Article VIII. — DIVISIONS OF THE PARIETAL BONE IN MAN AND OTHER MAMMALS.

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I. General Remarks.

The subject of divisions of the parietal bone was for the first time brought to the attention of anatomists in 1753, when Tarin, in his 'Osteographie,' described a human skull, given to him by Winslow, in which the left parietal bone was divided into two by a horizontal suture. Since Tarin, observations on parietal divisions have slowly multiplied until the present time, and the literature of the subject has grown considerably in bulk as well as importance. The authors to whom we are particularly indebted for casuistic material or scientific research in this field are W. Gruber, Welcker, Hyrtl, Toldt, and Ranke; besides these authors, however, there are others who have made especially valuable reports of individual cases or contributed more or less to the elucidation of the problems arising from the observations, such as Soemmering, Calori, Putnam, Turner, Dorsey, Fusari, Coraini, and others.

With increase in the number of observations of parietal divisions the subject extended to all stages of life in man, from adults to fœtuses and embryos. Eventually the anomaly was also found in apes and certain monkeys; no case, however, has thus far been signalled in any lower mammals than

monkeys. There are on record, considering only the complete antero-posterior divisions, 9 such cases in human embryos, fœtuses, and children, and 18 in human adolescents and adults; and of different complete divisions 2 instances in apes and 4 in monkeys.

As the material augmented there became apparent an increasing diversity in the nature of the parietal divisions. In Tarin's case the anomalous suture was complete and ran between the anterior and posterior borders of the bone in a nearly *horizontal* direction, or nearly parallel with the sagittal suture. A number of sutures of the same class was reported subsequently; but there appeared also records of divisions running *obliquely* between the anterior and posterior borders; obliquely between the posterior and *inferior* borders; and *vertically* between the superior and inferior borders of the parietal. In addition there were described in the course of time a few angular sutures, which look like combinations of vertical and horizontal, or vertical and oblique divisions. A certain amount of attention was further given to incomplete sutures and the fœtal, apparently normal, fissures in the parietal.

While the observations on divisions of the parietal bone multiplied, no serious efforts to explain the anomaly were made before the latter part of the 19th century. Soemmering, in 1826, recognized the congenital nature of the divisions, but expressed no theory as to their causation. Welcker, in 1862, was of the opinion that where the parietal bone is divided into two large portions, these portions are of a different nature from simple intercalated bones (bibl. note 17[1]; p. 109); but in 1892 (55), notwithstanding the already known work of Toldt, Welcker[2] denies the possibility of the two portions of a divided parietal developing from two centers. For Calori (1867, bibl. note 20; p. 341) the division of the parietals was the result of a separation and independent growth of a portion of the center of ossification of each bone, the separation being due to the mechanical effects and nutritive disturbance

[1] The number 17 refers to a bibliographical note at the end of the paper.
[2] Abnorme Schädelnähte, p. 21: "Von einer Entwickelung der beider Hälften des getheilten Scheitelbeinen aus zwei 'Kernen' kann wohl nicht die Rede sein."

caused by hydrocephalus. Hyrtl, in 1871 (23), misled by the occasional close relation of a horizontal or oblique parietal suture with the temporal ridge, was inclined to connect this latter with the causation of the suture. Toldt (1882–83; 48, 49) and Ranke (1899; 36) have undertaken new researches into the development of the parietal bone, and the result of these was a conclusion, arrived at by both the authors, that the parietal bone does not develop from one focus, as has been taught, but from *two* distinct centers of ossification, which ordinarily fuse early and form one, but occasionally remain separate and then give rise to a double parietal. Since Toldt's publication the theory that a double parietal center is the *original* cause of the complete antero-posterior parietal divisions has gained adherents in Putnam, Turner, Coraini, and others.

In 1896–97 Maggi, of Pavia (59, 60), announced, basing his conclusions on his own observations on human fœtuses, that the parietal bone develops from *three* centers, two of which, however, soon coalesce. In a few cases he noticed as many as four centers in the parietal. For all instances of multiple foci of ossification we find, according to Maggi, homologies among the stegocephali, batrachians, and in *Dicynodon*.

Finally, most recently (1900; 70) Frassetto, another Italian author, basing his views on some of the observations of Maggi and some old as well as new clinical material, advances the theory that the human and primate parietal develops regularly from *four* centers of ossification.

The *active* cause, or causes, which in the exceptional cases prevents the parietal centers from fusing and allows them to develop into two or more separate bones, has been touched upon only by Calori (*l. c.*) and more recently (1894) by Coraini (33), to whose views we shall return later.

II. The Published Cases of Parietal Division in Man.

Before proceeding with the series of new observations, or with individual critical considerations on the subject of parie-

tal divisions, it is essential to review with some detail the material that has already been published. In order to facilitate the task, I have collected and arranged the records in the following groups and tables. The partial and complete ANOMALOUS divisions of the human parietal bone will alone be here considered; parietal fissures in fœtal and infant bones will be treated of in a special chapter.

(*a*) *Incomplete, Anomalous Parietal Divisions in the Young.*

Hyrtl, in 1871 (23), reported, besides his other cases, one of a posteriorly incomplete division in the left parietal bone of a female fœtus before term. The division runs from a deep cleft in the middle of the anterior border of the parietal, with a slightly curved course over the eminence, ending half an inch in front of the lambdoid suture.

Ranke (36) reports numerous instances of posterior and a few of anterior parietal fissures on the skulls of 8–10-months-old fœtuses and infants; but most, if not all, of these cases belong in the category of normal divisions. The same may be said of the observations of Albinus, Gerdy, Welcker, Hamy, Augier, and Debierre (38–47).

(*b*) *Incomplete Parietal Divisions in Adults.*

Cases of this nature were reported principally by Lobstein, Broca, Welcker, Coraini, and Ranke.

In Lobstein's case (10), the left parietal of a 38-year-old white male showed a vertical division, which began in the temporal squama and ascended towards the parietal eminence. Total length of the suture, 2 inches 9 lines (7.0 cm.). No signs of any injury.

In Broca's case (38), a partial vertical suture passed into each parietal from about the point at which is located in early life the sagittal fontanel. (Allied cases are mentioned by Barkow (39), Otto (40) in Tiedemann's 'Zeitschr. f. Physiol.' (41), and by Pozzi (42).

Coraini reported a case (33) where the right parietal of a 29-year-old white male showed a superiorly incomplete

vertical division, allied somewhat in location and course to the complete vertical suture reported by Fusari (*vide* table of complete divisions).

Welcker describes briefly (55, p. 21, pl. ii, fig. 16) a case in a 50-year-old male native of New Hebrides. The skull shows on right a 1.6-, on left a 3.0-cm.-long, fairly serrated, horizontal suture running into each parietal from near the middle of its occipital border. Another skull (pl. ii, fig, 15) shows on each side a similar, 2.1-cm.-long division running forward from the middle of the lambdoid suture.

Ranke reported (36) three observations belonging to this category of cases. In one specimen the right parietal bone showed a 6.3-cm.-long horizontal suture in about the middle of its posterior portion. In the second case a similar peculiarity existed on both sides. The divisions started in about the middle of the posterior border of each parietal; it was 2.0 cm. long on the right, 1.5 cm. on the left side. The third skull showed a 5.8-cm.-long remnant of a horizontal suture running from the middle of its posterior border into the right parietal. All the three crania belonged to the old Bavarian population.

Total of incomplete parietal divisions (individual) in the young and adults (including only Broca's case of the sagittal vertical ones), 13; of which 4 horizontal were in the anterior and 5 horizontal ones in the posterior portion, 2 vertical in the superior and 2 vertical ones in the inferior portion of the parietal.

(*c*) *Complete Parietal Divisions.*

In order to present these cases with more advantage, I have arranged them into the annexed tables A and B.

Besides all the above there are in literature descriptions or mention of cases which cannot well be classified, or whose nature is doubtful. Due to the scarcity of the publications referred to, I was able to examine directly only Jung's and Gruber's communications.

Young.—Jung, C. G. (9), published in 1827 an observation on the skull of a new-born male child, which showed, besides an extreme number of Wormian bones, irregular divisions in

TABLES OF RECORDED COMPLETE DIVISIONS OF THE PARIETAL BONE IN MAN.

TABLE A. CASES IN FŒTUSES AND THE VERY YOUNG.

I. Antero-posterior Complete Divisions, Parallel, or nearly so, with the Sagittal or Squamous Sutures.

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Miscellaneous.		
							Asymmetry.	Pathological.	Intercalated bones, etc.
Van Doeveren 1765. (4).	white	?	? "child."	left	nearly across the middle of the parietal; exact terminations not stated	?	?	?	?
Murray, A. 1797. (5).	white	male	fœtus.	both	exact terminations ?	?	?	hydrocephalus	?
Pandolfini & Ragnotti 1898. (58)	white	?	fœtus	both	exact terminations ?	?	?	?	?
Total 3 cases,	all whites	1 male, 2 sex unknown,	1 in a "child," 2 in a fœtus	1 left, 2 both (of 6 parietals 5 divided)	Exact direction and terminations in all uncertain	?	?	2 ? one hydrocephalus	?

II. Antero-posterior Complete Divisions, Moderately to Markedly Oblique.

Calori, L. 1840. (12).	white	?	fœtus (one-eyed)	right	?	?	?	hydrocephalus	?
Gruber, W. 1852. (13).	white	male	9 mo. fœtus (with supernumerary digits)	left	the upper part of the parietal is higher anteriorly, the lower part posteriorly	?	?	cerebral hernia through the occipital fontanel; defect in hard palate.	?
Ramsay, H. Traquair 1863. (18.)	white	?	8–9 mo. fœtus	right	from sphenoidal angle to middle of occipital border	the divided parietal larger by ¼ than the undivided one	skull asymmetrical	"split palate"	in lambdoid and coronal sutures
Hyrtl, J. 1871. (23.)	white	female	5 mo. embryo	left	from near bregma, on the anterior, to just above asterion, on the posterior border	?	?	?	?
do. 1871. (23.)	white	?	4 mo. embryo	right	from above the middle of the anterior border to asterion	?	?	?	?
do. 1871. (23.)	white	?	6 mo. embryo.	right	from lower portion of anterior border backward and upward to the eminence and then backward and downward to below the middle of the posterior border	?	?	?	?
Bianchi, S. 1893. (31.)	white	?	3½ mo. embryo	left (traces on right)	the superior portion of the divided parietal is higher anteriorly but lower posteriorly than the inferior portion	?	?	?	interparietal and preinterparietal bones
Total 7 cases	all whites	1 male 1 female 5 ?	1—3½ mo. 1—4 " 1—5 " 1—6 " 2 near or at term 1 ?	4 right and (1 right traces) 3 left (of 14 parietals 7 divided and on 1 traces of division)	In 4 the division runs obliquely backward and upward, in 2 it runs obliquely backward and downward, in 1 ?	In 1 case the divided parietal considerably larger, in 6 ?	In 1 skull asymmetrical, in 6 ?	In 1 hydrocephalus, in 2 defect in hard palate, in 1 cerebral hernia, in 4 ?	In 2: in 5 ?

III. Oblique Divisions Terminating in the Posterior and Inferior Borders of the Parietal.

Pandolfini & Ragnotti 1898. (58); (after Frassetto)	white	?	fœtus (age ?)	both	bilateral separation of posterior-inferior angle of the parietal	?	?	?	?

Table B. Cases in Adolescents and Adults.

I. Antero-posterior Complete Divisions, Parallel, or nearly so, with the Sagittal or Squamous Sutures.

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Difference in size of the two parietals.	Miscellaneous.		
							Asymmetry.	Pathological.	Intercalated bones, etc.
Tarin, Winslow 1753. (1.)	white	?	adult	left	below middle, nearly parallel with the sagittal suture, posterior termination somewhat higher than the anterior	?	?	?	A few small ones in lambdoid sut. Metopic suture.
Soemmering, Th. 1826. (8.)	white	male	30–50 y.	both	nearly along the middle of each bone	—	skull slightly asymmetrical	—	Metopic and mastoid sutures.
Welcker, H. 1862. (17.)	white	male	25 y.	left	below the middle	divided bone considerably higher than that of the opposite side	skull asymmetrical	—	Wormian bones in middle of left coronal and lambdoid, and one in the right lambdoid suture. Metopic suture.
Deslongchamps, E. 1864-'5. (19.)	New Caledonian	male	18–20 y.	left	nearly along the middle of the parietal	?	?	?	?
Hyrtl, J. 1871. (23.)	white	male	abt. 20 y.	left	between the middle and lower thirds of the bone	divided bone higher than the undivided one	skull somewhat asymmetrical	—	A small Wormian at lambda.
Zoja, G. 1874. (53.)	white	female	18 y.	right	?	?	?	?	?
Putnam, F. W 1883. (26.)	prehistoric race in Tennessee	male	young adult	left	slightly above the inferior third of the parietal; terminates somewhat higher above asterion than above pterion	divided bone higher and more bulging than the undivided one	skull asymmetrical (due partly to artificial deformation)	— (Occipital region shows considerable artificial flattening).	For. magnum angular, very large; 13 intercalated bones, moderate to large size, in the lambdoid, two in the anomalous suture, and several in the temporo-parietal articulation on right
Turner, W. 1884. (27.)	native of Admiralty Islands	male	adult	right (traces on left)	slightly above the inferior third of the parietal	?	occipital region asymmetrical	—	One intercalated bone in the anomalous, several in lambdoid suture.
Turner, W. 1891. (29.)	native Australian	male	adult	right	somewhat below the middle	?	?	—	A small Wormian in left asterion.
Welcker, H. 1892. (55.)	white (Prague)	?	adult	right	?	?	?	?	Metopic suture.
	white (München)	male	25 y.	right	somewhat below the middle	divided bone higher	?	?	?
	white (Berlin)	male	?	left	?	divided bone higher	?	?	?
	white (Leubinger skull)	male	50 y.	right	runs from slightly above the middle of the lambdoid to slightly below the middle of the coronal	divided bone larger in all dimensions	slight	—	A small Wormian in the beginning of the anomalous suture posteriorly
Curnow, J. 1893. (30.)	white	?	?	left	nearly along the middle; posterior termination slightly higher than the anterior	?	?	—	An occipital 'apex' bone.
Zoia, G. 1895. (53.)	white	male	22 y.	right	?	?	?	?	?
Dorsey, G. A. 1897. (34.)	Maori	male	adult	left	nearly along the middle, terminating somewhat higher posteriorly than anteriorly	divided bone higher than the undivided one	somewhat asymmetrical	—	One small Wormian in and one below the anomalous, and several small ones in other sutures.
Ranke, J. 1899. (36.)	white	male	adult	right (remnant on left)	between the middle and inferior thirds of the bone (the anteriorly remaining portion of the division on left runs between the fourth and inferior fifths of the bone)	divided bone on right slightly higher than the parietal of the opposite side	skull slightly asymmetrical	—	A few small Wormians in the lambdoid suture
Pitzorno, M. (after Frassetto, 1900 (54)	white	?	?	left	?	?	?	?	?
Turner, W. 1902. (.)	white	male	adult	left	runs nearly between the lowest and the upper two thirds of the parietal	?	?	?	?
Total 19 cases	14 whites 1 New-Caledonian 1 American Indian 1 Admiralty-Islander 1 Australian 1 Maori	14 males 1 female 4 ?	3 adolescents 13 adults 3 ?	1 both 10 left 2 right, with traces on left 6 right (of 38 parietals 20 divided and 2 with traces of division)	Along or nearly along the middle of the parietal..5 cases (6 parietals) below the middle..... 4 cases (9 parietals) between the middle and lower thirds.. .5 cases (9 parietals) exact location doubtful in 5 cases.....(5 parietals)	In 8 cases the divided parietal higher than the undivided one; 10 ? In 1 case, where both parietals were completely divided, the bones were nearly equal.	more or less asymmetry in 8; 11 ?	No pathological condition reported in 9; 10 ?	Metopic suture persistent in 4; mastoid sutures persistent in one to many intercalated bones in ordinary sutures in 9; none in 1; ? 8. Intercalated bones in the anomalous suture in 4.

TABLE B. *II. Antero-posterior Complete Divisions, Moderately to Markedly Oblique.*

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Difference in size of the two parietals.	Miscellaneous.		
							Asymmetry.	Pathological.	Intercalated bones, etc.
Lucae, J. C. G. 1857. (16.)	white	?	young adult	right	from the lower end of the coronal to slightly above the middle of the lambdoid suture	divided bone considerably larger than the undivided one	skull asymmetrical	?	The illustration shows a small Wormian bone in the sagittal, and one or two small ones in the lambdoid suture
Calori, L. 1867. (20.)	white	female	37 y.	both	on right: from a point 2.2 cm. above asterion to 1.5 cm. from bregma; on left: from near lambda to a point 4.6 cm. below bregma	not much difference	skull somewhat asymmetrical	—	Intercalated bones at both ends of the left anomalous suture, and in both pterions; mastoid sutures persistent
Gruber, W. 1879. (25.)	white	probably female	adult	right	from a point 1.0 cm. above the parieto-sphenoidal suture, to a point 4.0 cm. above the parieto-mastoidal suture, 5.0 cm. below the lambda.	the divided parietal is higher than the undivided one	skull somewhat asymmetrical	—	No Wormian bones mentioned or visible on illustration
Putnam, F. W. 1883. (26.)	prehistoric race in Tennessee	male	adult (45–55 y.)	left (on right a separation of posterior-inferior portion)	left: from a cleft at a point 2.3 cm. above asterion; descends towards the anterior ¼ of the squamous suture, then obliterated, but traceable to a point 2.0 cm. above the lower end of the coronal suture. (right: the separate portion measures 2.0 cm. along the lambdoid, 3.5 cm. along the parieto-mastoid, 3.9 cm. along the squamous suture, and 4.5 cm. in a straight line from its superior lambdoid to its anterior termination)	left parietal higher than the right	skull slightly asymmetrical	— (Occiput moderately compressed)	A large Wormian bone in the cleft from which starts the left anomalous suture; a small Wormian in right lambdoid suture Persistence of metopic suture
Boyd, Stanley 1893. (32.)	white	male	adult	right	from a point "½ inch above the articulation with the lateral angle of the occipital" (asterion) obliquely forward and upward, to within "an inch from the anterior border, slightly above the middle"	?	?	?	?
Smith, Barclay, 1899. (35.)	Egyptian	?	?	?	"from the lambda to the pterion"	?	skull asymmetrical	?	?
Terry, R. J. 1899. (71.)	white	female	aged	both	the left anomalous suture runs from lambda to slightly above the middle of the coronal; the right from a little below lambda to slightly above the middle of coronal	?	?	bones very light, brittle; other skeletal abnormalities	A larger Wormian bone at the base of the left anomalous in lambdoid suture
Total 7 cases	5 in whites 1 in an American Indian 1 in an Egyptian	2 males 2 females 1 probably female 2 ?	5 adults 1 probably adult	3 right 2 both 1 left 1 ? (of 14 parietals 9 divided)	In 7 the suture ran backward and upward (terminating higher posteriorly than anteriorly), in 2 it ran backward and downward (terminating higher anteriorly)	In 3 the completely divided bone was higher than that of the opposite side 3 ? In 1 case, where both parietals were completely divided, the bones were nearly equal	In 5 skull slightly to markedly asymmetrical, in 2 ?	In 3 — 3 ? In 1 advanced changes in all the bones; other skeletal abnormalities	In one case a persistence of metopic, in another case mastoidal sutures Intercalated bones at one of the ends of the anomalous suture in 3 2 ?

TABLE B. *III. Oblique Divisions Terminating in the Posterior and Inferior Borders of the Parietal.*

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Miscellaneous.		
							Asymmetry.	Pathological.	Intercalated bones, etc.
Ekmark, C. D. 1763. (3.) (Ascribed by Calori to Aurivillius)	white	?	45 y.	?	? separates the mastoid angle of the bone	?	?	hydrocephalus	?
Welcker, H. 1862. (17.)	whites	?	?	?	"several skulls," where a suture runs from the middle of the margo-lambdoideus to the inferior border of the bone	?	?	?	?
Hyrtl, J. 1871. (23.)	Gypsy	male	abt. 20 y.	right	"from the point of the occipital squama (lambda) to the middle of the squamous suture"	divided parietal somewhat longer than that of the opposite side	skull symmetrical	—	A Wormian bone in lambda
Gruber, W. 1879. (25.)	white	male	abt. 30 y.	both	on right: no details as to the terminations; on left: from "the middle of the superior border of the temporal squama, 4.5 cm. posteriorly to the wing of the sphenoid, to a point 2.5 cm. from the posterior extremity of the sagittal suture.	?	?	(Occipital flattening)	Wormian bones in various locations; an epactal bone
Gruber, W. 1879. (25.)	white	male	advanced age (all sutures patent, hence less than 50 y.)	left (traces on right)	on left: "from the middle of the lambdoid" "to the middle of the parieto-temporal suture;" (on right: from a point below the upper ⅔ of the lambdoid suture, forward and downward; incomplete inferiorly)	?	?	?	?
Welcker, H. 1892. (55.)	white	female	70 y.	left	from slightly above the middle of the lambdoid to nearly the middle of the temporo-parietal suture	?	?	?	?
Coraini, E. 1894. (33.)	white	?	adult	?	from middle of squamous to lambdoid suture	?	?	—	?
Ranke, J. 1877 & 1899. (36.)	white	?	adult	left	from upper portion of the lambdoid to near the middle of the squamous suture	?	?	—	Two "spitz" bones in lambda
do. do. (36.)	white	?	adult	right (left incomplete)	on right: a 6.5 cm. long suture, separating the mastoid angle; (on left: a 2.9 cm. long suture, in same location, incomplete inferiorly)	?	?	—	Metopic suture Wormian bones in lambdoid suture
do. do. (36.)	white	?	adult	right	from a point a little inferior to lambda towards anterior part of the squamous suture, reaching to within 2.6 cm. of the same.	?	?	?	?
Total of cases (including Putnam's described under II) = 11–12	1 in a Gypsy, the remaining in whites	3 in males, 1 in a female, in the remaining sex ?	1 adolescent, the remaining probably all adults	3 right 3 left 1 both the others ? (of the 18 parietals, not including Welcker's 1862 & Putnam's cases, 12 with divisions)	the posterior termination is not restricted to any part of the occipital border of the parietal; it occurs below, at, and also above the middle of the border; the inferior termination most frequently takes place at, or not far from, the middle of the tempero-parietal articulation.	In 1 case the divided parietal is reported to have been longer than the undivided one; in the remaining cases ?	In 1 skull symmetrical; in the remaining ?	In 1 hydrocephalus, 4 — the remaining ?	Metopic suture in 1 Wormian bones in 3 Epactal bone in 1 "Point" bones (in lambda) in 1 In the remaining ?

TABLE B. *IV. Vertical-horizontal and Vertical, Complete, Divisions.*

Gruber, W. 1852. (14.)	white	?	adult	left	a vertical horizontal suture, separating a 2½ inches high and 1¾ inches broad piece of the posterior-inferior part of the parietal	?	?	?	?
do. 1876. (24.)	white	male	adult	right	separation of the posterior-inferior portion by a slightly curved horizontal-vertical suture; antero-posterior branch of the suture begins 4.2 cm. above asterion, the vertical branch ending in the middle of the squamous suture.	?	?	?	?
Fusari, R. 1889. (28.) (Reported again in 1897 by G. Mondio 57)	white	male	23 y.	right	a complete vertical suture from the superior to the inferior border of the parietal, near its posterior third; and a horizontal division between the lambdoid and anomalous sutures, well above their middle	?	?	?	?
Total 3 cases	all whites	2 males 1 ?	all adults	2 right 1 left (of 6 parietals, 3 with divisions)	In 2 separation by a vertical-horizontal suture of the posterior-inferior portion of the parietal in 1 a complete vertical division with a transverse division of the posterior separate portion	?	?	?	?

both parietals. The right bone was separated into 5, the left into 3 portions.

Gorgone's case (11): According to Coraini's citation (33) it seems that Gorgone has observed a vertical division of a parietal bone in a fœtus ("essendo sempre più rara la division verticale osservata da Soemmering (?) e da me una sola volta redutta . . . in parietale però di feto").

Hartmann's case(50): Ranke mentions (36, p. 33) this case as one that possibly belongs among the lambdoid-squamous parietal divisions.

A cranium of a new-born child, with a parietal suture, has also been reported, according to Ranke (36, p. 58), in Rüdinger's catalogue of the skulls and skeletons in the Munich Anatomical Institute.

Adults.—The first of these cases is that of Sue (2), referred to by Calori and Coraini. According to a citation by Calori (20, p. 340, footnote), the specimen showed either a separation of a portion of the postero-superior angle of the left parietal, or a large Wormian bone in that location ("J'ai vu un pariétal gauche dont le quart de la partie postérieure et supérieure n'est qu'un os wormiens dont la largeur excedoit un travers de doigt").

Blumenbach's case (7): This observation is mentioned by Welcker, who says the illustration of the specimen can be seen in Blumenbach's 'Nova Pentas,' LXI. According to Welcker there is seen, on a skull of an old German, "a transverse suture of the right parietal bone, running from the middle of the temporal to the sagittal border, parallel in whole to the coronal suture."

Gruber's case (22): The right parietal of the skull of a 15–18-year-old white male showed an oblique, partly occluded division, and this was continuous with a division in the occipital squama. The illustration of the division shows none of the distinctive characters of a suture. Both Hyrtl and Ranke exclude this case from the category of anomalous parietal sutures.

Gruber's Prague Museum case: A mention is made of this case by Gruber (22). The author expresses the belief that

one of the skulls he has seen in the Prague Museum showed an antero-posterior division of one of its parietals. It is probable that this is the same case later on (1892, 55) referred to by Welcker and given in Table B, 1.

Finally there is the case of a Fidji-Islander, No. 50 in the Rabl-Rüchard's Katalogue of the Berlin collection. Welcker is of the opinion (55) that this case, referred to in the Katalogue as one presenting on the left side a Wormian bone that extends between the parietal and temporal bones from the coronal to the lambdoid suture, is only another instance of a complete horizontal parietal suture.

RÉSUMÉ.—Leaving the incomplete and doubtful cases aside, the above records comprise 51 to 52 cases with in all 58 to 59 anomalous parietal sutures running completely from one to another border of the parietal bone.

Age.—11 of the cases here considered were observed in embryos, fœtuses and a "child," 40 to 41 in adolescents and adults.

Race.—If in all the cases where the race of the subject has not been reported we assume that the subject was a white, there were then among the young all whites, among the adolescents and adults 43 to 44 (84 to 86 %) of whites and 8 (bet. 16 and 14 %) individuals of other races.

The absence of representatives of other races among the young is probably entirely due to the comparative scarcity of material from those races.

Of the individuals of other races than the white among the adults, there were

2 ancient Americans (Tennessee),
1 gypsy,
1 "Egyptian,"
1 Maori,
1 from the Admiralty Islands,
1 New Caledonian, and
1 Australian.

Sex.—Among the 29 cases in which the sex was reported 23 are males, 5 females, and 1 "probably" female. The males preponderate over the females in the ratio of nearly 5 to 1.

Side.—The anomalous divisions where their location was mentioned, were:

In the young: 4 right, 3 left, 3 bilateral, 1 left, with traces on right.
In adolescents and adults: 14 right, 15 left, 5 bilateral, 2 right, with traces on left.
Total, 18 right, 18 left, 8 both sides, 2 right and 1 left with traces on the opposite side.

Location.—In 41 instances the suture extended horizontally or obliquely between the anterior and posterior, in 16 to 17 between the inferior and posterior, and in 1 between the inferior and superior border of the parietal.

Among the young in 3 of the cases (27 %), or 5 instances, the divisions were probably horizontal (parallel with the sagittal suture); in 7 cases, or the same number of instances, (63.5 %), oblique; and in one case, or two parietals (9 %) oblique infero-posterior. Among the adolescents and adults the division was in 19 of the cases, or 20 instances (52.6 %), horizontal; in 7 cases, or 9 instances (18.4 %), oblique antero-posterior; in 11 to 12 cases (28.9 %), oblique infero-posterior; in 2 cases (5.3 %), angular infero-posterior; and in 1 case (2.6 %) vertical, or infero-superior, with a partial horizontal ramus.

Of the 25 horizontal divisions all, so far as reported, ran at or below (the majority) the middle of the parietal bone. Of the 16 antero-posterior oblique divisions, 4 in the young and 7 in the adults ran in a backward and upward, 2 in the young and 2 in adults in a backward and downward direction from the anterior border of the parietal: in one instance the exact course of the division is uncertain.

Size of the parietals.—The divided parietal bone is generally larger than the undivided one in the same skull; the excess in size is mainly at, or nearly at, a right angle to the anomalous suture.

Asymmetry.—Unless both parietals are completely and similarly divided, more or less asymmetry of the skull is probably the rule. This asymmetry is principally due to the unequal growth of the two parietals.

Pathological.—Of the *fœtal* skulls every one in which we have a report on this point, showed some pathological or teratological features. There were in four specimens two hydrocephali, two defects in the hard palate, an abnormally

large posterior fontanel with a cerebral hernia, one instance of monoculism, and one of polydactyly. One case of a hydrocephalus is reported among the adolescents and adults.

Intercalated Bones.—One to a considerable number of such bones of various sizes were present in a large majority of the cases. In 7 instances there was one or more Wormian bones present at the beginning or in the course of the anomalous suture.

Persistence of Early Normal Sutures.—The persistence of the metopic or frontal suture is reported in 6, mastoid sutures in 2, transverse occipital in 1 of the adults.

Characteristics of the Anomalous Sutures.—The antero-posterior horizontal or moderately oblique parietal sutures in adults are generally well serrated in their middle or their middle and posterior thirds; anteriorly, however, these divisions are often of a more or less squamous character, the border of the inferior overlapping that of the superior portion (cases of Lucae, Hyrtl—20-year male, Gruber—"probably female," Putnam, Ranke). The infero-posterior divisions show on the average a less pronounced serration than the antero-posterior ones; occurrence of squamous character is uncertain.

The relative persistence of the anomalous divisions seems occasionally to equal that of the majority of the normal parietal articulations, or even to slightly exceed the same. In Soemmering's, one of Hyrtl's and Ranke's cases, the anomalous sutures were still externally patent, while some of the normal parietal articulations showed traces of occlusion. In Dorsey's case the anomalous division was patent externally, but occluded ventrally, and there was a partial synostosis in the sagittal suture. On the other hand, some of the partial divisions in adults seem to point to an occasional early occlusion of the supernumerary suture.

The preceding data make it evident that divisions of the human parietal bone may be encountered at all ages from the embryonic to advanced adult life. The process of suture obliteration may somewhat interfere with the detection of such divisions in the aged.

Considering the relative supply of material, it seems that the divisions occur more commonly in the colored races than in the whites; this point, however, cannot be decided before there are opportunities of examining very much larger numbers of crania belonging to the various colored races than has been possible up to the present time. The anomaly is certainly exceedingly rare in both prehistoric and more recent native Americans.

A very striking feature is the predominance of parietal divisions in males. The proportion of 5 males to 1 female might possibly be slightly altered if we had reliable records as to the sex of the subject in all the cases.

Parietal divisions in man are more often uni- than bi-lateral (in about the proportion of 5 to 1). The unilateral divisions occur with about equal frequency on the two sides; apparently there is no cause in man which would influence the phenomenon to appear more frequently on one side than on the other.

According to their terminations and direction, the anomalous parietal sutures can be, as has been done in the tables, arranged into several classes. The antero-posterior divisions predominate over the infero-posterior ones, but this may be due to the fact that the former, through their more striking character, have received greater attention (*v.* Ranke, 36, p. 33). The vertical or infero-superior sutures are apparently exceedingly rare.

Of the antero-posterior divisions, the oblique are somewhat more common than horizontal ones in the young, while in adolescents and adults the condition is reversed, the oblique sutures being in a decided minority. It is not improbable that some divisions, originally oblique, do gradually, as the bones grow, assume a more horizontal direction.

The fact of the existence in the four skulls of fœtuses at or near term, in which a parietal division was observed, of pathological or teratological abnormalities, can hardly be without a special significance. We shall return to this point in the concluding chapter. There cannot, however, before we possess additional data, be much meaning attached to the

frequent presence of intercalated bones in crania with a parietal division, or to the occasional persistence in such specimens of the metopic or mastoid sutures. In some reports these features are not touched upon, in consequence of which the figures cannot well be reduced to percentages and used for comparison with observations on similar conditions in crania which do not present a division of the parietal. The occurrence of Wormian and even fontanel bones in crania in which the parietal bones are normal is very common, nor is it rare to find in such specimens, as is well known, a complete metopic or a more or less preserved mastoid suture.

III. The Published Cases of Parietal Division in Apes and Monkeys.

The data and remarks in the preceding chapter cover briefly the accumulated published material on parietal divisions in man. In addition we have in literature a smaller number of observations, by Gruber, Coraini, Maggi, Ranke, myself, and Frassetto, on similar anomalies of the parietal bone in the apes and monkeys. These observations, which by their nature add much additional interest to the whole matter of parietal divisions, are as follows:

APES: COMPLETE PARIETAL DIVISIONS.

Ranke's Case: Complete Division of a Parietal Bone in an Orang.[1]— Among the 245 orang skulls of the Selenka's collection in the München Anthropological Institute. Ranke found one in which the right parietal bone is divided into a larger upper and a smaller lower portion by a horizontal suture. The skull is that of an adolescent female. The abnormal suture "runs nearly parallel with the sagittal suture"; but its posterior end bends downward and ends on the inferior border of the bone, near the junction of the squamous with the lambdoid suture. The abnormal suture shows but little serration and is squamous in character, the lower overlapping the upper portion of the bone. The height of the superior is

[1] *L. c.*, p. 310.

to that of the inferior portion, at the anterior border of the parietal, as 3 to 1 (6.0 and 2.0 cm.). The lower portion projects further forward than the upper.

Frassetto's Case (69). — The right parietal of a well-formed, slightly asymmetrical skull of an orang (adolescent) shows

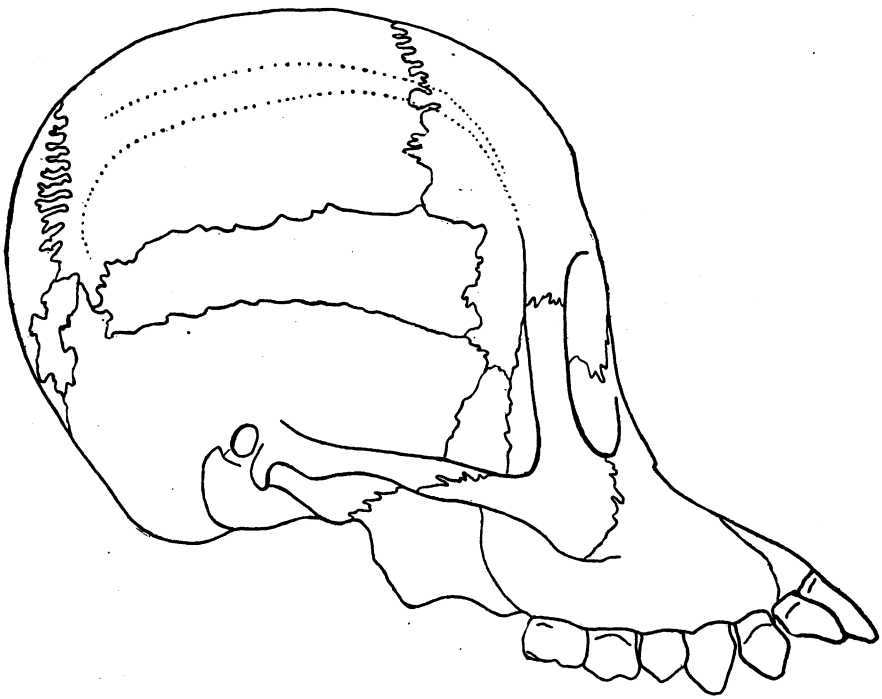


Fig. 1. An Orang, showing a complete antero-posterior parietal division. (After Ranke.)

an oblique, complete division, beginning 0.7 cm. below the lambda and ending in the coronal below its middle. The posterior half of the anomalous suture is well serrated, the anterior half simple. A moderate-size Wormian (more properly fontanel) bone is seen in the posterior end of the suture. The right parietal bone is slightly larger than the left. (The division here described is strikingly similar to those reported in a human subject by Terry, Table B, 11.)

My Case in a Chimpanzee (37). — A bilateral complete divi-

sion of the parietal bones in the skull of a 9-year-old male chimpanzee ('Chico').

"The skull shows in general a good development and an almost perfect symmetry. The capacity of the brain cavity, measured according to Flower's method, is 390 c.c.

"The masculine features of this skull, and particularly the temporal ridges, are not quite as marked as those of another skull of an adolescent male chimpanzee in the American Museum. The temporal ridges are slightly prominent, and in their middle third, over part of the frontal and the parietal bones, not more pronounced than in some human crania. They are, however, situated very high. Their upper lines or boundaries touch each other over a part of the sagittal suture, a little back of the bregma; while the lower lines approach to within 6 mm. of the sagittal suture. The supraorbital ridges are not very massive, although prominent to such a degree that, when the skull rests on the occipital condyles and on the teeth, the plane of the orbits is almost vertical. The sagittal crest is insignificant; the occipital crest is high, but not very massive. The zygomatic arches are less strong than they are in an average white male; and the mastoids are small, even smaller than in an average adult white female.

"The second dentition is incomplete; the third molars have not reached the level of the opening of their sockets. The condition of the sutures, so far as their patency is concerned, does not bear the same relation to the stage of dentition as it does in man: all the sutures of this skull are more or less obliterated. There are no signs on any part of the skull that point to the closure of any of the sutures as premature.

"The temporo-parietal sutures, with the exception of 8 mm. of the anterior end of the suture on the right side, are both entirely closed and hardly traceable. The coronal suture is partly open on the left, and wholly open on the right, up to a point a little below the middle of the anterior border of the parietal bone. At this point on each side, the lower portion of the coronal suture appears as if it bent backward and continued as the anomalous suture; the upper portion of the coronal, particularly on the right, is completely obliterated,

though still traceable. There are no signs left of the sagittal and lambdoid sutures, and only the basal portions of the temporo-occipital articulation remain. The palatine sutures, also, are entirely obliterated.

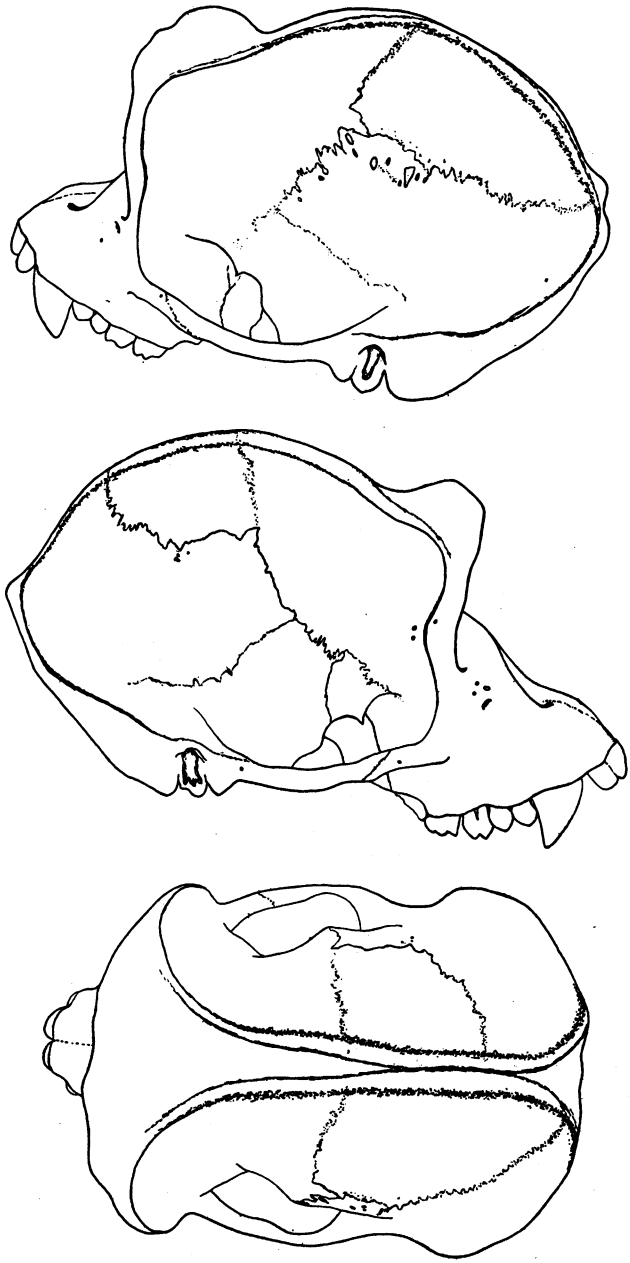
"The skull shows no important anomalies besides the division of the parietals.

"The divisions of the parietal bones begin on the left 32 mm., on the right 28 mm. (measured with a tape), above the point of junction of the coronal and temporo-parietal sutures. From the point where the anomalous sutures leave the coronal suture to the bregma the distance on the left is 44 mm., on the right 42 mm.

"The excess of size of the left over the right parietal bone along the coronal suture (6 mm.) compensates the greater height of that portion of the right temporal squama which articulates with the frontal bone. Measured across their middle from the temporo-parietal suture, the two parietals appear to be almost of equal size (left 82 mm., right 80 mm.). In an antero-posterior direction, from the beginning of the division to the middle of the parietal portion of the occipital crest, both bones measure the same, namely, 75 mm.

"The division in the left parietal begins at a V-shaped cleft, which is filled with a process of the frontal bone. There are slightly distinct markings on the bone and a number of insular ossicles, which make it probable that the cleft had been originally much greater and was largely filled by a Wormian or, rather, a fontanel bone, the lower border of which has subsequently united with the parietal.

"For 30 mm. from its beginning the abnormal suture proceeds directly backward, and to this extent shows but little obliteration. The original cleft has, it seems, extended up to this point. From here the suture takes a slight bend upwards, and proceeds almost directly upwards and backwards, becoming gradually obliterated, until it disappears at the temporal ridge, 16 mm. from the median line. Originally the suture must have terminated on the posterior border of the parietal bone, not far from the lambda. The whole suture shows fairly good serration. The coronal suture on this side,



Figs. 2, 3, 4. Skull of an adolescent male Chimpanzee, showing a bilateral parietal division.

below the division, shows serration about equal to that of the abnormal suture; the obliterated portion above this was, so far as can be seen, more simple.

"On the right side the division of the parietal may also have begun with a cleft in the anterior border of the bone, but, owing to the advanced state of obliteration of the upper portion of the coronal suture on this side, the existence of the cleft cannot be fully ascertained. Here also the abnormal suture, at first wholly open, runs for the first 26 mm. directly backwards; at this point the suture, still quite patent, takes a turn somewhat sharper than that on the left, and proceeds for 16 mm. backwards and upwards; here it takes a second turn, and proceeds almost directly upwards towards the sagittal suture. This last portion of the abnormal suture is considerably obliterated, and on and beyond the temporal ridge is scarcely traceable. The point at which the division has reached the sagittal suture is situated a little behind the middle of the latter. The abnormal as well as the open part of the coronal suture on this side shows a simpler serration than the corresponding sutures on the left side.

"In this specimen there is on neither side any encroachment of the lower portion of the parietal bone upon the frontal, such as Ranke lays stress on in the case of his orangs. A second skull of an adolescent male chimpanzee, in the Museum of Natural History, has a decided bend in the coronal suture, not unlike that which Ranke describes, and which, as he thinks, generally indicates an old parietal division; but in this case the bend is situated between the inferior and superior boundaries of the prominent temporal ridge, and apparently owes its origin to the latter."

The main interest in the case just described centers in the so far unique (up to the publication of 37) location of the abnormal sutures, and in the clearness with which the two divisions appear as equivalent and of the same origin, although one divides the parietal completely, while the other is restricted to one of its angles.

In 1901 (73) there appeared in the Proceedings of the

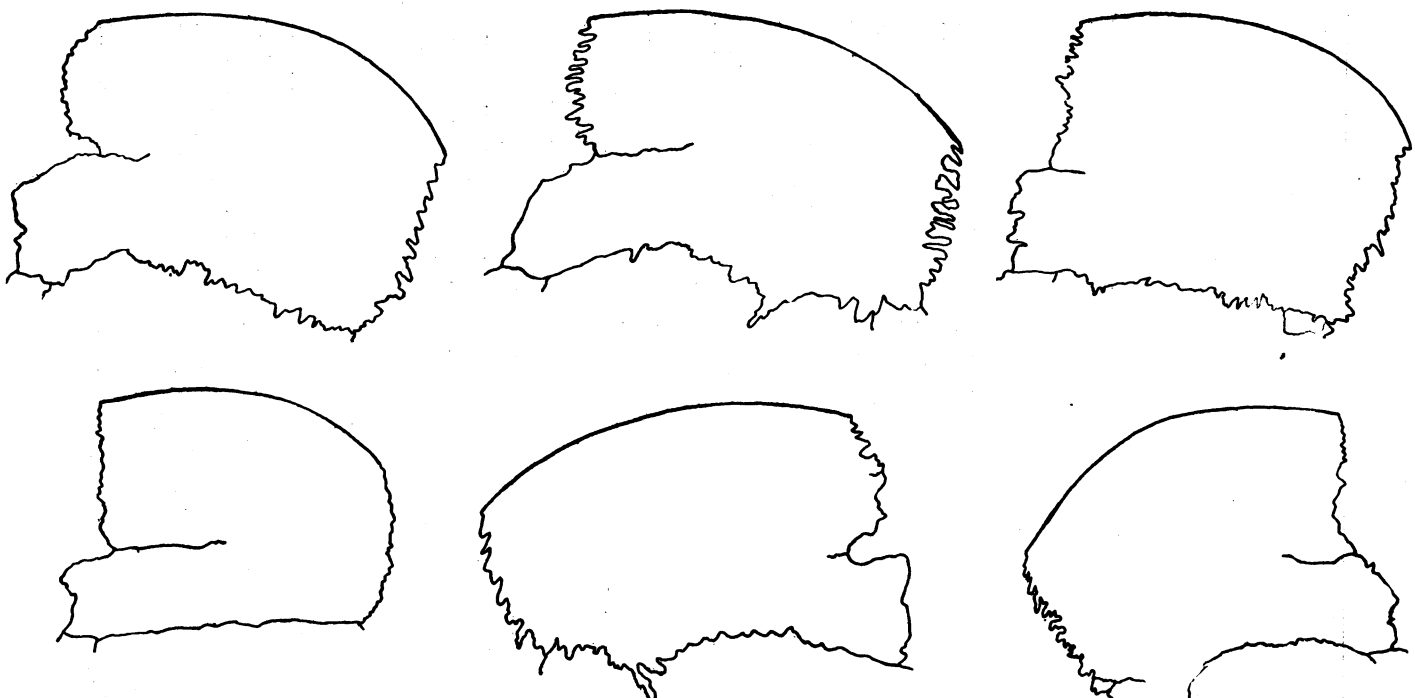


Fig. 5. Partial anterior parietal divisions in Apes. (After Ranke.)

Anatomical Society of Great Britain and Ireland, with some notes on a demonstration before the Society by Dr. L. H. Duckworth, a drawing of a "Chimpanzee Skull in Museum of Copenhagen," in which the left parietal shows a division much like that on the same side in my case, but terminating more anteriorly in the sagittal suture. No description whatever accompanies this illustration.

CASES OF INCOMPLETE DIVISIONS OF THE PARIETAL BONES IN APES.

Orangs.—Among the 245 orang skulls examined by Ranke (36, p. 314 et seq.), there were 13 with an incomplete parietal division. This began invariably in the coronal border of the parietal, at the point where the coronal suture makes the bend

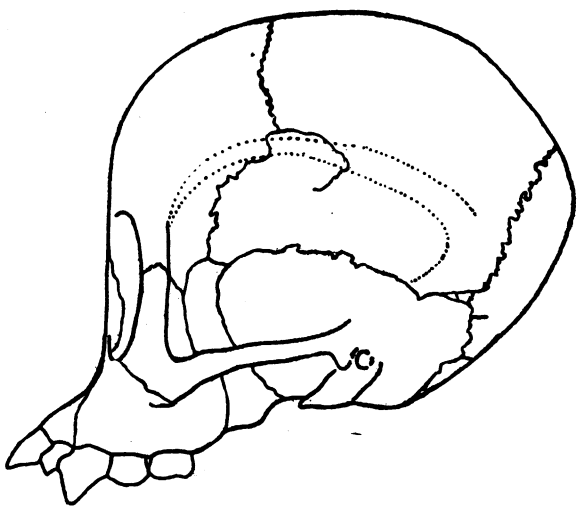


Fig. 6. The skull of a young Orang, showing a partial anterior parietal division.

forward, and passed horizontally into the bone. All the 13 skulls with parietal divisions belonged to younger animals.

Gorillas. — Among 8 young gorilla skulls 1 showed a short suture running backward from about the middle of the anterior border of the left parietal.

Chimpanzees. — Among 11 young Chimpanzee skulls there

was one with an incomplete suture in each parietal; the division proceeded from the middle of the coronal border to the middle of each bone.

Gibbons. — Among 70 skulls of *Hylobates concolor* there is no one with any parietal division.

The only other observer who reports incomplete parietal sutures in apes is Frassetto (67). He saw a bilateral short anterior division in three orangs, and in one of these there was in addition on the left side a 6-mm.-long vertical fissure in the posterior third of the superior border of the parietal.

MONKEYS: COMPLETE PARIETAL DIVISIONS.

Gruber's Case in a Monkey (15). — "*Simia silenus*" (apparently adolescent, sex ?), presenting an oblique-vertical division of the left parietal.

"The left parietal is divided, by an angular suture, composed of a horizontal and a vertical branch, into two segments, one quadrangular, situated antero-superiorly, the other triangular, situated postero-inferiorly."

The horizontal branch of the anomalous suture, as seen on the figure, begins a short distance above the squamo-coronal point on the coronal border of the parietal, runs for a short distance downward and backward, then makes an angular turn and runs backward and somewhat upward, diverging from the squamous suture to or slightly beyond the beginning of the last fourth of the antero-posterior dimension of the bone. At this point the "horizontal" branch meets the vertical one, the two making a moderate obtuse angle open forward and upward. The vertical branch is seen to run upward and slightly backward, and end at or slightly before the lambda. The anterior branch deserves more the term oblique than horizontal.

The anomalous suture is moderately serrated and, with the other cranial sutures, appears to be still open.

There is a large, rhomboidal Wormian bone in the lower part of the coronal suture.

Welcker's Case (55). — The anterior-superior angle of the right parietal of a *Semnopithecus* is separated by an anomalous

suture running in a curve (convex downward) from the middle of the coronal to the middle of the sagittal suture.

Coraini's Case (*a*) (33). — A vertical division of the left parietal in an "*Arctopithecus*"; a partly obliterated oblique division of the parietal bone on the right side; and a double division in the left temporal squama.

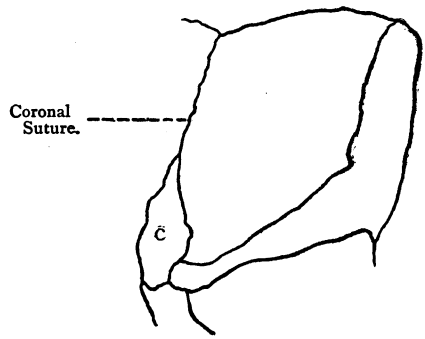


Fig. 7. Gruber's case of a parietal division in a monkey. *C*, a rhomboidal Wormian bone in the lower part of the coronal suture.

Cranium regular; all normal sutures patent, with the exception of the anterior portion of the right squamous suture, which shows some occlusion.

The left parietal bone is divided into a large, quadrate anterior and a narrow posterior trapezoidal portion.

On the right side an oblique, partially obliterated suture runs from the sagittal border of the parietal, from a point a few mm. anterior to the superior termination of the suture on the left side, to the sphenoidal angle.

The left temporal squama shows one partly oblique and one vertical division (details given not sufficient to determine exact location).

Coraini's Case (*b*) (33). — A vertical division of the left parietal bone in a *Cercopithecus*.

Cranium regular, all sutures patent, a persistence of metopic suture. A bregmatic bone; Wormian bones about left pterion; a separate bone in lambda.

The anomalous suture runs from the middle of the superior to the inferior border of the parietal, diverging a little from the lambdoid suture.

Right parietal bone normal and of about the same size as the left one.

Maggi's Cases: Macacus cynomolgus (63). The right parietal is divided into two by a vertical suture running from the

sagittal at the parietal foramen to the temporo-parietal suture.

Macacus cynomolgus (63). Frassetto mentions this case (70) as one of a bilateral, complete, horizontal parietal division. No description in 63.

Cercopithecus (?) (63). An oblique, complete, unilateral parietal division. The anomalous suture runs from the superior part of the coronal to the inferior part of the lambdoid suture. No further particulars.

Cercopithecus patas (63). Mentioned in Frassetto as a case of a complete vertical parietal division on the right side.

Frassetto's Cases: Cercopithecus (?) (68). A complete vertical division of the left, incomplete, superior, similar and opposite division of the right parietal.

Cercopithecus (67). A young animal. The left parietal is divided by a complete vertical suture, and the posterior separate portion is subdivided into a superior and an inferior segment by a horizontal suture (parietale tripartitum). On the right parietal can be seen traces of a superior vertical and a horizontal division.

MONKEYS: INCOMPLETE PARIETAL DIVISIONS.

Maggi's Cases: A *Cercopithecus patas* (63) shows a bilateral incomplete vertical division starting on each side from the sagittal suture at the parietal foramen; also another superior, vertical, incomplete division on the left side somewhat more anteriorly. No one of these divisions is very long.

Cercopithecus campbelli (63). An incomplete division in the superior border of the right parietal anterior to the parietal foramen.

Rankè's Cases (36, p. 44). — A skull of *Cynocephalus ursinus* shows an incomplete suture passing from the coronal border into each parietal.

A skull of *Mycetes seniculus* shows a 4-mm.-long suture, passing from its anterior border into the right parietal.

Frassetto's Cases: Cercopithecus (?) (67, 70). The superior border of each parietal shows a short vertical division (not opposite).

Cebus fatuellus (67, 170). A horizontal fissure in the anterior border of each parietal somewhat below the middle (right 1.2, left 0.5 cm.).

Cebus (67, 70). Traces of lower half of vertical suture in the right parietal.

Résumé of Published Cases of Parietal Division in Apes and Monkeys.

Apes. — 1. A complete antero-posterior, nearly horizontal division of the right parietal, with a remnant of a similar division in the left parietal, in an adolescent female orang (Ranke).

2. A complete oblique division, upper part of lambdoid to below middle of coronal suture, on the right side in an adolescent orang (Frassetto).

3. A bilateral complete division, oblique (antero-superior) on the left, vertical-horizontal (antero-superior) on the right side, in a nearly adult male chimpanzee (Hrdlička).

4. A complete oblique antero-superior division in the left parietal of a chimpanzee (Copenhagen Museum).

Incomplete horizontal divisions in the anterior portion of the parietal observed by Ranke in 13 younger orangs, 1 gorilla, and 1 chimpanzee, and by Frassetto in 3 orangs.

Monkeys. — 1. A complete oblique (sphenoidal angle-lambda) division in the left parietal of a "*Simia silenus*" (*Macacus silenus*, or *Semnopithecus silenus*) (Gruber).

2. A complete vertical and a partly obliterated oblique (sphenoidal angle-sagittal suture) division of respectively the left and right parietal, in an "*Arctopithecus*" (Coraini).

3–6. A complete vertical division in the left parietal bone of an adolescent *Cercopithecus* (Coraini); in a *Macacus cynomolgus*, right (Maggi); in a *Cercopithecus patas*, right (Maggi); and in a *Cercopithecus* (?) on both sides, right incomplete (Frassetto).

7. In one *Cercopithecus* (?) Frassetto found a complete vertical and posterior horizontal suture on the left, and traces of a vertical and a horizontal suture on the right.

8. In one *Cercopithecus* (Maggi) a suture runs obliquely in one of the parietals from the superior part of the coronal to the inferior part of the lambdoid suture.

9. In a *Macacus cynomolgus* there is a bilateral antero-posterior parietal division (Maggi).

10. In a *Semnopithecus* an anomalous suture runs from the middle of the coronal to the middle of the sagittal suture (Welcker).

Incomplete horizontal divisions in the anterior portion of the parietal observed by Ranke in one *Cynocephalus ursinus* and one *Mycetes seniculus*, and by Frassetto in a *Cebus;* incomplete vertical divisions in the sagittal border of the parietal are reported in two *Cercopitheci* by Maggi and in one *Cercopithecus* by Frassetto, and vertical division in the inferior portion of the parietal in one *Cebus* by Frassetto.

The more remarkable features of these records are the occurrence of comparatively numerous vertical and some very oblique, but only two (one case) of complete horizontal sutures in the monkeys; the frequency of remnants of divisions and their uniformly anterior location and horizontal direction in the orangs; and the antero-superior divisions in the chimpanzees. These conditions not only enlarge the field of possibilities of parietal divisions, but they also directly urge a thorough inquiry into the subject of development of the parietal bones in various mammals.

IV. New Material.

To the preceding two categories of published cases I am able to add some new observations of parietal divisions, particularly in monkeys. It was a parietal division in a monkey skull that attracted my attention to the subject in 1897, and since then I have been able to gather quite a number of other cases of the anomaly in these animals.

My examinations have not been confined to monkeys, but have extended, thanks to the courtesies of the various curators, over a large series of human and various mammalian crania, including the collections in the anthropological and zoölogical departments of the American Museum of Natural History

and the anatomical collection in the Medical Department (College of Physicians and Surgeons) of the Columbia University in New York, and parts of the anthropological collections in the Peabody Museum, Cambridge; the Museum of Sciences and Art, Philadelphia; and the National Museum, Washington. The material examined comprises nearly 3000 Indian and 400 white and negro crania; a little over 400 skulls of apes and monkeys; and a little over 2000 skulls of other mammals.

The most striking results of my search, so far as confined to adolescent and adult crania, are the comparative frequency of parietal divisions in monkeys, particularly in certain of their species; the great scarcity of the anomaly in man; and its complete, or almost complete, absence in other mammals. Among 14 skulls of apes one specimen (chimpanzee) presented a bilateral complete parietal suture; among 392 skulls of monkeys of various kinds, there were 17 with complete and 35 with incomplete, single or multiple, parietal divisions. On the other hand, among the 3400 human adolescent or adult crania I saw but two with complete, none with large, and but six with minor partial divisions in the parietal bone. The two cases with complete sutures were those previously published by Professor Putnam, in Prehistoric Indian Crania from Tennessee. Among the skulls of various mammals other than man, apes, and monkeys, there was but one with a complete parietal suture, and even in this isolated case the congenital character of the division is not as clear as would be desirable. There were also found in these animal skulls three cases with a separation of a portion of one of the angles of the parietal; and there were many incomplete sutures in the parietal bones; but these sutures are of a different origin and meaning from the majority of those thus far considered, and will, like the more or less normal parietal fissures in the young, be dealt with in a special chapter.

GROUP I. CASES IN MAN.

Having received permission from Professor Putnam to re-examine the two Tennessee Indian crania with parietal

divisions, I am able to supplement the previously published facts concerning the specimens by a few additional points of interest and by illustrations of the divided parietals.

Putnam's 1st Case (26). *Original Report.* — A male adult cranium, from a prehistoric stone grave in Tennessee, showing an antero-posterior, almost horizontal, division of the left parietal (spec. 27205, Peabody Museum, Cambridge).

The skull is relatively broad and short, and shows a marked occipital compression. "The left parietal is divided into two quadrilateral pieces by a transverse serrated suture, crossing the bone at one third its height above the squamous suture. The transverse arc formed by the divided left parietal exceeds that of the normal right parietal by one fourth. The longitudinal arc of the left parietal is also greater than that of the right parietal, and the left side of the skull bulges upwards and outwards. The abnormal suture encloses a pair of Wormian bones (size 3 of Broca's scale)." "The coronal and sagittal sutures are simple and all the sutures except the basilar are open." The sutures of the back of the skull are crowded with supernumerary bones (over 20 in number).

Additional data and measurements. — The skull shows an apparently congenital absence of both upper lateral incisors; the other teeth are all present, well developed, and healthy. The foramen magnum is very large (diam. antero-posterior max., 3.7 cm.; diam. lateral max., 3.6 cm.), and of a somewhat irregular hexagonal form; projecting into the foramen from the middle of its anterior border is a 0.4-cm.-high bony tubercle. The skull is asymmetrical, which is partly due to the greater height and bulging of the left parietal, and partly to the somewhat one-sided occipital compression. At least one, and possibly two, of the separate bones in the lambdoid suture must be considered as portions of the occipital squama. Occlusion is manifested in the internasal, left masto-occipital, and about a few of the intercalated ossicles in the lambdoid suture. The skull as a whole is large and shows nothing pathological. There is no division on the right side, but the anterior border of the right parietal shows, in a position corre-

sponding to the point at which the anomalous suture begins on the left, a marked indentation.

Surface Measurements of the Two Parietal Bones.

Junction of the squamous and temporo-sphenoidal sutures to the anterior termination of the anomalous division	left 4.6 cm.	right —
Junction of the squamous and temporo-sphenoidal sutures to bregma	" 13.4 "	" 12.15 cm
Infero-superiorly at middle	" 14.5 "	" 12.2 "

(The posterior height cannot be measured accurately, the left asterion being obliterated and the right affected by the Wormian bones; but the height of the left parietal exceeds also here quite considerably that of the right one. The greatest height of the lower separate portion of the left parietal is found about 2.0 cm. anteriorly to the lambdoid suture, amounting to 5.5 cm. The superior piece measures 6.9 cm. along the lambdoid suture.)

Antero-posteriorly, from the middle of the coronal suture to a point about midway between the asterion and lambda, on the anterior boundary of the intercalated bones, the left parietal measures 12.6, the right 12.7 cm.; to the posterior boundary of the intercalated bones the left is 16.1, the right 15.1 cm.

Putnam's 2d Case (26). *Original Record.* — A brachycephalic, posteriorly somewhat compressed, adult male skull, from a prehistoric stone grave in Tennessee, with an oblique division of the left parietal and an angular separation of the postero-inferior extremity of the right parietal (spec. 12797, Peabody Museum).

"The extra suture (on left) springs from the left arm of the lambdoid suture at the junction of its middle and lower third, and passes nearly horizontally half way across the parietal. It is then deflected and runs towards the pterion. Posteriorly this suture is finely dentated, but anteriorly it becomes simple and is so much obliterated that it is impossible to trace its entire course. A large Wormian bone occurs in the left arm of the lambdoid suture at and above the origin of this anomalous suture."

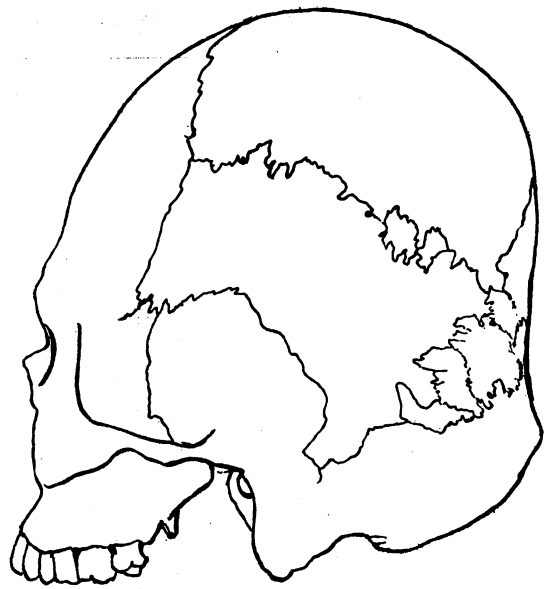


Fig. 8. Putnam's first case of parietal division. (Drawn from a photograph.)

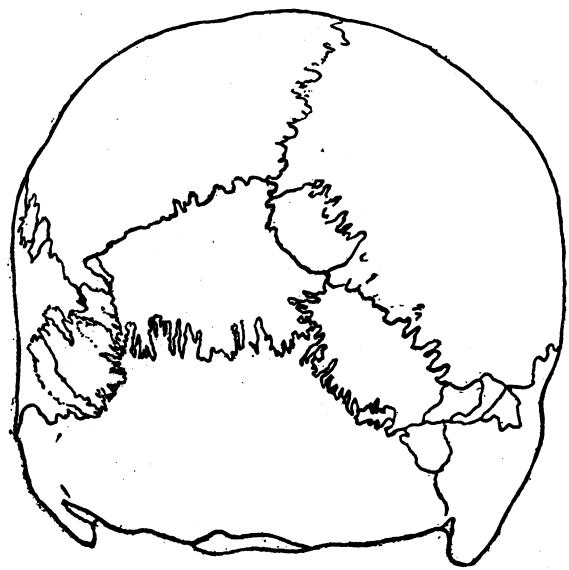


Fig. 9. Putnam's first case of parietal division, posterior view. (Drawn from a photograph.)

"The postero-inferior angle of the right parietal of this skull is also developed from a separate center. It is united with the main portion of the bone by a simple suture running from the squamous suture almost horizontally till it approaches the lambdoid, when it turns downward and enters this suture at a point opposite the middle of the squamous border of the intercalated bone."

"This skull has simple sutures which are open except near the pterion" (coronal).

Additional Remarks. — The skull is very large, measuring 1825 c.c. in capacity. It shows but a little asymmetry, and that mainly due to the artificial occipital compression. Nothing pathological. A number of sutures show more or less occlusion (partial synostosis in both malo-maxillary, left zygomatic, internasal, and all the intraorbital sutures; a complete occlusion of the coronal suture on both sides below the temporal ridge; traces of occlusion about lambda and in left lambdoid suture; and advanced occlusion in both spheno-parietal and both temporo-occipital articulations). The lambdoid suture contains four smaller Wormian bones, one of which is situated in a pronounced cleft from which begins the left anomalous division.

The division on the left runs in an irregular way across the whole length of the bone. The cleft from which it starts posteriorly extends along the lambdoid suture from a point 2.0 cm. to one 5.5 cm. above asterion, and is nearly as deep as high. The suture runs at first horizontally, then, somewhat anterior to the middle of the parietal, it bends downward, but soon bends again and proceeds forward, and finally forward and upward, terminating at a point about 2.2 cm. above the lower end of the coronal suture. The anterior portion of this anomalous suture was squamous, the posterior serrated. The anterior fourth of the division is totally occluded and hardly traceable; the occlusion diminishes backward, and the posterior three fifths of the suture are largely patent.

The anomalous suture on the right side is open, and of a moderately squamous character, the border of the lower overlapping somewhat that of the upper portion of the parietal.

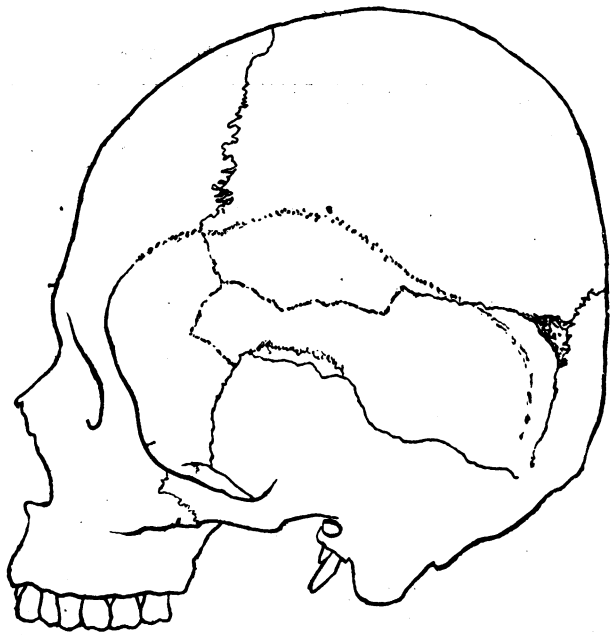


Fig. 10. Putnam's second case of parietal division. (Drawn from a photograph.)

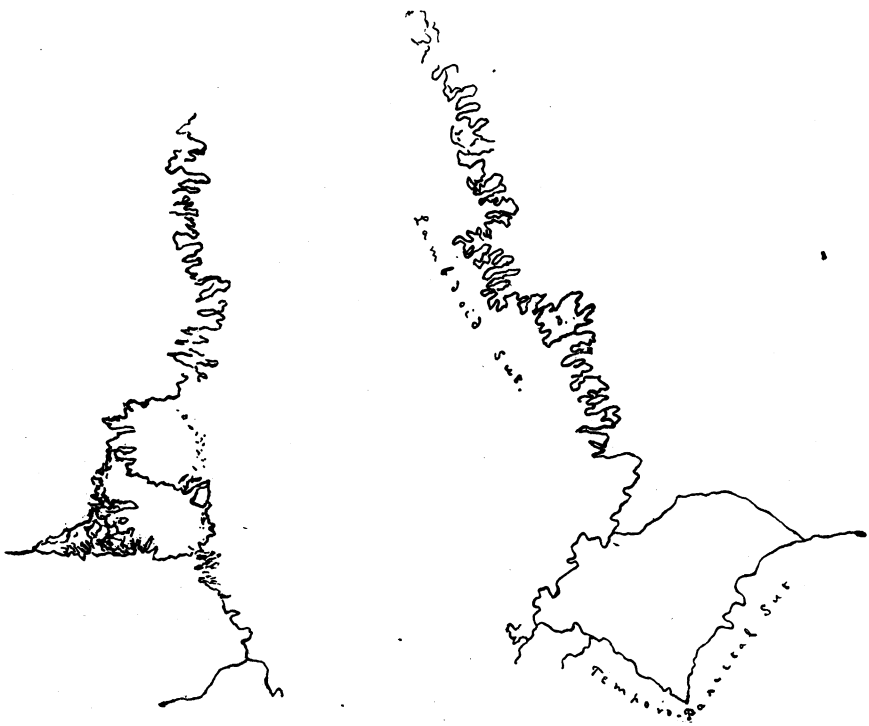


Fig. 11. Putnam's second case of parietal division; the occipital borders of the parietals.

The division begins posteriorly 2.3 cm. above the asterion and passes at first upward, then forward and slightly downward to the squamous suture. It separates a five-sided portion of bone, which measures 5.5 cm. in its greatest length, and 4.0 cm. in its greatest height parallel to the lambdoid suture. Near the middle of the lambdoid suture is a moderate-sized intercalated bone (γ), which may be of some importance; the signification of this ossicle will be referred to at the end of this section.

Surface Measurements of the Two Parietals:

Temporo-sphenoidal point	to anomalous suture	left,	2.2 cm.	right	—		
do.	to bregma	"	14.5	"	"	13.1	cm.
Infero-superior at middle	to anomalous suture	"	3.0	"	"		
	total	"	16.0	"	"	14.3	"
Asterion to lambda	to lower boundary of cleft	"	2.0	"	"	to suture 2.3	cm.
	to upper " " " "	"	5.5	"	"		
	to lambda	"	109	"	"	to lambda 11.5	"
Antero-posteriorly at middle		"	14.2	"	about	14.0	"

The chief of these additional facts is the possibility of tracing the left division in the second case to, or at least very near to, the coronal suture. The case is one of a complete antero-posterior parietal division, and it would be erroneous to class it, as Ranke has done, on the basis of the original data, among the separations of the mastoid angle. The coexistence of an infero-posterior suture on the right with the antero-posterior one on the left side imparts to the case a considerable additional interest.

The *partial parietal divisions* in man which I have found comprise the following:

Case *a*. A calvarium of an adult male skull, No. 1003, Medical Department, Columbia University,[1] N. Y.

The calvarium comprises most of the frontal squama and about the anterior $\frac{3}{4}$ of each parietal. No abnormalities. Advancing synostosis in both the sagittal and coronal sutures.

The anterior portion of the right parietal shows an incomplete division. This begins at the summit of a 0.5 cm. deep cleft in the anterior border of the bone, at the level of the

[1] Prof. Geo. S. Huntington's Morphological Museum.

superior line of the temporal ridge, and runs for 1.7 cm. closely to this line in a backward and upward direction. The division was somewhat serrated; externally it shows an advanced, internally a complete occlusion. There are traces of a more vertical suture that probably connected with the antero-posterior one between the third and median fourth of the latter, and bounded a large Wormian or fontanel bone situated in the coronal suture. On the left side there is in the anterior border of the parietal a 0.7 cm. deep cleft, located a little above the temporal ridge, but no trace of any division.

Cases *b*, *c*, *d*. Skull of an adult white, sex uncertain; No. 1002, M. D., C. U., N. Y.

Calvarium somewhat asymmetrical; a broad, shallow depression posteriorly to the coronal suture, and a somewhat abnormal elevation of the sagittal region at vertex. A large epactal bone, with a moderate-sized separate bone above it in lambda. Synostosis of the sagittal suture about obelion.

The left parietal bone shows in its anterior portion a 0.6 cm. long, straight, slightly serrated incisure. The division starts from the coronal suture between the two lines of the temporal ridge, 6.7 cm. below the bregma, and is directed backward and slightly upward. There is a trace of a similar incisure in the same location on the right parietal.

Two other calvaria showed similar short divisions situated between (2), or a slight distance above (1) the temporal lines.

Case *e*. Skull of a female, Swiss, 65 years old; No. 613, 1899–1900, M. D., C. U., N. Y.

Present only parts of the temporal, occipital, and right parietal bones.

The postero-inferior portion of the parietal bone shows a straight, slightly serrated, 1.3 cm. long, ventrally occluded division; the division begins in the posterior border of the parietal, 0.9 cm. above the asterion, and runs upward and forward, in the direction of the parietal eminence.

There are remnants of the suturæ mendosæ and the squamo-mastoid sutures.

Case *f*. Skull of a male white in advanced adult life (about 55 y.), No. 1067, M. D., C. U., N. Y.

The posterior portion of the left parietal bone shows remnants of an oblique division. This begins 0.7 above asterion and runs upward and forward toward the parietal eminence. The division can be plainly traced for 1.1 cm. externally, but is completely occluded ventrally.

The skull shows nothing pathological and no further anomalies.

Among the total of six cases in this category there are four with slight, more or less horizontal, anterior, and two with moderate, oblique, postero-inferior divisions of the parietal, all occurring in apparently normal adult skulls of whites.

New Instances of Anomalous Divisions of the Parietal Bones in Monkeys.

The total number of apes, monkeys, and lemurs examined by me for parietal divisions was 410, and of this there were:

Apes	Chimpanzee	2,	divisions	found	in	1
	Gorillæ	7	"	"	"	0
	Orangs	3	"	"	"	0
	Gibbons	2	"	"	"	0
		14	"	"	"	1
Old World Monkeys	Cynocephali	29	"	"	"	2
	Cercopitheci	43	"	"	"	1
	Chlororebi	3	"	"	"	0
	Cercocebi	7	"	"	"	0
	Colobus	1	"	"	"	0
	Macaci	190	"	"	"	32
		273	"	"	"	35
American Monkeys	Cebi	39	"	"	"	9
	Ateles	41	"	"	"	7
	Mycetes	2	"	"	"	0
	Alouatas	5	"	"	"	0
	Nyctipithecus	1	"	"	"	0
	Hapale	30	"	"	"	1
		118	"	"	"	17
Lemurs		5	"	"	"	0
Total		410	"	"	"	53

Of the 52 cases in monkeys there are 23 with but one complete or incomplete division in one of the parietals, the other bone showing no anomaly of this nature; in 1 instance there is more than one division in one parietal bone and none in the other; and in 28 cases there is one or more divisions in each parietal. In 9 of the 52 skulls there are co-existing partial divisions on one (7) or both sides (2) in the temporal squama, in line with, and looking like the extension of, the parietal suture.

In order to facilitate their description the new cases can be arranged, on the basis of the nature of the divisions, into several groups. These are:

(1) Partial vertical (infero-superior) divisions;
(2) Complete " " "
(3) Partial and complete vertical-oblique (sagittal to mastoid border) divisions;
(4) Partial and complete vertical sutures or fissures communicating with a temporal division;
(5) Partial and complete more or less horizontal (antero-posterior) divisions; and
(6) Compound cases. This last group includes some oblique divisions.

The cases in detail are as follows:

GROUP 2. PARTIAL VERTICAL (INFERO-SUPERIOR) DIVISIONS IN MONKEYS.

Case 1. *Cynocephalus baboon*, male, adolescent; No. '56, M. D., C. U., N. Y.

There is a 0.2 cm.-long vertical incisure in the sagittal portion of the left parietal bone, near its middle. Besides this the skull shows nothing special.

Case 2. *Macacus rhesus*, sex unknown, adolescent; No. 3775, A. M. N. H.,[1] N. Y.

There are plain traces of an occluded vertical division on the sagittal portion of each parietal. The divisions begin opposite each other, a little posterior to the anterior third of the sagittal border of each bone (1.6 cm. from bregma, 3.0

[1] Zoölogical Collection.

cm. from lambda), and both run straight downward, diverging slightly from the coronal suture. The left division can be traced for 1.8 cm., the right one 1.6 cm.

The skull is symmetrical and without other exceptional features. The parietal bones are almost equal in size.

Case 3. *Macacus rhesus*, male, adolescent; No. 3843, A. M. N. H., N. Y.

The sagittal portion of the right parietal bone is divided by a vertical fissure. The division begins very near the middle of the sagittal border (2.05 cm. from bregma, 2.0 cm. from lambda) and runs downward, parallel with the lambdoid suture. It is patent for 0.45 cm., but can be plainly traced 1.1 cm. further.

The skull is symmetrical and without other abnormalities.

The right parietal is slightly lower over its anterior two thirds, but throughout, except at the sagittal border, appreciably longer, than the left.

Surface measurements of the two parietal bones:

Lower end of coronal suture to bregma.....	left 4.05,	right	4.0	cm.
Infero-superiorly at middle.....	" 4.2	"	4.0	"
Asterion-lambda.....	" 3.2	"	3.2	"
Lower end of coronal suture to asterion.....	" 4.6	"	4.75	"
Antero-posteriorly at middle.....	" 4.45	"	4.65	"

Case 4. *Macacus rhesus*, male, adolescent; No. 3, M. D., C. U., N. Y.

There is a 0.5 cm.-long straight incisure in the sagittal portion of the left parietal bone. The division begins somewhat anterior to the middle of the sagittal border (1.6 cm. from bregma, 2.2 cm. from lambda) and runs parallel to the coronal suture.

The skull is symmetrical, without any other remarkable features. The two parietals are almost exactly alike in measurements.

Case 5. *Macacus rhesus*, male, adolescent; No. 13, M. D., C. U., N. Y.

The sagittal portion of the left parietal bone shows a 0.95 cm. long, slightly serrated, straight division, running nearly

parallel with the lambdoid suture. The division begins between the middle and fourth fifth of the sagittal border of the bone (2.55 cm. from bregma, 1.7 cm. from lambda).

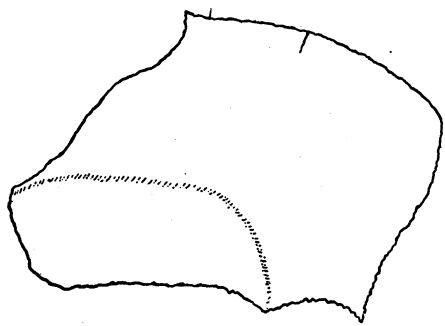


Fig. 12. *Macacus rhesus* (No. 3, Morphological Museum, Columbia University). Incisure in the sagittal border of the left parietal.

There is no trace of any division in the right parietal. The surface measurements of the two lower show the right parietal to be slightly longer, and in the anterior three fourths also appreciably higher than the left one.

The skull is fairly symmetrical. There is a small bregmatic bone. No signs of any injury.

Surface measurements of the two parietals:

Point of junction of squamous and coronal sutures to bregma	left 4.15,	right 4.2	cm.
Infero-superiorly at middle	" 4.2	" 4.45	"
Asterion to lambda	" 3.2	" 3.2	"
Squamo-coronal junction to asterion	" 4.7	" 4.75	"
Antero-posteriorly at middle	" 4.95	" 5.0	"

Case 6. *Macacus rhesus*, sex unknown, adolescent; No. 106, M. D., C. U., N. Y.

The left parietal shows a 1.2 cm.-long mark of a vertical division, running from the sagittal border, parallel to the coronal suture. The division began slightly anterior to the middle of the border (1.8 cm. from bregma, 2.1 cm from lambda).

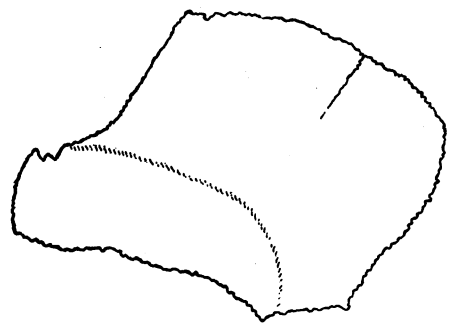


Fig. 13. *Macacus rhesus* (No. 13, Morphological Museum, Columbia University). Partial vertical division of the left parietal.

Skull symmetrical, no injuries or other anomalies. The left parietal is slightly shorter inferiorly, but slightly longer above the lowest third, than the right, the height of both bones being very nearly equal.

Surface measurements of the two parietal bones:

Lower end of coronal suture to bregma.....	left	4.5,	right	4.5 cm.
Infero-superiorly at middle	"	4.3	"	4.35 "
Asterion to lambda.....	"	3.2	"	3.2 "
Lower end of coronal suture to asterion.....	"	4.6	"	4.75 "
Antero-posteriorly at middle	"	4.95	"	4.8 "

Case 7. *Macacus rhesus*, female, young adolescent; No. 111, M. D., C. U., N. Y.

The parietal bones show each a vertical, straight, almost entirely occluded division in their superior portion. The division on left begins in the sagittal border of the parietal, 2.45 cm. from the bregma and 1.85 cm. from the lambda, that on right 2.7 cm. from the bregma and 1.6 cm. from the lambda. Both run almost parallel to the coronal suture. The division in the left parietal can be plainly traced for 2.3 cm., that in the right for 1.1 cm.

The skull shows no injuries or other gross anomalies. The two parietals are almost identical in measurements.

Case 8. *Macacus rhesus*, male, adolescent; No. 120, M. D., C. U., N. Y.

There is a partial vertical division in the sagittal portion of the left parietal bone. The division begins slightly posterior to the anterior third of the sagittal border (1.6 cm. from bregma, 2.4 cm. from lambda). It is 0.55 cm. long, but can be traced, particularly by transmitted light, 1.0 cm. further; it is straight, not serrated or squamous, and runs downward, diverging slightly from the coronal suture.

There is no trace of any division on the right parietal. The skull is symmetrical and without other gross anomalies. No sign of any injury. The surface measurements of the two parietals are very nearly equal.

Case 9. *Macacus rhesus*, sex unknown, young; No. 134, M. D., C. U., N. Y.

The right parietal shows a plain trace of a vertical division,

running from the sagittal border of the bone to near the temporal ridge. It begins 1.65 cm. posterior to the bregma and 2.65 cm. from the lambda, and runs nearly parallel with the coronal suture. The skull is symmetrical, the parietals of very nearly the same size.

Case 10. *Macacus rhesus*, sex unknown, adolescent; No. 137, M. D., C. U., N. Y.

There are traces of a vertical division in the superior portion of each parietal. Both divisions begin posterior to the middle of the sagittal border, that on left 2.45 cm. from bregma and 1.65 cm. from lambda; that on right 2.95 cm. from bregma and 1.15 cm. from lambda. The sagittal extremity of both is still open. The division on the left can be traced for 1.1 cm., that on the right for 1.7 cm. Both are straight and nearly parallel with the lambdoid suture.

The measurements show that the anterior two thirds of the right parietal are slightly higher, while the length of the two bones is very nearly the same.

The frontal bone shows on left, near the eminence, a 1.3 cm.-long, 0.9 cm.-broad, and 0.25 cm.-deep depression, and in the floor of this are two small oval perforations. There are no signs of fracture or inflammation, and the origin of the depression is not clear. It stands in no perceivable connection with the parietal divisions.

Case 11. *Macacus rhesus*, sex unknown, adolescent; No. 148, M. D., C. U., N. Y.

The right parietal shows a 2.4 cm.-long mark of a vertical division, which begins in the middle of its sagittal border and runs downward parallel with the coronal suture.

The skull is fairly symmetrical; there are no injuries or other anomalies. The skull being open the parietals cannot be properly measured.

Case 12. *Macacus cynomolgus*, female, adolescent; No. 122, M. D., C. U., N. Y.

The left parietal bone shows near its middle traces of what was probably originally a complete anomalous parietal division. The skull is symmetrical and without further anomalies.

Case 13. *Macacus erythræus*, sex unknown, adolescent; No. 1613, A. M. N. H., N. Y.

The sagittal portion of each parietal bone shows a vertical division.

The division on the left begins superiorly almost at the middle of the sagittal border of the parietal (2.2 cm. from bregma, 2.1 cm. from lambda), is 0.4 cm. long, straight, and parallel with the lambdoid suture. The division on the right begins sagittally near the posterior fourth of the border, passes for 0.45 cm. downward nearly parallel with the lambdoid suture, then becomes considerably occluded, but can be followed 0.8 cm. further, running downward and somewhat forward, in the direction of the parietal eminence.

The skull is symmetrical, the parietals nearly equal. No injuries or other anomalies.

Case 14. *Macacus erythræus*, sex unknown, adolescent; No. 4347, A. M. N. H., N. Y.

The right parietal bone shows a short vertical incisure between the middle and posterior thirds of its sagittal border. From this incisure a plain mark of an occluded division runs downward, parallel with the lambdoid suture, to the temporal ridge (3.2 cm. from the sagittal, 1.0 cm. from the squamous suture).

The skull is symmetrical and free from signs of injuries and other anomalies. The right parietal bone is somewhat higher, but at middle a little shorter than the left one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma.....	left	4.1,	right	4.3	cm.
Infero-superiorly at middle.....	"	4.05	"	4.2	"
Asterion to lambda	"	2.85	"	2.95	"
Squamo-coronal junction to asterion.....	"	4.7	"	4.7	"
Antero-posteriorly at middle.....	"	4.7	"	4.6	"

Case 15. *Cebus*, sex unknown, young; No. 86, M. D., C. U., N. Y.

The superior part of the anterior portion of the left parietal bone shows one, and the sagittal portions of both the left and right parietal each two marked clefts.

The anterior division on left is 0.4 cm. long and directed

downward and backward. The more anterior of the left sagittal clefts begins superiorly nearly at the middle of the border, is 1.1 cm. long, and runs downward and slightly forward. The second left sagittal cleft begins between the third and last fourths of the border, is 0.35 cm. long and is also directed downward and slightly forward.

On the right side, the more anterior of the two clefts begins 0.3 cm. posteriorly to the bregma, is 0.4 cm. long, and runs nearly parallel with the coronal suture, showing a slight tendency to turn backward. The more posterior cleft on this side begins superiorly between the middle and last thirds of the sagittal border, is 0.6 cm. long, and passes downward with a tendency to curve backward. (Pl. IX.)

The skull is fairly symmetrical and free from other anomalies.

Case 16. *Ateles ater*, young, sex unknown; No. 187, M. D., C. U., N. Y.

The sagittal portion of the left parietal shows a partly occluded 1.0 cm.-long division, running parallel with the lambdoid suture.

The skull is symmetrical; the right parietal bone is both slightly longer and broader than the left one.

Case 17. *Hapale*, sex unknown, young; No. 58*a*, M. D., C. U., N. Y.

The right parietal bone shows a remnant of, in all probability, a formerly complete vertical-horizontal suture. The remaining part of the division begins distally in the sagittal border of the parietal, 0.3 cm. anteriorly to the lambda. It runs with several bends and curves downward and forward over the eminence and to near the temporal ridge, where it becomes totally occluded.

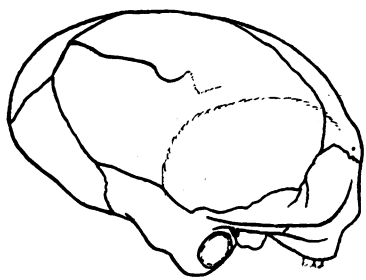


Fig. 14. *Hapale* (No. 58*a*, Morphological Museum, Columbia University). Division of right parietal.

The skull shows no other special features. The right parie-

tal bone is very slightly longer, and a little lower than the left one.

GROUP 3. COMPLETE VERTICAL PARIETAL DIVISIONS IN MONKEYS.

Case 18. *Macacus rhesus*, male, advanced adolescent; No. 10, M. D., C. U., N. Y.

The parietal bones show each a vertical division.

The division in the left parietal begins slightly anterior to the point between the most anterior and middle thirds of the sagittal border of the bone (1.6 cm. posterior to the bregma, 3.6 cm. anterior to the lambda). It runs in a slightly wavy course downward and a little backward to the upper boundary of the temporal ridge, beyond which no marks of any further division are visible. Below its superior two fifths the division shows advancing occlusion.

The right parietal bone shows a superior and an inferior fissure, but these two are joined by a plainly traceable line of occlusion; it is evident that originally the bone was separated into two by a complete vertical suture. The division began superiorly between the middle and posterior third of the sagittal border (3.2 cm. from bregma, 2.0 cm. from lambda) and ran parallel with the lambdoid suture. The inferior open segment reaches the lower boundary of the temporal ridge.

The normal sutures are still all patent. The anomalous sutures were, so far as can be seen in their remnants, of a very slightly squamous nature, the border of the anterior overlapping those of the posterior portions.

The skull is symmetrical and the two parietals differ but insignificantly in size, as can be seen from the following surface measurements:

Junction of squamous and coronal sutures to bregma	left	4.4,	right	4.45	cm.
Junction of squamous and coronal sutures to asterion	"	4.8	"	4.85	"
Asterion to lambda	"	3.35	"	3.3	"
Antero-posteriorly at middle	"	5.4	"	5.3	"
Infero-superiorly " "	"	4.65	"	4.6	"

The same skull shows, without any sign of an injury in any part, a separation of a portion of the lower border of the nasal bones, and two supranasal ossicles. (Fig. 15 and Pl. VII.)

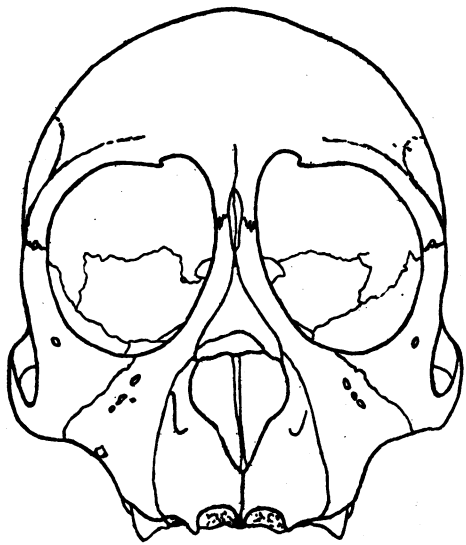


Fig. 15. *Macacus rhesus* (No. 10, Morphological Museum, Columbia University). Showing a separation of the lower portion of the nasal bones, and two independent supranasal ossicles.

Case 19. *Macacus cynomolgus*, sex ?, nearly adult; No. 38, M. D., C. U., N. Y.

The cranium presents well-marked traces of a complete vertical division of the right parietal.

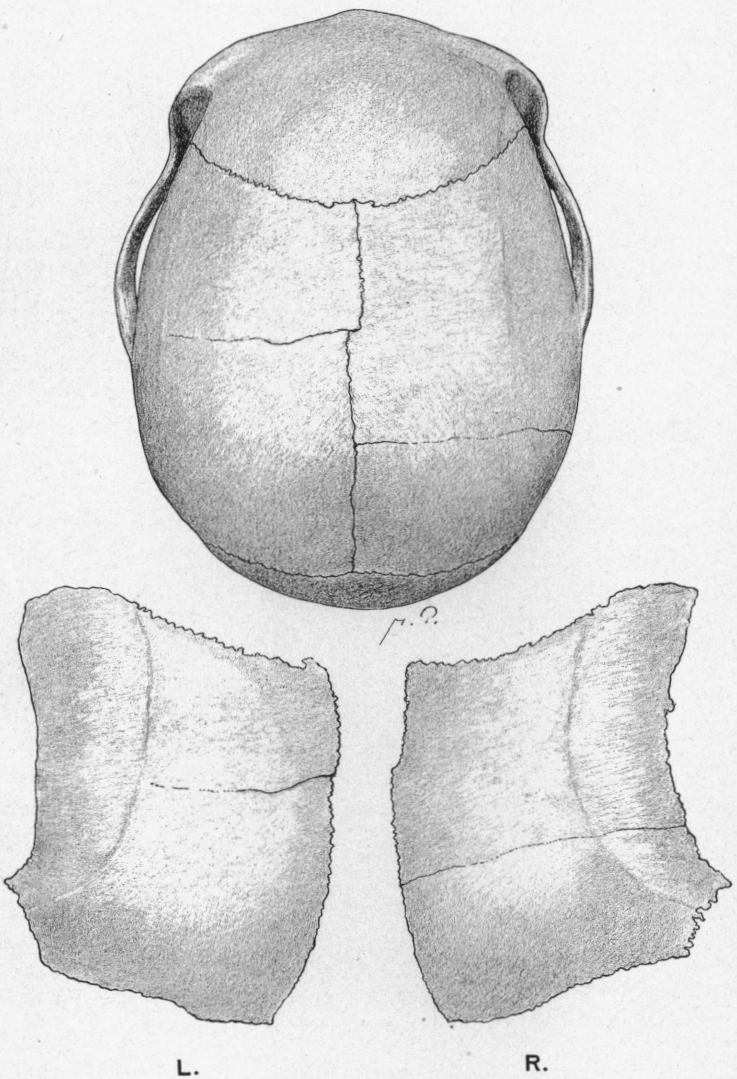
The anomalous suture consists of a superior, open, 7 mm.-long extremity, which begins slightly posteriorly to the middle of the sagittal border of the right parietal, and runs almost parallel with the vertical axis of the bone; and of an obliterated, but traceable part, which proceeds from the open extremity downward, in the same direction, to the temporal border of the parietal. Eleven mm. from the sagittal border a small open slit is seen in the course of the division.

Measurements of the two parietal bones:

Length	in middle	left 5.05,	right 5.4	cm.
"	squamo-coronal point to asterion	" 4.45	" 4.5	"
Hight,	" " " " bregma	" 4.1	" 4.25	"
"	in middle	" 4.15	" 4.15	"
"	asterion to lambda	" 3.0	" 3.0	"

The right bone is throughout larger antero-posteriorly, and is also slightly higher in front than the left.

The skull as a whole is not perceptibly asymmetrical, shows



Macacus rhesus, Male (No. 10, Morphological Museum, Columbia University). Vertical, partly obliterated, Parietal Divisions.

no signs of injuries and no further anomalies. All the normal sutures are open and there are no Wormians.

Case 20. *Macacus rhesus*, young adolescent, sex unknown. No. 101, M. D., C. U., N. Y.

The right parietal shows two extremities of a vertical suture, connected by traces of the same.

The superior end of the division begins 2.4 cm. posterior to bregma, 2.1 cm. anterior to lambda, is straight, and 0.4 cm. long. The lower end, nicely serrated, is 0.7 cm. in length. The intervening traces of the complete suture show that this was of a nearly straight course and ran parallel to the lambdoid suture, crossing the parietal eminence. The eminence is somewhat rough and irregular.

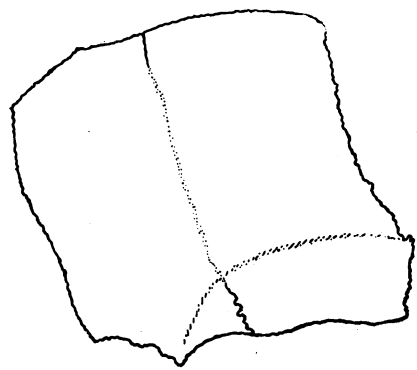


Fig. 16. *Macacus rhesus* (No. 101, Morphological Museum, Columbia University). Vertical, partly obliterated, parietal division.

Surface measurements of the two parietals show that the divided bone is slightly longer than the one on the opposite side:

Bregma to lambda	left 4.3,	right 4.5	cm.
Temporo-sphenoidal junction to bregma	" 4.4	" 4.5	"
" " " to asterion	" 4.2	" 4.2	"
Asterion to lambda	" 3.4	" 3.5	"
Antero-posteriorly at middle	" 4.55	" 4.8	"
Infero-superiorly " "	" 4.4	" 4.35	"

The skull is fairly symmetrical and without further anomalies.

GROUP 4. VERTICAL-OBLIQUE PARIETAL DIVISIONS IN MONKEYS.

Case 21. *Macacus rhesus*, female, adolescent; No. 37, M. D., C. U., N. Y.

Both parietals show remnants of a vertical-oblique division, which began superiorly in the sagittal border of each bone, 2.0 cm. from bregma and 2.4 cm. from lambda, and ended on each side in or near the mastoid angle. The division on the left is partly, that on the right entirely, occluded. Both divisions ran nearly parallel with the coronal suture up to the parietal eminence, but began to curve backward between this and the temporal ridges. The deflection is most marked in the neighborhood of the ridges. The unoccluded portion of the left division shows it to have been of a slightly squamous nature, the border of the anterior portion of the parietal overlapping that of the posterior. (Pl. VIII.)

The skull is fairly symmetrical, without other anomalies and without any signs of injury. The right parietal bone exceeds the left slightly in all the measurements.

Surface measurements of the parietals:

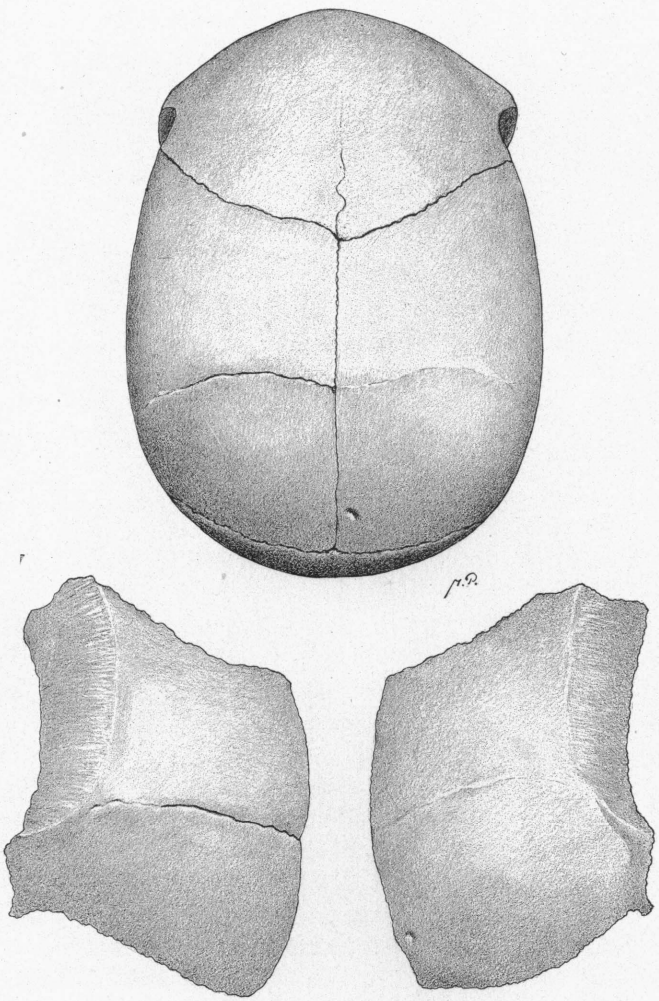
Lower end of the coronal suture to bregma...	left	4.0,	right	4.1	cm.
Infero-superiorly at middle.....	"	4.15	"	4.3	"
Asterion to lambda.....	"	3.2	"	3.3	"
Lower end of the coronal suture to asterion...	"	4.15	"	4.35	"
Antero-posteriorly at middle.....	"	4.8	"	5.1	"

Case 22. *Macacus rhesus*, young, sex unknown; No. 47, M. D., C. U., N. Y.

The specimen presents a division of the right parietal bone by a complete vertical-oblique suture, and traces of a similar division on the left parietal.

The right anomalous division begins superiorly on the sagittal border of the parietal, 1.7 cm. posterior to the bregma and 2.5 cm. anterior to the lambda. It runs in a slightly wavy course for 1.8 cm. parallel to the vertical axis of the bone, then bends in a broad curve backward, and proceeding backward and downward terminates, after making a small loop, at the beginning of the parieto-mastoid border. The whole suture is patent, and of the squamous character, the anterior division of the bone overlapping the posterior. In the terminal 5 mm. of the suture the border of the overlapping anterior portion shows a well-marked serration.

On the sagittal border of the left parietal, 0.85 cm. pos-



Macacus rhesus (No. 37, Morphological Museum, Columbia University). Parietal Divisions (right nearly obliterated).

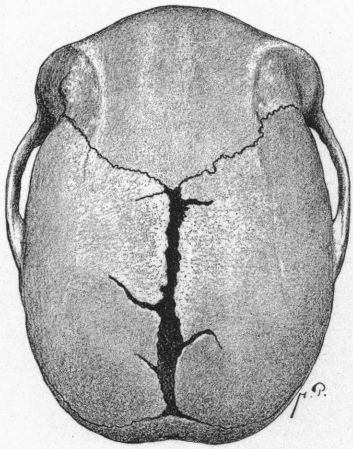


FIG. 1.

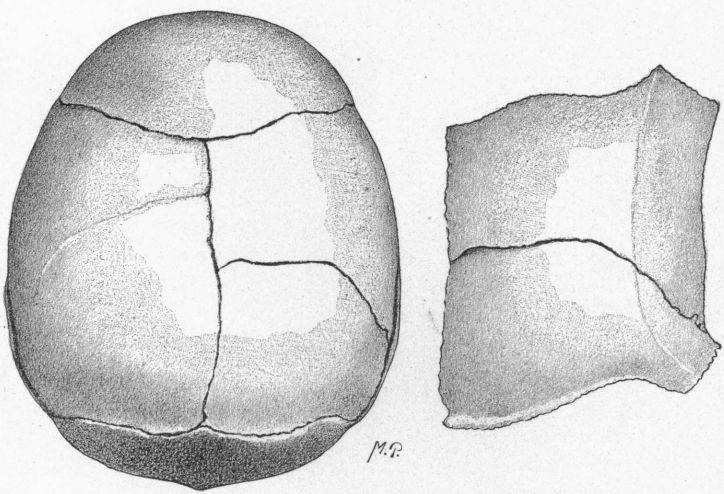


FIG. 2.

FIG. 1.—CEBUS, YOUNG (No. 86, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). PARIETAL INCISURES.

FIG. 2.—MACACUS RHESUS (No. 47, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). SHOWING PARIETAL DIVISIONS.

teriorly to the bregma, we find a trace of obliterated division which may be followed, with some difficulty, downward and backward, to near the beginning of the parieto-mastoid border. The border of the anterior portion of the bone along the upper part of this scar-like mark is elevated into a distinct ridge. (Pl. IX.)

The skull shows no signs of injuries and no anomalies besides the parietal divisions. All the ordinary cranial sutures are patent. There are no Wormian bones. The border of the occipital squama projects, on an average, about 1 mm. above the plane of the parietals (a condition quite common in macaques).

The two parietals show the following proportion (surface measurements):

Length along sagittal suture	left	4.2,	right	4.2	cm.
Squamo-sphenoidal point to asterion	"	4.25	"	4.25	"
" " " " bregma	"	3.9	"	4.05	"
Hight in middle	"	4.3	"	4.0	"
Asterion to lambda	"	2.95	"	3.1	"

The length of the two bones is about the same. In hight the right parietal predominates anteriorly and posteriorly, the left parietal in the middle.

Case 23. *Macacus rhesus*, male, young adolescent; No. 118, M. D., C. U., N. Y.

The skull presents a considerably occluded, vertical-oblique division of the right parietal bone, and a trace of a similar division on the left parietal.

The right anomalous division begins superiorly almost exactly in the middle of the sagittal border of the parietal. It proceeds for 3.2 cm. in a straight course and parallel to the lambdoid suture, to the temporal lines, then curves and runs backward and downward across the lines, and in an irregular course to the mastoid angle. The suture is distinct, but entirely occluded, with the exception of two small segments just above and below the temporal ridge. On the ventral surface of the bone the whole division is represented by a distinct, though shallow and narrow groove.

The external surface of the left parietal bone shows traces

of an occluded division, which began directly opposite the division on the right, ran vertically for nearly 2 cm., then curved backward and ran backward and downward. It can be traced to within 1 cm. of the asterion. This division is much less distinct than that on the right, and is not marked internally. Along the vertical part of the same, the border of the anterior portion of the parietal is elevated above that of the posterior.

Measurements of the two parietals:

Length along sagittal border	left 4.7,	right 4.7	cm.
" squamo-coronal to squamo-lambdoid point	" 5.05	" 5.15	"
Hight, squamo-coronal point to bregma	" 4.7	" 4.5	"
" in middle of the bone	" 4.6	" 4.6	"
" squamo-lambdoid point to lambda	" 2.85	" 2.8	"

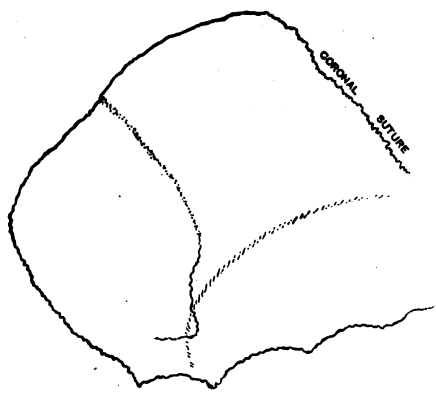


Fig. 17. *Macacus rhesus* (No. 118, Morphological Museum, Columbia University). Vertical-oblique parietal division.

The two bones differ slightly in individual measurements, but their area, which may be represented by an average of all the measurements taken on each bone, is almost equal. The inequalities do not affect the symmetry of the skull, which shows no further anomalies, save a small Wormian bone in bregma, and no signs of injuries. All the normal cranial sutures are open.

GROUP 5. VERTICAL PARIETAL DIVISIONS WITH EXTENSION INTO THE TEMPORAL SQUAMA, IN MONKEYS.

Case 24. *Macacus rhesus*, female, adolescent; No. 15711, A. M. N. H., N. Y.

The right parietal bone shows a partial vertical division affecting its inferior portion, and this division connects ex-

ternally with an incisure in the temporal squama, running in the same direction.

The parietal division can be traced but 0.35 cm. above the squamous suture, which it meets at a point very near the middle between the squamo-lambdoid and squamo-coronal junctions.

The temporal fissure runs from a point very slightly anterior to that at which the parietal division reaches the squamous suture for 0.35 cm. straight downward, then makes two little loops backward, and ends in the upper portion of the depression above the base of the zygoma.

The skull is fairly symmetrical and shows no signs of any injury or any other anomalies. The right parietal bone is al-

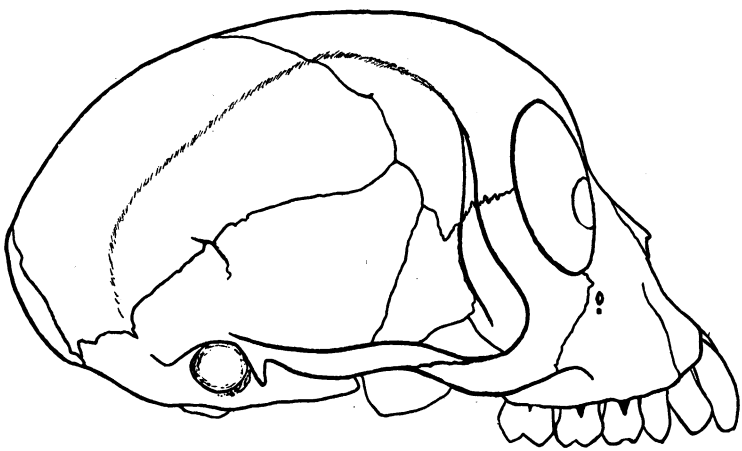


Fig. 18. *Macacus rhesus* (No. 15711, A. M. N. H.). Partial temporo-parietal division.

most throughout its whole extent longer and anteriorly quite considerably higher, but posteriorly lower, than the left one.

Surface measurements of the two parietals:

Hight, squamo-coronal junction to bregma...	left 3.95,	right 4.5	cm.
" infero-superiorly at middle.....	" 4.2	" 4.2	"
" asterion to lambda.....	" 3.5	" 3.2	"
Length, squamo-coronal junction to asterion..	" 5.0	" 5.0	"
" 0.5 cm. above squamo-coronal junction and asterion.....	" 5.0	" 5.1	"
" in middle.....	" 4.35	" 4.5	"
" along sagittal suture.....	" 3.45	" 3.65	"

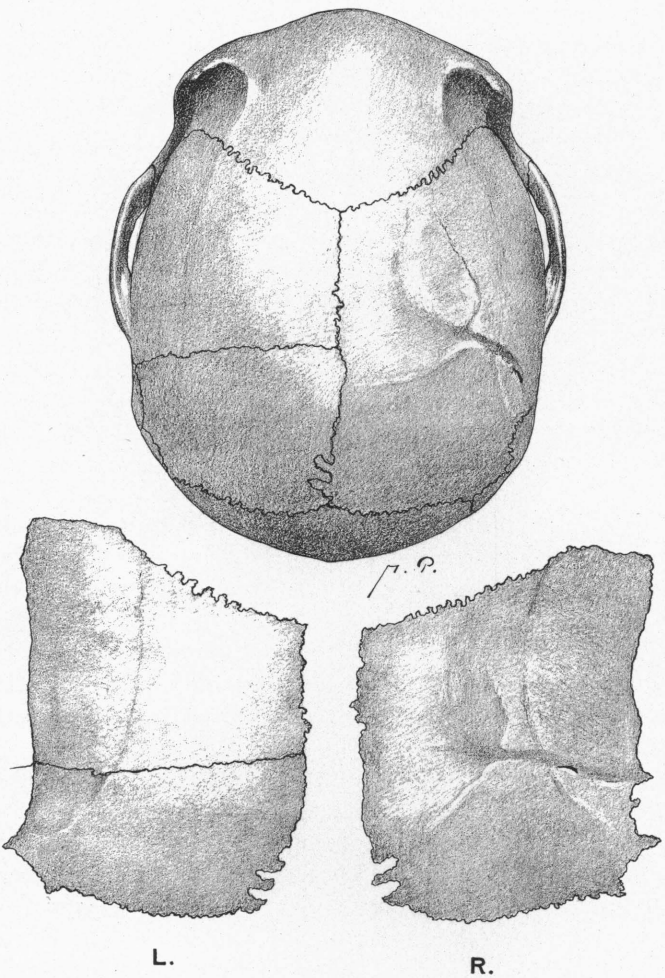
Case 25. *Macacus rhesus*, female, adolescent; No. 14, M. D., C. U., N. Y.

The left parietal bone shows a complete, the right a partly obliterated, vertical parietal division, and both these divisions are externally slightly prolonged downward by a fissure in each temporal squama.

The division in the left parietal begins superiorly in the sagittal border of the bone, 1.7 cm. from bregma and 2.1 cm. from lambda, and runs in a nearly straight course, converging slightly from above downward with the lambdoid suture, to a point on the squamous suture distant 3.0 cm. from the squamo-coronal junction and 1.8 cm. from the asterion. At this point the division is met by the 0.35 cm.-long temporal incisure, which runs downward in the same direction with the parietal suture. The anomalous division is slightly squamous in character, the border of the anterior overlapping that of the posterior portion of the bone.

The division in the right parietal begins inferiorly directly above a 0.2 cm.-long vertical fissure in the temporal squama, at a point distant 3.0 cm. from the squamo-coronal junction and 1.8 cm. from asterion. The parietal division soon becomes occluded, but can be easily followed upward, as a quite broad mark, to the sagittal fourth of the bone, where it curves forward and becomes indistinct. One centimeter above the squamous suture there is in the just-mentioned mark a second, short, patent segment of the division; while 2.1 cm. above the squamous suture there diverge from the mark two moderate elevations. The anterior of these elevations runs in a slightly wavy course to within a short distance from the superior fourth of the coronal; the posterior, in a similar course, to within a short distance from the posterior fourth of the sagittal suture. The part of the parietal bone immediately above these elevations is slightly depressed. It appears as if the elevations and the depression above them represented the borders of inferior and superior portions of the parietal bone, separated formerly by now occluded divisions. (Pl. X.)

Neither the right parietal bone nor any other part of the



Macacus rhesus, Female (No. 14, Morphological Museum, Columbia University). Bilateral Vertical Parietal Division, extending on each side slightly into the Temporal Squama. The suture in the right Parietal is nearly obliterated.

skull shows any signs of violence or any pathological condition. Judging from this fact and the symmetry of the inferior part of the division on the right to that on the left side, it is probable that the marks on the right parietal are remnants of anomalous divisions of the bone. The divisions superior to the parietal eminence must have become occluded very early, and the direction of the marks may have been modified somewhat by an unequal growth of the various portions of the bone.

The parietal region of the skull is slightly asymmetrical. The right parietal bone is throughout somewhat higher and at middle also slightly longer than the left one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma.....	left	4.2,	right	4.5	cm.
Infero-superiorly at middle.....	"	4.0	"	4.15	"
Asterion to lambda.....	"	2.7	"	2.9	"
Squamo-coronal junction to asterion.....	"	4.8	"	4.8	"
Antero-posteriorly at middle.....	"	4.8	"	4.95	"

Case 26. *Macacus rhesus*, sex unknown, adolescent; No. 107, M. D., C. U., N. Y.

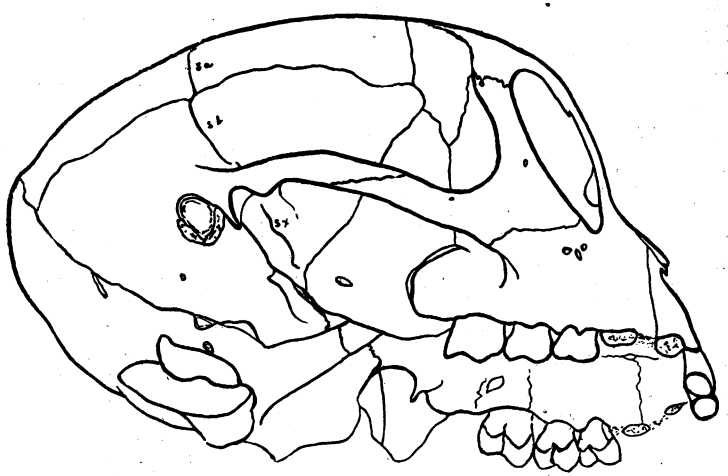


Fig. 19. *Macacus rhesus* (No. 107, Morphological Museum, Columbia University). Temporo-parietal division.

The inferior portion of the right parietal bone is separated by a vertical division, and this is met at the squamous suture

by a division in the temporal bone, running in the same direction.

The parietal division is patent from the inferior border of the bone to 1.4 cm. above the squamous suture, which it meets nearly at the middle point between asterion and the squamo-coronal junction. The course is upward and slightly forward; it reaches the lower boundary of the temporal ridge, beyond which it is not traceable. The superior 0.4 cm. of the division shows several points of occlusion.

The temporal division begins slightly posterior to the point at which that of the parietal meets the squamous suture and runs downward to above the base of the zygoma, where externally it becomes obliterated. Slightly below and anteriorly to the end of the superior division another fissure begins and runs for about 0.6 cm. through the zygomatic fossa and along the middle of the base of the zygoma. Upon examining the right glenoid fossa, we find that anterior to the Glasserian fissure the fossa is traversed by still another slightly wavy, 1.05 cm. long division, which begins on the basal surface of the zygoma and ends before reaching the median border of the temporal bone. The superior and this basal temporal division run in nearly the same line.

The very unusual condition just described is explained when we remove the parietal bones and examine the skull ventrally. It is then seen that the superior divisions, as well as that in the glenoid fossa, penetrate the bone and form on the inside of the skull parts of a slightly serrated suture, which runs from the superior border of the squama downward and inward to and over the border of the basilar portion of the temporal bone anterior to the Glasserian fissure, and connects with the basilar extremity of the temporo-sphenoidal suture. There are a few small points of obliteration in the basal end of this anomalous division.

The skull shows absolutely no sign of any injury, or any sign of restitution (porosity or new bone formation) along the temporal or parietal divisions. The skull is symmetrical and free from other anomalies. The right parietal bone is longer and slightly higher, and the right temporal squama is equally

slightly longer and higher than the same parts on the left side.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma	left 4.3,	right 4.5	cm.
Infero-superiorly at middle	" 4.75	" 4.8	"
Asterion to lambda	" 3.2	" 3.2	"
Squamo-coronal junction to asterion	" 4.9	" 5.1	"
Antero-posteriorly at middle	" 4.15	" 4.3	"

The exact nature of the parieto-temporal division in this case must remain somewhat uncertain until large numbers of other specimens have been reported upon. There are factors, such as the absence of injury and signs of restitutive processes; the involvement of the whole temporal bone ventrally, while there are interruptions externally; the signs of occlusion at the extremities of the division; the beginning of the temporal division at a little distance from the point at which the parietal division reaches the temporal squama and in a notch, which was observed in all other cases of parieto-temporal division; and the similarity of location of the divisions with that in cases where there is no doubt as to the anomalous nature of the divisions; all of which favor more or less the assumption that in this case, also, we have examples of anomalies. What creates doubt as to this conclusion are the unusual location of the temporal division and another fact, not yet mentioned: when we separate the edges of the divided bones, we see that in parts of both the parietal and temporal bones the borders do not show articular surfaces, but an open cellular structure.

Case 27. *Macacus*, species and sex unknown, adolescent; No. 11022, A. M. N. H., N. Y.

The specimen presents on each side an anterior episquamous bone, which, as comparison with other macaque skulls shows, is either formed at the expense of, or, (more probably) is a separation, of the extremity of the sphenoidal angle of each parietal; and there are two incisures, one on each side, in the superior portion of the temporal squama, one connecting with, and the other in the neighborhood of, the suture that bounds superiorly the separate ossicles.

The separate bones are triangular in shape. The one on

the left measures 0.3 cm. along the coronal and 0.5 cm. along the squamous suture; that on the right is slightly larger.

The temporal incisure on the left is 0.7 cm., that on the right 0.4 cm. long. The left incisure runs parallel with the temporo-sphenoidal suture; that on the right side passes vertically downward, but at its end makes a slight curve forward and would end, if prolonged, in the upper portion of the sphenoidal portion of the temporal.

Posterior to the beginning of the left temporal incisure the squamous suture turns downward and runs to the extremity of the division, thus forming a deep notch, and leaving uncovered a narrow strip of the subsquamous portion of the parietal bone. This condition shows that the incisure is not recent. (Pl. XI.)

Ventrally, the conditions are almost the same as externally; the separate bones have all the appearance of being portions of the parietal bone.

The skull shows no signs of any injury or any pathological condition. It is symmetrical, and, with the exception of an oblong ossicle between the left nasal bone and superior maxilla, is free from further anomalies.

Surface measurements of the two parietals show the left bones to be inferiorly slightly longer, while superiorly the condition is reversed, the right bone being very slightly the longer.

Hight, lower end of the coronal-suture to bregma	left	4.3,	right	4.3	cm.
" infero-superiorly at middle	"	3.8	"	3.8	"
" asterion to lambda	"	2.2	"	2.15	"
Length, lower end of coronal suture to asterion	"	4.45	"	4.25	"
" antero-posteriorly at middle	"	4.7	"	4.7	"
" bregma to lambda	"	3.45	"	3.55	"

Case 28. *Cebus albifrons*, male, nearly adult; No. 8309, A. M. N. H., N. Y.

The inferior portion of the right parietal bone shows, near its middle, a vertical division, and this is met externally by a partial division in the temporal squama running in the same direction.

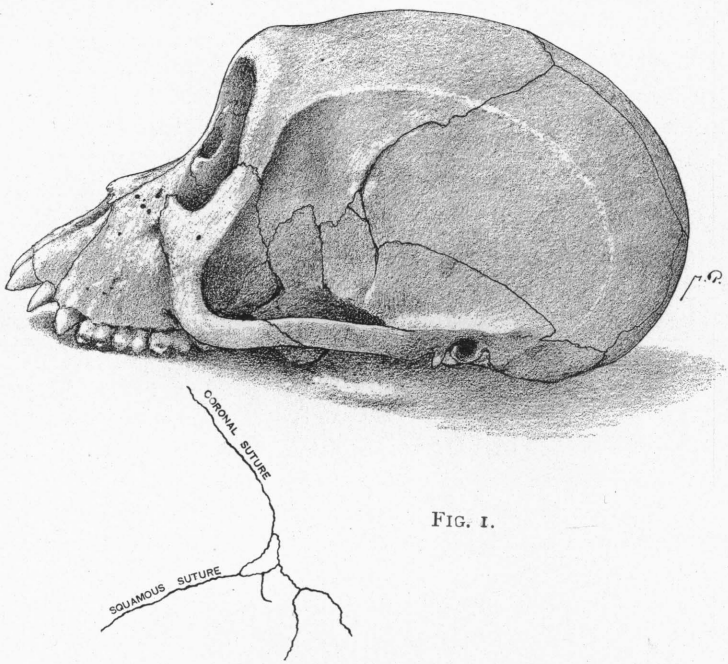


FIG. 1.

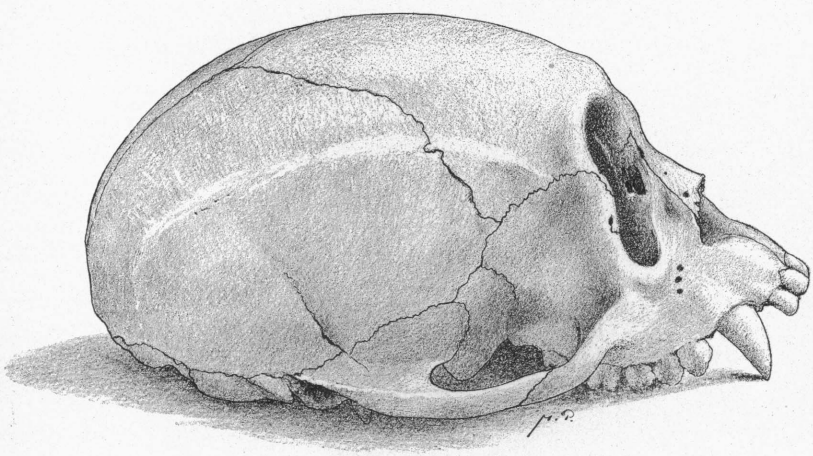


FIG. 2.

FIG. 1.—MACACUS (No. 11,022, A. M. N. H.) BILATERAL SEPARATION OF THE TIP OF THE SPHENOIDAL PROCESS OF THE PARIETAL; EXTENSION OF THE DIVISION INTO THE TEMPORAL.

FIG. 2.—CEBUS ALBIFRONS (No. 8309, A. M. N. H.). PARIETO-TEMPORAL DIVISION.

The parietal division begins inferiorly in the border of the bone and runs upward, with a few serrations, parallel with the coronal suture. It is patent from the border of the parietal to 0.6 cm. above the external line of the squamous suture, but can be traced 0.8 cm. further upward.

The temporal fissure begins superiorly in a notch in the border of the squamous portion, situated slightly anterior to the point at which the parietal division meets the squamous suture. It is 0.5 cm. long, but probably a part of its inferior extremity is obliterated. The division is nearly straight and ends in the upper part of the fossa above the base of the zygoma. (Pl. XI.)

The skull shows no signs of any injury or other anomalies, and is symmetrical. The right parietal bone is longer and at middle higher, but posteriorly slightly lower than the left one.

Surface measurements of the two parietals:

Junction of coronal and fronto-malar sutures to bregma	left 5.0,	right	5.0	cm.
Infero-superiorly at middle	" 5.15	"	5.4	"
Asterion to lambda	" 3.45	"	3.3	"
Junction of coronal and fronto-malar sutures to asterion	" 4.6	"	4.75	"
Antero-posteriorly at middle	" 5.5	"	5.7	"

Case 29. *Cebus hypoleucus*, sex unknown, adolescent; No. 10720, A. M. N. H., N. Y.

There is a vertical division in the left parietal, extending from the inferior border of the bone to the temporal ridge; and a temporal division, following directly in the course of the parietal one and ending in the fossa above the base of the zygoma.

Externally both divisions begin at the squamous suture, at a point slightly anterior to the middle between the lower end of the coronal suture and the asterion. Their course is almost parallel with that of the coronal suture. The total external length of the parietal division is 1.9 cm., that of the temporal 0.6 cm. The parietal division shows considerable occlusion advancing from above; the inferior extremity of the temporal fissure shows also some occlusion. (Pl. XII.)

The skull is symmetrical. There are no signs of any injury or other anomalies. The left parietal bone is inferiorly very slightly longer, at middle very slightly shorter, and at middle and posteriorly slightly lower than the right one.

Surface measurements of the two parietals:

Junction of squamous and malo-frontal sutures, left	4.75,	right	4.75	cm.
Infero-superiorly at middle	" 4.8	"	5.0	"
Asterion to lambda	" 2.9	"	3.0	"
Junction of squamous and malo-frontal sutures,	" 4.65	"	4.6	"
Antero-posteriorly at middle	" 5.05	"	5.0	"

GROUP 6. ANTERO-POSTERIOR PARIETAL DIVISIONS IN MONKEYS.

Case 30. *Cynocephalus mormon*, male, adolescent; No. 121, M. D., C. U., N. Y.

The left parietal bone is partly divided by a suture, which begins distally in a notch in the sagittal border of the bone, 2.5 cm. from the bregma and 0.6 cm. from the lambda. The division is 2.5 cm. long, quite straight, slightly serrated, and runs in a downward and slightly forward direction to the parietal eminence. The median fourth of the division shows some occlusion. The parietal eminence on this side is represented by a circular, rather broad but low bulging, with a moderate central depression. A shallow groove runs from this depression forward toward the coronal suture, representing the anterior part of a complete antero-superior division. There is no trace of any inflammatory action, and the indications are against the depression being due to an injury. (Pl. XII.)

The sagittal third of the divided parietal is somewhat more bulging than the same region on the right, and the whole left parietal bone is slightly higher, but shorter, than the right one.

Case 31. *Macacus rhesus*, male, adolescent; No. 145, M. D., C. U., N. Y.

This specimen presents a beautiful division of each parietal by a curved antero-posterior suture.

The suture begins on the frontal border of the parietal

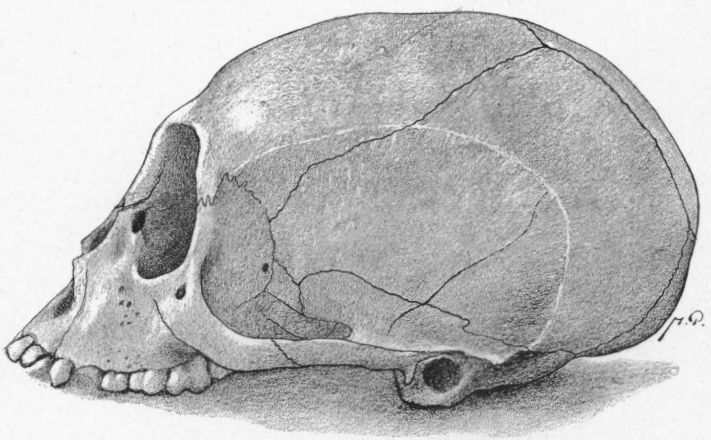


FIG. 1.

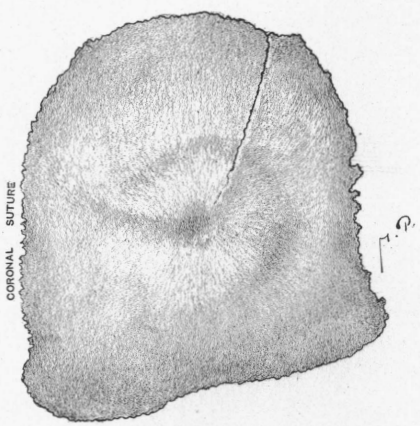
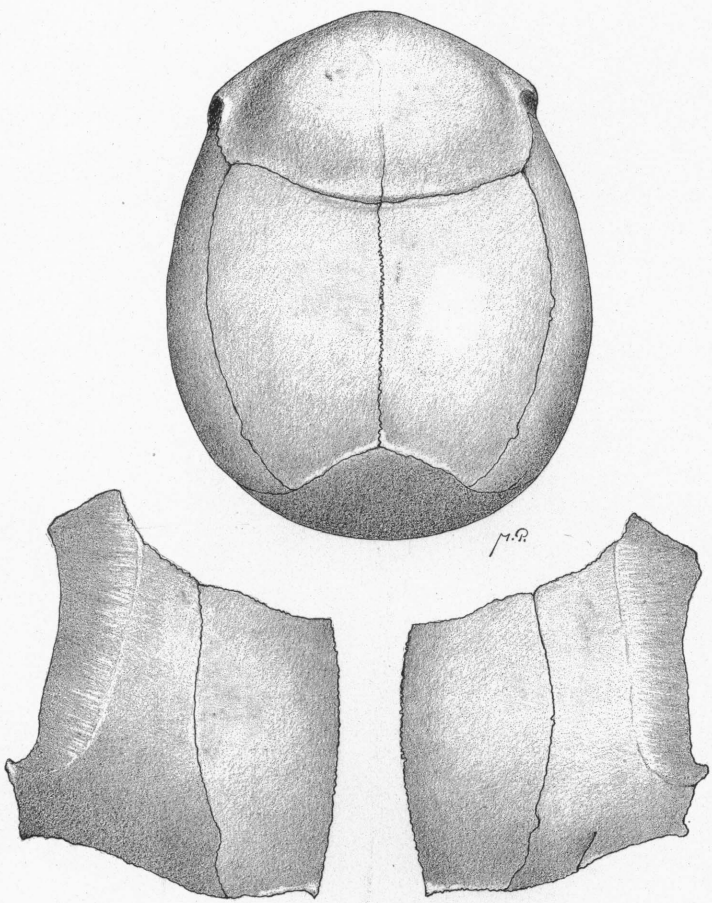


FIG. 2.

FIG. 1.—CEBUS HYPOLEUCUS (No. 10,720, A. M. N. H.). PARIETO-TEMPORAL DIVISION ON THE LEFT SIDE.

FIG. 2.—CYNOCEPHALUS MORMON (No. 121, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). INCOMPLETE VERTICAL DIVISION IN THE LEFT PARIETAL.



MACACUS RHESUS (No. 145, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). BILATERAL ANTERO-POSTERIOR PARIETAL DIVISION.

bones, the left 2.25 cm., the right 1.7 cm. from bregma. They both proceed in a gentle, symmetrical curve backward, to end each on the occipital border of the parietal bones, 1 cm. from lambda. Both sutures are open and of a squamous character, the border of the inferior position of each bone overlapping that of the superior one.

Eleven mm. below the termination of the right anomalous suture, the occipital border of the parietal is divided by a 1.5 cm.-long, open fissure, which runs parallel with the suture. (Pl. XIII.)

Measurements of the two parietals:

Length, along sagittal border	left	3.5,	right	3.5	cm.
" squamo-coronal point to asterion	"	4.45	"	4.5	"
Hight, " " " " bregma	"	4.5	"	4.2	"
" at middle	"	4.8	"	4.7	"
" asterion to lambda	"	4.1	"	4.0	"

The left parietal is higher than the right, especially anteriorly; this, however, does not affect appreciably the symmetry of the whole cranium.

The skull shows no further anomalies and no signs of any injury. The normal sutures are all pervious. There are no Wormians.

Case 32. *Macacus rhesus*, sex unknown, adolescent; No. 195, M. D., C. U., N. Y.

The left parietal bone shows a 3-millimeters-long, slightly oblique incisure in its posterior border, a short distance above the asterion. No other anomalies.

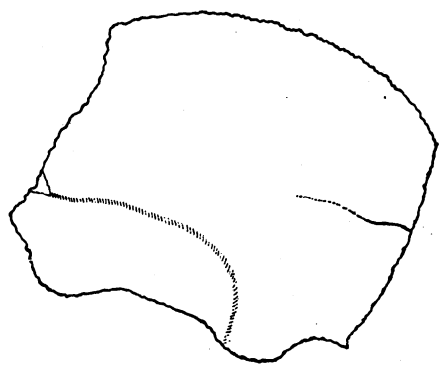


Fig. 20. *Macacus erythræus* (No. 1616, A. M. N. H.). Division in the left parietal.

Case 33. *Macacus erythræus*, sex unknown, adolescent; No. 1616, A. M. N. H., N. Y.

The left parietal bone shows a 1.35-cm.-long, antero-pos-

terior division in the middle of its posterior, and a 0.3 cm.-deep, V-shaped notch, situated immediately above the temporal ridge, in its anterior portion.

The posterior division runs in a slightly wavy course forward and a little downward; its anterior half is occluded. The notch in the anterior portion of the bone is filled with an ossicle.

The skull is asymmetrical in the parietal region; the left parietal bone is slightly smaller and less bulging than the right one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma	left 4.0,	right 4.1	cm.
Infero-superiorly at middle	" 4.3	" 4.35	"
Asterion to lambda	" 3.1	" 3.2	"
Squamo-coronal junction to asterion	" 4.35	" 4.35	"
Antero-posteriorly at middle	" 4.85	" 5.1	"

There are no signs of any injury or further anomalies.

Case 34. *Cebus capucinus*, male, young; No. 164, M. D., C. U., N. Y.

There is a horizontal incisure 0.9 cm. long in the anterior portion of the right and a similar incisure 0.6 cm. long in the anterior portion of the left parietal bone, both situated a short distance above the sphenoid angle.

Skull symmetrical, parietals nearly equal. No injuries or further anomalies. (Compare *Cebi* 5050, 11037, 6323.)

Case 35. *Ateles belzebub*, sex unknown, adolescent; No. 119, M. D., C. U., N. Y.

There is a horizontal fissure 0.3 cm. long in the anterior portion of the left parietal, slightly below its middle. The temporal ridge passes beneath the fissure.

The skull shows no other exceptional features.

Case 36. *Ateles vellerosus*, male, nearly adult; No. 14484, A. M. N. H., N. Y.

The left parietal bone shows an oblique antero-posterior, well serrated, but for the most part obliterated anomalous division.

The still visible part of the suture begins distally on the occipital border of the parietal, 5 mm. above the asterion.

The suture runs horizontally, until it reaches the temporal ridge, after which it curves slightly and runs forward and upward, on to the parietal eminence. Beyond the eminence the division, which up to that point was but slightly so, becomes entirely obliterated. The anomalous suture shows considerable serration (for a suture in an *Ateles*). (Pl. XV.)

Surface measurements of the two parietals:

Length, at middle		left 6.05,	right 6.35	cm.
"	junction of coronal and malo-frontal sutures to asterion	" 5.1	" 5.5	"
Hight,	junction of coronal and malo-frontal sutures to bregma	" 5.7	" 5.6	"
"	at middle	" 5.9	" 5.9	"
"	asterion to lambda	" 3.0	" 2.7	"

The right parietal is somewhat longer, but anteriorly as well as posteriorly slightly lower than the left bone.

The skull is not perceptibly asymmetrical, and shows no signs of injuries or any further anomalies, with the following exceptions: There are nine Wormian bones in the coronal suture (5 small ones on left, 4 larger on right); the bregma fontanel is occupied by five comparatively large Wormians; and there are 20 small Wormian bones in an irregular row in the anterior two thirds of the sagittal suture. In addition there is a moderate-sized intercalate bone in the right asterion.

GROUP 7a. INSTANCES OF COMPOUND INCOMPLETE PARIETAL DIVISIONS IN MONKEYS.

Case 37. *Macacus rhesus*, female, adolescent; No. 20, M. D., C. U., N. Y.

The mastoid portion of the right parietal bone is divided by a slightly serrated, 1.35-cm.-long suture. The division begins in the middle of the mastoidal margin, runs for a short distance forward, then bends and proceeds forward and upward, in the direction of the parietal eminence, until it reaches the temporal ridge, between the boundaries of which it ends. The further course of the suture cannot be followed. The sagittal border of the bone shows, a little anterior to its middle, a slight vertical incisure; it is possible that this point marks

the original superior termination of the postero-inferior division.

The left parietal bone shows a 1.6-cm.-long, straight trace of a division which began in the sagittal border of the bone, 0.35 cm. anterior to the little incisure on the right (1.65 cm. from bregma, 3.1 cm. from lambda), and ran in a slightly converging course with the lambdoid suture.

The skull is symmetrical and free from other anomalies. The right parietal bone slightly exceeds the left one in the inferior length (by 0.1 cm.), otherwise the bones are equal.

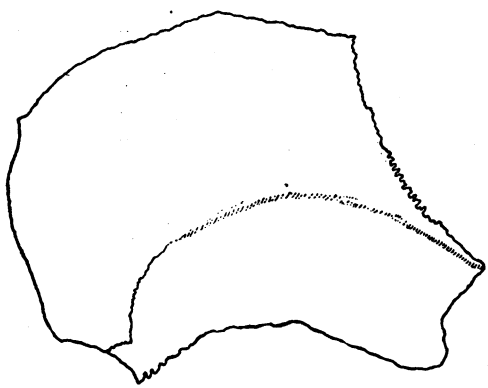


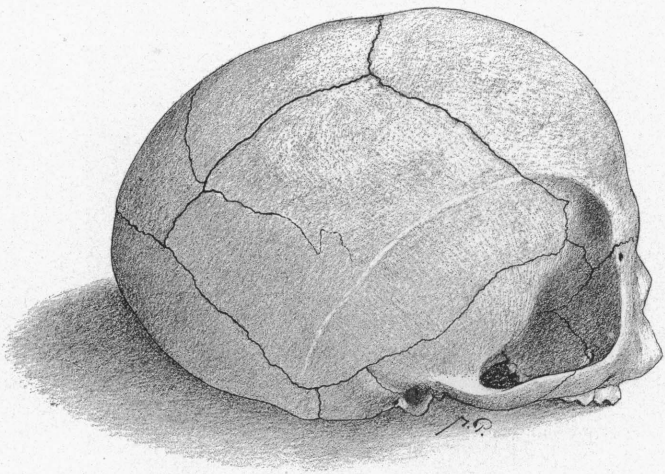
Fig. 21. *Macacus rhesus*, female (No. 20, Morphological Museum, Columbia University). Suture in the mastoid angle of the right parietal.

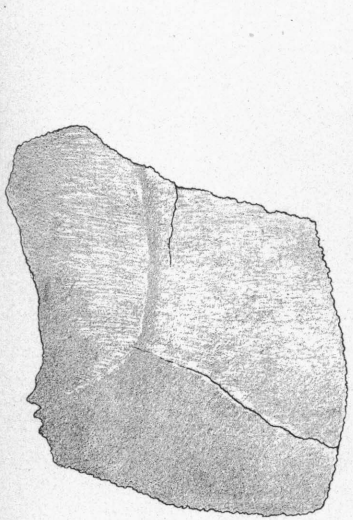
Case 38. *Macacus rhesus*, sex unknown, adolescent; No. 58, M. D., C. U., N. Y.

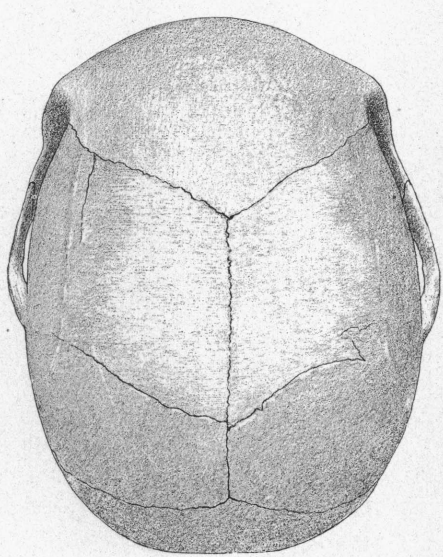
Both parietal bones show incomplete divisions. There are a vertical and a horizontal division on the left, and a vertical one on the right side.

The vertical divisions begin opposite in the sagittal border of the bones, slightly posterior to the third fourth of the same (3.2 cm. from bregma, 0.9 cm. from lambda), and both run with a slightly wavy course in the direction of the parietal eminence. That on the right terminates 1.15 cm. from its superior end; that on the left is 2.5 cm. long and terminates directly above the upper boundary of the temporal ridge. Both these divisions show some fine serration. When the parietal bones are viewed against the light, a dark line, undoubtedly a former extension, is seen running from each of the divisions and in the same direction with their patent portions toward the squamous suture.

The horizontal division in the left parietal begins nearly







L.

Macacus rhesus (No. 58. Morphological Museum, Columbia University). Parietal Divisions.

at the middle of its anterior border (2.1 cm. from the lower end of the coronal suture, 2.0 cm. from bregma) and a little above the temporal ridge. It runs nearly parallel with the squamous suture, is 0.8 cm. long, slightly wavy, and shows traces of occlusion. (Pl. XIV.)

The skull is symmetrical and without signs of any injury, or other marked exceptional features. The right parietal is throughout somewhat higher than the left, but the length of the two is nearly equal.

Surface measurements of the parietal bones:

Squamo-coronal junction to bregma.....	left 4.0,	right 4.2	cm.
Infero-superiorly at middle.....	" 4.1	" 4.25	"
Asterion to lambda.....	" 2.95	" 3.1	"
Squamo-coronal junction to asterion.....	" 4.4	" 4.35	"
Antero-posteriorly at middle.....	" 4.5	" 4.5	"

Case 39. *Macacus rhesus*, sex unknown, young adolescent; No. 114, M. D., C. U., N. Y.

The left parietal shows an incomplete anterior horizontal, the right, traces of what probably was a complete vertical division.

The division on the left is very much like that in Macaque No. 58. It begins in the anterior border of the parietal, 1.4 cm. from the squamo-coronal junction, 2.65 cm. from bregma, 0.5 cm. above the upper boundary of the temporal ridge. It runs in a slightly wavy course and with a few fine serrations backward and a little downward, until it reaches the temporal ridge, beyond which point it is obliterated. Externally the division is 0.8 cm. long; ventrally it runs 0.35 cm. further, reaching a total length of 1.15 cm.

The division on the right begins superiorly by a 2-millimeter-long slit in the sagittal border of the parietal, at a point distant 2.7 cm. from bregma and 1.85 cm. from lambda. The division runs downward, converging slightly with the lambdoid suture. Above the temporal ridge it curves moderately backward; beyond this curve all its traces are obliterated. Apparently the division terminated in or near the mastoid angle of the parietal.

The skull is symmetrical; no signs of any injuries and no

other anomalies. The right parietal bone is both longer and higher than the left one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma.....	left 4.05,	right	4.3	cm.
Infero-superior at middle.....	" 4.4	"	4.5	"
Asterion to lambda.....	" 3.2	"	3.2	"
Squamo-coronal junction to asterion.....	" 4.2	"	4.3	"
Antero-posteriorly at middle.....	" 4.7	"	4.8	"
" " along sagittal suture.....	" 4.55	"	4.9	"

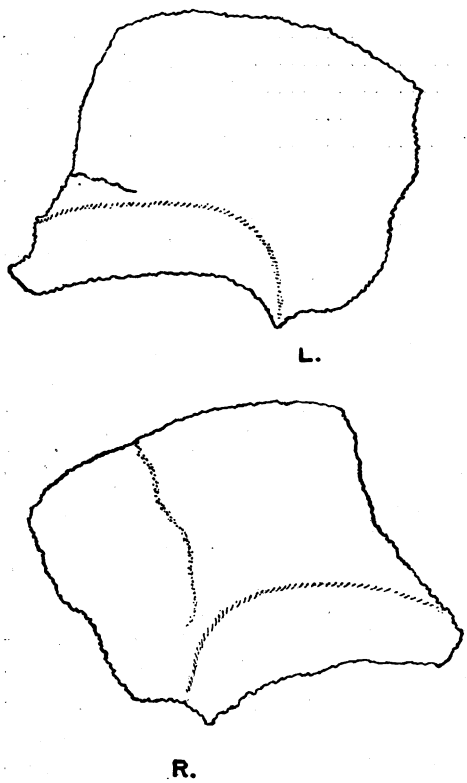


Fig. 22. *Macacus rhesus* (No. 114, Morphological Museum, Columbia University). Parietal divisions.

Case 40. *Cebus capucinus*, female, young adolescent; No. 6323, A. M. N. H., N. Y.

The left parietal shows a forked antero-posterior, the right a partial vertical and a segment of an antero-posterior division.

The division on the left begins in a cleft, now filled with an ossicle, in the anterior portion of the parietal, somewhat below the temporal ridge. It runs for a short distance as a single branch and then divides, the inferior portion, 0.55 cm. long, passing almost directly downward, while the superior portion, 0.9 cm. long, bends upward and then backward and runs in the direction of the mastoid angle.

On the right side the vertical division, an 0.8-cm.-long, narrow cleft, begins superiorly in the sagittal border of the parietal, 0.7 cm. anterior to the lambda, and runs slightly divergent with the lambdoid suture. In addition the bone shows, on its anterior third and somewhat below the temporal ridge, a 0.9-cm.-long, patent segment of an antero-posterior division. A slight notch in the anterior border of the bone at about the same hight marks probably the original anterior termination of this division.

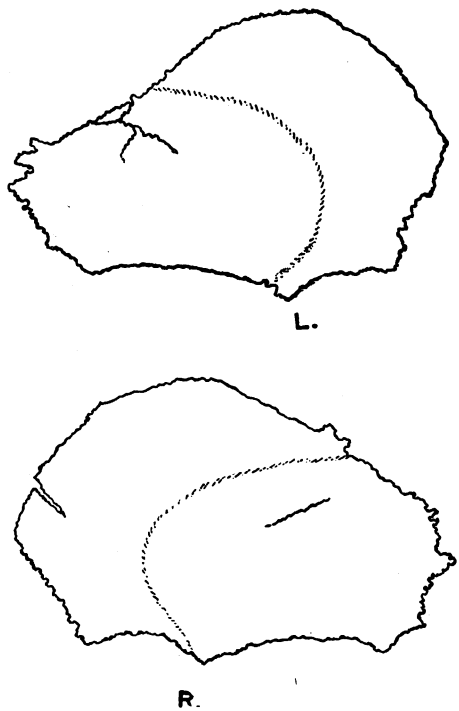


Fig. 23. *Cebus capucinus* (No. 6323, A. M. N. H.). Incomplete parietal divisions.

The skull is symmetrical; the parietals show but insignificant differences in dimensions. No signs of injury and no further anomalies.

The case is allied to those of *Cebi* 5050 and 11037, A. M. N. H. (*q. v.*).

Case 41. *Cebus*, adolescent, species and sex not determined; No. 143, M. D., C. U.

The skull shows two parietal divisions, one oblique and one horizontal, in the right, and a partial oblique division in the left parietal.

The oblique divisions begin on each side by a cleft in the postero-superior angle of the parietal, and run, as narrow clefts, downward and somewhat forward. The left division is 6.5 millimeters long. That on the right is in two segments, being interrupted by a narrow band of ossification; it

measures *in toto* 3.1 cm.; its inferior extremity is lost, just above the temporal ridge.

The horizontal division on the right begins in the posterior border of the parietal, 0.9 cm. below the lambda and 1.6 cm. above the asterion; it is straight, 0.5 cm. long and serrated. (Pl. XV.)

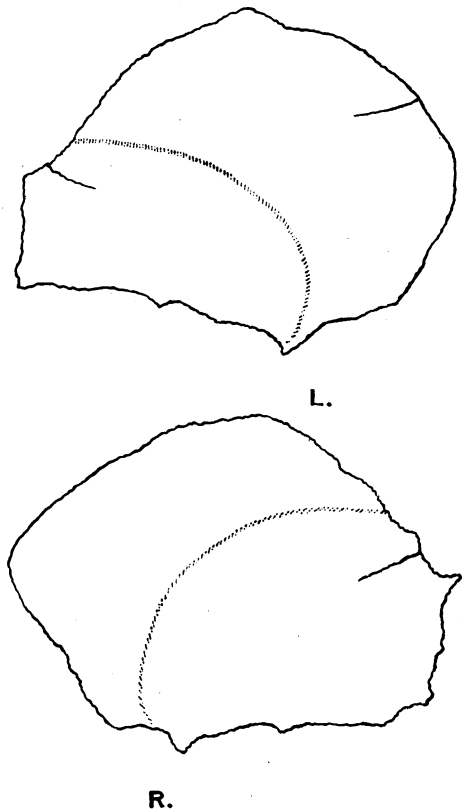


Fig. 24. *Ateles ater* (No. 1628, A. M. N. H.). Parietal incisures.

The skull is symmetrical and without further anomalies; the parietals are nearly equal.

Case 42. *Ateles ater*, sex unknown, adolescent; No. 1628, A. M. N. H., N. Y.

There are two pronounced incisures in the left, and one in the right parietal bone.

Of the incisures on the left, one is situated in the anterior, and the other in the superior portion of the bone. The anterior division begins distally 1.6 cm. above the point of junction of the coronal and malo-frontal sutures, 3.5 cm. below the bregma, and 0.8 cm. below the temporal ridge. The incisure is 0.8 cm. long, slightly wavy, and directed backward and very slightly downward. The second division on the left side begins superiorly between the third and last fourths of the sagittal border of the parietal (2.4 cm. from bregma, 0.8 cm. from

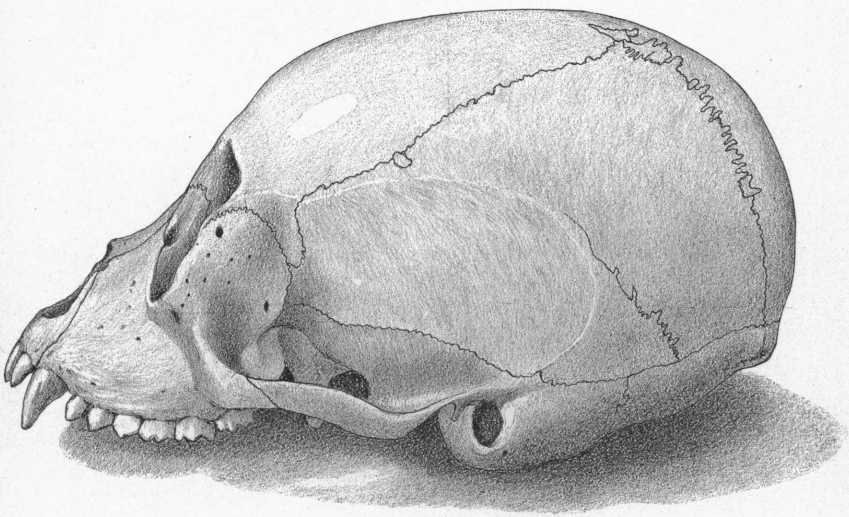


FIG. 1.

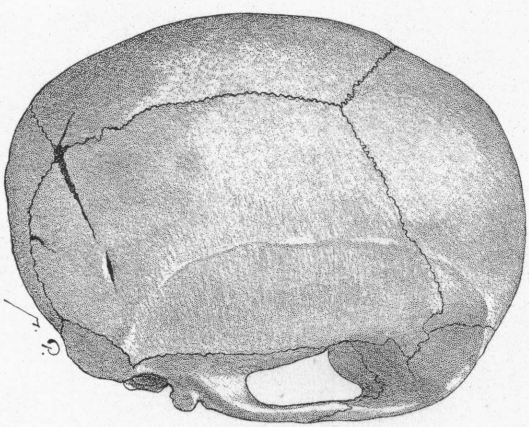


FIG. 2.

FIG. 1.—ATELES (No. 14,484, A. M. N. H.). PARTLY OBLITERATED DIVISION OF THE LEFT PARIETAL.

FIG. 2.—CEBUS (No. 143, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). PARIETAL DIVISIONS.

lambda), is 1.4 cm. long, and runs obliquely downward and somewhat forward.

The incisure in the right corresponds to the anterior division in the left parietal. It begins distally 1.6 cm. above the point of junction of the coronal and malo-frontal sutures, 3.6 cm. below the bregma and 0.8 cm. below the temporal ridge. It is 0.9 cm. long and runs in a nearly straight course backward and somewhat downward.

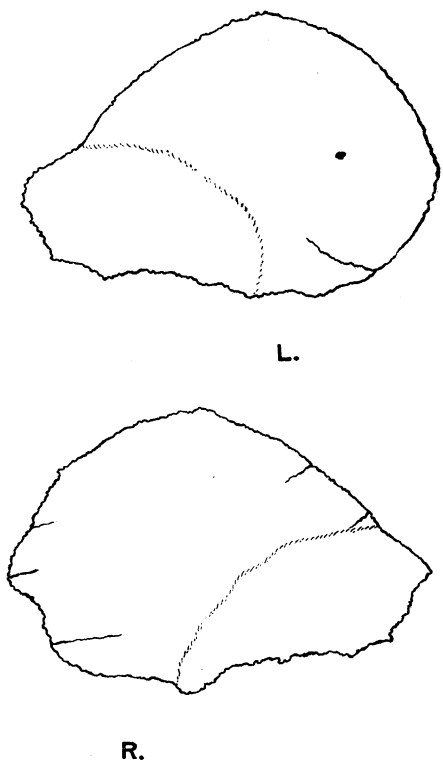


Fig. 25. *Ateles* (No. 6313, A. M. N. H.). Parietal incisures.

The skull is quite symmetrical. No signs of injuries or further anomalies. The right parietal is higher in its middle three fifths than the left one (infero-superiorly at middle, right 4.5 cm., left 4.2 cm.), but other measures of the bones are equal. There are traces of occlusion in the lower fourths of the coronal sutures.

Case 43. *Ateles*, male, young; No. 6313, A. M. N. H., N. Y.

The skull shows five marked incisures in the right, and two in the left parietal bone. Of those on the right, two are in the anterior, two in the posterior, and one in the superior portion; of those on the left, one is in the anterior and one in the posterior portion of the bone.

The lower of the two anterior divisions on the right begins distally 1.1 cm., the higher one 2.0 cm. above the junction of the coronal and malo-frontal sutures, or, respectively 3.1 cm.

and 2.2 cm. from the bregma. The inferior division is situated a short distance above the temporal ridge, is 0.45 cm. long, straight, and directed backward and slightly downward. It runs up to the temporal ridge. The superior incisure is also 0.45 cm. long and straight, and runs parallel with the lower division.

Of the two posterior incisures on the right, the lower begins distally 0.9 cm. above the asterion, or 1.8 cm. from the lambda, while the higher one begins distally at the lambda itself. Both the incisures are straight, and run forward and slightly downward; the lower one is 1.0 cm., the upper one 0.7 cm. long.

The sagittal division begins superiorly 0.7 cm. from the lambda, is 0.7 cm. long, and runs in a downward and forward direction.

The anterior division on the left begins distally 0.9 cm. above the point of junction of the coronal and malo-frontal sutures, and slightly above the temporal ridge; it is 0.35 cm. long, straight, and runs backward and slightly downward to the ridge.

The posterior left division begins distally 0.9 cm. above the asterion, or 1.85 cm. from the lambda, is 1.0 cm. long, straight, and directed forward and slightly downward.

The skull is quite symmetrical, the parietals nearly equal. There are no signs of injuries, or other anomalies.

Case 44. *Ateles*, species not determined (probably *A. vellerosus*), male, adolescent; No. 13690, A. M. N. H., N. Y.

The right parietal bone shows two partial divisions, one in its sagittal, the other in its posterior border.

The vertical incisure begins superiorly at very near the middle of the sagittal border, is 1.35 cm. long, nearly straight, and runs downward and somewhat backward. The lower fifth of the division shows advanced occlusion.

The posterior incisure is 0.5 cm. long, and straight; it begins distally in the middle of the occipital border of the parietal, and runs forward parallel with the horizontal axis of the bone.

The skull shows several other peculiarities. The fontanel at bregma is filled with a quite large, somewhat diamond-

shaped separate bone; and there is on each side in the lower part of the coronal suture a number of moderate-sized to comparatively large Wormians. On the left, one of these Wormian bones enters 0.85 cm. deep into the anterior portion of the parietal bone, just below the temporal ridge. (Pl. XVII, Fig. 1.)

The two parietals are equal in height, but the right bone is longer than the left one.

Surface measurements of the two parietal bones:

Point of junction of the squamous and temporo-sphenoidal sutures to bregma.....	left 6.2,	right 6.2	cm.
Infero-superiorly at middle.....	" 6.1	" 6.1	"
Asterion to lambda.....	" 3.9	" 3.9	"
Point of junction of the squamous and temporo-sphenoidal sutures to asterion.....	" 4.05	" 4.25	"
Antero-posteriorly at middle.....	" 6.1	" 6.2	"

GROUP 7b. INSTANCES OF COMPOUND COMPLETE PARIETAL DIVISIONS IN MONKEYS.

Case 45. *Cercopithecus callitrichus*, female, adult; No. 13923, A. M. N. H., N. Y.

The left parietal bone shows a complete vertical division, and this is met at the squamous suture by an incisure in the temporal squama running in the same direction. On the right side there is a complete separation by an oblique suture of the postero-inferior portion of the parietal, and in addition traces of a vertical division.

The anomalous division in the left parietal bone begins superiorly at a point distant 0.85 cm. from the lambda and 2.25 cm. from the bregma. It passes downward and slightly forward to the temporal ridge, where it makes a bend, and after that descends more directly downward, running nearly parallel with the coronal suture. With the exception of a few points of occlusion the division is patent, and it shows a moderate serration.

The temporal fissure begins superiorly at a point slightly anterior to that at which the parietal meets the squamous suture, is 0.65 cm. long, though traceable a little further

downward, and runs with a slightly wavy course to the upper portion of the supra-zygomatic fossa.

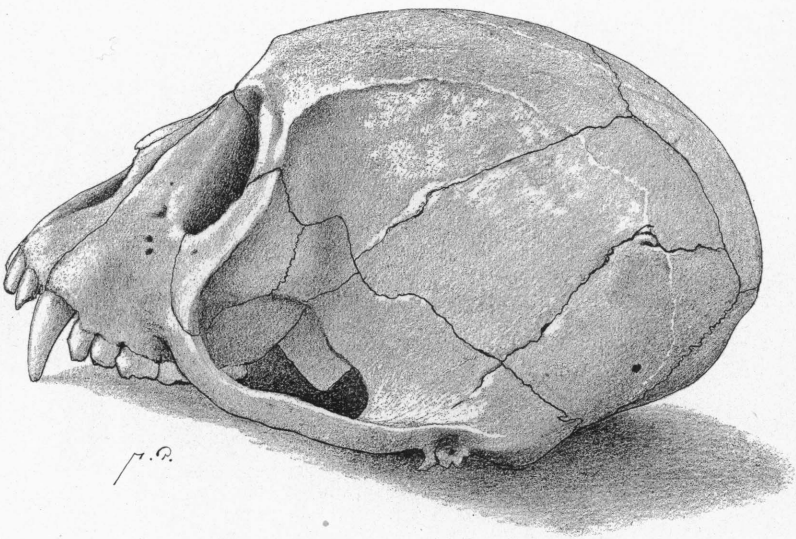
On the right side both the vertical and the oblique divisions begin inferiorly at the same point, which is distant 1.4 cm. from the asterion and 2.6 cm. from the point of junction of the temporo-parietal and temporo-sphenoidal sutures. The vertical division is almost entirely occluded, but can be traced for 2.2 cm. above the squamous suture, running upward and slightly backward. Six millimeters above the border of the temporal bone we find in the course of the vertical division a moderate-sized oblong foramen, and there is a similar opening at exactly the same hight in the left parietal suture.

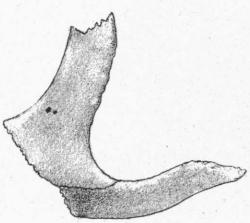
The oblique division on the right passes backward and upward, terminating 0.8 cm. above the asterion. The piece of bone it separates is of a triangular shape and measures 0.8 x 1.4 x 1.65 cm. An oblong opening, slightly larger than that in the right vertical, is found also in the anterior portion of the oblique division. On the left side there is no oblique or antero-posterior division discernible, but 1.1 cm. vertically above the squamous and 0.3 cm. from the lambdoid suture is a quite large, ventrally occluded foramen, which possibly is a remnant of such a separation. The portion of the left parietal below the slightly oblique line which passes from the foramen in the vertical, through the more posterior isolated foramen, to the lambdoid suture, is somewhat flattened.

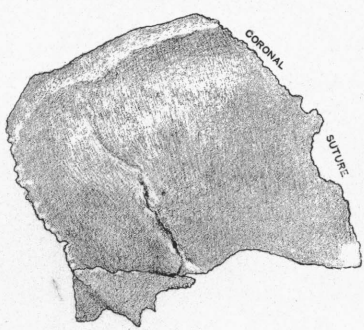
The skull is symmetrical, and there is no trace of any injury. *The left malar bone is divided by a serrated, horizontal, still patent suture.* (Pl. XVI.)

Of the two parietals the left one is a little higher anteriorly and posteriorly, but slightly lower at middle, and shorter both inferiorly and at middle, than the right one. The surface measurements are as follows:

Junction of squamous and temporo-sphenoidal sutures to bregma	left	4.3,	right 4.1	cm.
Infero-superiorly at middle	"	3.7	" 3.9	"
Asterion to lambda	"	3.2	" 3.0	"
Junction of squamous and temporo-sphenoidal sutures to asterion	"	3.7	" 4.0	"
Antero-posteriorly at middle	"	4.3	" 4.4	"







L.M. R.P.

CERCOPITHECUS CALLITRICHUS (No. 13,923, A. M. N. H.). PARIETAL DIVISIONS. MALAR DIVISION.

Fig. 1.

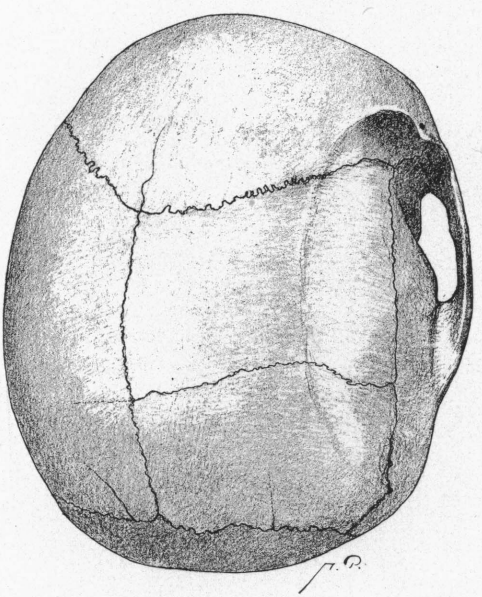


Fig. 2.

Fig. 1.—Ateles (No. 13,690, A. M. N. H.). Partial Sutures in the Right Parietal.

Fig. 2.—Macacus rhesus (No. 46, Morphological Museum, Columbia University). Vertical Parietal Division.

Case 46. *Macacus rhesus*, sex unknown, adolescent; No. 46, M. D., C. U., N. Y.

The specimen shows a complete vertical, and traces of a partial horizontal division of the right, and remnants of two divisions, one vertical and one oblique, on the left parietal bone.

The vertical suture on the right begins superiorly a little posterior to the middle of the sagittal border of the bone (2.6 cm. from the bregma, 1.85 cm. from the lambda). It runs very nearly parallel with the lambdoid suture up to the temporal ridge, at which it curves slightly backward. It terminates 3.1 cm. posterior to the squamo-coronal junction and 1.8 cm. anterior to the asterion.

The suture is throughout patent. It is throughout moderately squamous in character, the border of the anterior overlapping that of the posterior portion of the parietal; at the same time the suture shows externally a fair serration.

The horizontal division can be traced as a slight, straight elevation, running from the middle of the posterior border of the parietal 1.2 cm. forward, parallel with the sagittal suture.

The vertical division on the left parietal bone began sagitally exactly opposite the similar division on the right side. It is completely occluded, but can be plainly traced for 1.3 cm., running straight downward parallel to the lambdoid suture.

The oblique division on the left, probably the counterpart of the horizontal one on the right, begins as an open fissure 3 millimeters below the lambda. The fissure becomes soon occluded, but can be traced, running in a straight line in the direction of the parietal eminence, for 1.0 cm. (Pl. XVII, Fig. 2.)

The skull is fairly symmetrical and shows no further anomalies. The right parietal is slightly longer at middle, but slightly lower, especially at middle, than the left one.

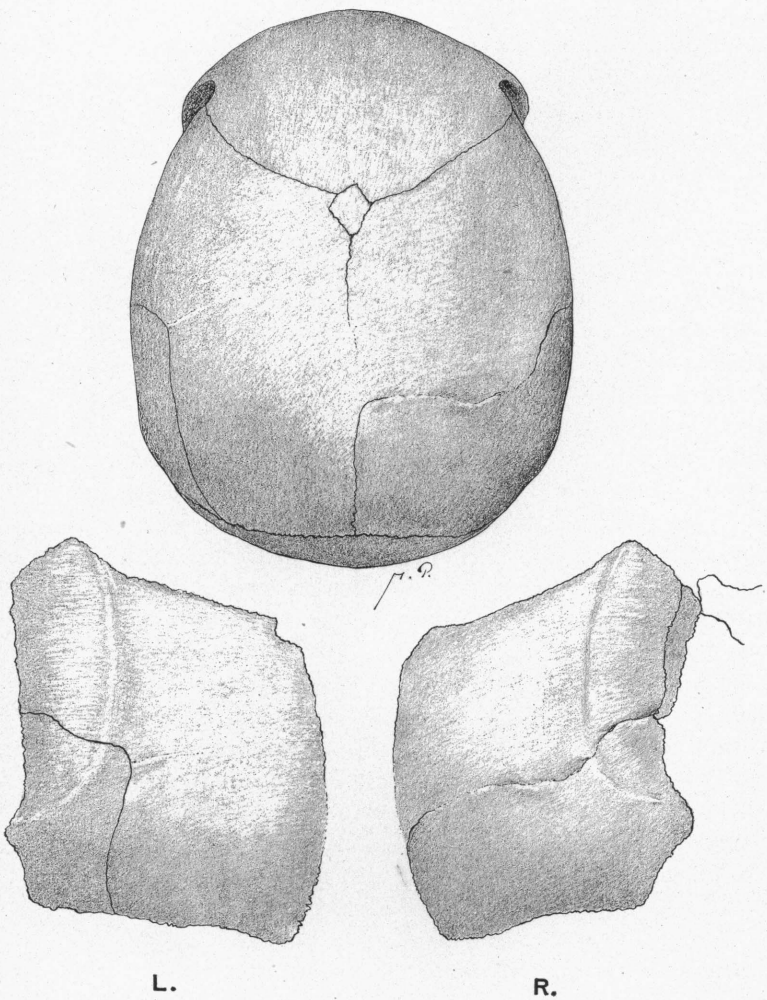
Surface measurements of the two parietal bones:

Squamo-coronal junction to bregma.....	left 4.3,	right 4.2	cm.
Infero-superiorly at middle.....	" 4.2	" 3.9	"
Asterion to lambda.....	" 3.2	" 3.2	"
Squamo-coronal junction to asterion.....	" 4.9	" 4.9	"
Antero-posteriorly at middle.....	" 5.0	" 5.1	"

Case 47. *Macacus rhesus*, sex unknown, adolescent; No. 50, M. D., C. U., N. Y.

The skull presents a complete, partly occluded vertical division of the right, and a fully patent vertical-horizontal division of the left parietal bone.

The division on the right side begins superiorly somewhat posterior to the middle of the sagittal border of the parietal (about 2.6 cm. from bregma, 1.8 cm. from lambda) and, a portion of the sagittal suture immediately in front being obliterated, it appears like a prolongation of the posterior, patent segment of the suture. Four and a half millimeters from the line of the sagittal suture the division becomes totally occluded, but, if the skull is inclined in a certain way to the light, the line of the division can be quite plainly traced. This mark runs almost straight downward, parallel with the lambdoid suture, and in the lower third of the parietal joins the inferior open portion of the division. This latter portion, which shows the character of a squamous suture, with the border of the posterior piece overlapping that of the anterior one, makes a moderate knee-like deflection forward and downward, and after a course of 1.5 cm. reaches the temporo-parietal suture, slightly anterior to the middle point between the squamo-coronal junction and asterion. But the division does not end here. Externally, following directly in its course, but soon bending forward, is a squamous suture, which runs to the temporo-sphenoidal suture and apparently has separated a portion of the temporal squama 2.1 cm. long by 0.55 cm. in its greatest hight. Ventrally, the right parietal bone is seen to reach throughout its anterior two thirds unusually low, much more so than the left one; the overlapping of the inferior portion by the temporal squama is very considerable, averaging nearly 0.5 cm. in hight. The parietal division proceeds in the same direction in which it reached the squamous suture to the border of the bone. The portion of the parietal anterior to the division reaches the wing of the sphenoid. The squamous suture, which appears externally like the continuation of the parietal division, is seen running immediately below the anterior half of the lower border of



Macacus rhesus (No. 50, Morphological Museum, Columbia University). Parietal Divisions.

this portion. The hight of the temporal squama from the external border of the glenoid fossa to the beginning of the fronto-parietal suture is 1.7 cm. on the left, 1.95 cm. on the right (including the 0.55 cm. high separate portion).

The left parietal shows what is probably the lower portion of a formerly complete vertical division, and a horizontal suture passing from this to the posterior border of the bone.

The vertical division begins inferiorly at a point distant 1.8 cm. from the squamo-coronal junction and 3.0 from the asterion. It is of a squamous character, the border of the posterior separate portion overlapping that of the anterior one. It runs in a nearly straight course for 1.7 cm. upward, parallel with the coronal suture. At this point it ends and is joined at nearly a right angle by the antero-posterior suture. The separated piece of the parietal being removed, a small oblique incisure is seen in the angle between the two divisions, and above this incisure the surface of the bone bears slight traces of an extension of the vertical suture.

The antero-posterior division is also nearly straight and of a squamous character, the border of the lower overlapping the anterior half of the border of the upper separate part. It runs parallel to the sagittal, but converges somewhat from before backward with the squamous suture. It terminates in the posterior border of the parietal, 0.5 cm. above the asterion. (Pl. XVIII.)

The skull is quite symmetrical. It is larger than the average macaque skull at a similar period of life, and shows ventrally marked impressions of cerebral convolutions. The right parietal bone exceeds the left one in its antero-posterior dimensions, while the hight, except along the coronal suture, shows externally no difference. Ventrally the right parietal is also higher.

Surface measurements of the two parietal bones:

Squamo-coronal junction to bregma.....	left	5.0,	right	4.75 cm.
Infero-superiorly at middle.....	"	4.7	"	4.7 "
Asterion to lambda.....	"	3.0	"	3.0 "
Squamo-coronal junction to asterion.....	"	4.8	"	5.1 "
Antero-posteriorly at middle.....	"	4.95	"	5.25 "

The middle third of the sagittal suture is obliterated; other normal sutures are patent. There is a moderately large, irregularly quadrilateral bregmatic bone.

Case 48. *Macacus rhesus*, sex ?, adolescent, No. 102, M. D., C. U., N. Y.

This skull presents a number of puzzling features. The parietal bones show several divisions, and two of these appear to be prolonged into the adjoining parts of the frontal and temporal squamæ. The majority of the divisions have the appearance of, and in all probability are, genuine anomalous parietal sutures, but two of the smaller divisions on the right side suggest by their location and character more a possible injury, of which, however, there are no distinct signs present. After many repeated and careful examinations, it seems equally improbable that all the divisions are natural anomalies, or that they are all due to some injury. The most probable fact is that we have here a combination of highly interesting anomalous divisions with some secondary effects of violence, — a violence, perhaps, of some peculiar nature.

The left parietal bone is divided into three large, more or less quadrilateral segments, two anterior and one posterior, by two true anomalous sutures, one vertical and one horizontal. The vertical suture begins sagitally 2.2 cm. posterior to bregma and 2.1 cm. anterior to lambda, proceeds almost parallel to the coronal suture, reaches the squamous suture 1.5 cm. posterior to the junction of this with the coronal, bends and runs 0.85 cm. forward and downward into a notch in the border of the temporal squama, then bends again and passes for a little over two millimeters directly downward into the squama itself. Ventrally the division continues from this point directly forward as the spheno-parietal suture, bounding a long, narrow, subsquamous sphenoidal process of the parietal bone. A similar, though shorter sphenoidal process exists on the opposite side.[1] The course of this vertical suture in the left parietal is almost straight, with the exception of a moderate double curve above the temporal ridge. The suture is of a squamous

[1] Similar processes exist in other macaques, with the result that while externally there is a fronto-temporal, we have internally a parieto-sphenoidal articulation; and this condition is not restricted to these monkeys.

nature, particularly inferiorly. Superiorly the posterior segment of the parietal overlaps slightly the superior anterior one, while inferiorly the conditions are reversed, the inferior anterior portion overlapping to a marked degree the posterior one.

The horizontal or antero-posterior division on the left begins in the anterior border of the parietal 2.5 cm. above the squamo-coronal junction, or 1.9 cm. inferiorly to the bregma, and proceeds with a moderate curve backward and slightly downward to a little below the middle of the vertical suture. The suture is partly squamous, the superior overlapping somewhat the inferior portion of the parietal. From the anterior extremity of this suture a partial division passes into the frontal squama. This division is obliterated, but can be plainly traced; it is straight, 1.2 cm. long, and directed toward the frontal eminence.

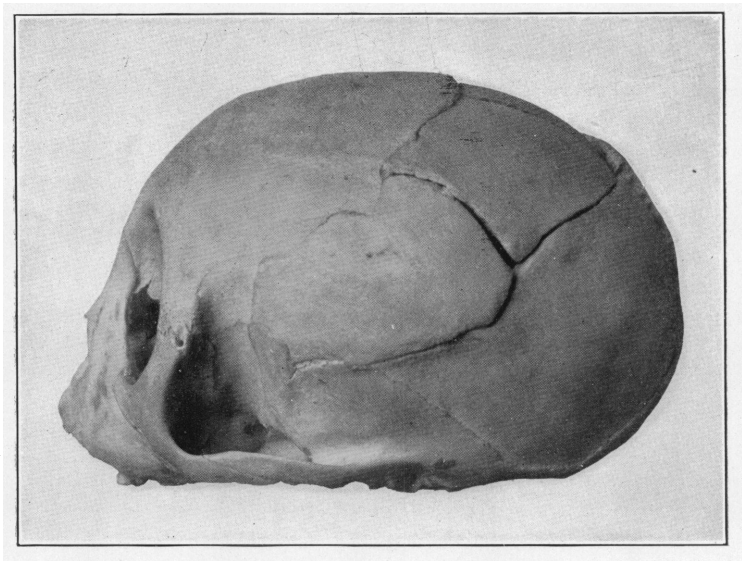
There is not the slightest trace of any injury on the left side of the skull, and the character of the divisions is such that they cannot be regarded as anything else than anomalous sutures. The coexistence of the incisure in the temporal squama can, I think, be attributed to a mechanical interference in the growth of that part of the squama caused by a somewhat uneven growth (the anterior part is even now higher) of the underlying portions of the two segments of the parietal. The frontal division is more difficult to be accounted for, nevertheless a method suggests itself by which it may have been produced by the influence of the horizontal parietal division. This point will be dealt with at the end of this paper.

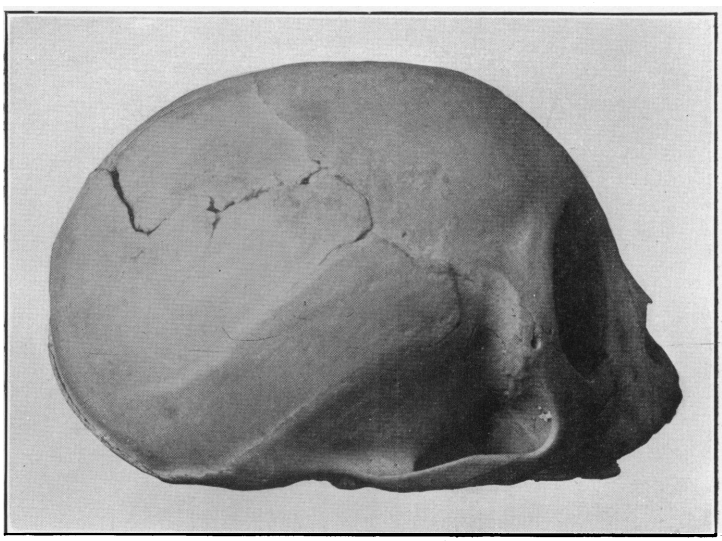
The right parietal bone of the skull under consideration presents a partial vertical and a partial horizontal suture, which separate a quadrilateral piece of the antero-superior portion of the bone. The piece is much like the antero-superior segment of the left parietal, and is very probably of a similar origin, the sutures separating it being true anomalous divisions. The vertical suture begins on the sagittal border of the parietal two millimeters anterior to that on the left, namely, 2.25 cm. from the bregma and 2.15 cm. from the lambda. It

is nearly straight, parallel to the coronal suture, and inferiorly slightly squamous, the adjoining part of the parietal overlapping here the separated segment. Eighteen millimeters below the sagittal suture the vertical meets an antero-posterior division. This latter begins 2.1 cm. below the bregma, hence two millimeters lower than the antero-posterior division on the left. It runs 1.4 cm. backward and slightly upward, then makes a sharp, irregular bend and runs 3 mm. upward, after which it bends again and runs 7 mm. backward, parallel with the sagittal suture, and meets the vertical division. From the bend and from the angle between the horizontal and vertical sutures, two incisures, nearly straight, and for the most part obliterated, the inferior 1.1 cm., the superior 0.9 cm., run backward and downward into the parietal. Ventrally it is seen that these two divisions have joined, separating a piece of bone 2.3 cm. long by 0.7 cm. in maximum hight. This piece is subdivided by a vertical slit, which is directly continuous with the vertical division, but is obliterated dorsally, into two smaller portions.

On the same parietal (right) we find still another division. It is an incomplete antero-posterior suture of squamous nature, beginning 3.15 cm. below the bregma, 1.55 cm. above the squamo-coronal junction, and ending within 7 millimeters from the lambdoid suture. The course of this division for the anterior three fourths of its extent is parallel to the squamous suture, but then it makes a moderate curve upward. The border of the lower portion of the parietal along this division is higher than the upper portion and overlaps the same. The more superior partial antero-posterior division is but slightly squamous, but there also the border of the inferior tends to overlap that of the superior portion; but in the two shorter divisions which begin from this superior horizontal suture, the conditions are reversed, the superior borders distinctly overlapping the inferior. On the left, as remarked before, the border of the superior overlaps that of the inferior portion.

The inferior horizontal division is mostly closed, only 1.2 cm. of its anterior end remaining patent. It opens by a





MACACUS RHESUS (NO. 102, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). SHOWING A PARIETAL AND A PARTIAL TEMPORAL DIVISION.

slight cleft into a wide, 2.5 millimeters deep, V-shaped indentation in the anterior border of the parietal. A similar indentation is found on the left side in the same location.

Five millimeters below the just-described inferior horizontal division on the right parietal, just where the temporal ridge crosses, there is in the border of the frontal bone (seen with the parietal removed) a V-shaped cleft, from which leads forward and downward a peculiar suture which completely separates a portion of the frontal squama. Externally this suture is somewhat obliterated, but can be traced forward, running below the temporal ridge, on to the malar process of the frontal bone, and from here in nice serrations to a foramen situated a little more than one millimeter below the malo-frontal suture. It reappears again in the orbit running in a curve above and to the wing of the sphenoid. Ventrally the whole course of the suture can be followed without any difficulty, though in places there are signs of obliteration. The division passes downward and forward to the angle between the squama and orbital portion of the frontal bone, and then inward across this latter to the fronto-ethmoidal suture. The separated portion of the frontal bone measures 1.0 cm. in maximum width and a little over 2.0 cm. of surface length, measured ventrally. There are no radiations, and the division has the characteristics of an ordinary suture. There is no connection between this and the inferior parietal division on the same side.

The surface of the right parietal shows a slight, irregular unevenness in the middle, and some fine roughness along the superior horizontal and the vertical divisions. There is no depression in the bone. (Pl. XIX.)

Judging from the similarity of the divisions on the two sides, the vertical and superior horizontal sutures on the right side may quite safely be considered as true anomalous sutures. The wide and quite deep angle in the border of the parietal bone from which begins the cleft which is prolonged backward as the inferior horizontal suture on the right, favors the assumption that this division, also, may be a true anomalous one. The origin of the shorter division over and beyond the

middle of the right parietal I am inclined to attribute to some violence, though this opinion is based rather on the very unusual character of the divisions than on any reliable signs of an injury.

The suture in the frontal bone, equally as the incisure in the same on the left, is difficult to explain. There is no record of any similar observations, nor have I seen any other case of like nature, nor can we explain it from what we know of the development of the frontal bone. The divisions may possibly be secondary (tension) effects of the anomalous sutures, or, if the skull has suffered an injury, be the direct results of the same, their location being influenced by that of the pre-existing anomalous divisions.

The surface measurements of the two parietals show the right one to be the larger, in both the antero-posterior and vertical directions:

Squamo-coronal junction to bregma.....	left	4.4,	right	4.7	cm.
" " " to asterion.....	"	4.5	"	4.4	"
Asterion to lambda.....	"	3.05	"	3.15	"
Antero-posteriorly at middle.....	"	4.75	"	5.15	"
Infero-superiorly " "	"	4.45	"	4.6	"

Case 49. *Cebus*, sex unknown, adult (basilar suture occluded, second dentition complete); No. 16288, A. M. N. H., N. Y.

The left parietal bone shows a now incomplete oblique, the right an incomplete vertical, and a trace of an oblique division.

The division on the left runs from the upper fifth of the anterior border of the parietal downward and backward, until it reaches the temporal ridge, beyond which it is entirely occluded. Upon close examination, the remainder of the division can be traced, particularly ventrally. It runs with a marked double curve from the ridge downward and a little backward to a point slightly anterior to the middle of the inferior border of the parietal. At a point 0.9 cm. from its anterior origin, the division is met by a 0.2 cm. long branch,

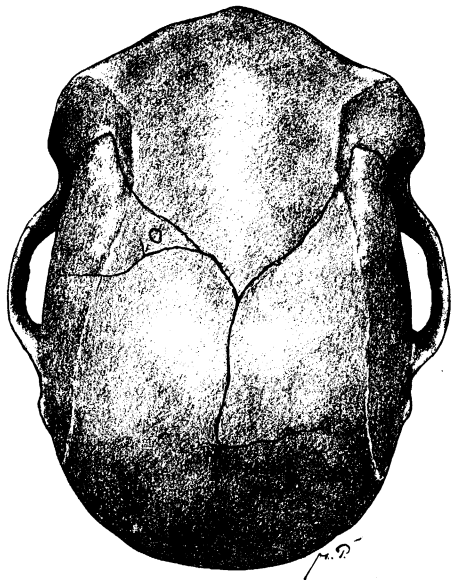


FIG. 1.

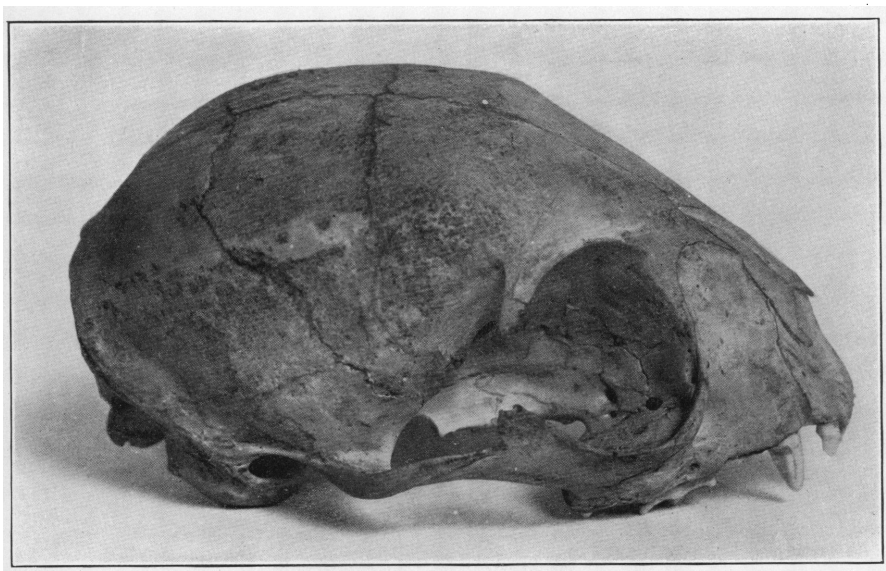


FIG. 2.

FIG. 1.—CEBUS (No. 16,288, A. M. N. H.). BILATERAL DIVISION OF THE PARIETAL.

FIG. 2.—FELIS PARDALIS, FEMALE (No. 11,039, A.M.N.H.). SHOWING A PARIETAL DIVISION.

the prolongation of which forward would reach the anterior border of the parietal a little above its middle; at about this point we find a small oblong foramen in the border. It is apparent that originally the parietal suture began at the summit of a deep and broad cleft. This cleft became filled with a separate bone, and the larger part of the suture between the lower border of this and the antero-inferior portion of the frontal bone became subsequently occluded. In fact, the separate piece is still completely isolated on the ventral surface of the parietal. The separate bone itself shows in middle a small, irregularly oval defect, filled with a secondary ossicle.

On the right side the vertical anomalous division begins superiorly a little beyond the middle of the sagittal border of the parietal (1.9 cm. from bregma, 1.7 cm. from lambda), runs 1.5 cm. downward, nearly parallel with the coronal suture, and then becomes obliterated. Posterior to and a little above the lower extremity of this there is a 0.6 cm. long, partly occluded segment of a division, directed downward and backward. The coronal border of this parietal bone shows two short incisures, one 0.9 cm. and the other 2.3 cm. below the bregma. (Pl. XX, Fig. 1.)

The skull as a whole is fairly symmetrical and without any signs of injuries or other anomalies. The left parietal bone is slightly higher anteriorly and posteriorly than the right one, but somewhat lower in the middle; the left parietal is also slightly shorter in its inferior two thirds than the right one.

Surface measurements of the two parietals:

Inferior end of coronal suture to bregma.....	left 4.8,	right 4.65 cm.
Infero-superiorly at middle.....	" 4.5	" 5.0 "
Asterion to lambda.....	" 2.8	" 2.6 "
Inferior end of coronal suture to asterion....	" 4.65	" 4.8 "
Antero-posteriorly at middle.....	" 5.05	" 5.1 "

Case 50. *Cebus albifrons*, male, young; No. 5050 A. M. N. H., N. Y.

The skull shows some generalized pathological condition, possibly rachitis. The bones contain an excess of organic matter, and the superior parts of the frontal and parietal

bones show many small indentations of surface and considerable pigmentation.

Each parietal presents a posteriorly somewhat incomplete division, running parallel with the squamous suture. In addition, the sagittal portion of the right parietal is divided by a vertical fissure.

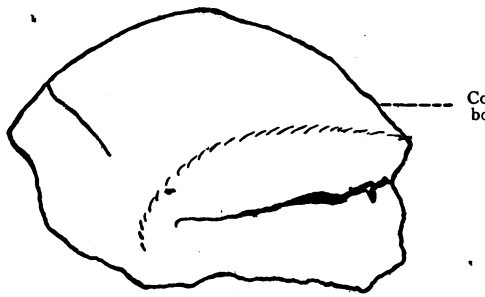


Fig. 26. *Cebus albifrons* (No. 5050, A. M. N. H.), showing division of the right parietal bone.

The antero-posterior divisions, more clefts with irregular borders than sutures, begin each about 1.0 cm. above the lower extremity of the coronal suture, run across more than two thirds of the bone, and become occluded as they near the mastoid angle; if prolonged in a straight line, they would terminate in the border of this angle.

The vertical division begins superiorly 0.8 cm. from lambda and 2.2 cm. from bregma; it is patent for 1.6 cm. and runs nearly parallel with the lambdoid suture.

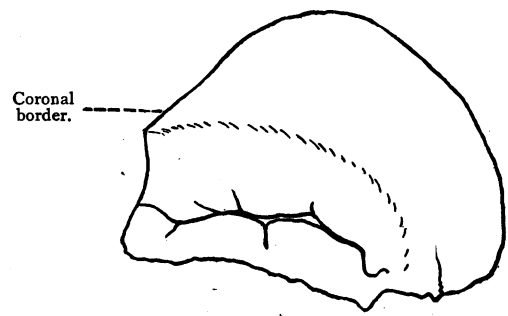


Fig. 27. *Cebus hypoleucus* (No. 11,037, A. M. N. H.), showing an antero-posterior division of the left parietal.

Case 51. *Cebus hypoleucus*, male, young; No. 11037, A. M. N. H., N. Y.

The skull is much pigmented and shows signs of a generalized pathological condition, possibly rachitis.

Each of the parietal bones shows a horizontal, posteriorly slightly incomplete (occluded) division. Each division is in the form of a narrow cleft with irregular borders, and with

incisures radiating into these borders. The axis of each of the divisions runs parallel with the squamous suture of the same side. The left division begins 0.8 cm., the right 1.1 cm. above the lower end of the coronal suture.

The left parietal shows also a 0.7 cm. long fissure, which passes from the lambdoid suture directly above the asterion toward the parietal eminence.

The horizontal divisions are very similar to those observed in *Cebus albifrons*, No. 5050, A. M. N. H.

The skull is symmetrical, the parietals nearly equal. No signs of injuries, or other anomalies.

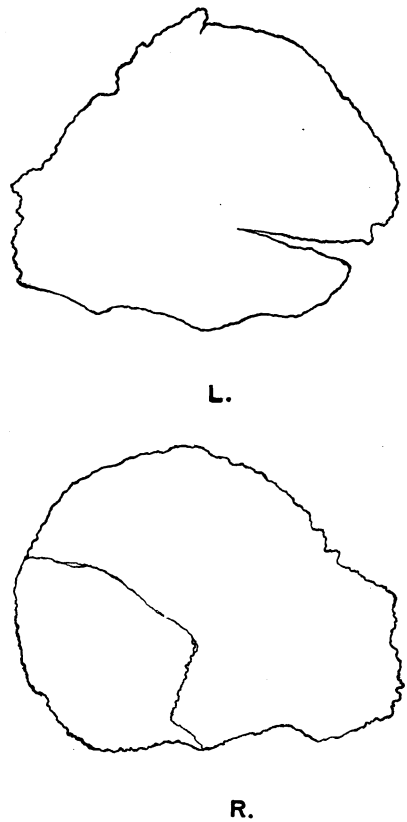


Fig. 28. *Ateles* (No. 59, Morphological Museum, Columbia University). Parietal division.

Case 52. *Ateles*, sex unknown, young; No. 59, M. D., C. U., N. Y.

The right parietal bone is completely divided by an irregular vertical cleft-suture, while the left parietal shows a small anterior and a large posterior cleft-fissure both of which run antero-posteriorly, nearly parallel with the squamous suture.

The division on the left begins sagitally near a point between the middle and posterior third of the superior border of the parietal (1.8 cm. from bregma, 0.85 cm. from lambda). It runs downward and slightly forward to beyond the eminence,

after which it bends and runs backward to within 0.5 cm. of the border of the temporal bone, when it bends again and runs forward and downward to the inferior border of the parietal. It meets the temporo-parietal suture slightly posterior to its middle. There are several oblong openings in the course of this division, and its lowest portion shows some occlusion.

In the anterior portion of the lower fourth of the right parietal bone is a 0.2 cm. long horizontal fissure.

The anterior division in the left parietal is 0.25 cm. long and directed backward and downward; it is situated 0.5 cm. above the anterior point of the sphenoidal angle. The posterior division or cleft begins distally slightly below the middle of the occipital border of the parietal, is 1.35 cm. long and directed forward and very slightly downward, running almost parallel with the squamous suture.

The skull is quite symmetrical. The bones are all very thin in spots. Temporal ridges indistinct. The left parietal bone is somewhat higher than the right one, while the length of the two is nearly the same.

Infero-superiorly at middle.....left 4.8, right 4.65 cm.
Antero-posteriorly at middle..... " 4.7 " 4.7 "

IV. Résumé.

Numbers. — Among the 391 Old World and American monkeys examined by me 52, or 13.3 per cent., show some form or other of anomalous parietal division. According to the species of the monkeys, the proportions of cases with division are as follows:

		Complete Divisions, alone or in combinations.	Incomplete Divisions alone.	No Divisions.
Old World Monkeys	29 Cynocephali..	0	2 (6.9 %)	27 (93.1 %)
	43 Cercopitheci..	1 (2.3 %)	0	42 (97.7 %)
	3 Chlorocebi....	0	0	3
	7 Cercocebi.....	0	0	7
	1 Colobus.....	0	0	1
	190 Macaques....	15 (7.89 %)	17 (8.95 %)	158 (83.16 %)
Total.....273		*16 (5.86 %)*	*19 (6.96 %)*	*238 (87.18 %)*
American Monkeys	39 Cebi.....	0	9 (23.1 %)	30 (76.9 %)
	41 Ateles.....	1 (2.44 %)	6 (14.6 %)	34 (82.9 %)
	2 Mycetes.....	0	0	2
	5 Alouatas.....	0	0	5
	1 Nyctipithecus.	0	0	1
	30 Hapale.....	0	1 (3.3 %)	29 (96.7 %)
Total.....118		*1 (0.84 %)*	*16 (13.56 %)*	*101 (85.6 %)*
Grand Total 391		*17 (4.35 %)*	*35 (8.95 %)*	*339 (86.7 %)*

Among the 17 previously reported cases of monkeys with complete or incomplete parietal divisions, there are 13 Old World (1 *Cynocephalus*,[1] 8 *Cercopitheci*, 3 *Macaci*, and 1 *Semnopithecus*) and 4 New World monkeys (2 *Cebi*, 1 *Mycetes*, 1 *Arctopithecus* = *Hapale*).

The Old World monkeys show in general a considerably larger proportion of complete, but a smaller proportion of incomplete, divisions than the American ones. If we count all the divisions together, their proportions in my two series of cases (there are no data as to the number of cases examined in other instances) are almost equal (12.8 % in the Old World, 14:4 % in the American monkeys); but such a combination and comparison are not fully justifiable: they would imply an equivalence of the divisions which cannot thus far be clearly proven.

The *proportion* of the anomalies under consideration differs quite markedly in the various species of monkeys. Divisions of various nature are comparatively very frequent in the Macaques, particularly the *Macacus rhesus*, and quite frequent in the *Cebi* and *Ateles*, but rare in the largest and smallest monkeys inspected, namely, the Cynocephals and Marmosets.

Age. — With a few exceptions all the instances of parietal division in monkeys were found in the young or adolescent animals; even in these cases, however, the anomalous division was often seen to present greater or lesser signs of occlusion, thus showing a lesser stability than that of the regular sutures. There is no example in the monkeys of a whole or even a part of an anomalous parietal suture persisting after occlusion has much advanced in the normal parietal articulations.

Sex. — Contrary to what is found in man, in monkeys the females are well represented among the individuals with parietal divisions. In fact, they surpass the males in a proportion of 2 to 1 in the category of complete sutures, but are in turn surpassed by the males, in nearly the same proportion, in the class of incomplete divisions. Counting all the divisions, the proportions of the same in the two sexes are very nearly

[1] Maggi (63) mentions another case of parietal division in a "*Papio Mormon*," but gives in that place no particulars.

equal. It is not impossible that the smaller proportion in the males of complete, and a larger one of incomplete, divisions is due to the fact that in the majority of the male skulls with the anomaly, obliteration of the anomalous sutures has from some cause advanced further than was the case in the majority of the female skulls with parietal divisions.

The coincidence of unequal proportions of the anomalous divisions when separated into complete and incomplete ones, and the equalization of these proportions when such a distinction is abandoned, in the case of the males and females as well as that previously considered of the Old World and American monkeys, is remarkable and opens an interesting little field for further investigation.

The following table gives the details of the proportions of the complete and incomplete divisions in my cases, in the two sexes:

OLD WORLD MONKEYS.

	Number Examined.	Complete Divisions (between any two borders of the parietal), alone or in combinations.	Incomplete Divisions, alone.	No Division.
		Cynocephali.		
Males	2	0	2	0
Females	—	—	—	—
Sex unknown	27	0	0	27
	(29)	(0)	(2)	(27)
		Cercopitheci.		
Males	—	—	—	—
Females	1	1	0	0
Sex unknown	42	0	0	42
	(43)	(1)	(0)	(42)
		Chlorocebi, Cercocebi, Colobus.		
Sex unknown	11	0	0	11
		Macaci: M. rhesus.		
Males	35	3 (8.57 %)	2 (5.73 %)	30 (85.7 %)
Females	31	4 (12.9 %)	2 (6.4 %)	25 (80.6 %)
Sex unknown	64	7 (10.9 %)	9 (14.1 %)	48 (75.0 %)
	(130)	(14)	(13)	(103)
		M. cynomolgus.		
Males	—	—	—	—
Females	1	1	0	0
Sex unknown	9	0	0	9
	(10)	(1)	(0)	(9)
		M. erythræus.		
Sex unknown	8	0	3 (37.5 %)	5 (62.5 %)

	Number Examined.	Complete Divisions (between any two borders of the parietal), alone or in combinations.	Incomplete Divisions, alone.	No Division.
		M., various undetermined species.		
Males.....	—	—	—	—
Females.....	1	0	0	1
Sex unknown...	41	0	1	40
	(42)	(0)	(1)	(41)
		Total of Macaques.		
Males.....	35	3 (8.57 %)	2 (5.73 %)	30 (85.7 %)
Females.....	33	5 (15.15 %)	2 (6.06 %)	26 (78.8 %)
Sex unknown..	122	7 (5.747%)	13 (10.65 %)	102 (83.65 %)
	(190)	(15)	(17)	(158)
		AMERICAN MONKEYS.		
		Cebi.		
Males.....	1	0	1	0
Females.....	—	—	—	—
Sex unknown...	38	0	8	30
	(39)	(0)	(9)	(30)
		Ateles.		
Males.....	12	0	12	0
Females.....	—	—	—	—
Sex unknown..	38	1	3	34
	(41)	(1)	(6)	(34)
		Hapale.		
Sex unknown...	30	0	1	29
		Mycetes, Alouatas, Nyctipitheci.		
Sex unknown...	8	0	0	8

TOTALS.

	Number Examined.	Complete Divisions, alone or with others.	Incomplete Divisions, alone.	Total of Cases with Divisions.	No Divisions.
Males.....	41	3 (7.3 %)	7 (17.1 %)	10 (24.4 %)	31 (75.6 %)
Females.....	35	6 (17.14 %)	3 (8.57 %)	9 (25.7 %)	26 (74.3 %)
Sex unknown...	315	8 (2.54 %)	25 (7.94 %)	33 (10.48 %)	282 (89.5 %)
	(391)	(17)	(35)	(52)	(339)

The sex was not reported in any of the previous 17 records.

Direction. — Among the total 69 monkeys with parietal divisions now on record, including the above, there are 36 in which the anomaly is bilateral and 32 in which it is unilateral; or, counting the separate parietal bones, there are, out of a total of 138 of these, 105 with, and 33 without, divisions.

The total number of individual divisions amounts to 133, and of these there are:

15 instances of complete vertical (infero-superior) suture;
51 " " incomplete " " " "
3 " " complete division running from the sagittal suture to the mastoid angle;
4 " " incomplete division running from the sagittal suture to the mastoid angle;

Total, 73 *instances of more or less vertical divisions.*

4 instances of complete antero-posterior suture;
40 " " incomplete " " "

Total, 44 *instances of more or less horizontal divisions.*

8 instances of complete oblique suture;
8 " " incomplete " "

Total, 16 *instances of oblique divisions.*

The previously published observations on monkeys, included in the preceding summary, comprise 6 complete and 8 incomplete vertical, 2 complete and 7 partial horizontal, 1 sphenoidal angle-lambda, 1 sphenoidal angle-sagittal suture, 1 middle of coronal to middle of sagittal suture, and 1 superior part of coronal to inferior part of lambdoid suture divisions. Altogether we have then in monkeys, known to date,

73 instances (55. %) of more or less vertical,
44 " (33. %) " " " " horizontal, and
16 " (12. %) " oblique divisions.

The preponderance of the vertical over all other divisions is very evident, and constitutes one of the most interesting results of my examinations. We will return to these data in the succeeding chapter.

Location. — Among the 106 parietal divisions in my 52 cases, 56 (33 vertical, 17 horizontal, 5 oblique) are on the right and 50 (26 vertical, 18 horizontal, and 6 oblique) on the left side; which is a pretty even distribution. Among the previously known 27 divisions 15 were on the right, 11 on the left side, and 1 ? The total: 71 instances (53. %) in the right and 61 instances (47. %) in the left parietal. The difference in the two sides is too small to be of much significance.

Of the incomplete vertical divisions a very large majority is found in the superior portion of the parietal, and particularly in the posterior four fifths of this portion.

Of the 40 incomplete horizontal divisions, 25 are in the anterior and 14 in the posterior portion of the parietal bone, (1?), and communicate respectively with the coronal and lambdoid sutures.

Of the minor oblique divisions, 2 separate the tip of the sphenoidal angle; 1 runs from the posterior to the inferior border; and 1 is situated in the anterior, 1 in the superior, 3 in the postero-superior, 3 in the posterior, and 1 in the postero-inferior portions of the parietal.

Size of the Parietals. — Where both parietal bones are divided in a similar manner, the size of the two bones is generally very nearly equal; where the division is unilateral, or bilateral but dissimilar, the size of the bones generally differs. The presence of a division is probably, as a rule, a feature favorable to the growth of the bone with the anomaly, particularly to a growth in the direction at right angles to the division, which agrees with the well-known law of growth of the bones under similar circumstances in man. There is noticeable in the monkeys a lesser regularity and lesser prominence of the differences in growth than is usually found in man; this is undoubtedly partly due to the smaller dimensions of the bones in the monkeys and partly, probably, to a frequent earlier presence of a bilateral division.

The following table shows the relative proportions of the parietals in which but one parietal showed a division:

Case. No.	Parietal Divided.	Nature of Division.	Right Parietal Exceeds in:	Right Parietal is smaller in:
29	left	incomplete inferior vertical	hight, length at middle	length, inferiorly
36	left	incomplete posterior horizontal	length	hight, especially posteriorly
3	right	incomplete superior vertical	length	hight
24	right	incomplete inferior vertical	length, hight anteriorly	hight posteriorly
26	right	incomplete inferior vertical	length, hight	—
19	right	vertical (partly occluded)	length, hight	—
14	right	incomplete vertical	hight	length at middle slightly
28	right	incomplete inferior vertical	length, hight at middle	hight posteriorly
44	right	incomplete horizontal and incomplete vertical	length	—

Asymmetry. — While minor irregularities in form, determinable mostly only by measurements, are common in monkeys with parietal divisions, the more marked asymmetries, amounting to plagiocephaly, such as occur very frequently under similar circumstances in man, are very rare. Here again we must consider the naturally small size of the monkey parietals on which asymmetries are less visible than on the considerably larger human bones. It is very probable, however, that in man there is felt more than in monkeys the influence of an additional factor in producing an excess of growth in the divided parietal, and thus leading to asymmetry of the cranial vault, which factor is the more rapid and longer continued brain growth.

Pathological. — The monkey skulls with parietal divisions which I examined are almost absolutely free from pathological conditions. The only exceptions to this are the skulls of two young *Cebi* (Cases 50 and 51), which show what is probably a generalized rachitic condition. Hydrocephalus is a condition that is either absent or excessively rare in monkeys, and no one of the specimens with divisions shows the slightest traces of it.

Intercalated Bones; Early Normal Divisions. — There is no indication that intercalated bones, comparatively rare in monkeys in general, are more frequent in the skulls with divided parietals; and the same may be said of metopic and other earlier normal sutures. Not one of my specimens with a parietal division, and only one of those described by others (*Cercopithecus*, Coraini), has a fully preserved metopic suture, though one or both terminal portions of the same are common in the younger subjects.

Characteristics of the Anomalous Divisions. — The complete or longer parietal divisions in monkeys show generally more or less the character of a suture. Many show more or less of a serration, which usually approaches in type that of the regular sutures. Besides the superficial serration, the divisions show often a tendency to a squamous arrangement, and some are distinctly of a squamous nature. Among these in cases 18, 21, 22, 25, and 46, the border of the anterior over-

lapped that of the posterior; in case 47 the border of the posterior overlapped that of the anterior; and in cases 47 and 31 the border of the inferior overlapped that of the superior portion of the divided bone.

Occlusion. — As a general rule, to which there may be some exceptions, the anomalous parietal divisions in monkeys tend to an earlier synostosis than the normal articulations of the parietal. They are also affected by a relatively earlier synostosis than is the case with similar divisions in man, which probably stands again in connection with the differences in the growth of the brain.

The preceding data show, in the main, that anomalous parietal divisions are much more common in monkeys and apes, particularly in certain species, than they are in man; that they occur with about the same frequency in both sexes and offer a much greater variety than in man; that divisions of a certain kind, particularly such as run more or less parallel with the coronal and lambdoid sutures, while extremely rare in man, are quite common in the monkeys; that the divisions in the monkeys give rise to relatively lesser deformities of the cranial vault and are subject to a relatively earlier occlusion than those in man; and that pathological conditions of the skull play apparently no rôle in the production or sustenance of the divisions in monkeys; all of which conditions are undoubtedly of some importance in the study of the phenomenon of parietal divisions in general.

V. Parietal Divisions in Mammals Lower than the Monkeys.

In more than two thousand adolescent and adult crania of various mammals lower than monkeys, which I inspected within the last six years, I found but one with a major, and two with minor, complete parietal separations. These will be the first cases on record, which is proof of the great rarity of this sort of anomalies in the parietal bone in adolescent and adult mammals below the monkeys.

The major separation consists of a complete vertical-oblique suture in the right, and an incomplete similar suture in the left parietal of an adolescent ocelot. The minor cases are a separation of a portion of the mastoid angle of one of the parietals in a puma, and a separation of a portion of the sphenoidal angle in a seal and a deer. In detail these cases are as follows:

Felis pardalis (No. 11039, A. M. N. H.), male, adolescent.—The skull shows no signs of injuries and no anomaly besides the parietal divisions. No Wormian bones.

Both parietals are affected by what is apparently an anomalous division. Both divisions begin at the same point from the sagittal suture, 1.6 cm. posteriorly to the bregma and 2.2 cm. anteriorly to the lambda.

On the right parietal the anomalous suture passes from the superior border at first for 1.3 cm. downwards, and then, after a bend, downward and forward, to end in the posterior extremity of the sphenoidal border of the parietal, directly opposite the temporo-sphenoidal suture. The anomalous suture shows on both sides a moderate serration and is patent.

On the left parietal the division is incomplete. It proceeds for 8 mm. nearly parallel with the vertical axis of the bone, after which it becomes much less distinct, curves slightly forward, and is lost near the well-marked temporal ridge. (Pl. XX, Fig. 2.)

Measurements of the two parietals show the following differences:

Antero-posterior arc at middle	left 3.8,	right 3.6	cm.
" " " temporo-sphenoidal point to asterion	" 2.6	" 2.55	"
Hight, temporo-sphenoidal point to bregma	" 3.4	" 3.65	"
" at middle	" 3.3	" 3.15	"
" asterion to lambda	" 2.35	" 2.35	"

The left parietal, according to these measurements, is slightly longer and higher at middle than the right parietal, this latter being higher anteriorly. The actual area of the two bones does not show much difference, and the skull is not appreciably asymmetrical.

There are, as already mentioned, no signs of injuries on the skull. The normal sutures show the first traces of ossification.

Felis concolor (No. 5034, A. M. N. H.), adolescent, sex unknown.— The right parietal bone shows a separation of a portion of its postero-inferior angle by a 1.5 cm. long, slightly serrated suture, running straight between the posterior and inferior parietal borders. No other anomalies, no signs of injury. No intercalated bone or a separation in same location in 14 other pumas.

Dorcelaphus hemionus (A. M. N. H.), adolescent, sex not determined. — The right parietal shows a separation of the extremity of its sphenoidal angle. Nothing similar in 10 other *Dorcelaphi*, but a slightly incomplete separation of like nature in a *Phoca fœtida*.

There are in the American Museum numerous skulls of various species of South American rodents of the genera *Ctenomys* and *Lagidium*, every one of which skulls presents at the asteric angle a comparatively large, regular, quadrate (more often) or triangular bone. This bone, which apparently is characteristic of these species, is either a regular fontanel bone or a separation of the postero-inferior angle of the parietal. The former of these suppositions seems more probable, but the point can only be settled by further observations, particularly on the young of the species.

For *fissures* in the parietal bone in mammals .below the monkeys *v.* detail chart at the end of the chapter on 'Divisions to Foramina.'

VI. Pathological and Accidental Defects and Divisions in the Parietals.

This category of cases will be noticed only because some of the defects and divisions present at times forms which it is difficult to distinguish from the normal or anomalous parietal separations.

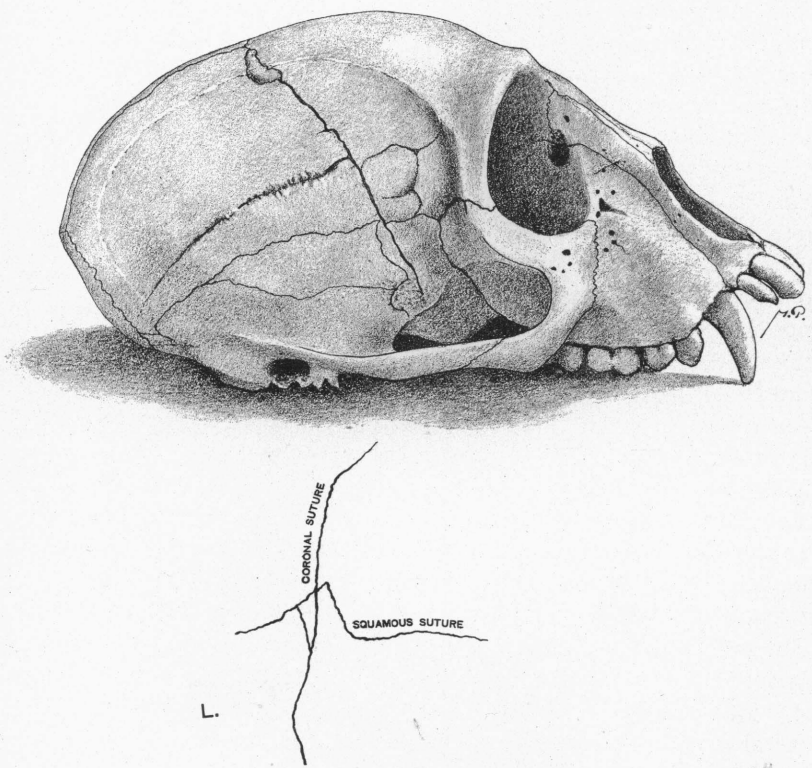
The pathological defects in the parietals occur as irregular, large perforations; smaller rounded or oval perforations; and

circular or oblong foci, which, sieve-like, are full of minute perforations or pores. The proper diagnosis of these defects can but rarely present much difficulty; they may, however, coexist with other divisions and be separable with less facility.

Effects due to mechanical influences appear on the parietal bone as simple or radiating fissures, and as more or less complete and suture-like, simple or branching, lineal, or, much more commonly, irregular separations. In some of these cases a differential diagnosis of the division from a normal or anomalous fissure or suture is very difficult and may be impossible. The circumstances which in doubtful cases would favor the recognition of a division or a fracture are (already partly mentioned when the very oblique and infero-posterior sutures were considered): signs of a cranial injury, especially when in connection with the division; irregular course, branching, one-sidedness, incompleteness, and a very unusual location of the division; and its extension into neighboring bones. As contributive signs of secondary importance in favor of a fracture may be considered an absence in the division of Wormian bones, separation of the borders of the bone along the division, bluntness of the borders, and callus formation. No one of the above signs of differentiation is alone decisive, and with all of them in mind we will still meet with cases which shall baffle our efforts at a distinction of the division. The following instance shows a fracture of the parietal which, though recognizable, offers nevertheless a considerable similarity to a sagittal parietal suture.

Case a. *Cercopithecus fuliginosus*, nearly adult; No. 2065, A. M. N. H., N. Y.

The lower part of the squama of the frontal bone on the right side shows the signs of a considerable injury. Apparently the bone was fractured, and two pieces, the superior of which was quite large, were separated, but have since reunited together and with the frontal bone. One of the breaks extended forward to the temporal ridge. The superior wall of the orbit shows two larger and several pin-point defects. The fronto-parietal articulation on each side appears as if it had been forcibly spread, and the coronal suture extends straight



Cercopithecus fuliginosus (No. 2065, A. M. N. H.). Parietal Suture or Fracture (?).

downward, separating the anterior extremity of the temporal squama on the left and a portion of the wing of the sphenoid on the right. The surface of the sphenoid and temporal bone, below the termination of the prolongation of the coronal suture on the right side, shows fine superficial porosity.

Besides the thus far mentioned effects of the injury we see on the right side a temporal and a parietal division. The temporal division begins at the extended coronal suture, 1.1 cm. below the squamo-coronal junction, and, passing backward and upward, terminates a little posterior to the middle of the squamous border. Though plainly traceable, this division is well on the road to occlusion.

The parietal division begins 1.1 cm. above the squamo-coronal junction and 0.2 cm. above the external mark of the superior fracture of the frontal bone. It runs downward and backward to within 0.55 cm. of the squamous suture, and then almost directly backward to a point 0.4 cm. above the asterion, terminating a short distance anterior to the lambdoid suture. The division is not squamous nor serrated; the borders of the two portions of the parietal bone lie simply in apposition. Parts of the division show occlusion and very slight superficial signs of inflammation (roughness, deposition of new bone, fine porosity).

In the superior portion of the right coronal suture, 0.25 cm. from bregma, is a quite large Wormian bone, formed almost entirely at the expense of the parietal.

The skull is symmetrical. The right parietal bone is higher anteriorly and at middle, but lower posteriorly, than the left one, while the length of the two is very nearly equal. The parietal division, other lesions excluded, could very easily be taken for an anomalous suture. (Pl. XXI.)

VII. The Causes of Anomalous Parietal Divisions.

The original condition which makes the "typical" complete anomalous division of the human parietal bone possible is, as is to-day probably generally acknowledged, the existence of more than one center of ossification of the bone. These

centers, which ordinarily unite and form one bone, persist in rare instances in their separation and give rise to a parietal composed of two or more portions, similarly as happens sometimes in the human malar.

The theory of the development of the parietal bone in man regularly from two centers, and the ensuing elucidation of the origin of the typical parietal division on this basis, is due almost entirely to the researches of Toldt (1882–83) and Ranke (1899). Before Toldt it was a generally accepted opinion that the parietal bone develops from one center, and the origin of a parietal suture was a matter of speculation. Soemmering (8) recognized it to be of congenital origin. Certain expressions of Hyrtl (50), Gruber (25, pp. 12–15), and even Welcker (17, p. 109) make it probable that all these observers suspected that the original cause of the divided parietal is a presence of a double center of ossification of the bone, but neither author has made a definite statement on that point. In fact Welcker later on, as already mentioned (55), declared a development of the parietal from more than one center inadmissible. Hyrtl, in particular, reflected more upon a relation between the temporal ridges and the parietal suture than on that between this and a greater number of the centers of ossification. Calori (20, p. 341) attempted to explain the divisions in the cases that came under his observation by the theory that in the apparently divided parietals the additional portion of the bone was developed from an accessory portion of the ossifying parietal that became isolated and failed to unite with the real center of ossification because of an abnormal distention of the cranial vault.[1] Coraini, considerably later (1893) and after Toldt's work, advanced, partly in agreement with Calori's view, the hypothesis that in the apparently divided parietal one portion of the bone is the real parietal and the other is an accessory one, closely allied in nature with the Wormian bones (33, pp. 140–144; *v.* following foot-notes).

[1] "Quindi la circonferenza esterna, o l'inferior-anteriore del germe osseo dei parietali non potendosi assimilare la sostanza ossea depositantesi al di fuori di lei, e rimanendo tale sostanza sciolta e libera e dilungandosi per la distensione via via crescente dal germe cui doveva servire ad augumento, resasi indipendente ha fato di sè centro di ossificazione a sè stessa, e si è costituita in osso distinto, separato dal germe osseo proprio a' parietali," etc.; *v.* also the following foot-notes.

Maggi and Frassetto, finally, advanced, as already mentioned in the introductory chapter, the theories of respectively three- and four-center origin of the parietal.

Toldt's investigations concerned the regular development of the normal human parietal bone, and the explanation of the formation of a divided parietal was an inference based on the results of that research. The author expresses himself in the following language (48): "The ossification of the parietal begins in the 10th week of the embryonal life. It commences in the form of a wide-meshed net, composed of slender laminæ of bone. During the 11th to 13th week this net shows the formation of two, superimposed, more dense centers. The laminæ of bone radiate from each of these centers and meet on the opposed portions of the periphery of the two sets. In some cases the radiate arrangement is less pronounced in one than in the other center. Both centers unite gradually during the 4th month, nevertheless their former separation is still marked by a more or less deep anterior and posterior cleft in the bone. In the 5th month the development of the parietal eminence takes place, in the situation where the two centers have met. There are, in consequence, in opposition to the commonly accepted opinion, two well-distinct, even if not completely separated, points of ossification for the parietal bone. This makes it possible to explain the occasional sagittal suture in the parietal bone."

In 1883 (49) Toldt supplemented the above statement by further explanation and by an illustration, showing a case with two clearly marked, though not fully separated, parietal centers.

Since Toldt the theory of a two-center development of the divided as well as the undivided parietal has been gaining a gradual recognition (Putnam, Turner, Coraini, Dorsey, O. Schultze, Graf von Spee) until 1899, when it received an important corroboration by the work of Ranke (36). Before the work of this author, however, there appeared in 1896 and 1897 (59, pp. 900, 901, and 60, p. 1165 *et seq.*) the contributions of Maggi, who declared, basing his conclusion on his observations on human fœtuses, that the human parietal

develops from three centers, but that even four centers of ossification may be encountered.[1] Of the three centers two may fuse early and leave but two separate. The formation of these different centers is *posterior* to that of the unique center that appears about the 45th day of fœtal life. According to this the ossification of the parietal would start about the 6th or 7th week of intrauterine life from one focus, but a little later on there would appear two, or more rarely three, additional centers. Thus far this theory has not been substantiated by any other author, though it is utilized by Frassetto; but it must be remarked that, with the exception of Ranke, no author since Maggi has made any extensive embryological inquiries into the matter.

Ranke's researches extended over some embryological material on which he found no such centers as announced by Maggi (he does not mention Maggi's work), but conditions similar to those announced by Toldt, that is, an early and usually brief, but apparently regular, existence of two foci of ossification for the parietal. Following with investigations on older subjects, Ranke shows that more or less marked traces of the original two portions of the parietal are, in man, common at birth, and can occasionally be detected even much later in life; and that similar, only still more marked and longer-lasting signs of a similar condition can be seen on the skulls of apes, particularly the orangs.

But Ranke's conclusions also differ in several details from those of Toldt. In Ranke's words (36, p. 52): "My tests of Toldt's teachings have resulted in a complete agreement in the main points of our observations. There is, however, one point in which I must go further. I find that we have not simply 'two to a certain degree independent centers of ossification,' but that: *The human parietal bone is a complex of two embryonal, separated, superimposed, elementary bones of*

[1] 59, p. 900: "I centri di ossificazione dei parietali, che finora potei chiaramente vedere in feti umani da 2 mesi e mezzo a 3 mesi e mezzo, sono tre per ciascun osso. Talora di questi tre centri, sempre in feti dello stesso tempo di sviluppi suindicato, due si uniscono in un solo e si hanno allora soltanto due centri di ossificazione per parte. La formazione di questi diversi centri segue a quella, ammessa dagli antori, di un punto unico di ossificazione per ciascun parietale, che appare verso il 45° giorno di vita intrauterina, e precede quella della gobba parietale."

[2] 60, p. 1167: "Quatro centri di ossificazione per ciascun parietale, che talora si vedono nei feti umani," etc.

the skull, which unite only during the later progress of development."

"The occurrence of the horizontal division of the parietal bone results, as established by Toldt, from an individual development of the two portions of the bone." "The parietal is a complex of two elementary bone-individuals, whose separation can from certain causes persist just as well, even if less frequently, as the frontal suture, the embryonal separation of the two frontals" (p. 56).

The parietal eminence is "formed from the fused centers of ossification of the upper and lower parietal," "and not at the point of the former dividing line of the two centers" (pp. 55, 56).

"The form of the parietals shows in all the new-born, as well as older products in our race, traces of the former division of bone by a parietal suture into an upper and a lower parietal" (p. 29).

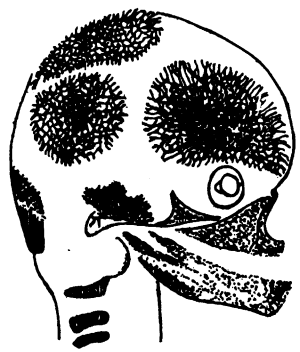


Fig. 29. Head of a Human Embryo, showing two separate parietal centers of ossification. (After Ranke.)

The principal observations upon which Ranke based his conclusions are as follows (36, pp. 52–56, figs. 29–32):

1. An embryo 6.5 cm. long shows the upper and lower parietals fully developed, but still completely separated. (Fig. 29.)

2. An embryo of 9.0 cm. total length shows also a still complete separation of the upper and lower parietals; but there appear to be differences in the position and size of the elementary bones.

3 and 4. In two embryos of respectively 10.0 and 11.0 cm. length, the two original centra of the parietal bone are united, but their existence is still recognizable and traces of their union are still patent.

5. An embryo of 12.0 cm. length showed similar conditions as the preceding. (Fig. 30.)

These cases show very plainly the formation of the human parietal from two superimposed foci and there is no trace of

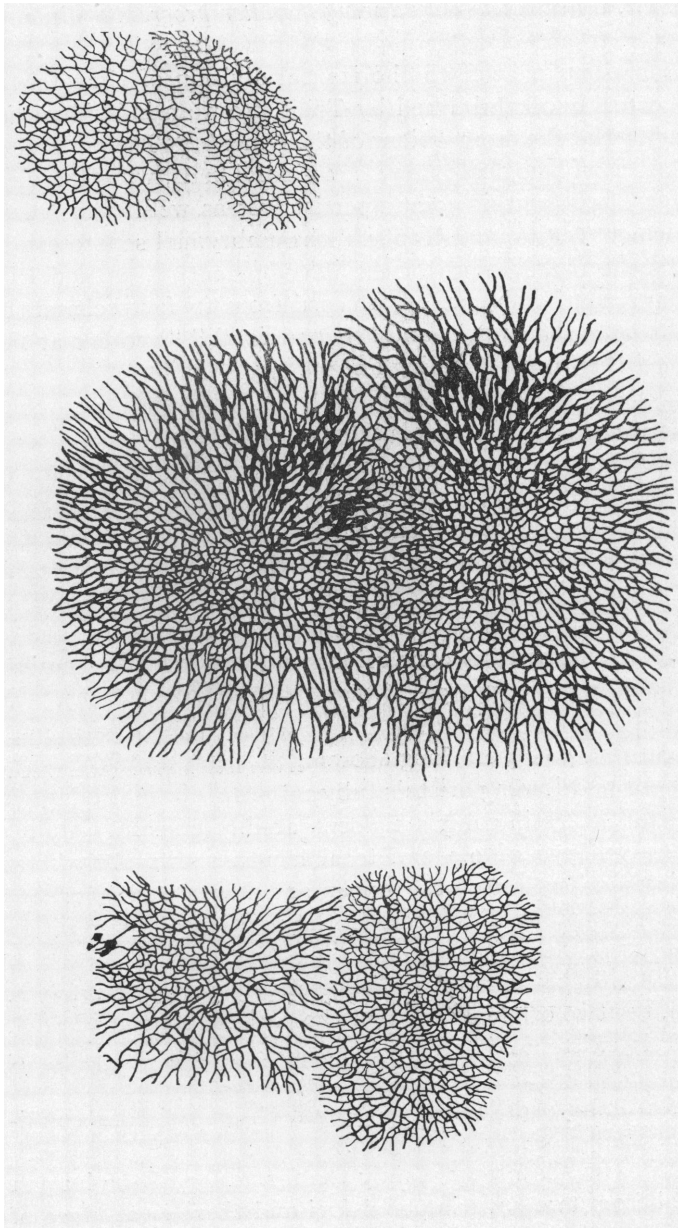


Fig. 30. Embryonal Parietal Bones, showing two centers of ossification. (After Ranke.)

such a condition as is mentioned by Maggi. It is difficult, however, to accept as demonstrated Ranke's view that these foci represent or are two distinct parietals, for we meet with similar foci in all the cranial and facial as well as all the other bones of the skeleton, and we should have to assign to all a similar morphological value. We shall return to this view later. The essential point which concerns us in this place, and which Toldt's and Ranke's investigations seem to establish, is the real manner of the development of, particularly, the human parietal bone, which enables us to comprehend the formation of the anomalous parietal divisions, particularly the "typical" horizontal parietal divisions.

Frassetto's four-center theory (70) needs scarcely more than be mentioned; it lacks a proper substantiation.

Toldt's and Ranke's, and we may include Maggi's, researches explain the original condition which makes the anomalous parietal divisions, at least those of a certain sort, possible; the plain fact of the original existence of two (or even more than two) separate centers of ossification does not, however, reveal, and, in fact, has hardly any relation to, the *actual* cause or causes of the persistence of the separation of these centers. This persistence requires, as Ranke well says (p. 27), "an additional individual cause, without which such 'supernumerary' sutures would not be found in the adult crania."

What that *determining* cause or causes may be is still largely a matter of conjecture. Calori,[1] and after him Coraini,[2]

[1] 20, p. 338 *et seq.:* The parietal bone develops from one unique center of ossification, and in consequence of that, the mode of formation of a division in the bone must differ from that of the frontal, squamo-mastoidal, or transverse occipital suture. "Ci possiamo però valere delle altri condizioni, cioe dello svilupparsi ed aumentarsi od ampliarsi del cervello e della capsula cranica o normalmente, o per ipotrofia di esso, ovvero per idrocefalo, sproporzionatamente allo sviluppo ed incremento delle ossa. Posto dunque che il cervello cresca sproporzionatamente, o vi abbia idrocefalo, e la capsula predetta consentendo al contenuto si dilati, dee necessariamente sonseguitare che il processo ossificante si rallenti sì per la compressione come per la diversione di una parte di materiali nutrizi da esso lui, materiali che a se attrate il cervello, o l' idrocefalo che cresce a sue spese. Per questa scarseggiante nutrizione gli spazi membranosi interposti ai punti di ossificazione od alle ossa che essi compongono, rimarranno molto estesi; anzi si estenderanno vieppiù in forza della distensione. I punti ossei poi crescendo e dilatandosi per l'aggiunta di sostanza ossea alla loro circonferenza non avranno in virtù della forza distendente molta agevolezza di appropriarsela, anzi ne saranno impediti, per forma che rimarrà ella libera e si dilungherà da essi, e ci apparirà, come non di rado, sotto forma di isolette in quegli spazi membranosi, le quali cresceranno in wormiani, e radoppieranno le suture, od in forza della sinostosi congiugerannosi e comporrannoi in un osso solo, che più tardi si articolerà per suture con le ossa vicine." *Seq.*, pp. 340, 341.

[2] 33, p. 142 *et seq.:* "La causa di questa serie di fenomeni e della divisione quidi dell parietale ritengo, con Calori, che debba essere considerata una sproporzione fra l'accrescimento del contento cranico e l'accrescimento delle ossa del cranio, di tal maniera

search for such an influence in a disproportion, due to physiological or pathological causes, between the growth of the cranial contents, in favor of these, and the cranial, especially the parietal, bones. The disproportion may be due either to physiological (rapid growth of brain) or pathological causes (hydrocephalus). Coraini further sees in the phenomenon a tendency to an appearance of a new bone, an example of neomorphism.

Maggi, as already referred to under 'General Remarks,' considers the divided parietals homologous with the multiple parietal scales in stegocephali, etc. This comparison seems to imply that the anomaly in the human parietal is reversive in nature.

There is no further expression of opinion on the determining cause of the parietal divisions except by Ranke. This author's view, that the two foci from which the parietal develops represent two independent parietal bones, would seemingly tend to approach the parietal sutures to examples of neomorphism. Ranke, however, expresses another theory, which is as follows (36, pp. 27–28): "It has long since been established by Virchow that the so-called supernumerary sutures are very often observed in company with prematurely synostosed normal sutures. It can be imagined that the pressure of the growing brain against the cranial vault, meeting with an abnormal resistance in the locality of the premature synostosis, expands more strongly those parts of the vault, such as bones divided by a suture, at which it meets with a lesser resistance, and thereby hinders the normal closure of those fœtal sutures and fissures that are still open. The earlier this normal process of closure in fœtal life tends to be effected, the more rare will be the corresponding supernumerary sutures in the adult."

da fare sisentire la sua influenza specialmente nell' ambito dei parietali, i quali per ciò non possono da soli completare la corrispondenta parte della scatola cranica."

P. 144: If confirmed, "l'anomalia rappresentarebbe dunque un fatto, che potrebbe dirsi de neomorphismo; rappresentarebbe una variazione che tende a fissarsi e che porta formazione di un nuovo osso, il parietali accessorio, il quale sarà nei singoli casi o unico o multiplo."

P. 144: "Ma in ogni singolo cranio essa potrà avere inaltre un altro e speciale significato, potrà rappresentare un carattere di superiorità, nel senso antropologico, qualora la sproporzione, indicata come causa della sua comparsa, sia dovuta ad un aumento della massa cerebrale conginuto a superiorità di attività psichica; oppure rappresenterà un carattere patologico, qualora tale sproporzione sia prodotta da una conditione patologica."

We shall return to most of the just-mentioned theories of origin and causation of parietal divisions later. What needs to be remarked in this place is that they all, except those of Maggi and Frassetto, apply principally to the *complete typical* antero-posterior divisions. These are, however, not the only divisions which occur even in the human parietal.[1] There have been observed also some very oblique divisions crossing the whole bone, and others, oblique or angular, which separate one, usually the mastoid, angle of the bone. About the nature of these *atypical* and *minor* divisions there is considerable uncertainty. Welcker apparently considered the minor as equivalent with the major sutures. He says (17, p. 109): "I know a number of skulls on which can be seen a suture beginning at the middle of the lambdoidal margin of one of the parietals and passing over this bone; but this particular suture, instead of halving the parietal, bends towards the temporal border, separating only the mastoidal angle of the bone. The separated piece has the appearance of a large intercalated bone. When the separated lower segment is equally as large as the upper part, as in a horizontal division of the whole parietal bone, the term intercalated bone (Schalt oder Nahtknochen) is not applicable to either of the pieces; yet the process of production of the two segments, when of equal size, must have been exactly the same as in the case where pieces of unequal size have resulted." Gruber, in describing an instance of a separation of the mastoid angle (25, pp. 12–15) calls the separate postero-inferior portion a "parietale secundarium posterius," which term gives that portion a similar morphological value with the larger antero-superior bone, and approaches the suture dividing the two to the typical antero-posterior anomalous suture. Putnam (26), speaking of the postero-inferior (as later shown, inferior) segment in his second Tennessee specimen, considers this as developed from "a separate center," which also tends to give the anomalous suture a similar value to that of the typical antero-posterior one. For Toldt (49, p. 86) the very oblique antero-posterior

[1] The material in apes and monkeys being almost wholly very recent must be excluded from these and following notes; these should be understood to apply solely, unless specified otherwise, to the human parietals.

sutures of the parietal had the same significance with the typical horizontal ones, and were due to a preponderance of growth in one of the centers of ossification. For Coraini, the divisions that separate only an angle of the parietal bone have practically the same significance as the divisions that halve the bone,—they are all accessory bones, allied to the Wormians formed from accessory centers of the parietal. The restriction of the division to one angle may be explained either by a later appearance or lesser growth of the accessory center; or, even more probably, by the supposition that there were originally two superimposed accessory centers, and possibly formed portions, as in the case of Fusari, one of which, however, united early with the main portion of the bone or the real parietal. The nature of the sutures, transverse, oblique, or vertical, depends on the relative position of the centers from which the particular parietal is developed.[1] Maggi, with his three- or even four-center theory finds naturally an easy explanation for all forms of division of the parietal; and so does Frassetto.

For Graf Spee (51), "the typical development of the parietal bone from two centers does not afford any explanation for those fissures which divide the planum temporale of the bone." "It is possible that the portions of temporal squama and those

[1] 33, p. 140 *et seq.*: "Io penso che la divisione del parietale possa essere intesa nel modo seguerite: Quando il parietalo sorge anormalmente da due punti di ossificazione, si potrà avere una delle prime quatro (α, β, γ, δ) varietà di divisione dell' osso; si avrà cioè un parietale bipartito da una sutura soprannumeraria, l'audamento della quale, trasversale, verticale, o variamente obliquo, dipenderà dalla posizione reciproca occupata dai due germi del parietale al loro insergere e dal vario potere di accrescimento che ognuno di essi verrà manifestando nella contesa, direi, dello spazio.

"Anche le due successive varietà (ϵ, η) di parietale diviso per separazione dell' angolo mastoideo pare che possano ripetere il medesimo meccanisimo. Il parietale deriverebe egualmente da due germi di ossificazione, uno di quali però sarebbe sorto molto eccentricamente cioè nell ambito di uno dei detti angoli parietali, ed inoltre o sarebbe sorto tardi rispetto al' altro, o sarebbe stato dotato di minore attività formativa.

"Senza escludere questa maniera di prodursi delle due dette varietà, parmi si possa pensare ancora ad un meccanismo diverso, e mi dimando: é possibile che in questi casi si tratti di parietali sorti, come nel caso di Fusari, da tre germi d'ossificazione? Ammettendo una precoce sinostosi fra il germe anteriore ed il posterior-inferiore si comprenderebbe la divisione del parietale per separazione dell' angolo occipitale; ammettendo la sinostosi fra il germe anteriore ed il posterior-superiore, si comprenderebbe la divisione del parietale par separazione dell' angolo suo mastoideo; ammettendo la sinostosi del germe posterior-superiore coll' anteriore e col posterior-inferiore si comprenderebbe la divisione del parietale per separazione incompleta dell' angolo suo mastoideo mediante una breve sutura soprannumeraria verticale come nei casi di Gruber e mio."

This latter hypothesis has the advantage over the former, "che l'origine del' parietale da tre germi è un fatto (si pure una sola volta) constatato e che essa ha il vantaggio di darci ragione della forma e della grandezza del pezzo del parietale separato, dell' audamento della sutura anomala, e ci permette di spiegare facilmente tutte i singoli casi compressi nelle due dette varietà."

of the lower part of the parietal which are separated by these extremely rare fissures can be referred to the Wormian bones (Schaltknochen)."

Ranke's opinion as to the sutures that separate only an angle of the parietal differ from all the preceding (36, pp. 33–35) is, that the separations of the mastoid angle "possess something decidedly typical." Nevertheless I should not fully agree with Putnam's supposition that in these conditions we have to deal with a primarily "separate center." "Yet, the oblique and the sagittal parietal suture, cutting into the parietal from the same point (posteriorly), have something in common in development."

Ranke considers Putnam's case as similar to his three cases of an incomplete sagittal suture, and on this assumption (incorrect in view of the more detailed description of the case here given) bases the following conclusion: "When we accept that the (posterior) incomplete horizontal resp. sagittal parietal suture and the oblique parietal suture are primarily the same formations, it still remains for us to explain why under these circumstances *the incomplete sagittal parietal suture suffers a deflection downward*, so that it changes either wholly or in its anterior part from a sagittal to one of an oblique direction."

Ranke's above statement embraces the theory of an identity of the posterior incomplete horizontal parietal suture with (at least) that which passes in an oblique or angular direction, between the posterior and the inferior borders of the parietal, separating its mastoid angle, or, rather, its postero-inferior portion; and the existence of conditions capable of deflecting the horizontal suture downward and making it reach the inferior parietal border. The deflection of the suture is produced, according to Ranke, "through a break (Einknickung) in the 'plastically' (after G. H. Mayer) upturned posterior border of the parietal."[1] He says: "It is my opinion that these formations occur mostly in a similar way as the

[1] "Sind schon aus früheren Entwickelungsepochen kürzere sagittal spaltungen im Scheitelbein vorhanden, so führt die Abknickung diese Spalten in der Knickhaute nach abwärts."

artificially produced sutures by Gudden,[1] and that is by the cracking (Einknickung) of the skull in consequence of the counterpressure (maintained by Mayer[2]) of the spinal column against the heavy, exceedingly pliant and breakable skull. In instances where there are no primary sagittal clefts in the parietal, which would facilitate the cracking in a definite direction, there will be split off, through the same process and parallel with the lambdoid suture, quadrilateral pieces of the parietal, those well-known so-called 'colossal intercalated bones (Schaltknochen),' which are in reality pieces of the parietal bone, and are mostly separated from the neighboring parts by well-formed and serrated sutures."

On pages 63 and 64 of his memoir, Ranke reiterates his opinion, and his final expressions on the point are as follows: "The investigations into the development of the parietal bone have brought forth no better explanation of the *oblique parietal suture* than those previously attempted. In any case, there is no ground on which we could attribute to the separated, independently appearing mastoid angle the same significance with the inferior elementary parietal, as was the desire of Gruber. Neither can I agree unconditionally with the ideas of Toldt, who also means that, without anything further, he can refer the condition, equally as the separation of an 'upper' from a 'lower half,' to the 'typical dicentric foundation' of the parietal." "I would adhere primarily to the before expressed opinion, that in cases of the 'oblique parietal suture' we have to deal with a deflection, due to some, perhaps a *mechanical*, cause, of that, even in the newborn, so frequent, posterior *incomplete* sagittal parietal suture; this suture through a mechanical breaking off of the mastoid angle not only is bent downward, but carried even to the border of the parietal." "It should, however, also not be passed over in silence that such a small separation, as shown on fig. 13, p. 303, can arouse the thought that here, perhaps, we are confronted with something that is no more than a fontanel-bone." . . .

[1] Gudden, Experimentaluntersuchungen ü. d. Schädelwachsthum, München, 1874.
[2] Mayer, G. H., Statik und Mechanic d. menschl. Knochengerüstes, Leipzig, 1873, pp. 233–236.

No opinion has thus far been formulated (unless it was by Zoja, whose publication was not accessible to me) in regard to the instances of an apparent extension of a parietal division into the temporal squama. . . .

Résumé: Causation of Parietal Divisions in Man.

The above notes illustrate that we are confronted by a number of more or less varying theories, formulated mainly on the basis of the rather scanty human material, both as to the fundamental and the determining causes of parietal divisions, particularly those of a very oblique course or extending between two connecting, instead of two opposed, borders of the parietal.

In so far as the *fundamental* cause of the "typical" sagittal divisions are concerned, there is a general agreement as to the development of these by an independent growth of, and the eventual forming of, a regular articulation by two portions of the parietal, the only points of difference among the authors relating to the exact morphological value of these two portions. As to the very oblique and the infero-posterior divisions we have several radically distinct tendencies of opinion. There is a series of authors who are inclined to consider these divisions as equivalent with the "typical" sagittal ones, or, at least, developed as a consequence of a separate center of ossification of the parietal; a smaller group, represented mainly by Coraini, who associate the additional portion of the parietal with intercalated bones; and finally one observer, Ranke, looks upon these formations as at mechanically extended normal fœtal fissures which are ordinarily found in the posterior border of the parietal bone.

As to the *determining* cause of the anomaly in its "typical" form, we have the theory of Calori and Coraini, which attributes the formation of the additional parietal bone and the subsequent parietal suture to the effects of a disproportion from physiological or pathological cause between the growth of the cranial contents and the cranial vault; and the theory of Virchow and particularly Ranke, which seeks the cause

in a premature union of other normal cranial sutures, and the consequent increased strain on the separation between the two embryonal portions of the parietal, if this separation happens to be still open; and, somewhat indirectly, the implied theory of reversion or reminiscence, of Maggi. The *determining* cause of the very oblique antero-posterior, the infero-posterior and other parietal divisions is, with those who consider these divisions as equivalent to the "typical" ones (including, notwithstanding their varying view of the whole subject, Calori and Coraini, as well as Maggi and Frassetto), evidently primarily the same as that of the "typical forms." For Ranke, as we have seen, the cause of these atypical parietal divisions is entirely different from that of the "typical" ones, and consists primarily in the counterpressure of the spinal column against the cranium, the influence inducing direct or indirect breaks in the postero-inferior part of the parietal bone, which breaks persist in the form of a suture.

The Morphological Value of the Complete Antero-Posterior Parietal Divisions in Man.

The differences of opinion as to the *morphological value* of the two portions of the sagitally divided parietal are represented by the views of Toldt, Maggi, Calori, and Ranke. Toldt held that two separate portions develop from the ordinary two foci of ossification, to which foci he attributed no special significance; and Maggi's (with Frassetto's) position, though assuming more than two centers of ossification for the parietal, is similar. For Calori, and particularly Coraini, of the two portions of a divided parietal, one represents the real, original, the other an accessory, Wormian-like bone. For Ranke the two portions represent two *ab origine* distinct and equivalent parietal bones.

Of these several views that of Calori and Coraini appears to me to be the least tenable. It is true that large "accessory" bones occur in the location of the fœtal fontanels and in all the normal parietal sutures. It is also true that in extremely rare cases the accessory bone, particularly that which

occurs in the temporo-parietal suture, may extend, with one or more interruptions (and possibly continuously), along the whole border of the parietal; I have seen two or three instances of that condition and find several such cases on record. But the "typical" sagittal parietal divisions have characters of their own which will easily differentiate them from the formations just referred to. Let us take such a case as Soemmering's, or Ranke's, or those of Turner. Both portions of the divided parietal in these cases are large, though the upper exceeds more or less the lower one; the parieto-temporal accessory bones have never been seen to attain at any point comparable dimension. The suture that separates the two portions of the divided parietal is usually well serrated, though it may at the same time be slightly to moderately squamous; the suture that separates the accessory temporo-parietal bone from the parietal is only and eminently squamous. The accessory formations are, with the rarest exceptions, very irregularly subdivided, but there is no instance where either portion of a sagittally divided parietal has shown the slightest indication of a subdivision. Calori and Coraini suggest that the large accessory bone may have been produced from but one accessory center, which brings their theory very much nearer that of Toldt and his followers; but how can we account, especially in the absence of marked signs of an excess of a physiological brain-growth, a hydrocephalus, or other abnormalities, for a development of the necessarily secondary and later "accessory" center, equalling, or almost equalling, the original center of ossification of the parietal? It seems to me that on the basis of these considerations alone, and without reference to the embryological data now in our possession, or to the normal partial parietal divisions in the new-born in a situation corresponding to that of the anomalous, complete, "typical" division, the accessory-center theory of the origin of the "typical" sagittal parietal divisions must be abandoned.

Toldt's, Maggi's, and Ranke's views differ essentially in the attributed morphological value to the two centers from which the "typically" divided, as well as the ordinary, parietal

develops. For Toldt and Maggi the centers have apparently no different meaning from that of similar centers of other cranial and skeletal bones; for Ranke, it does not appear on what basis, they represent two distinct parietals. Should Ranke's view be correct, and as we do not meet with double parietals as a regular feature in lower mammal life, we should be in the presence of either an early stage of a highly interesting neomorphism or appearance of a new cranial bone, or a very far-reaching reversion, such as implied by Maggi. The presence of a double parietal would then either denote a sign of organic precociousness, and individually rather a progressive character, a superiority; or a very inferior animal feature. There would be little need, then, of searching for a cause of the "typically" divided parietal in the pathological premature synostosis of some of the normal cranial sutures. Also, there is no barrier which would restrict the idea of an equivalence of the centers of ossification with distinct bones, to the centers of the parietal; it would have to be extended to the centers of other bones, the occipital, the malar, the superior maxilla, the scapula, pelvic bones, femur, etc., which would give an entirely different aspect from that which we now have of our osteology, and for this we are as yet hardly prepared. However, Ranke's theory cannot be lightly disposed of. It seems to disturb our current notions about bones; but it only seems so, for upon reflection it must be acknowledged that we have no clear and generally established notions relating to the morphological value of the centers from which our bones develop. What proofs, or even indications, are there that our adult bones are *primary* morphological units and not composites of different, at some period in the individual or even terrestrial life, independent parts? There are not only no such proofs, but there is much that favors the assumption that our adult bones are such composites, that they are really phylogenetic and ontogenetic resultants from a varying number of more or less independent bone units. We do not consider a normally synostosed cranium or a part of the spinal column or any other portion of the skeleton a single bone, yet the relation between an adult bone and its early constituents, and

the synostosed cranium and its early constituents, is more an apparent than a real one. It is decidedly attractive and seems possible to look at the early steady constituents of all the adult skeletal parts as at separate formations, separate units of the organism. They do not, however, it seems to me, represent distinct "parietals," or "malars," or "maxillæ," or "scapulæ," etc.; these terms belong only to the composites, to the synostosed aggregates, of the earlier, elementary portions. In the case of the "typical" division of the parietal it is not *two parietals* that we have, so much as *two parts of the parietal*, or, at most, *two persisting elementary parietals*. Properly, we should not speak of these cases as *divisions*, but rather as of *anostoses* of the parietal; and, similarly, of anostoses instead of divisions of the malar, etc.

The Morphological Value of the Very Oblique Divisions and those that Run between two Connecting Borders of the Parietal in Man.

Due to their location and extent, the *very oblique* antero-posterior and the *infero-posterior* parietal sutures have been separated into a special group, and are considered, principally by Ranke, as being of a different signification from the "typical" sagittal sutures of the parietal bone. Such a separation is, so far as the very oblique antero-posterior sutures are concerned, entirely artificial. There is no such a thing as a "typical" sagittal suture. In all the instances of a bipartite parietal the suture was more or less oblique, never perfectly horizontal, that is, terminating at exactly the same distances from the pterion and asterion as from the bregma and lambda; and there were observed, without any great interruption, all the degrees of obliquity. There are cases on record, speaking still exclusively of man, where the suture nearly halves the parietal antero-posteriorly, as in Soemmering's specimen and others, particularly two of the fœtal skulls of Hyrtl, where the division runs very nearly from one angle of the parietal to an opposite angle. In such circumstances on what basis can we separate morphologically any special

number of the antero-posterior sutures from the others? Toldt's and Ranke's embryological investigations both show that the elementary parts of the parietal are seldom, if ever, situated perfectly one above the other; and if not so at that early stage of life, why should we wonder at finding them in a similar, perhaps more or less accentuated, position later? The accentuation of the obliquity of the space, later on, suture, between the two parts, is easily explainable by differences in growth of the two, differences which we know to exist, for probably the parts are never, when full grown, of the same dimensions. There seems to me to be no possibility, unless some further evidence of their difference is adduced, of separating the more from the less oblique antero-posterior sutures of the parietal, and I cannot but second the opinion of Toldt and others, that the more oblique antero-posterior parietal sutures are morphologically identical with the less oblique ones that cross the bone in the same direction. They both form the boundaries between the variously developed, persisting elementary parts of the parietal.

There is a greater difficulty in determining the proper significance of those portions of bone which occasionally represent in a separate state more or less of the postero-inferior portion of the parietal. The sutures separating these differ in nothing, except in a greater tendency to angularity, from the antero-posterior parietal sutures. In location they range from those that run from the middle of the posterior to, or even anterior to, the middle of the inferior border of the parietal, to those that are unmistakably the boundaries of Wormian or fontanel bones. Their posterior termination, as Ranke remarks, is mostly at about the same point as that of the antero-posterior sutures. The bones which these postero-inferior sutures represent have distinctly the appearance of parts of the parietal. They never encroach in any marked degree, as Wormian or fontanel bones are apt to do, on the neighboring bones, nor have they been seen to be in any way subdivided, or to extend into the temporo-occipital suture, or appear extended by Wormians along and at the expense of the posterior or inferior parietal border.

There are, as mentioned, in the main, three theories about these "separations" of the postero-inferior portions of the parietal. Of these the theory of Ranke, attributing them to a mechanical separation extending in the course of the partial posterior parietal suture, appears to be the least tenable. In the majority of instances of the anomaly there is no evidence of any turning up of the posterior border of the parietal, nor any other abnormality which would point to any special effects of the counterpressure of the spinal column. The first effect of such a counterpressure in a case of an abnormally yielding skull is exerted on the base of the skull, and results in a depression of the region about the foramen magnum. Should the effects of the counterpressure of the spinal column lead to a cracking of the parietal, it is reasonable to suppose that a similar effect would be even more observable on the more directly affected occipital bone, which is also provided at birth, and considerably after birth, with incomplete sutures; but thus far there is no evidence of any such cracking on the occipital. I have examined more than a dozen skulls with a more or less pronounced basal depression, and quite a large number of crania with various, in some instances very pronounced, degrees of turning up or bulging of the posterior, or anterior, or both posterior and anterior parietal borders, without finding any cracks or a separation of mastoid or other angle. Besides this, it is well known that in cracks or fractures of the parietal there is generally a tendency, even in adults, to repair and not to a persistence of the separation; and, if it occurs in addition, why should the cracking in the posterior part of the parietal lead always downward, and never very irregularly, as is common with fractures, or forward or upward?

There is another consideration to which I have referred in a previous publication (37, p. 289 *et seq.*), namely, how can a turning up or bulging of the posterior border of the parietal affect, without apparently displacing its posterior termination, the anterior end of the incomplete parietal suture? This suture, which is dealt with more in detail in another chapter, is the remnant of the space that exists normally in fœtal life

between the distal portions of the growing and centrally united segments of the parietal. This being its origin, its course must always lie in the line of the union of the segments, and this line points generally towards the parietal eminence. By the time the posterior parietal border comes in contact with the occipital, the posterior incomplete parietal suture is bounded both superiorly and inferiorly by firm bone substance, under which circumstance it is quite impossible to imagine any disturbance, mechanical or pathological, that could affect mainly or solely the more central portion of the suture, and deflect as well as extend it downward to the inferior border of the parietal. There are, to quote partly from my previous paper on this subject, only two factors that could possibly affect and modify the course of the incomplete posterior parietal suture, and both of these would show their influence mainly or entirely on the distal portion of the same. These two factors are, first, an abnormal development, either defective or excessive, of the posterior part of one of the original parietal segments; and, secondly, influences that would interfere with the freedom of full growth of the posterior border of the parietal. In the instances of the first order, as can easily be imagined or even artificially demonstrated, there would be possibly only a lower or higher situation or an obliquity affecting mostly the marginal portion of the division. The results would be oblique or curved sutures diverging from the parietal eminence,— effects entirely different from the actually observed oblique sutures that sever the lower portion of the parietal, or its mastoid angle.

Influences interfering with the free development of the posterior border of the parietal bone could only deflect upward or downward the marginal end of an incomplete parietal suture; only in cases of a very short suture could they possibly render it oblique or curved in its entirety. But even in these cases it would be the peripheral termination of the suture that would be mainly affected. Of this, however, the known instances of postero-inferior parietal sutures, in man or other mammals, afford no illustration.

A theory which meets with so many practical difficulties

as the theory of Ranke under consideration, should not be accepted before it can be supported by more convincing arguments and practical demonstrations.

The above considerations do not, of course, deny the possibility of an ordinary parietal fracture from the usual causes of such an accident, and the possibility of this fracture appearing similar to, or even indistinguishable from, a postero-inferior parietal suture. Actually I was not able to find any record or any example of such a fracture; but that does not make it an impossibility. I have seen several skulls where the ordinary, more or less irregularly sagittal or vertical parietal fracture simulated very closely an anomalous parietal suture. Gruber (22) describes one case as an instance of an oblique parietal suture, while Hyrtl and Ranke both consider that case as one with an acquired division. To differentiate a congenital real oblique suture from a division which is the result of a fracture, we must be guided largely by the situation, form, and serration of the division, and the condition of the surrounding bones, especially that of the opposite parietal. A straight course, ending with one extremity in or near the middle of the anterior or posterior border of the parietal, a complex serration, no continuity of the division on the neighboring bones or multiplicity, and particularly a co-existence of an allied or similar division on the opposite parietal,—all favor the conclusion that the division under consideration is a real congenital suture, and not the result of a fracture.

As to the theory of a morphological equivalence or identity of the minor portions of the parietal separated by an infero-posterior with the inferior ones separated by an antero-posterior suture, there are reasons to believe that in at least some instances this view is a correct one. Without adducing in this place the evidence of other material than that in man, we have one fact of considerable value in support of this opinion. This fact is the almost general and sometimes (cases of Gruber, Putnam) very marked preponderance anteriorly of the superior over the inferior part of the bipartite parietal. In view of this fact it beomes very probable that at times the relative position and growth of the elementary parietals may

be such as to condition an inferior instead of an anterior termination of the parietal suture. We shall return to this point later, when considering the evidence afforded by the material on monkeys.

The accessory- or Wormian-bone theory of Calori and Coraini, to which also Graf Spee inclines, would be more defensible if we still held to the old view of the one-center development of the parietal. Yet, even with our present knowledge, the compensatory-bone theory cannot be entirely refuted, and may be right in some instances. The formation of accessory bones arising from accessory foci of ossification in places of defects of the normal bones is the rule, and occasionally such bones reach dimensions which fully equal those that appear to be the separated postero-inferior part of the parietal. The mastoid angle of the parietal develops somewhat later than the other angles of the bone, which rather favors the development of accessory bones in the posterior lateral fontanelles. Due to these facts, in some instances, such as one of Ranke's cases (36, fig. 13) or the Peruvian in my former paper (37, fig. 6), a diagnosis between a part of a parietal, developed from an original center, and a Wormian or fontanel bone, developed from an accessory and relatively late focus of ossification, is, I believe, impossible. But we can not extend the accessory-bone explanation to all the independent pieces of bone that form postero-inferiorly a portion of the parietal. I have adduced some of the reasons for this before, but they may be repeated. In the first place, as even Ranke acknowledged, the majority of the postero-inferior sutures have something characteristic, in that they terminate posteriorly in nearly the same location, which corresponds to the location of the normal incomplete posterior parietal suture, or the remnant of the original space between the two elementary parts of the parietal. In the second place, there were not observed in the recorded cases of the postero-inferior parietal suture signs of an inordinate cranial distention or other marked defects in the ossification of the normal cranial bones, which, though perhaps not constant, are certainly more frequent in crania with the more marked Wormian formations.

The real postero-inferior fontanel bones are usually irregular in form; all intercalated bones tend to encroach on all the surrounding parts; and there is a pronounced tendency to multiplicity in the intercalated bones — all of which is different with the portions separated by the postero-inferior parietal suture.

As to the suggestion of Coraini that in these cases the accessory bone ossifies from one accessory centre and represents an advanced phase of a Wormian formation, it may be remarked that the single Wormian bones are passive results of conditions in individuals, and can have no definite history of their own, no regularity, no phases of evolution. Should ever a Wormian bone show a tendency to a regularity and differentiation it would be on the road to become a new cranial member, equivalent with the normal cranial bones, and cease to be a Wormian.

Coraini's reference to the possibility of an occasional development of the parietal from three centers is, leaving the "accessory" denomination of two of the centers aside, well worth consideration. There is but one, and that not very satisfactory, case in man (Fusari's) of a tripartite parietal; but there are several cases on record of a distinctly angular postero-inferior parietal suture which could be most satisfactorily explained on the basis of a tricentric, not, however, necessarily Maggi's, theory. This point, also, will be more advantageously treated later.

The Determining Causes of Parietal Divisions in Man.

The subject of the *determining* causes of the bipartite parietals has been partly touched upon. The objections were stated in regard to Ranke's theory of breaks, due to the counterpressure of the spinal column upon the cranium, as causes of the very oblique antero-posterior and the infero-posterior parietal sutures. Calori's and Coraini's theory of a disproportion of growth between the cranial bones and the cranial contents, with the consequent detraction of nutrition from the original one, and an appearance of an accessory center, must fall, as it is mainly with the old one-center view of the

development of the parietal. The theory can, however, be slightly modified and made to apply to the di-centric or tri-centric parietal. The question arises, could such a disproportion of growth between the cranial contents and vault, due either to physiological or pathological causes, prevent the union of the elementary parts of the parietal? Such disproportions of growth, particularly those due to pathological causes, above all hydrocephalus, do occur; but do they ever occur early enough to prevent the normal very early union of the parietal portions? This question can be properly answered only by further research in embryology. Should in any instance the normal union of the parietal portions be delayed until those periods in the fœtal life in which we know hydrocephalus to occur, it is very probable that the condition would further delay, from the very causes mentioned by Calori (mechanical and effect on nutrition of the bones), the union of the parts, or even induce their persistent separation. That a hydrocephalus or any other condition could ever separate centers that have already more or less coalesced seems highly improbable.

Virchow's and Ranke's theory attributes the determining cause of the "typical" sagittal parietal sutures to a premature union of some of the normal cranial sutures. This hypothesis evidently comprises two distinct elements, acting more or less conjointly or even interdependently, namely, a retardation in the normal closure of fœtal divisions of bones and a very premature synostosis of sutures which normally persist well into life. Applied to the parietal bone it presumes, to start with, besides the existence of a complete separation of the two foci of ossification, also a separation of the two portions of the parietal bone developing from those foci up to the time of the formation of the parietal articulations. When the parietal centers fuse normally, the event occurs much earlier than the meeting of the parietal with other bones and the formation of cranial articulations, hence much earlier than before synostosis is possible. If a union of the elementary parts of the parietal is present from another cause until the occurrence of a premature synostosis of some cranial articulation, this latter event will undoubtedly favor the persistence

of the parietal suture. The cause is of approximately equal value with that of hydrocephalus. It does not reach the primary cause of the parietal suture: the retardation of the parietal union.

Both Coraini and Ranke suggest, though the latter only indirectly, that the bipartite parietal represents a neomorphism. Should this view be correct, the retardation of the union of the elementary parts of the parietal would be attributable to the trophic nervous centers, under whose direction or influence all growth proceeds. The objection against neomorphism is the extreme rarity of the anomaly in man. The phenomenon might be imagined as neomorphism in a stage of otherwise overcome need or a stage of failure, and then really a sort of atavism, — but with the material on man alone this would be mere conjecture.

Maggi's view of the homology of the divided parietal with certain conditions in the Stegocephali, Batrachians, etc., needs, to say the least, very much further study and demonstration.

Critical Remarks Concerning Parietal Divisions in Apes, Monkeys, and other Mammals.

After the above considerations, which were made solely in reference to man and on the basis of previously known material, it remains for us to briefly point out in which way the material on apes, monkeys, and lower animals, including that here published, influences the discussed theories concerning the various parietal sutures.

Perhaps the most striking phenomenon of those that may now be considered as fairly established, is the absence or excessive rarity of all forms of parietal separations in the lower mammals, up to the monkeys; the sudden frequency of such divisions in monkeys, particularly in certain groups; and a probably similar frequency in the apes, or at least in the orang and chimpanzee. The frequency of the anomaly in man is considerably less than that in monkeys and apes, though greater than that in the carnivora and lower mammals.

There are no traces of any pathological conditions, such

as hydrocephalus; no traces of premature synostoses of normal sutures; and no traces of any effects of a counterpressure of the spinal column upon the skull. This shows plainly that, at least in the apes and monkeys, parietal separations are not due to any of these conditions. Parietal separations in apes and monkeys seem to be examples of disturbed normal development, or *dismorphism*, with, perhaps, a tendency towards neomorphism. The much more frequent occurrence of the separations in monkeys and apes than in man makes it possible that, after all, the anomalies in man may represent more or less a sort of atavism.

Parietal sutures in the apes and monkeys show a greater variety in location than those in man. Among this variety there is a very marked preponderance of vertical, and a relative scarcity of sagittal, sutures in the monkeys; in the apes, and particularly in man, it is the sagittal sutures that preponderate. This phenomenon can only be explained by an assumption of a difference in the relative location in monkeys and apes with man of the centers of ossification of the parietal. In monkeys these centers are apparently mostly anterior and posterior, in the apes and man almost as a rule more or less inferior and superior, or, rather, ranging from an antero-superior and postero-inferior to almost perfectly superior and inferior. There has been manifested somewhere between monkeys and apes a tendency towards a reaccommodation of the not very steady position of the centers, directed, in all probability, towards an arrangement more suitable to the needs of the higher organism. With the various cases in monkeys and apes at hand, it is easy to understand the oblique parietal sutures and even the more or less vertical ones, as those of Fusari and Coraini. The vertical parietal sutures in man represent apparently a greater degree of atavism than others.

In several of the monkeys and particularly in the chimpanzee, we have a practical demonstration of the mode of formation of those parietal sutures that run between two continuous borders. In the chimpanzee the suture is equivalent to the antero-posterior one of the other parietal; in this case both

the parietals developed from two elementary parts. In some of the monkeys (cases 47 and 48), on the other hand, it is clear that the parietal developed from three centers. Case 47 is particularly instructive, showing the formation, by an early synostosis between the anterior and the postero-superior parts, of the "separation of the mastoid angle." Barring the "accessory" nature of any of the parts, this case is a beautiful illustration of Coraini's hypothesis relating to the angular postero-inferior parietal sutures and a proof of the validity in at least some cases of Maggi's three-center theory.

The theory of an identity of the minor parietal separations with Wormian bones finds no support and much contradiction when our observations are extended to apes and monkeys, in which formation of even very small intercalated bones is quite a rarity.

A number of very interesting observations which require a special notice is presented by the parietal separations with an apparent extension into the temporal or frontal squama. Only two such cases have been thus far mentioned in literature. One of these, of which I have no particulars, not having been able to obtain the publication, was described by Zoja (52), while the other has been mentioned in the following words by Graf Spee (51, p. 115): "There is in the local (Kiel) anatomical collection a skull in which the temporal squama is divided into an upper and a lower half by a sagittal suture. This division proceeds backward into the parietal bone, in the direction of the summit of the occipital bone, without, however, reaching the lambdoid suture. The pieces of the upper part of the temporal squama and lower part of the parietal bone, separated by this extremely rare suture, are perhaps referable to intercalated bones (Schaltknochen)."

Graf Spee's explanation of the anomaly is not applicable to the cases that came under my observation, where the apparent prolongation of the parietal suture or fissure was mostly incomplete, and often directed in such a way that there was no possibility of its having been a part of the boundary of any intercalated bone. In these cases we have to search for another explanation.

It is not impossible that in extremely rare cases two independent sutures or fissures, each in a different bone, may terminate opposite each other in such a manner as to appear like one division; or that both divisions are the unrecognized results of fracture. However, the more ordinary and perhaps almost regular origin of these separations which seem to continue in the adjacent bone, is, I believe, as follows:

It is a well-known law (Virchow) that all persisting sutures or fissures in a bone, such as the parietal, favor a greater growth of so much of the bone as is affected by the separation, than takes place in the parts not so affected, and the augmentation takes place principally at right angles to the separation. Granted that we have a more or less vertical division of some sort in the inferior portion of the parietal, this portion will increase in length. If in a rare instance this increase shall be hindered by a firm articulation with the temporal squama, there will be developed a state of tension acting on the squama, and under such conditions a jar or a blow, or possibly even the strength of the tension itself, may cause a fissuring of the squama. Other bones than the temporal are not so often affected by such a fissuring because of their greater strength and resistance.

This theory is able to account for all the instances of a parietal suture or fissure with an extension that I have come across, and may account for others. Why the anomaly is not present in all cases in which a parietal division terminates in the inferior border of the bone, can only be explained by the suppositions that in such cases either the border of the squama is very resistant, or it is not firmly articulated with that of the parietal, or, finally, it grows at a like rate with the parietal border.

A notable fact about the anomalous parietal sutures is their preponderance in the male sex in man, while no such difference is marked in monkeys. The phenomenon is not easy to explain or even to form a plausible theory in relation to. It nevertheless seems to indicate that some one or more of the characters by which, regularly or perhaps but occasionally, the

male skull differs from the female, act in their earliest or fœtal stages as direct or indirect causes of the parietal division. The occurrence of the anomaly in the female would then be explainable by the presence in the particular skull of those same masculine characters to which the just-made reference may be applicable. What these characters may be is thus far purely a matter of speculation. They could, perhaps, be detected if all the known specimens of complete parietal sutures could be brought together and be carefully re-examined and measured, and compared with average normal male and female crania of the same nationalities to which belonged the skulls with the anomaly.

A few words in conclusion about the relation of the parietal sutures with the temporal ridges. The relation between the complete sagittal sutures and the superior line of the ridge, which Hyrtl hinted at, is now well known to be but accidental (*v.* Ranke), and it is clear that neither part of the ridge can stand in any etiological or morphological relation with the vertical or very oblique parietal sutures. It is true that the anterior extremity of the complete or incomplete sagittal parietal suture in man terminates not infrequently near or in that portion of the ridge that crosses the coronal suture, but this seems to be mainly, if not entirely, due to the fact that normally and independently both the ridge and suture reach the anterior border of the parietal near the same point.

General Conclusions.

All the data thus far adduced make possible the following main conclusions:

(1) Complete separations in the parietal bone are nearly, if not entirely, restricted to monkeys, apes, and man.

(2) The separations are much less frequent in man than in apes and monkeys. They also are not equally frequent in all the subdivisions of apes and monkeys, and possibly in the different races of man, but in the latter this point is still uncertain. In man there is a preponderance of parietal

sutures in the males, but in the monkeys the sex seems to have but little influence on the frequency of the anomalies.

(3) The parietal sutures are divisible into two main groups, namely, into those that run between two opposed, and those that run between two connected, borders of the parietal. The former group comprises all the complete antero-posterior and infero-superior, the latter group, all the other oblique or angular sutures.

(4) There is a marked preponderance of infero-superior and scarcity of antero-posterior sutures in monkeys, while the reverse is the case in apes and man. Of the minor complete divisions the ones almost exclusively met with in man are the postero-inferior ones; in monkeys and apes we meet with these and also with postero-superior, antero-superior, and antero-inferior sutures.

(5) The possibility of the major parietal separations is explainable by a persistence of the original separation between two regular and ordinarily early coalescing centers or elementary parts, with which we became acquainted mainly through the researches of Toldt and Ranke. The presence of a congenital major division of the parietal of an ape, monkey, or other mammal is only explainable on a similar basis. Judging from certain cases, particularly in monkeys, the development of the parietal may take place from more than two centers; how frequently this is the case remains to be determined by further embryological investigations.

(6) The difference in location of the major parietal sutures in man with apes and monkeys points to a different original location of the parietal centers. There is also probable, in view of the variety of parietal separations, a lesser fixity of the centers, both in location and number, in the monkeys than in man.

(7) A preponderance of growth in one of the elementary parts is accountable for the smaller differences in the location and direction of the major sutures, and the same condition, if excessive, may produce a suture that runs between two continuous borders of the parietal.

(8) The majority of the parts of bone that are separated

from the body of the parietal by a suture, particularly an angular suture, that runs between continuous borders, are developed from one of the original parietal centers.

(9) The occasional smaller bones that bear the aspect of parietal separation cannot be distinguished from the purely compensatory (Wormian or fontanel) bones, developed from accessory foci of ossification.

(10) The determining causes of the various parietal separations are divisible into primary and contributive. The primary cause of the anomalies in the monkeys is probably *dismorphism*, a disturbance of development originating in the trophic centers, perhaps more or less allied to neomorphism; in man the cause is probably what may be termed a reminiscence, or a mild form of atavism. A reversion reaching much farther back in the organic life can not be accepted without much satisfactory demonstration. The contributive causes of the parietal divisions, which can become effective only after the influence of the primary ones has been manifested to a certain degree, are all those conditions which more considerably augment the intracranial pressure, such as, in man, hydrocephalus and very premature closure of some of the normal cranial sutures.

(11) The apparent extensions of parietal sutures, complete or incomplete, are almost restricted to the temporal squama, and are, at least in the majority of instances, acquired products, due principally to the tension produced by the augmented growth of the portion of the parietal affected by the separation.

(12) Neither part of the temporal ridge stands in any causative or morphological relation with any kind of parietal sutures; but the ridges affect the synostosis and more or less the course of the sutures, if these extend into or across the ridges or into their close neighborhood.

A number of points not touched upon here will be explained in the following chapters.

VIII A. Partial Divisions of the Parietal Due to the Manner of Ossification of the Bone.

The conditions which will be discussed under this head cannot be considered as abnormal, unless they persist beyond the age at which they regularly disappear.

The parietal bone in man, monkeys, and probably also in other mammals, develops usually, as was shown in another division of this paper, from two, and occasionally from more than two, centers of ossification, or elementary parts. These parts grow rapidly in all directions until their convex borders meet at some point, soon after which in normal cases they begin to fuse at this point of contact. As the two parts grow, which they apparently still do quite independently, though in the process of fusing, their median borders gradually extend their apposition and synostosis in the direction from the original point of contact, which usually corresponds to the eminence of the parietal, towards the periphery. Between the portions in contact and the periphery there is always in man in the fœtal life, and occasionally beyond this, anteriorly and especially posteriorly (where the growth of the parts seems to be slower) a more or less wide wedge-shaped membranous space; or, in later stages, a fissure or suture-like separation. In the full term fœtus the anterior separation has in most cases already disappeared; the posterior cleft, fissure, or suture, which still mostly persists, is situated generally not far from the middle of the posterior border of the parietal and points in the direction of the parietal eminence.

These separations and clefts, or "false fontanelles," were known to Gerdy, Velpeau, Hyrtl (50), and probably other earlier observers; their origin was explained by Toldt (49, p. 85), Maggi (61, 62) and Ranke (36, p. 59). Ranke, who examined a large number of skulls of human fœtuses and children as well as a considerable number of skulls of apes for these features, has shown the interesting facts that separations of this nature may extend for a considerable distance into the parietal; and that, while in man the separations are very much more frequently posterior than anterior, the con-

ditions are the reverse in the orang, and the anterior clefts and sutures are much the more frequent. The material used by Ranke consisted of 162 skulls of human fœtuses and infants, ranging from the eighth to the tenth month in age, and 245 skulls of mostly young orangs, 8 skulls of young gorillas, 11 of young chimpanzees, and 70 of *Hylobates concolor* of various ages. The remnants and traces of the "parietal suture" were distributed among these as follows (36, pp. 59 *et seq.*, 40 *et seq.*):

"INCOMPLETE SAGITTAL PARIETAL SUTURE."

	"Remnants."		"Traces."	
	Anteriorly.	Posteriorly.	Anteriorly.	Posteriorly.
162 young human skulls.....	5 (in 3.08 %)	13 (in 8.02 %)	1 (in 0.62 %)	27 (in 16.78 %)
245 skulls of orangs.	13 (" 5.3 %)	0 —	0 —	0 —
8 skulls of young gorillas.....	1 (" 12.5 %)	0 —	0 —	0 —
11 skulls of young chimpanzees.	1 [1] (in 9.1 %)	0 —	0 —	0 —
70 skulls of *Hylobates concolor*	0 —	0 —	0 —	0 —

[1] On both sides.

Besides these, Ranke found the incomplete suture anteriorly on both sides in a *Cynocephalus ursinus* and on one side in a *Mycetes seniculus* (cases mentioned before).

My own investigations on this incomplete, normal separation in the parietal bone have resulted as follows: Among 21 well-preserved skulls of new-born to 10-months-old children, I found it posteriorly in 13 cases (62 %) on both sides, in 3 (14 %) on the left side, and in 2 (10 %) on the right side. In two additional cases (skulls of a 3-months and 10-months child) there were in about the location of the division marked indentations; in one case only (skull of a new-born child) there was no trace of it to be seen. In 7 skulls (14 instances) the division was marked, corresponding probably to what Ranke calls a "remnant of the parietal suture." Anteriorly, I found in seven of the skulls, or one third of the number examined, five times unilateral and twice bilateral, smaller fissures, located between the sphenoidal angle and the middle

of the anterior border of the parietal. It was not possible to determine whether all these anterior fissures represented portions of the anterior incomplete separation between the portions of the bone developed from its centers, or were fissures of other nature.

Traces of the posterior incomplete parietal suture can be met with in many crania of children of all ages, and occasionally even in skulls of adolescents and adults. I come frequently across them in the crania of Indians. In children above one year of age and older subjects we are liable to find, as already signalled by Maggi and Ranke, the posterior as well as the anterior cleft filled by an intercalated bone; we will return to these bones in the succeeding chapter.

There are a few points of additional interest concerning the incomplete parietal sutures which appear to have not been mentioned by any author. The two portions of the parietal squama between which the crevice exists do not unite, when coming into apposition, in the manner in which the edges of the other clefts and fissures of the parietal border (*v.* below) unite. There is formed at first between the two parts a squamous articulation, in which the lower part always overlaps the upper. The obliteration of the fissure proceeds from its summit, the two portions of the shell uniting by means of fine bony spiculæ, which all have a backward and upward direction, starting from the border of the lower portion. This border shows occasionally a slight serration.

In all my cases without an exception the incomplete parietal suture was directed towards the parietal eminence.

In a number of instances the suture was traceable further ventrally than dorsally.

The posterior suture is present, though I do not know with what frequency, in new-born negroes and, as I mentioned before, it is not rare in the Indians. I have also seen it in monkeys (*v.* Part IV), and in seven very young coyotes, but in no other mammals.

When an incomplete parietal suture, which is a normal feature of the fœtal and even the young infant parietal bone, persists into advanced childhood or even into adult life, as

in the three Bavarian skulls Ranke mentions, it assumes the significance of an anomaly and a relation to the persistent complete parietal separation.

But, incomplete parietal sutures are not the only divisions which may be normally observed in the borders of the parietal during its development. The two elementary parts of the parietal ossify in rays, which radiate in all directions. These rays, I have been convinced by numerous examinations, advance in the osteogenetic membrane not indiscriminately, but, possibly under well-established influences of the nervous system and the blood supply, in a definite and quite constant manner. They constitute several tufts, separated by more or less marked clefts or fissures. The periphery of each tuft is composed of many individual rays of bone, and these rays also are separated on the periphery by clefts or fissures. These separations between the tufts of the bone seem to me to be of some morphological significance and they may be conveniently termed the *primary parietal fissures* (reserving for the intercentral separations the term suture). The numerous minor clefts between the individual rays, which are of but a very little if any importance, may be distinguished as the *secondary parietal fissures*.

The form of the primary fissures in a new-born child is mostly that of a narrow V, but it may be that of a line. Not rarely the border of the parietal will show about the mouth of the fissure more or less deficiency, the result of which is a small, triangular or irregular membranous space, a sort of a supernumerary fontanel.

Any of the primary fissures may be fully synostosed at birth, though this occurs more frequently a little later and sooner with some than with others. The fissures that are still present at birth ranged in length in the skulls I examined from a few millimeters to two centimeters.

As to the exact number of the primary fissures I am not fully certain; this point has to be settled by further investigations on bones of fœtuses obtained at various periods before birth. There are four situations in which the fissures occur almost constantly.

The first and only well known of the slits is situated at about the junction of the middle with the posterior third of the sagittal border of the parietal bone. This point, which corresponds to *obelion* (Broca), is about 2.5 cm. above the lambda in the new-born child (Hamy), or about 7 cm. above the lambda in the adult (Broca). In the adult the location of the obelion is generally marked by a moderate flattening or depression of the parietal borders, by a marked simplification of the sagittal suture, and by one or two vascular openings, the parietal foramina. In the new-born child there occurs at this point either a marked triangular fissure, or a deficiency in the border of the bone, or, most frequently, both, fissure and deficiency. The formation has been studied clinically particularly by Gerdy (44), Barkow (39), Welcker (17), Hamy (45), Broca (38), and Augier (46), and more recently especially by Maggi (61, 62).

When the just-mentioned primary incisure is narrow and not accompanied by a marked deficiency of the sagittal border of the parietal bone, Broca terms it the *parietal incisure.* When the slit is wide at its mouth or accompanied by a deficiency in the border of the bone, it forms, alone or with its fellow of the opposite side, a membranous space, the *parietal fontanel*, or, as it has been termed by Hamy, the *fontanel of Gerdy.* This fontanel occurs, according to Broca (with whose examinations my own agree), about once in every four cases of new-born children. Broca properly attributes to both, the incisure and the fontanel, the same signification and the same etiology; they are, however, both represented as being due to 'a somewhat retarded development of the parietal in this situation, due to a more feeble nutrition in this than in other parts of the bone,' which theory is hardly tenable. There are cases in which such a "retarded development" may account for the deficiency in the parietal border; the fissure, however, is distinctly a normal slit of a different signification.

Maggi's and especially the still more recent Frassetto's (67, 69, 70) contributions to this subject tend to give the "parietal incisure" the valency of a partial parietal suture, while the

"fontanel of Gerdy" is likened to the parietal pore in the *Stegocephali.*

The "parietal incisure," or the fontanel, when this is present, becomes occluded in most cases within three months after birth (Broca); exceptionally, however, it may remain open longer. I have seen cases where the incisures were marked at the ninth and twelfth months after birth, and in rare cases the incisure may last even after this period. In rare instances there is found in adults in this location a suture, which runs in a more or less vertical direction over a portion of the parietal. Such a suture, instances of which have been seen by Otto, Broca, Pozzi, and Hamy (*v.* Part II), represents probably in most cases a persistence of a larger portion of the primary fissure, though it may also be a remnant of a formerly complete, *anomalous*, more or less vertical parietal suture.

The membrane which fills the fissure under consideration is in most instances traversed, at various distances from the median line or line corresponding to the later-formed sagittal suture, by a small blood-vessel. As the closure of the fissure advances, this blood-vessel is embraced by the borders of the fissure and runs henceforth in a canal, which on the skull is known as the parietal foramen. Occasionally the part of the primary fissure between this foramen and the sagittal suture remains patent, simulating, but not identical with, the *sutures to foramina* found in the parietal in many mammals (*v.* special chapter on these sutures).

In rare instances, as pointed out by Hamy, a fontanel bone develops in the "sagittal" fontanel. This bone may unite with one parietal and appear as a process of the same.

Similar slits and deficiencies as in man occur at the sagittal point in various mammals, but they seem to be generally more advanced in obliteration at birth than is the case in man. Most commonly we find in the new-born animal simply a greater or lesser depression at the sagittal point. This occurs in monkeys and in the carnivora. I saw the bilateral depression very marked in five tiger fœtuses, and somewhat less pronounced in a number of new-born lions, coyotes, and dogs. I have no observations on new-born apes. In the ungulates

the parietal bone is relatively narrower (especially in Bovidæ) than in the carnivora or primates, and, with the exception of one young camel, I could find no fissures or fontanels at a point which would correspond with the obelion.

For parietal sutures terminating at this point, *v.* Part IV.

The primary fissure next in importance occurs in the posterior border of the parietal between the incomplete parietal suture and asterion, commonly nearer or at this latter.

The only author in whom I find a mention of this fissure (though a fontanel at this point is known to Maggi and Frassetto) is Ranke, and even this observer refers to it but very briefly. In Ranke's words (36, p. 65), one of the fissures of the parietal border "can be quite frequently observed to run, in a radiating direction, from the point of the postero-inferior or mastoid angle of the parietal towards the parietal eminence." According to my investigations the fissure terminates thus mostly in the parietals of fœtuses and the new-born, but in older skulls remnants or traces of it are more generally situated slightly to moderately above the point of the mastoid angle or asterion. Its direction, as Ranke states, is towards the parietal eminence.

But there are other points of interest about this fissure. The feature is quite constant in the new-born infants and for some months afterwards; I found it, more or less well marked, and generally bilateral, in 16 (80 %) out of twenty skulls of new-born and infants less than one year old; and I have seen plain traces of it in skulls of older children. In rare instances (*v.* Part II) the fissure may persist into adult life.

The form of this slit corresponds to that of the obelion primary fissure. Like this latter it can be occasionally traced, especially ventrally, for a considerable distance towards the parietal eminence. But, while the obelion fissure seems to unite by a simple apposition, the supra-asteric fissure synostoses mostly, if not generally, in the squamous manner of the posterior incomplete parietal suture. The mouth of the postero-inferior is generally smaller than that of the obelion fissure, nevertheless it is much more frequently than the latter filled by an intercalated ossicle.

The postero-inferior or supra-asteric primary fissure seems to be rare, if not absent, in monkeys; I have never seen it in the specimens that I examined, which, however, did not comprise fœtal material. I found the fissure more or less well defined in five lion fœtuses, two young hyænas, two young red foxes, two young Virginia deer, two young sheep, one young goat, one young *Boselaphus*, two young camels, and two young pigs (*v.* detail list in Part IX, 'Divisions to Foramina').

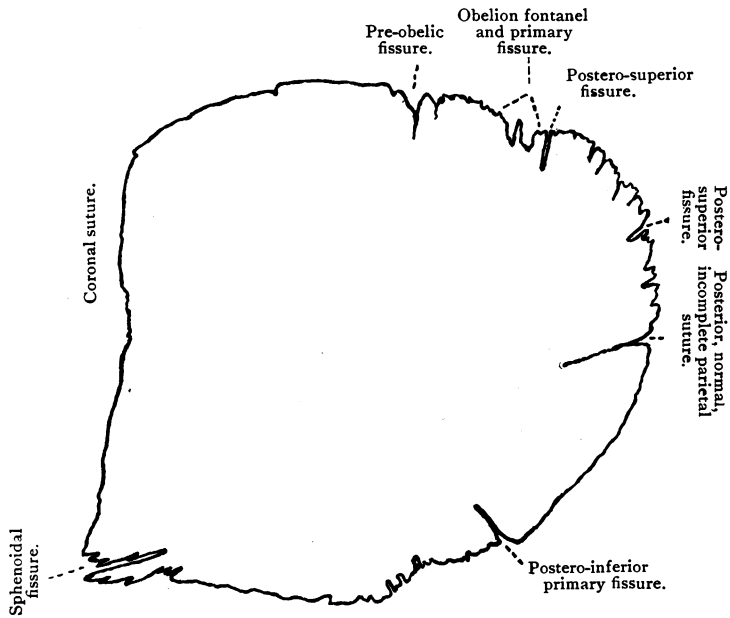


Fig. 31. Left Parietal Bone of a new-born child, showing most of the primary fissures.

This distribution shows that, whatever may be the importance of the fissure, it is a well-established feature of the parietal.

The *sphenoidal fissures* of the parietal bone may possibly belong to the primary slits; they are generally two or three in number, and are constantly present in the skulls of new-born children. Their appearance at this stage is that of well-marked, open clefts, 0.4 to 1.0 cm. long, directed towards the parietal eminence. The clefts become obliterated soon after

birth. I found them fully obliterated on both sides in a child of three months, and on the right side in another child of about the same age. They were still present, though not very marked, on both sides in a child of about six months; but were absent in all the older specimens which I examined.

Besides the described, there are several other fissures which may possibly be primary, and which occur with some degree of frequency in the parietal bones of new-born children. One

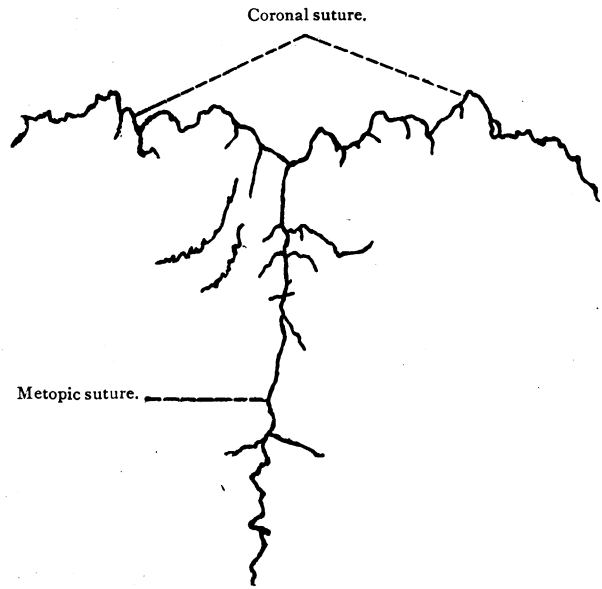
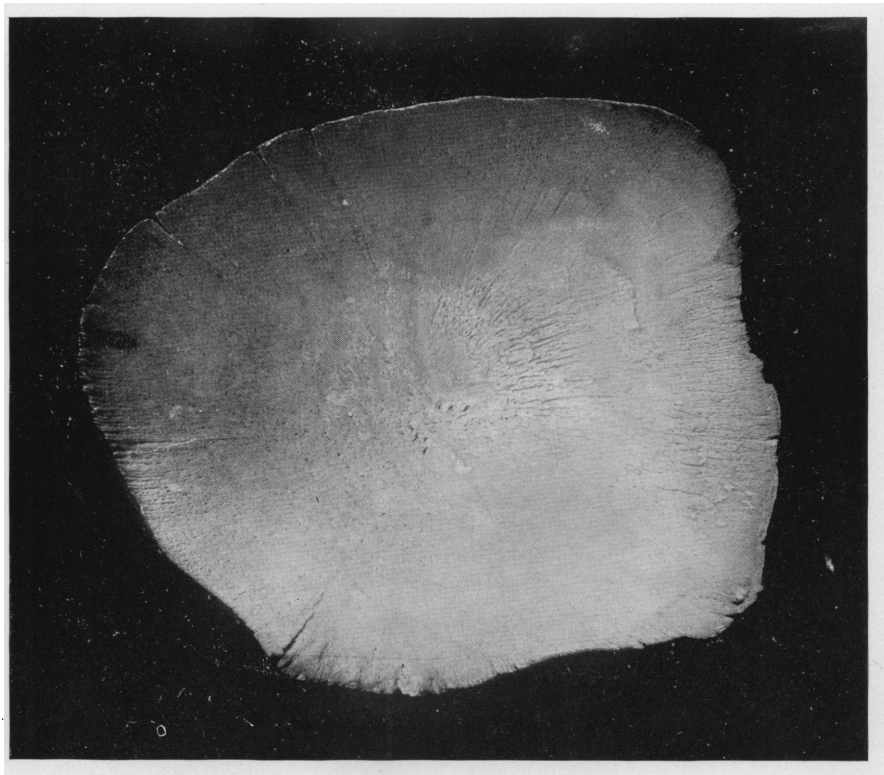


Fig. 32. Radiations from the metopic and coronal suture in a nearly adu t *Alces americanus* (No. 13,796, A. M. N. H.).

of such marked slits occurs at bregma; two in the superior parietal border; one 1.0 to 2.0 cm. anteriorly, and the other 1.0 to 1.5 cm. posteriorly, to the obelion fissure; and one in the posterior border between the lambda and the posterior incomplete parietal suture. The slit between the obelion fissure and lambda becomes much more frequently than the obelion fissure or fontanel filled with an intercalated bone. Further observations are necessary to establish the exact nature of these clefts. (Fig. 31; Pl. XXII.)



THE LEFT PARIETAL BONE OF A NEW-BORN CHILD (VENTRALLY), SHOWING THE PRIMARY FISSURES (SPECIMEN IN THE COLLECTION OF THE MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY).

FISSURES IN THE PARIETAL BONES OF NEW-BORN AND SLIGHTLY OLDER CHILDREN.

Spec. No.	Age.	Obelion Fissure.	"Sagittal Fontanel" (Gerdy's).	Postero-inferior Fissure.	Postero-superior Fissure.	Sphenoidal angle Fissures.	Anterior Fissure in Superior Border.	Pre-lambdoid Fissure in Superior Border.	Exceptional.
1	New-born	—	—	both sides	both sides	both sides	—	—	—
2	"	right	—	—	—	both sides	—	—	—
3	"	both sides	—	both sides	—	both sides	—	both sides	—
4	"	—	both sides	—	left	both sides	—	—	—
5	"	both sides	—	both sides, marked	?	both sides	left	—	—
6	"	left	—	both sides marked	—	both sides	—	both sides (Wormian)	—
7	"	right		both sides	left	both sides	both sides, small	—	—
8	"	—	both sides	both sides, marked	—	both sides	—	both sides	A marked fissure in l. bregmatic angle.
9	"	—	both sides	both sides, marked	both sides	both sides	right	—	
10	"	right	—	both sides	—	both sides	?	—	—
11	"	both sides	—	both sides	both sides	both sides	—	—	—
12	"	left	—	both sides, marked	—	both sides	right	—	—
13	"	both sides	—	both sides, marked	?	both sides, marked	both sides	—	—
14	New-born, or a little later	—	both sides	—	right	both sides	—	—	—
15	1st or 2d mo.	left	right	both sides	—	both sides	—	—	—
16	abt. 3 mos.	—	—	—	—	—	—	—	—
17	abt. 3 mos.	both sides	—	both sides	—	left	—	—	—
18	abt. 6 mos.	—	—	?	—	both sides	—	—	On both sides 1 marked vert. incisure beyond the 1st third of squamous suture.
19	abt. 9 mos.	both sides	—	both sides	both sides	—	—	—	
20	abt. 10 mos.	both sides	—	both sides, marked	—	—	—	—	—
21	abt. 10 mos.	both sides	—	both sides	—	—	—	—	—
(21)	13 at birth, 8 birth to one year	8 both sides = 38 % 3 left side = 14 % 3 right side = 14 %	4 both sides = 19 % 1 right = 5 %	16 both sides = 80 % (in 7 pronounced);	4 both sides = 19 % 2 left side = 10 % 1 right side = 5 %	16 both sides = 76 % (in one especially pronounced); 1 left side = 5 %	2 both sides = 10 % 2 right side = 10 % 1 left side = 5 %	3 both sides = 14 %	
		Total per cent. of occurrence 66.7 % = ⅔ of the cases.	Absent in all the cases above 2 mos. 24 % = abt ¼ of the cases.	80 % = ⅘ of the cases.	33.3 % or ⅓ of the cases.	Present in all new-born and up to first or second month. 81 % = ⅘; Absent after 9th month.	24 % = abt. ¼	14 % or abt. 1 in 7 cases	

The following list shows with what frequency and in what combinations I found the various slits in my series of 21 skulls of new-born and young infants.[1]

If we can judge from some of the persistent partial parietal divisions, some, if not all, of the last described slits occur also in the monkeys. In lower mammals relatively pronounced fissures are not infrequently seen in the very young in or near the angles of the parietal. Thus a fissure in or near the supero-anterior or bregmatic angle of the parietal was found in one young fallow deer, four young Indian buffaloes, and one young *Boselaphus*. Fissures in or a short distance above the sphenoidal angle were noticed in two young hyænas, one young sheep, two young fallow deer, one young *Bos indicus*, one young *Boselaphus*, one adolescent pig, one young hippopotamus, and in some, mostly young, seals and *Zalophi*. Fissures in or just below the superior-posterior angle of the bone were observed in three arctic foxes (adults), and one young Virginia deer. The fissures in or above the postero-

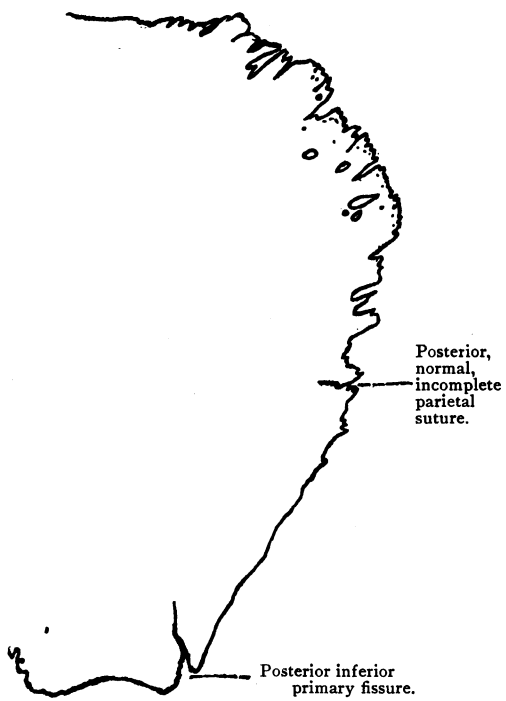


Fig. 33. Posterior third of the left parietal bone of a child within the first month after birth, showing the advancing ossification in the parietal comb, and the formation of foramina or inclosures (Morphological Museum, Columbia University).

[1] Specimens in the Morphological Museum, Medical Department of the Columbia University, New York City.

inferior or mastoid angle have already been mentioned. Some of the slits seem to be characteristic of certain species of animals, but this point must be settled on large series of proper material.

The constancy or frequency of the various primary and primary-like parietal fissures in man and mammals imparts to these formations a peculiar interest. Apparently these fissures are not casual, meaningless features, or mere accidents of growth. Some of them may be due to the mechanism of growth of the parietal, but some are undoubtedly regular features of the development, the manifestations of some as yet not understood law of the development of the bone. In view of the constancy or frequency and a definite location of the fissures, the tufts of bone which condition them assume the rôle of regular constituents, of subordinate elementary portions, of the main elementary parts of the parietal.

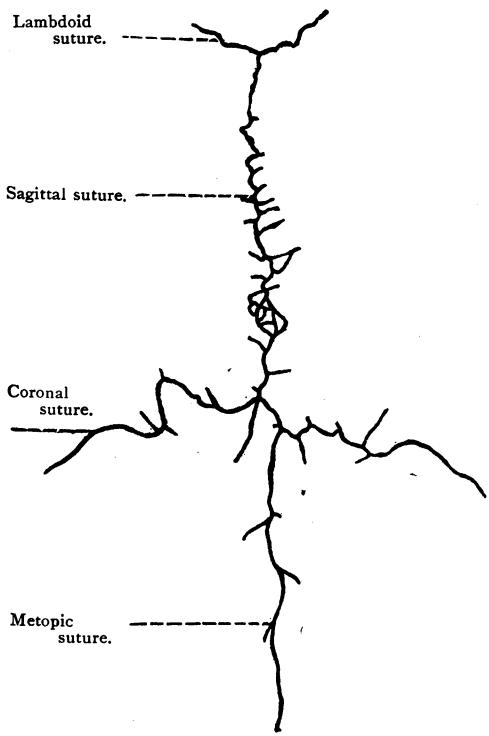


Fig. 34. Radiations from the cranial sutures in an adolescent Black Bear (No. 6639, A. M. N. H.).

The numerous *secondary parietal fissures* need only brief mention. They are present on all parts of the border of the older fœtal parietal, constituting the parietal comb. The obliteration of these crevices presents one little peculiarity. As the rays of the growing bone reach its limits, and possibly

somewhat before this, the osseous rays meet with increasing resistance to their advance. Not being able to progress freely, the ends of the rays grow laterally, thus spreading and approaching each other. A close approach between these ends is effected before the proximal part of the crevice has been filled, and a union of the ends taking place, this proximal part of the crevice is converted into a foramen (*v.* Fig. 33). The foramina thus formed in the parietal border transmit no blood-vessels and soon disappear. The cranial sutures are partly due to the interlinking of the rays and secondary fissures of the parietal and other bones.

The union of even these secondary parietal fissures may be retarded, in which case the parietal border will appear full of incisures, as in the bear and moose shown in the following figures. (Figs. 32, 34.)

VIIIB. Wormian or Fontanel Bones in the Locations of the Incomplete Parietal Sutures and the Primary Parietal Fissures.

The formation of intercalated bones in the "false fontanels" of the parietal has been known to Hyrtl, Ranke, and other observers, especially Maggi,[1] and has already been partly referred to (*v.* Part VIIIA). The bones belonging to this category are usually of moderate size and oblong, but do not differ materially from other Wormian bones, and cannot be distinguished from these except by their location. Occasionally, mainly on account of multiplicity and similar shape of the Wormians, all effort at separation of the fontanel bones must be abandoned. The recognition of the fontanel bones adds considerably to our proper understanding of the subject of intercalated bones, and diminishes very much the numbers of the purely accidental of these ossicles.

An examination of 45 complete skulls and 105 detached calvaria of whites, all with still patent cranial sutures, enabled me to find intercalated bones in the location of the incomplete parietal sutures and also in that of all the fissures

[1] (62); also Frassetto (69).

mentioned as primary, except in the antero-inferior and antero-superior angles.

The 45 complete skulls comprised 21 males, 12 females, and 5 children; there were among these 45, 14 without any Wormian; of the 31 remaining there were 17 (8 males, 8 females, 1 child) with one or more of the "fontanel" ossicles. There were, in total, 33 clearly discernible "fontanel" bones, beside which 10, in the same 17 and other skulls, were doubtful. The distribution and combinations of the 33 bones were as follows:

		left.	right.		
α	A Wormian in the mouth of the ant. incompl. par. sut.	1	4, or in	5.56 %	of the 90 parietals.
β	" " " " " " post. " " "	5	3, " "	8.9 %	
γ	" " " " " " post.-inf. prim. fiss.	7	6, " "	14.4 %	
σ	" " " " " " post.-sup. " "	3	3, " "	6.67 %	
ε	" " " " " " pre-lambdoid " "	1	1, " "	1.1 %	

Combinations: α and β in 1
α and γ in 2
β and γ in 1
β and δ in 3
γ and ε in 1.

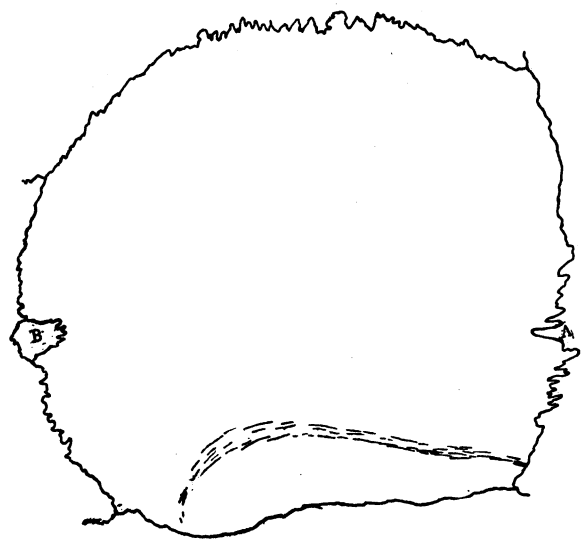


Fig. 35. Right Parietal Bone of a Southern Utah Cliff-dweller (child), showing remnants of anterior and a posterior parietal cleft; the posterior indentation is filled by a Wormian bone, the anterior by a spur of the frontal (No. 25, Hyde Collection, A. M. N. H.).

In the 105 calvaria, with only parts of the parietals present

α was seen clearly in 3 cases and in 4 others was doubtful; ϵ was observed in four instances and a preobelic bone in two instances. The β and γ bones could not be examined in this series; neither could a low situated α or γ have been detected.

The fontanel bones are by no means restricted to whites. They are quite frequent in the Indians, but seem to be rare in the negroes. As to other ethnic groups I have not enough proper material.

In numerous instances the mouth of the anterior or posterior incomplete parietal suture, or that of a primary fissure, is occupied by what appears to be a spur or process of the neighboring bone. In some of these instances the process is undoubtedly a partly attached Wormian. The following illustration shows a parietal in which the remnant of the anterior incomplete suture is filled by a process of the frontal, that of the posterior suture being filled by a moderate-sized Wormian. (Fig. 35.)

IX. Partial Divisions of the Parietal Bone Resulting from a Mechanical Obstruction in the Ossifying Bone; or, Divisions to Foramina.

The divisions coming under this title form distinctly a class of their own. They have a totally different etiology and signification from the sutures and fissures considered in the preceding chapters. They occur typically as fissures, or, more frequently, as nicely serrated sutures, which extend between a border of the bone and a foramen situated at some distance from the border.

Divisions of this class are very rare in the parietal bone of man and the primates, but are almost constantly present in some lower mammals. They are not restricted to the parietals, but occur in many other bones of the skull, particularly in the temporal squama and within the orbit. They are closely related to, though not identical with, the divisions which in man are so commonly observed to pass from one of the sutures within the orbit, or from the

malo-maxillary suture outside the orbit, to the infraorbital foramen.

The only location on the human parietal bone (and also on that of primates) where a suture or a fissure between a foramen and the border of the bone occurs is at the parietal point or obelion. The division, when typically present, which is very rare, connects the sagittal border of the bone and the parietal foramen. It should not be confounded with a simple incisure or suture at this point, though at times a distinction may be very difficult.

In lower mammals by far the most frequent, though by no means exclusive, location of a suture or fissure to a foramen is in the posterior half of the lower third of the parietal. (I state on the appended list the approximate location of every division found in the different animals.)

The location of divisions of this class, particularly on other bones than the parietal, is occasionally peculiar to a single species of animal and may serve as an additional sign of differentiation of the species.

In form the sutures or fissures to foramina are generally straight, or but slightly curved. The serration, when present, is fine and regular. The fissure and suture are seen to be absolutely equivalent, for in many specimens on one parietal bone we see a fissure, and on the other, in the same location, a suture.

In length the divisions under consideration range from one or two millimeters to as many centimeters. (The detail list gives the measurements of most of the divisions I found. The majority of the sutures and fissures, it will be seen, range in length from 4 to 8 mm.)

In some cases the division, although running directly towards a foramen, will not quite reach it. Apparently a part of the division, proximal to the foramen, has in these cases become obliterated. This view is substantiated by the fact that complete divisions can be found in the same locations to similar foramina in other individuals of the same species. The whole division may be found ossified; but I have never seen a case in which the distal extremity (from the foramen)

of the division would be occluded alone. Occasionally we will find a fissure or a suture in the border of a bone, without a foramen, but in a location where in other individuals of the species, or perhaps on the other side in the same individual, occur divisions from foramina. In such a case it is quite safe to conclude that the foramen, from which the division originally ran, became occluded earlier than the division.

The ossification of fissures and sutures of this class proceeds regularly from the foramen towards the border of the bone in which they occur, hence in the direction of the original ossification of the bone.

The obliteration of the sutures and fissures to foramina may occur very early, but often these divisions are patent even after some of the regular cranial sutures have united. They seem often to become occluded at about the same time that the cranial suture to which they lead is thus affected.

The number of the divisions to foramina on the same bone in the same species is not strictly limited. There may be but one, or several such divisions in one bone. As a rule there is but one suture or fissure to any one foramen; on the other hand one division may lead to more than one foramina. The frequency of the divisions stands in direct relation to the number of larger foramina present on a given bone in a given species.

The nature of the openings from which a fissure or a suture passes to the border of the bone cannot always be ascertained on a skull, but the greater majority of them seem to be vascular foramina. It is probable that a division may also proceed from a nerve foramen.

There is one more feature about the divisions under consideration which deserves a special notice. It can be frequently seen that the distal extremity of the suture or fissure, that is, the part nearest to the border of the bone, is filled with or covered by a spine, which proceeds from the adjacent bone. (In divisions in the lower portion of the parietal bone the spines proceed from the temporal squama, while in divisions of this latter the spines proceed mainly from the parietal.) The spine may simply occlude the extremity of the

fissure or suture; or it may cover a large part of the same; or, finally, it may outwardly take entirely the place of the division and reach to the foramen. The spine is usually broad and deep at its base, becoming gradually narrower and more superficial towards the extremity.

The tendency to the formation of these spines is much more marked in some species of animals than in others. When they occur in man, they usually cover a vascular canal.

The etiology of divisions that lead from foramina to the border of a bone is different from that of the anomalous divisions, as well as from that of the primary fissures of the cranial bones. The foramina from which fissures or sutures are seen to pass are very early formations, and date in all probability to the membranous condition of the bone. If we examine the growing bones in man or animals, we find the openings to present the following characters: The proximal part of the foramen—that is, that part which faces towards the center or body of the bone—is well defined, rounded, and smooth. The distal parts of the opening are more or less deficient, and this deficiency continues to the border of the bone. In very young specimens the defect in the border will be a cleft with diverging sides. On little older subjects the walls of the cleft are seen to approach. In still older specimens the walls have come into apposition, and from the now completed foramen a fissure runs to the border of the bone. Still later, the fissure gradually unites, or, the process of primitive ossification diminishing, it remains permanent. As the bone continues to grow, serration may develop in the fissure and transform it into a suture. The approach of the walls of the cleft proceeds in most cases from the foramen downward. Where the approach of the walls of the cleft had been slow, a compensatory process or spine is liable to develop from the margin of the adjacent bone, and more or less fill the existing cleft. The process or spine plays a similar rôle to that of Wormian or fontanel bones.

All the foregoing facts point to the following conclusion as to the nature of the divisions under consideration: the fis-

sures and sutures that run from foramina to the border of a bone are not characters or properties *inherent* in the bone, as were the divisions considered in Part VIIIA of this paper. They are acquired, consecutive characters, the results of mechanical obstruction, which early developed blood-vessels (or nerves) offered to the ossification of the bone. They differ from the anomalous divisions in that they are independent of the number and location of the centers from which the bone develops.

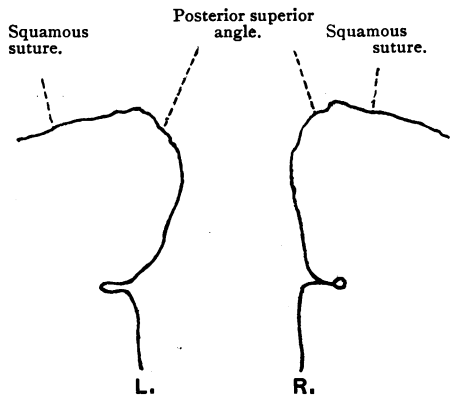


Fig. 36. The posterior parts of the temporal squamæ of a young Virginia Deer (No. 8121, A. M. N. H.), showing different stages of the formation of a fissure from a foramen.

Of the following figures the first shows the process of formation of a fissure to a foramen, as actually observed on the two sides in the temporal bone of a young Virginia deer. (Fig. 36.) The second figure shows the middle two thirds of the right temporo-parietal articulation in an adult dog. In this case an apparently large slit, a short distance beyond which is situated a small foramen, has been filled by a Wormian bone and by an irregular rounded piece of bone now united with the parietal. (Fig. 37.) The third figure is a schema of the several varieties of divisions and spines from and to foramina, which can be observed in full-grown individuals. (Fig. 38.) The fourth figure shows a division in an

Fig. 37. The middle two thirds of the right temporo-parietal suture and the squama underneath, in an adult native dog from British Columbia (No. 13,773, A. M. N. H.), showing an irregular defect in the bone (A), now filled with a small separate bone, and a marginal defect in the squama (B), now filled with a portion of the parietal bone. Both defects, and probably the underlying foramina, are remnants of a former fissure in the squama.

oryx, which is continued from a notch in the parietal border to three parietal foramina. (Fig. 39.)

The appended list gives in detail the various divisions found in the parietal bones of different mammals below man and monkeys. The extent of the material made it imperative to use certain abbreviations in the records; the index of the abbreviations is given at the head of the table.

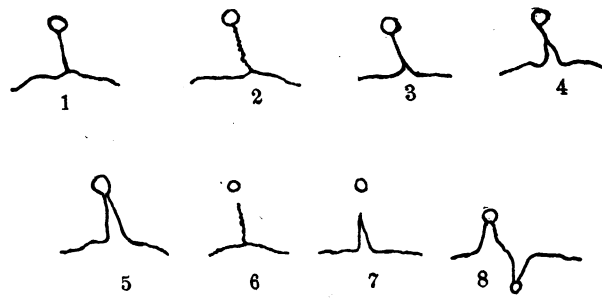


Fig. 38. Divisions and Spines from and to Foramina on the Parietal, Temporal, and other Cranial Bones in Mammals and Man. 1, simple fissure from a foramen to the border of the bone; 2, suture; 3, fissure and a small spine; 4, fissure and a spine of moderate size; 5, complete spine; 6, incomplete suture; 7, incomplete spine; 8, double spine.

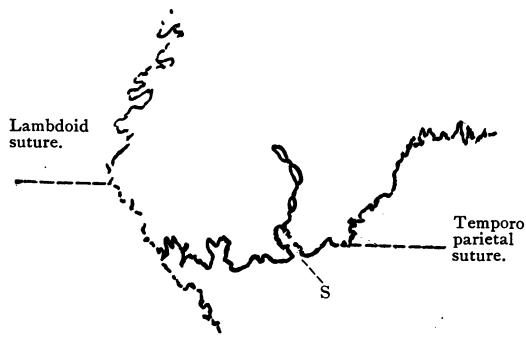


Fig. 39. The postero-inferior portion of the parietal bone of an Oryx (No. 13,552, A. M. N. H.), showing, S, a spine filling a cleft in the border of the parietal bone, and above that a suture, running to three superimposed foramina.

FISSURES AND SUTURES TO FORAMINA IN THE PARIETAL BONE IN ANIMALS.

Abbreviations.

f = linear fissure.
ff = multiple linear fissure.
f sp = fissure with a spine in its mouth.
s = suture, incomplete, not ending in a foramen nor directed to it.
s d = incomplete suture directed to a foramen.
s f = " " ending in a foramen.
s sp = " " with a spine in its mouth.
sp. = spine.
sp f = " to a foramen.
$\frac{1}{3}$ = at the end of the first or upper (coronal and l'd) third of the suture.
$\frac{2}{3}$ = " " " " " middle third of the suture.
$\frac{3}{4}$ = " " " " " third fourth " " "
m = at middle.
r = right.
l = left.
v. or vert. = vertical.
h. or hor. = horizontal.
o. or obl. = oblique.
1.0 = 1.0 cm. long.
b. s. = both sides.
bil. = bilateral.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Carnivora : Ursidæ.				
U. americanus.				
(1) 3762,[1] adol.	—	—	—	—
(2) 5045, "	—	—	sp f, 0.3, r, vert., $\frac{3}{4}$	—
(3) 14053, ad.	—	—	—	—
(4) 5044, adol.	—	—	—	—
(5) 3767, "	—	—	—	—
(6) 49, ad.	—	—	—	—
(7) 7376, "	—	—	—	—
(8) 6639, young	ff, b. s., 0.2 to 0.4	ff, b. s., 0.2 to 0.5	—	—
(9) 4282, "	—	—	—	—
(10) 11136, "	ff, b. s., 0.1 to 0.3	ff, b. s., 0.1 to 0.3,	—	—
(11) 14504, adol.	—	ff, l., 0.1 to 0.3	—	—
(12) 8580, ad.	—	—	sp. f, 0.2, r, v. near lamb. suture.	—
(13) 7374, ad.	—	—	sp f, 0.2, r, v, near lamb. suture.	—
(14) 11167, adol.	—	—	sp f, 0.3, r, o, $\frac{2}{3}$	—
(15) 6283, "	—	—	—	—
(16) 2000, "	—	—	—	—
(17) 6292, ad.	—	—	—	—
(18) 13964, adol.	—	—	—	—
(19) 280, ad.	—	—	—	—
(20) 116, "	—	—	—	—
Black Bear (20)	Multiple fissures in 2 young.	Multiple fissures in 2 young and 1 adolescent.	Short spine, to a foramen, in the last $\frac{1}{3}$ of the bone, in 3, 2 adolescents and 1 adult.	—
U. maritimus.				
(1) No number, adol.	—	—	—	—
(2) 50, adol.	—	—	—	—
(3) 5031, "	sp, 0.7, r., 0.5 from Bg.	—	—	—
(4) 5032, ad.	—	—	s f, 0.2, l, near lamb. s.	—
(5) 56, "	—	—	s f, 0.3, r, $\frac{2}{3}$	—
(6) 55, "	—	—	—	—
(7) 290, "	—	—	—	—
(8) 14054, "	—	—	—	—
(9) 11051, "	—	—	—	—
(10) 10240, "	—	—	—	—
Polar Bear (10)	A spine, in 1, into the parietal on right near bregma (adolescent.)	—	Short suture, to a foramen, in the last $\frac{1}{3}$ of the bone, in 2 adults.	—

[1] All the specimens here referred to are from the Zoölogical Collection of the American Museum of Natural History, New York.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Felidæ.				
F. leo				
(1) 13904, adol.	—	—	—	—
(2) 13998, "	—	—	—	—
(3) 8355, young	—	—	f, 0.2, b. s., into the mastoid angle.	—
(4) 6259, "	—	—	—	—
(5) fœtus at term.	—	—	—	—
(6) " " "	—	—	f, b. s., 0.3, into mast. angle.	—
(7) " " "	—	—	f, b. s., 0.2 & 0.1, into mast. angle.	—
(8) " " "	—	—	f, b. s., small, into mast. angle.	—
(9) " " "	f, 0.8, r. $\frac{1}{3}$	—	—	—
(10) " " "	—	—	f, 0.4, b. s., into mast. angle.	—
Lion (10)	A fissure, in 1 fœtus, on right side, below the upper $\frac{1}{3}$ of the parietal bone.	—	In 4 fœtuses and 1 young a fissure in each mastoid angle of the parietal.	—
F. tigris.				
(1) 61, ad.	—	—	—	—
(2) 63, "	—	—	—	—
(3) ? "	—	—	—	—
(4) 62, "	—	—	—	—
(5) 298, near ad.	—	—	—	—
(6) 10556, ad.	—	—	—	—
(7) fœtus at term.	—	—	—	—
(8) " " "	—	—	—	—
(9) " " "	—	—	—	—
(10) " " "	—	—	—	—
Tiger (10)	—	—	—	—
F. onca.				
(1) ? adol.	—	—	—	—
(2) 6293, "	—	—	—	—
(3) 68, "	—	—	—	—
(4) 6354, "	—	—	—	—
(5) 11086, "	—	—	—	—
(6) 64, "	—	—	—	—
(7) 11085, near ad.	—	—	—	—
(8) 6246, ad.	—	—	—	—
(9) 11083, near ad.	—	—	—	—
(10) 11084, "	—	—	—	—
Jaguar (10)	—	—	—	—
F. concolor.				
(1) 6295, young	—	—	—	—
(2) 1334, adol.	—	—	—	—
(3) 6249, "	—	—	—	—
(4) 1323, ad.	—	—	—	—
(5) 1331, near ad.	—	—	—	—
(6) 1339, "	—	—	—	—
(7) 6677, ad.	—	—	f sp, 0.8, l., $\frac{3}{4}$	—
(8) 1337, near ad.	—	—	—	—
(9) 1336, adol.	—	—	f sp, 0.5, r., $\frac{1}{3}$	—
(10) 1340, "	—	—	—	—
(11) 10259, "	—	—	—	—
(12) 1338, ad.	—	—	—	—
(13) 1327, adol.	—	—	—	—
(14) 117, ad.	—	—	—	—
(15) 5034, adol.	—	sp, 1.7, l, obl., fr. obelion.	s, 1.5, r., sq. to lamb.	—
Puma (15)	—	In 1, adolescent, a suture to a foramen, on left, from obelion.	In 2 spine and fissure in the last $\frac{1}{4}$: in one a suture separating a portion of the mastoid angle.	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
F. pardalis.				
(1) 14022, near ad.	—	—	—	—
(2) 13960, "	—	—	—	—
(3) 10073, "	—	—	—	—
(4) 10507, adol.	—	—	—	—
(5) 69, near ad.	—	—	—	—
(6) 2100, ad.	—	—	—	—
(7) 354, adol.	—	—	—	—
(8) 6248, near ad.	—	—	—	—
(9) 5938, adol.	—	—	—	—
(10) 11039, "	—	—	A suture, slightly serrated throughout, fr. sq. at pterion over whole r. pariet. and o.8 over l. par.; (*v.* Part *V.*)	—
(11) 4318, adol.	—	—	—	—
(12) 5369, ad.	—	—	—	—
(13) 6250, adol.	—	—	—	—
(14) 6406, "	—	—	—	—
(15) 352, ad.	—	—	—	—
(16) 5518, near ad.	—	—	—	—
(17) 72, adol.	—	—	—	—
(18) 13917, "	—	—	—	—
(19) 2087, near ad.	—	—	—	—
(20) 13999, young	—	—	—	—
Ocelot (20)	—	—	In 1 a complete vertical division of the right and incomplete division of the left parietal bone.	—
F. canadensis.				
(1) 1349, young	—	—	—	—
(2) 237, "	—	—	—	—
(3) 1351, "	—	—	—	—
(4) 1343, adol.	—	—	—	—
(5) 1962, "	—	—	—	—
(6) 1345, "	—	—	—	—
(7) 535, "	—	—	—	—
(8) 6420, ad.	—	—	—	—
(9) 1350, "	—	—	—	—
(10) 1352, adol.	—	—	—	—
(11) 1954, "	—	f, o.8, l, at the height of the tempor. ridge, a depression towards obelion.	—	—
(12) 8624, near ad.	—	—	—	—
(13) 1953, "	—	—	—	—
(14) 70, ad.	—	—	—	—
(15) 2443, near ad.	—	—	—	—
(16) 2851, ad.	—	—	—	—
(17) 4606, near ad.	—	—	—	—
(18) 1958, "	—	—	—	—
(19) 1961, "	—	—	—	—
(20) 2187, ad.	—	—	—	—
Lynx (20)	—	In 1 adol. a separated segment of a fissure, on left, along the temporal ridge.	—	—
Felis catus.				
(1) 3778, ad.	—	—	—	—
(2) 3799, near ad.	—	—	—	—
(3) F. domestica, 3778, ad.	—	—	—	—
(4) F. domestica, 71, ad.	—	—	—	—
(5) " " 1963, ad.	—	—	—	—
(6) F. domestica, 11151, near ad.	—	—	—	—
(7) F. domestica, 11152, ad.	—	—	—	—
(8) F. domestica, 1964, near ad.	—	—	—	—
(9) F. domestica, 10289, ad.	—	—	—	—
(10) F. domestica, 11266, young	—	—	—	—
Cat, wild and domestic (10)	—	—	—	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Hyænas.				
(1) H. macul., 8304, v. young	—	—	f l. o.6, r. o.8, curved, in the sphenoidal angle; a small fiss. on each side in the mastoid angle.	f, small, b. s., o.6 above asterion
(2) H. macul., 971, young	—	—	f 10.3, ab. sphen. angle.	—
(3) H. ? 615, adol.	—	—	—	—
(4) " str. 1544, n. ad.	—	—	—	—
(5) " " 67, ad.	—	—	—	—
Hyænas (5)	—	—	In 1 young a fissure into the sphenoidal angle, in another young slightly above it. In 1 young a fissure into each mastoid angle.	In 1, young, a fissure on both sides slightly above asterion.
	—	—		
Canidæ.				
(1) C. famil., very young	—	—	—	—
(2) " " " "	—	—	—	—
(3) " " " "	—	—	—	—
(4) " " " "	—	—	—	—
(5) " " " "	—	—	—	—
(6) C. famil., 1203, adol.	—	—	—	—
(7) " " 11013, ad.	—	—	—	—
(8) " " 78, adol.	—	—	—	—
(9) " " 11105, ad.	—	—	—	—
(10) " " 408, ad.	—	—	—	—
(11) C. ? 13681, ad.	—	—	—	—
(12) C. fam., 115, ad.	—	—	—	—
(13) " " 77, "	—	—	—	—
(14) C ? "	—	—	—	—
(15) C. Brit. Col., adol.	—	—	—	—
(16) " " " (13773), ad.	—	—	—	—
(17) C. Mexic., ad.	—	—	—	—
(18) " " adol.	—	—	—	—
(19) " Esquimo, ad.	—	—	—	—
(20) " " adol.	—	—	—	—
Dog (20)	—	—	—	—
Vulpes lagopus.				
(1) 10207, ad.	—	—	—	—
(2) 82, "	—	—	—	—
(3) 10227, adol.	—	—	—	—
(4) 10170, ad.	—	—	—	—
(5) 10173, ad.	—	—	—	—
(6) 10691, "	—	—	—	—
(7) 10228, near ad.	—	—	—	—
(8) 10175, ad.	—	f, r., o.3, sup.-post. angle, continues on interpar. for o.3.	—	—
(9) 10228, near ad.	—	depression, in same location, on left.	—	—
(10) 10232, ad.	—	depression, in same location, on r., ending in a minnute foramen, o.4 in toto.	—	—
Arctic Fox (10)	—	In 3 a depression, or a fissure, in the lambdoidal angle of the parietal.	—	—
Vulpes fulvus.				
(1) 6413, young	—	—	—	—
(2) 6412, "	—	—	—	—
(3) 6369, "	—	—	f, small, into each mastoid angle.	—
(4) 3796, "	—	—	f, small, into each mastoid angle.	—
(5) 6415, "	—	—	—	—
(6) 11809, "	—	—	—	—
(7) 6414, "	—	—	—	—
(8) 3749, adol.	—	—	—	—
(9) 4279, "	—	—	—	—
(10) 11066, ad.	—	—	—	—
American Red Fox (10)	—	—	In 2 young a small fissure in each mastoid angle of the parietal.	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Canis lupus gris.-alb.				
(1) 111, adol.	—	—	—	—
(2) ? ad.	—	—	—	—
(3) 2384, "	—	—	—	—
(4) 4609, "	—	—	—	—
(5) 76, "	—	—	—	—
(6) 458, "	—	—	—	—
(7) 112, n. ad.	—	—	—	—
(8) 481, ad.	—	—	—	—
(9) 5381, adol.	—	—	—	—
(10) 2247, ad.	—	—	—	—
Gray Wolf (10)	—	—	—	—
Canis latrans.				
(1) very young	—	—	—	b. s. depression, abt. m., running towards the eminence.
(2) " "	—	—	—	b. s. depression, abt. m., running towards the eminence.
(3) " "	—	—	—	b. s. depression, abt. m., running towards the eminence.
(4) " " 9582	—	l., f, o.7, nearly vert. $\frac{4}{5}$	—	b. s. depression, abt. m., running towards the eminence.
(5) young	—	—	—	depression, b. s., n. middle.
(6) " 14489	—	traces of 1.1 obl. f. on r., $\frac{1}{2}$, and of a f. o.45, l. $\frac{3}{4}$	—	depression, n. m., marked.
(7) " 14488	—	depression ov. both pariet's, beginning at middle.	—	—
(8) "	—	—	—	marked depression on each side, fr. m. towards eminence.
(9) adol.	—	—	—	—
(10) ad.	—	—	—	—
(11) 2846, near ad.	—	—	—	—
(12) 3753 ad.	—	—	—	—
(13) 5383, adol.	—	—	—	—
(14) 5385, near ad.	—	—	—	—
(15) 3739, ad.	—	—	—	—
Coyote (15)	—	Fissure, in the post. $\frac{1}{3}$ of the parietal, in 2 young.	—	A depression probably the remnant of a fissure, about the middle of the occipital border of the parietal, in almost all young.
Carnivora. (195)	Multiple fissures in 2 black bears, young; A spine in 1 adol. polar bear; A fissure in 1 lion fœtus.	Multiple fissures in 3 black bears; Suture to a foramen in 1 puma; Segment of a fissure in 1 lynx; Fissure or a depression in the lambdoid angle in 3 arctic foxes; Fissure from obelion in 2 young coyotes.	Fiss. in sphenoidal angle in 2 hyænas; Spine to a foramen in 3 black bears; Suture to a foramen in 2 polar bears; Fiss. in mastoid angle in 5 lions, 1 hyæna, 2 red foxes (all young). Spine and fiss., post. $\frac{1}{4}$, of par., 2 pumas. Separation of part of mastoid angle, 1 puma. Division of whole parietal, 1 ocelot.	Fissure, above asterion, in 1 young hyæna; Depression, at middle, in 7 young coyotes.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Ungulata.				
(1) Ovis tragelaphus, 10707, v. young	Several small incisures in the squam. portion which underlies the frontal.	o.9 f. on each side, ⅓ o.4 f. on each side, just before this, o.4 f. on each side, beyond m.	—	—
(2) Ovis tragelaphus, 6360, young	—	—	f, l., o.5, m.	f, c.2, r., post-inf. angle.
(3) Ovis musim., 6294, adol.	—	—	—	—
(4) Ovis montana, 14004, ad.	—	—	—	—
(5) Ovis musim., 6233, adol.	—	—	—	—
(6) Ovis ? 6358, ad.	—	—	—	—
(7) " ? 6238, "	—	—	—	—
(8) " tragelaph, 10261, ad.	—	—	—	—
(9) Ovis tragelaph, 10260, ad.	—	—	—	—
(10) Ovis trage., 11019, adol.	—	—	—	—
(11) Ovis ? 5028, ad.	—	—	—	—
(12) Ovis aries 6361, ad.	—	—	—	—
(13) Ovis aries, 10262, ad.	—	—	—	—
(14) " " 14083, "	—	—	—	—
(15) " ?, v. young	f, b. s., ab. sphen. angle.	—	—	small f. in each mastoid angle.
(16) " stonei, ad.	—	—	2 sp. to for., ⅛	—
(17) " stonei, ad. 11052	—	—	sp. f, small, r., ⅝	—
(18) Ovis stonei, ad. 12719	—	—	f for, r., o.3, near aster. f for l., o.7, near aster.	—
(19) O. montan., 13793, near ad.	—	—	—	—
(20) ? 6232, young	—	7 f., b. s., o.3 to o.5	f, l., o.4, m.	—
Sheep (20)	Several fissures in 1 young. Fiss. above each sphenoidal angle in 1 young.	Multiple fiss. in 1 young. 6 fiss. in 1 young.	In 1 a fissure at mid. In 2 a spine to a foramen. In 1 a fissure to a foramen.	In 2, young, fissure in the mastoid angle.
(1) Capra res., 2074, v. young	—	—	—	f, b.s., ab. mastoid angle.
(2) Capra ?, 10728, v. young	—	—	—	—
(3) Capra ?, 6237, young	—	—	—	—
(4) " ? 6236, "	—	—	f for, l., o.2, ⅛	—
(5) Capra angora, 8360, young	—	—	—	—
(6) Capra angora, 6359, ad.	—	—	f for, l., o.2, ⅛	—
(7) Capra angora, 10268, ad.	—	—	—	—
(8) Capra angora, 8354 ad.	—	—	s f, r., o.3, ¾	—
(9) Capra angora, 2083, ad.	—	—	—	—
(10) Capra ?, ad.	—	—	—	—
Goats (10)	—	—	In 2 young a fissure to a foramen; in one adult a suture to a foramen, all in last ¼ of the parietal.	In 1 a fissure on each side in the mastoid angle.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Cervidæ.				
Alces amer.				
(1) 6408, near ad.	—	—	sp f, b. s., ¾, large, on left double.	—
(2) 3796, adol.	—	—	s f, r., o.3, ⅔	—
Cervus canadensis.				
(1) 6351, young	—	—	—	—
(2) 209, ad.	—	—	—	—
(3) 5037, adol.	—	—	—	—
(4) 368, near ad.	—	—	—	—
Rangifer groenl.				
(1) 14237, ad.	—	—	—	—
(2) 14233, "	—	—	—	—
(3) 14239, young	—	—	—	—
Rangifer tarandus.				
(1) 5035, young	—	—	—	—
(2) 5141, ad.	—	—	—	—
(3) 3460, near ad.	—	—	—	—
Elks and Rangifers (12)	—	—	In one elk a spine to a foramen, in the other a suture to a foramen, both in the last ⅓ of the parietal.	—
Dorcelaphus hemion.				
(1) 13903, ad.	—	—	—	—
(2) 11109, "	—	—	sp f, r., o.6, ¾	—
(3) 12792, "	—	—	3 small sp to for. on l., 1 on right.	—
(4) 11142, near ad.	—	—	s f, 1 on l., 2 on r., small, ⅔.	—
(5) 11143, adol.	—	—	sp f, small, l., ⅔.	—
(6) 11116, ad.	—	—	—	—
(7) 11141, adol.	—	—	sp f, r., ⅔	—
(8) 11118, ad.	—	—	sp f, b. s., ¾	—
(9) 11139, "	—	—	2 sp f on r., ¾	—
(10) 11114, near ad.	—	—	f for. on l., sp f on r., ⅔	—
Dorcelaphus. (10)	—	—	Spine to a foramen in 6; fissure to a foramen in 1; suture to a foramen in 1.	—
Cervus elaphus.				
(1) 13911, v. young	—	—	f, 2 on l., 1 on r., ⅔ (o.2 to o.4).	—
(2) 10713, young	—	—	—	—
(3) 10076, ad.	—	—	—	—
(4) 141, near ad.	—	—	2 sp f., small, on l., ⅔.	—
(5) 142, ad.	—	—	3 sp f, small, on r., ⅔	—
Red Deer (5)	—	—	Spine to a foramen in 2. Fissure in 1 young.	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Cervus virgin.				
(1) 10706, adol.	—	—	f for, b. s., o.9, $\frac{3}{8}$	—
(2) 14084, "	ff, o.1 to o.3, b. s. of bregma.	—	f, l., o.7, partly occluded, $\frac{1}{4}$	—
(3) 3764, near ad.	a number of small, f on both sides of bregma.	—	f for, o.2, l., near sphen. angle.	—
(4) 3766, ad.	—	—	—	—
(5) 8363, near ad.	—	—	f for, o.5, l., $\frac{3}{8}$, on r. a depression.	—
(6) 3798, v. young	—	—	f, o.3, in each mastoid angle.	f, l., o.2, r., o.5, 1.1 fr. lda.
(7) 11144, ad.	—	—	r. sp f for, $\frac{1}{4}$	—
(8) 11028, ad.	—	—	f for, b. s., o.8, $\frac{1}{4}$, sp in base; on r., for. obliterated.	—
(9) 3777, "	—	—	sp and depression to for. b. s., $\frac{1}{4}$	—
(10) 7368, "	—	—	depression to for., b. s., $\frac{3}{8}$.	—
(11) 812, v. young	—	—	(depression.)	—
(12) 2838, "	—	—	(depression.)	b. s., marked cleft, above mastoid angle.
(13) 2078, young	ff, on both sides of bregma.	—	(depression.)	—
(14) 10290, "	—	—	(depression.)	—
(15) 10514, adol.	—	—	sp and depression, b. s., $\frac{1}{4}$	—
Virginia Deer (15)	Multiple fissures in 3.	—	Fissure in 2; fiss. to a foramen in 4; depression to a for. 6; spine and depress. to a for. 2; spine and fissure to a for. 1. In 1 —.	In 1 young a fissure in mastoid angle, in 1 y. a fissure below upper $\frac{1}{3}$.
Cervus axis.				
(1) 11165, v. young	—	—	f, b. s., o.2, $\frac{3}{8}$	—
(2) 13961, young	—	—	—	—
(3) 10710, near ad.	—	—	—	—
(4) 3765, ad.	—	—	—	—
(5) 10553, ad.	—	—	depression, on left traces, on r. deep; connects two foramina-vascular.	—
Axis Deer (5)	—	—	In 1 a fissure on both sides; in 1 a depression.	—
Cervus dama.				
(1) 6365, v. young	—	—	—	—
(2) 10714, "	f, o.4, r., m. (hidden beneath the squama of the frontal.	—	s, b. s., o.3, in the sphen. angle.	f, o.2, r., $\frac{1}{3}$
(3) 10718, "	—	—	f, o.4, b. s., near middle, hidden under tempor. squama.	f, o.2, r., $\frac{1}{3}$
(4) ? "	f, o.2, b. s., near m. (hidden). f, in each bregma angle.	—	depression; l. suture in sphen. angle; trace on right.	—
(5) 11036, young	ff, on both sides of bregma.	—	—	—
(6) 11157, "	—	—	—	—
(7) 8359, "	—	—	(depression.)	—
(8) 10272, ad.	—	—	(depression.)	—
(9) 10257, "	—	—	(depression.)	—
(10) 10079, "	—	—	(depression) left.	—
Fallow Deer (10)	Multiple fissures in 1 young. Fissure in middle in 2. Fissure in each bregmatic angle in 1 young.	—	Suture in sphenoidal angle in 2; fissure near middle in 1; depression in 5.	Fissure, below the upper $\frac{1}{3}$ of the parietal, in 2.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Arizona Deer.				
(1) 3, adol.	—	—	—	—
(2) 1976, ad.	—	—	—	—
(3) 1972, "	—	—	—	—
(4) 1966, near ad.	—	—	—	—
(5) 2, adol.	—	—	—	—
Arizona Deer (5)	—	—	—	—
Coassus (Trinidad).				
(1) 375, ad.	—	—	—	—
(2) 146, "	—	—	—	—
(3) 145, "	—	—	—	—
(4) 147, "	—	—	depression, $\frac{2}{3}$	—
(5) 377, "	—	—	—	—
Coassus Deer (5)	—	—	A depression at the end of second third in 1.	—
Antilocapridæ.				
Antilocapra amer.				
(1) 11133, near ad.	—	—	—	—
(2) 11105, ad.	—	—	—	—
(3) 11130, "	—	—	f for., small, r., $\frac{3}{4}$	—
(4) 11099, "	—	—	—	—
(5) 11134, "	—	—	—	—
(6) 11104, "	—	—	—	—
(7) 11100, near ad.	—	—	sf, r., 0.4, near asterion.	—
(8) 11096, ad.	—	—	—	—
(9) 11107, "	—	—	—	—
(10) 11128, adol.	—	—	—	—
American Antelope (10)	—	—	Fiss. to foramen in 1; Suture to foramen in 1; both in the last $\frac{1}{4}$ of the parietal.	—
Antilopidæ.				
Antilope cervicapra.				
(1) 12049, young	—	—	depress. to for. b. s., $\frac{1}{4}$ (vascular depression).	—
(2) 10741, adol.	—	—	depress. to for. b. s., $\frac{1}{4}$ (vascular depression).	—
(3) 13913, young	—	—	depress. to for. b. s., $\frac{1}{4}$ (vascular depression).	—
(4) 11029, ad.	—	—	depress. to for. b. s., $\frac{1}{4}$ (vascular depression).	—
(5) 10708, adol.	—	—	depress. to for. b. s., $\frac{1}{4}$ (vascular depression).	—
Common Antelope (5)	—	—	A vascular depression from a foramen under the squama, on the last $\frac{1}{4}$ of the parietal in all.	—
Madoqua.				
(1) 13540, ad.	—	—	—	—
(2) 13538, "	—	—	—	—
(3) 13541, "	—	—	—	—
Madoqua (3)	—	—	—	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Oryx.				
(1) 10724, ad.	—	—	sp f, b. s., small, ⅛	—
(2) 14115, "	—	—	f for, o.4, b. s., near aster.	—
(3) 13552, "	—	—	sp f to a chain of 3 foramina, r., ⅛	—
(4) 10080, near ad.	—	—	f for, small, b. s., near aster.	—
Oryx (4)	—	—	Spine or a fissure to a foramen in all, in last ⅓ of the parietal.	—
Nylghai.				
(1) 5024, ad.	—	—	—	—
(2) 166, "	—	—	large depression, vascular, near asterion.	—
(3) 14095, ad.	—	—	large depression, vascular, near asterion.	—
Nylghai (3)	—	—	In 2 a large, bilateral, vascular groove near the asterion.	—
Boselaphus tragocam.				
(1) 12412, v. young	f, b. s, small, ab. sphen. angle, also a f, b. s., next to bregma.	—	f, b. s. o.3, into mastoid angle.	—
(2) 11035, young	—	—	depression, ⅛	—
(3) 11168, "	—	—	depression, ⅛	—
(4) 11169, ad.	—	—	depression, ⅛	—
(5) 13797, "	—	—	—	—
Boselaphus trag. (5)	In 1 young fissures above the sphenoidal angle and near bregma.	—	In 1 young fissure in mastoid angle. In 3 vascular grooves in the last ⅓ of the parietal.	—
Bubalis swaynei.				
(1) 13536, young	—	—	—	—
(2) 13537, ad.	—	—	—	—
(3) 14443, "	—	—	—	—
Bubalis swaynei (3)	—	—	—	—
Bovidæ.				
(1) Bos grunniens, adol.	—	—	—	—
(1) " caffer, ad.	—	—	—	—
(2)	—	—	—	—
(1) Bison amer. ad.	—	—	—	—
(2) " " "	—	—	—	—
(3) " " "	—	—	—	—
(4) " " "	—	—	—	—
(5) " " adol.	—	—	—	—
Bison (5)	—	—	—	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Bos indicus.				
(1) v. young	f, b. s., in bregma. angle.	—	f, b. s., in sphen. angle.	—
(2) 6403, young	f, b. s., in bregma. angle.	—	—	—
(3) 10080, "	f, b. s., in bregma. angle.	—	—	—
(4) 6357, "	f, b. s., in bregma. angle.	—	—	—
(5) 10500, ad.	—	—	—	—
Indian Bull (5)	In 4 young a fissure on each side in the bregmatic angle.	—	In 1 young fissure on each side in the sphenoidal angle.	—
(1) Bos taurus, ad.	—	—	—	—
(2) " " "	—	—	—	—
(2)	—	—	—	—
Other Ungulates. *Equidæ.*				
(1) Equus 295, adol.	—	—	—	—
(2) " 140, "	—	—	—	—
(3) Burro, "	—	—	—	—
(4) Zebra, "	—	—	—	—
Horses (4)	—	—	—	—
Camelidæ				
(1) Camel, 14124, ad.	—	—	—	—
(2) " 6368, young	f, b. s., beneath the spine.	f, b. s., o.8, ⅔	f, b. s., o.4, ⅔	f, b. s., above mastoid angle.
(3) Camel, 10271, young	f, b. s., small.	ff, small, ant. ⅓	—	f, b. s., on right.
(4) Llama, 14121, ad.	—	—	—	—
(5) " 5140, near ad.	—	—	—	—
(6) " 6235, young	—	—	—	—
Camels and Llamas. (6)	In 2 young a fissure on each side below the temporal ridge.	In 1 young multiple fissures; in 1 young a fissure at about the obelion.	In 1 young a fissure on each side between the second and last thirds of the parietal.	In 2 young a fissure above the mastoid angle.
Suidæ.				
(1) S. scrofa, young	—	—	f, b. s., small, in mast. angle.	f, b. s., small, above mastoid angle.
(2) S. scrofa, domest., 10739, adol.	—	2 small f on each side ⅔	—	—
(3) S. scrofa, domest., 10740, adol.	f, b. s., ab. temp. r. f, o.6, r. sphen. angle.	—	—	—
(4) S. scrofa, 387, n. ad.	—	—	—	—
(5) " 14126, "	—	—	—	—
(6) " 14124, "	—	—	—	—
Boars and Pigs (6)	In 1 adolesc. a fissure on each side above the temporal ridge, and another in the right sphenoidal angle.	In 1 adoles. 2 fissures, at the end of the 2d third of the border.	In 1 young a fissure on each side in the mastoid angle.	In 1 young a fissure on each side above the mastoid angle.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Ungulata (160)	Multiple fissures in upper $\frac{1}{3}$ of the frontal border of the parietal bone, in: 1 young sheep, 3 subadult Virginia deer, 1 fallow deer. Fissure in the super.-anterior angle, in: 1 young fallow deer, 4 young Bos indic. Fissure near bregma, in: 1 young Boselaphus. Fissure near the temporal ridge, in: 2 young camels, 1 adol. pig. Fissure at middle, in: 2 young fallow deer. Fissure above the sphenoidal angle, in: 1 young sheep, 1 young Boselaphus, 1 adolesc. pig.	Multiple fissures, in: 1 young camel, 1 adol. pig. Fissure at first $\frac{1}{3}$ in 1 Ovis tragel. Fissure at second $\frac{1}{3}$ (about obelion), in 1 young camel.	Fissure at middle, in: 1 Ovis tragel., 1 y. fallow deer. Fissure at $\frac{2}{3}$, in: 1 young red deer, 1 y. axis, 1 y. camel. Fissure at $\frac{3}{4}$ or near asterion, in: 1 adol. Virginia deer. Fissure or suture in sphenoidal angle in: 2 y. fallow deer, 1 y. Bos indicus. Fiss. in mastoid angle, in: 1 y. Virginia deer, 1 y. Boselaphus, 1 y. pig. Fiss. to a foramen, in: 1 Ovis stonei (near aster.), 3 goats ($\frac{1}{2}$), 1 Dorcelaphus ($\frac{2}{3}$), 4 Virginia deer ($\frac{1}{2}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{4}$), 1 Amer. antelope ($\frac{3}{4}$), 2 Oryx (near aster.). Suture to a foram., in: 1 goat ($\frac{1}{2}$), 1 elk ($\frac{2}{3}$), 1 Dorcelaphus ($\frac{2}{3}$), 1 Amer. antelope (near aster.). Spine to a foramen, in: 2 sheep ($\frac{1}{2}$, $\frac{2}{3}$), 1 elk ($\frac{2}{3}$), 6 Dorcelaphi ($\frac{2}{3}$, $\frac{3}{4}$), 2 red deer ($\frac{2}{3}$), 3 Virgin. deer (2 with a depression, $\frac{3}{4}$, 1 with a fissure, $\frac{3}{4}$), 2 Oryx ($\frac{1}{2}$). Vascular depression, in: 8 Virginia deer ($\frac{3}{4}$), 1 axis, 5 fallow deer, 1 Coassus, 5 Antilope cervicapra, 2 nylghai, 3 Boselaphi.	Fissure in poster.-infer. or mastoid angle: 2 young sheep. Fissure a small distance above mastoid angle: 1 young goat, 1 young Virginia deer, 2 young camels, 1 young pig. Fissure at the end of the upper $\frac{1}{3}$ of the occipital border, in: 2 young fallow deer. Fissure near lambda: 1 young Virginia deer.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Pinnipedia.				
Eleven Phoca grœnl.	—	—	—	—
Ten " fœtida	—	—	—	—
One " "	On each side several fissures above the sphenoidal angle, one almost dividing the angle.	—	—	—
Seven " vitulina	—	—	—	—
Six Zalophus calif.	—	—	—	—
One " "	2 small fiss. ab. sphen. angle. 1 suture to a for. above r. sphen. angle.	—	—	—
One " "	1 fiss. above l. sphen. angle.	—	—	—
One " " young	large fissure, ab. the sph. angle.	—	—	—
Two Seals (spec. ?)	fissure above the sphen. angle.	—	—	—
Six " "	—	—	—	—
Six Walrus	—	—	—	—
Pinnipedia (52)	In some seals and Zalophi one or more fissures above the sphenoidal angle of the parietal bone.	—	—	—
Rodentia.				
Six Castor fiber.	—	—	—	—
Thirty " canad.	—	—	—	—
One Fiber zibeth.	—	—	—	—
One Lepus camp.	—	—	—	—
One Hystrix lucar.	—	—	—	—
Thirty Sciurus huds.	—	—	—	—
Twenty Cynomys	—	—	—	—
Twenty-five Arctomys	—	—	—	In a few cases a spine from the occipital, below the interparietal bone.
Thirty Spermophilus	—	—	—	—
Twenty Muridæ	—	—	—	—
One Mus, y.	—	—	bilatreal fissure, from squamous suture, about middle, towards the lambdoid suture, up to ½ the distance.	—
Twenty Neotoma mex.	—	—	—	—
Rodents. (185)	—	—	In 1 a bilateral oblique fissure (young rat).	In a few marmots a spine from the occipital into the parietal bone, below the interparietal.

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