LELAND STANFORD JUNIOR UNIVERSITY PUBLICATIONS
UNIVERSITY SERIES

Fossil Fishes of Diatom Beds of Lompoc, California

BY

DAVID STARR JORDAN
Chancellor-Emeritus of Stanford University

AND

JAMES ZACCHEUS GILBERT
Teacher of Zoology, Los Angeles High School

STANFORD UNIVERSITY, CALIFORNIA
PUBLISHED BY THE UNIVERSITY
FEBRUARY, 1920

UNIVERSITY SERIES

Inheritance in Silkworms, I. Vernon Lyman Kellogg, Professor of Entomology. 89 pp., 4 plates. 1908. Price $1.00.

The Opisthobranchiate Mollusca of the Branner-Agassiz Expedition to Brazil. Frank Mace McFarland, Professor of Histology. 105 pp., 19 plates. 1909. Price $1.00.

A Study of the Normal Constituents of the Potable Water of the San Francisco Peninsula. John Pearce Mitchell, Assistant Professor of Chemistry. 70 pp., 1 map. 1910. Price 50c.

Synopsis of the True Crabs (Brachyura) of Monterey Bay, California. Frank Walter Weymouth. 64 pp., 14 plates. 1910. Price 50c.

The Osteology of Certain Scombroid Fishes. Edwin Chapin Starks, Assistant Professor of Zoology. 49 pp., 2 plates, 1 text figure. 1911. Price 50c.

A Physical Theory of Electrification. Fernando Sanford, Professor of Physics. 69 pp., 2 plates. 1911. Price 50c.

The Matzke Memorial Volume. Papers by John Ernst Matzke, late Professor of Romanic Languages, and Thirteen Colleagues. 162 pp. 1911. Price $1.00.

Das Historische Präsens in der Älteren Deutschen Sprache. Bruno Boezinger, Assistant Professor of Germanic Languages. 91 pp. 1912. Price 50c.

The Effect of a Strictly Vegetable Diet on the Spontaneous Activity, the Rate of Growth, and the Longevity of the Albino Rat. James Rollin Slonaker, Assistant Professor of Physiology. 36 pp., 1 plate, 15 text figures. 1912. Price 50c.

Catalogue de Tous les Livres de Feu M. Chapelain. (Bibliothèque Nationale, Fonds Français, Nouv. Acq., No. 318.) Colbert Searles, Associate Professor of Romanic Languages. 119 pp., 2 plates. 1912. Price 75c.

The Dudley Memorial Volume. Papers by William Russell Dudley, late Professor of Botany, and Several Colleagues. 137 pp., 12 text figures, 9 plates. 1913. Price $1.00.

The Fishes of the Stanford Expedition to Brazil. Edwin Chapin Starks, Assistant Professor of Zoology. 77 pp., 15 plates. 1913. Price 75c.

The Birds of the Latin Poets. Ernest Whitney Martin, Associate Professor of Greek. 260 pp. 1914. Price $1.00.

Acceleration in the Development of the Fossil Cephalopoda. James Perrin Smith, Professor of Paleontology. 30 pp., 15 plates. 1914. Price 75c.

A Morphological Study of Some Members of the Genus Pallavicinia. Douglas Houghton Campbell, Professor of Botany, and Florence Williams. 44 pp., 23 text figures. 1914. Price 50c.

The Evolution of Brazil Compared with that of Spanish and Anglo-Saxon America. Manuel de Oliveira Lima, Minister of Brazil to Belgium. 160 pp. 1914. Price $1.00.

The Hemolymph Nodes of the Sheep. Arthur William Meyer, Professor of Anatomy. 74 pp., 1 plate, 4 colored plates. 1914. Price $1.00.

An Introduction to the Study of the Endocrine Glands and Internal Secretions. (Lane Medical Lectures.) Sir Edward Schäfer, Regius Professor of Physiology in the University of Edinburgh. 94 pp., 1914. Price 75c.

The Pronoun of Address in English Literature of the Thirteenth Century. Arthur Garfield Kennedy, Instructor in English Philology. 91 pp. 1915. Price $1.00.

The Anoplura and Mallophaga of North American Mammals. Vernon Lyman Kellogg, Professor of Entomology, and Gordon Floyd Ferris. 74 pp., 18 text figures, 8 plates. 1915. Price 75c.

The Flügel Memorial Volume. Papers by Ewald Flügel, late Professor of English Philology, his Colleagues and Students. 232 pp. 1916. Price $1.50.

(Continued on third page of cover.)

LELAND STANFORD JUNIOR UNIVERSITY PUBLICATIONS
UNIVERSITY SERIES

Fossil Fishes of Diatom Beds of Lompoc, California

BY

DAVID STARR JORDAN
Chancellor-Emeritus of Stanford University

AND

JAMES ZACCHEUS GILBERT
Teacher of Zoology, Los Angeles High School

STANFORD UNIVERSITY, CALIFORNIA
PUBLISHED BY THE UNIVERSITY
FEBRUARY, 1920

THE FOSSIL FISHES OF THE DIATOM BEDS OF LOMPOC, CALIFORNIA

In a previous paper *(Fossil Fishes of Southern California:* Leland Stanford Junior University Publications, issued September 16, 1919) the present writers have noted a number of new species of fishes, of Miocene Age, from the deposits at Lompoc.

Since that time, through the courtesy of Mr. Arthur H. Krieger, director of the Celite Products Company, and his assistants, Messrs. Edward J. Porteous and Edward B. Starr, Dr. Gilbert and Dr. Jordan have successively visited these deposits, making extensive collections. Still later, Mr. Willard J. Classen, a student in Geology at Stanford University, through the kindly interest of Mr. Timothy Hopkins, has spent some time there securing fossil fishes for Stanford University. A large collection of fish has been obtained, this forming the basis of the present paper.

The Lompoc deposit itself is wholly unique. It lies in Santa Barbara County, California, within an angle on the north side of the Sierra Santa Ynez, a range composed mainly of Miocene sandstones and shales. This angle or ancient bay covers about four square miles. In this space a continuous and almost uniform mass of diatoms has been deposited, to the maximum depth of 1,400 feet.

The erosion of a stream on the west side has cut this deposit through to its bottom of yellowish sandstone. Over most of this space, the diatom deposits come to the surface, but in places the mass is overlaid by a coarse, hard breccia or conglomerate, containing many bones of whales, and occasionally teeth of sharks. On the extreme west, it is overlaid by limestone in which a species of Pecten is very abundant.

In places, there are thin layers of flinty rock, apparently of animal origin, interstratified with diatoms. At one horizon, about six feet above the Xyne layer noted below, there is a thin stratum of volcanic glass. Scarcely anywhere in the whole mass does any sand or clay appear. This shows that the deposit was made in quiet water undisturbed by fresh water or rains. It may be noted that in deposits of the Monterey period of the Miocene age, from Monterey to San Diego, diatoms abound, sometimes mixed or interstratified with sand or clay as about Los Angeles, at other places forming immense deposits. It has been thought that such deposits when buried under later rocks, as in Kern County and parts of Santa Barbara, are the source of the oil found in these districts. When the deposits are not covered, as at Lompoc, it is presumed that the oil has all evaporated.

The probable conditions of the deposits at Lompoc are thus indicated by Dr. Albert Mann of the Carnegie Institution at Washington, to whom we have sent specimens of material from various parts of the beds.

"The samples of diatom material received seem to indicate the following facts, unfortunately of small value for your fish-deposit problem:

"1. Marine, with no infiltration of fresh or brackish water forms.

"2. Not plankton material. Diatoms all large and massive. Heavy sponge-spicules abundant; heavy Radiolaria present, though few.

"3. Not transported a great distance nor by swift or violent currents to their present position, as the diatoms, though somewhat broken by pressure, show no wear; also as there is an absence of any appreciable quantity of sand, shells, clay, etc.

"4. Not a complex of materials from different localities, as the diatoms, though abundant, are remarkably few in species, being chiefly two species of COSCINODISCUS.

"5. Slowly and evenly deposited in their present position, with regular fluctuations in quantity (seasonal ?), resulting in the mass being formed of thin laminated plates, easily separable, but uniform in composition.

"It looks to me as if my samples were laid down *in situ,* in some quiet, shallow marine bay, into which no considerable quantity of fresh water drained. . . .

"As to the oil relationship, I do not know a thing. As you know, all sorts of theories, have been advanced regarding the contribution of diatoms to the so-called mineral oils. But I had the good luck last summer at Woods Hole to secure a perfectly pure gathering of plankton diatoms of a single species, unmixed with a single Copepod, Nematode, or any other organism. I secured a solid liter of it, and it is now in the hands of a chemist for the ether extraction of the oil, which will be sufficient in quantity for the first accurate analysis of diatom oil. . . .

"The large amount of oil laid up as a reserve food material by diatoms is certainly significant. I have found it making fully 50 per cent of the bulk, and I have never found it to be less than 5 per cent."

The economic use of these deposits, made up of the silicious shells of microscopic plants, known as diatoms, is at present two-fold. The material is cut into bricks, which, being non-conductors of heat, are used as packing about steam-pipes and the like, and sold as Sil-O-Cel. The second use is for filtering liquids. The silicious shells are insoluble, and poured into any fluid, they carry at once to the bottom all solids in suspension. The whole can then be filtered and the liquid is left perfectly clear. This is "Filter-cel," made of the crushed rock. "Celite" is a meaningless trade name, adopted for the output of this particular deposit.

Since the period of deposition, the rocks of the Santa Ynez range have undergone some folding, leaving the strata of diatoms nowhere horizontal. The Xyne layer stands where examined by us at an angle of about thirty degrees, the north side highest.

From the natural history view, this stratum is the most remarkable feature of the deposit. At about 950 feet from the bottom, at a certain horizon everywhere the same, is a layer of an extinct herring, described by us in a previous paper as XYNE GREX. Individuals lie on the bottom wherever this layer has been exposed. They are all of about the same size, about six inches long, all adult and nowhere mixed with any other fish. Apparently the species swarmed in the bay for spawning purposes, and the entire mass was heated, suffocated, or otherwise killed in an instant and with no evidence of agony or distortion.

In the rocks above, occasional examples are found, always as imprints, while those of the main mass have been mostly carbonized and left black or nearly so. The other fishes found in these deposits mainly occur in the upper strata. Only large fishes, a foot or more—herrings excepted—are found here, these being mainly mackerel, flounders, bass, rock-fish and the like, which were apparently in pursuit of the herring. All of these are described and figured in the pages which follow. This Lompoc fauna contrasts strongly with that described from the impure diatomaceous shales at El Modena and Bairdstown—of the same age, but evidently under different conditions. All the fishes of these deposits are immature, evidently residents of shallow bays within the archipelago which now forms the counties of Los Angeles and Orange.

The species thus far found at Lompoc are the following (new names in italics):

Family LAMNIDÆ

1. CARCHARODON ARNOLDI Jordan.

Family CLUPEIDÆ

2. XYNE GREX Jordan and Gilbert (J. Z.).
3. XYNE *fitgeri* Jordan and Gilbert.
4. LYGISMA TENAX Jordan and Gilbert.

Family SCOMBRIDÆ

5. *Turio wilburi* Jordan and Gilbert.
6. *Thyrsion velox* Jordan.
7. *Thyrsocles* KRIEGERI Jordan and Gilbert.

7A. *Thyrsocles escharion* Jordan.

8. *Ocystias sagitta* Jordan.

Family ZAPRORIDÆ.

9. *Aræosteus rothi* Jordan and Gilbert.

Family ZAPHLEGIDÆ

10. *Zaphleges longurio* Jordan.

Family SERRANIDÆ

11. EMMACHÆRE RHACHITES Jordan and Gilbert.

Family SPARIDÆ.

12. *Rhythmias starrii* Jordan and Gilbert.
13. *Plectrites classeni* Jordan.

Family SCIÆNIDÆ.

14. LOMPOQUIA RETROPES Jordan and Gilbert.
15. *Lompochites hopkinsi* Jordan

Family SCORPÆNIDÆ.

16. *Rixator porteousi* Jordan and Gilbert.
17. *Rixator ineziæ* Jordan and Gilbert.

Family HEXAGRAMMIDÆ.

18. HEXAGRAMMOS ACHRESTOS Jordan and Gilbert.

Family OPHIODONTIDÆ.

19. OZYMANDIAS GILBERTI Jordan.

Family PLEURONECTIDÆ

20. EVESTHES JORDANI J. Z. Gilbert.
21. EVESTHES *hooveri* Jordan.
22. DIATOMŒCA ZATIMA Jordan and Gilbert.
23. *Zororhombus veliger* Jordan.

Family BROTULIDÆ.

24. ECLIPES VETERNUS Jordan and Gilbert.

Family ———.

25. *Atkinsonella strigilis* Jordan.

Family DUSSUMIERIIDÆ.

QUÆSITA *alhambræ* Jordan and Gilbert.
QUÆSITA *fragilis* Jordan and Gilbert.

Family **LAMNIDÆ**

1. **Carcharodon arnoldi** Jordan.

No teeth of sharks have been found in the diatom deposits. In the breccia which overlies part of these beds, shark's teeth occur occasionally among the broken bones of whales.

We obtained two such teeth corresponding to the form called CARCHARODON RIVERSI Jordan, which we take to be a back tooth of the common CARCHARODON ARNOLDI.

Family **CLUPEIDÆ.**

2. **Xyne grex** Jordan and Gilbert.

(Plates I, II, III)

In the original description of this species (Jordan and Gilbert, Fossil Fishes S. Cal., p. 25) it is stated that numbers XXIV and XXVIII, Stanford Collections, came from Bairdstown. This is an error: all came from the same stratum as the type slab (CVIII) from Lompoc.

Outside the mass of this species, which covers four square miles of deposit all at the same geological level, this fish is scantily distributed through the rocks higher up.

The most remarkable feature of the diatom beds is the evidence of a tremendous catastrophe which overwhelmed millions of individuals of this herring, at a single moment, apparently in the spawning season.

It is evident that these fishes were gathered together in the sheltered bay in which these deposits occur. At a horizon 950 feet from the base of the deposit is the layer of this species. The individuals are of about the same size (6 to 8 inches) lying flat, not distorted nor much piled. All are in the same horizon and this wherever opened is covered with these fishes. No other species is mixed with them, and there are but few remains of the species in the rocks higher up. Nearly all these specimens are dark brown or black, showing them to have been carbonized. In the rocks above, this and other species are mainly prints merely, the marks of their bones being replaced by diatoms.

Of this species numerous slabs were obtained, through the energetic help of Messrs. Krieger, Porteous, and Starr, and Mr. John Sells, foreman. These were taken from a tunnel near the north side of the deposit. The largest slab is about eight feet by four, containing hundreds of individuals.

The genus XYNE is characterized by a symmetrical herring-like form, the belly, however, compressed and armed with sharp lanceolate scutes, the dorsal nearly median and opposite the ventrals, the bones of

the head finely striated and enameled. The vertebræ are about 45, a character which separates the genus from the modern forms with sharp ventral scutes. We find no trace of dorsal scutes nor of finlets; the slender ribs are about as long as head and nearly four in length to base of caudal. Intermuscular bones are very evident: the ribs are forked below, and the ventral spinules are well marked.

We give the record of the most perfect examples found above the horizon in which the multitudes occur.

No. 110 is about six inches long, the back abruptly broken and the head crushed; ribs 4½ in length of body. Vertebræ 43; 24 behind insertion of ventrals. These are nearly under middle of dorsal, as usual in this group.

No. 116. Eight inches long; is well preserved: mouth large, the lower jaw projecting; ventrals just behind front of dorsal; vertebræ 43; 23 caudal vertebræ; depth of body 5 in length.

24. Broken in three parts, the head much crushed.

27. Fair.

36. Two specimens with ECLIPES VETERNUS. Tail and posterior dorsal rays.

39. Backbone.

51. Fairly good imprint.

123. Fair.

126. Two in bad order.

153. Bad condition.

157B. In fair shape; no head nor fins.

203. Fragments of four fishes.

243. Fair condition.

288. Two damaged skeletons.

3. **Xyne fitgeri** Jordan and Gilbert, new species.
(Plates IV, V)

Besides XYNE GREX, a second species of herring occurs in these deposits. This we may provisionally refer to the same genus. It is deeper in body, with the head much heavier, the form much less symmetrical. The vertebræ are 45 in number, rather heavier than in XYNE GREX, and the anterior vertebræ seem loosely connected, becoming readily crushed out of place, or as in the type example bowed into an arch. The ribs are longer than in XYNE GREX, nearly as long as head, about 3¾ in length of body.

The form of the head and the tendency to curvature of the backbone, with the less symmetrical form of the body, may indicate generic distinction for this species, but it is certainly a near relative of XYNE.

The two species (possibly identical with each other) already described by us from El Modena and Carpinteria (ELLIMMA ELMODENÆ * and ELLIMMA BARBARÆ) are certainly nearer XYNE than ELLIMMA; and may be temporarily assigned to XYNE, with which they agree in general traits and especially in the number of vertebræ (44). The ribs are longer than in X. GREX or X. FITGERI, being about 3⅓ to 3½ in length of body. It is very doubtful whether these species belong to the group of double-armed herring, the presence of dorsal scutes being uncertain. In this group the Eocene genera, DIPLOMYSTUS, KNIGHTIA, ELLIMMA, and ELLIMICHTHYS, find their place.

The type of XYNE FITGERI is a specimen (No. 167) seven inches long, lacking the upper and lower fins.

Body heavy forward with large head. Head 2⅘ in length to base of caudal; depth about 2½. Head very large, with steep, straightish profile; eye moderate; lower jaw long, low, protruding; maxillary 1⅗ in head. Vertebræ 43, the first 24 forming a notable arch, its arc 2½ times its height, a character apparently due to distortion, as only partially shown in other specimens. Vertebræ rather longer than deep, ribs many, very slender, 1¼ in head, nearly 3¼ in body; some intra-muscular bones; neurals and hæmals moderate, interspinal bones weak and mostly obliterated; pectoral fins narrow, inserted low; dorsal, anal, ventrals, and scales wholly obliterated except for the lanceolate sharp ventral scutes which are about 15 in number; caudal strong, well forked, the lobes 1⅕ in head, the rays slender, about twenty-five to be counted.

This specimen is preserved in duplicate, the other half (167B) being exactly like it. The species is named for Mr. August Fitger, the excellent proprietor of the Lompoc quarries.

A second specimen (26) is in fair condition, 6 inches long, the vertebral column elevated anteriorly, but not perfectly arched; dorsal and ventral present, the ventral just behind front of dorsal. Head 3 in length; depth 3; vertebræ 43.

Another specimen (No. 241), 4½ inches long, has the head large and with steep profile. The head is, however, crushed back on the body, so that the dorsal fin is close behind it, and the anterior vertebræ are dislocated and scattered about the nuchal region. There are 25 to 28 vertebræ behind the line of insertion of dorsal. The vertebral column in this species seems exceptionally fragile, for when not arched, it is usually broken or distorted.

A specimen 3½ inches long (the total fish about five) (No. 205), with the head and tail broken, much resembles the type of ELLIMMA EL-

* We may here note that in the original description of ELLIMMA ELMODENÆ "head 2½ in length" is a misprint for "head 3¼."

MODENÆ as figured by Jordan and Gilbert. It is, however, unquestionably a member of this species. The dorsal, pectoral, and ventral fins are fairly preserved, as are also the vertebræ and the ribs. There are eight vertebræ before the ventrals. Ribs about 22. Vertebræ rather deeper than long, those anteriorly a little elevated.

Other specimens are the following:

29. Probably the same, body only, anterior vertebræ out of place.

44. Vertebral column little arched; pectoral complete, short, 2½ in head; about 15 scutes before ventrals.

124. Fair; head large, broken; ventrals a little nearer gill opening than base of caudal. Caudal well forked, anterior vertebræ moderately arched, vertebræ 45, dorsal and anal wanting.

140. Young—the vertebral column little arched. Vertebræ about 40—poor condition.

507. In fair condition, much like No. 26. The backbone not arched, but undulated.

146. Column a little arched; paired fins wanting.

149. Bad order; column little arched.

150. Broken head.

196. An example with a big head, deep body, and median dorsal. Vertebræ about 40, the column somewhat arched anteriorly; belly with strong scutes.

244. Broken torso, showing 15 ventral scutes.

235. Shows a short dorsal nearer head than base of caudal; spinal column little arched, broken, apparently very fragile. The whole structure very weak.

274. Broken torso, vertebral column somewhat arched.

278. Part of a large example. No new features.

291. Part of side—no arch in vertebral column.

314. Broken skeleton and head. The vertebral column a little arched anteriorly.

324. Head and torso much broken.

411. Fair condition; shows ventral scutes and paired fins. Head large, 3½ in length, depth 3; 13 scutes before ventrals.

In addition to those noted above there are numerous fragments more or less definitely referable to this species.

4. **Lygisma tenax** Jordan and Gilbert.

No. 79. Seven inches long.

Head and vertebral column, the head badly crushed, the vertebral column intact and much twisted as in the original types; neural and

hæmal spines strong, interhæmals, interneurals and fins lost; head large, with large orbit, median in position; lower jaw prominent; pectoral inserted low. Vertebræ about 40, reduced posteriorly, longer than deep and constricted. No scales or scutes preserved.

We identify this specimen doubtfully by the tough and twisted spinal column, which seems to be a distinctive trait.

No. 121 shows the head with some of the vertebræ, of the same species.

Family **SCOMBRIDÆ**

Next to the evidence of the extraordinary catastrophe which overwhelmed the herring known as XYNE GREX, the most remarkable feature of the Lompoc beds is the presence of five different species of mackerel—predatory fishes, doubtless lured into the bay to feed on the herring.

All of these forms are related to the living species known as Spanish mackerels, SCOMBEROMORUS Lacépède (CYBIUM Cuvier). But differences in the vertebral column, the dentition and the interspinal bones, necessitate the recognition among them of four distinct genera. To these, we assign the names of TURIO (WILBURI), THYRSION (VELOX), THYRSOCLES (KRIEGERI), and OCYSTIAS (SAGITTA).

The six genera of SCOMBRIDÆ found in the Miocene deposits of Southern California may be thus compared with each other and with the living genera of this type.

(*a*) Anterior vertebræ simple, not "trellis-like"; teeth not serrate, nor greatly enlarged; posterior vertebræ not held immovable by backward extensions from apophyses; no canine teeth; body without corselet of modified scales, as far as known.

(*b*) Vertebræ few, about 28 in number; dorsal spines about 10 in number, slender, close-set. (Allies of SCOMBER.)

(*c*) Interspace between dorsals short, not more than the length of two vertebræ; body rather deep, tapering backward; the depth about 3½ in length; teeth unknown; opercular region short. TUNITA.

(*cc*) Interspace between dorsals long; as long as four or more vertebræ; body elongate, tapering slowly backward; depth about 4⅔ in length; interhæmals slender and short, weak.

(*d*) Opercular region moderate, teeth unknown (supposedly conic and pointed, close set). AUXIDES.

(*bb*) Vertebræ about 28; dorsal spines about 20. Opercular region very long, longer than distance from front of eye to edge of preopercle; teeth compressed, wide set, about 20/20 on each side; body moderately elongate, the depth about 5 in length; dorsal spines slender, close-set, the anterior elevated. (Ally of EUTHYNNUS.) TURIO.

(*bbb*) Vertebræ numerous, 40 to 55, subquadrate, strongly grooved; post-ocular region not expanded, shorter than rest of head; dorsal spines low, slender. (Allies of SCOMBEROMORUS).

(*e*) Vertebræ 40 to 42, rather strong, deeper than long, the depth of one about equal to one-third the distance to the base of the soft dorsal; opercle strongly striate; interneurals short, slender, and weak.

(*f*) First dorsal of about 10 spines; body rather robust; teeth conic, pointed, subequal, in bands, 35 to 40 on each side of jaw; depth about 5 in length. THYRSION.

(*ff*) First dorsal of about 22 slender spines; body very slender, the depth about 7 in length; teeth unknown. OCYSTIAS.

(*ee*) Vertebræ 46 to 48; deeper than long. Interhæmals very long and rather strong, arranged in a parallel grate-like series, reaching about ⅔ distance to backbone. Vertebræ $22 + 25 = 47$; body rather robust, the depth about 5 in length.

(*g*) First dorsal of 15 to 20 slender spines; teeth compressed, well-spaced; probably about 35 on each side. THYRSOCLES.

(*gg*) First dorsal of 15 to 18 low, slender spines.

(*h*) Teeth scarcely compressed, about 25 in each side; depth 5¼ in length. CHRIOMITRA.

(*hh*) Teeth much compressed, wide-set, about 12 in each side; interhæmals of moderate length, close-set, parallel and nearly straight, depth 4½ in length. SCOMBEROMORUS.

Of the other generic names applied to fishes of this group, ACANTHOCYBIUM Gill (PETUS), with broad, serrated teeth, and the body robust, is well defined. LEPIDOCYBIUM (Gill) (FLAVOBRUNNEUM), with canine teeth, is doubtless also valid. APODONTIS (Bennett) (IMMUNIS), scantily described (teeth conical, wide-set), is probably a typical SCOMBEROMORUS, as is also CYBIUM (Cuvier) (COMMERSONI). CHRIOMITRA is, no doubt, a valid genus, with interhæmal as in THYRSOCLES and numerous gill-rakers.

The fossil genus SCOMBERODON van Beneden (*Bull. Acad. Royale, Belgique* (2), XXXI, 504-512, 1871) is based on a huge mackerel found in the clays of Rupelian age (Oligocene) at Boom and Rupelmonde in Belgium. It is allied to ACANTHOCYBIUM and remotely to SCOMBEROMORUS, but its teeth are very large, entire, unequal, and subconic, set in extremely massive jaws. The teeth are relatively few, about 18/18 in each jaw. The caudal vertebræ are remarkable in having a special bone covering, depriving them of all mobility, as in the tunnies. This character is not found in the Miocene genera nor in SCOMBEROMORUS. The species in question, SCOMBERODON DUMONTI, must have reached the length of seven feet (two meters). There seems to be no doubt of the validity of the genus SCOMBERODON.

Turio (Jordan and Gilbert), new genus.

(Type: TURIO WILBURI Jordan and Gilbert.)

Mackerels of rather small size, with the body moderately elongate, the vertebræ about 28; longer than deep and not strongly grooved. Head long, apparently pointed; mouth large; traces of a strong lower jaw; the opercular region much expanded, its length about 1½ in rest of head and greater than distance from front of eye to edge of preopercle; teeth compressed, rather wide-set, smaller than in SCOMBEROMORUS, the number about 25/25 on each side. First dorsal anteriorly high, of about 20 slender spines; interhæmals short, slender, and not straight, almost hair-like. This genus has the vertebral column of SCOMBER and AUXIDES, differing from these, as well as from THYRSOCLES, in the very much longer opercular region. From TUNITA, which has also high dorsal spines it is separated by the much longer first dorsal. It differs from THYRSOCLES in the form of the dorsal fins and in the very much weaker interneurals, in the much more slender vertebræ, in their smaller number and in the weakness of the lateral ridges. The opercular region is much longer in TURIO than in THYRSOCLES and the head perhaps more pointed.

The dentition of AUXIDES, which genus TURIO much resembles, is unknown, but that genus is presumably related to SCOMBER, which has conical teeth, in bands. The nearest ally of TURIO is probably EUTHYNNUS.

We propose for this genus the name TURIO, a wand or shaft, the the Latin equivalent of Θύρσις, the root of THYRSITES.

5. **Turio wilburi** Jordan and Gilbert, new species.
(Plates VI, VII)

Type 49A. Body with 28 vertebræ, head broken, showing wide mouth and a gill arch with filaments. Head 3½ in length; depth 3¾; three spines of dorsal perfect; the third very long, 1⅔ in head, 7 or 8 others lying down, the total number indicated by interneurals being 20; 13 rays of soft dorsal shown, a short interspace between; vertebræ constricted, longer than deep, with three grooves. Caudal wide, forked, on a slender peduncle; neurals and hæmals long; interneurals and interhæmals very short and slender, almost hair-like; those above in pairs; ribs very oblique, short. Ventrals I, 5, the stout spine long. Specimen a foot long.

No. 21 is a body without head, 11 inches long. This specimen shows 26 vertebræ from the front of the spinous dorsal, 15 from the front neural spine of the first anal ray; these are relatively slender, longer than deep and somewhat constricted, with no conspicuous lateral ridges,

and with moderate, not very oblique, neurals and hæmals; the interneurals and interhæmals notably short and slender; the interneurals very much smaller than in THYRSOCLES. Ribs slender, short, directed strongly backward; hypural plate obscure. First dorsal of about 20 spines, these very slender, close-set, and rapidly shortened to the last, the first three high, nearly equal to depth of body at base, which is 5½ times in distance from the snout to base of caudal. Second dorsal showing about 12 slender rays; the distance from its front to front of first dorsal 2⅙ in distance from front of first dorsal to base of caudal; distance between dorsals 3⅙ in this measurement; insertion of anal under about fifth ray of second dorsal. Caudal strong, widely forked, its rays 15 + 15, its lobes equal, 5½ in length of body, the outer rays much shortened.

Another specimen, apparently of the same species (No. 178), shows the head and body to the second dorsal fin. It is in poor condition, being crushed and distorted, the long head badly broken, a few teeth, compressed, formed as in SCOMBEROMORUS, preserved, but the fins all twisted from their natural position and none well preserved. About twelve vertebræ precede front of soft dorsal.

A counterpart (No. 177) shows crushed head only, with straight profile, pointed snout, longer than eye, which is twice in distance to front of opercle, and 2½ in breadth of opercle behind it, thus nearly 6¼ in head. The long straight gape extends beyond the eye. Opercular region very long, the distance from gill opening to preopercle greater than distance thence to front of eye.

Occasional rather small narrowly triangular compressed teeth occur along the edges of both jaws, rather less narrowed and crowded anteriorly than in THYRSION VELOX.

Another specimen (180) shows the head and anterior parts badly damaged, with but few vertebræ preserved, these longer than deep, and with traces only of first dorsal and anal fins.

Pectoral well preserved, of about eighteen rays, inserted high; ventrals well developed but broken, inserted before pectoral; posterior part of head rather long.

Another head with part of body (No. 7) seems to belong to this species. Head long, with pointed snout and long jaws on which a few compressed, spaced teeth are shown, the length of head greater than depth of body. The opercular region very long, much longer than in THYRSOCLES. Preopercle with an enlarged angle turned downward, as in the types of AUXIDES, but the striæ on its surface very fine, much finer than in AUXIDES.

First dorsal with slender close-set spines, apparently about 20 in number; pectorals and ventrals present but distorted. Vertebræ slender,

longer than deep, somewhat constricted, the first neural spines of the dorsal attached to the first vertebra. Eleven vertebræ preserved.

No. 6. Broken fish 14 inches long. Vertebræ $13 + 25 = 28$, longer than deep, smaller anteriorly, more or less three-grooved, part of them nearly plain. Head much broken, 3⅔ in length to base of caudal; depth about 5¼ in length; preopercle with fine striæ on exserted part; pectorals much broken; ventrals just behind their insertion; first dorsal with 8 spines preserved, slender, close-set; soft dorsal well separated, small, of about 12 feeble rays preserved. The interneurals of both dorsals very short and slender, a little shorter than the slender interhæmals. Caudal broken, forked. Same slab with a small sample of XYNE GREX.

No. 180. Fragments of a large fish, apparently TURIO, in bad condition.

10B. Backbone with anal fin, 7½ inches long.

The species is named for Dr. Ray Lyman Wilbur, President of Stanford University.

Thyrsion Jordan, new genus.

(Type THYRSION VELOX Jordan.)

This genus is characterized by the general form of the Spanish mackerels, the depth about five times in length to base of caudal, the vertebræ strong, 40 in number. The interspinal bones weak, the spinous dorsal of 10 to 20 weak spines, and the teeth conical, in bands. The number of dorsal spines cannot be ascertained.

6. **Thyrsion velox** Jordan.

(Plates VIII, IX)

The type of the species (No. 153) shows the head and anterior part of the body. The whole part preserved, 9 inches long. Head large, with long pike-like jaws, its length half more than presumable depth of body at front of first dorsal. Depth of head about 1⅘ in its length; jaws very long, apparently pointed, the tips broken, the maxillary 1⅔ in head. Teeth in upper jaw sharp, entire, even, close-set, rather narrowly triangular or possibly conical in form, 50 or 60 on each side in upper jaw, none of them canine-like, and perhaps all in one row; more likely in bands. Anterior teeth narrowed and crowded; lower jaw strong, its teeth partly preserved, similar to those above, opercle large, rounded.

Fourteen vertebræ preserved, these rather small and squarish; 10 in the length of upper jaw; the neural spines slender, directed rather evenly backward; hæmal spines smaller. First dorsal with but three slender,

shortish spines preserved, the first longest, inserted behind pectorals over the sixth vertebra; its interneural springs from between first and second; pectoral little below vertebral column, of about 18 rays of moderate length, the upper longest, the lower rays rapidly shortened; about 2⅘ in head; a trace of ventrals just before insertion of pectorals, eye obliterated; no trace of scales.

No. 127. Fourteen inches long.

This specimen shows the whole body with crushed head, soft dorsal and anal lost; vertebræ certainly 40, all much deeper than long, with fine grooves. Head long, conic, pointed, 3½ in body. Depth about 5¼; postocular part of head rather long, about as long as snout, opercle strongly striated. Teeth obliterated; pectorals lost, ventrals moderate, apparently I 5. First dorsal slender, represented by about six close-set spines, the first of those over ninth vertebra; interneurals slender and weak. Anal, with interhæmals, wholly lost; caudal forked, damaged. Caudal peduncle less slender than in THYRSOCLES. The caudal with rudimentary rays at base.

If Nos. 127 and 153 are really of the same species, the teeth are materially different from those of SCOMBEROMORUS.

The fish has much in common with ZAPHLEGES and may prove to be not a mackerel at all.

Ocystias Jordan, new genus.

(Type: OCYSTIAS SAGITTA Jordan.)

A large mackerel with the body very slender, the depth 6⅔ in length, the vertebræ 21 + 21 = 42, as deep as long, the posterior more elongate, all sharply grooved. Head moderate, the opercle not expanded, less than half postorbital part of head; teeth unknown. First dorsal of about 22 slender spines, the soft dorsal inserted close behind it; interneurals very short and slender, curved, almost hair-like.

This genus resembles SCOMBEROMORUS in form, and in the form of the spinous dorsal; its interhæmals are much more slender than in that genus. The vertebræ are fewer in number than in SCOMBEROMORUS. Whether the teeth are those of SCOMBEROMORUS is as yet unknown. The body of no other known mackerel is quite as slender.

7. **Ocystias sagitta** Jordan, new species.

(Plate X)

Type (No. 20) 27 inches long, the whole fish, with damaged head.

Body very long and slender, even for a mackerel, more elongate than in THYRSOCLES or TURIO. Head 5½ in length to base of caudal; depth 7⅕. Head broken, the opercle rounded, the posterior part of head much shorter than in TURIO.

Vertebræ 21 + 21 = 42, the anterior hour-glass shaped, as deep as long, the posterior larger and more elongate, sharply grooved.

Dorsal fins separate, the first beginning behind base of pectoral, of about 22 very slender spines, rather wide-set, the anterior highest, 2½ in depth of body. Soft dorsal low, of 16 or more slender rays, anal similar, beginning just behind front of first dorsal. The number of rays not certain. No trace of finlets; pectorals rather broad, of 15 or more rays, broken; ventrals obliterated. Caudal rather large, wide forked, the equal lobes about 5 in body; neural and hæmal spines rather strong, especially mesially; the last few vertebræ with but traces, indicating a very slender caudal peduncle. Interneurals all short and small, shorter than the dorsal spines and rays, interhæmals also very small and slender, shorter than the rays, about five times in depth of body at that point, very oblique, contrasting sharply with the strong, long, parallel interhæmals of THYRSOCLES; ribs slender, very oblique.

With much resemblance to the associated THYRSOCLES and THYRSION, the present species is sharply distinguished by the very short and weak interhæmals and interneurals, by the many-rayed first dorsal fin and by the relatively short tail. From TURIO, which has also weak interneurals, it is separated by the more numerous and shorter vertebræ; it is the most slender species of the mackerel family yet known. For this species is proposed the name of OCYSTIAS SAGITTA (ὀκύστος, swiftest).

Thyrsocles Jordan and Gilbert, new genus.

(Type: THYRSITES KRIEGERI Jordan and Gilbert (1919).

Large mackerels with the body rather elongate, the depth about 4⅔ in body, the vertebræ about 22 + 25 = 46 in number, quadrate in form, little constricted, each about as deep as long, each conspicuously three-ridged. Head large, the operc̀le moderate, occupying less than half post-orbital part of head; mouth large, with small, compressed, wide-set teeth so far as ascertainable. First dorsal weak, of 10 to 20 slender spines, not much elevated. Interhæmal bones unusually long, parallel, the anterior curved, the others straight, forming a conspicuous grate-like structure, these bones extending two-thirds the distance to the back bone, and more than one-third depth of body at insertion of anal, which is well behind front of soft dorsal.

This genus may be regarded as an ally of SCOMBEROMORUS, having similar vertebræ and interhæmals, but the anal farther back, and the teeth smaller and apparently much more numerous. The number of dorsal spines is uncertain. In SCOMBEROMORUS (MACULATUS, CAVALLA, COMMERSONI examined) the interhæmals are strong and parallel, much as

in THYRSOCLES, but rather shorter, ¼ to ⅓ depth of body at insertion of anal. In these species the teeth are large, wide-set, about 11 to 13 on each side.

8. Thyrsocles kriegeri Jordan and Gilbert.
(Plates XI, XII)

Of this species we have a fine example (No. 303). Body without head, well preserved, fifteen inches long. Depth under front of anal 2⅕ times in distance to base of caudal; anal inserted below eighteenth vertebra, under middle of second dorsal; neurals nearly straight; anal fin with about 18 slender rays, the first not falcate, the rays progressively shortened, the interhæmals very long, slightly curved, parallel, the hæmal spines bent strongly backward. Body deeper than in the type of T. KRIEGERI, the depth 4 in length of body proper, the caudal peduncle seeming stouter, an appearance due to the crushing together of the last five vertebræ. Pectoral with about 25 rays, the upper longest, the fin very broad, the lower rays very rapidly shortened, the lowest not one-tenth the length of the upper, which are 2½ in depth of body. Ventrals I, 5, well developed, inserted slightly before pectoral, nearly ⅔ length of pectorals. Vertebræ probably $22 + 24 = 46$, little constricted, about as deep as long, the last four or five smaller. No hypural plate. Caudal deeply forked, its rays about $15 + 15$, the lobes about equal to the depth of body. The soft dorsal with about 15 rays. No trace of scales or finlets. First dorsal obliterated, and only the anterior interneurals showing. In this specimen the upper edges of the vertebral centra are turned backward from the axis.

No. 306, in duplicate. Twenty inches long, the whole fish about 25. A large fish, the head altogether crushed, but showing compressed moderately spaced teeth in a single row. Vertebræ 40 or more, deeper than long. Neurals and hæmals strong; first dorsal lost; second rather high, with strong parallel interneurals reaching more than half way to backbone. Interhæmals long, slender, curved, oblique, parallel. Anal fin inserted much behind soft dorsal; ventrals misplaced, apparently I, 5; pectorals broken.

No. 51. 8½ inches long, preserved in duplicate. Each half is the imprint of the middle of the body. It shows twenty-three vertebræ, quadrate, little constricted, with three strong lateral ridges on each side, appearing as grooves in the imprint. Soft dorsal and anal preserved, the first with about 20 rays (19 interneurals showing), the latter with about 18, 12 interhæmals showing very distinctly.

No. 327 shows 25 vertebræ of the side of the body without head or fins. Neurals and ribs are well shown, with a trace of the spinous dorsal and some small ctenoid scales, perhaps belonging to some other fish.

No. 316 represents a section of the vertebral column, with 22 vertebræ, these short, quadrate, with three strong ridges (grooves) on the side, a characteristic of THYRSOCLES. The long interneurals and many ribs are preserved, but not the head or fins.

No. 29. Vertebræ quadrate, with deep grooves; first dorsal mostly lost; second very perfect, with long, straight interneurals, about 23 rays; 22 long, straight interhæmals; ribs very short and oblique; interneurals and interhæmals much larger than in TURIO.

7A. **Thyrsocles escharion** Jordan, new species.

(No plate)

About half our specimens of Thyrsocles (280, 15, 20) differ from the type in the relatively shorter interhæmal bones, which become rapidly shortened from the first, the eighth being not more than half the first, which is 2½ to 2⅓ in depth of the body at the front of anal, this depth being equal to the length of eleven or twelve vertebræ, the body being rather deeper than in T. KRIEGERI.

In T. KRIEGERI (303, 306, 51) the interhæmals are much longer and nearly equal in length, the eighth being nearly as long as the first and about half depth of body at front of anal, this depth equal to length of nine vertebræ.

The type specimen (No. 280) of this fine species, 15 inches in length, shows fairly well all parts behind the head.

Vertebræ $22 + 25 = 47$, short, subequal, quadrate, little constricted about as deep as long, each with three ridges and grooves along its side. Body fairly robust, depth 4⅔ in body (from gill opening to base of caudal). Caudal peduncle slender, about 2½ in greatest depth.

Pectoral rays about 16, the fin rather broad, the lower rays shortened; ventrals mostly obliterated, apparently just behind pectorals; first dorsal mostly obliterated, the spines slender, close-set, inserted before pectorals, the interneurals weak, about 10 spines traceable at the bases; interspace between dorsals considerable; soft dorsal with rather long and strong interneurals, nearly straight, the fin broken; interneurals 16; the fin rays at least as many, probably about 20, the last rays and interneurals obliterated; anal with long, strong interhæmals, the anterior ones very oblique, and all parallel, making a conspicuous grate-like appearance. Insertion of fin rather behind middle of second dorsal; the fin rather high, apparently falcate, of about 20 rays; caudal widely forked, of about 20 rays on each side. The lobes ⅕ more than greatest depth of body. In this specimen the axis of each vertebral centrum is turned forward above,

and the interhæmals are shorter than in 303 and 306 and shorter than in the type of T. KRIEGERI.

No trace of finlets or of scales preserved.

It is evident that this species cannot be placed in the genus THYRSITES, the form of the first dorsal and pectoral being quite different, the caudal fin being much stronger.

(ἐσχαρίον, a small grate, or gridiron.)

Side of a large example (No. 12), 20 inches long in life, the fragment 12 inches without head or tail, but showing the strong quadrate vertebræ, as deep as long, with the dorsals and anal fin; distance from front of first dorsal to front of anal ⅕ more than depth of body below second dorsal. First dorsal of 15 to 20 slender spines, the count not exact; soft dorsal falcate, with 17 rays evident and probably 4 or 5 more lost, there being 21 interneurals corresponding to rays. Anal rays not to be counted, probably about 25, the first interhæmals very oblique, curved backwards, the others long and parallel; first interhæmal inserted nearly under front of soft dorsal, the first anal ray nearly under middle of dorsal fin; vertebræ strong, sub-quadrangular, deeper than long, each with two strong lateral ridges, between 45 and 50 in all, but some at both ends broken, about 12 having interhæmals along base of anal fin. The caudal vertebræ (16 preserved) must have been about 24.

No. 23 is a fragment about 10 inches long of a large fish, with quadrate vertebræ, each three-ridged, along the side. The head and tail are wanting.

The pectoral fin shows twelve or more rays. The soft dorsal shows about 14 interneurals and a few anal rays show.

Another specimen (in duplicate, 69A and 69B) seems to belong to THYRSOCLES ESCHARION. It shows the anterior region, a head wholly crushed, with twelve vertebræ, short and quadrate. A few dorsal spines may be traced. The posterior part of the head is relatively short, a character which, with the numerous vertebræ, will distinguish the species from TURIO.

No. 15. Body with tail, well preserved; interhæmals relatively short; vertebral axis turned forward above. A typical example, much like No. 280.

12B. Posterior region showing well, 20 dorsal rays, and anal rays 24. Interneurals and interhæmals typical.

No. 318. The tail of a fairly large fish, the caudal itself entirely crushed and displaced. It shows 19 vertebræ, each quadrate, deeper than long, with three longitudinal ridges and grooves, the neural and hæmal spines rapidly shortened behind.

For purposes of comparison we add the following notes on living species:

SCOMBEROMORUS MACULATUS (Mitchill). Vertebræ 47, rather deeper than long, moderately grooved. Interhæmals 15, short, straight, parallel, close-set, a little more than ⅓ depth of body above anal fin. Tail with neural spines; teeth, 12 + 12 in each jaw, wide-set, compressed, those in front smaller but not crowded. Maxillary half head or a bit more. Postorbital part of head a little shorter than eye and snout; opercle very short, 2¼ in postorbital part of head. Dorsal spines slender, low, well spaced. Second dorsal inserted nearer opercle than caudal.

This species is closely related to SCOMBEROMORUS REGALIS (Bloch) = S. PLUMIERI Lacépède, the type of the genus SCOMBEROMORUS of which (Lacépède), type of CYBIUM from the Philippines, is an exact synonym. SCOMBEROMORUS COMMERSONI has the interhæmals strong, straight, parallel, ⅓ depth of body; teeth on each side 12, subequal, much compressed. SCOMBEROMORUS CAVALLA (Cuvier and Valenciennes), the big kingfish of the Florida Keys, has the interhæmals similar but shorter, ¼ depth of body; teeth 12 on each side, much compressed, subequal.

Family ZAPHLEGIDÆ

Zaphleges Jordan, new genus.

(Type ZAPHLEGES LONGURIO Jordan.)

Body elongate, symmetrically formed, much as in SPHYRÆNA; head moderately elongate; mouth large; teeth rather small, slender, conical, pointed, somewhat spaced, about 60 on the side of the lower jaw; teeth in upper jaw and roof of mouth obliterated; no evidence of canines; vertebræ small, slender, longer than deep, about 54 in number; interneurals strong; interhæmals obliterated; dorsal fins separate, the first not far behind head, of about 9 slender spines; soft dorsal rather long, not elevated; anal apparently similar, inserted behind its front, with two slender spines; pectorals moderate, inserted opposite middle of opercle; ventrals directly below pectorals; their rays apparently I, 5; caudal fin large, well forked, with short, strong basal rays like fulcra; scales cycloid, of moderate size, the number probably about 60, but no accurate count possible.

This genus resembles the section of elongate APOGONIDÆ, DINOLESTES, SCOMBROPS, and TELESCOPIAS. But, with many vertebræ, it has no near affinity to any of these, and the teeth, so far as preserved, are small and equal. The resemblances to the herring on the one hand and to the mackerels on the other are fallacious. From ATHERINIDÆ and SPHYRÆNIDÆ it differs in the strictly thoracic ventrals. Its vertebræ are much more numerous than in any of these forms. (Ζαφλέγης, full of fire, vigorous.)

9. **Zaphleges longurio** Jordan, new species.

(Plate XIII)

Type No. 100, a very fine example, 18½ inches long, showing the entire fish, the head crushed, the first dorsal, ventrals, anal, and ribs injured.

Head 3½ in length to base of caudal; depth 6¼; head moderate, rather pointed; half of lower jaw preserved; this with about 60 slender, pointed teeth apparently in one row, rather small anteriorly; no trace of canines; part of gill arches with fringes preserved; bones of head apparently all entire.

First dorsal inserted not far behind head, somewhat displaced in the type; 8 or 9 slender, low, close-set spines preserved; one or two longer detached spines preserved behind it, these probably not belonging to this fish. Soft dorsal of about 25 slender rays, the anterior longest; anal fin detached, partly obliterated, the interhæmals all lost; first two rays apparently short, slender spines; about 12 rays preserved, its insertion behind front of soft dorsal; caudal fin very long and strong, well forked, its lobes equal, exceeding depth of body, outer rays much shorter, like fulcra, the number 9, 10 — 10, 9, the peduncle not very slender, with strong neural and hæmal spines on each vertebra. Pectoral fin inserted opposite curve of opercle, rather broad and shortish, of 16 to 18 rays, the fin not symmetrical, the lower rays rapidly shortened. Ventrals inserted just below pectorals, largely obliterated.

Vertebræ about 54, slender, constricted, longer than deep; the neural and hæmal spines rather strong; ribs lost; interneurals of soft dorsal long, rather strong, and very oblique.

Scales preserved in various parts of the body, rather small, cycloid (apparently about 60 in a row).

Note on ZELOSIS Jordan and Gilbert, new genus: Type CLUPEA HADLEYI Jordan and Gilbert (Fossil Fishes of Southern California, p. 29). The fish described by us a CLUPEA HADLEYI is certainly not a true herring, and it bears a striking resemblance to ZAPHLEGES LONGURIO in its general form, squamation, vertebral column, and rudimentary caudal rays. But its ventral fins are plainly abdominal (not clearly shown in the plate), there is no trace of spinous dorsal, the caudal fin is much smaller with much shorter caudal peduncle. The dorsal and anal fins are far back and opposite each other as shown by the interspinals. It may be made type of a genus ZELOSIS (Ζελόσις, imitation).

(Plate XXIX)

Family **ZAPRORIDÆ** (?)

Aræosteus Jordan and Gilbert, new genus.

(Type: ARÆOSTEUS ROTHI Jordan and Gilbert.)

Body elongate, rather robust. Head unknown, the bones striate; vertebræ about 43, slender, hour-glass shaped, not grooved. Interneurals and interhæmals moderate, very oblique; dorsal fin of 30 to 40 rays, all simple and flexible, subequal, the fin continuous; anal with about 15 rays all simple; other fins lost.

The location of this genus is uncertain. In its vertebral column it resembles some COTTIDÆ. The dorsal fin has analogies among the dolphin-like fishes and among the allies of the blennies. But on the whole the long series of simple rays suggests most strongly the Pacific Coast genus, ZAPRORA Jordan. Nothing, however, is known of the vertebral column of the very rare type of that genus, ZAPRORA SILENUS Jordan, thus far found only about Vancouver Island. The affinities of ZAPRORA are not yet determined.

On the whole, it seems safest to assume that ARÆOSTEUS is an ally of ZAPRORA, which is probably a last relic of a disappearing group.

(Αραιός, slender; ὀστέον, bone.)

10. **Aræosteus rothi** Jordan and Gilbert, new genus and species.

(Plate XIV)

Type No. 315. Part of a fish 10 inches long to end of anal, the head crushed, showing strong striæ on opercles. Head 3½ to end of anal; depth 4½; vertebræ slender, not grooved, hour-glass shaped, 10 + (7) + 13 to middle of anal, probably about 43 in all. First dorsal of 15 to 20 slender spines, rather wide set. Second with 15 to 20 slender rays, apparently simple, no sign of branching anywhere. No evidence that the spines and soft rays are differentiated. The last rays certainly and perhaps some intervening spines are lost. The fin was most likely continuous. Interneurals moderate, oblique, in pairs. Interhæmals very oblique, rather strong, the fin inserted far behind front of soft dorsal. Anal showing about 15 rays, all simple. Some or all of interhæmals and interneurals in pairs, two springing from one neural or one hæmal, one or often two between each two interhæmals and interneurals, mostly longer than the hæmals and neurals; ribs slender, very oblique.

This seems to be the same as No. XI, from Lompoc, an indetermined specimen figured in our *Fossil Fishes of Southern California*. (Named for Almon Edward Roth of Stanford University.)

Family SERRANIDÆ.

Emmachære Jordan and Gilbert.

(Type: EMMACHÆRE RHACHITES Jordan and Gilbert.)

Allied to STEREOLEPIS Ayres, but with stronger dorsal spines. Body robust, the depth about equal to length of head, nearly three times in length to base of caudal; caudal region tapering rather rapidly. Mouth large, the lower jaw projecting, the teeth bluntish, in broad bands, no serrations or spines on head as far as known. Vertebræ 24, strong, about as deep as long, strongly grooved; spinal bones, strong and with interneurals dagger-shaped (dilated at base). Dorsal rays X, I, 16, the fin deeply notched, the spines very strong, the median longest, 2½ in head; soft dorsal with its base about equal to that of the spinous part, its base nearly horizontal, the rays about as long as the spines. Anal III, 8 or 9, the second spine strongest, but not longer than third. Caudal broad, subtruncate, with large hypurals and no median split. Ventrals I, 5 inserted just before pectorals; pectoral broad and rounded, unsymmetrical. The broken specimen on which this genus was based (1919) is now supplemented by two large examples.

11. Emmachære rhachites Jordan and Gilbert.

(Plates XV, XVI)

Our best example (No. 220) is 19½ inches long; complete except for the crushed head. Head 3⅕ in length; depth about the same; form robust, tapering posteriorly. Vertebræ 9 + 15 = 24, rather strong, about as deep as long, somewhat constricted, with a strong double groove on the lower side of each; neurals and hæmals strong, even; interneurals of spinous dorsal almost as long as neurals, dagger-shaped, one between each pair of neurals, dilated at base, those of soft dorsal much smaller, also shorter, mostly two between each pair of neurals; interhæmals strong, the anterior very long, dagger-shaped, the second somewhat enlarged, one between each pair of hæmals; ribs small.

Lower jaw strong, apparently projecting, 2⅔ in head, with moderate rather broad bands of teeth preserved; sides of head with imprints of rather large scales. Dorsal fin continuous, deeply notched, the first of 10 strong spines, the median longest, about 2½ in head. Soft dorsal with its base scarcely longer than that of the spinous part, with a slender spine and 15 or 16 soft rays, its base nearly horizontal, the rays about as long as the spines. Anal inserted slightly behind soft dorsal, its three spines strong, the second strongest, about as long as third. Spines graduated, the rays about III, 8 or 9; base of anal somewhat shorter than that of

soft dorsal. Caudal broad, not forked, apparently subtruncate; hypurals broad, without open median space behind. Ventrals I, 5, inserted just before pectorals, the fin well developed. Pectoral rays about 16, the fin broad and rounded, a little more than half head, unsymmetrical, the upper rays longest.

A second specimen (No. 311) shows the side of a large fish, the part preserved 17 inches long, head crushed. Vertebræ about 24, strong, constricted and grooved. Anterior neurals very strong. Dorsal deeply notched, apparently X, I, 15, the spines very strong, the longest 2⅓ in depth; a strong imprint marks the second spine, much stouter, though shorter, than third, with long, stout, dagger-shaped interneurals dilated at base; soft rays lower, but high. Second dorsal spine twice height of last. Anal probably about III, 10, the spines broken. Soft dorsal interneurals mostly double. Body formed like a large bass. Depth a little more than length of spinous dorsal. Soft dorsal and anal with the base nearly horizontal, not set obliquely as in BANJOS and HAPALOGENYS.

This fish must belong to the SERRANIDÆ, though having stronger dorsal spines than any living species. It may be nearest STEREOLEPIS, the giant bass or Jewfish of Japan and California, but the spines are stronger and the anal fin longer than in that genus, the ventrals farther forward.

Family **SPARIDÆ.**

Rhythmias Jordan and Gilbert, new genus.

(Type: RHYTHMIAS STARRII Jordan and Gilbert.)

A genus of SPARIDÆ, having the broad-elliptical form of the living genus LAGODON. Head rather large, obtuse, the upper profile evenly curved, its length nearly 3 in body; depth about 2½. Mouth and teeth unknown; bones of head apparently without spines or serrations. Vertebræ about 25, small, longer than broad, the spines even; interneurals short and slender, dilated at base, one or sometimes two between each pair of neurals; second interhæmal somewhat enlarged.

Dorsal fin low, continuous, scarcely notched, the rays about XIII, 12 or 13; no antrorse spine before first spine; middle spines highest; anal rays about III, 8, the second spine strong and curved, higher than third or than the soft rays; pectorals narrow; ventrals thoracic, inserted just behind pectorals. Caudal I, 5, forked, the lobes very long. Scales unknown.

This genus is no doubt an ally of SPARUS, but its exact position cannot be determined until the teeth can be examined. The caudal fin is larger than in any living sparoid fish. (ῥύθμη, symmetry).

12. **Rhythmias starrii** Jordan and Gilbert, new species.
(Plate XVII)

The type (No. 175), 7½ inches long, shows the whole fish, the head, however, badly damaged and the fins imperfect.

Head rather large and blunt, 2⅘ in length to base of caudal; depth 2⅖; upper profile forming an even curve from snout to caudal; snout rather blunt; mouth broken, apparently small; eye moderate, as long as snout and apparently 4 in head; no spines on head; vertebræ 10 + 15 = 25, small, longer than broad, with two narrow grooves, neural and hæmal spines moderate, directed evenly upward and backward; interneurals slender, dilated at base; second interhæmal enlarged. Dorsal fin low, continuous, scarcely notched, the spines XIII, the middle ones a little the highest; the first dorsal spine over second vertebra, the rays not to be counted. Anal low, with the second spine strong, curved, apparently higher than any soft rays; pectoral obliterated; ventrals displaced, apparently I, 5; caudal injured, its outline apparently lunate; no scales preserved.

The species is named for Mr. Edward B. Starr of the Celite Products Company of Lompoc.

A similar specimen is No. 43, 10 inches long, 12½ in life, the side of a large porgy, without head. Depth 2¾ in body from gill opening to base of caudal about as long as deep, each with a conspicuous median groove (ridge): 10 + 15 = 25 (probably 24) preserved; neurals slender, similar to the hæmals; interneurals small, those posteriorly double or divided.

Dorsal fin continuous, somewhat notched, 10 rather slender spines present, the fourth longest, about 3⅓ in depth of body; soft dorsal apparently short, its rays obliterated; probably not over 10 in number.

Anal with three spines, the second and third about equal, the rays apparently not more than 8; second interhæmal a little enlarged, rather longer than its spine, which is shorter than longest dorsal spine and 3¾ in body. Caudal very long, forked, its lobes 1½ in depth of body. Ventrals just behind pectorals, I, 5, well developed; pectorals rather narrow, crushed.

This specimen seems to have the dorsal spines rather higher than in the type, and the anal spine smaller. This difference may be due to imperfections in preservation.

Another (22A) is in poor condition, 13 inches long. Interneurals small, oblique, those of first dorsal moderate, one for each pair of neurals, each vertebra with two narrow ridges and three grooves. Vertebræ 24, strongly grooved. Dorsal with 10 to 12 low spines preserved, and 15 to 20 low soft rays. Anal about III, 18, the second spine longest but still short; caudal long, subtruncate. Spinous dorsal with rather

long and strong interneurals. Second dorsal with interneurals short and weak. Ventrals well developed, with a strong spine, inserted well behind pectorals, but attached to a very strong and long pelvic bone. Pectorals moderate. Head obliterated.

Five more specimens, since examined, are without antrorse dorsal spine, the sole character by which PLECTRITES can be separated from RHYTHMIAS. But in no case are we sure that it was actually absent.

Plectrites Jordan, new genus.

(Type: PLECTRITES CLASSENI Jordan).

Spariform fishes with a sharp horizontal spur directed forward, at the base of the first dorsal spine. Body elliptical, compressed, rather deep. Head not preserved, the depth of body about 3½ in length to base of caudal. Vertebræ about 30, deeper than long, slightly grooved, neural strong; interneurals straight, not expanded at base, those in front well separated, two or three for each pair of neurals; those under soft dorsal short, close-set, parallel, two or three for each pair of neurals; interhæmals all short and weak.

Dorsal continuous, scarcely notched; the rays low, D. XII, I, 11. Anal opposite soft dorsal. Other fins lost.

13. Plectrites classeni Jordan, new species.
(Plate XVIII)

Type No. 313, part of side of fish, 8½ inches long. Body regularly elliptical, compressed, deepest mesially. Depth about 3½; head lost, vertebræ about 25, deeper than long, slightly grooved; neurals rather strong, interneurals straight, not expanded at base, those in front well separated, those under second dorsal close together, short and parallel.

Dorsal with a sharp antrorse spine at base of first spine and almost as long. It is attached at the base of the first spine and to the same interneural. Dorsal spines thirteen. The first spine ¼ length of fourth, the rest shortened behind, connected closely with second dorsal, which is low, even, with slender rays. D. XII, I, 11.

Anal opposite soft dorsal, its interhæmals all short and weak; ventrals and pectorals lost; a few moderate scales. This fish has the dorsal fin and its antrorse spine much as in the SPAROID genera, STENOTOMUS (STENESTHES) and LAGODON. The presence of this spine with a rather more elongate body alone separates this genus from RHYTHMIAS. The antrorse dorsal spine is found also in AMBASSIS, SCATOPHAGUS, ACANTHURUS and SIGANUS, but the present genus is evidently sparoid.

The species is named for its discoverer, Mr. WILLARD J. CLASSEN of Stanford University.

Family SCIÆNIDÆ.

14. **Lompoquia retropes** Jordan and Gilbert.

(Plate XIX.)

Only the original type yet found. The body is largely covered with small, thin scales, smaller below. Vertebræ 14 + 10, as in CYNOSCION, its nearest living relative.

Lompochites Jordan, new genus.

(Type: LOMPOCHITES HOPKINSI Jordan.)

A long and slender fish, apparently belonging to the SCIÆNIDÆ, but quite as likely a CARANGOID. Head about 4 in length, the depth 4½; mouth rather large, the teeth unknown. Vertebræ 14+10 = 24, little constricted and with a broad ridge between two grooves. Neurals and hæmals slender; interneurals slender and sharp, one for each neural anteriorly, two between each pair posteriorly, these shorter and more oblique, interhæmals stronger, forked, one for each pair of hæmals.

Dorsal fins separated; the rays about XII, 20, the first short, the second long and low. Anal apparently II, 18; ventrals inserted well behind pectoral, much as in LOMPOQUIA. Caudal lost; no scales preserved.

15. **Lompochites hopkinsi** Jordan, new species.

Type No. 101, a shadowy impression of a large fish, complete but very faint, ten inches long to base of caudal. A long, slender fish, the head 4⅙ in length; depth 4½; the head rather long and low, the mouth apparently rather large, the maxillary perhaps reaching front of eye; bones of head obscure, except that one gill arch is uncovered showing the prints of its fringes; vertebræ longer than deep, 10 + 14, little constricted; with a broad rounded median ridge between two grooves, not showing the two narrow ridges and three grooves so evident in the type of LOMPOQUIA RETROPES.

Neural and hæmal spines slender, even; ribs evident; dorsal apparently divided, the first dorsal short, of 10 to 12 slender spines; soft dorsal long and low, of 15 to 20 slender rays; first dorsal inserted behind ventrals over the fifth vertebra, its interneurals springing from the third; anal apparently with two small spines and about 18 rays; caudal lost;

pectoral mostly obliterated; ventrals inserted well behind it, just before first dorsal spine with a long pelvic bone, much as in LOMPOQUIA RETROPES.

A renewed study indicates that LOMPOCHITES may be one of the CARANGIDÆ; perhaps nearest ELAGATIS.

Named for Mr. Timothy Hopkins, founder of the Hopkins Marine Station.

Family **SCORPÆNIDÆ.**

Rixator Jordan and Gilbert, new genus.

(Type: RIXATOR PORTEOUSI Jordan and Gilbert.)

The species described below as RIXATOR PORTEOUSI would certainly come under the head of SEBASTODES as defined by Jordan and Evermann. But that genus covers a great variety of forms and must be subdivided, and the present species is allied to the type-group.

The following generic characters are shown by R. PORTEOUSI: Body rather elongate, compressed, the back straight, scarcely arched, with a very large head, 3 in length, the depth about 4¼; mouth large, the cleft extending beyond eye; larger than in SEBASTOSOMUS and ROSICOLA; lower jaw prominent, with bands of even, pointed teeth.

Vertebræ 24 (25), large, mostly longer than deep, strongly grooved; neurals and hæmals strong; interneurals long and strong, expanded or dagger-shaped at base, especially anteriorly, one and sometimes two posteriorly between each pair of neurals. Interhæmals small, slender, and very oblique except the second, which is robust and very long, half head; two or three set irregularly between each pair of hæmals. Dorsal continuous, deeply notched, its rays XII, I, 13. Anal rays III, 6, or possibly 7, the second spine very long and strong. Pectorals broad, rounded, unsymmetrical. Caudal broad, subtruncate, the hypural plates large, about two on a side, with an open median split which separates the caudal rays in the skeleton.

Cranium unknown; armature of head and squamation of body, with character of gill rakers, undetermined. Among living forms the species in question is certainly nearest typical SEBASTODES, but the second anal spine and its interhæmal are greatly enlarged.

In SEBASTODES proper the cranial ridges are very small, mostly without spines at tip, the jaws unequal; the cranium thick, very broad between the eyes, somewhat convex; scales moderate; gill rakers long and slender. Vertebræ 24, besides the small vertebra which forms the base of the expanded hypural; the vertebræ, especially the mesial ones, notably longer than deep; parietal bones not meeting. Anal inserted under middle of

soft dorsal, its rays II, 9 to III, 12. In SEBASTODES the anal spines are quite small, with small second interhæmal, and the anal fin has more rays than in related forms.

This genus, RIXATOR (no cranial characters being available) seems to differ from ROSICOLA Jordan and Evermann in the very long second anal spine and weaker skeleton. From the less nearly related SEBASTOMUS Gill (ROSACEUS), with which it agrees in these regards, it is separated by the smaller number of vertebræ, 24 (25) instead of 27. Those who choose may regard ROSICOLA and RIXATOR alike as sections of SEBASTODES.

The genus RHOMARCHUS (ENSIGER), described by us in 1919, seems related rather to SCORPÆNA than to these SEBASTINE forms. It has much stronger dorsal spines and the second anal spine still longer. The count of 18 vertebræ in the type is evidently an error, some six of the body vertebræ being crushed.

The group of Rock-fish or Rock Cod (SEBASTINÆ), allies of the Rose-fish (SEBASTES MARINUS) of the Atlantic, forms a most conspicuous feature of the living fish fauna of both shores of the North Pacific. About fifty-three species are known from the American shores and twenty-two others from Japan.

These fish differ enormously among themselves, especially in cranial characters; but these features are subject to a variety of intergradations defying all attempts at sharp division. All possess thirteen dorsal spines, three anal spines, a broad, divided hypural plate, and small rough scales. These facts have led Jordan and his associates, Gilbert, Evermann, and Cramer, to refer the whole assemblage to the single genus SEBASTODES, characterized by the presence of 13 dorsal spines and 27 vertebræ. Meanwhile these authors have recognized the groups defined by Gill and by Eigenmann as subgenera.

A recent study of these fishes made by Dr. Jordan at Monterey inclines him toward a revival of some of these suppressed genera, especially of the groups called SEBASTODES, ROSICOLA, SEBASTOSOMUS, SEBASTOMUS, HISPANISCUS, PTEROPODUS and SEBASTICHTHYS.

The number of vertebræ is not uniformly 27 as supposed. In most of the species, but not in all, the number is 27, counting the smaller one, which forms the base of the hypural plate. He finds 27 (26 + 1) vertebræ in SEBASTOSOMUS (MYSTINUS, FLAVIDUS) in PTEROPODUS (VEXILLARIS, ATROVIRENS, NEBULOSUS, CARNATUS and CHRYSOMELAS), as well as in SEBASTOMUS (ROSACEUS and CONSTELLATUS).

But in the species called SEBASTODES (PAUCISPINIS, GOODEI) and ROSICOLA (PINNIGER, MINIATUS) the vertebræ number but 25, including the hypural one. The elongate form of the body, the low, straight outline

of the back, with the great size of the mouth, the small anal spine, besides the almost spineless cranium, sufficiently define SEBASTODES.

16. Rixator porteousi Jordan and Gilbert, new species.
(Plates XXI, XXII, XXIII)

Type No. 300. A complete large fish with crushed head, 18 inches long. Head very large, about 3 in length, depth about 4¼; maxillary 1½ in head, extending to just beyond eye; orbit 3¾ in head; snout about 3¾; jaws unequal, the lower prominent, both with small, even, close-set conical teeth, as far as shown. Form relatively elongate, the outline of the back straight, scarcely arched.

Vertebræ 10 + 15 = 25, rather large anteriorly, as deep as long, posteriorly longer, grooved; neurals and hæmals strong, even; interneurals strong, all more or less dagger-shaped, expanded at base, extending half way or more to backbone.

Interhæmals much smaller, slender and very oblique, reaching about one-third distance to backbone, the second interneural excepted, which is robust and very long, very oblique, about half length of head, and equal to depth of body at insertion of anal, D. XII, I, 13, A. III, 7, or possibly 6. Dorsal continuous, deeply notched, with 12 strong spines in its first part, the third spine longest, 2⅓ in depth of body, the first spine very short. Second dorsal I, 13, the rays high, subequal, about as high as longest spines, the second strongest, longer than third, 2 in depth of body (broken in type), first spine more than half second, the fin inserted farther back than in related species, nearly under middle of soft dorsal, about as in SEBASTODES.

Pectorals broad, rounded, very long, unsymmetrical, of about 18 rays, 7¼ in length of body, nearly ⅖ of head, almost as long as in ROSICOLA PINNIGER; ventrals lost; caudal broken, subtruncate, rounded, split mesially, with strong hypurals, about 3 on each side, of about 24 rays, the outer shortened; soft rays of all fins much branched. No bones of head with serrate edges. No trace of scales. This species is apparently nearest the living SEBASTODES GOODEI Eigenmann. It differs from those called ROSICOLA (PINNIGER, MINIATUS) in the larger mouth, straighter back, longer vertebræ and most posterior position of the anal fin.

To RIXATOR PORTEOUSI we refer two smaller examples, which differ from the type only in the very slender interneurals; a matter probably of age.

No. 243 is a small fish, lacking the head, the part preserved 5 inches long, of depth of about 4½ in length from front of spinous dorsal. Vertebræ 10 (7 preserved) + 14 or 15 = 25, slightly longer than broad, especially posteriorly; each vertebra somewhat grooved; neurals and hæmals moderate; interneurals straight, simple, distinctly expanded at

base; interhæmals small, except the second, which is much enlarged, bearing the very long, curved second anal spine, the length of which is greater than depth of body above it.

Head large; body oblong; the back scarcely elevated; mouth rather large, with sharp, even teeth; vertebræ 24 or 25, small, deeper than long, each with a median groove; neural and hæmal spines moderate; interneurals simple, straight, not much dilated, those under soft dorsal smaller; interhæmals, except the second, weak, oblique. Dorsal continuous, rather low, deeply notched, the rays about XII, I, 13. The spines strong, the longest spine not longer than those next to it, and not double length of next-to-last spine; last spine as long as soft rays, which taper rapidly backward. Dorsal apparently XII, I, 3 or 4, I, 14; the soft rays not to be counted; anal rays III, 7, the number uncertain. Caudal not forked; ventrals and pectorals detached and broken.

No. 246. Body with broken head, 9 inches long. Vertebræ apparently 25; depth about 5; head about 3¼ in length, bones all entire, neurals and hæmals meeting them at an angle, and mostly not so long. Second interhæmals very long and strong; interneurals all simple, not at all expanded at base, those behind quite slender. Dorsal spines XIII, the first small one, third highest 1⅔ in depth; fin notched, the rays XII, I, 13 or 14. Anal mostly lost, its second spine enlarged, its oblique interhæmal ¾ depth of body. Caudal truncate, mesially divided, the number of soft rays about 16. This specimen is finely preserved.

17. Rixator ineziæ Jordan, new species.
(Plate XXII, fig. 2)

Some of our specimens of RIXATOR seem to differ from the type. In R. PORTEOUSI, the anal, as in SEBASTODES, is inserted posteriorly, its first spine about under middle of soft dorsal, the second spine usually extending beyond the soft dorsal rays; the body is slender, the depth at front of anal about equal to longest dorsal spine. In the other form, which I may call RIXATOR INEZIÆ, the anal is inserted about under front of soft dorsal, as in nearly all the other SEBASTINE fishes, its long spine not extending beyond dorsal, and the depth of body at front of anal more than longest dorsal spine, these spines rather higher than in R. PORTEOUSI.

Type No. 45B, 7½ inches long, the body without head, the whole fish about 9 inches, the counterpart, 45A, similar but fractured. Depth 1⅓ in distance from front of anal to caudal; about 3⅖ in distance from snout to base of caudal. Vertebræ $10 + 14 = 24$, constricted, about as deep as long, with a median groove; neural and hæmal spines moderate, straight; interneurals simple, slender, but apparently expanded at base.

Dorsal fin continuous, XII, I, 14, deeply notched, the spines high, slender, stiff; 13 present (12 in the duplicate), these much higher than

the soft rays, which number about 14, and nearly equal to depth of body. The anterior soft rays are high, the posterior rather rapidly shortened; anal with the second interhæmal very strong, more than half depth of body, supporting the very strong curved second spine, which is twice the first spine and longer than the third, ⅖ depth of body, as long as dorsal spines. Seven soft rays preserved, these rapidly shortened behind; pectorals very broad, of about twenty rays, broken behind; ventrals just below them, apparently I, 5. Caudal fin large, subtruncate; hypural rather broad; no trace of scales.

No. 341, whole small fish with broken head, 7¼ inches. Vertebræ 24, a little longer than deep, each with 3 grooves; caudal lost, ventrals I, 5, under broad pectorals. D. XII, I, 12 or 13, an accurate count. A. III, about 8. Dorsal spines high. Second anal spine large, with strong interhæmal.

No. 76. Fragment, showing some dorsal spines and large anal spine.

No. 310. Pectoral and ventral fins of a large fish.

No. 323. Eight spines of the first dorsal, with a few vertebræ.

No. 141. The head and part of the body 7 inches long, preserved in counterpart, the total length about 10 inches; seems to belong to Rixator inezlæ.

Head large, as long as body from gill opening to front of anal fin; jaws long, apparently subequal, armed with small, sharp, even teeth. Maxillary about reaching front of eye, and apparently 3 in head; preopercle apparently entire; opercle large, nearly smooth, without evident spine; upper part of head crushed; greatest depth of body 1¾ in length of head.

Body vertebræ 14 to front of soft anal; 7 present behind these; 3 or 4 lost, the actual number probably $10 + 14$ or $15 = 25$; vertebræ small, deeper than long, each with a median groove with moderate neural and hæmal spines; ribs rather short; interneurals simple, straight, directed slightly backward and with a thin wing; those of soft dorsal smaller, scarcely winged or "dagger-shaped"; interhæmals weak. Dorsal fin deeply notched, XIII, I, 13, but continuous, the anterior part of 12 spines, the third being longest, 2¼ in head; last spine a little longer than first, 4⅔ in head; first dorsal spine close behind head, attached to first interneural. First ray of second dorsal a slender spine, 2¾ in head; the first soft ray high, the others progressively shorter to the last, which is not ¼ the longest; anal inserted behind soft dorsal, its rays damaged; the spines lost, although a trace of a strong interhæmal is present, with a mark below it, a trace perhaps of the second spine. Pectoral very broad, the rays 15 or more, the fin 2⅖ in head; ventral fins lost. Some traces of small scales on side of head.

Family HEXAGRAMMIDÆ.

18. Hexagrammos achrestus Jordan and Gilbert.
(Plate XIX)

The original type of this species is from Lompoc. The block on which it occurs was unfortunately cut in two just before the middle of the body. The parts remaining agree with the genus HEXAGRAMMOS.

Another block (No. 301), with counterpart, was also secured. This represents 10 inches taken from a larger fish, and further forward, the species apparently the same; the only difference we notice is that in the type of H. ACHRESTUS the slender interneurals are thrust between the neurals, while in the present specimen they meet nearly tip to tip. This is probably due to the fact that No. 301 shows the spinous dorsal fin, while the type (No. CXL) shows mainly the soft dorsal.

In No. 301 the head is crushed; the pectoral rounded, very wide, with about 18 rays, scarcely procurrent below. Vertebræ very large, deeply grooved, deeper than long; 16 shown, the pectoral reaching eighth; neurals simple, strong, slightly longer than interneurals, which are simple, straight, sharp, and well spaced, one interneural for each neural and meeting its neural squarely. Dorsal spines beginning over opercle, moderate, slender, well spaced, 16 of them apparent. Opercles apparently entire. Total number of vertebræ probably about 45 to 50. In living species of HEXAGRAMMOS (DECAGRAMMUS, SUPERCILIOSUS) there are 50 to 52.

Family OPHIODONTIDÆ.

19. Ozymandias gilberti Jordan.
(Plate XXIV)

No. 332 is part of the large fish supposed to be OZYMANDIAS GILBERTI Jordan (*Fossil Fishes of Southern California,* p. 44, pl. XXI). It consists of a fragment, 8½ inches long, with 12 large quadrate vertebræ from near the head, with their appendages. Vertebræ without ridges or grooves on the side, the median portion on each side a little prominent. The neurals are strong, directed well backward, well separated, with two dagger-shaped interneurals between each pair below first dorsal; these corresponded to a long first dorsal fin of a dozen rays or more; ribs well separated, very strong, curved strongly backward, each as long as six vertebræ. Body of even depth, the dorsal and ventral outlines seeming straight.

A broad, shortish pectoral fin of 12 to 15 rays detached from body, on side of belly.

It is not certain that this specimen belongs to OZYMANDIAS, nor is it clear in what family it should be placed. The vertebræ and interneural structures agree very closely with those of the living genus OPHIODON Girard (O. ELONGATUS), which now inhabits California waters. This is the sole representative of its family among recent fishes.

Family PLEURONECTIDÆ

Evesthes J. Z. Gilbert (1910).

(Type: EVESTHES JORDANI Gilbert.)

A genus of flounders, allied to HIPPOGLOSSINA Steindachner and EOPSETTA Jordan and Goss, with fewer vertebræ than HIPPOGLOSSOIDES and smaller and more oblique mouth.

Eyes normally on the right side; mouth rather large and very oblique; body deep, compressed, the depth about half the length. Vertebræ 32 to 36, three of the anterior ones having very large, expanded neural spines curved forwards; dorsal rays slender, about 65 to 80 in number. Ventral fins far behind eye; hypural plate of many united slender neural and hæmal spines, its disk strongly striate.

20. Evesthes jordani Gilbert.

(Plate XXIV)

A fine example (No. 509), 8½ inches long. Body short and deep, with short body cavity and very large head. Head 2⅖ in length; depth 2 to base of caudal; mouth very large, the jaws equal, straight, the maxillary 1⅓ in head; lower jaw with strong, sharp teeth subequal, well spaced, seemingly in a single row. Vertebræ rather small, more elongate posteriorly, the number $10 + 22 = 32$; hypural plate strong; anterior neurals directed somewhat forward; posterior more backward; interhæmals all double, about as long as hæmals, two to each hæmal spine, and attached to its tip. Vertebral column anteriorly bowed downward, more than in type of E. JORDANI. Interhæmals slender, two to each neural, as usual among flounders.

Eyes probably on the left side, there being no trace of them in the imprint, which is that of the right side; dorsal fin beginning over the eye, the fin low anteriorly, becoming higher behind. Body region very short, 2½ in head, the anal beginning almost under front.

This specimen is without doubt identical with EVESTHES JORDANI, described some years since, from Lompoc, by Dr. J. Z. Gilbert. The genus EVESTHES, as Mr. C. L. Hubbs has shown, is not far from the living genus HIPPOGLOSSINA Steindachner of tropical America. The downward curving of the anterior vertebræ is characteristic of both.

Another example (No. 220), 7½ inches long, lacking the dorsal region, evidently belongs also to EVESTHES JORDANI. The anal fin is better preserved, having apparently 38 rays, caudal large, rounded, 1⅗ in head, of about eighteen rays. Pectoral inserted high, about 2¼ in head, ventral and scales obliterated.

A well-preserved example, No. 510, is 10½ inches long. In this specimen the three expanded, curved neural spines shown in E. HOOVERI are plainly evident, though less marked than in the latter species. These show faintly in No. 509, but cannot be made out on the original type.

The vertebral column in No. 510 is not at all decurved anteriorly. Anal rays definitely 42; vertebræ 32. Pectoral rays 16.

The hypural plate in this specimen is strongly striate, made up of many coalescent slender neurals and hæmals. This structure is obliterated in the original type of the species.

Still another example, with head and thoracic region only (No. 296), shows the complete pectoral fin of about 13 rays, 2¼ in head. Eleven dorsal vertebræ well arched. The body cavity very short, 2¼ in head; maxillary half head. The fish was about as large as the others—the part preserved six inches long.

Another specimen (No. 33) shows part of the head with twenty-one vertebræ, the insertion of the anal being about under the tenth, the fins, interneurals and interhæmals being all lost.

No. 276 is a fragment of the same species.

21. **Evesthes hooveri** Jordan, new species.

(Plate XXVI)

Type No. 512, 9¼ inches long, in a fine state of preservation. Body deep, the head 2¾ in length, the depth 1⅔, the anterior profile even. Head blunt, as deep as long; mouth rather large, very oblique, the maxillary extending to below eye, 2⅓ in head, being much shorter than in EVESTHES JORDANI. Orbit about equal to snout, 5 in head; the imprint being on the left side of the fossil, the eye was on the right side of the fish. Interorbital ridge narrow, a somewhat elevated ridge. Vertebral column not bent downward anteriorly, the vertebræ 35 in number. Three of the anterior neural spines much expanded, curved and bent forward, all the others slender, needle-like; interneurals all short, thin, hair-like, placed at angles with the neurals and much more numerous, 2 to 4 in each interspace.

Hæmals much longer than neurals, the first three or four expanded and joined to form a curve or "pelvic bone" about the belly, extending to

front of anal; several of those farther back bifurcate, each bearing several fine interhæmals, each with a slender ray; vertebræ smaller behind; no anal spine.

Dorsal rays about 75, the fin low, beginning over the eye; the rays all very slender, the short anterior ones turned forward and inserted much before the enlarged neurals; ribs few, short, hair-like. Anal rays about 57, not certainly counted. Ventrals with about 5 rays, inserted far behind eye, apparently just before pectorals, which are obliterated; caudal peduncle short. Caudal moderate, rounded, the hypural as in EVESTHES, made up of slender coalescent neurals and hæmals, the surface, therefore, strongly striate.

The species is named for Theodore J. Hoover, Professor of Mining in Stanford University.

Zororhombus Jordan, new genus.

(Type: ZORORHOMBUS VELIGER Jordan.)

A near ally of the living genus BOTHUS Rafinesque (RHOMBUS Cuvier), differing in the excessively high dorsal fin and rather more posterior insertion of the ventrals.

Form broadly and regularly elliptical, the depth two-thirds the length to base of caudal; eyes on the left side, mouth large, terminal, with conical teeth. Vertebræ small, deeper than long, 37 in number. Neurals strong, two interneurals, each supporting a ray between each pair; interhæmals similar, the anterior very oblique. Dorsal beginning on head, much elevated posteriorly, the longest rays two-thirds length of head. Dorsal rays about 80; anal about 65; ventral separated from anal and extended along ridge of abdomen, a little in advance of pectorals, the rays 6 or 7. Caudal separate from dorsal and anal, the peduncle short.

(Ζόρος, clear; ῥόμβος, brill or turbot.)

22. **Zororhombus veliger** Jordan, new species.

(Plate XXVII)

Type No. 230. A flounder, 8½ inches long, fairly perfect. Head 2⅗ in length to base of caudal; depth 1½. Body very deep, broadly elliptical, the dorsal and ventral outlines corresponding. Head large, its outline regular; mouth large, terminal, the lower jaw prominent. The maxillary a little more than half head; jaws with moderate, conical teeth, a few present; opercle moderate, striate. Vertebræ rather small, about $15 + 25 = 37$ in number, rather deeper than long, moderately grooved, each with a strong, straight neural spine, about a fourth of depth of body, and each corresponding to a pair of interneurals of about the same length, each of which in turn supports a dorsal fin ray. Occasionally a

third interneural is interspersed. The dorsal fin begins on the head and is greatly elevated posteriorly, but the anterior rays are short, the longest rays 1½ in head, 2⅔ in depth of body, last rays rapidly shortened. Anal quite similar to dorsal, with long interhæmals, one corresponding to each ray and two to each of the strong, long hæmals; posterior part of anal similarly elevated, about 1½ in head. First eight or ten interhæmals shortened and placed very obliquely; ribs almost obliterated. Body cavity very short, 2⅕ in head, the first hæmal and interhæmal enlarged, forming together a sort of curved pelvic bone, bounding the intestinal cavity, as described by Dr. Günther in PSETTA MAXIMA. No anal spine. Dorsal rays about 80 (76 +); anal rays about 65; ventral rays, 6 or 7. Ventral fin small, somewhat in advance of pectorals, well behind eyes, apparently extending along the ridge of the abdomen; well separated from the anal fin; pectoral short, broken, of about 13 rays. Caudal mostly obliterated, the dorsal and anal crowding it closely. Eyes apparently on the left side. Several small patches of cycloid scales preserved, much like those of BOTHUS.

To all appearance this species is an ally of the European brill, BOTHUS RHOMBUS (L), with which it agrees in general form, in number of vertebræ, and in the number of fin rays. It differs, however, notably in the great elevation of the vertical fins. The character of the gill rakers and lateral line cannot be ascertained. We may apparently distinguish the genus ZORORHOMBUS from the European genus BOTHUS Rafinesque (RHOMBUS Cuvier) by the high, sail-like dorsal fin.

No. 21. A flounder, 8½ inches long. Back bone with 36 vertebræ, some lost; dorsal beginning at the head, depth nearly or quite half length at head. Vertebral column bent upward at first; 36 vertebræ present, one or two lost. Dorsal low anteriorly, even, beginning on front of head, much elevated; 26 rays over first 12 vertebræ. Other fins mostly destroyed. Neurals strong; interneurals divided from below for most of their length.

This is evidently same as the type of ZORORHOMBUS VELIGER.

23. Diatomœca zatima Jordan and Gilbert.
(Plate XIX)

The original type of this species, No. 336 (CXXXIII), is a fine specimen from Lompoc, on a slab unfortunately cut off at both ends for commercial purposes. The part preserved is 7 inches long, the whole fish about 14.

There are, in general, two interneurals between each pair of neurals, each interneural corresponding to a fin ray; the same adjustment holds

in regard to the anal fin. The vertebræ are very large and strong for a flounder, deeper than long, with a rough surface but not grooved; the neural and hæmal spines are very long and strong; the interneurals very much shorter and weaker than in ZORORHOMBUS.

Family **BROTULIDÆ.**

24. **Eclipes veternus** Jordan and Gilbert.

(MERRIAMINA ECTENES Jordan and Gilbert.)

A specimen (No. 190) 4 inches long, the head fairly preserved, snout pointed; jaws oblique, straight, the lower probably the longer; eye large, as long as snout, 3½ in head, crossed by a narrow process, the interorbital shelf; maxillary more than half head, reaching beyond the middle of eye; bones of head entire; head almost exactly that of the specimen figured by us as ECLIPES VETERNUS; vertebræ about 34, with a few lost, probably about 40 in all, rather slender, hour-glass shaped, those posteriorly more elongate and smaller, the anterior rather strong with strong neural and hæmal spines: pectorals placed high, their tips broken; dorsal beginning not far behind pectorals, the rays all soft and close set, the fin highest posteriorly where its rays are more than half head; caudal and last vertebræ lost; a trace of ventrals before pectoral; anal similar to dorsal, but only half as long, the last rays almost equally high.

The body of this fish agrees fully with our specimens of MERRIAMINA ECTENES, the head is equally evidently that of ECLIPES VETERNUS, the two forms, which at first seemed wholly unlike, being apparently one and the same species. What appeared in ECLIPES to be the large forked caudal is really the elevated posterior rays of the dorsal and anal fins, beyond which the vertebræ plainly extend in No. 190, ending in the type (No. XIII) of MERRIAMINA, with a narrow, truncate caudal fin. The species belongs apparently to the BROTULIDÆ. Unfortunately the name ECLIPES has page priority over MERRIAMINA.

A small example with more perfect head (No. 40), but lacking most of the body, shows the head long, with oblique gape and long, straight jaws, the maxillary 1¾ in head.

No. 54 is another imperfect specimen.

Family (uncertain)

Atkinsonella strigilis Jordan, new genus and species

A fossil (No. 511) was provisionally referred by us to LOMPOCHITES HOPKINSI. Renewed examination, however, shows its distinctness, the body being covered with small scales of very peculiar form, a character

which distinguishes the new genus ATKINSONELLA, of uncertain relationship. It is named for William Sackston Atkinson, natural history artist of Stanford University, in recognition of his interest in restorations of these ancient fossils. The type of the species (No. 511) is 9½ inches long (in life about 13). The head is crushed, and the anal and caudal fins destroyed; otherwise the specimen is in good condition.

Head about 4 in length to base of caudal; depth about 4⅓. Vertebræ longer longer than deep, rather smooth, each mesially constricted and with two ridges and three grooves; the number probably 24 (16 preserved). Neural spines moderate, directed upward and backward, the anterior more curved and directed more backward; ribs strong.

Dorsal fin nearly continuous, the rays about IX, 17, not certainly counted; first part of 8 to 10 slender spines, the third longest somewhat more than depth of body; the others progressively shorter; soft rays long, and apparently all short; pectoral fin rather short, acute; the upper rays longest, about 3 times in depth of body. Ventrals inserted just behind them; the fin, if correctly interpreted, a little longer than the pectorals and of about 8 slender rays. Unfortunately this very exceptional character is uncertain—as the fin as preserved may be a misplaced fin, possibly a pectoral from the other side.

Scales small, of unique form, largest on the thorax, and rather loosely attached, being scattered in the matrix about the fish. Each scale is rounded in form, with entire edges, but marked by 6 to 9 sharp ridges which diverge forward and upward, about 100 in a lengthwise series.

ADDENDUM

Family DUSSUMIERIIDÆ

We may here insert two fossil species just received as these pages pass through the press.

Quæsita alhambræ Jordan and Gilbert.

(Plate XXVIII)

Type No. 198. A minute fish but three-fourths of an inch long, from a Miocene outcrop of diatomaceous shale near Alhambra, Los Angeles County, California, presented by Mr. George E. Malcolm. The head, dorsal fin and spinal column are fairly preserved.

Body fusiform, elongate. General shape of QUÆSITA, rather heavier at the nape, decreasing rather rapidly backward. Head large, 2.6 in length to base of caudal, its depth 4½ times in length, depth at nape about 5 in length of body; eye obliterated, the interorbital shelf strong; mouth rather short, oblique, the lower jaw projecting, reaching front of orbit; maxillary about 4½ in head; no teeth evident; opercle rounded, with five or six strong striæ, radiating from above; preopercle narrow; cheeks broad.

Vertebræ large, about 30 in all, the number uncertain, as in part they are rather vaguely defined; each is apparently deeper than long, their strength well maintained backward; the vertebræ are peculiarly formed, looking like a succession of cross-plates, each crossed by a median notch; neurals and hæmals obliterated; ribs slender; no trace of interneurals; hypural plate obliterated; caudal split, widely forked, its lobes 4 in length of body; ⅓ in head; about 16 rays in each lobe, the lobes acuminate. Dorsal inserted just behind middle of body, opposite twelfth vertebra, 6 to 8 rays visible; trace of ventrals just below it; anal mostly obliterated, with traces of about 12 rays. No scales preserved.

This fish seems allied to QUÆSITA and other genera referred to the DUSSUMIERIIDÆ, but the large vertebræ, deeper than long and less than 35 in number, may distinguish it generically from all the other fishes of this group. For the present we treat it as a second species of QUÆSITA.

Quæsita fragilis Jordan and Gilbert, new species.

Type No. 110, a small fish, one and a half inches long, from the San Pedro Hills, one mile west of "Wilmington Road" station on Pacific Electric Railway from Los Angeles to San Pedro.

Head 2⅗ in length, depth at dorsal 5½ times in length, eye 3½ in

head, snout 3½, head large, its depth not less than that of body at dorsal, orbital region crossed by a marked interorbital shelf. Dorsal rays 10, anal 10 to 12; vertebræ 20 + 14 = 34. Opercle well developed, broadly rounded. Vertebræ strong, longer than deep, maintaining their strength well backward, nine or ten before the dorsal. Neurals and hæmals strongly developed in the caudal region, but obliterated anteriorly. Hypural plate obscure. Head and mouth large, jaws subequal, the mandible reaching to opposite the eye. Dorsal fin relatively large, opposite the moderate ventrals, its insertion very slightly behind the middle of distance from front of eye to base of caudal; pectorals narrow, slender, inserted low as in other herring-like fish; ventrals shorter than pectorals, the number of rays indistinct; anal longer and lower than the dorsal, its rays more numerous; caudal broadly forked, its lobes long, subequal, a little greater than depth of body, one and one-fifth times in head.

This little fish is certainly congeneric with QUÆSITA QUISQUILIA, described and figured by us from Miocene shales at El Modena, California, in our *Fossil Fishes of Southern California,* Plate XVII. It differs in the rather stouter form and fewer vertebræ. In Q. QUISQUILIA we find 38 vertebræ, 13 before dorsal. QUÆSITA ALHAMBRÆ, above described, has the head more depressed, the insertion of the dorsal fin much farther back than in Q. QUISQUILIÆ, and the vertebræ apparently 31. In most respects it is very similar.

This example is from a diatomaceous shale lying just above a Miocene ledge. Its age is almost certainly Pliocene. As to the locality, Dr. Gilbert writes that the fish was secured while on a trip with Mr. Robert Hastings Palmer of Stanford. The reason why he places it as Pliocene is because in Los Angeles city he finds a division line which is likely between the upper Miocene and lower Pliocene, and this outcrop has certain clams in abundance at this particular horizon, similar to those at San Pedro. The superimposed layers of Pliocene lie unconformable to the stratum in question.

Thyrsocles and Thyrsion (page 13).

Just as these pages leave the press, Mr. Edward J. Porteous of Lompoc has sent to Stanford University a large and perfect example (No. 505: 22½ inches long) of the fish we have called THYRSOCLES ESCHARION. This has the long jaws and crowded conical teeth of THYRSION VELOX. The two species are in fact identical, and THYRSION seems to be an exact synonym of THYRSOCLES. The name VELOX has page priority and the species (if distinct from T. KRIEGERI) becomes THYRSOCLES VELOX. THYRSOCLES mentioned on page 7 was first associated with a known species.

THYRSOCLES, with the neural structures of SCOMBEROMORUS (obliterated on plate IX), is widely separated by the long jaws and close-set conical teeth.

ZAPHLEGES agrees with it in almost all regards, but has scales larger than in any known mackerel. We have found no scales in THYRSOCLES, but the two genera may prove identical. ZAPHLEGES certainly belongs also to the SCOMBRIDÆ.

PLECTRITES (page 28); an additional example shows the sides of the jaws beset with molar teeth, as in LAGODON. PLECTRITES is probably a synonym of RHYTHMIAS, the plectroid spine probably obliterated in the type of R. STARRII.

LOMPOCHITES (page 30) is not related to LOMPOQUIA. It is nearer some of the CARANGIDÆ, perhaps to ELAGATIS.

DIATOMŒCA (page 40) certainly cannot belong to the PLEURONECTIDÆ. No flounder has its peculiar arrangement of ribs and interhæmals. We find as yet nothing like it, except perhaps in LAMPRIS.

ECLIPES (page 41) belongs to the GADIDÆ or perhaps MERLUCCIIDÆ. It cannot be a BROTULID.

PLATES

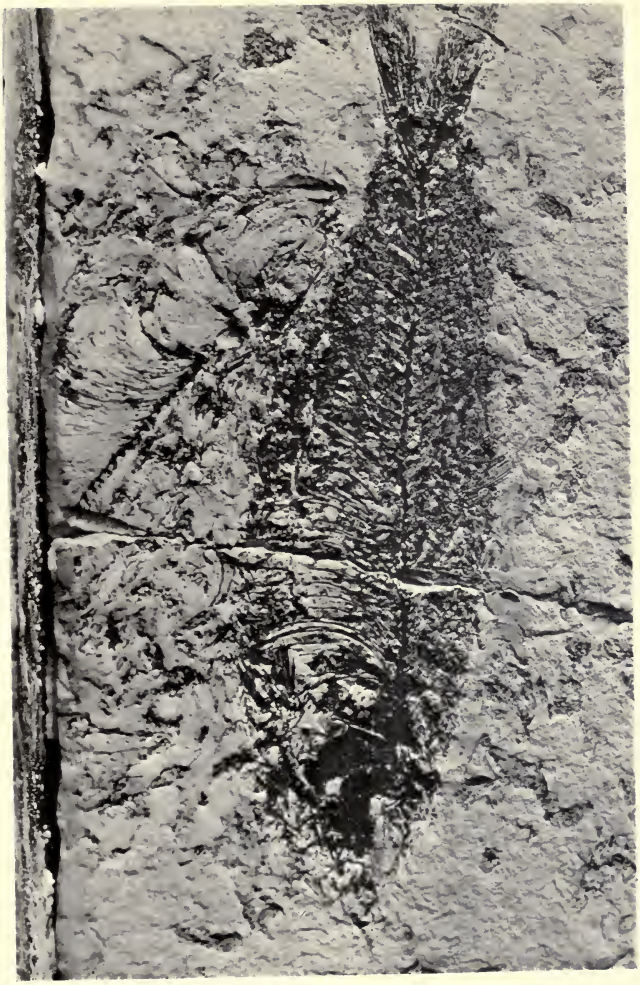


PLATE I.

Xyne grex Jordan & Gilbert; No. 116 (slightly reduced).

PLATE IV.

Xyne fitgeri Jordan & Gilbert; type No. 167 (natural size).

PLATE V.

NYNE FITGERI Jordan & Gilbert; No. 26 (natural size).

PLATE VI.

TURIO WILBURI Jordan & Gilbert; type No. 49-A (somewhat reduced).

PLATE VII.

Turio wilburi Jordan & Gilbert; No. 178.

PLATE VIII.

THYRSION VELOX Jordan; type No. 153 (slightly reduced).

PLATE IX.

THYRSION VELOX Jordan; No. 127 (reduced one-half).

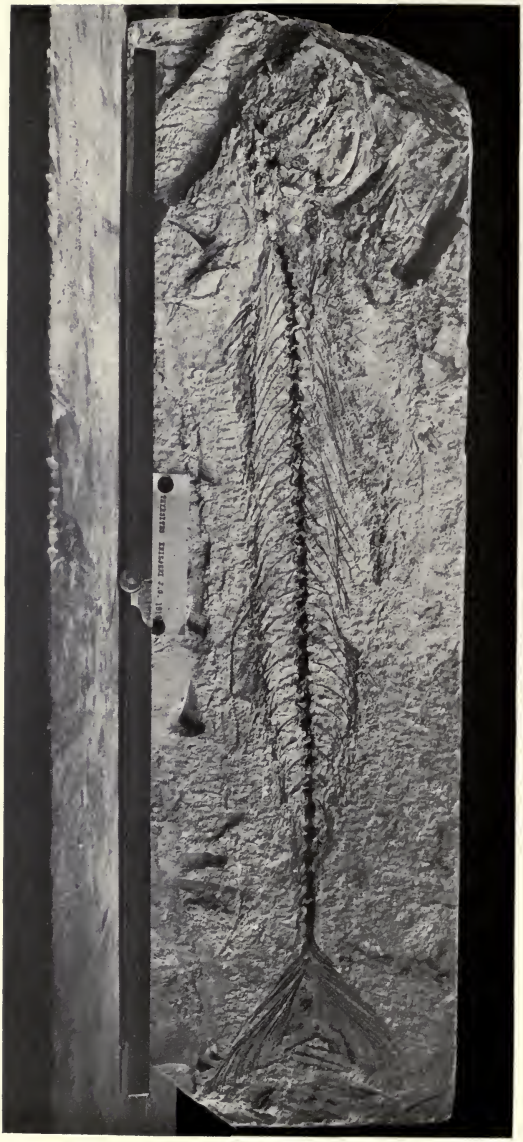


PLATE X.

Ocystias sagitta Jordan; type No. 20 (reduced to about one-third).

PLATE XI.

THYRSOCLES KRIEGERI Jordan & Gilbert; No. 303 (reduced to two-fifths)

PLATE XII.

THYRSOCLES KRIEGERI Jordan & Gilbert; No. 306 (reduced to about one-third).

PLATE XIII.

ZAPHLEGES LONGURIO Jordan; No. 100 (reduced to about two-fifths length); ventral fin obscured in the plate.

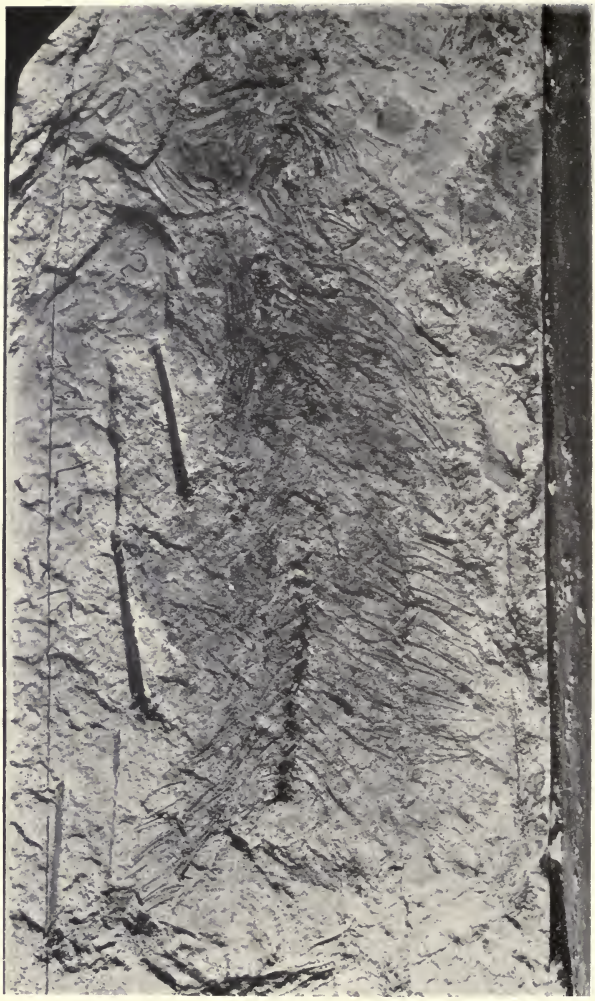


PLATE XIV.

ARÆOSTEUS ROTHI Jordan & Gilbert; type No. 315 (two-thirds natural size).

PLATE XV.

EMMACHÆRE RHACHITES Jordan & Gilbert; type No. CXLIII (natural size).

PLATE XVI.

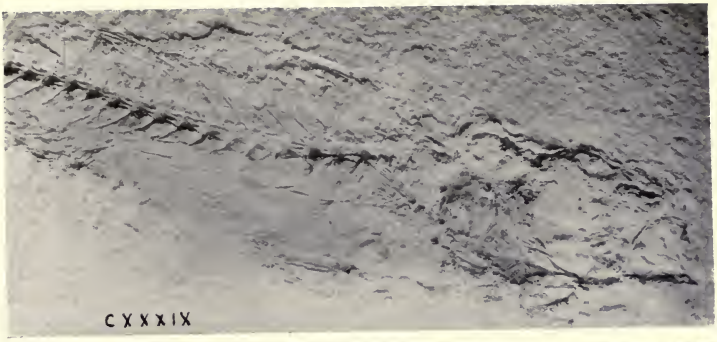
EMMACHÆRE RHACHITES Jordan & Gilbert; No. 220 (reduced to about two fifths size).

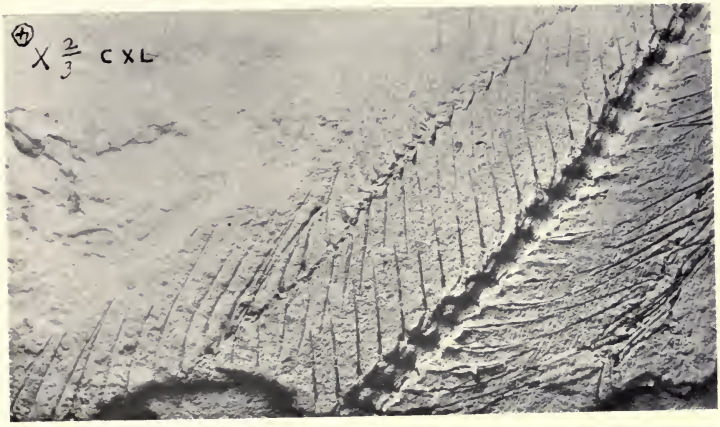
PLATE XVII.

RHYTHMIAS STARRII Jordan & Gilbert; type No. 175 (slightly reduced).

PLATE XVIII.

PLECTRITES CLASSENI Jordan & Gilbert; type No. 313 (slightly reduced)





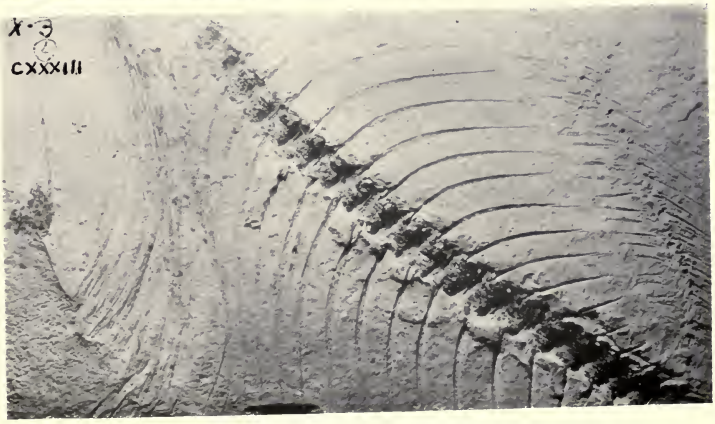


PLATE XIX.

Lompoquia retropes Jordan & Gilbert; type CXXXIX (slightly reduced).
Hexagrammos achrestus Jordan & Gilbert; type CXL.
Diatomœca zatima Jordan & Gilbert; type CXXXIII.

PLATE XX.

LOMPOCHITES HOPKINSI Jordan & Gilbert; type No. 301 (reduced two-thirds natural size).

PLATE XXI.

RINATOR PORTEOUSI Jordan & Gilbert; type No. 300 (one-third size); second anal spine broken.

PLATE XXII.

RIXATOR INEZIÆ Jordan & Gilbert (young); No. 243 (slightly reduced).

PLATE XXIII.

Figure 1. RINATOR PORTEOUSI Jordan & Gilbert (young); No. 246 (two-thirds natural size).

Figure 2. RINATOR INEZLÆ Jordan; type 145-B (two-thirds natural size).

PLATE XXIV.

OZYMANDIAS GILBERTI Jordan; No. 13 (reduced about half): identification uncertain.

PLATE XXV.

EVESTHES JORDANI Gilbert; No. 509 (three-fifths natural size).

PLATE XXVIII.

QUÆSITA ALHAMBRÆ Jordan & Gilbert; type No. 198 (four times natural size).

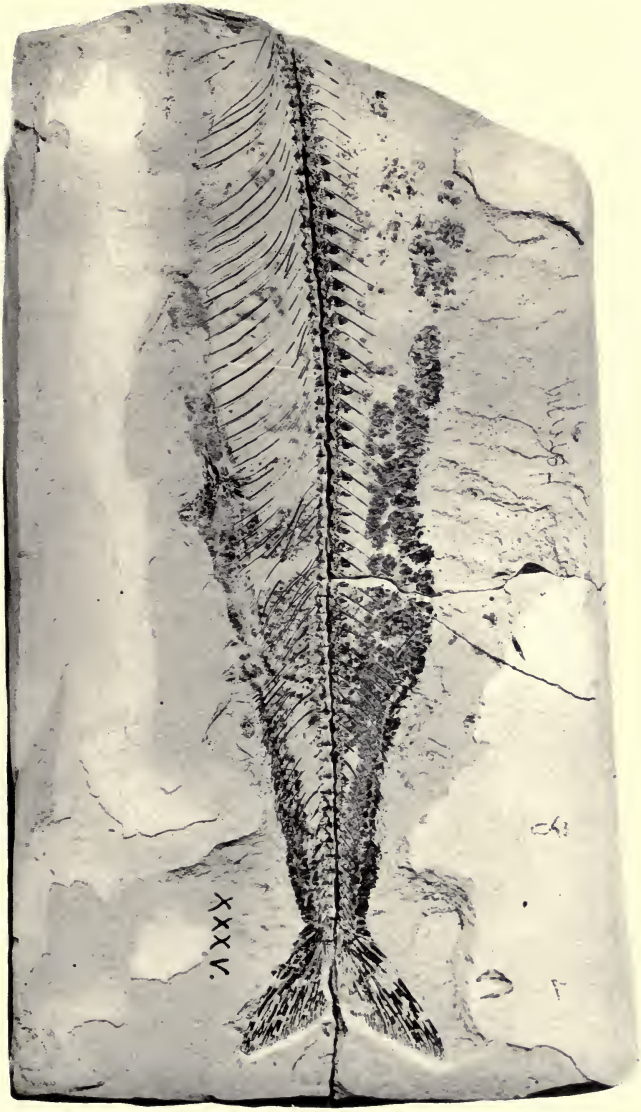


PLATE XXIX.

ZELOSIS HADLEYI Jordan & Gilbert; type No. XXXV, "CLUPEA HADLEYI," from El Modena (slightly reduced); the small ventral fins plainly evident in the fossil are barely indicated on the plate.

UNIVERSITY SERIES

The Sesamoid Articular: A bone in the mandible of fishes. Edwin Chapin Starks, Assistant Professor of Zoology. 40 pp., 15 text figures. 1916. Price 50c.

A Study of German Verbs Compounded with aus, ein, etc., as contrasted with those compounded with heraus, hinaus, herein, hinein, etc. Charles Reining, Instructor in German. 142 pp. 1916. Price $1.00.

The Pathology of Nephritis. William Ophüls, Professor of Pathology. 103 pp., 64 text figures and plates. 1916. Price $1.00.

Bone and Joint Studies, I. Leonard W. Ely, Associate Professor of Surgery, and John Francis Cowan, Assistant Professor of Surgery. 139 pp., 41 text figures and plates. 1916. Price $1.00.

A Study of the Magmatic Sulfid Ores. C. F. Tolman, Jr., Associate Professor of Economic Geology, and Austin F. Rogers, Associate Professor of Mineralogy and Petrography. 76 pp., 7 text figures, 20 plates. 1916. Price $1.00.

The Genera of Fishes, from Linnæus to Cuvier, 1758 to 1833 (seventy-five years), with the accepted type of each. David Starr Jordan, Chancellor Emeritus. 161 pp. 1917. Price $1.00.

The Use of Ye in the Function of Thou in Middle English Literature from MS. Auchinleck to MS. Vernon. Russell Osborne Stidston, late Acting Instructor in English. 95 pp. 1917. Price 75c.

Emerson: A statement of New England Transcendentalism as expressed in the philosophy of its chief exponent. Henry David Gray, Associate Professor of English. 110 pp. 1917. Price 75c.

The Neo-Classic Movement in Spain During the Xviii Century. Robert E. Pellissier, late Assistant Professor of Romanic Languages. 187 pp. 1918. Price $1.00.

The Original Version of "Love's Labour's Lost," with a Conjecture as to "Love's Labour's Won." Henry David Gray, Associate Professor of English. 55 pp. 1918. Price 75c.

The California Species of Mealy Bugs. Gordon Floyd Ferris, Instructor in Entomology. 78 pp., 16 text figures, 3 plates. 1918. Price $1.00.

Liberal and Vocational Studies in the College. Henry Waldgrave Stuart, Professor of Philosophy. 72 pp. 1918. Price 75c.

The Derivation of the Flora of Hawaii. Douglas Houghton Campbell, Professor of Botany. 74 pp. 1919. Price 50c.

A Contribution to the Knowledge of the Coccidae of Southwestern United States. Gordon Floyd Ferris, Instructor in Entomology. 66 pp., 38 text figures. 1919. Price $1.00.

The Genera of Fishes, Part II, from Agassiz to Bleeker, 1833 to 1858 (twenty-six years), with the accepted type of each. David Starr Jordan, Chancellor Emeritus. Pp. 163-284, with Index. 1919. Price $1.00.

The Electrical Charges of Atoms and Ions. Fernando Sanford, Professor of Physics. 130 pp. 1919. Price $1.00.

Fossil Fishes of Southern California. David Starr Jordan and James Zaccheus Gilbert. 64 pp. and 31 plates. 1919. Price $1.00.

The Genera of Fishes, Part III, from Günther to Gill, 1859 to 1880 (twenty-two years), with the accepted type of each. David Starr Jordan, Chancellor Emeritus. Pp. 285-408, with index. 1919. Price $1.00.

Studies in Ichthyology, a monographic review of the family of atherinidae or silversides. David Starr Jordan and Carl Leavitt Hubbs. 87 pp. and 12 pp. plates. 1919. Price $1.00.

Contributions Toward a Monograph of the Sucking Lice, Part I. Gordon Floyd Ferris, Instructor in Entomology. 51 pp., 32 text figures. 1919. Price $1.00.

Fossil Fishes of Diatom Beds of Lompoc, California. David Starr Jordan and James Zaccheus Gilbert. 45 pp. and 29 pp. plates. 1920. Price $1.00.