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FOSSIL FISHES OF SOUTHERN CALIFORNIA

I. FOSSIL FISHES OF THE SOLEDAD DEPOSITS

DAVID STARR JORDAN.

II. FOSSIL FISHES OF THE MIOCENE (MONTEREY) FORMATIONS

DAVID STARR JORDAN and JAMES ZACCHEUS GILBERT

III. FOSSIL FISHES OF THE PLIOCENE FORMATIONS

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STANFORD UNIVERSITY
PRESS

I.

FOSSIL FISHES FROM THE SOLEDAD DEPOSITS OF SOUTHERN CALIFORNIA

DAVID STARR JORDAN

In the Sierra Santa Monica of Southern California is a body of sandstones and shales, which are considerably older than the diatomaceous deposits referred to the Monterey age of the Miocene period. The latter are sometimes segregated under the name of Puente. The fish-fauna of these earlier rocks is evidently much older than that of the Monterey deposits and of the lowest Miocene or possibly of the Oligocene age. As this peculiar fish-fauna is well developed in the fine sandstones about Soledad[1] Pass, in the extreme northern part of Los Angeles County, we may provisionally call this group the Soledad deposits, using a new but temporary name, leaving the stratigraphical determination to geologists.

From Soledad deposits as thus indicated the geological collection of Stanford University has received fossil fishes from four localities—

1. **Brown's Cañon** in the Sierra Santa Monica, four miles north of Soldiers' Home and about ten miles northeast of the city of Santa Monica. The specimens from this locality are in a pale yellowish sandstone, and mostly fairly preserved. ETRINGUS SCINTILLANS is well represented, with two incomplete specimens and many detached scales of GANOLYTES CAMEO. There is also a single fine example and some fragments of AUXIDES SANCTÆ-MONICÆ. The two small examples of BULBICEPS RANINUS come from Brown's Cañon as also the type of ROGENITES BOWERSI.

2. **Moore's Cañon** in the same neighborhood, in soft, fine, white sandstone. The specimens found here are mainly ROGENIO SOLITUDINIS.

3. **Soledad Pass,** near Lancaster, about forty miles north of Los Angeles. The numerous specimens are in rather fine, white shaly sandstone, much like that of Moore's Cañon. Here were found many examples of ROGENIO SOLITUDINIS, a fragment of AUXIDES SANCTÆ-MONICÆ, several

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[1]"The snowy hills where Silence,
All unmoved by human uproar,
Holds his court, on Soledad."
—Rhyme of the Palos Verdes, 1880.

The name "Soledad" does not occur on recent maps, but the term was formerly used for mountains in the region south of Lancaster, where the Southern Pacific Railway crosses the main chain of the Sierra Madre.

examples of ETRINGUS SCINTILLANS and scales of GANOLYTES CAMEO. The type example of RHOMURUS FULCRATUS is from these deposits.

4. **Walnut,** in Puente Valley (not Puente), a locality north of the Sierra Santa Monica.

It is a matter of doubt whether these deposits which I call provisionally Soledad belong to the lower Miocene or to the Oligocene period. The following extracts from a letter of Dr. Frank M. Anderson, dated Berkeley, July 13, give the latest available information:

> I have endeavored to ascertain from some one some satisfactory information as to the locality at the head of Brown's Canyon, said to be four miles north of the Soldiers Home. I note also what you have said regarding the probable age of the strata from which the specimens of this locality came. Recently I drove up this cañon as far as I could, and as far as it seemed necessary to go, for the necessary information regarding the possible occurrence of Tertiary or Cretaceous strata in this part of the Santa Monica range. I also drove up the next cañon west of Brown's Cañon.
>
> The formations in the central and higher parts of the Santa Monica range here, and to the eastward, are all of Pre-Cretaceous age, and include some igneous rocks. The stratified rocks are slates and old semicrystalline sandstones, and not such as would likely contain fish remains, or any other organic forms.
>
> If there are any Tertiary strata near the head of the Brown's cañon they might be on the north slope of the range, and therefore not in the cañon itself, or there might possibly be a very small remnant of the Tertiary strata left lying on the older rocks, but this seems to me to be unlikely. If such remnant is there, or if Tertiary strata are conceded to exist there at all, they are much more probably of lower Miocene, than of Oligocene age, since the former are found on both flanks of the range, while the latter have not been found, as far as known, about this range at all.
>
> The locality mentioned near Olinda is quite accessible, but in this case the strata are all represented to be, and I believe *are* of Miocene age, and Middle, or lower Miocene. I am quite familiar with the locality and with the formations there, and have seen no very good reason to regard any strata very near Olinda as Oligocene, though Oligocene sandstone and shale, or such strata that may be of that age do occur about two miles east of Olinda.
>
> I have little or no information regarding the occurrence of Tertiary strata in the Soledad Pass. Sandstone, and perhaps shale do occur there, and they are doubtless of Tertiary age, but I do not know their age more definitely. Oligocene strata are well known on both sides of the Santa Clara Valley (of Ventura County), and as the Soledad cañon, and pass, are the axial continuation of the Santa Clara Valley toward the east, there is nothing improbable in their supposed occurrence in the Soledad Pass, though they have not been reported from there.

I here enumerate the species known from the rocks of the group I call Soledad. The main reason for thinking that these deposits are older than the Miocene is that the whole fish fauna is distinct from that of the Monterey series. The genera are all extinct and mainly of Eocene type, while those from the overlying shales and diatomaceous deposits

are distinctly modern. It may be, however, that the difference in conditions of life kept the offshore fishes away from the sheltered archipelago where the diatoms were piled up.

The species here enumerated are the following (new names in italics):

Family PHOLIDOPHORIDÆ.

1. ETRINGUS SCINTILLANS Jordan. Brown's Cañon, Moore's Cañon, Soledad Pass.
2. *Ganolytes cameo* Jordan. Brown's Cañon, Soledad Pass, Puente Valley.

Family ROGENIIDÆ.

3. ROGENIO SOLITUDINIS Jordan. Soledad Pass, Moore's Cañon.
4. *Rogenites* BOWERSI (Jordan). Brown's Cañon.

Family COBITOPSIDÆ.

5. *Rhomurus fulcratus* Jordan. Soledad Pass, Brown's Cañon.

Family SCOMBRIDÆ.

6. *Auxides sanctæ-monicæ* Jordan. Soledad Pass, Brown's Cañon.

Family LIPARIDÆ.

7. *Bulbiceps raninus* Jordan. Soledad Pass.

Family **PHOLIDOPHORIDÆ.**

1. **Etringus scintillans** Jordan.

(Plate I; Plate III, fig. 1)

In my paper on the "Fossil Fishes of California,"[2] a new genus of fishes is described under the name of ETRINGUS. Renewed examination of the original type (No. LIII, Stanford Collections, from Brown's Cañon) and of numerous variously imperfect specimens from the Miocene of Brown's Cañon, Soledad Pass, and Olinda necessitates certain changes in the original account. The rather large thin scales, about 35 in a longitudinal series, are covered with enamel (ganoine), and they are without ornamentation except the thin concentric circuli. The ridge along the side of the abdomen, taken for a lateral line in the original description, is fallacious, apparently due to irregularities in the rock. There is no evidence of a lateral line and no trace of ventral scutes. Apparently none of the scales are especially deepened, and they are nowhere arranged in hard and fast oblique rows, as is usually the case in the related genus, PHOLIDOPHORUS. Vertebræ $14 + 23 = 37$, well

[2] *University of California Publications,* Geology, **5**, 121, fig. 17, 1907.

ossified, the neural and hæmal spines rather strong, short, directed backward. The tail is not heterocercal. The fin rays cannot be exactly counted. The head is not well preserved in any specimen except for the rather strong lower jaw and the small eye. Its surface bones are enameled and smooth. Figure 20, entitled "A Clupeoid Fish, A," represents a specimen of ETRINGUS SCINTILLANS. Figures 18 and 19, labeled doubtfully ETRINGUS SCINTILLANS, belong, however, to a different fish, GANOLYTES CAMEO.

I present here a restoration of the species by Mr. William S. Atkinson, and also a drawing of the tail vertebræ from a specimen in which these are well preserved. The body vertebræ are deeper than long, scarcely constricted, not hourglass-shaped.

The species much resembles PHOLIDOPHORUS STRICKLANDI Agassiz, as figured by Agassiz and by Woodward. This species, from the Lower Lias of Leicester and Somerset, differs from the type of PHOLIDOPHORUS in having but few of its scales arranged in oblique series. ETRINGUS seems to differ from PHOLIDOPHORUS in the entire absence of this arrangement and in the strictly homocercal tail. It belongs to a more recent horizon than most of the other PHOLIDOPHORIDÆ. The genus has also much in common with the LEPTOLEPIDÆ, and it may really belong to that family.

Cotypes are numbers LXV, LXVI, LXXV, LXXVI, LXXVII, LXXXIX, XCV, XCVI, XCIX, CI, CII, and CIV from Brown's Cañon, and LXXXIV from Soledad.

Four other specimens (No. XCVII, XCVIII, C, and CIII) from Brown's Cañon differ in having the bones and scales entirely black, the scales not lustrous. This distinction appears to be due to the fact that these specimens lie in the surface where one stratum is separable from another, the change perhaps due to infiltration of water. The lustrous scales are from specimens hermetically sealed, within a stratum of fine sandstone.

The name ETRINGUS is from ἦτρον, abdomen, and ἰγγος, short for σύριγγος, σύριγξ, a tube, referring to the (fallacious) appearance of a lateral line along the abdomen.

2. Ganolytes cameo Jordan, new genus and species.

(Plate II, fig. 3; Plate IV, figs. 1, 2)

The specimens figured on page 123, figures 18 and 19, in my "Fossil Fishes of California," as probably belonging to ETRINGUS SCINTILLANS, certainly represent a different species, characterized by ornamental sculpture of the relatively thick and strongly enameled scales. Of this fish, much larger than any specimen of ETRINGUS SCINTILLANS,

we have numerous fragments. These show two segments of the side of the body with many detached scales. The type, No. LX, Stanford University Collection (fig. 18). Another example, from Brown's Cañon, represents the broken side of the head of a large example with a few of the scales behind the gill opening. These are considerably longer than deep, obliquely placed and finely striate, as is also the enameled surface of the opercle. The scales of the body are everywhere finely striate and some of them ornamented with radiating lines and occasionally the edge clearly serrated. The scales are not arranged in rigid oblique cross-series, and the frequency with which they have become detached would indicate that they are less firmly fixed than in ETRINGUS. The vertebræ must have numbered about thirty-five. They are hourglass-shaped, deeper than long and well ossified.

We here present drawings of well ornamented scales. For this material I propose the name of GANOLYTES CAMEO, the genus GANOLYTES being separated from ETRINGUS by the thick, sculptured scales, these next the head but not the others, being much deeper than long. The type of the species is the specimen represented in figure 18, page 123, in the "Fishes of California," here reproduced as figure 4. The three principal specimens (much reduced in figs. 18 and 19) must be fragments of a fish between two and three feet long. The type of ETRINGUS SCINTILLANS is about six inches in length.

I have fragments of this species from Brown's Cañon, Soledad Pass, and Walnut. The body scales on the three "torsos" before me seem relatively smooth while the detached scales are highly ornamented. This apparent difference is due to the fact that on the specimens the inside of the scales (nearly plain) is shown, or else the inside imprint.

Cotypes of GANOLYTES CAMEO are LXI, LXII, LXIII, LXIV, LXX, LXXI, LXXIII, LXIV, XCI, XCII, and XCIII from Brown's Cañon, LXII and LXXXIV from Soledad. We have also a specimen in duplicate, LXVII, from near Walnut, Puente Valley, Sierra Santa Ynez. This small specimen has neither scales nor fins, but small scales of GANOLYTES lie about it in the rock. Specimens from Olinda identifiable by the scales are numbered LXVIII and LXIX, but these may belong to G. CLEPSYDRA.

The name GANOLYTES is from γάνος, brightness, splendor, hence the words ganoid and ganoine, used for enameled scales; λῦτής, one who loosens or casts off.

Family ROGENIIDÆ.

3. Rogenio solitudinis Jordan.

(Plate II, fig. 1)

Of this little species, type LVI, Stanford Collections, we have more than thirty specimens, from the white sand-diatomaceous deposits from Soledad Pass, and from the fine sandrock of Moore's Cañon. All are in the form of very delicate imprints in the soft white matrix and none over two inches in length. The depth of body was probably not over six or eight times in the length, not ten as stated in the original account. The head is rather large, in the best preserved examples anteriorly pointed; the lower jaw seems to be the longer, the cleft of the mouth being at least half head. In all, the dorsal and anal are low, about equally developed, opposite each other, the front of the fin being near the middle of the body, the rays of each eight or ten. The caudal is well forked, apparently gephyrocercal, that is, without hypural bones; the vertebræ slender, hourglass-shaped. We find no trace of pectoral or ventral fin in any specimen. We are unable to assign this genus to any recognized family. The resemblance to COBITOPSIS, suggested in the original description, is probably fallacious. We find nothing nearer, however, and adopt the provisional family of ROGENIIDÆ for this genus and its possible allies.

With the type (No. LVI) are many cotypes, all of about the same size. Other groups are LVII, LXXIX, and LXXXI from Soledad, and LXXXVII from Brown's Cañon. There are about thirty-five specimens in all, but none show more characters than the original type. In all the head seems to be pointed, the anal is opposite the dorsal, near the middle of the body, and no pectoral nor ventral fin appears. The original figure of the type is here reproduced through the courtesy of Dr. John C. Merriam of the University of California.

4. Rogenites bowersi Jordan,[3] new genus.

(Plate II, fig. 2)

The little fish (No. LIX, Stanford University) described from the sandy shales of the Miocene age at Brown's Cañon, under the name of ROGENIO BOWERSI cannot belong to the genus ROGENIO.

Its salient characters are the long and slender form, the depth being eight to ten times in the length of the body, the short anal and dorsal very far back, inserted about opposite the 36th vertebra, the anal a shade the shorter and beginning a little farther back. What may be a small ventral fin is well behind the middle of the body, about opposite the 25th vertebra. There is no trace of pectoral fin or caudal,

[3] *University of California Publications*, Geology, **5**, 130, fig. 24.

the tail vertebræ seeming to be progressively smaller, without hypurals. The mouth seems to be large, the mandible strong, more than half length of head, its base angular, and there is a shadowy trace of large teeth in front: this appearance may be elusive. The vertebræ are small and numerous, upwards of sixty in all, longer than deep and little constricted.

This fish may be related to ROGENIO, but additional specimens are needed to show its affinities. Meanwhile I take it as the type of a new genus, ROGENITES. There is a remote possibility that ROGENITES is an ally of HEMIRAMPHUS.

The original figure of the species is here reproduced.

Family **COBITOPSIDÆ.**

5. Rhomurus fulcratus Jordan, new genus and species.

(Plate IV, figs. 3, 4; Plate V, fig. 1)

The type (No. L, Stanford University) the print of a dainty little fish three inches long in a fine sandstone from Soledad Pass, the front of the head broken. Head 3¾ in length to base of caudal; depth about 5½. Form lanceolate, the back little elevated, the greatest depth at the nape. Eye large, about equal to posterior part of head; jaws seemingly rather strong, the form of the mouth unknown. Vertebræ 35, elongate, hourglass-shaped, growing shorter posteriorly; the last eleven with very strong neural and hæmal spines, the last six neurals bearing projecting points or fulcra; no sign of hypural plate. Dorsal low and apparently short, inserted somewhat in front of middle of length from nape to base of caudal, its distance from nape 1⅓ in its distance to base of caudal, its rays not to be counted; ventrals inserted just behind middle of dorsal; pectoral apparently very short and narrow, placed low; (the fin below the pectoral in the type apparently the left pectoral brought around by distortion); anal well behind the dorsal, mostly obliterated. Caudal fin broad, well forked, its rays fine and numerous.

This little fish is well marked by the strong armature of its spinal column behind the anal fin. The restoration by Mr. William Sackston Atkinson gives a good idea of its form and its tail structure. The restoration of the head before the break in front of the eye is wholly uncertain. Below the eye a faint outline of the left eye seems to show through.

Some traits of this fish suggest the genus COBITOPSIS Sauvage. We may provisionally place it in the COBITOPSIDÆ, without deciding on the relationships of COBITOPSIS. It is probably, however, an ally of the more primitive ISOSPONDYLI or herring-like fishes. It has certainly no

affinity with AMMODYTES, a group in which the ventrals, when present, are attached below the pectoral fins. The type specimen was presented to Stanford University by its discoverer, the late Dr. Stephen Bowers.

Besides this specimen two others seem referable to the same species. No. LXXIX from Brown's Cañon is the vertebral column of a rather larger fish; the vertebræ are very strong, with long and strong processes. XC from Brown's Cañon is a strong tail with twenty vertebræ and a very strong, well-forked caudal fin as long as the last seventeen vertebræ. XCIV is an uncertain fragment from the same beds.

The name RHOMURUS is from ῥώμη, strength; οὐρά, tail.

Family **SCOMBRIDÆ.**

6. Auxides sanctæ-monicæ Jordan, new genus and species.

(Plate V, fig. 2)

(Type of the genus: THYNNUS PROPTERYGIUS Agassiz.)

From the sandstone of Brown's Cañon in the Sierra Santa Monica, I have three broken sections of a mackerel-like fish about sixteen inches in length, which represents a genus new to science and apparently a new species also. A third specimen from Brown's Cañon presents a crushed head with a part of the body as far as the end of the first dorsal fin. The torso represented anterior to the break in the accompanying figure (No. LI, Stanford Geological Collections, from Brown's Cañon) is taken as the type of the species. It is not certain that the posterior part belonged to the same actual individual, but it is assuredly of the same species and approximately the same size. It is this posterior part which is noticed as No. 41, "a Scombroid fish," on page 133 of my "Fossil Fishes of California." A much abraded head of the same species is represented on page 128 of the same paper, figure 22, as a "Pterothrissoid fish." Fragments are in the collection from Brown's Cañon, Moore's Cañon, and Soledad Pass.

Head 4¼ in length to base of caudal; depth at first dorsal 4⅔; dorsal with seven spines, the longest probably a shade more than half head; dorsals widely separated, the interspace probably two-thirds head; this not certain, as the soft dorsal is mostly obliterated; caudal deeply forked, its tips broken, angle of the lobes about as in SCOMBER, much less than in AUXIS. Vertebræ about 12 + 14 = 26, the number not quite certain, as two or three may be lost in the break, but certainly less than in SCOMBER (31); all the vertebræ normal in form, with no trace of the peculiar "trellised" structure seen in EUTHYNNUS and AUXIS. Neural and hæmal spines large and strong. Angle of preopercle enlarged, forming a conspicuous bony plate with strong radiating ridges. Mouth

oblique, large, the mandible projecting, its length uncertain but one-third to one-half head. Second dorsal and pectorals mostly obliterated; anal entirely so; finlets all destroyed. Body formed about as in the mackerels, apparently evenly covered with small, smooth scales, larger than in Scombroid fishes generally, those of the pectoral region not modified to form a corselet, as is the case in AUXIS, THUNNUS, etc.; twenty-five to thirty scales between the place the lateral line should occupy and the ventral edge. Scales on the narrow caudal peduncle apparently but little smaller than those near the head.

In the "Poissons Fossiles," V, part 1, 55, plate XXVII, Professor Agassiz figures from the Upper Eocene of Monte Bolca, a mackerel-like fish resembling our specimen almost exactly in all details, under the name of THYNNUS PROPTERYGIUS. The name THYNNUS is preoccupied and the smaller tunnies, once referred to it, now constitute the genus EUTHYNNUS of Lütken, while the great tunny and the albacore are placed in the genus THUNNUS of South. Our species belongs to neither. Its dorsal fins are far apart and it has not the specialized corselet seen in THUNNUS, while its vertebræ lack the extraordinary modification which is characteristic of EUTHYNNUS, well figured by Lütken in "Spolia Atlantica."

Kramberger, in 1882, doubtfully referred Agassiz's THYNNUS PROPTERYGIUS to the genus AUXIS Cuvier, and in this reference, the doubt included, he is followed by Woodward (*Cat. Fossil Fishes*, IV, 464).

But the species is much more related to the true mackerel or SCOMBER. The only genera with the first dorsal short are SCOMBER and AUXIS, and AUXIS has modified vertebræ as in EUTHYNNUS, and also a much more widely forked caudal fin. It has likewise a pectoral corselet of modified scales, the rest of the body being nearly naked or very minutely scaled. There are thirty-nine vertebræ in AUXIS, and the tail is more slender, with a single strong keel.

In SCOMBER the scales are very minute, with no pectoral corselet. The vertebræ are thirty-one, and the caudal keel is double and much smaller than in AUXIS. The mouth is much larger than in AUXIS, though smaller than in our specimen.

I propose the new genus, AUXIDES, with Agassiz's THUNNUS PROPTERYGIUS as type. It is distinguished from SCOMBER by the fewer vertebræ, larger scales, stronger dorsal spines and more oblique mouth. To this genus I refer my species, as AUXIDES SANCTÆ-MONICÆ.

A fish in many ways similar to AUXIDES is described in a subsequent paper by Jordan and Gilbert as TUNITA OCTAVIA. TUNITA has a shorter, deeper body, tapering more rapidly backward, and stronger dorsal spines,

the dorsal fins closer together. In making the restoration of the broken parts of the head of AUXIDES the artist has drawn somewhat on the type of TUNITA, which does not visibly differ from our idea of the head of AUXIDES, and which, when the drawing was made, we supposed to be the same species.

Family **LIPARIDÆ.**

7. **Bulbiceps raninus** Jordan, new genus and species.

(Plate VI)

In the sandstone from Soledad are two impressions (No. LVIII) of small tadpole-like fishes, each about two inches long. To all appearances they are Liparids or sea-snails. Little more than the general form can be described and the great size of the head may be due in part to the specimens having been pressed flat in the rock.

Head 2½ in length; depth of head 2⅗; depth of body at front of dorsal four. Eye small, shorter than snout; mouth small; only a trace of dorsal and ventral left; anal and pectoral wholly obliterated; caudal fin well developed, 1½ in head, apparently deeply forked in both examples. Traces of eight vertebræ with their neural and hæmal spines visible; the total number apparently about twenty-five; apparently no hypural bones; skin smooth.

Of the living genera of Liparids, PROGNURUS Jordan & Evermann is the only one having a forked caudal, but the species in hand bears no other likeness to PROGNURUS CYPSELURUS (Gilbert), a deep-water fish of the northern sea. I therefore place it in a separate genus, BULBICEPS, the complete characters of which await further study.

I may here notice EOPERCA Jordan, a new genus of PERCIDÆ from the Eocene of Wyoming, its type being MIOPLOSUS MULTIDENTATUS Cope.

The species from the Ree Hills, described by Cope[4] as MIOPLOSUS MULTIDENTATUS, can hardly be retained in MIOPLOSUS. It represents a new generic type, EOPERCA, midway between MIOPLOSUS and the existing genus, PERCA. From MIOPLOSUS, as Cope points out, it differs in having twelve dorsal spines instead of nine, fourteen dorsal vertebræ instead of ten, and nine antrorse spines on the lower limb of the preopercle instead of five.

In PERCA, the dorsal spines are fourteen or fifteen, the vertebræ $20 + 21 = 41$, and the antrorse serræ are smaller, more than twelve in number. Like the perch, which it must have resembled, EOPERCA was a river-fish. All the others noticed in these pages were strictly marine.

[4] *Amer. Nat.*, **25**, 1891, p. 657.

II.

FOSSIL FISHES OF THE (MIOCENE) MONTEREY FORMATIONS OF SOUTHERN CALIFORNIA

DAVID STARR JORDAN and JAMES ZACCHEUS GILBERT.

Southern California, as the term is used in this paper, includes all that part of the state lying to the southward of the arbitrary straight line which forms the northern boundary of the counties of San Luis Obispo and Kern. Much of the surface rock of this region belongs to the Miocene age. This is especially true of large sections of the counties of Los Angeles, Santa Barbara, and Kern.

The most notable feature of the Miocene deposits lies in the fact that in places hundreds of feet are composed solidly of diatoms, forming a very white shaly rock of low specific gravity and extremely friable. This is known as Celite, and the organic matter it once contained is thought to be a source of the oil which abounds in the same general region.

In certain places these rocks, in the so-called Puente formation of the Monterey period, abound in remains of fossil fishes. These are mostly of small size and delicate structure, inhabitants of shallow bays, and while most of them represent extinct genera, the general character of the fish-fauna does not differ widely from that of the California fauna of today.

The present writers will not venture on a discussion of the stratigraphy of this region, nor on the conditions under which such prodigious masses of diatoms were deposited. It would appear that the region south of the Tehachapi range was composed of sheltered islands in an arid region, the temperature not far from that of San Diego today. The diatoms may have been driven from the open ocean by the trade winds. The region must have been arid, else sand would have been washed in and mixed with the diatom deposits. In some districts this is the case.

The small size of the fishes and the fact that all or most of them are shore species would indicate bays of small extent or an archipelago of small islands. Sharks' teeth are common in rocks of this period elsewhere, but none have been found in the diatomaceous shales. These shales have been sometimes segregated as the Puente formation, a matter which we must leave to geologists.

As to the nature of the deposits called Monterey or Puente, we have the following information from Dr. Frank M. Anderson:

The white shales about Shorb and El Modena are well known to be diatomaceous and often considerable bodies of these rocks, that is, a considerable thickness of them is comparatively free from grit. I have been accustomed to regard these shales as of Puente age, as I believe they have been classified by Dr. Arnold, and I have been of the opinion that the Puente formation is middle or lower Miocene in age, and is the equivalent of the Monterey, taken in that sense.

The Puente group is certainly not the base of the Miocene in the region about Los Angeles, and in the localities mentioned in your letter, namely, Shorb and El Modena, the beds are near the middle, or a little below the middle of the Miocene section.

I presume you have some information regarding the large number of fossil fishes found in the diatomaceous beds of near the same horizon some three or four miles south of Lompoc, Santa Barbara County. The rock here is almost entirely made of diatom material some 600 to 800 feet thick.

I believe that diatoms, or the marine species of the Monterey group, are, or were northern forms, and lived in the cooler waters of the north Pacific of the Miocene, and were brought south by the ocean currents of the time, and were trapped and impounded in such favorable places as were found along the Pacific coast of the period.

Such favorable places were local, and more or less land-locked, or protected areas of sea, free from sedimentation from the land, and where the surface waters of the sea were free to enter and escape, but where they were detained long enough to lose their contents of northern forms under conditions of temperature too high to permit their survival. It appears to me that the deposits of diatomaceous strata, as they are known in California, are all more or less local, and in their occurrence and distribution, conform to this idea.

I have also imagined that the climatic conditions of the coast in middle Miocene times were different from those before and after, for there is a well known change in the character of the sediments of the Miocene, those of the middle being largely organic and those of the lower and upper Miocene being generally coarse detrital matter in which the organic contents are inappreciable.

It may be that physiographic changes in the continental border and in the ocean currents could have brought about these differences in sediments, but there are certain established facts that point to great climatic changes during Miocene times.

As to the length of time covered by any of the epochs of the past and embraced in the Miocene or Eocene, or in the interval between, I have no very exact idea.

Strata of supposed Oligocene age have been found in the Santa Monica range, as well as Eocene, but I have no information at hand regarding their occurrences.

The following localities are represented in our collections:

(1) **Los Angeles.**

1. *Los Angeles City.* Collection of J. Z. Gilbert, of Ray G. Van Cleve, and of high-school students assisting. These are mostly from clay shales or thin sandstone. Of the species thus obtained, the new Blue-fish, LOPHAR MIOCÆNUS, in Dr. Gilbert's collection, is the most important.

Several different localities within the city limits have yielded valuable specimens, as indicated under the descriptions of species.

These may be enumerated as follows:

a. Bairdstown, a hamlet midway between Los Angeles and South Pasadena, an outcrop of diatomaceous shale, mostly, not quite, pure and alternating with thin sandstone, in the hill above Titus Avenue. Many species obtained.

b. Los Angeles Brick-yard, 1000 Chavez Ravine Road; clay of the upper Miocene (LOPHAR).

c. Reservoir Hill (Silverwood Hill), Elysian Hills, south of Chavez Ravine, uppermost Miocene sandstone (SCOMBERESOX EDWARDSI).

(2) **Shorb,** Los Angeles County, about ten miles east of Los Angeles. Collection of Dr. Ralph Arnold. This collection contains numerous imprints of small fishes, all those which are identifiable being ZANTECLITES HUBBSI.

(3) **El Modena,**[5] Orange County, at Hews Park.

The fine collection of Mr. E. E. Hadley includes an unusual number of new species, as indicated below. The specimens are from chalky diatomaceous shales. This collection was placed temporarily by Mr. Hadley in the Lorquin Natural History Society of Los Angeles, the types of new species being transferred through the courtesy of Mr. Hadley and of the curator to the geological collections of Stanford University.

(4) **Lompoc** (Sierra Santa Ynez) Santa Barbara County, in diatomaceous shale. Collection of Dr. Edward J. Porteous, of A. H. Krieger and of Miss J. M. Telford. Here the primitive flounder, EVESTHES JORDANI Gilbert, was obtained in 1909.

(5) **Santa Ana** and **Orange.** Occasional sharks' teeth in clay or sandstone deposits.

(6) **Pine Cañon,** near Santa Maria, Santa Barbara County, in clay shale, reputed to be of "Monterey" age. In this FORFEX HYPURALIS occurs.

[5] The name *El Modena* applied to this village is unfortunate, as it is not correct Spanish. There is no Spanish word *Modena,* and if there were, it would be a feminine noun, not preceded by *El.* The history of the name seems to be this, as derived from the postmaster of the town and from others. The station was first called "Earlham." To this objection was made, and an Italian citizen suggested *Modena,* the name of a province in Italy. This became confused with Medina, and the suggestion was made by some one ignorant of Spanish to place *"El"* before it as in the neighboring village of *El Toro.* The name might be written correctly as *El Modeno, La Modena,* or, as suggested by Professor A. M. Espinosa, *"El Médano,"* the sandy tract. It might also be frankly meaningless, as *Elmodena,* yet it seems a pity that a locality of such interest in paleontology should have a name at once incorrect and meaningless.

(7) **Brea Cañon,** one and a half miles from Olinda, Orange County, Collection of W. O. Clark. The rock at this locality is a very hard sandstone of a dark greenish-gray color; a few fragments of fishes preserved, scarcely identifiable. In the Olinda rocks is found a single, small mussel, apparently an ally of MYTILUS. In none of the other rocks have any animals other than fishes come to my notice. Of fishes there are several specimens of some CLUPEOID fish in poor condition, and a small, much crushed GANOLYTES, presumably G. CLEPSYDRA.

(8) **Miocene deposits** of Kern County, Ocoya Creek, Oil City, Barker's Ranch, Bena. From these deposits thousands of sharks' teeth have been taken. We list these for completeness' sake, but mostly without comment, referring the student to papers of Agassiz,[6] Jordan, Leriche,[7] and Jordan and Beal,[8] in which all that is known of these species is given.

(9) **Miocene deposits** of Fresno County, at Coalinga and Zapata Chino.

(10) **Carpinteria,** Santa Barbara County.

We acknowledge our obligations to different naturalists and to the curators of local museums about Los Angeles, for their interest in this work and for the loan of specimens. The large collections of Mr. E. E. Hadley were placed for safe-keeping in the Museum of the Lorquin Natural History Society at Los Angeles. From these a series of types has been presented to Stanford University by Mr. Hadley. The specimens collected by Mr. Ray G. Van Cleve, Dr. Gilbert, and their sudents in the Los Angeles High School have also been presented from the Science and Arts Museum at the High School. Dr. Charles Lincoln Edwards has presented specimens from the museum of the city grade schools. Specimens of fossil pipe-fish have been borrowed from Professor H. H. Nininger of La Verne College, and specimens of living species from Professor William E. Ritter of the Seaside Laboratory at La Jolla.

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[6] Louis Agassiz: "Notice of Fossil Fishes Found in California by W. P. Blake," *American Journal of Sciences and Arts,* 1856, pp. 272-275. Repeated with plates in Williamson's "Report on Explorations in California," U. S. Pacific R. R. Survey for 1853, pp. 313-316.

David Starr Jordan: *University of California Publications,* Geology, **5**, 95-144, 1907.

[7] Maurice Leriche: "Observations sur les Squales Neogènes de la Californie," *Annales de la Société Géologique du Nord,* **36**, 302, Dec. 1908.

[8] Jordan and Beal (Carl Hugh): "Supplementary Notes on Fossil Sharks," *University of California Publications,* Geology, **7**, 243-256, 1913.

Unless otherwise noted, all specimens here described were collected by Dr. J. Z. Gilbert and by him presented to the department of Geology in Stanford University.

From the deposits called Puente of the Monterey group the following species are described (new names in italics):

Family HETERODONTIDÆ.

1. WODNIKA *ocoyæ* Jordan, Bena, Kern County.

Family HEXANCHIDÆ.

2. HEPTRANCHIAS ANDERSONI Jordan, Kern Miocene.

Family GALEORHINIDÆ.

3. TRIAKIS *beali* Jordan, Kern Miocene.
4. GALEOCERDO PRODUCTUS Agassiz, Kern Miocene.
5. GALEORHINUS HANNIBALI Jordan and Beal, Kern Miocene.
6. HEMIPRISTIS HETEROPLEURUS Agassiz, Kern Miocene.
7. CARCHARHINUS ANTIQUUS Agassiz, Kern Miocene.

Family CARCHARIIDÆ.

8. CARCHARIAS CLAVATUS (Agassiz) Kern Miocene.
9. CARCHARIAS MORRICEI Jordan and Beal, Kern Miocene.

Family LAMNIDÆ.

10. ISURUS HASTALIS (Agassiz), Orange County, Fresno County, San Diego County.
11. CARCHARODON RECTUS (Agassiz), Ocoya Creek, Kern Miocene.
12. CARCHARODON ARNOLDI Jordan, Orange County, Kern Miocene, Los Angeles.
13. CARCHARODON MEGALODON Charlesworth, Santa Ana, Kern Miocene, Marin County.

Family SCYMNORHINIDÆ.

14. SCYMNORHINUS OCCIDENTALIS (Agassiz).

Family ECHINORHINIDÆ.

15. ECHINORHINUS BLAKEI Agassiz.

Family SQUATINIDÆ.

16. SQUATINA LERICHEI Jordan and Beal, Kern Miocene.

Family MYLIOBATIDÆ.

17. MYLIOBATIS MERRIAMI Jordan and Beal, Kern Miocene.
18. RHINOPTERA SMITHI Jordan and Beal, Kern Miocene.

Family PHOLIDOPHORIDÆ.

19. GANOLYTES *clepsydra* Jordan and Gilbert, El Modena.

Family ROGENIIDÆ.

20. ROGENIO *vanclevei* Jordan and Gilbert, Los Angeles.

Family CLUPEIDÆ.

21. *Xyne grex* Jordan and Gilbert, Lompoc, Bairdstown.
22. ELLIMMA *elmodenæ* Jordan and Gilbert, El Modena.
23. ELLIMMA *barbaræ* Jordan and Gilbert, Carpinteria.
24. *Alisea grandis* Jordan and Gilbert, San Pedro.
25. CLUPEA *hadleyi* Jordan and Gilbert, El Modena.

Family DUSSUMIERIIDÆ.

26. *Smithites elegans* Jordan and Gilbert, Bairdstown.
27. *Quæsita quisquilia* Jordan and Gilbert, El Modena.
28. *Azalois angelensis* Jordan and Gilbert, Bairdstown.
29. *Lygisma tenax* Jordan and Gilbert, El Modena.

Family SYNGNATHIDÆ.

30. SYNGNATHUS *avus* Jordan and Gilbert, Bairdstown.

Family FORFICIDÆ.

31. *Forfex hypuralis* Jordan, Pine Cañon.

Family SCOMBERESOCIDÆ.

32. SCOMBERESOX *edwardsi* Jordan and Gilbert, Elysian Hills.
33. SCOMBERESOX *acutillus* Jordan and Gilbert, El Modena.

Family ATHERINIDÆ.

34. *Zanteclites hubbsi* Jordan and Gilbert, Bairdstown, Shorb.

Family TRACHICHTHYIDÆ (?).

35. *Eritima evides* Jordan and Gilbert, Bairdstown.

Family GEMPYLIDÆ.

36. THYRSITES *kriegeri* Jordan and Gilbert, Lompoc.

Family SCOMBRIDÆ.

37. *Tunita octavia* Jordan and Gilbert, El Modena.

Family LUVARIDÆ (?).

38. *Ozymandias gilberti,* Jordan, San Pedro.

Family POMATOMIDÆ.

39. *Lophar miocænus* Jordan and Gilbert, Los Angeles.

Family APOGONIDÆ (?).

40. *Eclipes veternus* Jordan and Gilbert, El Modena.

Family LUTIANIDÆ (?).

41. LUTIANUS (?) *hagari* Jordan and Gilbert, El Modena.

Family SCIÆNIDÆ.

42. *Lompoquia retropes* Jordan and Gilbert, Lompoc.

Family LABRIDÆ.

43. *Xyrinius houshi* Jordan and Gilbert, Los Angeles.

Family SCORPÆNIDÆ.

44. *Sebastavus vertebralis* Jordan and Gilbert, El Modena.
45. *Rhomarchus ensiger* Jordan and Gilbert, El Modena.

Family HEXAGRAMMIDÆ.

46. *Hexagrammos achrestus* Jordan and Gilbert, Lompoc.

Family COTTIDÆ.

47. *Eoscorpius primævus* Jordan and Gilbert, Bairdstown.
48. *Hayia daulica* Jordan and Gilbert, Los Angeles.

Family GOBIIDÆ.

49. ABOMA *antiqua* Jordan and Gilbert, Bairdstown, Shorb.

Family BROTULIDÆ.

50. *Merriamina ectenes* Jordan and Gilbert, El Modena.

Family PLEURONECTIDÆ.

51. EVESTHES JORDANI Gilbert, Lompoc.
52. *Diatomœca zatima* Jordan and Gilbert, Lompoc.

Family LOPHIIDÆ

53. *Emmachære rhachites* Jordan and Gilbert, Lompoc.

Family DELPHINIDÆ.

PHOCÆNA OCCIDUA (Leidy), San Pedro, Lompoc.

Family **HETERODONTIDÆ.**

1. **Wodnika ocoyæ** Jordan, new species.

(Plate VII, fig. 8)

The type, a single tooth, 15 millimeters long by 10 broad, elliptic-oval, perfectly smooth, without ridges or furrows, but with a softly rounded and finely reticulate but smooth surface. This specimen resembles a large brown bean. It is in the collection of the California Academy of

Sciences, obtained by Dr. F. M. Anderson from the lower Miocene of Kern County, the locality listed as 543, the west side of a high hill three miles northwest of the village of Bena.

It is obviously the tooth of a HETERODONTID (CESTRACIONT) shark but it differs from HETERODONTUS and related genera by the entire absence of ridges and furrows on the tooth, which evidently comes from the middle of the side of the jaw.

The genus WODNIKA Münster is defined as having the teeth all large and adapted for crushing, the coronal surface smooth and gently rounded. The latter character applies to the specimen before us, but we are not sure as to other teeth.

WODNIKA ALTHAUSI Münster comes from the upper Permian (Kupferschiefer) of Reichelsdorf, Germany.

It is very likely that additional material may place this specimen in some other genus.

The specific name OCOYÆ recalls the locality (Ocoya Creek) in Kern County from which Dr. Blake obtained for Agassiz the first examples of California Miocene sharks.

Family **HEXANCHIDÆ.**

2. Heptranchias andersoni.

Of Kern Miocene. Perhaps the same as HEPTRANCHIAS PRIMIGENIUS (Agassiz) of Europe.

Family **GALEORHINIDÆ.**

3. **Triakis beali** Jordan, new species.

(Plate VII, fig. G)

The type, a single tooth in the collections of the California Academy, from the Kern River Miocene, is quite unique. It is triangular, almost equilateral, the sides slightly convex. It is nearly erect, but notched on the outer margin, beyond which is a strong denticle, narrower than the main tooth, but similar in form and about two-fifths its height. The main tooth is finely serrate on both edges; the denticle is entire. It is probable that one or more other denticles existed and have been broken off, on the outer side of the tooth, but there were none on the inner side. The total height of the tooth is ten millimeters. The main tooth from the base downward to the outer notch is five millimeters, the diameter two and one-half. This tooth indicates relation to the species of TRIAKIS, but its pertinence to that genus doubtful.

The species is named for Carl Hugh Beal, a student who worked with me on fossil sharks in 1912.

4. Galeocerdo productus Agassiz.

Of Kern County. Perhaps identical with GALEOCERDO ADUNCUS Agassiz of Europe.

5. Galeorhinus hannibali Jordan and Beal.

Of Kern County, Temescal Cañon, Sierra Santa Monica, in Pliocene rocks; the type from the Miocene of Kern County.

6. Hemipristis heteropleurus Agassiz.

From different localities in Kern County, Ocoya Creek, Oil City, Barker's Ranch. Perhaps the same as HEMIPRISTIS SERRA of Europe.

7. Carcharhinus antiquus (Agassiz).

From the Miocene of Kern County.

Family **CARCHARIIDÆ.**
(ODONTASPIDÆ.)

8. Carcharias clavatus (Agassiz).

Of Kern County Miocene. Perhaps the same as CARCHARIAS CUSPIDATUS (Agassiz), of the European Miocene and Oligocene.

9. Carcharias morricei Jordan and Beal.

Of the Kern Miocene.

Family **LAMNIDÆ.**

10. Isurus hastalis (Agassiz).

(Plate VII, figs. A, B, C, D, H)

(OXYRHINA PLANA Agassiz, OXYRHINA TUMULUS Agassiz, ISURUS SMITHI Jordan.)

Numerous sharks' teeth of the genus ISURUS of various sizes and forms were obtained in Orange County from Miocene deposits. They seem to be referable to the European fossil shark described as OXYRHINA HASTALIS Agassiz.

Teeth like these have been described by Agassiz as OXYRHINA PLANA and OXYRHINA TUMULUS from Kern County Miocene. These were figured in Jordan's paper of 1907, being referred to the genus ISURUS, a name older than OXYRHINA. Some of the teeth called ISURUS TUMULUS came from near Santa Ana, in Orange County. Dr. Leriche is probably right in regarding ISURUS TUMULUS as the lower teeth, ISURUS PLANUS as the upper teeth, and ISURUS SMITHI as the sharp median teeth of the same species, the widely distributed ISURUS HASTALIS of Europe and of South America. In ISURUS the teeth from different parts of the same jaw differ greatly, more than teeth of different species.

11. **Carcharodon rectus** Agassiz.

This species of the Kern Miocene seems to differ from CARCHARODON ARNOLDI, by the presence of a small, blunt, lateral denticle at base on each side. It is not common.

12. **Carcharodon arnoldi** Jordan.

(Plate VIII, fig. 1)

(CARCHARODON RIVERSI Jordan)

Two very perfect teeth of the form called CARCHARODON ARNOLDI (No. CXXVIII) were found in the shales of the upper Pliocene at Fourth and Hill Streets, Los Angeles. These are slightly flexuous without distinct median ridge, no basal denticle, and about forty-five sharp serrations on each side, these serrations extending to the tip.

From deposits Miocene or Pliocene in Orange County we have also seven specimens of sharks' teeth corresponding to the type of CARCHARODON RIVERSI. The type of this species is from the Santa Monica range near Santa Monica. Another is from Port Los Angeles in rock regarded by Dr. J. J. Rivers as of Pliocene age.

The essential feature of CARCHARODON ARNOLDI lies in the small number of the serrations, thirty to fifty on each side, the teeth being small and of varying width, some (outer) being much narrower than the median teeth. There is no median ridge on any of these teeth. One very small (outer) tooth is very narrow and flexuous, looking like a tooth of ISURUS, but it has about thirty serræ on each side, while the teeth of ISURUS are smooth-edged.

It is on the whole likely that C. RIVERSI represents outlying or imperfect teeth of the species called CARCHARODON ARNOLDI.

13. **Carcharodon megalodon** Charlesworth.

(CARCHARODON BRANNERI Jordan)

This giant shark was described in the *University of California Publications*, Geology, 1907, p. 116, as CARCHARODON BRANNERI, the type being from Bolinas Bay, Marin County, the co-type from Santa Ana, Orange County. We have examined others from the Miocene of Kern County.

The sole difference between C. BRANNERI and the still more huge C. MEGALODON from South Carolina and elsewhere, lies in the smaller number of serrations on the teeth of C. BRANNERI, there being 80 to 100 on each side, and 100 to 120 in C. MEGALODON. Later comparison makes this distinction doubtful, the median teeth having more serrations than the smaller outer ones.

There probably have been four distinct species of the Great White Sharks in California, one of these (CARCHARODON CARCHARIAS) still living.

These may be thus distinguished:

a. Base of tooth on each side with a serrated protuberance or denticle—tip of tooth without serrations; serrations 50 to 60 on each side. Miocene of Kern County. RECTUS.

aa. Base of tooth without denticle; tip of tooth serrate, like the sides.

b. Serrations few, mostly 20 to 50 on each side; teeth small, less than 3 inches high.

c. Species living; serrations 20 to 40; teeth relatively narrow. CARCHARIAS.

cc. Species extinct; teeth broader; serrations 30 to 40 (RIVERSI), 45 to 50 (ARNOLDI). ARNOLDI.

bb. Serrations 80 or more; teeth broad, 4 to 7 inches long. (Serrations 80 to 90, very fine, BRANNERI, or 100 to 120, rather coarse; MEGALODON.) MEGALODON.

Family **SCYMNORHINIDÆ.**

14. Scymnorhinus occidentalis (Agassiz).

Of Kern Miocene. This genus should apparently stand as SCYMNORHINUS. SCYMNUS is preoccupied and the type of DALATIAS is probably a species of CENTROPHORUS.

Family **ECHINORHINIDÆ.**

15. Echinorhinus blakei Agassiz.

Of Kern Miocene. I have seen no teeth referable to this genus.

Family **SQUATINIDÆ.**

16. Squatina lerichei Jordan and Beal.

(Plate VII, fig. E)

Of Kern Miocene.

Family **MYLIOBATIDÆ.**

17. Myliobatis merriami Jordan and Beal.

Of Kern Miocene.

18. Rhinoptera smithi Jordan and Beal.

Of Kern Miocene.

Family **PHOLIDOPHORIDÆ.**

19. Ganolytes clepsydra Jordan and Gilbert, new species.

(Plate XI, fig. 1)

Type a specimen (VI) from El Modena, Hadley collection, 7 or 8 inches long in life. Head about 3⅙ in length to base of caudal; depth,

3⅛. Vertebræ about 17 + 25 = 42, the number of caudal vertebræ not to be exactly counted. Dorsal apparently small, inserted slightly behind the middle of the body, nearly opposite the ventral fin, which is short. Pectoral short, of 14 rays; inserted low, its length 3½ times in depth of body; caudal forked. The stout, shortish ventral seems to contain more than six rays. The opercle is rather strong and rounded behind; the occipital crest is rather high and the mandible seems strong. The bones of the head cannot be made out. The vertebræ are strong, numerous, and distinctly hourglass-shaped, with rather strong neural spines; ribs moderate.

The scales are characteristic, rather large, thick, and covered with ganoine, almost as in GANOLYTES CAMEO. They seem to be regularly arranged, between 12 and 18 in a cross series. Some of the scales show traces of digitate markings, but less distinctly than in GANOLYTES CAMEO.

Family **ROGENIIDÆ.**

20. **Rogenio vanclevei** Jordan and Gilbert, new species.

(Plate XXXI, fig. 3)

Type a little fish 1¼ inches long (No. XXIII), from a gritty diatomaceous shale of Miocene age at Bairdstown, near Los Angeles.

Except for the much greater distinctness of its various bones it cannot be distinguished from the genus ROGENIO, the type species of which abounds in the Soledad deposits.

Body elongate, lanceolate, deepest anteriorly, the depth about eight in length. Head large, depressed, its length 4⅒ to base of caudal; bones of head obliquely placed; jaws long, subequal, the maxillary extending to beyond the eye; opercle strongly convex behind; vertebræ 32 or 33, 17 behind the vent; dorsal fin inserted about midway from nape to base of caudal, its rays not well shown, about eight in number, rather low; anal similar, inserted a shade behind the dorsal, caudal peduncle behind these fins much longer than their base, the length greater than depth of body. Pectoral imperfectly shown, inserted rather low, not much shorter than head but narrow and slender; a vague trace of a small ventral midway between pectoral and anal; this perhaps fallacious; ribs delicate, well preserved; neural and hæmal spines strong; hypural plate not evident; caudal deeply forked, as long as head.

This fish probably is congeneric with ROGENIO SOLITUDINIS, with which it agrees in the anterior insertion of the anal, almost exactly opposite the dorsal. Its relations to any group of living fishes are uncertain.

The type was collected at Bairdstown in diatomaceous shale by a class of students from the Los Angeles High School under direction of Mr. Ray

G. Van Cleve, science teacher. It is presented to the Museum of Stanford University.

Family **CLUPEIDÆ.**

21. Xyne grex Jordan and Gilbert, new genus and species.

(Plate IX, fig. 1; Plate X, fig. 2; Plate XI, figs. 2, 3)

Type No. CVIII, block of diatomaceous shale from Lompoc, about 20 inches by 16, containing 24 skeletons of a herring-like fish, besides fragments, each specimen about 6 inches in length, presented to Stanford University.

No. XXXIV, seven similar skeletons also in rock of absolutely pure diatom substance without sand or grit, was obtained at Bairdstown, near Los Angeles; as also a third slab (No. XXVIII), with five skeletons of similar character. A fourth slab (No. XV), with four specimens, is from Lompoc. In these the scattered loose scales give the fish a rather curious resemblance to an ear of Indian corn or maize surrounded by loose kernels. Another large block, altogether similar to CVIII, also from Lompoc, and containing 16 fine skeletons, is in the Academy of Sciences at San Francisco.

The species has the general form of a herring, rather deeper than in CLUPEA HADLEYI or in any living species of herring, the ventral outline more convex than the back, but not prominent.

Head about 3½ in length to base of caudal; depth 3 to 3 1/10; body cavity very long, the region provided with ribs, about equal to distance from last rib to base of caudal; length of a rib 3¾ in length of body. Ribs strongly curved, hair-like, finer than in CLUPEA. Mouth rather large, oblique, the lower jaw somewhat projecting. Vertebræ 17 to 19 + 28 = 45 to 47 in number, small, slender, constricted, subequal, nearly as deep as long, not reduced posteriorly; each with two strong longitudinal ridges on each side; opercles rounded, smooth, with enameled surface; rather deep, smaller than the very broad preopercle; ventral scutes strong, with entire edges, evident in three specimens, lost in the others; the scutes large, pointed, enameled; no trace of dorsal scutes. Neural bones rather long and strong for a herring, directed moderately backwards, interspersed with fine, hair-like intermuscular bones set very obliquely. Opercle finely and evenly striate under the glass.

Dorsal median, of moderate size, its insertion slightly nearer base of caudal than snout, about twenty rays traceable, ventral inserted slightly before dorsal; anal rays apparently about twelve; pectoral sixteen.

Scales cycloid, of moderate size, apparently about sixty in a longitudinal series, regularly placed, thin, but more or less enameled; many loose scales scattered about most of the specimens.

For this genus we suggest the name XYNE (ξύνος, ξύνη, comrade). XYNE is allied to CLUPEA, from which it differs in its thicker enameled scales, enameled opercular bones and in the strong ventral scutes. It has marked affinities with the Cretaceous genus, SCOMBROCLUPEA Kner, the opercular bones and ventral scutes being similar. XYNE differs, however, in the much larger mouth, and in the absence of any suggestion of finlets behind dorsal or anal. The type of SCOMBROCLUPEA should be known as S. PINNULATA Kner (1863), not as S. MACROPHTHALMA (Heckel), the earlier name, CLUPEA MACROPHTHALMA Heckel (1843) being preoccupied by CLUPEA MACROPHTHALMA Ranzani (1842), a living species of the West Indies.

22. Ellimma elmodenæ Jordan and Gilbert, new species.

(Plate XII, fig. 1)

Type No. XLVII, a small double-armored herring, about four inches long, taken at El Modena by Mr. Hadley, in a matrix of pale diatomaceous shale. Its structure agrees closely with that of the genus ELLIMMA Jordan, differing in the smaller size and greater number of the vertebræ. ELLIMMA Jordan is a substitute name, proposed[9] in placed of ELLIPES Jordan,[10] which was preoccupied by ELLIPES Scudder,[11] a genus of crickets.

ELLIMMA ELMODENÆ is a short, deep, compressed fish, formed much as ELLIMMA BRANNERI, the type of the genus. It has $27 + 17 = 44$ vertebræ. Head $2\frac{1}{2}$ in length, depth $2\frac{1}{2}$, eye $4\frac{1}{2}$ in head; snout 4, dorsal rays 18, anal 18; ventral 10, pectoral 15. Length of longest rib $1\frac{1}{3}$ in head; mouth moderate, slightly oblique, the lower jaw prominent, strong, slightly projecting; dorsal scutes moderate, about 14 in number, apparently simple; ventral scutes sharply defined, $12 + 12 = 24$ in number; back not elevated; the profile nearly straight from dorsal to snout; belly very convex; dorsal fin low and small, its base seven in length, its posterior rays at end of first third of length to caudal. Eighteen rays apparent, the first simple, ventral small, inserted opposite middle or dorsal, about equal to pectoral, which is inserted very low. Ribs long, fine, and numerous. No scales are preserved. Spinous serratures on belly short and stout, followed by twelve weaker ones behind ventrals.

Anal fin very weak, base ten in length to base of caudal. It begins at posterior fifth of length to caudal; first ray short, spine-like, second longest, about half the height of dorsal, sixteen rays corresponding to nine vertebræ; lower lobe of caudal only preserved; this is equal in length to longest rib; ribs long, fine, and numerous; eye large, in front of middle of head; opercle strongly developed, broadly convex pos-

[9] *Proc. Biol. Soc. Wash.*, p. 79, 1913.

[10] *Ann. Carnegie Mus.*, 7, 1910.

[11] *Psyche*, 9, 308, 1902.

teriorly; preopercle strong, as high as the opercle, its upper limb vertical; branchiostegals apparently broad; no teeth are shown and no scales are preserved.

MEASUREMENTS

Length to base of caudal	96 mm.
Depth midway	38 mm.
Length of head	37 mm.
Length of longest rib	28 mm.
Length of caudal, lower lobe	28 mm.
Diameter of eye	8 mm.

ELLIMMICHTHYS Jordan, new genus.

As compared with the type of the genus ELLIMMA, E. BRANNERI Jordan, from the lower Eocene at Riacho Doce, Alagoas, Brazil, the California species has a much greater number of vertebræ ($16 + 17 = 33$ in E. BRANNERI), but is otherwise very similar, and it may probably be placed in the same genus. The dorsal fin, small in E. BRANNERI, larger in E. RIACENSIS, is very small in E. ELMODENÆ. All three of these species lack the sharply elevated back of E. LONGICOSTATUM (Cope). This species, in fact, cannot be retained in ELLIMMA and may be made the type of a distinct genus, ELLIMMICHTHYS Jordan. It comes from the upper Cretaceous near Itacaranha, Brazil.

The type specimen of ELLIMMA ELMODENÆ is presented to Stanford University by Mr. E. E. Hadley.

23. Ellimma barbaræ Jordan and Gilbert, new species.

(Plate IX, fig. 3)

Type a small fish, 3⅜ inches long (No. XXXII) from fine-grained Miocene sand shales at Carpinteria, Santa Barbara County, loaned by Mr. Martin, principal of the Carpinteria High School.

Form of ELLIMMA ELMODENÆ: head nearly 4 in length, depth 2⅖, eye 3 in head, half longer than snout. Dorsal rays about 12, five visible. Anal rays 12 to 14; ventral serratures 11 or $12 + 8$ or 10; dorsal scutes mostly obliterated. Vertebræ 22 to $24 + 14 = 36$ to 38. Body deep, compressed, the ventral outline prominent; head rather short, depressed above eye; mouth moderate, apparently oblique, the jaws subequal; no trace of teeth; eye rather small, but longer than the short snout; opercle higher than long, scarcely angled; preopercle striate; body cavity very large, crossed by long, moderately curved ribs, each a little longer than head; caudal region very short, little longer than head; ventral serræ strong; a few traces of dorsal scutes; back feebly arched; vertebræ rather weak, scarcely deeper than long, maintaining their strength well backward.

Dorsal fin beginning about midway of length to base of caudal; its height about equal to its base, the anal apparently smaller and weaker; pectoral inserted low, in advance of posterior border of opercle, its rays broken; ventral fins mostly obliterated; inserted about under middle of dorsal; caudal broken, apparently forked.

This species apparently belongs to the genus ELLIMMA. From ELLIMMA ELMODENÆ it seems to differ in the notably shorter head, and caudal region, the larger body cavity, stronger ventral serratures and fewer caudal vertebræ. The vertebræ are $27 + 17 = 44$ in ELLIMMA ELMODENÆ, and $16 + 17 = 33$ in ELLIMMA BRANNERI, the Brazilian Eocene type of the genus ELLIMMA.

24. Alisea grandis Jordan and Gilbert, new genus and species.

(Plate XVII, fig. 3)

Type No. CXXXV, from San Pedro, in hard, flinty sandstone of Miocene age.

It is the posterior part of a large shadlike fish, the fragment preserved being 23 inches long, the whole fish in life upwards of 2¾ feet.

Body elongate, compressed, no trace of protuberant ventral region; ventral scutes, if present, all obliterated.

Insertion of dorsal fin nearly midway from nape to base of caudal, the depth at that point 2⅖ times in distance from insertion of dorsal to base of caudal fin. As the anterior region is wanting the different measurements may be compared with the greatest depth. Length of base of dorsal uncertain, the posterior part obliterated.

Anal fin better preserved, its insertion about under tenth ray of dorsal, at distance from front of dorsal about two-fifths of depth of body; the hæmal spines, however, being very oblique, their insertion much behind (five or six vertebræ behind) insertion of dorsal neurals; length of anal fin from first ray to the last ray shown, about equal to depth of body. Anal rays not far from thirty, the longest (anterior) two and a half in depth of body.

Vertebræ moderate, subequal, hourglass-shaped. Caudal vertebræ twenty-eight, fourteen indicated in advance of these, the total number of vertebræ not far from fifty. Last visible anal ray attached to the sixteenth vertebra from the last, the fin covering about sixteen vertebræ; caudal vertebræ with strong, very oblique, neural and hæmal spines. Hypural obscured, apparently much as in a shad.

Caudal fin very long and widely forked with numerous accessory rays, the upper lobe pointed, its length one-fourth or more greater than depth of body; lower lobe broken.

Scales very small, smooth, cycloid, present on most of the body and scattered in the rock about the back. The number was not far from

35-200-40. Over forty scales in a cross series below dorsal, caudal fin largely scaly.

Whether ventrals are present or not we have no means of knowing.

Least depth of caudal peduncle about seven and a half times in the length of the caudal region, about three times in its own length, and about five times in length of the caudal lobe. The caudal fin of a second specimen is preserved on the block containing PHOCÆNA OCCIDUA.

This large, shadlike fish belongs evidently to the family of CLUPEIDÆ. Its elongate body and long anal fin place it in the vicinity of the genus ILISHA, from which it differs obviously in the insertion of the dorsal fin notably in advance of the anal and apparently in the shortness of the anal fin itself, but of that we are not sure, nor can we tell how long is the dorsal fin itself.

In ILISHA Gray the anal fin is inserted under about the tenth ray of the dorsal, but the fin extends farther back, with forty-eight rays. In the section PELLONA Cuvier & Valenciennes, the anal fin is shorter, of about forty rays, and the anal is inserted farther back.

From both groups, ILISHA and PELLONA, our fish is separated by the minute scales, smaller than in any living form of herring or shad. There is no evidence of scutes in front of the dorsal fin, and the species is probably not one of the double-armored herrings. In case it should prove to be such, it will be distinguished from COPEICHTHYS (DIPLOMYSTUS) of the Eocene by its very small scales.

We give the genus the name of ALISEA, Alise being a Hindu name of a related species, ILISHA MOTIUS.

25. **Clupea hadleyi** Jordan and Gilbert, new species.

(Plate XIII)

Type No. XXXV, the well-preserved skeleton and impression of a herring found in the diatomaceous deposits in Hews Park near El Modena, by Mr. E. E. Hadley. The type specimen lacks the head and most of the fins, the body and the caudal fin being well-preserved. The number of vertebræ indicated is 58, about $33 + 25 = 58$, a very few being lost with the head. Depth about 4¼ in length to base of caudal; length of caudal lobes more than half greatest depth. Ventral small, eight-rayed, inserted behind middle of body, midway between opercle and base of caudal, about under middle of dorsal, which is mostly obliterated; dorsal higher than anal, of about equal length and number of rays, anal very low, its base as long as the caudal lobe or the base of the dorsal; seventeen rays are counted. Ribs moderate, slender, shorter than in CLUPEA PALLASI, the living species. The neural processes are much shorter than in the latter, barely two-thirds as high, and straight,

instead of curving backwards. This species has a few more vertebræ than any known herring, but it can hardly be placed in any genus other than CLUPEA. For the present, we leave it among the true herrings, to which it seems most closely related. The California Sardine, SARDINIA CÆRULEA (Girard) has still weaker spinal processes and ribs. It has fifty vertebræ. The California herring (CLUPEA PALLASI, Cuv. & Val.), has fifty vertebræ. The Atlantic herring (CLUPEA HARENGUS L.) has 56.

A second specimen in almost all respects identical with the type and lacking also the head was also obtained by Mr. Hadley. (No. CVII.)

MEASUREMENTS

Length (estimated) to base of caudal . . .	285 mm.
Depth	60 mm.
Length of head (estimated)	75 mm.
Length of caudal lobe	40 mm.

Family **DUSSUMIERIIDÆ.**

26. Smithites elegans Jordan and Gilbert, new genus and species.
(Plate XXIX, fig. 3)

A small slender fish two and a half inches long (No. IV), well-preserved, the snout and front of the jaws lost, the anal fin obliterated; no scales present. From the diatomaceous shales of Bairdstown. Head about 4¾ in length to base of caudal, the greatest depth 5¾. Dorsal rays, about six present, some of the last rays obliterated; ventrals extremely well preserved, with six rays. Vertebræ apparently $25 + 32 = 57$, perhaps 53 to 55; the neural and hæmal spines well developed for the whole length of the vertebral column. Caudal fin large, deeply forked, its lobes one and a quarter times greatest depth of body. Eye moderate, about four in head; mouth apparently rather large; pectorals moderate, one and a quarter in depth; ventrals about two in depth, inserted under middle rays of dorsal; dorsal rather low and short, its insertion about midway between tip of snout and base of caudal; anal entirely obliterated.

This species much resembles the little fish of the Gulf of Mexico, known as JENKINSIA STOLIFERA (Jordan and C. H. Gilbert). It has much in common with the genus JENKINSIA, which is a near ally of the East Indian SPRATELLOIDES Bleeker. But the vertebræ in JENKINSIA number but forty-two, a feature indicating generic distinction and according with the supposed fact that the Monterey fauna lived in relatively cold water. It must therefore be placed in a distinct genus which we name in honor of Dr. James Perrin Smith, paleontologist of Stanford University.

27. Quæsita quisquilia Jordan and Gilbert, new genus and species.
(Plate VIII, fig. 3; Plate X, fig. 2; Plate XVII, fig. 1)

Type three and a quarter inches in length (No. XVII) from El Modena, E. E. Hadley, the head, fins and spinal column fairly well preserved. Head 4½ in length to base of caudal; depth nearly 6; eye 3½ in head; snout nearly 3½; dorsal about 12; anal 10-12; vertebræ 24 + 14 = 38, relatively strong, not decreasing rapidly backward, the neural spines unusually well-developed posteriorly, not evident anteriorly. Head large, the jaws subequal or the lower rather longest, the maxillary reaching front of orbit, jaws with traces of fine teeth; dorsal opposite ventral, its insertion midway from snout to base of caudal; dorsal short and rather low, opposite five or six vertebræ, the ventral about as high as dorsal; anal longer and lower than dorsal; caudal forked, the last eight or ten vertebræ with strong neural spines, those of the rest of the spinal column obscure. Hypural plate ill defined, but apparently rather strong, triangular.

The relationships of the genus QUÆSITA are obviously with the herring group. At present we place it in among the "Round Herrings" or DUSSUMERIIDÆ, near SMITHITES, from which it differs in the much smaller number of vertebræ.

Nine other examples of this species found at El Modena by Mr. Hadley are before us. These range from 1¾ inches in length to 3½ (Nos. XCII to CXX). The insertion of the dorsal in all is very slightly nearer the base of caudal than the snout; the ventrals slightly behind the first dorsal rays. The dorsal is short, of about ten rays, its insertion about twice as far from the base of caudal as from the nape and about over the thirteenth vertebra.

The posterior vertebræ are strong, those behind the anal fin having especially long and strong hæmal and neural processes. Hypural plate apparently broad, thin. The number of verterbræ is about thirty-six. The caudal fin is moderate and forked. The eye is large, about as long as snout, three and a half in head.

Specimen No. CXIX shows the dorsal and ventral fins very well as well as the tail and caudal fin. The anal is imperfectly shown, and the vertebræ are partly obliterated.

No. CXVI, a good specimen, shows the head; the eye nearly four in its length, the mouth short, very oblique, reaching to opposite front of eye, the maxillary about as long as eye, and the jaws equal. Head four in length. Ventrals opposite about fourth ray of dorsal, tail with its vertebral spines well developed, the caudal moderate, one and a fifth in head.

No. CXVIII, also good, shows the head and the vertebral column, with the pectoral and ventral fins and the strong hæmal and neural spines; the pectorals are narrow and inserted low, as usual in herring-like fishes. No. CXII shows the dorsal and anal, with the tail; the head is partly shown. CXIII shows the form of the vertebral column and parts of the

dorsal, both ventrals and the anal. No. CXV shows a broken head with the vertebral column; the tail as usual well preserved; CXX is shadowy, showing a broken head, part of the dorsal fin and a well-preserved tail. No. CXVII is a very small example, poorly preserved. Most of these specimens have been returned to the Lorquin Natural History Society, the type and some others retained at Stanford University.

To this species we refer provisionally a block containing a school of little fishes about thirteen in number, 1¾ inches in length (No. XVII) variously distorted, also from El Modena, E. E. Hadley, and imbedded in diatomaceous shales. The characters as well as we can make them out are as follows:

Head large, 3 in length; depth 5⅓; snout pointed; jaws long, subequal, extending to opposite the very large eye; edge of upper jaw apparently curved, with small teeth; vertebræ about as deep as long, about forty in number, fourteen behind front of anal fin; posterior vertebræ with well developed neural and hæmal spines, hypural plate small, apparently present; caudal deeply forked, two-thirds length of head, the rays about eight to ten; caudal peduncle about equal to space between dorsal and anal; a detached pectoral contains five rays, slender, two-thirds length of caudal lobes; a pectoral fin in place is attached rather high to the middle of the opercular border, its position probably due to distortion. Dorsal small, rather low, six or eight rays visible, inserted a little in front of middle of body, its first ray over the ventrals which are also small, with eight or ten rays; anal fin very obscurely shown, its insertion well behind the dorsal.

These specimens are no doubt the young of QUÆSITA QUISQUILIA, as we see no characters by which they can be separated.

On the same block with these (lower left-hand corner) is a small example of AZALOIS ANGELENSIS.

28. Azalois angelensis Jordan and Gilbert, new genus and species.

(Plate XV, fig. 2)

A little fish (No. XLII) about two and a half inches long, from Bairdstown, in diatomaceous shales. The form of the body and the head are fairly well preserved. In outline it bears considerable resemblance to the figure of YARRELLA BLACKFORDI Goode & Bean, though differing widely in details. In technical characters it approaches QUÆSITA.

Head about 4 in length to base of caudal, depth 5½, eye 3¼ in head; depth in head 1½; snout 3; vertebræ 26 + 16 = 42. Body moderately elongate, deepest before the dorsal fin, probably considerably compressed; body depth sustained well backward, the caudal peduncle more slender; head large; the mouth large, oblique, the mandible projecting, and with

a sharp projecting knob at its insertion, its length about half head; side of the mandible apparently with broad-based, uniform, rounded, sharp-edged teeth, rather low and apparently incisor-like, eight to ten in number; no canines (it is possible that these teeth are misinterpreted); opercles well developed, snout short and blunt. Eye large, the orbit crossed by a narrow depression (a bony interorbital shelf). Fin rays not to be accurately counted; dorsal small, with about twelve rays, nearly midway between occiput and base of caudal; ventrals short but with numerous rays, nearly half length of mandible, inserted a shade in advance of front of dorsal. Anal partly obliterated, with perhaps seven rays traceable; no trace of adipose fin, caudal fin crushed, apparently large and forked. No certain trace of scales on body, one loose scale large, nearly circular, its edges indistinct. About twenty vertebræ shown behind front of ventral fin, nearly as many before it being obliterated. Vertebræ deeper than long, with weak spines; no ribs preserved; hypural obliterated.

This form apparently belongs to the ISOSPONDYLI, but it seems to fit into no existing genus. The dentition, if correctly interpreted, is unique in the group. We leave this genus with QUÆSITA provisionally among the DUSSUMIERIIDÆ.

(The name is from ἀζάλόεις, not stormy, that is, living in a sea free from ζάλος, muddy foam.)

29. Lygisma tenax Jordan and Gilbert, new genus and species.

(Plate VIII, fig. 2; Plate XIV, fig. 1)

Type (No. XVI) 3¼ inches in length, from the Hadley collection at El Modena. It shows the head from above with the vertebral column and the long, strong caudal fin complete. The other fins are scarcely indicated. Head large, broad, about five in length, a little longer than caudal fin; vertebræ about forty-three, well ossified and hourglass-shaped, the column holding firmly together; eyes very large, longer than the bluntish snout and broader than the concave interorbital space; post-temporal bones present; no spines on head; caudal strong, well forked, the lobes nearly as long as head. No trace of other fins preserved. In the example before us the vertebral column fully intact is much distorted and twisted in a fashion almost comical. The neural spines seem weak. Hypural strong, but ill-defined.

A second example (No. CVII) shows the same species from a different angle. The large head, seemingly three and a half in length, is badly crushed, but indicates a conical form, with large eyes, and apparently short, oblique mouth; the depth is not far from five in length; pectoral inserted low, the fin split, about 6 rays in each half; ventrals long, both

being shown; each of about six soft rays, the insertion far behind front of dorsal and slightly nearer tip of snout than base of caudal; insertion of dorsal midway between gill opening and base of ventrals, the fin broken, only six rays being visible; vertebral column much bent posteriorly, as in the type specimen, vertebræ strong, the neurals weak, caudal fin broken; no trace of anal fin. No scales preserved.

The genus LYGISMA is probably related to the herrings, although the vertebral column is much stronger than in these. It may find a temporary place among the DUSSUMIERIIDÆ, with which it has probably no close affinity.

The name is from λύγισμα, a twisted object.

Family **SYNGNATHIDÆ.**

30. **Syngnathus avus** Jordan and Gilbert, new species.

(Plate XXIX, fig. 2)

The fossil *pipe-fish,* here described (Nos. V, XLVI, etc.) as new, was obtained in the Miocene chalk-shale near Titus Avenue, Bairdstown, a suburb of Los Angeles. The material consists of twelve specimens more or less complete. All are apparently of the same species.

Head seven in length to base of caudal; body rings $18 + 43 = 61$; dorsal 36; dorsal on rings $\frac{1}{2} + 7\frac{1}{2}$; pouch rings 22; caudal 6; pectoral 12; snout 1.8 in head; eye 10.6; depth 3.1; dorsal base in head 1.3; dorsal height in its length 4.25; caudal in head 4.4; body in tail 2.4; extent of latter 1 line to 22.

Body long and slender, covered with bony plates united in rings, as usual in SYNGNATHUS; egg-pouch, sub-caudal; dorsal fin beginning slightly in advance of the vent, its base short; head in line with axis of body, caudal straight. Dorsal-lateral caudal ridge not continuous with lateral line nor with the dorsal ridge; pectoral fin well developed; caudal fin small, having more than six rays; gill-cover striæ coarse; ridges prominent; lattice-work of the plates faint; stellar platelets angularly oval, dorsal high.

This species is evidently closely related to the living species of the California coast and seems nearest to SYNGNATHUS LEPTORHYNCHUS Girard, a species common from San Francisco to San Diego, and to S. CALIFORNIENSIS Storer. It has more dorsal rays (36 instead of 30 to 32), and its rings are $18 + 43$, instead of 17 to $18 + 36$ to 41. The snout also is longer, length in adult 12.5, young 10.6, while in S. LEPTORHYNCHUS 15.4 and 17.2. The lateral line extends farther in the type (twenty-second ring) than in either of the related living forms (nineteenth ring) and the dorso-lateral caudal ridge divides earlier,

dropping to the side at the thirty-third ring, while in the living forms this occurs on the twenty-seventh. The type further differs from S. CALIFORNIENSIS, in the greater depth of head, fewer dorsal rays and rings, less extent of brood pouch and in the total number of rings.

S. GRISEOLINEATUS Ayres, also common along the coast, has its dorsal on 0 + 9 or ½ + 9 caudal rings instead of ½ + 7½, as in S. AVUS. The latter deviates furthermore in having fewer dorsal rays and shorter snout. S. BARBARÆ Swain differs from the type in having its dorsal on 0 + 8 rings. S. AULISCUS Swain has its dorsal on 1 + 8 rings, with fewer rays (29 to 33), fewer rings, and shorter head (in length being 9.4 instead of 7). The Atlantic and Gulf Coast species of pipefish have the dorsal farther forward on 4 + 5 rings, and head in length 9. The common European species, S. ACUS L. is much like the species from California. S. AVUS thus differs from each of the living forms in essential points, standing unique in its stouter body, deeper head, greater number of caudal fin rays, greater extent of the lateral line, distinctness of ridges, coarseness of the gill-cover striæ, larger eye, angularly oval stellar platelets, the higher and shorter dorsal fin, and the faintly latticed scales.

The large number of vertebræ in S. AVUS suggests that it lived in a cool sea, and a few fossil seaweeds imprinted in the chalky matrix indicate habits similar to those of living species.

TABULATED MEASUREMENTS IN HUNDREDTHS TO CAUDAL OF THREE SPECIMENS.

	A	B	C
Length to caudal fin in mm.	225	128	141
Length to vent	97	.....	72
Length of head	32	20	22
Length of snout	18	12	13
Greatest depth snout	5	.....	4
Least depth snout	.....	.....	3
Diameter of eye	3	2	3
Greatest depth trunk	10.5	4.4	7
Length dorsal base	.....	.....	17
Length brood pouch	75	.....	.....
Depth of head	9	3	.....
Dorsal Rays	.....	36	.....
Dorsal fin rings	½+(?)	.....	½+7+½
Rings	.....	18	18+43
Pouch rings	22	.....	.....
Caudal fin rays	6+	10+	10+
Pectoral fin rays	8	12	.....
Extent of lateral line	16	22	.....

Family **FORFICIDÆ.**

31. **Forfex hypuralis** Jordan, new genus and species.

(Plate XIV, fig. 3)

Type (No. CV) a small fish from soft clay shales of Monterey age, obtained in Pine Cañon, Santa Maria oil-fields, Santa Barbara County, by Mr. R. E. Cullom.

The total length of this specimen, including beak and caudal fin, must have been 100 millimeters or about four inches. Head, exclusive of the slender beak, 3¾ to 4 times in length to base of caudal; depth about five, eye about one-third of head exclusive of beak.

Vertebræ about 38, about 12 of those under front of dorsal fin being obliterated; the vertebræ small and little constricted, the anterior short, the posterior longer than deep, those toward base of caudal with small, oblique dorsal and hæmal spines, much weaker than in RHOMURUS; no trace of ribs preserved.

Head badly broken, low and elongate, evidently ending in a very slender beak, the broken parts of which are distorted and displaced. This must, however, have been as long as the rest of the head. The jaws are provided with small, sharp teeth, visible only under the lens, not close set and apparently in one row, an occasional one twice as high as the others; a bone, apparently the opercle, small, quadrate, with shining surface. Pectoral fin short and narrow. Seven rays apparent, the fin inserted higher than in soft-rayed fishes generally, but not so high as in the BELONIDÆ; ventral fins obliterated, perhaps represented by two slight marks about midway between gill opening and front of dorsal; dorsal fin long, of moderate height. The distance from insertion to gill opening 1⅘ in the distance from insertion to base of caudal; length of base of dorsal, 2⅑ in body from gill opening to base of caudal; the rays apparently 1, 16 in number, the first short and spinous, the rest soft rays, and the anterior soft rays apparently highest. Anal represented by three or four broken rays just behind middle of dorsal on posterior third of body, the rest obliterated. Caudal fin long and broad, apparently truncate, certainly not forked; the upper lobe a little longer than head—without beak; the rays 7, 14, 7, the slender outside rays graduated. Hypural plate broadly triangular, unusually large and distinct, bearing all the long rays of the caudal, a narrow line of division between the parts. Obscure prints of rather large scales occur in parts of the body. There were perhaps forty in a lengthwise series.

The relations of this singular fish are uncertain. Probably the form of the hypural plate will give the final clue. Externally it bears some resemblance to the BELONIDÆ, but its dorsal fin is much farther advanced

than in any of these, the caudal is not forked, the teeth are smaller. The pectoral is a shade lower in insertion than in any of the living SYNENTOGNATHOUS fishes. We may provisionally record it as the type of a new family, FORFICIDÆ.

Family **SCOMBERESOCIDÆ.**

32. Scomberesox edwardsi Jordan and Gilbert, new species.
(Plate XVIII)

This stout form of skipper (No. XXXVI) was found fossil in the Elysian Hills of the uppermost Miocene formation in the hard sand shale in the city of Los Angeles. The type was picked up by a student and loaned by Dr. Charles L. Edwards for identification and description. Only the head and a few vertebræ are preserved.

Snout in head 1.15; depth of head at middle of opercle in head 2.56; eye 12.82; no fins shown; body stout, elongate, cylindrical, covered with oblong scales much larger than in S. ACUTILLUS or in the living S. SAURUS of the Atlantic, each set with many concentric striæ; ribs weak and hair-like; vertebræ comparatively weak, angularly diamond-shaped, 8½ in 25 mm. space; without zygapophyses, and curved upward toward the head; opercle deeper than long, sub-opercle small; upright limb of the preopercle broad and vertical, rising to two-thirds height of opercle. Jaws unequal, very strong, increasing in strength rapidly backward, set with uniform teeth, stout, sharp, and strongly recurved, thirty-five teeth in the space of 10 mm. below and weaker above and on adjoining parts. Structures resembling teeth occur on the very ends of the jaws, and structures resembling preorbital plates occur in the region between and in front of the eyes. The mandible does not extend to the eyes.

This specimen was probably over a foot long. It differs from S. SAURUS in its shorter, stouter snout, stouter head and body, shorter opercle, and the more nearly vertical upright limb. It is named for its discoverer, a former student of the senior author, Dr. Charles Lincoln Edwards, now in charge of science teaching in the graded schools of Los Angeles. It was presented to Stanford University by Dr. Edwards.

33. Scomberesox acutillus Jordan and Gilbert, new species.
(Plate XIV, fig. 2)

This long-nosed skipper (No. XLIII) is from the diatomaceous shale of the Miocene age at El Modena. The type was obtained by Mr. E. E. Hadley. The anterior half only of the type specimen is preserved. A second specimen (No. XLIV), four and a half inches long, shows more of the body, but the head is crushed. Both are considered in this description, the first being the type. Head two and a third

in length to base of caudal. Snout in head 1.56; depth of head in its length 4.42; eye 12; pectoral 12; ventral 6; anal 6+1; vertebræ 56; depth of head in head 4.42; body slender, cylindrical, covered with very small scales; ribs and spines of hair-like slenderness; vertebræ diamond-shaped, without zygapophyses; scales small and silvery, each with many minute concentric striæ; beak with faint traces of very fine teeth; jaws weak, unequal, pointed; premaxillary free; upper jaw four-fifths length of lower; preopercle very oblique, broadening rapidly downward, while from its lower margin from a center radiates a number of fine striæ; subopercle and branchiostegals broad. Ventral rays 6, the fin midway between eye and base of caudal, shorter than pectoral; anal rays 6 + V., inserted slightly nearer ventral than caudal fork, followed by traces of five finlets. Caudal represented by trace of lower border, four vertebræ supporting fin elements; dorsal obliterated. The second specimen is rather deeper than the type, though beak apparently rather stronger. This specimen resembles the living skipper, SCOMBERESOX SAURUS L., an example of the latter from Woods Hole, being used for comparison. It differs from it in the more slender head and body, longer beak, and slenderer pectoral fin, which stands oblique. The association of this fish with the pipe-fish and algæ indicates its resort to shallow sea and seaweeds for shelter and food.

MEASUREMENTS.

Column 1, S. SAURUS; 2, S. ACUTILLUS; 3, S. EDWARDSI. Measurements of S. SAURUS are taken from figure 355 in Jordan's "Fishes."

	1. mm.	2. mm.	3. mm.
Length of head	31	53	77
Depth of head	8	12	30
Depth of body	10.5	15	32
Length of snout	19	34	53
Snout in head	1.64	1.56	1.15
Depth of head in head	3.87	4.42	2.56
Length of eye	3	4	6
Eye in head	10.3	13.2	13—
Length of pectoral fin rays	7.3	7.3	.....
Length of vertebræ	.....	1.66	3
Length of upper jaw from orbit	17	28	43

Family **ATHERINIDÆ.**

34. Zanteclites hubbsi Jordan and Gilbert, new genus and species.
(Plate XV, fig. 3; Plate XVI)

A little fish about four inches long (No. XLV, Stanford Geological Collection), from Bairdstown, with the head crushed, certainly belongs to the ATHERINIDÆ.

Head about 3 in length; to base of caudal, the depth 5; D VIII—? A I, 7 or 8; scales about 34; vertebræ about $16 + 20 = 36$. Body moderately elongate, formed as in ATHERINA, mouth apparently oblique, the jaws subequal, extending to below posterior part of eye; faint traces of small uniform teeth on a fragment of the mandible. (In another specimen, No. 1, from Shorb, the premaxillary border appears straight, as in ATHERINA and HEPSETUS, very slightly bent downward at tip.)

First dorsal fin median, entirely before the anal, the fin relatively large, the first spine very short, the second and third moderate, the other spines filamentous and flexuous for more than half their length, their height about equal to depth of body and greater than length of base of fin. Dorsals close together, the soft dorsal inserted slightly in front of anal; the fin, except for three rays, obliterated, the longest rays about one and a half in depth of body. Caudal well forked, the length of lobes about equal to depth of body; pectorals inserted high, narrow and very long, some of the rays streamer-like, reaching middle of base of first dorsal. Ventrals partly destroyed, inserted midway between base of pectoral and that of anal, under the fifteenth vertebra and opposite middle of spinous dorsal. Scales moderate, smooth, evident over most of body, nearly circular, with fine concentric striæ crossing a few low radiating ridges, the edges crenate rather than ctenoid. Neural and hæmal spines short.

Caudal fin with twenty-four rays, deeply forked and filmy, with weak rays. The hypural is peculiarly branched; it divides into the two general halves with a diamond-shaped space between. These hypural parts branch again into a major and a minor part. The major supports the middle portion of fin rays on either side, the minor branch supports the shorter, fewer, innermost rays, while the neural spines of the last vertebra support the longest and external rays, and the next to the last vertebra joins in supporting the most external, short, stout, spine-like rays.

Branchiostegals moderate in breadth, with irregular margins; subopercle strong.

In the diatomaceous shales at Shorb a number of fragments of this species also occur. One of these shows the mouth parts fairly well. The

mouth is rather large, its cleft oblique, the outline of the premaxillary slightly convex downward near the tip, otherwise nearly straight, the very tip a little protruding. The form is therefore much as in ATHERINA and HEPSETUS and in general similar to that of the more slender and short-nosed genera among the MELANOTÆNIINÆ. It is quite unilke the American types.

In its filamentous dorsal spines and in the approximation of the two dorsals, this genus agrees with some of the MELANOTÆNIINÆ of Australia, notably with PSEUDOMUGIL Kner. In another paper written before the discovery of ZANTECLITES, Jordan and Hubbs have regarded the MELANOTÆNIINÆ as probably the most primitive of ATHERINIDÆ.

The name ZANTECLITES recalls its possible affinity with MELANOTÆNIA Gill, an Australian genus, of which the name ZANTECLA Castelnau is a synonym. An account of this genus is given by Jordan and Hubbs in a paper which should soon follow the present one.

The species is named for Carl Leavitt Hubbs of the Field Museum, who has made a careful study of the type specimen. Mr. Hubbs is himself a graduate of the Los Angeles High School, as well as of Stanford University.

Family **TRACHICHTHYIDÆ.**

35. **Eritima evides** Jordan and Gilbert, new species.

(Plate XXIII, fig. 1)

A small fish (No. XXXI) about four inches long, with a large head, deep body, and delicate fins, obtained from sandy diatomaceous shales at Bairdstown.

Head 3¼ in length to base of caudal; depth 3. Body rather deep, compressed; head large; the large mouth oblique, the jaws subequal or the lower projecting; teeth rather small, even, but evident; snout bluntish; preopercle strong, entire, the lower limb with fine, sharp, radiating lines; bones of head slender, unarmed; opercle obtuse, unarmed. Eye small, the orbit crowned by a slender ridge.

Vertebræ slender, short, $10 + 14 = 24$ in number, the neural spines straight, weak, directed backward, the hæmal spines rather stronger.

Dorsal inserted a little nearer tip of snout than base of caudal fin, of about twenty slender rays, none of them appearing spinous, its height half greater than length of its base, and rather less than depth of body; the distal part of the rays filmy and flexible. There may have been another dorsal fin before or behind this, but of this there is no evidence. Anal inserted well forward, nearly under middle of dorsal, its rays about fifteen, all slender, except the first, which is short and spine-like, much shorter than the second, which is the longest and

strongest; the fin shorter and smaller than the dorsal. Pectoral slender, inserted high, of about twelve slender rays, the fin narrow, reaching nearly to the front of the anal. The fin is high and the rays filmy at tip.

Ventral fins, jugular, of about seven rays, certainly more than I, 5, inserted very slightly before the pectoral. Caudal peduncle broad; caudal fin short, apparently lunate; the rays filmy, about twenty in number, evenly branched, the margin broken, the upper rays having the strongest supports; hypural plate evident; no trace of scales preserved.

Just below this specimen (which is preserved in duplicate, the impression of both sides distinct) there is a caudal fin, with four vertebræ, apparently of the same species, belonging to another fish.

The jugular ventrals and the absence of spines in the fins would seem to ally this fish with the BROTULIDÆ or GADIDÆ. The tail vertebræ are, however, unlike those of these fishes. The small number of vertebræ seems to indicate a widely different affinity. The few vertebræ, the jugular ventrals with more than six rays, and perhaps the make-up of the tail point towards the TRACHICHTHYIDÆ or some other aberrant ally of the BERYCIDÆ. Except for the ventral rays, it might be left with the APOGONIDÆ.

It is thought that the Sunset Bluff, from which this fish was taken, belongs to the lower Pliocene rather than to the Miocene. It has been classified with the "Fernando" deposits.

(The name ἐριτίμος (high-prized) was used by Aristotle for some fish, not now known.)

Family **GEMPYLIDÆ.**

36. **Thyrsites kriegeri** Jordan and Gilbert, new species.

(Plate XVII, fig. 2)

The tail of a long and slender fish from the diatomaceous Miocene of Lompoc, loaned by Mr. A. H. Krieger of Lompoc (No. XXXIII) through the courtesy of Mr. Starr and Mr. Porteous. The portion preserved is eleven inches in length to base of caudal; the whole fish must have been three feet long. The depth at base of the soft dorsal is 3⅝ inches. Dorsal with 18 soft rays; anal with III, 18 to 20.

Caudal vertebræ strong, twenty-four in number. Soft dorsal fin inserted over the first of these and somewhat in advance of the anal; its height about equal to depth of the body below it, the fin weakly falcate; first three rays short, the next rays high, close set, the last rapidly shortened; anal fin apparently similar to the soft dorsal, the first rays shorter and apparently simple, the insertion of the fin opposite middle of dorsal; no trace of finlets; caudal peduncle long, slender and with strong vertebræ; its least depth eleven times in caudal region, six in length of a caudal lobe, and 3⅜ in depth of body under dorsal.

Caudal broadly forked, its rays about twenty-two, equal and about half greater than depth of body, its lobes slender and strong. Hypural plate evident but short.

We place this interesting species provisionally in the living genus, THYRSITES of Cuvier, with which it seems to agree fully so far as the parts preserved are concerned. From the type of THYRSITES (ATUN) it seems to differ in the larger caudal fin and possibly slightly longer, soft dorsal and anal. The slender form excludes it from the genus SCOMBEROMORUS.

Family **SCOMBRIDÆ.**

37. Tunita octavia Jordan and Gilbert, new genus and species.

(Plate XII, fig. 2)

From the diatomaceous shales at El Modena, Mr. E. E. Hadley has obtained several fragments of a mackerel about a foot in length and having much in common with AUXIDES SANCTÆ-MONICÆ already described from the Soledad deposits near Santa Monica.

The type, No. VII, is a torso about seven inches long, representing the body from the preopercle to the end of the anal, a fish of about a foot in length. The depth is half the distance from the gill opening to the last ray of the anal fin. In this distance about twenty-two vertebræ are included, about twelve in the abdominal region. These have strong spinous processes and short and strong ribs. Body tapering rapidly backward, the depth at last ray of dorsal little more than half that under first dorsal spine; dorsal fin beginning over about the third or fourth vertebra; its spines eight in number, the first being highest, two and a quarter in depth of body. Second dorsal fin beginning close behind the first, barely the length of two vertebræ intervening, of fourteen to sixteen soft rays; anal fin similar, its insertion farther back, at the end of the first third of soft dorsal; the rays about fourteen; ventral fins well developed, inserted directly below first dorsal spine, somewhat behind the pectorals which are broken; scales rather large for a mackerel, cycloid, not forming a corselet. Bones of head obscure, the broad preopercle with radiating ridges obliterated.

Another example (No. CXXI, from El Modena) shows the head with long oblique mouth, subequal jaws, and with a large plate with strong radiating ridges at the angle of the preopercle as in AUXIDES. The torso ends at the last dorsal spine; the two ventrals are well shown. Some of the details in our restoration of the head of AUXIDES SANCTÆ-MONICÆ are drawn from this specimen, which proves to belong to a genus distinct from AUXIDES. The small smooth scales of the anterior

part of the body are fairly shown. The vertebræ are strong, not longer than deep, and without the peculiar structure called "trellised" in AUXIS and EUTHYNNUS.

No XII is another torso, similar, but with the dorsal fin and the preopercle obscured; depth about one and a half in head; no scales shown; dorsal with about eight spines visible, the first opposite sixth vertebra and opposite ventrals. A short or broken pectoral and ventral, so distorted as to lie close together, the pectoral shorter than the snout, the ventral a little shorter; lower jaw strong and projecting.

No. X consists of two caudal fins relatively perfect, each with one or two basal vertebræ. The rays cannot be exactly counted.

No. VIII is the posterior portion of a large fish, supposed to be from the diatomaceous shale at Lompoc, loaned from the collection of Miss J. M. Telford. Twelve vertebræ are shown and about ten dorsal rays. The scales and other fins are obscure, but the species is evidently the same as the TUNITA of El Modena.

The genus TUNITA differs from AUXIS, AUXIDES and SCOMBER, the latter its nearest relative, in the close approximation of the two dorsal fins, the first short and high, of eight spines only, and in the rapid tapering of the body backward. From AUXIS and EUTHYNNUS it differs in the simple form of the vertebræ.

We propose for this genus the name of TUNITA, a local Spanish term, for the smaller tunnies (EUTHYNNUS).

Family **LUVARIDÆ** (?).[12]

38. **Ozymandias gilberti** Jordan, new genus and species.

(Plate XXII)

Type a large fossil collected at San Pedro, in rocks now regarded as of Miocene age. No. CXXXII.

This consists of part of a robust vertebral column of a fish which must have been nearly six feet in length in life. These vertebræ preserved are about twenty-four in number. The largest is two and a half inches long and one and a half in depth, decreasing in size backward but not much in length. Traces of strong neural spines. There were probably about forty vertebræ in life. The vertebræ are very robust, more or less hourglass-shaped. No traces of head or fins remain. While in a general way this suggests a scombroid fish, there are no data to indicate that it belongs to LUVARUS or any other recognized genus.

To draw attention to this large fish, I attach to the type the name of OZYMANDIAS GILBERTI, the specific name in honor of its discoverer, Dr. James Z. Gilbert. The generic name refers to the heroic giant

[12] LUVARUS species (?). Jordan: "Fossil Fishes of California," 1907, p. 134.

noticed by Shelley, of whom nothing is known save the feet of his gigantic statue in the desert.

Through the courtesy of the University of California, we reproduced the original plate of the species.

The type of OZYMANDIAS GILBERTI was found on the Third "Moon Beach" at about 2000 feet from the lighthouse at Point Firmin, southwest of San Pedro. There occur five moon-shaped beaches from the lighthouse to the foot of the breakwater. The rock from which the specimen was taken was not *in situ* but near a ledge of similar structure and appearance. The matrix is of a hard volcanic material overlying sandstone which is readily cleavable.

Family **POMATOMIDÆ.**

39. Lophar miocænus Jordan and Gilbert, new genus and species.

(Plate III, fig. 2; Plate XIX; Plate XX)

Type (No. XLVIII) from the Puente division of the Monterey formation in Los Angeles. It is closely allied to the existing Blue-fish, POMATOMUS SALTATRIX (L.), differing generically in the dentition, the teeth being of more robust character, without sharp unequal canines; preopercle also somewhat differently formed and the supra-occipital crest notably lower.

The specimen was found in the sand shales of the Miocene age by workmen of the Los Angeles Brick Company, No. 1000 Chavez Ravine Road.

The type specimen is a very perfect imprint on clay suitable for brick-making, 15¾ inches long, 12½ to base of caudal. It was preserved in the collection of the Southern California Academy of Sciences at Los Angeles. The restoration here attempted is by Mr. William S. Atkinson.

Head 3 in length to base of caudal; its depth 3.27 in its length; eye 5 in head; snout 3; D. —, I. 20; V. I. 5; P. 11; C. 34; A. (II) I, 28. Body elongate, fusiform, compressed, developed slightly more below the axial line than above it; scales (mostly lost) incompletely ctenoid; mouth oblique, rather large and terminal, with lateral cleft, lower jaw projecting; teeth stout, conical, unequal, the outer rather strong; no sharp canines; opercle well developed, preopercle finely serrate; ventral fin inserted slightly in advance of the pectoral; pectoral fin entire; anal fin probably with three spines (but one evident), this connected with the many soft rays; length of base of anal one-third the length of the fish to base of caudal; anal and dorsal fins long and low, opposite each

other from the insertion; a single spine of the dorsal present, this joined by a membrane to the soft rays (the rest obliterated). No traces of finlets, armed lateral line or barbels.

Ventral fin with its spine beneath the third vertebra, the pectoral beneath the fourth and fifth. The ventral has one spine and five soft rays, the spine being short and strong; shorter than the pectoral.

Dorsal fin D. — I, 20, with one evident spine of medium strength, opposite the fourteenth vertebra. Presumably the other spines have been lost, as interneural impressions begin opposite the seventh vertebra and doubtful traces of an external fin here are shown. Base of soft dorsal slightly longer than anal and very similar to it. In both the anterior rays are moderately elevated; the other rays decrease rapidly backward. Dorsal spine is half the length of snout and three-fourths the orbit.

Pectoral fin entire, acutely pointed, the upper rays quite long, lower quite short, the middle of the base rather low.

Anal fin (II) I, 28, slightly shorter than the dorsal, its posterior elements very weak. The single stout spine present seems joined by membrane to the soft rays. There are three interhæmals for spines plainly visible, the middle one of which is the strongest, suggesting the probability of three spines in the original fish, as in the living Blue-fish.

Caudal fin of thirty-four rays, is deeply forked with a hypural divided, with a long diamond-shaped space between. Each part supports nine strong rays and eight short weak rays on either side, supported also by the last vertebra; the stronger support is given to the upper rays.

Preopercle apparently finely serrate, ending in a single, blunt, flattened point, in front of which it is broadly rounded.

Lower jaw projecting, set with decidedly stout conical teeth of moderate length, in definite sockets, and comparatively uniform in size. Each tooth is slightly appressed, feebly curved inward and backward, armed with a smooth cutting edge fore and aft, the posterior edge being the more sharply so; some small teeth are found among the larger ones and not all seem to be in the same direct row. No distinct canines are found, and teeth are shown only on the premaxillaries and dentaries, the other bones not being visible. The articulation of the mandible occurs just before the front of the eye.

Eye large, set midway in head.

Scales ctenoid, judging, however, by only one incomplete scale. It has eleven or twelve coarse radiating ridges crossed near the margin by very fine concentric striæ. The distribution cannot be determined, since nearly all are lost. The scale occurs in the matrix near the caudal fin.

Vertebræ, $11 + 14 = 25$ in number, decreasing slightly from the fourth forward; caudals from the twentieth backward diminishing to the

hypural, which in turn has no neck but branches quickly into the two supporting elements; the upper 5 mm. longer than the lower and supporting the longer fin rays. Strength of the vertebræ carried far backward (to the twentieth), the intervertebral cartilage plates standing quite oblique in the middle region.

Subopercle and interôpercle strong, the former half-way to the base of the pectoral from the opercle and ending with a rounded obtuse angle. The outlines of other bones of head not defined and the backward extent of the maxillaries is not shown. The extent of the teeth cannot be determined since the premaxillary is broken and the inferior arrangement of the teeth is much distorted.

Five teeth occur in the maxillaries in the space of 7 mm. and ten teeth or definite impressions of teeth occur in the mandible in a space of 20 mm., and spaces apparently for two more are found, one between the fourth and fifth and the other between the last two. The faintest impressions of tiniest structures appear back of this row and to one side which may have been made by groups of villiform teeth. Between the two jaws lie broken fragments of teeth and impressions of others likely from the dentary. The dental surface is two-fifths of the length of the lower jaw, which is nearly half the length of the head.

The genus LOPHAR agrees with POMATOMUS in the general form, in the number of vertebræ, the form of the mouth, the weak spinous dorsal (obliterated in the type) the feeble anal spines and especially in the long and low soft dorsal and anal which are about equal in form and extent. This condition is not found among the PERCIFORM fishes, and but rarely outside of the allies of CARANX and some other aberrant mackerels. The CARANGINÆ all show caudal scutes, of which no trace is found on our specimen. As in POMATOMUS, the preopercle seems to be weakly serrated.

LOPHARI (λοφάρι), according to Forskål, is the modern Greek name of the Blue-fish (POMATOMUS SALTATRIX L.) at Constantinople. At Athens, as shown by Hoffman and Jordan,[13] it is γουφάρι or γοφάρι, a name probably more primitive than λοφάρι and which Hoffman derives from γόυφος, a spike.

[13] *Proc. Acad. Nat. Sci. Phila.*, 1892, p. 230.

MEASUREMENTS.

Length (to first caudal, 12th, 186)	314	mm.
Length over all	396	mm.
Depth at 11th vertebra (caudal peduncle, 34)	96	mm.
Depth to middle of spinal column, and to a line from end snout to middle hypural	139	mm.
Head	107	mm.
Snout	37	mm.
Eye	21	mm.
Lower jaw	50	mm.
Dorsal spine 15, fin	41	mm.
Ventral spine 11, fin	30	mm.
Anal spine 16, fin	36	mm.
Caudal fin, upper fork 96, lower fork (from last vertebra.)	85	mm.
Pectoral fin, below 12, above	42	mm.
Hypural, above 20, below	15	mm.
Vertebral column	220	mm.
Vertebra, 1st 5 (?), 2d 5.5, 3d 7, 10th 9, 14th 9.5, 20th 10, 25th 6.5 mm.		
Length of head to first vertebra	92(?)	mm.
Depth of head at posterior margin of orbit	68	mm.
Depth at posterior margin, sub-operculum	87	mm.
Length of orbit	21	mm.
Length of teeth in premaxillary	2.11	mm.
Width at base	1.05	mm.
Length of tooth in mandible, 6th	2.42	mm.
Width at base	1.25	mm.

Family **APOGONIDÆ.**

40. Eclipes veternus Jordan and Gilbert, new genus and species.

(Plate VIII, fig. 4)

Type a small fish (No. IX), two inches long, from the diatomaceous shales of El Modena. Coll. E. E. Hadley. It has the head distorted, the fins partly obliterated, and the body with a short median break. Head 3⅔ in length; depth 4; a little greater than length of head. Snout 3 in head; vertebræ 9 + 16, visible, about 26 in all, perhaps two or three others obscured with the head; vertebræ strong, with strong neural and hæmal spines, directed strongly backward. Body lanceolate, the back somewhat elevated under the first dorsal. Head large, apparently pointed anteriorly; the jaws apparently equal; the mouth rather large,

oblique; the broad maxillary 2⅗ in head; traces of small teeth in bones of lower jaw; bones of head not evidently serrate. Dorsal fin apparently with eight to ten short and slender spines, beginning not far behind head; soft dorsal obliterated; pectoral inserted high, narrow, and long, about as long as head, reaching apparently to front of anal, perhaps through distortion; ventrals apparently I, 5, almost obliterated, inserted well behind pectoral (a feature also perhaps due to distortion); anal fin long, beginning well forward, with traces of one or two spines, and the bases of ten to fifteen rays, the number not to be counted; caudal badly broken, the hypural plate obscure, the posterior vertebræ smaller than the anterior and with the neurals and hæmals smaller. Traces of rather small scales on sides of head and on front of body.

We are unable to indicate the relationships of this fish. With a general resemblance to ATHERINIDÆ, it has the relatively few strong vertebræ of a percoid fish, but the long anal seems to separate it from the living forms of APOGONIDÆ, to which it has most resemblances. It has also traits in common with PARAPERCIS and others of the PTEROPSARIDÆ. Its narrow pectorals exclude it from the Gobies and Blennies. The name is from ἐκλιπής, overlooked.

Family **LUTIANIDÆ.**

41. Lutianus hagari Jordan and Gilbert, new species.

(Plate XIV, figs. 1, 4)

Two little fishes, about two and a half inches long (No. XIX), from El Modena, Hadley collection, have the external form and marks of species of HÆMULIDÆ or LUTIANIDÆ.

Head about 2⅔ in length; depth 3½. Eye 4⅘ in head; vertebræ strong, 10 + 12 or 14 = 24. Dorsal rays visible, VII ±. 6 ±, A. III, 6, the spines very weak, the rays more or less obliterated so that these numbers are tentative only. V. I, 5. Dorsal spines slender, higher than the anal spines, which seem slender and graduated. Caudal well preserved, strongly forked, its rays about sixteen, the middle rays half length of the others. Ventrals apparently somewhat behind pectorals, behind front of dorsal.

Body elevated at the shoulders, tapering evenly backward; parts of head obliterated.

There can be no doubt of the relationship of this fish to the HÆMULIDÆ or to the LUTIANIDÆ. The slender dorsal and anal spines differentiate it from most of the living genera of each family. The apparent shortness of the soft dorsal and anal, with the seeming presence of three spines in the anal fin, exclude this species from the SCIÆNIDÆ, with which it has much in common.

The species is named for Dr. Harry Hagar, long interested in the palæontology of Southern California, associated with Dr. Gilbert in the discovery and exploration of the fossil beds of Rancho La Brea, where many extinct mammals were found buried in asphalt; these described by Dr. John C. Merriam.

Family **SCIÆNIDÆ.**

42. Lompoquia retropes Jordan and Gilbert, new genus and species.

(Plate XXIV, fig. 1)

Type (No. CXXXIX) from Lompoc, Mr. Edward J. Porteous. A specimen, of which about six and a quarter inches from the snout to the end of dorsal is preserved.

The form is slender, perch-like in general appearance. The head (2½ inches long) is 2⅜ times in length to end of dorsal fin and a little greater than depth of body at front of dorsal fin. The head is not well preserved, its bones apparently all entire and apparently somewhat cavernous; profile above not depressed; the nuchal region low; the line from the bluntish snout to the dorsal nearly straight. The mouth seems rather short, its cleft about three in head, but the lower jaw is strong and as long as the upper. No teeth visible; preopercle with its posterior limb upright.

Pectoral fin short and rather narrow, inserted high, with about eighteen slender rays, forming an angle below, the part preserved about four in head. Ventrals inserted well behind pectoral, at a distance nearly equal to their own length; the rays I, 5, the length about equal to that of pectoral.

Spinous dorsal inserted opposite ventral, the first part of slender spines, the second part apparently distinct, of rather strong rays; the dorsal covering eleven vertebræ.

Anal fin mostly obliterated, the insertion opposite that of the soft dorsal.

Twenty vertebræ shown, twelve belonging to the abdominal region, the total number probably twenty-six to thirty. Vertebræ rather small, slender and longer than deep, the centrum deeply fluted with three or four ridges on either side. Neural and hæmal spines rather small, turned backward and not strongly curved.

Traces of small scales on the head.

This fish is evidently one of the PERCOIDEI, and on the whole it seems most likely to be one of the SCIÆNIDÆ. Its salient features are the posterior insertion of the ventrals, the entire and probably cavernous bones of the head, and the fluted vertebræ.

Family **LABRIDÆ.**

43. Xyrinius houshi Jordan and Gilbert, new genus and species.
(Plate XXXI, fig. 2)

A very small fish 1⅛ inches in length (No. XXV), from fine-grained sandstone of the Monterey-Puente formation of Los Angeles, obtained by Mr. R. G. Van Cleve.

Head 3½ in length, depth 2⅘; vertebræ apparently 12 + 16 = 28, the anterior ones not certainly counted. General form of the Razor-fish, XYRICHTHYS PSITTACUS—the body very deep at the nape, the front approaching the vertical, the suborbital very deep, the rather small eye high and the opercle very short and deep. Mouth small, horizontal, placed very low; outlines of body behind the shoulder nearly straight, the form tapering rapidly backward. Spinous dorsal lost, a few rays present near middle of body. Vertebræ stout, the interhæmals of the ventral region notably so; pectorals vaguely shown; ventrals thoracic, I 5. Caudal rather large, its length a little more than half greatest depth of body, the fin apparently truncate. Traces only of large cycloid scales. The fine hair-like bones are well preserved.

The characteristic form of the body of this little fish leaves not much doubt of its close relation to the Razor-fishes, XYRICHTHYINÆ. From XYRICHTHYS it differs in the number of vertebræ, there being at least twenty-eight or more, perhaps thirty-four. This would indicate a more northern range than that of the tropical species of XYRICHTHYS, in which the vertebræ are 9 + 16 = 25, the standard number of tropical LABRIDÆ. The increased number of vertebræ with the apparent relationship to XYRICHTHYS may define the new genus XYRINIUS.

The generic name is from ξύρον, a razor; ἰνίον, the nape. The species is dedicated to William H. Housh, principal of the Los Angeles High School.

Family **SCORPÆNIDÆ.**

44. Sebastavus vertebralis Jordan and Gilbert, new genus and species.
(Plate XXXI, fig. 1)

Type an immature fish, less than three inches long (No. III), lacking the head and anterior part of the body about to the middle of the spinous dorsal. It is from the diatomaceous shales at El Modena, presented by E. E. Hadley.

Body robust, the depth probably about 3½ in length; caudal peduncle stout. Dorsal fin deeply notched, the anterior part of stiff spines, of moderate height, the highest two in depth of body, the soft part of I, 11 rays, the highest two in depth of body. Anal fin well preserved, its rays about ten, its spines rather small and graduated; anal beginning

behind front of soft dorsal; caudal well developed, slightly lunate; scales rather small, present from the middle of the soft dorsal backward, thirteen or fourteen in a cross series; vertebræ small with short hæmal and still shorter neural spines; vertebræ as preserved 10 + 20 in number, the total being apparently about thirty-two. The vertebral column is directed strongly upwards posteriorly in the type specimen, an appearance due to distortion.

This species must belong to the SEBASTINÆ, as no other fishes with stiff dorsal spines found in the North Pacific unite the character of small scales with that of more than twenty-four vertebræ. More than twenty-seven vertebræ are found in the genera SEBASTES and SEBASTOLOBUS only, and with these genera our specimen has no spceial affinity. These northern forms have much smaller scales, and a much shorter anal with stronger anal spines. So far as external characters go, the species which seems to come nearest to ours is SEBASTODES or SEBASTOSOMUS MYSTINUS Jordan and Gilbert (C. H.), but that again has much smaller scales, a shorter anal and a longer soft dorsal, besides the generic difference of twenty-seven vertebræ instead of about thirty-two. We therefore propose for this extinct species the generic name of SEBASTAVUS, distinguished from SEBASTOSOMUS by its more numerous vertebræ.

A second specimen (No. XLI), apparently of the same species, shows a broken and distorted head, without evident spines, the chief feature being the broad, pectoral fin of twelve to fourteen rays, its tip broken, and its position brought very low by distortion; the other fins are indicated by obscure shades; the caudal region is wanting, and there is no trace of scales. The vertebræ seem much as in the type of SEBASTAVUS VERTEBRALIS, to which species this example probably belongs.

45. Rhomarchus ensiger Jordan and Gilbert, new genus and species.

(Plate XXXI, fig. 5)

Two small fishes from the diatomaceous shales of El Modena belong apparently to the SCORPÆNIDÆ, being allied more or less closely to SCORPÆNODES Bleeker (SEBASTOPSIS Gill) and to other forms with strong spines. The present genus is especially characterized by the very long second anal spine and by the small number of vertebræ.

The type is the larger specimen (No. XLIX), about four inches long, the smaller (No. CXXIV) about two and a half. Head crushed in both examples, apparently large, two and a half in length; depth of body about the same, the form robust. Dorsal fin apparently continuous but notched; twelve spines shown in the larger example, there being prob-

ably no more, the longest being the eighth, which is about half the depth of the body; last spines shorter; soft dorsal short, lower than spinous dorsal. Anal inserted well forward, about under the eighth dorsal spine; its second spine very long, strong, and curved, four-fifths the depth of the body; third spine slender, nearly as long; rest of fin obscurely shown; pectoral and ventral obliterated; caudal fin long, one and a fourth in depth of body, obliquely truncate; its rays about fifteen; the caudal is well preserved in the smaller example, the anal spine mostly obliterated. Vertebræ strong, with strong hæmal and neural spines, the number not more than eighteen in all; hypurals weak, obscure.

This genus can hardly be placed elsewhere than among the SCORPÆNIDÆ, although its head characters are lost. In this family it is uniquely distinguished by its few, strong vertebræ and its very large anal spine.

The name is from ῥώμη, strength; ἄρχος, for anal fin.

Family **HEXAGRAMMIDÆ.**

46. Hexagrammos achrestus Jordan and Gilbert, new species.

(Plate XXIV, fig. 2)

Type No. CXL from Lompoc, on a block of celite, a torso from which the head and tail have been unfortunately cut away. What there is left seems to agree in all respects with the living genus HEXAGRAMMOS, abundant northward from Point Concepcion to Alaska. The species may be placed provisionally with that group.

Body elongate, the depth at front of anal three inches, which is the length of eleven and a half vertebræ; twenty vertebræ, representing most of the caudal series, appear, the total number probably being about forty. Vertebræ strong, not fluted, not much constricted, about as long as deep, those posteriorly being longer. Neural processes rather short, wholly straight; hæmal processes longer, weakly curved. The dorsal seems continuous but deeply notched in the middle; the anterior part of rather long, slender spines; the posterior part of slender rays, rather higher. The rays represented are XIV, 16 = 30, but the actual number of both must have been somewhat larger. Dorsal spines 1⅔ in depth at front of anal, 1⅓ in base of first dorsal. Anal inserted slightly behind front of second dorsal, its rays about 18, rather lower than the dorsals. Interneurals straight and slender, shorter than the straight and slender interhæmals. No stiff spines anywhere. No trace of scales. Caudal, ventrals and pectoral lost, as also the head.

Family COTTIDÆ.

47. Eoscorpius primævus Jordan and Gilbert, new genus and species.
(Plate XXX)

This form was obtained from the diatomaceous rock or Miocene sand shale at Bairdstown. In the imprint the head is crushed, the caudal region behind the anal is wanting and the body interiorly is much confused, being crushed at the shoulder girdle. The fossil (No. XXXIX, from Bairdstown, J. Z. Gilbert) permits the following characterization:

Head (205 mm., approximated) in length to the anal fin 1.6 times; depth at ventral fin about 2.5 in head; at the anterior dorsal 2.7; D. rays roughly counted X — 20; P. 12 (?); V. I, 5 (?); A. III, —; vertebræ 19-20 + 6 (?). Body rather elongate; scales comparatively small, with coarse, radiating ridges on the exposed surfaces, crossed by very fine concentric striæ, without spinous or pectinated margin shown, but few present and not clearly defined; mouth large, oblique, terminal; the mandible apparently extending behind the eye, which is rather large; teeth small, pointed, equal, sharp, and recurving; opercle below the eye well developed; a well-developed suborbital stay, without spines, its surface striate and rising to a blunt point in the center; ventral fin weak, its rays about I, 5, inserted in front of the pectoral, its place perhaps due to distortion, and even its existence questionable; pectoral practically obliterated and displaced, of perhaps eleven rays; vertebræ as deep as long, with weak spines and frail ribs, the number to front of anal apparently twenty-two, probably about forty in all.

The dorsal fin had probably about thirty-three rays; the anterior part consists of about ten short and rather sharp spines; the interneurals are about as strong as the neural spines; the soft rays following are weaker, as indicated by the interneurals, the rays themselves being obliterated. The dorsal begins about opposite the fourth vertebra; the two dorsals may have been connected; the second has strong rays indicated by the interneurals, but no subsequent rays are shown, all the posterior region being broken away; the total number may have been from eighteen to twenty-two.

The anal fin is indicated by three rather strong and three weaker interhæmals. The last of the three slender spine-like rays is stoutest and longest, perhaps equal in length to the rays which follow. The anal fin lies immediately below the middle of the base of the second dorsal, opposite the 22d, 23d, and 24th vertebræ. The interhæmal spines would indicate a fin about equal in height to the dorsal, but the rays themselves are lost. The anal was probably shorter than soft dorsal. The eye was

apparently rather large; the jaws, badly crushed, seem to be stout; no teeth are shown except in a fragment on the side which shows very small, even, sharp, recurved teeth. The opercle has the posterior margin very oblique, feebly convex, making a greater than a right angle with the inferior border. The angle is rounded and the bones show no spines. The suborbital stay, the large bone below and behind the eye, is well developed, conspicuous, and with entire edges, with a central elevation scarcely spine-like.

MEASUREMENTS.

Length of head, approximated	205	mm.
Length of snout, estimated	30	mm.
Length from anterior border of eye—		
to posterior end of opercle	175	mm.
to the anal fin	303	mm.
to the dorsal fin	197	mm.
to the ventral	130	mm.
to the first caudal	278	mm.
Depth at ventral fin	82	mm.
Depth at first dorsal fin	76	mm.
Length of base of dorsal fins	120	mm.
Length of 12th vertebra	6.5	mm.
Depth of 12th vertebra	7.5	mm.
Vertebræ in 113 mm.	19	
Body vertebræ	19	

If we correctly interpret the characters of this fish, it is a member of the COTTIDÆ, and the number of its ventral rays, if accurately stated, suggests affinity with the relatively primitive genus SCORPÆNICHTHYS Girard, represented by a large species (S. MARMORATUS Ayres) on the coast of California.

Geologically the family of COTTIDÆ is very recent, the oldest genus known (EOCOTTUS Woodward) dating from the Upper Eocene of Monte Bolca.

As currently understood, the family seems to represent two main lines of descent. The typical COTTIDÆ are large-headed forms, with irregular scutes or bony plates, if armed at all, never regular scales. The slender, small-headed forms, with weak armature and the body primitively covered with small scales, form a distinct group.

The most primitive living genus of the true COTTIDÆ is probably SCORPÆNICHTHYS Girard. It has typical armature of the head and the ventral rays I, 5, as in most spiny-rayed fishes. The skin is without scales. The oldest known fossil of this type is EOSCORPIUS, if we have

properly interpreted the remains of that form. Among the principal genera of this group are MYOXOCEPHALUS Steller and its reduced fresh-water representative, COTTUS L. While in some of the genera bony plates or detached prickly scales are developed, none of the known species has a regular squamation. The affinities of the true COTTIDÆ with the SCORPÆNIDÆ are apparent.

The other and doubtless more primitive group may be known as ICELIDÆ. The most primitive of its living genera is JORDANIA Starks, a slender fish with the ventral rays I, 5, and the body covered with normal scales. The extinct genera, EOCOTTUS Woodward and LEPIDOCOTTUS Sauvage are related to JORDANIA. The living genera of ZANIOLEPIDÆ (ZANIOLEPIS Girard and XANTOCLES Jordan) may have sprung from similar stock. The living species of ICELIDÆ are numerous in the North Pacific. Among the principal genera are ICELUS Kröyer, ICELINUS Jordan and TRIGLOPS Reinhardt. ARTEDIUS Girard and HEMILEPIDOTUS Cuvier probably belong to this group, though approaching MYOXOCEPHALUS in general form.

Through the courtesy of Professor Theodore D. A. Cockerell we present a photograph of a specimen of LEPIDOCOTTUS BREVIS (Agassiz) (Plate XXXI, fig. 4) from its type locality, the upper Miocene at Oeningen, Baden.

Of a specimen of some fish from Lompoc, Coll. Miss J. M. Telford, XI we present the photograph. The species may be COTTOID, but we are unable to restore it or to indicate its relationship (Plate XXIII, fig. 3).

48. Hayia daulica Jordan and Gilbert, new genus and species.
(Plate XXIII, fig. 2)

Head and anterior region of a large fish (No. XXVII) from fine gray shales in Los Angeles. The part preserved is seven and a half inches in length, the head five inches. The whole fish must have been over two feet long.

Head triangular in outline, its depth at nape one and four-fifths in its length. Mouth long, oblique, the mandible apparently projecting, the maxillary oar-shaped, slightly emarginate behind; its length about four in head; no teeth preserved; bones of head much confused; a rather sharp bony ridge running horizontally back from the eye, and apparently a broader bony ridge on temporal region behind this; opercle large, rough, but without spines, the lower part with coarse, radiating ridges. Vertebræ very strong, deeper than long, with strong interneurals. Six neural spines visible under the spinous dorsal, its insertion is opposite third and fourth vertebræ, the spines stout (broken), the number not to be ascertained; the highest about half depth of head; some broken spines out of place about the head; imprint of a rather broad pectoral obscure.

The character and make-up of the bones of the head suggest the genus ASPICOTTUS, but this resemblance may be wholly elusive, and the fish may not belong to the COTTIDÆ. The spines on the head if present are all broken. Some moderate, thin scales, apparently cycloid, are scattered about, but they may not belong to this fish.

It is named for Dr. Oliver Perry Hay, who has contributed much to our knowledge of fossil fishes.

Family **GOBIIDÆ.**

49. Aboma antiqua Jordan and Gilbert, new species.

(Plate XXIX, fig. 1)

Two specimens of a small goby from the diatomaceous shales at Bairdstown, Dr. J. Z. Gilbert. These are two and three inches in length. Two others, about three and a half inches long, were obtained by Dr. Ralph Arnold in the same rock at Shorb, California. The largest of the specimens (No. II) from Bairdstown may be taken as the type of the species. The description is drawn from all. The figure is from a photograph of the type. Head about 4¼ times to base of caudal; depth about 4. D. VII or VIII—9 to 12 (probably VIII—12); anal destroyed; ventrals fully united, each I, 5; pectoral short and narrow, about 12. Scales about 35-9, rather large, probably ctenoid, each with about three marked striæ; no scales seen on head; vertebræ apparently about 14 + 16 = 30 to 32; mouth low, rather small, the jaws subequal; the snout rather pointed; eye moderate; dorsal fins low, the spines slender; about as high as the soft rays; ventral rather large (the fin displaced in the specimen photographed), its insertion as usual well in front of dorsal; caudal rather large, rounded, the lower edge cut obliquely, the upper rays being longer.

The species, so far as may be seen, agrees with the genus ABOMA Jordan and Starks, now represented on the Pacific shore of Mexico and in Japan.

Family **BROTULIDÆ.**

50. Merriamina ectenes Jordan and Gilbert, new genus and species.

(Plate XXVI, figs. 1, 3)

Type (No. XIII) an example about 8½ inches in length from El Modena, Hadley collection. A smaller specimen from the same collection 4¼ inches long is No. XIV. In both the head is badly crushed and the fins more or less broken, but the posterior parts are well preserved.

In the type the head is nearly 4 in length, the depth about 5, 1½ in head. Vertebræ obscured anteriorly, 24 visible, the total number apparently about 36; in the smaller specimen there are one or two more; the best count (No. CVII) shows 42 to 44. Body elongate, lanceolate, deepest at the shoulder, tapering to a slender tail, dorsal and ventral outlines corresponding and nearly straight. Dorsal fin beginning well forward, not far

behind the nape, and extending to the base of the caudal, with which it is possibly joined (the caudal region broken on the smaller example (No. XIV), the tail being detached); dorsal rays subequal, the highest posteriorly, opposite longest rays of the anal; tail becoming very narrow, the caudal short, weak, truncate, its rays about as long as the longest of dorsal and anal, one and a half in depth and not far from two in head; last rays of dorsal and anal reach a little beyond base of caudal; pectoral narrow and long, inserted high, on the axis of the vertebral column, reaching fully to front of dorsal, its length equal to depth of body and about half more than the other fin rays; pectoral rays twelve to fifteen; a trace of jugular ventrals well in advance of the pectorals; anal fin originating before middle of body, similar to the dorsal but much shorter. Vertebræ strong, with well-developed neural and hæmal spines which grow short backward; no evident hypural plate. No scales preserved. What seem to be small, pointed teeth occur on a fragment which seems to belong to the mandible. Cranium apparently rounded above, opercle well rounded behind.

Of this species five other examples, more or less perfect, have been found by Mr. Hadley in the diatomaceous shales of El Modena. These range from three to four inches in length.

No. CVII has body parts well shown; the vertebræ are about $19 + 25 = 44$, posterior vertebræ elongate and hourglass-shaped; anal rays $20+$, pectoral rays about 10; ventrals $7+$, the rays very slender and branched; pectorals inserted high, the long and slender ventrals directly below them, their tips almost reaching front of anal, which is inserted at a point nearer tip of snout than base of caudal. Dorsal rays about 5-37, the first rays seemingly detached from the others. Body growing slender posteriorly, the caudal narrow and short, apparently lunate.

No. XXXVIII is a broken tail with part of the dorsal fin.

Another example (No. CIX) is very similar, but has the fins less clearly shown; the head is less crushed, but shows little save that the bones are thin and entire, and the form seems conical.

No. CX is still less perfect, little more than the vertebral column, which has $40+$ segments, being traceable.

No. CXI is still worse crushed, but is identifiable by the many-rayed dorsal and anal and the slender tail.

This fish is apparently a Brotulid, not very different from the existing types, but not identical with any of the numerous living genera so far as we can see. It may be not very far from the existing California genus, Brosmophycis Ayres, but the form is more elongate.

The name Merriamina is given in honor of Dr. John C. Merriam, palæontologist of the University of California.

Family **PLEURONECTIDÆ.**

51. **Evesthes jordani** Gilbert.

(Plates XXV, XXVI)

This remarkable flounder, described in the *University of California Publications,* Geology, **5**, 407, Nov., 1910, was found in diatomaceous shales in the Miocene of Lompoc, on the north side of the Sierra Santa Ynez in Santa Barbara County. It is probably the most primitive flounder known, related to the living genus, PARALICHTHYS Girard, but with fewer fin-rays, fewer vertebræ, and especially a much larger body-cavity.

The original plates of this species are here reproduced through the courtesy of Dr. John C. Merriam.

52. **Diatomœca zatima** Jordan and Gilbert, new genus and species.

(Plate XXIV, fig. 3)

It is a custom at Lompoc to cut the diatomaceous celite into large blocks or bricks for the trade. On the surface of these bricks are often found fossil fishes, especially specimens of LOMPOQUIA AGILE.

On the surface of one of these blocks presented by Mr. Edward J. Porteous is the torso of a large flounder which we call DIATOMŒCA ZATIMA.

Type No. CXXXIII, Lompoc, Edward J. Porteous, the part preserved six and three-eighths inches in length. This specimen shows the usual flounder structure in the backward curve and close approximation of the hæmal spines before the anal fin. But this condition is much more pronounced than in EVESTHES JORDANI, from the same deposits. The specimen shows twenty-two of the caudal vertebræ, the total number having been probably twenty-six. These are very stout, much stronger than in EVESTHES, deeper than long, not constricted, and with fine roughish longitudinal ridges. The neural and hæmal processes are remarkably long, the latter especially, and all are strongly curved. The processes in EVESTHES are much shorter and nearly straight, while the vertebræ are fewer in number, slender, and much longer than deep. The depth at front of anal fin is almost equal to the length of twenty vertebræ.

The dorsal rays are slender, rather low, twenty-four of them in four and a half inches of the length of the body. The rays are close set, decreasing rapidly backward. The anterior rays are obliterated. The anal fin is represented by the bases of a few anterior rays. There was apparently no procurrent spine before the fin. The few ribs represented are long, slender and bent backward. The head, with the pectorals, ventrals, and caudal, was unfortunately cut off in preparing the slab.

There is not much doubt that these remains represent a large flounder, probably big-mouthed, and allied to the PARALICHTHYS group. It is not possible to determine in which side the eyes were.

Two other torsos of large fishes (CXLIII) with strong vertebræ have been sent to us by Mr. Porteous. All seem to be new to science, but the characters shown do not allow us to venture on giving them places in the system.

Family **LOPHIIDÆ** (?).

53. Emmachære rhachites Jordan and Gilbert, new genus and species.

(Plate XXVIII, fig. 2)

Type (No. CXLIII) the torso of a large fish, lacking the head, remarkable for the large dagger-shaped interneurals, found in diatomaceous deposit at Lompoc, Mr. Edward J. Porteous. Head and anterior region wanting; fourteen vertebræ preserved, these very stout and straight, about as long as deep, without expanded interhæmal; depth at front of anal (3 inches) equal to length of 8½ vertebræ. First dorsal, if present, now obliterated. Soft dorsal with short, stout rays; anal inserted 3 vertebræ in front of it, showing traces of about sixteen rays, decreasing rapidly backward; anterior interhæmals long and stout; interneurals present very strong, dagger-shaped with edges somewhat expanded at base. Caudal represented by part of lower lobe, its rays strong; hypural plate divided, the lower part broadly triangular, the distal truncated border nearly equal to its length.

We cannot place this fish with certainty, but as its vertebral column and appendages bear a degree of resemblance to like parts in LOPHIUS, we place it provisionally among the Pediculate fishes. A comparison of interneural bones and vertebræ should finally determine its affinities.

The name is from ἔν, within; μαχαίρις, a dagger.

Family **DELPHINIDÆ.**

Phocæna occidua (Leidy).

(DELPHINUS OCCIDUUS Leidy, *Proc. Acad. Nat. Sci. Phila.*, 1868, p. 197.)

(Plate IX, fig. 2; Plate XXVIII, figs. 1, 3)

Besides the fishes described in this paper we have also the posterior part of the vertebral column of a species of dolphin. Our knowledge of the group does not permit us to assign it to any particular species, or even genus. We see, however, no difference from the living genus, PHOCÆNA.

No. CXXXVI, from San Pedro, in rocks of Miocene age, a friable sandstone shale.

This fossil is broken into two pieces on the same slab. It represents in the first part the imprint of eight segments with traces of three others,

the animal lying prone; in the second part, of nine segments, these lying supine, the two parts preserved being 15½ inches in length. Each segment in the anterior part is 2¼ times as broad as long, in the smaller part about 1½, the anterior ones being about 2¼ inches in length, the posterior tapering very rapidly backward.

The anterior part is the imprint of vertebræ lying supine, the blunt lateral wings appearing as quadrate imprints on the side of each vertebra. The posterior vertebræ lack these wings, and their position is reversed. The impressions of these vertebræ, which are without lateral processes, are marked on the anterior part of each segment by three rounded knobs, becoming more distinct posteriorly. Each of these knobs was a rounded depression in the living animal. These markings on the posterior vertebræ and the flanges on the anterior vertebræ correspond almost exactly to the structures on the skeleton of a living California species before us. The latter we suppose to be the Harbor Porpoise, PHOCÆNA PHOCÆNA L., although we are not sure as to the identification.

Near the posterior end of the vertebral column of the type specimen appear a few small vertebræ and part of the caudal fin of a large fish, ALISEA GRANDIS, of the same period. It is evident that this fin does not belong with the rest of the fossil.

Since these pages were in type we have received from Mr. Edward J. Porteous of Lompoc two bricks of celite containing remains of the vertebral columns of a porpoise, doubtless the same as the one noted above.

No. CXXXVII shows a series of nine large vertebræ as seen from the side and showing the strong dorsal processes. Each vertebra has the length of seven-eighths of an inch and the depth of one and one-eighth inches.

No. CXXXVIII shows seven large vertebræ, apparently from the caudal region, as seen from below. These measure one and a fifth inches in length and one and a half in depth. The articular surface is spherical, deeply concave. The margins of the centrum are roughened by many ridges and what seems to be a deep V-shaped neural canal.

We have no means of comparing this porpoise with DELPHINUS OCCIDUUS Leidy, known from a jaw in the Miocene at Half Moon Bay.

III.

FOSSIL FISHES OF THE PLIOCENE FORMATIONS OF SOUTHERN CALIFORNIA

DAVID STARR JORDAN and JAMES ZACCHEUS GILBERT

A small number of fishes has been obtained about Los Angeles from sandstones and shales which lie above the Puente or Monterey deposits and which are regarded as of Pliocene age. In these rocks there are no diatomaceous deposits and the fishes are of a different character from those found imbedded in the masses of diatoms.

The following localities are represented:

1. Sunset Bluff, near Broadway Tunnel: sandy shales of the lower Pliocene. ARNOLDINA.
2. Third Street Tunnel: clay shale of the upper Pliocene. ECTASIS.
3. Fourth and Hill Streets: clay shale, upper Pliocene. CARCHARODON.
4. Temescal Cañon, Sierra Santa Monica.
5. Rustic Cañon, Sierra Santa Monica.
6. Port Harford.

The following species were obtained from rocks of Pliocene age (new names in italic):

Family GALEORHINIDÆ.

1. GALEORHINUS HANNIBALI Jordan and Beal, Temescal Cañon.

Family LAMNIDÆ.

2. CARCHARODON ARNOLDI Jordan, Los Angeles, Rustic Cañon.

Family SCYMNORHINIDÆ.

3. SCYMNORHINUS OCCIDENTALIS (Agassiz), Temescal Cañon.

Family DASYATIDÆ.

4. UROBATIS HALLERI (Cooper) (?), San Pedro.

Family GONORHYNCHIDÆ

5. *Ectasis proriger* Jordan and Gilbert, Third Street Tunnel.

Family SCORPÆNIDÆ.

6. SEBASTODES ROSÆ Eigenmann, Port Harford.

Family GADIDÆ

7. Arnoldina iniistia Jordan and Gilbert, Sunset Bluff.

Family **GALEORHINIDÆ.**

1. Galeorhinus hannibali Jordan and Beal.

Recorded from Pliocene deposits in Temescal Cañon, the type from the Miocene of Kern County.

Family **LAMNIDÆ.**

2. Carcharodon arnoldi Jordan.

In Pliocene deposits in Los Angeles, also recorded as CARCHARODON RIVERSI Jordan, from Quaternary deposits about Santa Monica and San Pedro. The actual age of these detached teeth may be uncertain.

Family **SCYMNORHINIDÆ.**

3. Scymnorhinus occidentalis (Agassiz).

Recorded by Jordan and Beal from the Pliocene of Temescal Cañon. The type is from the Miocene of Kern County at Ocoya Creek.

Family **DASYATIDÆ.**

4. Urobatis halleri (Cooper) (?).

Dr. Ralph Arnold records from San Pedro the sting of a ray not distinguishable from that of the living species, UROBATIS HALLERI.

Family **GONORHYNCHIDÆ**(?).

5. Ectasis proriger Jordan and Gilbert, new genus and species.

(Plate XXII)

The type of this species (No. CXXV) is a long slender fish from the Pliocene of the Los Angeles clayey shale at the Third Street Tunnel. It is 21 inches long to base of caudal; caudal and pectoral fins lost; bones of the head indistinct.

Head in length $3\frac{1}{10}$, depth in head a little more than 2; in length of body $6\frac{2}{3}$; D. 18; A. 20 or more; vertebræ $36 + 22 = 58$; snout $4\frac{1}{4}$ in head; eye nearly 4 in head; mandible extending to eye. Body long and slender; scales small, cycloid, their characters indistinct; bones of head shadowy, apparently heavy and with entire edges; mouth apparently large, oblique, terminal, mandibles strong. Eye comparatively large; no teeth plainly visible, but very doubtful traces of strong blunt teeth appear at one point; opercle back of the eye well developed, the angle rounded posteriorly; preopercle indistinct; branchiostegals apparently broad; pectoral and ventral fins obliterated.

The dorsal fin begins exactly midway in the length to base of the caudal; it is small, with at least twelve weak rays distinct, their basal swelling conspicuous, the anterior rays longest and nearly equal in height to length of base, which in turn is shorter than that of the anal. This latter is weaker than the dorsal, its first rays inserted midway between the beginning of the dorsal and the base of caudal. There are apparently more than twenty rays, but much of the fin is obliterated, the bases of about fifteen rays distinct. The remnant of the caudal is the inferior lobe, indicating strong, widely divergent rays well supported at the base; hypural lost.

The vertebræ are strong, markedly wider than long, maintaining their strength well backward, weaker near the head, strongest below the dorsal fin, where the neurals and back of which the hæmals are stoutest and recurved. Anterior vertebræ not modified.

The relations of this genus are with the Clupeiform fishes, but it is not clear to what family it belongs. The skeleton has much in common with that of NOTOGONEUS OSCULUS Cope, a large fresh-water fish of the Green River Eocene. But the form of the mouth is quite different if we can trust the shadowy tracing on the fossil.

With the family of GONORHYNCHIDÆ we may provisionally, and very doubtfully, associate the genus ECTASIS. The name is from ἔκτασις, extension.

But one living genus of GONORHYNCHIDÆ is known. The fossil genus CHARITOSOMUS is evidently related to GONORHYNCHUS. But NOTOGONEUS diverges considerably from GONORHYNCHUS, and ECTASIS, far more if we can trust the outlines of the mouth as indicated in the fossil form.

Family **SCORPÆNIDÆ.**

6. **Sebastodes rosæ** Eigenmann.[14]

A preopercle of some Sebastes-like fish was found by Dr. Carl H. Eigenmann, in Tertiary deposits at Port Harford, the port of San Luis Obispo.

Family **GADIDÆ.**

7. **Arnoldina iniistia** Jordan and Gilbert, new genus and species.

(Plate XXVII, fig. 2)

A small, slender fish (No. XXVI), 3¼ inches in length, from Pliocene deposits of soft shale at Sunset Bluff, near Broadway Tunnel, Los Angeles, the skeleton perfectly preserved, the fins partly obliterated, the first dorsal well indicated. It was collected by High School students under direction of Mr. Ray G. Van Cleve.

[14] Eigenmann: "Zoe," 1, 17.

Head about 4 in length to base of caudal, depth 5½ to 6; a little more than half head; eye moderate, about half snout, 5 in head; snout nearly 3. Snout rather pointed, the jaws subequal, mouth oblique, the maxillary about reaching posterior border of orbit; opercle rounded behind; branchiostegals apparently few and large; bones of head apparently entire; first dorsal of about eight slender rays or spines, its height almost equal to depth of body, its insertion at the nape, not far behind gill opening, over third vertebra; the middle rays highest, but all high; pectoral insertion moderately high; nine rays visible, the fin apparently narrow, about as long as snout; second dorsal, caudal, anal and ventrals obliterated; certain marks under the throat indicating perhaps jugular ventrals. Vertebræ thirty-nine to forty-one, small and even, growing smaller posteriorly, with short processes and few ribs, one or two of the last vertebræ with base of caudal obliterated.

This fish seems to belong to the GADIDÆ, the short, anterior dorsal inserted at the nape, the unarmed head and the narrow pectorals placed rather low, showing some resemblance to the genera POLLACHIUS and THERAGRA.

The genus is named for Dr. Ralph Arnold, in recognition of his admirable work on the fossil Mollusks of Southern California.

65

PLATE I.

Figure 1. ETRINGUS SCINTILLANS Jordan; type LII (Brown's Cañon).

Figure 1

Figure 2

Figure 3

PLATE II.

Figure 1. ROGENIO SOLITUDINIS Jordan; type LVI (Soledad Pass).
Figure 2. ROGENITES BOWERSI (Jordan); type LIX (Brown's Cañon).
Figure 3. GANOLYTES CAMEO Jordan; type LX (Brown's Cañon).

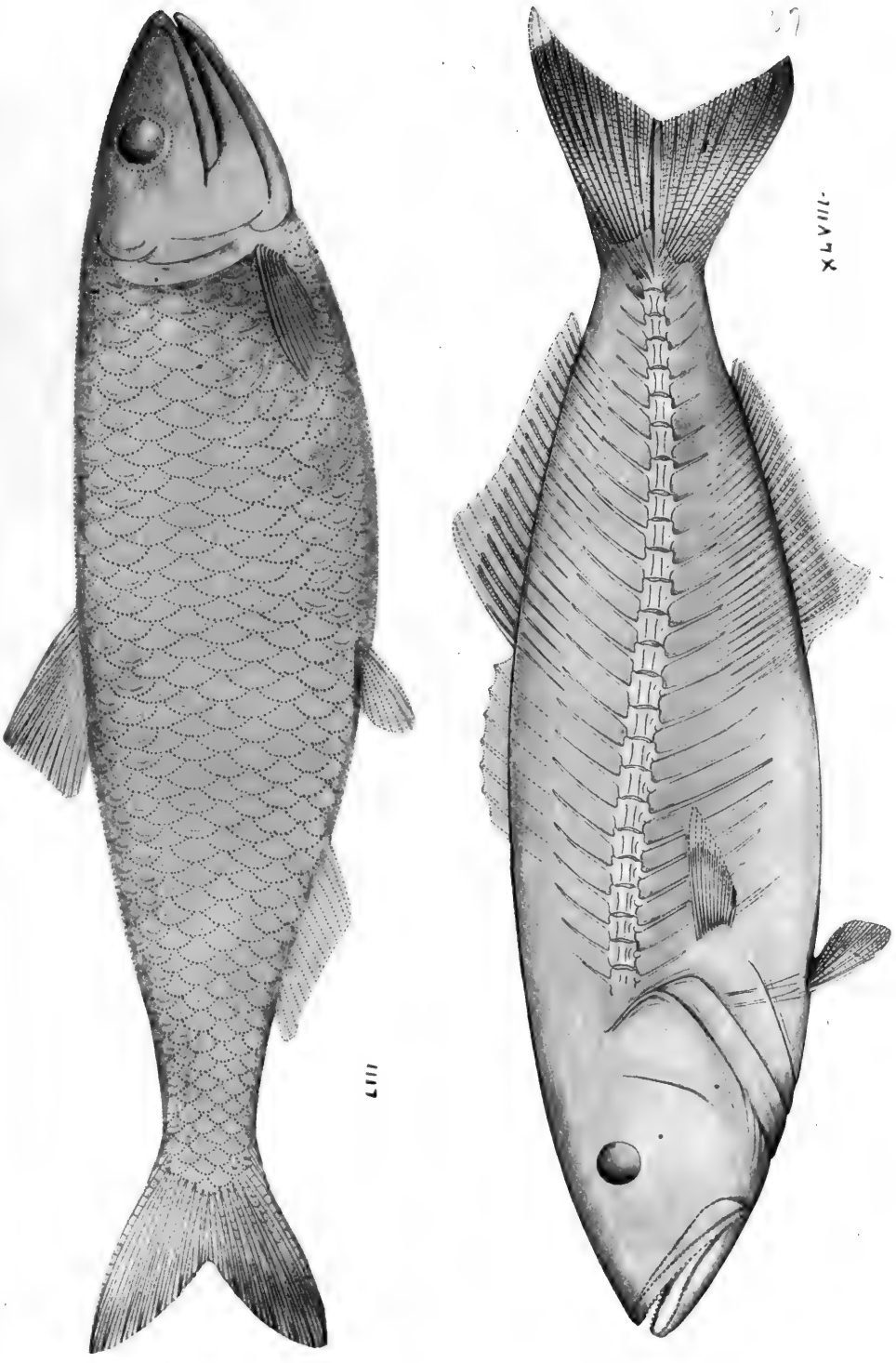


PLATE III.

Figure 1. ETRINGUS SCINTILLANS Jordan (restoration).
Figure 2. LOPHAR MIOCÆNUS Jordan & Gilbert (restoration).

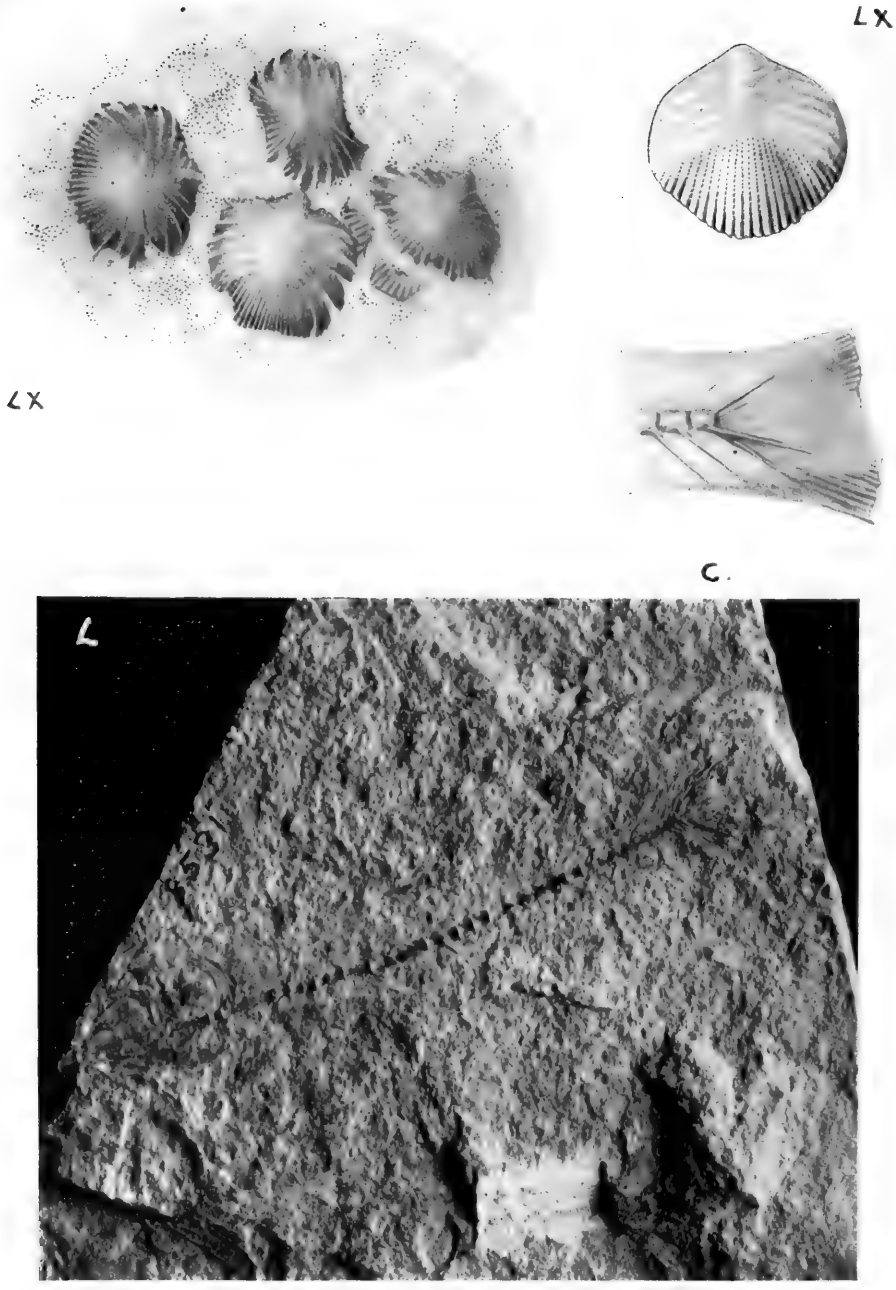


PLATE IV.

Figures 1 and 2. GANOLYTES CAMEO Jordan (scales).
Figure 3. RHOMURUS FULCRATUS Jordan (tail vertebræ).
Figure 4. RHOMURUS FULCRATUS Jordan; type L (Soledad Pass).

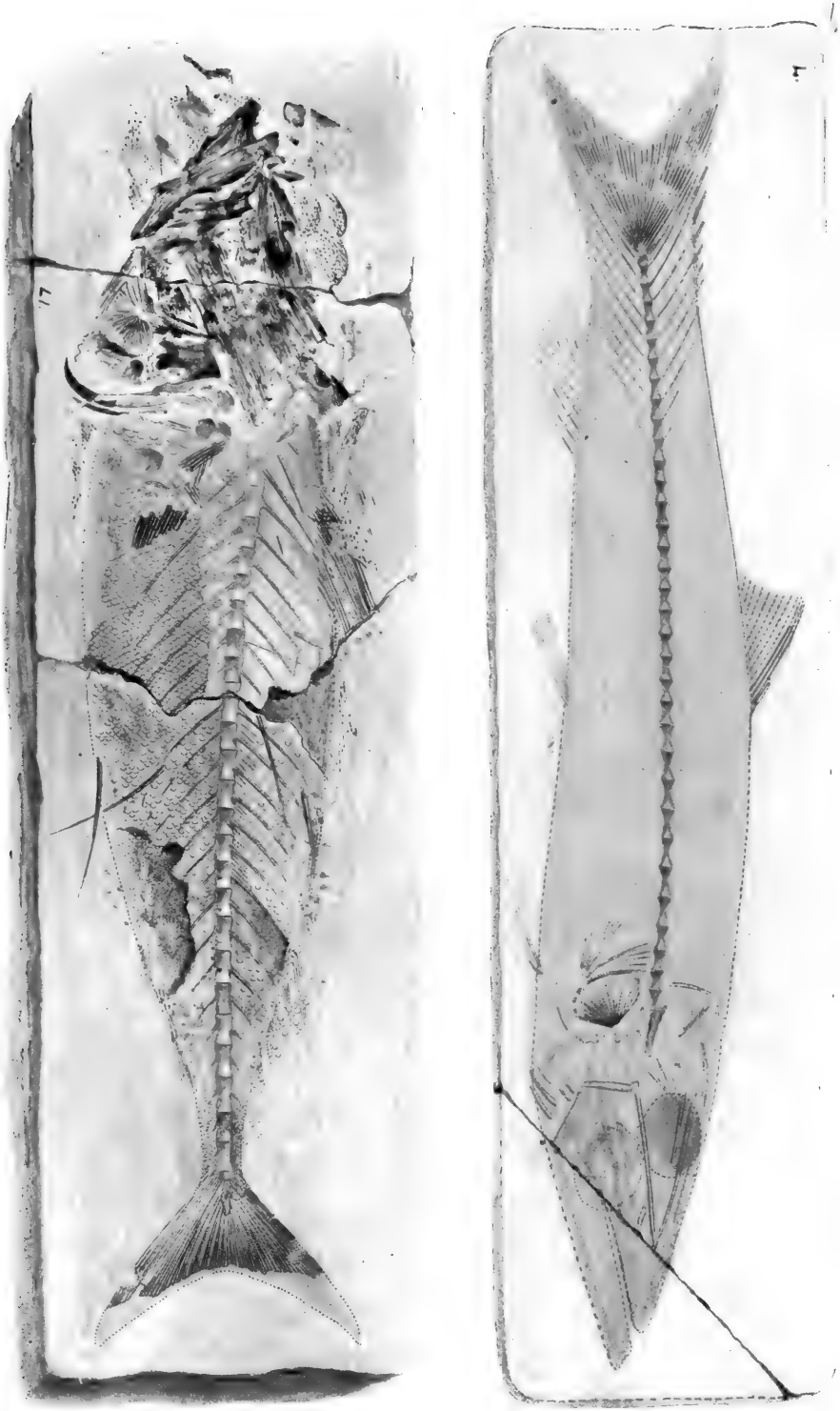


PLATE V.

Figure 1. RHOMURUS FULCRATUS Jordan (restoration).
Figure 2. AUXIDES SANCTÆ-MONICÆ Jordan; type LI (Brown's Cañon).

PLATE VI.

BULBICEPS RANINUS Jordan; type LVIII (restoration) (Soledad Pass).

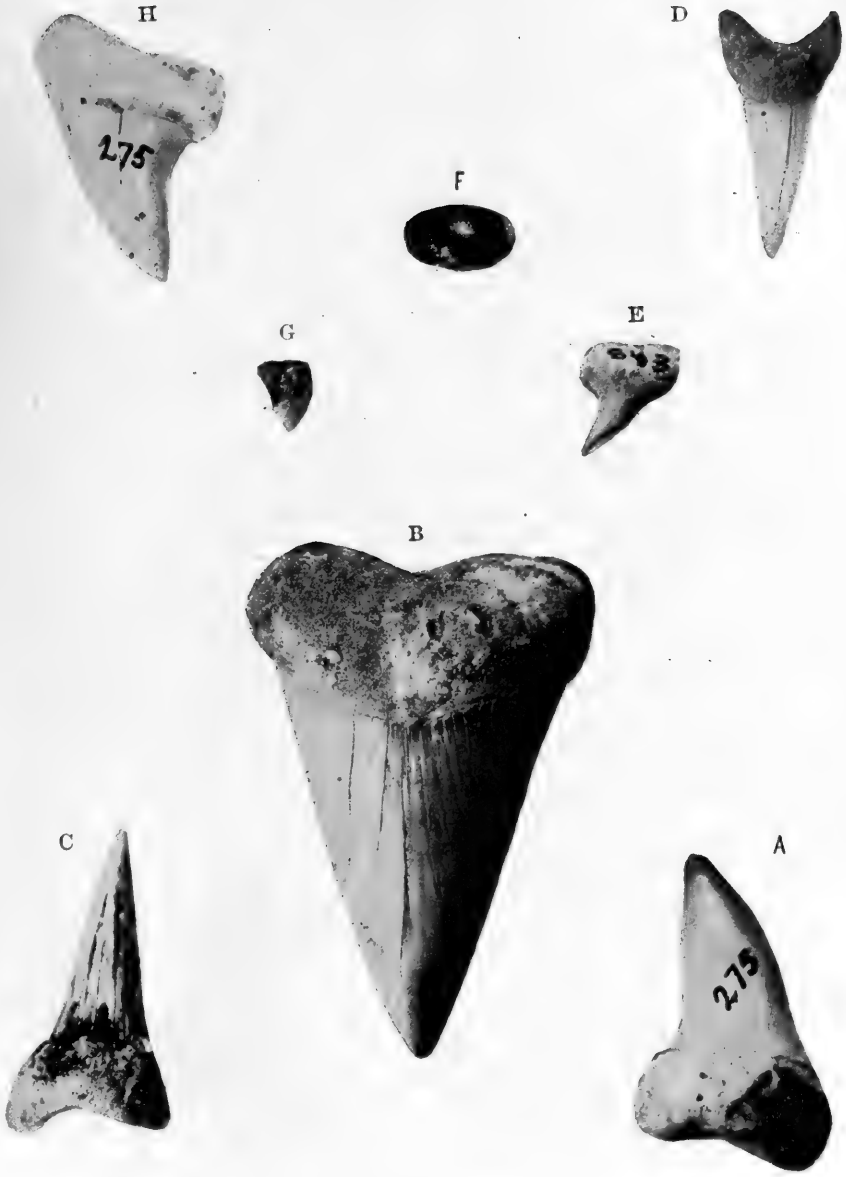
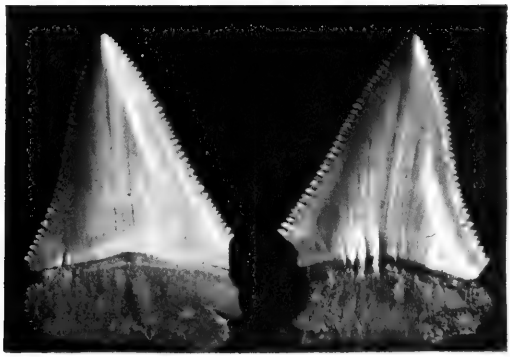
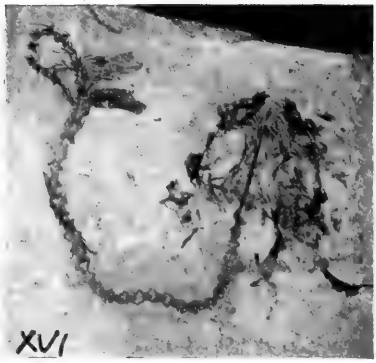


PLATE VII.

ISURUS HASTALIS Agassiz, A, B, C, D, H (teeth from different parts of mouth).
SQUATINA LERICHEI Jordan & Beal, E (Kern River).
WODNIKA OCOYÆ Jordan, F; type, California Academy of Sciences (Bena).
TRIAKIS BEALI Jordan, G; type, California Academy of Sciences (Kern River).





CXXVIII.

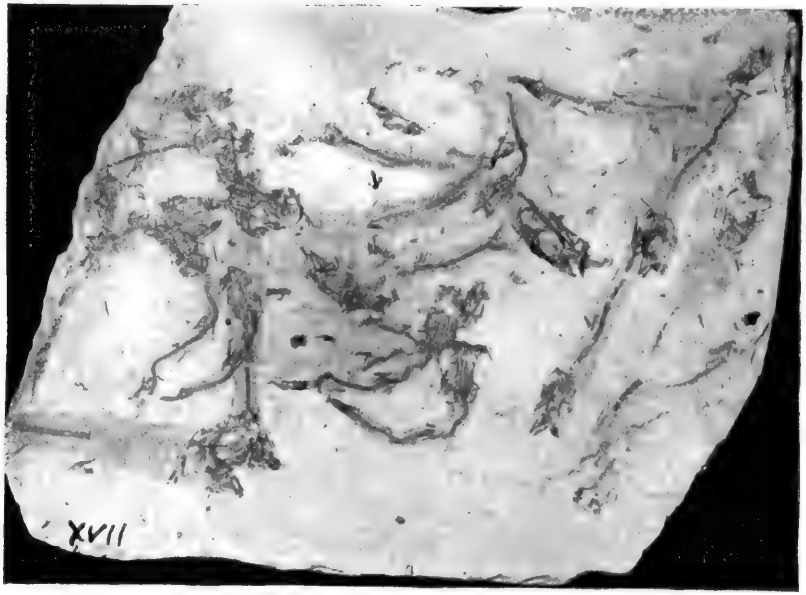
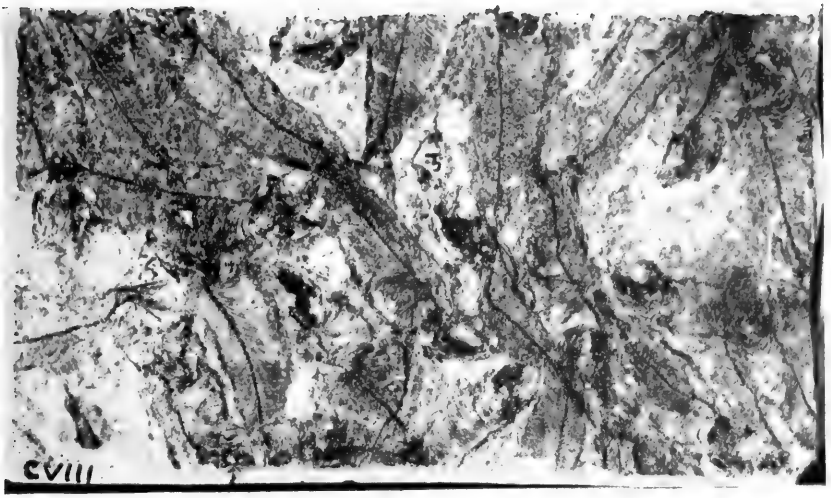
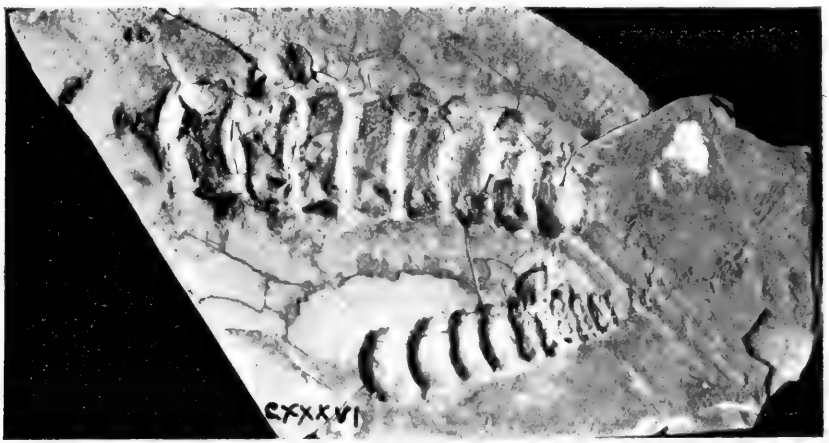


PLATE VIII.

Figure 1. Carcharodon arnoldi Jordan; cxxviii (Los Angeles).
Figure 2. Lygisma tenax Jordan & Gilbert; type xvi (El Modena).
Figure 3. Quæsita quisquilia Jordan & Gilbert; type xvii (El Modena).
Figure 4. Eclipes veternus Jordan & Gilbert; ix (El Modena).





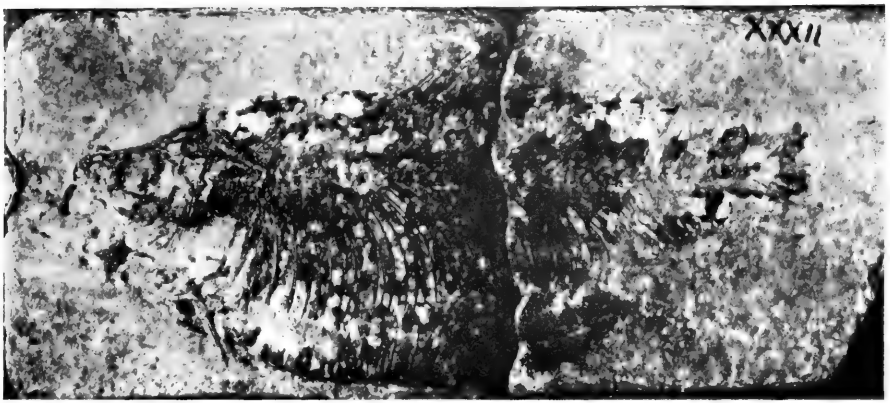


PLATE IX.

Figure 1. Xyne grex Jordan & Gilbert; type cviii (Lompoc).
Figure 2. Phocæna occidua (Leidy) (San Pedro).
Figure 3. Ellimma barbaræ Jordan & Gilbert; type xxxii (Carpinteria).

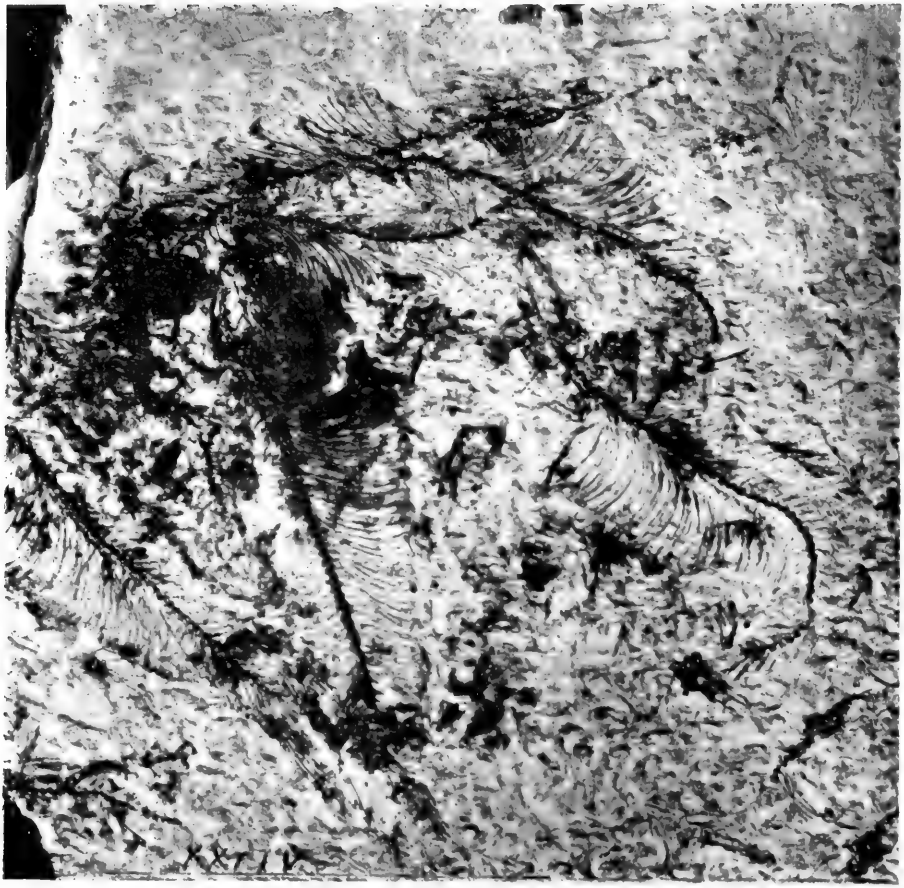


PLATE X.

Figures 1 and 2. Xyne grex Jordan & Gilbert; xviii and xxxiv (Bairdstown).

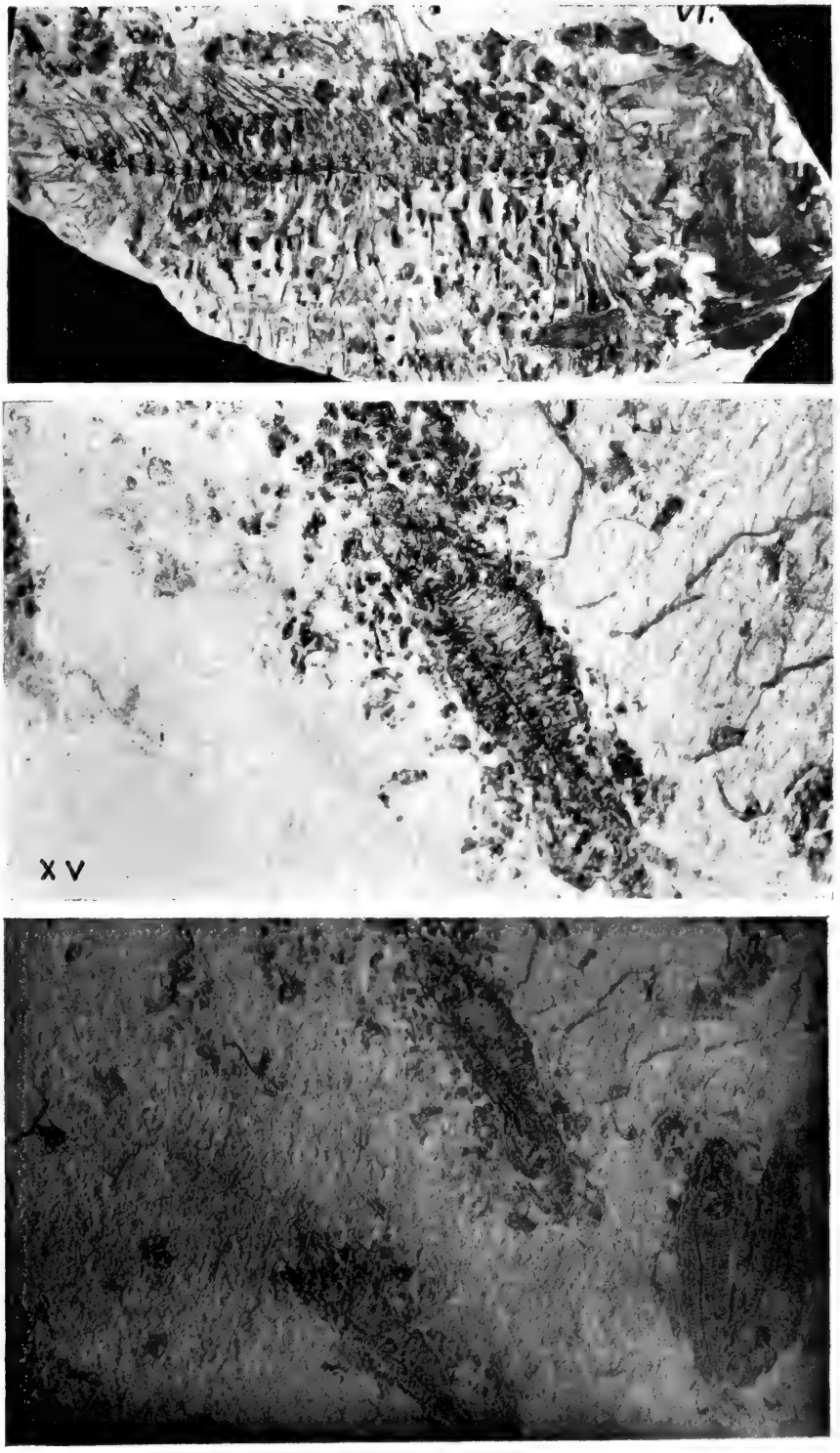


PLATE XI.

Figure 1. GANOLYTES CLEPSYDRA Jordan & Gilbert; type VI (El Modena).
Figures 2 and 3. XYNE GREX Jordan & Gilbert; XV (Lompoc).

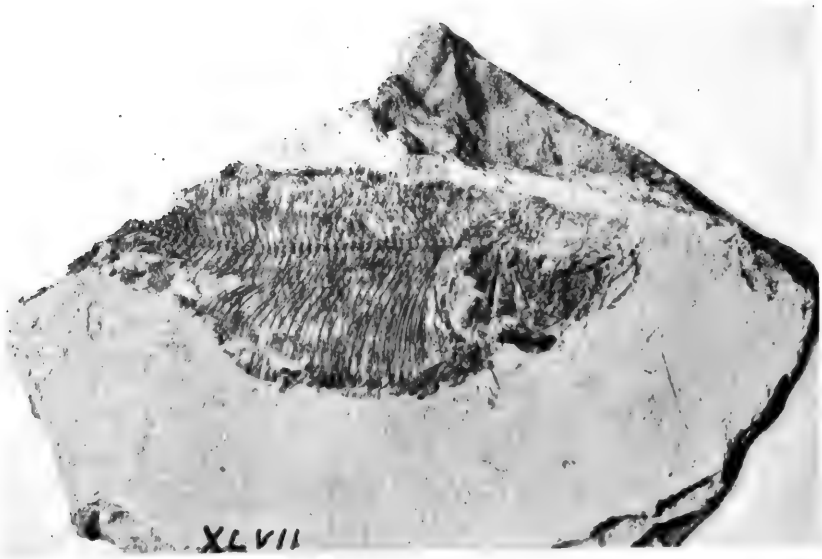


PLATE XII.

Figure 1. ELLIMMA ELMODENÆ Jordan & Gilbert; type XLVII (El Modena).
Figure 2. TUNITA OCTAVIA Jordan & Gilbert; type VII (El Modena).

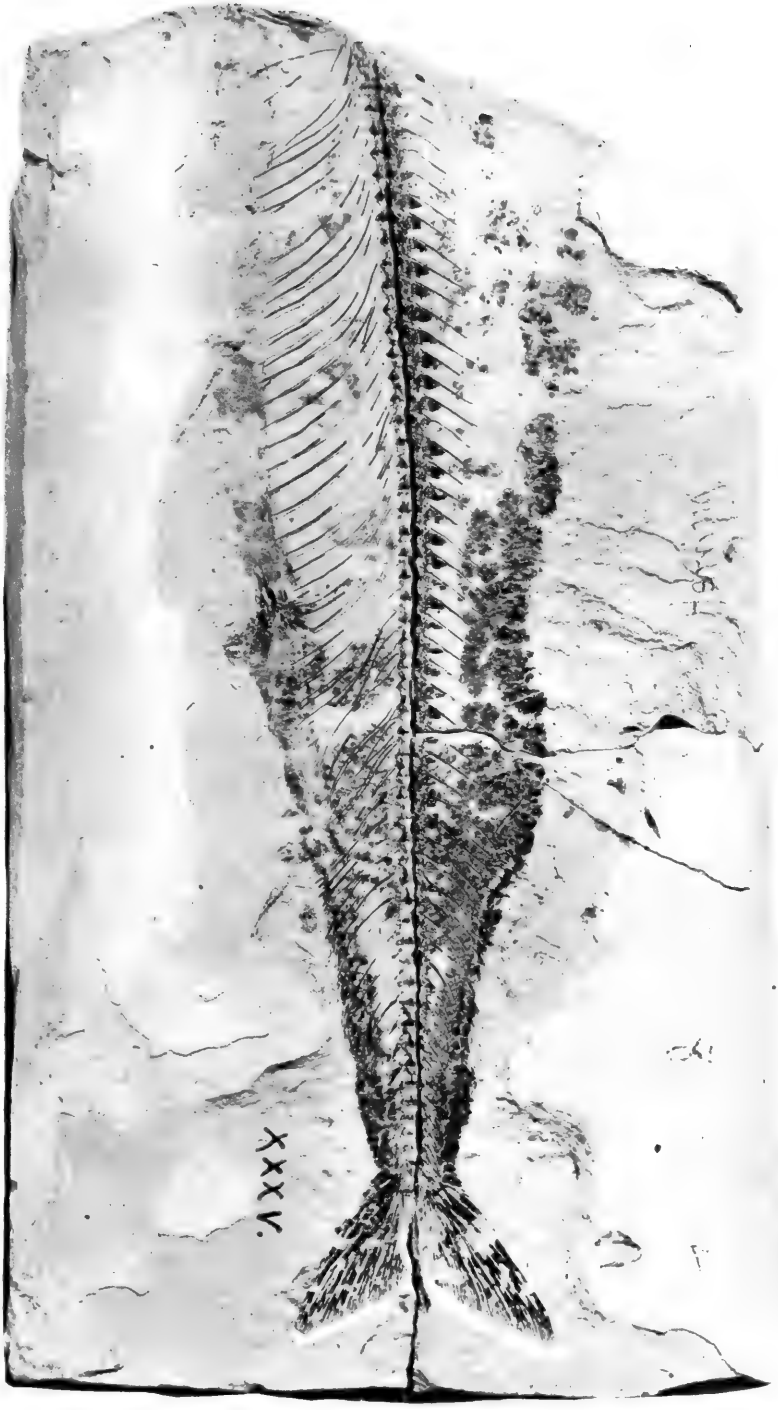
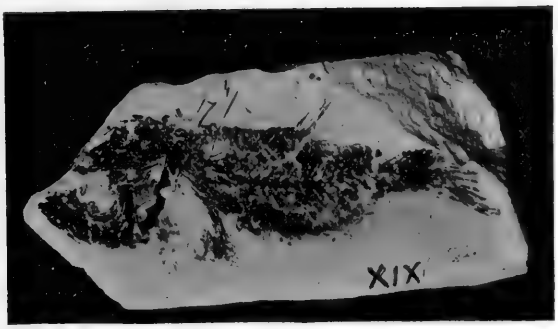


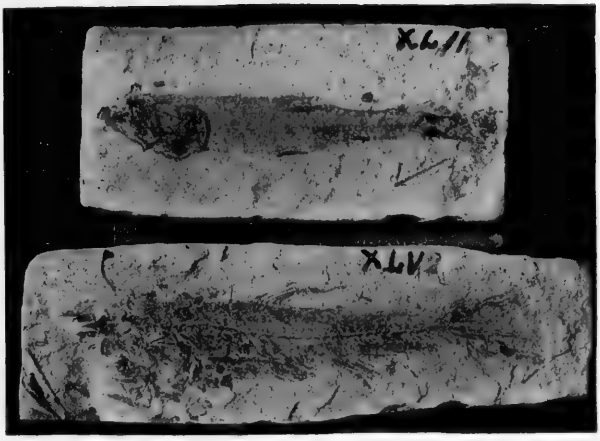
PLATE XIII.

CLUPEA HADLEYI Jordan & Gilbert; type XXXV (El Modena).

PLATE XIV

Figure 1. Lygisma tenan Jordan & Gilbert; cvii (El Modena).
Figure 2. Scombereson acutillus Jordan & Gilbert; xliv (El Modena).
Figure 3. Forfex hypuralis Jordan; type cv (Pine Cañon).





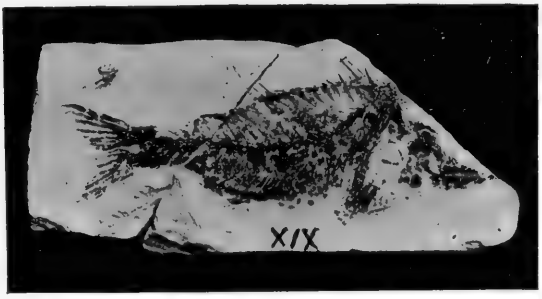
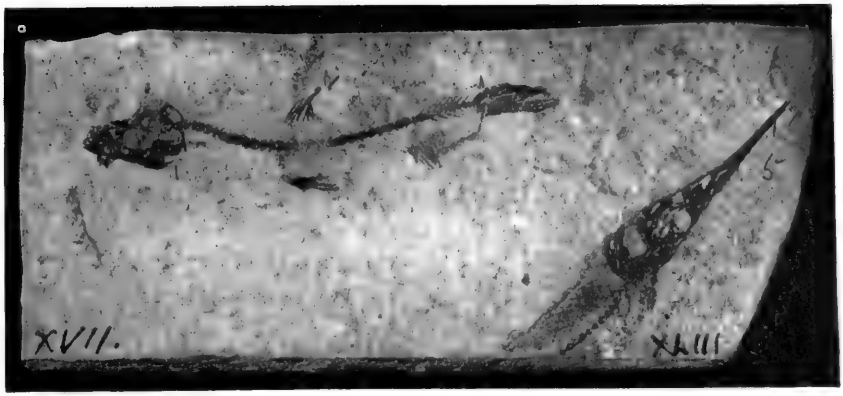


PLATE XV.

Figure 1. LUTIANUS HAGARI Jordan & Gilbert; type XIX (El Modena).
Figure 2. AZALOIS ANGELENSIS Jordan & Gilbert; type XLII (Bairdstown).
Figure 3. ZANTECLITES HUBBSI Jordan & Gilbert; type XLV (Bairdstown).
Figure 4. LUTIANUS HAGARI Jordan & Gilbert; XIX (El Modena).

PLATE XVI.

ZANTECLITES HUBBSI Jordan & Gilbert (restoration).



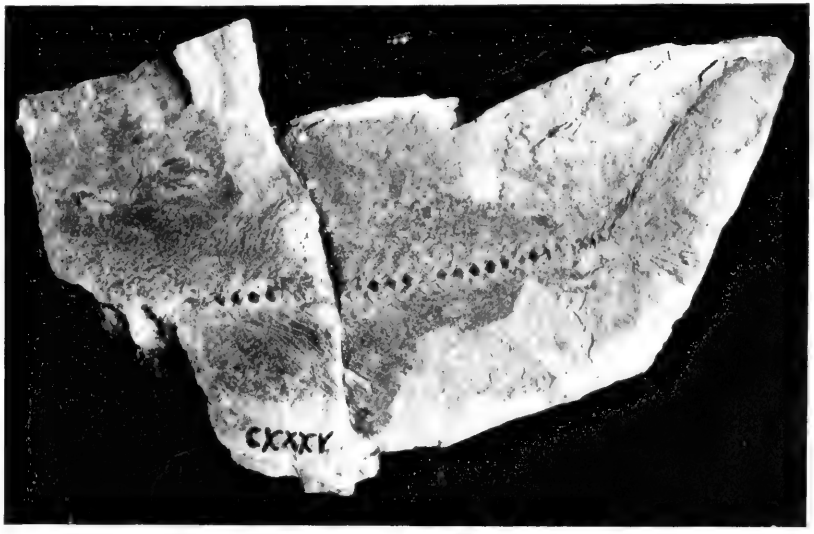


PLATE XVII.

Figure 1. Quesita quisquilia Jordan & Gilbert; type XVII (El Modena).
Figure 2. Thyrsites kriegeri Jordan & Gilbert; type XXXIII (Lompoc).
Figure 3. Alisea grandis Jordan & Gilbert; type CXXXV (San Pedro).

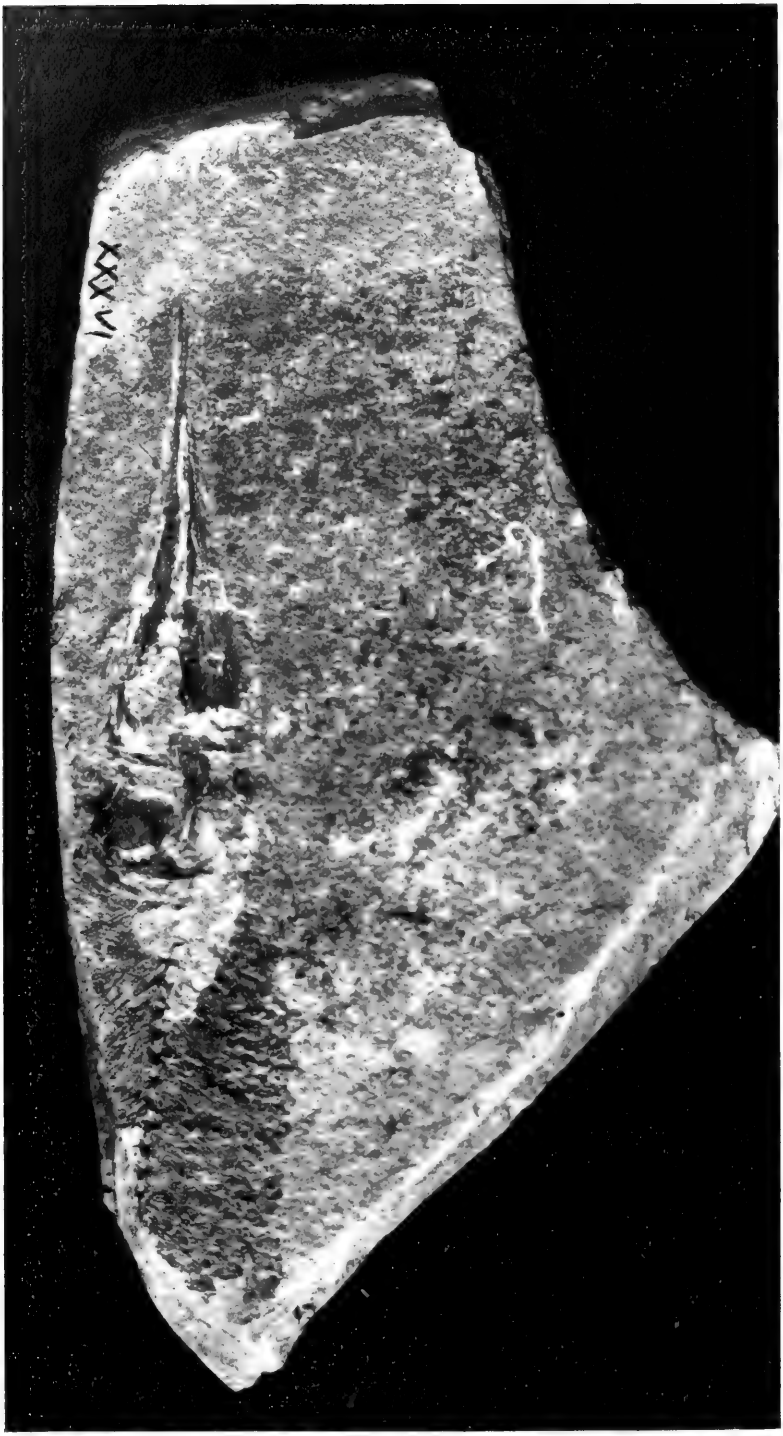


PLATE XVIII

SCOMBEREsox EDWARDSI Jordan & Gilbert; type XXXVI (Elysian Hills).

PLATE XIX.

LOPHAR MIOCÆNUS Jordan & Gilbert; type XLVIII (Chavez Ravine).

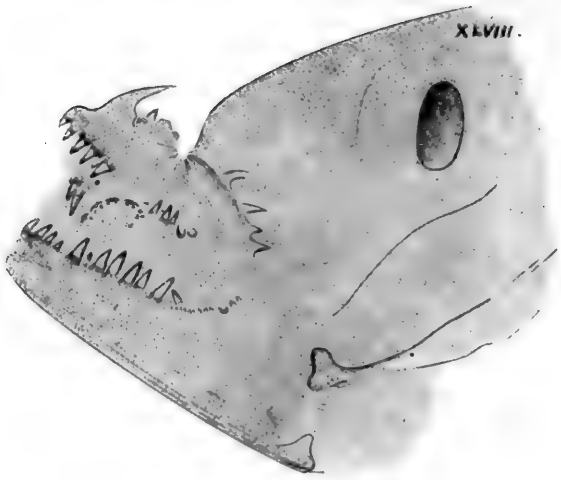


PLATE XX.

LOPHAR MIOCÆNUS Jordan & Gilbert (dentition of XLVIII).

PLATE XXI.

OZYMANDIAS GILBERTI Jordan; type CXXXII (San Pedro).

PLATE XXII.

ECTASIS PRORIGER Jordan & Gilbert; type CXXV (Los Angeles).

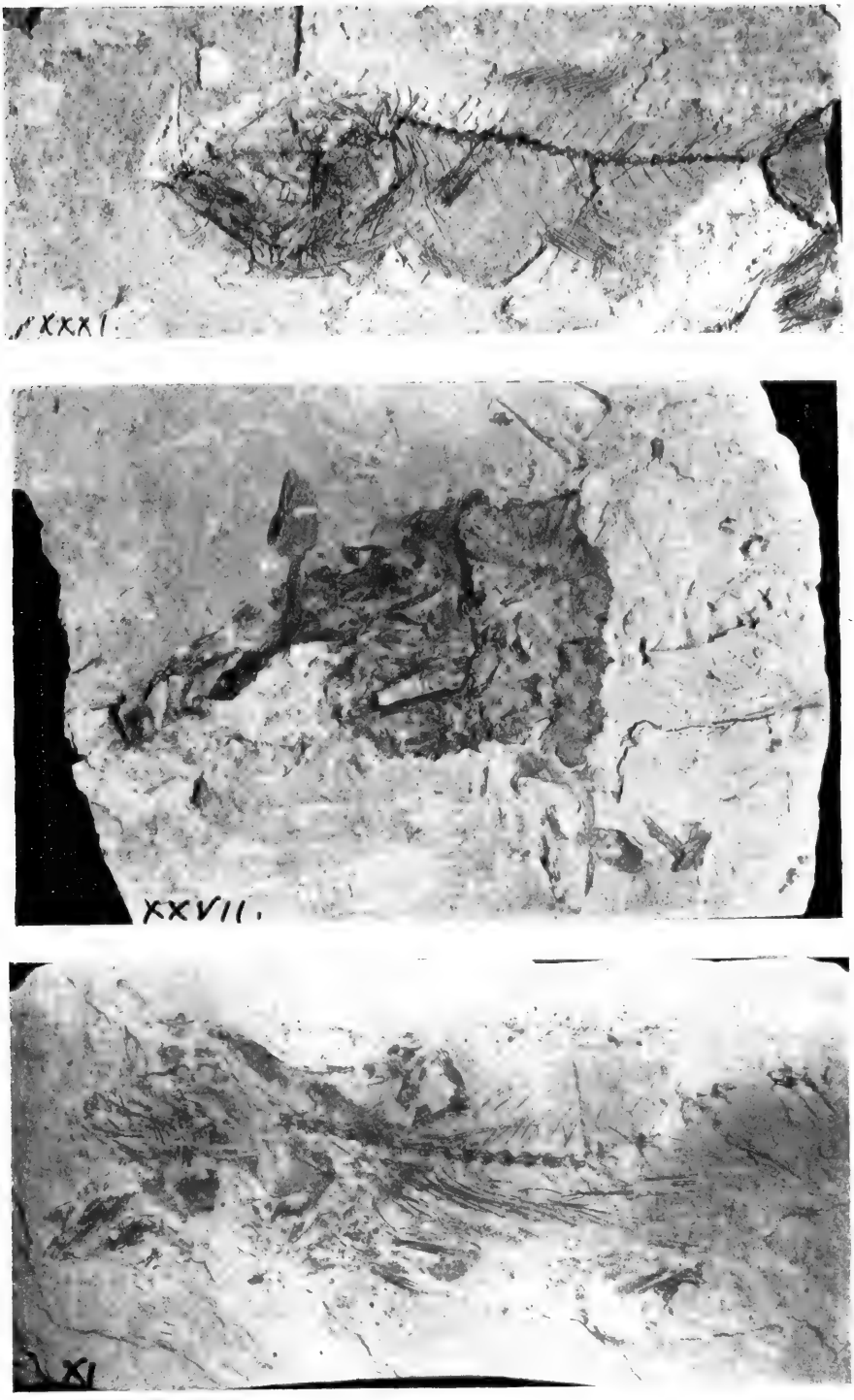


PLATE XXIII.

Figure 1. ERITIMA EVIDES Jordan & Gilbert; type XXXI (Bairdstown).
Figure 2. HAYIA DAULICA Jordan and Gilbert; type XXVII (Los Angeles).
Figure 3. Undetermined; XI (Lompoc).

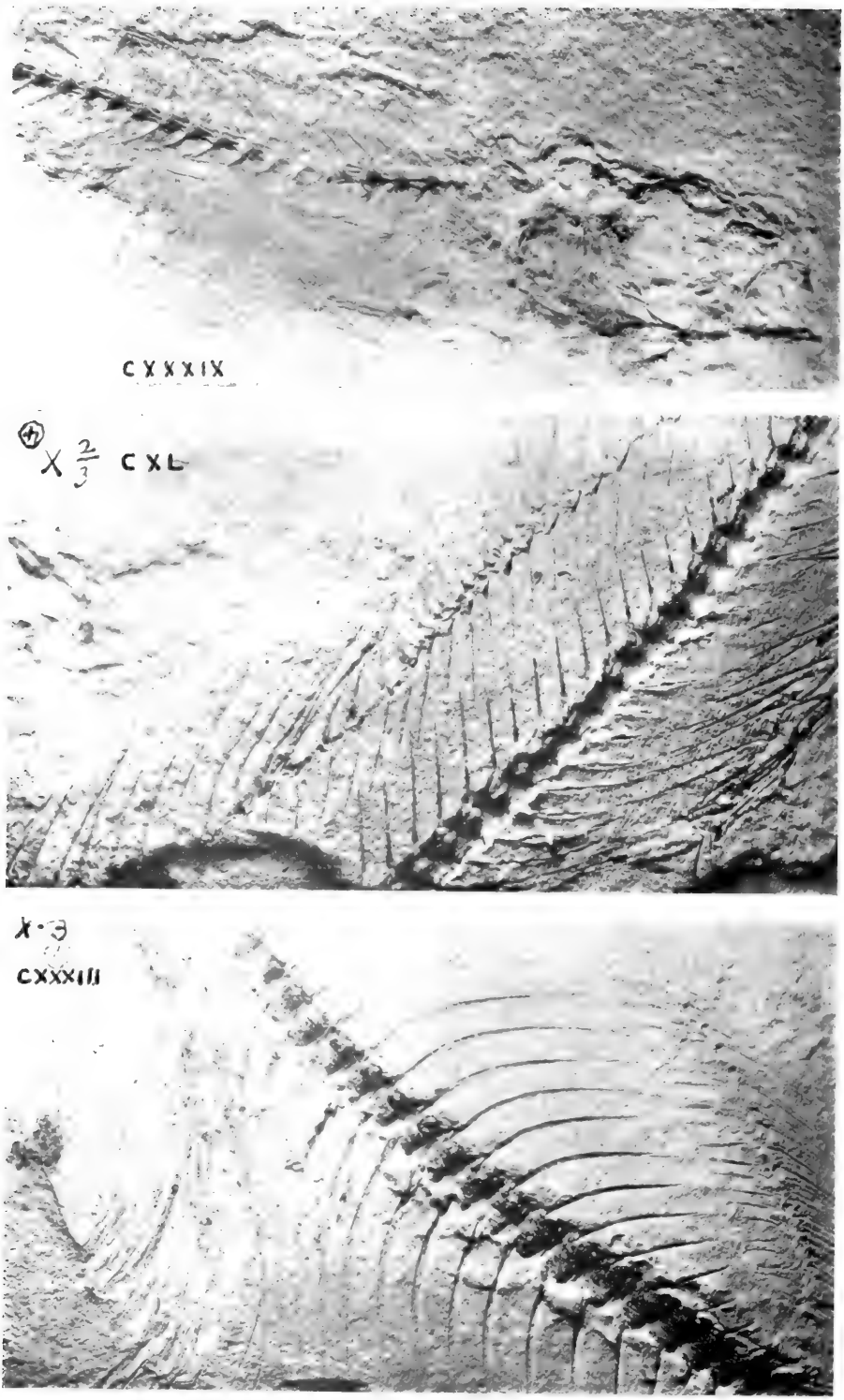


PLATE XXIV.

Figure 1. LOMPOQUIA RETROPES Jordan & Gilbert; type CXXXIX (Lompoc).
Figure 2. HEXAGRAMMOS ACHRESTUS Jordan & Gilbert; type CXL (Lompoc).
Figure 3. DIATOMŒCA ZATIMA Jordan & Gilbert; type CXXXIII (Lompoc).

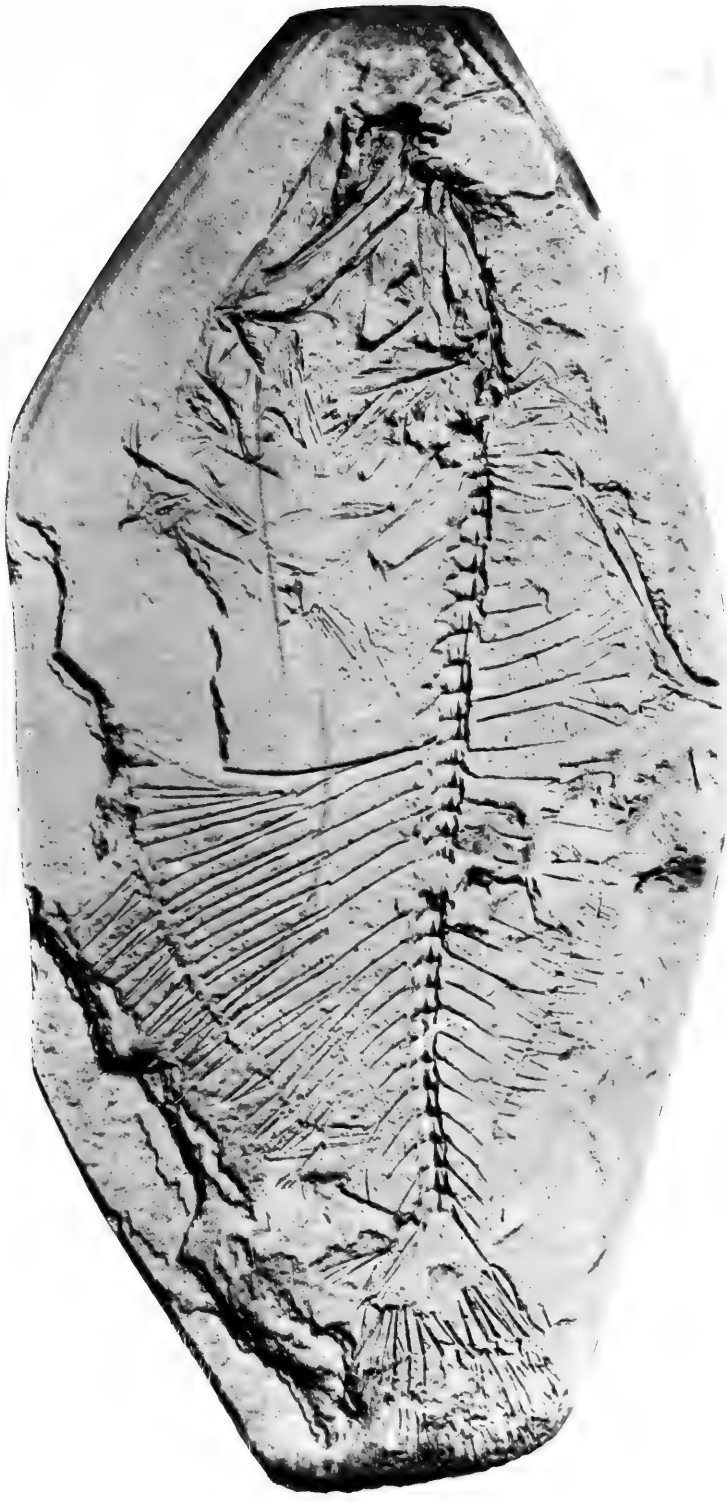


PLATE XXV.

EVESTHES JORDANI Gilbert; type (Lompoc).

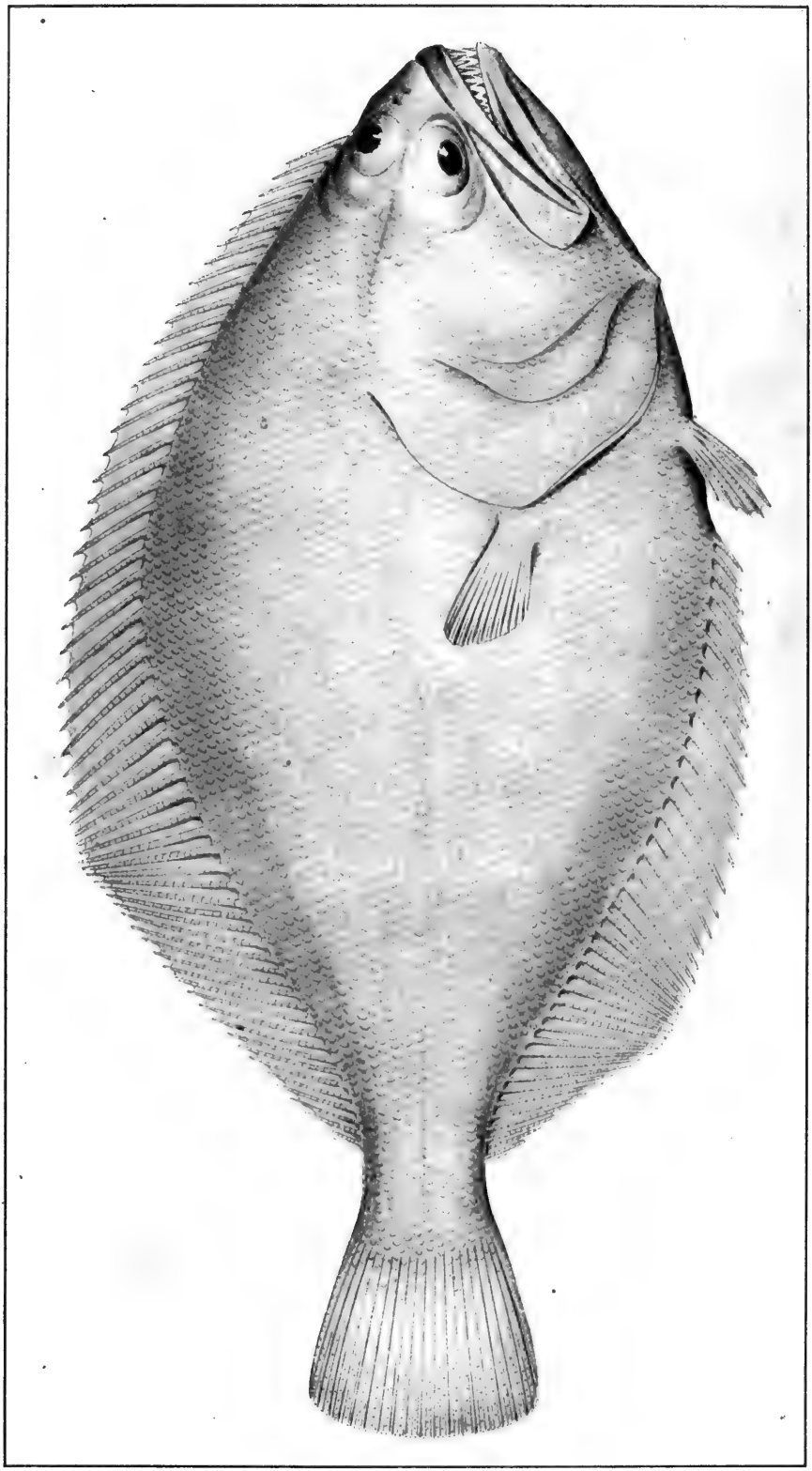
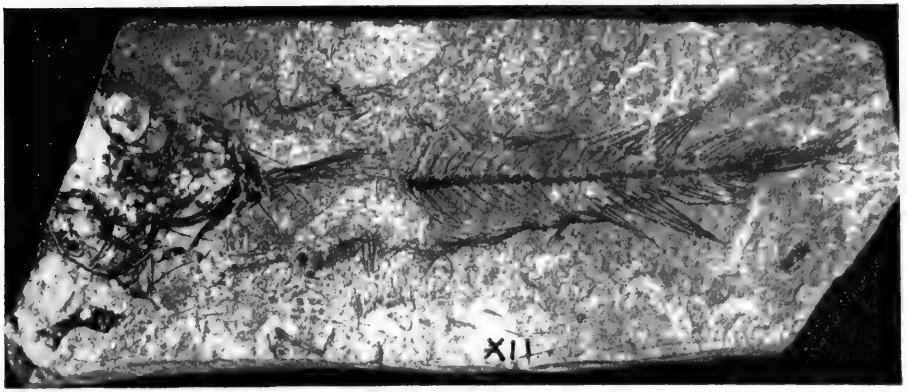


PLATE XXVI.

EVESTHES JORDANI Gilbert (restoration).



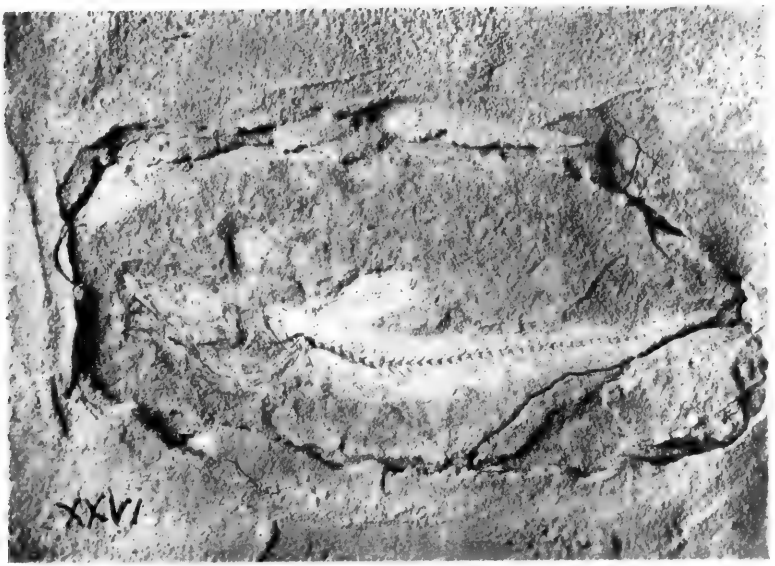


PLATE XXVII.

Figure 1. MERRIAMINA ECTENES Jordan & Gilbert; type XIII (El Modena).
Figure 2. ARNOLDINA INJUSTIA Jordan & Gilbert; type XXVI (Sunset Bluff).
Figure 3. MERRIAMINA ECTENES Jordan & Gilbert; XIV (El Modena).

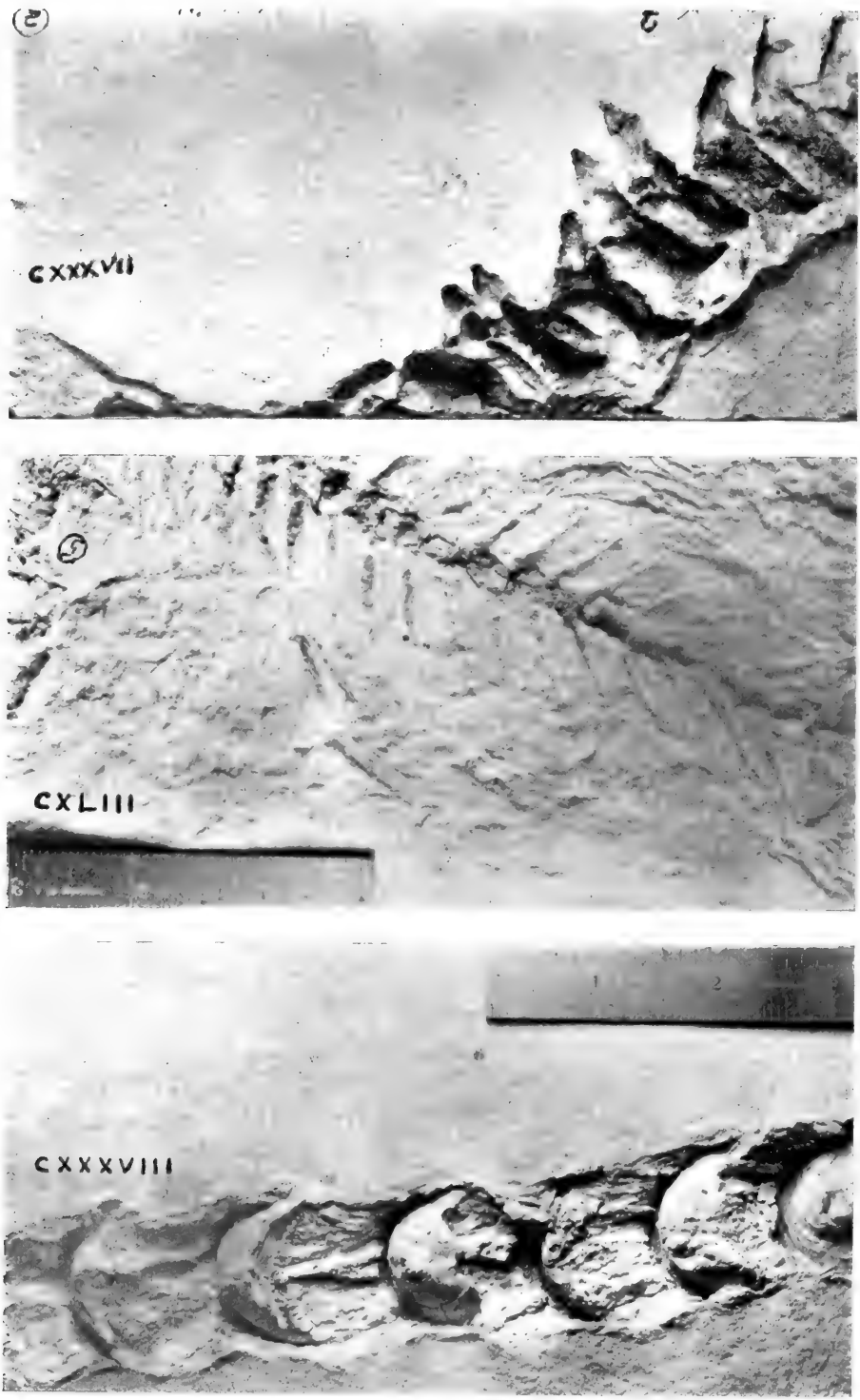


PLATE XXVIII.

Figures 1 and 3. PHOCÆNA OCCIDUA (Leidy); CXXXVII and CXXXVIII (Lompoc).
Figure 2. EMMACHÆRE RHACHITES Jordan & Gilbert; type CXLII (Lompoc).

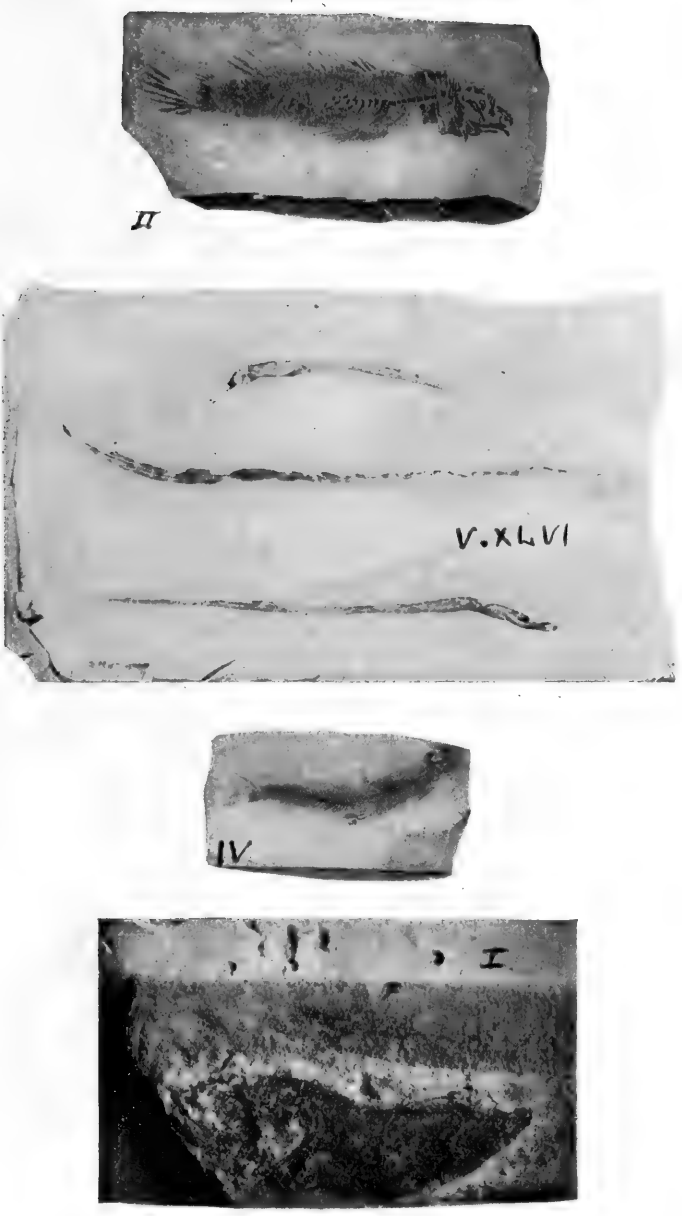
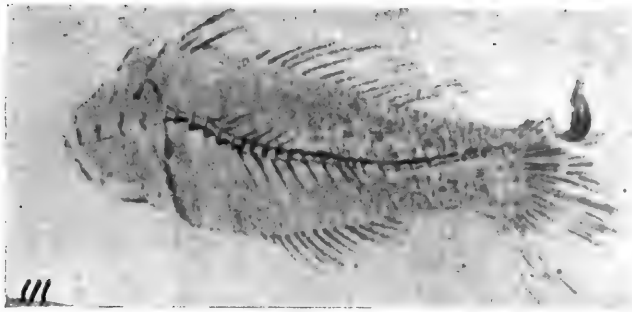


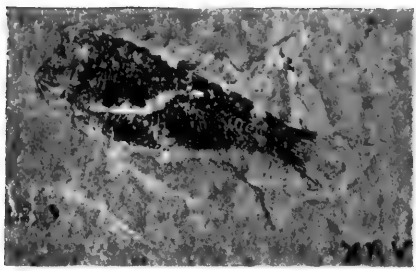
PLATE XXIX.

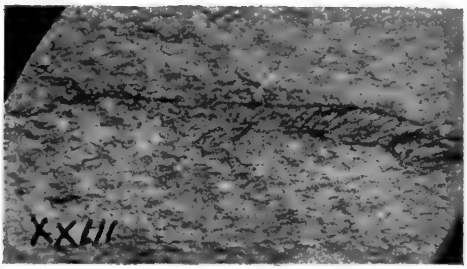
Figure 1. Aboma antiqua Jordan & Gilbert; type II (Bairdstown).
Figure 2. Syngnathus avus Jordan & Gilbert; type XLVI (Bairdstown).
Figure 3. Smithites elegans Jordan & Gilbert; type IV (Bairdstown).
Figure 4. Zanteclites hubbsi Jordan & Gilbert; I (Shorb).

PLATE XXX.

EOSCORPIUS PRIMÆVUS Jordan & Gilbert: type XXXIX (Bairdstown).







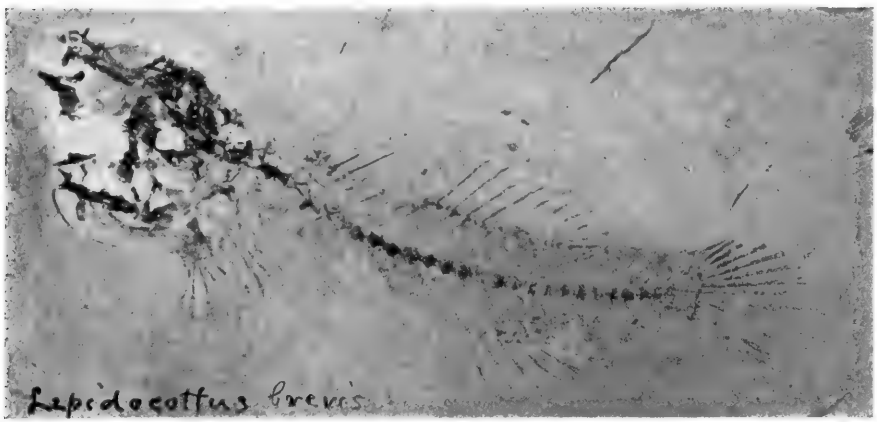


PLATE XXXI.

Figure 1. Sebastavus vertebralis Jordan & Gilbert; type III (El Modena).
Figure 2. Xyrinius houshi Jordan & Gilbert; type XXV (Los Angeles).
Figure 3. Rogenio vanclevei Jordan & Gilbert; XXIII (Los Angeles).
Figure 4. Lepidocottus brevis (Agassiz) Œningen.
Figure 5. Rhomarchus ensiger Jordan & Gilbert; type XLIX (El Modena).

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