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LATE EOCENE SELACHIANS FROM SOUTH-CENTRAL GEORGIA

BY

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With 9 plates, 9 text-figures and 3 tables in text

Zusammenfassung

Funde von Haifischen, die aus drei Abschnitten des Eozän (Jackson) aus zwei Counties von South-Central Georgia geborgen wurden, erlauben es uns, eine große Faunenliste aufzustellen, die sechs neue Arten enthält.

Die Fauna umfaßt die folgenden neuen Taxa: *Heterodontus pineti* nov. sp., *Lamna twiggsensis* nov. sp., *Galeorhinus huberensis* nov. sp., *Dasyatis borodini* nov. sp., *Dasyatis charlisae* nov. sp. und *Pristis pickeringi* nov. sp.

Im übrigen enthält die Fauna die folgenden bekannten Arten: *Procarcharodon auriculatus* (Blainville); *Isurus oxyrhinchus* Rafinesque; *Odontaspis acutissima* Agassiz; *Odontaspis cuspidata* Agassiz; *Ginglymostoma obliquum* (Leidy); *Scyliorhinus distans* (Probst); *Scyliorhinus enniskilleni* White; *Hemipristis wyattdurhami* White; *Galeocerdo clarkensis* White; Negaprion eurybathrodon (Blake); *Scoliodon terraenovae* (Richardson); *Rhizoprinonodon* sp., *Galeorhinus galeus* (Linnaeus); *Sphyrna zygaena* (Linnaeus); *Squatina prima* (Winkler); *Rhinobatos* cf. *casieri* Hermann; *Pristis Lathami* Galeotti; *Propristis schweinfurthi* Dames; *Rhinoptera daviesi* Woodward; *Aetobatis* sp. und *Myliobatis* sp.

Die Zusammensetzung der Fauna bildet einen Übergang zu der des Neogens, wo die meisten der bekannten Arten im unteren Miozän (Aquitanium-Burdigalium) von Nordamerika und Europa vorkommen.

Schlüsselwörter: Selachier — Eozän — U.S.A. — Georgia.

Abstract

Shark material collected in three formational members of Late Ecocene (Jackson) age, in two counties in South-Central Georgia, enables us to list a large fauna which contains six new species in the Eocene of North America.

The fauna is comprised of the following new taxa: *Heterodontus pineti* nov.sp., *Lamna twiggsensis* nov.sp., *Galeorhinus huberensis* nov. sp., *Dasyatis borodini* nov. sp., *Dasyatis charlisae* nov. sp., and *Pristis pickeringi* nov. sp.

The remainder of the fauna is composed of these previously described types: *Procarcharodon auriculatus* (Blainville); *Isurus oxyrhinchus* Rafinesque; *Odontaspis acutissima* Agassiz; *Odontaspis cuspidata* Agassiz; *Ginglymostoma obliquum* (Leidy); *Scyliorhinus distans* (Probst); *Scyliorhinus enniskilleni* White; *Hemipristis wyattdurhami* White; *Galeocerdo clarkensis* White; *Negaprion eurybathrodon* (Blake); *Scoliodon terraenovae* (Richardson); *Rhizoprinondon* sp.; *Galeorhinus galeus* (Linnaeus); *Sphyrna zygaena* (Linnaeus; *Squatina prima* (Winkler); *Rhinobatos* cf. *casieri* Herman; *Pristis lathami* Galeotti; *Propristis schweinfurthi* Dames; *Rhinoptera daviesi* Woodward; *Aetobatis* sp.; and *Myliobatis* sp.

The faunal assemblage is transititional to the Neogene, where most of the above previously described species are found in the Lower Miocene (Aquitanian-Burdigalian) of North America and Europe.

Key words: Selachians — Eocene — U.S.A. — Georgia.

Contents

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1. Introduction

A large variety of selachian remains have been recovered from three formational members of the Late Eocene provincial stage: Jacksonian, in south-central Georgia.

The outcroppings of this present study are situated in the counties of Twiggs and Houston, in the State of Georgia (text-fig. 1 A).

The majority of the specimens (mostly the teeth of sharks) are found in Twiggs County in the open-pit mining operations located southeast of Macon, near the small town of Huber, and alongside of the Interstate Highway 16. The other locality of this present study is situated directly south of Macon near the town of Clinchfield in Houston County. This latter site is a mining or quarrying operation as well.

All three formational members of the Jackson group must be considered in this report, as the species are all transitional to the Neogene, while many of the species in this report are also ancestral to certain Early Miocene species fond in recent outcroppings to the northeast, in Craven County, North Carolina (CASE, 1980)

2. Geology

The provincial stage "Jacksonian" of the Upper Eocene consists of clastics and waterworn limestones, marine in origin, and in the State of Georgia, has an outcropping belt running northeast by southwest, from Augusta (on the South Carolina border) down through Macon (including the Twiggs and Houston county sites of this study), and towards the southwestern corner of the State, continuing on into the southeastern corner of Alabama and the northcentral portion of the Florida panhandle (CARVER 1974; GLAWE 1974; PICKERING 1970; and HUDDLESTUN et al 1974).

The uppermost part of the Jackson group is the Clinchfield Sand (formerly referred to as the "Gosport Sand") (HUDDLESTUN et al 1974). Outcroppings of which can be found at both the Penn-Dixie and Medusa Cement Company quarries near Clinchfield, Georgia, as well as at several road-cut outcroppings between Perry and Clinchfield in Houston County.

The Clinchfield Sand overlies the Ocala Limestone (formerly referred to as the "Tivola Limestone") (HUDDLESTUN et al 1974).

Outcroppings for the Ocala Limestone are found in a small tongue southwest through Houston County, beneath the predominant Clinchfield Sands, but, by far are deeper in their outcroppings to the northeast (from a band running northeast towards Augusta-with the Ocala Limestone overlying the Twiggs Clay at Huber on up to Sandersville, and with occassional outcroppings in or near the Fort Gordon Military Reservation area just southwest of Augusta).

Outcroppings for the Ocala Limestone are quite common in the north to north-central portions of Florida, especially near the town of Ocala, from which the Limestone member derives its name.

The Ocala Limestone in turn overlies the Twiggs Clay member of the Barnwell Formation (HUDDLESTUN et al 1974; and PICKERING 1970).

The Twiggs Clay member of the Barnwell Formation is best observed in outcropping at the clay pits of Twiggs County, Georgia, especially at "pit No. 22', a large pit from which the Huber Kaolin Products Company recovers the earth clay mineral: Kaolinite. A commercially valuable product. Kaolin, when refined, has many diversified commercial "by-products", such as; cosmetics, toothpaste, paints, and the coating on glossy-stock magazine paper, among others (CASE 1975).

The topographic map data on the localities of this report

Penn-Dixie Portland Cement Company, Clinchfield, Houston County, Georgia: Quarry (strip mines) is situated in the lower right-hand sector of the Perry East Quadrangle (7,5 min. ser.). The range (longitude) is approximately: 83°25'30" and the township (latitude) is approximately: 32°25'30".

Huber Kaolin Products Company, Huber, Twiggs County, Georgia: Quarry (strip mines) is situated in the upper right-hand sector of the Warner Robins N. E. Quadrangle (7.5 min. ser.). The range (longitude) is approximately: 83°30'0" and the township (latitude) is approximately: 32°44'30":

2a. Paleontology

The fossils recovered from the Clinchfield sands and the Ocala Limestones (as represented by shark's teeth and other fish remains) are not as abundant as those from the Twiggs Clay member of the Barnwell Formation, where fish remains are recovered from the "spoil-piles" and "fish-beds" (or "bone" layers) in the quarry walls at pit 22 and several of the surrounding pits. (text-fig. 1 B).

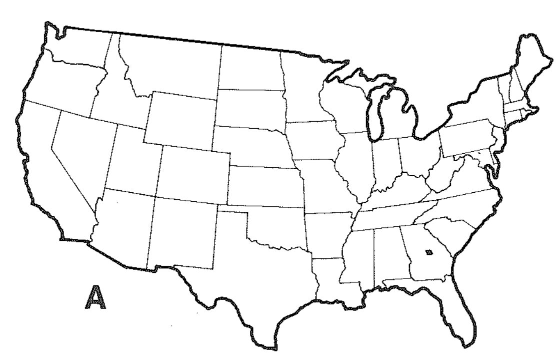
The fauna of this report represents 27 species, 6 of which are newly described species: *Heterodontus pineti; Lamna twiggsensis; Galeorhinus huberensis: Dasyatis borodini; D. charlisae;* and *Pristis pickeringi.*

The remainder of the faunal assemblage has been previously described by other authors.

Heterodontus pineti n. sp. is the first reported "Bull-head" or "Port Jackson" shark in the Eocene, and the second reported from the Atlantic Coastal Plain of the United States (CASE 1980).

Along with the new species of *Heterodontus,* the two new species of the "Clear-nose skate": *Dasyatis borodini* and *D. charlisae* are the earliest representatives of *Dasyatis* in North America.

The distinctive new species: *Galeorhinus huberensis* is the first representative of a rather large species of "Liver-oil" or "Tope" shark and this species was short-lived, having only existed in the Upper Eocene — Twiggs Clay.



Text-fig. 1. A. Map of the United States showing Twiggs County, Georgia, B. View of the east wall in Pit 22 showing the Twiggs Clay Member of the Barnwell Formation (strata is exposed beneath the uppermost limestone ledge in the wall). The overlying Ocala Limestone has been removed from the top of the wall. Fauna is present in a bedding plane about midway in the wall.

The new species: *Pristis pickeringi* ("sawfish") is unique to the Clinchfield Sands and is not found elsewhere in either the Ocala or the Twiggs Clay. Its enameloid osteodentinous rostral tooth surface is unique among the pristids.

The new species of the Isurid: *Lamna twiggsensis* is unique to the Twiggs Clay member of the Barnwell Formation. It is quite distinctive and has no relationship to either: *Odontaspis vincenti* (WOODWARD) ARAMBOURG or to *Lamna lerichei* CASIER.

3. Systematics

CLASS CHONDRICHTHYES

SUBCLASS ELASMOBRANCHII

Order Selachii

Suborder Heterodontoidei

Family Heterodontidae REGAN, 1914

Heterodontus BLAINVILLE, 1816

Heterodontus pineti nov. sp.

Plate 1, figs. 1 a—d and 2 a—e and text-fig. 2

Material: Two specimens: 1 anterior tooth of a juvenile individual, and 1 median-lateral tooth of an adult.

Derivatio nominis: Named in honor of Dr. PAUL R. PINET, Department of Geology, the University of Georgia, Athens, Georgia.

Holotype: (UNSM 23501) Plate 1, figs. 2 a—e.

Paratype: (UNSM 23500) Plate 1, figs. 1 a—d.

Locality: Pit 22, Huber Kaolin Products mine, Huber, Twiggs County, Georgia.

Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Diagnosis— Anterior tooth: of a juvenile, crown height approximately 1.5 mm, and width of the tooth across the three cusps approximately 1.5 mm, a partially fragmented tooth, missing portions of the root base, enameloid tooth surface is complete, although it is smooth-devoid of any plication or rugosity.

Median-lateral tooth: of an adult, approximately 5 mm in its longest width, and approximately 2 mm in its greatest height (from the base of the root to the tip of the crown apex), and in its occlusal aspect, the median-lateral tooth of *Heterodontus pineti* n. sp., shows an overall "conchoidal" ornamentation on its enameloid surface (pl. 1, fig. 2 d), root base slightly less than the length of the crown, and noticeable foramina and fenestration present.

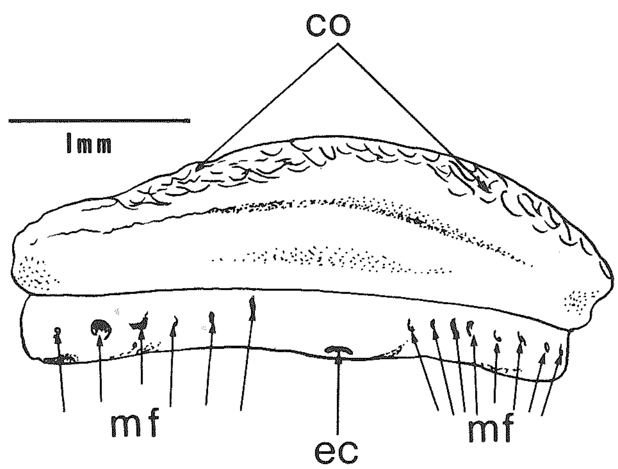
Description: The tooth has two cusplets, one on either side of the central cusp. They are not very distinctive, and they take up slightly more than 1/2 of the height of the tooth crown (pl. 1, fig. 1 a). No ornamentation is present on the crown enameloid. There is a rather worn carina on the lingual-occlusal surface of the tooth, traversing the apex of the three cusps (pl. 1, fig. 1 c). A fragment of the anterior portion of the root can best be seen on the profile view (Pl. 1, fig. 1 b). The remainder of the root (a circular portion, with root lobe extensions) has been lost on the specimen.

The median-lateral teeth fit together with buttresses of adjoining teeth to form an overall "crusher-plate". The present specimen is "low-crowned", and worn at the apex with usage. The surface enameloid of the tooth crown is fully ornamented with dozens of small "conchoidal" depressions, probably functional, by assisting in the crushing of shell-fish (a "gripping" surface). No forward (anteriorly directed) crest on the specimen, possibly indicating a centrally located tooth within the pavement "file". A distinct apical foramen (or "internal protuberance" of CASIER (1947 b)) (pl. 1, fig. 2 e), on the upper medial portion of the root base. Multiple fenestration (cf. text-fig. 2) on the lingual portion of the root apron, with an exiting canali for the apical foramen.

Discussion: *Heterodontus pineti* n. sp. represents the earliest example of a "Bull-head" shark (or Port Jackson shark) from the fossil record of the Eastern seaboard. Although this author has published (CASE 1980), another new species of *Heterodontus* from the Early Miocene (Aquitanian) of North Carolina.

Bull-head sharks are known in the Middle Miocene Temblor Formation of Shark Tooth Hill, Kern County, California (MITCHELL 1965).

Port Jackson and Bull-head sharks are still present, although not in great numbers, along the west coast of the United States from Southern California down to Baja California. They are far more abundant in Australian and New Zealand waters, a bit scarcer in the China Seas (Sea of Japan) and in the Indian Ocean (CASE 1980).



Text-fig. 2. Median-lateral tooth (UNSM 23501—TYPE) of *Heterodontus pineti* n. sp. Lingual view showing: co = conchoidal ornamentation, mf = multiple fenestration, and ec = exiting canali (for the apical foramen).

Order Galeiformes

Suborder Isuroidei

Family Isuridae

Procarcharodon CASIER, 1960

Procarcharodon auriculatus (BLAINVILLE)

Plate 1, figs. 3a—b and 4a—b and Plate 2, figs. 1a—b and 2a—b

1818 *Squalus auriculatus* de BLAINVILLE, p. 384.
1843 *Carcharodon angustidens* AGASSIZ, p. 255, pl. 28, figs. 20—25 & pl. 30, fig. 3.
1843 *Carcharodon auriculatus* AGASSIZ, ibid; p. 254, pl. 28, figs. 17—19.
1843 *Carcharodon turgidus* AGASSIZ, ibid; p. 256, pl. 30a, fig. 9.
1875 *Carcharodon auriculatus* — MCCOY, p. 8, pl. 11, figs. 2—3.
1888 *Carcharodon angustidens* — DAVIS, pl. 1., figs. 4—6.
1888 *Carcharodon robustus* DAVIS — ibid; pl. 1., fig. 7.
1889 *Carcharodon auriculatus* — WOODWARD, pt. 1., p. 411.
1895 *Carcharodon sokolowi* — JAEKEL, p. 25, pl. 1, figs. 1—5.
1895 *Carcharodon turgidus* AGASSIZ — ibid; p. 27, pl. 2, figs. 1—7.
1897 *Carcharodon auriculatus* — PRIEM, p. 216, pl. 7, fig. 7.
1900 *Carcharodon auriculatus* — SEGUENZA, p. 501, pl. 5, figs. 14—18.
1901 *Carcharodon auriculatus* — STORMS, p. 261, pl. 7, figs. 1—11.
1904 *Carcharodon auriculatus* — CHAPMAN & PRITCHARD, pt. 1, p. 283.
1906 *Carcharodon auriculatus* — LERICHE, p. 220.
1906 *Carcharodon angustidens* — PRIEM, p. 199, pl. 8, figs. 14—15.
1910 *Carcharodon angustidens* — LERICHE, p. 291, pls. 17 & 18 (all figures).
1910 *Carcharodon angustidens* — LERICHE, p. 330.
1914 *Carcharodon auriculatus* — CHAPMAN, p. 268, 269, 271, fig. 130E.
1914 *Carcharodon robustus* DAVIS — ibid; p. 269.
1918 *Carcharodon auriculatus* — CHAPMAN, p. 18—19, pl. 1, figs. 4—7.
1923 *Carcharodon auriculatus* — JORDAN & HANNIBAL, p. 56, pl. 3, fig. DD.
1943 *Carcharodon* aff. *angustidens* var. *turgidus* — WEILER, p. 79, fig. 11.
1950 *Carcharodon auriculatus* — CASIER, p. 18, pl. 2, fig. 7.
1959 *Carcharodon angustidens* — AVNIMELECH, p. 36, (name only).

1960 *Carcharodon auriculatus* — CASIER, p. 13.
1967 *Carcharodon auriculatus* — PLEDGE, p. 154, pl. 4, fig. 11.
1967 *Carcharodon angustidens* — CASE, p. 17, fig. 91.
1971 *Carcharodon auriculatus* — KEYES, p. 6. pl. 1, fig. 2.
1972 *Carcharodon auriculatus* — KEYES, p. 237, (name only).
1973 *Carcharodon auriculatus* — MEIJER, p. 35, fig. 10a—e.
1973 *Carcharodon angustidens* — CASE, p. 36—37, figs. 138—139.
1976 *Carcharodon auriculatus* — WELTON, p. 149, pl. 5, fig. 4a—c.

Material: 1 upper lateral tooth; 1 upper postero-lateral tooth; 1 upper posterior (anomalie) tooth; and 1 lower jaw anterolateral tooth.

Specimens: (UNSM 23579, 23580, 23581 and 23582)

Localities: Pit 22 (Ocala 1/s), Huber Kaolin Products mine, Huber, Twiggs County, Georgia. Penn-Dixie Portland Cement Company quarry (Clinchfield Sand), Clinchfield, Houston County, Georgia.

Age: Jacksonian, Ocala Limestone and Clinchfield Sand.

Description: Teeth of medium size dimensions (not as large as those found in the Early Miocene-Aquitanian, of North Carolina) ranging from 4 to 8 cms. The teeth of the upper jaw averaging 1 to 3 cms for posteriors, and from 4 to 6.5 cms for laterals and anteriors. The teeth of the lower jaw average 1.5 for the posteriors, and from 5 to 8 cms for laterals and anteriors.

Teeth of entire jaw show the presence of lateral cusps. The cusps are slightly less than 1/5th of the entire tooth enameloid height. The cusps are serrated as well as the central blade. The serrations are slightly course, not as fine as on the teeth of *Procarcharodon megalodon* (CHARLESWORTH), but not as course as those of *P. sulcidens* (MÜLLER & HENLE) (*Carcharodon* cf. *carcharias*).

Discussion: The teeth of *Procarcharodon auriculatus* find their origin in the Eocene (possibly evolving from a Creto-lamnoid stock, i.e.; "*Cretolamna-Otodus*"). The presently described species: *P. auriculatus* is the earliest reported representative of the "Giant white shark" in North America. This particular species ranges up into the Middle Miocene (Helvetian) and becomes extinct shortly thereafter, along with *P. megalodon*, and they are both replaced in the Upper Miocene (Sahelian) by the modern species: *P. sulcidens (Carcharodon* cf. *carcharias).*

Genus Isurus RAFINESQUE, 1810

Isurus oxyrhinchus RAFINESQUE

Plate 2, figs. 3a—b, 4a—b and 5a—b

1810 *Isurus oxyrhinchus* RAFINESQUE, p. 12, pl. 13, fig. 1.
1810 *Isurus spallanzanii* RAFINESQUE, p. 45 & 60.
1829 *Lamia oxyrhinchus* — BORY de St. VINCENT, p. 596.
1830 *Squalus cepedii* — VOY, p. 93.
1838 *Lamna oxyrhina* L. AGASSIZ, p. 86, pl. A.
1839 *Isurus oxyrhinchus* — SWAINSON, p. 313.
1839 *Oxyrhina spallanzanii* — BONAPARTE, pl. 136, fig. 1.
1839 *Oxyrhina glauca* — BONAPARTE, p. 9.
1841 *Oxyrhina gomphodon* MÜLLER & HENLE, p. 68, 191, pl. 28.
1842 *Lamna punctata* DEKAY, p. 352, pl. 63, fig. 206.
1843 *Lamna cornubicus* CUVIER, pl. 114, fig. 3.
1846 *Oxyrhina spallanzanii* — BONAPARTE, p. 17.
1853 *Lamna latro* OWEN, p. 496.
1862 *Isuropsis dekayi* GILL, p. 409.
1865 *Carcharias tigris* ATWOOD, p. 81.
1870 *Lamna spallanzanii* — GÜNTHER, p. 380.
1870 *Lamna glauca* — CÜNTHER, p. 391.
1876 *Lamna punctata* (?) — GOODE, p. 73.
1877 *Isuropsis* sp. — GOODE, p. 293.
1882 *Isurus dekayi* JORDAN & GILBERT, p. 241.
1883 *Isurus glaucus* JORDAN & GILBERT, P. »—.
1895 *Isurus (Isurus) oxyrhinchus* — JORDAN & EVERMANN, p. 218.
1895 *Isurus (Isuropsis) dekayi* — JORDAN & EVERMANN, p. 218.

1903 *Isurus oxyrhinchus* — SCHREINER & RIBEIRO, p. 79.
1906 *Isurus dekayi* (?) — BEAN, p. 30.
1913 *Isurus tigris* GARMAN, p. 36.
1934 *Lamna oxyrhinchus* — BORRI, p. 92.
1936 *Isurus cepedii* — FOWLER, p. 34.
1936 Mako shark *(Lamna)* — KAPLAN, p. 104.
1937 *Lamna tigris* — NORMAN & FRASER, p. 12.
1942 *Isurus oxyrhinchus* — FOWLER, p. 127.
1945 *Isurus cepedii* — FOWLER, p. 43, figs. 3 & 4.
1948 *Isurus oxyrhinchus* — BIGELOW & SCHROEDER, p. 124—133, p. 125, fig. 18, p. 126, fig. 19.
1950 *Isurus (Oxyrhina) desori* — ZBYSZEWSKI & d'ALMEIDA, p. 329—330, pl. 1, fig. 31—33.
1950 *Isurus (Oxyrhina) hastalis* — ZBYSZEWSKI & d'ALMEIDA, p. 330—334, pl. 2, fig. 40—42, 51—55, & 58.
1950 *Isurus oxyrhinchus* — ZBYSZEWSKI & d'ALMEIDA, p. 335, pl. 1, fig. 34—35.
1954 *Isurus* cf. *desori* — SERRALHEIRO, p. 46—47, pl. 1, fig. 11—12.
1954 *Isurus hastalis* — ROMAO-SERRALHEIRO, p. 47—48.
1954 *Isurus hastalis* var. *escheri* — SERRALHEIRO, p. 48—49. fig. 13 & 13a.
1954 *Isurus oxyrhinchus* — ROMAO-SERRALHEIRO, p. 49—50, pl. 1, fig. 17—18.
1954 *Isurus retroflexus* — ROMAO-SERRALHEIRO, p. 50, pl. 1, fig. 19—20.
1964 *Oxyrhina desori* — JONET, p. 35. *(Isurus desori).*
1964 *Oxyrhina hastalis* — JONET, p. 35—36. *(I. hastalis).*
1964 *Oxyrhina hastalis* var. *lusitanica* — JONET, p. 36—41, pl. 1, fig. 1—6, pl. 2, fig. 1—6.
1964 *Oxyrhina oxyrhynchus (I. oxyrhynchus)* — JONET, p. 42.
1967 *Isurus hastalis* — CASE, p. 16, fig. 81.
1967 *Oxyrhina desori (I. desori)* — CASE, p. 16, fig. 84.
1969/70 *Isurus* cf. *oxyrhinchus* — ANTUNES & JONET, p. 137, pl. 6, fig. 14—21, and pl. 7, fig. 22 & 24.
1970 *Isurus hastalis* — CAPPETTA, p. 18, pl. 5, fig. 1—13.
1972 *Isurus oxyrhinchus hastalis* — CARETTO, p. 28, pl. 6, fig. 1—12.
1972 *Isurus oxyrhinchus* — CARETTO, pl. 5, fig. 1—2.
1972 *Isurus oxyrhinchus hastalis* — CARETTO, pl. 7, fig. 1—7, and fig. 6, p. 37.
1973 *Isurus hastalis* — CASE, p. 38, fig. 150, p. 40 fig. 169.
1973 *Oxyrhina (Isurus) desori* — CASE, p. 38, fig. 151.
1974 *Isurus hastalis* — MENESINI, p. 129, pl. 2, fig. 8.
1974 *Isurus desori* — MENESINI, p. 131, pl. 3, fig. 1—8.
1974 *Isurus retroflexus* — MENESINI, p. 132, pl. 3, fig. 1—6.

Material: 1 upper jaw lateral tooth; 1 lower jaw antero-lateral tooth; and 1 lower jaw anterior tooth.
Specimens: (UNSM 23502, 23503 and 23504).
Locality: Pit 22, Huber Kaolin Products mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Ocala Limestone and Twiggs Clay Member-Barnwell Formation.

Description: Teeth ranging in size from 1.5 to 4 cms and averaging 3 cm. Teeth of both upper and lower jaw similar in design, with the exception that the lower anterior and antero-lateral teeth are slightly more dorso-ventrally curvate and tensile (pl. 2, figs. 3a—b), the lower jaw is "jutted-cut" to grab at food. The upper jaw anterior teeth are sigmoidal and the blade direction (especially in the lateral and posterior teeth) is directed toward the commissure (pl. 2, figs. 5a—b).

Discussion: The Isurid teeth described here in this report are essentially the same as those of the modern species: *Isurus oxyrhinchus* RAFINESQUE. Therefore, this author places the presently described Ocala/Twiggs specimens in favorable comparison with the modern form.

Genus *Lamna* CUVIER 1817

Lamna twiggsensis nov sp.

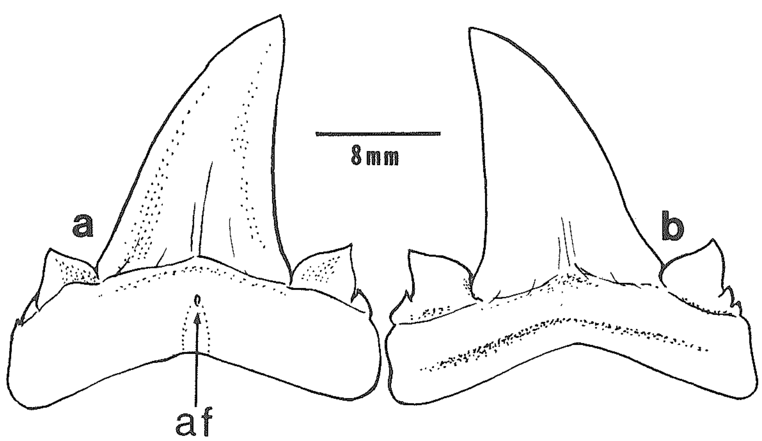
Plate 3, figs. 4a—b, 5a—b, 6a—b, 7a—b and 8a—b and text-fig. 3

Material: 5 specimens: 1 upper jaw lateral tooth; 1 upper jaw postero-lateral tooth; 1 lower jaw anterior tooth; 1 lower jaw antero-lateral tooth; and 1 lower jaw lateral tooth.
Derivatio nominis: Species named after the county of Twiggs.
Specimens: (UNSM 23506, 23507, 23508, 23509 and 23510).
Holotype: (UNSM 23506) Plate 3, figs. 4a—b and text-fig. 3.

P a r a t y p e s : (UNSM 23507, 23508, 23509 and 23510) Plate 3, figs. 5a—b, 6a—b, 7a—b and 8a—b.
L o c a l i t y : Pit 22, Huber Kaolin Products mine, Huber, Twiggs County, Georgia.
A g e : Jacksonian, Twiggs Clay Member-Barnwell Formation.

D i a g n o s i s : Teeth ranging in size from 1.5 to 3 cms, and averaging 2.5 cms, a vestigial median furrow (groove) on the root area, teeth with from 1 to 2 lateral cusps on either side.

D e s c r i p t i o n : Lower jaw teeth erect. Anterior teeth with slender cuspidate lateral cusps. Lateral teeth wider, with from 1 to 2 lateral cusps, triangular in shape, and the larger of the cusps — flaring out in opposite directions from the tooth blade. No medial furrow (groove), but an imperfectly developed "furrow" on some specimens (pl. 3, fig. 7a and text-fig. 3a), with a definitive apical foramen positioned on the lingual boss of the tooth's root.



Text-fig. 3. a. Lingual view. — b. Labial view (UNSM 23506—TYPE) of an upper lateral tooth of *Lamna twiggensensis* n. sp. af = apical foramen.

D i s c u s s i o n : The teeth of *Lamna twiggsensis* n. sp. are quite distinctive and at the present time, appear to be restricted to the Twiggs Clay member of the Barnwell Formation.

In appearance, the closest species to *Lamna twiggsensis* n. sp., is *Lamna lerichei* CASIER (CASIER 1946). *Lamna lerichei* was formerly known as: *Lamna vincenti* (WINKLER) WOODWARD (WOODWARD 1899), afterwards, ARAMBOURG (1952) changed the generic name to *Odontaspis vincenti* (WOODWARD).

The basic difference between *Lamna twiggsensis* n. sp. and *Lamna lerichei* CASIER, is that the former is a lamnid shark and the latter is an odontaspid shark. The lack of a definitive median furrow (groove) on the lingual root face, assures us that *Lamna twiggsensis* n. sp. is indeed a lamnid. The presence of a definite median furrow (groove) on the root boss of *Lamna lerichei* indicates it to be an odontaspid. Any similarities between these two species are purely superficial.

Family Odontaspidae

Odontaspis acutissima AGASSIZ

Plate 2, figs. 6a—b, 7a—b and 8a—b and Plate 3, figs. 1a—b and 2a—c

1910 *Odontaspis acutissima* — LERICHE, pl. 14, fig. 1—27.
1911 *Odontaspis* aff. *contortidens* — PRIEM, pl. 3, fig. 1—6.
1912 *Odontaspis contortidens* — JOLEAUD, pl. 4, fig. 16—21 and pl. 5, fig. 14.
1912 *Chiloscyllium fossile* — JOLEAUD, pl. 8, fig. 21—23.
1912 *Odontaspis cuspidata* — PRIEM, pl. 6, fig. 10—16.
1912 *Odontaspis contortidens* — PRIEM, pl. 6, fig. 18—25.
1912 *Scyllium* sp. — PRIEM, p. 226, fig. 7.
1926 *Odontaspis acutissima* mut. *vorax* — LERICHE, pl. 28, fig. 31—49.
1927 *Odontaspis acutissima* — LERICHE, pl. 1, fig. 2 and pl. 8, fig. 1—6.
1927 *Carcharias taurus* — ARAMBOURG, pl. 45, fig. 18—19.
1942 *Odontaspis acutissima* — LERICHE, pl. 4, fig. 16—17.
1943 *Odontaspis acutissima* — DARTEVILLE & CASIER, pl. 5, fig. 33—36.

1949 *Odontaspis acutissima* — BAUZA-RULLAN, pl. 15, fig. 3—4.
1949 *Odontaspis acutissima* — BAUZA-RULLAN, pl. 31, fig. 1—5.
1950 *Carcharias taurus* — ZBYSZEWSKI & d'ALMEIDA, pl. 1, fig. 12—30.
1957 *Odontaspis acutissima* — LERICHE, pl. 1, fig. 7—12.
1959 *Odontaspis acutissima* — DARTEVILLE & CASIER, pl. 25, fig. 2—4 and ?9.
1967 *Carcharias contortidens* — PLEDGE, pl. 3, fig. 11.
1967 *Carcharias* cf. *cuspidatus* — PLEDGE, pl. 3, fig. 12.
1967 *Odontaspis cuspidata* — CASE, p. 16, fig. 77.
1967 *Odontaspis acutissima* — MENESINI, pl. 1, fig. 1.
1967 *Odontaspis acutissima* — CAPPETTA et al, p. 292, name only.
1969 *Odontaspis acutissima* — CAPPETTA, pl. 5, fig. 9—49.
1969 *Odontaspis acutissima* — CAPPETTA, pl. 5, fig. 9—49.
1969—1970 *Odontaspis taurus* — ANTUNES & JONET, p. 133, pl. 4, fig. 5—11.
1970 *Odontaspis acutissima* — CAPPETTA, p. 29—32, pl. 1, fig. 1—22; and pl. 2, fig. 1—16.

Material: 1 lower jaw anterior tooth; 1 upper jaw lateral tooth; 1 upper jaw anterior tooth; 1 lower jaw lateral tooth; and 1 upper jaw intermediate tooth.
Specimens: (UNSM 23512, 23513, 23514, 23515 and 23516).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth ranging in size from 4 mm to 4 cm, and averaging 2.5 cm. Teeth similar in jaw position to *Odontaspis (Carcharias) taurus* (RAFINESQUE), the modern form. Teeth similar in appearance in both the upper and lower jaws, with the exception that the lower jaw anterior teeth are slightly more recurved and sigmoidal. Intermediate teeth only in upper jaw. Lower jaw contains symphysial teeth.

Discussion: The most common tooth of the Neogene especially in the Lower Miocene (Aquitanian). It is scarce in the Middle Miocene (Helvetian), where it is replaced (in quantity) by *Odontaspis cuspidata* AGASSIZ. *Odontaspis acutissima* replaces *O. macrota* of the Lower to Middle Eocene (Ypresian to Claibornian).

Odontaspis cuspidata AGASSIZ

Plate 3, figs. 3a—b

1879 *Odontaspis cuspidata* — PROBST, pl. 2, fig. 59—63.
1907 *Odontaspis cuspidata* — PRIEM, pl. 1, fig. 2—4.
1907 *Lamna clavata* — JORDAN, p. 106, fig. 8.
1910 *Odontaspis cuspidata* — LERICHE, pl. 15, fig. 1—21.
1927 *Odontaspis cuspidata* — LERICHE, pl. 1, fig. 5—10 and pl. 8, fig. 9—14 and 16—20.
1942 *Odontaspis cuspidata* — LERICHE, pl. 5, fig. 1—8.
1949 *Odontaspis cuspidata* — BAUZA-RULLAN, pl. 31, fig. 6, 7 and 9.
1950 *Carcharias cuspidata* — ZBYSZEWSKI & d'ALMEIDA, pl. 1, fig. 6—7.
1957 *Odontaspis cuspidata* — LERICHE, pl. 1, fig. 14—17.
1969 *Odontaspis cuspidata* — SCHULTZ, pl. 1, fig. 13—14 and 19—21.
1969 *Odontaspis cuspidata* — CAPPETTA, pl. 5, fig. 50—54.
1970 *Odontaspis cuspidata* — CAPPETTA, p. 32, pl. 3, fig. 6—10.
1973 *Lamna acutissima* — CASE, p. 37, fig. 146.

Material: 1 lower jaw antero-lateral tooth.
Specimen: (UNSM 2318).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth up to 4 cm, with a distinctive lateral cusp on either side of the main cusp of the tooth, comprised of a cuspidate ridge with from two to three vestigial cusplets along the entire margin of the ridge. Teeth more robust than the previously described species.

Discussion: Species quite rare in the Late Eocene deposits, and scarce in the Lower Miocene (Aquitanian), but quite commonly distributed throughout the Middle Miocene (Helvetian), where it displaces *Odontaspis acutissima* AGASSIZ.

Family Orectolobidae

Sub-family Nebriinae

Ginglymostoma MÜLLER & HENLE, 1837

Ginglymostoma obliquum (LEIDY)

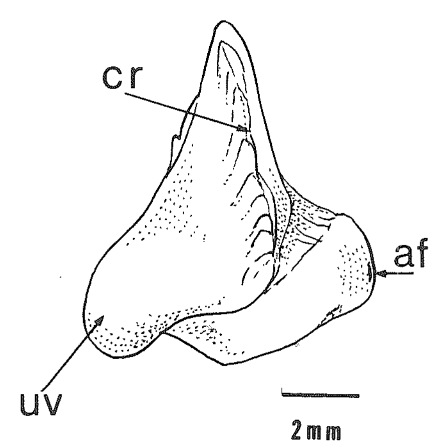
Plate 4, figs. 1a—d and text-fig. 4

1877 *Acrodobatis obliquus* LEIDY, p. 250, pl. 34, fig. 14.
1889 *Ginglymostoma serra* — WOODWARD, p. 348, pl. 16, fig. 9.
1901 *Ginglymostoma obliquum* — HAY, p. 310.
1911 *Ginglymostoma obliquum* — FOWLER, p. 30.
1942 *Ginglymostoma obliquum* — LERICHE, p. 52 (name only).
1956 *Ginglymostoma obliquum* — WHITE, p. 124 (name only).

Material: 1 lower jaw lateral tooth.
Specimen: (UNSM 23520).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth of fairly large size, ranging from 3 mm to 1 cm in height, and a bit more in their width, averaging 7 mm. Teeth inclined in their labial aspect, directed lingually, with flat bases (root area) containing one large orifice (pl. 4, fig. 1d) approximately in the center of the base. An apical foramen is apparent on the root boss in the lingual aspect. Tooth serrated on a hemispheric enameloid blade (pl. 4, fig. 1a). From 7 to 9 serrations or denticles on either side of a larger, centrally located cusp. Teeth similar in design in both the upper and lower jaws. Large overhanging uvula on the posterior portion of the tooth (text-fig. 4).

Discussion: The tooth specimens of *Ginglymostoma obliquum* are of comparable size to *G. blanckenhorni* from the Eocene (Ypresian) of Morocco, and even in outward appearance, are similar to the Moroccan species, although *G. blanckenhorni* has less denticulation (serrations) on the tooth blade than *G. obliquum*. The teeth of *Ginglymostoma obliquum* are common in the Twiggs Clay Member of the Barnwell



Text-fig. 4. Profile view of a lower lateral tooth (UNSM 23520) of *Ginglymostoma obliquum* (LEIDY). cr = crest (or carinal ridge of lateral cusplets), uv = uvula, and af = apical foramen.

Formation, even though no examples were recovered in the GEO-1 "control" sampling from Pit 22 (students may have either overlooked them or claimed them as souveniers during the screening of sands and clays for the collection), at any rate, the teeth of *Ginglymostoma obliquum* have been recovered with some regularity from the tailings at Pit 22 and adjoining pits, especially in the gravels washing out of the various clay units.

Ginglymostoma obliquum was short-lived, and was replaced in the Miocene by *G. serra*.

Family Scyliorhinidae

Genus *Scyliorhinus* BLAINVILLE, 1816

Scyliorhinus distans (PROBST)

Plate 4, figs. 2a—c and 3a—c

1879 *Scyllium distans* PROBST, pl. 3, fig. 23—26.
1879 *Scyllium acre* PROBST, pl. 3, fig. 27.
1879 *Scyllium gattatum* PROBST, pl. 3, fig. 28—29.
1912 *Scyliorhinus distans* — JOLEAUD, pl. 6, fig. 23—29.
1914 *Scyllium* sp., PRIEM, p. 127, fig. 24 and 25, p. 128, fig. 26.
1943 *Scyliorhinus* aff. *venloensis* WEILER, p. 77, fig. 1.
1943 *Scyliorhinus venloensis Weiler*, p. 83, fig. 21 and 22.
1949 *Scyliorhinus guttatum* — BAUZA-RULLAN, pl. 15, fig. 1—2.
1954 *Catulus minutissimus* — ROMAO-SERRALHEIRO, pl. 2, fig. 55 and 57, not fig. 54 and 56.
1967 *Scyliorhinus distans* — CAPPETTA et al, p. 292, name only.
1970 *Scyliorhinus distans* — CAPPETTA, p. 41—42, pl. 9, fig. 1—18.

Material: 1 upper jaw anterior tooth and 1 lower jaw lateral tooth.
Specimens: (UNSM 23521 and 23522).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth minute in size averaging 1 mm in overall dimensions. Teeth with a central cusp with a shorter lateral cusp on either side. All cusps lean lingually. Root has a flat base with a bi-lobed appearance caused by a centrally located furrow (median groove). An apron of plications on the lower margin of the tooth enameloid in labial aspect. Plications are rugose on some specimens. Lateral teeth wider and side cusps flare-out more as opposed to the slightly sigmoidal cusps of the anterior teeth. Bases of lateral teeth not as flat-and tooth does not lean forward as drastically as anterior positioned teeth.

Discussion: A "Cat-shark" with its origins as far back as the Cenomanian of the Upper Cretaceous. Teeth abundant in microzone of Pit 22. *Scyliorhinus* with its various species still exists in our oceans, particulary in the Mediterranean and the South Atlantic.

Scyliorhinus enniskilleni WHITE

Plate 4, figs. 4a—c, 5a—b and 6a—b

1956 *Scyliorhinus enniskilleni* WHITE, p. 128, fig. 1—19.
1975 *Scyliorhinus enniskilleni* — CASE, p. 7, pl. 1, fig. 6.

Material: 1 upper jaw anterior tooth, 1 upper jaw antero-lasteral tooth, and 1 lower jaw lateral tooth.
Specimens: (UNSM 23524, 23525 and 23526).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth of large size for the genus, ranging from 5 mm to 12 mm, with an average of 1 cm in tooth height on anterior teeth and slightly less than 1 cm on lateral teeth. Teeth with a lengthy central cusp with a pair of divergent lateral denticles, positioned one on each side of the central cusp. Denticles slightly sigmoidal on anterior teeth and blade-like or flattened on the lateral teeth. Teeth directed towards the inside of the mouth. Teeth have flattened, bi-lobed root bases, with a median furrow/groove at the base of the root. No striae or rugose ornamentation is present on the tooth enameloid.

Discussion: *Scyliorhinus enniskilleni* has the largest teeth known of the genus *Scyliorhinus*, in either the fossil record or of any modern species. *S. enniskilleni* was short-lived, having only existed in Middle to late Eocene seas. It was replaced in dominance by *S. distans* (cf. preceding descr.)

Family Carcharhinidae

Genus *Hemipristis* AGASSIZ, 1843

Hemipiristis wyattdurhami WHITE

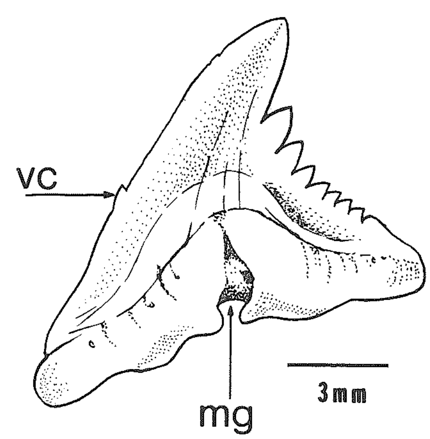
Plate 5, figs. 1a—b, 2a—b, 3a—b and 4a—c and text-fig. 5

1956 *Hemipristis wyattdurhami* WHITE, pl. 2, fig. 4, p. 135, fig. 40—43.
1975 *Hemipristis wyattdurhami* — CASE, p. 7, pl. 1, fig. 3—4.

Material: 1 upper jaw latero-posterior tooth, 1 upper jaw lateral tooth, 1 lower jaw anterior tooth, and 1 lower jaw lateral tooth.
Specimens: (UNSM 23528, 23529, 23530 and 23531).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth ranging in size from 6 mm to 1.5 cm, averaging 1 cm. Tooth design differs in Upper and lower jaws: lower jaw teeth more erect, with sigmoidal denticles along the outer margin of the enameloid, to half the tooth height, especially on the anterior teeth. Upper jaw teeth fully serrated on one side, with a single or vestigial denticle on the opposite side (text-fig. 5). This feature of the upper jaw teeth of *H. wyattdurhami* differentiates this species from the Middle Miocene *H. serra*, the upper jaw teeth of this latter species is fully serrated on both sides of the tooth enameloid.

Discussion: In general, the teeth of *Hemipristis wyattdurhami* from the Twiggs Clay are smaller in dimension than those of *H. wyattdurhami* found in the Trent Marl (Aquitanian-Early Miocene) of North Carolina. *Hemipristis wyattdurhami* had its range from the Late Eocene (Twiggs Clay-Jacksonian stage) up until the Lower Miocene (Aquitanian stage).



Text-fig. 5. Lingual view (UNSM 23528) of an upper latero-posterior tooth of *Hemipristis wyattdurhami* WHITE. vc-vestigial cusplet (serration), mg = medial groove.

Genus *Galeocerdo* MÜLLER & HENLE, 1837

Galeocerdo clarkensis WHITE

Plate 5, figs. 7a—b, 8a—b and 9a—b

1956 *Galeocerdo clarkensis* WHITE, p. 145, figs. 24—26, pl. 2, fig. 12—14.
1975 *Galeocerdo clarkensis* — CASE, p. 7, pl. 1, fig. 7.

Material: 1 lower jaw lateral tooth, 1 upper jaw latero-posterior tooth, and 1 lower jaw anterior tooth.
Specimens: (UNSM 23533, 23534 and 23535).
Localities: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, and Penn-Dixie Quarry, Clinchfield, Houston County, Georgia.
Age: Jacksonian, Clinchfield Sand and Twiggs Clay Member (Barnwell Fm.).

D e s c r i p t i o n : Teeth of large size averaging 2 cm on their greatest width. Teeth similar in upper and lower jaws. Teeth crescent-shaped with full serrations on both edges of the tooth blade. Serrations directed towards the commissure are much more robust than the opposing side serrations. Teeth are uniformly flat, with or without a median furrow (groove) on the lingual boss. Some fenestration along the root apron on the labial aspect.

D i s c u s s i o n : The teeth of *Galeocerdo clarkensis* are much larger in size than the Miocenic forms: *G. aduncas* and *G. contortus*, but smaller than *G. cuvieri* of the Pliocene to recent. The teeth of *Galeocerdo clarkensis* differ from other forms of the genus by the distinct inclination of the tooth blade on the apex angle, and the larger serrations of the tooth edge. This species existed in the Middle and Late Eocene.

Negaprion WHITLEY, 1939

Negaprion eurybathrodon (BLAKE)

Plate 6, figs. 1a—b, 2a—b and 3a—b

1862 *Lamna eurybathrodon* BLAKE, p. 316.
1942 *Sphyrna magna* — LERICHE, p. 85.
1950 *Cestracion (Sphyrna) magnus* — ZBY. & ALMEIDA, p. 350, pl. 7, figs. 149—156. (fig. 154 doubtful).
1954 *Cestracion elongatus* — SERRALHEIRO, pp. 67—68, pl. 2, figs. 58—59.
1954 *Cestracion magnus* (COPE) — ibid; pp. 68—69.
1955 *Negaprion eurybathrodon* — WHITE, pp. 191—193, figs. 1—10.
1955 *Negaprion magnus* (COPE) — ibid; figs. 11—14.
1957 *Aprionodon* cf. *collata* — LERICHE & SIGNEUX, p. 35, pl. 2, figs. 12—13.
1967 *Negaprion* sp. — CAPPETTA et al., p. 292 (name only).
1968 *Negaprion magnus* — GINSBURG & ANTUNES, p. 28 (name only).
1969 *Negaprion kraussi* — CAPPETTA, pp. 93—96, pl. 8, figs. 40—56 (figs. 50—52 are *Sphyrna*).
1969—70 *Negaprion* cf. *eurybathrodon* — ANTUNES et JONET, p. 175, pl. 12, figs. 80—81.

M a t e r i a l : 1 upper jaw lateral tooth; 1 lower jaw anterior tooth; and 1 lower jaw antero-lateral tooth.
S p e c i m e n s : (UNSM 23537, 23539 and 23540).
L o c a l i t y : Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
A g e : Jacksonian, Twiggs Clay Member-Barnwell Formation.

D e s c r i p t i o n : Teeth average 1 cm in height, central cusp on all teeth devoid of serrations (denticulation), and no lateral (accessoric) cusps. (pl. 6, figs. 1a—3b).

D i s c u s s i o n : A most abundant species in the Late Eocene of Georgia (Twiggs Clay). This species represents an extinct "Lemon shark".

Negaprion eurybathordon (BLAKE) evolved into a separate (and new) taxon in the Early Miocene (Aquitanian) of North Carolina. This newly described species (CASE 1980), has strong similarities to *N. eurybathrodon*, but with vestigial (or almost fully erupted) — lateral cusplets, quite distinct and without serrations. This new species of *Negaprion furimskyi* in the Trent Marl Limestone Formation of the Eastern part of North Carolina, is assumed to be a direct descendant from the precursor: *Negaprion eurybathrodon*.

Genus Scoliodon MÜLLER & HENLE, 1837

Scoliodon terraenovae (RICHARDSON)

Plate 8, figs. 5a—b

1836 *Squalus (Carcharias) terrae-novae* RICHARDSON, p. 289.

M a t e r i a l : 1 lower jaw lateral tooth.
S p e c i m e n : (UNSM 23542).
L o c a l i t y : Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
A g e : Jacksonian, Twiggs Clay Member-Barnwell Formation.

D e s c r i p t i o n : Teeth of average size ranging from 4 mm to 1 cm in their greatest width. Upper jaw teeth flat and elongated, with an obvious recurve to the blade directed towards the commisure. Teeth of the lower jaw are shorter with a lesser angle, along with a slight recurve near the tip of the blade, also directed towards the commissure. Teeth have a clean cutting surface-devoid of any serrations along their edges. A notch (created by the upper part of the median furrow (groove) is apparent on the upper root margin in labial aspect.

Discussion: Species uncommon in the Eocene, but rather commonly distributed in the Lower and Middle Miocene. Species exists today in our oceans.

Genus *Rhizoprionodon* WHITLEY, 1929

?*Rhizoprionodon* sp.

Plate 8, fig. 3a—b

Material: 1 dozen specimens.
Specimen: (UNSM 23584).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia (Geo. 1).
Age: Jacksonian, Twiggs Clay Member, Barnwell Formation.

Description: Lower jaw anterior tooth from the symphysial area. Characteristic large groove on the root boss in the lingual aspect (somewhat constricted in the figured specimen), but otherwise indicative of the species.

Discussion: As this author has already stated in his report on the fossil shark's teeth from the Trent Marl Formation, Lower Miocene (Aquitanian) of eastern North Carolina (CASE 1980), this is a rather rare species of galeoid shark in the fossil record.

Certain of its characteristics are similar to those of *Scoliodon*. It may in fact be just an aberrant tooth from the symphysio-anterior tooth files of *Scoliodon*.

Genus *Galeorhinus* BLAINVILLE, 1816

Galeorhinus galeus (LINNAEUS)

Plate 6, fig. 9

1758 *Squalus galeus* LINNAEUS, p. 234.
1902 *Galeus canis* GILCHRIST, p. 163.
1914 *Galeorhinus canis* — THOMPSON, p. 140.
1949 *Galeorhinus galeus* — J. L. B. SMITH, p. 44, fig. 15.

Material: 1 lower jaw lateral tooth.
Specimen: (UNSM 23544).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia. (Geo. 1).
Age: Jachsonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth quite small, 4 mm on the average (root width). There are from four to six lateral cusps on one side of the tooth surface-directed towards the commissure. These lateral cusps are large and slightly curved. The opposing side of the tooth is without denticles or cusps. The lingual root surface contains a boss with a pronounced median furrow (groove), but this area is missing from the figured specimen, as part of the root is broken away.

Discussion: The lingual surface of the figured specimen is badly pitted and part of the lower margin of the enameloid and root boss is missing. A view of the labial aspect is shown (pl. 6, fig. 9) to represent the species in the fauna.

Teeth as in the modern species: *Galeorhinus galeus* (LINNAEUS).

Galeorhinus huberensis nov. sp.

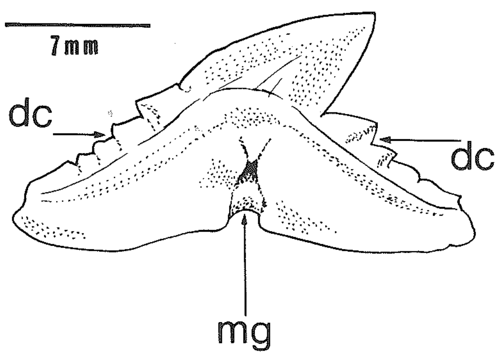
Plate 6, figs. 4a—b, 5a—b, 6a—b, 7a—b and 8a—b and text-fig. 6

Material: Five specimens: 2 upper jaw anterior teeth; 1 upper jaw lateral tooth; and 2 lower jaw lateral teeth.
Derivatio nominis: Named after the township of Huber, Twiggs County, Georgia.
Holotype: (UNSM 23550). Plate 6, figs. 6a—b and text-fig. 6.
Paratypes: (UNSM 23546, 23547, 23548 and 23549). Plate 6, figs. 4a—b, 5a—b, 7a—b and 8a—b.
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

D i a g n o s i s : Teeth with a series of from 4 to 5 large divergent denticles (or serrations) on either side of the central cusp or blade of lower jaw lateral teeth (pl. 6, figs. 6a—6b and text-fig. 6), anterior teeth with one side of lateral denticles-on the side directed towards the commissure, with vestigial denticles present on some specimens, on the opposing tooth blade.

D e s c r i p t i o n : Teeth with robust root bosses, large sized (for *Galeorhinus*) averaging 1 cm in width. Teeth flattened as with *Galeocerdo clarkensis*, with a distinct median furrow (or groove) on the root boss of the lingual aspect. Lateral denticles pronounced and divergent on some specimens.

D i s c u s s i o n : A new type of Liver-oil shark or "Tope" as represented by distinctive teeth showing large divergent lateral serrations on the tooth margin. *Galeorhinus huberensis* nov. sp. is known only from the Late Eocene Twiggs Clay of Georgia.



Text-fig. 6. Lingual view (UNSM 23550—TYPE) of *Galeorhinus huberensis* n. sp. dc = divergent cusplets (serrations), and mg = medial groove.

Family Sphyrnidae

Genus *Sphyrna* RAFINESQUE, 1810

Sphyrna zygaena (LINNAEUS)

Plate 8, figs. 4a—b

1758 *Squalus zygaena* LINNEAUS, p. 409.
1768 *Squalus zygaena* — BRÜNNICH, p. 4.
1796 *Squalus malleus* — SHAW & NODDER, p. 375, pl. 267.
1798 Le aquale marteau — LACÉPÈDE, p. 156 and 257, pl. 8, fig. 3.
1810 *Sphyrna zygaena* — RAFINESQUE, p. 46.
1817 *Zygaena zygaena* — CUVIER, p. 127.
1826 *Zygaena malleus* — RISSO, p. 125.
1830 *Zygaena vulgaris* — CLOQUET, p. 621.
1839 *Zygaena* sp. — STORER, p. 200.
1847 *Sphyrna zygaena* — NARDO, p. 3 (name only).
1848 *Zygaena subarcuata* — STORER, p. 70.
1848 *Zygaena malleus* — BUSCH, p. 22, pl. 2, fig. 5.
1851 *Sphyrnias zygaena* — GRAY, p. 48 (name only).
1855 *Sphyrna malleus* — van der HOEVEN, p. 262.
1861 *Cestracion subarcuata* — GILL, p. 59 (name only).
1861 *Sphyrna lewini* — DUMÉRIL, p. 261.
1862 *Sphyrna zygaena* — GILL, p. 403 (name only).
1870 *Cestracion (Sphyrna) zygaena* — STEINDACHNER, p. 576.
1877 *Zygaena vulgaris* — REGUIS, p. 58.
1881 *Sphyrna (zygaena) zygaena* — IMMS, p. 43 (name only).
1933 *Sphyrna (Cestracion) zygaena* — von BONDE, p. 377, pl. 1, fig. 3—4.
1935 *Zygaena zigaena* — NOBRE, p. 425.
1941 *Sphyrna* sp. — NORRIS, pl. 1, fig. 3.
1948 *Sphyrna zygaena* — BIGELOW & SCHROEDER, p. 436—449, p. 437, fig. 85, p. 438, fig. 86.
1969—1970 *Sphyrna zygaena* — ANTUNES & JONET, p. 197, pl. 18, fig. 133—134; pl. 19, fig. 133, 135—140; and pl. 20, fig. 141.

Material: 1 lower jaw lateral tooth.
Specimen: (UNSM 23552).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth ranging in size from 6 mm to 1 cm. Teeth devoid of denticulation (serrations). Robust root with median furrow (groove) on the lingual boss. Upper jaw teeth slightly recurved towards the commissure, while the lower jaw teeth stand erect with slender central cusps.

Discussion: Teeth of *Sphyrna zygaena* are scarce in the Late Eocene, being far more commonly distributed in the Lower to Middle Miocene. The species finds its origins in the Late Eocene and still exists today in our modern oceans.

Sub-order Squatinoidei

Family Squatinidae

Genus *Squatina* DUMERIL, 1806

Squatina prima (WINKLER)

Plate 5, figs. 5a—c and 6a—c

1873 *Trigonodus primus* WINKLER, p. 14, pl. fig. 18—21.
1876a *Trigonodus primus* — WINKLER, p. 13, pl. 1, fig. 18—21.
1881 *Trigonodus primus* — RUTOT ET VINCENT, p. 142 (name only).
1886 *Squatina prima* — NOETLING, p. 16.
1888a *Rhina winkleri* DAIMERIES, p. 43
1889a *Rhina winkleri* DAIMERIES, p. 7
1889a *Squatina prima* — DAIMERS, p. 7.
1899 *Squatina* sp. WOODWARD, p. 2, pl. 1, fig. 4 & 5.
1902 *Squatina prima* — LERICHE, pp. 16, 28, pl. 1, fig. 17—22.
1902 *Squatina gaudryi* PRIEM, p. 482, pl. 2, fig. 23 & 24.
1905c *Squatina prima* — LERICHE, pp. 72, 96, 177, pl. 4, fig. 3—5.
1906b *Squatina prima* — LERICHE, pp. 178—181, pl. 7, fig. 3—5.
1909 *Squatina prima* — LERICHE, p. 230, pl. 3, fig. 1—5.
1923a *Squatina prima* — LERICHE, pp. 178—181, pl. 8, fig. 1.
1926 *Squatina prima* — BÖHM, p. 81.
1931 *Squatina prima* — WHITE, p. 68, fig. 87–93 (in text).
1936a *Squatina prima* — ARAMBOURG, p. 419, pl. 20, fig. 16—17.
1936b *Squatina prima* — DAVIS, p. 334 (name only).
1943b *Sqautina prima* — CASIER, p. 6 (name only).
1946 *Squatina prima* — CASIER, p. 53, pl. 1, fig. 3.
1947b *Squatina prima* — CASIER, pp. 2, 12, 16, pl. 3, fig. 3, fig. 1c, 4a, 5a in text.
1952 *Squatina prima* — ARAMBOURG, p. 176, pl. 27, fig. 1—16.
1966 *Squatina prima* — CASIER, p. 57, pl. 2, fig. 1—7.

Material: 1 lower jaw antero-lateral tooth, and 1 upper jaw lateral tooth.
Specimens: (UNSM 23554 and 23555).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth ranging in size from 4 mm to 8 mm and averaging 6 mm. One single recurved, sigmoidal central cusp directed lingually. The cusp overhangs the root slightly on the labial aspect and forms an uvula. No enameloid on the root boss area, only on the tooth cusp. An apical foramen on the lingual face of the root and some fenestration on the upper apron of the root below the tooth enameloid. Root with flat (slightly concave) base, and with a large centrally located foramen.

Discussion: No dermal denticles of *Squatina prima* were recovered at Pit 22, probably due to their minute size — they passed through the collection screens.
The presence of the "Angel shark" *Squatina prima* in the Late Eocene Barnwell Formation along with the "Guitarfish skate" *Rhinobatos casieri*, and the dasyatids: *Dasyatis borodini* n. sp. and *D. charlisae* n. sp., indicate that some estuarial fishes were present in the predominantly marine fauna.

Order Rajiformes

Sub-order Rhinobatoidei

Family Rhinobatidae WOODWARD, 1889

Genus *Rhinobatos* LINCK, 1790

Rhinobatos cf. *casieri* HERMAN

Plate 3, fig. 9

1973 *Rhinobatos casieri* HERMAN, p. 273, pl. 13, fig. 1.

Material: 1 upper jaw lateral tooth.
Specimen: (UNSM 23557).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Teeth minute, averaging 1.5 mm in diameter. Tooth enameloid slightly larger than the bi-lobed root base, with two overhanging "cusplets", one on either side of the central "cusp". Tooth in profile has a crown with a pronounced apex, no carinae (on specimens showing wear from crushing shells). Gross lateral facette foramina on the root in lingual aspect, one on either side of the "uvula" caused by the central cusp overhanging the root boss. Foramina in median furrow (groove) on basal aspect.

Discussion: Teeth of the "Guitarfish skate" *Rhinobatos casieri* are quite rare in the Late Eocene, being more commonly represented in the Upper Cretaceous and the Early to Middle Eocene. *Rhinobatos* was finally replaced in abundance by *Rhynchobatus* (Lower Miocene to recent). The presence of *Rhinobatos casieri* in the Late Eocene extends its known geologic range.

Suborder Dasyatoidei

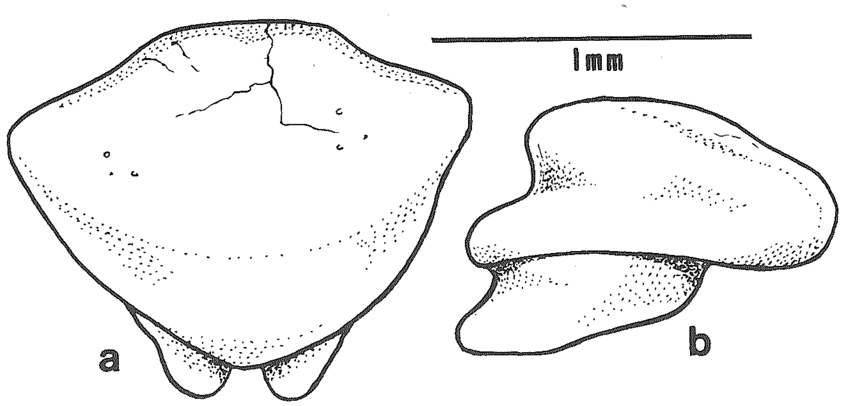
Family Dasyatidae BERTIN, 1939

Genus *Dasyatis* RAFINESQUE, 1810

Dasyatis borodini nov. sp.

Plate 8, figs. 1a—e and 2a—e and text-fig. 7

Material: One specimen: 1 lower jaw lateral tooth ♀.
Derivatio nominis: Named in honor of Mr. PAUL BORODIN, Malba, New York.
Holotype: (UNSM 23559). Plate 8, figs. 1a—e and text-fig. 7.
Paratype: (UNSM 23558). Plate 8, figs. 2a—e.
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member — Barnwell Formation.



Text-fig. 7. a. Oral view b. Left profile view (UNSM 23559—TYPE) of a lower lateral tooth of *Dasyatis borodini* n. sp. ♀

Diagnosis: Teeth low crowned with little or no conchoidal ornamentation, large enameloid crown over a short, protruding root base, no distinctive carinae on the occlusal aspect of the tooth crown.

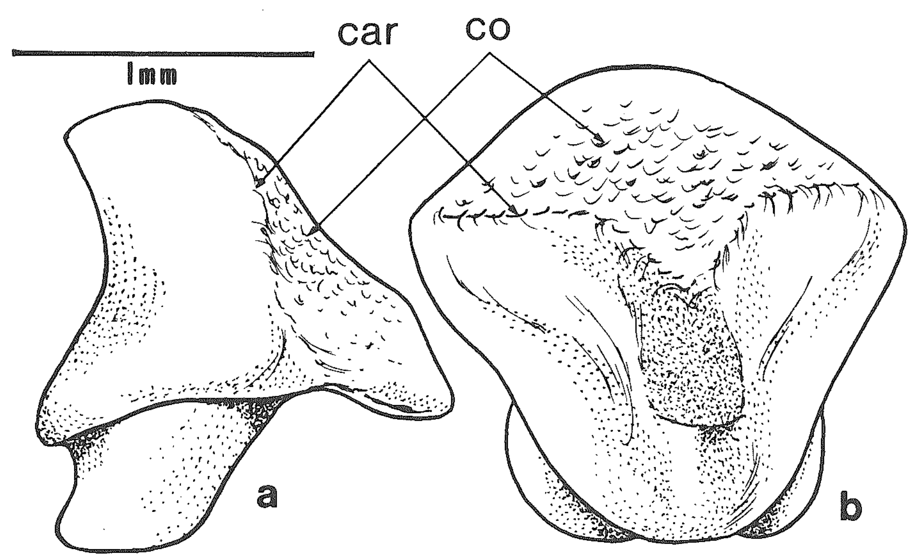
Description: Teeth averaging 1 mm in size (diameter). Tooth crown is composed of enameloid coating dentinous material. Anterior shelf or collar on the lower portion of crown, with an elevation of the upper part of the crown directed posteriorly (cf. p, 8, fig. 1e and text-fig. 7). Slight indication (on some specimens) of a conchoidal type of ornamentation on the posterior portion of the occlusal surface of the crown. Root bi-lobed with a foramen in the center of the median furrow (groove). No lateral facette foramina.

Discussion: *Dasyatis borodini* nov. sp. differs from *D. charlisae* nov. sp., by the flattened, shelf-collar and sparsely ornamented crown and the lack of a distinctive carina. So far only the teeth of the female of the species have been recovered. This species of a clear-nose skate is restricted to the Late Eocene-Barnwell Formation.

Dasyatis charlisae nov. sp.

Plate 7, figs. 1a—e, 2a—e, 3, and 4a—d and text-fig. 8

Material: 1 lower jaw lateral tooth ♂, 1 lower jaw antero-lateral tooth ♀, and 1 upper jaw anterior tooth ♂.
Derivatio nominis: Named in honor of (Mrs.) CHARLIS BORODIN of Malba, New York.
Holotype: (UNSM 23563). Plate 7, figs. 1a—e, text-fig. 8.
Paratypes: (NSM 23561 and 23562). Pl. 7, figs. 2a—e, 3, and 4a—d.
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member — Barnwell Formation.



Text-fig. 8. a. Profile view. b. Oral view (UNSM 23563—TYPE) of an upper anterior tooth of *Dasyatis charlisae* n. sp. car = carina, co = conchoidal ornamentation.♂

Diagnosis: Teeth low crowned (females) with distinctive carinae, teeth high crowned (males) with distinctive carinae (text-fig. 8), posterior occlusal surface has strong ornamentation in a conchoidal pattern covering complete posterior aspect (pl. 7, fig. 1e), short root as with previous species.

Description: Teeth averaging 1.5 mm in size (diameter). Tooth crown is composed of enameloid over dentine material. No shelf or collar on the crown as with the previous species (a feature which distinguishes the two species). A most distinctive pattern on the occlusal surface of the tooth crown posterior to the carinae, made up of a multitude of "pits" or conchoidal fractures. Root is bi-lobed with a foramen in the center of the median furrow (groove). No lateral facette foramina.

Discussion: *Dasyatis charlisae* nov. sp. is a distinctive species of a "clear-nose skate", and is restricted along with the previous species, to the Late Eocene-Barnwell Formation.

Family Pristidae

Sub-family Pristinae

Genus Pristis LATHAM, 1794

Pristis lathami GALEOTTI

Plate 9, figs. 1a–c

1837 *Pristis lathami* GALEOTTI, p. 45, pl. 2

Material: 1 large rostral "tooth"
Specimen: (UNSM 23570)
Locality: Pit 22, Huber Kaolin Products mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Ocala Limestone.

Description: Rostral denticles (or "teeth") ranging in size 5 to 10 cms, averaging 8 cms (in denticle length). The present specimen is 9.5 cms at its greatest length, and represents a rostral "tooth" from the left-side, anterior end near the tip of the rostrum. The specimen is quite large and probably indicates the denticle came from a rostrum of an approximate size (rostrum measured from the orbits to the tip) —120 to 130 cms.

The rostral "tooth" has a thick, eliptical body, with a deep furrow or groove traversing the entire length of the posterior edge of the denticle, and the tip comes to a flattened (dorso-ventrally) point (from the "wear" of slashing and thrashing about in schools of fishes).

The rostral "tooth" is dentinous in composition, but it is devoid of any enameloid sheathing on the denticle surfacing.

Discussion: The rostral "teeth" (or denticles) of *Pristis lathami* are fairly common in Eocene marine deposits, although the majority of specimens are fragmented or worn-down in usage — post mortem, and fairly complete material such as the specimen figured pl. 9, figs. 1a—1c) is a rarity in of itself.

The lack of "trace" enameloid on the surface tips of the rostral denticle (although modern representatives of *P. lathami* have a thin veneer of enameloid, 1/3 to 1/4 of the anterior portion of the denticle) only indicates one or two possibilities: a) The enameloid portion of the denticle was worn-away by usage "post-mortem", or b) As a direct result of wear during fluvial transportation prior to its ultimate deposition.

Pristis lathami still exists today in our modern oceans, however, in the fossil record, *Pristis* became less dominant during the Late Miocene and Pliocene periods, and was replaced in a dominant position by *Anoxypristis*.

Pristis pickeringi nov. sp.

Plate 9, figs. 2a—c

Material: 1 rostral tooth (spine). (UNSM 23572). pl. 9, figs. 2a—c.
Derivatio nominis: Named in honor of Mr. SAMUEL PICKERING, State Geologist of Georgia.
Locality: Penn-Dixie Cement Company Quarry, Chlinchfield, Houston County, Georgia.
Age: Late Jacksonian, Clinchfield Sand.

Diagnosis: Rostral tooth (spine) finely striated along the keel, groove, and both lateral faces, having a thin veneer of enameloid overlying dentinous material.

Description: The rostral tooth (spine) of a rather large sawfish. The "spine" averaging about 5.5 cm in length (even though the tip of the spine has been worn down with usage). The width across the length of the spine is approximately 13 mm. Rostral attachment section of the spine is intact and shows a "spongy"osteo-dentinous material. Fine, closely spaced striae covering the entire half (posterior) of the spine, traversing the keel, both lateral faces and into the groove area as well. No oral teeth recovered at the present time.

Discussion: Unlike the preceding species, the rostral teeth of *Pristis pickeringi* nov. sp. has an enameloid sheathing over its dentinous structure. Furthermore it is ornamented on all of its surfaces by fine parallel striations (pl. 9, figs. 2a—2c). *Pristis pickeringi* nov. sp. seems to be restricted to the Late Jackson-Clinchfield Sands.

Genus Propristis DAMES, 1883

Propristis schweinfurthi DAMES

Plate 9, figs. 3a—b, 4a—c, 5a—c and 6a—c

1883 *Propristis schweinfurthi* DAMES, p. 136, pl. 3, figs. 1—2.
1905 *Propristis schweinfurthi* — STROMER, p. 53, pl. 6, figs. 17—17a—b.
1905 *Amblypristis cheops* — PRIEM, p. 637, fig. 7.
1906 *Propristis schweinfurthi* — ANDREWS, p. 318 (name only)
1907 *Propristis schweinfurthi* —FRAAS, pl. 1, figs. 1—3.
1951 *Propristis schweinfurthi* — DUNKLE, p. 346, fig. 2.
1973 *Propristis schweinfurthi* — CASE, p. 35, figs. 132—133.
1975 *Propristis schweinfurthi* — CASE, p. 7, pl. 1, fig. 11.

Material: 3 rostral teeth; and 1 rostrum cartilage fragment.
Specimens: (UNSM 23565, 23566, 23567, and 23568).
Locality: Pit 22, Huber Kaolin Products mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Rostral teeth (pl. 9, figs. 4a—6c) ranging in size from 1.5 to 2 cms, and averaging 1.5 cm in width of denticle blade. Osteo-dentinous (devoid of enameloid sheathing) flat surfaces on two sides, the dorsal and ventral, with a sharp cutting edge on the anterior. In lateral view (posterior), a concave and pourous indentation (pl. 9, figs. 4b, 5b and 6b) which fits up against a rostral groove (pl. 9, figs. 3a—3b). No oral teeth have been recovered at the present time.

Discussion: Rostral "teeth" (actually, modified "dermal"denticles) which fit in a notch or groove alonge the rostrum border (pl. 9, figs. 3a—3b). These "teeth" overlap one another slightly, along the rostral edge, and form a "saw" for cutting (or "slashing") ZITTEL, 1932, p. 82, fig. 128).

The rostral "teeth" (or "spines" — in the European usage), are quite distinctive, scythe-like or crescent-shaped in appearance, and differ from all other known pristid dermal (rostral) denticles, such as; *Pristis* or *Anoxypristis.*

Propristis rostral denticles are found in the Qasr-el-Sagha and Ravine beds at Birket-El-Qurun in the Fayum Depression of Late Eocene (Oligocene) age in Egypt (VONDRA, 1967).

In North America, rostral denticles of *Propristis schweinfurthi* have been recovered (although, not reported) from the Gosport Sand (Clinchfield Sand equivalent in Georgia) at Little Stave Creek, near the town of Jackson, Clarke County, Alabama. Material is in the author's collection.

Rostral denticles of *Propristis* have also been recovered (but, not reported) from the Yazoo Clay (Jacksonian), 1 mile south of Columbia, Caldwell Parish, Louisiana (Personal communication and sample specimens from Mr. SYLVESTER BREARD of Monroe, Louisiana).

P. schweinfurthi rostral denticles have been reported from the Barnwell (Twiggs Clay) at the Georgia Kaolin Company mines, near Dry Branch, Twiggs County, Georgia (DUNKLE, 1951).
Illustrations (without descriptions) of the denticles of *P. schweinfurthi* were reported from Egypt and Pit 22 in two popular works (CASE, 1973, 1975).

Propristis schweinfurthi appears to be restricted to the upper Eocene, and at the present time are only known from Louisiana; Alabama; and Georgia in the United States, and in the Oligocene of Egypt.

Family Myliobatidae MÜLLER & HENLE 1841

Genus *Rhinoptera* (KUHL) CUVIER, 1829

Rhinoptera daviesi WOODWARD

Plate 9, fig. 7

1889c *Rhinoptera daviesi* WOODWARD, p. 126, pl. 3, fig. 6

Material: 1 isolated pavement crusher (tooth) chevron.
Specimen: (UNSM 23573).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian, Twiggs Clay Member-Barnwell Formation.

Description: Very small mouth plates, individual upper jaw chevrons averaging 1 cm in width, probably the same for the chevrons of the lower jaw (although no lower jaw plate sections were found in screenings at Pit 22). Chevrons have a dentinous crushing surface, with no enameloid in evidence (may have been worn off with usage), and no surface ornamentation. Basal attachment is composed of from 9 to 12 individual root lobes, distinguishing it from either *Myliobatis* or *Aetobatis.*

Discussion: *Rhinoptera* (the "Cow-nose" ray) has existed in the fossil record since the Lower Eocene and does exist in our modern seas, mostly around the coastlines and in estuaries and bays. More commonly distributed in the fossil record during the Middle Eocene (Ypresian) and sparse in the Late Eocene-Lower Miocene. *Rhinoptera* probably evolved out of an Upper Cretaceous *Myledaphus/Brachyrhizodus* stock.

Family Myliobatidae BONAPARTE 1838

Genus *Myliobatis* DUMERIL (CUVIER) 1817

Myliobatis sp.

Plate 9, figs. 8a—c, 9a—b and 10a—c

Material: 1 fragment of a stinger barb spine from the caudal region, 1 isolated chevron tooth (lower jaw), and 1 fragmentary lower jaw plate (2/3rds complete).
Specimens: UNSM23575, 23576 and 23578).
Locality: Pit 22, Huber Kaolin Products Mine, Huber, Twiggs County, Georgia.
Age: Jacksonian (Middle and Lower), Twiggs Clay Member-Barnwell Formation, and the Ocala Limestone (Lower jaw plate — UNSM 23576).

Description: An isolated lower jaw chevron (complete), averaging 2 cm in greatest width. Smooth, un-ornamented crushing surface. Root lobes numbering 24. Chevron from median section of the lower jaw (pl. 9, figs. 8a—8c). Twiggs Clay Member-Barnwell Formation. Pit 22.

A partial lower jaw section containing 7 complete and 2 partial median chevrons, plus a total of 17 lateral lozenge-shaped chevrons. Root lobes intact on obverse of the 7 complete chevrons, while lost on the 2 additional fragmented chevrons. The size of the total specimen is approximately 8×8 cm (width and height). (pl. 9, figs. 10a—10c). Ocala Limestone. Pit 22.

A mesial fragment of a stinger barb spine containing a total of approximately 32 intact recurved barbs along the edge of the spine. (pl. 9, figs. 9a—9b). Twiggs Clay Member-Barnwell Formation. Pit 22.

Discussion: Dental pavements along with their disassociated chevrons and fragmented stinger barb spines are most common elements in the fossil record. *Myliobatis* and its related genera: *Rhinoptera* and *Aetobatis* have their remnants strewn about in most fossil marine deposits of Tertiary age. A complete dental pavement crusher plate (either upper or lower jaw) is very difficult to find intact, as the sutures that separate individual chevrons usually become disassociated, unless the complete plate is preserved intact in a mud-ball concretion.

Rhinoptera, Myliobatis and *Aetobatis* have their origins in the Eocene. *Rhinoptera* in the Lower or Early Eocene, *Myliobatis* in the Middle Eocene, and *Aetobatis* in the Late Eocene. Rhinoptera may have been directly descended from the Upper Cretaceous batoids: *Myledaphus-Rhombodus-Brachyrhizodus.*

Genus *Aetobatis* BLAINVILLE 1816

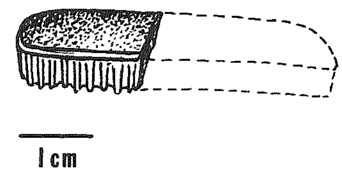
Aetobatis sp.

Text-fig. 9

Material: 1 upper jaw chevron fragment.
Specimen: (UNSM23583).
Locality: Penn-Dixie Cement Company Quarry, Clinchfield, Houston County, Georgia.
Age: Late Jacksonian, Clinchfield Sand.

Description: An isolated pavement crusher chevron fragment from the upper jaw of a fossil Duck-bill ray. Left-hand chevron fragment lacking ornamentation on the crushing surface, and with 9 root lobes intact. Fragment probably from the median section of the upper jaw.

Discussion: *Aetobatis* seems to find its origin in the Late Eocene, quite possibly in the Clinchfield Sands. *Aetobatis* is not known from the earlier Ocala Limestone or Twiggs Clay Member of the Barnwell Formation. *Aetobatis* is quite commonly distributed in the Neogene: Aquitanian-Burdigalian-Helvetian. Known in the Atlantic Coastal Plain fossil record in the Trent Formation (Aquitanian) of North Carolina (CASE 1980), and in the Pungo River Marl Formation (Helvetian) of North Carolina as well as its correlated Formation: the Calvert of Maryland and Virginia.



Text-fig. 9. Fragment of an upper jaw chevron (UNSM 23583) of *Aetobatis* sp. Dotted lines indicate missing portion of the pavement tooth.

4. Results and conclusions

The recovery in South-central Georgia of the present study material, has given us an insight into the "evolutionary" progress of certain Selachian species, and the possible "origins" of some other species.

The material as collected was recovered from both "float" as well as "in situ" methods. The *float* material was weathered-out of a combination of calcareous and clay-like materials containing numerous pebbles and small pieces of taconite and iron-oxide nodules (Twiggs Clay). The in situ material was found in a formational member of the Twiggs Clay.

The teeth of selachians recovered from the Clinchfield Sand, came from a silicate and pebble-laden clay-rock, in situ, while the Ocala material was derived from a rock mainly composed of foraminifera and fragmentary echinoid plates.

The preservation of the study material was most satisfactory, and allowed the author to study in much detail, the specimens for this work.

Composition of the fauna

Table 1 shows a comparison of faunas between the present Georgia Eocene material and material of comparable age from the "El-Fayum Depression" of Egypt (VONDRA 1967). We can see a similarity between the genera. The Egyptian material is Late (or Upper) Eocene in age, and table 1 allows us an immediate species comparison between the Georgia material and a foreign faunal assemblage.

Table 2 shows a comparison of faunas between the present Georgia Eocene material and the material of Early (Lower) Miocene age (Aquitanian) of North Carolina (CASE 1980).

50% of the species in the North Carolina faunal assemblage are conspecific with the Georgia study material, showing not only a relationship (ancestry), but a transition from the Eocene to the Miocene of the basic taxa.

As the author has stated earlier (in text) and in another publication (CASE 1980), many of the transitional taxa became either extinct or evolved to another specific type by the Middle Miocene (Helvetian).

Table 3 shows the occurrence of the individual species (population) within the formation/formations, from a distribution of abundant to extremely rare. The table is self-explanatory.

Distribution of species within each formational member of the report

Clinchfield Sand:	*Procarcharodon auriculatus* (BLAINVILLE) *Galeocerdo clarkensis* WHITE *Pristis pickeringi* nov. sp. *Aetobatis* sp.
Ocala Limestone:	*Procarcharodon auriculatus* (BLAINVILLE7 *Isurus* cf. *oxyrhinchus* RAFINESQUE *Pristis lathami* GALEOTTI
Twiggs Clay member-Barnwell Fm:	*Heterodontus pineti* nov. sp. *Isurus* cf. *oxyrhinchus* RAFINESQUE *Lamna twiggensis* nov. sp.

Odontaspis acutissima Agassiz
Odontaspis cuspidata Agassiz
Ginglymostoma obliquum Leidy
Scyliorhinus distans (Probst)
Scyliorhinus enniskilleni White
Hemipristis wyattdurhami White
Galeocerdo clarkensis White
Negaprion eurybathrodon (Blake)
Scoliodon cf. *terraenovae* (Richardson)
Galeorhinus cf. *galeus* (Linnaeus)
Galeorhinus huberensis nov. sp.
Sphyrna cf. *zygaena* (Linnaeus)
Squatina prima (Winkler)
Rhinobatos cf. *casieri* Herman
Dasyatis borodini nov. sp.
Dasyatis charlisae nov. sp.
Pristis lathami Galeotti
Propristis schweinfurthi Dames
Rhinoptera cf. *daviesi* Woodward
Myliobatis sp.

Note: This list represents as complete a species recovery from each formational member as is possible at the present time, and does not necessarily indicate an absolutely complete faunal representation. There is no doubt that other species may still be recovered at some future date. In this event, an additional note on the fauna may be appropriate.

Table 1

Comparison of faunas (Selachians) late Eocene USA to Late Eocene Egypt.

Twiggs — Ocala — Clinchfield	El Fayum — Qasr el Sagha and Ravine Beds
Late Eocene — Georgia	Late Eocene — Egypt
Heterodontus pineti	
Procarcharodon auriculatus	*Procarcharodon auriculatus*
Isurus cf. *oxyrhinchus*	*Isurus* cf. *oxyrhinchus*
Lamna twiggsensis	*Lamna gafsana (aschersoni)*
Odontaspis acutissima	*Odontaspis koerti*
Odontaspis cuspidata	*Odontaspis* sp.
Ginglymostoma obliquum	
Scyliorhinus distans	
Scyliorhinus enniskilleni	*Scyliorhinus* cf. *enniskilleni*
Hemipristis wyattdurhami	*Hemipristis* cf. *wyattdurhami*
Galeocerdo clarkensis	*Galeocerdo eaglesomei*
	Galeocerdo semilevis
	Negaprion cf. *euybathrodon*
Negaprion eurybathrodon	*Scoliodon* sp.
Scoliodon cf. *terrae novae*	*Physodon* sp.
Galeorhinus cf. *galeus*	
Galeorhinus huberensis	
Spyrna cf. *zygaena*	*Sphyrna* sp.
Squatina prima	
Rhinobatos cf. *casieri*	
Dasyatis borodini	
Dasyatis charlisae	
Pristis lathami	
Pristis pickeringi	
Propristis schweinfurthi	*Propristis schweinfurthi*
Rhinoptera cf. *daviesi*	
Myliobatis sp.	*Myliobatis* sp.
Aetobatis sp.	

Table 2
Comparison of faunas (Selachians) Late Eocene Georgia — Early Miocene N. C.

Twiggs — Ocala — Clinchfield	Trent marl Formation
Late Eocene–Georgia	Early Miocene-North Carolina
Heterodontus pineti	*Heterodontus janefirdae*
Procarcharodon auriculatons	*Procarcharodon auriculatus*
Isurus cf. *oxyhinchus*	*Isurus* cf. *oxyrhinchus*
Lamna twiggsensis	*Alopias* cf. *superciliosus*
Odontaspis acutissima	*Odontaspis acutissima*
Odontaspis cuspidata	*Odontaspis cuspidata*
Ginglymostoma obliquum	
Scyliorhinus distans	*Scyliorhinus distans*
Scyliorhinus enniskilleni	*Anomotodon cravenensis*
Hemipristis wyattdurhami	*Hemipristis wyattdurhami*
Galeocerdo clarkensis	*Galeocerdo aduncas*
	Galeocerdo contortus
	Carcharhinus cf. *priscus*
Negaprion eurybathrodon	*Negaprion furimskyi*
	Negaprion gibbesi
Scoliodon cf. *terraenovae*	*Scoliodon* cf. *terraenovae*
	Aprionodon cf. *acuarias*
	Galeorhinus cf. *affinis*
Galeorhinus cf. *galeus*	*Galeorhinus* cf. *galeus*
Galeorhinus huberensis	*Galeorhinus* cf. *latus*
Sphyrna cf. *zygaena*	*Sphrna* cf. zygaena
Squatina prima	*Squatina subserrata*
Rhinobatos cf. *casieri*	*Rynchobatus pristinus*
Dasyatis borodini	
Dasyatis charlisae	*Dasyatis cavernosa*
Pristis lathami	
Pristis pickeringi	
Propristis schweinfurthi	
Rhinoptera cf. *daviesi*	*Rhinoptera* cf. *daviesi*
Myliobatis sp.	*Myliobatis* sp.
Aetobatis sp.	*Manta melanyae*

Table 3

Occurrence of species of selachians in the Late Eocene Formations — abundant to rare.

Scyliorhinus enniskilleni	Abundant
Negaprion eurybathrodon	Abundant
Scoliodon cf. *terrae novae*	Abundant
Myliobatis sp.	Abundant
Hemipristis wyattdurhami	Uncommon
Galeocerdo clarkensis	Uncommon
Odontaspis acutissima	Uncommon
Scyliorhinus distans	Uncommon
Rhinoptera cf. *daviesi*	Uncommon
Odontaspis cuspidata	Rare
Propristis schweinfurthi	Rare
Ginglymostoma obliquum	Rare
Isurus cf. *oxyrhinchus*	Rare
Dasyatis borodini	Rare
Dasyatis charlisae	Rare
Procarcharodon auriculatus	Rare

Lamna twiggensis	Extremely rare
Squatina prima	Extremely rare
Galeorhinus cf. *galeus*	Extremely rare
Galeorhinus huberensis	Extremely rare
Sphyrna cf. *zygaena*	Extremely rare
Pristis lathami	Extremely rare
Pristis pickeringi	Extremely rare
Rhinobatos cf. *casieri*	Extremely rare
Heterodontus pineti	Extremely rare
Aetobatis sp.	Extremely rare

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The specimens (types, paratypes, and figured) herein described, will be housed in the collections of the University of Nebraska State Museum at Lincoln, Nebraska. A topotypic collection will be presented to the American Museum of Natural History in New York.

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Explanation of plates

Plate 1

Figs. 1—2. *Heterodontus pineti* nov. sp.
1. Paratype (UNSM 23500), x20 (SEM picture). a. Labial view, anterior tooth. — b. Profile view. — c. Occlusal view. — d. Lingual view.
2. Holotype (UNSM 23501), x7 (SEM picture). a. Labial view, median-lateral tooth. — b. Lingual view. — c. Profile view (x15). — d. Occlusal view. — e. Basal view.

Figs. 3—4. *Procarcharodon auriculatus* (BLAINVILLE)
3. (UNSM 23579), x1. a. Labial view, lower antero-lateral tooth. — Lingual view.
4. (UNSM 23582), x2.5. a. Lingual view, upper extreme posterior tooth. — b. Labial view.

Plate 2

Figs. 1—2. *Procarcharodon auriculatus* (BLAINVILLE)
1. (UNSM 23581), x1. a. Lingual view, upper lateral tooth. — b. Labial view.
2. (UNSM 23580), x1. 5. a. Lingual view, upper posterolateral tooth. — b. Labial view.

Figs. 3—5. *Isurus oxyrhinchus* RAFINESQUE
3. (UNSM 23502), x1. a. Lingual view, lower anterior tooth. — b. Labial view.
4. (UNSM 23504), x2. a. Lingual view, lower antero-lateral tooth. — b. Labial view.
5. (UNSM 23503), x1. 5. a. Lingual view, upper lateral tooth. — b. Labial view.

Figs. 6—8. *Odontaspis acutissima* AGASSIZ
6. (UNSM 23514), x1. 8. a. Lingual view, lower anterior tooth. — . Labial view.
7. (UNSM 23513), x2. a. Lingual view, upper lateral tooth. — b. Labial view.
8. (UNSM 23512), x1. 8. a. Lingual view, upper anterior tooth. — b. Labial view.

Plate 3

Figs. 1—2. *Odontaspis acutissima* AGASSIZ
1. (UNSM 23515), x2. a. Lingual view, lower lateral tooth. — b. Labial view.
2. (UNSM 23516), x4. a. Lingual view, upper intermediate tooth. — b. Profile view. — c. Labial view.

Fig. 3. *Odontaspis cuspidata* AGASSIZ
3. (UNSM 23518), x1.8. a. Lingual view, lower anterolateral tooth. — b. Labial view.

Figs. 4—8. *Lamna twiggsensis* nov. sp.
4. Holotype (UNSM 23506), x1.5. a. Lingual view, upper lateral tooth. — b. Labial view.
5. Paratype (UNSM 23507), x2.5. a. Lingual view, upper latero-posterior tooth. — b. Labial view.

6. Paratype (UNSM 23508), x1.8. a. Lingual view, lower anterior tooth. — b. Labial view.
7. Paratype (UNSM 23510), x2. a. Lingual view, lower lateral tooth. — b. Labial view.
8. Paratype (UNSM 23509), x2. a. Lingual view, lower antero-lateral tooth. — b. Labial view.

Fig. 9. *Rhinobatos casieri* HERMAN
9. (UNSM 23557), x35 (SEM picture). Oral view, upper antero-lateral tooth.

Plate 4

Fig. 1. *Ginglymostoma obliquum* (LEIDY)
1. (UNSM 23520), x4. a. Labial view, lower lateral tooth. — b. Profile view. — c. Lingual view. — d. Basal view.

Figs. 2—3. *Scyliorhinus distans* (PROBST)
2. (UNSM 23521), x15 (SEM picture. a. Lingual view, lower lateral tooth. — b. Profile view. — c. Labial view.
3. (UNSM 23522), x17 (SEM picture). a. Lingual view, upper anterior tooth. — b. Profile view. — c. Labial view.

Figs. 4—6. *Scyliorhinus enniskilleni* WHITE
4. (UNSM 23524), x3. a. Lingual view, upper anterior tooth. — b. Profile view. — c. Labial view.
5. (UNSM 23525), x3. a. Lingual view, upper antero-lateral tooth — b. Labial view.
6. (UNSM 23526), x3. a. Lingual view, lower lateral tooth. — b. Labial view.

Plate 5

Figs. 1—4. *Hemipristis wyattdurhami* WHITE
1. (UNSM 23528), x2.5. a. Labial view, upper latero-posterior tooth. — b. Lingual view.
2. (UNSM 23531), x5. a. Lingual view, upper lateral tooth. — b. Labial view.
3. (UNSM 23529), x4. a. Lingual view, lower lateral tooth. — b. Labial view.
4. (UNSM 23530), x3.5. a. Lingual view, lower anteror tooth. — b. Profile view. — c. Labial view.

Figs. 5—6. *Squatina prima* (WINKLER)
5. (UNSM 23554), x5. a. Lingual view, lower antero-lateral tooth. — b. Profile view. — c. Labial view.
6. (UNSM 23555), x7 a. Lingual view, upper lateral tooth. — b. Profile view. — c. Labial view.

Figs. 7—9. *Galeocerdo clarkensis* WHITE
7. (UNSM 23534), x2. a. Labial view, lower lateral tooth. — b. Lingual view.
8. (UNSM 23533), x2. a. Labial view, upper latero-posterior tooth. — b. Lingual view.
9. (UNSM 23535), x2.5. a. Labial view, lower anterior tooth. — b. Lingual view.

Plate 6

Figs. 1—3. *Negaprion eurybathrodon* (BLAKE)
1. (UNSM 23537), x3. a. Lingual view, upper lateral tooth. — b. Labial view.
2. (UNSM 23540), x3.5. a. Lingual view, lower anterior tooth. — b. Labial view.
3. (UNSM 23539), x3.5. a. Lingual view, lower antero-lateral tooth. — b. Labial view.

Figs. 4—8. *Galeorhinus huberensis* nov. sp.
4. Paratype (UNSM 23549), x3.5. a. Labial view, upper anterior tooth. — b. Lingual view.
5. Paratype (UNSM 23546), x3.5. a. Labial view, upper anterior tooth. — b. Lingual view.
6. Holotype (UNSM 23550), x2.5 a. Lingual view, lower lateral tooth. — b. Labial view.
7. Paratype (UNSM 23547), x2.5. a. Lingual view, upper lateral tooth. — b. Labial view.
8. Paratype (UNSM 23548), x3.5. a. Lingual view, lower lateral tooth (anomalie). — b. Labial view.

Fig. 9. *Galeorhinus galeus* (LINNAEUS)
9. (UNSM 23544), x9 (SEM picture). Labial view, lower lateral tooth.

Plate 7

Figs. 1—4. *Dasyatis charlisae* nov. sp. ♂
1. Holotype (UNSM 23563), x48 (SEM picture). a. Labio-basal view, upper anterior tooth. — b. Lingual view. — c. Profile view. — d. Oral view. — e. Labial view.
2. Paratype (UNSM 23561), x42 (SEM picture). a. Oral view, lower lateral tooth. — b. Labio-basal view. — c. Profile view. — d. Occlusal view. — e. Lingual view.
3. Paratype (UNSM 23561), x42 (SEM picture). Basal view.
4. Paratype (UNSM 23562), x42 (SEM picture). a Oral view, lower lateral tooth. — b. Profile view. — c. Occlusal view. — d. Lingual view.

Plate 8

Figs. 1—2. *Dasyatis borodini* nov. sp. ♀

1. Holotype (UNSM 23559), x23 (SEM picture). a. Oral view, lower lateral tooth. — Occlusal view. — Right profile view. — d. Lingual view. — e. Left profile view.
2. Paratype (UNSM 23558), x23 (SEM picture). a. Oral view, lower lateral tooth. — b. Occlusal view. — c. Right profile view. — d. Lingual view. — e. Left profile view.

Fig. 3. *Rhizoprionodon* sp.

3. (UNSM 23584), x12 (SEM picture). a. Lingual view, lower anterior tooth. — b. Profile view.

Fig. 4. *Sphyrna zygaena* (Linnaeus)

4. (UNSM 23552), x4. a. Lingual view, lower lateral tooth. — b. Labial view.

Fig. 5. *Scoliodon terraenovae* (Richardson)

5. (UNSM 23542), x4, a. Lingual view, lower lateral tooth. — b. Labial view.

Plate 9

Fig. 1. *Pristis lathami* Galeotti

1. (UNSM 23570), 9.5 cm. Right profile view, rostal spine. — b. Border view. — Left profile view.

Fig. 2. *Pristis pickeringi* nov. sp.

2. Holotype (UNSM 23572), xl.2. a. Right profile view, rostal spine, — b. Border view. — c. Left profile view.

Figs. 3—6. *Propristis schweinfurthi* Dames

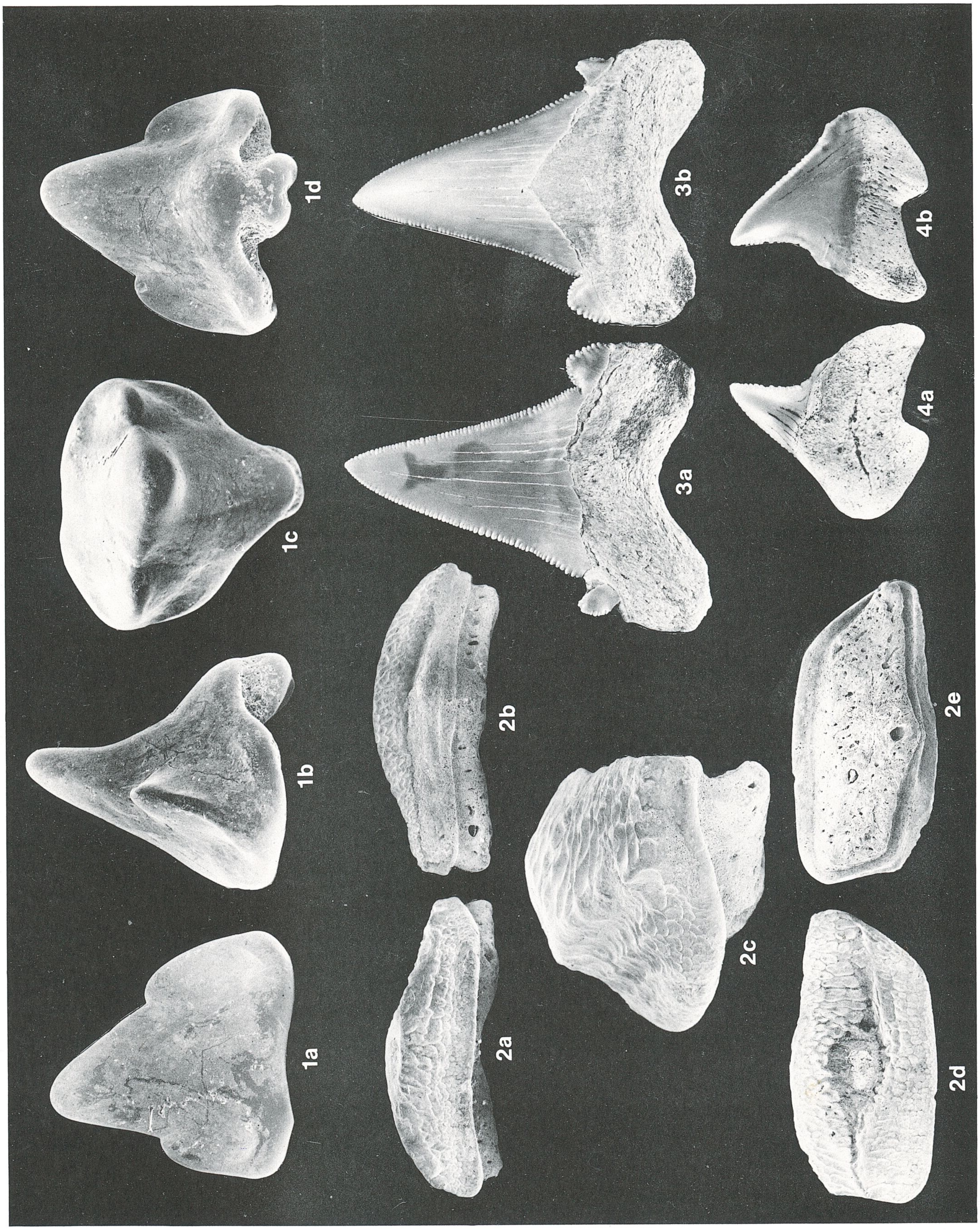
3. (UNSM 23568), x1.5 a. Right profile view, rostum fragment. — b. Border view. (Note notches for attachement of soines).
4. (UNSM 23566), xl.7. a. Left profile view, rostal spine. — b. Border view. — c. Left profile view.
5. (UNSM 23565), x2.5. a. Left profile view, rostal spine. — b. Border view. — c. Right profile view.
6. (UNSM 23567), x2. a. Left profile view, rostal spine. — b. Border view. — c. Right profile view.

Fig. 7. *Rhinoptera daviesi* Woodward

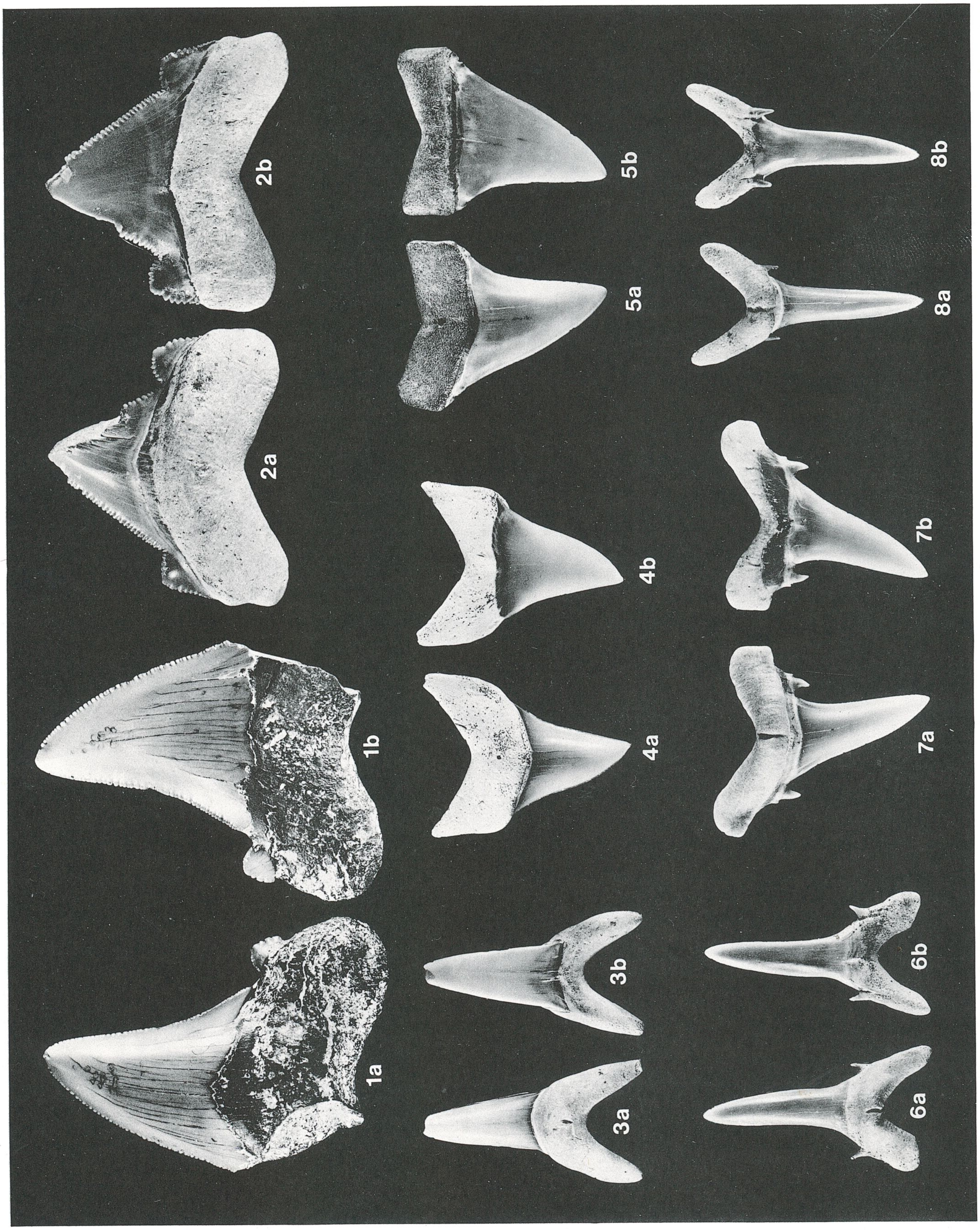
7. (UNSM 23573), x13 (SEM picture). Fragment of a chevron from the lower jaw.

Figs. 8—10. *Myliobatis* sp.

8. (UNSM 23575), x2.2. a. Ventral view (attached to cartilage). of an isolated pavement crusher chevron. — b. Profile view. — c. Dorsal (occlusal) view.
9. (UNSM 23578), xl.2. a. Dorsal view, of a fragment (mesial) of a stinger barb spine (from tail region). — b. Ventral view.
10. (UNSM 23576), 8.2 cm. a. Profile view, section (specimen 2/3rd complete) of a lower jaw dentition. — b. Occlusal view. — c. Ventral (attached view.



Gerard R. Case: Late Eocene Selachians from South-Central Georgia.



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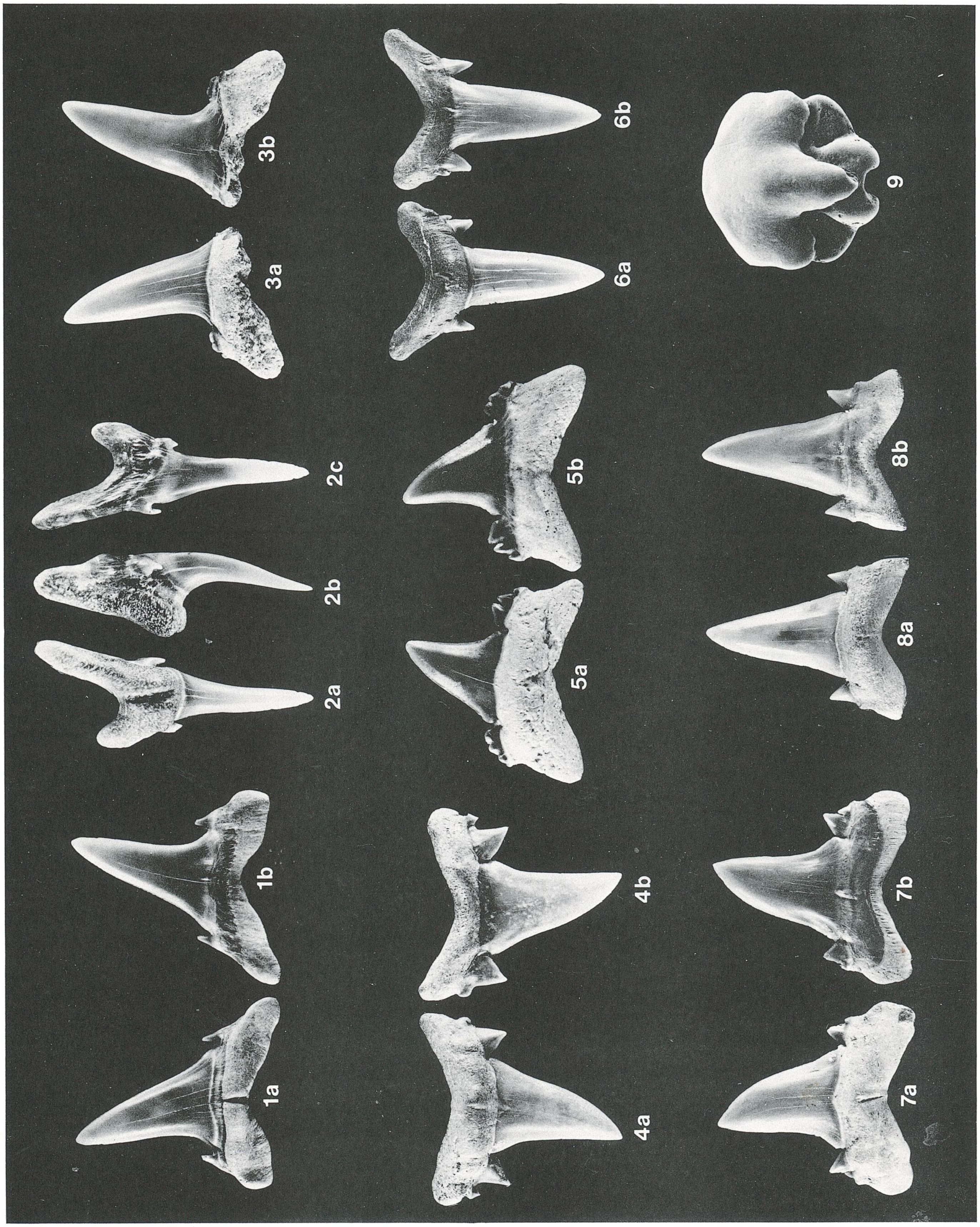

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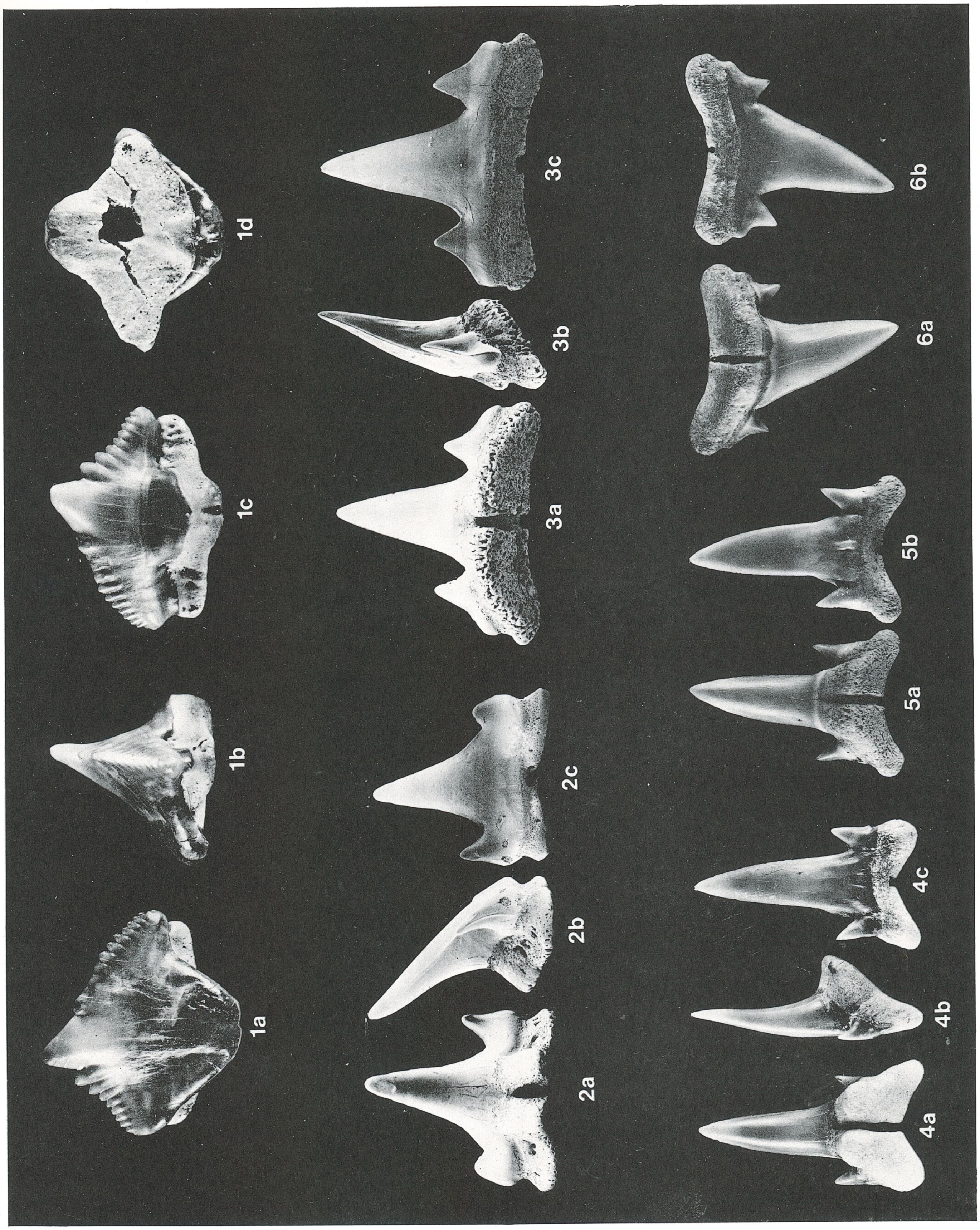

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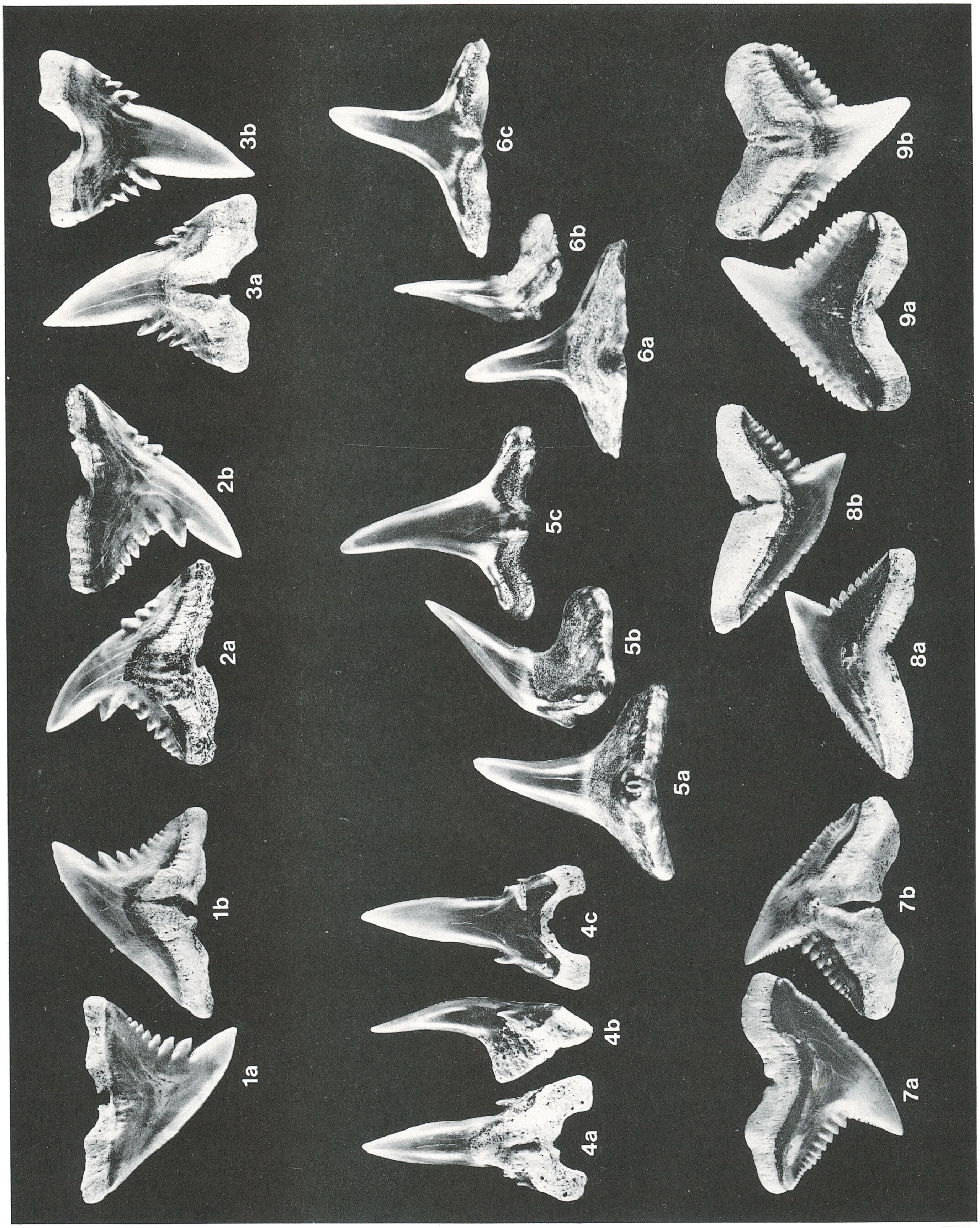

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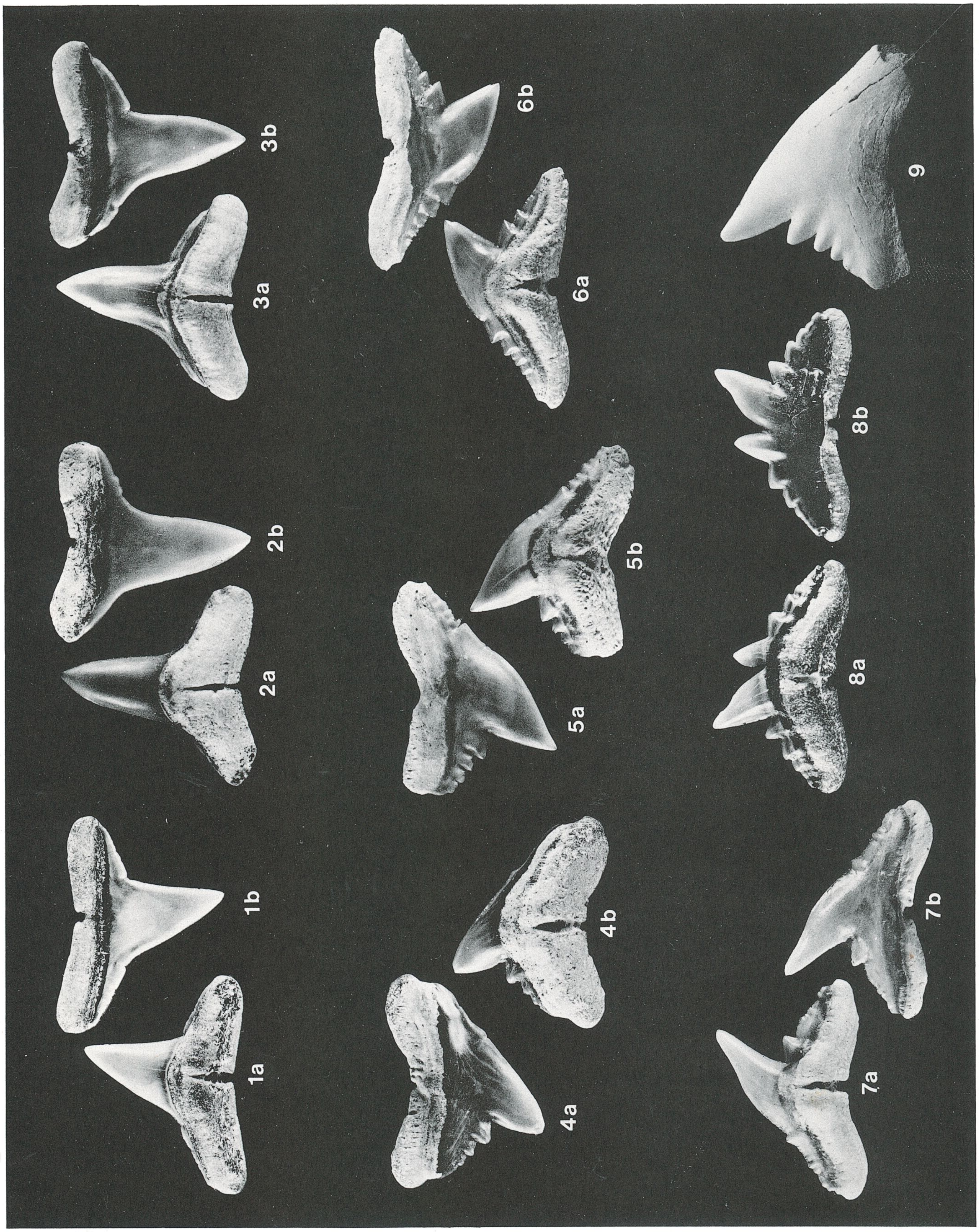

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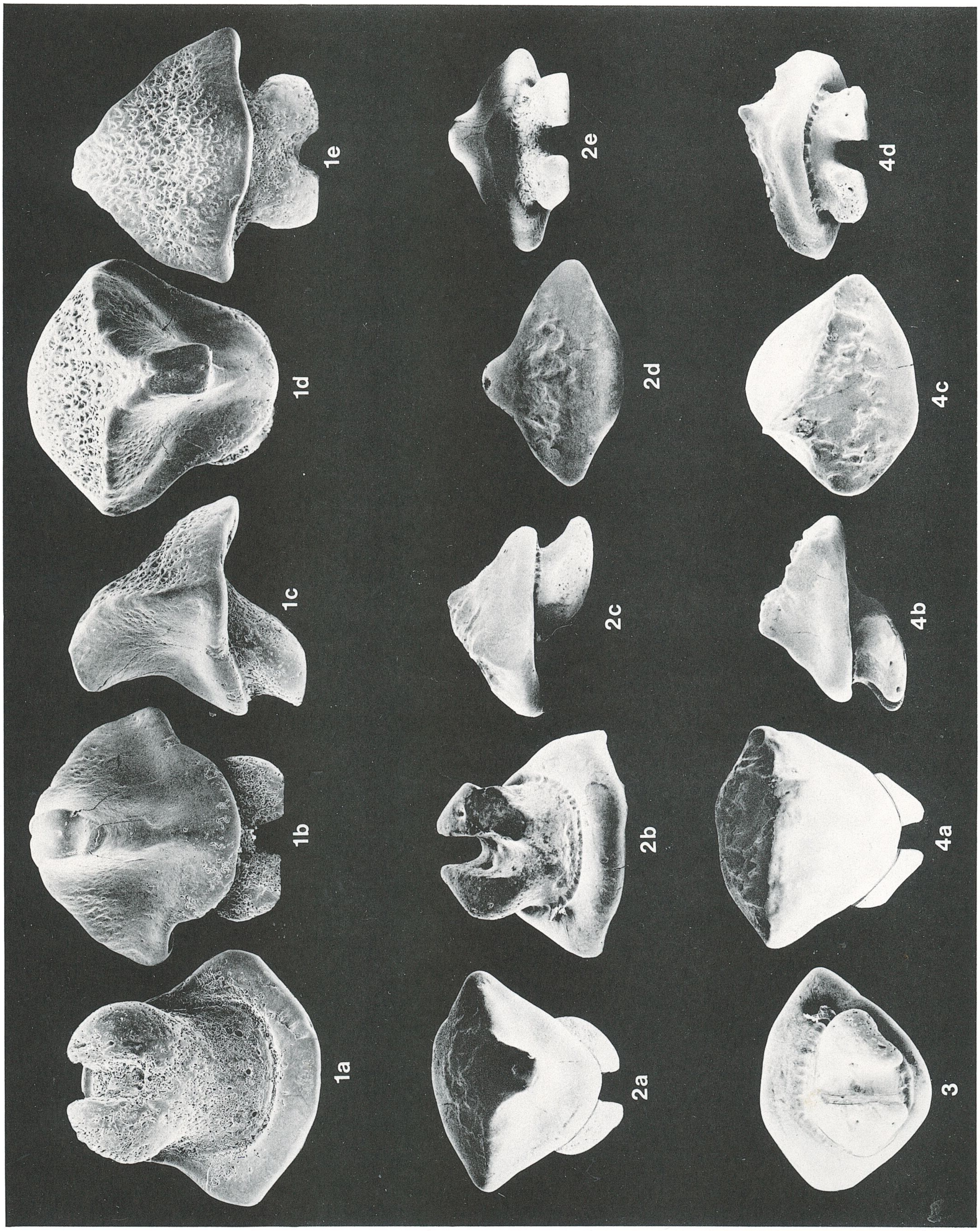

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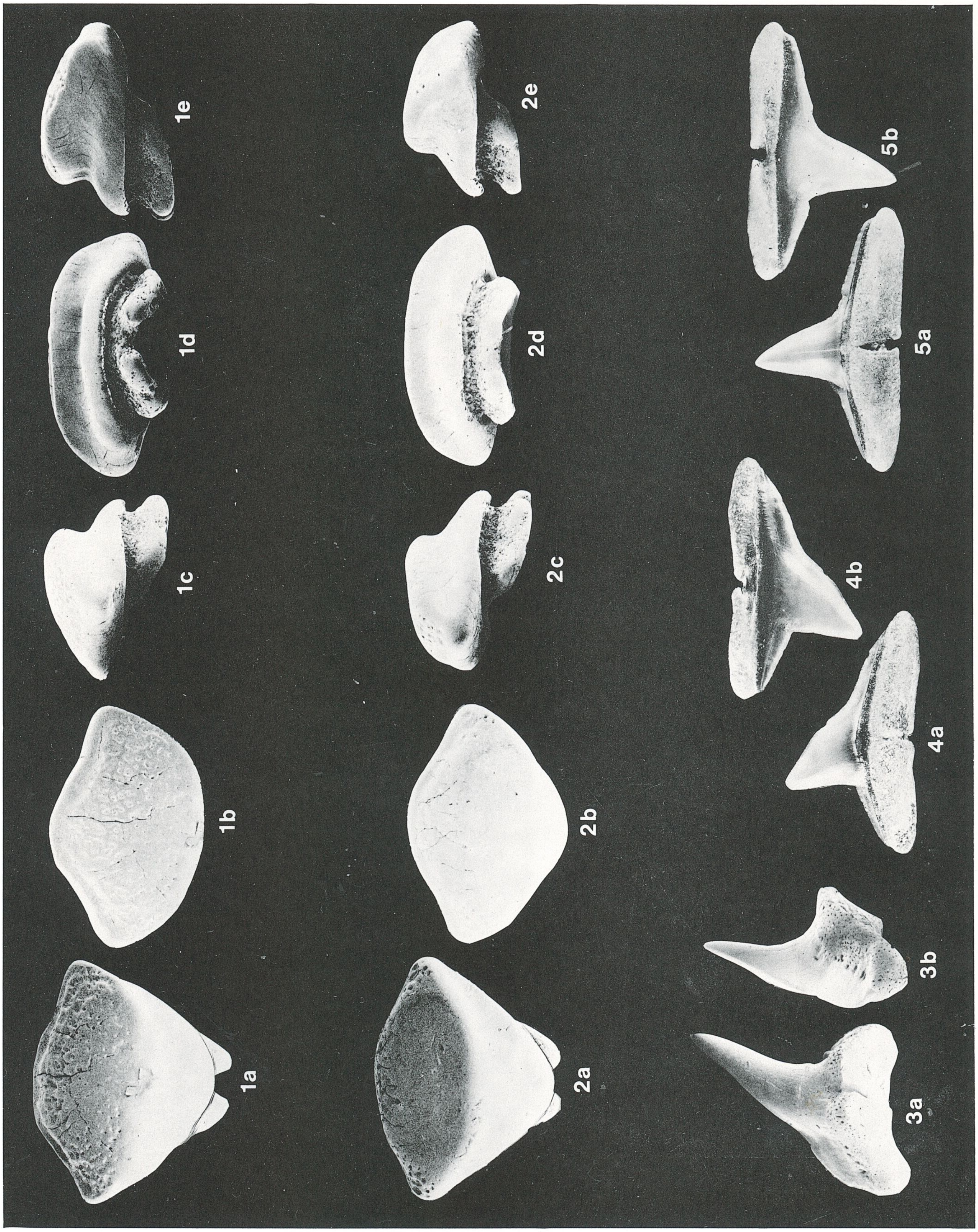

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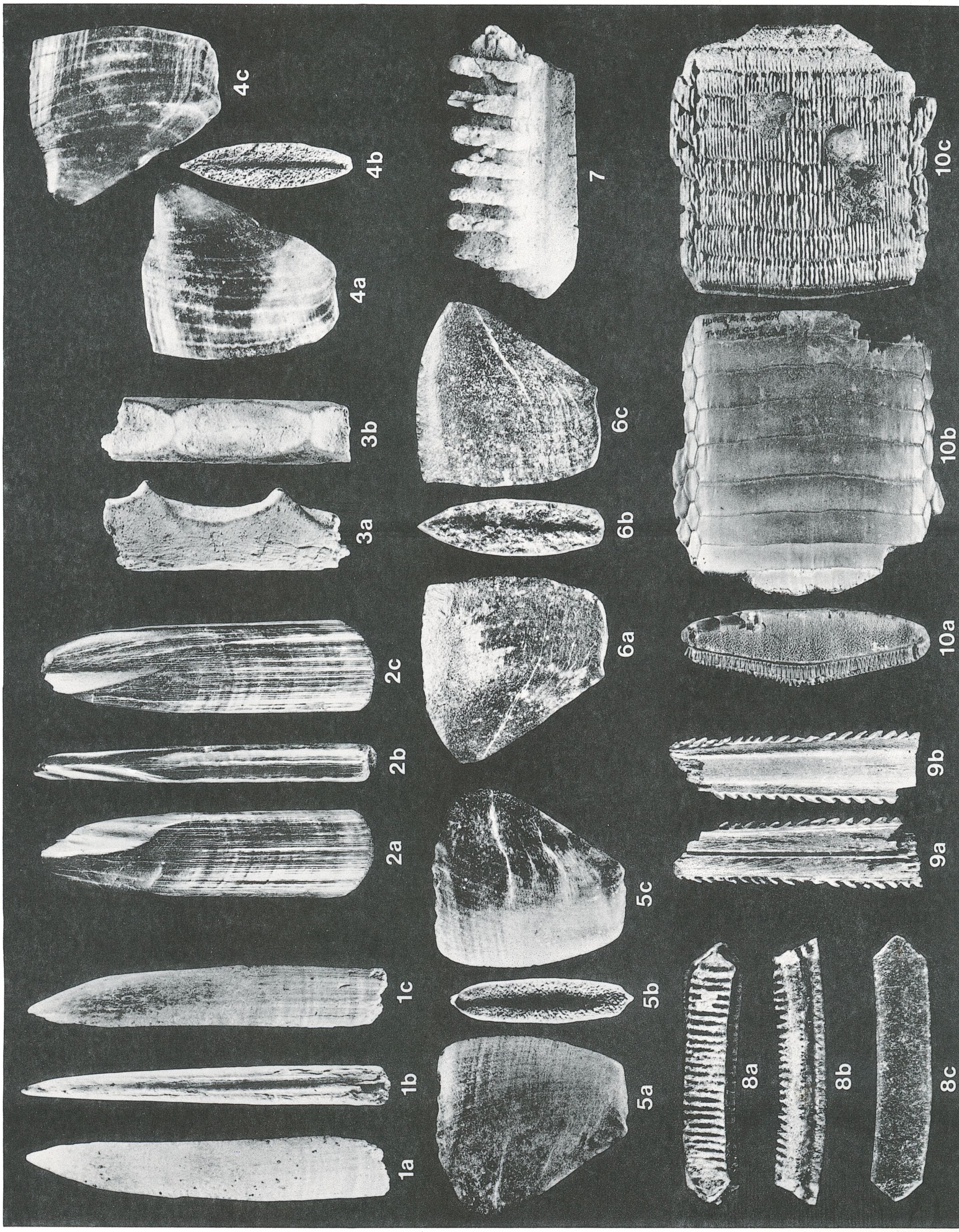

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