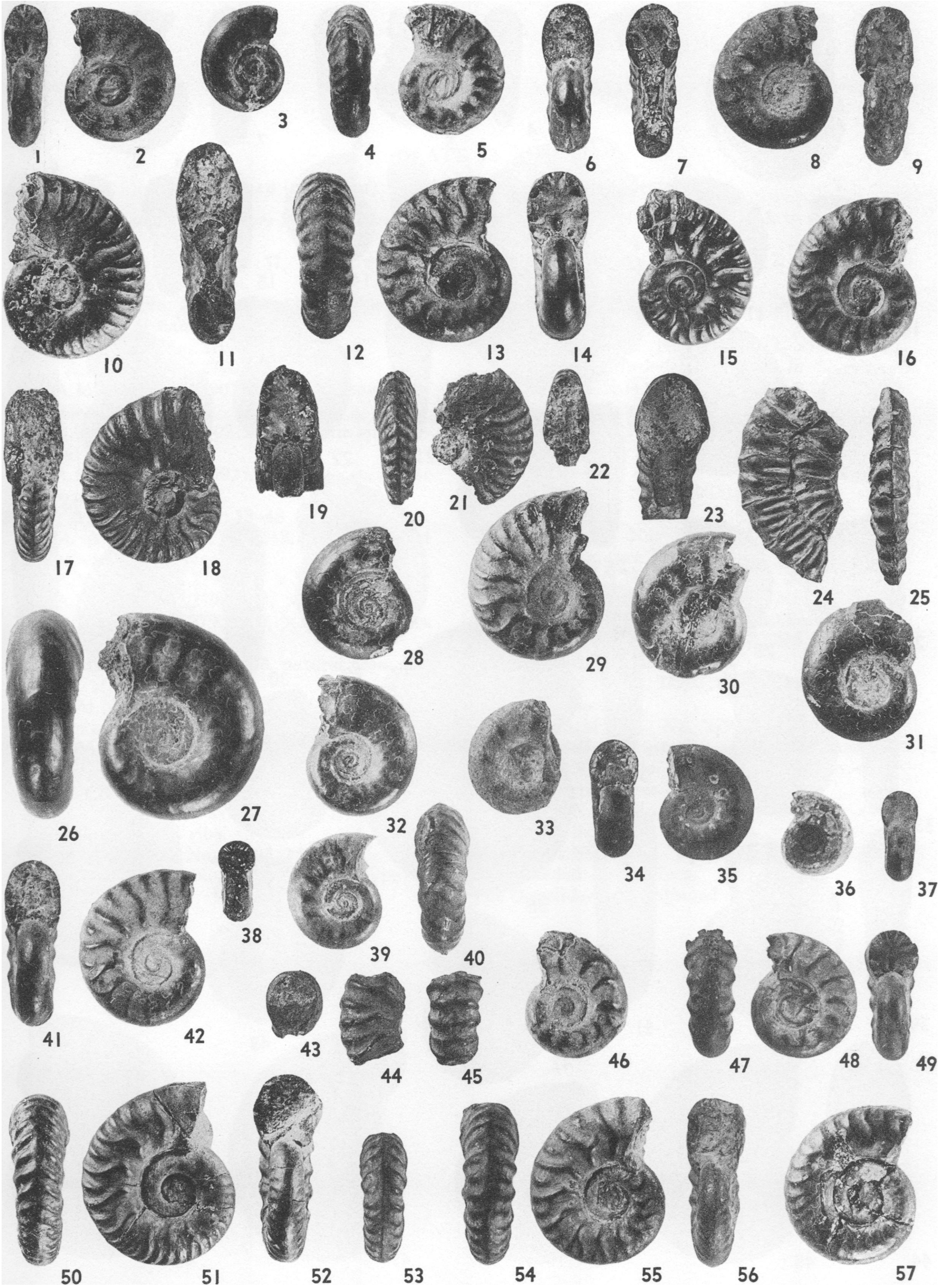
50–52. A.M.N.H. No. 27902:48, syntype A, ×2.

53. A.M.N.H. No. 27902:40, ×2, to show distinct keel.

54–56. A.M.N.H. No. 27902: 46, ×2.

57. A.M.N.H. No. 27902:33, ×3, to show costation and suture lines.

The Oppelidae, *Hecticoceras* (*Putealiceras*), and *H.* (*P.*) *solare* are continued on plate 12.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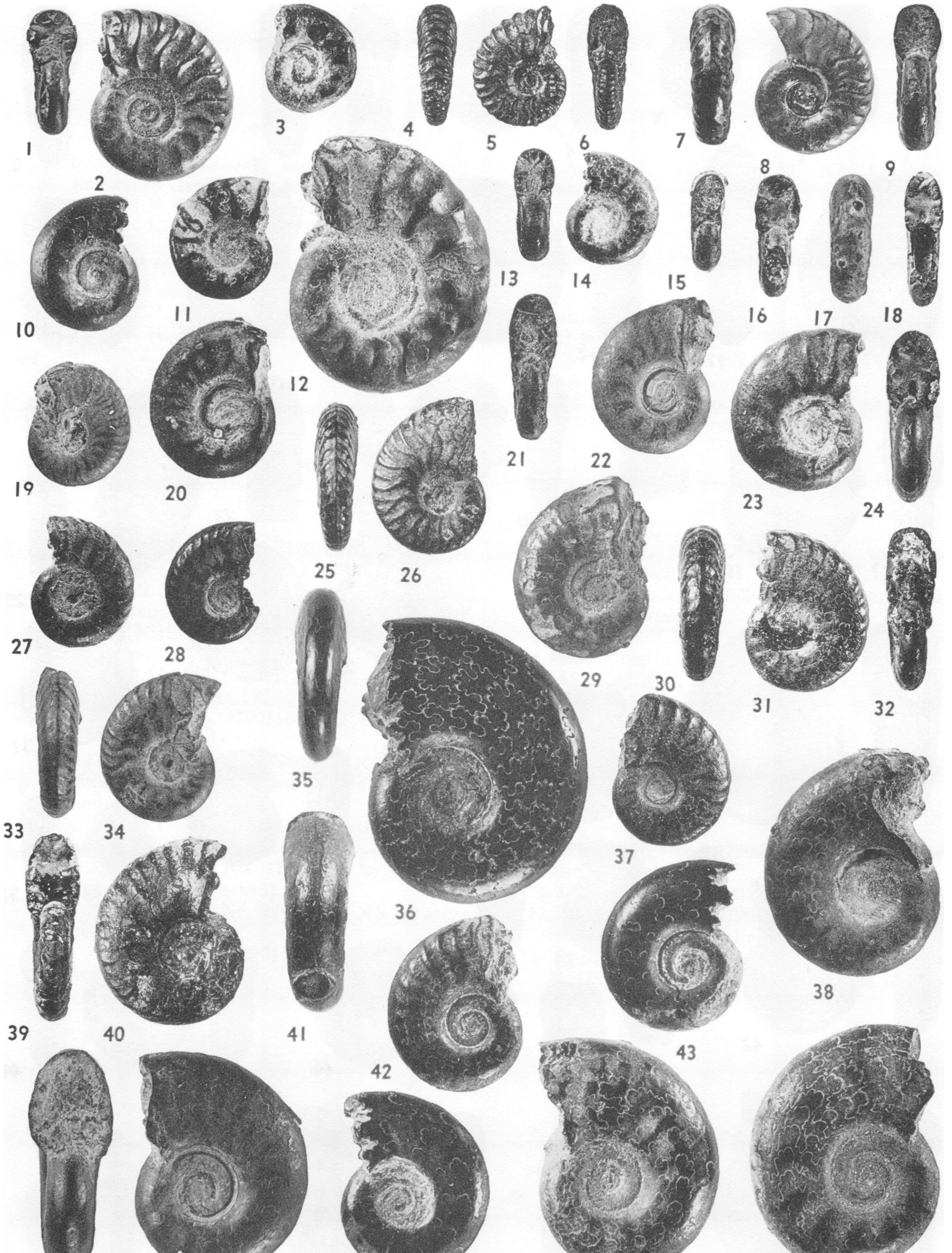
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PLATE 12

OPPELIDAE (*continued*): (*Hecticoceras Putealiceras*) (*continued*)

Hecticoceras (*Putealiceras*) *solare* Haas (*continued*): 1–12

1, 2. A.M.N.H. No. 27902:37, ×2; 2, to show characteristic costation.

3. A.M.N.H. No. 27902:14, ×3; note "hooks" on middle of flank.

4–6. A.M.N.H. No. 27902:50, ×1.

7–9. A.M.N.H. No. 27902:43, ×2.

10. A.M.N.H. No. 27902:8, ×5, to show early suture lines.

11. A.M.N.H. No. 27902:21, ×3; note anteriormost suture line.

12. A.M.N.H. No. 27902:59, ×5, to show last suture lines.

H. (*P.*) *separandum* Haas: 13–48

13, 14. A.M.N.H. No. 27903:8, ×3, note short ribs and suture lines in 14.

15. A.M.N.H. No. 27903:7, ×3.

16. A.M.N.H. No. 27903:32, ×2.

17. A.M.N.H. No. 27903:10, ×3; note tongues formed by ribs on venter.

18. A.M.N.H. No. 27903:58, natural cross section, ×3.

19. A.M.N.H. No. 27903:33, ×2, to show delicate costation.

20. A.M.N.H. No. 27903:1, ×5, to show early ornamentation.

21. A.M.N.H. No. 27903:38, ×2.

22. A.M.N.H. No. 27903:23, ×3, to show weak, sigmoidal ribs.

23, 24. A.M.N.H. No. 27903:26, ×3.

25, 26. A.M.N.H. No. 27903:49, syntype B, ×3/2.

27. A.M.N.H. No. 27903:11, ×3, to show weak costation.

28. A.M.N.H. No. 27903:31, ×2, to show costation.

29. A.M.N.H. No. 27903:30, ×3, to show suture lines.

30–32. A.M.N.H. No. 27903:42, syntype A, ×2; note crowded suture lines in 30, 31.

33, 34. A.M.N.H. No. 27903: 40, ×2, to show ornamentation.

35, 36. A.M.N.H. No. 27903:59; 35, ×3; 36, ×5, to show sharp umbilical edge and suture lines.

37. A.M.N.H. No. 27903:39, ×2, to show costation.

38. A.M.N.H. No. 27903:14, ×5, to show crowded suture lines.

39, 40. A.M.N.H. No. 27903:47, ×2.

41. A.M.N.H. No. 27903:50, ×5, to show siphonal lobes and external saddles.

42. A.M.N.H. No. 27903:27, ×3, to show costation and suture lines.

43. A.M.N.H. No. 27903:61, ×5, to show early suture lines.

44, 45. A.M.N.H. No. 27903:15, ×5; 45, to show delicate costation and suture lines.

46. A.M.N.H. No. 27903:62, ×5, to show early suture lines.

47. A.M.N.H. No. 27903:20, ×5, to show suture lines.

48. A.M.N.H. No. 27903:51, ×5, to show crowded suture lines.

The Oppelidae are continued on plate 13.

PLATE 13

OPPELIDAE (*continued*): *Ochetoceras* (*Campylites*)

Ochetoceras (*Campylites*) *delmontanum* (Oppel): 1–43

1–3. A.M.N.H. No. 27908:1, ×5; note suture lines in 2, three fine threads foreshadowing keels in 1.

4, 5. A.M.N.H. No. 27908:7, ×3; note beginning costation in 4.

6. A.M.N.H. No. 27908:6, detail, ×5, to show primitive early suture lines.

7. A.M.N.H. No. 27908:25, ×3, to show suture lines.

8. A.M.N.H. No. 27908:80, ×5, to show protoconch and early suture lines.

9, 10. A.M.N.H. No. 27908:21, ×3; note delicate keel in 9, sickles and suture lines in 10.

11. A.M.N.H. No. 27908:16, ×3, to show whorl profile.

12. A.M.N.H. No. 27908:89, ×3, to show sickles and suture lines.

13. A.M.N.H. No. 27908:95, ×2, to show characteristic costation.

14. A.M.N.H. No. 27908:12, ×4, to show early suture lines.

15–17. A.M.N.H. No. 27908:42, ×2; note suture lines in 15 and 16, delicate costation in 16.

18. A.M.N.H. No. 27908:27, ×3, to show subdued costation and suture lines.

19. A.M.N.H. No. 27908: 82, ×3, to show recurved sickles and suture lines.

20–22. A.M.N.H. No. 27909:53, ×2; note costation and suture lines in 21, triple keel in 20.

23–25. A.M.N.H. No. 27908:33, ×3; note suture lines in 23 and 24.

26. A.M.N.H. No. 27908:50, ×2, to show delicate costation.

27. A.M.N.H. No. 27908:44, ×2, to show costation and suture lines.

28–29. A.M.N.H. No. 27908:45, ×2; note suture lines in 28 and 29, triple keel in 28, subdued costation in 29.

31–33. A.M.N.H. No. 27980:63, ×2; note suture lines in 31 and 32.

34. A.M.N.H. No. 27908:87, ×2, to show sharp umbilical edge and suture lines.

35. A.M.N.H. No. 27908:72, ×2, to show costation and suture lines.

36. A.M.N.H. No. 27908:100, ×5, to show asymmetrical suture lines.

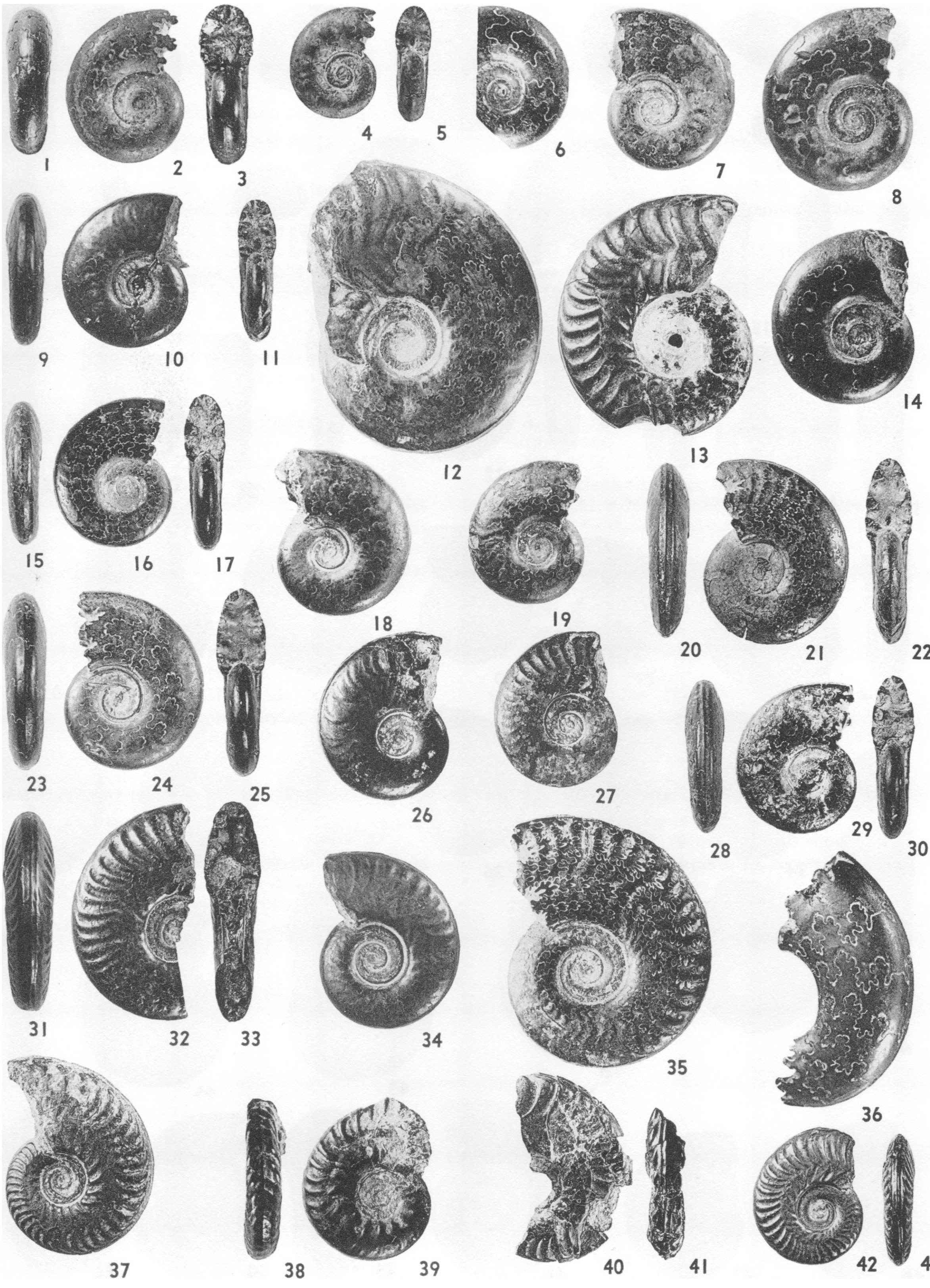
37. A.M.N.H. No. 27908:77, largest disk present, ×1.

38, 39. A.M.N.H. No. 27908:97, ×2; note tongues on venter in 38.

40, 41. A.M.N.H. No. 27908:76, ×1; note deep groove between median and left keels in 41.

42, 43. A.M.N.H. No. 27908:73, finest specimen present, ×1.

The Oppelidae and *Ochetoceras* (*Campylites*) are continued on plate 14.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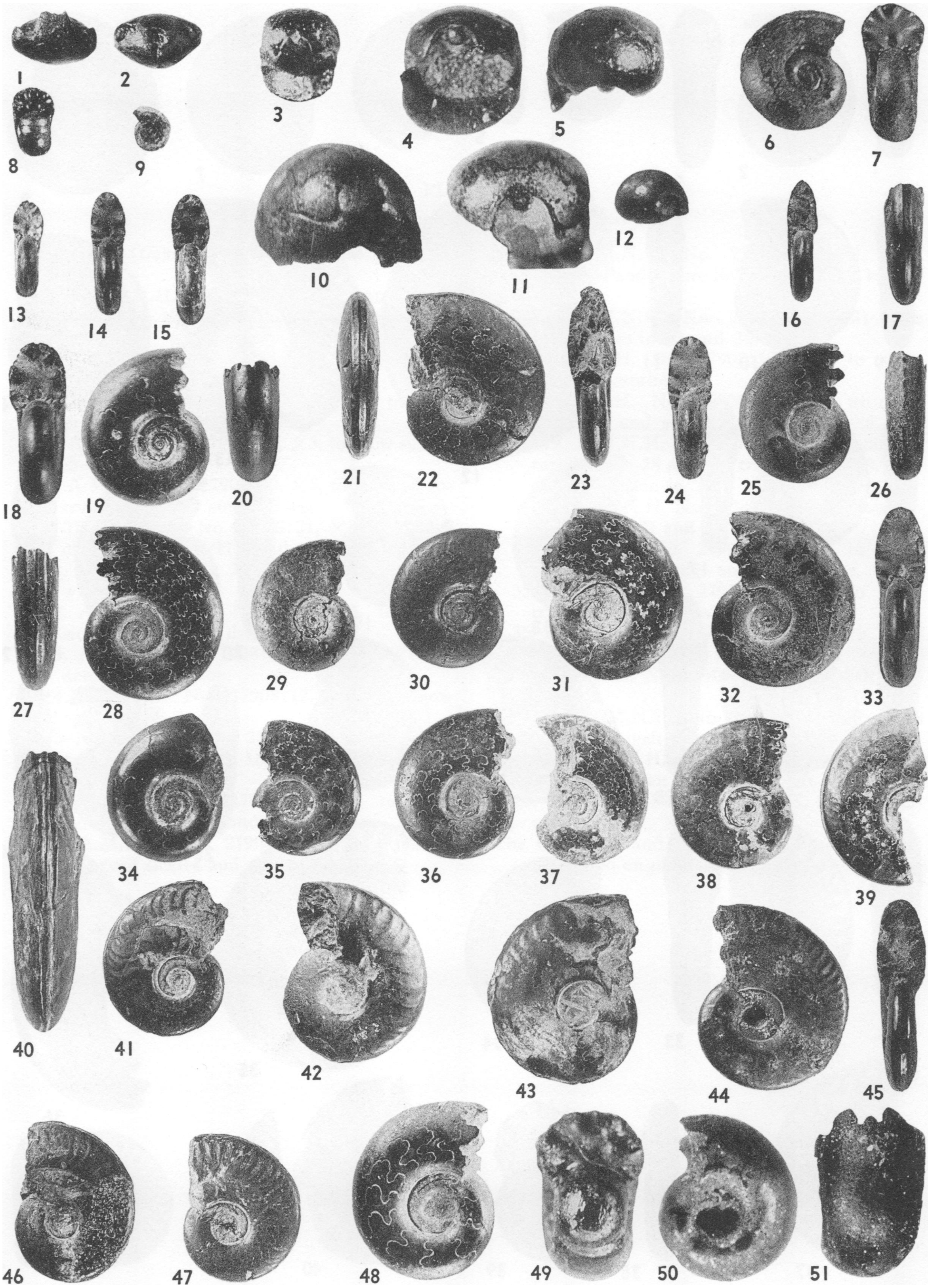
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PLATE 14

OPPELIDAE (*continued*): *Ochetoceras* (*Campylites*) (*continued*)

Ochetoceras (*Campylites*) *freboldi* Haas: 1–45

1, 2. Photomicrographs, A.M.N.H. No. 27909: 103, protoconch, in ventral and frontal views; 1, × *ca.* 29; 2, × *ca.* 30.

3. Photomicrograph, A.M.N.H. No. 27909:100, nucleus in inverted frontal view, × *ca.* 29.5.

4, 5. Photomicrographs, A.M.N.H. No. 27909:98, nucleus in inverted frontal and ventral views; 4, × *ca.* 40; 5, × *ca.* 38; note in both views caecum projecting into cavity left by broken-out protoconch.

6, 7. A.M.N.H. No. 27909:4, nucleus, ×10; note suture line in 6.

8. A.M.N.H. No. 27909:2, nucleus, ×10; note constriction.

9. A.M.N.H. No. 27909:94, nucleus, ×10; note constriction. (See also text fig. 2.)

10–12. Photomicrographs, A.M.N.H. No. 27909:91, nucleus in two oblique side views (10, 12) and in ventral view (11); 10, × *ca.* 46.5; 11, × *ca.* 44.5; 12, × *ca.* 24; for explanations see text. (See also text fig. 1.)

13. A.M.N.H. No. 27909:9, ×3.

14. A.M.N.H. No. 27909:14, ×3.

15. A.M.N.H. No. 27909:21, ×3.

16. A.M.N.H. No. 27909:45, ×2.

17. A.M.N.H. No. 27909:23, ×3, to show median keel and accompanying furrows.

18–20. A.M.N.H. No. 27909:10. ×5; note suture lines in 19, three fine threads on venter in 20.

21–23. A.M.N.H. No. 27909:80, syntype A, ×2; note triple keel in 21, faint sickles and suture lines in 22.

24–26. A.M.N.H. No. 27909:29, ×3; in 26 note teeth into which keel dissolves.

27, 28. A.M.N.H. No. 27909:48, ×3; note incipient triple keel in 27, suture lines in 28.

29. A.M.N.H. No. 27909:22, ×3, to show suture lines.

30. A.M.N.H. No. 27909:65, ×2, to show delicate costation.

31. A.M.N.H. No. 27909:76, ×2, to show suture lines.

32, 33. A.M.N.H. No. 27909:50, ×3; note sporadic sickles in 32, pronounced umbilical edge in 33.

34. A.M.N.H. No. 27909:7, ×5, to show early suture lines.

35. A.M.N.H. No. 27909:24, ×3, to show suture lines.

36. A.M.N.H. No. 27909:37, ×3, to show suture lines.

37. A.M.N.H. No. 27909:96, ×2, to show suture lines.

38. A.M.N.H. No. 27909:71, ×2, to show suture lines.

39. A.M.N.H. No. 27909:78, ×2, to show faint sickles and suture lines.

40, 41. A.M.N.H. No. 27909:86, syntype B; 40, ×2, to show development of triple keel; 41, ×1.

42. A.M.N.H. No. 27909:89, ×2, to show weak, recurved sickles.

43. A.M.N.H. No. 27909:81, ×2, to show short sickles and sharp umbilical edge.

44, 45. A.M.N.H. No. 27909:83, ×3/2; note short sickles in 44.

46. A.M.N.H. No. 27909:85, ×1; note costation in anteriormost quarter-whorl.

47. A.M.N.H. No. 27909:82, ×3/2, to show costation and suture lines.

7, 8, 13–16, 18, 23, 24, 33, and 45, to show development of whorl profile.

O. (*C.*) *evolutum* Haas: 48–51

48. A.M.N.H. No. 27910:5, ×5, to show early suture lines; see also plate 15, figure 2.

49–51. Photomicrographs, A.M.N.H. No. 27910:1, nucleus; 49, × *ca.* 23; 50, × *ca.* 23.25; 51, × *ca.* 27.5; note one constriction in 49, two in 50, septal margin at anterior end in 51.

The Oppelidae, *Ochetoceras* (*Campylites*), and *O.* (*C.*) *evolutum* are continued on plate 15.

PLATE 15

OPPELIDAE (*continued*): *Ochetoceras* (*Campylites*) (*continued*), *Taramelliceras* (*Proscaphites*)

Ochetoceras (*Campylites*) *evolutum* Haas (*continued*): 1–29

1. A.M.N.H. No. 27910:6, ×5, to show earliest ornamentation.
2. A.M.N.H. No. 27910:5, ×3; see also plate 14, figure 48.
3. A.M.N.H. No. 27910:11, ×3.
4. A.M.N.H. No. 27910:16, ×3.
5. A.M.N.H. No. 27910:20, ×3, to show delicate costation of anteriormost part and suture lines.
6. A.M.N.H. No. 27910:35, ×2.
7. A.M.N.H. No. 27910:30, ×3, to show costation and suture lines.
8. A.M.N.H. No. 27910:8, ×5, to show delicate, sigmoidal costae and suture lines.
9. A.M.N.H. No. 27910:17, ×3, to show high and steep umbilical wall and suture lines.
10. A.M.N.H. No. 27910:32, ×3, to show early suture lines.

11, 12. A.M.N.H. No. 27910:28, ×3; note three threads, foreshadowing keels, on venter in 11 and sickles and suture lines in 12.

13. A.M.N.H. No. 27910:22, ×3.

14–16. A.M.N.H. No. 27910:46, ×2, note costation and suture lines in 15, steep umbilical wall in 16.

17. A.M.N.H. No. 27910:41, ×2, to show costation.

18. A.M.N.H. No. 27910:42, ×2, to show suture lines.

19. A.M.N.H. No. 27910:51, ×3/2; note triple keel.

20, 21. A.M.N.H. No. 27910:50, ×2; note robust costation and suture lines in 20.

22–24. A.M.N.H. No. 27910:55, syntype A, ×2; note suture lines in 23.

25–27. A.M.N.H. No. 27910:60, syntype B, ×1.

28 A.M.N.H. No. 27910:58, ×3/2.

29. A.M.N.H. No. 27910:62, ×2, to show shift of siphonal lobe far to the right.

Taramelliceras (*Proscaphites*) *hermonis* (Noetling): 30–59

30. A.M.N.H. No. 27921:3, oblique ventral view, ×5, to show suture lines.

31. A.M.N.H. No. 27921:11, ×3, to show delicate circumumbilical folds.

32. A.M.N.H. No. 27921:12, ×3.

33. A.M.N.H. No. 27921:16, ×3.

34. A.M.N.H. No. 27921:30, ×3, to show incipient median beads.

35, 36. A.M.N.H. No. 27921:7, ×5, note early suture lines in 36.

37. A.M.N.H. No. 27921:23, ×3, to show circumumbilical folds.

38. A.M.N.H. No. 27921:25, ×3, to show circumumbilical folds and suture lines.

39. A.M.N.H. No. 27921:17, ×3, to show circumumbilical folds and suture lines.

40. A.M.N.H. No. 27921:70, ×1.

41. A.M.N.H. No. 27921:60, ×1.

42. A.M.N.H. No. 27921:67, ×1.

43. A.M.N.H. No. 27921:62, ×3/2, to show median beads.

44, 45. A.M.N.H. No. 27921:33, ×3; note delicate median nodes and fine longitudinal striation in 44, sickles and last suture lines in 45.

46–49. A.M.N.H. No. 27921:45; 46, 47, 49, ×2; 48, ×3; note median beads in 46.

50. A.M.N.H. No. 27921:44, ×3, to show costation.

51. A.M.N.H. No. 27921:39, ×3, to show costation.

52, 53. A.M.N.H. No. 27921:69; 52, ×3/2, to show ornamentation; 53, ×1.

54. A.M.N.H. No. 27921:24, ×3.

55. A.M.N.H. No. 27921:65, ×3/2, to show ornamentation.

56, 57. A.M.N.H. No. 27921:72, ×1; note circumumbilical folds in 57.

58. A.M.N.H. No. 27921:52, ×2.

59. A.M.N.H. No. 27921:55, ×2.

Note elaborate suture lines in 43, 48, 50–52, and 55–57.

The Oppelidae, *Taramelliceras* (*Proscaphites*), and *T.* (*P.*) *hermonis* are continued on plate 16.

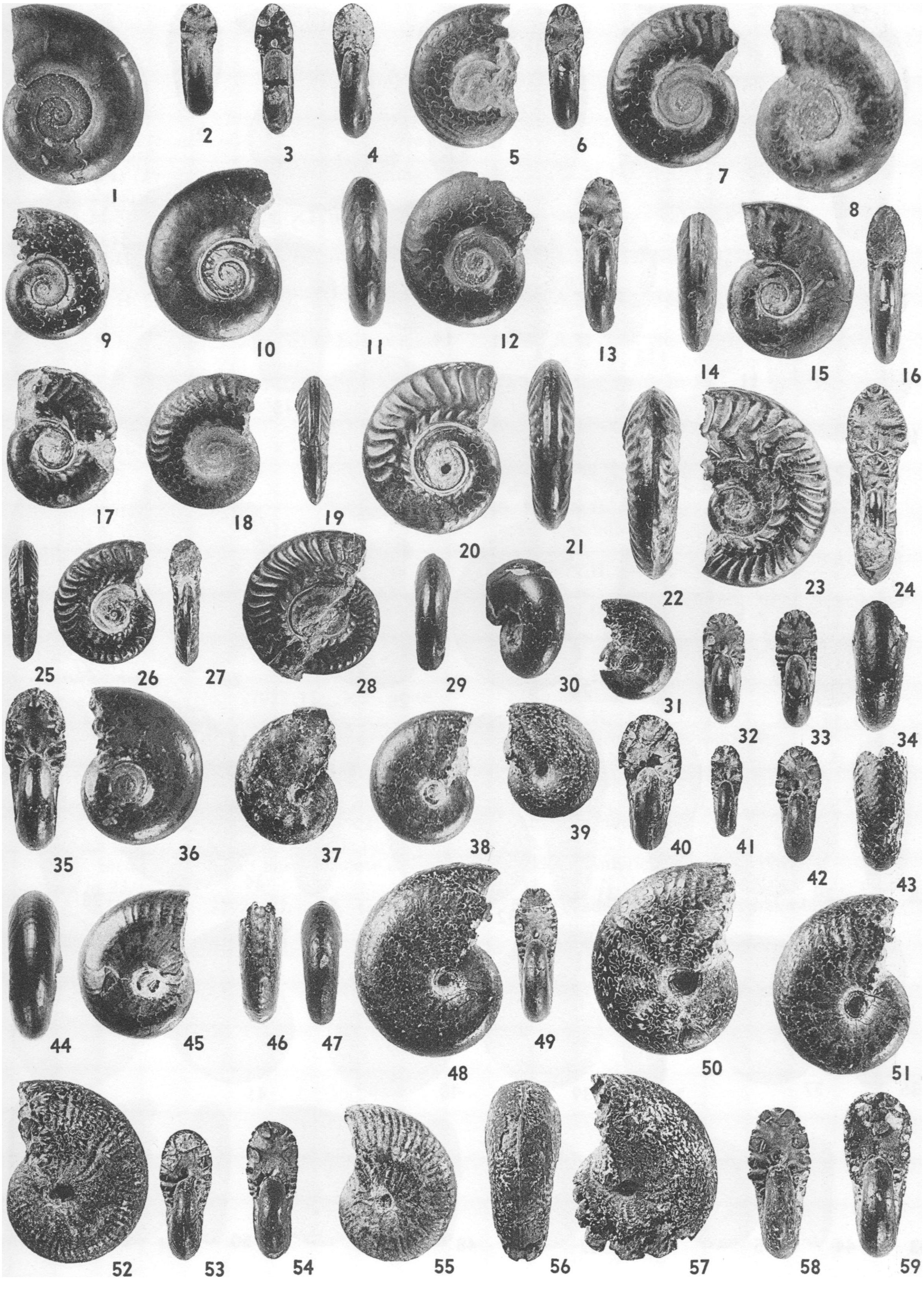


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PLATE 16

OPPELIDAE (*continued*): *Taramelliceras* (*Proscaphites*) (*continued*), *Taramelliceras* (*Richeiceras*)

Taramelliceras (*Proscaphites*) *hermonis* (Noetling) (*continued*): 1–5
- 1, 2. A.M.N.H. No. 27921:74, ×1; note beaded median keel in 1.
- 3. A.M.N.H. No. 27921:66, ×2, to show ribs crossing venter and beaded keel.
- 4. A.M.N.H. No. 27921:40, ×3, to show longitudinal striation.
- 5. A.M.N.H. No. 27921:20, ×5, to show suture lines.

T. (*P.*) *globosum* (de Loriol): 6–27
- 6, 7. A.M.N.H. No. 27922:3; 6, ×3; 7, ×5, to show early suture lines.
- 8. A.M.N.H. No. 27922:4, ×3, to show early costation.
- 9. A.M.N.H. No. 27922:2, ×3, to show incipient circumumbilical folds.
- 10, 11. A.M.N.H. No. 27922:7; 10, ×5, to show early suture lines; 11, ×3.
- 12. A.M.N.H. No. 27922:12, ×3.
- 13. A.M.N.H. No. 27922:13, ×3.
- 14. A.M.N.H. No. 27922:15, ×3, to show suture lines.
- 15. A.M.N.H. No. 27922:25, ×3, to show suture lines.
- 16–18. A.M.N.H. No. 27922:11, ×2; note median beads in 16.
- 19. A.M.N.H. No. 27922:30, ×2, to show costation.
- 20, 21. A.M.N.H. No. 27922:19, ×3; note suture lines and sparse costation in 20.
- 22, 23. A.M.N.H. No. 27922:31, ×3; note median keel, sunk between two wide furrows, in 22, median beads and fine reticulate striation in 23.
- 24. A.M.N.H. No. 27922:27, ×2, to show suture lines.
- 25. A.M.N.H. No. 27922:23, ×3, to show costation and suture lines.
- 26, 27. A.M.N.H. No. 27922:32, ×2; note suture lines in both, median keel and accompanying furrows in 27.

T. (*P.*) cf. *langi* (de Loriol): 28–35.
- 28–30. A.M.N.H. No. 27923:1, ×2; note suture lines in 29.
- 31, 32. A.M.N.H. No. 27923:2, ×3/2; note suture lines in 32.
- 33–35. A.M.N.H. No. 27923:3, ×1; note three rows of nodes and suture lines in 33 and 34, fine median beads in 35.

T. (*Richeiceras*) *richei* (de Loriol): 36–52
- 36, 37. A.M.N.H. No. 27924:4, ×5; 37, to show early suture lines.
- 38, 39. A.M.N.H. No. 27924:7, ×5; 39, to show suture lines.
- 40. A.M.N.H. No. 27924:68, ×2, to show circumumbilical folds and indications of sickles.
- 41. A.M.N.H. No. 27924:9, ×5, to show suture lines.
- 42. A.M.N.H. No. 27924:12, ×5, to show suture lines.
- 43. A.M.N.H. No. 27924:40, ×2.
- 44. A.M.N.H. No. 27924:42, ×2, to show early median nodes.
- 45. A.M.N.H. No. 27924:11, ×3, to show incipient circumumbilical folds.
- 46, 47. A.M.N.H. No. 27924:48, ×2; note incipient sickles in 47.
- 48. A.M.N.H. No. 27924:49, ×2, to show delicate, continuous keel.
- 49. A.M.N.H. No. 27924:58, ×2, to show sickles in anteriormost quarter-whorl.
- 50–52. A.M.N.H. No. 27924:59, ×2; note finely beaded keel in 50, circumumbilical folds and suture lines in 51.

The Oppelidae, *Taramelliceras* (*Richeiceras*), and *T.* (*R.*) *richei* are continued on plate 17.

PLATE 17

OPPELIDAE (*continued*): *Taramelliceras* (*Richeiceras*) (*continued*), *Creniceras*, *Scaphitodites*

Taramelliceras (*Richeiceras*) *richei* (de Loriol) (*continued*): 1–17

1. A.M.N.H. No. 27924:32, ×5, to show suture lines.
2, 3. A.M.N.H. No. 27924:56, ×3; right side view to show smoothness, left to show suture lines.
4, 5. A.M.N.H. No. 27924:62, ×3, chiefly to show suture lines. This specimen was illustrated in Haas (1952, p. 858, figs. 3, 4).
6–8. A.M.N.H. No. 27924:71, ×2; note low median nodes in 7.
9. A.M.N.H. No. 27924:74, ×2, to show sickles.
10–12. A.M.N.H. No. 27924:72, ×2; note ventrad convergence of flanks in 10, suture lines in 11 and 12, median nodes in all three.
13. A.M.N.H. No. 27924:76, ×3, to show suture lines.
14. A.M.N.H. No. 27924:29, ×4, to show circumumbilical depression, traversed by folds, and suture lines.
15–17. A.M.N.H. No. 27924:75, ×2; note median nodes in 16.

Creniceras renggeri (Oppel): 18–37

18–20. A.M.N.H. No. 27925:4, ×2; note siphonal groove in 18, suture lines in 19.
21, 22. A.M.N.H. No. 27925:1, ×2.
23, 24. A.M.N.H. No. 27925:9, ×3/2; note faint costation in 24.
25–27. A.M.N.H. No. 27925:6, ×2; note sharp teeth in 25, delicate costation in 26.
28. A.M.N.H. No. 27925:5, ×2, to show median teeth.
29, 30. A.M.N.H. No 27925:12, ×1; note faint circumumbilical folds and suture lines in 29.
31. A.M.N.H. No. 27925:16, ×2; close-up of teeth.
32, 33, A.M.N.H. No. 27925:7; 32, ×2; 33, ×3, to show suture lines.
34. A.M.N.H. No. 27925:15, detail, ×2; last septum, forming posterior end of fragment, to show whorl profile.
35. A.M.N.H. 27925:14, ×1.
36, 37. A.M.N.H. No. 27925:11; 36, ×1; 37, ×3, to show two sharply engraved grooves between three ridges in the internodals.

Scaphitodites scaphitoides (Coquand): 38–47

38. A.M.N.H. No. 27926:9, ×3.
39. A.M.N.H. No. 27926:30, ×2.
40. A.M.N.H. No. 27926:8, ×3.
41. A.M.N.H. No. 27926:40, ×3.
42, 43. A.M.N.H. No. 27926:39, ×2.
44. A.M.N.H. No. 27926:37, ×2.
45. A.M.N.H. No. 27926:5, ×3.
46. A.M.N.H. No. 27926:10, ×3.
47. A.M.N.H. No. 27926:2, ×3.

Note characteristic scaphitoid shell shape in 38, 39, and 44, particularly pronounced "humps" and degeneration of last suture lines in 41 and 42.

The Oppelidae, *Scaphitodites*, and *S. scaphitoides* are continued on plate 18.


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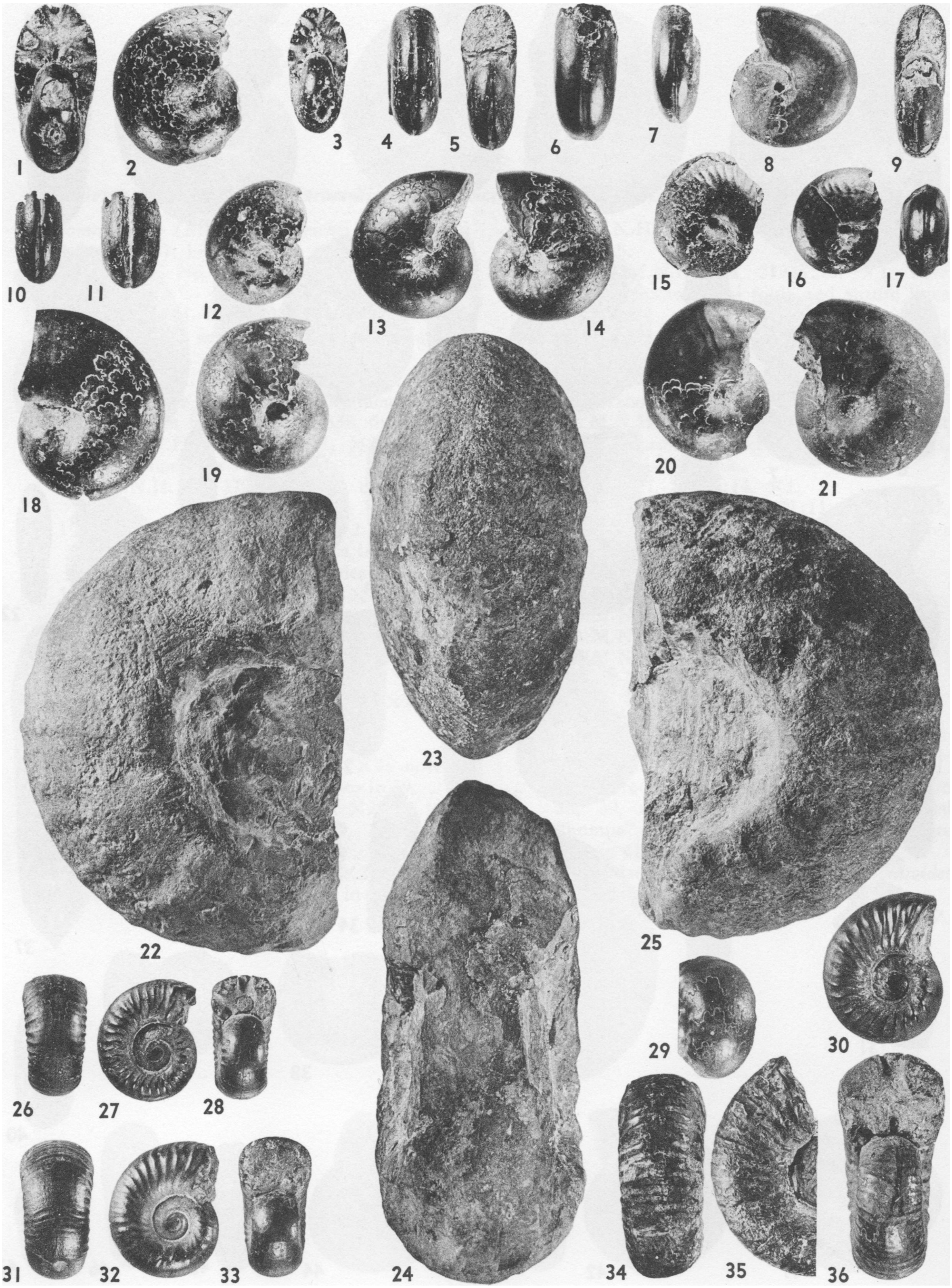
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PLATE 18

OPPELIDAE (*continued*): *Scaphitodites* (*continued*)
CARDIOCERATIDAE: *?Quenstedtoceras* (*Pavloviceras*)
PERISPHINCTIDAE: *Perisphinctes* (*Alligaticeras*)

Scaphitodites scaphitoides (Coquand): (*continued*): 1–21

1, 2. A.M.N.H. No. 27926:20, ×3; note suture lines in 2.
3. A.M.N.H. No. 27926:23, ×2.
4, 5. A.M.N.H. No. 27926:33, ×2.
6. A.M.N.H. No. 27926:12, ×3.
Note gradual disappearance of siphonal groove in 4 and 6.
7. A.M.N.H. No. 27926:42, ×2; note weak keel in siphonal groove.
8. A.M.N.H. No. 27926:32, ×2; note characteristic shell shape.
9. A.M.N.H. No. 27926:36, ×2.
10. A.M.N.H. No. 27926:13, ×2, to show siphonal groove.
11. A.M.N.H. No. 27926:21, ×2, to show siphonal groove.
12. A.M.N.H. No. 27926:6, ×3, to show circumumbilical folds and suture lines.
13, 14. A.M.N.H. No. 27926:15, ×3, to show suture lines and, in 14, grooves surrounding the saddles and radial folds.
15. A.M.N.H. No. 27926:41, ×2, to show rursiradiate ribs.
16, 17. A.M.N.H. No. 27926:16, ×2, note short sickles in 16, strong median keel in 17.
18. A.M.N.H. No. 27926:26, ×3, to show suture lines; note bifid lateral lobes.
19. A.M.N.H. No. 27926:2, ×5, to show early suture lines.
20. A.M.N.H. No. 27926:43, ×3, to show last suture lines.
21. A.M.N.H. No. 27926:3, ×5, to show last suture lines.
Note degeneration of last suture lines in 20 and 21.

?Quenstedtoceras (*Pavloviceras*) *?mariae* (d'Orbigny): 22–25

22–25. A.M.N.H. No. 27927, ×1.

Perisphinctes (*Alligaticeras*) *?paneaticus* Noetling: 26–36

26–28. A.M.N.H. No. 27765:28, ×3.
29. A.M.N.H. No. 27765:12, detail, ×5, to show early suture lines.
30. A.M.N.H. No. 27765:42, ×3.
31–33. A.M.N.H. No. 27765:38, ×3.
34, 35. (detail). A.M.N.H. No. 27765:34, ×3/2, to show costation.
36. A.M.N.H. No. 27765:33, ×3, to show whorl profile.

The Perisphinctidae, *Perisphinctes* (*Alligaticeras*), and *P.* (*A.*) *?paneaticus* are continued on plate 19.

PLATE 19

PERISPHINCTIDAE (*continued*): *Perisphinctes* (*Alligaticeras*) (*continued*), *Perisphinctes* (*?Dichotomosphinctes*), *Perisphinctes* (*Properisphinctes*)

Perisphinctes (*Alligaticeras*) *?paneaticus* Noetling (*continued*): 1–12

1, 2. A.M.N.H. No. 27765:70, ×2.

3. A.M.N.H. No. 27765:58, ×3.

4–6. A.M.N.H. No. 27765:57, ×3.

7. A.M.N.H. No. 27765:46, without damaged part, ×1, to show costation.

8. A.M.N.H. No. 27765:7, ×5, to show suture lines.

9, 10 (detail). A.M.N.H. No. 27765:68, ×3, to show suture lines.

11. A.M.N.H. No. 27765:39, ×5, to show suture lines.

12. Whorl fragment A.M.N.H. No. 27765:76, ×1.

Perisphinctes (*?Dichotomosphinctes*) *?orthocyma* Noetling: 13–21

13, 14. A.M.N.H. No. 27835:1, ×3.

15–17. A.M.N.H. No. 27835:2, ×2.

18–20. A.M.N.H. No. 27835:3, ×2.

21. A.M.N.H. No. 27835:4, ×1.

Perisphinctes (*Properisphinctes*) *vicinus* Haas: 22–23

22, 23. A.M.N.H. No. 27836:51, ×3.

24, 25. A.M.N.H. No. 27836:48, ×3.

26. A.M.N.H. No. 27836:56, ×2; note triangular umbilicus.

27. A.M.N.H. No. 27836:11, ×5, detail, to show last suture line.

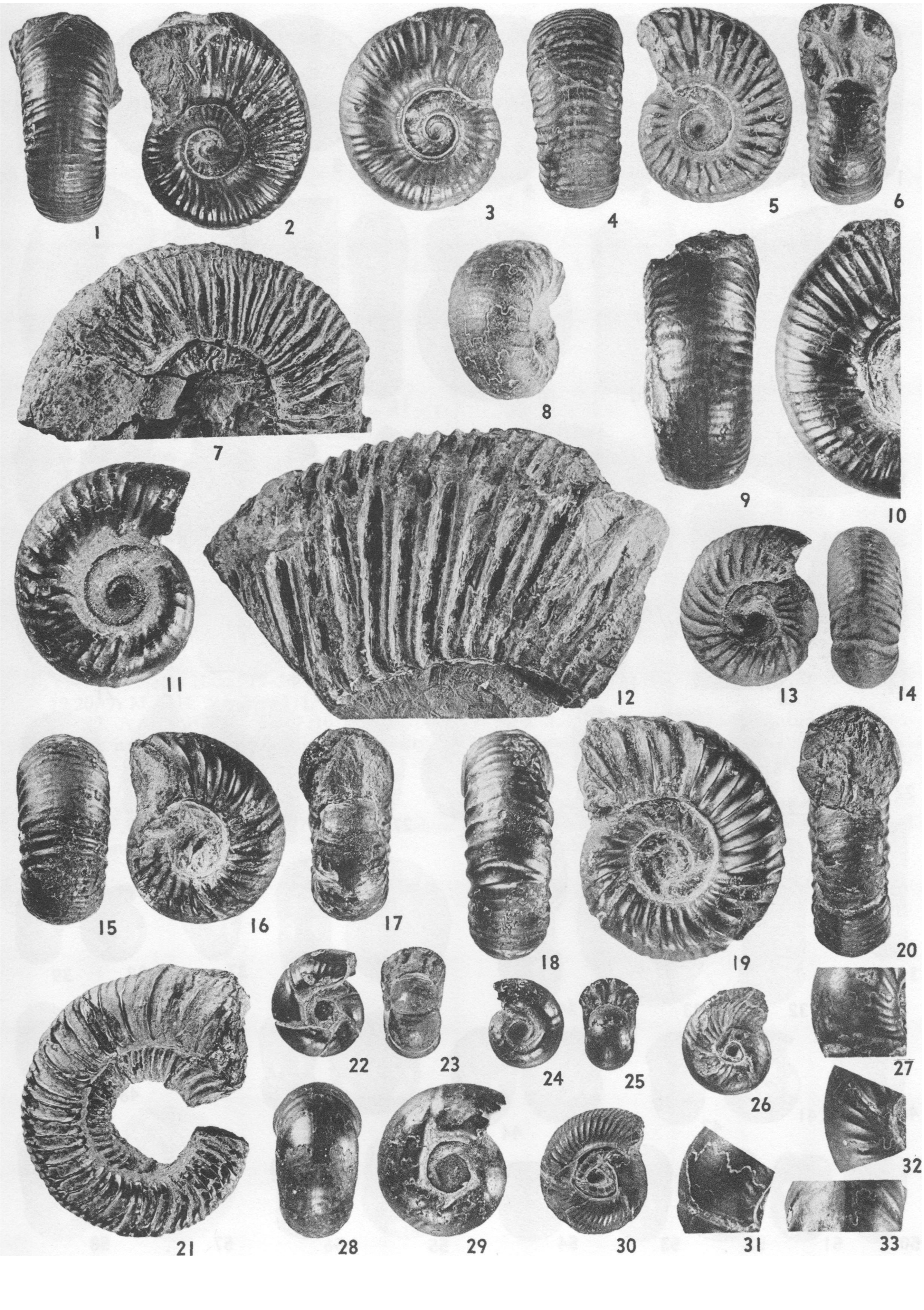
28, 29. A.M.N.H. No. 27836:58, ×5, to show suture lines.

30. A.M.N.H. No. 27836:57, ×2; note triangular umbilicus.

31. A.M.N.H. No. 27836:54, ×5, detail, to show last suture line.

32, 33. A.M.N.H. No. 27836:52, ×5, details; to show two last suture lines.

The Perisphinctidae, *Perisphinctes* (*Properisphinctes*), and *P.* (*P.*) *vicinus* Haas are continued on plate 20.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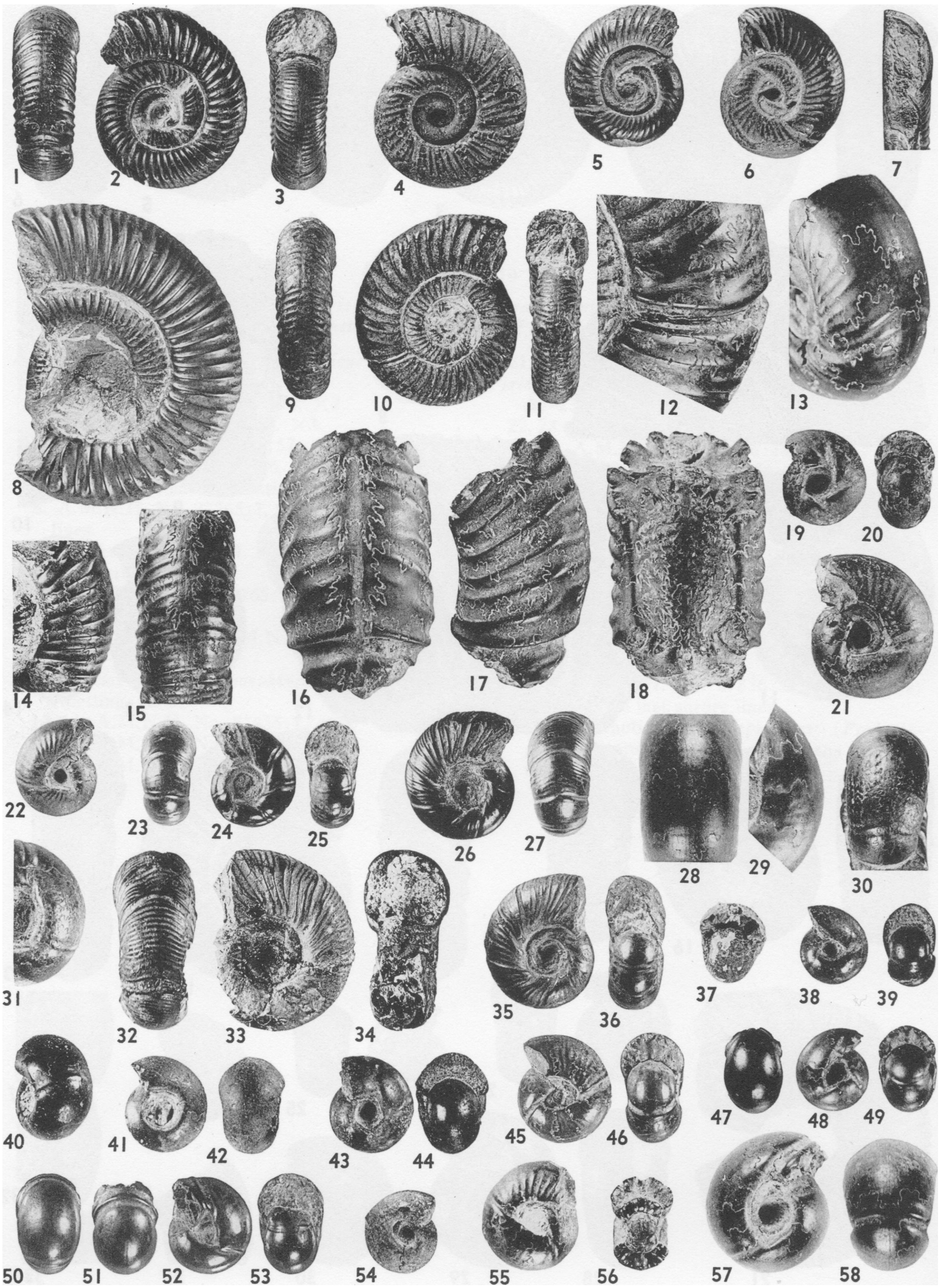


PLATE 20

PERISPHINCTIDAE (*continued*): *Perisphinctes* (*Properisphinctes*) (*continued*)

Perisphinctes (*Properisphinctes*) *vicinus* Haas (*continued*): 1–8

1–3. A.M.N.H. No. 27836:55 ×3/2; note siphonal groove in 1 and 3.

4. A.M.N.H. No. 27836:32, ×2.

5. A.M.N.H. No. 27836:45, ×2.

6. A.M.N.H. No. 27836:30, ×2.

7, 8. A.M.N.H. No. 27836:44, syntype B, ×1; 7, frontal view at anterior end, to show whorl profile.

9–12. A.M.N.H. No. 27836:42, syntype A; 9–11, ×1; note siphonal groove in 9 and 11; 12, detail, ×3, to show two suture lines about one-half of whorl from anterior end.

13. A.M.N.H. No. 27836:59, ×5, detail, to show suture lines.

14, 15. A.M.N.H. No. 27836:38, ×3, details, to show suture lines.

16–18. A.M.N.H. No. 27836:61, ×3, to show suture lines.

P. (*P.*) *filocostatus* Haas: 19–36

19,20. A.M.N.H. No. 27837:1, ×5.

21, 22. A.M.N.H. No. 27837:10; 21, ×3; 22, ×2; note triangular umbilicus, especially in 22.

23–25. A.M.N.H. No. 27837:11, ×2.

26, 27. A.M.N.H. No. 27837:12, ×2.

28, 29. A.M.N.H. No. 27837:7, ×5, to show last suture lines.

30, 31. A.M.N.H. No. 27837:13, ×3, to show last suture lines.

32–34. A.M.N.H. No. 27837:17, holotype, ×2.

35, 36. A.M.N.H. No. 27837:14, ×2.

P. (*P.*) *bernensis* de Loriol: 37–58

37. A.M.N.H. No. 27843:3, ×5.

38, 39. A.M.N.H. No. 27843:14, ×5.

40. A.M.N.H. No. 27843:7, ×5, to show suture lines.

41, 42. A.M.N.H. No. 27843:4, ×5.

43, 44. A.M.N.H. No. 27843:5, ×5; note pentagonal umbilicus in 43.

45, 46. A.M.N.H. No. 27843:63, ×2; note suture lines in both figures.

47–49. A.M.N.H. No. 27843:17, ×3; note suture lines in 47 and 48, triangular umbilicus in 48.

50–53. A.M.N.H. No. 27843:24, ×3; note ridge subdividing a constriction in 51.

54. A.M.N.H. No. 27843:18, ×3.

55. A.M.N.H. No. 27843:91, ×3; note early ribs.

56. A.M.N.H. No. 27843:92, natural cross section, ×3.

57, 58. A.M.N.H. No. 27843:94, ×5, to show early suture lines.

The Perisphinctidae, *Perisphinctes* (*Properisphinctes*), and *P* (*P.*) *bernensis* are continued on plate 21.

PLATE 21

PERISPHINCTIDAE (*continued*): *Perisphinctes* (*Properisphinctes*) (*continued*)

Perisphinctes (*Properisphinctes*) *bernensis* de Loriol (*continued*): 1–31

1. A.M.N.H. No. 27843:96, ×5, to show suture lines.
2. A.M.N.H. No. 27843:87, ×3.
3. A.M.N.H. No. 27843:89, ×3.
4. A.M.N.H. No. 27843:88, ×3.
5. A.M.N.H. No. 27843:90, ×3.

Note triangular umbilici in 2–4, subquadratic umbilicus in 5.

6, 7. A.M.N.H. No. 27843:52, ×3; note delicate costation and suture lines.

8. A.M.N.H. No. 27843:40, ×5, to show suture lines.

9–11. A.M.N.H. No. 27843:65, ×2; note suture lines.

12. A.M.N.H. No. 27843:80, ×3/2; note triangular umbilicus.

13. A.M.N.H. No. 27843:73, ×3/2; note high and sharp varix.

14. A.M.N.H. No. 27843:95, ×3, to show last suture lines.

15. A.M.N.H. No. 27843:74, ×3, to show suture lines.

16–18. A.M.N.H. No. 27843:81; 16, 18, ×3/2; 17, ×2; note suture lines in 16 and 17.

19. A.M.N.H. No. 27843:75, ×2.

20. A.M.N.H. No. 27843:57, ×3, to show last suture lines.

21. A.M.N.H. No. 27843:77, ×2.

22–24. A.M.N.H. No. 27843:84, ×1; note siphonal band in 24.

25. A.M.N.H. No. 27843:82, ×2; note suture lines.

26–29. A.M.N.H. No. 27843:85; 26, detail, whitened with ammonium chloride, ×5, to show elaborate suture lines of outer whorl; note siphonal lobes at far left; 27–29, ×1; note siphonal groove in 27.

30, 31. A.M.N.H. No. 27843:86, ×1; note siphonal band in 31.

P. (*P.*) *radiocostatus* Haas: 32–46

32, 33. A.M.N.H. No. 27841:1, ×3; in 32 note suture lines, especially "suspensive lobes."

34, 35. A.M.N.H. No. 27841:5, ×1; in 35 note fine siphonal groove.

36, 37. A.M.N.H. No. 27841:3, syntype A, ×1: note siphonal groove in 37.

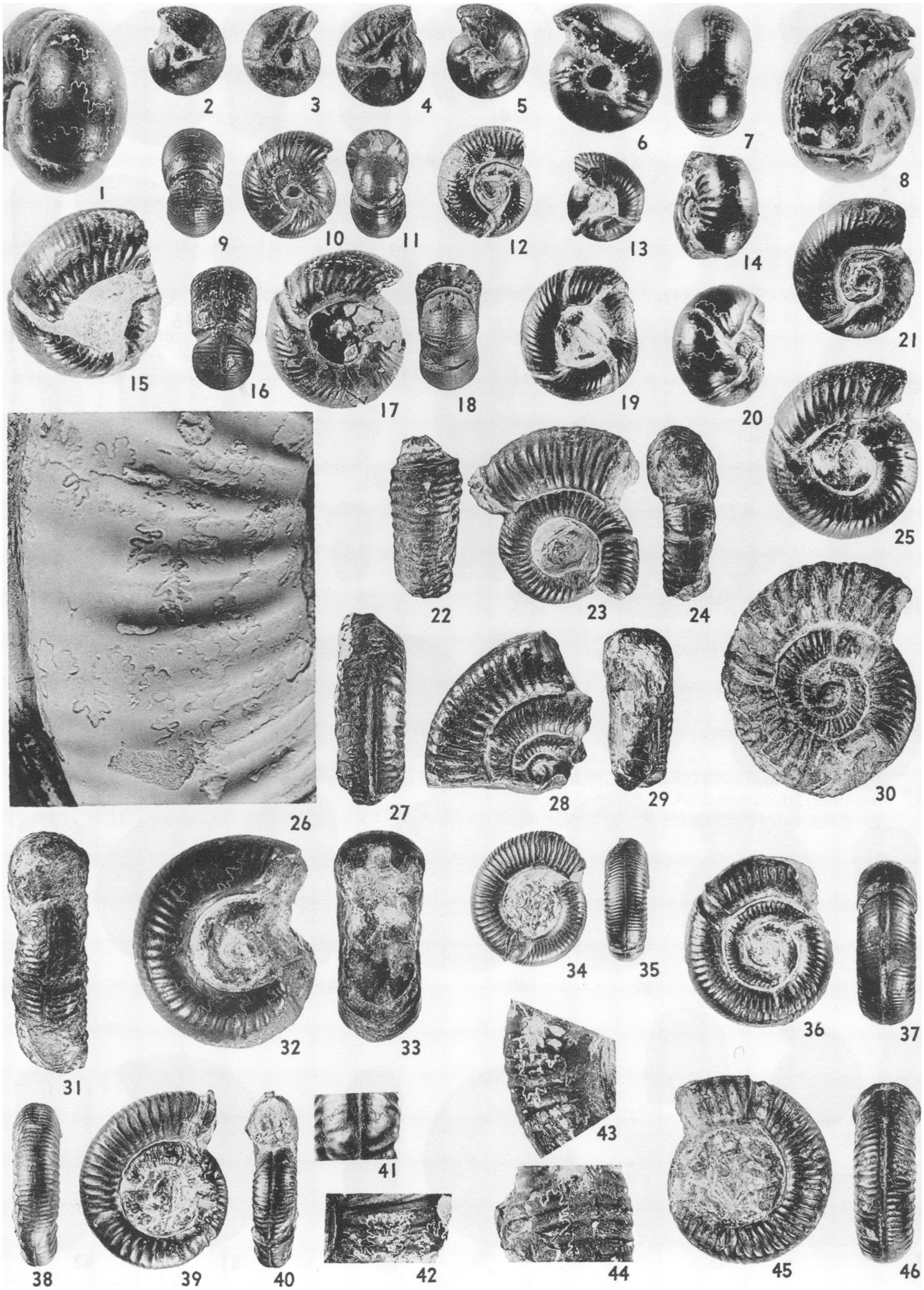
38–41. A.M.N.H. No. 27841:6, syntype B; 38–40, ×1; note siphonal groove in 40; 41, detail, ×2, to show a suture line with siphonal lobe shifted to left.

42. A.M.N.H. No. 27841:10, detail, ×1, to show elaborate last suture line.

43, 44. A.M.N.H. No. 27841:13, details, ×3, to show last suture lines; in 43 note "suspensive lobes."

45, 46. A.M.N.H. No. 27841:4, ×3/2; note siphonal groove in 46 and suture lines in both figures, especially siphonal lobes shifted to right in 46.

The Perisphinctidae and *Perisphinctes* (*Properisphinctes*) are continued on plate 22.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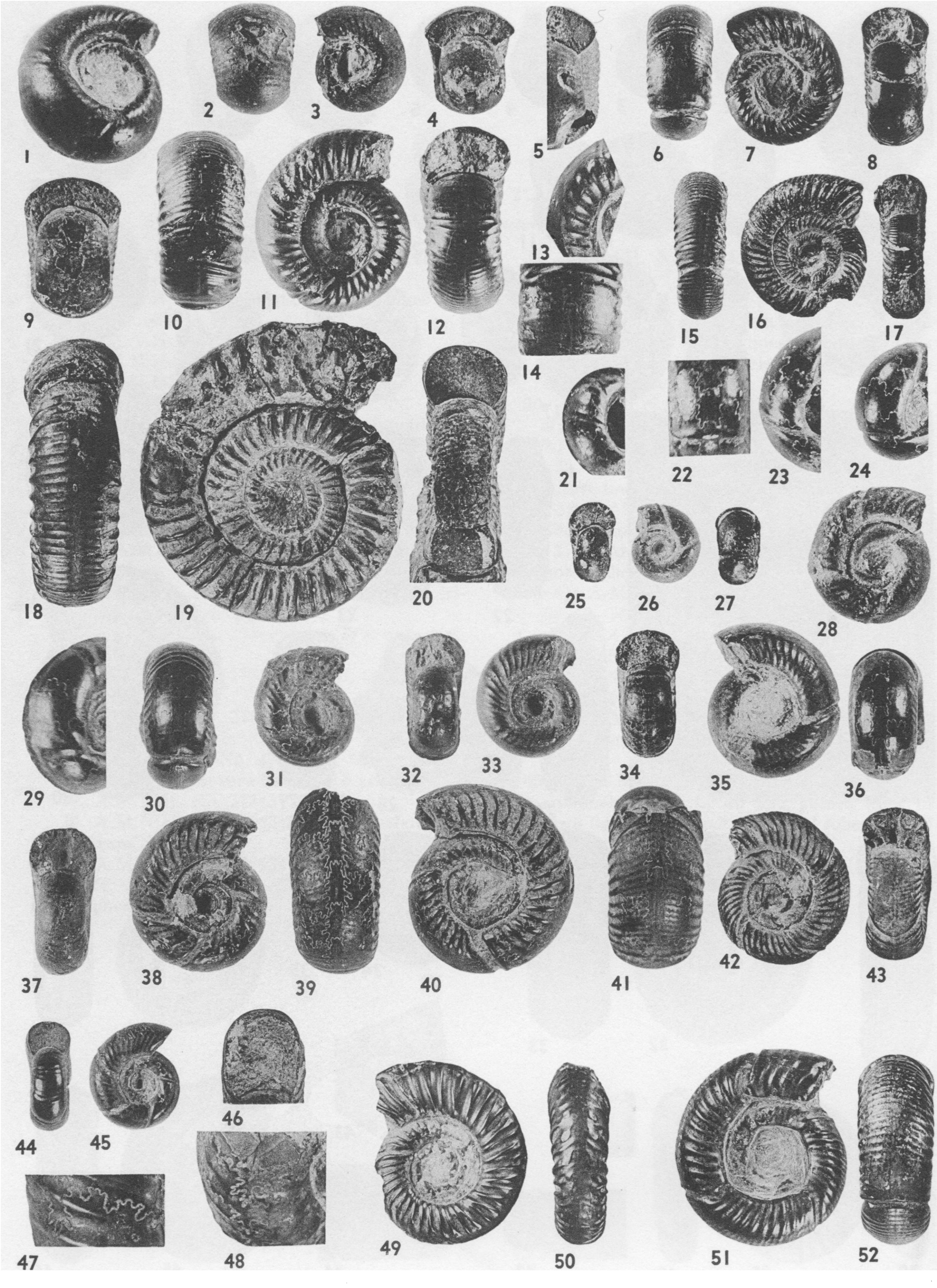
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PLATE 22

PERISPHINCTIDAE (*continued*): *Perisphinctes* (*Properisphinctes*) (*continued*)

Perisphinctes (*Properisphinctes*) *trapezoidalis* Haas: 1–20

1. A.M.N.H. No. 27840:3, ×5, to show early suture lines.

2–4. A.M.N.H. No. 27840:4, syntype A, ×3.

5. A.M.N.H. No. 27840:10, detail, ×3, to show whorl profile.

6–8. A.M.N.H. No. 27840:12, ×2.

9. A.M.N.H. No. 27840:9, ×3.

10–14. A.M.N.H. No. 27840:13; 10–12, ×2; note fine siphonal groove in 10 and 12; 13, 14, details, ×3, to show last suture lines.

15–17. A.M.N.H. No. 27840:14, ×1.

18–20. A.M.N.H. No. 27840:15, syntype B, ×1; 20, natural cross section, to show profiles of penultimate and last whorls.

P. (*P.*) *latilinguatus* Noetling: 21–52.

21. A.M.N.H. No. 27839:8, detail, ×5, to show last suture lines.

22, 23. A.M.N.H. No. 27839:19, details, ×5, to show suture lines.

24. A.M.N.H. No. 27839:16, detail, ×5, to show suture lines.

25–27. A.M.N.H. No. 27839:6, ×3; note constrictions and suture lines in 26.

28. A.M.N.H. No. 27839:2, ×3; note constrictions.

29. A.M.N.H. No. 27839:21, detail, ×3, to show suture lines.

30. A.M.N.H. No. 27839:17, ×3, to show suture lines on venter.

31. A.M.N.H. No. 27839:22, note suture lines.

32, 33. A.M.N.H. No. 27839:25, ×3.

34. A.M.N.H. No. 27839:28, ×3; note suture lines.

35, 36. A.M.N.H. No. 27839:40, ×3; note suture lines.

37. A.M.N.H. No. 27839:34, ×3.

38. A.M.N.H. No. 27839:42, ×3; note suture lines.

39. A.M.N.H. No. 27839:58, ×3, to show elaborate suture lines.

40. A.M.N.H. No. 27839:61, ×3; note suture lines.

41–43. A.M.N.H. No. 27839:64, 41; ×3, to show suture lines on venter; 42, 43, ×2.

44, 45. A.M.N.H. No. 27839:41, ×2.

46. A.M.N.H. No. 27839:76, detail, ×2, to show whorl profile at anterior end.

47. A.M.N.H. No. 27839:100, detail, ×3, to show last suture line.

48. A.M.N.H. No. 27839:73, detail, ×3, to show elaborate last suture lines.

49, 50. A.M.N.H. No. 27839:67, ×2; note, in 50, trapezoidal tongues.

51, 52. A.M.N.H. No. 27839:97, ×2.

The Perisphinctidae, *Perisphinctes* (*Properisphinctes*), and *P.* (*P.*) *latilinguatus* are continued on plate 23.

PLATE 23

PERISPHINCTIDAE (*continued*): *Perisphinctes* (*Properisphinctes*) (*continued*)

Perisphinctes (*Properisphinctes*) *latilinguatus* Noetling (*continued*): 1–15

1, 2. A.M.N.H. No. 27839:69, ×3/2; note siphonal groove in 1, suture lines in both.

3, 4. A.M.N.H. No. 27839:70, ×1; note siphonal groove and parabolic nodes in 3.

5. A.M.N.H. No. 27839:83, ×1; note triangular umbilicus.

6, 7. A.M.N.H. No. 27839:74, ×1; note parabolic nodes in 6.

8, 9. A.M.N.H. No. 27839:75, ×1, note two consecutive pairs of parabolic nodes in 9.

10, 11. A.M.N.H. No. 27839:81, ×1; 10, natural cross section.

12. A.M.N.H. No. 27839:79, ×1.

13, 14. A.M.N.H. No. 27839:80; 13, ×1; 14, detail, ×2, to show last seven suture lines.

15. A.M.N.H. No. 27839:68, detail, ×3, to show suture lines.

P. (*P.*) *hermonis* Haas: 16–42.

16, 17. A.M.N.H. No. 27838:3; 16, ×3; note deep and wide constriction; 17, detail, ×5, to show last suture line.

18. A.M.N.H. No. 27838:20, detail, ×5, to show last suture lines.

19, 20. A.M.N.H. No. 27838:17, details, ×5, to show last two suture lines.

21. A.M.N.H. No. 27838:23, ×3.

22. A.M.N.H. No. 27838:14, ×3.

23. A.M.N.H. No. 27838:40, ×3, to show suture lines.

24–26. A.M.N.H. No. 27838:8, ×3.

27. A.M.N.H. No. 27838:35, ×2, to show constrictions and costation.

28. A.M.N.H. No. 27838:49, natural cross section, ×3.

29. A.M.N.H. No. 27838:33, ×3, to show suture lines.

30–32. A.M.N.H. No. 27838:24, ×3; note deep constrictions and, in 32, varix beneath constriction.

33. A.M.N.H. No. 27838:39, ×3.

34, 35. A.M.N.H. No. 27838:28, ×3; 34, detail, to show penultimate suture line on venter.

36. A.M.N.H. No. 27838:50, natural cross section, ×3.

37–40. A.M.N.H. No. 27838:30, holotype; 37–39, ×1; 40, oblique-ventral view of last suture line visible on penultimate whorl.

41. A.M.N.H. No. 27838:31, ×2; note constrictions.

42. A.M.N.H. No. 27838:38, ×1.

P. (*P.*) *delicatulus* Haas: 43–60

43. A.M.N.H. No. 27842:8, ×3.

44. A.M.N.H. No. 27842:12, ×3.

45–47. A.M.N.H. No. 27842:22, ×3.

48. A.M.N.H. No. 27842:73, ×3, to show suture lines, especially pinched external saddles.

49, 50. A.M.N.H. No. 27842:17, ×3, to show suture lines.

51, 52. A.M.N.H. No. 27842:5, ×5, to show early suture lines.

53, 54. A.M.N.H. No. 27842:2, ×5; note early constrictions.

55. A.M.N.H. No. 27842:16, ×3, to show suture lines on venter.

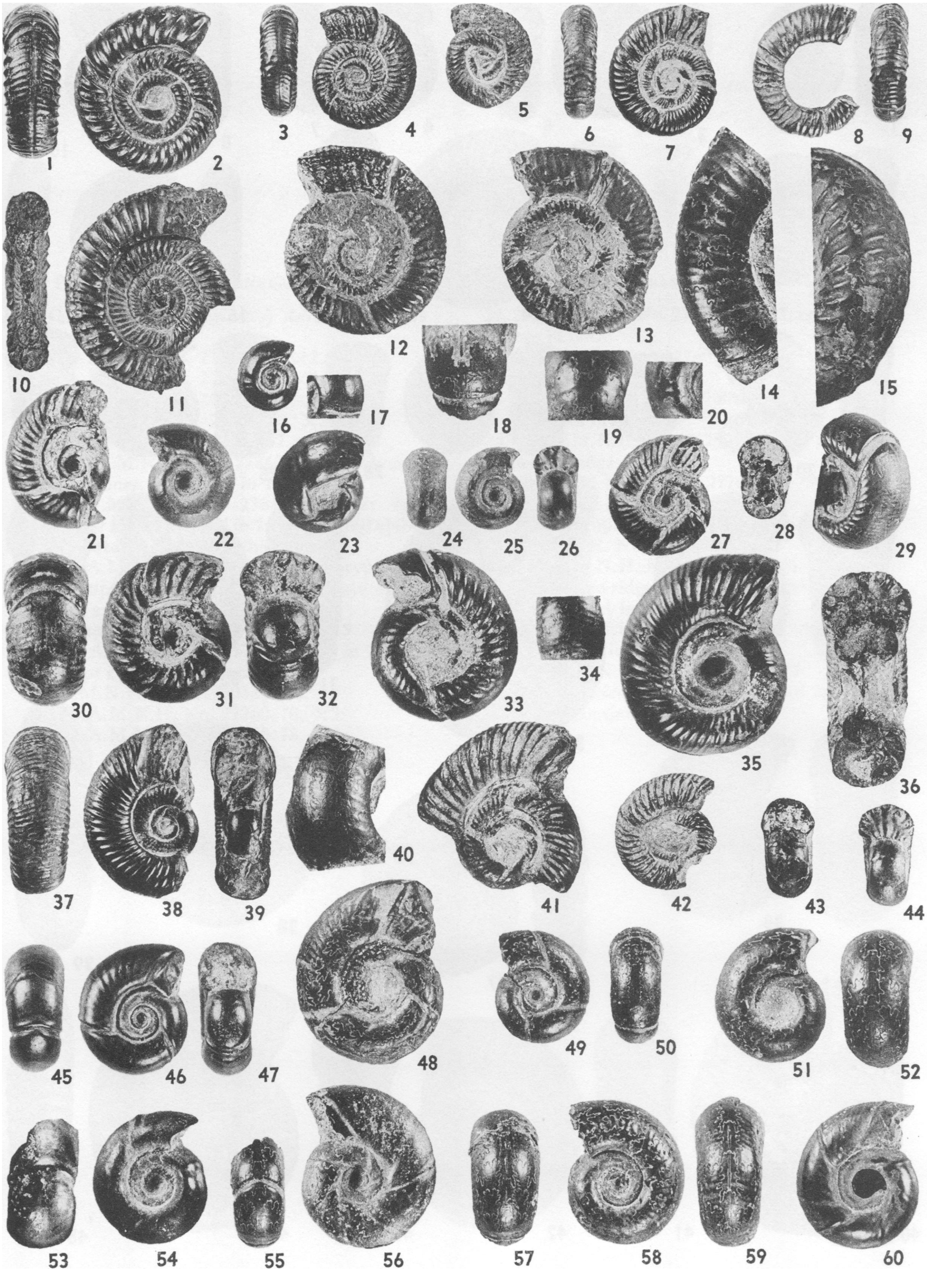
56. A.M.N.H. No. 27842:42, ×3; note seven constrictions of outer whorl.

57. A.M.N.H. No. 27842:72, ×3, to show suture lines on venter.

58, 59. A.M.N.H. No. 27842:36, ×3, to show suture lines.

60. A.M.N.H. No. 27842:38, ×3; note smoothness, and seven constrictions on outer whorl.

The Perisphinctidae, *Perisphinctes* (*Properisphinctes*), and *P.* (*P.*) *delicatulus* are continued on plate 24.



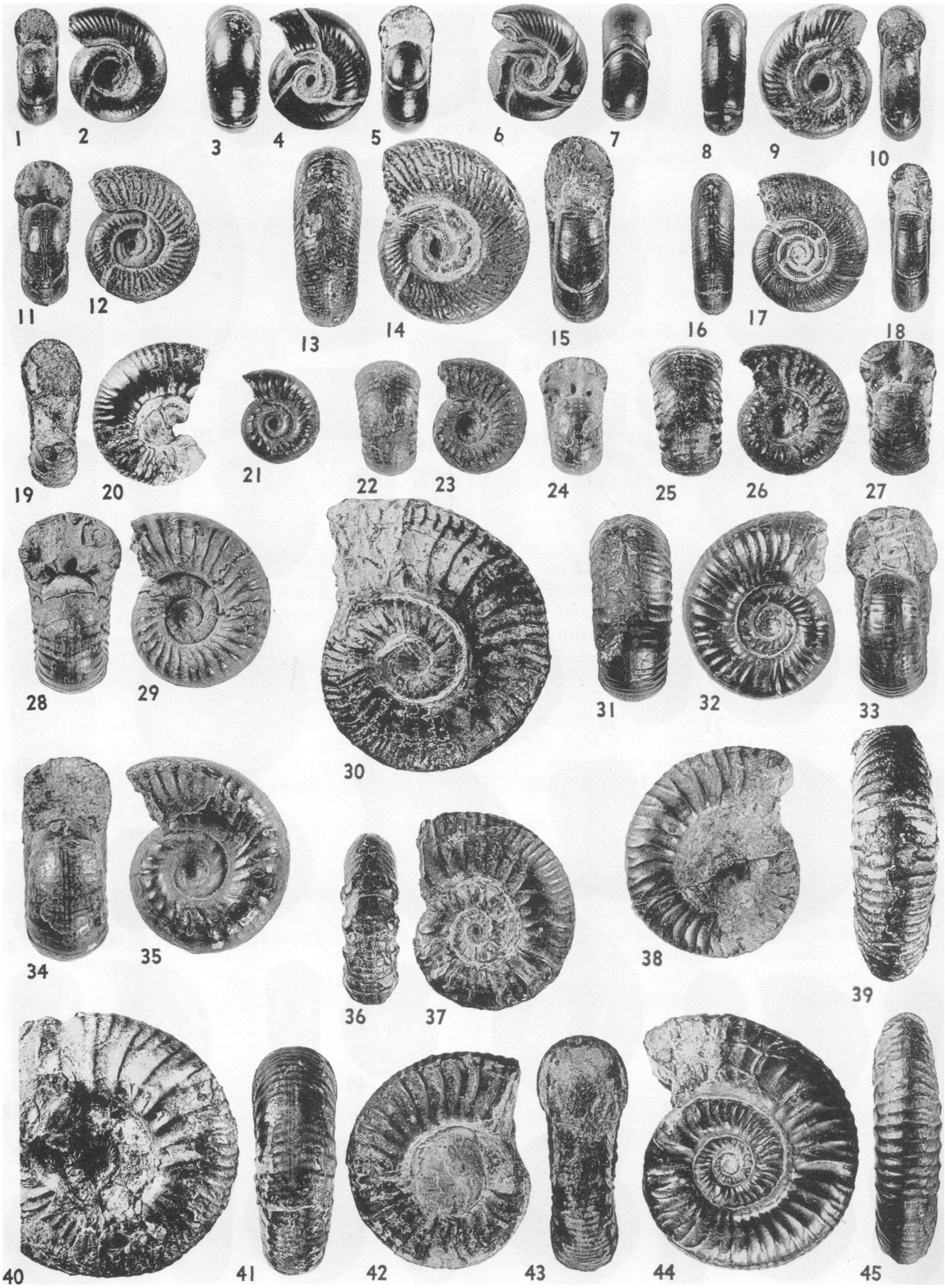

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PLATE 24

PERISPHINCTIDAE (*continued*): *Perisphinctes* (*Properisphinctes*) (*continued*), *Mirosphinctes*

Perisphinctes (*Properisphinctes*) *delicatulus* Haas (*continued*): 1–18

1, 2. A.M.N.H. No. 27842:43, ×2.

3–5. A.M.N.H. No. 27842:48, ×2.

6, 7. A.M.N.H. No. 27842:47, ×2.

8–10. A.M.N.H. No. 27842:53, ×2.

Note deep constrictions in 4–7 and 9.

11, 12. A.M.N.H. No. 27842:59, ×3/2; note suture lines, especially in 11.

13–15. A.M.N.H. No. 27842:61, ×2; note shallow siphonal band in 13 and 15 and elaborate suture lines in all three.

16–18. A.M.N.H. No. 27842:63, holotype, ×1; note siphonal band in 16 and 18, suture lines in 16 and 17.

Mirosphinctes syriacus (Noetling): 19–45

19, 20. A.M.N.H. No. 27760:6, ×1; in 20 note abrupt change in costation.

21. A.M.N.H. No. 27760:2., ×3.

22–24. A.M.N.H. No. 27760:70, ×3.

25–27. A.M.N.H. No. 27760:78, ×3.

28, 29. A.M.N.H. No. 27760:90, ×3; note suture lines in both.

30. A.M.N.H. No. 27760:59, ×1; note last suture lines.

31–33. A.M.N.H. No. 27760:69, ×2; note suture lines in all three.

34, 35. A.M.N.H. No. 27760:91, ×3; note five median ridges in 34.

36, 37. A.M.N.H. No. 27760:60, ×1; note strong parabolic nodes and last suture lines in 36, abrupt change in costation in 37.

38. A.M.N.H. No. 27760:62, ×1.

39, 40. A.M.N.H. No. 27760:67, ×1; note delicate median ridge in 39, deep constriction near anterior end in 40.

41–43. A.M.N.H. No. 27760:63, ×1; note suture lines in 42.

44, 45. A.M.N.H. No. 27760:65, ×1.

The *Perisphinctidae*, *Mirosphinctes*, and *M. syriacus* are continued on plate 25.

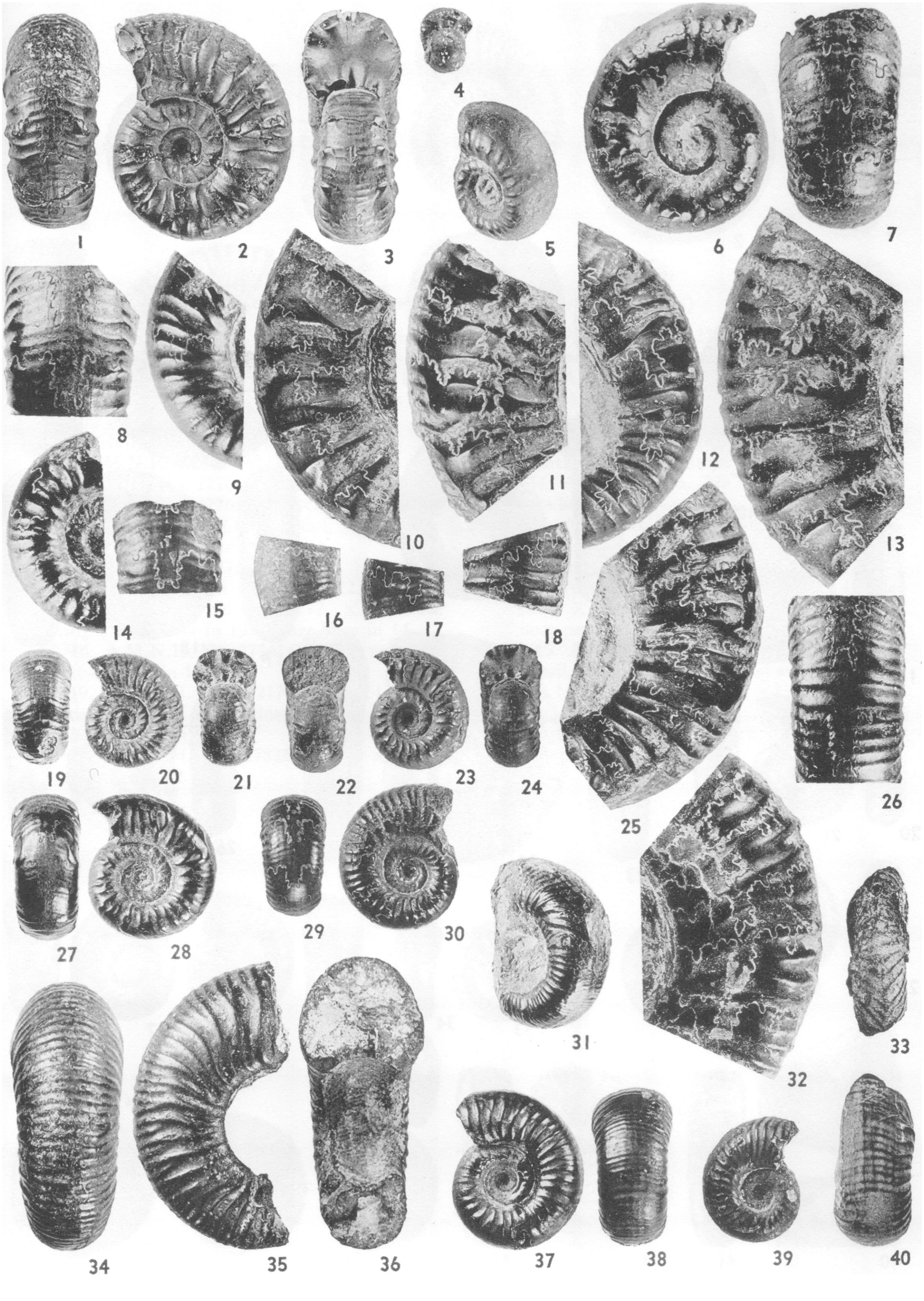
PLATE 25

PERISPHINCTIDAE (*continued*): *Mirosphinctes* (*continued*)

Mirosphinctes syriacus (Noetling) (*continued*): 1–13
- 1–4. A.M.N.H. No. 27760:37; 1–3, ×2; note suture lines in all three; 4, innermost whorls, ×10.
- 5. A.M.N.H. No. 27760:1, ×5, to show early suture lines.
- 6, 7. A.M.N.H. No. 27760:82, ×5.
- 8, 9. A.M.N.H. No. 27760:88, details, ×5.
- 10. A.M.N.H. No. 27760:97, detail, ×3.
- 11. A.M.N.H. No. 27760:41, detail, ×3.
- 12. A.M.N.H. No. 27760:4, detail, ×3.
- 13. A.M.N.H. No. 27760:56, detail, ×3.
- 6–13 to show suture lines.

M. regularis (Noetling): 14–40
- 14, 15. A.M.N.H. No. 27761:26, details, ×5.
- 16. A.M.N.H. No. 27761:4, detail, ×5.
- 17. A.M.N.H. No. 27761:65, detail, ×3.
- 18. A.M.N.H. No. 27761:151, detail, ×3.
- 14–18 to show suture lines.
- 19–21. A.M.N.H. No. 27761:19, ×3.
- 22. A.M.N.H. No. 27761:28, ×3.
- 23, 24. A.M.N.H. No. 27761:29, ×3; note suture lines in 23.
- 25. A.M.N.H. No. 27761:85, detail, ×3, to show suture lines.
- 26. A.M.N.H. No. 27761:71, detail, ×3, to show suture lines on venter.
- 27, 28. A.M.N.H. No. 27761:39, a specimen transitional in ornamentation to *Aspidoceras* (*Euaspidoceras*) *perisphinctoides*, ×3; note parabolic nodes in 27.
- 29, 30. A.M.N.H. No. 27761:43, ×3; note suture lines in both.
- 31. A.M.N.H. No. 27761:148, ×2, to show costation disturbed by a lesion of the shell.
- 32. A.M.N.H. No. 27761:152, ×3, to show last suture lines.
- 33. A.M.N.H. No. 27761:150, ×1; note disturbed costation on venter.
- 34–36. A.M.N.H. No. 27761:79, considered the specimen most characteristic of this species, ×2.
- 37, 38. A.M.N.H. No. 27761:117, ×3.
- 39. A.M.N.H. No. 27761:107, ×3.
- 40. A.M.N.H. No. 27761:121, ×3; note ridges on venter.

The Perisphinctidae, *Mirosphinctes*, and *M. regularis* are continued on plate 26.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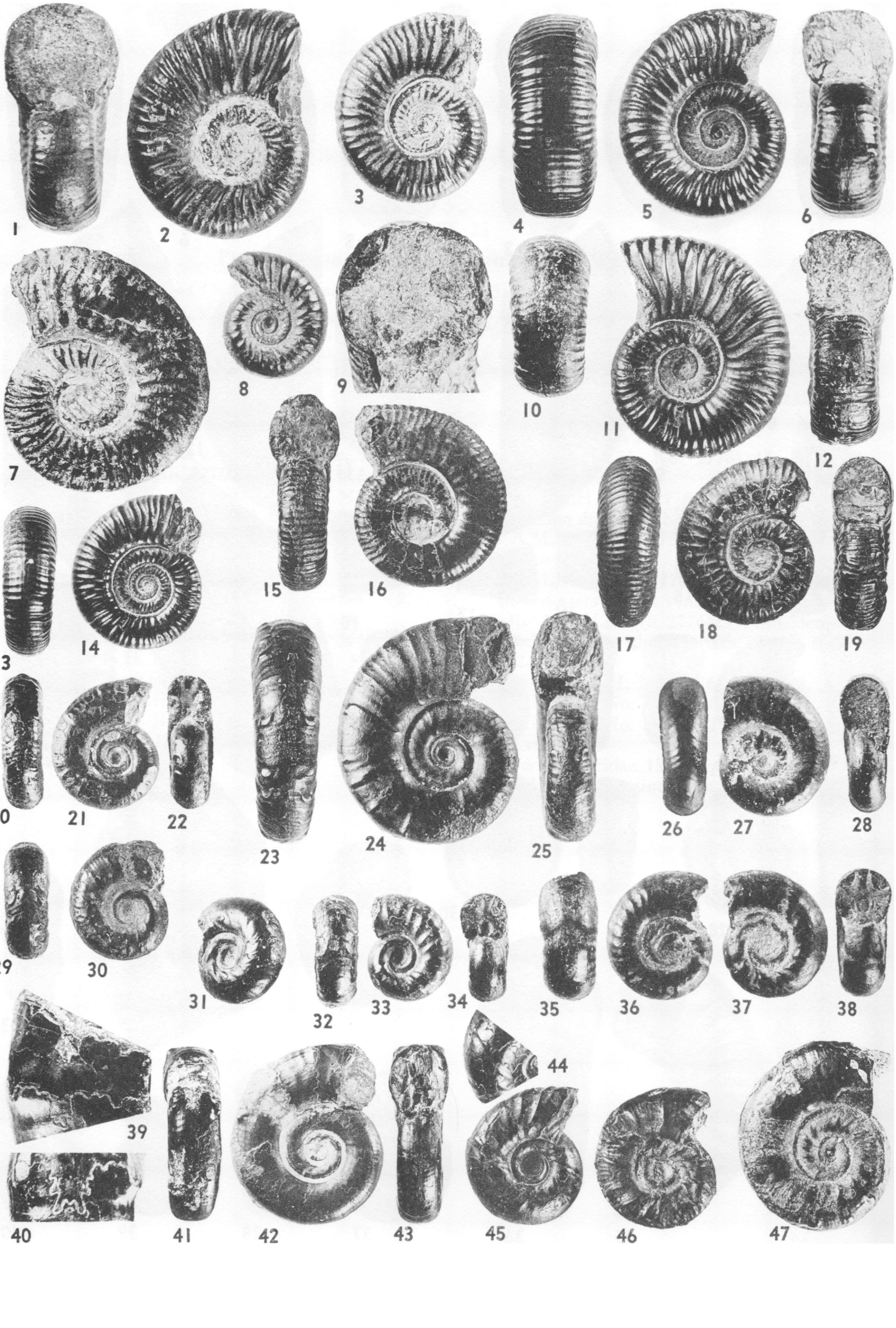
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PLATE 26

PERISPHINCTIDAE (*continued*): *Mirosphinctes* (*continued*)

Mirosphinctes regularis (Noetling) (*continued*): 1–19

1, 2. A.M.N.H. No. 27761:93, ×3; note, in 2, secondary bifurcation of fifth rib from anterior end.

3. A.M.N.H. No. 27761:96, ×2.

4–6. A.M.N.H. No. 27761:133, ×3.

7. A.M.N.H. No. 27761:87, ×1.

8. A.M.N.H. No. 27761:106, ×3.

9. A.M.N.H. No. 27761:98, detail, ×3, to show whorl section at anterior end.

10. A.M.N.H. No. 27761:125, ×3.

11, 12. A.M.N.H. No. 27761:97, ×2.

13, 14. A.M.N.H. No. 27761:72, ×3/2; note ridges on venter in 13, suture lines in 14.

15, 16. A.M.N.H. No. 27761:86, ×1; note last suture lines in 16.

17–19. A.M.N.H. No. 27761:89, ×1; note "commas" and suture lines in 18.

M. kobyi (de Loriol): 20–47

20–22. A.M.N.H. No. 27826:4, ×3; note suture lines in 21.

23–25. A.M.N.H. No. 27826:7, ×3; note parabolic nodes in 23 and 25, suture lines in 24.

26–28. A.M.N.H. No. 27826:1, ×5.

29, 30. A.M.N.H. No. 27826:3, ×3; note parabolic nodes in 29, fine secondary ribs in 30.

31. A.M.N.H. No 27826:8, ×3, to show ornamentation and last suture lines.

32–34. A.M.N.H. No. 27826:2, ×3; note suture lines in 33.

35–38. A.M.N.H. No. 27826:9, ×3; note contrast in ornamentation between 36 and 37, last suture line in 37.

39–43. A.M.N.H. No. 27826:11; 39, 40, details, ×5, to show suture lines; 41–43, ×2; note parabolic nodes, especially in 41.

44, 45. A.M.N.H. No. 27826:10; 45, ×3; 44, detail, ×5, to show three last suture lines.

46. A.M.N.H. No. 27826:5, ×3; note secondary ribs.

47. A.M.N.H. No. 27826:6, ×3, to show ornamentation.

PLATE 27

ASPIDOCERATIDAE: *Aspidoceras* (*Euaspidoceras*)

Aspidoceras (*Euaspidoceras*) *perisphinctoides* Sintzov: 1–38

A. *Forma typica:* 1–23

1, 2. A.M.N.H. No. 27816:63, ×5.

3, 4. A.M.N.H. No. 27816:64, ×5; note suture lines, especially in 4.

5. A.M.N.H. No. 27816:6, ×3.

6–8. A.M.N.H. No. 27816:7; 6, ×3; 7 (detail), 8, ×5, to show suture lines.

9–11. A.M.N.H. No. 27816:16, ×3; note "lacets" in 10.

12. A.M.N.H. No. 27816:17, ×3; note shallowly engraved growth striae, siphuncular band, and suture lines.

13, 14. A.M.N.H. No. 27816:30, ×3; in 13 note shallowly engraved growth striae and suture lines.

15, 16. A.M.N.H. No. 27816:47, × *ca.* 3/2; note "lacets," nodes, and suture lines.

17–19. A.M.N.H. No. 27816:60, × *ca.* 3/2; note suture lines in 17 and 18.

20–21. A.M.N.H. No. 27816:59, × *ca.* 3/2; in 20 note S-shaped rib on left side, abrupt change in costation, and last suture lines.

22. A.M.N.H. No. 27816:43, × *ca.* 3/2, to show ornamentation.

23. A.M.N.H. No. 27816:34, detail, ×5, to show suture lines.

B. Var. *margaritata* Haas: 24–38

24, 25. A.M.N.H. No. 27817:1, ×3, to show ornamentation.

26, 27. A.M.N.H. No. 27817:6, ×2, to show ornamentation.

28. A.M.N.H. No. 27817:3, ×2.

29, 30. A.M.N.H. No. 27817:4, ×2, to show ornamentation.

31–33. A.M.N.H. No. 27817:18, holotype, ×2; note "lacets" and nodes.

34, 35. A.M.N.H. No. 27817:17, ×2, to show ornamentation.

36. A.M.N.H. No. 27817:21, ×3, to show ornamentation.

37, 38. A.M.N.H. No. 27817:20, ×2; note circumumbilical tubercles in 38, suture lines in both.

Note beads on lateroventral shoulders in 25–32, 34–38.

A. (*E.*) *subbabeanum* Sintzov

A. *Forma typica:* 39–46

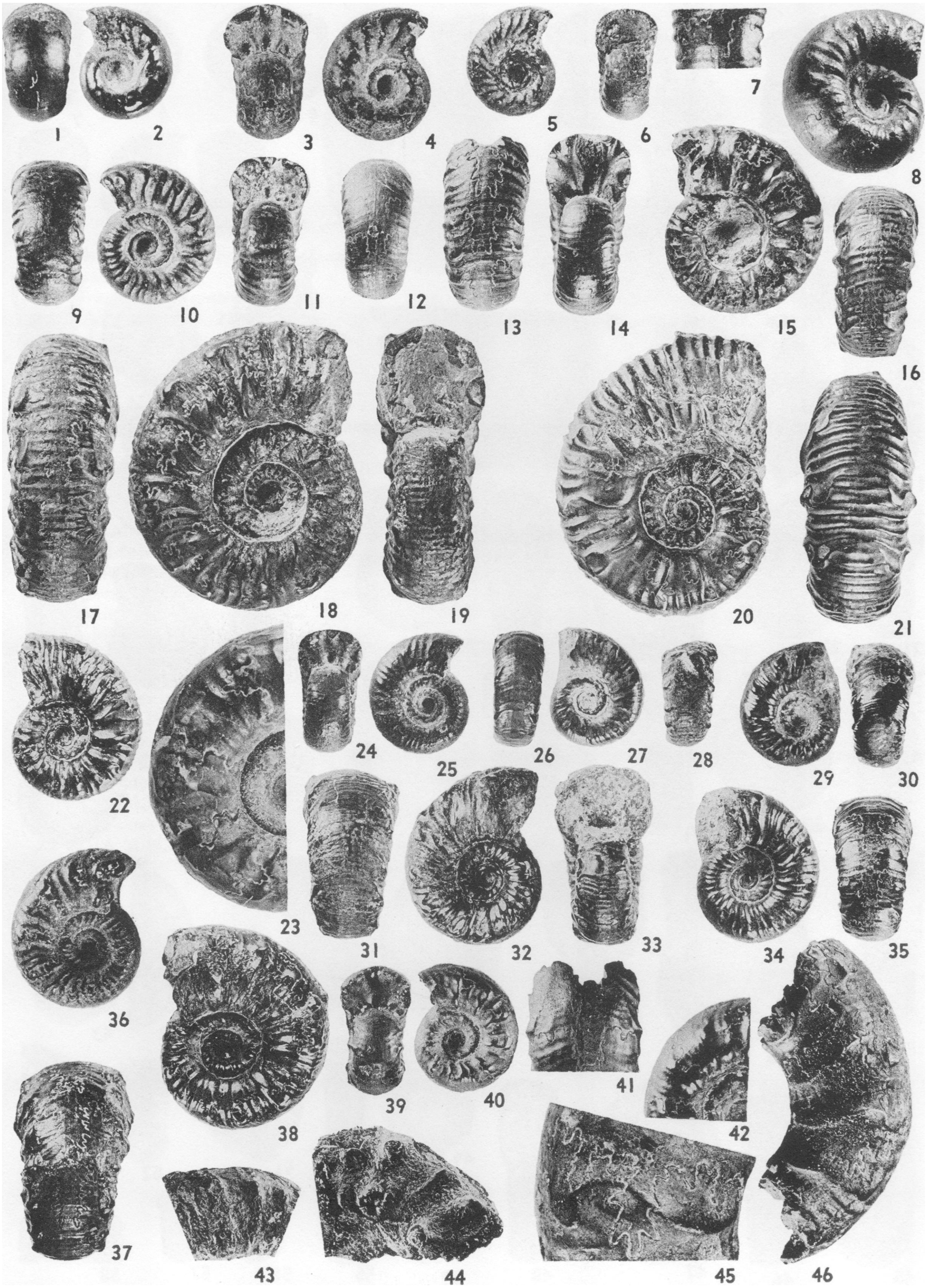
39–42. A.M.N.H. No. 27820:1; 39, 40, ×3; 41, 42, details, ×5, to show suture lines.

43. Detail of fragment A.M.N.H. No. 27820:13, ×1, to show ribs and nodes.

44. Detail of fragment A.M.N.H. No. 27820:14, ×1, to show ribs and nodes.

45, 46. A.M.N.H. No. 27820:10; 45, detail, ×5, to show a suture line; 46, ×3.

The Aspidoceratidae, *Aspidoceras* (*Euaspidoceras*), and *A.* (*E.*) *subbabeanum*, *forma typica*, are continued on plate 28.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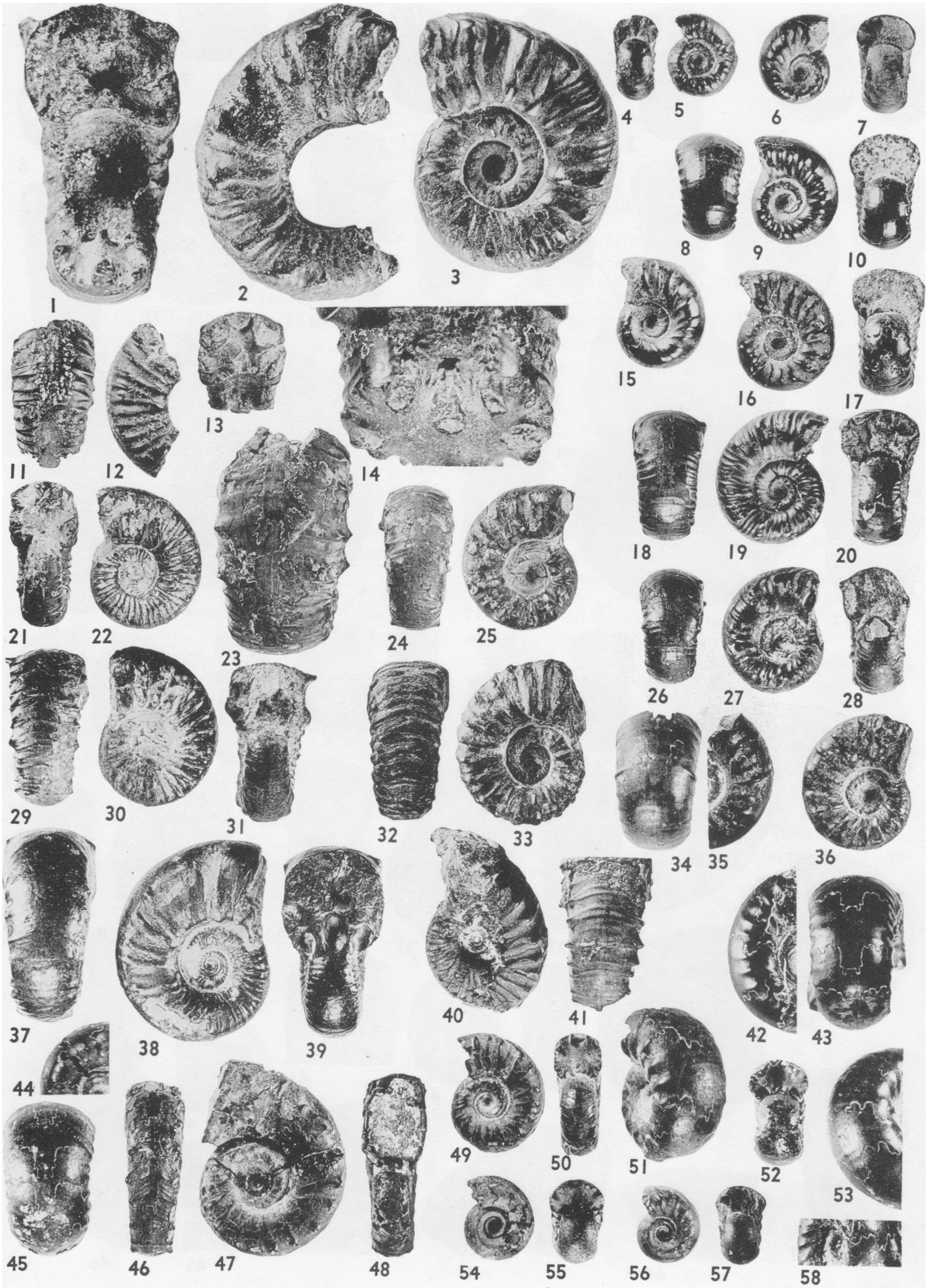
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PLATE 28

ASPIDOCERATIDAE (*continued*): *Aspidoceras* (*Euaspidoceras*) (*continued*)

Aspidoceras (*Euaspidoceras*) *subbabeanum* Sintzov (*continued*): 1–3

A. *Forma typica* (*continued*): 1, 2

1, 2. A.M.N.H. No. 27820:5, ×3.

B. Var. *emaciata* Haas: 3

3. A.M.N.H. No. 27821:1, ×3.

A. (*E.*) *subcostatum* Spath: 4–45

4, 5. A.M.N.H. No. 27818:4, ×3.

6. A.M.N.H. No. 27818:13, ×3; note suture lines in first quarter of outer whorl.

Note spiral ridges connecting the tubercles in 5 and 6.

7. A.M.N.H. No. 27818:22, ×3.

8–10. A.M.N.H. No. 27818:27, ×3; note incipient tubercles in 8.

11–14. A.M.N.H. No. 27818:70; 11–13, ×1; 13, section at anterior end; 14, detail, ×3, to show internal suture line.

15. A.M.N.H. No. 27818:29, ×3.

16, 17. A.M.N.H. No. 27818:39, ×3.

18–20. A.M.N.H. No. 27818:50, ×2; note suture lines in 18 and 19.

21–23. A.M.N.H. No. 27818:68; 21, 22, ×1; 23, ×2, to show suture lines on venter.

24, 25. A.M.N.H. No. 27818:71, ×1; note suture lines, especially in 24.

26–28. A.M.N.H. No. 27818:49, ×2; note suture lines in all three.

29–31. A.M.N.H. No. 27818:72, ×1.

32, 33. A.M.N H. No. 27818:73, ×1.

34, 35 (detail). A.M.N.H. No. 27818:11, ×5, to show suture lines.

36. A.M.N.H. No. 27818:67, ×1.

37–39. A.M.N.H. No. 27818:75, ×1; note hornlets in 37 and 39.

40, 41. A.M.N.H. No. 27818:74 (crushed), ×1.

42 (detail), 43. A.M.N.H. No. 27818:30, ×5, to show suture lines.

44 (detail), 45. A.M.N.H. No. 27818:16, ×5, to show suture lines.

A. (*E.*) *douvillei* Collot: 46–50

46–48. A.M.N.H. No. 27822:2, ×2; note suture lines in 46 and 47.

49, 50. A.M.N.H. No. 27822:1, ×3; note suture lines, especially in 49.

A. (*E.*) *hermonis* Haas: 50–58

51. A.M.N.H. No. 27823:7, ×5, to show suture lines.

52. A.M.N.H. No. 27823:12, ×3.

53. A.M.N.H. No. 27823:28, ×5, to show suture lines.

54, 55. A.M.N.H. No. 27823:50, ×5.

56, 57. A.M.N.H. No. 27823:2, ×3.

58. A.M.N.H. No. 27823:4, detail, ×5, to show a suture line.

The Aspidoceratidae, *Aspidoceras* (*Euaspidoceras*), and *A.* (*E.*) *hermonis* are continued on plate 29.

PLATE 29

ASPIDOCERATIDAE (*continued*): *Aspidoceras* (*Euaspidoceras*) (*continued*)

Aspidoceras (*Euaspidoceras*) *hermonis* Haas (*continued*): 1–16

1, 2. A.M.N.H. No. 27823:38, ×2, note suture lines in 2.

3. A.M.N.H. No. 27823:37, ×3.

4–6. A.M.N.H. No. 27823:11, ×3.

7, 8. A.M.N.H. No. 27823:46, ×1; note tubercles encrusted with matrix in 7, suture lines in 8.

9, 10. A.M.N.H. No. 27823:27, ×3.

11. A.M.N.H. No. 27823:45, ×1; note two horn-like tubercles.

12, 13. A.M.N.H. No. 27823:42, ×3/2; note suture lines in both, old apertural margins in 13.

14. A.M.N.H. No. 27823:47, ×1.

15. A.M.N.H. No. 27823:34, ×3; note suture lines.

16. A.M.N.H. No. 27823:43, ×1.

A. (*E.*) *lyra* Spath: 17–31

17. A.M.N.H. No. 27824:2, ×3.

18, 19. A.M.N.H. No. 27824:9, ×3.

20, 21. A.M.N.H. No. 27824:11, ×3; note lyre shape of 20.

22. A.M.N.H. No. 27824:12, ×3.

23. A.M.N.H. No. 27824:1, ×5, to show early suture lines.

24. A.M.N.H. No. 27824:13, ×5, to show early suture lines.

25. A.M.N.H. No. 27824:29, whorl section at anterior end, ×2.

26. A.M.N.H. No. 27824:25, ×2.

27. A.M.N.H. No. 27824:28, ×2.

28–30. A.M.N.H. No. 27824:20, ×3; note suture lines in 29 and 30.

31. A.M.N.H. No. 27824:32, detail, ×3, to show elaborate suture lines on venter.

The Aspidoceratidae, *Aspidoceras* (*Euaspidoceras*), and *A.* (*E.*) *lyra* are continued on plate 30.


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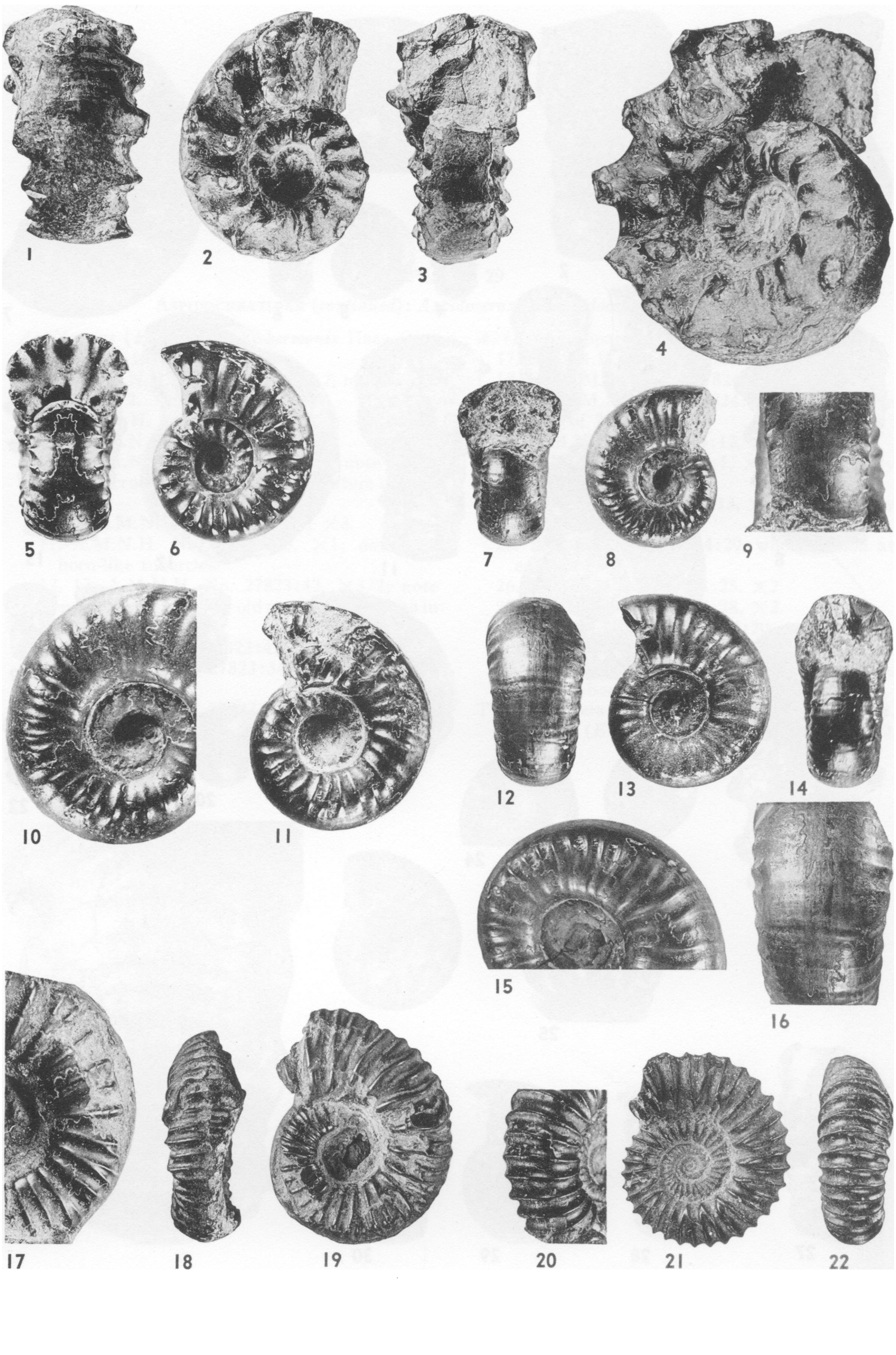
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PLATE 30

ASPIDOCERATIDAE (*continued*): *Aspidoceras* (*Euaspidoceras*) (*continued*), *Peltoceras* (*Peltoceratoides*), *Peltoceras* (*Parapeltoceras*)

Aspidoceras (*Euaspidoceras*) *lyra* Spath (*continued*): 1–4

1–4. A.M.N.H. No. 27824:31; 1–3, ×1; 4, ×3/2, to show strong tubercles and last suture lines.

A. (?*E.*) *rotundatum* Haas: 5–16

5, 6. A.M.N.H. No. 27825:6, ×3; note suture lines.

7–10. A.M.N.H. No. 27825:10, a specimen transitional to *A.* (*E.*) *subcostatum*; 7, 8, ×3; note suture lines, especially in 8; 9 (detail), 10, ×5, to show suture lines better.

11. A.M.N.H. No. 27825:9, ×2; note suture lines.

12–16. A.M.N.H. No. 27825:8, holotype; 12–14, ×2; 15, 16, details, ×3, to show suture lines better.

P. (*Peltoceratoides*) cf. *arduennense* (d'Orbigny): 17–19

17–19. A.M.N.H. No. 27834:1; 17, detail, ×3, to show suture lines; 18, 19, ×3/2.

P. (*Parapeltoceras*) *annulare* (Reinecke *in* Quenstedt): 20–22

20–22. A.M.N.H. No. 27833; 20, detail, ×5, to show suture lines; 21, 22, ×3.