

Article X.—ON A COLLECTION OF UPPER CRETACEOUS FISHES FROM MOUNT LEBANON, SYRIA, WITH DESCRIPTIONS OF FOUR NEW GENERA AND NINETEEN NEW SPECIES.¹

PLATES XXIV-XXXVII.

BY O. P. HAY.

In accordance with an arrangement entered into between Professor H. F. Osborn, Curator of the Department of Vertebrate Palæontology, and Professor R. P. Whitfield, Curator of the Department of Geology, the writer has studied the collection of fishes which was made in 1901 by Professor Alfred Ely Day in the Cretaceous deposits of Mount Lebanon, Syria. This collection consists of several hundred specimens of fishes, besides a considerable number of crustaceans and a few mollusks. The result of the examination of the fishes has been the discovery of a considerable number of undescribed species and various additions to our knowledge of the structure of species already described. A large part of the collection and nearly all of the new species come from a village called Hajula. This may be regarded as really a new locality, since I have been able to find it mentioned only once in Dr. A. S. Woodward's Catalogue of the Fossil Fishes in the British Museum. From a letter written by Professor Day to Professor Whitfield we learn that Hajula and Hakel are each about twelve miles nearly northeast of the seacoast town of Jebeil, the ancient Biblus. Hajula is situated six miles south of Hakel; and between the two villages there are two westwardly projecting spurs of Mount Lebanon and an intervening valley. Professor Day estimates the elevation of these villages to be

¹ The collection of fossil fishes, of which the new forms hereinafter described form a part, was made by members of the staff of instructors of the Syrian Protestant College at Beirut, Syria, during the year 1901, and donated to the American Museum of Natural History by the Rev. D. Stuart Dodge. They now form a part of the Museum's exhibit in the Geological Hall as part of its chronological series, under the head of the Cretaceous formation, in the foreign series of fossil forms.

As Dr. O. P. Hay has recently been engaged in preparing a catalogue of the fossil fishes of the Museum collection and is familiar with the forms found at the Syrian localities, it has been considered advisable to place this collection in his hands for identification. While doing this he has found several interesting species not hitherto known to science. These are described and illustrated in the following pages as a contribution to the work of this department.—R. P. WHITFIELD, *Curator of the Department.*

between 2500 and 3000 feet. In both places there are clear evidences of faulting by which the fish-bearing strata have been let down into the midst of older strata. Those at Hakel have been let down to the level of the hippurite limestone of Lebanon, being above the *Trigonia* sandstone. Professor Day thinks that the Hajula beds are an extension of those at Hakel. This study of the fishes appears to show that the horizon of the beds at Hajula is some what higher than that of the beds at Hakel. Professor Day says that one notable difference is found in the great abundance of crustaceans at Hajula.

According to Professor Day, the fish-bearing strata at Hakel are exposed over a space of half an acre or more on the side of a valley, which slopes about 30° to the northeast, the dip of the strata corresponding nearly with the slope. The outcrop at Hajula is similar, but more broken up and irregular. At both localities the slabs of rock which lie on the surface are more easily and perfectly split than are those which are dug up from some depth.

Professor Day was not permitted to work at Sahel Alma.

Much credit is due to the Rev. D. Stuart Dodge, at whose suggestion and expense this collection was made, and to Professor Day, who has displayed great industry and good judgment in gathering the materials.

At the close of this paper the writer will add a few words on the age of the strata.

In the following pages most of the specimens are recorded under two numbers, of which the second is enclosed within parentheses. The first number is the one given to the specimen in the Department of Geology, while the number in parentheses is the one which it bears in the general catalogue of fishes. This catalogue belongs to the Department of Vertebrate Palæontology.

Figure 2, Plate xxvi; figures 3 and 4, Plate xxxvi; and figures 4-6, Plate xxxvii, have been reproduced from photographs made by Mr. A. E. Anderson. Figures 3 and 4, Plate xxvi, are from drawings made by Mrs. L. M. Sterling. All the other figures are from photographs made by Mr. Rudolph Weber.

Class ELASMOBRANCHII.

LAMNIDÆ.

Otodus sulcatus Geinitz.

PLATE XXVI, FIGURES 3 AND 4.

Otodus sulcatus GEINITZ (H. B.), Char. Schicht. u. Petrefakt. sächs.-böhm. Kreidegeb., Nachtr., 1843, p. 5, pl. iv, fig. 2.

Lamna sulcata WOODWARD (A. S.), Cat. Foss. Fishes, 1, 1889, p. 398. (Synonymy and literature.)

In the collection there is a single tooth of a shark, and this I refer to the above species. The number of the tooth is 4508 (3867).

The height of the crown has been about 15 mm., but the apex is broken off. The crown has resembled that of a specimen figured by Geinitz in 1875 (Palæontogr., XX, pt. 1, pl. lxxv, fig. 4d). At the base of the crown, in front, the width is 6.25 mm. At the base, the anterior face is somewhat concave, but it soon becomes slightly convex. There are a few short grooves at the base of the crown in front. The cutting edges are very sharp. The posterior face is very convex, and there are present numerous sharp costæ of various lengths. The lateral denticles are relatively large, close to 5 mm. high, and are costate both in front and behind, although the anterior costæ are feeble.

The root is relatively large, and its branches make a very acute angle with each other. The outer borders descend from the lateral denticles so as to be nearly parallel with each other. In this respect the root resembles that of Sauvage's *Odontaspis rochebrunei* (Bull. Soc. géol. France [3], VIII, p. 437, pl. xiii, fig. 3). The tooth from Hakel differs from the one just referred to in having a less slender crown and more prominent lateral denticles. The length of one branch of the root is 10 mm.; of the other, 12 mm.

Collected at Hakel.

PRISTIDÆ.

Sclerorhynchus Woodward.

PLATE XXIV, FIGURE 1.

WOODWARD (A. S.), *Cat. Foss. Fishes*, I, 1889, p. 76.

In the collection there is found the greater portion of the trunk of a sawfish, No. 4502 (3686). To what species this may belong cannot now be determined. The shagreen granules of this trunk are small, and are furnished with two or three longitudinal ridges and intervening furrows. In two of the species of this genus here described, *S. sentus* and *S. hiram*, no shagreen is satisfactorily observable behind the rostrum, while in *S. solomonis* the shagreen appears to be wholly smooth. Hence, while it is improbable that the trunk belongs to the latter-mentioned species, it cannot be connected with either of the others. The shagreen of the trunk resembles that of *Pristis perrotteti*.

The structure of the species of *Sclerorhynchus* here described, especially the evidence that the gill-slits opened on the lower side of the head, shows that the genus is to be referred to the Pristidæ.

To whatever species this trunk may belong, it gives us a clear idea of the form of the body of the Upper Cretaceous sawfishes. And this form is remarkably like that of *Pristis*. As is to be observed from the figure (Pl. xxiv, Fig. 1), the body is long and slender. The portion at hand begins apparently near the base of the pectoral fin and ceases about the root of the caudal fin. The length of the part is 280 mm. It is not certain that any portion of the pectoral fin is seen. The depth of the body anteriorly is 47 mm. Both the dorsal fins and one ventral are presented. All are triangular in form and approximately of the same length. The base of the first dorsal is 36 mm.; the height, 21 mm. The apparent height of the ventral fin is 14 mm. At the base of each fin are seen impressions of the cartilaginous supports of the fin. At the base of the first dorsal there are at least 16 rays; at the base of the second dorsal, a somewhat greater number; at the base of the anal, at least a dozen.

The vertebræ have been well calcified. In front of the first dorsal there are present 24 vertebræ; from the front of the first dorsal to the front of the second dorsal, 34; behind the latter, 20. The diameter of those beneath the first dorsal fin is 5 mm.

In the abdomen of the specimen just described, is seen the skull and most of the vertebral column of a bony fish, probably *Eurypholis boissieri* (Pl. xxiv, Fig. 1).

It is interesting to observe how closely the sawfishes of the Upper Cretaceous resemble those of our own day in most of their characters, and yet how primitive is the condition of their rostral teeth. We cannot doubt that our modern species of *Pristis* have descended from forms closely like those found at Mount Lebanon.

No species known to belong to *Pristis* has, I believe, yet been found in Cretaceous strata. In my work, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' page 316, I have credited *Pristis curvidens* Leidy to the Cretaceous of New Jersey; but on examining the matter more closely, I have concluded that the deposits from which Leidy's specimens were derived belong really to the Eocene.

***Sclerorhynchus solomonis*, sp. nov.**

PLATE XXV.

The specimen on which this species is based, No. 4503 (3706), consists of the rostrum complete or nearly so, the head somewhat damaged, and a faint impression of one pectoral fin. It is the upper surface of the head which is directed toward the observer. The plate will impart a sufficiently clear idea of the form and proportions of the parts.

Dr. A. S. Woodward has described and figured the type of the genus *Sclerorhynchus*, *S. atavus* (Cat. Foss. Fishes, I, 1889, p. 76, pl. iii, fig. 1). The only part which this author had at his command was a portion of the rostrum, with the teeth along its borders. That the present species is distinct from *S. atavus* is evident from various considerations.

The tip of the rostrum is slightly damaged, so that there is

some doubt regarding a small patch of scales seen there. Measuring from the mouth to this patch of scales, which appear to form the tip, the distance is 150 mm. The borders of the rostrum have been straight or slightly convex. At 50 mm. in front of the mouth the width of the rostrum is 50 mm.; at a distance of 100 mm. the width equals 35 mm. Beyond this the rostrum appears to have narrowed somewhat more rapidly. A glance at the rostrum described by Dr. Woodward shows that it was of a different form, the lateral borders being concave. In *S. solomonis*, at a point 45 mm. in advance of the mouth, the head begins to expand rapidly, so that at a line slightly in front of the mouth the width is 100 mm. In *S. atavus* the width in a corresponding position could not have been more than 75 mm.

The preservation of the rostrum is due to its being composed of a mosaic of minute hexagonal calcifications, such as we find in the same cartilages of *Pristis*. If there was a shagreen overlying these cartilages, it does not now show itself. A stellate shagreen is present along the sides of the head as far forward as where these join the rostrum. Over the base of the fin rays the shagreen scales are polygonal, convex, smooth, and enameled.

The rostral teeth of this species are quite different from those of *S. atavus*, in size at least. The longest of those represented in Dr. Woodward's figure are 7 mm. long, and there are about 4 of them in a distance of 10 mm. In *S. solomonis* there are no teeth more than 3 mm. long, and there are 8 of them in 10 mm. These teeth have a stellate base, as in *S. atavus*, and they appear to have been directed somewhat backward. For some distance beyond the base, for one third or one half of its length, the tooth is terete; then the diameter is suddenly increased, forming a sort of shoulder. The remainder of the tooth is gently curved backward, slightly flattened, and brought to an edge on the convex border. It is apparently only the distal portion of the tooth which is enameled. Toward the extremity of the rostrum the teeth are somewhat smaller. Posteriorly, the teeth become very small and are hardly to be distinguished from some of the

shagreen scales on the border. Some of these scales are also stellate.

There are some indications of gill arches and of the base of the pectoral fin, but they are not distinct enough for description. On the right side is seen the outline of the mouth, and a few small teeth appear.

This specimen was collected at Hajula.

Named in honor of Solomon, king, philosopher, poet, and naturalist. "And he spake of trees from the cedar that is in Lebanon even unto the hyssop that springeth out of the wall; he spake also of beasts and of fowl and of creeping things and of fishes."

***Sclerorhynchus hiram*, sp. nov.**

PLATE XXVI, FIGURE I.

The type of this species consists of the head, with probably most of the rostrum, the pectoral fins, and the anterior portion of the vertebral column. Its number is 4501 (3705), and it was collected at Hajula.

The extremity of the rostrum is missing. The portion present extends 103 mm. in front of the mouth. The form of the rostrum corresponds quite accurately to that of *S. atavus*. From the latter species *S. hiram* is to be distinguished principally by the size and structure of the teeth of the rostrum. Those of *S. atavus* reach a length, according to Dr. Woodward's figure (Cat. Foss. Fishes, I, 1889, pl. iii, fig. 1), of 7 mm.; and there are not more than 4 of them in a length of 10 mm. In *S. hiram* they are not more than 3 mm. long, and about 8 of them are found in a distance of 10 mm.

In *S. atavus* each rostral tooth is said to comprise "a high, round base, crimped, and having a somewhat stellate appearance when viewed from beneath; upon this is fixed a backwardly directed crown, compressed to an anterior and posterior edge." In *S. hiram* each enameled crown is fixed on a high, round base, but this base is not crimped, but perfectly smooth, and no evidences have been observed of any stellate appearance. Each crown is curved, but, in addition to this,
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the crown as a whole is directed backward so as to make an angle of 45° with the axis of the pedicel produced. As in *S. atavus*, the crown is flattened to anterior and posterior edges. As in *S. atavus*, again, the teeth appear to graduate posteriorly into the dermal scales; but this occurs at a greater distance in front of the mouth than in the species from Sahel Alma.

At 50 mm. in front of the mouth the rostrum is 46 mm. wide; at a distance of 100 mm., 35 mm. wide; at the mouth, 75 mm. wide. The rostral cartilages have been well developed and have left their impress on the matrix. These and all the other cartilages present a mosaic of hexagonal calcifications. From the point where these cartilages begin to narrow, in front of the mouth, a band of stellate shagreen runs backward along the sides of the head. In a few other places the shagreen appears to have been circular in form and smooth. The mouth resembles that of the living species of *Pristis*, and it has a width of 50 mm. The teeth are small, and some of them appear to have been furnished with one or more sharp ridges, one of which was doubtless the cutting edge.

The position of the gill arches is seen in the figure. On the outer borders of each are seen the rays which supported the gill septa. There can be no doubt that the gill slits opened out on the lower side of the body, and that hence the genus belongs to the *Pristidæ*.

This species is dedicated to Hiram, king of Tyre, the friend of Solomon, who furnished for the latter cedar-trees and fir-trees from the forests of Lebanon.

***Sclerorhynchus sentus*, sp. nov.**

PLATE XXVII, FIGURE 1.

The only portion of this fish that is known is a part of the rostrum. This fragment, numbered 4504 (3864), has a total length of 153 mm. The distal end of this rostrum is missing. The proximal end of the specimen is supposed to have come close to the mouth. From the distal end, where the width is 29 mm., the specimen expands gradually until, at a distance of 80 mm. from the distal end, the width has become 45 mm.

From this point backward the width again diminishes until at the proximal end the width is about 35 mm. It might be supposed that immediately behind the widest part of the rostral cartilages the shagreened skin would part from the cartilages and pass outward and backward to the sides of the head. There is, however, no indication of such expansion of the head, and a few teeth are found at a little distance behind this broadest part of the rostrum.

The rostral teeth resemble most those of *S. solomonis*, but they are still smaller, not exceeding 2.5 mm. in length, and numbering 10 in 10 mm. The base does not appear to be distinctly stellate. From *S. hiram* the teeth differ in that the enameled blade does not form any considerable angle with the pedicel.

The form of the rostrum is quite different from that of *S. solomonis*, in that it does not contract so rapidly toward the distal end, and it has evidently been longer in proportion to its width. The rostrum has been composed of small, hexagonal, smooth calcifications. Most of these are now removed from the fossil, only their imprints remaining. A peculiar feature, one not found in either *S. hiram* or *S. solomonis*, is the presence of two rows of denticles throughout about the anterior two-thirds of the fragment, one row on each side of the midline. These denticles appear to have had a height of about a millimeter. Only their bases are seen, the remainder being buried in the matrix. The bases are stellate on their hinder borders, but not in front. The denticles are placed about 3 mm. apart. Whether they were on the upper or the lower side of the rostrum I am unable to determine. These doubtless belonged to the shagreen, and they appear to be all of the dermal structures, except the teeth, that now remain.

It will, perhaps, be profitable to note certain differences in the forms of the rostra of the three species described in this paper. In *S. hiram* the rostral cartilages have a width, where widest, of 44 mm., and the mouth is placed 55 mm. behind this. In *S. solomonis* the greatest width is 55 mm., and the mouth is only 40 mm. behind this widest portion. In *S. sen-tus* the rostrum has a maximum width of 45 mm., and the

mouth must have been at least 75 mm. behind this. As will be observed from the figures, the rostrum of *S. solomonis* tapers toward the distal end more rapidly than that of either of the two other species.

Locality, Hajula.

RHINOBATIDÆ.

Rhinobatus eretes, sp. nov.

PLATE XXIV, FIGURE 2.

The type and only known specimen of this species was collected at Hajula. It has the number 4500 (3715). As may be seen from the figure, Pl. xxiv, Fig. 2, the specimen is quite incomplete, neither the extremity of rostrum nor the tail being present. The species has probably resembled *R. tenuirostris* Davis in having had a much-prolonged snout, but this is uncertain. There appear, however, to be characters which are sufficient to distinguish the present form from the Sahel Alma species just mentioned.

In general, the type has about the same size as the type of *R. tenuirostris*. The distance from the pectoral arch to the mouth is the same in the two; the distance between the inner borders of the hinder lobes of the pectoral fins is a little greater in *R. eretes*. The differences noted between the two species are the following:

The concavity of the sides of the head opposite the gill arches is considerably greater in *R. eretes* than in *R. tenuirostris*. In the latter the pectoral fin extends forward to a point somewhat in front of the mouth; in *R. eretes* it lacks about 25 mm. of reaching a point opposite the mouth. In the type of *R. tenuirostris* the pectoral measures, fore and aft, 180 mm.; in *R. eretes* they measure 103 mm. It is thus seen that the latter species has a much shorter fin in proportion to the size of the animal.

It is evident that the ventral fins are also relatively smaller than in *R. tenuirostris*. In the latter the length of this fin along the body is 75 mm.; in *R. eretes* the hinder extremity of this fin is broken away, but the whole length could not have been more than 60 mm. The anterior border of the ven-

tral of *R. eretes* is about 30 mm. and the breadth 20 mm., as compared with 50 mm. and 25 mm. respectively in *R. tenuirostris*.

We cannot be certain what was the form of the apex of the pectoral fin of the species here described, since, after taking into account the remnants of the right and the left fins, there yet remains about 30 mm. of the border unrepresented, and this includes the apex.

The mouth of *R. tenuirostris* appears to have been smaller than that of *R. eretes*, the former being said to measure about 33 mm. from side to side, while the latter measures 40 mm. In the mouth of *R. eretes* there are seen several rows of teeth. They each measure a millimeter in length parallel with the jaw, and each has a thin cutting edge, in the middle of which is a conical point.

The vertebræ have a diameter of about 7 mm. Davis states that those of *R. tenuirostris* have a diameter of 0.1 inch, but this is obviously an error. The length of those of *R. eretes* is 2.6 mm.; and, according to this, there would be about 15 of them between the pectoral and the pelvic girdles. Davis states that those of *R. tenuirostris* have a length of .15 inch, and that there are 14 of them between the two girdles.

Over the greater portion of the body of the specimen here described the shagreen has been removed. There is, however, a band of stellate scales along the margin of the rostrum; and further toward the midline, apparently on the upper side of the rostrum, there are three or four rows of similar scales. Along the greater part of the border of the front lobe of the pectoral fin the shagreen has become smooth, and each scale nearly circular in form. Probably this represents the general character of the shagreen.

RAJIDÆ.

Raja whitfieldi, sp. nov.

PLATE XXVIII.

This new species is represented in the collection by three specimens, No. 4505a (3707), No. 4505b (3708), and No.

4505c (3709), all from Hajula. Of these the first-named is taken as the type, inasmuch as it presents a greater portion of the body than either of the others does. Even in this, the tail is missing and a part of the right side is gone.

The disk is broad and rounded. The snout is slightly drawn out, but its tip is rounded. The greatest width across the pectorals is 156 mm. The distance from the snout to the hinder border of the pectoral girdle equals 82 mm.; from the snout to the pelvic girdle, 117 mm. There appear to be 15 vertebræ between the pectoral and pelvic girdles.

The disk is everywhere covered with a very fine shagreen, and no asperities are anywhere visible. On the upper surface of the snout there are a few enlarged scales, each nearly 2 mm. across. On the upper surface, on each side of the midline and over the pectoral girdle, is a patch of scales, some of which are about .5 mm. in diameter.

On each side of the head, where the scales have been broken away so as to expose the mouth, may be seen a few small teeth. The impressions of the gill arches are faintly seen; likewise those of the eyes and the nasal cavities.

The other specimens add little or nothing to our knowledge of the species.

Three other species of *Raja* have been described from Mount Lebanon. *Raja expansa* (Davis), from Hakel, has a very broad disk, and the pectoral fins are acute at their outer angles. This species was regarded by Davis as belonging to *Rhinobatus* (Trans. Roy. Dublin Soc., (2), III, 1887, p. 486, pl. xviii). *Raja primarmata* A. S. Woodward (Cat. Foss. Fishes, I, 1889, p. 85, pl. iv, figs. 1-3), from Sahel Alma, also has the outer angles of the pectorals acute. *Raja minor* Davis (*op. cit.*, p. 493, pl. xxi, fig. 2), from Sahel Alma, is either a very small species or the young of a species otherwise unknown. The pectorals are rounded. There is little or no shagreen on the disk. The disk is very broad.

This species is named in honor of Professor R. P. Whitfield, Curator of the Department of Geology of this Museum, who is the author of many important memoirs on palæontology, among them one entitled 'Observations on some

Cretaceous Fossils from the Beyrut District, Syria, in the Collection of the American Museum of Natural History, with Descriptions of some New Species' (Bull. Amer. Mus. Nat. Hist., III, 1891, pp. 381-441, pls. iv-a-x).

Class PISCES.

BELONORHYNCHIDÆ?

Stenoprotome, gen. nov.

The writer finds it difficult to determine with any certainty either the relationships or the characters of this genus. The following characters are given provisionally:

Body furnished with large tuberculated bony scutes. Vertebral centra not developed. Head elongated, the snout slender, obtuse at the apex. Teeth of moderate size, conical. Opercular? bone furnished with a long, curved spine. Type, *Stenoprotome hamata* sp. nov. Derivation of name, στενός, narrow, and προσωμή, the face.

Stenoprotome hamata, sp. nov.

PLATE XXVI, FIGURE 2; PLATE XXVII, FIGURE 2.

The specimen which forms the basis of the following description was obtained at Hakel, and the number is 4509 (3863). The head is the part most satisfactorily preserved, and figures are here presented of both the counterparts. The most striking feature of the fish is the possession of two long, curved spines, one on each side of the head. Each of these ends in a sharp point; and just proximad of the point is a sharp barb. The distal end of the spine resembles closely the point of a fishhook. The writer has not been able to determine conclusively what bone supports this spine. On looking at *Coccodus* it is suggested to one that the spine is homologous with the lateral spine of that genus, but further consideration makes it evident that the present form has no relationships with the pycnodonts; and the close attachment of the spine to the side of the head and its evident great extension forward indicates that it is rather the opercular bone.

The length of the head, from the apex of the snout to a line joining the hinder borders of the lateral spines, is 35 mm. The apex of the snout is rounded and only 3.5 mm. wide. The skull lies with the upper surface toward the viewer. The bones are so closely united that their limits cannot be distinguished. The surface is almost everywhere covered with tubercles, sometimes scattered, but usually arranged in rows more or less regular. A few of those on the upper surface of the snout form short spines.

Along the borders of the snout, for about 20 mm., there are seen, at intervals of two or three millimeters, what appear to be teeth, but which are possibly only enlarged marginal tubercles. Between the larger ones are others of smaller size. Some medium-sized ones are found at the apex of the snout. At a considerable distance behind the head is seen a stout bone bearing four or five teeth larger than those of the rostrum, the largest about 1.5 mm. in length. This bone seems to the writer to be a portion of the lower jaw, which has been displaced.

As may be seen from Pl. xxvi, Fig. 2, *orb.*, there are, between the bases of the spines, two rings of bone. These appear to be the sclerotic rings and to indicate the position of the eyes; but, incomprehensibly enough, these have been overlain by some bones of the upper surface of the skull. The appearances of the fossil are not consistent with the supposition that the lower surface of the head is presented. There is probably some distortion here.

Behind the bases of the spines the fossil contracts for about 10 mm. Whether this region belongs to the skull or not is not easily decided. There appear to be five bones here, an elongated median one, extending the full length of the area, and two others on each side. Of the latter, the hindmost sends an arm forward along the outside of the more anterior one. These bones can be distinguished on the specimens only by close inspection.

Behind the area mentioned, at *a*, Pl. xxvii, Fig. 2, there is a bony mass whose surface is covered with ridges which converge to a point at one side. These ridges may repre-

sent either the sculpture of a bony scute or a number of rays of a dorsal fin. On one side of this, *b*, is a bony scute whose axis runs obliquely to the axis of the head; while at *c* there is another scute whose greater axis is transverse to that of the head. Still farther away, at *d*, is found the supposed lower jaw. Around this are some remains apparently of fin rays. Finally, at *e*, is seen a very large bony plate, 33 mm. long and 21 mm. wide. One end is narrowed and rounded off. Near this plate also there are seen scattered fin rays. All the plates are tuberculated.

Nowhere are there any certain evidences of vertebral centra or ribs. There seem to be some evidences of neural or hæmal arches.

PYCNODONTIDÆ.

Coccodus lindstroemi Davis.

PLATE XXIX, FIGURE I.

Coccodus lindstræmi DAVIS (J. W.), Jour. Geol. Soc., XLVI, 1890, p. 565, pl. xxii.—WOODWARD (A. S.), Cat. Foss. Fishes, III, 1895, p. 268.

Of this not well-known species there are in the collection three specimens. One of these, No. 4517*a* (3698), with its counterpart, presents the head. The second, No. 4517*b* (3699), much damaged, shows a part of the head, with the occipital spine, and a portion of the abdominal region. The third, No. 4517*c* (3793), also presents the head and a complete occipital spine. The first-mentioned specimen is here figured (Pl. xxix, Fig. 1). On the hinder border of the spine there are 14 denticles. The region below the orbit has been covered with bony plates, whose surface was ornamented with more numerous and smaller tubercles than the other portions of the head. Behind the occipital spine is seen a series of fin rays, 10 in number. They are slender, and present distinct evidences of segmentation, but none of longitudinal division. They extend downward beneath the bony covering of the region and toward the neural spines, or between them. No. 4517*c* (3793) shows the presence of the

same rays, and here they seem to be longitudinally divided. They appear to form a feeble anterior dorsal fin.

Through a fracturing of the snout some of the teeth, apparently those of the splenial bone, are exposed. The rows cannot be counted, but the teeth themselves are very much smaller than those of *Coccodus armatus*. At the tip of the lower jaw is seen a small, conical, pointed tooth.

The specimens are from Hakel.

***Coccodus insignis*, sp. nov.**

PLATE XXIX, FIGURES 2-5.

Of this species there are in the collection several specimens, all from Hajula. The following six are especially to be mentioned: Nos. 4516a (3666), 4516b (3700), 4516c (3701), 4516d (3702), 4516e (3703), and 4516f (3794). Of these, No. No. 4516b (3700) and No. 4516d (3702) are to be regarded as the types. The former consists of a somewhat damaged fish which has been flattened from above downward, and may be taken as showing the form of the fish when seen from above. Only the tip of the tail fin is missing. The total length is 80 mm. On each side is seen a broad, hooked spine, a part of the shoulder girdle. The head is pointed in front, and it and the anterior body region expand backward to the ends of the spines mentioned, so as to be wedge-shaped. These lateral spines appear to be much broader than the corresponding ones of *C. armatus*, as figured by Davis (Trans. Roy. Dublin Soc., III, pl. xxx, fig. 1) and Woodward (Cat. Foss. Fishes, III, p. 267). The anterior, or outer, border of each is finely denticulated. The upper and lower surfaces are ornamented with fine ridges, which start from the base and converge to the point. Anteriorly these ridges become tuberculated. In front and behind, the base of each spine passes into anterior and posterior processes of the pectoral arch. Lying in the curve of the hinder border of the pectoral spine and on the matrix from which a portion of the spine has been removed are seen abundant remains of pectoral fin rays; but these have been much disturbed. The rays of the dorsal are so

much disturbed that their number cannot be determined; but they are not numerous. Somewhat in front of a perpendicular from the origin of the dorsal fin are seen the ventral fins and their supports. The latter are 6 mm. long and rather slender. So far as can be determined, there are only 5 fin rays in each, and the outermost of these is short and claw-like. The divided rays are also segmented. The anal fin is disturbed, and the caudal is missing. Another specimen, No. 4516f (3794) (Pl. xxix, Fig. 2 v. f.), appears to have an additional divided ray in the ventral fin.

In No. 4516b (3700) two or three rows of teeth can be seen. Nothing more can be said of them than that they resemble those of *C. armatus*. There are indications given by the neural and hæmal arches that there were 15 or more vertebral segments.

The block bearing this specimen has been broken along the length of the fish in such a manner as to expose the occipital spine, which was buried in the matrix. This is represented by Fig. 3 on Pl. xxix. It is readily seen to be different from that of either *C. lindstræmi* or *C. armatus*, being broad antero-posteriorly and relatively short. The posterior edge is finely denticulated; the anterior edge is nearly smooth. The lateral surfaces are ornamented with fine ridges, which rise from the base and either terminate in the borders or ascend to the apex. Just behind this spine there is another process of bone which may be either another spine or a ridge passing across the rear of the skull. Its hinder border overhangs the anterior vertebræ.

The co-type, No. 4516d (3702) (Pl. xxix, Fig. 4), is a small fish having a length of 97 mm. from the snout to the end of the caudal fin. The specimen is especially interesting because it presents the shoulder girdle from below. It is difficult to determine what sutures exist in this region. The lower ends of the right and left halves of the girdle join in the midline, and here the bones are 8 mm. wide, fore and aft. The suture between them is very distinct for a part of the distance across the bridge, but it then becomes indistinct. Whether or not these bones are separated by suture from the bases of the

lateral spines I have been unable to determine with any certainty; but they are possibly distinct bones.

Dorsal and anal fins are present, but their rays are disturbed.

What are probably vomerine teeth are presented. There are three rows on one side of the midline and one row on the other, and there were not less than 5 rows. Those of one of the rows farther from the midline are compressed laterally and each forms a longitudinal cutting edge. The other teeth have a part of their triturating surface mammillated and the borders finely crenulated.

No. 4516e (3703) is a fish which has been spread out either by crushing or by inflation by gases during decomposition. The space occupied by the notochord is enlarged so that the bases of the neural arches and those of the ribs are from 6 to 11 mm. apart. This specimen shows that both the neural arches and the hæmal arches had their proximal ends expanded against the notochord. The expansions of the neural arches join and form a continuous covering for the upper side of the notochord. The ends of the hæmal arches probably did not come into contact with each other or with the neural arches.

Beneath the dorsal rays I count 10 interneural supports. There appear to have been 8 anal rays. There are traces of both pectoral and ventral fins. In one gill chamber are seen the impressions of four series of gill filaments.

No. 4516a (3666) shows the fish as seen from the side, and thus gives us an idea of the elevation of the head and body. The total length is 120 mm. The height of the body at the pectoral spine is 30 mm. Only a faint impression of the occipital spine remains. The rays of the dorsal fin cannot be counted. The lower rays of the caudal are the longest and the fin ends rather bluntly. The anal appears to comprise 8 rays. The ventrals are distinctly displayed. There is a continuous line of bones along the upper side of the notochordal region, the bases of the neural arches. Eleven neural arches are counted from the middle of the back to the base of the caudal fin. Vomerine and splenial teeth are seen, but the number of rows cannot be determined.

No. 4516c (3701) lacks the hinder portion of the body (Pl. xxix, Fig. 5). The fish presents the body as seen from above, but damaged somewhat, the roof of the skull being gone, as well as the occipital spine. The head is 40 mm. long, from the snout to a transverse septum formed apparently by the shoulder girdle. Splenial teeth are present, three rows on each splenial. Six teeth are found in each row, and there were probably three or four more. The ones in front are small. The inferior transverse portion of the shoulder girdle is seen, on the left side, passing across beneath remains of probably gill arches. Faint indications of pectoral fin rays are seen on one side.

No. 4516f (3794) appears to deserve description and illustration (Pl. xxix, Fig. 2). The inferior surface of the body lies toward the viewer, and the apex of the occipital spine has been found by excavating on the opposite side of the block. From the base of one pectoral spine to the other, a bar of bone crosses the body. It presents a fractured edge toward the abdominal surface, and has, in all probability, been a ridge, or plate, of bone which extended upward from the inferior transverse portion of the shoulder girdle.

Behind the right (left in the figure) pectoral spine are seen the neural arches with their conjoined expanded proximal ends. Each arch is seen to have a wing-like expansion in front of the spine. Crossing the upper ends of the hindermost spines are seen some interneural supports of the rays of the dorsal fin. Immediately behind the bar of bone, passing from one pectoral spine to the other, are seen some confused ribs. Then come the supports of the ventral fins and the fins themselves, and immediately behind and above these, the expanded ends of the hæmal arches. Behind each pectoral spine are seen the remains of pectoral fin rays. Twelve of these may be counted behind the right spine. The proximal ends of these rays are to be seen on the matrix mesiad of the base of the spine. This proves that the pectoral fins were inserted above the spines.

In front of the transverse bar of bone mentioned above is seen the parasphenoid. In front it appears to receive

between two prongs the hinder end of the vomer. On the latter there appear to have been four rows of teeth, but many of these teeth are broken away.

The counterpart of specimen No. 4516c (3701) presents the parasphenoid bone. Posteriorly this seems to join a basi-sphenoid. On the lower surface of the latter, in the midline, there is a short, pointed, downwardly directed process.

All the specimens were collected at Hajula.

ELOPIDÆ.

Holcolepis attenuatus (Davis).

Clupea attenuata DAVIS (J. W.) Trans., Roy. Dublin Soc. (2), III, 1887, p. 580, pl. xxxiii, fig. 4.

Osmerooides attenuatus WOODWARD (A. S.), Ann. and Mag. Nat. Hist. (7) II, 1898, p. 409; Cat. Foss. Fishes, IV, 1901, p. 19.

No. 4526 (3781), from Hakel, is a specimen which the writer is unable to distinguish from Davis's *Clupea attenuata*, a species hitherto known only from Sahel Alma. In the present specimen the total length is 95 mm.; to the base of the caudal fin, 77 mm. The head, including the opercular apparatus, is about 23 mm., but the extremity of the snout is missing. The depth is only 15 mm. There are a few more than 50 vertebræ, of which not more than 20 belong to the caudal region. There are 20 interneurals supporting the dorsal fin. Davis reports the presence of only 10 rays in the dorsal, but this is doubtless an error. This fin, in our specimen, is equally distant from the occiput and the base of the caudal fin. The ventrals are inserted below the front of the dorsal. The anal is disturbed, but there are 7 supporting interhæmals present. It is entirely behind the dorsal. The bones of the head are smooth. Nothing can be determined regarding the size or the form of the scales.

There are various reasons for not identifying this specimen as *H. sardinioides* (Pictet). It is entirely too slender to be *H. lewisi* (Davis). The dorsal and ventral fins of the latter are farther backward, and there are said to be 35 vertebræ in the abdominal region behind the operculum.

Dr. A. S. Woodward has called our attention to the fact that the name *Holcolepis* antedates *Osmeroides* as a name for the species of this genus (Cat. Foss. Fishes, IV, p. 11).

ICHTHYODECTIDÆ.

Eubiodes, gen. nov.

Teeth in sockets? Vertebrae with lateral grooves; the centra pierced by the notochord. Some of the anterior pectoral rays expanded distally, and longitudinally divided. Anal fin elongated, falcate in front. Type, *Chirocentrites libanicus* Pictet and Humbert. Derivation of name, εὖβιος, *well-living*; and δήκτης, *a biter*.

Eubiodes libanicus, (PICT. and HUMB.).

PLATE XXX, FIGURE 1.

Chirocentrites libanicus PICTET and HUMBERT, Nouv. Rech. Poiss. Foss. Mt. Liban, 1866, p. 88, pl. xiii.—DAVIS (J. W.), Trans. Roy. Dublin Soc. (2), III, 1887, p. 585.

Ichthyodes libanicus WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 105.

This species has been referred by Dr. Woodward to the genus *Ichthyodes*. However, a comparison with *I. anaides*, the type of *Ichthyodes*, will convince one that the Syrian species belongs elsewhere. In *I. anaides* the anterior pectoral ray is very stout, but it does not expand distally; and I know of no evidence that its distal end was split into fine filaments. It formed rather a sort of spine, like that of *Portheus*. The succeeding rays were considerably smaller than the anterior one and were distally divided, as is usually the case with such rays. In *I. anaides* the notochord seems not to have passed continuously through the centrum of the vertebra; but in the Syrian species under consideration there was free communication between the concave ends of the centrum. In this Syrian species the anal fin is very long; we have no proof that it was so in the American species of *Ichthyodes*. For these reasons I place the *Chirocentrites libanicus* of Pictet and Humbert in a distinct genus. I have not seen the teeth,

nor have I found any statement that they are lodged in sockets. If they are not in sockets, this will furnish another character to distinguish the species from *Ichthyodectes*.

In the collection there are several portions of this fish, but no complete specimen. None of these furnish the teeth. One example, No. 4506a (3681), shows the fish from apparently just behind the pectoral girdle to the base of the caudal fin. This length is 400 mm. In this distance there are about 54 vertebræ, but these have been disturbed anteriorly. The depth at the origin of the anal fin is 120 mm. The anal fin begins 186 mm. in front of the base of the caudal. There are apparently about 8 strong rays in front; behind these the rays are weak and, in the fossil, form an obscure fringe along the body. There are altogether 34 interhæmal fin supports. The whole length of the anal base is 137 mm.

So far as indicated by the specimen, the dorsal fin begins 110 mm. in front of the base of the caudal fin and opposite the beginning of the hinder third of the anal. Only 10 rays can be counted, but there may have been others posteriorly. Large interneurals are present in front of the fin, but there seem to have been no rays attached to them. The neural and hæmal spines are long, slender, and sigmoid in form. The vertebræ both of the abdominal and caudal regions are somewhat higher than long, about 7 mm. long and 9 mm. high. The side of the centrum is excavated by a pair of rather deep pits or grooves. Where the centra happen to be split longitudinally they show that the notochordal perforation is a millimeter or more in diameter.

About 95 mm. in front of the dorsal fin, and therefore not far behind the head, there is, on the back, a rounded mass of bone. This seems to be connected with the distal ends of some rather stout interneurals. This mass is about 27 mm. long, 10 mm. high, and 5 mm. thick from side to side.

Most of the scales are removed from the fossil. They appear to have been about 15 mm. high, and their exposed portion about 8 mm. fore and aft.

Another specimen, from Hajula, No. 4506b (3646), confirms the above description, except that it does not include

the region of the bony mass behind the head. There are apparently 13 dorsal rays. A considerable portion of the body is covered with scales. No. 4506c (3799), from Hakel, exposes on the matrix an impression of the caudal fin. It has been deeply forked. The larger rays have been obliquely segmented; the median ones split up into smaller filaments.

No. 4506d (3866) is part of a fish which had a depth of at least 125 mm. It presents the ventral fins; but no other fins are present to afford us a means of locating the position of the ventrals. These fins appear to have been about 30 mm. long.

No. 4506e (3823), from Hakel, is about as large as No. 4506a (3681). It seems to present some traces of the ventrals at a point 75 mm. in front of the anal fin. There are also some faint indications of the bony mass on the back, to which reference has been made above.

No. 3899, of the Cope Collection, is probably from Hakel. The specimen resembles much the one figured by Pictet and Humbert, but not so much of the body is present. One pectoral fin is well exposed, mostly as an impression on the matrix (Pl. xxx, Fig. 1). The longest ray, the most anterior, has a length of 65 mm., and its distal end is slightly more than 7 mm. wide. The next ray, somewhat shorter, is 9 mm. wide distally. The other rays are successively shorter and narrower. All the rays, for a great part of their distal portions, are longitudinally divided. There appear to be somewhat more than 10 rays. No teeth are seen in this specimen.

CTENOTHRISSIDÆ.

Ctenothrissa signifer, sp. nov.

PLATE XXXI, FIGURES 1 AND 2.

Two fishes which were collected at Hajula belong evidently to an undescribed species of *Ctenothrissa*. The number of the type is 4521a (3651). With its counterpart, it furnished all parts of the animal. A second specimen is numbered 4521b (3813).

[June, 1903.]

The total length of the type is 80 mm.; to the base of the caudal fin, 55 mm. The body is deeper than it is in *C. vexillifer* (Pictet), the greatest depth, 30 mm., being contained in the length to the base of the caudal somewhat less than two times; and in the distance from the pectoral arch to the base of the caudal, one and one fourth times. The length of the head, 21 mm., is less than the greatest depth of the body.

The height of the dorsal fin is fully 30 mm., and when depressed its distal end would reach beyond the base of the caudal fin. It contains 20 rays, including the anterior undivided ones. The anal fin has a height of 13 mm., but the rays are broken and zigzagged, so that it is evident that originally the fin was still higher. There are present in it 13 or 14 rays.

The body is slightly turned, so that both ventral fins come into view. These sweep backward along the lower border of the body and cross all the anal fin-rays. The pectoral fins are only dimly seen.

The maxilla is provided with short conical teeth. This bone and the supramaxilla resemble those of *C. radians*, as figured by Dr. A. S. Woodward (Cat. Foss. Fishes, IV, pl. x, figs. 2, 3). The cheeks and the opercular bones are covered with scales.

No. 4521b (3813) shows only the posterior half of the body. The dorsal fin is depressed and overlaps the base of the caudal fin. The anal rays pass somewhat behind the last caudal vertebra. Some of the rays of the ventrals extend beyond the origin of the anal.

This species differs from *C. vexillifer* in having a shorter and deeper body, much higher dorsal and anal fins, and longer ventral fins.

No. 4522 (3802) is a small fish from Hakel which I identify as *C. vexillifer*. The length to the base of the caudal is 35 mm. and the depth is 14 mm. The fish is therefore considerably slenderer than the specimens of *C. signifer*. The pectoral fin in this Hakel specimen also is long, as in those from Hajula; but the dorsal is not more elevated than usual.

DERCETIDÆ.

Leptotrachelus serpentinus, sp. nov.

PLATE XXXII, FIGURE 1.

This species is represented in the collection by two specimens, No. 4511a (3683), which was collected at Hajula, and No. 4511b (3739), which was obtained at Hakel. The first mentioned specimen is regarded as the type. It lacks a large part of the caudal region and the whole of the head, except a part of the opercular apparatus. The length of the specimen in its present condition is 260 mm., and the total length in life could hardly have been less than 300 mm., and was probably more. The distance from the opercular region to the ventral fins is 134 mm. The diameter (probably the horizontal) at the ventral fins is contained in the distance from the operculum to these fins thirteen times. In *L. triqueter* the diameter at the ventral fins, as shown by Pictet and Humbert's figure (Nouv. Rech., pl. xiv, fig. 1), is contained in the part of the body in front of the ventral fins about seven times. We have in both of these cases apparently the breadth of the body and not its height. *L. serpentinus*, therefore, appears to have been a much slenderer fish than *L. triqueter*. This slenderness is shown also by the bodies of the vertebræ, which are more than three times as long as the diameters of their articular ends. In *L. triqueter* the bodies are said to be twice as long as deep.

There are 31 vertebræ between the operculum and the ventral fins, about the same number as in *L. triqueter*. The vertebral centra are much constricted. Each vertebra of the abdominal region sends out on each side two long processes, which diverge from the middle of the centrum. The broader one is directed outward and forward. Near its end there is articulated to it the head of a long, slender rib. The posterior and narrower process is directed outward and backward. Its distal end approaches very closely the rib-bearing process of the next vertebra behind. In the region of the ventral fins these processes are nearly 5 mm. long. These lateral processes are found on about 12 of the vertebræ behind the ven-

tral fins. The posterior process appears to be the one first reduced, but both soon disappear. From the figures and descriptions of *L. triqueter* we must conclude that there is only a single process on each side of each centrum.

There are present about 6 or 7 rays of one pectoral fin, and these are about 15 mm. long. A broad bone having a posteriorly directed process lies just behind the operculum. This may belong to the pectoral arch. The dorsal fin is missing, unless it is represented by two or three rays which lie above the ventral fins.

One of the ventral fins is present and appears to contain 6 rays. Its supporting bone is 7 mm. long and 2.5 mm. wide posteriorly, and is pointed in front. No remains of the anal fin are seen.

As may be seen from the figure, on the upper side and behind the ventral fin, there is a row of triradiate dermal scutes running along one side of the body. A similar row is found on the other side, but the bone is broken away and only the imprints of the scutes are left on the matrix. These scutes continue for some distance in front of the ventral fins. They appear to have a longer anterior branch than do those of *L. triqueter*. There are also numerous fine intermuscular bones throughout the length of the fish.

The condition of the vertebræ and dermal scutes occupying some distance behind the head is not easy to determine, on account of the presence there of the bodies of three small fishes. It is possible that these had been swallowed, but their presence there is more probably accidental.

The specimen collected at Hakel is a fragment 98 mm. long. It is from the portion of the body behind the ventral fins. It presents no new features.

From *Leptotrachelus gracilis* Davis (Trans. Roy. Dublin Soc., III, 1887, p. 623, pl. xxxviii, fig. 3), this species differs in having a much less slender anterior abdominal region and probably a longer post-pelvic region. Davis's species likewise had quite different lateral vertebral processes.

Collected at Hajula and Hakel.

ENCHODONTIDÆ.

***Enchodus marchesettii* ? (Kramberger).**

PLATE XXX, FIGURES 2 AND 3.

Eurygnathus marchesettii KRAMBERGER (D. G.), Djela Jugoslav. Akad., XVI, 1895, p. 34, pl. vii, fig. 2.

In the collection are two specimens of an *Enchodus* which seems to be distinct from *E. longidens*; and, since there are no species of fishes known to be common to Sahel Alma, where the latter species is found, and Hakel, where *E. marchesetti* was found, it appears to be best for the present to retain the two species as distinct. It is proper to state that I have had no specimens of *E. longidens* for direct comparison, and I have not been able to see Kramberger's description and figure of his species. The present identification is therefore wholly provisional.

The two specimens are numbered respectively 4507a (3779) and 4507b (3859). The former (Pl. xxx, Fig. 2) presents the head, except a portion of the lower jaw, and the body to the rear of the anal fin, except a portion of the back. No. 4507b (3859) consists of the body and tail from the beginning of the dorsal fin. The two specimens have been almost identical in size, and they supplement each other quite completely.

The head of No. 4507a (3779) is 55 mm. long to the hinder border of the operculum. The lower jaw has been broken away just below the tooth-line, leaving the teeth, but rendering it impossible to determine the depth of the jaw. The teeth have been slender, some of them quite long; and they are furnished with a few sharp grooves, especially distally. The premaxilla has been of moderate size, and furnished with a long, now missing, fang. The skull and opercular bones appear to have been ornamented as in *E. longidens*.

In front of the dorsal fin are three dermal scutes. These are of an elongated oval form, with pointed ends. The anterior and largest is 8 mm. long and a little more than .3 mm. wide. From the centre of each, ridges radiate to the circumference. Below each scute there is seen a plate of bone which

appears to be an expansion of an interneural bone. This has probably formed a support for the scute. The first interneural support of the dorsal fin is similarly expanded. Along the position of the lateral line is seen a succession of small thin scutes, each not more than 2 mm. long. These are to be observed as far backward as the rear of the dorsal fin, where they lie close to the upper border of the vertebræ. It is probable that they continue to the base of the caudal. I have observed no traces of the hooked dermal scutes that are described as occurring at the base of the tail of some species.

The pectoral fin has had a length of at least 25 mm., and it must have had somewhat more than 15 rays. The ventrals arise about 30 mm. behind the pectorals and slightly behind the origin of the dorsal fin. Its rays are somewhat damaged in both specimens, but they were at least 17 mm. long. The number of dorsal fin rays cannot be accurately determined, since some are wanting in both specimens; but there were probably 16, as in *E. longidens*. The anal fin was supported by 19 rays, so that the fin does not appear to have differed from that of *E. longidens*. The caudal fin is deeply forked, and some of the external rays are rather strongly developed.

In the specimen showing the head there are 24 vertebræ in front of the origin of the dorsal fin, and 15 behind this point; therefore 39 altogether, possibly 40. Dr. A. S. Woodward, in his description of *Enchodus longidens* (Cat. Foss. Fishes, IV, p. 199), states that there are 24 vertebræ in the caudal region of the latter species. In our specimens from Hakel, the twenty-fourth vertebra from the base of the caudal fin will be on a line joining the base of the ventral fins with the anterior portion of the dorsal. Not more than 19 or 20 vertebræ can be fairly assigned to the caudal region. This may furnish us with one difference between *E. longidens* and *E. marchesettii*. Another will probably be found in the different forms of the dorsal scutes, those of *E. longidens* being broadly oval, those of our Hakel specimens elongated oval.

Besides the specimens described above, there are in the collection three others which probably belong to the same species. One of these, No. 4527a (3735), is from Hakel; the

others, No. 4527*b* (3840) and No. 4527*c* (3832), are from Hajula. The first-mentioned presents the head and the body to behind the ventral fins; the two others, only the heads. In the first, the lower jaw has a width of 11 mm. and a length of 45 mm. The teeth behind the anterior fangs appear to be compressed to edges and to be striated and grooved. The fangs are slender. No dorsal scutes are present. In No. 4527*c* (3832), the jaw is 12 mm. wide and apparently 55 mm. long. The teeth, upper and lower, are mostly damaged, but they are rather coarsely striated; and many of them, even the large fangs, are furnished with edges.

No. 4527*b* (3840) and its counterpart furnish the head of a large individual. The length of the head to the hinder border of the operculum is 120 mm. The length of the lower jaw is 80 mm.; its depth is 21 mm. The head has been crushed from above. Both tumid palatines are shown, each with a long slender fang. The fang is nearly smooth on the outer side, but coarsely striated on the inner side. Whether cutting edges are present is not certain. The lower fang is likewise striated on the inner surface. This belongs possibly to a different species, but this cannot now be demonstrated.

Specimens from both Hakel and Hajula.

MYCTOPHIDÆ.

Osmeroides Agassiz.

Osmeroides AGASSIZ (L.), Poiss. Foss., V, pt. ii, 1844, p. 103.—PICTET (F. J.), Poiss. Foss. Mt. Liban, 1850, p. 27.

Sardinioides MARCK (W. v.), Zeitschr. deutsch. geol. Gesellsch., X, 1858, p. 245.—WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 236; Foss. Fishes English Chalk, 1902, p. 32.

Dermoptychius MARCK (W. v.), Palæontogr., XV, 1868, p. 287.

The employment of the name *Sardinioides* for this genus is an evident violation of the law of priority; a law recognized by all naturalists, but obeyed with reluctance by many when their prepossessions are attacked; and the only means now provided for deciding between rival systematic names. The type of the genus is *O. monasteri* Agassiz.

The species which are satisfactorily determined as belonging to the genus are the following: *Osmeroides monasteri* Agassiz, *O. crassicaudus* (Marck), *O. megapterus* Pictet, *O. pusillus* (A. S. Woodward), *O. woodwardi*, nom. nov. (= *Sardinioides attenuatus* A. S. Woodward), *O. macrophthalmus* (Marck), and the two new species below described, *O. pontivagus* and *O. ornatus*.

Three other species of doubtful value, according to Dr. A. S. Woodward, have been described by von der Marck, *O. macropterygius*, *O. minutus*, and *O. tenuicaudus*.

***Osmeroides pontivagus*, sp. nov.**

PLATE XXXIII, FIGURES 1-4.

This species is represented by at least 15 individuals. The size is small, and the fish is closely related to *O. pusillus*, which has been described as *Sardinioides pusillus* by Dr. A. S. Woodward from Sahel Alma (Cat. Foss. Fishes, IV, p. 240, pl. xvi, figs. 2, 3). *O. pontivagus* differs from the latter in several important respects. Dr. Woodward states that in *O. pusillus* the serrations of the scales are deep and conspicuous. In *O. pontivagus*, on the contrary, they are very obscure, and it is only in favorable situations on the matrix, and with the aid of a good lens, that they can be seen at all. There are also more rays in the dorsal fin than there are in the species from Sahel Alma, 12 or 13, instead of 10 or 11. There are quite certainly 9 rays in the anal fin. The ventrals are inserted somewhat behind the origin of the dorsal fin, and they show the presence of 7 rays. Several specimens present at least 13 rays in the pectoral.

The mouth of this species is large, the articulation of the lower jaw being placed well behind the orbit. No. 4524b (3846) has the mouth widely opened and shows the slender and toothed premaxilla as forming the whole of the upper border of the mouth (Pl. xxxiii, Fig. 1). There is a patch of teeth on the palatopterygoid arch. The maxilla is expanded at the distal end. There were probably 8 branchiostegal rays on each side. There are about 30 vertebrae, not more.

No. 4524a (3845) (Pl. xxxiii, Fig. 2), is taken as the type of this species. It has a length of 60 mm.; to the base of the caudal, of 47 mm. The head is 16 mm. long, and the depth is 20 mm.

Among the specimens which I am compelled to refer to this species there is much variation in the depth of the body. On Pl. xxxiii, Figs. 1, 2, are represented two specimens which have very deep bodies. Fig. 3 of the same plate shows another specimen, No. 4524c (3855), whose body has less depth. In this, the depth of the body, 15 mm., equals the length of the head. The distance from the snout to the base of the caudal fin is 50 mm. No structural differences are to be seen. Still slenderer specimens occur, as No. 4524e (3852), which is 37 mm. long from the snout to the base of the caudal fin, while the depth is only 10 mm. Between the extremes there are all gradations in relative depth.

In some of the slenderer specimens there is a tendency toward a deepening of the fins. In No. 4524f (3841) (Pl. xxxiii, Fig. 4), about 50 mm. long to the base of the caudal and 15 mm. deep, the rays of the dorsal fin extend backward two thirds of the distance from the fin to the base of the caudal. The anal is rather deep, while the pectoral rays fully reach the base of the ventrals, and the rays of the latter lack but little of attaining the front of the anal. In No. 4524g (3842) from Hakel, the dorsal and anal fin-rays extend backward to the base of the caudal.

In some, but not all, of the slender individuals, the scales appear to be quite thick; but this condition may be due to some peculiarity of preservation.

The slender specimens described here resemble somewhat *O. woodwardi* (= *Sardinoides attenuatus*), described by Dr. A. S. Woodward, from Hakel (Cat. Foss. Fishes, IV, p. 241, pl. xii, fig. 5). However, the latter is a more elongated fish, having the length of the head contained in the distance between the pectoral arch and the base of the caudal fin three times. It also has the scales conspicuously serrated, and only 10 or 11 rays in the dorsal fin.

All of the specimens, except two, are from Hajula.

***Osmeroides ornatus*, sp. nov.**

PLATE XXXIII, FIGURE 5.

No. 4518 (3870), from Hakel, appears to belong to an undescribed species of *Osmeroides*. Only a single specimen has been found in the collection. The total length is 48 mm.; to the base of the caudal 36 mm. The length of the head, including the opercular apparatus, equals 14 mm. The greatest depth is 12.5 mm. It will be seen, therefore, that the depth is less than the length of the head, and is contained in the distance from the pectoral arch to the base of the caudal fin less than twice. There are 25 vertebræ behind the operculum; hence not more than 30 altogether. There are 11 or 12 in the caudal region. The dorsal fin arises 7.5 mm. behind the occiput. The number of its rays is uncertain, but there are probably not more than 10. The ventrals are inserted below the anterior half of the dorsal. The rays of the anal cannot be counted, but the fin is short. The caudal is deeply forked. The pectoral fins are delicate and inserted well above the ventral border.

The scales are thick and deeply serrated, as may be seen on the matrix, and even in some places where the scales overlap one another. The operculum is conspicuously ornamented with coarse ridges and rows of tubercles, which radiate from the articulation of the bone with the hyomandibular. There seem to be similar ridges on the other opercular bones and apparently on the cheeks.

The mouth appears to have been relatively small, the articulation of the lower jaw being advanced to a perpendicular line from the front of the orbit. The lower jaw is only 5 mm. long. The orbit is rather large.

This species differs from *O. megapterus*, a Sahel Alma species, in having fewer vertebræ, 30 or fewer instead of 40. From *O. woodwardi* Hay (= *S. attenuatus* A. S. Woodward), from Hakel, it differs in being less elongated and in having coarsely serrated scales. It appears to resemble most *O. pusillus*, described as *Sardinioides pusillus* by Dr. Woodward, from Sahel Alma, but the latter is a more robust species, with

evidently a larger mouth. Nothing in the description indicates that its opercular bones are ornamented like those of *O. ornatus*.

Collected at Hakel.

Acrognathus Agassiz.

Acrognathus AGASSIZ (L.), Poiss. Foss., V, pt. ii, 1844, p. 108.—WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 243; Foss. Fishes English Chalk, 1902, p. 36.

The type of this genus is *A. boops* Agassiz. The type specimen of this species is practically the only known example. It is refigured in Dr. Woodward's publication of 1902, cited above. Unfortunately this author has not figured his *A. libanicus*, from the Cretaceous of Sahel Alma. The following species is believed to be congeneric with the one described from Sahel Alma, but it is doubtful if either belongs to the genus *Acrognathus*.

***Acrognathus dodgei*, sp. nov.**

PLATE XXXIV, FIGURE 3.

The type of this species is No. 4520a (3673). It has a total length of 88 mm.; to the base of the caudal fin 68 mm. The head and the opercular region together measure 20 mm. The depth is 21 mm. The rays of the dorsal fin are somewhat confused, but there appear to be 12 interneural supports. The pectoral fin is wanting in the specimen. The ventrals are slightly in front of the origin of the dorsal, but this is probably due to slight displacement. The rays are stout. The anal is somewhat damaged, but it was evidently short. The vertebræ number 32 or 33. The scales are thick.

The premaxilla is furnished with small teeth. The mandible is high posteriorly. Its length is 10 mm. The articulation is brought forward to beneath the eye.

At the base of the caudal fin, both above and below, are about half a dozen reduced rays, and these are preceded by a very short, but stout, modified ray, which appears to have

been pointed at both ends. It resembles a similar ray seen in the same situation in *Microcælia dayi*.

Another example, No. 4520b (3696), shows the ventrals placed slightly farther backward than in the type. The pectoral fin has 10 rays. Other specimens, referred to the same species, present the pectoral fin as placed considerably above the ventral border.

It is probable that normally the ventral fins of this species are inserted opposite the middle of the dorsal fin.

This species differs from *A. boops* Agassiz and *A. libanicus* A. S. Woodward in having a shorter head and a smaller orbit. All the specimens, about 10 in number, are from Hajula, except No. 4520c (3836), No. 4520d (3767), No. 4520e (3730), which are from Hakel.

Named in honor of Rev. D. Stuart Dodge, the donor of the collection here described.

Nematonotus longispinus (Davis).

PLATE XXXIV, FIGURE 2; PLATE XXXV.

Pseudoberyx longispina DAVIS (J. W.), Trans. Roy. Dublin Soc. (2), III, 1887, p. 511, pl. xxv, fig. 2.

Nematonotus bottæ (in part) WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 250.

Among the fishes collected by Professor Day at Hajula there is a considerable number which appear to me to be different from *Nematonotus bottæ*, and which I have no means of distinguishing from the species described by Davis, as above cited. The latter has been identified by Dr. A. S. Woodward as *N. bottæ*; and his procedure may prove to be correct. If so, the form here described will require a new specific name.

These Hajula specimens differ from *N. bottæ* especially in the great length of one of the anterior dorsal fin-rays. It also appears to attain a much greater size than does the species from Hakel. Six specimens are especially to be mentioned, as follows: Nos. 4510a-f (3655, 3663, 3664, 3678, 3679, 3723).

No. 4510a (3655) has a total length of 95 mm. The pectorals and ventrals appear to be larger than they are in speci-

mens of *N. bottæ*. The pectoral seems to have had 13 rays. Of these the third is the largest, its breadth being 1 mm, and it is broken off at a distance of 16 mm. from its base. The ventral fin appears to have comprised 8 rays. These are broken off at a distance of 10 mm. from the base, but they have evidently extended much farther. The dorsal probably possessed 12 rays; there are 12 interneurals. Of the rays, the third is greatly elongated, extending nearly to the tip of the caudal fin. In the anal there are 8 or 9 rays. The caudal is deeply forked. There appear to be 28 vertebræ. The scales are large. I count 4 above the lateral line.

No. 4510b (3663) has the caudal region and the caudal fin wanting. The total length must have been close to 170 mm. The head is 39 mm., the depth of the body, 47 mm. The elongated dorsal ray is only 50 mm. long, but had doubtless in life been longer. The pectoral rays are 24 mm. long, but may originally have been longer. The stomach and intestines are represented by their phosphatic contents, the former having formed an S-like loop.

No. 4510c (3664) lacks the body in front of the dorsal fin and most of the remainder of the body below the vertebral column. This individual has had a total length of about 200 mm., a giant when compared with the described specimens of *N. bottæ*. From the fork of the caudal fin to the front of the dorsal is 107 mm. The third dorsal ray has no remarkable length, but it appears to have had the extremity broken off.

No. 4510d (3678) (Pl. xxxiv, Fig. 2), lacks most of the caudal fin. The specimen measures 70 mm. to the base of the caudal. The third dorsal ray has a length of 56 mm., and would extend nearly to the extremity of the caudal fin. The head is 24 mm. long; the body 37 mm. deep. The longest pectoral ray is nearly as long as the head.

No. 4510e (3679) is a nearly complete fish, but it has suffered some weathering. The total length is 102 mm.; to the base of the caudal fin 76 mm. The longest dorsal fin-ray equals 62 mm. No. 4510f (3723) (Pl. xxxv), has a total length of 170 mm. The elongated dorsal ray runs to the

edge of the block bearing the fish; the part remaining measures 77 mm., and would have overlapped somewhat the caudal rays.

Other specimens of the genus found at Hajula are referred to *N. bottæ*. Some of these are quite certainly such, but others may belong to *N. longispinus*; being either quite young individuals, or having had the elongated dorsal ray broken off. If the form here called *N. longispinus* is really *N. bottæ*, it appears strange that more individuals have not been found at Hakel, Davis's specimen being the only one found there possessing a greatly elongated dorsal.

***Microcœlia dayi*, sp. nov.**

PLATE XXXI, FIGURE 3; PLATE XXXIV, FIGURE 1.

There is in the collection a considerable number of specimens of what must be regarded as a distinct species of the genus *Microcœlia*. Of these, No. 4525a (3692) is taken as the type (Pl. xxxiv, Fig. 1). The total length of this is 98 mm.; to the base of the caudal fin 75 mm. All portions of the body are represented, although in places the scales are flaked off, leaving only their imprint on the fine matrix. The length of the head, including the opercular apparatus equals 23 mm. The depth of the body, greatest between the pectoral and the ventral fins, is 28 mm.; but other specimens seem to indicate that this is not natural. From the shoulder girdle to the base of the caudal fin is 53 mm. There are 42 vertebræ behind the pectoral arch, of which 24 belong to the caudal region. Altogether there are 49 vertebræ. Each vertebral centrum is strengthened by about 5 longitudinal ridges on each side. The jaws are tightly closed, so that the teeth cannot be observed. The gape is evidently large and considerably oblique, the length of the lower jaw being 15 mm. The orbit is large; the diameter of the eye, as shown by the sclerotic bones, is 7 mm. There are 25 or 26 rays in the dorsal fin, including 5 short, undivided ones in front. I count 22 supporting interneurals. In the anal fin there appear to be

18 or 19 rays, but there are 20 interhæmals present. The middle of the back, from the occiput to the dorsal fin, is occupied by a line of crimpings, such as have been mentioned by Dr. A. S. Woodward in the case of *M. libanicus*. These have the appearance of narrow folds or ridges, which are directed upward and backward, each ending in a point. What the relation of these crimpings is to the median row of scales has not been determined.

The pectoral fins are missing from this specimen. The ventrals are inserted somewhat in front of the origin of the dorsal, but they may have been moved slightly forward through distortion.

Another specimen, No. 4525*b* (3677), is a slenderer fish than the type, but this elongation may not be wholly natural. The head has a length of 19 mm., while the depth is only 16 mm. The length of the head is contained in the total length of the fish 4 times, as in the type. The fin rays agree closely with those of the type. The ventrals are placed beneath the origin of the dorsal. Fifteen rays are counted in the pectorals and 13 in the ventrals. In front of the interneural bones which support the dorsal fin rays there are at least 12 others which have no rays. These have the upper ends expanded and turned somewhat forward. These are seen also in the type of the species. Both specimens show also an enlarged, free, and spine-like ray in the midline above and below and just in front of the first caudal rays. It was wholly, or almost wholly, buried in the flesh. There are on each side at least 9 branchiostegal rays.

No. 4525*c* (3798) is a third specimen of this species. It is nearly complete, and it has a length of 84 mm.; to the base of the caudal of 65 mm. The head is 21 mm. long; the depth is 19 mm. There are 49 vertebræ. The origin of the ventrals is beneath that of the dorsal fin. There are apparently 26 rays in the dorsal, and these are supported by 23 interneurals. The anal fin is supported by 20 interhæmals. The crimped scales in front of the dorsal are seen.

No. 4525*d* (3803) has a length of 110 mm. No. 4525*e* (3816) shows unusually well the crimpings in front of the

dorsal (Pl. xxxi, Fig. 3, *cr. sc.*). These appear to consist of squarish masses whose broad sides are applied to the similar masses in front and behind, while the narrower sides look outward and upward. There seem to be about three or four of such masses for each median scale.

All the specimens are from Hajula. The species is named in honor of Professor Alfred Ely Day, of the Protestant Syrian College at Beirut, who made the collection which is described in this paper.

***Rhinellus delicatus*, sp. nov.**

The type of this species is a small and probably young fish. Its number is 4530 (3661). The total length is only 32 mm.; from the snout to the base of the caudal fin is 26 mm. It is also quite slender, the greatest depth being only 2.5 mm. The head is injured, so that little except the upper and lower jaws remains. The whole head seems to have been 7 mm. long. The jaws are slender and are 4 mm. long, but it is not certain that the extremities are not broken off. No teeth are to be seen. Pectoral, ventral, dorsal, anal, and caudal fins are all present. The pectorals have a length of 4 mm. The ventrals are inserted 4.8 mm. behind the base of the pectorals. The number of the rays cannot be determined. The origin of the dorsal fin is about 2 mm. behind that of the ventrals. The rays are delicate, and those that can be counted are 8 in number, but these probably do not represent the whole number originally present. The anal fin is placed halfway between the dorsal and the caudal fins. The number of its rays cannot be determined. The caudal fin is deeply forked.

There appear to be 43 vertebræ. These, especially the more anterior ones, are somewhat longer than deep. No ribs are seen. Scales are present, but their boundaries are indistinguishable.

This fish differs from others of the genus in having the origin of the dorsal fin much nearer the occiput than to the base of the caudal fin.

This species comes to us from Hajula.

GONORHYNCHIDÆ.

Charitosomus hakelensis (Davis).

Spaniodon hakelensis DAVIS (J. W.), Trans. Roy. Dublin Soc., III, 1887, p. 591, pl. xxxiv, fig. 4.

Charitosomus hakelensis WOODWARD (A. S.), Ann. and Mag. Nat. Hist. (7), II, 1898, p. 412; Cat. Foss. Fishes, IV, 1901, p. 274.

Some specimens of this species appear to have the ventral fins situated immediately below the origin of the dorsal. No. 4523a (3746) is from Hakel. It is much elongated and very slender, but this form may be due to distortion. The anterior portion of the head is missing. The ventrals are placed just below the origin of the dorsal. No. 4523b (3817) has apparently 44 vertebræ, and the ventrals are situated slightly behind the front of the dorsal.

In the Cope collection there is a small lot of fishes from Mount Lebanon. There is no record of the locality, but all the species are those found at Hakel. Among these are two specimens of this species. No. 3895 is a nearly complete fish, only the anal fin and a portion of the caudal being gone. The length to the base of the caudal is 82 mm. The elements of the snout are injured, so that not much information regarding them is to be obtained. Dr. A. S. Woodward's conclusions regarding the small size of the mouth are confirmed. No teeth are observed. In this specimen also the ventral fins are below the front of the dorsal. There are 44 vertebræ. Where the scales are present they form an incrustation whose elements cannot be distinguished. Where they are flaked away from the matrix but little impression is left. There are, however, faint lines which seem to indicate that the scales were of an elongated diamond-shaped form, ending behind in a sharp point. Nothing is seen to suggest the spiny scales of *Gonorhynchus*.

The other specimen, No. 3894, is without the head and the caudal fin. The length from the pectoral arch to the base of the caudal has been more than 100 mm. The ventral fins are placed below the middle of the dorsal. Each ventral fin has plainly 8 rays. There are at least 11 rays in the pectoral

[*Fune, 1903.*]

fin. Where the incrustation of scales remains there is seen a number of very distinct narrow, longitudinal, whitish lines along the body. These probably indicate rows of scales. I count about 10 of these lines below the vertebral column, and apparently 5 or 6 above it. Possibly this species was longitudinally striped. No additional information regarding the scales is to be obtained.

ANGUILLIDÆ.

Urenchelys A. S. Woodward.

Urenchelys WOODWARD (A. S.), Ann. Mag. Nat. Hist. (7), V, 1900, p. 322; Cat. Foss. Fishes, IV, 1901, p. 337; Foss. Fishes English Chalk, 1902, p. 30.

Urenchelys germanus, sp. nov.

PLATE XXXVI, FIGURE 1; PLATE XXXVII, FIGURE 7.

There are several specimens of eels from Hajula which are referred to this supposed new species. None of these are complete fishes, more or less of the caudal region being missing in all of them. No. 4515a (3654) is regarded as the type (Pl. xxxvi, Fig. 1). Of this individual, perhaps about 25 mm. of the extremity of the tail is gone. The remainder of the animal is well preserved. Anteriorly the head and trunk are viewed from above; from just in front of the anal fin backward the fish lies on its side. This species is closely related to *U. avus*, described by Dr. A. S. Woodward from the Upper Cretaceous of Sahel Alma (Cat. Foss. Fishes, IV, p. 337, pl. xviii, figs. 1, 2), and there are few characters by means of which it may be distinguished. However, it appears that the part of the trunk which lies in front of the anal fin has a greater number of vertebræ, and it is longer in proportion to the length of the head than in *U. avus*. The latter is stated to have about 35 vertebræ in front of the anal, whereas *U. germanus* possesses over 40. This portion of the trunk is also about 5 mm. longer than that of *U. avus* relatively to the length of the head.

For these reasons I regard the Hajula specimens as forming a distinct species.

There is in none of the individuals any trace whatever of the ventral fins, although the fishes must have been enclosed in the matrix without any disturbance of their parts. This is indicated by a brown stain on the matrix, which shows that the outline of the body is unbroken in the region where the ventrals would have been located. It is further evident that they are not specimens of *Anguillavus quadripinnis*, since the head of the latter is longer and more pointed; furthermore, in the specimens referred to *Urenchelys* there are no indications of plates in the region of the lateral line.

The head of the type of *U. germanus* has a length of 24 mm.; the portion of the trunk between the head and the anal fin measures 46 mm., and the part of the caudal region remaining equals 74 mm. Between the occiput and the anal fin I count 43 vertebræ. The neural arches of this region are broken away. Slender ribs project on each side. Behind the origin of the anal fin are 47 vertebræ, making 90 in all. In case the caudal region was more than twice as long as the portion of the trunk in front of the anal, as is the case with *U. avus*, there must have been considerably more than 100 vertebræ in the vertebral column.

The upper surface of the skull closely resembles that of *Anguilla*. Vomer, ethmoid, united frontals, the parietals, and probably the supraoccipital and epiotics can be located, although the sutures cannot always be seen. The opercular apparatus is well developed, showing apparently all the elements found in *Anguilla*, and possessing the peculiarities of the latter genus. The lower jaw is two thirds the length of the cranium. The palatopterygoid bar seems to have the structure seen in *Anguillavus*. Many teeth are seen on both the maxilla and dentary.

Both pectoral fins are well displayed, and each had at least 18 rays. As already stated, there are no evidences of ventral fins. The dorsal fin is seen to come as far forward as the 13th vertebra from the occiput. Just behind the head there are 8 vertebræ in 10 mm.; in the anterior portion of the caudal region there are only 6 in this space. From this and other specimens it is seen that the notochord passed uninter-

ruptedly through the vertebral centra. The neural spines of the caudal region are moderately stout and are smaller at their bases than in the middle of their length. The hæmal spines are slender and tapering, and have long, delicate flesh-bones attached to them.

No. 4515*b* (3762) appears to have only 40 or 41 vertebræ in front of the anal fin. In No. 4515*c* (3695) we have what seem to be the most anterior rays of the dorsal fin, and these are placed over the 12th vertebra behind the occiput. Another specimen confirms this view.

No. 4515*d* (3790), from Hakel, probably belongs to this species, since it is too large to belong to *U. hakeleensis*. This presents the vertebral column seen from above. In the case of some of the vertebræ the neural arches have slipped to one side of their centra, so that the upper surfaces of the latter are exposed. The right and left portions of each arch are distinct, never having been co-ossified (Pl. xxxvii, Fig. 7).

No. 4515*e* (3860) presents the head and the trunk to a short distance behind the origin of the anal fin. Here also there are 43 vertebræ in front of the anal. The head is flattened from above, and its hinder portion is broken away. Numerous short blunt teeth are seen on the dentary and the maxilla. There are also traces of vomerine teeth. Eleven branchiostegal rays are counted on one side. They extend far backward and the distal ends of some are curved upward. Both pectoral fins are displayed, and each seems to have possessed at least 20 rays. There are no traces of ventral fins, although the conditions seem favorable for their preservation had they existed.

ANGUILLAVIDÆ, fam. nov.

Apodes with well-developed cleithrum, pectoral arch, pectoral and ventral fins, and a distinct caudal fin. Dorsal and anal fins extended. Palatopterygoid arch developed. Scales rudimentary or absent; in some cases a row of enlarged plates on each side, probably on the lateral lines. Ribs present. One genus, *Anguillavus*.

Anguillavus, gen. nov.

The characters of this genus are included in those of the family. The type of the genus is *Anguillavus quadripinnis*.

Anguillavus quadripinnis, sp. nov.

PLATE XXXVI, FIGURES 2 AND 3.

Of this species there is recognized in the collection only a single specimen, No. 4512 (3796), collected at Hajula. This specimen lacks the whole of the caudal region. It is lying on the block with the dorsal surface directed upward. The following dimensions are noted: Length of the head to the occiput, 25 mm.; to the posterior border of the opercular apparatus, 33 mm. Length from the snout to the thirty-eighth vertebra, 90 mm.; height of the body, 14 mm.

The suspensory apparatus of the jaws is extended laterally. Hyomandibular and quadrate are present, and from the distal end of the latter the mandible runs forward and projects somewhat beyond the snout, as in *Anguilla*. Parallel with the premaxillæ on each side are the maxillæ. Starting from the quadrate there runs forward on the left side a very distinct palatopterygoid arch. The pterygoid portion terminates 7 mm. behind the snout. For a great part of its length this portion has a width of only one millimeter, and the width is occupied by two distinct bones. Of these, the inner is regarded as the entopterygoid, the outer, as the ectopterygoid. The anterior ends of these bones lie on the upper surface of the parasphenoid, as do also the corresponding bones of the other side; but this position is probably due to some shifting during decomposition. Immediately in front of these pterygoids there is, on each side, a small, scale-like bone which may be the prefrontal. Outside of these, underlapping the anterior ends of the pterygoids, and extending forward toward the snout, are two delicate bones, one on each side, and these I regard as the palatines. The appearance of these bones indicates that they were already much reduced. There are almost certainly no teeth on the arch thus constituted. A bone resembling a supramaxilla lies above the maxilla.

Behind and mesiad of the palatopterygoid arch are seen the anterior ends of the stout hyoids. Slender branchiostegals appear to be attached to these near their anterior ends. Some of the upper branchiostegals are widened out at their posterior ends and curled upward, but not so conspicuously so as in *Anguilla*. The opercular bones appear to have resembled those of *Anguilla*, but mostly only impressions of these on the matrix remain.

The bones of the roof of the skull have been considerably injured, so that the exact limits of the elements cannot be determined.

Fragments of the cleithrum are present. The pectoral fins are well preserved, and the rays, apparently 16 in number, had a length of nearly 9 mm. The number of the baseosts cannot be determined. There are distinct evidences of the scapula and the coracoid.

Both ventral fins are present, attached to their supporting bones (Pl. xxxvi, Figs. 2, 3, *v. f.*). The latter are only slightly more than 2 mm. long. The extremities of the fin rays are broken off. There appear to have been about 8 rays in each fin. These fins are placed 65 mm. behind the occiput, and were doubtless only a short distance in front of the anal fin. Owing to the position of the fish, the dorsal fin is not displayed.

There are 31 vertebrae preserved, the last of which lies over the ventral fins. The centra are constricted, and 5.5 of them occupy the space of 10 mm. The ribs are slender and rather long, some of them 5.5 mm.

There are evidences of the presence of two rows of bony plates, one on each side of the body. These probably occupy the position of the lateral line. On the right side these are shown as impressions on the matrix, and, beginning just behind the cleithrum, continue as far as the specimen is preserved. On the left side, they may be followed throughout the greater part of the abdominal region, and in several places are represented by thin bony scales. These plates, or scales, are relatively large, six of them being found in 10 mm. No other scales or plates are seen on the body.

Collected at Hajula.

***Anguillavus bathshebæ*, sp. nov.**

PLATE XXXVII, FIGURE 1.

The type of this species is No. 4513a (3704), while No. 4513b (3685) is regarded as the paratype. The type is from Hakel, the paratype is from Hajula. No. 4513c (3868) is a second specimen from Hajula.

The type is a nearly complete fish, wanting only the tip of the snout and the extremities of the rays of the caudal fin (Pl. xxxvii, Fig. 1). The paratype presents the hinder half or more of the body. The total length of the type is 168 mm. Two millimeters may be added for the missing portion of the snout. The whole head would then measure, to the occiput, 12 mm.; to the cleithrum, 19 mm. The dorsal fin has evidently had its origin 13 mm. behind the occiput, since there the first rays are seen, and in front of these a stain on the matrix plainly reveals the outline of the body. The dorsal fin continues backward to near the caudal fin, but is plainly distinct from the latter. The caudal is fan-shaped, rounded at the extremity, and is supported by 5 or 6 hypural bones. These characters are confirmed by the paratype. The anal begins 59 mm. behind the occiput and continues to near the caudal fin. The ventral fins have their origin 50 mm. behind the occiput. In the type only one of these fins is preserved, and an injury to the matrix has removed both the supports of these fins. Another flaking away of the rock occurs just behind the ventral; but these rays cannot belong to a detached portion of the anal, since they have the structure of ventral rays, and not that of anal rays. Moreover, the course of the hinder portion of the intestine is shown by its fossilized contents, and this passes above the rays in question. In the paratype both ventrals are in their normal position and attached to their supports. Each of these fins is about 5 mm. long and is composed of 8 rays.

There are apparently 44 vertebræ in front of the origin of the anal fin and 57 behind its origin. The neural arches are long and low, and each is overlapped in front by the preceding arch. The centra are long, constricted in the middle

of the length, and they are permitted the notochord to pass continuously through them. In the abdominal region there appear to be no neural spines. These are first seen as low and rather broad plates just over the origin of the anal fin. They soon become considerably higher and quite slender, but expanding somewhat toward their distal ends. The hæmal arches are well developed, the spines of many of the anterior ones being expanded at their distal extremities. Only the merest traces of a few ribs are seen in the specimens.

The rays of the dorsal and anal fins are slender, and there are, on an average, two and one third interneurals and interhæmals for each vertebra.

The cleithrum is preserved in its natural position. It is sigmoid in form, and is pointed at both the upper and the lower end. The substance of the pectoral fins is wanting, but there is present what appears to be the imprint of one on the matrix.

So far as preserved, the head resembles that of *Anguilla*. The hinder portion of the lower jaw is present, articulated to the quadrate. It is not certain that any part of the palatopterygoid arch is seen. A strongly developed hyoid arch is present, and to each side are attached at least 15 branchiostegal rays. These are long and slender, some of the uppermost ones being broadened at their hinder ends and turned upward. The opercular bone is probably represented by a flake of bone.

Both the specimens appear to have been enveloped in a fine matrix without any part having been disturbed. The lower outline of the body is distinctly marked by a brown stain. This stain and minute patches of similar stain on the sides of the abdominal region may indicate the existence of scales, but of these there is no other evidence. There are no traces of enlarged scales along the sides of the body, such as are found in *A. quadripinnis*.

This eel resembles rather closely Davis's *Urenchelys hakeleensis*, and at first it was regarded as such. A closer study has, however, made it certain that the two are distinct species. In *U. hakeleensis* the dorsal fin probably came forward to the

occupit. According to the published figures of *U. hakelensis*, the vertebral centra are higher than long. This is confirmed by the examination of three small specimens in this collection. In *A. bathshebæ*, on the contrary, the centra are longer than high, longer, in fact, than the height of the centrum and the neural arch taken together. The figures of *U. hakelensis* show that the portion of the body in front of the anal fin measures 38 mm., the portion behind this fin to the base of the caudal, 53 mm. In *A. bathshebæ* the two portions of the body are practically equal. Of course, the presence of ventral fins in *A. bathshebæ* and their absence in *U. hakelensis* constitutes the most important difference between the two species; but the other differential characters given may enable us to distinguish specimens when the region of the ventral fins is injured or absent.

Named in honor of Bathsheba, who attained the distinction of being a wife of one great king and poet and the mother of another great king and poet.

ENCHELIIDÆ, fam. nov.

Apodes destitute of cleithrum, of all paired fins, and, so far as known, of all median fins. Opercular apparatus greatly reduced. Vertebral centra apparently diplospondylous. No scales.

Enchelion, gen. nov.

Characters included in those of the family. Type *E. montium*. Derivation, *εγγέλειον*, a little eel.

Enchelion montium, sp. nov.

PLATE XXXVII, FIGURES 2-6.

The types of this species are No. 4514a (3765) and No. 4514b (3766). These specimens are both from Hakel.

No. 4514a (3765) (Pl. xxxvii, Fig. 2) presents a vertebral column extending from the extremity of the tail forward to an unknown distance behind the head. The length of the

part of the column present is 143 mm. No. 4514b (3766) (Pl. xxxvii, Figs. 3, 4) presents the head and 45 mm. of the vertebral column. It has belonged to a somewhat smaller specimen than the other. The striking feature of the vertebral axis of this form is that all the vertebræ, from the head to the tail, have been represented each by two rings or "bodies," apparently just such a condition as we find in the middle of the caudal region of *Amia* among living fishes and in that of *Eurycormus* of the Jurassic. That this condition exists in the species before us is shown by the fact that throughout the series only alternate vertebral centra possess neural spines, while in the caudal region only those centra bear hæmal spines which have neural spines.

In view of my results in the study of the vertebral column of *Amia* (Field Columbian Mus. Pubs., Zoöl. Ser., I, p. 37, 1895), I hold that a vertebral ring possessing a neural arch and one without such an arch together constitute the equivalent of such a vertebra as we find in ordinary fishes; and that the archless ring belongs, not with the ring situated immediately in front of it, but with the one just behind it. In the species before us the rings, or "bodies," which have no neural spines appear to possess neural arches, and thus seem to differ from the corresponding elements in *Amia*. However, in the tail of *Amia* the rings which have no neural arches have their upper halves formed from ossifications which develop on the upper surface of the notochord and on each side of the myelon; and there appears to be no reason why these ossifications should not sometimes grow upward and form an arch over the myelon. Such an arch would not, however, be the equivalent of the arch which develops the spine, since this arch is formed, in *Amia* at least, by a pair of bones distinct from the centrum on which it rests.

For reasons detailed in the paper referred to, I shall call the 'centrum' which is devoid of either neural spine or hæmal arch an epihypocentrum; that provided with either or both arches, a pleurohæmacentrum. The former corresponds with what Dr. Zittel and others call the hypocentrum; the latter with what is called a pleurocentrum.

In the species before us I find 17 vertebral rings in a length of 10 mm. in the larger specimen, and 23 in the same length of the smaller one. The pleurohæmacentra are usually somewhat shorter than their companion rings. Both have their neural arches low and extending backward so as to overlap the arch just behind it. The epihypocentra present a short backwardly directed spine and a shorter process which extends forward somewhat over the arch in front. The pleurohæmacentra possess neither process. Both kinds of centra send downward a rather broad, short process, that of the epihypocentrum being apparently somewhat longer. No ribs are found articulating with any of these processes. Both the pleurohæmacentra and the epihypocentra are constricted about the middle. I have not been able to determine whether or not they permitted the passage of the notochord.

When we come to examine the caudal region we find the pleurohæmacentra not especially different from those of the abdominal region (Pl. xxxvii, Fig. 6). The inferior processes are, however, somewhat smaller. On the other hand, the epihypocentra are furnished with well-developed hæmal arches. These can be seen to continue to near the tip of the tail. Altogether there are close to 275 vertebral rings preserved in the larger specimen. Of these about 170 belong to the caudal portion of the body. This would indicate that in the tail there are 85 complete vertebræ.

No traces are seen anywhere of either fin rays or of inter-neural or interhæmal bones. All were probably absent. The extremity of the tail is shown only by a faint impression on the matrix, and there are no traces of a caudal fin. Likewise, there are no indications anywhere of scales.

The head of this species appears to be remarkably small. Its length in the smaller specimen, measured to the occiput, is only 4.5 mm.; but, including the branchiostegal rays, 9.5 mm. Its height is 1.5 mm. The snout appears to have been conical. In the jaws are small teeth in more than a single row. The branchiostegal rays are slender, much longer than the skull, and the hinder ends are somewhat curved upward. No opercular bones or pectoral arch is present.

BERYCIDÆ.

***Pycnosterinx levispinosus*, sp. nov.**

PLATE XXXVI, FIGURE 4.

This small species was found at Hajula. The number of the type and only specimen is 4528 (3671).

This has been a very short-bodied, elevated, and compressed fish. It is possible that distortion has somewhat diminished its length, but of this there is no evidence. The length from the snout to the base of the caudal fin is 29 mm., while the greatest depth is 30 mm. The length of the head to the border of the operculum is 12.5 mm. The body has been covered with scales of moderate size. Whether or not these were ctenoid is yet uncertain. There is some indication that they were feebly ctenoid. The scales have also covered the bases of the dorsal and anal fins.

The dorsal fin has been composed of 7 or 8 spines and apparently 16 soft rays. Seven spines are present, but it seems probable that the most anterior one has been eroded away. The spines are stout and entirely smooth. The tip of the hindermost has apparently been segmented, but its size makes it proper to count it with the spines. Through erosion of portions of the bone it is seen that the spines and the supporting interneurals have been hollow, their lumen being now filled with calcite. It is also revealed that the notochord passed continuously through the vertebral centra.

The anal fin has had 3 or 4 spines and 10 to 12 soft rays. It seems probable that the most anterior one has been weathered away. These spines are stout and smooth.

The caudal fin has been forked. The pectoral fin is present in its natural position, but the rays have been damaged. The ventrals arise below the pectoral. The spine has been stout, and long enough to reach to the first soft rays of the anal fin. It is now represented mostly by its imprint in the matrix.

From the other species of the genus found at Mount Lebanon, except *P. dubius*, this species differs in the greater number of dorsal spines and smaller number of soft rays.

From *P. dubius* it differs in having fewer soft rays in the dorsal and anal fins, and in having these smooth, instead of ribbed.

The possibility that this fish is specifically identical with the one here described as *Aipichtys formosus* has not escaped the attention of the writer. Were the dorsal spines present in the latter species, this question could be settled more satisfactorily. It is regarded as belonging to *Aipichtys* rather than to *Pycnosterinx*, because the scales are smooth-edged, and there appear to be thickened scales along the border of the abdomen. Aside from the generic differences, *Pycnosterinx levispinosus* has almost certainly been a deeper-bodied fish. If we measure the distance from the anterior anal spine to the anterior soft rays of the dorsal in the two fishes, we find that in *P. levispinosus* this measurement is equal to the distance from the base of the caudal fin to the snout; while in the case of *Aipichtys formosus* the dimension will be equal only to the distance from the caudal base to the front of the opercular apparatus. Again, the ventral spine of *P. levispinosus* extends backward to the first soft ray of the anal fin, while in *A. formosus* it reaches only to the first spine. Lastly, there do not seem to have been any thickened scales on the abdomen of *P. levispinosus*.

CARANGIDÆ.

Aipichtys formosus, sp. nov.

PLATE XXXII, FIGURES 2 AND 3.

Of this supposed new species there is in the collection only a single specimen, No. 4519 (3831). This is incomplete, the head and the anterior portion of the body being broken away from about the articulation of the lower jaw to the middle of the dorsal fin. As a consequence, various characters are undetermined, and we cannot be wholly certain regarding the generic position of the fish.

No dorsal spines remain in the specimen. Of the articulated rays there are 13 present; possibly, but not certainly, all that were possessed by the fish. The anal fin comprises

4 short stout, spines and 12 articulated rays. The longest anal spine is only 7 mm. long, and all the spines are entirely smooth. The ray which I recognize as the first articulated one is very stout and resembles one of the spines, but it is divided and articulated at the distal end.

The base of the left pectoral fin is present. The pelvic fin has its origin directly below the pectoral. The first ray is long and thick, the length being 13 mm. and the extremity reaching the anal fin. There are at least 5, and possibly 6 or 7, articulated rays; but the number cannot be definitely determined. The caudal fin is forked, but the extremities of the rays are not exposed. Seven branchiostegal rays are counted. There are 14 caudal vertebræ.

The scales are thin, and their hinder borders have a perfectly smooth edge. They are rather large, there being about 8 longitudinal rows above the vertebral column and 12 below it. The greatest height of the body equals 38 mm.; the distance from the pectoral arch to the base of the caudal is about 28 mm.

This fish has been assigned provisionally to the genus *Aipichtys*, but it possibly belongs to *Acrogaster*, of the Berycidæ. Nothing is known regarding the structure of the head, and the number of the pelvic soft rays is uncertain. The rather large scales suggest *Acrogaster*; while, on the other hand, there appears to be a series of thickened scales along the lower edge of the abdomen, as in *Aipichtys*.

From all the described species of *Aipichtys* this differs in having a smaller number of anal rays.

From *Acrogaster heckelii* this fish differs in having a greater number of anal spines and a smaller number of articulated rays.

Collected at Hajula.

List of the Fishes found at the Three Fish-bearing Localities of Mount Lebanon.

Sahel Alma.	Hakel.	Hajula.
	HEXANCHIDÆ.	
Heptranchias? gracilis.		
	SCYLLIIDÆ.	
Scylliorhinus elongatus.		
Scylliorhinus curtirostris.		
Scylliorhinus tumidens.		
Mesiteia sahel-almæ.		
	LAMNIDÆ.	
Scapanorhynchus lewisii.		
Scapanorhynchus elongatus.		
Otodus latus.	Otodus sulcatus.	
	SQUALIDÆ.	
Squalus latidens		
S. ? primævus.		
	SQUATINIDÆ.	
Squatina crassidens.		
	PRISTIDÆ.	
Sclerorhynchus atavus.		Sclerorhynchus solomonis.
		Sclerorhynchus hiram.
		" sentus.
	RHINOBATIDÆ.	
Rhinobatus tenuirostris.	Rhinobatus maronita.	Rhinobatus eretes.
Rhinobatus intermedius.		
Rhinobatus latus.		
	RAJIDÆ.	
Raja primarmata minor.	Raja expansa.	Raja whitfieldi.
	DASYATIDÆ.	
	Cyclobatis oligodactylus.	Cyclobatis oligodactylus.
	Cyclobatis major.	

Sahel Alma.	Hakel.	Hajula.
	BELONORHYNCHIDÆ?	
	<i>Stenoprotome hamata.</i>	
	PYCNODONTIDÆ.	
	<i>Coccodus armatus.</i>	<i>Coccodus insignis.</i>
	" <i>lindstroemi.</i>	
	<i>Xenopholis carinatus.</i>	
	<i>Palæobalistum goedeli.</i>	
	MACROSEMIIDÆ.	
	<i>Petalopteryx syriacus.</i>	
	" <i>dorsalis.</i>	
	OLIGOPLEURIDÆ.	
	<i>Spathiurus dorsalis.</i>	
	ELOPIDÆ.	
<i>Holcolepis gracilis.</i>	<i>Holcolepis attenuatus?</i>	
" <i>attenuatus.</i>	" <i>sardinioides.</i>	
<i>Spaniodon blondeli.</i>	" <i>lewisi.</i>	<i>Holcolepis lewisi.</i>
" <i>elongatus.</i>		
" <i>latus.</i>		
<i>Thrissopteroides tenuiceps.</i>		
<i>Thrissopteroides pulcher.</i>		
<i>Istieus lebanonensis.</i>		
	ICHTHYODECTIDÆ.	
	<i>Eubiodectes libanicus.</i>	<i>Eubiodectes libanicus.</i>
	CTENOTHRISSIDÆ.	
	<i>Ctenothrissa vexillifer.</i>	<i>Ctenothrissa signifer.</i>
	" <i>ovalis.</i>	
	CLUPEIDÆ.	
<i>Histiothrissa crassipinna.</i>	<i>Pseudoberyx syriacus.</i>	<i>Pseudoberyx syriacus.</i>
	" <i>bottæ.</i>	
	" <i>grandis.</i>	
	<i>Scombroclupea macrophthalma.</i>	<i>Scombroclupea macrophthalma.</i>
	<i>Scombroclupea gaudryi.</i>	<i>Scombroclupea gaudryi.</i>
	<i>Diplomystus brevissimus.</i>	<i>Diplomystus brevissimus.</i>
	<i>Diplomystus birdi.</i>	

Sahel Alma	Hakel	Hajula
HALOSAURIDÆ		
Enchelurus syriacus.		
NOTACANTHIDÆ.		
Pronotacanthus sahel- almæ.		
DERCETIDÆ.		
Leptotrachelus triqueter.	Leptotrachelus serpentinus.	Leptotrachelus serpentinus.
Leptotrachelus gracilis.	Leptotrachelus hakelensis.	
ENCHODONTIDÆ.		
Enchodus longidens.	Enchodus marche- settii.	Enchodus marche- settii?
“ major.		
Pantopholis dorsalis.	Eurypholis boissieri. Halec microlepis. Prionolepis cata- phractus. Prionolepis laniatus.	Eurypholis boissieri. Halec microlepis. Prionolepis cata- phractus.
MYCTOPHIDÆ.		
Osmeroides megap- terus.	Osmeroides wood- wardi.	
Osmeroides pusillus.	Osmeroides ponti- vagus.	Osmeroides ponti- vagus.
	Osmeroides ornatus.	
Acrognathus libanicus.	Acrognathus dodgei.	Acrognathus dodgei.
Leptosomus macrurus.	Leptosomus minimus.	Leptosomus minimus.
	Nematonotus bottæ.	Nematonotus bottæ.
	“ longispinus.	“ longispinus.
Opistopteryx gracilis.	Microcœlia libanica.	Microcœlia dayi.
Rhinellus furcatus.		Rhinellus delicatus.
“ ferox.		
“ damoni.		
GONORHYNCHIDÆ.		
Charitosomus major.	Charitosomus	
“ lineolatus.	hakelensis.	
CHIROTHRICIDÆ.		
Chirothrix libanicus.	Telepholis? tenuis.	
“ lewisi.	Exocoetoides minor.	Exocoetoides minor.
ANGUILLIDÆ.		
Urenchelys avus.	Urenchelys hakelen- sis.	Urenchelys germanus.

Sahel Alma.	Hakel.	Hajula.
ANGUILLAVIDÆ.		
	Anguillavus bathshebæ.	Anguillavus quadripinnis. Anguillavus bathshebæ.
ENCHELIIDÆ.		
	Enchelion montium.	
BERYCIDÆ.		
Acrogaster heckeli. " davisii.		
Pycnosterinx russeggeri.		Pycnosterinx levispinosus.
Pycnosterinx discoides. " gracilis. " dubius. " elongatus. " latus.		
Hoplopteryx syriacus. " stachei. " oblongus.	Hoplopteryx lewisi.	Hoplopteryx lewisi.
Dinopteryx spinosus.		
STROMATEIDÆ.		
Orosoma sahel-almæ. " intermedium. " pulchellum.		
CARANGIDÆ.		
	Aipichtys velifer. " minor.	Aipichtys formosus. " minor.

An examination of the lists given above shows that the beds at Sahel Alma contain an assemblage of species which is quite different from that found at either of the other localities; furthermore, that the fauna of Hajula closely resembles that of Hakel. From Sahel Alma there have been collected 62 species; from Hakel, 50 species; and from Hajula, 34 species. Of those obtained at Sahel Alma it is not certain that a single species has been collected at either of the other localities. It is possible that *Holcolepis attenuatus*, of Sahel Alma, occurs also at Hakel, and that *Enchodus longidens* is common to all three localities; but this is not yet proved. On the other hand, out of the 34 species found at Hajula, 20 are

common to this place and Hakel. This indicates that the fish-bearing beds of these two localities are on nearly the same geological level. In case the deposits are not synchronous, can we reach any conclusion regarding their relative ages?

We observe that the Hajula fauna is related to that of Sahel Alma by the presence of three genera which are not found at Hakel, viz., *Sclerorhynchus*, *Rhinellus*, and *Pycnosterinx*. Furthermore, that pycnodonts, especially abundant during the Jurassic, are well represented at Hakel, but by only a single species at Hajula; that, of *Pseudoberyx*, there are three species at Hakel, and only one, so far as we know, at Hajula. While too great reliance must not be placed on these observations, they appear to indicate that the beds at Hakel are the lowest; that these are followed at no great distance by those at Hajula; and that those at Sahel Alma are considerably above the latter. That the latter beds are higher in the series than those at Hakel has been the conclusion of most geologists. This is further confirmed by the occurrence of Macrosemiidæ, one oligopleurid, and many pycnodonts at Hakel; while at Sahel Alma there are few or none of these, but many Berycidæ, altogether 12 species. The large number of sharks found at Sahel Alma, mostly belonging to living genera, may be regarded as indicating a more recent time than that during which the beds of the other localities were deposited.

Explanation of the Abbreviations employed on the Plates.

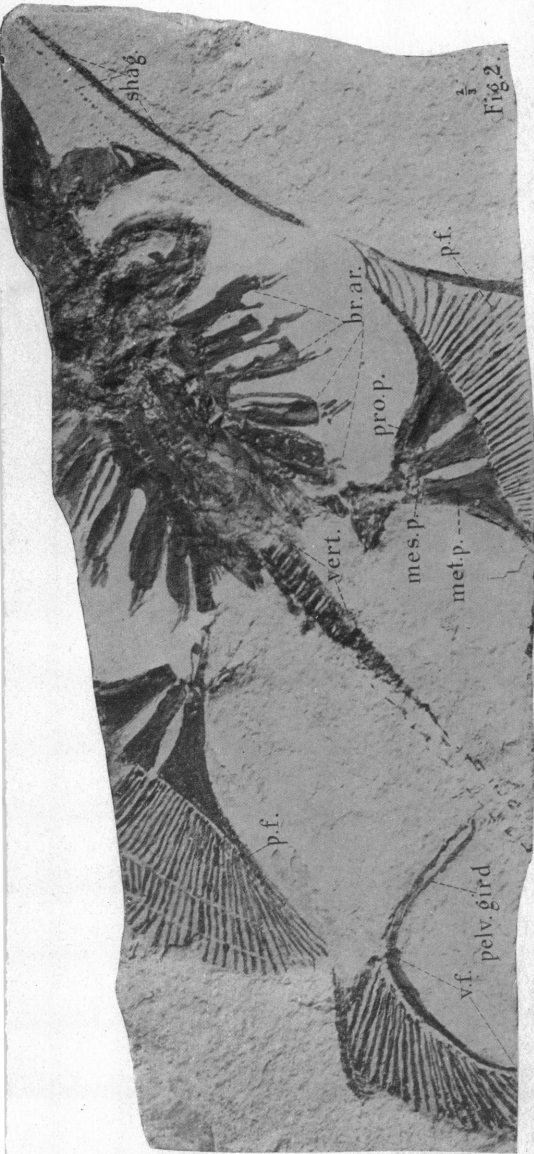
- | | |
|---|--------------------------|
| a. f. anal fin. | d. r. dorsal fin ray. |
| ant. pr. anterior transverse process (<i>Leptotrachelus</i>). | d. sc. dorsal scutes. |
| br. branchiostegals. | ep. hy. epihypocentrum. |
| br. ar. branchial arches. | h. a. hæmal arch. |
| c. f. caudal fin. | hy. hyoid. |
| cl. cleithrum. | hym. hyomandibular. |
| cran. cranium. | int. intestine. |
| cr. sc. crimped scales (<i>Microcalia</i>). | i. op. interoperculum. |
| den. dentary. | lat. sc. lateral scutes. |
| derm. sc. dermal scutes. | mes. pt. mesopterygoid. |
| d. f. dorsal fin. | met. pt. metapterygoid. |
| | mo. mouth. |

mx.	maxilla.	pro. p.	propterygium.
na, cp.	nasal capsule.	p. sp.	pectoral spine.
nar.	nares.	pt.	pterygoid.
n. sp.	neural spines.	qu.	quadrate.
oc.	occiput.	rost.	rostrum.
op.	operculum.	rost. t.	rostral teeth.
orb.	orbit.	shag.	shagreen.
par.	parasphenoid.	s. op.	suboperculum.
pelv. gird.	pelvic girdle.	spl. t.	splenia teeth.
pl. h.	pleurohæmocentrum.	v. a.	neural arches.
p. op.	preoperculum.	v. c.	vertebral centra.
post. pr.	posterior transverse process.	v. f.	ventral fin.
		v. f. s.	ventral fin support.

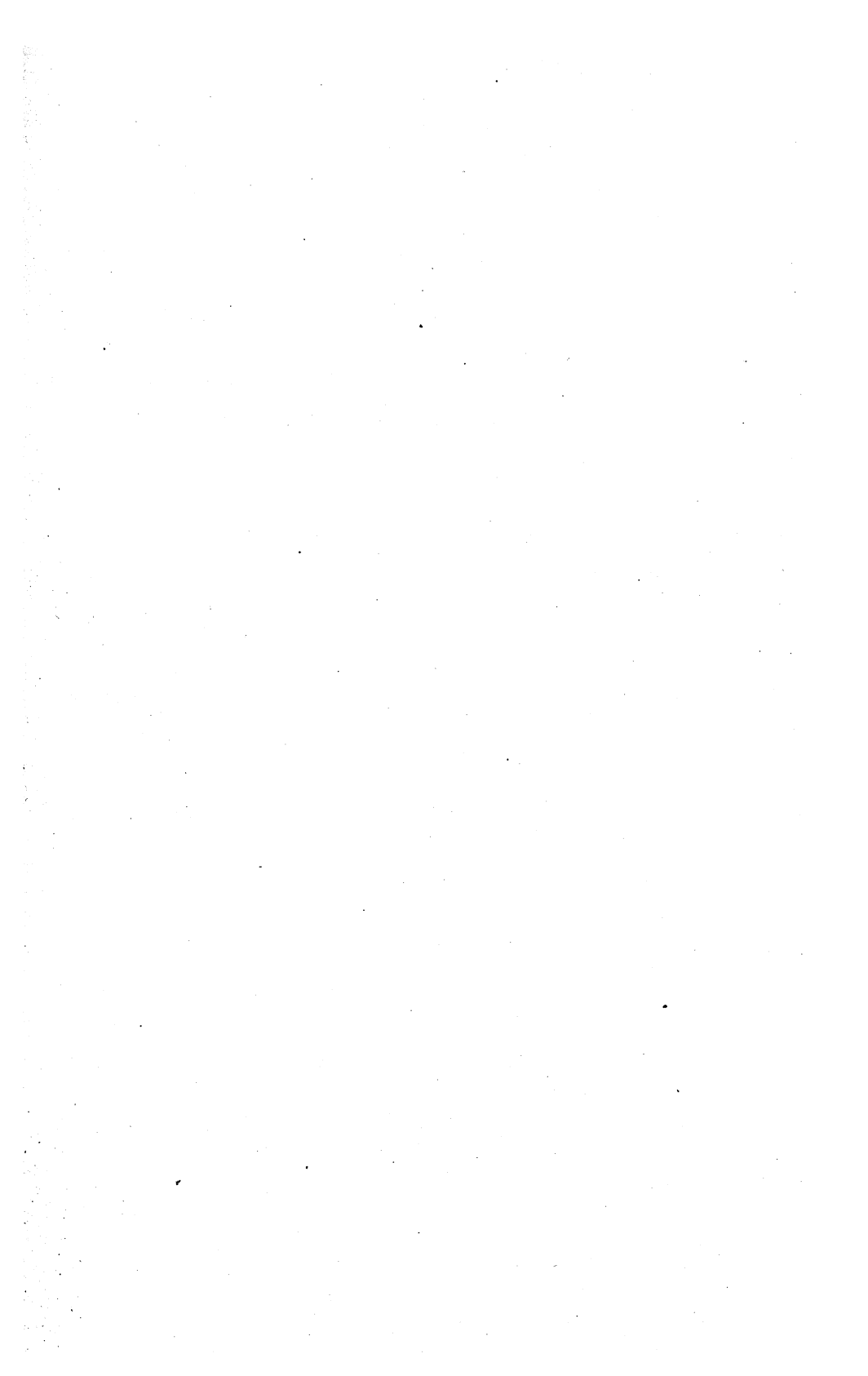
EXPLANATION OF PLATE XXIV.

FIG. 1.—*Sclerorhynchus* sp. undet. Page 398. Trunk from near pectoral fin to near root of caudal fin. $\times \frac{2}{3}$. No. 4502 (3686). *d. f.*, anterior dorsal fin; *d. f.*', posterior dorsal fin; *v. f.*, ventral fin. Anteriorly is seen the skeleton of a swallowed fish.

FIG. 2.—*Rhinobatus eretes* Hay. Page 404. Part of head and part of trunk. Type. $\times \frac{2}{3}$. No. 4500 (3715). *br. ar.*, branchial arches; *mes. p.*, mesopterygium; *met. p.*, metapterygium; *p. f.*, pectoral fin; *pelv. gird.*, pelvic girdle; *pro. p.*, propterygium; *shag.*, shagreen; *v. f.*, ventral fin; *vert.*, vertebræ.

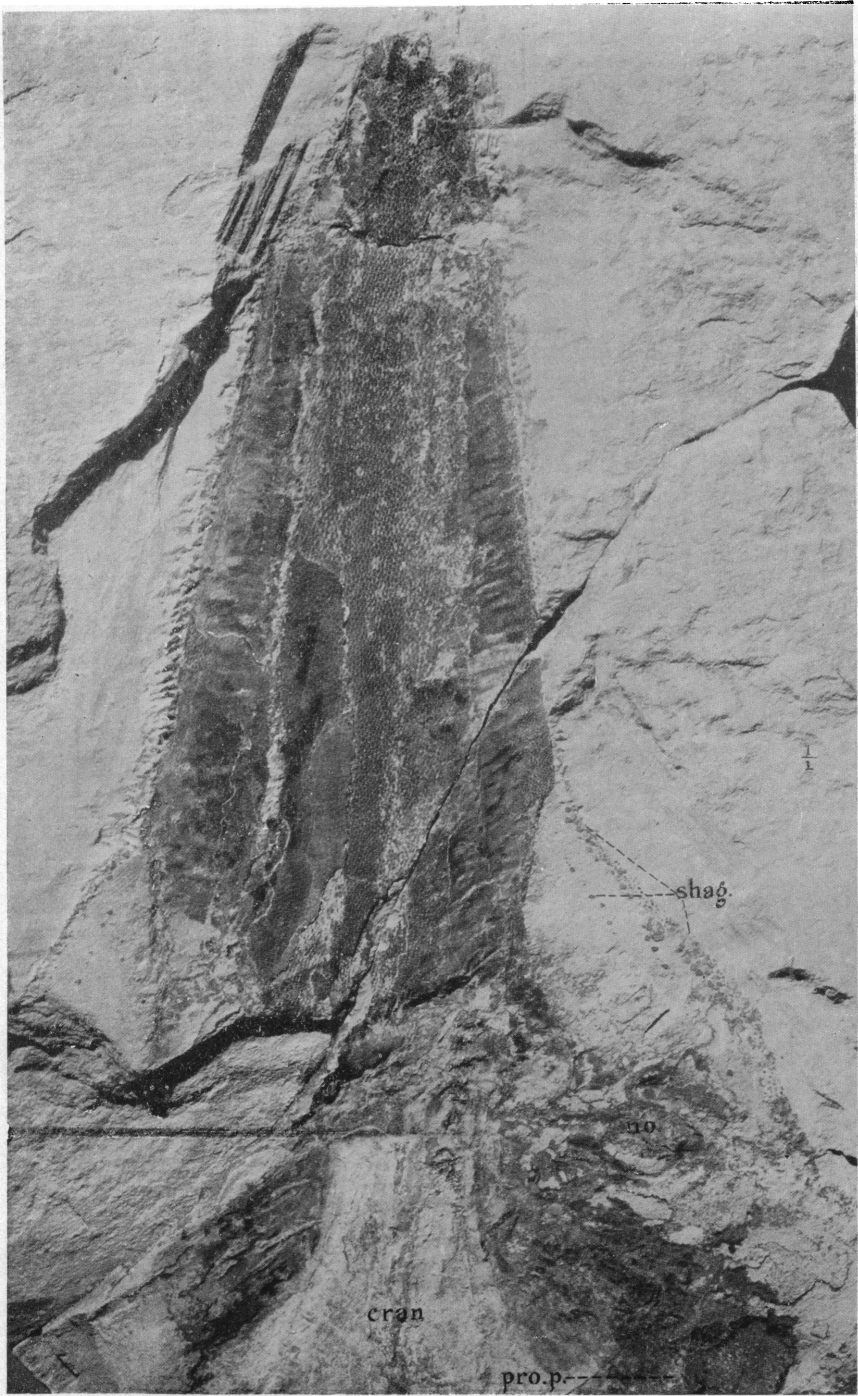


MOUNT LEBANON CRETACEOUS FISHES

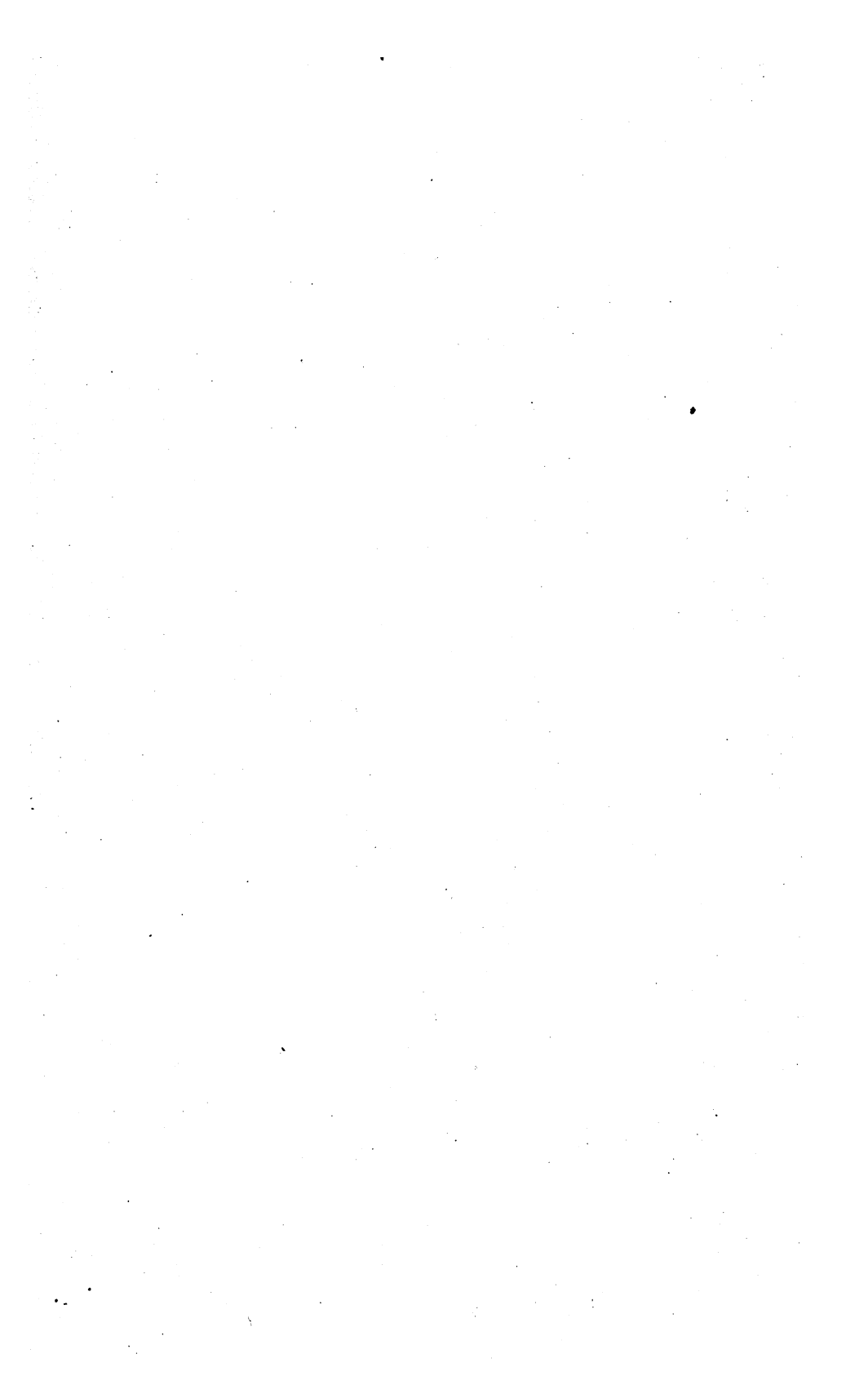


EXPLANATION OF PLATE XXV.

Sclerorhynchus solomonis Hay. Page 399. Rostrum and portion of cranium and pectoral fin. Type. $\times\frac{1}{4}$. No. 4503 (3706). *cran.*, cranium; *mo.*, mouth; *pro. p.*, portion of propterygium; *shag.*, shagreen. On the left side of the rostrum are seen some of the rostral teeth.



MOUNT LEBANON CRETACEOUS FISHES



EXPLANATION OF PLATE XXVI.

- FIG. 1.—*Sclerorhynchus hiram* Hay. Page 401. Head, part of rostrum, and pectoral fins. Type. $\times\frac{3}{4}$. No. 4501 (3705). *br. ar.*, branchial arches; *mo.*, mouth; *mes. p.*, mesopterygium; *met. p.*, metapterygium; *nar.*, nares; *p. f.*, pectoral fin; *pro. p.*, propterygium; *rost.*, rostrum; *rost. t.*, rostral teeth; *shag.*, shagreen.
- FIG. 2.—*Stenoprotomie hamata* Hay. Page 407. Head and part of trunk. Type. $\times\frac{1}{2}$. No. 4509 (3863).
- FIG. 3.—*Otodus sulcatus* Geinitz. Page 397. Tooth wanting the tip. Front view. $\times\frac{1}{2}$. No. 4508 (3867).
- FIG. 4.—Side view of same tooth.



Fig. 2.



Fig. 3.

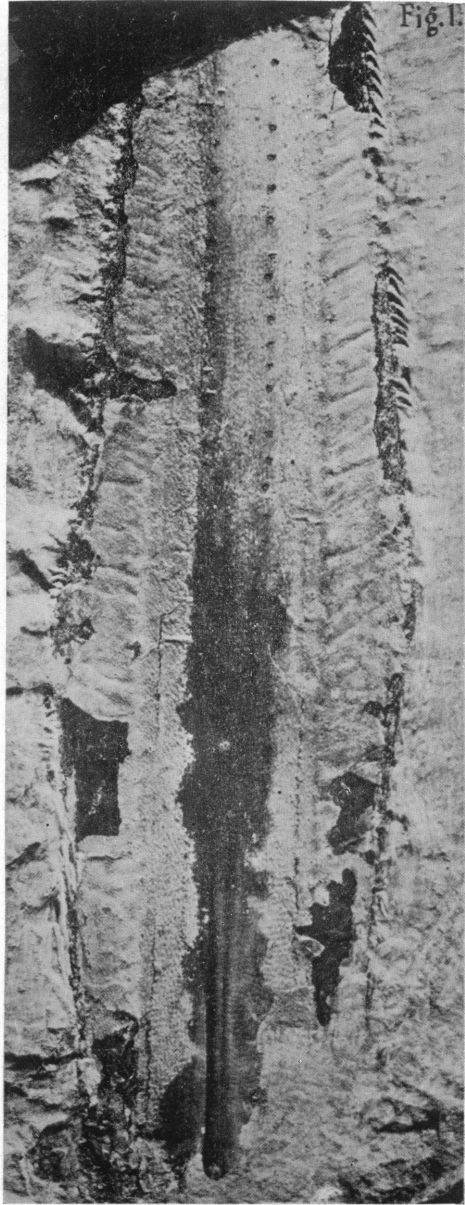


Fig. 4.



EXPLANATION OF PLATE XXVII.

- FIG. 1.—*Sclerorhynchus sentus* Hay. Page 402. Portion of the rostrum. Type. $\times\frac{1}{2}$. No. 4504 (3864). The rostral teeth are shown on the right side of the anterior end.
- FIG. 2.—*Stenoprotome hamata* Hay. Page 407. Head and several dermal scutes. Type. $\times\frac{1}{2}$. No. 4509 (3863). *a, b, c, e*, dermal scutes; *d*, supposed lower jaw.

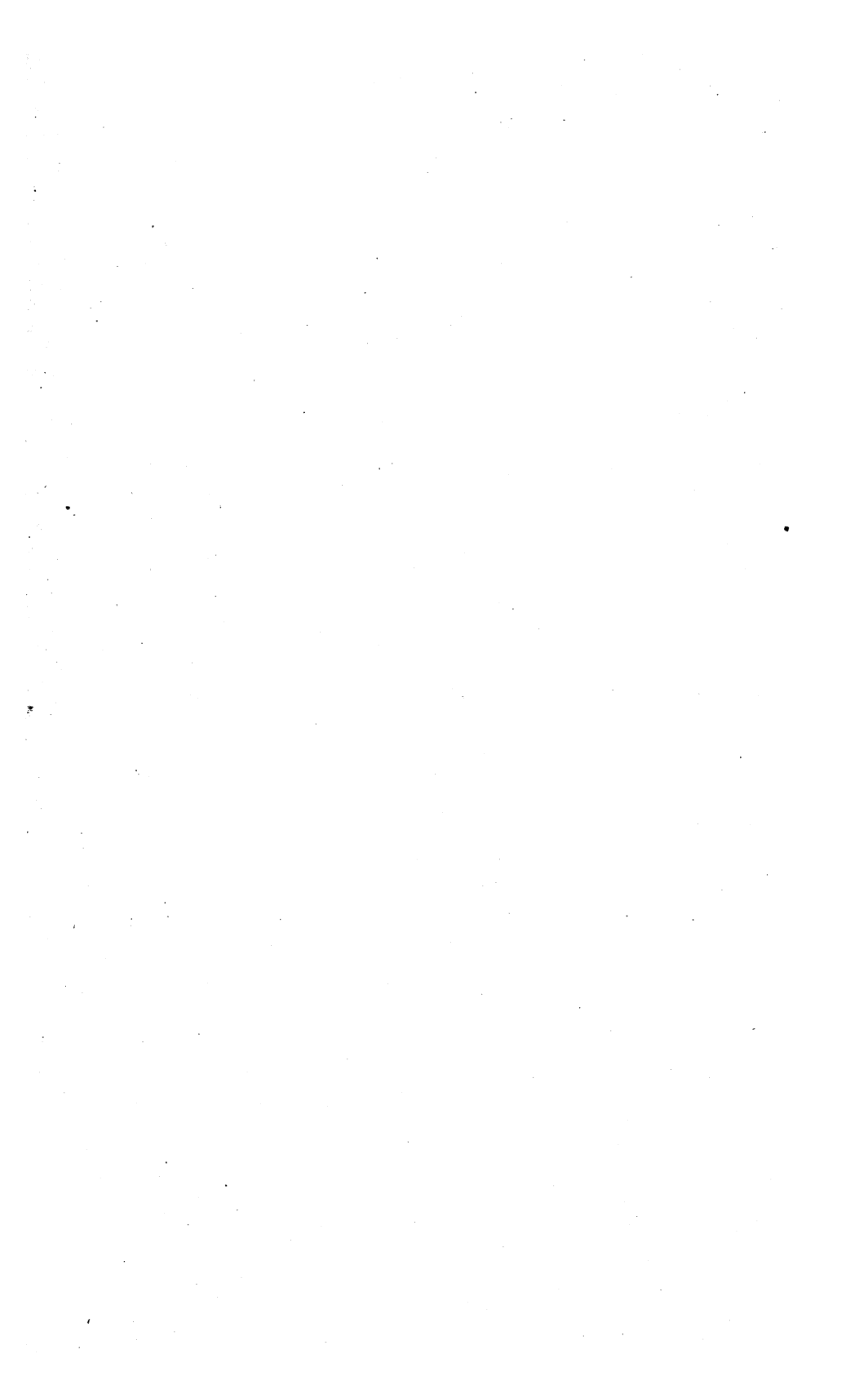


EXPLANATION OF PLATE XXVIII.

Raja whitfieldi Hay. Page 405. Head and trunk. Type. X $\frac{1}{4}$. No. 4505b (3708). *mo.*, mouth; *na. cp.*, nasal capsule; *p. f.*, pectoral fin; *rost.*, rostrum; *v. f.*, ventral fin; *vert.*, vertebræ.

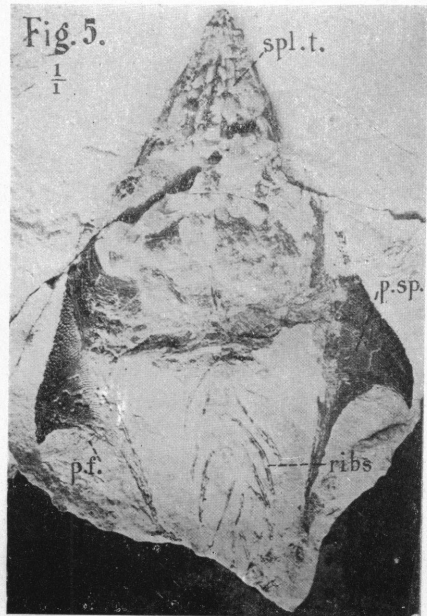
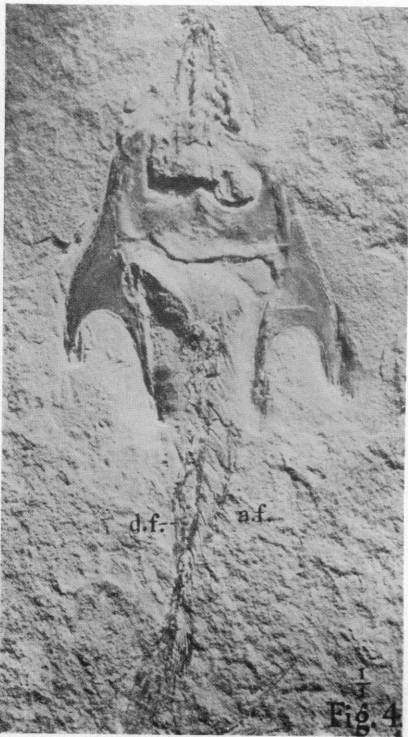
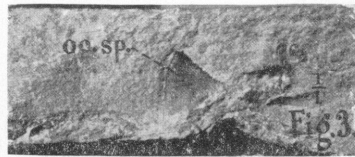
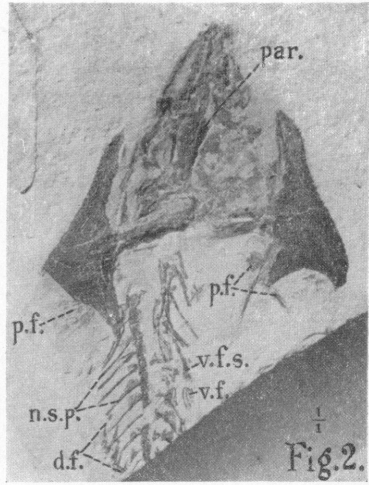
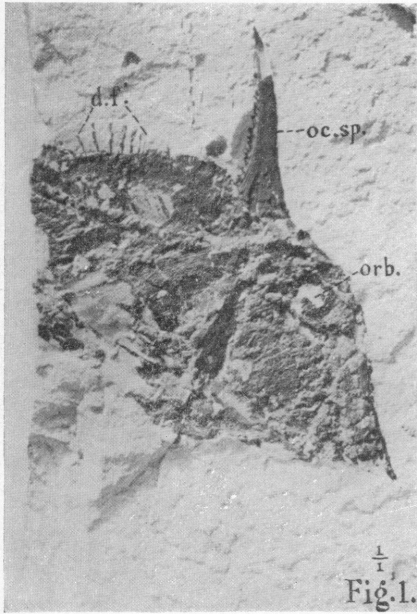


MOUNT LEBANON CRETACEOUS FISHES



EXPLANATION OF PLATE XXIX.

- FIG. 1.—*Coccodus lindstræmi* Davis. Page 409. Head. $\times\frac{1}{2}$. No. 4517a (3698). *d. f.*, supposed anterior dorsal fin; *oc. sp.*, occipital spine; *orb.*, orbit.
- FIG. 2.—*Coccodus insignis* Hay. Page 413. Fish wanting the tail. $\times\frac{1}{2}$. No. 4516f (3794). *d. f.*, dorsal fin; *n. sp.*, neural spine; *par.*, parasphenoid; *p. f.*, pectoral fin; *v. f.*, ventral fin; *v. f. s.*, ventral fin support.
- FIG. 3.—*Coccodus insignis* Hay. Page 410. View of occipital spine. Cotype. $\times\frac{1}{2}$. No. 4516b (3700). *oc.*, occiput; *oc. sp.*, occipital spine.
- FIG. 4.—*Coccodus insignis* Hay. Page 411. View of fish from below. Cotype. $\times\frac{1}{2}$. No. 4516d (3702). *a. f.*, anal fin; *d. f.*, dorsal fin.
- FIG. 5.—*Coccodus insignis* Hay. Page 413. Head and part of trunk. $\times\frac{1}{2}$. No. 4516c (3701). *p. f.*, pectoral fin; *p. sp.*, pectoral spine; *spl. t.*, splenial teeth.





EXPLANATION OF PLATE XXX.

- FIG. 1.—*Eubiodectes libanicus* (Pict. and Humb.). Page 417. Pectoral fin. $\times\frac{1}{2}$. No. 3899, Dept. Vert. Pal.
- FIG. 2.—*Enchodus marchesettii* ? (Kramb.). Page 421. Head and trunk. $\times\frac{1}{2}$. No. 4507a (3779). *a. f.*, anal fin; *d. f.*, dorsal fin; *d. sc.*, dorsal scutes; *lat. sc.*, lateral scutes; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 3.—*Enchodus marchesettii* ? (Kramb.). Page 421. Trunk and tail. $\times\frac{1}{2}$. No. 4507b (3859). *a. f.*, anal fin; *v. f.*, ventral fin.

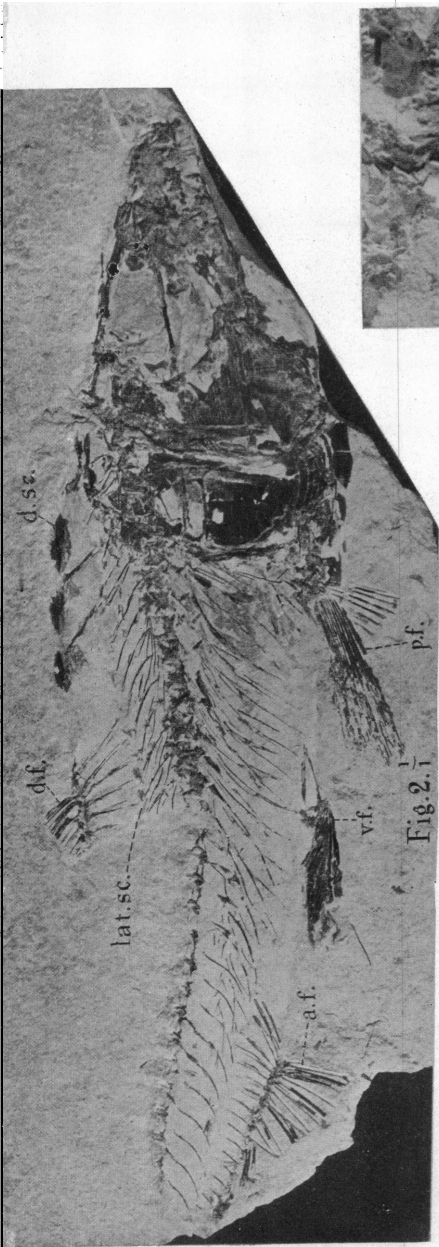


Fig. 2. 1

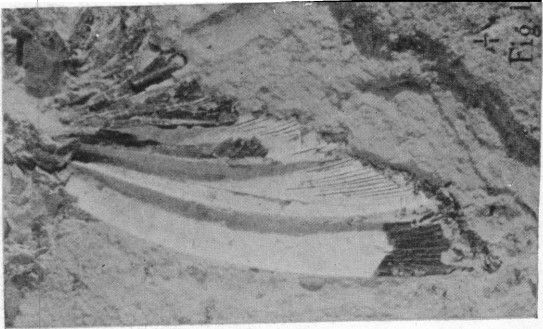


Fig. 1

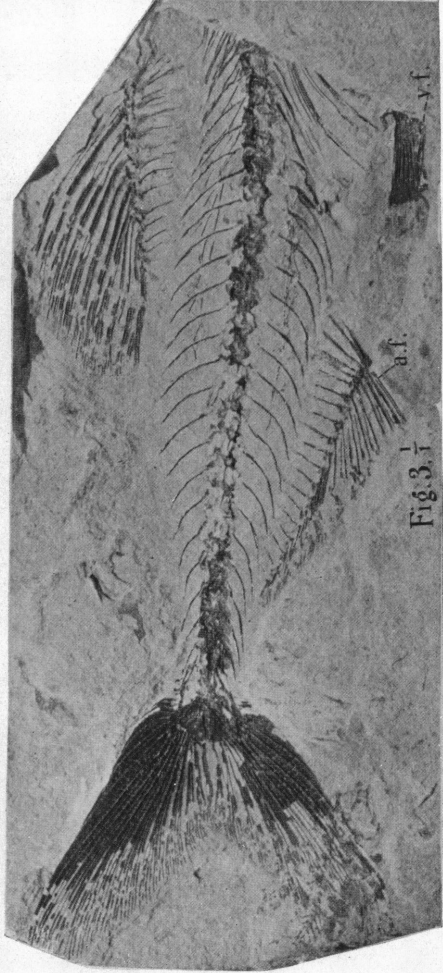
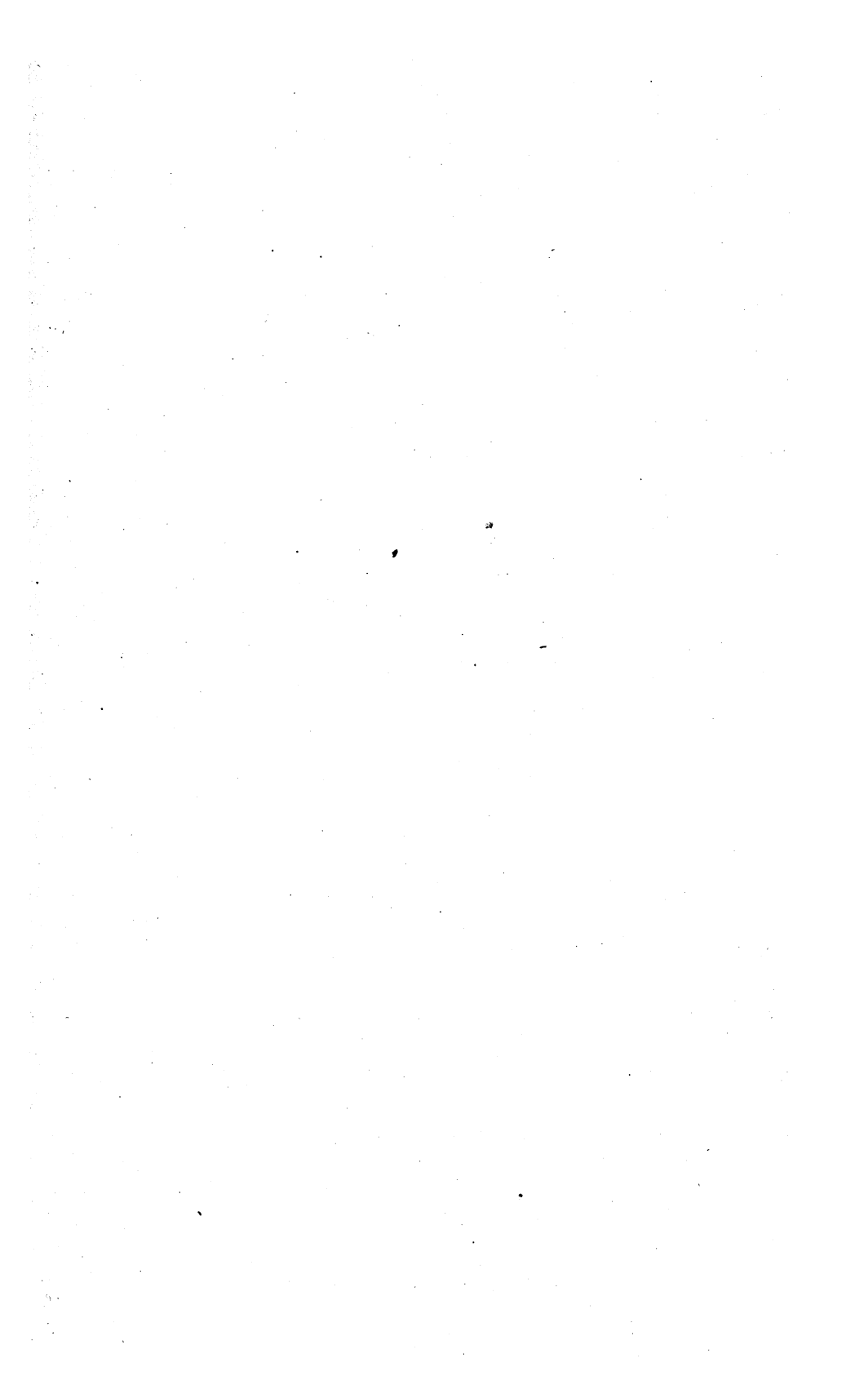
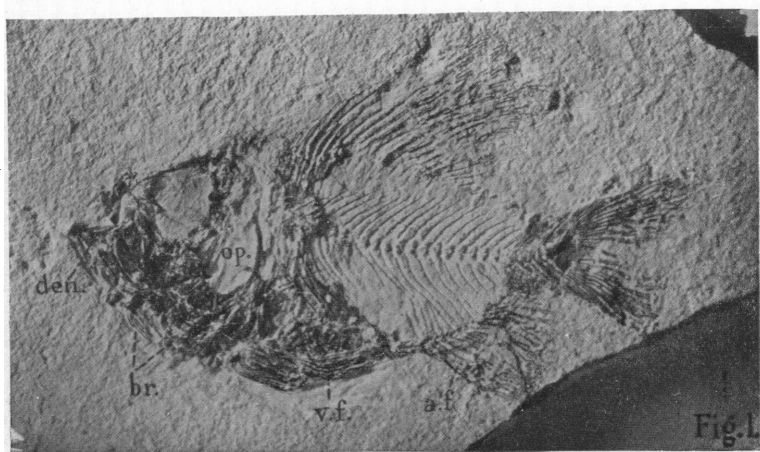
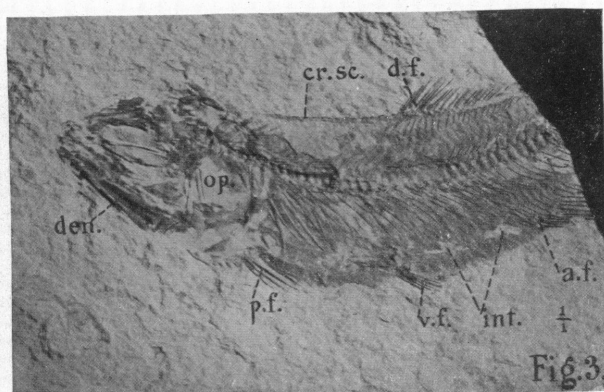


Fig. 3. 1



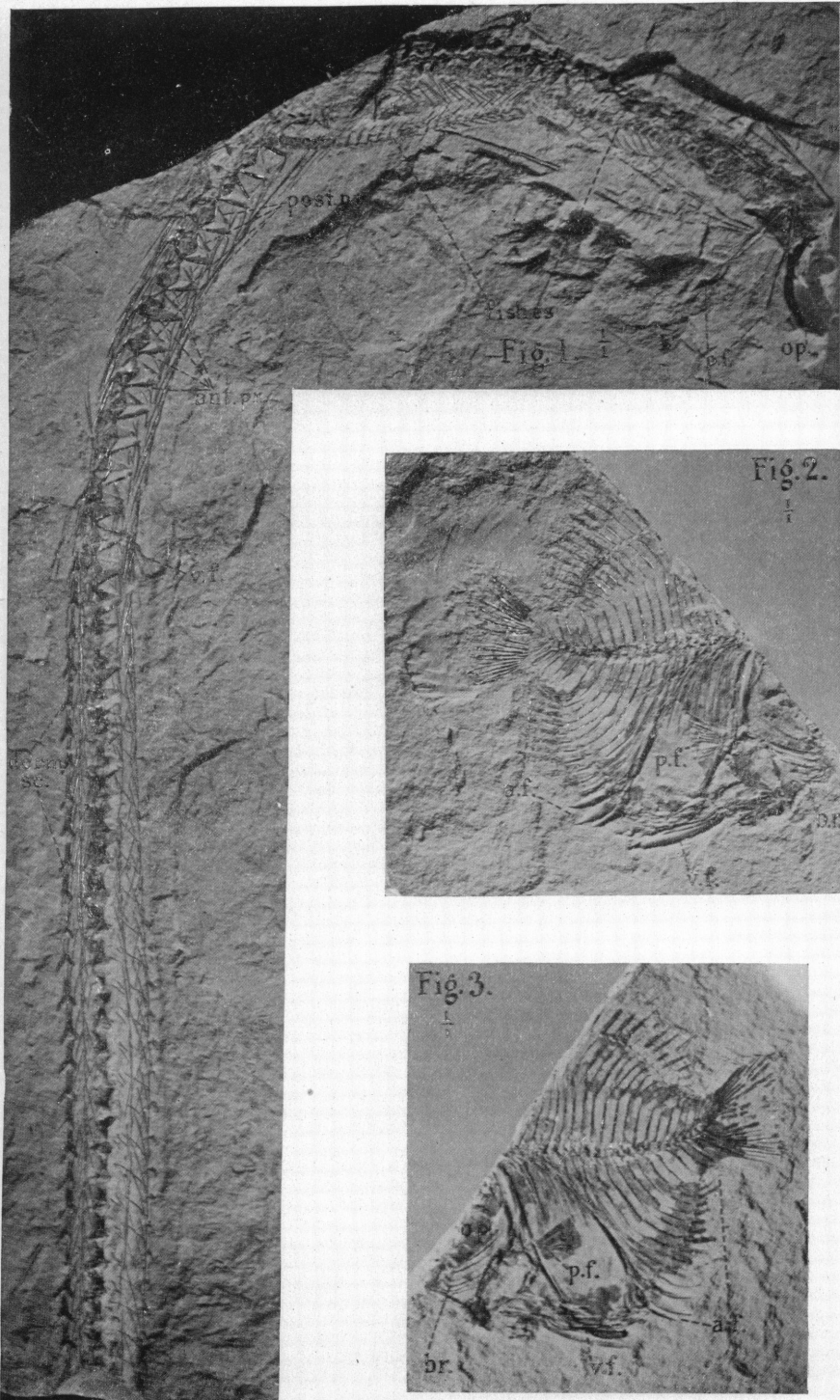
EXPLANATION OF PLATE XXXI.

- FIG. 1.—*Ctenothrissa signifer* Hay. Page 417. Complete fish. Type. $\times \frac{1}{4}$. No. 4521a (3651). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *op.*, operculum; *v. f.*, ventral fins.
- FIG. 2.—Counterpart of same fish as above. *p. f.*, pectoral fin; *mx.*, maxilla.
- FIG. 3.—*Microcælia dayi* Hay. Page 431. Head and part of trunk. Type. $\times \frac{1}{4}$. No. 4525e (3816). *a. f.*, anal fin; *cr. sc.* crimped scales; *den.*, dentary; *d. f.*, dorsal fin; *int.*, intestine; *op.*, operculum; *p. f.*, pectoral fin; *v. f.*, ventral fin.



EXPLANATION OF PLATE XXXII.

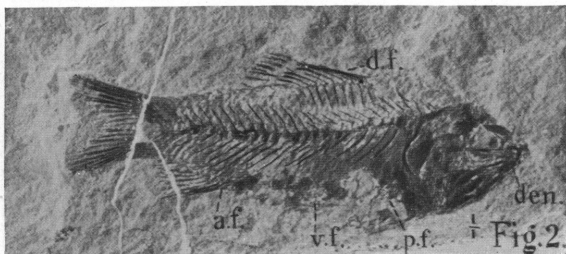
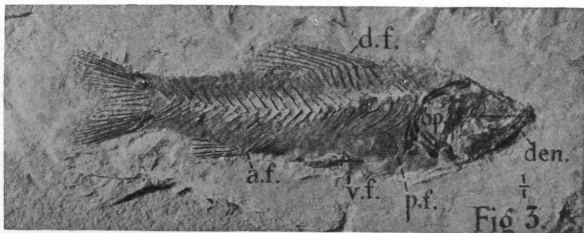
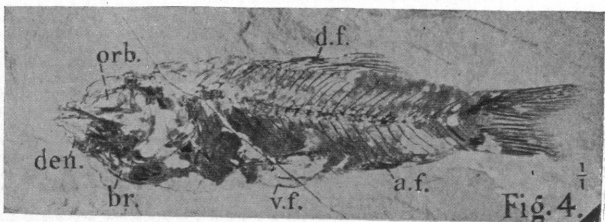
- FIG. 1.—*Leptotrachelus serpentinus* Hay. Page 419. Trunk. Type. $\times\frac{1}{2}$. No. 4511a (3683). *ant. pr.*, anterior transverse processes of vertebræ; *derm. sc.*, dermal scutes; *op.*, operculum; *p. f.*, pectoral fin; *post. pr.*, posterior processes of vertebræ; *v. f.*, ventral fin.
- FIGS. 2 and 3.—*Aipichtys formosus* Hay. Page 445. Fish and its counterpart, without head. Type. $\times\frac{1}{2}$. No. 4519 (3831). *a. f.*, anal fin; *br.*, branchiostegals; *op.*, operculum; *p. f.*, pectoral fin; *v. f.*, ventral fin.



MOUNT LEBANON CRETACEOUS FISHES

EXPLANATION OF PLATE XXXIII.

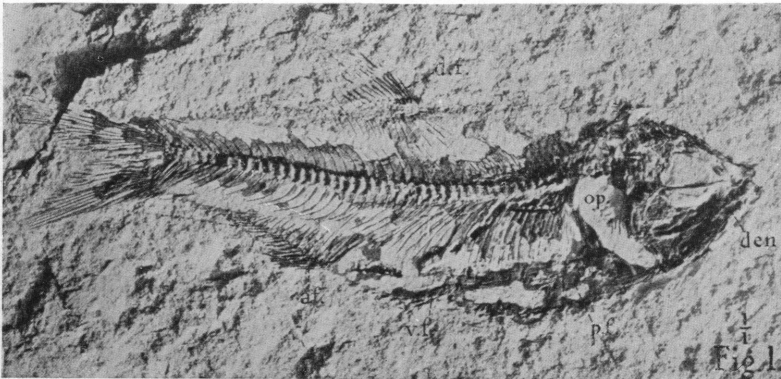
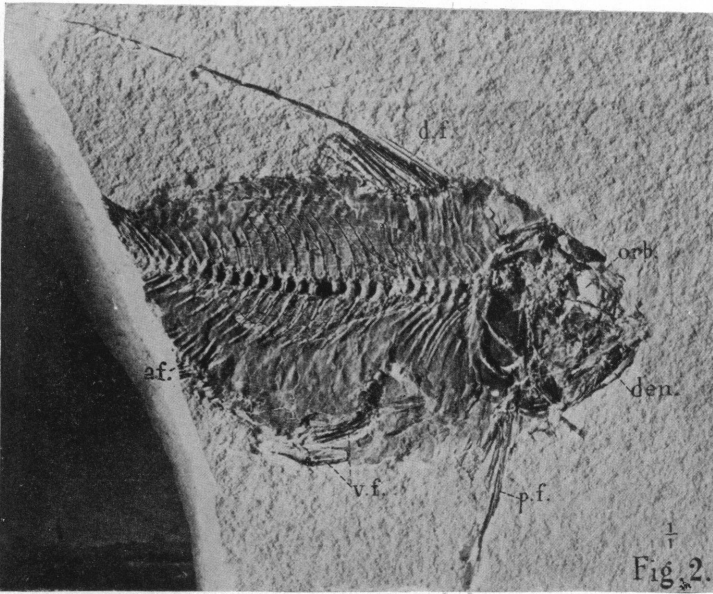
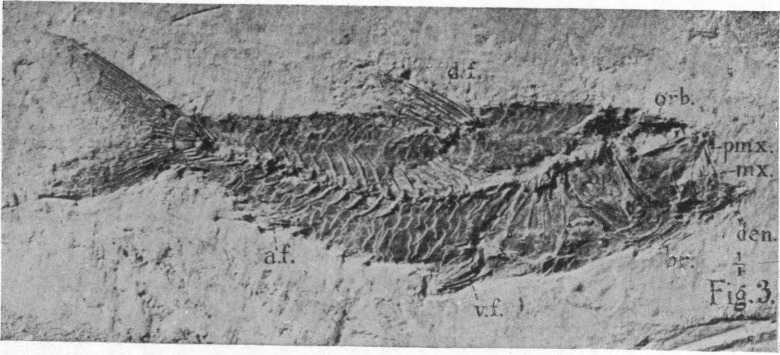
- FIG. 1.—*Osmeroides pontivagus* Hay. Page 424. Complete fish. $\times\frac{1}{2}$. No. 4524b (3846). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *d. f.*, dorsal fin; *hy.*, hyoid; *mx.*, maxilla; *p. f.*, pectoral fin; *pmx.*, premaxilla; *v. f.*, ventral fin.
- FIG. 2.—*Osmeroides pontivagus* Hay. Page 425. Complete fish. Type. $\times\frac{1}{2}$. No. 4524a (3845). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 3.—*Osmeroides pontivagus* Hay. Page 425. Complete fish. $\times\frac{1}{2}$. No. 4524c (3855). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 4.—*Osmeroides pontivagus* Hay. Page 425. Complete fish. $\times\frac{1}{2}$. No. 4524f (3841). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 5.—*Osmeroides ornatus* Hay. Page 426. Type. $\times\frac{1}{2}$. No. 4518 (3870). *a. f.*, anal fin; *d. f.*, dorsal fin; *v. f.*, ventral fin.



MOUNT LEBANON CRETACEOUS FISHES

EXPLANATION OF PLATE XXXIV.

- FIG. 1.—*Microcalia dayi* Hay. Page 430. Complete fish. Type. $\times\frac{1}{2}$. No. 4525a (3692). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 2.—*Nematonotus longispinus* (Davis). Page 429. Fish wanting tail. $\times\frac{1}{2}$. No. 4510d (3678). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *orb.*, orbit; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 3.—*Acrognathus dodgei* Hay. Page 427. Complete fish. Type. $\times\frac{1}{2}$. No. 4520a (3673). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *d. f.*, dorsal fin; *mx.*, maxilla; *orb.*, orbit; *pmx.*, premaxilla; *v. f.*, ventral fin.



MOUNT LEBANON CRETACEOUS FISHES



EXPLANATION OF PLATE XXXV.

Nematonotus longispinus (Davis). Page 429. Complete fish. $\times\frac{1}{2}$.
No. 4510f (3723). *a. f.*, anal fin; *den.*, dentary; *d. r.*, long dorsal
ray; *op.*, operculum; *p. f.*, pectoral fin; *v. f.*, ventral fin.

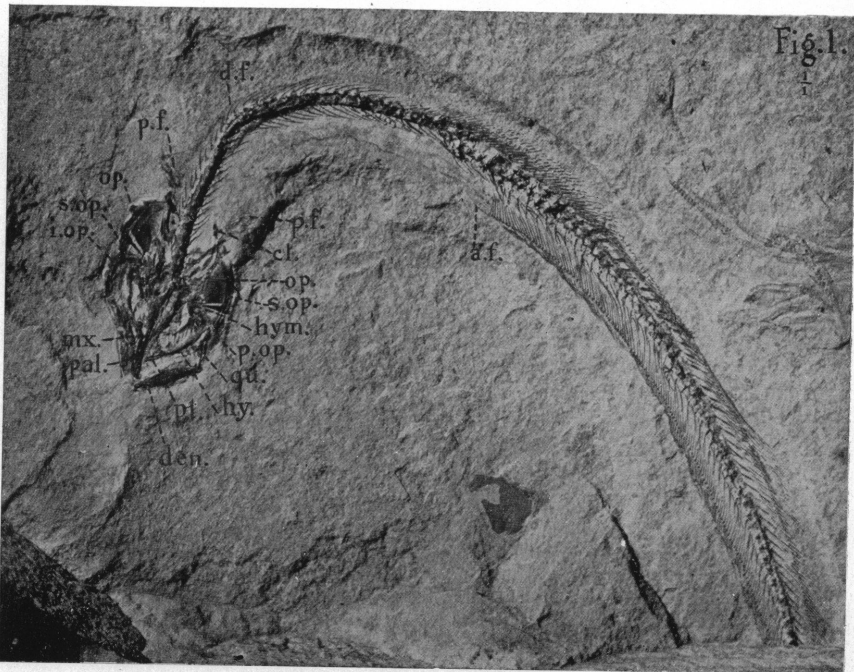
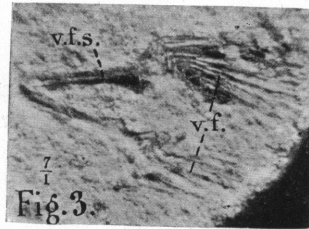
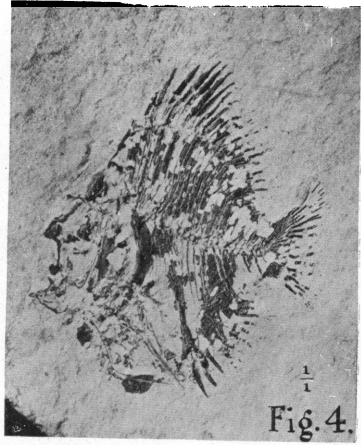
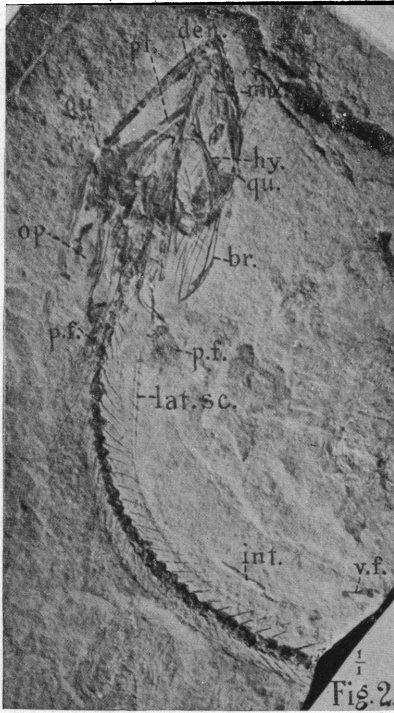


MOUNT LEBANON CRETACEOUS FISHES



EXPLANATION OF PLATE XXXVI.

- FIG. 1.—*Urenchelys germanus* Hay. Page 434. Nearly complete fish. Type. $\times\frac{1}{2}$. No. 4515a (3654). *a. f.*, origin of anal fin; *cl.*, cleithrum; *den.*, dentary; *d. f.*, origin of dorsal fin; *hy.*, hyoid; *hym.*, hyomandibular; *i. op.*, interoperculum; *mx.*, maxilla; *op.*, operculum; *pal.*, palatine; *p. f.*, pectoral fin; *p. op.*, preoperculum; *pt.*, pterygoid; *qu.*, quadrate; *s. op.*, suboperculum.
- FIG. 2.—*Anguillavus quadripinnis* Hay. Page 437. Anterior half of fish. Type. $\times\frac{1}{2}$. No. 4512 (3796). *br.*, branchiostegals; *den.*, dentary; *hy.*, hyoid; *int.*, intestine; *lat. sc.*, lateral scutes; *mx.*, maxilla; *op.*, operculum; *p. f.*, pectoral fin; *pt.*, pterygoid; *qu.*, quadrate; *v. f.*, ventral fins.
- FIG. 3.—Ventral fin of the same specimen as Fig. 2. Page 437. Enlarged 7 diameters. *v. f.*, ventral fins; *v. f. s.*, ventral fin supports.
- FIG. 4.—*Pycnosterinx levispinosus* Hay. Page 444. Complete fish. Type. $\times\frac{1}{2}$. No. 4528 (3671).





EXPLANATION OF PLATE XXXVII.

- FIG. 1.—*Anguillanus bathsheba* Hay. Page 439. Complete fish. Type $\times \frac{1}{2}$. No. 4513a (3704). *a. f.*, anal fin, origin and end of; *br.*, branchiostegals; *c. f.*, caudal fin; *cl.*, cleithrum; *den.*, dentary; *d. f.*, dorsal fin, origin of; *hy.*, hyoid; *int.*, intestine; *p. f.*, pectoral fin; *v. f.*, ventral fin.
- FIG. 2.—*Enchelion montium* Hay. Page 441. Fish wanting head. Cotype. $\times \frac{1}{2}$. No. 4514a (3765).
- FIG. 3.—*Enchelion montium* Hay. Page 442. Head and anterior part of trunk. $\times \frac{1}{2}$. No. 4514b (3766).
- FIG. 4.—Part of same specimen as Fig. 3. Page 442. Enlarged 4 diameters. *br.*, branchiostegals; *den.*, dentary.
- FIG. 5.—Part of same specimen as Figs. 3 and 4. Page 442. Enlarged 4 diameters, showing alternation of epihypocentra and pleuro-hæmacentra.
- FIG. 6.—Part of same individual as Fig. 2. Page 443. Vertebrae 88 mm. behind anterior end, enlarged 9 diameters. *ep. hy.*, epihypocentra; *ha.*, hæmal arches; *n. sp.*, neural spines; *pl. h.*, pleuro-hæmacentra.
- FIG. 7.—*Urenchelys germanus* Hay. Page 436. Portion of vertebral column. $\times 3$. No. 4515d (3790). *v. c.*, vertebral centra; *v. a.*, displaced neural arches.

