A REVISION OF THE ORECTOLOBIFORM SHARK FAMILY HEMISCYLLIDAE (CHONDRICHTHYES, SELACHII)

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BULLETIN
OF THE
AMERICAN MUSEUM OF NATURAL HISTORY
VOLUME 176 : ARTICLE 1 NEW YORK : 1983

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This article completes Volume 176.

BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY
Volume 176, article 1, pages 1–94, figures 1–93, tables 1–28
Issued December 19, 1983
Price: $8.25 a copy

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ISSN 0003-0090

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ABSTRACT

The genera *Hemiscyllium* and *Chiloscyllium* and their species are revised, and two new species of *Chiloscyllium* are described. *Hemiscyllium* includes five species: *H. freycineti, H. hallstromi, H. ocellatum, H. strahani,* and *H. trispeculare.* One juvenile specimen cannot be assigned to species and differs from all known juveniles. It may represent a new species, but adults must be acquired before this can be conclusively shown. *Chiloscyllium* includes seven species: *C. burmensis,* new species, *C. confusum* new species, *C. hasselti, C. griseum, C. indicum, C. punctatum,* and *C. plagiosum.* Skeletal anatomy and dermal denticles are studied and described for all species. A scheme of interrelationships within the family is proposed. The family Hemiscyllidae and the included genera of *Hemiscyllium* and *Chiloscyllium* are shown to be monophyletic.

INTRODUCTION

The Indo-Pacific shark family Hemiscyllidae contains the genera *Hemiscyllium* and *Chiloscyllium* (Compagno, 1973). At present there are five species in *Hemiscyllium,* and in *Chiloscyllium* there are five described species and two new species discussed below. Most species have a strong pigmentation pattern as juveniles, which is lost partly or completely as they mature into adults. They are hardy under captive conditions, and attain a maximum size of about 1 m. Their hardiness, small size, and beautiful patterning have caused them to be commonly imported for the pet trade.

In 1837 Müller and Henle erected the genus *Chiloscyllium* in which they (1841) included *Scyllium plagiosum* Bennett, *Squalus tuberculatus* Schneider (=*C. indicum* here), and two new species that they described as *C. griseum* and *C. punctatum.* Müller and Henle (1838) erected the genus *Hemiscyllium* for *Squalus ocellatus* Bonnaterre. In 1841 Müller and Henle considered both genera to be scyliorhinids, and noted the close relationship between the two genera; in 1841 they placed *Scyllium malaisianum* Lesson (which they spelled *malaianum*; =*H. freycineti* here) into the genus *Chiloscyllium.* Bleeker (1852) maintained the two genera, and described *C. hasselti,* which for a long time was considered a synonym of *C. griseum,* but here it is shown to be a distinct species. Duméril (1853) maintained the two genera, and kept the species *malaisianum* (which he spelled *malaianum,* following Müller and Henle, 1841; =*H. freycineti* here) in *Chiloscyllium.* Gill (1862) maintained both these genera and erected a third genus, *Synchismus,* for *C. tuberculatum* (=*C. indicum* here). He placed all three genera in the family Scyliorhinidae, but put *Hemiscyllium* into its own subfamily of Hemiscyllinae, and *Chiloscyllium* and *Synchismus* in the Chiloscyllinae. Günther (1870) placed all the species in the genus *Chiloscyllium,* family Scyliorhinidae. Waite (1901) again separated the two genera *Chiloscyllium* and *Hemiscyllium,* and first placed them in their own family of Hemiscyllidae. Regan (1908) placed all the species in *Chiloscyllium* in the family Orectolobidae. Garman (1913) separated the genera *Chiloscyllium* and *Hemiscyllium* again, but maintained them in the family Orectolobidae. Fowler (1941) put all the species in the genus *Hemiscyllium,* but maintained *Chiloscyllium* and *Synchismus* as subgenera and maintained the genus in the family Orectolobidae. Bigelow and Schroeder (1948) separated the genera *Hemiscyllium* and *Chiloscyllium* again in the family Orectolobidae. Whitley (1967) transferred the two genera to the family Hemiscyllidae, where Compagno (1973) maintained them. Whitley (1967) also described two new species of *Hemiscyllium* from New Guinea, *H. hallstromi* and *H. strahani.* We recently identified a new species of *Chiloscyllium* at Oregon State University and another at the National Museum of Natural History, Smithsonian Institution; both are described below.

ACKNOWLEDGMENTS

We thank the following for their assistance and advice during the course of this study: Dr. J. W. Atz, Ms. M. N. Feinberg, Mr. C. Ferraris, Drs. D. E. Rosen, C. L. Smith, K.

Lazara, G. Nelson (AMNH); Dr. J. Paxton (AMS); Dr. W. Smith-Vaniz (ANSP); Drs. P. Whitehead, A. Wheeler, K. E. Banister, Mr. G. Howes, Ms. B. Brewster, Dr. L. Parenti, Mr. J. Chambers (BMNH); Dr. J. Randall, Mr. A. Suzumoto (BPBM); Drs. T. Iwamoto, W. Eschmeyer, J. McCosker, Ms. P. Sonoda (CAS); Dr. E. Brothers, Mr. R. Schocknecht (CU); Dr. R. Johnson (FMNH); Dr. M. Stehmann, Ms. G. Schulze (ISH); Dr. C. Swift, Mr. J. Siegel (LACM); Drs. K. Liem, W. Fink, Mr. K. Hartel (MCZ); Dr. M. L. Bauchot, Ms. M. Desoutter (MNHN); Dr. C. Bond, Mr. J. Long (OSU); Drs. M. J. P. van Oijen, M. Stiassny (RMNH); Dr. C. Gilbert, Mr. G. Burgess (UF); Dr. R. R. Miller (UMMZ); Drs. R. Gibbs, V. Springer, R. Vari, B. B. Collette (USNM); Mr. U. E. Friese (former Curator of Taronga Zoo Park Aquarium); Dr. B. Seret, Mr. W. Dun, Drs. P. Janvier, L. J. V. Compagno, R. Zweifel; Ms. M. N. Feinberg kindly assisted with the radiography; we thank Dr. J. Osinchak, Mr. J. Downey, Ms. J. Whelan, and Mr. R. Koestler for assistance with the SEM work.

Various parts of this work were supported by GSC grants from City College of New York, a grant from the Lerner-Gray Fund for Marine Research, and the Department of Ichthyology, AMNH. Assistance for publication costs came from the Mead Fund (AMNH).

Institutional Abbreviations

AMNH, American Museum of Natural History, New York, New York
AMS, Australian Museum, Sydney, New South Wales, Australia
ANSP, Academy of Natural Sciences, Philadelphia, Pennsylvania
BMNH, British Museum of Natural History, London, England
BPBM, Bernice P. Bishop Museum, Honolulu, Hawaii
CAS, California Academy of Sciences, San Francisco, California
CU, Cornell University, Ithaca, New York
FMNH, Field Museum of Natural History, Chicago, Illinois
ISH, Ichthyologie—Institut für Seefischerei, Hamburg, Federal Republic of Germany
LACM, Los Angeles County Museum of Natural History, Los Angeles, California
MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
MNHN, Museum National d'Histoire Naturelle, Paris, France
OSU, Oregon State University, Corvallis, Oregon
RMNH, Rijksmuseum van Natuurlijke Historie, Leiden, The Netherlands
SU(CAS), Stanford University Collection, now at CAS
UF, Florida State Museum, University of Florida, Gainesville, Florida
UMMZ, University of Michigan Museum of Zoology, Ann Arbor, Michigan
USNM, National Museum of Natural History, Smithsonian Institution, Washington, D.C.
ZMH, Zoologisches Museum der Universität, Hamburg, Federal Republic of Germany

METHODS AND MATERIALS

Morphometric measurements were made to the nearest 0.5mm using a Helios dial caliper. Measurements are defined in figure 1. Fin base measurements are from where the fin base first begins to erupt from the main body line. Tip of nose to mouth measurements are from the tip of the nose to the most anterior point of the upper lip at the ventral midline. Three measurements are not shown in the tables, as they completely overlap among all species. These were: spiracle diameter (ranged from 0.60% TL to 2.00% TL), first dorsal fin free margin (2.00% TL to 5.40% TL), and second dorsal fin free margin (2.00% TL to 4.10% TL). All morphometrics are given in percentage of total length (TL) or in percentage of head length (HL), head length being the distance from nose tip to origin of the pectoral fin. All measurements are from the left side of the specimen. In tables 1 through 28, the intervals which contain the measurements of the primary type (holotype, lectotype, or neotype) for each species are in boldface type. Under each species, where ranges for the morphometrics are listed, these ranges are followed by the measurement for the primary type in parentheses.

In males, maturity was determined by the degree of calcification of the clasper cartilages. Fully developed claspers were unbendable, and these specimens were judged to be adult males. Females could not be accurately determined to be adults without dissection and examination of the ovaries. Since this could be done on only very few specimens, maturity of females was estimated either by

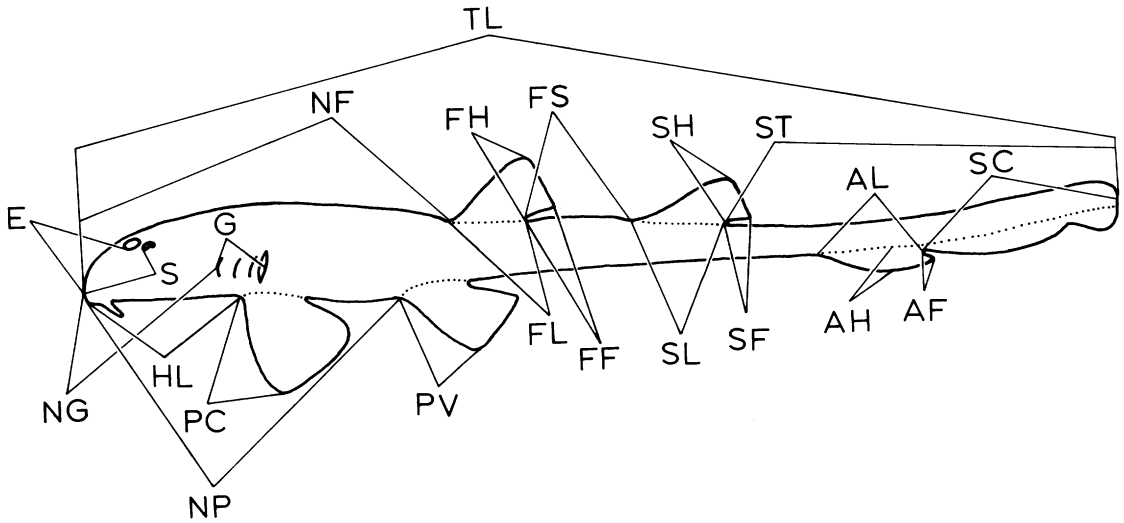

FIG. 1. Diagram of a typical *Chiloscyllium* showing most morphometric measurements. *Abbreviations*: AF—anal fin free margin; AH—anal fin height; AL—anal fin base; E—nose tip to eye; FF—first dorsal fin free margin; FH—first dorsal fin height; FL—first dorsal fin base; FS—first to second dorsal fin; G—first to fifth gill opening; HL—nose tip to pectoral fin origin (head length); NF—nose tip to first dorsal fin; NG—nose tip to first gill slit; NP—nose tip to pelvic fin origin; PC—pectoral fin length; PV—pelvic fin length; S—nose tip to spiracle; SC—subcaudal fin; SF—second dorsal fin free margin; SH—second dorsal fin height; SL—second dorsal fin base; ST—second dorsal fin to tail tip; TL—nose tip to tail tip (total length).

possession of the adult color pattern, where applicable, or by their being an overall size equal to, or greater than, mature males of the same species.

Vertebral centra counts and some skeletal studies were made from soft x-ray radiographs. Representative specimens of most species were alcian blue–alizarin red stained and cleared following the procedure of Dingerkus and Uhler (1977) for skeletal studies. Specimens studied for skeletal morphology either by clearing and staining, or by dissection, are marked by asterisks (*) in the material examined lists under each species. Skeletal drawings were made through an American Optics dissecting scope with a camera lucida.

Dermal denticles were studied with Cambridge Scanning Electron Microscopes (SEM) at City College of New York and the American Museum of Natural History. Skin samples for these studies were taken from the right medial shoulder area of the specimens studied. These samples were dried, washed in acetone and absolute ethyl alcohol, and gold coated for the SEM. Photographs were taken at 10 kv.

KEY TO GENERA AND SPECIES OF THE HEMISCYLLIDAE

1a. Distance from nose tip to mouth goes more than five times in head length; narial barbel length goes more than 10 times in head length; distance from vent to origin of anal fin usually more than 30 percent of TL . . . genus *Hemiscyllium* 2
(juveniles under 250mm TL will not key to species)

1b. Distance from nose tip to mouth goes less than five times in head length; narial barbel length goes less than 10 times in head length; distance from vent to origin of anal fin usually less than 38 percent of TL . . . genus *Chiloscyllium* 6

2a. Underside of head with dark spots or bands; epaulette spot blending into background color which is very dark . . . *H. strahani*

2b. Underside of head uniformly light in color, no dark bands or spots, epaulette spot easily discernible from background color which is light 3

3a. Anterior portion of head (in front of eyes) with dark spots 4

3b. Anterior portion of head uniformly light in color with no spots 5

4a. Dark spots on anterior portion of head mostly subequal to eye diameter ..... *H. trispeculare*

4b. Dark spots on anterior portion of head distinctly less than half of eye diameter . . . *H. freycineti*

5a. All body spots distinctly smaller than epaulette spot ..... *H. ocellatum*

5b. Some body spots subequal to or larger than epaulette spot ..... *H. hallstromi*

6a. Second dorsal fin base longer than first dorsal fin base, or rarely equal; if equal, body is not banded . . . *C. confusum,* new species

6b. Second dorsal fin base shorter than first dorsal fin base, or rarely equal; if equal, body is banded 7

7a. Posterior margins of first and second dorsal fins distinctly concave . . . *C. punctatum*

7b. Posterior margins of first and second dorsal fins distinctly straight or convex 8

8a. Body color uniform 9

8b. Body banded or patterned 11

9a. Eyes small, less than 1.25 percent of TL; distance from vent to tail tip more than 67 percent of TL; head length less than 15.8 percent of TL; distance from nose tip to vent less than 31 percent of TL ..... *C. burmensis,* new species

9b. Eyes large, more than 1.25 percent of TL; distance from vent to tail tip less than 67 percent of TL; head length more than 15.8% of TL; nose tip to vent more than 31 percent of TL 10

10a. Distance from first to second dorsal fin usually more than 9.3 percent TL; first dorsal fin height more than 6.6 percent of TL; second dorsal fin height usually more than 5.8 percent of TL .... *C. griseum* adults

10b. Distance from first to second dorsal fin less than 9.3 percent TL; first dorsal fin height less than 6.6 percent of TL; second dorsal fin height less than 5.8 percent of TL . . . . *C. hasselti* adults

11a. Along anterior dorsal midline, most dark bands twice, or more, as wide as light bands; no lateral dermal ridges 12

11b. Along anterior dorsal midline, all dark bands less than twice as wide as light bands, usually subequal; lateral dermal ridges usually present 13

12a. Dark bands on body outlined in black; black spots interspersed over dorsal side of body ..... *C. hasselti* juveniles

12b. Dark bands on body not outlined in black; no black spots interspersed over dorsal side of body ..... *C. griseum* juveniles

13a. Anal fin height goes six times or more in anal fin base ..... *C. indicum*

13b. Anal fin height goes less than six times in anal fin base ..... *C. plagiosum*

IDENTIFICATION OF *HEMISCYLLIUM* JUVENILES (UNDER 250MM TL)

Juveniles are known only from three of the five described species of *Hemiscyllium*. There is also a juvenile specimen of *Hemiscyllium* which is very distinctive with regard to both color pattern and morphometrics, and which cannot be identified to species at the present time (see discussion of *Hemiscyllium* species, below). The juveniles of *Hemiscyllium freycineti, hallstromi,* and *ocellatum* are shown, respectively, in figures 26, 29, and 32. Juveniles of *H. freycineti* can be distinguished from those of the other two species by the presence of numerous small dark spots in the dark head band which overlies the eyes and spiracles. These spots are absent, or only a few are present, in juveniles of *H. hallstromi* and *ocellatum*. In *H. freycineti* there is also a large dark spot on the lateral sides of the abdomen just anterior to the pelvic fins. This spot is very small in juveniles of the other two species. The caudal bands of *H. freycineti* are offset from the dorsal fins (see fig. 26), whereas in the other species, two of the bands are directly below the dorsal fins, and they are continuous onto the dorsal fins (see figs. 29 and 32).

Juveniles of *Hemiscyllum hallstromi* can be distinguished from those of *H. ocellatum* by the presence of large dark spots within the dark bands behind the epaulette spots, which are subequal to the size of the epaulette spots. In *H. ocellatum* these dark spots are distinctly smaller (less than half) than the size of the epaulette spots (compare figs. 29 and 32). There are more small dark spots within the light bands on the tail of *H. ocellatum* juveniles than there are in juveniles of *H. hallstromi*.

FAMILY HEMISCYLLIDAE GILL, 1862

Hemiscyllinae Gill, 1862, p. 42.
Hemiscyllidae Waite, 1901, p. 32.

TYPE GENUS: *Hemiscyllium* Müller and Henle, 1838; by monotypy.

DIAGNOSIS: Postoral fold continuous across chin, not split along midline (see fig. 2). Posterior end of anal fin base abuts anterior end of subcaudal lobe of caudal fin to the point where they are virtually contiguous.

DESCRIPTION AND DISCUSSION: Orectolobiform sharks of small size, rarely exceeding 1 m. TL. Reproduction oviparous (Whitley, 1967; Dral, 1981). Waite (1901) referred to them as ovoviviparous; however, his observations were based on *Hemiscyllium modestum* (=*Brachaelurus waddi*) which is currently placed in the family Brachaeluridae (Compagno, 1973). In most species coloration varies considerably from juveniles to adults. They are bottom-dwelling sharks feeding mainly on crustaceans and molluscs. There are two genera in the family, *Chiloscyllium* and *Hemiscyllium*.

GENUS *CHILOSCYLLIUM* MÜLLER AND HENLE, 1837

Chiloscyllium Müller and Henle, 1837, p. 395.
Chyloscyllium Duméril, 1853, p. 40.
Cheiloscyllium Hasse, 1878, p. 146.
Synchismus Gill, 1862, p. 47.

TYPE SPECIES: *Scyllium plagiosum* Bennett, subsequent designation by Gill (1862).

DIAGNOSIS: Distance from nose tip to mouth more than 3 percent of TL (more than 20% of HL); narial barbel length more than 1.3 percent of TL (more than 10% of HL); distance from vent to origin of anal fin usually less than 37.5 percent of TL; usually 135 to 180 vertebral centra; distance from nose tip to first gill slit more than 13.3 percent of TL.

DESCRIPTION: Hemiscyllid sharks reaching approximately 1 m. in length. Adults in general more heavy bodied than adults of *Hemiscyllium*. Juveniles, except of *C. confusum*, new species, strongly banded or patterned. Adults lose some or all banding or patterning.

DISCUSSION: There are seven species: *C. burmensis*, new species, *C. confusum*, new species, *C. griseum, C. hasselti, C. indicum, C. plagiosum*, and *C. punctatum*. All species, except *C. burmensis*, new species, are relatively widely distributed in the Indo-Pacific area. *C. burmensis*, new species is known from only one specimen. From x-rays, several species have been shown to feed at least partially on fish, as fish skeletons show up in the gut.

Gill (1862) erected the genus *Synchismus*

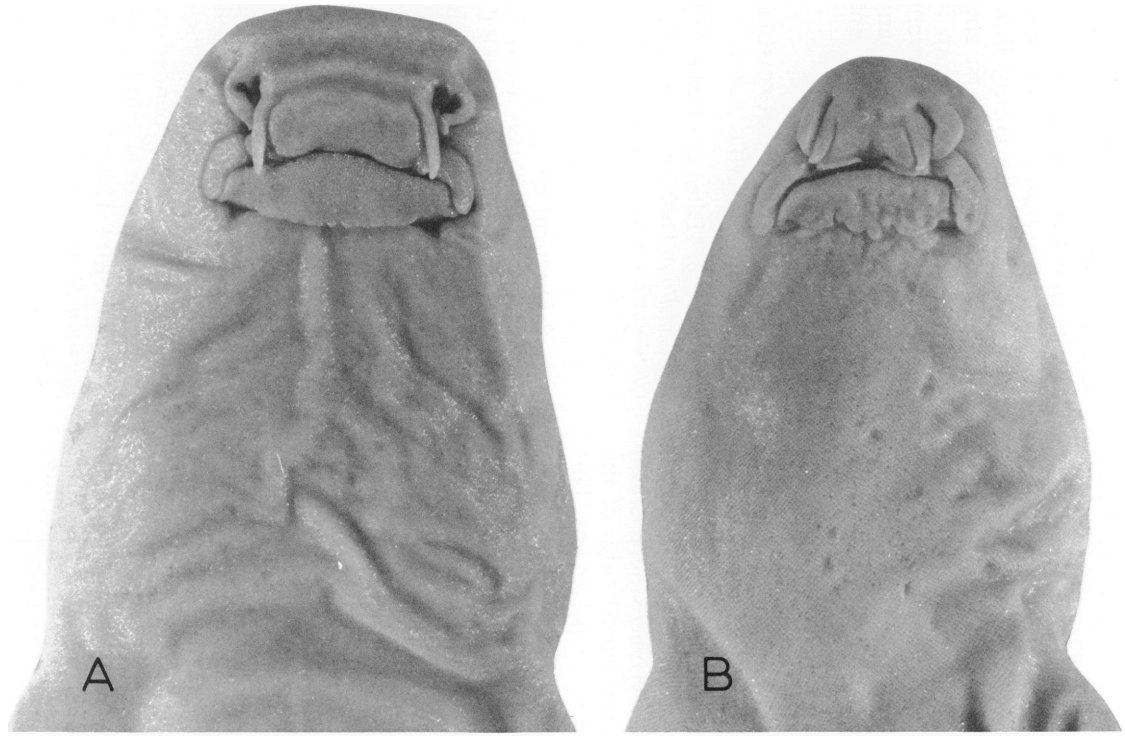

FIG. 2. Ventral views of head and neck of *Chiloscyllium* and *Hemiscyllium.* A) *Chiloscyllium confusum,* new species, USNM 148103; B) *Hemiscyllium ocellatum,* AMNH 44016. Note complete postoral fold in both genera; wider, more robust head in *Chiloscyllium.*

for *C. indicum* because of its distinctive lateral dermal ridges. *Chiloscyllium indicum* actually shares this feature with *C. plagiosum* (see below). In all other respects *C. indicum* fits into the genus *Chiloscyllium,* where *Synchismus* has been synonymized by Regan (1908) and Garman (1913). Herein we maintain *Synchismus* in the synonymy of *Chiloscyllium* (see also discussion of interrelationships, below).

ETYMOLOGY: *Chilo,* from Latin, signifying large lips; *scyllium,* new Latin, from Greek, *skylion,* meaning dogfish (a small shark); gender neuter.

Chiloscyllium burmensis, new species
Figures 3, 7, 59–60

HOLOTYPE: USNM 202672* (a male; 575mm); Burma: off Rangoon; 15°4′N, 95°51′E; March 31, 1963; *Anton Bruun.*

DIAGNOSIS: Separable from all other species of *Chiloscyllium* by the small size of the eyes (less than 1.25% of TL); separable from *C. plagiosum* and *C. indicum* in having no bands or patterns on the skin in adults; separable from *C. griseum, hasselti,* and *punctatum* by the distance from vent to tail tip being longer than 67 percent of TL; separable from the three previous species and *C. confusum* by having the distance from nose tip to pectoral origin less than 15.8 percent of TL; separable from *C. griseum* and *C. punctatum* by having the second dorsal fin to tail tip distance more than 38 percent of TL; separable from *C. griseum, hasselti,* and *confusum* in having the distance from nose tip to vent less than 31 percent of TL.

DESCRIPTION: A species of *Chiloscyllium* known only from the holotype, an adult male. Morphometric measurements of the holotype are as follows (as percentage of TL): nose tip to pectoral origin—15.65; nose tip to first gill slit—14.26; first to fifth gill slit—4.87; eye diameter—1.22; interorbital—4.87; nose tip to eye—6.78; nose tip to spiracle –8.17; nose tip to mouth—3.65; barbel—2.09; post oral fold—1.39; nose tip to first dorsal—36.35; nose tip to pelvic origin—29.22; nose tip to vent—30.78; vent to anal fin—35.48; vent to tail tip—67.30; first to second dorsal fin—11.13; second dorsal fin to tail tip—38.43; pectoral length –12.70; pelvic length—10.96; first dorsal fin base—8.00; first dorsal fin height—6.26; second dorsal fin base—7.30; second dorsal fin height—5.22; anal fin base—14.43; anal fin free margin—1.22; anal height—2.09; subcaudal—18.26; vertebral centra—176. Morphometric data are compared with other species in tables 1 to 28. Dorsally, body color is a uniform medium tan, to almost white on the ventral surface. Overall a more slender species of *Chiloscyllium* as can be seen in figure 3. X-rays of the holotype show fish skeletons in the gut, hence the species feeds at least in part upon other fishes. Distribution shown in figure 7.

ETYMOLOGY: Named for Burma, the country of origin of the holotype and only known specimen.

Chiloscyllium confusum, new species
Figures 2, 4–7, 51, 57, 61–64

MATERIAL EXAMINED: Holotype: AMNH 44126 (a male; 408mm); India: Kerala State; within 10 miles offshore of Calicut (Kozhikode); 1956; S. Wilkes.

Thirty-five Paratypes: AMNH 44127* (2; 101–153mm); OSU 1507 (3; 383–444mm); OSU 937 (3; 104–114mm); CAS 50893 (1; 119mm); all with same data as holotype. USNM 202654 (1; 290mm); India: Kerala State; Neendakarai; 8 Oct. 1966; F. H. Berry. ANSP 81662 (2; 140–186mm); India: Bombay; 1924; F. Hallberg. USNM 221698 (2; 607–612mm); West Pakistan: 25°11′N, 66°20′E; 8 Dec. 1963; *Anton Bruun* (Int. Indian Ocean Exped.). USNM 202674 (2; 606–623mm); Data same as USNM 221698. USNM 148105 (1; 546mm); Saudi Arabia: Persian Gulf; Tarut Bay, Ras Tanura, 1.5 mi. N of west pier; 11 May 1948; D. S. Erdman. USNM 148106 (1; 534mm); Saudi Arabia: Persian Gulf; Tarut Bay, Ras Tanura, Nejma, 3 mi. N of west pier; 17 April 1948; D. S. Erdman. USNM 148107 (1; 546mm); Saudi Arabia: Persian Gulf; Tarut Bay, Channel S of Zaal Island; 2 June 1948; D. S. Erdman. USNM 148108 (1; 446mm); Saudi Arabia: Persian Gulf; Fasht Al Jarim, 10 mi. N of Bahrain Island; 13 June 1948; D. S. Erdman. USNM 202671 (2; 541–547mm); India: Kerala State; Neendakarai, 8°56′N, 76°30′E; 8 Oct. 1966; F. H. Berry. MCZ 46564 (1; 352mm); India: Maharashtra State; Bombay

Harbor; July 1967; R. Baird. ISH 1/61 (1; 320mm); India: Maharashtra State; Arabian Sea, off Alibag; 25 Nov. 1955; von Maydell. ZMH 1370 (1; 361mm); Data same as ISH 1/61. ZMH 1371 (1; 115mm); India: Karnataka State; North Kanara, Arabian Sea off Karwar; 14 Feb. 1956; von Maydell. BPBM 27525 (1; 527mm); India: Kerala State; Cochin, fish landing dock; 31 Jan. 1980; J. E. Randall. LACM 38311-31 (3; 590–

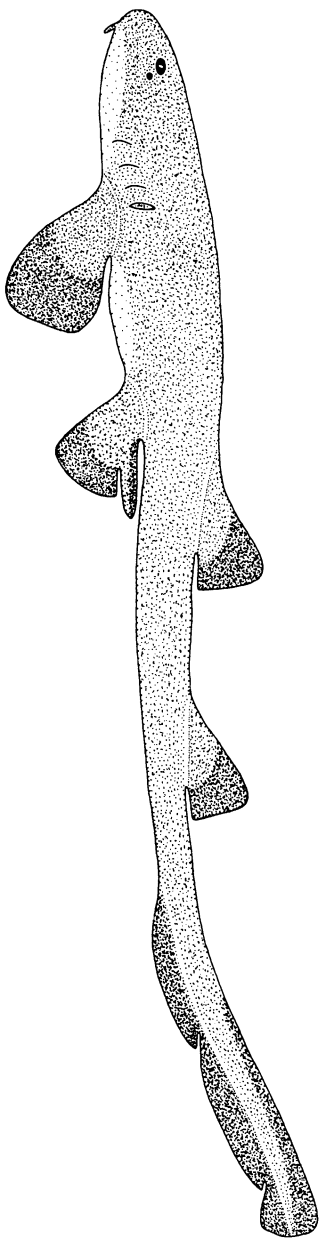

FIG. 3. *Chiloscyllium burmensis,* new species, Holotype. USNM 202672. 575mm, TL. Adult male.

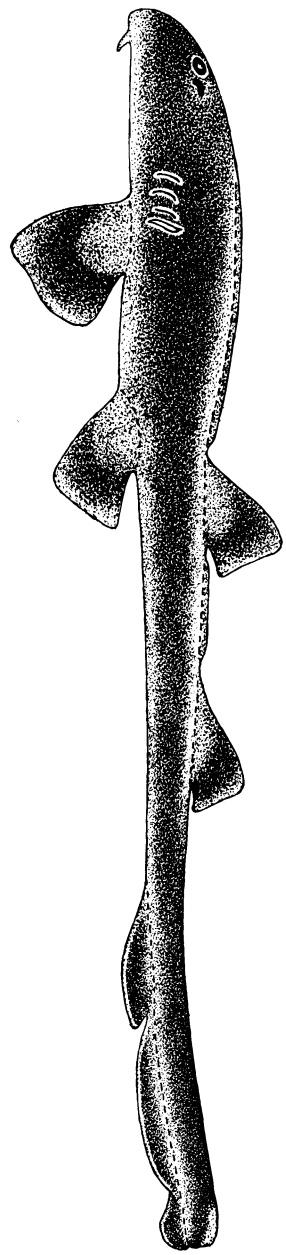

FIG. 4. *Chiloscyllium confusum,* new species, Holotype. AMNH 44126. 408mm, TL. Subadult male.

655mm); West Pakistan: state of Baluchistan; Sonmiani Bay; 4 Feb. 1979; C. C. Swift. BMNH 1868.10.25.22 (1; 247mm); India: Andra Pradesh State; Vizagapatam (=Vishakhapatnam); Capt. Mitchell. BMNH 1904.7.8.12 (1; 568mm); West Pakistan: Karachi; F. W. Townsend. BMNH 1912.3.1.49 (1; 295mm); India: Orissa; From Indian Museum. BMNH 1912.7.20.1 (1; 165mm); India: Kerala State; Trivandrum, Travancore; From Trivandrum Museum. MNHN 1969-29 (1; 147mm); India: Orissa State; Puri, Gulf of Bengal; July 1877; Endel.

REFERRED SPECIMENS: LACM 38312-24 (1; 590mm); West Pakistan: state of Baluchistan; Sonmiani Bay; 5 Feb. 1979; C. C. Swift. USNM 202671 (1; 548mm); India: Kerala State; Neendakarai; 8 Oct. 1966; F. H. Berry.

DIAGNOSIS: Second dorsal fin base longer than first dorsal fin base, rarely equal. Juveniles uniform in color, no bands or patterning. These two characters separate *C. confusum,* new species from all other species of *Chiloscyllium.*

DESCRIPTION AND DISCUSSION: Morphometric ranges for the species (with measurements of holotype in parentheses) are as follows (as percentage of TL): nose tip to pectoral origin—16.08, 19.61 (17.89); nose tip to first gill slit—13.86, 16.99 (16.18); first to fifth gill slit—3.84, 6.84 (4.84); eye diameter—1.38, 1.79 (1.47); interorbital—4.75, 6.93 (5.27); nose tip to eye—6.47, 8.94 (6.86); nose tip to spiracle—6.83, 10.71 (8.09); nose tip to mouth—3.41, 5.66 (4.41); barbel—1.37, 2.63 (2.21); postoral fold—1.29, 1.92 (1.47); nose tip to first dorsal fin—35.02, 40.33 (35.29); nose tip to pelvic origin—30.77, 34.46 (32.11); nose tip to vent—33.10, 36.29 (33.58); vent to anal fin—28.95, 38.25 (34.07); vent to tail tip—60.95, 67.58 (63.97); first to second dorsal fin—8.65, 14.51 (10.54); second dorsal to tail tip—33.94, 39.42 (37.74); pectoral fin length—10.00, 13.96 (12.01); pelvic fin length—8.50, 11.93 (10.29); first dorsal fin base—7.21, 8.82 (7.84); first dorsal fin height—4.29, 8.36 (6.00); second dorsal fin base—7.69, 9.92 (8.82); second dorsal fin height—4.20, 7.05 (5.15); anal fin base—10.58, 13.21 (11.27); anal fin free margin—0.65, 1.31 (0.98); anal fin height—1.43, 2.80 (1.96); subcaudal—16.82, 20.79 (18.87); vertebral centra—143, 171 (157). Morphometric measurements are compared with other species in tables 1 to 28. Adult and juvenile stages are illustrated in figures 4 and 5, respectively. This is the only species of *Chiloscyllium* in which the juvenile body color is uniform, and identical with that of the adult. Body color is medium tan dorsally, paler on the ventral surface. Edges of the fins darken from light to medium brown. In color slides of a freshly preserved specimen (BPBM 27525; courtesy of J. E. Randall), the edges of the pectoral and pelvic fins are an orange-yellow color. Adults look virtually identical with adults of *C. griseum,* with which they have long been confused. These two species can be easily separated by the dorsal fin base lengths. In *C. confusum,* new species the second dorsal fin base length is longer than the first, or rarely equal; in *C. griseum* the first dorsal base is always longer than the second. The same is true of *C. burmensis,* new species and *C. hasselti.* Juveniles of *C. confusum,* new species can easily be separated from those of *C. griseum* and *C. hasselti,* which always have characteristic banding patterns and spots (compare figs. 5, 9, and 11). Dermal denticles are illustrated in figures 61 to 64, and are discussed further below. Teeth are illustrated in figure 57. Breeding and embryology have been described by Dral (1981) under the name of *C. griseum.* Apparently fairly common west of the tip of India (fig. 7); relatively rare east of the tip of India. The two species, *C. confusum,* new species, and *C. griseum* live sympatrically around the tip of India, apparently without interbreeding. Maturity reached between 446 and 541mm TL. Presumably, breeding takes place around February as LACM 38311-31 (specimen no. 2), collected 4 Feb. 1979, has ripe eggs in the uterus with no signs of development. *Chiloscyllium confusum,* new species appears to be primarily a bottom feeder, feeding mainly on molluscs and crustaceans. On x-rays of several specimens the gut has opaque material in it, apparently pieces of shell and crustacean exoskeletons. In LACM 38311-31 (specimen no. 3) there is part of a squid (*Loligo* sp.) in its mouth. From x-rays one specimen, ZMH 1370, has what appears to be an ophichthyid eel (see fig. 6) in its gut.

ETYMOLOGY: From Latin *confusus,* meaning mixed up, in reference to the confusion

between this species and *C. griseum*. Gender neuter.

Chiloscyllium griseum Müller and Henle, 1841
Figures 8–9, 12, 24, 65–66

Chiloscyllium griseum Müller and Henle, 1841, p. 19.

MATERIAL EXAMINED: Lectotype (herein designated): MNHN 1010 (a male; 374mm); India: Kerala State; Malabar; Dussumier; (see discussion of locality below).

Four Paralectotypes: MNHN 1011 (1; 524mm); Data same as lectotype. MNHN 1009 (3; 453–548mm); Data same as lectotype.

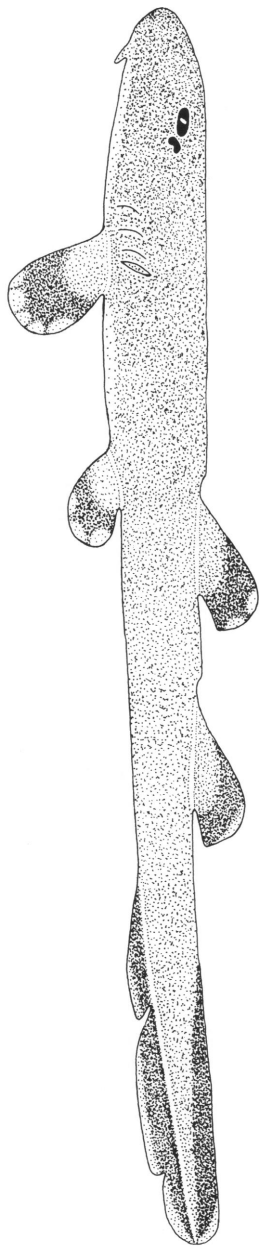

FIG. 5. *Chiloscyllium confusum,* new species, Paratype. OSU 937 104mm, TL. Juvenile male.

FIG. 6. *Chiloscyllium confusum,* new species, Paratype. ZMH 1370. 320mm, TL, subadult female. Print of radiograph, showing eel in stomach.

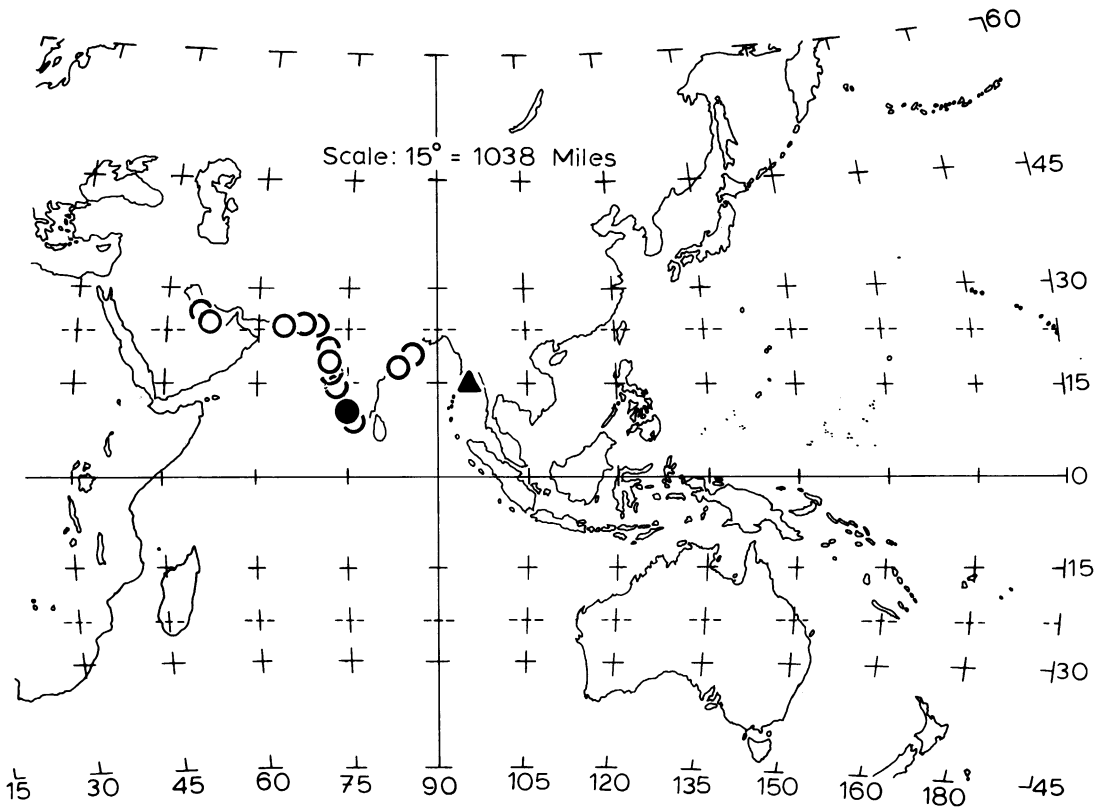

FIG. 7. Distribution of *Chiloscyllium confusum*, new species (circles), and *Chiloscyllium burmensis*, new species (triangle). Solid circle and triangle indicate primary type localities.

REFERRED SPECIMENS: OSU 942 (2; 115–181mm); India: Kerala State; within 10 mi. offshore of Calicut (Kozhikode); 1956; S. Wilkes. USNM 221695 (1; 752mm); Ceylon (Sri Lanka): off Mutwal; 9 March 1970; T. Roberts. USNM 205266 (1; 770mm); Ceylon (Sri Lanka): Mannar; Colombo; 24 August 1969; P. Heemstra. USNM 221697 (1; 225mm); Ceylon (Sri Lanka): off Payagala; 19 Dec. 1969; C. C. Koenig. SU(CAS) 41988 (1; 193mm); India: Kerala State; Calicut (Kozhikode); 13 June 1941; A. W. Herre. USNM 221688* (2; 232–343mm); Ceylon (Sri Lanka): off Lunawa; 6 Dec. 1969; C. C. Koenig. USNM 221696 (3; 219–264mm); Ceylon (Sri Lanka): Gulf of Mannar; Talainmar, point on S side of Adam's Bridge; 18 March 1969; F. J. Schwartz. FMNH 91305 (1; 228mm); India: Maharashtra State; Bombay, Kolaba; 5 Oct. 1976; J. Punjuani. BPBM 20585 (1; 615mm); India: Madras State; Tuticorin; 1 March 1975; J. E. Randall and R. Rao. LACM 38291-3 (8; 595–665mm); West Pakistan: Karachi; fish market; 14 Jan. 1979; C. C. Swift. BMNH 1868.10.25.23-4 (2; 150–155mm); India: Andhra Pradesh State; Vizagapatam (=Vishakhapatnam); Capt. Mitchell. BMNH 1889.2.1.4184-5 (3; 122–264mm); India: Kerala State; Malabar; F. Day. BMNH 1889.2.1.4181-3 (3; 132–345mm); India: Madras State: Madras; F. Day. ISH 2/61 (1); India: Karnataka State; N. Kanara, off Karwar; 14 Feb. 1956; German Indian Ocean Exped. ZMH 10114 (1); Ceylon (Sri Lanka): Colombo; 27 July 1904; J. Hagenbeck. RMNH 8543 (1; 290mm); India: Madras State; Madras; J. Day. ZMH 1372 (1); India: Maharashtra State; Alibag; 25 Nov. 1955; German Indian Ocean Exped. ZMH 1373 (1); Data same as ISH 2/61. BMNH 1850.11.18.54 (1; 350mm); No data; stuffed skin. FMNH 93576 (3); India: Madras State:

Musaltivu, n side, outer reef; 2 Jan. 1964; L. P. Woods.

DIAGNOSIS: Juveniles: separable from *C. confusum* in that *C. griseum* is banded, whereas *C. confusum* is unbanded; also *C. griseum* has the first dorsal base longer than the second and *C. confusum* has the second dorsal fin base longer than the first; separable from *C. hasselti* juveniles which have the bands outlined in black, whereas *C. griseum*

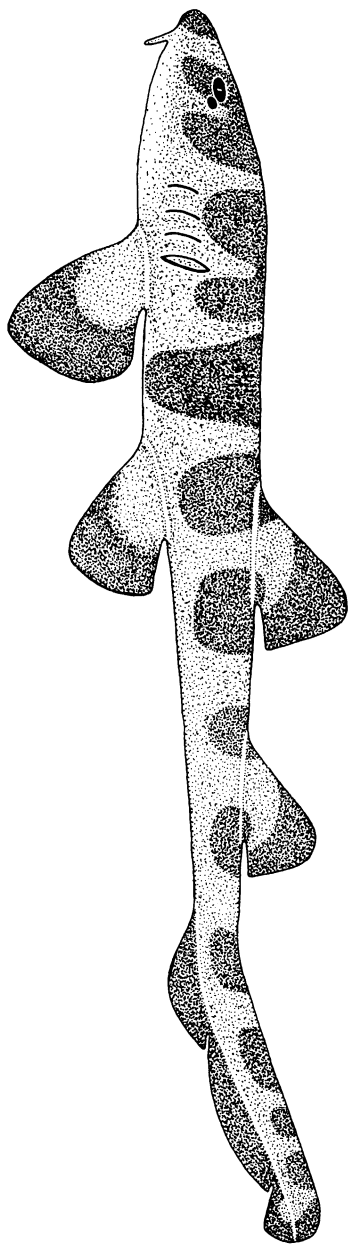

FIG. 8. *Chiloscyllium griseum* Müller and Henle, Lectotype. MNHN 1010. 374mm, TL. Subadult male.

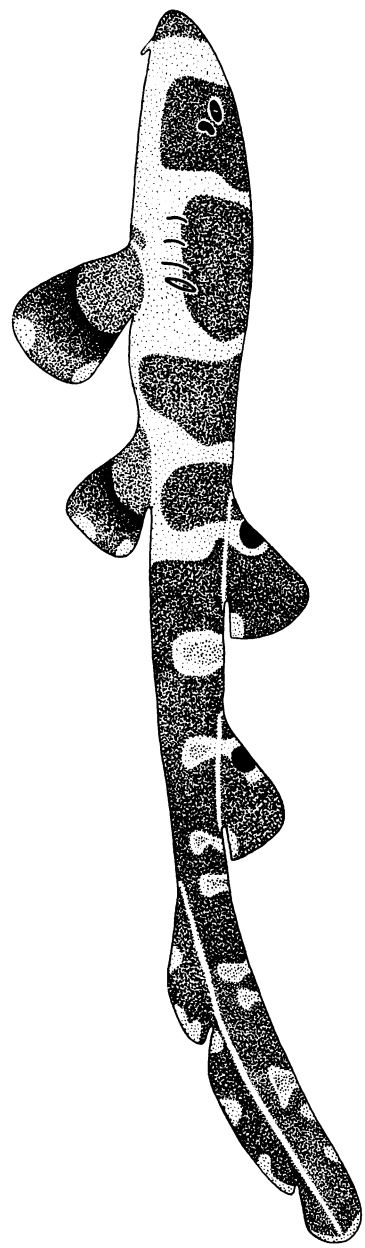

FIG. 9. *Chiloscyllium griseum* Müller and Henle. SU(CAS) 41988. 193mm, TL. Juvenile male.

does not have the bands outlined in black (compare figs. 9 and 11). Adults: can be distinguished from *C. confusum* in that the first dorsal fin base is longer than that of the second in *C. griseum,* whereas in *C. confusum* the second dorsal fin base is longer than the first; separable from *C. burmensis* in that the vent to tail tip is less than 65 percent of TL (more than 67% of TL in *C. burmensis*), nose tip to vent is more than 33 percent of TL (less than 31% in *C. burmensis*), second dorsal fin to tail tip is less than 37.25 percent of TL (more than 38.25% of TL in *C. burmensis*); separable from *C. hasselti* in that the first to second dorsal fin distance is usually more than 9.3 percent TL (less than 9.3% of TL in *C. hasselti*), first dorsal fin height is usually more than 6.6 percent of TL (less than 6.6% of TL in *C. hasselti*), second dorsal fin height is usually more than 5.8 percent of TL (less than 5.8% in *C. hasselti*).

DESCRIPTION: Morphometric ranges for the species (with the measurements of lectotype in parentheses) are as follows (as percentage TL): nose tip to pectoral origin—16.53, 19.53 (17.38); nose tip to first gill slit—13.93, 18.26 (15.24); first to fifth gill slit—4.11, 6.15 (6.15); eye diameter—1.34, 2.22 (1.60); interorbital—4.77, 6.96 (5.61); nose tip to eye—6.11, 8.89 (6.95); nose tip to spiracle—7.44, 10.34 (9.09); nose tip to mouth—3.65, 5.25 (4.01); barbel—1.83, 3.02 (2.67); postoral fold—1.29, 1.87 (1.87); nose tip to first dorsal fin—36.99, 41.56 (37.97); nose tip to pelvic origin—32.58, 37.14 (34.49); nose tip to vent—34.48, 38.31 (35.56); vent to anal fin—28.18, 34.54 (32.35); vent to tail tip—58.05, 64.35 (60.16); first to second dorsal fin—8.70, 11.45 (9.89); second dorsal fin to tail tip—31.30, 37.02 (34.49); pectoral fin length—10.67, 14.71 (14.71); pelvic fin length—9.34, 12.97 (11.50); first dorsal fin base—8.59, 10.05 (9.89); first dorsal fin height—6.22, 8.02 (8.02); second dorsal fin base—7.44, 9.13 (9.09); second dorsal height—5.33, 7.20 (6.68); anal fin base—10.13, 14.36 (11.76); anal fin free margin—0.89, 1.74 (1.34); anal fin height—1.78, 3.21 (3.21); subcaudal—16.03, 21.74 (18.98); vertebral centra—157, 169 (163). Morphometric data are compared with other species in tables 1 to 28. Juveniles are banded with light gray-brown and dark gray-brown bands. With age the bands become less distinct until adults are a fairly uniform tan to light brown dorsally; the ventral side is cream to light tan. Males reach sexual maturity between 453mm and 548mm TL. Distribution is shown in figure 12. Subadult and juvenile stages are illustrated in figures 8 and 9. Adults look very similar to adults of *C. confusum* with which they have long been confused. Adults of the two species can easily be separated on the basis of the comparative dorsal fin base lengths (see above). Both species have a mid-dorsal ridge extending from the back of the head to the first dorsal fin, continuing between the first and second dorsal fins, then running from the second dorsal fin somewhat onto the caudal peduncle. These ridges are somewhat higher in *C. confusum* than they are in *C. griseum.*

DISCUSSION: Müller and Henle (1841) described this species based upon one specimen from Malabar, collected by Dussumier, six specimens from Pondicherry, collected by Belanger, and they stated that all the specimens were in Paris. Investigations at MNHN in Paris yielded five specimens labeled from Malabar, collected by Dussumier, and no specimens from Pondicherry, collected by Belanger. The other two specimens cited are believed lost. However, this still leaves confusion because of the discrepancies in numbers of specimens from the two localities. Presumably either Müller and Henle inverted their data and meant to say six from Malabar and one from Pondicherry, or the collections were mixed up in Paris. Since *C. griseum* is known from both localities, either explanation is plausible. We accept the MNHN specimens as the series examined by Müller and Henle, but at present cannot support conclusively either explanation. Thus we accept the specimens as labeled at MNHN, and designate MNHN 1010 as the lectotype, and the remaining specimens as paralectotypes (MNHN 1009, MNHN 1011). Müller and Henle (1841) also gave Japan as the range of this species and on page 189 they corrected it to Java. However, for neither of these localities do they list any specimens coming from there in their examples studied.

Müller and Henle (1841), along with their description of *C. griseum,* published a plate (no. 4) labeled *C. griseum.* However, the specimen illustrated is actually *C. puncta-*

TABLE 1

Frequency Distribution of Nose Tip to Pectoral Origin as Percentage of Total Length

Species	11.81 to 12.40	12.41 to 13.00	13.01 to 13.60	13.61 to 14.20	14.21 to 14.80	14.81 to 15.40	15.41 to 16.00	16.01 to 16.60	16.61 to 17.20	17.21 to 17.80	17.81 to 18.40	18.41 to 19.00	19.01 to 19.60	19.61 to 20.20	20.21 to 20.80	N	$\bar{X}$
Chiloscyllium																	
burmensis, new species	–	–	–	–	–	–	**1**	–	–	–	–	–	–	–	–	1	15.65
confusum, new species	–	–	–	–	–	–	–	5	5	4	**5**	4	1	1	–	25	17.60
griseum	–	–	–	–	–	–	–	2	–	**2**	3	3	2	–	–	12	18.10
hasselti	–	–	–	–	–	–	–	**1**	–	3	4	3	5	2	1	19	18.77
indicum	–	–	–	–	–	1	1	2	3	1	2	–	–	–	–	10	16.73
plagiosum	–	–	–	3	1	1	5	**6**	3	4	–	–	1	–	–	24	16.66
punctatum	–	–	–	–	–	–	–	1	5	**6**	5	–	–	–	–	17	17.41
Hemiscyllium																	
freycineti	–	–	2	2	1	1	1	1	–	–	–	–	–	–	–	8	14.31
hallstromi	1	1	3	–	1	**2**	–	–	1	–	–	–	–	–	–	9	14.10
ocellatum	1	7	**7**	3	–	2	–	–	–	–	–	–	–	–	–	20	13.31
species	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	15.54
strahani	–	–	–	**2**	–	–	–	–	–	–	–	–	–	–	–	2	14.01
trispeculare	–	–	2	–	**3**	1	1	–	–	–	–	–	–	–	–	7	14.59

TABLE 2

Frequency Distribution of Nose Tip to First Gill Slit Length as Percentage of Total Length

Species	9.11 to 9.70	9.71 to 10.30	10.31 to 10.90	10.91 to 11.50	11.51 to 12.10	12.11 to 12.70	12.71 to 13.30	13.31 to 13.90	13.91 to 14.50	14.51 to 15.10	15.11 to 15.70	15.71 to 16.30	16.31 to 16.90	16.91 to 17.50	17.51 to 18.10	18.11 to 18.70	N	$\bar{X}$
Chiloscyllium																		
burmensis, new species	–	–	–	–	–	–	–	–	**1**	–	–	–	–	–	–	–	1	14.26
confusum, new species	–	–	–	–	–	–	–	2	8	7	3	4	1	–	–	–	25	15.16
griseum	–	–	–	–	–	–	–	–	1	1	**4**	1	1	1	2	1	12	16.16
hasselti	–	–	–	–	–	–	–	–	**1**	–	3	6	5	1	2	1	19	16.31
indicum	–	–	–	–	–	–	–	4	2	3	–	1	–	–	–	–	10	14.21
plagiosum	–	–	–	–	–	1	–	8	**8**	6	–	–	1	–	–	–	24	12.94
punctatum	–	–	–	–	–	–	–	2	**8**	3	3	1	–	–	–	–	17	14.61
Hemiscyllium																		
freycineti	–	–	1	1	4	1	1	–	–	–	–	–	–	–	–	–	8	11.87
hallstromi	–	1	3	1	1	**1**	1	–	–	–	–	–	–	–	–	–	9	11.50
ocellatum	1	–	**5**	6	6	2	–	–	–	–	–	–	–	–	–	–	20	11.26
species	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	12.84
strahani	–	–	–	**2**	–	–	–	–	–	–	–	–	–	–	–	–	2	11.29
trispeculare	–	–	–	**1**	4	2	–	–	–	–	–	–	–	–	–	–	7	12.10

TABLE 3
Frequency Distribution of First to Fifth Gill Slit Distance as Percentage of Total Length

Species	3.61 to 4.00	4.01 to 4.40	4.41 to 4.80	4.81 to 5.20	5.21 to 5.60	5.61 to 6.00	6.01 to 6.40	6.41 to 6.80	6.81 to 7.20	7.21 to 7.60	N	$\bar{X}$
Chiloscyllium												
burmensis, new species	—	—	—	**1**	—	—	—	—	—	—	1	4.87
confusum, new species	1	—	1	**8**	6	6	2	—	1	—	25	5.34
griseum	—	2	1	1	5	1	**2**	—	—	—	12	5.24
hasselti	—	1	3	7	**4**	2	2	—	—	—	19	5.18
indicum	—	3	3	3	1	—	—	—	—	—	10	4.71
plagiosum	2	3	**6**	9	2	2	—	—	—	—	24	4.76
punctatum	—	1	2	4	**5**	3	2	—	—	—	17	5.49
Hemiscyllium												
freycineti	—	1	2	2	1	1	—	1	—	—	8	5.01
hallstromi	—	—	**2**	1	3	2	—	—	—	1	9	5.54
ocellatum	—	**4**	2	10	2	2	—	—	—	—	20	4.82
species	—	—	—	—	—	—	1	—	—	—	1	6.08
strahani	—	—	1	—	**1**	—	—	—	—	—	2	5.01
trispeculare	—	**1**	2	—	1	3	—	—	—	—	7	4.70

tum. It was labeled as collected by Kuhl and van Hasselt from Java, and is probably RMNH 4178. This specimen matches the illustration in body proportions, and color pattern. This error in figures led to confusion between these two species.

ETYMOLOGY: From Latin, *griseus*, meaning grayish brown in color; gender neuter.

Chiloscyllium hasselti Bleeker, 1852
Figures 10–12, 24, 52, 67–70

Scyllium griseum van Hasselt, 1824, p. 89. *Nomen nudum.*
Chiloscyllium obscurum Gray, 1851, pt. 1, p. 35, *Nomen nudum.*
Chiloscyllium indicum var. *obscura* Günther, 1870, p. 413. New combination.
Chiloscyllium indicum var. *obscura* Ogilby, 1888, p. 8. New combination.
Chiloscyllium hasseltii Bleeker, 1852, p. 14.

MATERIAL EXAMINED: Lectotype (herein designated): BMNH 1867.11.28.196 (a male; 594mm); Indonesia: Moluccas; 1852; P. Bleeker.

Paralectotypes: RMNH 7408 (2; 490–602mm); Indonesia: Java or Sumatra; 1850–1860; P. Bleeker.

REFERRED SPECIMENS: BMNH 1845.6.22. 122 (1; 487mm); Indonesia; Moluccas; Mr. Frank (holotype of *C. obscurum* Gray). MCZ 47-S (1; 182mm); Malaysia: Penang; 21 Sept. 1859; W. H. Putnam. MCZ 48-S (3; 125–398mm); Malaysia: Singapore; 20 Sept. 1859; W. H. Putnam. MCZ 108-S (1; 609mm); Malaysia: Penang; 20 Aug. 1860; W. H. Putnam. ANSP 87196 (1; 307mm); Thailand: Rayong; 1936; R. de Schauensee. CAS 35819 (1; 228mm); Malaysia: off Kuching; Nov. 1975; F. Steiner. UMMZ 191397 (2; 118–213mm); Thailand: Prov. Prachuab Khiri Khan; Ban Khlong Wan, Gulf of Thailand; 12–13 Dec. 1964; K. F. Lagler. UMMZ 179034 (1; 197mm); Indonesia: Java; vicinity of Batavia (Djakarta); 1928–1929; A. Hardenberg. USNM 91837 (1; 197mm); China Seas; 7 Feb. 1889; from Australian Mus. SU(CAS) 8036 (1; 525mm); Indonesia: Sumatra; Padang; H. Fowler. AMNH 44017* (2; 437–537mm); Indonesia: Java; Batavia (Djakarta); March 1931; E. G. White. CAS 33856* (3; 138–204mm); Burma: Maungmagan; 1937; Meggitt. CAS 40583 (1; 223mm); Thailand: Prachuap Khiri Khan Prov.; 4 mi. offshore, E of Town, 11°48′N, 99°53′E; Sept. 1960; G. Vanderbilt Foundation. CAS 40584 (1; 259mm); Thailand: Prachuap Khiri Khan Prov.; W beach in front of Phukhao Chinh Kajok; 21 June 1961; Pairojana et al. FMNH 69875 (1; 158mm); Malaysia: Borneo; Sarawak, Niah; 1960; T. Harrison. BPBM 20006 (1; 94mm);

TABLE 4

Frequency Distribution of Eye Diameter as Percentage of Total Length

Species	1.06 to 1.15	1.16 to 1.25	1.26 to 1.35	1.36 to 1.45	1.46 to 1.55	1.56 to 1.65	1.66 to 1.75	1.76 to 1.85	1.86 to 1.95	1.96 to 2.05	2.06 to 2.15	2.16 to 2.25	2.26 to 2.35	2.36 to 2.45	N	$\bar{X}$
Chiloscyllium																
burmensis, new species	—	**1**	—	—	—	—	—	—	—	—	—	—	—	—	1	1.22
confusum, new species	—	—	2	5	**8**	4	4	2	—	—	—	—	—	—	25	1.53
griseum	—	—	2	1	—	**2**	3	1	1	—	—	2	—	—	12	1.71
hasselti	—	—	—	1	2	1	2	3	4	**3**	1	2	—	—	19	1.88
indicum	—	—	—	2	2	3	1	—	2	—	—	—	—	—	10	1.62
plagiosum	—	—	—	1	5	4	4	**4**	3	1	1	1	—	—	24	1.72
punctatum	—	—	—	—	1	2	3	2	3	3	**1**	—	—	2	17	1.90
Hemiscyllium																
freycineti	1	1	1	2	1	1	1	—	—	—	—	—	—	—	8	1.42
hallstromi	—	—	2	—	2	1	3	**1**	—	—	—	—	—	—	9	1.52
ocellatum	—	—	1	**5**	9	2	2	—	1	—	—	—	—	—	20	1.52
species	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	1.35
strahani	—	—	—	—	—	**1**	1	—	—	—	—	—	—	—	2	1.66
trispeculare	—	—	—	—	—	—	—	4	1	1	**1**	—	—	—	7	1.68

TABLE 5.

Frequency Distribution of Interorbital Distance as Percentage of Total Length

Species	3.61 to 3.90	3.91 to 4.20	4.21 to 4.50	4.51 to 4.80	4.81 to 5.10	5.11 to 5.40	5.41 to 5.70	5.71 to 6.00	6.01 to 6.30	6.31 to 6.60	6.61 to 6.90	6.91 to 7.20	7.21 to 7.50	N	$\bar{X}$
Chiloscyllium															
burmensis, new species	—	—	—	—	**1**	—	—	—	—	—	—	—	—	1	4.87
confusum, new species	—	—	—	2	3	**12**	—	2	2	2	1	1	—	25	5.54
griseum	—	—	—	1	—	1	**1**	3	1	2	2	1	—	12	6.04
hasselti	—	—	—	—	—	**2**	2	3	7	3	2	—	—	19	6.01
indicum	—	1	1	3	1	3	1	—	—	—	—	—	—	10	4.84
plagiosum	—	—	—	**3**	6	6	3	—	3	1	1	1	—	24	5.52
punctatum	—	—	—	1	4	4	2	3	**1**	—	1	—	1	17	5.52
Hemiscyllium															
freycineti	1	—	—	2	2	3	—	—	—	—	—	—	—	8	3.56
hallstromi	1	**5**	2	—	—	—	—	—	1	—	—	—	—	9	4.35
ocellatum	1	**5**	6	4	2	1	—	1	—	—	—	—	—	20	4.51
species	—	—	—	—	—	—	—	—	1	—	—	—	—	1	6.08
strahani	—	**1**	—	—	1	—	—	—	—	—	—	—	—	2	4.42
trispeculare	—	1	1	**4**	1	—	—	—	—	—	—	—	—	7	4.51

Malaysia: between E shore of Penang Island and mainland; 2 Dec. 1975; M. S. Doty. SU(CAS) 14312 (1; 590mm); Malaysia: Penang; 1937; A. W. Herre. ANSP 60409 (1; 307mm); Thailand: Bangkok; May 1934; R. de Schauensee. LACM 36871-4 (2; 360–451mm); Malaysia: Singapore market; 1966; R. Gooding. BMNH 1860.3.19.688 (1; 245mm); Malaysia: Penang; Dr. Cantor. BMNH 1860.3.19.894 (2; 175–210mm); East Indies. BMNH 1904.1.25.1 (1; 120mm); Malaysia: Malay Peninsula; Mr. Evans. RMNH 29210 (1; 550mm); Malaysia: Singapore; *ca.* 1851; Dutronquei; Bleeker Coll., rec'd. 1879. RMNH 4169 (1; 122mm); Indonesia: Java; S. Müller. RMNH 4171 (1; 188mm); Indonesia: Moluccas; E. A. Forster. RMNH 7409 (8; 155–445mm); From Bleeker Collection.

DIAGNOSIS: Juveniles: separable from *C. confusum* in having first dorsal fin base longer than second and body being banded rather than uniform in color; separable from *C. griseum* in having the bands on the body edged in black (compare figs. 9 and 11). Adults: separable from *C. confusum* in that the first dorsal fin base is longer than the second; separable from *C. burmensis* in that the vent to tail tip length is less than 65 percent of TL, nose tip to vent length more than 33 percent of TL, and the second dorsal fin to tail tip length less than 37.25 percent of TL; separable from *C. griseum* in that the distance from first to second dorsal fins is usually less than 9.3 percent of TL (more than 9.3% in *C. griseum*), first dorsal fin height usually less than 6.6 percent of TL (more than 6.6% in *C. griseum*), second dorsal fin height usually less than 5.8 percent of TL (more than 5.8% in *C. griseum*).

DESCRIPTION: Morphometric ranges for the species (with the lectotype's measurements in parentheses) are as follows (as percentage of TL): nose tip to origin of pectoral fin—16.50, 20.29 (16.50); nose tip to first gill slit—14.48, 18.16 (14.48); first to fifth gill slit—4.38, 6.19 (5.22); eye diameter—1.45, 2.24 (2.02); interorbital—5.22, 6.78 (5.22); nose tip to eye—6.73, 9.42 (6.73); nose tip to spiracle—8.57, 10.87 (8.59); nose tip to mouth—3.63, 6.37 (4.21); barbel—1.52, 3.43 (2.53); postoral fold—1.02; 1.81 (1.68); nose tip to first dorsal fin—36.23, 40.40 (40.40); nose tip to pelvic origin—31.33, 34.32 (34.18); nose tip to vent—33.16, 37.71 (34.51); vent to anal fin—26.81, 33.73 (33.16); vent to tail tip—58.86, 64.25 (62.79); first to second dorsal fin—6.63, 11.11 (11.11); second dorsal fin to tail tip—32.85, 38.41 (33.34); pectoral fin length—10.20, 13.46 (12.46); pelvic fin length—7.11, 12.10 (11.62); first dorsal fin base—7.46, 10.61 (9.26); first dorsal fin height—4.82, 8.01 (7.41); second dorsal fin base—6.38, 9.84 (8.08); second dorsal fin height—3.95, 6.70 (6.06); anal fin base—10.15, 14.89 (11.95); anal fin free margin—0.60, 1.60 (1.18); anal fin height—1.45, 3.11 (2.53); subcaudal—16.95, 21.74 (17.68); vertebral centra—156, 175. Morphometric data are compared with other species in tables 1 to 28. Adult and juvenile stages are illustrated in figures 10 and 11. Juveniles are banded with light gray-brown and dark gray-brown bands and are outlined in black. With age these bands become more and more indistinct until they become a uniform medium to dark brown color. The black edgings are the last parts of the color pattern to disappear, hence some almost adult specimens will have the appearance of being spotted. Ventral surface shows a cream to light tan color. Males reach sexual maturity between 437 and 537mm TL. Presumably eggs hatch in about December, as BPBM 20006, collected 2 Dec. 1975, was about to hatch. It had a yolk sac measuring 12 by 7 mm, and 94mm TL. The next smallest specimen (BMNH 1904.1.25.1) measured 120mm TL, and had a 2mm yolk stalk. There was no information with this specimen stating what month of the year it was collected. From these two specimens it can be assumed that *C. hasselti* hatches between 94 and 120mm TL. Also, BPBM 20006 was found with the egg case attached to the marine plant *Enhalus.* Adults of *C. hasselti* look almost identical with adults of *C. confusum, burmensis,* and *griseum* but can be separated by morphometric measurements (see above). The distribution of *C. hasselti* is shown in figure 12.

DISCUSSION: Bleeker (1852) described *C. hasselti* based upon five specimens, ranging in size from 480 to 590mm, from off Batavia, Java. There exist three specimens that may belong to this original type series: BMNH 1867.11.28.196, a 594mm male; RMNH 7408, two specimens of 490 and 602mm.

However, the BMNH specimen is labeled as coming from the Moluccas, and the RMNH specimens are labeled as coming from Java or Sumatra. None of these localities precisely match Bleeker's stated locality. Hence, these may not be of the original type series, or Bleeker may have mislabeled the localities on the specimens, or Bleeker may have misstated the locality in his 1852 publication. Which of these possibilities is accurate we cannot determine at the present time from

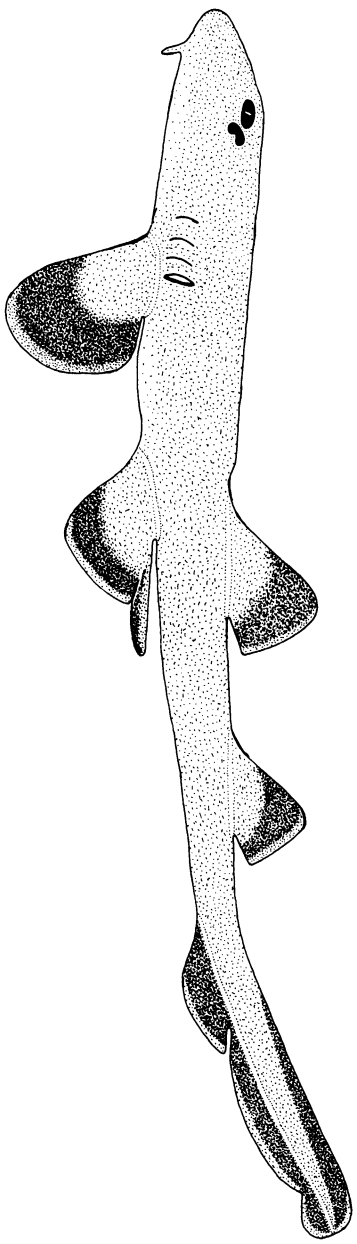

FIG. 10. *Chiloscyllium hasselti* Bleeker. AMNH 44017. 537mm, TL. Adult male.

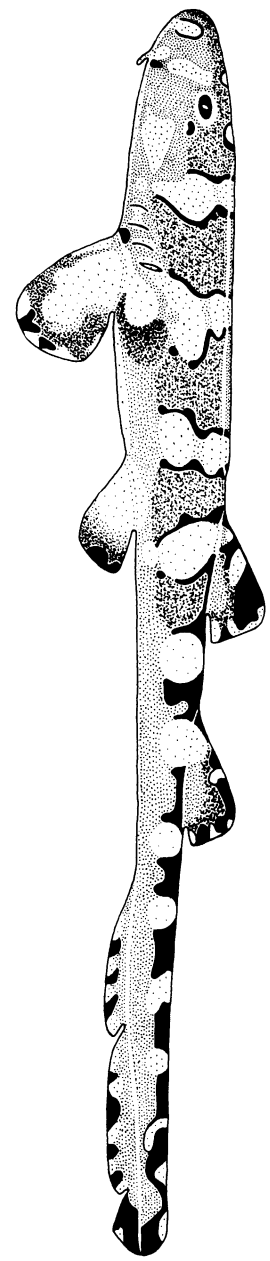

FIG. 11. *Chiloscyllium hasselti* Bleeker. CAS 35819. 228mm, TL. Juvenile female.

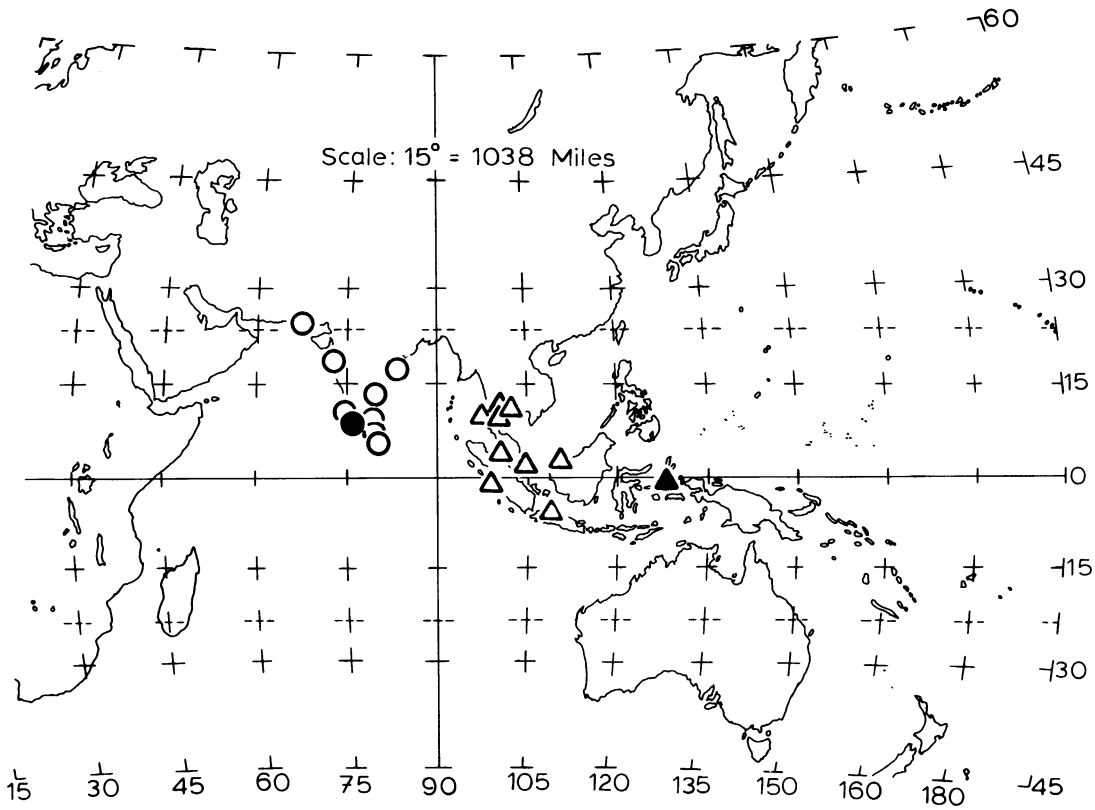

FIG. 12. Distribution of *Chiloscyllium griseum* (circles) and *C. hasselti* (triangles). Solid circle and triangle indicate primary type localities.

information that is available. The BMNH specimen was considered to be the type by Günther (1870). Since these three specimens approximate the size ranges stated by Bleeker (allowing for some stretching over time), and originate from the correct time period, we accept these three specimens as being of the original type series. The BMNH specimen, having been considered the type by Günther (1870), and being the best preserved specimen, appears to be the best specimen for the lectotype of the species. Accordingly, we herein designate BMNH 1867.11.28.196 as the lectotype of *Chiloscyllium hasselti* Bleeker. Since the label on this specimen states the locality as being the Moluccas, the type locality for the species must be emended to agree with the primary type. We herewith emend the type locality for *C. hasselti* Bleeker to the Moluccas.

ETYMOLOGY: Named for J. C. van Hasselt, an early explorer and collector in the East Indies.

Chiloscyllium indicum (Gmelin, 1789)

Figures 13–15, 24, 53, 71–74

Squalus indicus Gmelin, 1789, p. 1503.
Chiloscyllium indicum Günther, 1870, p. 411.
Squalus colax Meuschen, 1781. Made unavailable by the International Commission of Zoological Nomenclature (1950); also see Wheeler (1956).
Chiloscyllium colax Whitley, 1939, p. 228.
Hemiscyllium colax Fowler, 1941, p. 89.
Squalus tuberculatus Schneider, 1801, p. 137.
Scyliorhinus tuberculatus Blainville, 1816, p. 121.
Chiloscyllium tuberculatus Müller and Henle, 1841, p. 20.
Squalus gronovianus Shaw, 1804, p. 353.
Chiloscyllium phymatodes Bleeker, 1852, p. 21.
Chiloscyllium indicum var. *phymatodes* Günther, 1870, p. 413.
Squalus caudatus Gray, 1854, p. 8.

MATERIAL EXAMINED: Holotype: BMNH 1853.11.12.205 (1 female; 274mm); Eastern Indian Ocean; from Gronow Collection; dried skin (this specimen is also the type of *S. colax* Meuschen, *S. gronovianus* Shaw, and *S. caudatus* Gray; also syntype of *S. tuberculatus* Schneider).

REFERRED SPECIMENS: BMNH 1845.7.3.143 (1; 419mm); South Africa: Cape Sea; A. Smith; stuffed skin (Syntype of *S. tuberculatus* Schneider). RMNH 7406 (2; 410–415mm); Indonesia: Java; Semarang–Riau Archipelago; Bintan Island; rec'd. 1879; P. Bleeker (the smaller specimen, a female, is probably the type of *C. phymatodes* Bleeker, from Semarang). RMNH 7407 (1; 375mm); Indonesia: Bangka Island; Muntok; 1855–1856; J. J. Lindgreen; from Bleeker Collection. USNM 40032 (3; 185–225mm) China Seas; 7 Feb. 1889; from Australian Mus. USNM 151128 (1; 130mm); Malaysia: Penang Island. CAS 48267 (1; 355mm); Thailand: Rayong Province; 15–28 mi. SE Goh Chuang; 2–8 Jan. 1961; G. Vanderbilt Found. SU(CAS) 33702 (1; 434mm); Malaysia: Singapore; 8 May 1937; A. Herre. SU(CAS) 35598 (1; 416mm); Malaysia: Singapore; 9 May 1937; A. Herre. CAS 48269* (1; 265mm); Thailand: Prachuap Khiri Khan Prov.; 2–3 mi. E to 22 mi. SSW of Goh Leum; 6–11 May 1961; G. Vanderbilt Foundation. CAS 48268 (1; 316mm); Thailand: Prachuap Khiri Khan Prov.; *ca.* 16 mi. offshore Kau Sarmroiyord; 14–21 Sept. 1960; G. Vanderbilt Foundation. MCZ 51-S (1; 443mm); Malaysia: Penang; 28 Sept. 1859; W. H. Putnam. MCZ 54-S (3; 269–463mm); Malaysia: Penang; 30 Sept. 1859; W. H. Putnam. MCZ 736-S (1; 456mm); Malaysia: Penang; rec'd. 1878; from Copenhagen Mus. MCZ 737-S (1; 326mm); data same as MCZ 736-S. MCZ 35141 (1; 276mm); Malaysia: Singapore. LACM 36871-3 (3; 390–515mm); Malaysia: Singapore market; 1966; R. Gooding. BMNH 1867.11.28.200 (1; 274mm); Indonesia: Java; P. Bleeker. BMNH 1845.6.22.292 (1; 260mm); no locality data; Mr. Frank. BMNH 1983.2.14.3 (1; 295mm) no data. BMNH 1848.3.18.173 (1; 395mm); China; J. Richardson. ZMH 10121 (1); Malaysia: Singapore.

DIAGNOSIS: A species of *Chiloscyllium* with lateral dermal ridges and anal fin height goes more than six times in anal fin base.

DESCRIPTION: Morphometric ranges are as follows (in percentage of TL): nose tip to pectoral origin—15.21, 17.96; nose tip to first gill slit—13.33, 16.02; first to fifth gill slit—4.33, 5.38; eye diameter—1.42, 1.90; interorbital—4.10, 5.41; nose tip to eye—6.22, 8.25; nose tip to spiracle—7.56, 9.23; nose tip to mouth—4.10, 4.75; barbel—1.21, 1.62; postoral fold—0.77, 1.13; nose tip to first dorsal fin—36.44, 40.14; nose tip to pelvic origin—30.67, 32.72; nose tip to vent—32.44, 35.14; vent to anal fin—29.23, 34.34; vent to tail tip—62.31, 67.03; first to second dorsal fin—10.00, 12.00; second dorsal fin to tail tip—35.02, 38.92; pectoral fin length—10.22, 11.75; pelvic fin length—7.69, 9.22; first dorsal fin base—5.99, 10.57; first dorsal fin height—3.85, 5.38; second dorsal fin base—6.22, 7.55; second dorsal height–3.85, 5.06; anal fin base—12.20, 15.38; anal fin free margin—0.48, 1.13; anal fin height—1.54, 1.94; subcaudal—15.90, 18.92; vertebral centra—166, 169. Morphometric data are compared with other species in tables 1 to 28. The adult and juvenile stages are illustrated in figures 13 and 14. The coloration becomes fainter with age, and the bands become less distinct. The bands are medium to dark brown on a cream to light brown background. Darker spots are interspersed on the darker bands. The ventral surface shows a uniform cream color. Males mature between 393 and 416mm TL. Lateral dermal ridges are present, and are produced by modified dermal denticles (see dermal denticle discussion below). Distribution is shown in figure 15.

DISCUSSION: Günther (1870) stated that the anal fin of the holotype (BMNH 1853.11.12.205) was cut off. In fact the anal fin is present, but is virtually contiguous with the caudal fin, as is typical for all hemiscyllid sharks. Apparently he considered the anal fin to be part of the caudal fin.

ETYMOLOGY: Named for the Indian Ocean, locality of the type specimen.

Chiloscyllium plagiosum (Bennett, 1830)

Figures 16, 24, 54, 75–78

Scyllium plagiosum Bennett, 1830, p. 694.

Chiloscyllium plagiosum Müller and Henle, 1841, p. 17.
Chiloscyllium indicum var. *plagiosa* Günther, 1870, p. 412.
Chiloscyllium indicum var. *plagiosum* Ogilby, 1888, p. 8.
Hemiscyllium plagiosum Fowler, 1938, p. 7.
Chiloscyllium ornatum Gray, 1832, pl. 98, fig. 2. *Nomen nudum.*
Chiloscyllium margaritiferum Bleeker, 1864, p. 243.

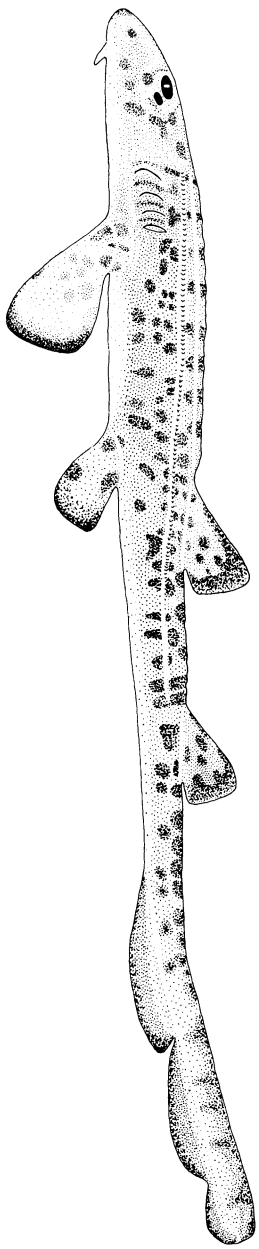

FIG. 13. *Chiloscyllium indicum* (Gmelin). SU(CAS) 33702. 434mm, TL. Adult female.

FIG. 14. *Chiloscyllium indicum* (Gmelin). CAS 48268. 316mm, TL. Juvenile female.

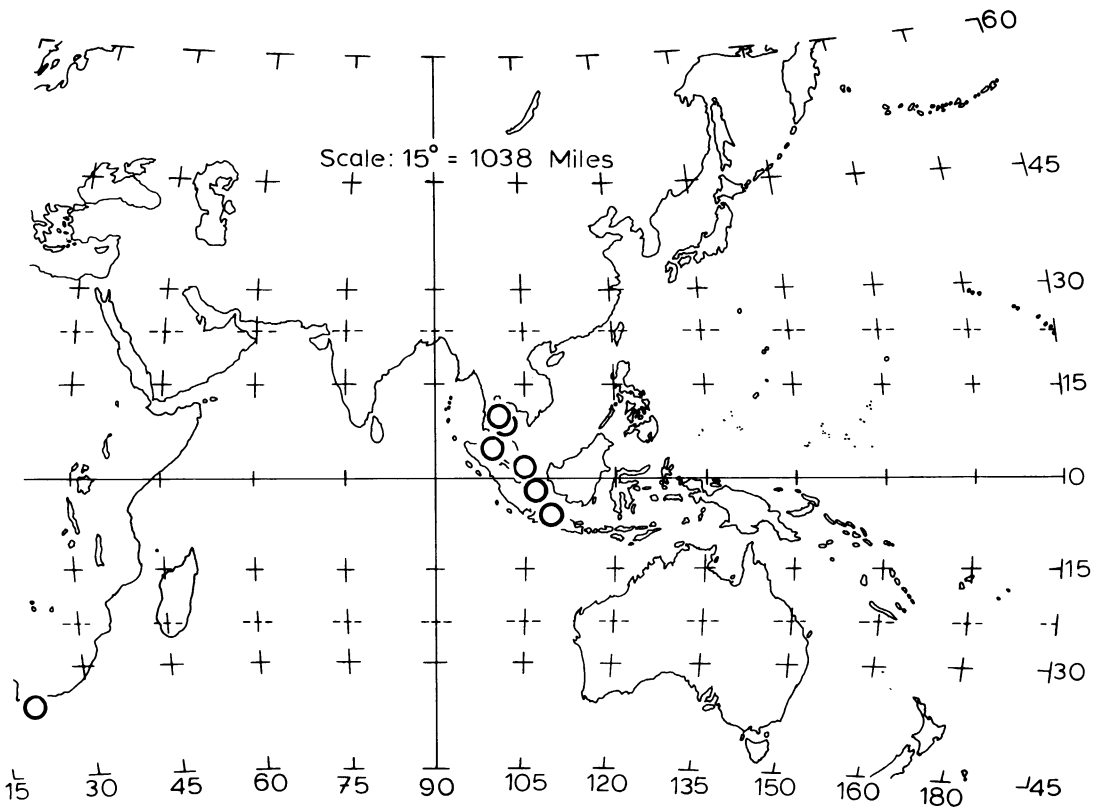

FIG. 15. Distribution of *Chiloscyllium indicum.*

Chiloscyllium indicum var. *margaritifera* Günther, 1870, p. 412.

Chiloscyllium caerulopunctatum Pellegrin, 1914, p. 230.

MATERIAL EXAMINED: Neotype (herein designated): CAS 36046 (1 male; 503mm); Indonesia: Java Sea; 5°58′S, 106°48′E; 5 Dec. 1975; F. Steiner.

REFERRED SPECIMENS: RMNH 7404 (2; 174–250mm); Indonesia: Moluccas; Obi Island; 1862; A. Bernstein; from Bleeker Collection; (larger specimen, a juvenile male, is the holotype of *C. margaritiferum* Bleeker). MNHN 14-9 (1 female; 653mm); Madagascar: Fort Dauphin; Madagascar Government; (holotype of *C. caerulopunctatum* Pellegrin). BMNH 1982.2.26.1 (1; 653mm); China Seas; Gen. Hardwicke; stuffed skin; (type of *S. ornatum* Gray). SU(CAS) 32423 (2; 160–164mm); China: Chusan Island; Tinghai; A. Herre. SU(CAS) 52606 (1; 455mm); Malaysia: Singapore. CAS 15845* (3; 337–375mm); Taiwan: Formosa Banks; F. B. Steiner. USNM 221166 (1; 517mm); Philippines: Visayan Sea; between N. Negros and Masabate Islands, N. of Tanguingui I.; 5 June 1978; L. Knapp. USNM 221165 (2; 243–638mm); Philippines: Visayan Sea; between N. Negros and Masabate Islands, E. of Madridejos; 7 June 1978; L. Knapp. USNM 170492 (1; 646mm); China: Kowloon; 5 Oct. 1908; *Albatross.* USNM 170491 (1; 548mm); China: Kowloon; 21 Oct. 1908; *Albatross.* UMMZ 17902 (1; 203mm); Japan: Kyūshū Island; vicinity of Nagasaki; rec'd. Oct. 1929; I. Kaneko. UMMZ 70329 (2; 359–409mm); China: Amoy or Swatow; Beal and Stoere. USNM 86968 (1; 139mm); China: Fukien Prov.; Foochow; Sept.–Dec. 1923; A. C. Sowerby. USNM 6449 (1; 630mm); China: Hong Kong; W. Stimpson (N Pacific Exploring Exped.). ANSP 76559 (1; 320mm); China: Hong Kong; 1930; G. Herklots. ANSP 91037 (1; 192mm); China: Fukien Prov.; San-Tu; Oct. 1935; T.

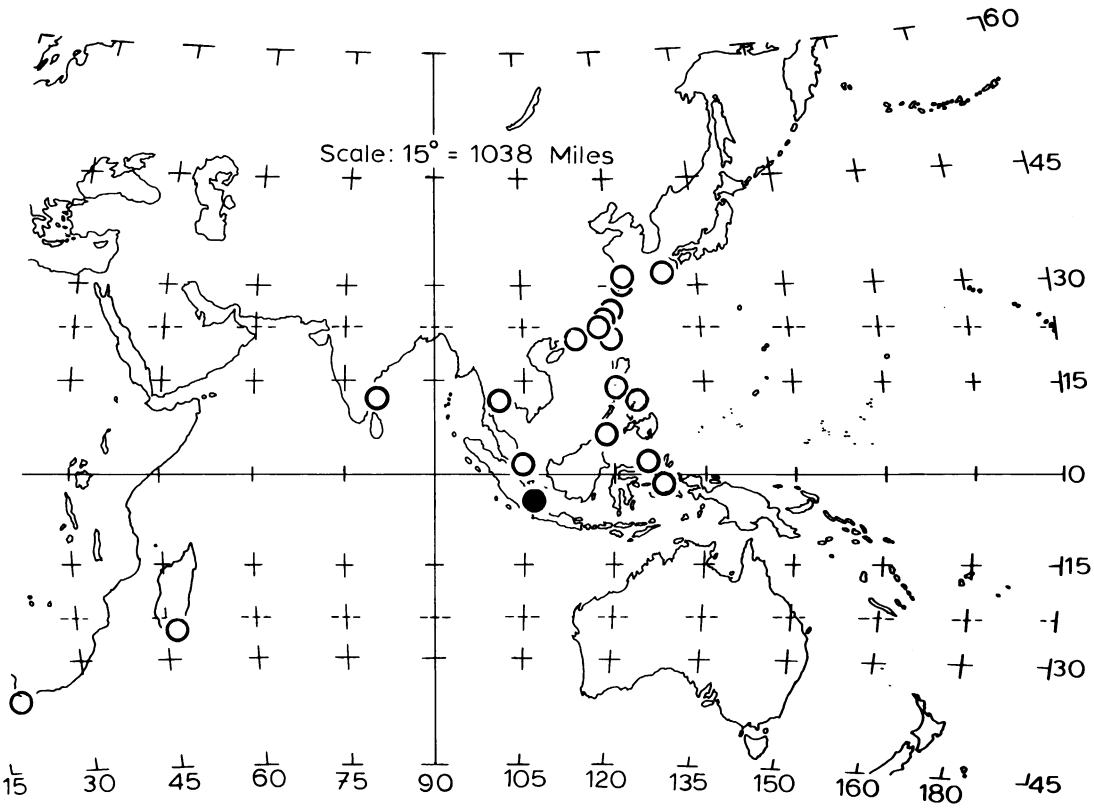

FIG. 16. Distribution of *Chiloscyllium plagiosum*. Solid circle indicates primary type locality.

H. Cheng. ANSP 49287 (1; 326mm); Philippine Islands. USNM 75953 (2; 98–404mm); Japan; P. L. Jouy. USNM 196046 (1; 177mm); Philippines: Mindoro; off Cape Calavite; J. E. Norton. ANSP 76973 (2; 210–254mm); China: Hong Kong; 1930; G. Herklots. MCZ 50-S (3; 293–441mm); China: Hong Kong; 29 Oct. 1861; W. H. Putnam. MCZ 53-S (2; 294–415mm); China; rec'd. April 1864; J. W. Williams. MCZ 58359 (1; 317mm); Malaysia: Singapore; 20 Sept. 1859; W. H. Putnam. MCZ 498-S (2; 172–228mm); Siam (Thailand); rec'd. May 1871; C. L. Salmin. MCZ 849-S (3; 708–795mm); China: Hong Kong; March 1861; W. H. Putnam. FMNH 23255-6 (2; 238–248mm); N. Borneo: Sandakan; June 1929; Crane Pacific Exped. FMNH 15648 (1; 515mm); Malaysia: Singapore; 1929; Chancellor Stewart Exped. BPBM 26484 (1; 675mm); Philippines: Cebu Island; Cebu City fish market; 2 Aug. 1978; J. E. Randall and J. Carpenter. LACM 36871-1 (1; 545mm); Malaysia: Singapore; 1966; R. Gooding. BMNH 1845.7.3.140 (1; 745mm); South Africa: Cape Sea; stuffed skin. BMNH 1880.2.2.55 (1; 715mm); India: Madras State; Madras; stuffed skin. BMNH 1888.12.30.18-9 (2; 720–740mm); India: Madras State; Madras; Thurston; stuffed skin. BMNH 1879.5.14.459 (1; 185mm); Philippines: Luzon Island; Manilla; Jan. 1875; *Challenger*. BMNH 1862.11.1.7.32 (2; 125–250mm); Japan; Mr. Jamrach. BMNH 1862.12.6.66 (1; 580mm); Formosa (Taiwan); R. Swinhoe. BMNH 1862.11.1.79-81 (3); Japan; Mr. Jamrach. BMNH 1862.11.1.42 (1; 675mm); Japan; Mr. Jamrach. BMNH 1983.5.6.1 (1; 467mm); Malaysia: Singapore; 1881; International Fisheries Exhibition. BMNH 1871.7.20.40 (1; 250mm); Indonesia: Celebes; Manado; B. Meyer. BMNH 1860.7.64 (1; 230mm); China: Fukien Prov.; Amoy; Mr. Stevens. 1851.12.24.267 (1; 156mm); China. BMNH

1928.4.24.3 (1; 225mm); China: Fukien Prov.; Amoy; Mr. Ping. BMNH 1983.2.14.4 (1; 149mm); China; J. R. Reeves. ZMH 10122 (1); Philippines: Luzon Island; Manilla; 1878. BMNH 1960.1.5.4 (1; 790mm); Off Formosa (Taiwan); March 1939; Shibayama Lab. ZMH 10117 (1); China: Fukien Prov.; Foochow; 18 Dec. 1905; G. Siemssen. ZMH 10115 (2); data same as ZMH 10117, except date is 1 June 1911. ZMH 10116 (2); data same as ZMH 10117, except date is 1 April 1905. ZMH 22303 (1); China: Fukien Prov.; 1906; G. Siemssen. ZMH 10119 (1); China: Kwangtung Prov.; Canton. ZMH 22307 (1); Philippines: Bohol Island; 1874; Semp. RMNH 7403 (1; 355mm); Malaysia: Singapore; Sept.–Oct. 1860; P. Bleeker. RMNH 4170 (1; 166mm); Indonesia: Celebes; van Delden. RMNH 4183 (1; 390mm); China: Fukien Prov.; Amoy; 20 Feb. 1862; G. Schlegel. RMNH 4182 (1; 375mm); data same as RMNH 4183.

DIAGNOSIS: A species of *Chiloscyllium* with lateral dermal ridges and the anal fin height goes less than six times in the anal fin base.

DESCRIPTION: Morphometric ranges (with measurements of the neotype in parentheses) are as follows (as percentage of TL): nose tip to pectoral origin—15.01, 19.42 (16.50); nose tip to first gill slit—12.58, 16.55 (13.92); first to fifth gill slit—3.75, 5.45 (4.57); eye diameter—1.43, 2.20 (1.79); interorbital—4.56, 6.71 (4.77); nose tip to eye—5.83, 7.91 (6.96); nose tip to spiracle—7.06, 9.35 (8.15); nose tip to mouth—3.17, 4.43 (3.98); barbel—1.39, 2.38 (1.39); postoral fold—1.11, 2.16 (1.39); nose tip to first dorsal fin—33.33, 38.16 (36.38); nose tip to pelvic origin—29.22, 34.67 (31.61); nose tip to vent—31.07, 35.11 (33.60); vent to anal fin—29.23, 35.65 (29.82); vent to tail tip—61.76, 67.08 (61.83); first to second dorsal fin—9.28, 11.59 (9.54); second dorsal fin to tail tip—33.49, 54.21 (37.18); pectoral fin length—10.17, 12.81 (11.53); pelvic fin length—7.93, 10.86 (9.94); first dorsal fin base—7.67, 9.29 (8.95); first dorsal fin height—5.35, 7.30 (6.36); second dorsal fin base—7.06, 8.80 (7.95); second dorsal fin height—4.69, 6.81 (5.57); anal fin base—9.54, 12.95 (10.93); anal fin free margin—1.19, 2.16 (1.59); anal fin height—2.01, 3.05 (2.19); subcaudal—18.41, 24.29 (21.07); vertebral centra—164, 185 (178). Morphometric data are

TABLE 6
Frequency Distribution of Nose Tip to Eye Distance as Percentage of Total Length

Species	5.01 to 5.40	5.41 to 5.80	5.81 to 6.20	6.21 to 6.60	6.61 to 7.00	7.01 to 7.40	7.41 to 7.80	7.81 to 8.20	8.21 to 8.60	8.61 to 9.00	9.01 to 9.40	9.41 to 9.80	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	—	—	—	—	**1**	—	—	—	—	—	—	—	1	6.78
confusum, new species	—	—	—	4	**9**	4	1	4	2	1	—	—	25	7.29
griseum	—	—	2	—	**2**	2	3	1	—	2	—	—	12	7.60
hasselti	—	—	—	—	**1**	4	5	2	3	3	—	1	19	7.91
indicum	—	—	—	3	4	1	1	—	1	—	—	—	10	6.86
plagiosum	—	—	4	8	**6**	4	1	1	—	—	—	—	24	6.72
punctatum	—	—	—	—	**5**	**8**	2	2	—	—	—	—	17	7.29
Hemiscyllium														
freycineti	1	2	3	2	—	—	—	—	—	—	—	—	8	6.00
hallstromi	2	2	**4**	1	—	—	—	—	—	—	—	—	9	5.76
ocellatum	**3**	8	6	2	—	1	—	—	—	—	—	—	20	5.84
species	—	—	—	—	—	—	1	—	—	—	—	—	1	7.43
strahani	**1**	—	1	—	—	—	—	—	—	—	—	—	2	5.53
trispeculare	1	2	**4**	—	—	—	—	—	—	—	—	—	7	5.79

TABLE 7

Frequency Distribution of Nose Tip to Spiracle Distance as Percentage of Total Length

Species	5.41 to 5.85	5.86 to 6.30	6.31 to 6.75	6.76 to 7.20	7.21 to 7.65	7.66 to 8.10	8.11 to 8.55	8.56 to 9.00	9.01 to 9.45	9.46 to 9.90	9.91 to 10.35	10.36 to 10.80	10.81 to 11.25	N	$\bar{X}$
Chiloscyllium															
burmensis, new species	–	–	–	–	–	–	**1**	–	–	–	–	–	–	1	8.17
confusum, new species	–	–	–	1	–	**6**	6	5	3	2	–	2	–	25	8.62
griseum	–	–	–	–	1	–	1	1	**5**	1	3	–	–	12	9.24
hasselti	–	–	–	–	–	–	–	**3**	5	3	5	2	1	19	9.60
indicum	–	–	–	2	1	2	4	1	2	–	–	–	–	10	8.31
plagiosum	–	–	–	–	2	10	**5**	3	2	–	–	–	–	24	8.17
punctatum	–	–	–	–	–	3	6	**5**	2	–	1	–	–	17	8.56
Hemiscyllium															
freycineti	–	1	2	3	2	–	–	–	–	–	–	–	–	8	6.84
hallstromi	2	1	3	**2**	–	1	–	–	–	–	–	–	–	9	6.61
ocellatum	1	**5**	7	6	–	–	1	–	–	–	–	–	–	20	6.56
species	–	–	–	–	–	–	1	–	–	–	–	–	–	1	8.11
strahani	–	**1**	1	–	–	–	–	–	–	–	–	–	–	2	6.43
trispeculare	–	2	3	**2**	–	–	–	–	–	–	–	–	–	7	6.56

TABLE 8

Frequency Distribution of Nose Tip to Mouth Distance as Percentage of Total Length

Species	1.11 to 1.40	1.41 to 1.70	1.71 to 2.00	2.01 to 2.30	2.31 to 2.60	2.61 to 2.90	2.91 to 3.20	3.21 to 3.50	3.51 to 3.80	3.81 to 4.10	4.11 to 4.40	4.41 to 4.70	4.71 to 5.00	5.01 to 5.30	5.31 to 5.60	5.61 to 5.90	5.91 to 6.20	6.21 to 6.50	N	$\bar{X}$
Chiloscyllium																				
burmensis, new species	–	–	–	–	–	–	–	–	**1**	–	–	–	–	–	–	–	–	–	1	3.65
confusum, new species	–	–	–	–	–	–	–	1	3	4	6	**3**	2	4	1	1	–	–	25	4.43
griseum	–	–	–	–	–	–	–	–	1	**3**	2	2	1	3	–	–	–	–	12	4.77
hasselti	–	–	–	–	–	–	–	–	1	1	**3**	3	2	3	1	3	1	1	19	4.92
indicum	–	–	–	–	–	–	–	–	–	1	4	4	1	–	–	–	–	–	10	4.39
plagiosum	–	–	–	–	–	–	1	4	3	**7**	8	1	–	–	–	–	–	–	24	3.89
punctatum	–	–	–	–	–	–	3	**7**	4	2	1	–	–	–	–	–	–	–	17	3.50
Hemiscyllium																				
freycineti	–	–	2	5	–	1	–	–	–	–	–	–	–	–	–	–	–	–	8	2.17
hallstromi	2	1	1	1	**3**	1	–	–	–	–	–	–	–	–	–	–	–	–	9	1.97
ocellatum	1	1	7	**7**	3	–	1	–	–	–	–	–	–	–	–	–	–	–	20	2.05
species	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	2.70
strahani	–	–	**1**	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	1.90
trispeculare	–	–	**1**	1	4	1	–	–	–	–	–	–	–	–	–	–	–	–	7	2.34

TABLE 9

Frequency Distribution of Barbel Length as Percentage of Total Length

Species	0.66 to 0.85	0.86 to 1.05	1.06 to 1.25	1.26 to 1.45	1.46 to 1.65	1.66 to 1.85	1.86 to 2.05	2.06 to 2.25	2.26 to 2.45	2.46 to 2.65	2.66 to 2.85	2.86 to 3.05	3.06 to 3.25	3.26 to 3.45	N	$\bar{X}$
Chiloscyllium																
burmensis, new species	–	–	–	–	–	–	–	**1**	–	–	–	–	–	–	1	2.09
confusum, new species	–	–	–	1	–	5	–	**6**	7	4	1	1	–	–	25	2.06
griseum	–	–	–	–	–	1	1	2	1	3	**2**	2	–	–	12	2.47
hasselti	–	–	–	–	1	–	2	5	2	**3**	1	1	3	1	19	2.43
indicum	–	–	–	4	3	1	–	–	1	–	–	–	–	–	10	1.53
plagiosum	–	–	–	**4**	10	6	2	2	–	–	–	–	–	–	24	1.75
punctatum	–	–	–	–	1	5	8	1	**1**	–	1	–	–	–	17	1.95
Hemiscyllium																
freycineti	5	–	2	1	–	–	–	–	–	–	–	–	–	–	8	0.94
hallstromi	–	**6**	3	–	–	–	–	–	–	–	–	–	–	–	9	1.03
ocellatum	**8**	9	3	–	–	–	–	–	–	–	–	–	–	–	20	0.92
species	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	1.01
strahani	–	**2**	–	–	–	–	–	–	–	–	–	–	–	–	2	0.98
trispeculare	3	3	**1**	–	–	–	–	–	–	–	–	–	–	–	7	1.06

TABLE 10

Frequency Distribution of Postoral Fold Length as Percentage of Total Length

Species	0.76 to 0.85	0.86 to 0.95	0.96 to 1.05	1.06 to 1.15	1.16 to 1.25	1.26 to 1.35	1.36 to 1.45	1.46 to 1.55	1.56 to 1.65	1.66 to 1.75	1.76 to 1.85	1.86 to 1.95	1.96 to 2.05	2.06 to 2.20	N	$\bar{X}$
Chiloscyllium																
burmensis, new species	–	–	–	–	–	–	**1**	–	–	–	–	–	–	–	1	1.39
confusum, new species	–	–	–	–	–	7	3	**4**	4	2	2	3	–	–	25	1.54
griseum	–	–	–	–	–	2	1	3	1	2	1	**2**	–	–	12	1.58
hasselti	–	–	1	–	–	2	2	5	4	**4**	1	–	–	–	19	1.54
indicum	1	2	2	5	–	–	–	–	–	–	–	–	–	–	10	1.00
plagiosum	–	–	–	1	4	5	**4**	4	2	1	1	1	–	1	24	1.46
punctatum	–	–	–	–	3	2	**5**	6	1	–	–	–	–	–	17	1.40
Hemiscyllium																
freycineti	–	–	1	2	1	–	2	1	1	–	–	–	–	–	8	1.30
hallstromi	–	–	–	–	–	3	**3**	2	1	–	–	–	–	–	9	1.40
ocellatum	**1**	–	–	7	1	5	5	–	1	–	–	–	–	–	20	1.25
species	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	1.35
strahani	–	**1**	–	–	–	–	–	1	–	–	–	–	–	–	2	1.24
trispeculare	–	–	–	–	–	1	4	–	**2**	–	–	–	–	–	7	1.44

compared with other species in tables 1 to 28. Both adults and juveniles are banded and patterned (fig. 17), the juveniles being very dark, almost black, the adults becoming lighter and the coloration becoming fainter with age. Bands are alternating light and darker gray, the dark bands have white spots interspersed on them. The light bands are interspersed with black spots (see fig. 17). The ventral surface shows a uniform light gray. Sexual maturity varies among males, subadults have been examined reaching 638mm

FIG. 17. *Chiloscyllium plagiosum* (Bennett), Neotype. CAS 36046. 503mm, TL. Adult male.

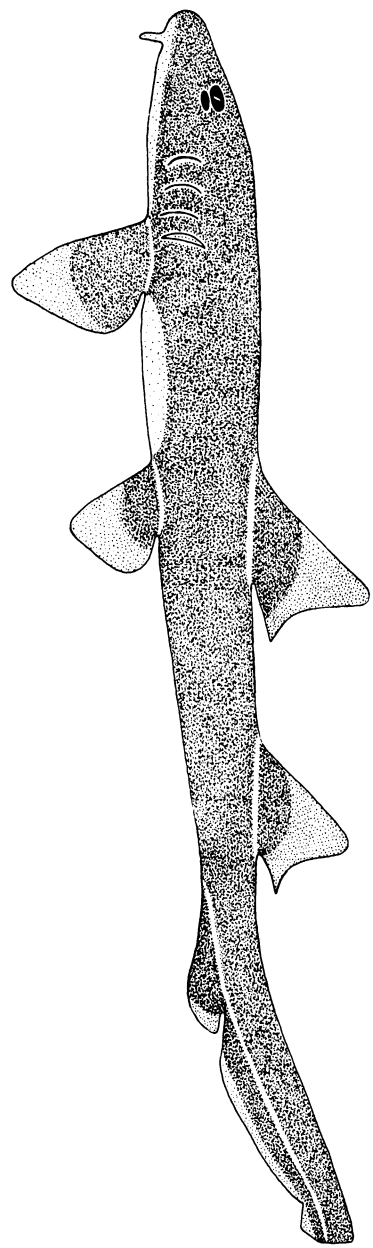

FIG. 18. *Chiloscyllium punctatum* Müller and Henle. AMNH 44013. 629mm, TL. Adult female.

TL, whereas others are already fully mature at 503mm TL. Distribution is shown in figure 16. Lateral dermal ridges are present to a greater or lesser extent, and are due to modified dermal denticles (see discussion of dermal denticles below). Feeds in part upon fishes, as shown by x-rays.

DISCUSSION: Bennett (1830) described the species based upon a specimen collected by Sir T. Raffles off Sumatra. Sir Raffles's collection went to the British Museum of Natural History. The specimen of *C. plagiosum* from which Bennett described the species could not be located at the British Museum, neither by A. Wheeler (personal commun.) nor by us. Also it was never listed in the catalogues by Gray (1851) or Günther (1870). Hence, it is assumed that the type is lost. Because of questions surrounding the species' identity (Bennett's description is very brief, and there is no illustration accompanying it), we deem a neotype necessary. CAS 36046, a well-preserved adult male, from SE Sumatra (Bennett's specimen came from Sumatra, no more specific location was given), is considered to be the best specimen to represent the species and is hereby designated the neotype of *Chiloscyllium plagiosum* (Bennett).

Bleeker (1864) described *C. margaritiferum* from Obi Island. For a long time this species was a synonym of *C. punctatum*. Examination of the type (RMNH 7404—larger specimen) showed conclusively that it is a specimen of *C. plagiosum*. Hence, *C. margaritiferum* Bleeker is herewith moved into the synonymy of *C. plagiosum*.

ETYMOLOGY: From Latin, *plāga,* meaning a stripe; and the Latin suffix *-osus,* meaning full of; gender neuter.

Chiloscyllium punctatum Müller and Henle, 1841

Figures 18–24, 39, 41, 43, 45–46, 49, 55, 79–80

Chiloscyllium punctatum Müller and Henle, 1841, p. 19, pl. 3.
Hemiscyllium punctatum Fowler, 1938, p. 7.

MATERIAL EXAMINED: Neotype (herein designated): AMNH 38153 (1 female; 352mm); Indonesia: Java; off Batavia (=Djakarta); 23 March 1940; Batavian Zeefisch Institute.

REFERRED SPECIMENS: AMNH 49535* (3; 373–401mm); data same as AMNH 38153. AMNH 44013* (2; 602–629mm); Indonesia: Java; off Batavia (Djakarta); March 1931; E. G. White. AMNH 44030 (2; 128–274mm); Philippines: Cebu Island; Lapu Lapu City, off Santa Rosa; March 1980; Marine Tropical Imports. AMNH 44022 (1; 164mm); data is same as AMNH 44030, but date is August 1979. USNM 202705 (1; 1040mm); Australia: Queensland; One Tree Island; 27 Nov. 1966; V. G. Springer. USNM 170490 (1; 391mm); Philippines: Siasi Island; 17 Feb. 1908; *Albatross.* USNM 176718 (1; 421mm); Australia: Queensland; Great Barrier Reef, near Brisbane; 8 Apr.–29 May 1952; J. K. Howard. USNM 170496 (1; 918mm); Philippines: Zambuanga; 27 May 1908; *Albatross.* USNM 170497 (1; 643mm); Philippines: Cebu Island; Cebu; 16 August 1909; *Albatross.* USNM 32700 (1; 745mm); Indonesia: Java; Batavia (Djakarta); from Leiden Museum. UMMZ 191398 (1; 147mm); Thailand: Prachuap Khiri Khan Prov.; Ban Khlong Wan; 12–13 Dec. 1964; K. F. Lagler. USNM 176709 (3; 741–945mm); data same as USNM 176718. UF 17310 (2; 165–174mm); Indonesia: Komodo Island; coral reef at Telok Slawi; Jan.–Feb. 1970; W. Auffenberg. MCZ 1257-S (1; 533mm); Indonesia: Celebes; Jan.–Aug. 1907; T. Barbour. MCZ 33405 (1; 214mm); Philippines: Mindoro Island; Lubang; 1933; P. DeMeza. MCZ 65-S (1; 398mm); Malaysia: Singapore. MCZ 475-S (1; 423mm); Philippines; rec'd. 1873; C. L. Salmin. MCZ 67-S (1; 681mm); no data. FMNH 50966 (1; 225mm); Philippines: Palawan Island; Puerto Princessa; May 1947; Phil. Zool. Exped. BPBM 22097 (1; 782mm); Philippines: Cebu Island; Cebu City fish market; 23 Aug. 1977; J. E. Randall and J. E. Carpenter. BPBM 26466 (1; 635mm); Philippines: Cebu Island; Cebu City fish market; 11 Aug. 1978; J. E. Randall and G. Tribble. FMNH 21835 (1; 780mm); Malaysia: North Borneo; Sandakan; 30 June 1929; Crane Pacific Exped. SU(CAS) 13660 (1; 510mm); Philippines; 1931; A. W. Herre. BMNH 1867.11.28.199 (1; 345mm); Indonesia: Java; P. Bleeker. BMNH 1983.2.14.5 (1; 640mm); Malaysia: Singapore; 1881; International Fisheries Exh. BMNH 1903.10.16.15 (1; 640mm); Australia: Queensland; Torres Straight, Thursday Island; Lord Crawford/

Valhalla. RMNH 4184 (1; 575mm); Indonesia: Java; Krawang; *ca.* 1828; S. Müller. RMNH 4178 (1; 520mm); Indonesia: Java; Kuhl and J. C. van Hasselt. RMNH 4179 (1); no data. ISH 53/82 (2; 720–910mm); Indonesia: S. Java; 7°28′S, 109°12′E 1981; T. Gloerfelt-Tarp.

DIAGNOSIS: A species of *Chiloscyllium* with the posterior margins of both dorsal fins convex in shape.

DESCRIPTION: Morphometric ranges (with measurements of the neotype in parentheses) are as follows (as percentage of TL): nose tip to pectoral origin—16.23, 18.37 (17.33); nose tip to first gill slit—13.51, 15.82 (14.49); first

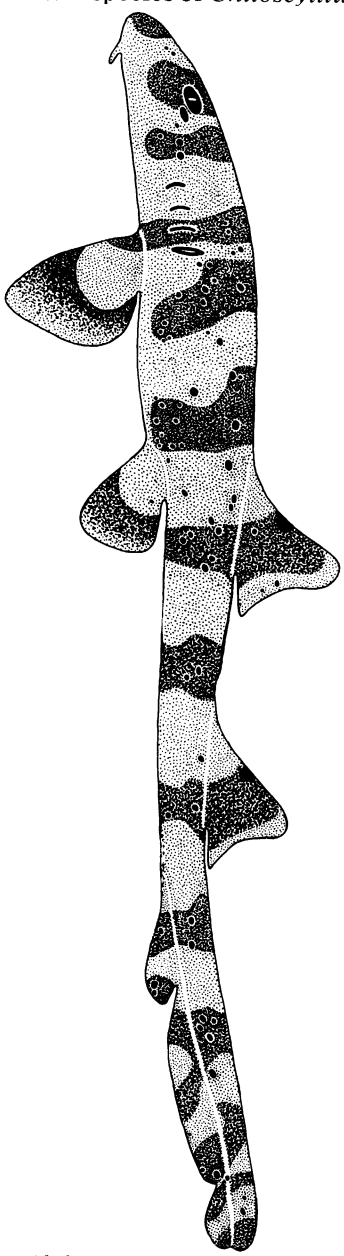

FIG. 19. *Chiloscyllium punctatum* Müller and Henle, Neotype. AMNH 38153. 162mm, TL. Subadult female.

FIG. 20. *Chiloscyllium punctatum* Müller and Henle. AMNH 44022. 162mm, TL. Juvenile male.

to fifth gill slit—4.38, 6.77 (5.40); eye diameter—1.53, 2.44 (2.13); interorbital—4.68, 7.32 (6.25); nose tip to eye—6.81, 8.16 (7.39); nose tip to spiracle—7.73, 10.20 (8.81); nose tip to mouth—2.94, 4.27 (3.41); barbel—1.62, 2.68 (2.27); postoral fold—1.22, 1.61 (1.42);

FIG. 21. *Chiloscyllium punctatum* Müller and Henle. AMNH 44030. 128mm, TL. Juvenile male. Specimen with skeletal abnormality in caudal region. Note closeness of first and second dorsal fins.

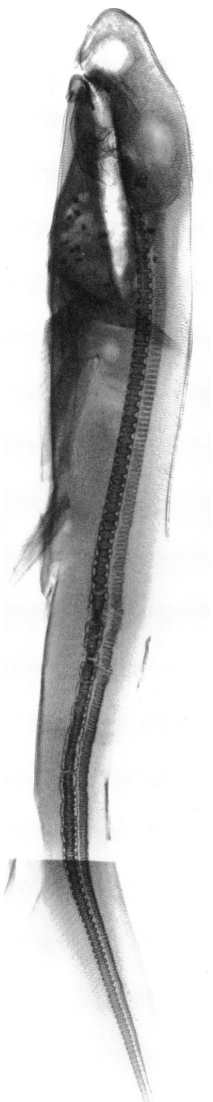

FIG. 22. *Chiloscyllium punctatum* Müller and Henle. AMNH 44030. 128mm, TL. Juvenile male. Print of radiograph, showing vertebral centra abnormality in the caudal region.

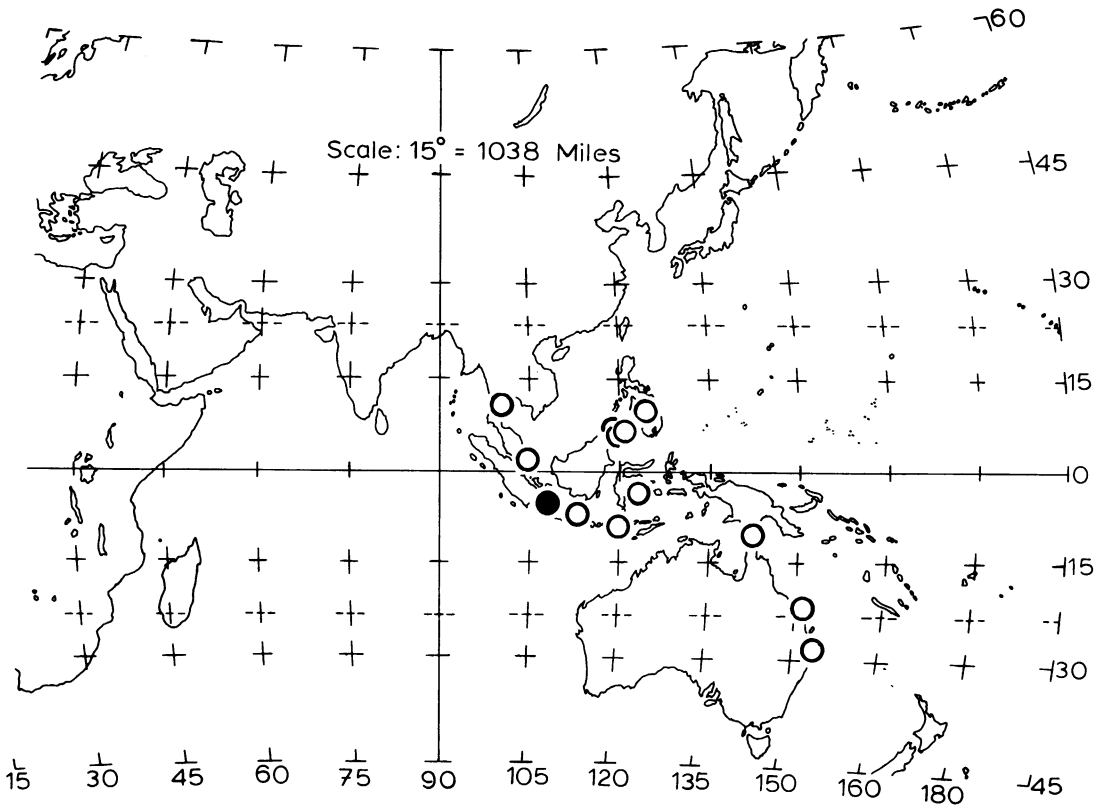

FIG. 23. Distribution of *Chiloscyllium punctatum*. Solid circle indicates primary type locality.

nose tip to first dorsal fin—32.21, 37.34 (35.23); nose tip to pelvic origin—30.29, 34.69 (32.95); nose tip to vent—32.71, 35.77 (35.51); vent to anal fin—29.26, 36.83 (29.26); vent to tail tip—61.06, 64.43 (62.22); first to second dorsal fin—9.12, 12.69 (10.80); second dorsal fin to tail tip—28.27, 36.05 (34.66); pectoral fin length—10.98, 14.90 (12.78); pelvic fin length—8.98, 11.35 (10.23); first dorsal fin base—9.94, 13.69 (9.94); first dorsal fin height—6.80, 9.85 (8.81); second dorsal fin base—8.44, 11.97 (10.80); second dorsal fin height—6.44, 8.39 (7.39); anal fin base—9.63, 12.60 (11.36); anal fin free margin—1.22, 1.82 (1.42); anal fin height—2.49, 3.58 (2.56); subcaudal—15.48, 22.56 (21.88); vertebral centra—139, 166 (166). Morphometric data are compared with other species in tables 1 to 28. Adult, subadult, and juvenile stages are illustrated in figures 18 to 20. Juveniles are strongly banded in alternating black and light, almost white, bands. As they become older, these alternating bands fade, a more uniform tan to brownish color appears, and small black spots appear over the body. As they reach maturity all signs of bands and spots disappear, leaving a uniform tan to light brown color, which is somewhat lighter on the ventral surface. Males reach sexual maturity between 681 and 745mm TL. Distribution is shown in figure 23. Size at hatching is probably about 165mm as UF 17310 still has 15mm of yolk stalk present.

DISCUSSION: One specimen examined, AMNH 44030 (128mm TL), has an unusual shortening of the caudal region (fig. 21). A radiograph of this specimen (fig. 22), revealed a skeletal anomaly involving the vertebral centra in this region. It appears that the centra have not fully formed, but rather a series of unconnected calcification centers have formed in the areas where centra should be. This is the first report of such a skeletal anomaly found in any species of shark. This speci-

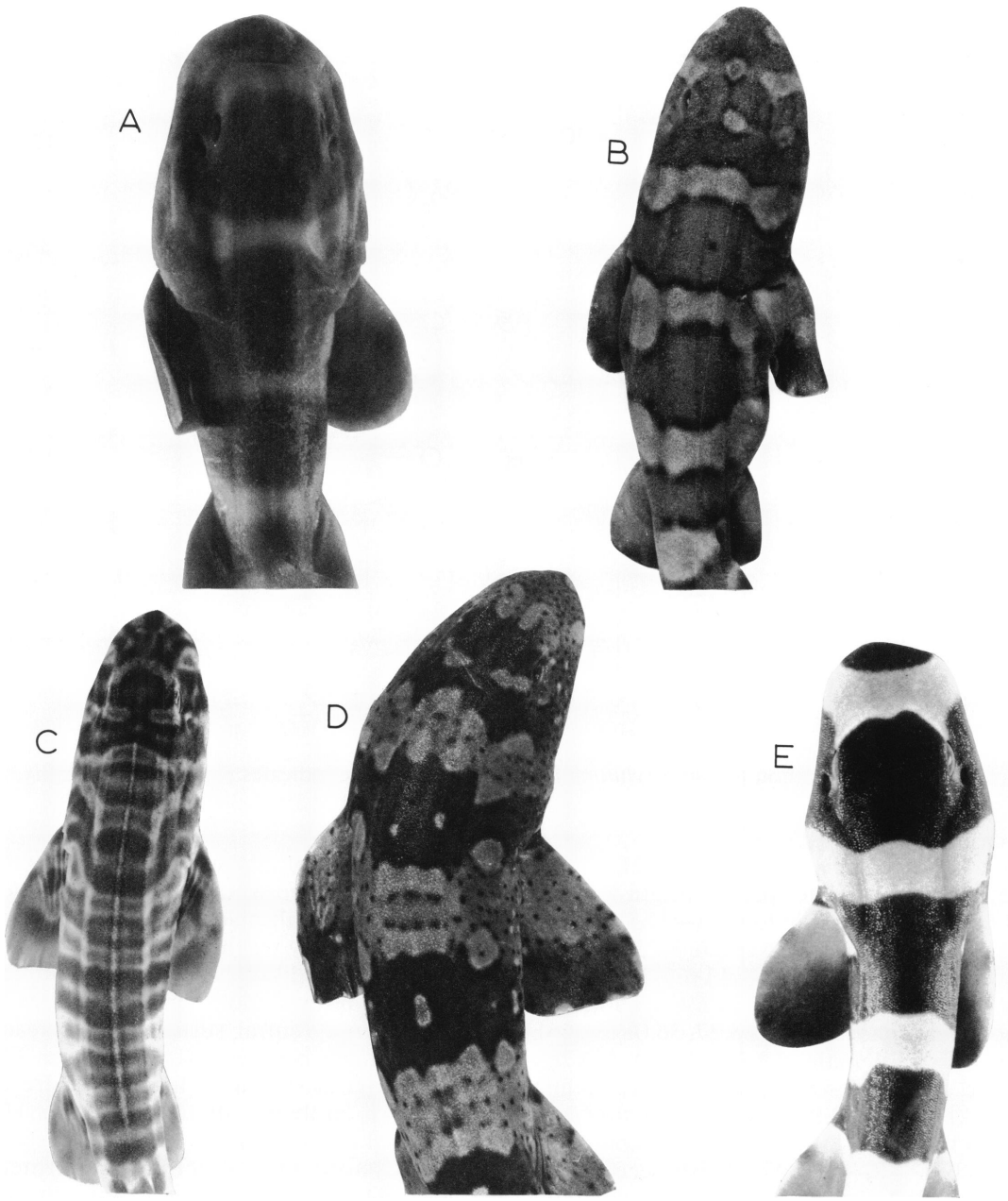

FIG. 24. Comparative dorsal views of five species of *Chiloscyllium* to show differences in dorsal color pattern. A) *C. griseum,* OSU 942, 193mm, TL, juvenile male. B) *C. hasselti,* CAS 35819, 228mm, TL, juvenile female. C) *C. indicum,* CAS 48268, 316mm, TL, juvenile female. D) *C. plagiosum* CAS 36046, 503mm, TL, adult male, neotype. E) *C. punctatum* AMNH 44022, 162mm, TL, juvenile male.

men's measurements are as follows (in percentage of TL): head length—23.44; nose tip to first gill slit—21.1; first to fifth gill slit—7.00; eye diameter—3.10; interorbital—9.4; spiracle—1.6; nose tip to eye—10.2; nose tip to spiracle—12.5; nose tip to mouth—5.47;

TABLE 11
Frequency Distribution of Nose Tip to First Dorsal Length as Percentage of Total Length

Species	32.01 to 33.00	33.01 to 34.00	34.01 to 35.00	35.01 to 36.00	36.01 to 37.00	37.01 to 38.00	38.01 to 39.00	39.01 to 40.00	40.01 to 41.00	41.01 to 42.00	42.01 to 43.00	N	$\bar{X}$
Chiloscyllium													
burmensis, new species	—	—	—	—	**1**	—	—	—	—	—	—	1	36.35
confusum, new species	—	—	—	**8**	8	6	2	—	1	—	—	25	36.17
griseum	—	—	—	—	1	**5**	3	2	—	1	—	12	38.28
hasselti	—	—	—	—	7	5	3	3	**1**	—	—	19	37.78
indicum	—	—	—	—	2	2	3	2	1	—	—	10	38.40
plagiosum	—	2	2	3	**9**	6	1	1	—	—	—	24	36.44
punctatum	2	2	5	**6**	1	1	—	—	—	—	—	17	34.80
Hemiscyllium													
freycineti	1	—	—	—	2	1	2	—	1	—	1	8	38.07
hallstromi	—	—	2	4	1	**1**	1	—	—	—	—	9	35.98
ocellatum	—	1	5	5	4	**2**	1	1	1	—	—	20	36.18
species	—	—	—	—	—	—	1	—	—	—	—	1	38.51
strahani	—	—	—	**1**	—	—	1	—	—	—	—	2	36.96
trispeculare	—	—	1	1	**5**	—	—	—	—	—	—	7	36.13

barbel—2.3; postoral fold—2.3; nose tip to vent—43.0; nose tip to first dorsal fin—42.2; pectoral fin—15.6; pelvic fin—13.3; first dorsal fin base—9.4; first dorsal fin height—10.9; second dorsal fin base—7.8; second dorsal fin height—10.9; anal fin base—8.6; anal fin free margin—3.9; anal fin height—4.7; subcaudal—25.8; vent to tail tip—52.3; vent to anal fin—18.8; first to second dorsal fin—4.7; second dorsal to tail tip—34.4; nose tip to pelvic origin—39.8.

Müller and Henle (1841) described *C. punctatum* based upon one specimen collected by Kuhl and van Hasselt off Batavia, Java. They stated this specimen was in Leiden. This specimen was searched for by M. J. P. van Oijen (personal commun.) and the senior author. It could not be located at the RMNH, nor was it recorded in the catalogue there. Dr. van Oijen (personal commun.) suggested that it might have been exchanged to either the BMNH or the MNHN. Searches at both institutions (A. Wheeler, personal commun.; M. L. Bauchot, personal commun.; and by the authors) did not reveal this specimen. We therefore assume that this specimen is lost. Due to the confusion that has existed between this species and *C. griseum* since Müller and Henle (1841) (see discussion under *C. griseum* above) it is deemed necessary to designate a neotype. AMNH 38153 is from the same locality as Kuhl and van Hasselt's, is almost the same size, and is the same sex; it is hereby designated the neotype of *Chiloscyllium punctatum* Müller and Henle.

ETYMOLOGY: From Latin, *punctatus* meaning spotted, gender neuter.

GENUS *HEMISCYLLIUM* MÜLLER AND HENLE, 1838

Hemiscyllium Müller and Henle, 1838, p. 34. [Whitley (1967) showed that Andrew Smith's *Hemiscyllium*, although dated 1837, was actually published on 13 Feb. 1838; whereas Müller and Henle's *Hemiscyllium* was published on 2 Jan. 1838. Following Whitley (1967), the name *Hemiscyllium* is herein attributed to Müller and Henle.]

TYPE SPECIES: *Squalus ocellatus* Bonnaterre, 1788, by monotypy.

DIAGNOSIS: Hemiscyllid sharks with the distance from nose tip to mouth less than 3 percent of TL (less than 20% of HL); narial barbel length less than 1.3 percent of TL (less than 10 percent of HL); distance from vent to origin of anal fin usually more than 38 percent of TL; more than 180 vertebral centra; and nose tip to first gill slit less than 13.3 percent of TL. Epaulette spot present on shoulder.

DESCRIPTION: Hemiscyllid sharks reaching approximately 750mm in total length. Adults

TABLE 12

Frequency Distribution of Nose Tip to Pelvic Origin Length as Percentage of Total Length

Species	26.01 to 27.00	27.01 to 28.00	28.01 to 29.00	29.01 to 30.00	30.01 to 31.00	31.01 to 32.00	32.01 to 33.00	33.01 to 34.00	34.01 to 35.00	35.01 to 35.00	36.01 to 37.00	37.01 to 38.00	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	—	—	—	**1**	—	—	—	—	—	—	—	—	1	29.22
confusum, new species	—	—	—	—	1	4	**13**	4	2	1	—	—	25	33.87
griseum	—	—	—	—	—	1	2	4	**4**	—	—	1	12	34.11
hasselti	—	—	—	—	—	4	11	2	**2**	—	—	—	19	32.80
indicum	—	—	—	—	3	4	2	—	1	—	—	—	10	31.76
plagiosum	—	—	—	3	3	**6**	8	1	3	—	—	—	24	31.95
punctatum	—	—	—	—	2	3	**9**	1	2	—	—	—	17	31.96
Hemiscyllium														
freycineti	—	—	3	2	1	2	—	—	—	—	—	—	8	29.70
hallstromi	—	1	**4**	3	—	1	—	—	—	—	—	—	9	25.93
ocellatum	3	4	7	3	**1**	1	1	—	—	—	—	—	20	28.58
species	—	—	—	—	—	1	—	—	—	—	—	—	1	31.76
strahani	—	—	**2**	—	—	—	—	—	—	—	—	—	2	28.63
trispeculare	—	—	3	**3**	—	1	—	—	—	—	—	—	7	29.39

TABLE 13

Frequency Distribution of Nose Tip to Vent Length as Percentage of Total Length

Species	27.01 to 28.00	28.01 to 29.00	29.01 to 30.00	30.01 to 31.00	31.01 to 32.00	32.01 to 33.00	33.01 to 34.00	34.01 to 35.00	35.01 to 36.00	36.01 to 37.00	37.01 to 38.00	38.01 to 39.00	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	—	—	—	**1**	—	—	—	—	—	—	—	—	1	30.78
confusum, new species	—	—	—	—	—	—	**11**	10	3	1	—	—	25	34.33
griseum	—	—	—	—	—	—	—	3	**5**	2	1	1	12	36.01
hasselti	—	—	—	—	—	—	4	**9**	2	3	1	—	19	34.84
indicum	—	—	—	—	—	2	5	1	2	—	—	—	10	33.69
plagiosum	—	—	—	—	4	4	**7**	7	2	—	—	—	24	33.46
punctatum	—	—	—	—	—	2	1	10	**3**	1	—	—	17	34.48
Hemiscyllium														
freycineti	—	1	2	—	2	2	1	—	—	—	—	—	8	31.09
hallstromi	—	1	3	**4**	1	—	—	—	—	—	—	—	9	30.07
ocellatum	1	1	8	5	2	—	**3**	—	—	—	—	—	20	30.32
species	—	—	—	—	—	—	1	—	—	—	—	—	1	33.11
strahani	—	—	**2**	—	—	—	—	—	—	—	—	—	2	29.36
trispeculare	—	—	—	**3**	3	—	1	—	—	—	—	—	7	31.51

TABLE 14

Frequency Distribution of Vent to Anal Fin Length as Percentage of Total Length

Species	26.51 to 28.00	28.01 to 29.50	29.51 to 31.00	31.01 to 32.50	32.51 to 34.00	34.01 to 35.50	35.51 to 37.00	37.01 to 38.50	38.51 to 40.00	40.01 to 41.50	41.51 to 43.00	43.01 to 44.50	44.51 to 46.00	46.01 to 47.50	N	$\bar{X}$
Chiloscyllium																
burmensis, new species	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—	1	35.48
confusum, new species	—	1	1	8	5	**5**	3	2	—	—	—	—	—	—	25	33.67
griseum	—	2	1	**4**	3	2	—	—	—	—	—	—	—	—	12	31.99
hasselti	1	2	7	4	**5**	—	—	—	—	—	—	—	—	—	19	31.29
indicum	—	1	—	1	5	3	—	—	—	—	—	—	—	—	10	33.29
plagiosum	—	1	**4**	6	9	3	1	—	—	—	—	—	—	—	24	32.49
punctatum	—	**1**	4	3	4	3	2	—	—	—	—	—	—	—	17	32.72
Hemiscyllium																
freycineti	—	—	—	—	—	—	—	1	—	4	3	—	—	—	8	40.67
hallstromi	—	—	—	—	—	—	—	—	—	**4**	2	1	1	1	9	42.67
ocellatum	—	—	—	—	—	—	—	—	—	3	**7**	6	4	—	20	43.11
species	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	40.34
strahani	—	—	—	—	—	—	—	—	—	—	**1**	1	—	—	2	43.82
trispeculare	—	—	—	—	—	—	—	1	2	**3**	1	—	—	—	7	39.96

TABLE 15

Frequency Distribution of Vent to Tail Tip Length as Percentage of Total Length

Species	57.51 to 58.50	58.51 to 59.50	59.51 to 60.50	60.51 to 61.50	61.51 to 62.50	62.51 to 63.50	63.51 to 64.50	64.51 to 65.50	65.51 to 66.50	66.51 to 67.50	67.51 to 68.50	68.51 to 69.50	69.51 to 70.50	70.51 to 71.51	N	$\bar{X}$
Chiloscyllium																
burmensis, new species	—	—	—	—	—	—	—	—	—	**1**	—	—	—	—	1	67.30
confusum, new species	—	—	—	1	3	8	**7**	3	1	1	1	—	—	—	25	63.82
griseum	1	—	**1**	1	3	4	2	—	—	—	—	—	—	—	12	62.29
hasselti	—	1	—	2	7	**5**	3	1	—	—	—	—	—	—	19	62.21
indicum	—	—	—	—	1	2	—	4	2	1	—	—	—	—	10	64.78
plagiosum	—	—	—	—	**3**	1	8	9	1	2	—	—	—	—	24	64.50
punctatum	—	—	—	4	**6**	5	2	—	—	—	—	—	—	—	17	62.40
Hemiscyllium																
freycineti	—	—	—	—	—	—	2	—	—	3	3	—	—	—	8	66.53
hallstromi	—	—	—	—	—	—	—	—	1	**1**	2	3	1	1	9	68.59
ocellatum	—	—	—	—	—	—	1	1	—	**4**	3	4	7	—	20	68.37
species	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	64.86
strahani	—	—	—	—	—	—	—	—	—	—	1	**1**	—	—	2	68.67
trispeculare	—	—	—	—	—	—	—	—	**3**	—	3	1	—	—	7	67.26

in general are more slender bodied than adults of *Chiloscyllium* (see fig. 2). Juveniles are banded and as they mature, the banding modifies into distinct spotting patterns. There are five described species: *H. freycineti, H. hallstromi, H. ocellatum, H. strahani,* and *H. trispeculare.* There is one juvenile specimen from New Guinea that at present is unassignable to species. All species are relatively narrowly distributed in the Australian–New Guinean area. They are bottom-dwelling sharks, feeding upon molluscs and crustaceans.

ETYMOLOGY: *Hemi,* Latin, meaning half; *scyllium,* new Latin from Greek *skylion,* meaning dogfish; gender neuter.

Hemiscyllium freycineti
(Quoy and Gaimard, 1824)
Figures 25–27, 38, 81–84

Scyllium freycineti Quoy and Gaimard, 1824, p. 192.
Chiloscyllium freycineti Richardson, 1843, p. 30.
Hemiscyllium freycineti Garman, 1913, p. 46.
Scyllium malaisianum Lesson, 1830, p. 94, pl. 6.
Chiloscyllium malaianum Müller and Henle, 1841, p. 20.
Hemiscyllium malayanum Bleeker, 1852, p. 6.
Hemiscyllium malaisanum Bleeker, 1857, p. 386.
Scyllium malaisanum Günther, 1870, p. 411.

MATERIAL EXAMINED: Lectotype (herein designated): MNHN A.7792 (a male; 323mm); Indonesia: Irian Jaya (Dutch New Guinea); Waigiou; L. de Freycinet/Voy. *Uranie.*

Paralectotype (herein designated): MNHN B.2962 (a male; 290mm); data same as lectotype, MNHN A.7792.

REFERRED SPECIMENS: MNHN 7767 (1; 685mm); Indonesia: Irian Jaya (Dutch New Guinea); Waigiou; R.P. Lesson and Garnot; (type of *S. malaisianum* Lesson). BMNH 1870.12.27.1 (1; 530mm); Indonesia: Irian Jaya (Dutch New Guinea); Waigiou. RMNH 7405 (1; 310mm); East Indies; 1879; P. Bleeker. RMNH 20499 (1; 435mm); Indonesia: Irian Jaya (Dutch New Guinea); Sissi near Misoöl; 6 Oct. 1929; Snellius Expedition. FMNH 23257-8 (2; 215–285mm); Indonesia: Irian Jaya (Dutch New Guinea); Waigiou; 7 June 1929; Crane Pacific Expedition. USNM 221705 (1; 261mm); Papua New Guinea: Trobriand Island; halfway up E side from village on Kuia Island; 11 June 1970; B. B. Collette. AMS IA.5741-2 (2; 285–367mm); Papua New Guinea: Samarai District; Feb. 1913; M. Ward. ANSP 81497 (1; 266mm); Indonesia: Irian Jaya (Dutch New Guinea); Batanta; 20 Aug. 1938; Denison–Crockett Expedition. CU 24992 (1; 722mm); Papua New Guinea: Milne Bay. USNM 218602 (1; 616mm); Papua New Guinea: N District; coral reef in Harvey Bay, E of Oro Bay; 6–7 Aug. 1975; T. Roberts. SU(CAS) 26686 (1; 187mm); Indonesia: Irian Jaya (Dutch New Guinea); Waigiou; 5 June 1929; A. Herre. SU(CAS) 26798* (1; 214mm); Indonesia: Irian Jaya; Waigiou.

DIAGNOSIS: A species of *Hemiscyllium* with the head anterior to the eyes covered with spots subequal to, or larger, than the eye.

DESCRIPTION: Morphometric ranges are as follows (in percentage of TL): nose tip to pectoral origin—13.08, 15.89; nose tip to first gill slit—10.80, 13.08; first to fifth gill slit—4.20, 6.66; eye diameter—1.07, 1.66; interorbital—3.74, 5.35; nose tip to eye—5.40, 6.54; nose tip to spiracle—6.23, 7.49; nose tip to mouth—1.88, 2.80; barbel—0.70, 1.40; postoral fold—1.05, 1.60; nose tip to first dorsal fin—32.98, 42.78; nose tip to pelvic origin—28.25, 31.78; nose tip to vent—28.88, 33.16; vent to anal fin—37.82, 42.11; vent to tail tip—63.55, 68.07; first to second dorsal fin—10.71, 14.74; second dorsal fin to tail tip—32.08, 37.19; pectoral fin length—8.87, 11.69; pelvic length—8.65, 11.20; first dorsal fin base—5.14, 8.77; first dorsal fin height—4.67, 8.60; second dorsal fin base—7.01, 8.12; second dorsal fin height—5.64, 7.79; anal fin base—7.94, 10.88; anal fin free margin—0.93, 1.62; anal fin height—1.40, 3.08; subcaudal—14.40, 18.51; vertebral centra—188, 194. Morphometric data are compared with other species in tables 1 to 28. Adult and juvenile stages are illustrated in figures 25 and 26. Adults have relatively large red-brown spots on a cream to light tan background. The ventral surface shows a uniform white to cream color with no spots whatsoever. Juveniles do not have a spotted pattern, but do have a series of alternating dark brown and tan bands (see fig. 26). The dark bands break up rapidly into spots, and more spots appear in the light bands, so that by 300mm TL the

adult pattern is quite developed. Males mature between 367mm and 616mm TL. Distribution is shown in figure 30.

DISCUSSION: Quoy and Gaimard (1824) described this species based upon two specimens from Waigiou. They attributed the name to Cuvier, stating that Cuvier had placed this name on the specimens in the exhibition halls of the Paris Museum. However, according to the rules of the International Code of Zoological Nomenclature, placing a name on museum specimens does not qualify for authorship of a species name. Hence, Quoy

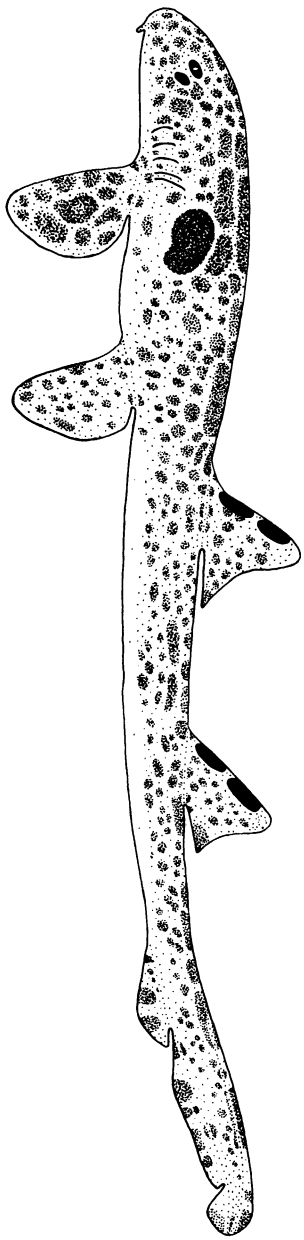

FIG. 25. *Hemiscyllium freycineti* (Quoy and Gaimard). CU 24992. 722mm, TL. Adult female.

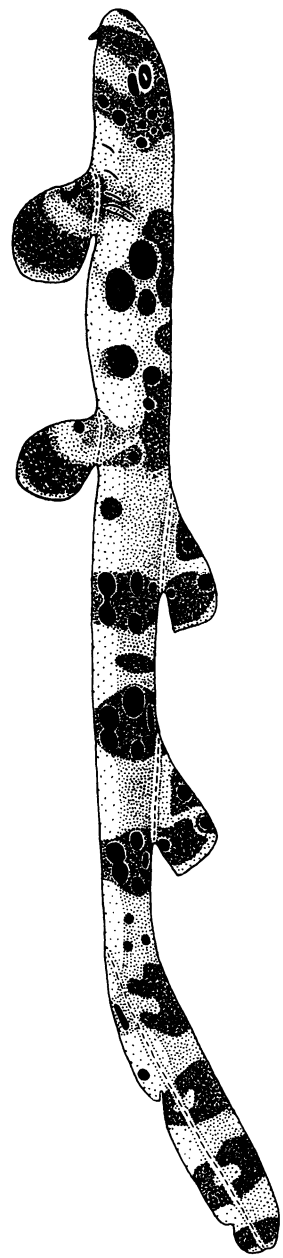

FIG. 26. *Hemiscyllium freycineti* (Quoy and Gaimard). SU(CAS) 26798. 214mm, TL. Juvenile female.

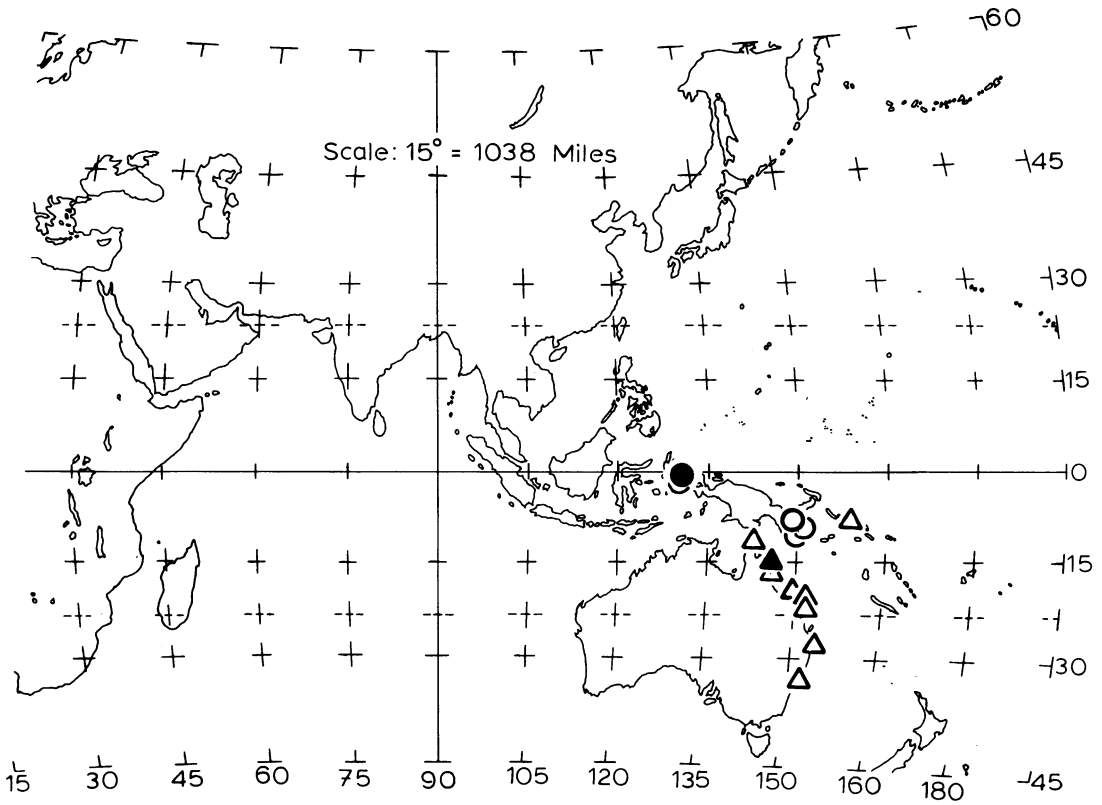

FIG. 27. Distribution of *Hemiscyllium freycineti* (circles) and *H. ocellatum* (triangles). Solid circle and triangle indicate primary type localities.

and Gaimard, who actually described the species, are credited with the authorship. We examined the type series at the MNHN. Both specimens are juvenile to subadult males, and the larger specimen, MNHN A.7792, displays more of the adult color pattern, and is in better condition. Hence, we designate MNHN A.7792 the lectotype of the species.

ETYMOLOGY: Named for L. de Freycinet, collector of the type specimens.

Hemiscyllium hallstromi Whitley, 1967

Figures 28–30, 38, 89

Hemiscyllium hallstromi Whitley, 1967, p. 178.

MATERIAL EXAMINED: Lectotype (herein designated): AMS I.15717-001 (a male; 730mm); Papua New Guinea: (restricted to Port Moresby vicinity below); rec'd. July 1970 from Taronga Zoo Park Aquarium.

Paralectotype (herein designated): AMS I.15584-001 (a male; 765mm); data same as lectotype.

REFERRED SPECIMENS: AMS IB.7938 (1; 188mm); born in Taronga Zoo Park Aquarium; received 1967 (one of the syntypes was father). USNM 30567 (1; 342mm); Papua New Guinea: Port Moresby; 7 May 1882; from Australian Museum. USNM 40018 (1; 395mm); data same as USNM 30567, but date is 7 Feb. 1889. USNM 40024* (1; 726mm); data same as USNM 40018. AMS I.11853 (1; 639mm); Papua New Guinea: Torres Strait; Murray Island; Oct. 1907. AMS I.13450 (1; 723mm); Papua New Guinea: Port Moresby; Sept. 1914; MacLean Museum. AMS I.17103-001 (1; 383mm); Papua New Guinea: SE of Port Moresby; Taukura Point; 20 June 1970; B. B. Collette. MCZ 971-S (1; 476mm); Papua New Guinea: Port Moresby; rec'd. June 1890; from Australian Museum.

DIAGNOSIS: A species of *Hemiscyllium* with

most of the body spots subequal or larger than the epaulette spot.

DESCRIPTION: Morphometric ranges (with measurements for the lectotype in parentheses) are as follows (as percentage of TL): nose tip to pectoral origin—11.85, 17.02 (15.07); nose to first gill slit—10.33, 13.30 (12.19); first to fifth gill slit—4.68, 7.34 (4.79); eye diameter—1.24, 1.78 (1.78); interorbital—3.72, 4.43 (4.11); nose tip to eye—4.82, 6.91 (6.03); nose to spiracle—5.43, 7.98 (7.12);

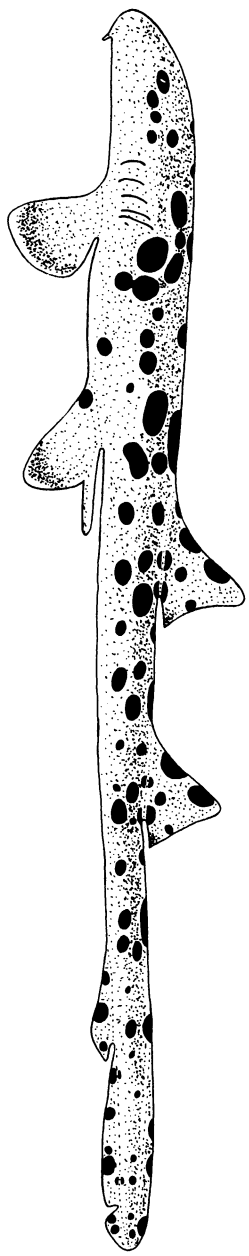

FIG. 28. *Hemiscyllium hallstromi* Whitley, Lectotype. AMS I.15717-001. 730mm, TL. Adult male.

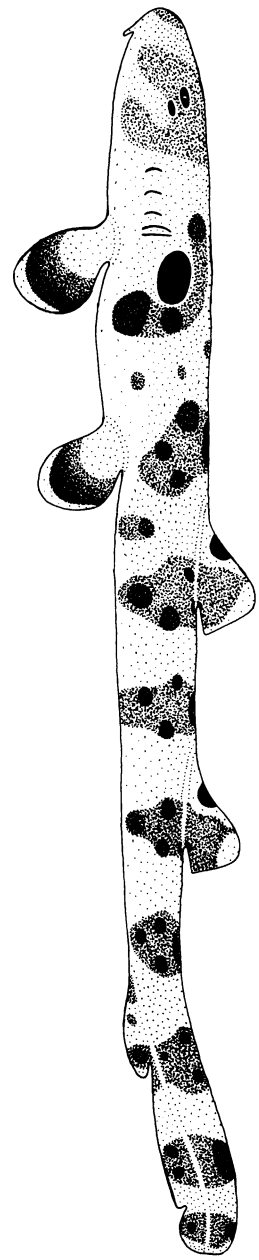

FIG. 29. *Hemiscyllium hallstromi* Whitley. AMS IB.7939. 188mm, TL. Juvenile male.

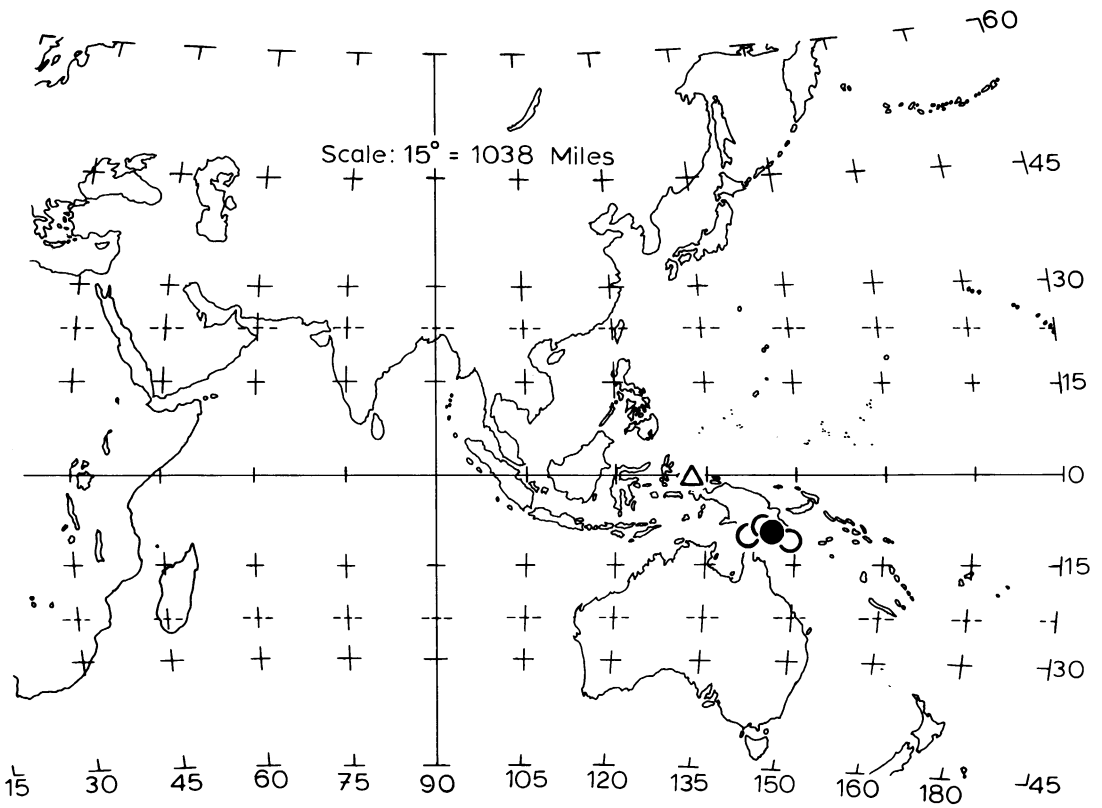

FIG. 30. Distribution of *Hemiscyllium hallstromi* (circles) and *H.* sp. (triangle). Solid circle indicates primary type locality.

nose tip to mouth—1.15, 2.66 (2.33); barbel—0.82, 1.10 (1.03); postoral fold—1.31, 1.60 (1.37); nose tip to first dorsal fin—34.02, 38.83 (37.81); nose tip to pelvic origin—28.01, 31.38 (28.77); nose tip to vent—28.72, 31.91 (30.14); vent to anal fin—40.41, 47.08 (40.41); vent to tail tip—65.96, 70.76 (67.12); first to second dorsal fin—11.10, 13.73 (11.10); second dorsal fin to tail tip—34.64, 37.72 (35.62); pectoral fin length—9.04, 12.05 (10.14); pelvic fin length—8.36, 11.42 (8.36); first dorsal fin length—7.98, 10.06 (8.08); first dorsal fin height—5.32, 7.88 (6.99); second dorsal fin base—6.91, 9.36 (7.12); second dorsal fin height—4.79, 7.67 (6.30); anal fin base—7.98, 11.35 (9.32); anal fin free margin—1.06, 1.52 (1.37); anal fin height—1.60, 2.97 (2.19); subcaudal—16.12, 17.75 (16.71); vertebral centra—186, 194 (188). Morphometric data are compared with other species in tables 1 to 28. Adult and juvenile color patterns are illustrated in figures 28 and 29. Adults have dark brown to black spots most of which are subequal or larger than the epaulette spot which is very dark brown or black. The background color is tan to light brown. The ventral side shows a uniform white to cream color. Juveniles have alternating dark brown and light tan bands. The dark brown bands are somewhat broken up into spots. With age the bands disappear while the spots intensify. Also, more spots appear in between the dark bands. Males mature between 476mm and 639mm TL. Distribution is shown in figure 30.

DISCUSSION: Whitley (1967) described *H. hallstromi* based upon two live specimens in Taronga Zoo Park Aquarium. He stated that there was a male holotype and a paratype. However, there were apparently three live specimens at Taronga Zoo Park Aquarium, two males and one female (J. Paxton, per-

TABLE 16
Frequency Distribution of First to Second Dorsal Fin Distance as Percentage of Total Length

Species	6.11 to 6.90	6.91 to 7.70	7.71 to 8.50	8.51 to 9.30	9.31 to 10.10	10.11 to 10.90	10.91 to 11.70	11.71 to 12.50	12.51 to 13.30	13.31 to 14.10	14.11 to 14.90	N	$\bar{X}$
Chiloscyllium													
burmensis, new species	—	—	—	—	—	—	**1**	—	—	—	—	1	11.13
confusum, new species	—	—	—	5	5	**5**	5	1	1	2	1	25	11.03
griseum	—	—	—	3	**6**	2	1	—	—	—	—	12	9.70
hasselti	1	1	8	5	2	1	**1**	—	—	—	—	19	8.69
indicum	—	—	—	—	1	2	5	2	—	—	—	10	11.15
plagiosum	—	—	—	1	**7**	12	4	—	—	—	—	24	10.32
punctatum	—	—	—	1	—	**8**	3	4	1	—	—	17	11.14
Hemiscyllium													
freycineti	—	—	—	—	—	1	1	3	2	—	1	8	12.31
hallstromi	—	—	—	—	—	2	**1**	4	1	1	—	9	12.06
ocellatum	—	—	—	—	—	**1**	4	4	8	2	1	20	12.48
species	—	—	—	—	—	1	—	—	—	—	—	1	10.14
strahani	—	—	—	—	—	—	**1**	—	1	—	—	2	12.33
trispeculare	—	—	—	—	—	**3**	1	3	—	—	—	7	11.60

sonal commun.; U. E. Friese, personal commun.). Upon their deaths, the two male specimens were preserved and sent to the Australian Museum, Sydney, but the female was not saved. It was impossible to tell which of the males was the holotype, and whether the other male or the female was the paratype. Hence, the two preserved specimens were labeled as syntypes in the AMS (J. Paxton, personal commun.). Due to its better condition and state of preservation, we herewith designate AMS I.15717-001 as the lectotype, and designate AMS I.15584-001 as the paralectotype. Whitley (1967) stated the locality for the type specimens as New Guinea. Information from U. E. Friese (personal commun.; former Curator of the Taronga Zoo Park Aquarium) indicates that Taronga Zoo Park Aquarium's collector did all of his New Guinean collecting around the Port Moresby area. Following this information, the type locality for *H. hallstromi* is hereby restricted to the vicinity of Port Moresby, Papua New Guinea.

ETYMOLOGY: Named for E. Hallstrom, former director of Taronga Zoo Park.

Hemiscyllium ocellatum (Bonnaterre, 1788)
Figures 2, 27, 31–32, 38–40, 42, 44, 47–48, 50, 56, 58, 85–88

Squalus ocellatus Bonnaterre, 1788, p. 8.
Scyliorhinus ocellatus Blainville, 1816, p. 121.
Hemiscyllium ocellatum Müller and Henle, 1841, p. 16.
Scyllium ocellatum Blyth, 1847, p. 726, pl. 25, fig. 2.
Chiloscyllium ocellatum Günther, 1870, p. 410.
Squalus oculatus Gray, 1827, p. 436.
Hemiscyllium oculatum Duméril, 1853, p. 119.

MATERIAL EXAMINED: Holotype: MNHN 1003 (a male; 353mm); Australia: [locality restricted to: Queensland; Cooktown, by Whitley (1967)]; 1770; J. Banks/*Endeavour* (Capt. J. Cook's first voyage); (also type of *S. oculatus* Gray).

REFERRED SPECIMENS: USNM 40025 (1; 608mm); Australia: New South Wales; Port Jackson; 7 Feb. 1889; from Australian Museum. AMNH 44016* (3; 492–643mm); Australia: Queensland; Heron Island; Jan.–May 1939; M. Lerner Expedition. AMNH 38151* (1; 213mm) no data. AMNH 44128 (1; 665mm); Australia: Queensland; Little Hope Island; 17 Jan. 1969; C. L. Smith and J. C. Tyler. USNM 176822 (3; 469–643mm); Australia: Queensland; Great Barrier Reef, off Brisbane; 8 Apr.–29 May 1953; J. K. Howard. USNM 176692 (2; 453–535mm); data same as for USNM 176822. USNM 176863 (3; 421–470mm); data same as for USNM 176822. USNM 205380 (2; 167–269mm); Australia: Queensland; Fairfax Island; Sept. 1966; J. Booth. ANSP 103829 (1; 581mm); data as for AMNH 44128. ANSP

TABLE 17

Frequency Distribution of Second Dorsal Fin to Tail Tip as Percentage of Total Length

Species	27.76 to 28.75	28.76 to 29.75	29.76 to 30.75	30.76 to 31.75	31.76 to 32.75	32.76 to 33.75	33.76 to 34.75	34.76 to 35.75	35.76 to 36.75	36.76 to 37.75	37.76 to 38.75	38.76 to 39.75	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	–	–	–	–	–	–	–	–	–	–	**1**	–	1	38.43
confusum, new species	–	–	–	–	–	1	4	5	7	**5**	2	1	25	36.23
griseum	–	–	–	1	–	–	**4**	4	2	1	–	–	12	35.04
hasselti	–	–	–	–	–	**3**	–	4	6	3	3	–	19	36.00
indicum	–	–	–	–	–	–	1	2	1	4	–	2	10	36.99
plagiosum	–	–	–	–	–	1	2	5	5	**4**	4	3	24	37.48
punctatum	1	–	1	2	3	–	**7**	1	2	–	–	–	17	33.20
Hemiscyllium														
freycineti	–	–	–	–	1	1	1	1	1	3	–	–	8	34.92
hallstromi	–	–	–	–	–	–	1	4	3	1	–	–	9	35.75
ocellatum	–	–	–	–	1	1	**4**	4	6	3	–	–	20	35.39
species	–	–	–	–	–	–	1	–	–	–	–	–	1	33.78
strahani	–	–	–	–	–	–	1	–	–	**1**	–	–	2	35.44
trispeculare	–	–	–	–	–	1	1	3	**2**	–	–	–	7	35.47

TABLE 18

Frequency Distribution of Pectoral Fin Length as Percentage of Total Length

Species	8.76 to 9.25	9.26 to 9.75	9.76 to 10.25	10.26 to 10.75	10.76 to 11.25	11.26 to 11.75	11.76 to 12.25	12.26 to 12.75	12.76 to 13.25	13.26 to 13.75	13.76 to 14.25	14.26 to 14.75	14.76 to 15.25	N	$\bar{X}$
Chiloscyllium															
burmensis, new species	–	–	–	–	–	–	–	**1**	–	–	–	–	–	1	12.70
confusum, new species	–	–	2	7	2	3	**5**	1	4	–	1	–	–	25	11.64
griseum	–	–	–	1	–	2	5	1	1	–	1	**1**	–	12	12.45
hasselti	–	–	1	4	2	5	2	**3**	1	1	–	–	–	19	11.69
indicum	–	–	1	5	1	3	–	–	–	–	–	–	–	10	10.80
plagiosum	–	–	1	4	4	**5**	3	5	2	–	–	–	–	24	11.68
punctatum	–	–	–	–	1	2	2	2	**3**	2	1	3	1	17	13.04
Hemiscyllium															
freycineti	3	3	–	–	1	1	–	–	–	–	–	–	–	8	9.78
hallstromi	2	1	**1**	2	–	2	1	–	–	–	–	–	–	9	10.49
ocellatum	–	**4**	4	6	1	3	–	–	–	–	–	–	–	20	10.28
species	–	1	–	–	–	–	–	–	–	–	–	–	–	1	9.46
strahani	–	–	–	**2**	–	–	–	–	–	–	–	–	–	2	10.51
trispeculare	–	–	–	–	3	1	**3**	–	–	–	–	–	–	7	11.47

TABLE 19
Frequency Distribution of Pelvic Length as Percentage of Total Length

Species	7.01 to 7.50	7.51 to 8.00	8.01 to 8.50	8.51 to 9.00	9.01 to 9.50	9.51 to 10.00	10.01 to 10.50	10.51 to 11.00	11.01 to 11.50	11.51 to 12.00	12.01 to 12.50	12.51 to 13.00	N	X̄
Chiloscyllium														
burmensis, new species	—	—	—	—	—	—	—	**1**	—	—	—	—	1	10.96
confusum, new species	—	—	1	3	3	4	**6**	4	2	2	—	—	25	10.10
griseum	—	—	—	—	3	1	2	2	**2**	—	1	1	12	10.70
hasselti	1	—	—	2	6	2	2	—	4	**1**	1	—	19	10.04
indicum	—	2	2	3	3	—	—	—	—	—	—	—	10	8.53
plagiosum	—	1	2	1	6	**7**	2	5	—	—	—	—	24	9.70
punctatum	—	—	—	—	—	7	**4**	3	3	—	—	—	17	10.29
Hemiscyllium														
freycineti	—	—	—	3	4	—	—	—	1	—	—	—	8	9.30
hallstromi	—	—	**1**	—	3	2	1	1	1	—	—	—	9	9.70
ocellatum	—	—	—	3	**6**	6	5	—	—	—	—	—	20	9.59
species	—	—	—	1	—	—	—	—	—	—	—	—	1	8.78
strahani	—	—	—	—	—	**1**	1	—	—	—	—	—	2	10.19
trispeculare	—	—	—	—	—	2	**1**	4	—	—	—	—	7	10.50

103828 (1; 603mm); data as for AMNH 44126, except date is 18 Jan. 1969. AMS IB.6041 (1; 614mm); Australia: Queensland; Swain Reefs, Gillett Kay; 1962; Aust. Mus. Exped. MCZ 36650 (1; 678mm); Australia: Queensland; Gladstone; July 1946; O. Barton. BMNH 1871.3.29.116 (1; 405mm); Solomon Islands. BMNH 1855.9.19.1367 (1; 380mm); N.W. Australia; Haslar Collection. BMNH 1846.9.11.119–120 (2; 425–430mm); Australia: Queensland; Sunday Island; Jukes. BMNH 1911.4.1.40–1 (2; 305–480mm); Australia: north Queensland; W. Saville-Kent. BMNH 1933.1.25.1 (1; 390mm); Australia: Queensland; Low Isles; Australian Museum Expedition. BMNH 1867.5.6.3 (1; 530mm); Australia: Queensland; Cape York; Mr. Higgins. BMNH 1927.2.1.1–2 (2; 555–620mm); Australia: Queensland; Great Barrier Reef, Russell Island; Mr. Paradice. BMNH 1933.1.25.2 (1; 380mm); Australia: Queensland; Capricorn Group, N West Island; from Australian Museum.

DIAGNOSIS: A species of *Hemiscyllium* with no spots on the head anterior to the eyes and body spots smaller than the epaulette spot.

DESCRIPTION: Morphometric ranges (with measurements of the holotype in parentheses) are as follows (as percentage of TL): nose tip to pectoral origin—12.41, 15.19 (13.03); nose tip to first gill slit—9.40, 12.57 (10.76); first to fifth gill slit—4.09, 5.80 (4.25); eye diameter—1.33, 1.87 (1.42); interorbital—3.89, 6.10 (3.97); nose tip to eye—5.10, 7.19 (5. 10); nose tip to spiracle—5.95, 8.38 (5.95); nose tip to mouth—1.41, 3.01 (2.27); barbel—0.66, 1.20 (0.85); postoral fold—0.85, 1.56 (0.85); nose tip to first dorsal fin—33.75, 40.12 (37.96); nose tip to pelvic origin—26.27, 32.34 (30.31); nose tip to vent -27.59, 33.33 (33.14); vent to anal fin—41.06, 45.72 (42.78); vent to tail tip—64.32, 70.43 (67.42); first to second dorsal fin—10.76, 14.35 (10.76); second dorsal fin to tail tip—32.34, 37.31 (34.28); pectoral fin length—9.29, 11.49 (9.35); pelvic length—8.92, 10.44 (9.07); first dorsal fin base—5.63, 10.52 (7.93); first dorsal fin height—5.16, 8.43 (6.23); second dorsal fin base—5.63, 8.86 (7.93); second dorsal fin height—4.79, 7.52 (5.38); anal fin base—6.59, 10.68 (8.50); anal fin free margin—1.01, 1.88 (1.13); anal fin height—1.20, 2.86 (1.42);

TABLE 20
Frequency Distribution of First Dorsal Fin Base Length as Percentage of Total Length

Species	5.01 to 5.80	5.81 to 6.60	6.61 to 7.40	7.41 to 8.20	8.21 to 9.00	9.01 to 9.80	9.81 to 10.60	10.61 to 11.40	11.41 to 12.20	12.21 to 13.00	13.01 to 13.80	N	$\bar{X}$
Chiloscyllium													
burmensis, new species	—	—	—	**1**	—	—	—	—	—	—	—	1	8.00
confusum, new species	—	—	2	**14**	9	—	—	—	—	—	—	25	7.21
griseum	—	—	—	—	3	5	**4**	—	—	—	—	12	9.34
hasselti	—	—	—	5	5	**5**	3	1	—	—	—	19	9.14
indicum	—	2	7	1	—	—	—	—	—	—	—	10	7.19
plagiosum	—	—	—	10	**11**	3	—	—	—	—	—	24	8.39
punctatum	—	—	—	—	—	—	**4**	6	5	1	1	17	10.62
Hemiscyllium													
freycineti	1	—	2	1	4	—	—	—	—	—	—	8	7.79
hallstromi	—	—	—	**3**	4	1	1	—	—	—	—	9	8.64
ocellatum	1	—	—	**7**	6	4	2	—	—	—	—	20	8.39
species	—	—	—	1	—	—	—	—	—	—	—	1	8.11
strahani	—	—	—	**2**	—	—	—	—	—	—	—	2	7.67
trispeculare	—	—	1	**2**	4	—	—	—	—	—	—	7	8.90

subcaudal—14.98, 17.94 (16.15); vertebral centra—183, 195. Morphometric data are compared with other species in tables 1 to 28. The adult and juvenile stages are illustrated in figures 31 and 32. Distribution is shown in figure 27. The adults are tan to light brown with dark brown to black spots which are smaller than the epaulette spot. The epaulette spot is very dark brown to black in color. The epaulette spot varies considerably in size, from approximately one-quarter the depth of the body to over one-half the body depth. Juveniles have alternating bands of dark brown and light tan to cream. The dark bands contain darker spots. With age the bands fade and the spots become more pronounced. Also more spots appear in the areas of the light bands. Reproduction is oviparous (Whitley, 1967), and eggs are reported to take about 120 days to hatch. At hatching the young are about 147mm TL. Males appear to mature over a range in size, as subadults have been measured as large as 620mm, whereas fully mature males have been measured at 590mm.

DISCUSSION: Bonnaterre (1788) described this species based upon Broussonet's (1780) description of Banks's specimen. Broussonet did not give a scientific name to the species. Shaw (1793) illustrated Banks's specimen, the type of the species.

ETYMOLOGY: From Latin, *ocellatus*, meaning eyed (presumably referring to the epaulette spots); gender neuter.

Hemiscyllium strahani Whitley, 1967
Figures 33–34, 36, 38, 91–92

MATERIAL EXAMINED: Holotype: AMS IB.7938 (a female; 735mm); Papua New Guinea: (locality restricted to vicinity of Port Moresby, below); circa 1960; rec'd. from Taronga Zoo Park Aquarium Oct. 1967.

REFERRED SPECIMEN: USNM 221701* (1 male; 594mm); Papua New Guinea: Massas Island; off southern tip; 6 Nov. 1978; V. G. Springer and C. L. Smith.

DIAGNOSIS: A species of *Hemiscyllium* possessing dark bands and spots on the ventral surface of the throat (fig. 34); having light spots on a dark body background (fig. 33).

DESCRIPTION: Morphometric ranges (with measurements of the holotype in parentheses) are as follows (as percentage of TL): nose tip to pectoral origin—13.88, 14.14 (13.88); nose tip to first gill slit—11.28, 11.29 (11.29); first to fifth gill slit—4.71, 5.31 (5.31); eye diameter—1.63, 1.68 (1.63); interorbital—3.95, 4.88 (3.95); nose tip to eye—5.17, 5.89 (5.17); nose tip to spiracle—6.12, 6.73 (6.12); nose tip to mouth—1.77, 2.02 (1.77); barbel—0.95, 1.01 (0.95); postoral fold—0.95, 1.52 (0.95); nose tip to first dorsal fin—35.37,

38.55 (35.37); nose tip to pelvic fin—28.57, 28.96 (28.57); nose tip to vent—29.25, 29.46 (29.25); vent to anal fin—42.86, 44.78 (42.86); vent to tail tip—68.35, 68.98 (68.98); first to second dorsal fin—11.70, 12.96 (11.70); second dorsal fin to tail tip—34.01, 36.87 (36.87); pectoral fin length—10.27, 10.75 (10.75); pelvic fin length—9.93, 10.44 (9.93); first dorsal fin base—7.58, 7.76 (7.76); first dorsal fin height—6.90, 6.94 (6.94); second dorsal fin base—7.41, 7.89 (7.89); second dorsal fin height—6.23, 6.39 (6.39); anal fin base—9.09,

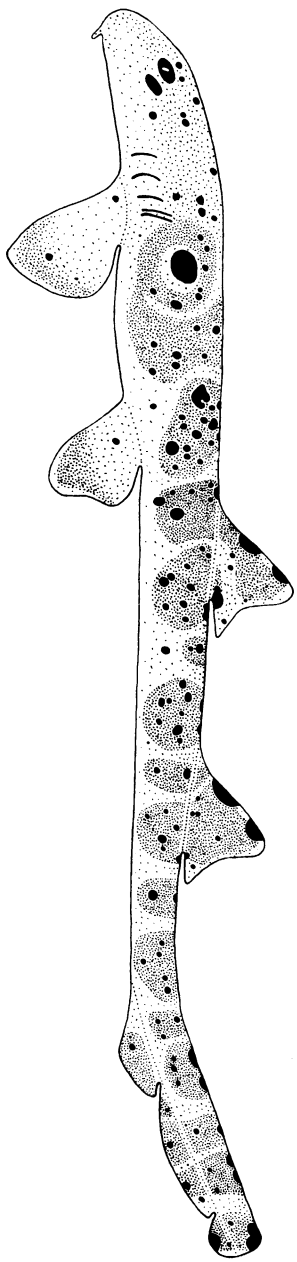

FIG. 31. *Hemiscyllium ocellatum* (Bonnaterre). AMNH 44016. 643mm, TL. Adult female.

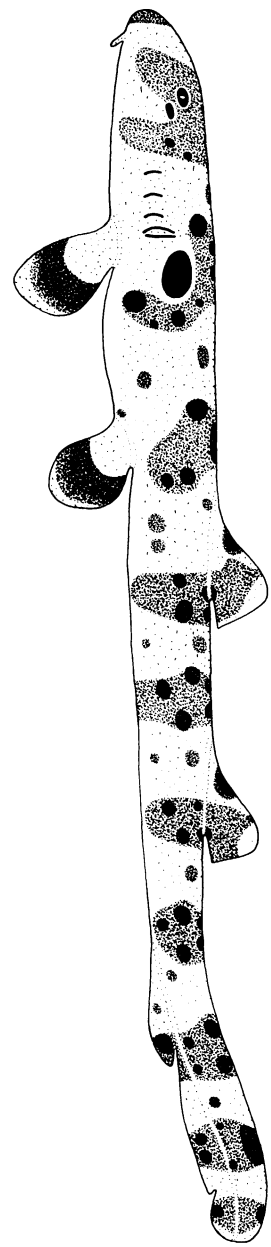

FIG. 32. *Hemiscyllium ocellatum* (Bonnaterre). USNM 205380. 167mm, TL. Juvenile female.

TABLE 21

Frequency Distribution of First Dorsal Fin Height as Percentage of Total Length

Species	4.01 to 4.40	4.41 to 4.80	4.81 to 5.20	5.21 to 5.60	5.61 to 6.00	6.01 to 6.40	6.41 to 6.80	6.81 to 7.20	7.21 to 7.60	7.61 to 8.00	8.01 to 8.40	8.41 to 8.80	8.81 to 9.20	9.21 to 9.60	9.61 to 10.00	N	$\bar{X}$
Chiloscyllium																	
burmensis, new species	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—	—	1	6.26
confusum, new species	1	—	2	4	**3**	5	2	3	2	2	1	—	—	—	—	25	6.25
griseum	—	—	—	—	—	2	4	3	2	—	**1**	—	—	—	—	12	6.92
hasselti	—	—	6	4	1	1	4	—	**2**	—	1	—	—	—	—	19	6.01
indicum	4	2	2	2	—	—	—	—	—	—	—	—	—	—	—	10	4.59
plagiosum	—	—	—	1	6	**10**	4	1	2	—	—	—	—	—	—	24	6.26
punctatum	—	—	—	—	—	—	1	—	1	4	2	2	**4**	1	2	17	8.56
Hemiscyllium																	
freycineti	—	1	2	—	1	1	1	—	1	—	—	1	—	—	—	8	6.14
hallstromi	—	—	—	1	—	—	2	**2**	—	4	—	—	—	—	—	9	6.97
ocellatum	—	1	—	—	2	**3**	3	5	3	2	—	1	—	—	—	20	6.48
species	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	5.41
strahani	—	—	—	—	—	—	—	**2**	—	—	—	—	—	—	—	2	6.92
trispeculare	—	—	—	—	—	—	—	—	—	—	5	1	**1**	—	—	7	8.42

TABLE 22

Frequency Distribution of Second Dorsal Fin Base Length as Percentage of Total Length

Species	5.61 to 6.00	6.01 to 6.40	6.41 to 6.80	6.81 to 7.20	7.21 to 7.60	7.61 to 8.00	8.01 to 8.40	8.41 to 8.80	8.81 to 9.20	9.21 to 9.60	9.61 to 10.00	10.01 to 10.40	10.41 to 10.80	10.81 to 11.20	11.21 to 11.60	11.61 to 12.00	N	$\bar{X}$
Chiloscyllium																		
burmensis, new species	—	—	—	—	**1**	—	—	—	—	—	—	—	—	—	—	—	1	7.30
confusum, new species	—	—	—	—	—	3	4	11	**5**	—	1	1	—	—	—	—	25	8.60
griseum	—	—	—	—	1	1	2	3	**5**	—	—	—	—	—	—	—	12	8.57
hasselti	—	—	—	—	—	3	**3**	4	5	3	1	—	—	—	—	—	19	8.33
indicum	—	4	3	2	1	—	—	—	—	—	—	—	—	—	—	—	10	6.67
plagiosum	—	—	—	2	3	**4**	8	6	1	—	—	—	—	—	—	—	24	8.05
punctatum	—	—	—	—	—	—	—	1	1	—	1	3	**6**	2	1	2	17	10.43
Hemiscyllium																		
freycineti	—	—	—	2	2	3	1	—	—	—	—	—	—	—	—	—	8	7.49
hallstromi	—	—	—	**2**	1	3	1	—	1	1	—	—	—	—	—	—	9	7.79
ocellatum	—	—	—	2	5	**4**	3	4	1	—	—	—	—	—	—	—	20	7.81
species	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	8.11
strahani	—	—	—	—	1	**1**	—	—	—	—	—	—	—	—	—	—	2	7.65
trispeculare	—	—	—	1	1	**4**	1	—	—	—	—	—	—	—	—	—	7	7.67

TABLE 23

Frequency Distribution of Second Dorsal Fin Height as Percentage of Total Length

Species	3.81 to 4.20	4.21 to 4.60	4.61 to 5.00	5.01 to 5.40	5.41 to 5.80	5.81 to 6.20	6.21 to 6.60	6.61 to 7.00	7.01 to 7.40	7.41 to 7.80	7.81 to 8.20	8.21 to 8.60	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	—	—	—	**1**	—	—	—	—	—	—	—	—	1	5.22
confusum, new species	1	3	5	**3**	4	3	3	1	2	—	—	—	25	5.48
griseum	—	—	—	1	2	4	2	**2**	1	—	—	—	12	6.17
hasselti	4	6	2	2	1	**2**	1	1	—	—	—	—	19	5.01
indicum	5	2	2	1	—	—	—	—	—	—	—	—	10	4.29
plagiosum	—	—	3	5	**9**	4	2	1	—	—	—	—	24	5.60
punctatum	—	—	—	—	1	—	1	4	**3**	3	4	1	17	7.26
Hemiscyllium														
freycineti	—	—	5	—	2	—	1	—	—	—	—	—	8	5.89
hallstromi	—	—	1	—	—	2	**3**	—	—	3	—	—	9	6.55
ocellatum	—	—	1	**2**	1	2	3	9	1	1	—	—	20	6.45
species	—	—	1	—	—	—	—	—	—	—	—	—	1	4.73
strahani	—	—	—	—	—	—	**2**	—	—	—	—	—	2	6.31
trispeculare	—	—	—	—	—	—	—	1	—	3	**3**	—	7	7.65

TABLE 24

Frequency Distribution of Anal Fin Base Length as Percentage of Total Length

Species	6.41 to 7.00	7.01 to 7.60	7.61 to 8.20	8.21 to 8.80	8.81 to 9.40	9.41 to 10.00	10.01 to 10.60	10.61 to 11.20	11.21 to 11.80	11.81 to 12.40	12.41 to 13.00	13.01 to 13.60	13.61 to 14.20	14.21 to 14.80	14.81 to 15.40	N	$\bar{X}$
Chiloscyllium																	
burmensis, new species	—	—	—	—	—	—	—	—	—	—	—	—	—	**1**	—	1	14.43
confusum, new species	—	—	—	—	—	—	1	6	**7**	6	3	2	—	—	—	25	11.23
griseum	—	—	—	—	—	—	2	3	**2**	3	—	1	—	1	—	12	11.71
hasselti	—	—	—	—	—	—	1	3	5	**3**	5	1	—	—	1	19	11.96
indicum	—	—	—	—	—	—	—	—	—	1	—	3	1	3	2	10	14.14
plagiosum	—	—	—	—	—	1	6	**5**	8	3	1	—	—	—	—	24	10.24
punctatum	—	—	—	—	—	4	5	4	**3**	—	1	—	—	—	—	17	10.64
Hemiscyllium																	
freycineti	—	—	2	1	3	—	1	1	—	—	—	—	—	—	—	8	9.04
hallstromi	—	—	2	—	**3**	3	1	—	—	—	—	—	—	—	—	9	9.02
ocellatum	1	2	1	**5**	5	3	—	1	2	—	—	—	—	—	—	20	9.02
species	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	8.78
strahani	—	—	—	—	**2**	—	—	—	—	—	—	—	—	—	—	2	9.17
trispeculare	—	—	—	—	**1**	1	3	2	—	—	—	—	—	—	—	7	10.25

TABLE 25
Frequency Distribution of Anal Fin Height as Percentage of Total Length

Species	1.21 to 1.40	1.41 to 1.60	1.61 to 1.80	1.81 to 2.00	2.01 to 2.20	2.21 to 2.40	2.41 to 2.60	2.61 to 2.80	2.81 to 3.00	3.01 to 3.20	3.21 to 3.40	3.41 to 3.60	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	—	—	—	—	**1**	—	—	—	—	—	—	—	1	2.09
confusum, new species	—	2	3	**6**	5	3	1	4	—	1	—	—	25	2.44
griseum	—	—	1	—	1	3	1	3	—	2	**1**	—	12	2.56
hasselti	—	4	2	4	3	2	**2**	1	—	1	—	—	19	2.09
indicum	—	1	5	2	1	1	—	—	—	—	—	—	10	1.77
plagiosum	—	—	—	—	**6**	5	6	1	5	1	—	—	24	2.55
punctatum	—	—	—	—	—	—	**2**	3	2	3	6	1	17	3.04
Hemiscyllium														
freycineti	—	1	1	2	2	—	—	1	—	1	—	—	8	2.10
hallstromi	—	1	—	—	**3**	2	—	2	1	—	—	—	9	2.33
ocellatum	1	**2**	—	2	1	5	3	4	2	—	—	—	20	2.28
species	—	—	—	—	1	—	—	—	—	—	—	—	1	2.03
strahani	—	—	—	—	—	—	**1**	—	1	—	—	—	2	2.66
trispeculare	—	—	—	—	1	—	—	—	3	2	**1**	—	7	2.91

9.25 (9.25); anal fin free margin—1.01, 1.36 (1.36); anal fin height—2.45, 2.86 (2.45); subcaudal—14.98, 16.19 (16.19); vertebral centra—187, 192 (187). Morphometric data are compared with other species in tables 1 to 28. Apparently a very rare species of shark, known only from two specimens, the holotype, an adult female, and USNM 221701, an adult male. A very dark species of *Hemiscyllium.* The epaulette spot is almost indiscernible on top of the dark body color. Dorsally, a dark gray to black background color with pale gray to white spots on this dark background (fig. 34). Ventral surface white to cream, except on head and throat where the anterior of the head is dark brown to black, except the distal portion of the barbels which are white, and on the throat where there are black bands (continuing from the dorsal side) and black spots (see fig. 33). Males mature at less than 594mm TL. USNM 221701 (the only specimen with detailed collection data) was collected at 18.3 m. depth. A bottom-dwelling shark presumed to feed on molluscs and crustaceans. Distribution is shown in figure 36. Juveniles unknown.

DISCUSSION: Whitley (1967) described this species from a live specimen living in Taronga Zoo Park Aquarium (now AMS IB.7938), which was preserved upon its death. It lived for approximately seven years at the aquarium. Whitley's description lists the type locality as New Guinea. Friese (former Curator of Taronga Zoo Park Aquarium; personal commun.) indicates that the aquarium's collector did all of his New Guinea collecting around the Port Moresby, Papua New Guinea, area. Therefore, the type locality is herewith restricted to the vicinity of Port Moresby, Papua New Guinea.

During its time in captivity the holotype was kept in a tank with specimens of *Hemiscyllium ocellatum,* which were actively breeding. The holotype was not known to have interbred with *H. ocellatum.*

ETYMOLOGY: Named for R. Strahan, former director of Taronga Zoo Park.

Hemiscyllium trispeculare Richardson, 1843

Figures 35–36, 38, 90

Hemiscyllium trispeculare Richardson, 1843, p. 5, pl. 1, fig. 2.

Chiloscyllium trispeculare Günther, 1870, p. 411.

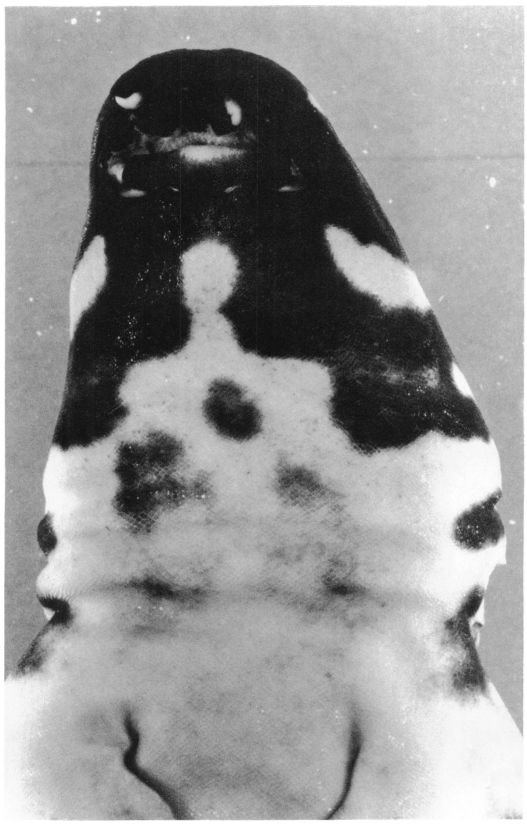

FIG. 33. *Hemiscyllium strahani* Whitley, Holotype. AMS IB.7938. Adult female. Ventral view of head and neck region.

MATERIAL EXAMINED: Neotype: BMNH 1953.5.10.1 (a male; 576mm); North West Australia; B. Bynoe/*Erebus and Terror*; [species redescribed upon this specimen by Richardson (1846), see discussion below].

REFERRED SPECIMENS: AMS I.5267-8 (2; 544–555mm); Australia: Northern Territory; Port Darwin; April 1902; C. Godfrey. AMS IA.7641 (1; 561mm); Australia: Northern Territory; Darwin; M. Ward. AMS IA.7746 (1; 575mm); data same as AMS IA.7641. USNM 174069* (1; 562mm); Australia: Northern Territory; near Darwin, E point reef, ±6 mi. NNW Darwin; 26 July 1948; R. R. Miller et al. USNM 174068 (1; 510mm); Australia: Northern Territory; coral reefs at Yirrhala, near Cape Arnhem; 11 Aug. 1948; R. R. Miller et al. RMNH 7402 (1; 790mm); E. Indies: G. Key Island; rec'd. 1879; P. Bleeker.

DIAGNOSIS: Head anterior to eyes covered with small spots, less than half the diameter of the eye; epaulette spot broken up into at least two and usually three separate spots; first dorsal fin height more than 8 percent of TL (less than 8% in all other species of *Hemiscyllium*).

DESCRIPTION: Morphometric ranges (with measurements of the neotype in parentheses) are as follows (as percentage of TL): nose tip to origin of pectoral fin—13.37, 15.48 (14.34); nose tip to first gill slit—11.28, 12.70 (11.28); first to fifth gill slit—4.34, 5.69 (4.34); eye diameter—1.34, 2.08 (2.08); interorbital—3.91, 5.05 (4.51); nose tip to eye—5.17, 6.13 (5.90); nose tip to spiracle—6.24, 6.85 (6.77); nose tip to mouth—1.91, 2.70 (1.91); barbel—0.77, 1.22 (1.22); postoral fold—1.15, 1.57 (1.56); nose tip to first dorsal fin—34.94, 37.55 (36.28); nose tip to pelvic origin—28.24, 31.32 (29.69); nose tip to vent—30.20, 33.99 (30.56); vent to anal fin—37.48, 41.76 (40.10); vent to tail tip—65.84, 68.75 (66.15); first to second dorsal fin—10.68, 12.35 (10.76); second dorsal fin to tail tip—33.63, 36.59 (36.11); pectoral fin length—9.58, 11.98 (11.98); pelvic fin length—9.20, 10.85 (10.42); first dorsal fin base—7.28, 8.47 (7.99); first dorsal fin height—7.98, 8.85 (8.85); second dorsal fin base—6.90, 8.19 (7.81); second dorsal fin height—4.98, 8.01 (7.81); anal fin base—8.43, 11.03 (9.38); anal fin free margin—1.15, 1.78 (1.56); anal fin height—1.92, 3.30 (3.30); subcaudal—14.41, 18.00 (17.53); vertebral centra—176, 188. Morphometric data are compared with other species in tables 1 to 28. The adult stage is illustrated in figure 35. In adults the epaulette is broken into three separate spots, rarely two, which are all black in color and are separated from each other by a cream-colored space. The rest of the dorsal surface is covered with small spots (less than half the diameter of the eye usually), especially the anterior part of the head. These spots are dark brown, with a slight greenish olive cast to them. The background is a tan to light brownish color, also often with a greenish cast. In many cases the background has slightly darker areas, giving the suggestion of bands. The ventral surface shows a uniform white to cream color. Males reach sexual maturity between 510 and 555mm TL. Distribution is shown in figure

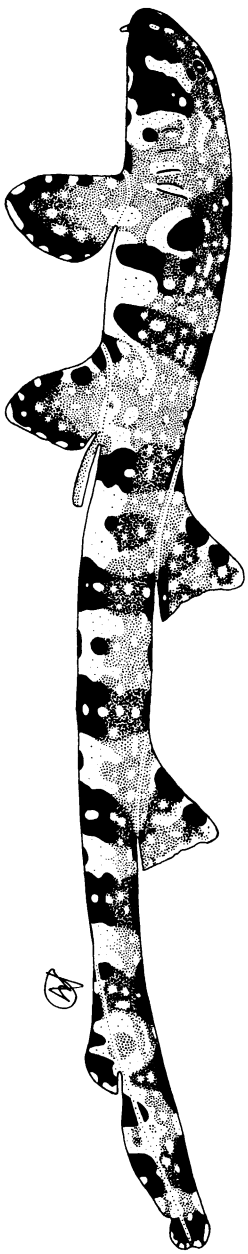

FIG. 34. *Hemiscyllium strahani* Whitley. USNM 221701. 594mm, TL. Adult male.

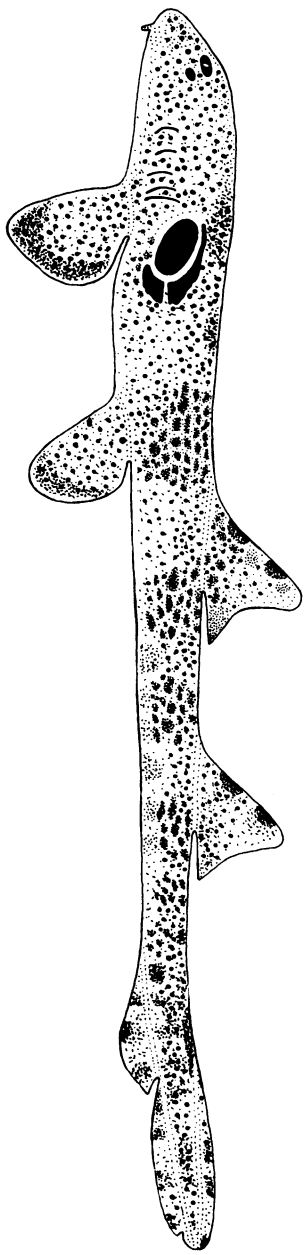

FIG. 35. *Hemiscyllium trispeculare* Richardson. USNM 174069. 562mm, TL. Adult female.

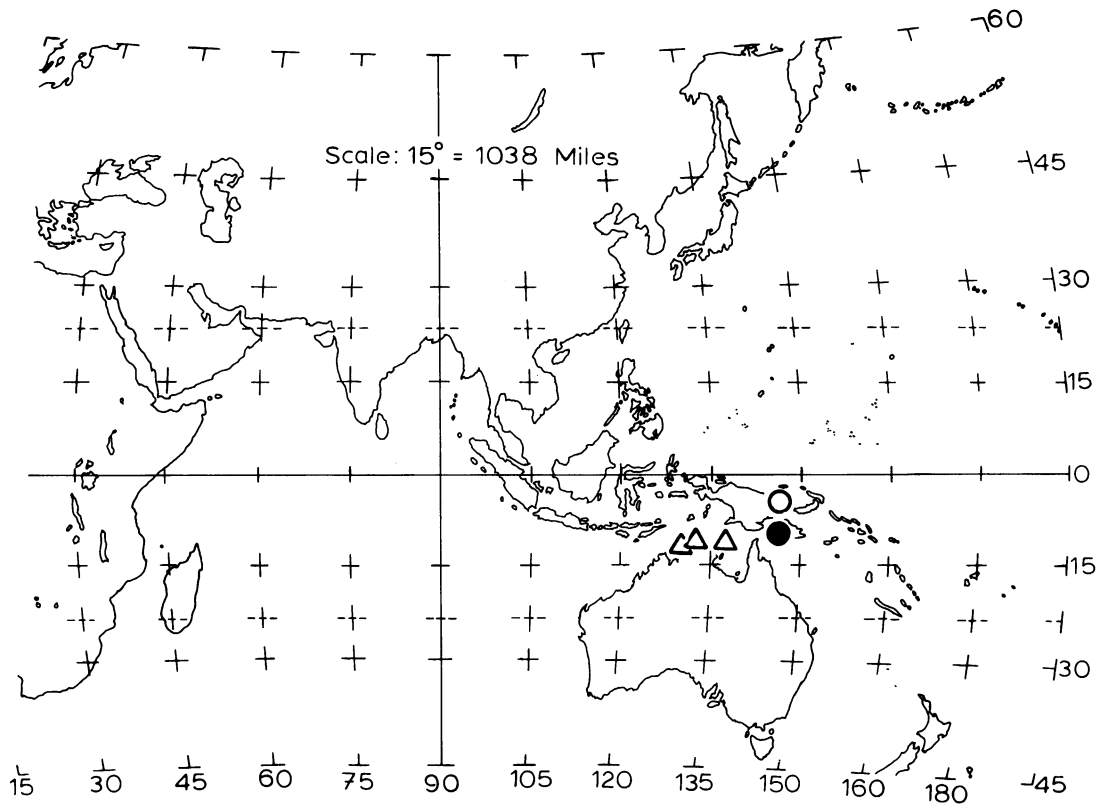

FIG. 36. Distribution of *Hemiscyllium strahani* (circles) and *H. trispeculare* (triangles). Solid circle indicates primary type locality.

36. Juveniles are unknown for this species. Usually found in shallow water.

DISCUSSION: Richardson (1843) originally described this species based upon a drawing he obtained from Lieut. Emery, made at Turtle Island, North West Australia. In 1843 he stated this might represent a new species, or just a variety of *H. ocellatum.* Richardson (1846) described a specimen he obtained from the *Erebus* and *Terror* Voyage. Based upon this specimen he concluded that this was definitely a distinct species, and further described the species, and some of its internal anatomy. Günther (1870) considered the *Erebus* and *Terror* specimen (BMNH 1953.5. 10.1) the type of the species. However, the real type of the species is the specimen upon which Emery's drawing was made. That specimen was not saved. Since the *Erebus* and *Terror* specimen is the one upon which Richardson (1846) redescribed the species, and definitely decided it was a distinct species, we consider it to be the neotype of the species, as recognized by Richardson (1846). Although the original specimen and drawing came from Turtle Island, North West Australia, the neotype from the *Erebus* and *Terror* only carries the locality data of North West Australia. Since the type locality must agree with the primary type, now BMNH 1953.5.10.1, the type locality for *H. trispeculare* must be emended to the more general location of North West Australia coast.

ETYMOLOGY: Latin, *tri,* meaning three; and *speculāris,* Latin, meaning to look; presumably in reference to the three "eye" spots on the shoulder of the species.

Hemiscyllium species
Figures 30, 37

MATERIAL EXAMINED: USNM 123025 (1 female; 148mm); Indonesia: Irian Jaya (Dutch

New Guinea); Amsterdam Island, 0°21'S, 132°10'E; 20 Sept. 1944; G. H. Penn.

DIAGNOSIS: Nose tip to eye distance more than 7.4 percent TL (less than 7.2 percent in all other species of *Hemiscyllium*); body covered with alternating white and black bands, no spots.

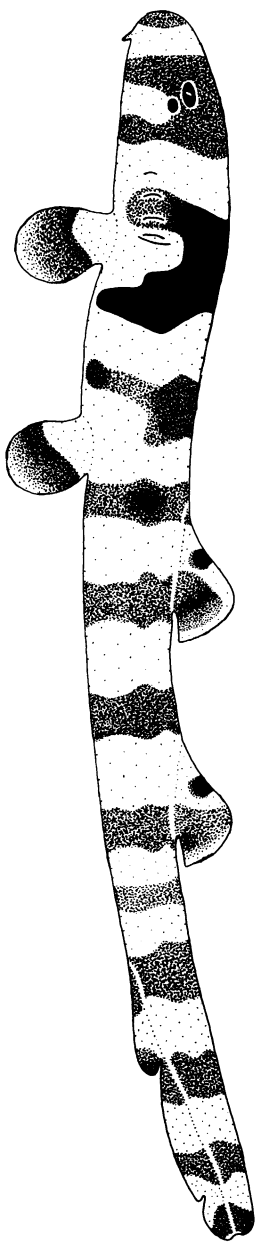

FIG. 37. *Hemiscyllium* sp. USNM 123025. 148mm, TL. Juvenile female.

DESCRIPTION: Morphometric measurements for the only known specimen are as follows (as percentage of TL): nose tip to pectoral origin—15.54; nose tip to first gill slit—12.84; first to fifth gill slit—6.08; eye diameter—1.35; interorbital—6.08; nose tip to eye—7.43; nose tip to spiracle—8.11; nose tip to mouth—2.70; barbel—1.01; postoral fold—1.35; nose tip to first dorsal fin—38.51; nose tip to pelvic origin—31.76; nose tip to vent—33.11; vent to anal fin—40.54; vent to tail tip—64.86; first to second dorsal fin—10.14; second dorsal fin to tail tip—33.78; pectoral fin length—9.46; pelvic fin length—8.78; first dorsal fin base—8.11; first dorsal fin height—5.41; second dorsal fin base—8.11; second dorsal fin height—4.73; anal fin base—8.78; anal fin free margin—2.03; anal fin height—2.03; subcaudal—16.89; vertebral centra—185. Morphometric data are compared with other species in tables 1 to 28. Known from only one juvenile specimen. Very distinctive in the alternating black and white bands on dorsal surface of body (fig. 37). Ventral surface pure white. Distribution is shown in figure 30.

DISCUSSION: Although known from only one specimen, this specimen is quite distinct from all other species where the juveniles are known (compare fig. 37 with figs. 26, 29, and 32—*H. freycineti, hallstromi,* and *ocellatum,* respectively). Although it is so distinctive, at the present time we cannot conclusively state whether or not it represents a distinct species, as juveniles of two described species are totally unknown. Although it does not appear to be similar to either of these species, the great transformation between juvenile and adult coloration makes it impossible to rule it out as a juvenile of one of these species. Intermediate specimens between this juvenile and an adult must be obtained in order to show what species this juvenile belongs, whether it is one of the known species, or a new species.

NOMINA DUBIA AND *NOMINA NUDA*

Scyliorhinus russellianus Blainville, 1816, p. 121. Name only; assumed by Fowler (1941) to be based upon *Bokee Sorrah* Russell, 1803, p. 10, pl. 16; placed in synonymy of *Chiloscyllium punctatum* by Fowler (1941) without comment.

Scyliorhinus unicolor Blainville, 1816, p. 121.

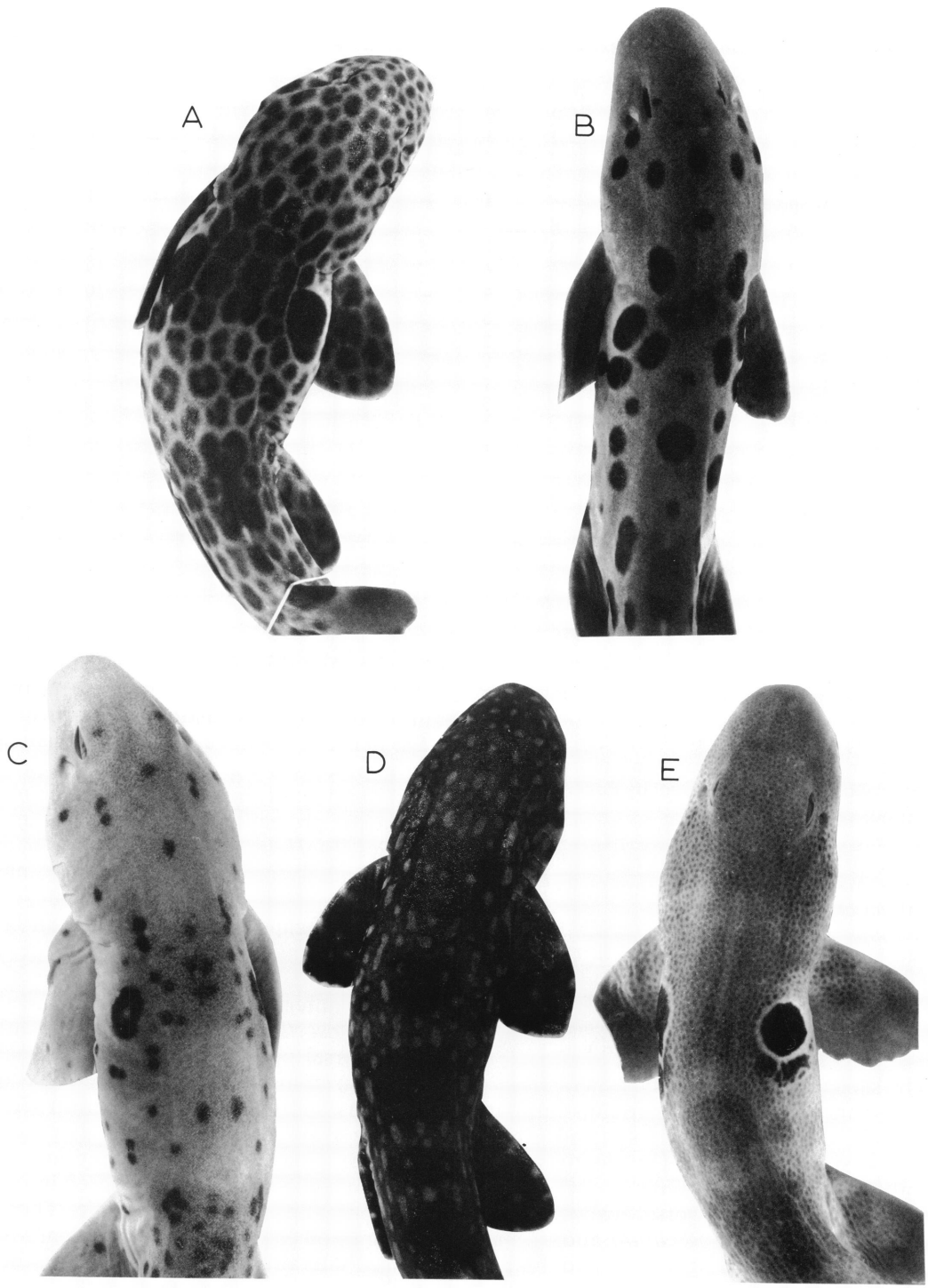

FIG. 38. Comparative dorsal views of five species of *Hemiscyllium* to show the differences in dorsal color pattern. A) *H. freycineti,* USNM 218602; B) *H. hallstromi,* AMS I.15717-001, Lectotype; C) *H. ocellatum,* AMNH 44016; D) *H. strahani,* USNM 221701; E) *H. trispeculare,* AMS I.5267.

TABLE 26
Frequency Distribution of Anal Fin Free Margin Length as Percentage of Total Length

Species	0.46 to 0.65	0.66 to 0.85	0.86 to 1.05	1.06 to 1.25	1.26 to 1.45	1.46 to 1.65	1.66 to 1.85	1.86 to 2.05	2.06 to 2.25	N	$\bar{X}$
Chiloscyllium											
burmensis, new species	—	—	—	**1**	—	—	—	—	—	1	1.22
confusum, new species	1	6	**8**	7	3	—	—	—	—	25	0.97
griseum	—	—	3	2	**5**	1	1	—	—	12	1.25
hasselti	1	—	6	**6**	2	4	—	—	—	19	1.34
indicum	1	3	3	3	—	—	—	—	—	10	0.87
plagiosum	—	—	—	3	5	**7**	5	2	2	24	1.60
punctatum	—	—	—	2	**5**	4	6	—	—	17	1.52
Hemiscyllium											
freycineti	—	—	2	3	—	2	1	—	—	8	1.28
hallstromi	—	—	—	2	**5**	2	—	—	—	9	1.33
ocellatum	—	—	—	**5**	10	3	1	1	—	20	1.35
species	—	—	—	—	—	—	—	1	—	1	2.03
strahani	—	—	1	—	**1**	—	—	—	—	2	1.19
trispeculare	—	—	—	1	3	**2**	1	—	—	7	1.44

Name only; placed in synonymy of *Chiloscyllium griseum* by Fowler (1941) without comment.

Scyliorhinus variegatus Blainville, 1816, p. 121. Name only; placed in synonymy of *Chiloscyllium colax* (=*C. indicum* here) by Fowler (1941) without comment.

Scyliorhinus dentatus Blainville, 1816, p. 121. Name only; placed in synonymy of *Chiloscyllium colax* (=*C. indicum* here) by Fowler (1941) without comment.

Scyliorhinus lambarda Blainville, 1816, p. 121. Name only; placed in synonymy of *Chiloscyllium colax* (=*C. indicum* here) by Fowler (1941) without comment.

SKELETAL ANATOMY

The skeletal anatomy of the genera *Hemiscyllium* and *Chiloscyllium* are illustrated in figures 39 through 56. Unless stated otherwise, the species illustrated is identical with all other species in that genus.

CHONDROCRANIUM: Dorsal views of the chondrocrania of *Chiloscyllium* and *Hemiscyllium* are shown in figures 39 and 40.

In both genera there is one ventrally originating medial rostral process pointing anteriorly from the chondrocranium (we use the term rostral process rather than rostral cartilage because this structure is actually a process projecting from the main chondrocranium rather than a distinct cartilage on its own; hence we believe it should be called a rostral process (see also Dingerkus, in prep.). In *Chiloscyllium* the rostral process is more elongated, projecting anterior to the nasal capsules. In *Hemiscyllium* it is shorter and stouter, barely projecting beyond the nasal capsules.

The nasal capsules are very large in both genera. In *Chiloscyllium* they are more laterally enlarged, whereas in *Hemiscyllium* they are more anteriorly oriented and enlarged.

In *Chiloscyllium* there are three separate major dorsal openings, a frontal fontanelle, a median fontanelle, and posteriorly one common endolymphatic foramen. In *Hemiscyllium* there are only two major dorsal openings. The anterior fontanelle and median fontanelle appear to have fused into one common anteromedian fontanelle. There is one common endolymphatic foramen, which is more laterally shaped than in *Chiloscyllium*.

On the posterior edge of the chondrocranium in *Hemiscyllium* there is one posteriorly pointing process projecting from the

TABLE 27
Frequency Distribution of Subcaudal Length as Percentage of Total Length

Species	14.41 to 15.00	15.01 to 15.60	15.61 to 16.20	16.21 to 16.80	16.81 to 17.40	17.41 to 18.00	18.01 to 18.60	18.61 to 19.20	19.21 to 19.80	19.81 to 20.40	20.41 to 21.00	21.01 to 21.60	21.61 to 22.20	22.21 to 22.80	22.81 to 23.40	23.41 to 24.00	24.01 to 24.60	N	X̄
Chiloscyllium																			
burmensis, new species	—	—	—	—	—	—	**1**	—	—	—	—	—	—	—	—	—	—	1	18.26
confusum, new species	—	—	—	1	4	5	3	**5**	3	1	3	—	—	—	—	—	—	25	18.52
griseum	—	—	1	—	1	1	2	**5**	—	1	—	—	1	—	—	—	—	12	18.58
hasselti	—	—	—	—	1	**2**	—	2	6	4	2	1	1	—	—	—	—	19	19.47
indicum	—	—	1	2	3	3	—	1	—	—	—	—	—	—	—	—	—	10	17.20
plagiosum	—	—	—	—	—	—	1	2	—	6	1	**6**	1	1	2	2	2	24	21.21
punctatum	—	1	—	—	—	1	3	—	1	4	2	2	**1**	2	—	—	—	17	19.94
Hemiscyllium																			
freycineti	1	1	—	1	—	**4**	1	—	—	—	—	—	—	—	—	—	—	8	17.00
hallstromi	—	—	2	**4**	2	1	—	—	—	—	—	—	—	—	—	—	—	9	16.69
ocellatum	—	2	**6**	4	—	7	1	—	—	—	—	—	—	—	—	—	—	20	16.75
species	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	16.89
strahani	1	—	**1**	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	15.59
trispeculare	1	—	—	—	2	**4**	—	—	—	—	—	—	—	—	—	—	—	7	17.11

midline of the chondrocranium. The rest of the posterior edge is smooth. In *Chiloscyllium* there are six posteriorly pointing processes, all lateral to the midline of the chondrocranium.

The barbels have a thin rod of cartilage inside, which is distinct from the chondrocranium but articulates to it ventrally.

PECTORAL GIRDLE: The pectoral girdles of *Chiloscyllium* and *Hemiscyllium* are shown in figures 41 and 42. They are drawn from a dorsal perspective except that the dorsal process of the scapula is bent and drawn posteriorly oriented.

The ventral bar of the scapula has an anteriorly enlarged process. This process and region of the scapular bar is concave dorsally. The heart rests in this concavity.

In *Chiloscyllium* the propterygium, mesopterygium, and metapterygium are all elongated. The propterygium is about half the length of the mesopterygium and metapterygium which are about equal in length. The mesopterygium along its distal leading edge has a series of depressions into which the associated radial elements fit. There are three rows of radial elements. There are two series of radials articulating with the propterygium, eight series articulating with the mesopterygium, and eleven series articulating with the metapterygium. The proximal radials of the second and third radial series are fused distally. The proximal radials of the twentieth and twenty-first radial series are fused proximally. The distal radials are paired in five series of radials.

In *Hemiscyllium* the mesopterygium and metapterygium are elongated. The propterygium is fused onto the mesopterygium, forming one Y-shaped cartilage, which we refer to as the mesopterygium, as it is the predominant part of the cartilage. The distal leading edge of the mesopterygium is not grooved to fit the radials, as it is in *Chiloscyllium*. There are three rows of radials in most of the radial series. The propterygial portion of the mesopterygium has one series of radials articulating with it, the mesopterygium proper has nine series of radials articulating to it, and the metapterygium has 10 series of radials articulating with it. There are no fusions of the radials as there are in *Chiloscyllium*. The distal radials of five radial series are paired.

TABLE 28
Frequency Distribution of Total Number of Vertebral Centra

Species	136 to 140	141 to 145	146 to 150	151 to 155	156 to 160	161 to 165	166 to 170	171 to 175	176 to 180	181 to 185	186 to 190	191 to 195	N	$\bar{X}$
Chiloscyllium														
burmensis, new species	—	—	—	—	—	—	—	**1**	—	—	—	—	1	176
confusum, new species	—	2	2	4	**5**	4	3	3	—	—	—	—	23	158.2
griseum	—	—	—	—	5	**6**	3	—	—	—	—	—	14	161.7
hasselti	—	—	—	—	2	2	5	2	—	—	—	—	11	166.1
indicum	—	—	—	—	—	—	4	—	—	—	—	—	4	167
plagiosum	—	—	—	—	—	1	2	1	**3**	1	—	—	8	173.9
punctatum	1	—	1	1	1	1	1	—	—	—	—	—	6	154.7
Hemiscyllium														
freycineti	—	—	—	—	—	—	—	—	—	—	3	3	6	190.8
hallstromi	—	—	—	—	—	—	—	—	—	—	**3**	3	6	189.7
ocellatum	—	—	—	—	—	—	—	—	—	1	3	3	7	189.7
species	—	—	—	—	—	—	—	—	—	1	—	—	1	185
strahani	—	—	—	—	—	—	—	—	—	—	**1**	1	2	189.5
trispeculare	—	—	—	—	—	—	—	—	1	—	3	—	4	184.3

The dorsal processes of the scapula in both genera have small suprascapular cartilages associated with them dorsally.

PELVIC GIRDLE: The pelvic girdles of *Chiloscyllium* and *Hemiscyllium* are illustrated in figures 43 and 44. In both genera the puboischiatic bar is quite broad. There is an anteriorly pointing process on each of the lateral edges of the puboischiatic bar in both genera; however, in *Hemiscyllium* it is much more elongated and tapered. The posterior edge of the main puboischiatic bar is concave in *Hemiscyllium* and convex in *Chiloscyllium*.

In both genera there are several small cartilages anterior to the leading edge of the first radial. In most radial series there are two rows of radial elements. The inner row of elements is greatly elongated. In *Chiloscyllium* the outer radial elements are short. In *Hemiscyllium* some of the outer elements are quite elongated. In *Hemiscyllium* the first radial series articulates directly with the puboischiatic bar, which has a greatly enlarged process for this articulation. In *Chiloscyllium* the first two radial series articulate with the puboischiatic bar. In *Hemiscyllium* there are 17 radial series articulating with the metapterygium. In *Chiloscyllium* there are 16 radial series articulating with the metapterygium. In males the last radial series becomes modified into the clasper (see fig. 43). In *Chiloscyllium* the sixteenth and seventeenth radials are fused proximally. Also the fifteenth radial is weakly branched distally.

DORSAL FINS: Dorsal fin skeletons of *Chiloscyllium* and *Hemiscyllium* are shown in figures 45–48. In both genera there is a row of basal elements supporting both the first and second dorsal fins. These basal elements approach the vertebral column, but do not actually articulate with it. There are two rows of radial elements distal from the basals.

In the first dorsal fin of *Chiloscyllium* there are 14 basal elements. The last basal element has grooves on the dorsal edge into which the radials articulate. There are 16 series of radials. The first basal element is small, whereas the other basal elements are elongated.

In the second dorsal fin there are 17 basal elements. The first three elements are small and the rest are elongated. The fourth, sixth, and seventh basals are forked proximally. The proximal part of the seventeenth basal ele-

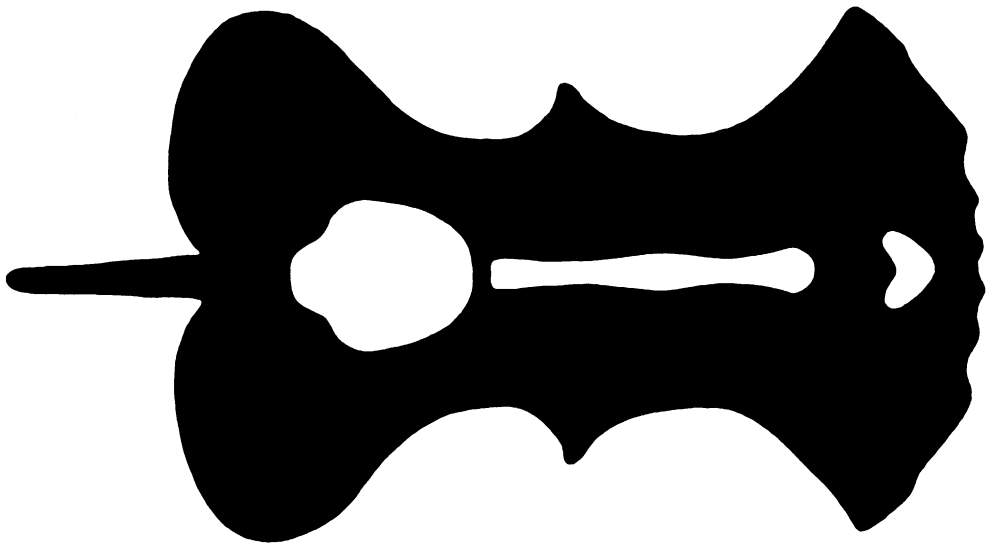

FIG. 39. Dorsal view of the chondrocranium of *Chiloscyllium punctatum,* AMNH 49535. Anterior to left.

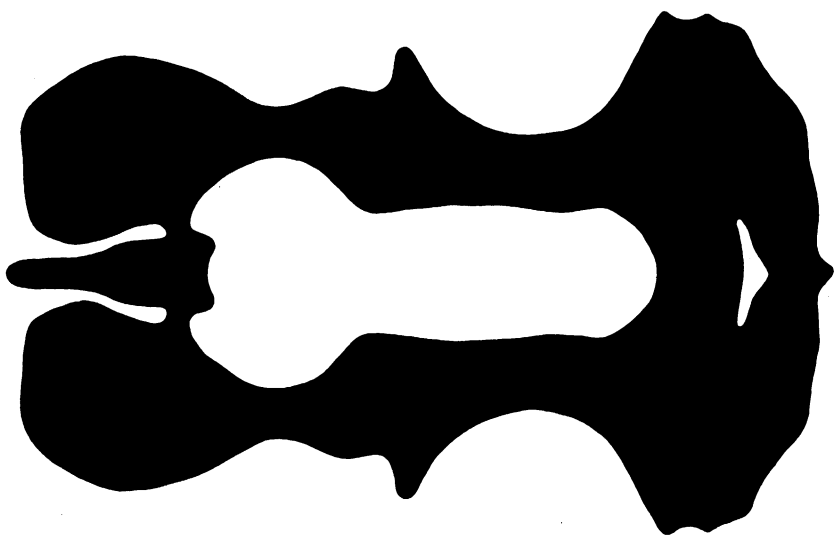

FIG. 40. Dorsal view of the chondrocranium of *Hemiscyllium ocellatum,* AMNH 38151. Anterior to left.

ment articulates with the distal part of the 16th. There are 19 series of radials.

In the first dorsal fin of *Hemiscyllium* there are 12 basal elements, all of which are elongated. There are 13 series of radials. The twelfth and thirteenth are fused proximally. The distal elements of the sixth and seventh radial series have pieces broken off of them into extra elements.

The second dorsal fin has 14 basal elements, of which the first is small, and the third has a proximal expansion which makes it T-shaped. The last basal element has dorsal grooves into which the radials articulate.

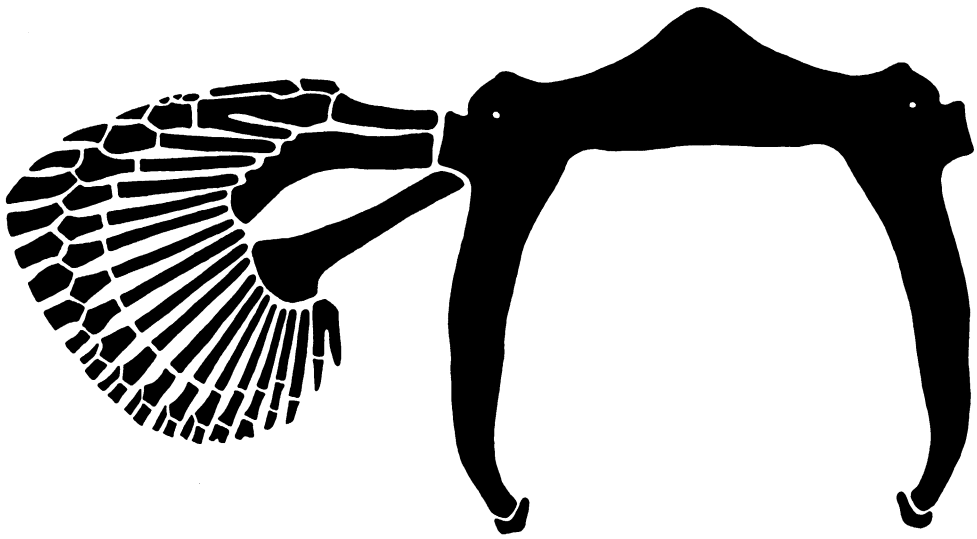

FIG. 41. Pectoral girdle and fin skeleton of *Chiloscyllium punctatum,* AMNH 49535. Dorsal view except dorsal process of scapula drawn bent posteriorly. Right pectoral fin not drawn.

FIG. 42. Pectoral girdle and fin skeleton of *Hemiscyllium ocellatum,* AMNH 38151. Annotations as for figure 41. Anterior to top.

There are 14 series of radials, most of which have two rows of elements. There are four series in which the distal elements have pieces broken off of them, producing extra elements.

In *Chiloscyllium* the first few vertebral centra under the first dorsal fin still have ribs, whereas in *Hemiscyllium* the ribs end anterior to the first dorsal fin.

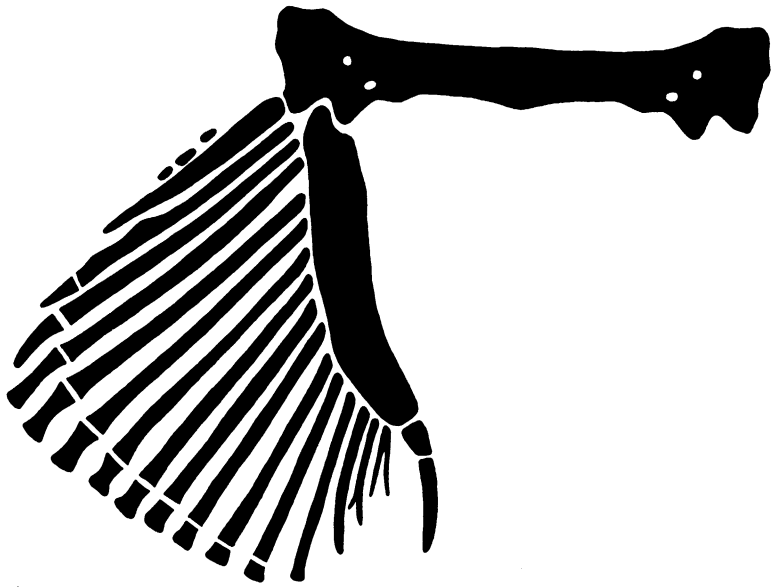

FIG. 43. Pelvic girdle and fin skeleton of *Chiloscyllium punctatum,* AMNH 49535. Dorsal view, right pelvic fin not drawn.

FIG. 44. Pelvic girdle and fin skeleton of *Hemiscyllium ocellatum,* AMNH 38151. Dorsal view, right pelvic fin not drawn.

ANAL FIN: The anal fins of *Chiloscyllium* and *Hemiscyllium* are illustrated in figures 49 and 50.

There are no basal elements in the anal fin skeletons of either genus. There are usually three rows of radial elements. They are small in the most distal as well as the most proximal rows. In the median row they are elongated. In both genera the more caudal series of radials overlap some of the caudal fin radials.

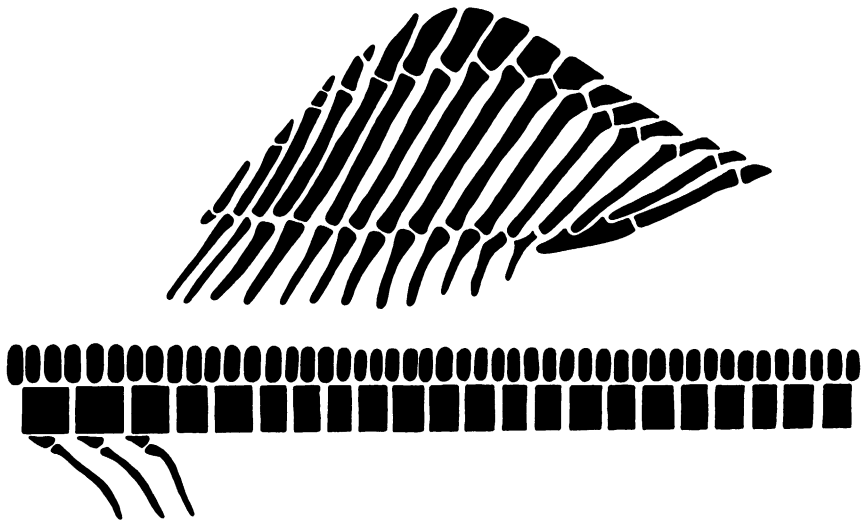

FIG. 45. First dorsal fin skeleton of *Chiloscyllium punctatum,* AMNH 49535. Lateral view. Anterior to left.

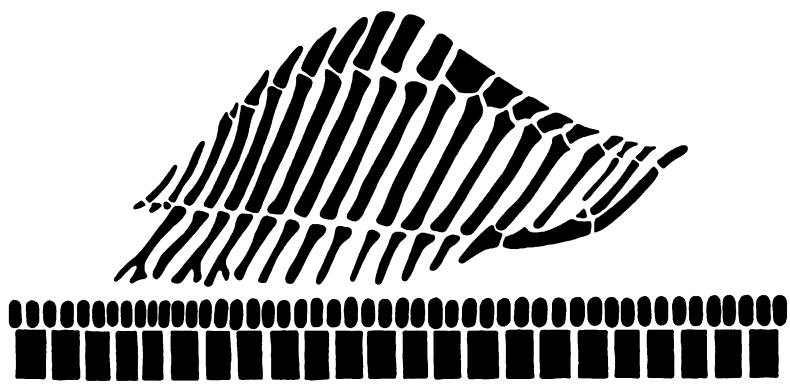

FIG. 46. Second dorsal fin skeleton of *Chiloscyllium punctatum,* AMNH 49535. Lateral view. Anterior to left.

In *Chiloscyllium* there are about 28 series of radials. In *Hemiscyllium* there are about 21 series of radials.

CAUDAL FIN: Caudal fins and anal fins are illustrated in figures 49 and 50.

The caudal fin skeleton is formed by a single row of radial elements on both the dorsal and ventral sides of the vertebral centra. In both genera the ventral radials are longer and broader, usually with an enlargement in the middle of each radial. In the ventral row of *Chiloscyllium* some of the radials fuse in the middle. The ventral row also starts more anteriorly than the dorsal row, and underlies the anal fin somewhat. In *Chiloscyllium* there are usually more dorsal radials than there are ventral ones. In *Hemiscyllium* the dorsal and ventral radials are usually in equal numbers. Radial series vary from about 50 to 70. In both genera the ventral elements basically match up with the centra, one radial row per centrum.

GILL AND HYOID ARCHES: The gill and hyoid arches of various species are illustrated in figures 51 to 56.

In general, in all species the basihyal is

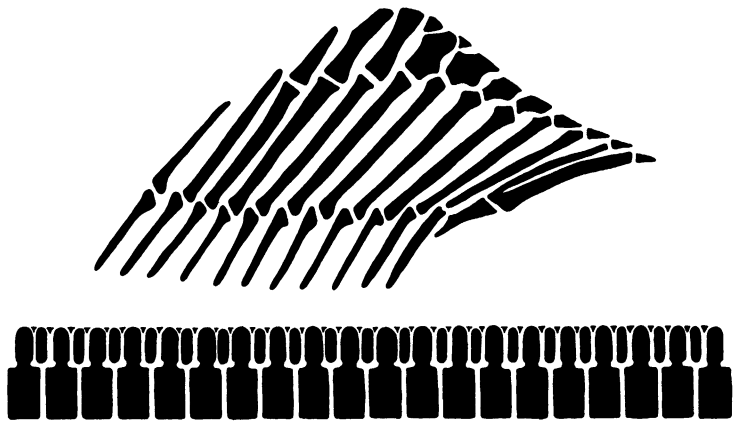

FIG. 47. First dorsal fin skeleton of *Hemiscyllium ocellatum,* AMNH 38151. Lateral view. Anterior to left.

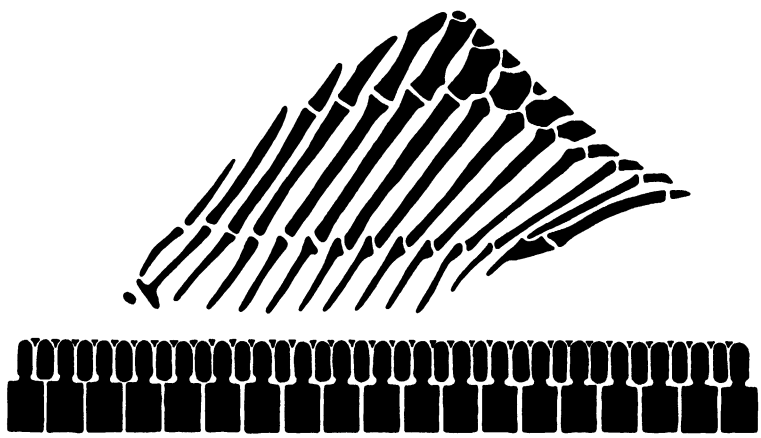

FIG. 48. Second dorsal fin skeleton of *Hemiscyllium ocellatum,* AMNH 38151. Lateral view. Anterior to left.

broader than it is long. The ceratohyal is long, bent, and robust. The epihyal is modified into a functional hyomandibula, and is short and robust. In some species there is one, or sometimes two, small basibranchial elements. The basibranchial plate is robust with a long tapering posterior process. There are two small pairs of cartilages, one lying between the first ceratobranchial and the basihyal, the second in close proximity to the articulation between the second ceratohyal and the second hypobranchial. There is no first hypobranchial pair. The first, second, third, and sometimes the fourth ceratobranchials have posterior processes that articulate with the following ceratobranchial, which often has an anterior process for the articulation with these posterior processes. The fifth ceratobranchial proximally has an articulation to the basibranchial plate. Distally it has a small posterior process. Epibranchials 1, 2, 3, and 4 are short and robust. Distally they have a groove into which the pharyngobranchials articulate. Pharyngobranchials 1, 2, and 3 are long and thin with large posterior processes that articulate with the distal part of the following epibranchial. Pharyngobranchials 4 and 5 and epibranchial 5 are fused together into one y-shaped cartilage.

In *Chiloscyllium confusum* (fig. 51) the hy-

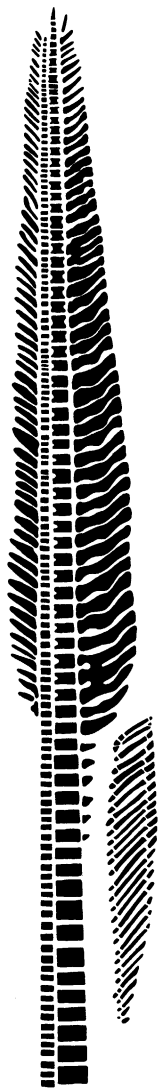

FIG. 49. Anal and caudal fin skeletons of *Chiloscyllium punctatum,* AMNH 49535. Lateral view. Anterior to left.

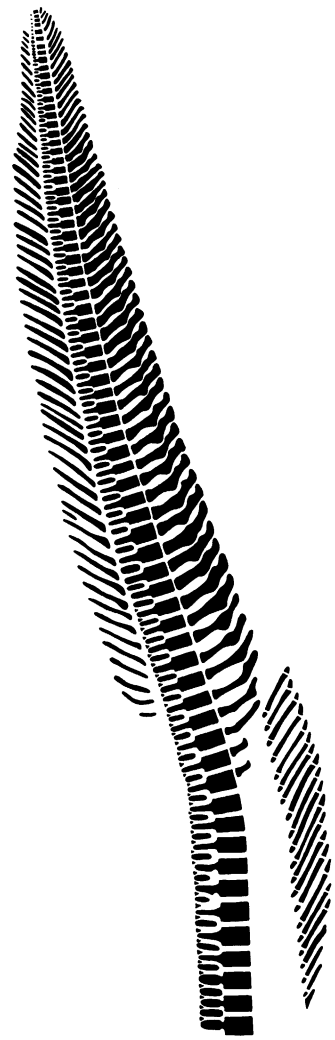

FIG. 50. Anal and caudal fin skeletons of *Hemiscyllium ocellatum,* AMNH 38151. Lateral view. Anterior to left.

pobranchial 2 pair are long and thin, and proximally they meet near the midline between the right and left third ceratobranchials. They do not approach the basibranchial plate. Hypobranchials 3 and 4 are long and thin, with hypobranchial 4 being shorter than 2 and 3. Both hypobranchials 3 and 4 articulate to the basibranchial plate, which has grooves on the anterior edge for this articulation. *Chiloscyllum burmensis* and *C. griseum* have gill and hyoid arches virtually indistinguishable from *C. confusum* (specimens USNM 202672 and USNM 221688, respectively). There are no other basal elements.

Chiloscyllium hasselti has all three hypobranchials thin and about equally long. As in *C. confusum,* hypobranchials 2 meet near the midline without articulating to the basibranchial plate. Both hypobranchials 3 and 4 articulate with the basibranchial plate. Hypobranchials 3 articulate with an anterior process off of the basibranchial plate. The hypobranchials 4 articulate into deep grooves into the basibranchial plate (fig. 52). There are no other basal elements.

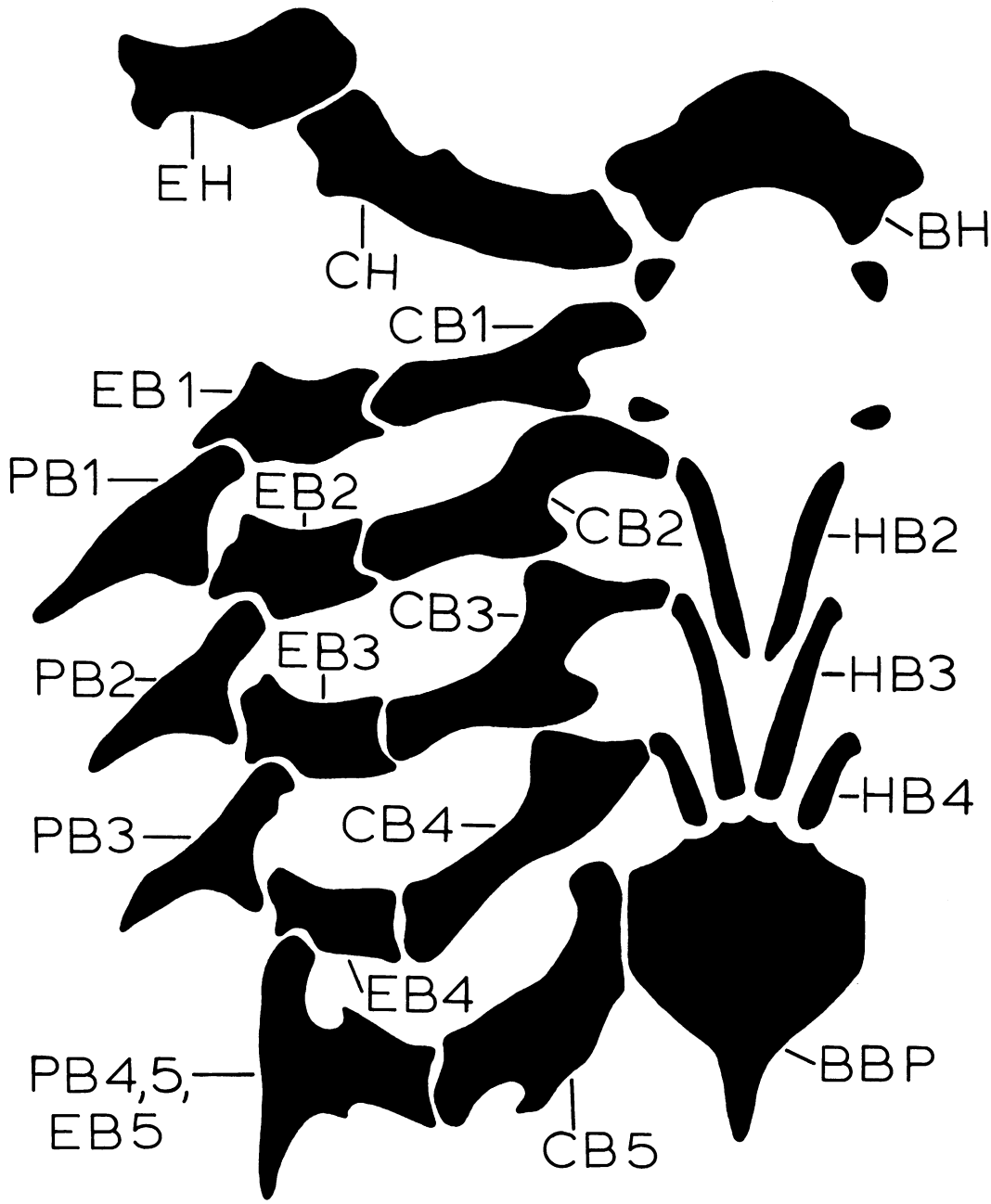

FIG. 51. Gill and hyoid arches of *Chiloscyllium confusum,* new species, paratype, AMNH 44127. Dorsal view, anterior to top, left dorsal elements have been opened up laterally, and right cerato-, epi-, and pharyngo-branchial and hyal elements are not illustrated. *Abbreviations:* BBP—basibranchial plate; BH—basihyal; CB1—first ceratobranchial; CB2—second ceratobranchial; CB3—third ceratobranchial; CB4—fourth ceratobranchial; CB5—fifth ceratobranchial; CH—ceratohyal; EB1—first epibranchial; EB2—second epibranchial; EB3—third epibranchial; EB4—fourth epibranchial; EH—epihyal (modified into a functional hyomandibula); HB2—second hypobranchial; HB3—third hypobranchial; HB4—fourth hypobranchial; PB1—first pharyngobranchial; PB2—second pharyngobranchial; PB3—third pharyngobranchial; PB4, 5, EB5—the element composed of the fusions of pharyngobranchials 4 and 5 and the fifth epibranchial.

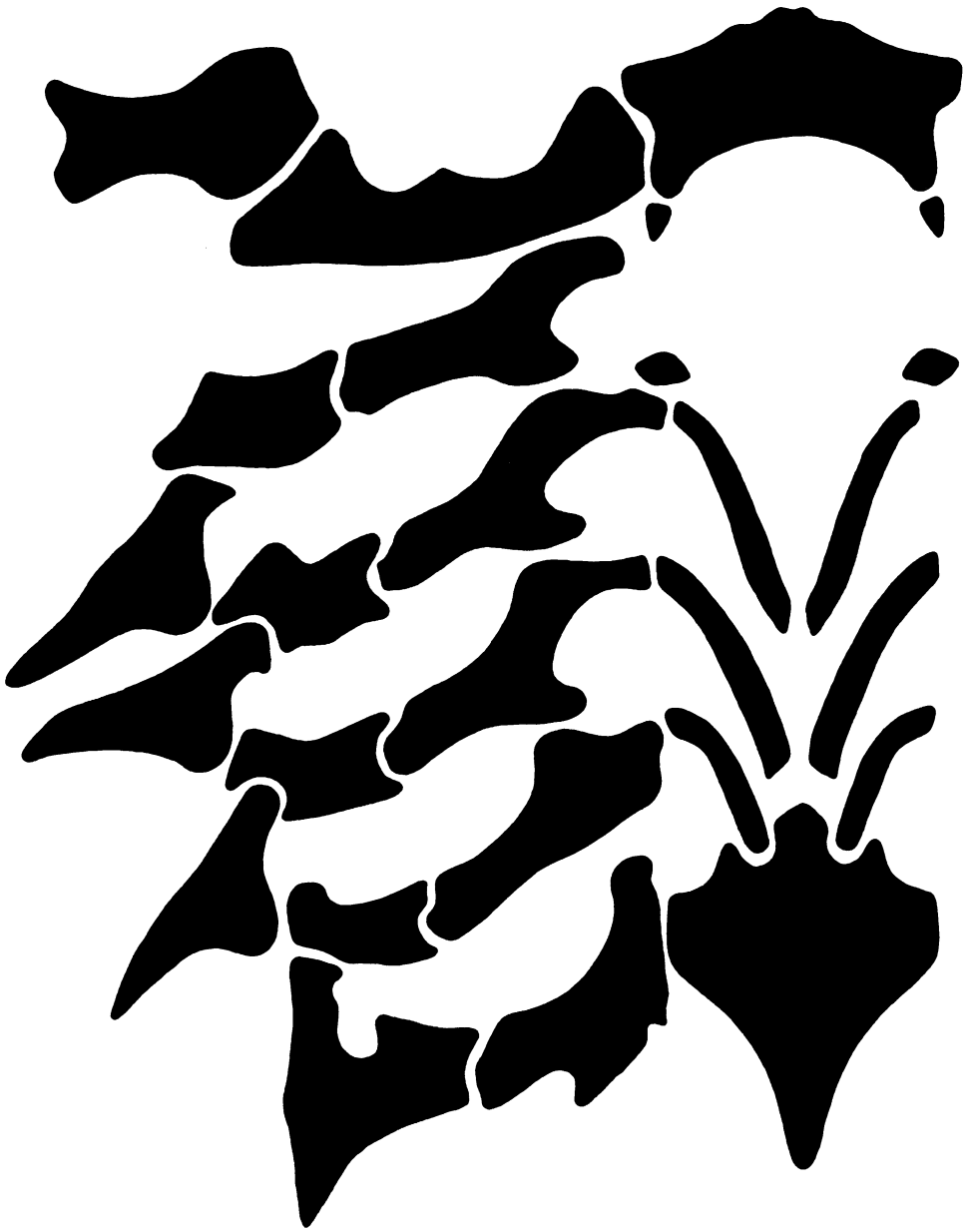

FIG. 52. Gill and hyoid arches of *Chiloscyllium hasselti,* SU(CAS) 33856. Annotations as for figure 51.

Chiloscyllium indicum (fig. 53) has all three pairs of hypobranchials thin and about the same length. Hypobranchials 2 meet at the midline between the third ceratobranchials. Hypobranchials 3 meet at the midline just anterior to the basibranchial plate without articulating to it. Hypobranchials 4 articulate to the basibranchial plate into shallow grooves, which are just lateral to a slight median anterior process of the basibranchial plate. There are no other basal elements.

In *Chiloscyllium plagiosum* (fig. 54) the second hypobranchials meet at the midline as in other species. Hypobranchials 3 artic-

FIG. 53. Gill and hyoid arches of *Chiloscyllium indicum,* CAS 48269. Annotations as for figure 51.

ulate onto a small basibranchial element which is just anterior to the basibranchial plate. This element has two grooves on its anterior edge for the hypobranchials to articulate into. The fourth hypobranchials are somewhat bent, and articulate onto shallow grooves in the basibranchial plate.

Chiloscyllium punctatum (fig. 55) has the

FIG. 54. Gill and hyoid arches of *Chiloscyllium plagiosum*, CAS 15845. Annotations as for figure 51.

third hypobranchials articulating onto a small cartilage anterior to the basibranchial plate. This basibranchial element does not have articular grooves for the hypobranchials as *C. plagiosum* has. There is also often another small basibranchial element next to this larg-

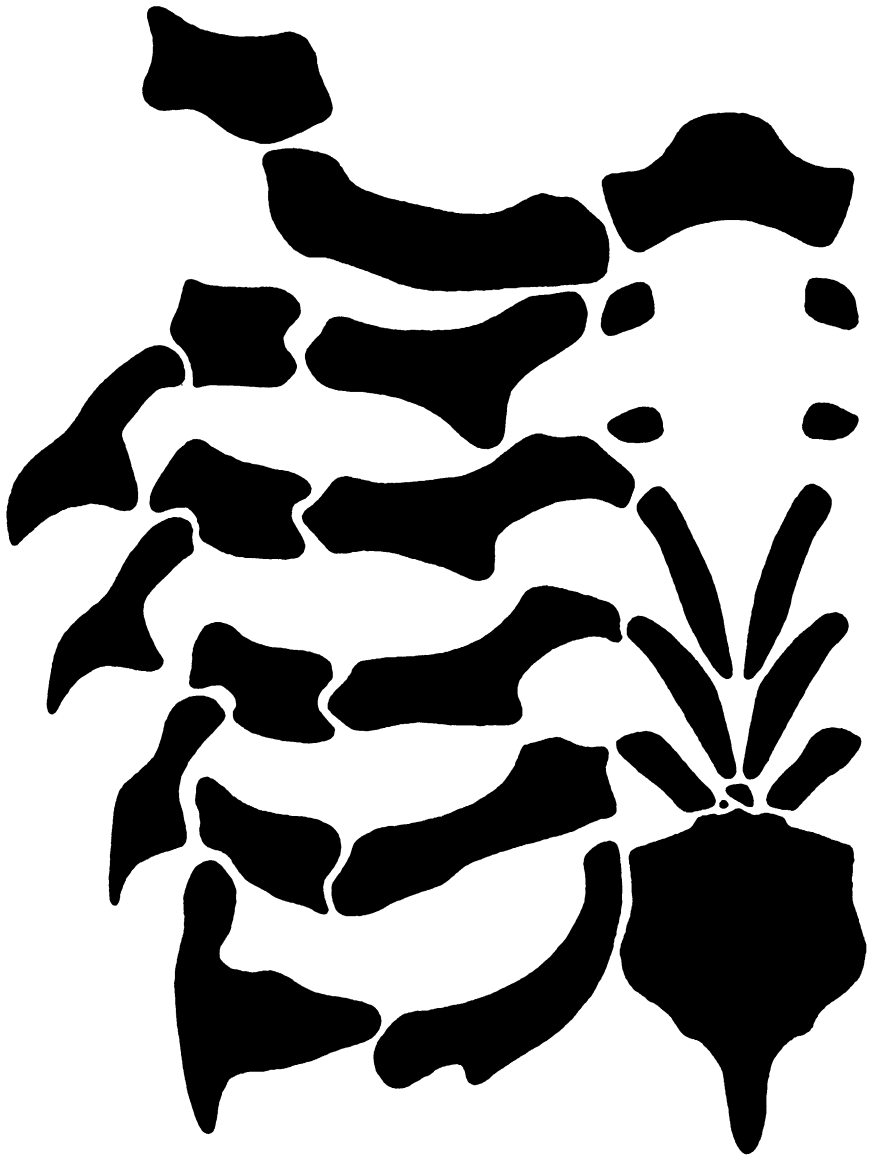

FIG. 55. Gill and hyoid arches of *Chiloscyllium punctatum,* AMNH 49535. Annotations as for figure 51.

er one. The fourth hypobranchials articulate onto the basibranchial plate, which has two slight lateral processes for this articulation.

Within *Chiloscyllium* therefore we see transformations wherein the small basibranchial elements are reduced and lost, the hypobranchials get longer and move backward to articulate with the basibranchial plate, and the basibranchial plate forms structures for these articulations with the hypobranchials.

Hemiscyllium ocellatum (fig. 56) has gill and hyoid arches virtually identical with those found in *H. freycineti, hallstromi, strahani,* and *trispeculare* (specimens SU(CAS) 26798 and CU 24992; USNM 40024; USNM 221701; and USNM 17406, respectively).

Hemiscyllium differs from *Chiloscyllium*

FIG. 56. Gill and hyoid arches of *Hemiscyllium ocellatum,* AMNH 38151. Annotations as for figure 51.

in having a basihyal which has a long, narrow anterior process. The basibranchial plate is relatively wide as in *Chiloscyllium,* but has a median posterior process which is long and tapered, and is longer than it is in *Chiloscyllium.* There are no other basibranchial elements. The second hypobranchials meet at the midline, somewhat behind the third cer-

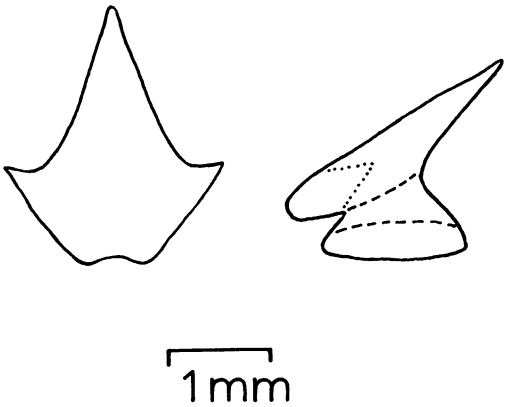

FIG. 57. Frontal and lateral views of a tooth of *Chiloscyllium confusum,* new species, OSU 1507. Anterior lower tooth shown.

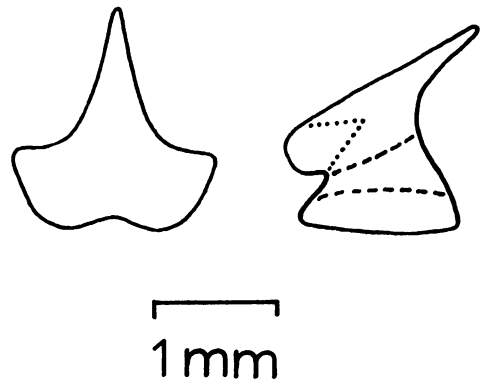

FIG. 58. Frontal and lateral views of a tooth of *Hemiscyllium ocellatum,* AMNH 44016. Anterior lower tooth shown.

atobranchials, but do not articulate with the basibranchial plate. Hypobranchials 3 and 4 articulate with the basibranchial plate, however the basibranchial plate does not have any grooves or processes for this articulation. The fifth ceratobranchial is more robust than it is in *Chiloscyllium.* The complex consisting of the fusion of pharyngobranchials 4 and 5 and epibranchial 5 is longer and more slender than it is in *Chiloscyllium.*

TEETH: A tooth of *Chiloscyllium confusum* is illustrated in figure 57. All species of *Chiloscyllium* have virtually the same tooth morphology. Each tooth has a median cusp and two smaller lateral cusps. The erupted part of the tooth angles backward from the base at about 45°. The posterior teeth are somewhat flatter and broader than the anterior ones.

A tooth of *Hemiscyllium ocellatum,* illustrated in figure 58, is representative of teeth in all species of *Hemiscyllium.* The teeth are similar to those of *Chiloscyllium* except that the median cusp is shorter, and the teeth overall are flatter and broader. The posterior teeth are somewhat shorter and broader. As in *Chiloscyllium,* the erupted part of the tooth angles backward from the base at about 45°.

DERMAL DENTICLES

The dermal denticles of *Chiloscyllium burmensis,* new species are illustrated in figures 59 and 60. They are about as broad as long with a strong median keel and two fairly strong keels at the lateral edges.

In *Chiloscyllium confusum,* new species there is a pronounced difference in the dermal denticles of juveniles and adults (compare figs. 61 and 62 with 63 and 64). In juveniles the denticles are widely spaced (fig. 61), whereas in adults the denticles are closely packed in a regular pattern (fig. 63). The juvenile denticles (fig. 62) are longer than broad, with a fairly strong median keel, but no lateral keels. The adult denticles (fig. 64) are broader, the median keel is stronger, and there are strong keels at the lateral edges of each denticle. Sometimes there are weaker midlateral keels between the median keel and the two outer lateral keels (see fig. 63).

In *Chiloscyllium griseum* (figs. 65 and 66) the denticles are quite broad. The median keel is long and strong. There are two lateral keels which are also strong. There are occasionally very weak midlateral keels.

The denticles of *C. hasselti* (figs. 69 and 70) are much like those of *C. confusum.* They have a median keel and two lateral keels. Like *C. confusum* they sometimes have an extra pair of midlateral keels. In juveniles (figs. 67 and 68) the denticles are more widely spaced. They are also much longer than broad, and the lateral keels are weak. The median keel is strong and relatively long. There are no midlateral keels in the juveniles.

Chiloscyllium indicum has denticles which are much longer than broad (figs. 71, 72, and 73). They have a strong median keel and two

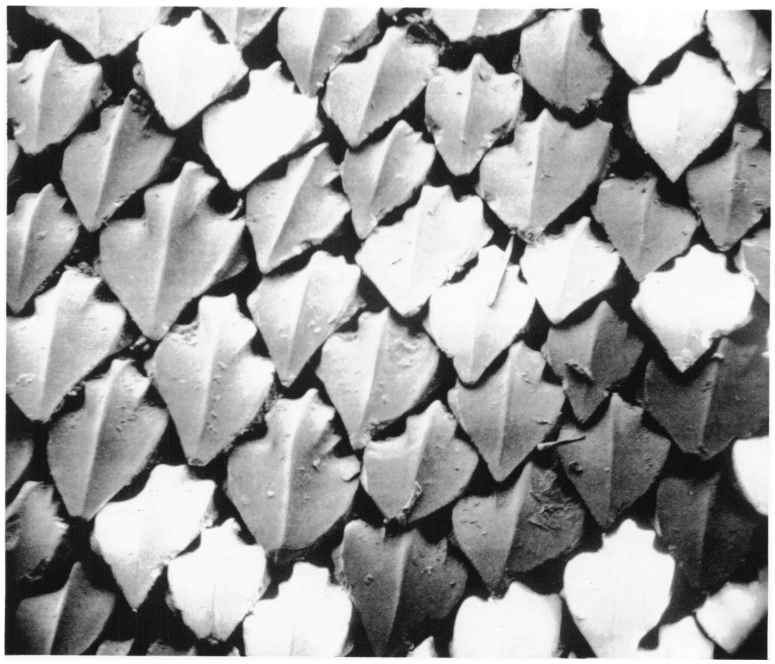

FIG. 59. Dermal denticle pattern of *Chiloscyllium burmensis,* new species, USNM 202672, Holotype. Anterior to top. 50×.

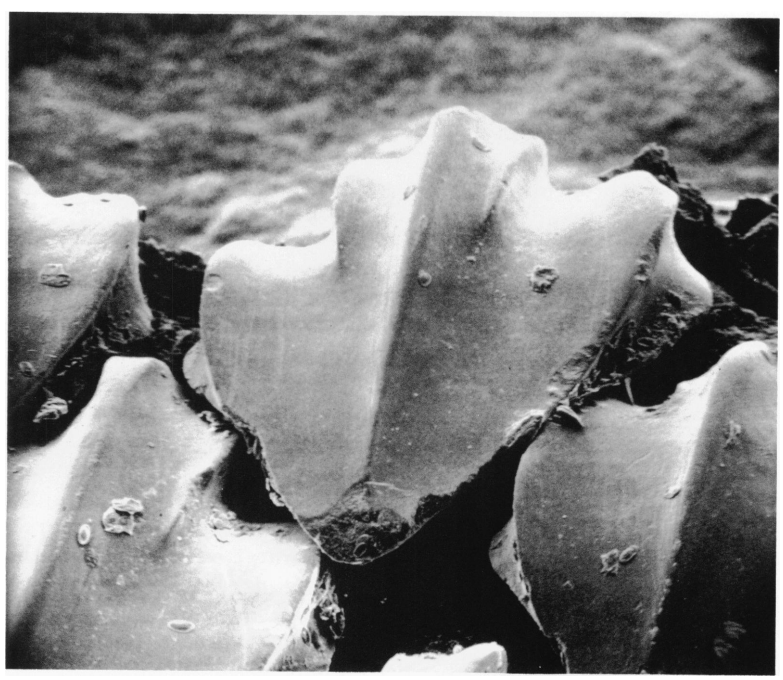

FIG. 60. Single denticle of *Chiloscyllium burmensis,* new species, USNM 202672, Holotype. Anterior to top. 200×.

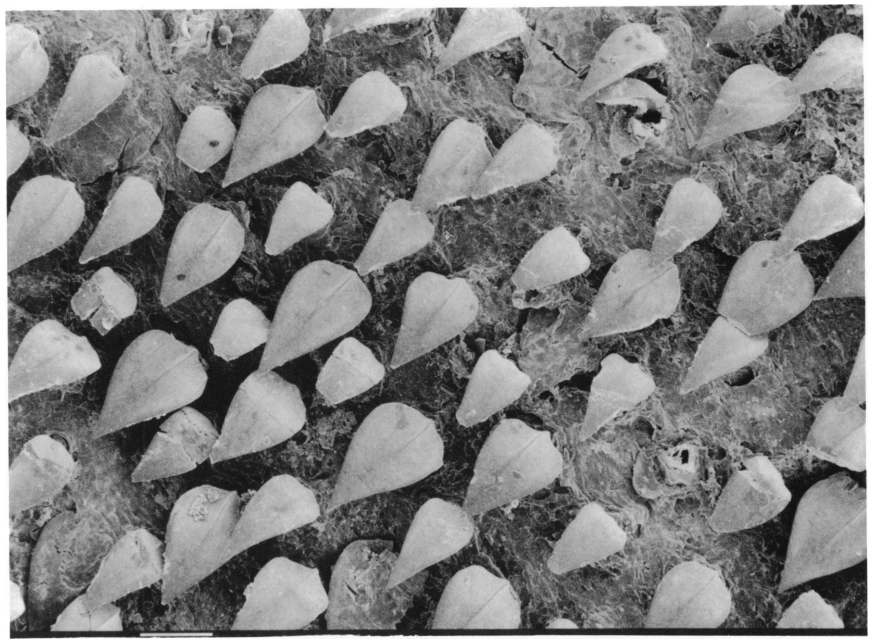

FIG. 61. Dermal denticle pattern of *Chiloscyllium confusum,* new species, AMNH 44127, juvenile paratype. Anterior to top right. Scale bar equals 100 μ.

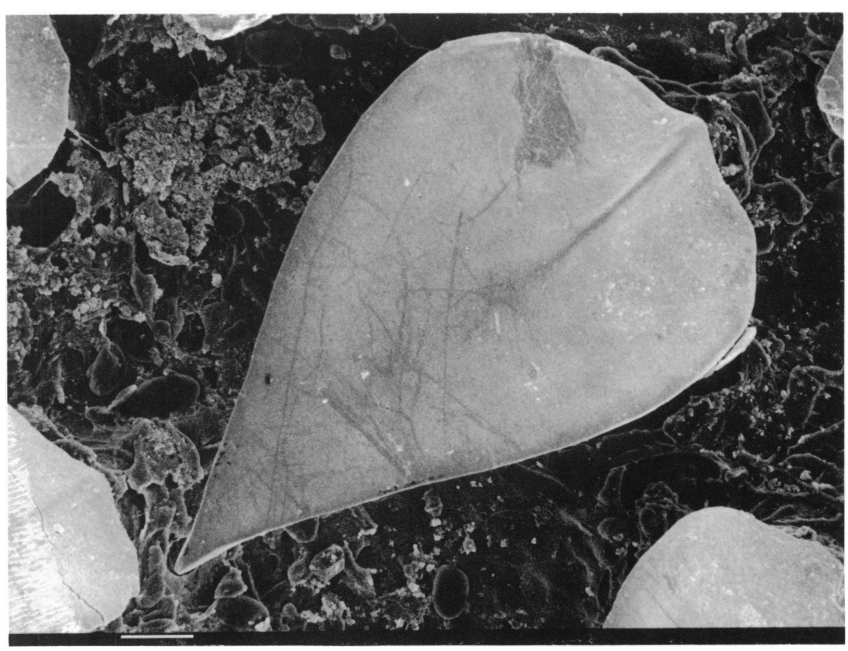

FIG. 62. Single dermal denticle of *Chiloscyllium confusum,* new species, AMNH 44127, juvenile paratype. Anterior to top right. Scale bar equals 20 μ.

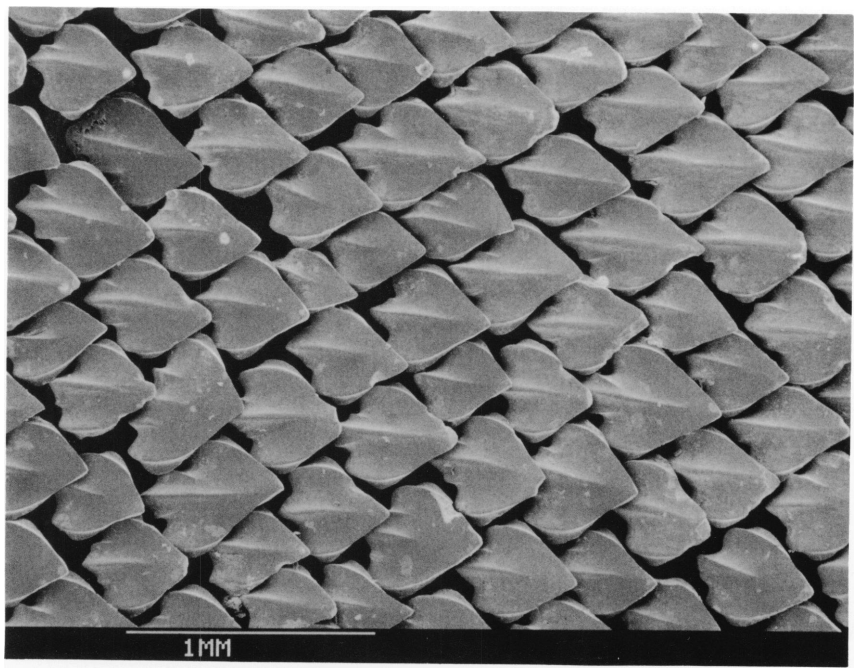

FIG. 63. Dermal denticle pattern of *Chiloscyllium confusum,* new species, USNM 202674, adult paratype. Anterior to left. Scale bar equals 1mm.

FIG. 64. Single dermal denticle of *Chiloscyllium confusum,* new species, USNM 202674, adult paratype. Anterior to left. Scale bar equals 100 μ.

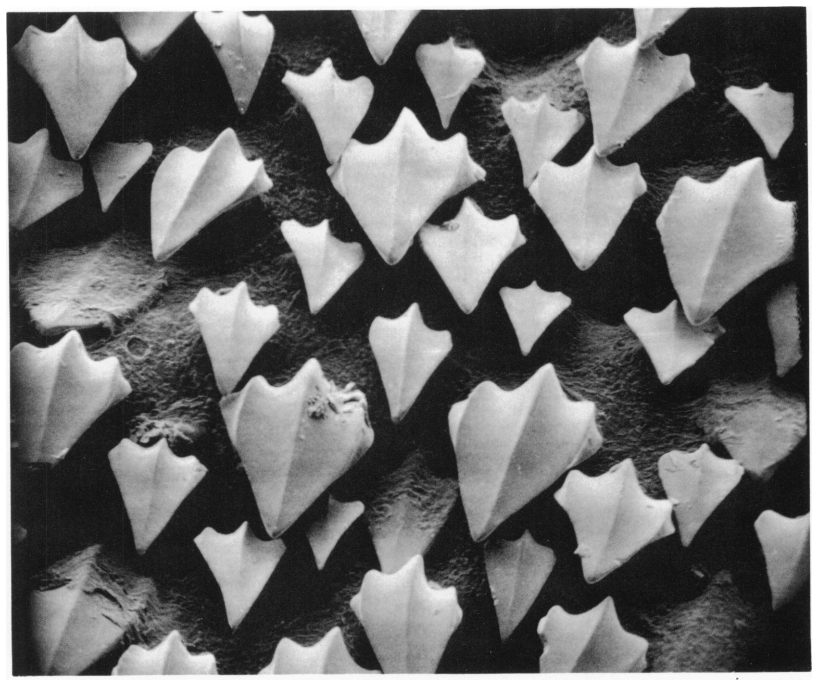

FIG. 65. Dermal denticle pattern of *Chiloscyllium griseum,* USNM 221688, subadult. Anterior to top. 100×. Note several denticles just in the process of erupting from the skin.

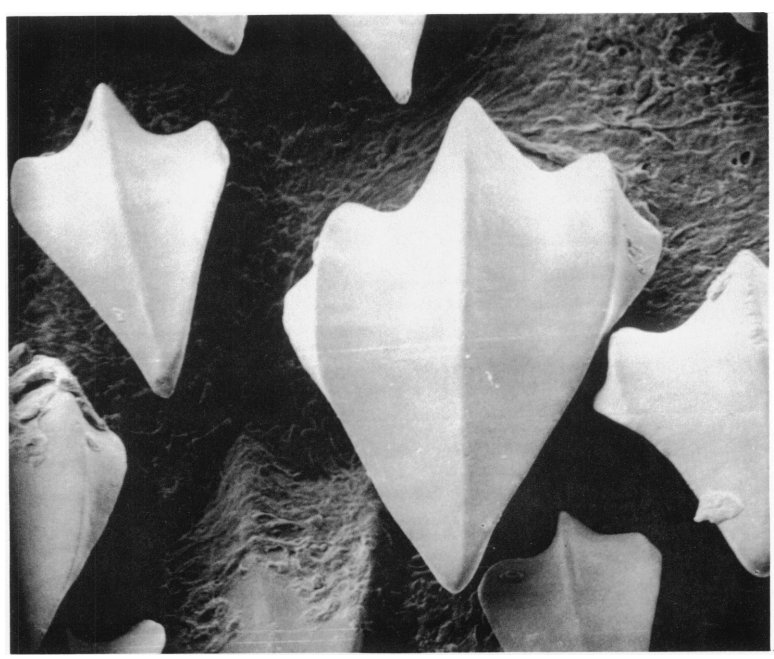

FIG. 66. Enlarged view of several denticles of *Chiloscyllium griseum,* USNM 221688, subadult. Anterior to top. 250×. Note denticle just to lower left of central one in the process of erupting from the skin.

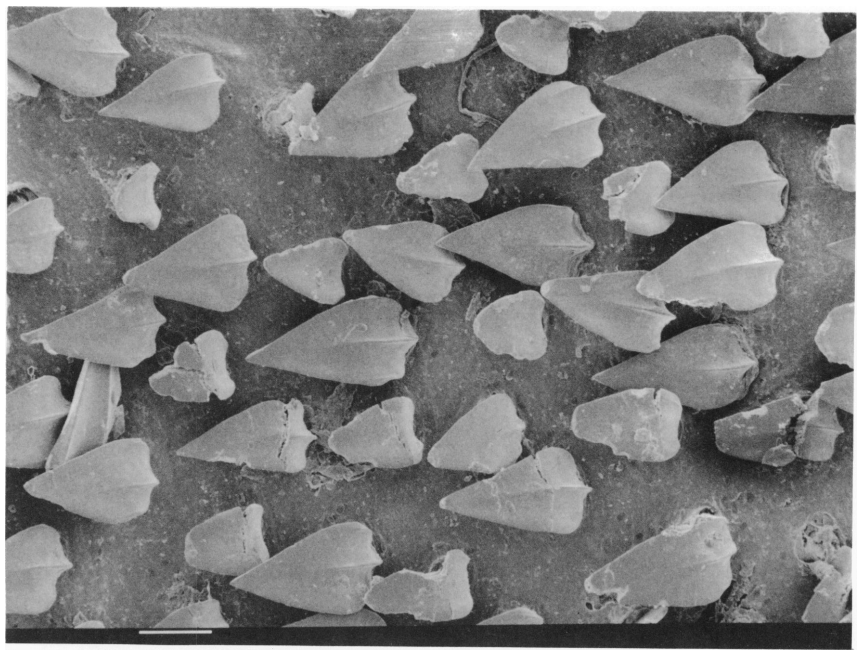

FIG. 67. Dermal denticle pattern of *Chiloscyllium hasselti,* CAS 33856, juvenile. Anterior to right. Scale bar equals 100 μ.

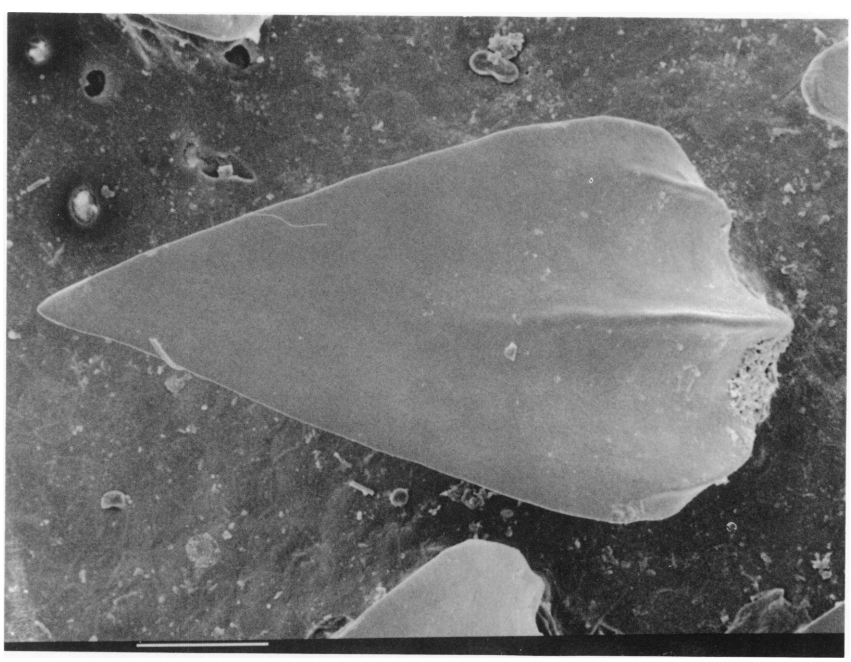

FIG. 68. Single dermal denticle of *Chiloscyllium hasselti,* CAS 33856, juvenile. Anterior to right. Scale bar equals 40 μ.

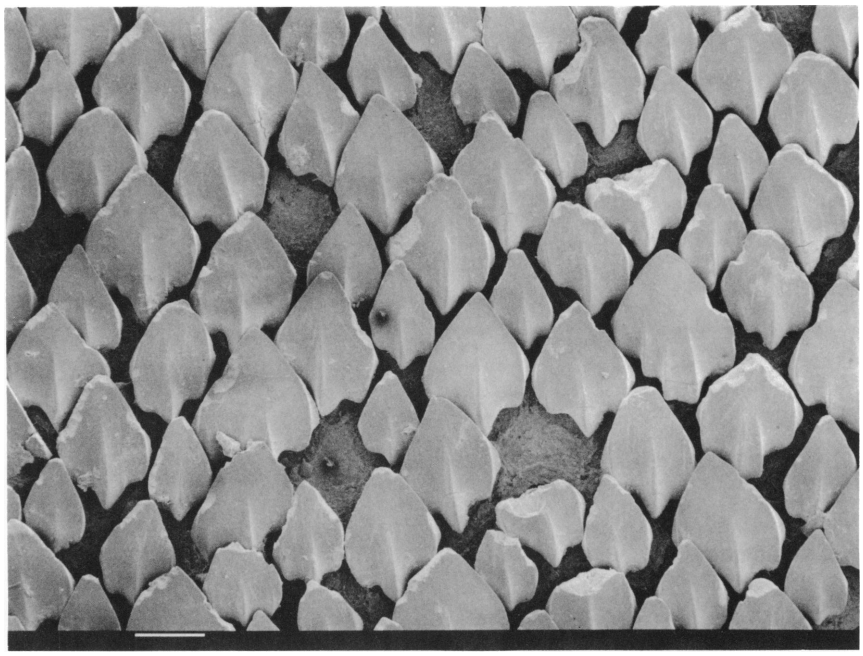

FIG. 69. Dermal denticle pattern of *Chiloscyllium hasselti,* AMNH 44017, adult. Anterior to bottom. Scale bar equals 200 μ.

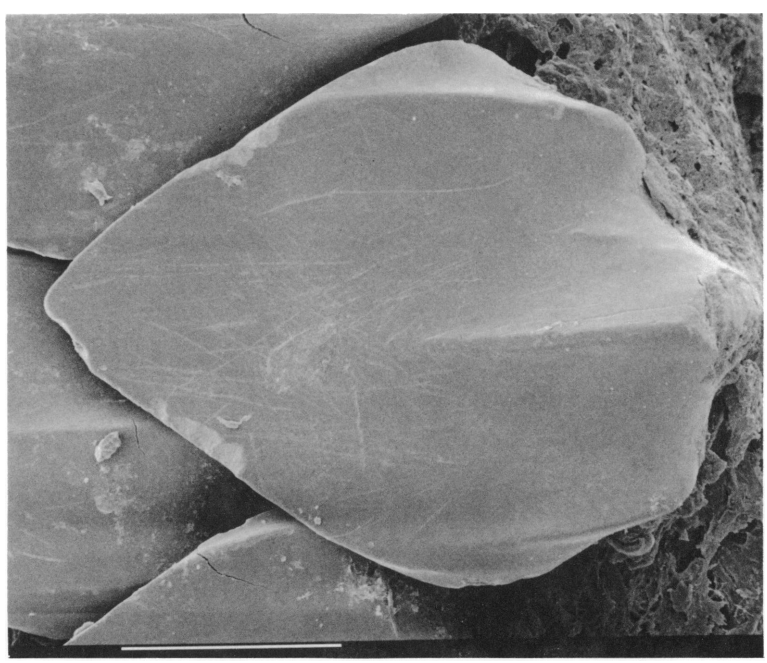

FIG. 70. Single dermal denticle of *Chiloscyllium hasselti,* AMNH 44017, adult. Anterior to right. Scale bar equals 100 μ.

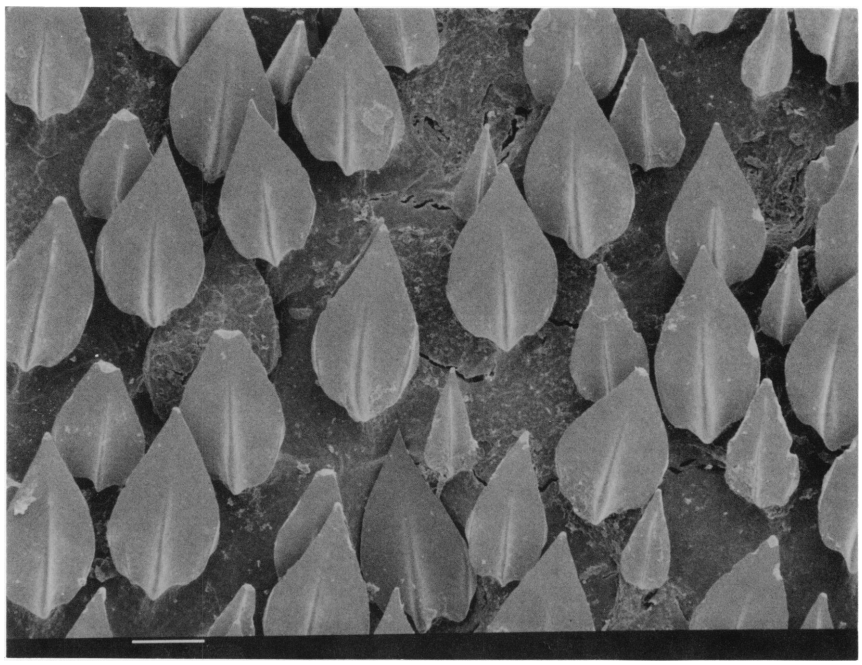

FIG. 71. Dermal denticle pattern of *Chiloscyllium indicum,* CAS 48269, subadult. Anterior to bottom. Scale bar equals 100 μ.

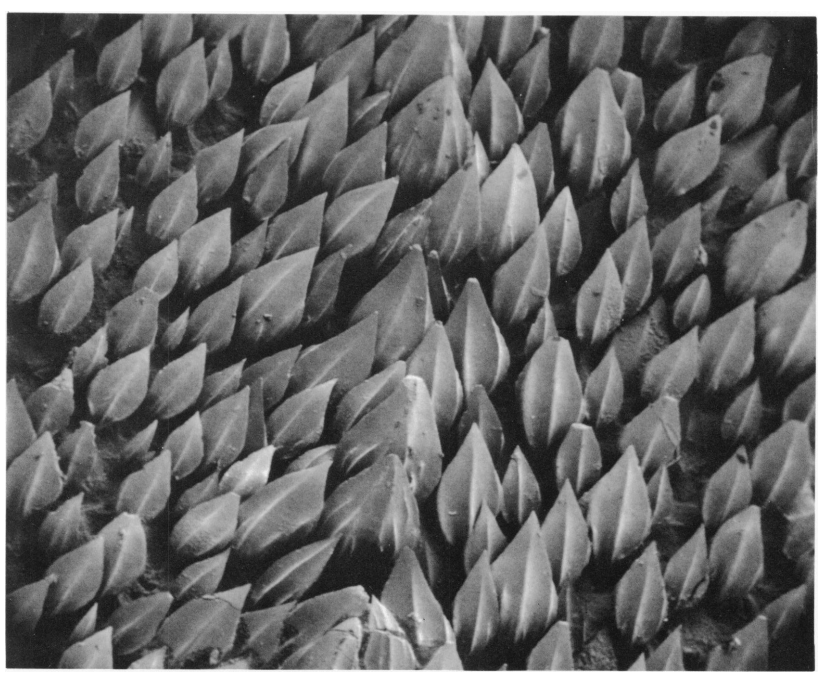

FIG. 72. Dermal denticle pattern at the lateral dermal ridge of *Chiloscyllium indicum,* CAS 48269, subadult. Anterior to bottom. 50×.

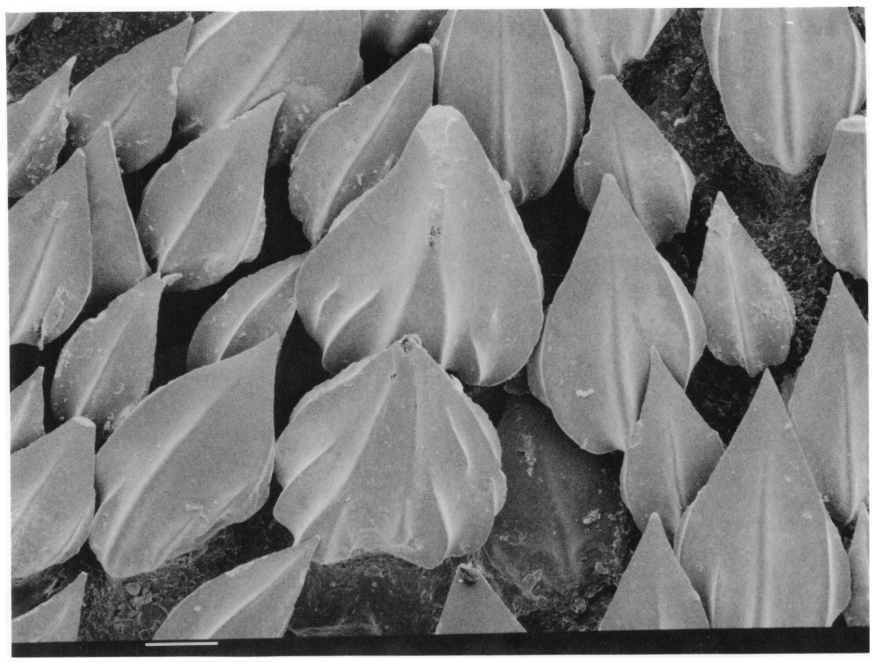

FIG. 73. Enlarged view of modified dermal denticles at the lateral dermal ridge of *Chiloscyllium indicum,* CAS 48269, subadult. Anterior to bottom. Scale bar equals 100 μ.

FIG. 74. Lateral view of dermal denticles of *Chiloscyllium indicum,* CAS 48269, subadult. Anterior to left. Scale bar equals 100 μ.

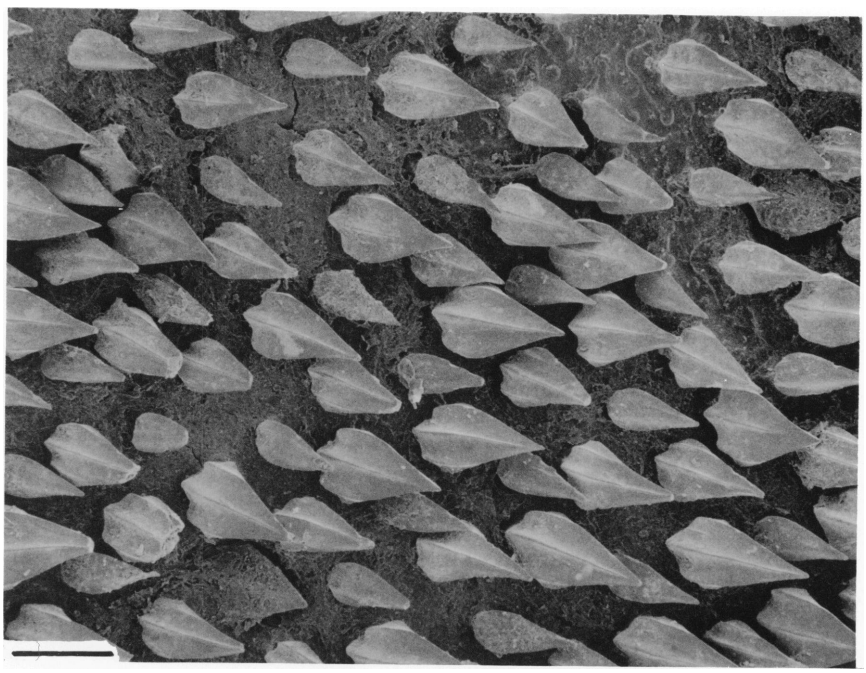

FIG. 75. Dermal denticle pattern of *Chiloscyllium plagiosum,* CAS 15845, subadult. Anterior to left. Scale bar equals 200 μ.

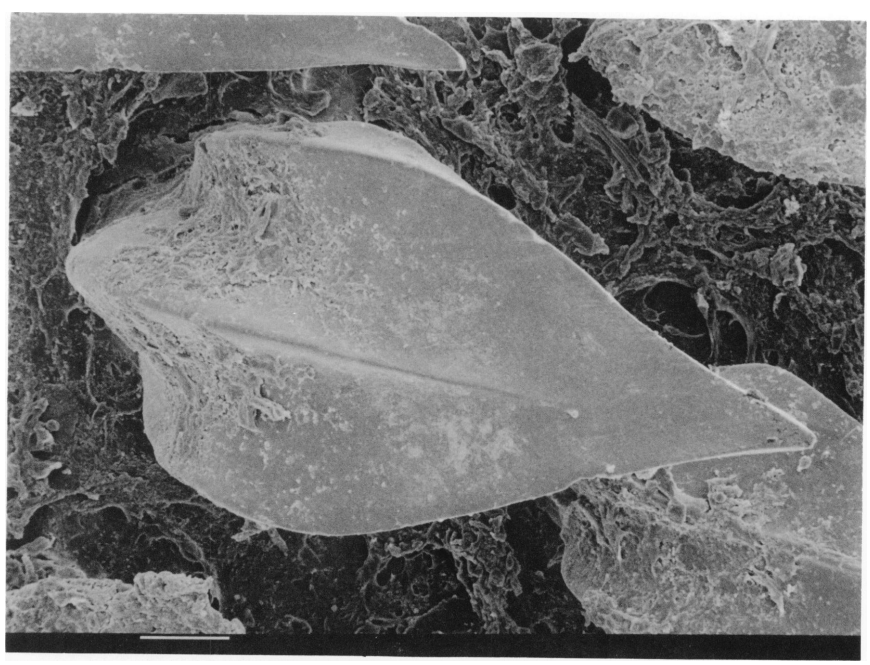

FIG. 76. Single dermal denticle of *Chiloscyllium plagiosum,* CAS 15845, subadult. Anterior to left. Scale bar equals 40 μ.

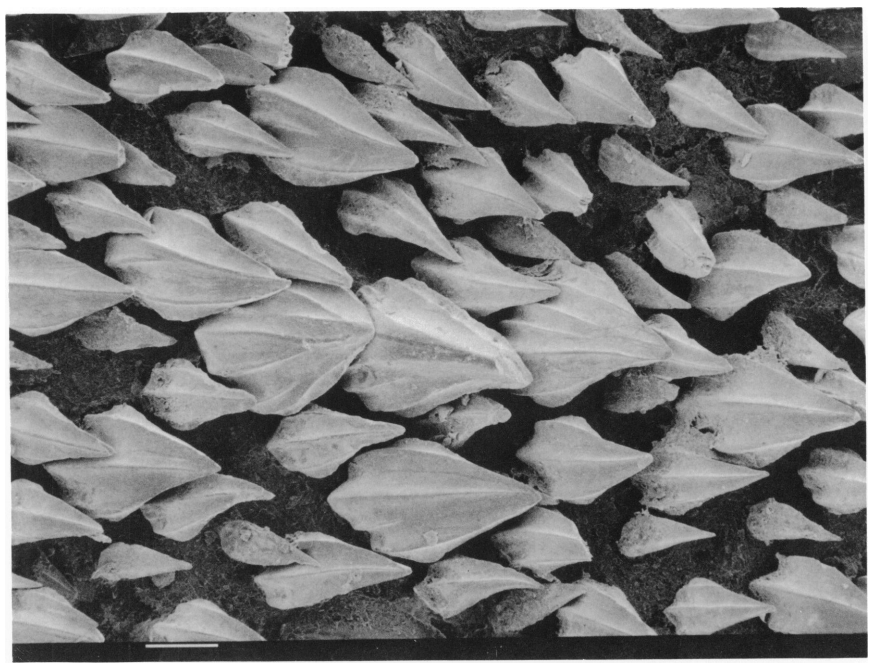

FIG. 77. Dermal denticle pattern at the lateral dermal ridge of *Chiloscyllium plagiosum,* CAS 15845, subadult. Anterior to left. Scale bar equals 200 μ. Note modified dermal denticles as in *C. indicum.*

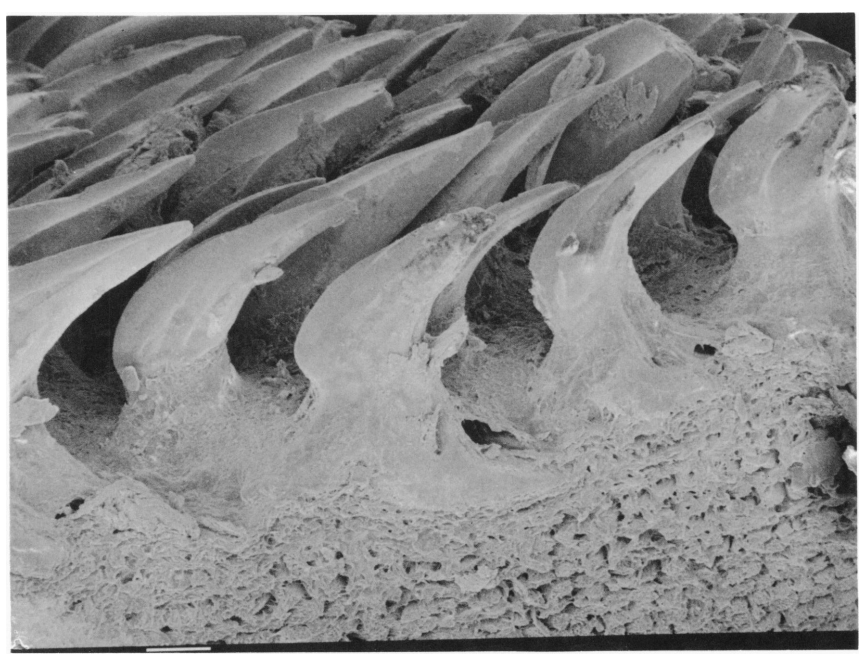

FIG. 78. Lateral view of dermal denticles of *Chiloscyllium plagiosum,* CAS 15845, subadult. Anterior to left. Scale bar equals 100 μ.

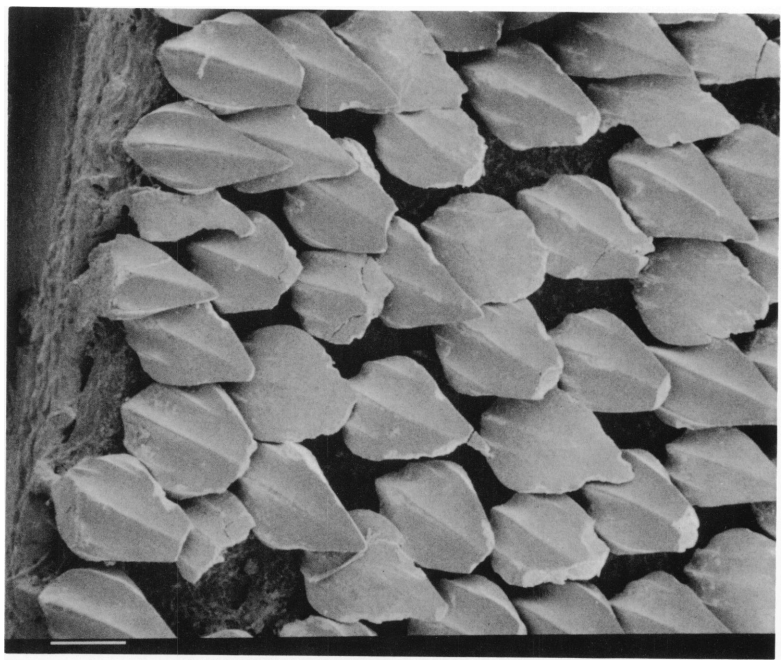

FIG. 79. Dermal denticle pattern of *Chiloscyllium punctatum,* AMNH 44013, adult. Anterior to left. Scale bar equals 200 μ.

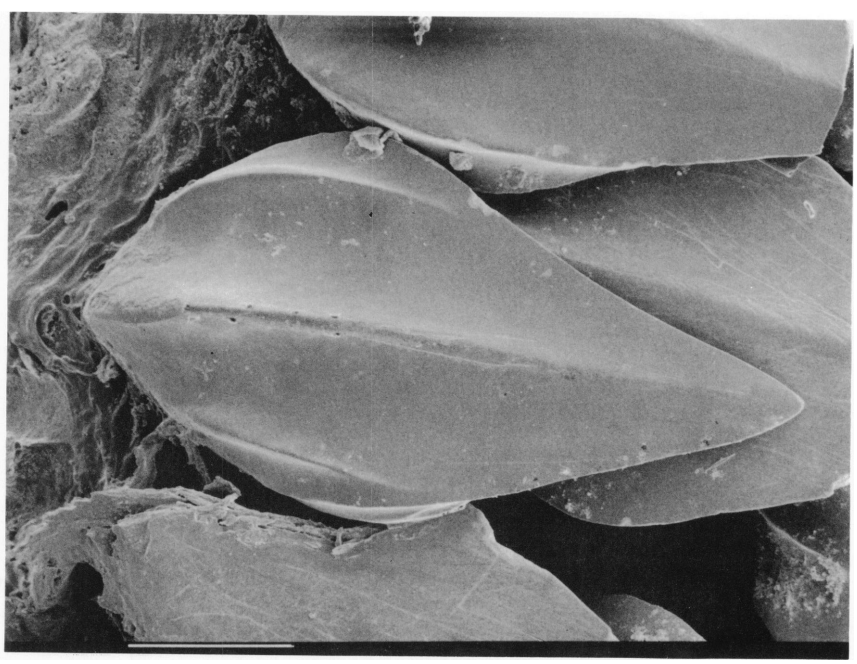

FIG. 80. Single dermal denticle of *Chiloscyllium punctatum,* AMNH 44013, adult. Anterior to left. Scale bar equals 100 μ.

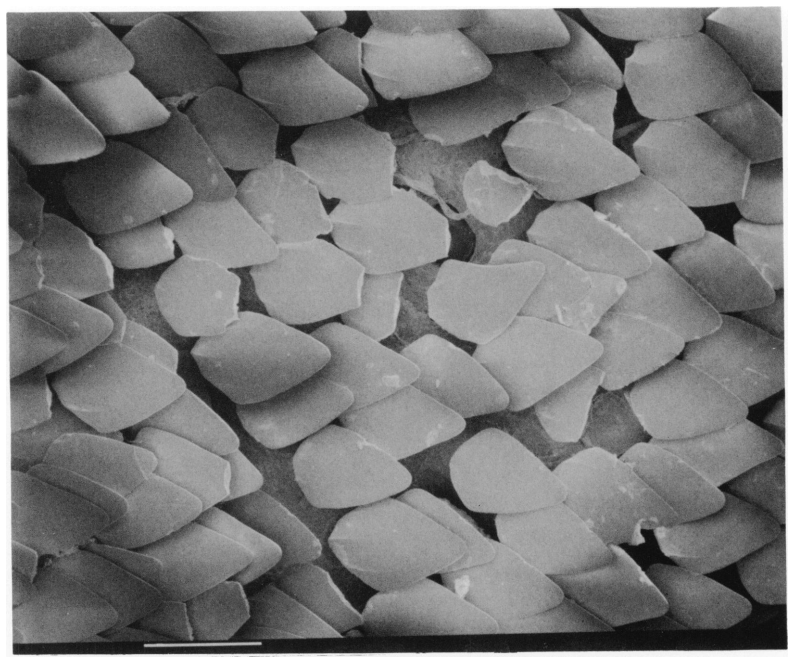

FIG. 81. Dermal denticle pattern of *Hemiscyllium freycineti,* SU(CAS) 26798, subadult. Anterior to top left. Scale bar equals 100 μ.

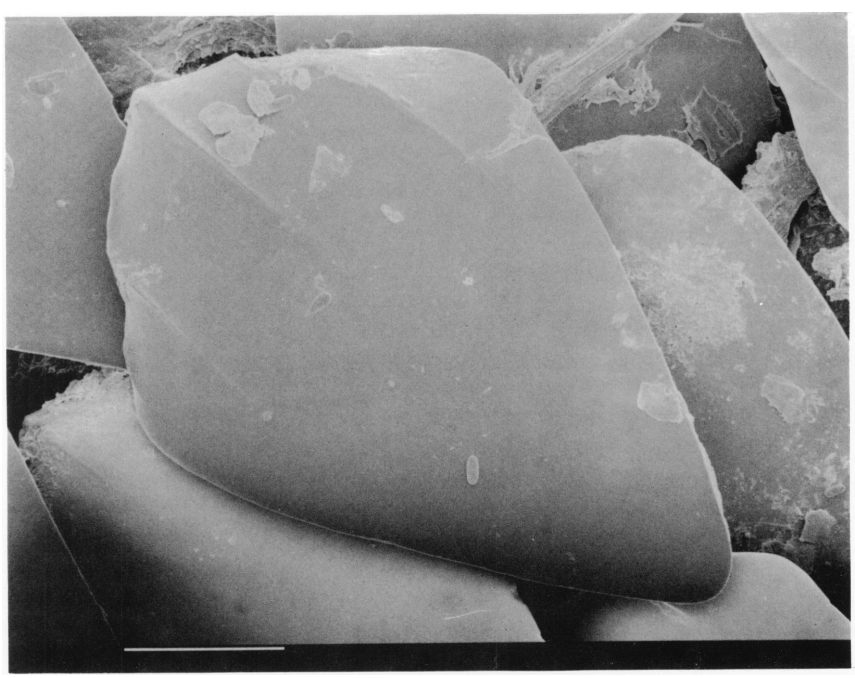

FIG. 82. Single dermal denticle of *Hemiscyllium freycineti,* SU(CAS) 26798, subadult. Anterior to top left. Scale bar equals 100 μ.

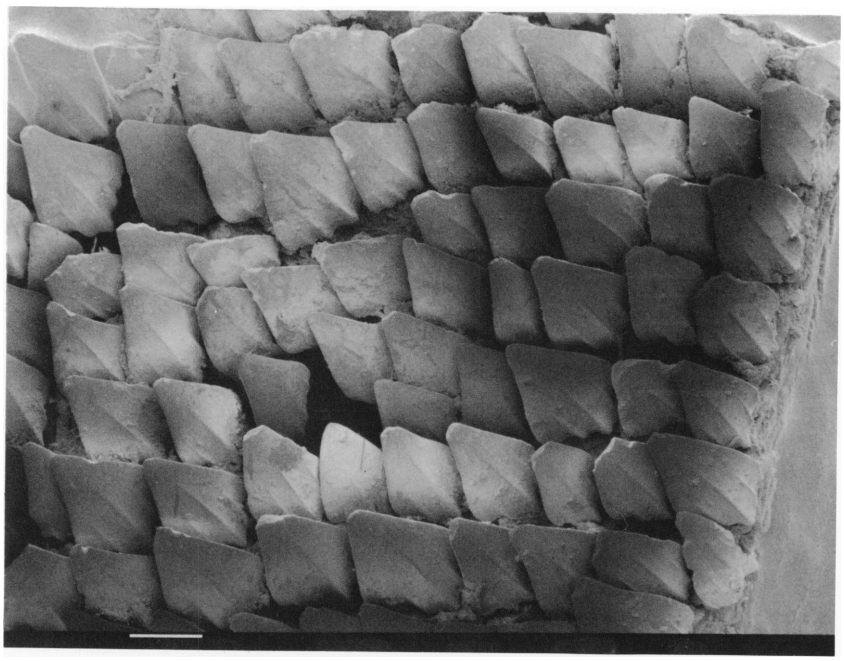

FIG. 83. Dermal denticle pattern of *Hemiscyllium freycineti,* CU 24992, adult. Anterior to right. Scale bar equals 400 μ.

FIG. 84. Single dermal denticle of *Hemiscyllium freycineti,* CU 24992, adult. Anterior to bottom right. Scale bar equals 100 μ.

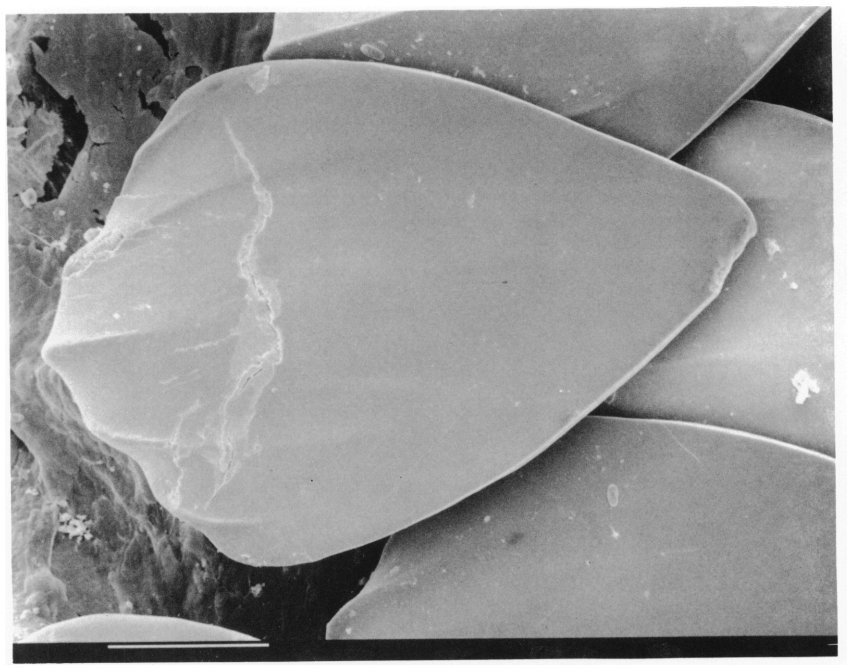

FIG. 85. Single dermal denticle of *Hemiscyllium ocellatum,* AMNH 38151, juvenile. Anterior to left. Scale bar equals 100 μ.

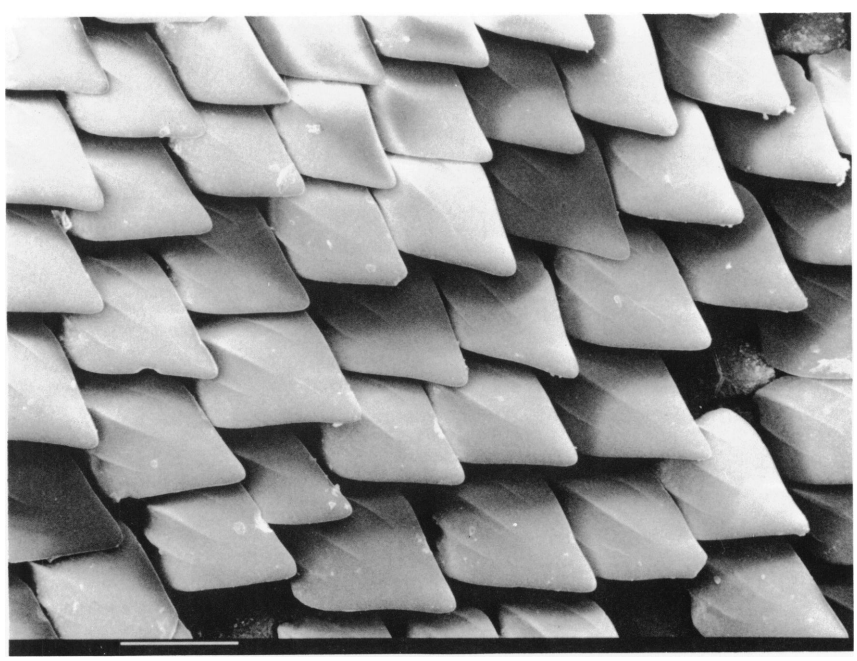

FIG. 86. Dermal denticle pattern of *Hemiscyllium ocellatum,* AMNH 44016, adult. Anterior to top left. Scale bar equals 400 μ.

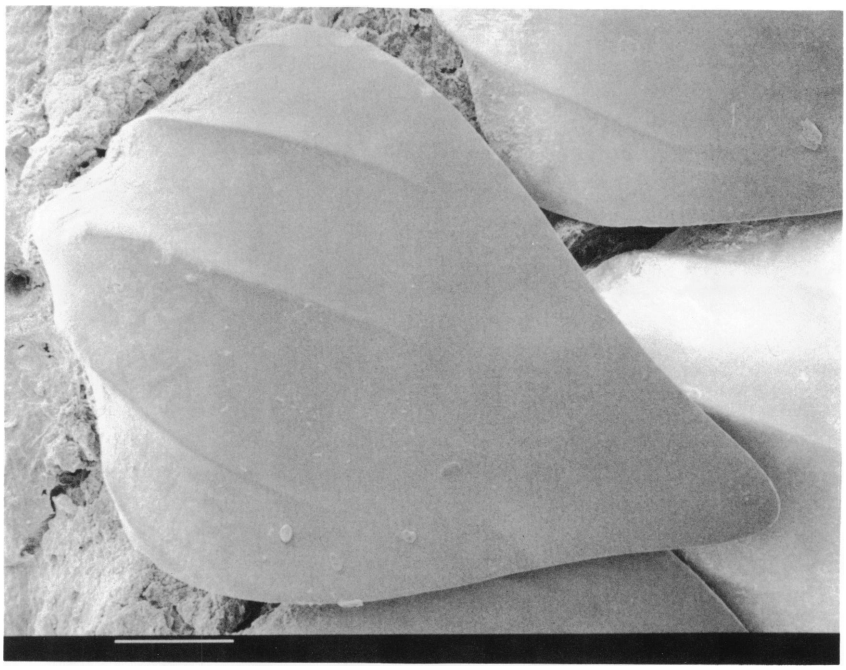

FIG. 87. Single dermal denticle of *Hemiscyllium ocellatum,* AMNH 44016, adult. Anterior to left. Scale bar equals 100 μ.

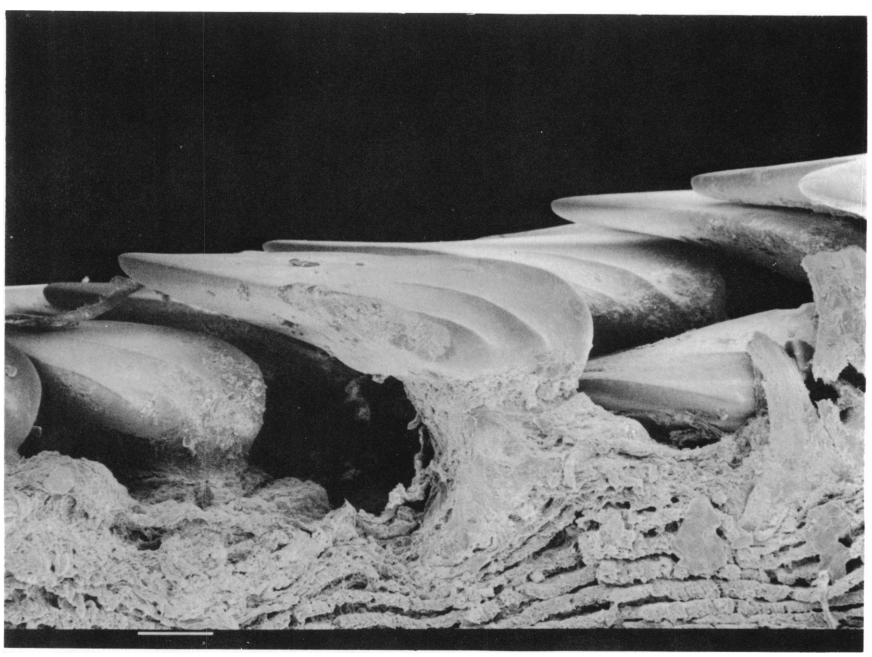

FIG. 88. Lateral view of dermal denticles of *Hemiscyllium ocellatum,* AMNH 44016. Anterior to right. Scale bar equals 100 μ.

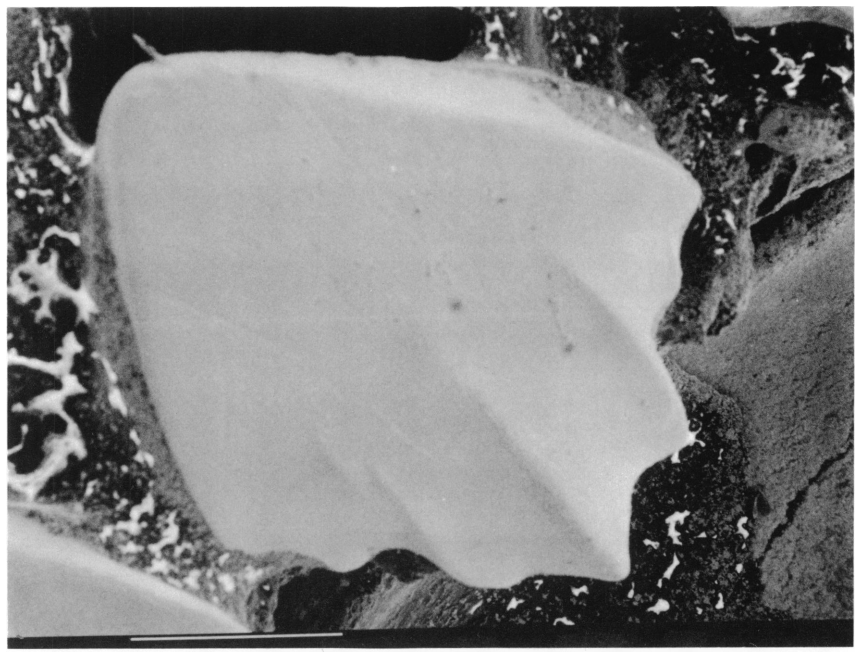

FIG. 89. Single dermal denticle of *Hemiscyllium hallstromi,* USNM 40024, subadult. Anterior to bottom right. Scale bar equals 205 μ.

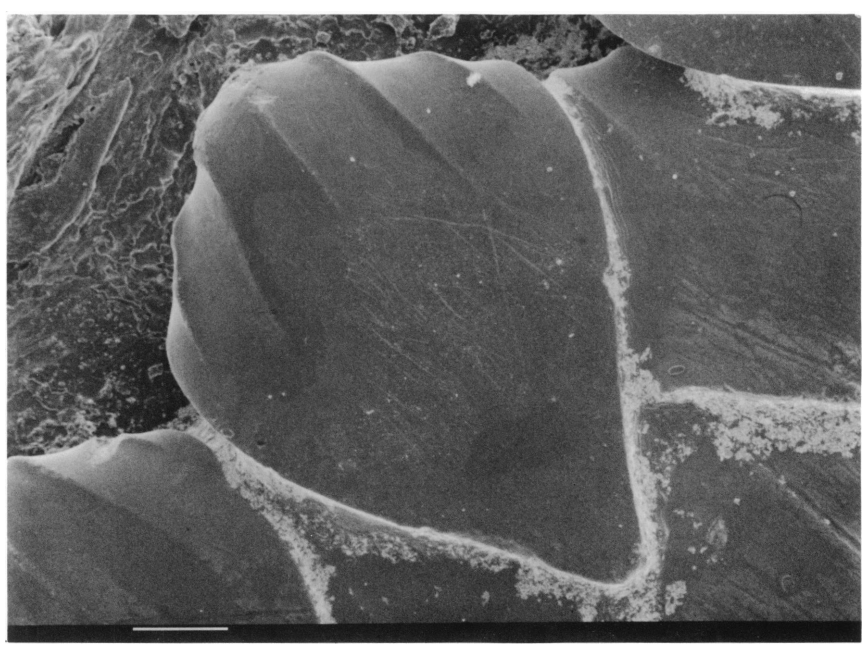

FIG. 90. Single dermal denticle of *Hemiscyllium trispeculare,* USNM 174069, adult. Anterior to top left. Scale bar equals 100 μ.

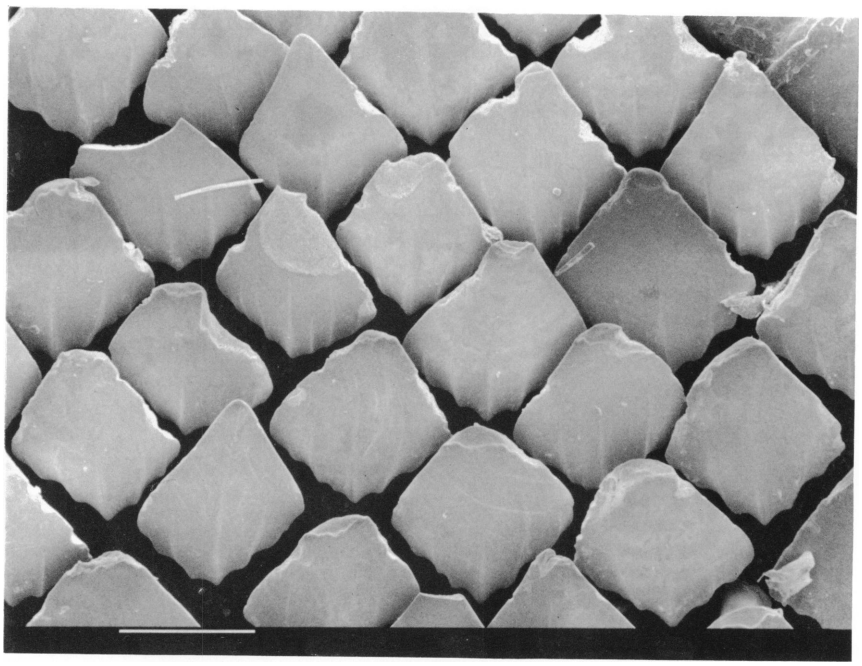

FIG. 91. Dermal denticle pattern of *Hemiscyllium strahani,* USNM 221701, adult. Anterior to bottom. Scale bar equals 400 μ.

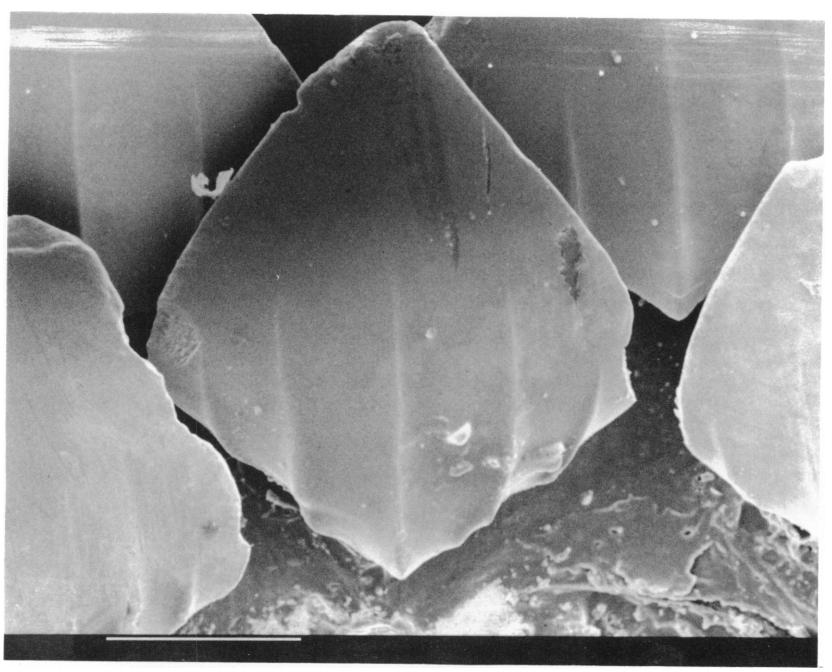

FIG. 92. Single dermal denticle of *Hemiscyllium strahani,* USNM 221701, adult. Anterior to bottom. Scale bar equals 200 μ.

weaker lateral keels. On the sides of the body where their lateral dermal ridges are, there are rows of denticles which have a different morphology (fig. 72). In closeup (fig. 73) these denticles are much larger, shorter, and broader. Instead of a median keel, there is a twin pair of median keels. There are lateral keels at the very edges of the denticles, and there are also a number (from two to three pairs) of extra lateral keels on the two lateral surfaces. These extra keels are usually fairly low and short. In a lateral view of the denticles (fig. 74), from where the base of the denticle erupts from the skin, it first narrows to form a "neck." This neck then enlarges to form the head of the denticle. This head flattens out, and is almost horizontal to the skin. In most species the denticles in lateral view look like those of *C. indicum* in figure 74.

In *C. plagiosum* the denticles look much like those of *C. indicum* (figs. 75 and 76). The denticles are longer than broad, with two lateral and one median keel. The median keel usually continues almost the whole length of the denticle. In the areas of the lateral dermal ridges on the sides of the body, the dermal denticles are modified, as in *C. indicum* (fig. 77). The morphology of these modified dermal denticles is almost identical with those in *C. indicum.* Presumably they produce the lateral dermal ridges on the sides of the body; they are found on no other part of the body in these two species, and are not found in any other species. In lateral view (fig. 78), the denticle heads of *C. plagiosum* are not almost horizontal to the skin as they are in other species. Rather, the heads project upward at almost a 45° angle from the skin.

In *C. punctatum* the denticles are much longer than broad (figs. 79 and 80). They have a median keel extending almost the entire length of the denticle, and there are two lateral keels.

In the juveniles of *Hemiscyllium freycineti* the denticles are not arranged in uniform rows (fig. 81). The denticles in the juveniles have a low median keel, and two weak midlateral keels (fig. 82). In adults (fig. 83) the denticles are arranged in uniform rows. In the adults the denticles have the median keel and midlateral keels more pronounced (fig. 84).

Denticles of *H. ocellatum* juveniles look much like those of *H. freycineti* juveniles except that there are two pairs of lateral keels (fig. 85). In adults, these keels become more pronounced (figs. 86 and 87) and also become broader and more tapered. In lateral view (fig. 88) the denticles are similar to those of *Chiloscyllium* but the necks are much shorter. As in *Chiloscyllium,* the heads are almost parallel to the skin.

The denticles of *H. hallstromi* are similar to those of *H. ocellatum.* They have a median keel which extends about half the length of the denticle. There are two pairs of lateral keels. The denticles (fig. 89) are shorter and broader than those of *H. ocellatum.*

Hemiscyllium trispeculare has denticles which have a weak median keel and two pairs of midlateral keels (fig. 90). These denticles are virtually indistinguishable from those of juvenile *H. ocellatum.*

Hemiscyllium strahani has denticles which are shorter and broader than those of the other species (figs. 91 and 92). Besides the median keel, they have two pairs of midlateral keels, and a pair of lateral keels.

DISCUSSION OF INTERRELATIONSHIPS WITHIN THE HEMISCYLLIDAE

We define the Hemiscyllidae as monophyletic based upon the following synapomorphies: possession of a complete postoral fold, and the anal fin base virtually contiguous with the caudal fin. We place them in the Orectolobiformes because of the following characters (synapomorphies for the Orectolobiformes): possession of narial barbels, nasal groove continuing into mouth, a single rostral process originating on the ventral side of the chondrocranium, and having both an anterior fontanelle and median fontanelle in the chondrocranium (which are sometimes fused into one long anteromedian fontanelle). At present we cannot place the relationships of the Hemiscyllidae within the Orectolobiformes, as the interrelationships within Orectolobiformes have not been analyzed. After this has been done the familial status of Hemiscyllidae may need to be altered (Dingerkus, in prep.).

Within Hemiscyllidae the genus *Hemi-*

scyllium can be defined as being monophyletic based upon the following derived characters: the propterygium is fused onto the mesopterygium in the pectoral fin (see pages 57–58), the narial barbel length is less than 10 percent of the head length, the nose tip to mouth length is less than 3 percent of TL, the distance from the vent to origin of the anal fin is more than 38 percent of TL, and nose tip to first gill slit distance is less than 13.3 percent of TL. The genus *Chiloscyllium* can be defined as monophyletic by possessing less than 180 vertebral centra, a strong mid-dorsal ridge that extends from the back of the head onto the tail, fourth and fifth gill openings that meet dorsally and ventrally, and a projection on the posterior border of the spiracular opening, pointing into the spiracle.

Primitively, *Chiloscyllium* has dermal denticles that are much longer than broad, each denticle having one long median keel, and sometimes two weak keels at its lateral edge (see dermal denticle section above). This can also be seen as an ontogenetic change: species with more complex denticles have the primitive condition in juveniles. The gill arches (see gill and hyoid arch section above) primitively have the third hypobranchials not articulating with the basibranchial plate and there is a small basibranchial element between the third hypobranchials and the basibranchial plate.

Chiloscyllium plagiosum and *C. indicum,* as sister species, share lateral dermal ridges on the body, and specially modified dermal denticles on these dermal ridges (see above). The dermal denticles covering the rest of the body and the gill arches are of the primitive *Chiloscyllium* type (see above), except that *C. indicum* has lost the small basibranchial element. Because of these lateral dermal ridges, Gill (1862) placed *C. indicum* into its own genus of *Synchismus.* In all other respects it is a typical *Chiloscyllium*; therefore, Regan (1908) and Garman (1913) considered the genus to be a synonym under *Chiloscyllium.* Fowler (1941), however, maintained *Synchismus* as a subgenus because of its distinctive lateral dermal ridges. But *C. plagiosum* also shares this unique character, and since *C. plagiosum* is the type species of *Chiloscyllium,* the name *Synchismus* cannot be maintained as a subgeneric name for this sister-species group. Hence, we maintain *Synchismus* as a synonym of *Chiloscyllium.* At present we do not feel that any other subgeneric names need to be assigned within the genus *Chiloscyllium.*

The remaining species of *Chiloscyllium—punctatum, hasselti, griseum, confusum,* and *burmensis*—form a group based upon the following shared characters: the hypobranchial 3 elements project backward to almost (or fully) touching the basibranchial plate, the basibranchial element being greatly reduced (or absent), and the adults being uniform in color dorsally, having lost any juvenile color or patterns. Their relationships are diagrammed in figure 93. The *C. hasselti-griseum-confusum-burmensis* group is defined by having the third hypobranchials articulating with the basibranchial plate, the absence of basibranchial elements, and dermal denticles as broad as long. *Chiloscyllium hasselti* is the sister group of *C. confusum* and *burmensis* based upon the presence of midlateral keels on the dermal denticles, and *C. confusum* and *C. burmensis* are sister species based upon the strong midlateral keels on their dermal denticles.

Within the genus *Hemiscyllium* anatomical characters and morphometric measurements yield no information on their interrelationships. Color pattern appears to yield some information as there is an ontogenetic change in the color pattern from juveniles to the adults for the species where juveniles are known. All known juveniles start with virtually the same color pattern (see figs. 26, 29, and 32). Thus, species maintaining a color pattern similar to the juveniles are presumed more primitive, and more complicated adult patterns are considered more derived conditions. Thus *H. hallstromi* and *H. ocellatum,* which cannot be differentiated as they maintain about the same amount of juvenile color pattern, form an unresolved trichotomy with a group including *H. freycineti, trispeculare,* and *strahani.* Within this group a sequential series of sister groups are formed by the species *H. freycineti, H. trispeculare,* and *H. strahani* (fig. 93), as determined by their increasing complexity of adult color pattern.

Dermal denticles also specify similar re-

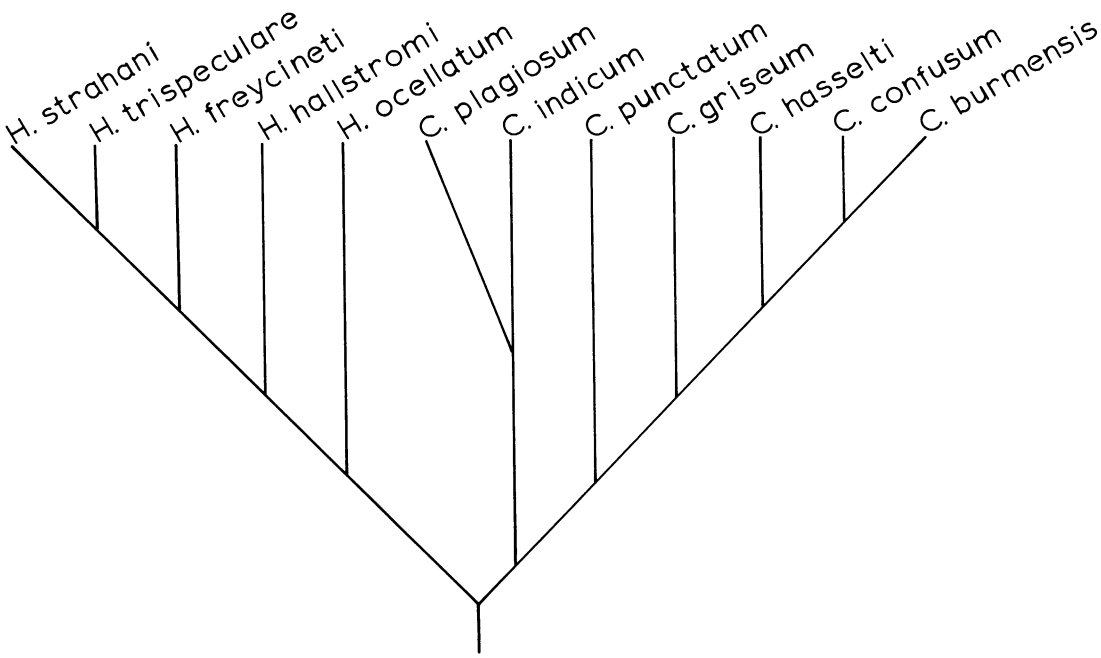

FIG. 93. Cladogram of interrelationships of the species in the genera *Hemiscyllium* and *Chiloscyllium.*

lationships. Juveniles have much longer, rounder denticles, while most adults have shorter and more angular denticles. The adults also usually have the keels more pronounced. *H. ocellatum* most nearly maintains the juvenile, presumed primitive, condition in adults. *Hemiscyllium hallstromi* also maintains much of this juvenile condition, but not so much as in *H. ocellatum,* therefore making it more derived than *H. ocellatum.* As with color pattern, the dermal denticles of *H. freycineti, H. trispeculare,* and *H. strahani* show a sequential series of more angular denticles and more pronounced keels, which presumably indicate more derived conditions.

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BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY

VOLUME 176
1983

PUBLISHED BY ORDER OF THE TRUSTEES
NEW YORK : 1983

Edited by
FLORENCE BRAUNER

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