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A NEW CRETACEOUS PLESIOSAUR FROM VENEZUELA

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INTRODUCTION

Several years ago Mr. Georges Pardo, a geologist associated with the Mene Grande Oil Company, of Barcelona, Venezuela, discovered fossil bones in sediments of Cretaceous age in the vicinity of Altagracia de Orituco, some 125 miles west by south of Barcelona, and about 50 miles southeast of Caracas. These fossils were collected by Mr. Pardo and removed to Barcelona where they were brought to the attention of Mr. H. D. Hedberg, Assistant Chief Geologist of the Mene Grande Oil Company. Mr. Hedberg got in touch with the American Museum of Natural History, and arrangements were made to have the fossils shipped to this institution for identification and study. They form the subject of the present contribution.

The fossils represent a partial skeleton of a plesiosaur of elasmosaurid relationships. Unfortunately no skull was discovered, but a series of vertebrae and ribs and a partial pectoral girdle with the humerus and some other bones of the limb on the left side give sufficient data for an identification of the animal. At best the fossil is fragmentary, and a published description of it would not be attempted except for the fact that it comes from a locality far removed from other known plesiosaur discoveries. Consequently it represents an important new record for the plesiosaurs, and because of the extension of zoological and paleogeographical knowledge resulting from this discovery, a published description and discussion of the fossil are, it is felt, fully warranted.

At this place I wish to express the debt of gratitude owed by the American Museum of Natural History and by myself to the

two gentlemen already mentioned, for permission to study the fossil and for assistance rendered in this study. Mr. Hedberg, on behalf of the company of which he was a representative, was most generous in placing the specimen at our disposal, while Mr. Pardo furnished the author with some detailed notes on his discovery of the fossil bones. In addition, Mr. Pardo prepared some maps to show the locality at which the fossils were found. These are reproduced in the present paper as figures 1 and 2. Figure 8 was drawn by Mr. John LeGrand.

Also, I wish to express at this place my very great appreciation to Dr. S. P. Welles of the University of California, the outstanding contemporary student in North America of the plesiosaurs, who was kind enough to spend some time in an examination of the specimen with me, and from whose advice I benefited greatly. The manuscript of this paper was sent to Dr. Welles for a critical reading before it was submitted for publication.

THE DISCOVERY OF THE FOSSILS

Fossils were discovered at two separate localities near Altagracia de Orituco. These two localities are shown on the map (fig. 2) where they are indicated by the numbers assigned to them by Mr. Pardo and his associates, A-7525 and A-7528, respectively.

Mr. Pardo's statements, contained in a letter, concerning the discovery of fossil vertebrate remains at these localities are as follows: "The fossil vertebrate fragments have been found south-east of Altagracia de Orituco, State of Guarico, District Monagas, Venezuela.

[Locality A-7525.]

"The bone fragments of this locality have been found in a large concretion of the Cretaceous Querecual limestone, which is a widespread stratigraphic unit in northern South America. All the pieces seem to belong to the same skeleton.

"This locality has a very rich mollusk fauna with very abundant cephalopods and pelecypods, which seem to indicate an age varying from the Cenomanian to Turonian. (Some specimens of *Inoceramus* are visible in the matrix of the bones.) It is impossible to define the stratigraphic position of this occurrence within the Querecual formation on account of structural complications.

"An attempt was made in the field to take as large blocks of rock as possible, making no attempt to isolate individual pieces and giving more importance to the vertebrae. Unfortunately,

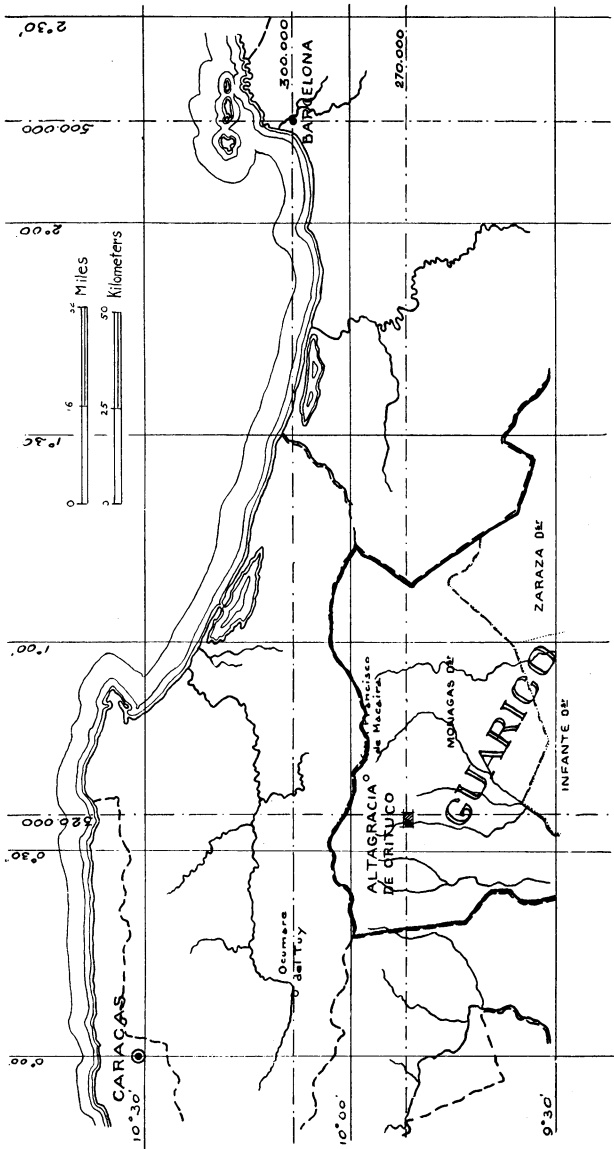


FIG. 1. Map of the northeastern part of Venezuela, showing the general location of Altigracia de Orituco with relation to Caracas and Barcelona. Scale: 32 miles to 1 inch. Map prepared and drawn by Georges Pardo.

many bones were broken; also the skull was not found. Some bones have been rebuilt, putting together small fragments with plaster. This was not made with the purpose of reconstruction, but only in an attempt to show the right position of a large amount of fragments which would probably have been lost otherwise.

[Locality A-7528.]

"Only one bone fragment was found in this locality, but the presence of this fragment so far away from the other locality seems to indicate the existence of a large deposit.

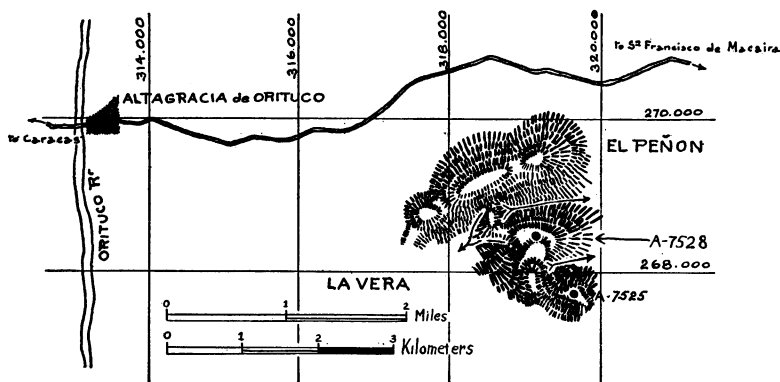


FIG. 2. Sketch map showing the fossil localities near Altagracia de Orituco. Scale: $1\frac{3}{5}$ miles to 1 inch. Map prepared and drawn by Georges Pardo.

"It seems also important to call attention to the fact that the inhabitants of the Altagracia de Orituco region commonly speak about 'enormous whale bones.' It might be then of interest to investigate this area in general."

***Alzadasaurus tropicus*, new species**

TYPE: A.M.N.H. No. 6796. A partial skeleton, consisting of the following elements: last cervical vertebra, four pectoral vertebrae and eight dorsal vertebrae, with some associated ribs, left scapula, left coracoid, left humerus, portions of left radius, ulna and carpus, middle portion and distal border of right coracoid, miscellaneous fragments for the most part consisting of sections of ribs.

HORIZON: Querecual limestone, of Upper Cretaceous age (Cenomanian to Turonian).

LOCALITY: About 4 miles, or 6.5 kilometers, east and a little south of Altagracia de Orituco, State of Guarico, District Monagas, Venezuela. Locality A-7525. (See map, fig. 2.)

DIAGNOSIS: A large elasmosaur, closely comparable to *Alzadasaurus riggsi*, the type of the genus. Vertebrae with round centra and rather high, compressed, neural spines. Scapula with a broad dorsal process and a fairly broad ventral plate, but with no median midline ventral bar. Coracoid elongated, and expanded along the posterior margin. The posterior blade of the coracoid is long, longer than in *Alzadasaurus riggsi*. Coracoids meeting along a median symphysis in their anterior portion, but posteriorly separated by an elongated median vacuity. Humerus elongated and distally expanded.

DESCRIPTION AND DISCUSSION

As indicated by the quotation above from Mr. Pardo's letter, the fossil bones comprising the type of *Alzadasaurus tropicus* were removed in a series of large blocks of stone. The bones were partially exposed in the matrix, but no attempt was made to extricate the fossils completely from the surrounding rock. Some additional preparation of the material has been carried on at the American Museum of Natural History, but even so the bones have not been completely freed from their matrix. This matrix is exceedingly hard, and it has been thought advisable to remove as little of it as possible, partly to avoid injury to the specimens and partly to preserve the relationships of the bones to one another as they were fossilized.

There are 12 vertebrae preserved in the specimen. Five centra are contained in each of two blocks of stone, while two centra are free. In addition, the spines belonging to some of these vertebrae are preserved in three other blocks of stone. It will be seen that the vertebrae form a continuous series, without any gaps. The most anterior centrum, which is only partially preserved, is identifiable as that of the last cervical vertebra, an identification based largely on the fact that the next succeeding vertebra is certainly the first pectoral, as shown by its vertically expanded rib facet, borne partly by the centrum and partly by a short transverse process.

It would appear that there are four pectoral vertebrae in this specimen, having rib facets partly on the centrum and partly on

the transverse process. Because the transverse process is broken in the fourth of this series of vertebrae, one cannot be absolutely certain as to the relationships of the rib facets. Therefore, it is quite possible that this vertebra is a true dorsal, with the rib

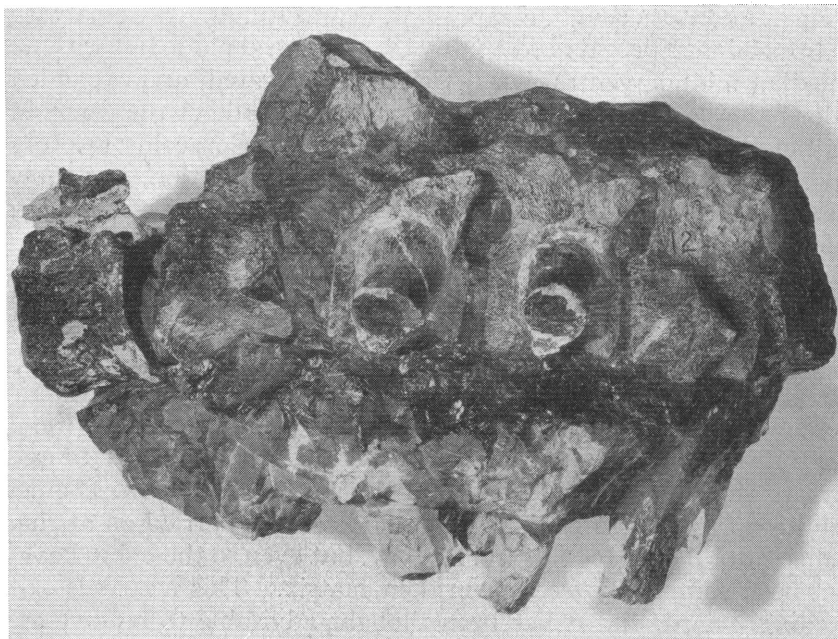


FIG. 3. *Alzadasaurus tropicus*, new species. A.M.N.H. No. 6796, type, vertebrae from the pectoral and dorsal regions of the column. The vertebrae have been identified, from right to left, as follows: fragment of last cervical vertebra, four pectoral vertebrae, and first dorsal vertebra. Right lateral view, one-fourth natural size.

facet borne entirely on the end of the transverse process, in which case there would be but three pectoral vertebrae, the more usual condition in the plesiosaurs. However this may be, the fact is that from the first pectoral vertebra back the rib facets are successively higher in position on each succeeding vertebra, so that on the fifth vertebra back from the end of the cervical series the facet is located quite high and entirely on the termination of the transverse process. Behind this vertebra the condition is similar, the transverse processes carrying the facets for the single-headed ribs.



FIG. 4. *Alzadasaurus tropicus*, new species. A.M.N.H. No. 6796, type, vertebrae, ribs, and portion of left coracoid. The vertebrae have been identified, from right to left, as the second to eighth dorsal vertebrae, inclusive. The blade of the coracoid is seen below the vertebrae, with the median edge of the bone facing ventrally. The figure shows the relatively straight median edge of the blade of the coracoid in this fossil. Right lateral view, one-fourth natural size.

These transverse processes in the dorsal vertebrae are long, and they project upward from their bases at considerable angles.

The vertebral centra are strong and heavy, and they are not appreciably, if at all, compressed. Indeed, as seen end on, the articulating faces of the centra are essentially round, with subequal vertical and transverse diameters. These faces are flat. The ends of the centra are expanded, while in their middle portions they are constricted to a certain extent. Ventrally each centrum shows two large nutrient foramina, one on either side. The dorsal surface of the centrum in each vertebra is notched longitudinally by the large neural canal.

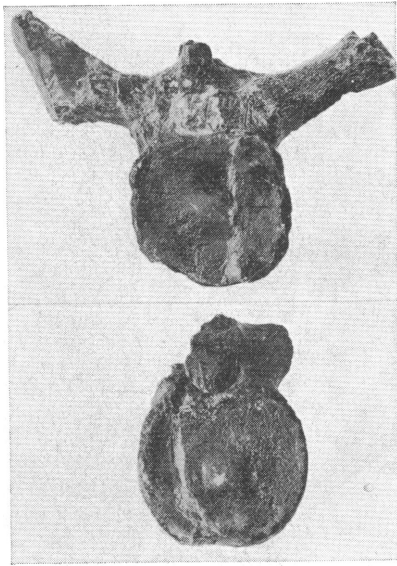


FIG. 5. *Alzadasaurus tropicus*, new species. A.M.N.H. No. 6796, type, dorsal vertebrae. Above, second dorsal vertebra, posterior view. Below, third dorsal vertebra, anterior view. One-fourth natural size.

The neural spines are transversely narrow, and they are rather tall.

A comparison of the vertebrae of this new specimen from Venezuela with comparable vertebrae in other elasmosaurs shows that the centra in *Alzadasaurus tropicus* are relatively somewhat longer than they are in, for instance, *Elasmosaurus serpentinus* and *Hydrotherosaurus*, or the somewhat earlier genus *Brancaesaurus*.

Thus, the length of the centrum of the vertebrae observed is about equal to its height, whereas in the other forms used for comparison the centrum is appreciably shorter than it is high.

Again, the Venezuelan specimen can be characterized by its very round centra. As shown by the measurements and indices, the height and breadth of the centrum as measured on one of its articulating faces are about equal. In some of the other elasmosaurs the breadth of the centrum seems to be appreciably less than the height, but this may be in part a result of crushing, so this character must be used with some degree of caution.

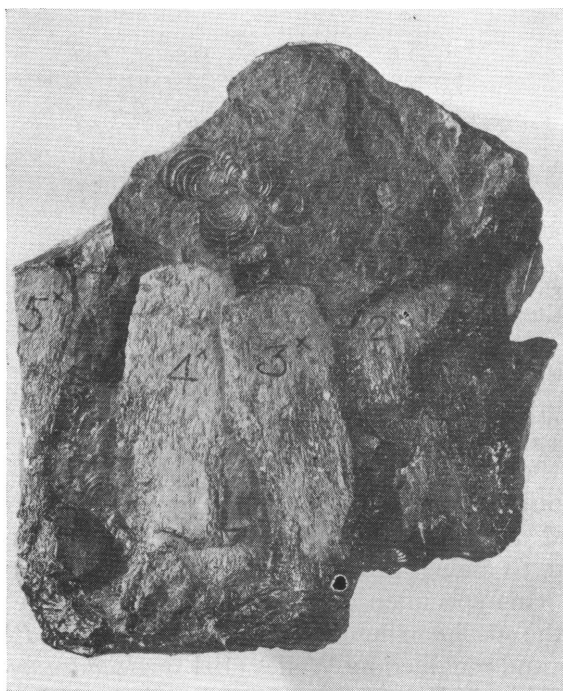


FIG. 6. *Alzadasaurus tropicus*, new species. A.M.N.H. No. 6796, type, spines of dorsal vertebrae. Lateral view, one-fourth natural size. Notice the associated *Inoceramus* shells.

More striking than either of the above-mentioned characters is that of the spines, which in the Venezuelan specimen are relatively quite a lot taller than they are in the other elasmosaurs with which it has been compared. Thus, the spines of the ver-

tebrae observed, namely, the sixth and ninth dorsals, are almost two and a half times taller than the height of the centrum, whereas in *Hydrotherosaurus* and *Brancaesaurus* the figure ranges from one and a half to two times the height of the centrum. These comparisons are illustrated in table 1.

TABLE 1
MEASUREMENTS IN MILLIMETERS AND INDICES OF VERTEBRAE

	<i>Alzadasaurus tropicus</i> A.M.N.H. No. 6796		<i>Hydrotherosaurus alexandrae</i> U.C.M.P. No. 33912 ^a		<i>Brancaesaurus brancai</i> ^b	
	D 6	D 9	D 6	D 9	D 6	D 9
Centrum						
Length	78	76	89	83	36	34
Height	79	80	116	111	45	49
Breadth	89	—	96	—	57	50
Spine						
Height	—	195	—	182	86	79
Centrum						
Length/height	101	95	77	75	80	70
Height/breadth	89	—	121	—	79	98
Spine height/ centrum height	244	—	—	164	191	161

^a U.C.M.P., University of California Museum of Paleontology.

^b From Wegner, 1914.

The scapula is of the elasmosaurid type, with a broad dorsal process and a rather broad ventral plate. The dorsal process, in addition to being broad, is also relatively low. Thus the scapula in this specimen resembles to a very large degree the scapula of the specimen described by Riggs (1939) as *Elasmosaurus serpentinus* and renamed by Welles (1943) *Alzadasaurus riggsi*.

In this specimen there is no median ventral bar on the scapula, such as is characteristic of so many plesiosaurs. Instead, the two scapulae were in life quite widely separated from each other along the median line, a condition found in certain other elasmosaurs, such as the types of *Alzadasaurus riggsi* and *Styxosaurus snowii*.

What interpretation is to be given to the varying form of the scapula in the several supposed genera of Upper Cretaceous elasmosaurs? Are these differing scapulae to be regarded as of valid

taxonomic significance, or are they individual variants? Or do they represent stages in ontogenetic growth?

A series can be arranged, based on the form of the scapula, ranging from those with the simplest scapula, such as *Alzadasaurus*, to those with the most highly developed scapula, such as *Elasmosaurus*, in the strict sense of the term. The series, beginning with *Alzadasaurus*, runs progressively through *Styxosaurus*, *Aphrosaurus*, and *Morenosaurus* to *Elasmosaurus*, and, from one extremity to the other, it can be seen that the scapula becomes progressively a more complex bone. The dorsal process in-

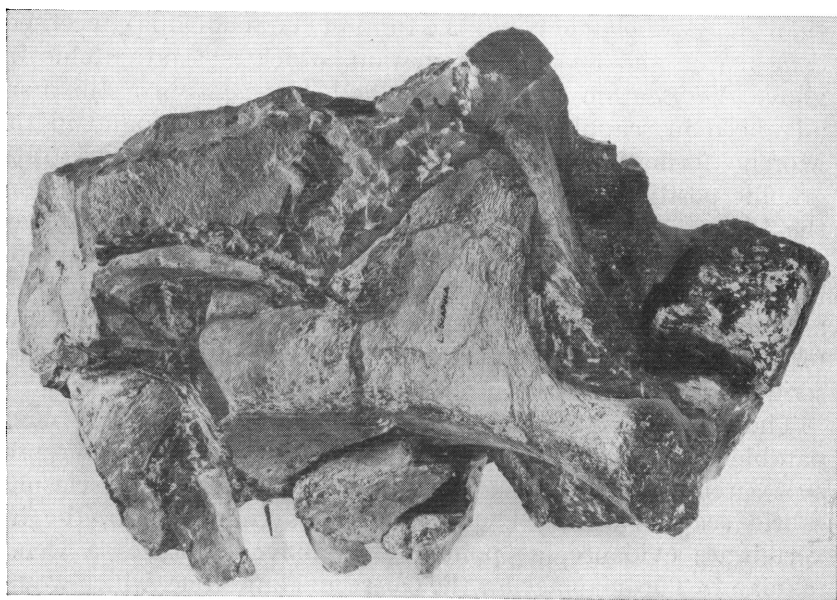


FIG. 7. *Alzadasaurus tropicus*, new species. A.M.N.H. No. 6796, type, left scapula, ribs, and associated bones. Lateral view of scapula, showing dorsal process. One-fourth natural size.

creases in length, and its base becomes narrower. Medially the ventral portion of the scapula becomes more and more expanded so that it approaches the median line and at the same time becomes produced backward to approach the median portion of the coracoid. Finally, the posteriorly projecting process of the scapula and the anteriorly projecting process of the coracoid, closely approaching each other in *Merenosaurus*, join to form the median bar in *Elasmosaurus*.

One might think that this series of progressive changes in the scapula was representative of a growth gradient, that it indicates the progressive expansion and ossification of the scapula from juvenile to full adult. Such a supposition might be valid if these elasmosaurs came from sediments of approximately the same age.

They come, however, from horizons of different ages, and their levels accord pretty well with the stages of their development. Thus *Alzadasaurus*, the least developed or least "progressive" scapula of the series, is found in the Benton formation. Then *Styxosaurus*, somewhat more developed or more "progressive" than *Alzadasaurus* so far as the form of the scapula is concerned, comes from the Niobrara formation, which is stratigraphically above the Benton. *Aphrosaurus* and *Morenosaurus*, still more advanced in scapular form than *Styxosaurus*, are found in the Moreno formation, which is rather definitely higher in stratigraphic position than the Niobrara. *Elasmosaurus* comes from the Pierre shale, an uppermost Cretaceous horizon, as high as, though possibly no higher than, the Moreno. This correlation between the progressive advancement in the form of the scapula as shown in successively higher stratigraphic levels would therefore seem to indicate that we are dealing with a phylogenetic series rather than with an ontogenetic growth gradient.

The scapula of the Venezuelan specimen, most closely comparable to that of *Alzadasaurus riggsi*, would thus seem to represent a relatively primitive stage in the evolution of the elasmosaurid scapula during Upper Cretaceous times. Also, the invertebrate evidence, as pointed out above, indicates a Cenomanian to Turonian age for the Querecual limestone, which would make it as old as, or even older than, the Benton formation of North America. Therefore, the evidence as to the relative position of this new elasmosaur, as deduced from the form of the scapula, accords very well with the stratigraphic evidence of the invertebrate fossils associated with it.

Figure 8 will help to make clear the points that are being stressed in the foregoing discussion, as well as the form of the coracoids, described immediately below.

Unfortunately, the coracoids of this new specimen from Venezuela are not completely preserved, so that our information must be gained from several fragments. Luckily, however, these fragments have enough contacts between them and supplement each

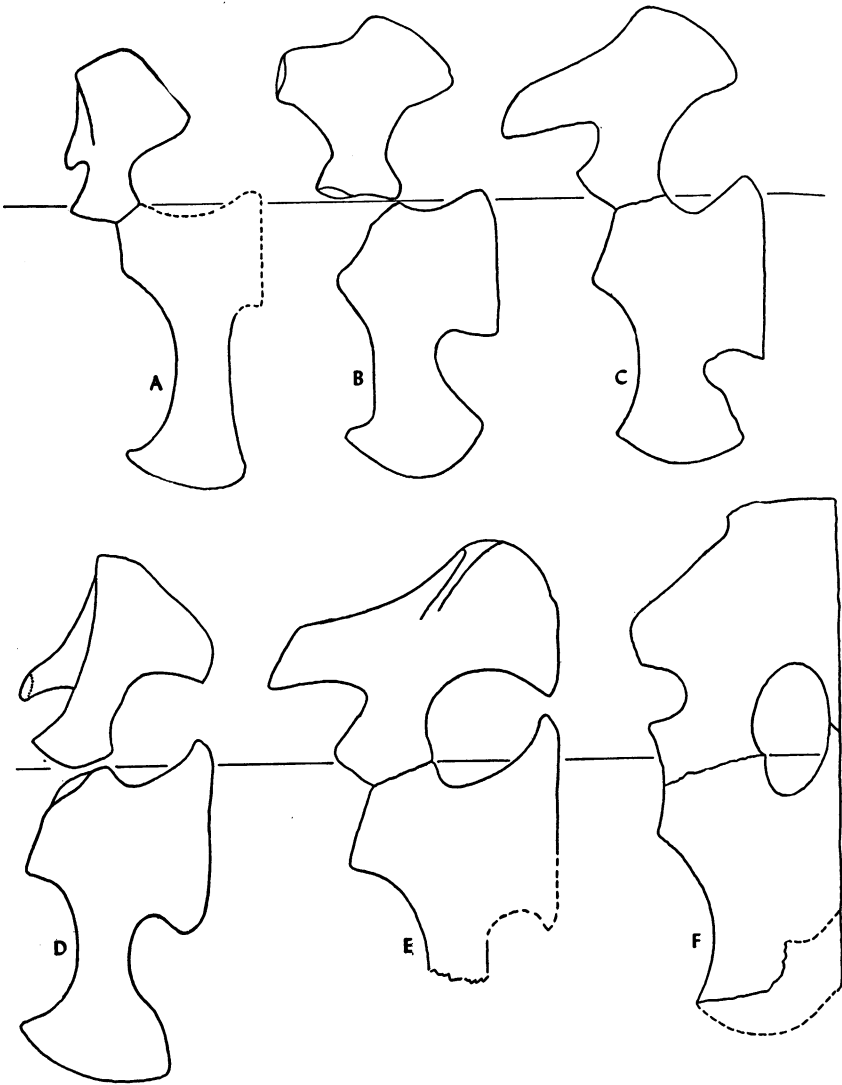


FIG. 8. Comparison of right scapula and coracoid of various elasmosaurs, ventral view. A. *Alzadasaurus tropicus*, new species. B. *Alzadasaurus riggsi*. C. *Styxosaurus snowii*. D. *Aphrosaurus furlongi*. E. *Morenosaurus stocki*. F. *Elasmosaurus platyurus*. All one-twelfth natural size. B, C, D, E, and F from Welles, 1943. These pectoral elements, A to F, form a series, characterized by the ever-increasing enlargement of the median-ventral portion of the scapula and the median-proximal portion of the coracoid, culminating in a median juncture of the two elements, and that shows a stratigraphic sequence as well. A is of Cenomanian or Turonian age, B of Coniacian age, C of Senonian age, and D, E, and F are of Maestrichtian age.

other in such a way that a reasonably accurate idea as to the shape and relationships of the coracoids can be obtained.

Medially and anteriorly the two coracoids are in contact along a heavy symphysis, as is usual in the elasmosaurid plesiosaurs. The dorsal surface of each coracoid is strongly convex from front to back in its anterior portion, this convexity reaching its greatest development opposite the mid-portion of the glenoid. Thus the bone is very thick in this region. Anteriorly the coracoid thins to its anterior edge, while posteriorly it also diminishes in thickness as it is continued back into a long posterior blade. Laterally the coracoid is also considerably thickened in the glenoid region.

The most notable feature of the coracoid in this plesiosaur is its long posterior blade. In this respect it is again most closely comparable to *Alzadasaurus*, but the blade is even longer than it is in the North American genus. As the blade is extended back, its narrowest portion is immediately behind the median symphysis, while more posteriorly it is expanded to form a broad, posterior edge. Yet even though the coracoid is expanded at its posterior margin, it does not join its fellow along the median line. Therefore the two coracoids are separated behind the symphysis by an elongated median vacuity—again a resemblance to *Alzadasaurus*, and to *Styxosaurus*, *Aphrosaurus*, and *Morenosaurus* as well. The Venezuelan specimen differs from the North American genera, however, in relative length and narrowness of the median vacuity.

The humerus of the specimen from Venezuela is unfortunately broken, so that distally it is incomplete. However, the proximal end is well preserved, while enough of its distal portion is present to indicate the length of the bone.

This bone shows the characters typical of the elasmosaurid humerus. It is massive proximally, but distally it is flattened and evidently was very broad in its complete condition. Certainly the anterior edge of the bone is straight, as is common in the plesiosaurs, and the portion of the posterior edge that is preserved would seem to indicate the bone to have been strongly concave along its posterior border.

The proximal thickening of the bone is very great indeed, so much so that the capitulum of the humerus is set off at an angle to the shaft. Dorsal to the capitulum is the large tuberosity, or, as it is sometimes called in the literature, the "trochanter," a prominent process set apart from the capitulum. It is almost as wide as

the head of the bone. Finally, there should be mentioned the well-developed process on the posterior border of the humerus, just below the capitulum and tuberosity, for the insertion of the subscapularis and subcoracoideus muscles.

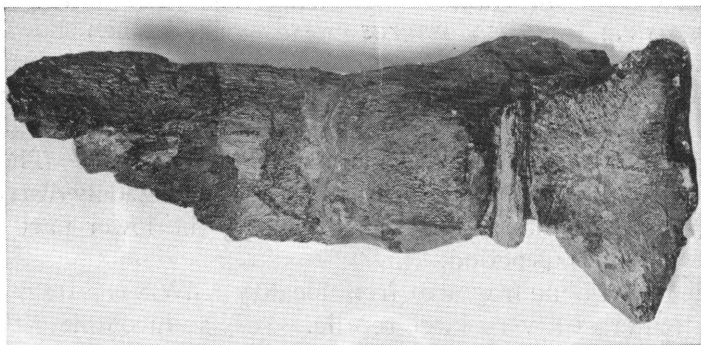


FIG. 9. *Alzadasaurus tropicus*, new species. A.M.N.H. No. 6796, type, portion of left coracoid and left humerus. Dorsal view, one-fourth natural size.

Since the humerus in the specimen under discussion is incomplete, comparisons are difficult. It might be said, however, that the bone appears to be long and comparatively slender, perhaps more slender than the same bone in *Alzadasaurus riggsi*. Comparisons of the humeri in certain plesiosaurs are given in table 2.

TABLE 2
MEASUREMENTS IN MILLIMETERS AND INDICES OF HUMERUS

	<i>Alzada- saurus tropicus</i> A.M.N.H. No. 6796	<i>Alzada- saurus riggsi</i> C.N.H.M. No. 12009 ^a	<i>Hydro- therosaurus alexandrae</i> U.C.M.P. No. 33912	<i>Aphrosaurus furlongi</i> C.I.T. No. 2748 ^b
Proximal breadth	107	153	135	147
Length	285	307	390	394
Index				
Breadth/length	38	50	35	37

^a C.N.H.M., Chicago Natural History Museum.

^b C.I.T., California Institute of Technology.

The distal portions of the left radius and ulna and parts of certain carpal bones from this limb are among the materials collected.

These bones are so fragmentary, however, that no description or comparisons will be attempted at this place.

Summing up the anatomical evidence that has been presented and discussed on the preceding pages, it can be said that *Alzadasaurus tropicus* is an elasmosaurid plesiosaur closely comparable to the North American elasmosaur described by Welles as *Alzadasaurus riggsi*. *Alzadasaurus riggsi*, as Welles has shown, is of Benton age, and *Alzadasaurus tropicus*, which comes from the Querecual limestone, is of approximately Turonian age (on the basis of invertebrate evidence) and is thus about equivalent in stratigraphic position to the North American form. Therefore it would seem that elasmosaurs of this type were widely distributed through the Western Hemisphere during the lower part of the Upper Cretaceous period.

The single bone fragment from locality A-7528 is a fragment of an articular of a very large reptile. It is so incomplete that no attempt has been made to identify it.

THE CRETACEOUS PLESIOSAURS OF SOUTH AMERICA

The importance of the specimen here being discussed is not so much in its intrinsic value as a plesiosaur as in the information it furnishes concerning the distribution and relationships of Cretaceous plesiosaurs in South America. Up to the present time our knowledge of these reptiles in South America has been based upon very fragmentary and isolated evidence, so that any additional information to be derived as to the plesiosaurs of that continental area is of the greatest importance. While the present specimen is far from complete, it does contain a sufficient number of bones in such a state of preservation that some of the crucial information we have needed for a long time can be obtained from it.

At the present time there is a complete plesiosaurian skeleton from Columbia at the University of California. This specimen, however, is not as yet prepared for study, and it will be some time before a published description of it can be made available. In the meantime, therefore, our knowledge of Cretaceous plesiosaurs from South America, in addition to the specimen that forms the subject of the present contribution, is based upon the following described species and materials.

"*Pliosaurus*" *chilensis* Gervais *in* Gay, 1848¹

Plesiosaurus chilensis Gervais *in* Gay, 1848.

Cimoliosaurus chilensis, Lydekker, 1889.

Pliosaurus chilensis, Deecke, 1895.

The species was originally founded upon a single vertebra, discovered at San Vicente, near Concepcion, Chile, and which is now in the British Museum. Subsequently, in his description of plesiosaurians from the Cretaceous sediments of Quiriquina Island in Talcahuano Harbor, also near Concepcion, Chile, Deecke referred a series of bones to this species and placed the species within the genus *Pliosaurus*. The elements comprising Deecke's specimen are: a cervical vertebra, a so-called coracoid, a fragmentary ischium, a complete left hind limb, a humerus, and a portion of a right fore foot.

It might be well to say at this place that the nomenclature and identity of the few Cretaceous plesiosaurs hitherto described from South America are so greatly confused that it is difficult to arrive at any definite opinions as to the zoologic relationships of the several known forms. The case of the species under consideration is particularly difficult, and because of this it is thought advisable to discuss briefly the nomenclatorial problems involved.

As pointed out above, the type of *Plesiosaurus chilensis* was a single caudal vertebra. This vertebra was compared by Lydekker with the type materials of *Cimoliasaurus magnus* Leidy. *Cimoliasaurus* is, as Welles (1942) has shown, an indeterminate genus, a sort of "catch-all" into which have been thrown many differing species, and although the species generally included within the genus

¹ In the literature Gay has been cited as the author of the species *Plesiosaurus chilensis*. This attribution of the species to Gay is based upon the fact that its first description appears on page 133 of the second volume devoted to zoology of "Historia Fisica y Politica de Chile" by Claudio Gay. However, on page 5 of this volume, which incidentally contains descriptions of reptiles, amphibians, and fishes, there is a footnote stating that "Esta clase [reptiles] la ha tratado el Sr. Guichenot, ayudante-naturalista del Museo de Historia natural de Paris, y miembro de la espedicion cientifica de Argelia." One might suppose, therefore, that Guichenot was the author of *Plesiosaurus chilensis*, but this would not seem to be the case. On page 132 of the same volume, immediately preceding the description of the species under consideration, is the following statement, "La que vamos á dar á conocer, segun la descripcion que el Sr. Gervais ha tenido á bien hacer, es la única hallada en el Nuevo Mundo." Evidently Guichenot, who was a student of living reptiles, submitted the fossil to Gervais, and Gervais wrote the description that appears in Gay's book. Consequently Gervais must be regarded as the author of the species.

Cimoliasaurus are of elasmosaurid relationships, the type species of the genus, *Cimoliasaurus magnus*, as Welles points out, may well be a pliosaur. What then are the relationships of the type of *Plesiosaurus chilensis*?

A reëxamination of the literature and particularly the figure of the type vertebra as presented by Deecke in his paper would seem to indicate that this type is actually of pliosaurian relationships. Such was the conclusion of Deecke, and because of this he placed the species now under consideration within the genus *Pliosaurus*. Although this type is obviously a pliosaur, its assignment to the genus *Pliosaurus* must be questioned. According to Welles, in a letter to the author: "*Pliosaurus* is a Kimmeridge genus and we don't know that it extends to the Senonian of Quiriquina. However, we have insufficient evidence to erect a new genus, so we must use *Pliosaurus* here advisedly."

Are the materials subsequently described by Deecke as of this same species actually cospecific with the type? Of course comparisons are exceedingly difficult with a type consisting of a single vertebra, and any conclusions drawn from such comparisons must be regarded as very tentative, to say the least. However, it can be said that the vertebra figured by Deecke as figure 3 of plate 1 of his paper is a pliosaur vertebra. Unfortunately no direct comparison is possible, since this is a cervical vertebra, while the type is a caudal. Yet it seems reasonable to assume that since these vertebrae, both of pliosaurian relationships, came from about the same horizon and from about the same locality, they very probably are representative of the same species.

As for Deecke's other materials of "*Pliosaurus*" *chilensis*, it must be said that they appear to be for the most part of elasmosaurid rather than of pliosaurid relationships. His so-called coracoid (pl. 1, fig. 1) certainly looks as if it might be the pubis of an elasmosaur. According to Welles, again in a letter to the present author, "plate 2, figure 1 [designated as *Pliosaurus chilensis* by Deecke], is probably the front paddle of an elasmosaur. It is certainly juvenile and is therefore indeterminate." The other limb elements assigned by Deecke to *Pliosaurus chilensis* are regarded by Welles as juvenile and indeterminate.

Such is the status of "*Pliosaurus*" *chilensis* at the present time. On the basis of the type it is definitely a pliosaur, but its generic determination is at best uncertain. As to the additional supposed pliosaur materials subsequently described from the general

region in which the type was discovered, some of the fossils assigned to this category are certainly of elasmosaurid relationships.

PLESIOSAURIAN PROPODIUM, WOODWARD, 1891

A humerus or femur found on the coast near Bahia, Brazil. The specimen was collected in shales of Cretaceous age.

"Cimoliasaurus" andium Deecke, 1895

Cimoliasaurus andium DEECKE, 1895.

The materials upon which Deecke based this species came from the Quiriquina beds of Upper Cretaceous age, and they were found on Quiriquina Island, where he collected his supplementary materials of "*Pliosaurus*" *chilensis*. Included in the type of this species are an atlas and an axis vertebra, a series of cervical vertebrae, a sacral or anterior caudal vertebra, four caudal vertebrae, and finally a humerus. The vertebrae and the humerus indicate this to be an elasmosaurid plesiosaur, but beyond this its relationships cannot be definitely determined.

Subsequently some additional materials of plesiosaurs were collected from Quiriquina Island, and these were described by Broili in 1930. He designated these new fossils as "*Cimoliasaurus*" *andium*, placing the generic name in quotation marks to indicate its unsatisfactory status. This same procedure is being followed in the present paper, because, as pointed out above, *Cimoliasaurus* is an indeterminate genus. It is to be hoped that in the future it will be possible to assign an accurate generic designation to this species.

The known Cretaceous plesiosaurs from South America can be listed as follows:

"*Pliosaurus*" *chilensis*, Quiriquina beds, Upper Cretaceous, Senonian, Concepcion, Chile

"*Cimoliasaurus*" *andium*, Quiriquina beds, Upper Cretaceous, Senonian, Concepcion, Chile

Plesiosaur propodium, Cretaceous shales, Bahia, Brazil

Alzadasaurus tropicus, Querecual limestone, Upper Cretaceous, Cenomanian or Turonian, Altagracia de Orituco, Venezuela

From this list, small though it may be, one can see that plesiosaurs were widely distributed around the borders of South America during Upper Cretaceous times. While nothing very definite can be said with regard to the specimens found in Chile and Brazil,

it is certainly clear that the plesiosaur found in Venezuela shows close relationships to the Upper Cretaceous plesiosaurs of North America, as pointed out above, and especially to *Alzadasaurus riggsi*.

This emphasizes the broad distribution of the plesiosaurs during middle and upper Mesozoic times, a fact that should occasion no great surprise. These pelagic marine animals must have been able, even as individuals, to traverse great areas of oceanic waters. They were probably very much like the modern marine turtles, such as *Chelonia*, which are encountered very widely along the sea coasts of the various continental regions, and of which individuals frequently travel long distances across the oceans. For instance, individuals of *Chelonia* are found as far north as Massachusetts or off the coast of England, yet it is known that these turtles do not breed north of Florida. It is probable that the distribution of the modern sea turtles is limited by temperature conditions as much as anything, these being essentially tropical reptiles. Hence it follows that in Cretaceous times, when there probably were not the marked differences in temperature on land or in the oceanic waters that hold today, there were vast expanses of ocean through which the plesiosaurs could swim almost at will.

For this reason, it is logical to suppose that at any particular time in geologic history a single plesiosaurian species might be distributed over great reaches of the earth's surface. Consequently *Alzadasaurus*, first described from North America, can be expected in Venezuela and in other equally distant regions as well. In the present instance the specimen from Venezuela has been placed in a species distinct from the North American form with the full realization that the two may actually have been members of a single species.

This brings up the question of the genera of plesiosaurs, especially those from the Upper Cretaceous of North America. It would seem to the present writer that there are at the present time too many described genera from the Upper Cretaceous of North America and that the differences between them probably have been based upon characters of minor significance. Perhaps, as more material is collected and studied, a resolution of the present plethora of names will be forthcoming. Surely upon the basis of an analogy with modern marine tetrapods and especially with the marine turtles, it would seem reasonable to assume that

single genera and species of plesiosaurs were very widely distributed during the Jurassic and Cretaceous periods. *Alzadasaurus*, found in localities several thousand miles apart in North and South America, affords an illustration of this assumption.

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