

## A REVISION OF THE HIGHER TAXA OF ORECTOLOBIDS

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### ABSTRACT

A comparison of characters among the orectolobids has resulted in a division of this group into an order with three suborders, eight families, and twelve genera. *Sutorectus* cannot be considered a valid genus. The orectolobids are the most primitive sharks with lamnoid vertebrae. The orectolobids probably represent an ancestral group from which the Lamniformes arose and may also be ancestral to the Carchariniformes. The orectolobids share characters with the Heterodontiformes, Squatiniformes, and the Pristiophoriformes, and it is believed that all of these sharks have a common hybodont ancestry.

### INTRODUCTION

PATTERSON (1965) placed living and fossil sharks and shark-like fishes in the class Elasmobranchimorphi. This taxon was divided into three subclasses: Arthrodira, Holocephali, and Selachii. The Selachii included all the sharks and rays. The Selachii may be divided into two superorders, the Paleoselachii, which includes the Paleozoic sharks exclusive of the hybodonts, and the Euselachii, which includes the hybodonts and their descendants among these rays. The orders which may be recognised in the Euselachii are: (1) Heterodontiformes, the horn sharks; (2) Chlamydoselachiformes, the frilled sharks; (3) Hexanchiformes, the six and seven gilled sharks; (4) Squatiniformes, the angel sharks; (5) Pristiophoriformes, the saw sharks; (6) Squaliformes, the spiny dogfishes; (7) Torpediniformes, the torpedo rays; (8) Pristiformes, the saw fishes; (9) Rhinobatiformes, the guitarfish; (10) Rajiformes, the skates; (11) Myliobatiformes, the stingrays; (12) Lamniformes, the mackerel shark group; (13) Carchariniformes, the bay shark group.

To this can be added a new order, Orectolobiformes, the nurse sharks, which are the subject of this paper. The Orectolobiformes are characterised as follows: the endocranium is lacking both a tripartite rostrum as well as a boat-shaped rostrum. The vertebral column is calcified, with vertebrae of the lamnoid or pristiuroid type (Applegate, 1967). Two dorsal fins and an anal fin are present. The mesopterygium does not reach the anterior margin of the pectoral fin. Claspers in the male so far as is known bear spurs (Applegate, 1965). Teeth of the orectoloboid type are as described by Casier (1947). A central canal lies below the tooth; there is a small posterior canal, and on either side of the base of the crown are two small posteriorly directed canal openings (a true bipartite root is not fully developed). The teeth may consist of osteodentine or orthodentine, a point discovered by Leonard Compagno (personal communication).

Externally, the mouth may be terminal or subterminal. Nasal flaps or cirri are well developed. At some time in development a groove connects the nostrils

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with the mouth. Ridges on the back are present in several of the families. Internally, the heart has two or three rows of valves. The spiral valve is of the ring type or spiral type. Reproduction is oviparous or ovoviviparous.

The exact origin of this order is not clear. The Orectolobiformes have a Jurassic record and show a relationship to the Hybodontiformes, Squatiniformes, and Squaliformes, with such common characters as a flange on the teeth and nasal cirri. The Squatiniformes and modern Squaliformes show a number of modifications not found in the Orectolobiformes, such as loss of the anal fin and elaboration of body scales. At the present time there is no good, single link that would tie the Orectolobiformes to the Heterodontiformes directly.

Available evidence shows that the Lamniformes (in the restricted sense) and the Carchariniformes are derived from the Orectolobiformes, either from extinct forms or from living groups within this order.

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The three suborders Rhincodontoidei, Orectoloboidei, and Parascyloidei, can be characterised as follows :

#### *Rhincodontoidei*—NEW SUBORDER

In this suborder there is only one family, Rhincodontidae, and one known species, *Rhincodon typus*. This is a shark with a high caudal axis. The upper caudal lobe is elongate and about twice the length of the lower; the lower lobe is prominent and triangular; the general shape of the caudal fin is lunate. There is an upper precaudal pit but no lower pit. A keel is present on the caudal peduncle but it is not greatly expanded, being more or less an extension of the dermal ridge. Three dermal ridges are present along the sides of the body, and in some specimens a medial ridge starts behind the eyes and runs to the dorsal fin. The vertebrae are of the general lamnoid type as described by Applegate (1967), but show so far as known, only four rays. The vertebrae have very prominent concentric rings. Scales are very small, only one mm long in a 31-foot specimen according to Bigelow and Schroeder (1948). Three keels are present on the blades, the middle keel being longest. The teeth (Plate III, figures 1, 2, 3) are small, averaging 1.5 mm in an 18-foot specimen, and very numerous, around 3600, in ten rows (Bigelow and Schroeder, 1948). They are composed of osteodentine. A flange is present. The crown is claw-like, without a definite lateral denticle. Gill rakers are present and modified into a sieve. There is no foramen between the mesopterygium and the metapterygium. The origin of the first dorsal is in advance of the pelvic fins; it is much larger than the second dorsal. The anal is the smallest fin. The mouth is terminal. Nasal flaps are present but simple. A nasal groove is present in the embryo, but seems to run only to the upper labial furrow in the adult. The family is oviparous.

*Orectoloboidei*—NEW SUBORDER

This comprises sharks characterised by having the origin of the first dorsal behind the pelvic fins. The tail is elongated and the axis is low. No pointed lower corner is present, nor is the lower part of the tail expanded as definite lobe. No caudal peduncle is to be found. There are no precaudal pits. Gill arches are without rakers or sieves. The nostrils are always connected to the mouth by a deep groove. The anterior margin of nostril has a well developed cirrus. The teeth are small, with one or more small cusps. The mesopterygium and metapterygium are separated by a large foramen. Medial teeth are present in both upper and lower jaws. Dermal ridges are present in several families.

In the *Orectoloboidei* there are four families, the *Orectolobidae*, *Ginglymostomatidae*, *Hemiscylliidae*, and the *Brachaeluridae*.

## BRACHAELURIDAE—NEW FAMILY

*Description*: The head is broad, almost tadpole-shaped. The inside edge of each of each nostril has a long cirrus that reaches well below the jaw and is continued anteriorly by a raised rim that terminates in a projection on the outside of the nostril. This projecting flap covers the end of the upper labial fold. The upper labial fold does not make a complete juncture with the nostril. The internarial flap is slightly overhanging but without division or projection. The lower labial fold is larger than the upper, going below the jaw but not continuous. The center of the lower outer lip of the jaw is divided by a deep symphyseal groove. A definite vestigial flap is present outside of the nasal groove, running from the nostril to the mouth, and another flap occurs under the cirrus and occupies the anterior inner portion of the nostril. The eye is elongate and small; the lids form a horizontal slit, a slight rim is present. The spiracle is equal to the eye length, with a definite raised rim present, particularly in adults; it is located behind and below the eye, about one eye length away. The axis of the spiracle is about 30° in relationship to a straight line formed by the eyelids; it is oval in shape. The eye length is about equal to the length of the first gill slit. All the slits are well separated from each other. The fifth gill slit is the longest, the fourth the shortest. From the first gill slit to the fourth, slits get progressively smaller.

Above and behind the head two faint ridges are present, arising from a point that is just behind the spiracle but on top of the shark. These ridges run to the tail. Scales on the back in young individuals show three faint ridges, which tend to disappear in adults, as the scales are replaced. Pit organ scales are present in the young but difficult to find in the adults. Both pit scales are similar in shape, being higher and more pointed than the surrounding scales. They occur inside of the two ridges and run back to the caudal peduncle. The teeth (Plate III, fig. 5) are in several rows, heterodonty is weak. On each side of the crown is a very distinct lateral denticle. The anterior flange is not strongly developed. The anterior teeth have an elongate, narrow crown. Two genera are placed in this family, *Brachaelurus* and *Heteroscyllium*. The status of the latter genus is open and it may represent a species of *Brachaelurus*. In many of its characters *Brachaelurus* seems to lie between the *Hemiscylliidae* and *Orectolobidae*. Whether *Brachaeluridae* is the most primitive family in the *Orectolobidae* is still an open question. It does, however, bear a number of resemblances in general shape and structure to the *Heterodontiformes*, a form which might be the expected ancestor.

## HEMISCYLLIIDAE WHITLEY

*Description* : These are elongate sharks with over half of their length behind the pelvic fins. The head is expanded in *Chiloscyllium* and narrow in *Hemiscyllum*. The internal nasal cirri reach the mouth. There is no anterior rim to the nasal aperture but a lateral rim is present with a definite flap. The upper labial fold reaches the nostrils. The internarial flap has three divisions : the two outer tabs extend over the teeth, and the median part of the flap is attached to the connective tissue immediately above the middle of the upper jaw. The spiracles are present below the back half of the eye and are from one half to three-quarters the length of the eye. There is no definite spiracle rim present. The first gill slit is small, about equal to the eye length. The gill slits become progressively larger from the first through the fifth. The fourth gill slit is above the fifth, but a strip of the fifth gill cover is visible. The last three gill slits are over the pectoral fins. The first dorsal fin is about equal to the second in size. The pelvic fins are larger than the dorsals, and the pectorals are larger than the pelvics. The anal fin is situated far behind the second dorsal fin and is only separated from the caudal fin by a slit, forming for all intents and purposes part of the tail. There is a median dorsal ridge behind the two dorsal fins. A lateral ridge may or may not be present, as well as a median ridge anterior to the first dorsal fin. The scales guarding the pit organs are two in number. The anterior scale is slightly smaller than the normal scale. The posterior scale is larger but neither is conspicuous. Body scales, in general, are spade-shaped with three ridges.

Functional teeth are in four or more rows, quite small, and vary greatly in shape. The lateral cusps are quite small, if developed at all. In most species, crowns tend to be asymmetrical. In this family at the present there are two genera, *Hemiscyllum* and *Chiloscyllium*, both with a number of species. There is a definite need for a review of this group at the specific level. The Hemiscylliidae seem allied to the Brachaeluridae, with which they share a number of characters. In turn, the Cirrhoscylliidae may be distinct from the Hemiscylliidae. However, they show as will be discussed, a number of non-orectolobid characters.

## FAMILY ORECTOLOBIDAE REGAN

*Description* : These are flat-headed, wide-bodied sharks (Plate I), with the greatest width just behind the eyes. The sides of the head have skinny flaps. The mouth is terminal. The pectoral fin is larger than the pelvic which is as large or larger than the dorsals. The two dorsal fins are of about equal size. The origin of the first dorsal is above or behind the middle of the pelvic fin and posterior to the second dorsal. The anal fin is close to the caudal fin. The caudal axis is almost straight. The lower lobe is almost symmetrical with a smooth curving edge. The caudal tip is larger than the anal fin. The posterior edge of this fin tends to be square. The backs of some species of these sharks bears two rows of raised bumps or papilliae that start above and behind the eyes. The skin below the lower jaw shows a distinct symphyseal groove. Long nasal cirri reach below the jaw. The anterior portion of the nostril has a definite rim that recurves laterally. There is a long upper labial groove which reaches the nostril. Below the groove is an anteriorly directed vertical flap. The nasal opening is confluent with the mouth. The lower labial fold almost reaches or does reach the symphyseal groove. The internarial flap is undivided externally. Internally there are three divisions and a fluted edge. On the sides of the head five or more lateral skin flaps are present with two or more behind

the spiracle. Flaps are simple or divided distally. The first four gills are almost equal in size. The fifth gill is larger than the fourth. The fourth gill slit is on top of the fifth. The last two gill slits are behind the pectoral fin. The eye is raised above the flat surface of the head and is approximately one half the length of the spiracle. The spiracle is situated below and behind the eye and is at least one eye length distance from it. The spiracle would make an angle of about thirty degrees from the horizontal.

Scales are short, spatulate, with three raised ribs on the anterior top of the blade. The posterior surface is smooth. Scales on top of the head are much larger than those of the body.

The teeth (Plate II, figs. 1, 2, 4) are high, sharp pointed, and dagger-like. An anterior flange is prominent, behind which are two lateral extensions of the crown that face down onto the root. Heterodonty is pronounced in this family. One or two rows of teeth are functional. In the upper and lower jaws a small median tooth is present above a large one below. A single, large anterior occurs on either side of the median teeth in both jaws. Four to six laterals and four to six posteriors are noted. The dental formula for *Orectolobus ornatus* is, for example :

$$\begin{array}{ccccccc} & & & \text{(small)} & & & \\ & & & \text{P5 L6 A1 M1 A1 L6 P5} & & & \\ \hline & & & \text{P4 L4 A1 M1 A1 L4 P4} & & & \\ & & & \text{(large)} & & & \end{array}$$

The Orectolobidae as here constituted consists of two genera: *Orectolobus* and *Eucrossorhinus*. The genus *Sutorectus* as differentiated by Whitley appears to have characters which only warrant specific distinction. The distance between the dorsal fins tends to be a variable in the genus *Orectolobus*, and other species in the genus have papillae, or at least definite bumps on their backs.

#### FAMILY GINGLYMOSTOMATIDAE WHITLEY.

*Description* : These sharks have a fusiform shape and a deep body. The caudal axis is slightly raised. The tail is about one-third of the total length. The dorsal fins vary in size; the first is much larger than the second. The anal fin is as big as the second dorsal fin. The trailing edge of the anal fin is in front and just below the origin of the caudal fin. The spiracles are minute and directly behind, or behind and slightly below the eye. The spiracles lie at a greater distance behind the eye than the eye length. There are no fleshy tabs or lobes on the side of the head. There are no fleshy bumps or papillae, on the back nor are dorsal ridges present. No longitudinal fold is present below the eye. Gill slits get progressively larger posteriorly. The last gill slit is the largest. The fourth gill slit lies over part of the fifth slit. The last two or three gill slits are over the pectoral fin. The upper and lower labial folds are prominent. The lower folds do not meet, nor is a symphyseal groove present. The first dorsal fin is over or slightly posterior to the pelvic fin. The second dorsal fin is anterior to the origin of the anal fin. The nasal cirri extends below the mouth. Flaps in the nostrils are poorly developed. A fleshy internarial flap is present. The teeth (Plates II & III) are large for the order as in the Orectolobidae. The crown consists of a central cusp and more than one lateral cusp on either side. Either there is a single large central cusp as *Ginglymostoma* (Plate II, figure 3) or all of the cusps are about equal in size as in *Nebrius*, (Plate III, fig. 4).

There are several functional rows of teeth. The Ginglymostomatidae consists of two genera, *Ginglymostoma* and *Nebrius*. The Ginglymostomatidae lie closer to the mackerel sharks, the Lamniformes, than does any other living group of orectolobids. Within the order Orectolobiformes, the Ginglymostomatidae lie closer to the Brachaeluridae than to any other group. They show a number of parallels with the Stegostomatidae but the differences are equally striking.

#### STEGOSTOMATIDAE—NEW FAMILY

*Description:* The head is broad and somewhat depressed. The nostrils have cirri that reach the mouth. There is no raised border around the anterior portion of the nostril, but there is a small flap on the anterior inner nostril border. Below the large inner cirrus is a ventral flap attached just below the cirrus and running to the mouth. On the other side of the nasal opening is a third flap which is mostly inside the nostril and runs anteriorly, its point of attachment forms a process on the lateral rim of the nostril. The upper labial fold is short and excluded from the nostril. The lower labial fold is even shorter than the upper. The lower labial fold does not go below the middle of the jaw. No symphyseal groove is present. The internarial flap is attached and not free; no projections are present but the edge is irregular and undulating. The eye is small and elongate. The spiracle is directly behind the eye; it is a vertical slit that is half the eye length and there is no definite rim. The distance from the spiracle to the eye is about half the eye length. The first gill slit is slightly longer than the eye and the slits become progressively longer. The fourth gill slit is directly over the fifth. The last three gill slits are over the pectoral fin. There is a dorsal ridge with enlarged scales beginning just posterior to the spiracles on the median line of the back and running to the first dorsal fin. A ridge occurs between the first and second dorsal fins, and again posterior to the second dorsal fin, continuing onto the caudal fin. A second pair of ridges starts slightly behind and below the beginning of the dorsal ridge, one on each side, and runs to the caudal fin on the anterior part of this second ridge. A line of pit organs runs below the second ridge. Below the pit organs is another ridge of enlarged denticles running to the center of the fleshy part of the caudal fin. Just behind and above the insertion of the pelvic fin is still another ridge running to the base of the caudal fin. A faint mid-ventral ridge runs from behind the pelvics to the origin of the anal fin and resumes as a more prominent ridge, continuing onto the caudal fin, where it forms the edge of the fin. The teeth (Plate III, figs. 6, 9, 10) are very small. On each side of the crown are several large lateral cusps. The roots are V-shaped and close together.

The first dorsal is much larger than the second. The anal is slightly larger than the second dorsal, and the pelvics are slightly larger than the first dorsal. The pectoral fins are the largest and are rounded at the rear. The insertion of the first dorsal is directly below the origin of the pelvics. The origin of the anal is below the posterior edge of the second dorsal. The Stegostomatidae consist of one genus *Stegostoma*, with probably one wide ranging variable species. Of all the living orectolobids, *Stegostoma* bears a closer resemblance to *Rhincodon* in a number of characters, such as differential dorsal fin size, small teeth, and prominent dorsal ridges. Within the Orectoloboidei it has affinities with the Brachaeluridae and the Hemiscylliidae.

*Parascyllioidei*—NEW SUBORDER

These are sharks with an elongate body and a low caudal axis. There are no ridges along the body. The vertebrae are of the pristiuroid type as described by Applegate (1967). The scales are small with some indication of keels. The teeth are double-rooted. In the pectoral fin only two basals are present, a mesopterygium and a metapterygium. The propterygium is lacking as a separate element though it may be fused to the mesopterygium. The meso and metapterygium are separated by a large foramen. The anal fin is widely separated from the caudal. The first dorsal fins are well behind the pelvic fins. The teeth have definite double roots. The chondrocranium is very complex and differs from that of the other orectolobids in a number of characteristics.

## PARASCYLLIIDAE—NEW FAMILY

*Description*: These are narrow-bodied elongate sharks with the highest part of the shark above the gill slits. No marked elevation occurs above the pectoral fins nor is there a marked narrowing of the body until after the first dorsal fin. There are no paired appendages under the throat. The upper labial fold does not reach the nostril but is quite short. The lower labial fold is at least three times longer than the upper labial fold but does not meet at the symphysis. No symphyseal groove is present. The nasal cirrus is adherent most of its length except at the tip which reaches only to the upper lip. There is no anterior narial rim but a single small projecting flap is present on the anterior wall of the nostril. The outer lateral edge of the nostril forms a strong rim that curves posteriorly, then runs anteriorly as a flap which is appressed to the outer side of the nostril. There is an internarial flap which, at its center, is attached to the gum of the upper jaw. The two lateral parts of the internarial flaps cover the internal narial opening. The spiracle is minute and located below the posterior corner of the eye about one-third of an eye length from its corner. Below the eye there is a definite groove in the skin and in *Parascyllum collare* there are two grooves above the orbit. The eye length is about one half the width of the jaw or the length of the last gill slit. There are numerous rows of functional teeth. The teeth are very small with scale-like crowns, and weakly developed lateral denticles. No striae were noted on the crown. The teeth are made of very thick orthodontine. The root is divided into two definite parts. A flange is poorly developed if it can be said to be present at all. The two root canals are just below the crown and are placed very far apart on the sides of the teeth. A central root canal is present below and between the roots. The scales are smooth on top of the blade with three or four ridges on the anterior edge of the blade. The scales are close together and give the appearance of a smooth continuous surface. The first dorsal fin is slightly larger than the second. The pelvic fin is as large or larger than the pectoral fin. The anal fin is placed a good distance from the caudal fin with its insertion in advance of the origin of the second dorsal. The first dorsal is almost two base lengths behind the pelvic insertion. The Parascylliidae consists of the single genus, *Parascyllum*. These sharks are closely related to the Cirrhoscylliidae but show a number of important differences. The teeth are not as scylliorhinoid as in the Cirrhoscylliidae. The Parascylliidae are closer to the Hemiscylliidae than to any other group in the Orectoloboidei.

## CIRRHOSCYLLIIDAE—NEW FAMILY

*Description*: These are narrow-bodied elongate sharks with a low caudal axis. The portion of the body above the pectoral fins is elevated. Behind this elevation

the body narrows to the tail. A pair of thread-like appendages are present on the underside of the throat. The upper labial fold does not reach the nostril. The lower labial fold extends to the symphysis. The nasal cirri are not pronounced in the type. The four anterior gill slits are narrow. The fourth gill slit opens on the wall of the fifth. The fifth gill slit is very wide. Both the fourth and fifth gill slits lie above the pectoral fin. The spiracle is minute and lies behind and below the eye. It appears (Smith, 1913, illustration) to be almost one half an eye length behind the eye. There is a well developed naked fold of skin around the eye. The eye length is equal to the last gill slit. The teeth (Plate III, figs. 7 & 8) are numerous and small. The crowns bear anterior striae. There is a definite and distinct lateral cusp on each side of the crown. The root is divided into two limbs. The division is best seen posteriorly (Plate III, fig. 8) where the central canal lies between the two roots. Scales with three keels run the length of the top of the blade. These scales are smoother on the abdomen. The dorsal fins are small and almost equal in size. The second dorsal origin is over the base of the anal fin. The pelvic and pectoral fins are large, both of about equal size. The Cirrhoscyllidae are known by one genus, *Cirrhoscyllium*. The family Cirrhoscyllidae is related to the Parascyllidae.

#### CONCLUSION

The diversity of living orectolobid sharks warranted a re-examination of their systematic position. The revised classification is as follows :

- Order Orectolobiformes
  - Suborder Rhincodontoidei
    - Family Rhincodontidae
      - Rhincodon*
  - Suborder Orectoloboidei
    - Family Brachaeluridae
      - Brachaelurus*
      - Heteroscyllium*
    - Family Hemiscylliidae
      - Hemiscyllium*
      - Chiloscyllium*
    - Family Orectolobidae
      - Orectolobus*
      - Eucrossorhinus*
    - Family Ginglymostomatidae
      - Ginglymostoma*
      - Nebrius*
    - Family Stegostomatidae
      - Stegostoma*
  - Suborder Parascyllioidei
    - Family Parascylliidae
      - Parascyllium*
    - Family Cirrhoscyllidae
      - Cirrhoscyllium*



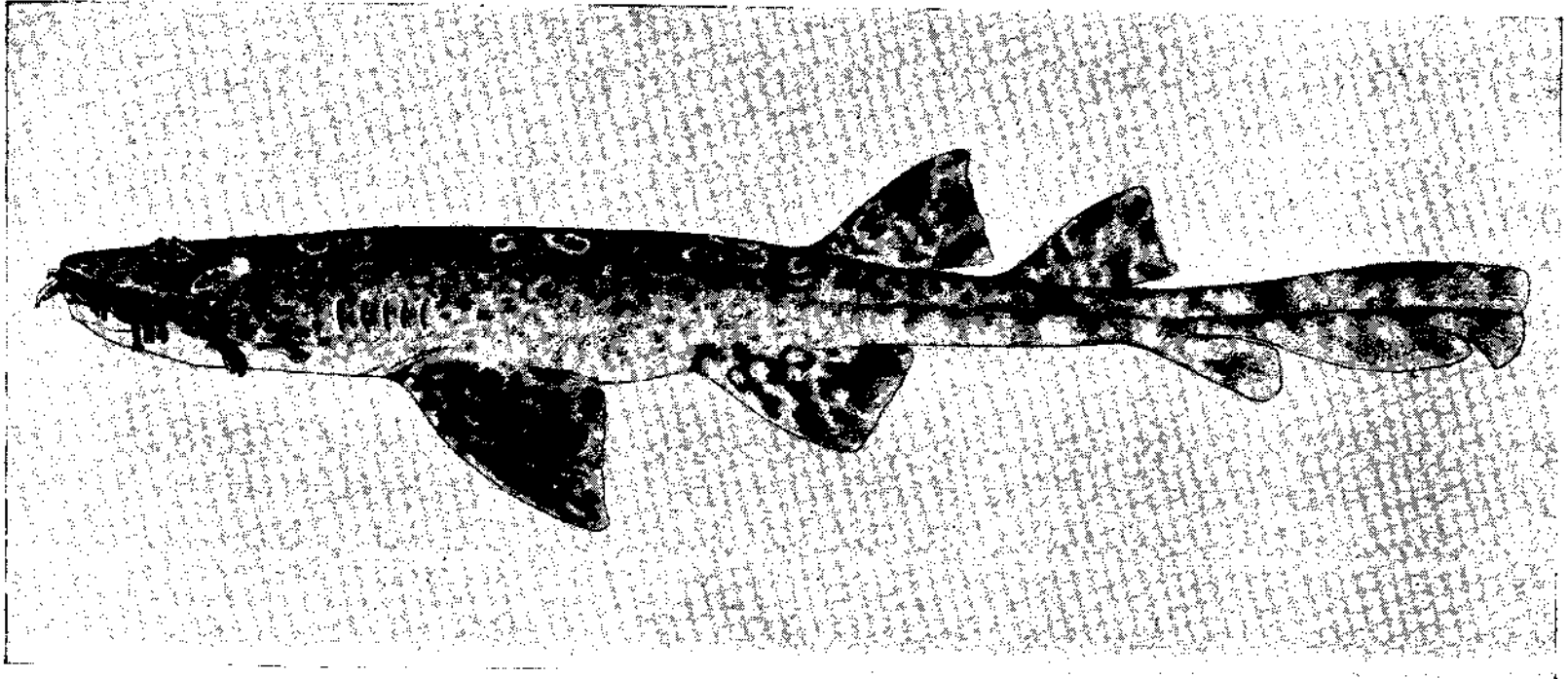


PLATE I. Drawing of *Orectolobus japonicus*—a typical orectolobid.

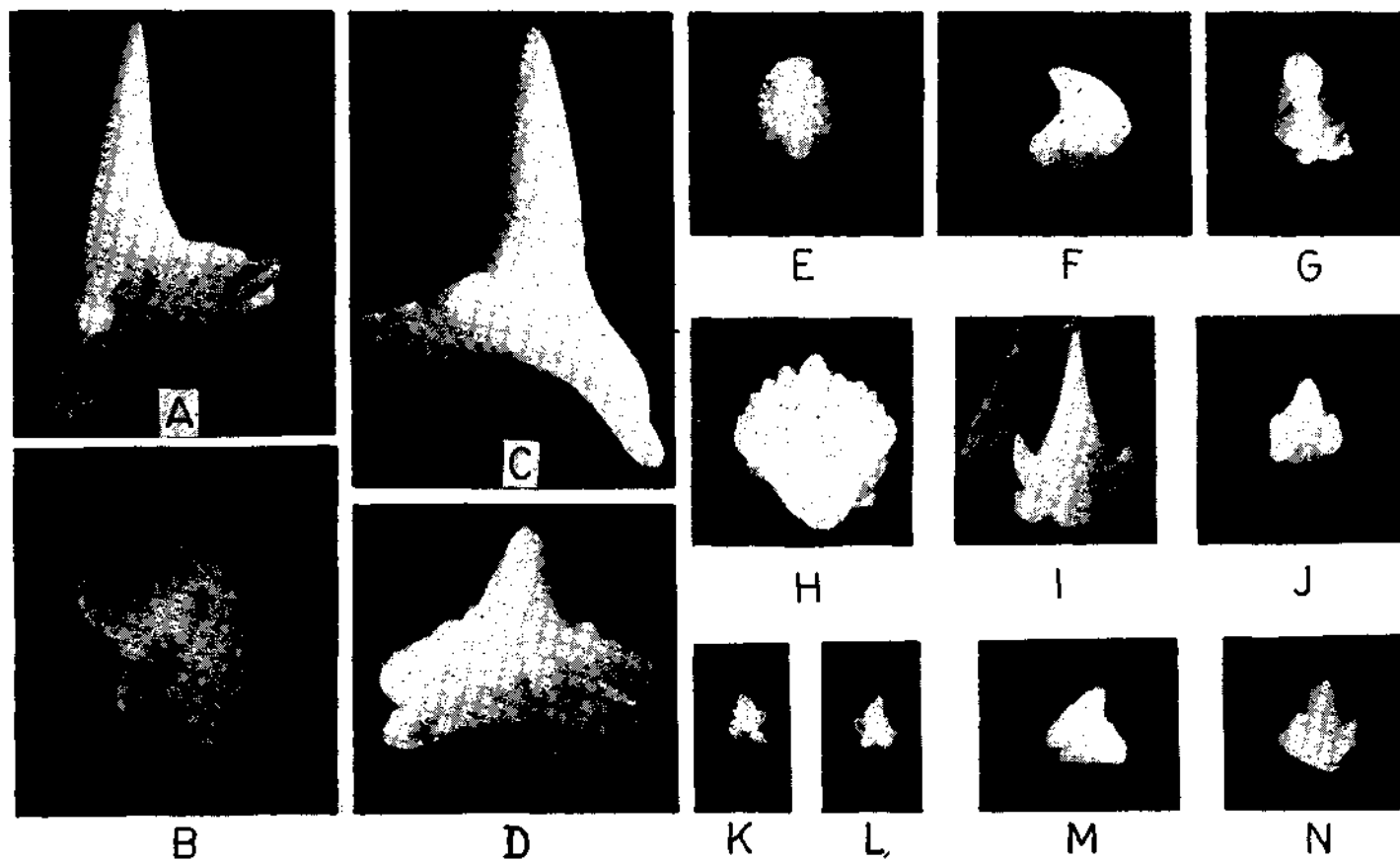


PLATE II. Teeth of Rhinodontidae, Orectolobidae, Ginglymostomatidae, Brachaeluridae, Cirrhoscyllidae and the Stegostomatidae, A-C. Tooth of *Orectolobus ornatus*, New South Wales, Australia. A. Anterior surface of tooth viewed from the side to show anterior flange; B. View of tooth base to show central canal; C. Posterior view to show posterior root canal; D. *Ginglymostoma cirratum* from Mexico. posterior view of an anterior tooth; E-G. Tooth of *Rhincodon typus*, USNM 27618; E. Tooth viewed from above. The tip of the crown points toward the top of the page; F. Lateral view of the tooth; G. Posterior view of the tooth showing the flange; H. Anterior view of the anterior tooth of *Nebrius concolor*, from Thailand; I. Anterior view of the anterior tooth of *Brachaelurus waddi* from Australia; J. M. and N. tooth of *Stegostoma fasciatum* from Thailand; J. Posterior view of tooth showing the V-shaped root, M. Lateral view; N. Anterior view; K. and L. Tooth of *Chirrhoscyllium exolitum* from the China Sea; K. Anterior view; and L. Posterior view.

## REFERENCES

- APPLEGATE, S. P. 1967. A survey of shark hard parts, p. 37-67. In P. W. Gilbert, (ed.), *Sharks, skates, and rays*. The John Hopkins Press, Baltimore.
- BERG, L. S. 1947. *Classification of fishes both recent and fossil*. J. W. Edwards, Ann Arbor, Michigan.
- BIGELOW, H. B. AND SCHROEDER, W. C. 1948. Sharks, p. 59-546. In *Fishes of western North Atlantic*. *Sears Found. Mar. Res. Mem.*, 1, Part 1.
- CASIER, E. M. 1947. Constitution et evolution de la racine dentaire des Euselachii. *Bull. 2. Musee Roy. Hist. Nat. Belgique*, 23 : 14 : 1-32.
- FOWLER, H. W. 1941. Fishes of the Philippines and adjacent seas. *U.S. Nat. Mus. Bull.* 100, 13 : 1-820.
- PATTERSON, C. 1965. The phylogeny of the chimaeroids. *Philos. Trans. Roy. Soc. London. Biol. Sci.*, 249 : 101-219.
- REGAN, C. T. 1908. Revision of the family Orectobidae. *Proc. Zool. Soc. (London)*, 347-363.
- SMITH, H. M. 1913. The hemiscyllid sharks of the Philippine Archipelago, with description of a new genus from the China Sea. *Proc. U.S. Nat. Mus.*, No. 1997, 45 : 567-569.
- WHITLEY, G. P. 1940. Sharks, rays, devil-fish, and other primitive fishes of Australia and New Zealand. In: *The fishes of Australia. Part 1*. *Roy. Zool. Soc. New South Wales, Sydney*.

## DISCUSSION

- DR. W. KLAUSEWITZ : One German zoologist is working on evolutionary problems in these fishes. It may be considered a basic group not only for sharks, rays but also for bony fishes.
- MRS. M. M. DICK : In this connection, the remarks of Eugene Clark may be important.
- DR. W. KLAUSEWITZ : I think those are more on behaviour pattern than on systematics. She studied well-known species.