

XII. TERTIARY FISH-REMAINS FROM SPANISH GUINEA IN WEST AFRICA.

BY C. R. EASTMAN.

Plates XXIII-XXIV.

In May, 1911, a shipment of natural history specimens was received by the Carnegie Museum which had been collected by Rev. A. I. Good, a missionary stationed at Benito, in Spanish Guinea, and by him forwarded to Director W. J. Holland in the fall of 1910.

The collections made by Mr. Good for the Carnegie Museum are chiefly entomological, but, included among the lot of insects and other objects illustrating the natural history of the region, were found a number of slabs of dark-colored fissile shale, containing an abundance of carbonaceous matter, with here and there a few small-sized concretions, valves of Entomostraca, and portions of Teleost fish-skeletons, these last being comparatively numerous.

The amount of carbonaceous matter present in the rock is so great that the shales might properly be called bituminous, and appearances indicate very strongly that they are of lacustrine, or perhaps estuarine origin, certainly not marine, and were deposited in a rather shallow basin. No means are at hand for determining the geological age of the strata except the evidence furnished by the remains of the fishes embedded within the shale, and they betoken an early Tertiary horizon, probably at least as early as the dawn of the Eocene. The geology of the region about Benito has not been studied or described, so far as the writer is aware, but it is a well-known fact that isolated patches of Tertiary rock occur frequently along the eastern and western coasts of Africa, and their distribution is indicated in a general way by Walcot Gibson in a sketch-map of the geology of the continent to be found in the first volume of the new *Encyclopedia Britannica*.¹

¹ The marine strata of the early Tertiary of South Togo, in West Africa, have furnished a number of vertebrate remains which are described by Dr. Ernst Stromer, of Munich (*Zeitschr. deutsch. geol. Ges.*, Vol. LXII, 1910, pp. 478-508). More recently the same writer has contributed a note entitled "Funde fossiler Fische in dem tropischen Westafrika" (*Centralbl. f. Min., etc.*, Jahrg. 1912, no. 3, pp. 87, 88), which mentions the discovery of fragmentary Teleost and Silurid fish-remains from near the mouth of the River Benito in Spanish Guinea, without, however, offering detailed descriptions of them.

Although dissociated parts of fish skeletons are present in considerable abundance in the fragmentary blocks of shale which make up the collection, and the appearance of these detached parts suggests that the remains have been subjected to a moderate amount of current action prior to fossilization, yet the number of species represented does not exceed three or four, and even the best preserved individuals are far from being complete. Nevertheless, the Clupeoid nature of most of the remains is easily recognizable, and in the case of the largest and best preserved species it is possible to work out nearly the entire structural organization by combining the data derived from a study of several individuals whose parts fortunately supplement one another.

Scanty as these newly discovered remains are, their bearing upon broad philosophical problems, such as the origin of modern fresh-water faunas on either side of the Atlantic, conditions affecting distribution in times past, and the theory of a former land connection between tropical America and Africa, is of prime importance. This must necessarily be so by virtue of their being the first indication yet reported of a post-Triassic fish-fauna in tropical or South Africa. We cannot forbear to note that only a few years ago, in 1905, our want of knowledge on such matters drew from Dr. Boulenger the following remarks: "It remains a matter for serious regret that we should still be without any information as to the precursors of the African fishes. In spite of diligent search over a considerable portion of the great continent, no remains of any post-Triassic fishes have yet been discovered in Tropical and South Africa, and our acquaintance with Tertiary Teleosts generally is still almost as scanty and fragmentary as it was twenty years ago, although much has been done by Dr. Smith Woodward in elucidating the affinities of such remains as have been exhumed. Under the circumstances we have to fall back on our imagination to explain the fauna, and much hazardous speculation has been indulged in."²

The species of fossil Teleosts in Mr. Good's collection which lends itself most readily to examination is evidently new to science, and belongs to the genus *Diplomystus*. It is described in the following pages under the appellation of *D. goodi*, the writer having pleasure in naming it at the suggestion of Dr. W. J. Holland in honor of the

² Boulenger, G. A., The Distribution of African Fresh-water Fishes. Presidential Address, Rept. Brit. Assoc. Adv. Sci., South African Meeting, 1905.

discoverer. A smaller form represented by several badly crushed and distorted individuals resembles more or less closely some of the remains which Dr. D. S. Jordan has recently described from the bituminous (Tertiary?) shales at Riacho Doce, State of Alagôas, Brazil, under the generic title of *Ellipes*. The latter is doubtfully distinct from *Diplomystus*, but may perhaps be retained provisionally as a subgenus of the latter. A single specimen in the collection is doubtfully identifiable as belonging to *Enchodus*.

Regarding the Brazilian fish-remains described by Dr. Jordan, their discoverer, Professor J. C. Branner, offers the following comments in his paper on the Geology of Alagôas, which accompanies that of Dr. Jordan in volume VII of the ANNALS of this Museum.

"Dr. Jordan feels some doubt in regard to the exact age of the beds, and he ventures only to say that 'the shales of the Riacho Doce were deposited in an estuary and that their age is Cretaceous or Lower Eocene, possibly Upper Cretaceous.'

"These fishes form the most important collection of fossils thus far made in the state of Alagôas, and they also make an interesting and valuable contribution to our knowledge of the coast sediments of eastern Brazil" (*loc. cit.*, p. 18).

Now it is an interesting and significant fact that species of the same genus, or at least of very closely related genera, should occur respectively in fresh-water deposits of the eastern coast of South America and western coast of Africa, the presumption being that the strata are approximately contemporaneous,—that is to say, early Tertiary. This coincidence points to a similarity of the fresh-water fish-faunas of the two continents extending as far back as the dawn of Tertiary time, and also suggests a correspondence of geological history between the land-masses on either side of the Atlantic.

An hypothesis which has recently found strong adherents among ichthyologists is that put forward by von Ihering and others, which postulates a late Cretaceous or early Tertiary land-bridge between tropical Africa and South America, possibly in contact with Guiana in the latter continent. This conjectural land-mass, "Helenis," may be supposed to have been populated by the ancestors of modern fresh-water fishes of tropical America, among others by the Lepidosirenidæ, Characinidæ, Cichlidæ, and Siluridæ. A submergence of the area called Helenis took place during Tertiary times, which brought about important changes in the ichthyic fauna, such for instance as

are described by Dr. Eigenmann as follows: " This land-mass sank beneath the surface of the ocean, forcing the fauna in two directions, towards Africa and towards South America, exterminating all types not moved to the east or the west. From these two rudiments have developed the present diverse faunæ of Africa and South America, each reinforced by intrusives from the ocean and neighboring land areas by autochthonous development within its own border. The one fauna cannot be said to have been derived directly from the other. The connection between Africa and South America existed before the origin of the present genera and even before the origin of some of the present subfamilies and families, some time before the earlier Tertiary. There has never been any exchange between Africa and South America since that time."³

Elsewhere in the same article the author whom we have just quoted remarks: " There has been a remarkable parallelism in the evolution of genera of cichlids, characins, and catfishes on the two continents. . . . The Cichlidæ are abundant in tropical America and Africa, a few species of Cichlidæ being also found in India. There is no means by which these two forms could have crossed the existing gap between Africa and South America. There has been no exchange of species in recent times, for there is no species or genus common to the two continents. The South American and African elements of these two families must have been derived from some intermediate land-mass or must have gone from one continent to the other over a land-bridge."

It may not be amiss to consider here somewhat briefly the present and former distribution of the genus *Diplomystus*, which is a typical example of the double-armed herrings. *Diplomystus dentatus*, the type species, was described by E. D. Cope in 1877 from the Middle Eocene (Green River) fresh-water deposits, and at the same time two previously described Clupeoids which accompany it in the same horizon and locality were transferred to the new genus. These were the so-called *Clupea humilis* and *C. altus* of Leidy. Cope recognized that the species comprised by *Diplomystus* might be divided into two sections, distinguished by the form of their dorsal ridge-scales. " In section I," he observes, " these shields are transverse and their posterior borders are pectinate, a median tooth being especially prominent. In section II, the scuta are not wider than long, and

³ Eigenmann, C. H., The Fresh-water Fishes of South and Middle America *Pop. Sci. Monthly*, Vol. LXVIII, No. 6, 1906, p. 528.

have but one, a median tooth, which is the extremity of a long median longitudinal carina. The species of section I are *D. dentatus*, *D. analis* and *D. pectorosus*; those of section II are *D. humilis* and *D. altus*.⁴

It remained for President Jordan, thirty years later, to give validity to the distinction just noticed by elevating Cope's "section II" of the genus *Diplomystus* to the rank of an independent genus (or subgenus, as suggested in the ANNALS OF THE CARNEGIE MUSEUM, Vol. VII, 1910). This was named *Knightia*,⁵ the species chosen for its type being the previously described *Clupea humilis* of Leidy, afterward renamed *C. pusilla* by Cope. Dr. Jordan substituted the new specific title *eocena* for that bestowed upon the species by the original author, the combinations of *Clupea humilis* and *Clupea pusilla* being preoccupied among recent fishes. In this connection it should be remarked that the name *Diplomyste* Bleeker (= *Diplomystax* Günther, and *Diplomystes* Duméril) refers to an existing genus of South American Silurids, and is not to be confused with the term proposed by Cope. *Copeichthys* of Dollo (Results Voyage Belgica, 1904, p. 159) is a synonym of *Diplomystus*, the former name having been substituted under an erroneous idea that Cope's term was preoccupied.

Other occurrences of *Diplomystus* in the fossil state are in the Upper Cretaceous of the Lebanon, Istria, Dalmatia, and Brazil; in the Lower Oligocene (Osborne beds) of the Isle of Wight; and in the supposed late Cretaceous or early Tertiary fresh-water shales at Riacho Doce, Brazil (two species described by Jordan as *Ellipes branneri* and *E. riacensis*).⁶

Besides the above mentioned fossil forms, a recent Diplomystid which has been described under the name of *Clupea* (*Hyperlophus*)

⁴ Cope, E. D., A Contribution to Our Knowledge of the Ichthyological Fauna of the Green River Shales, *Bull. U. S. Geol. Survey Territ.*, Vol. III, 1877, p. 808.

⁵ Univ. Cal. Publ., V, No. 7, p. 136, 1907.

⁶ Regarding *Ellipes* Dr. Jordan remarks in the paper above cited: "In any event I think that we are justified in recognizing *Ellipes*, *Potamalosa*, *Hyperlophus* and *Knightia* as distinct subgenera, even if we should wish to place all double-armored herrings in the single genus, *Diplomystus*" (*l. c.*, p. 25).

In Dr. Jordan's scheme Cope's species *D. longicostatus*, from the Upper Cretaceous of Bahia, Brazil, finds a place under the new generic or subgeneric caption of *Ellipes*. It is doubtful, however, if the proposed separation can be maintained in actual practice, as the majority of specimens fail to disclose the characters relied upon for distinctive criteria.

*spratellides*⁷ occurs in the river system of New South Wales, and is said also to inhabit certain rivers along the western coast of South America, especially in Chili. The distinctive character of the so-called "*Hyperlophus*," as contrasted with *Clupea*, consists in the presence of a series of enlarged dorsal scutes extending between the occiput and origin of the dorsal fin. In other words, it is a double-armored herring, and differs from the single-armored in precisely the same manner as does *Diplomystus*, and from the last-named genus it has not been possible to prove any separation at all. Smith Woodward⁸ is, therefore, apparently justified in claiming *Hyperlophus* to be a synonym of *Diplomystus*, although Dr. Jordan,⁹ without arguing the question, has expressed a contrary opinion, saying: "Dr. Woodward regards *Hyperlophus* as a synonym of *Diplomystus*, which is quite unlikely. One may be too hasty in regarding living forms as identical with extinct genera, as well as too hasty in separating them."

So much, then, for the general facts of distribution. It is now in order to present a description of the new species of *Diplomystus* from a supposed early Tertiary horizon at Benito, on the western coast of tropical Africa.

***Diplomystus goodi*, sp. nov.**

A deep-bodied species of moderate size, attaining a total length of about 15 cm., and resembling *D. longicostatus* (from South America) in that the caudal region is comparatively short and tapering. Dorsal region much elevated, the margin rising to the origin of the dorsal fin, behind which it abruptly descends; frontal profile steep. Maximum depth of the trunk equaling twice the length of the head with opercular apparatus. Abdominal vertebræ about sixteen in number, caudals not more than twelve or thirteen.

Pectoral fins small, and the much smaller pelvic pair opposed to the middle of the dorsal; the latter fin with about fifteen rays, and situated as in *D. longicostatus*; anal fin with about ten rays, arising considerably behind the posterior end of the dorsal. Ventral ridge-scales comparatively small in advance of the pelvic fins, but much larger beyond

⁷ Ogilby, J. Douglas, In Records of the Australian Museum, Vol. II, 1892, p. 24.

⁸ Woodward, A. S., Doubly-armoured Herrings. *Ann. Mag. Nat. Hist.* (6), Vol. X, p. 412.

⁹ Jordan, D. S., Description of a Collection of Fossil Fishes from the Bituminous Shales at Riacho Doce, State of Alagôas, Brazil. *ANNALS CAR. MUS.*, Vol. VII, No. 1, 1910, p. 25.

the pelvic fins, all smooth, and with only one spiniform projection, without serrations. Neural spines in advance of the dorsal fin with broad antero-lateral expansions, as in the type species. Scales of the flank thin, in most cases poorly preserved.

This species is represented in the collection by a number of more or less incomplete individuals, the better preserved of which are shown slightly reduced in size in Plates XXIII and XXIV, fig. 2. A composite drawing or restoration has not been attempted, but it is evident that an understanding of all the characters can only be gained by a synthesis of details exhibited by a number of fragmentary specimens. One must also be careful not to be misled by deceptive appearances, due to accident, or conditions of preservation. For instance, owing to weathering, or the effects of chemical action, the number of ribs and fin-rays sometimes appears to be larger than is natural, they having been split up. This condition is faithfully represented in respect to the dorsal fin-rays and anterior neural spines of the specimen shown in Plate XXIII, fig. 1. A similar splitting of the ribs, hæmal spines, and fin-supports is often observable in fishes from the Green River shales and elsewhere.

Diplomystus sp. ind.

A second Clupeoid species, probably of *Diplomystus*, but much smaller than that already described and of inferior preservation, is indicated by a number of crushed and otherwise distorted individuals, the total length of which does not exceed five or six centimeters. Very likely they are the fry of some larger form at present unknown, but differing from *D. goodi* in the lesser depth of the abdominal region. Their present condition does not, however, permit anything like an adequate description.

The manner in which the outline of the body is deformed in these fishes, a process which has sometimes been called "telescoping," suggests a slow current in the waters while sedimentation was in progress. Similar appearances are common in various Mesozoic and other horizons, especially in the Triassic sandstones of eastern North America, where the rock-making materials are supposed to have been laid down in shallow estuaries or brackish-water embayments partially cut off from the sea. It has not been thought worth while to illustrate these much dilapidated fish-remains.

Enchodus (?) sp.

A small-sized species which may be provisionally referred to this genus, but the precise relations of which cannot be determined with certainty, is indicated by the greater part of the caudal region and tail of a single individual, as shown in Plate XXIV, fig. 1. The form of body, as far as can be inferred from the portion preserved, is very similar to that of *E. longidens* (Pictet), from the Upper Cretaceous of Mount Lebanon, and it agrees also in size with the latter. The caudal fin in the African form is longer and more deeply furcate than in the Syrian species, and the dorsal fin is more remotely situated.

In the solitary specimen under examination more than a score of vertebræ are seen to be preserved in natural sequence, but it is impossible to tell whether these constitute the entire number of caudals, for the reason that the anal fin is not shown in its entirety. Of the dorsal only about ten of the widely spaced fin-supports, and the distal extremities of a few finely articulated fin-rays are to be seen. A few intermuscular bones are preserved above and below the axis, and the structure of the vertebral centra together with their spinous processes, and the relations of these latter to the median fin supports (interneurals and interhæmals) are in harmony with our determination of this species as belonging to the genus *Enchodus*, or to some closely related form. The remote position of the dorsal, its comparatively feeble fin-supports, and short caudal peduncle prevent an assignment of this species to the genus *Diplomystus*. The fact that *Enchodus* is an Upper Cretaceous genus must be granted some weight in ascribing the age of the fish-bearing beds at Benito to the early Tertiary.

We may conclude this paper with a few general remarks concerning *Diplomystus*, and other related doubly-armored herrings. True Clupeoids first appear at the beginning of the Cretaceous, and are probably descended from typical Jurassic Leptolepids, as indicated by their closely similar skeletal structure. The acquisition of enlarged ridge-scutes along the ventral margin, a character peculiar to *Clupea* and its allies, dates from the Lower Cretaceous, and toward the close of that period forms had become introduced and attained a wide distribution which possessed dorsal ridge-scutes as well as the ventral series. These are marine species, from Asia Minor, southern Europe, and Brazil, belonging to the genus *Diplomystus*. In North America a number of fresh-water species are found as early as the Middle Eocene.

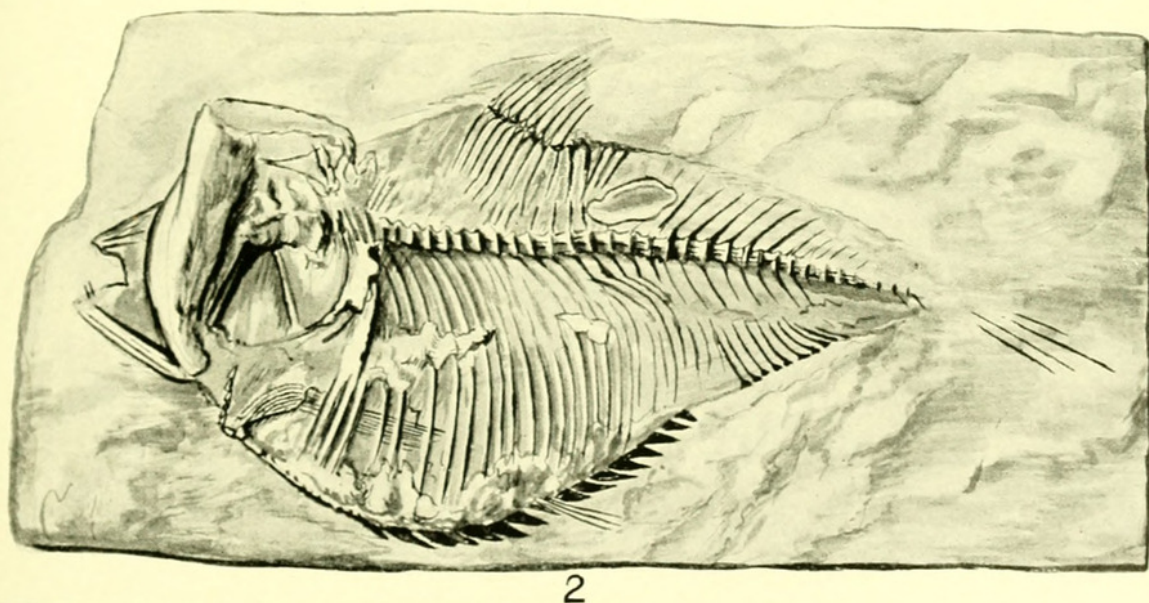
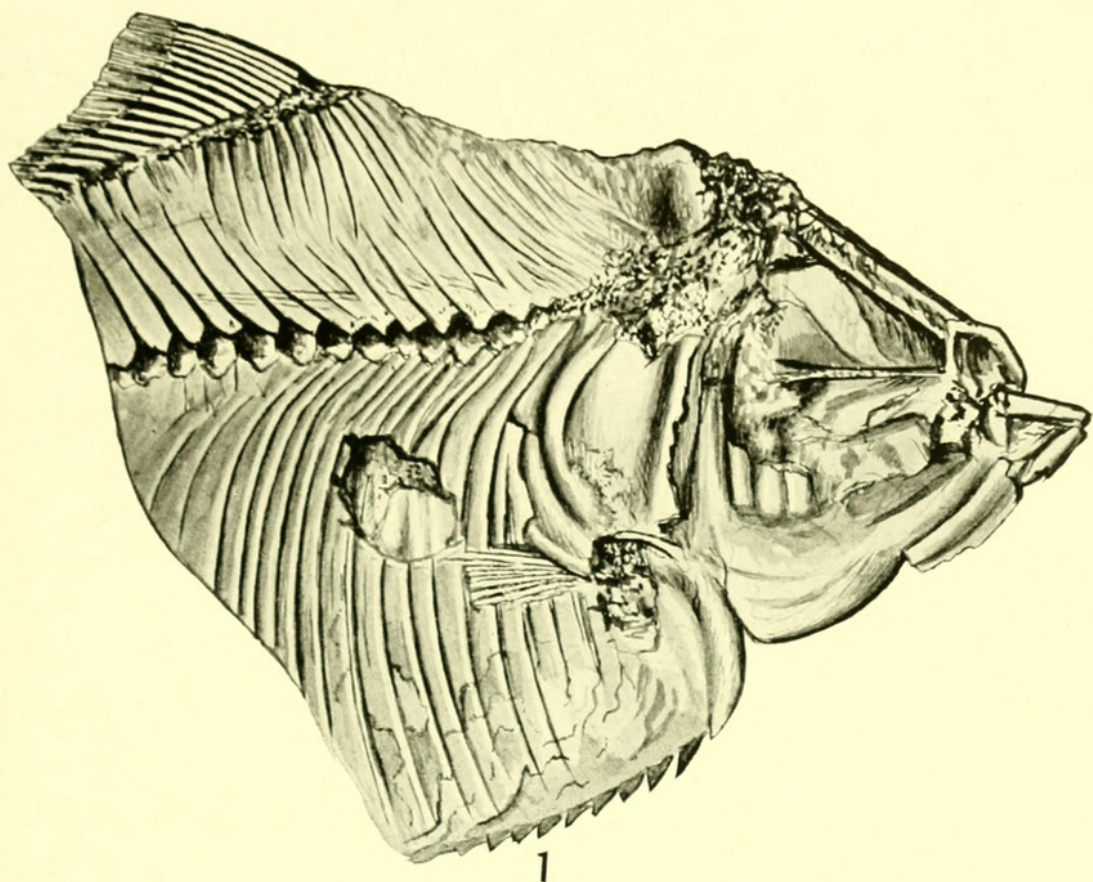
In South America and Africa related forms are known from supposed early Tertiary fresh-water strata, and at the present day the genus *Diplomystus* itself survives in the rivers of Chili and New South Wales.

The type-species *D. dentatus* Cope, and the scarcely separable *D. analis* and *D. pectorosus*, have the dorsal ridge-scutes broader than long, and finely denticulated at their posterior border. In species having a slenderer and more elongate form of body, like the so-called *D. humilis* and *D. aitus* of Leidy, the dorsal scutes are narrow and simple, with one pointed projection. This distinction is considered by Jordan to be of generic, or at least subgeneric importance, and the two last-named species are transferred from *Diplomystus* proper to the closely related genus or subgenus *Knightia* of Jordan. The type species of "Knightia" is *K. eocæna* Jordan, = *Diplomystus pusillus* Cope, = *Clupea humilis* Leidy.

A second closely related genus or subgenus, named *Ellipes*, has recently been established by Jordan upon the evidence of Brazilian Clupeoids from late Cretaceous and supposed early Tertiary horizons. The type species is named *E. branneri*, a small fish presenting much the same configuration as the type of *Diplomystus*; and accompanying it in the same horizon is the so-called *E. riacensis*, which is slenderer and more elongate, and hence approaches *D. eocæna* (= "Knightia") in general aspect. In the opinion of Dr. Jordan, *D. longicostatus* Cope, from the Upper Cretaceous of Brazil, should also be classed under *Ellipes*, but from this view the present writer dissents. When one has to deal with material that in the main is of fragmentary nature, and when much inconstancy is to be observed among the characters recognized as having specific value, it seems advisable to hold to a broad conception of genera and families, and to avoid drawing distinctions of such narrow margin as to obscure natural relationships

EXPLANATION OF PLATES.

- Pl. XXIII, Fig. 1. *Diplomystus goodi*, sp. nov. $\times 1/1$.
Pl. XXIII, Fig. 2. *Diplomystus goodi*, sp. nov. $\times 5/4$.
Pl. XXIV, Fig. 1. *Enchodus*, sp. ind. $\times 4/5$.
Pl. XXIV, Fig. 2. *Diplomystus goodi*, sp. nov. $\times 1/1$.



Diplomystus goodi Eastman, sp. nov.

Fig. 1 (type) $\times \frac{1}{4}$. C. M. Cat. Foss. Vert., No. 5250.

Fig. 2 (cotype) $\times \frac{3}{4}$. C. M. Cat. Foss. Vert., No. 5253.

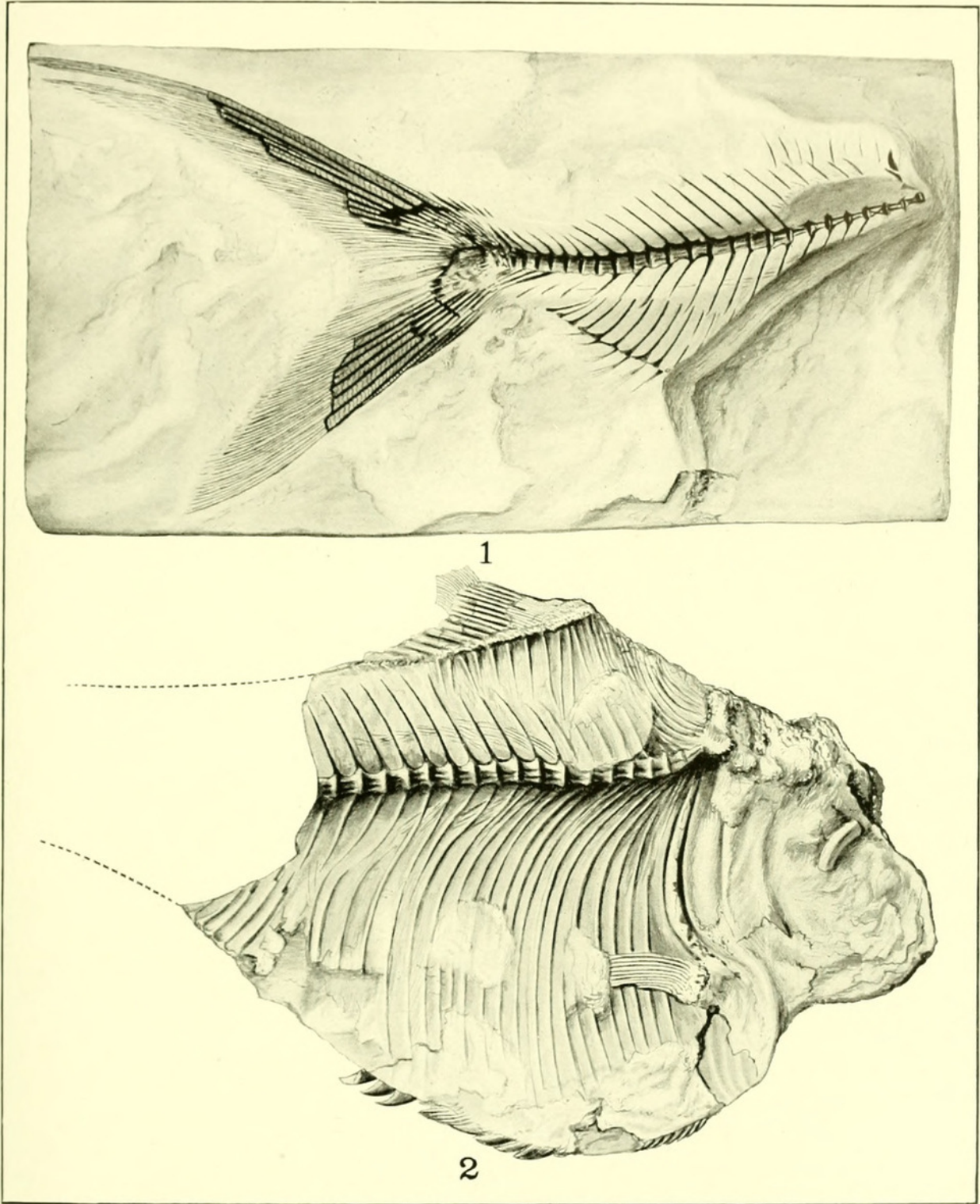


Fig. 1. *Enchodus* sp. ind. $\times \frac{4}{5}$. C. M. Cat. Foss. Vert., No. 5254.

Fig. 2. *Diplomystus goodi*, sp. nov. $\times \frac{1}{1}$. C. M. Cat. Foss. Vert., No. 5251.



Eastman, Charles Rochester. 1912. "Tertiary fish-remains from Spanish Guinea in West Africa." *Annals of the Carnegie Museum* 8(2), 370–378.
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