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MEMOIRS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY

AT

HARVARD COLLEGE.

VOL. XXXVI.

CAMBRIDGE, MASS., U. S. A.
1913.

TROPICAL PACIFIC.

The following Publications of the Museum contain Reports on the Dredging Operations in charge of Alexander Agassiz, of the U. S. Fish Commission Steamer "Albatross," during 1899 and 1900, Commander Jefferson F. Moser, U. S. N., Commanding.

I. A. Agassiz. Preliminary Report and List of Stations. With Remarks on the Deep-Sea Deposits by Sir John Murray. Mem. M. C. Z., Vol. XXVI. No. 1. January, 1902. 114 pp. 21 Charts.

II. A. G. Mayer. Some Species of Partula from Tahiti. A Study in Variation. Mem. M. C. Z., Vol. XXVI. No. 2. January, 1902. 22 pp. 1 Plate.

III. A. Agassiz and A. G. Mayer. Medusae. Mem. M. C. Z., Vol. XXVI. No. 3. January, 1902. 40 pp. 13 Plates, 1 Chart.

IV. A. Agassiz. The Coral Reefs of the Tropical Pacific. Mem. M. C. Z., Vol. XXVIII. February, 1903. 33, 410 pp. 238 Plates.

V. C. R. Eastman. Shark's Teeth and Cetacean Bones from the Red Clay of the Tropical Pacific. Mem. M. C. Z., Vol. XXVI. No. 4. June, 1903. 14 pp. 3 Plates.

VI. W. E. Hoyle. Cephalopoda. Bull. M. C. Z., Vol. XLIII. No. 1. March, 1904. 71 pp. 12 Plates.

VII. H. Ludwig. Asteroidea. Mem. M. C. Z., Vol. XXXII. July, 1905. 12, 292 pp. 35 Plates, 1 Chart.

VIII. W. E. Ritter and Edith S. Byxbee. The Pelagic Tunicata. Mem. M. C. Z., Vol. XXVI. No. 5. August, 1905. 22 pp. 2 Plates.

IX. Mary J. Rathbun. The Brachyura. Mem. M. C. Z., Vol. XXXV. No. 2. August, 1907. 54 pp. 9 Plates.

X. C. H. Gilbert. The Lantern Fishes. Mem. M. C. Z., Vol. XXVI. No. 6. July, 1908. 24 pp. 6 Plates.

XI. A. Agassiz. Echini: The Genus Colobocentrotus. Mem. M. C. Z., Vol. XXXIX, No. 1. November, 1908. 8, 33 pp. 49 Plates.

XII. J. Murray and G. V. Lee. The Depth and Marine Deposits of the Pacific. Mem. M. C. Z., Vol. XXXVIII. No. 1. June, 1909. 170 pp. 5 Plates, 3 Maps.

XIII. W. C. Kendall and E. L. Goldsborough. The Shore Fishes. Mem. M. C. Z., Vol. XXVI. No. 7. February, 1911. 106 pp. 7 Plates

XIV. H. Heath. The Solenogastres. Mem. M. C. Z., Vol. XLV. No. 1. June, 1911. 180 pp. 40 Plates.

XV. A. M. Westergren. Echini: Echinonëus and Micropetalon. Mem. M. C. Z., Vol. XXXIX. No. 2. August, 1911. 34 pp. 31 Plates.

MEMOIRS

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MUSEUM OF COMPARATIVE ZOÖLOGY

AT

HARVARD COLLEGE.

VOL. XXXVI.

CAMBRIDGE, MASS., U. S. A.
1913.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXXVI.

THE PLAGIOSTOMIA.

(SHARKS, SKATES, AND RAYS).

BY

SAMUEL GARMAN.

WITH SEVENTY-SEVEN PLATES.

PLATES.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
September, 1913.

CONTENTS.

List of Abbreviations.

ag.	angular.
ao.	antorbital.
aqv.	aqueducts of the vestibule.
ar.	angular.
bhy.	basihyal.
bra.	outer branchial stay.
bre.	inner branchial stay.
brr.	branchial rays.
bstr.	basitrabeculae.
cbr.	ceratobranchials.
chy.	ceratohyals.
co.	copula.
cp.	partial copula.
e.	eye or orbit.
ehy.	epihyal.
ebr.	epibranchial.
evs.	epitropeals, supra. & subtropeals.
exbr.	extrabranchials.
ebs.	ceratobranchials.
fo.	foramen.
g.	gill lamellae.
hbr.	hyobranchials.
hm.	hyomandibular.
int.	intestine.
l.	labials.
l'.	lateral expansion of rostral.
ls.	lateral stay.
mk.	lower jaws. Meckelian.
msp.	mesopterygium (nsp. pl. 67).
mtp.	metapterygium.
mx.	maxillaries, quadratopterygoids.
na.	prenarial cartilages.
nv.	nasal valves.
op.	opercular cartilages.
pbr.	epibranchials.
pbs.	posterior branchial support.
pct.	pectoral arch, shoulder girdle.
po.	post orbital process.
prp.	propterygium.
psp.	postspiracular cartilage.
qpg.	quadratopterygoid.
r. or rl.	rostral cartilage.
sbr.	suprabranchials.
sc.	scapular.
so.	supraorbital.
sp.	spiracular.
x.	basal element of eighth arch.

PLATE 1.

PLATE 1.

CESTRACIONTIDAE.

Fig. 1–3. CESTRACION ZYGAENA (Page 157). Fig. 4–6. CESTRACION TIBURO (Page 160).

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3. Teeth from the side of the jaw.
4. Lateral view of a specimen $21\frac{1}{2}$ inches long.
5. Head from below.
6. Teeth from the side of the jaw.


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PLATE 2.

PLATE 2.

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7. Teeth from the front and from the side of the jaw.
8. Scales from near the middle of the flank.

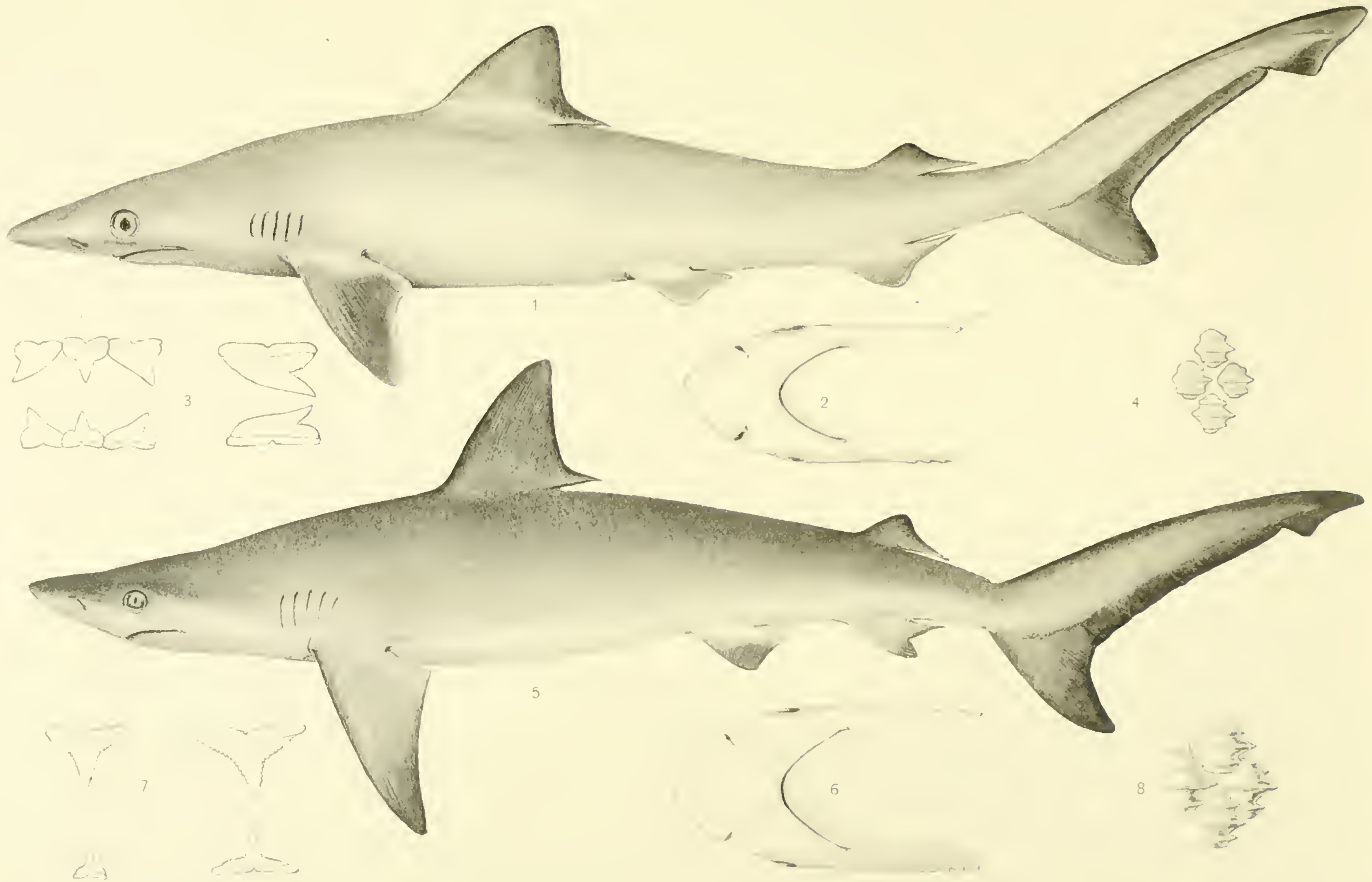
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PLATE 3.

CARCHARINIDAE.

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1. Lateral view.
2. Teeth from the forward end of the jaw.
3. Head from below.
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5. Teeth from the forward end of the jaw.
6. Head from below.

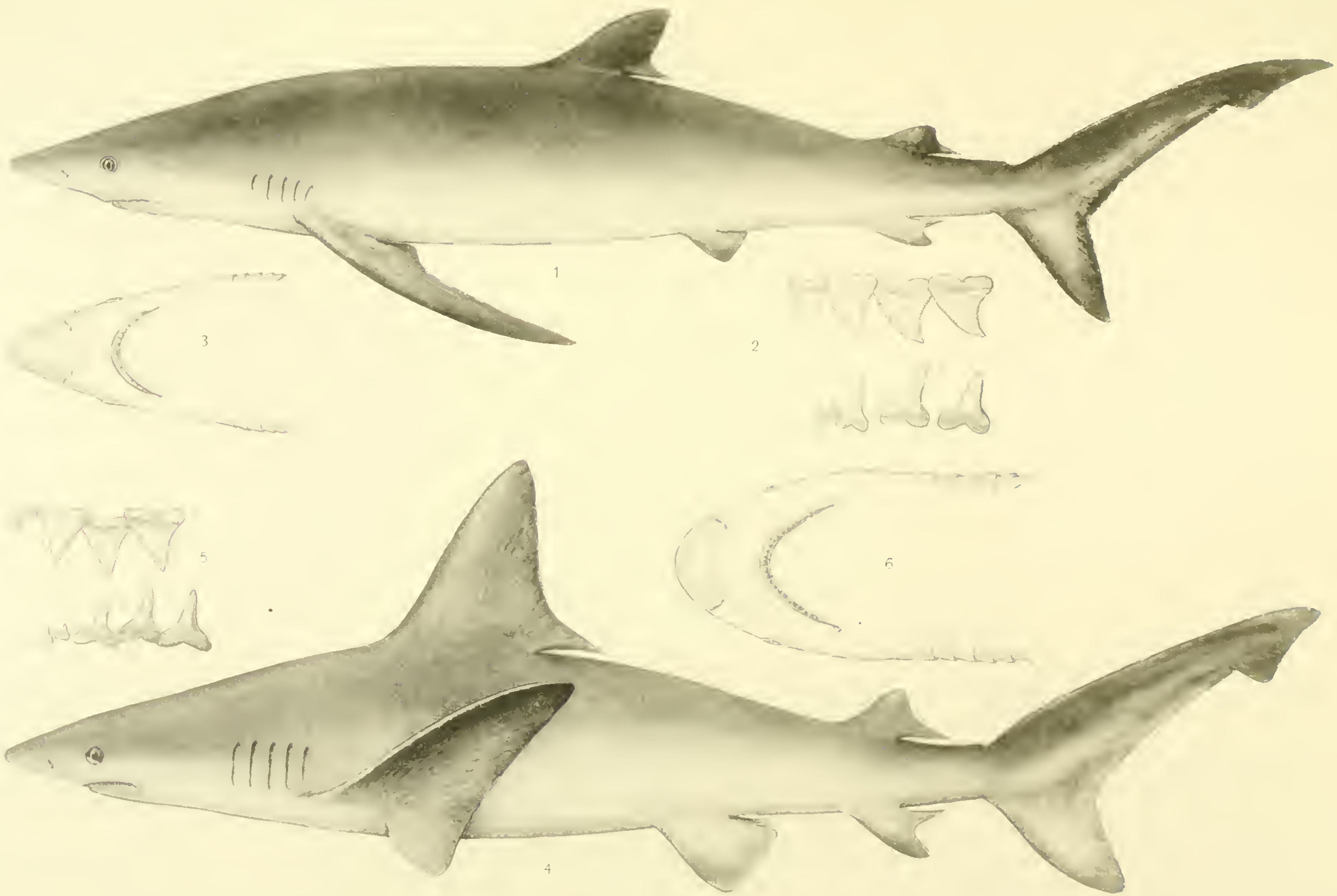
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PLATE 4.

CARCHARINIDAE and GALEORHINIDAE.

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GALEORHINIDAE and ISURIDAE.

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5. Lateral view.
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7. Nostril.
8. Head from below.
9. Scales from near the middle of the flank.

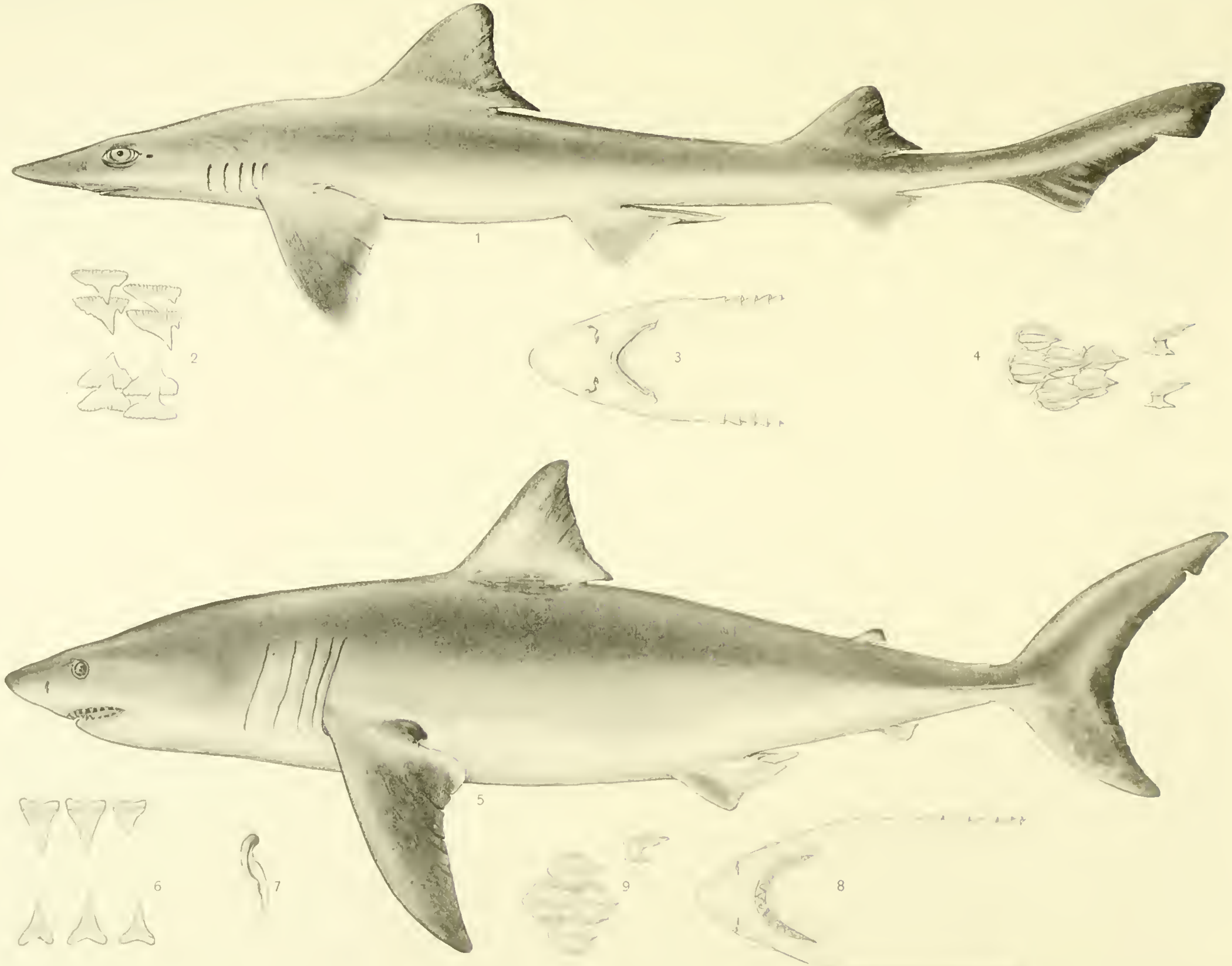
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PLATE 6.

CARCHARIIDAE and ISURIDAE.

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PLATE 7.

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PLATE 8.

PLATE 8.

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8. Teeth from near the front end of the jaw.
9. Scales from near the middle of the flank.
10. Lateral view of scales.

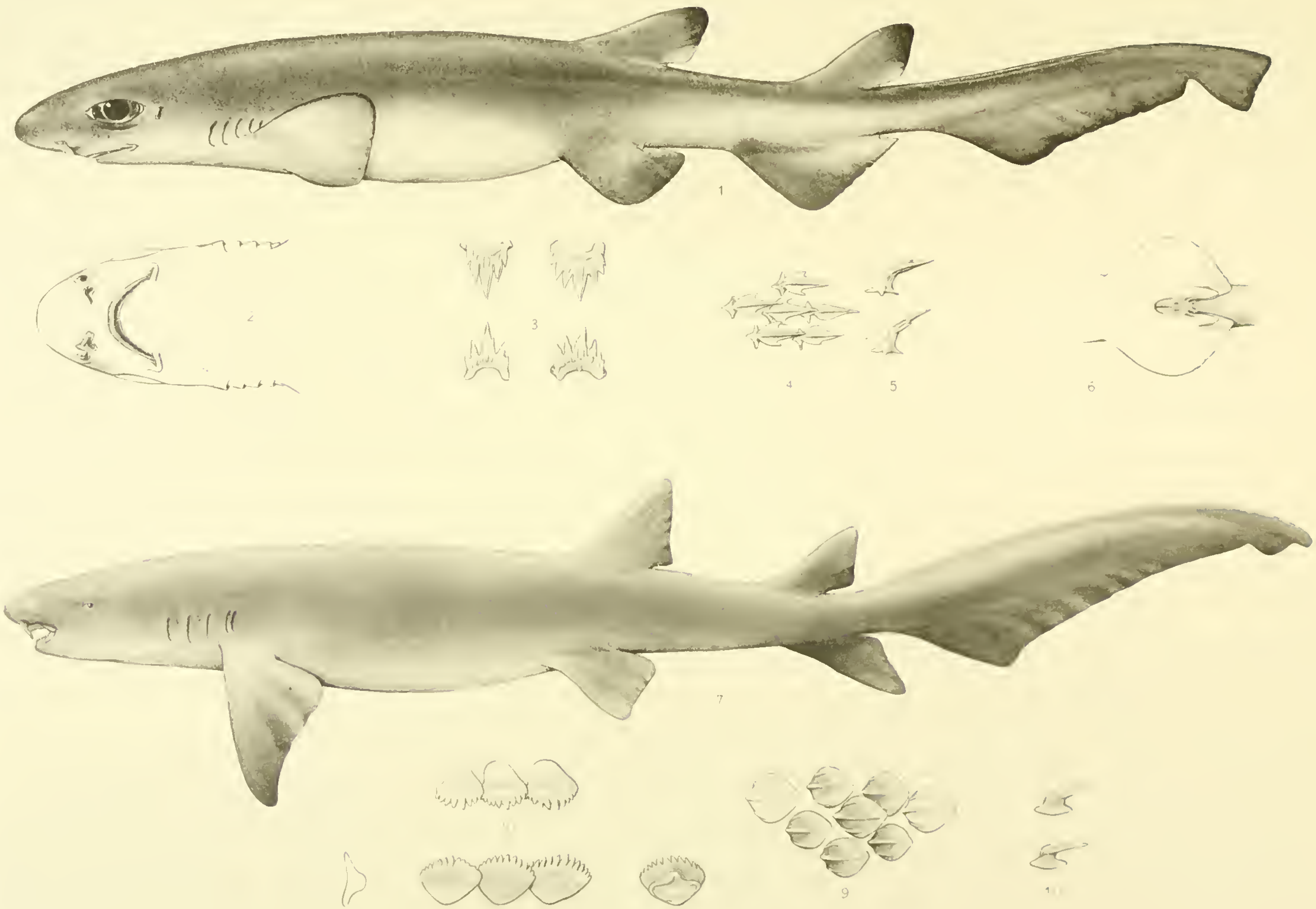
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PLATE 9.

PLATE 9.

CATULIDAE.

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7. Head from below.
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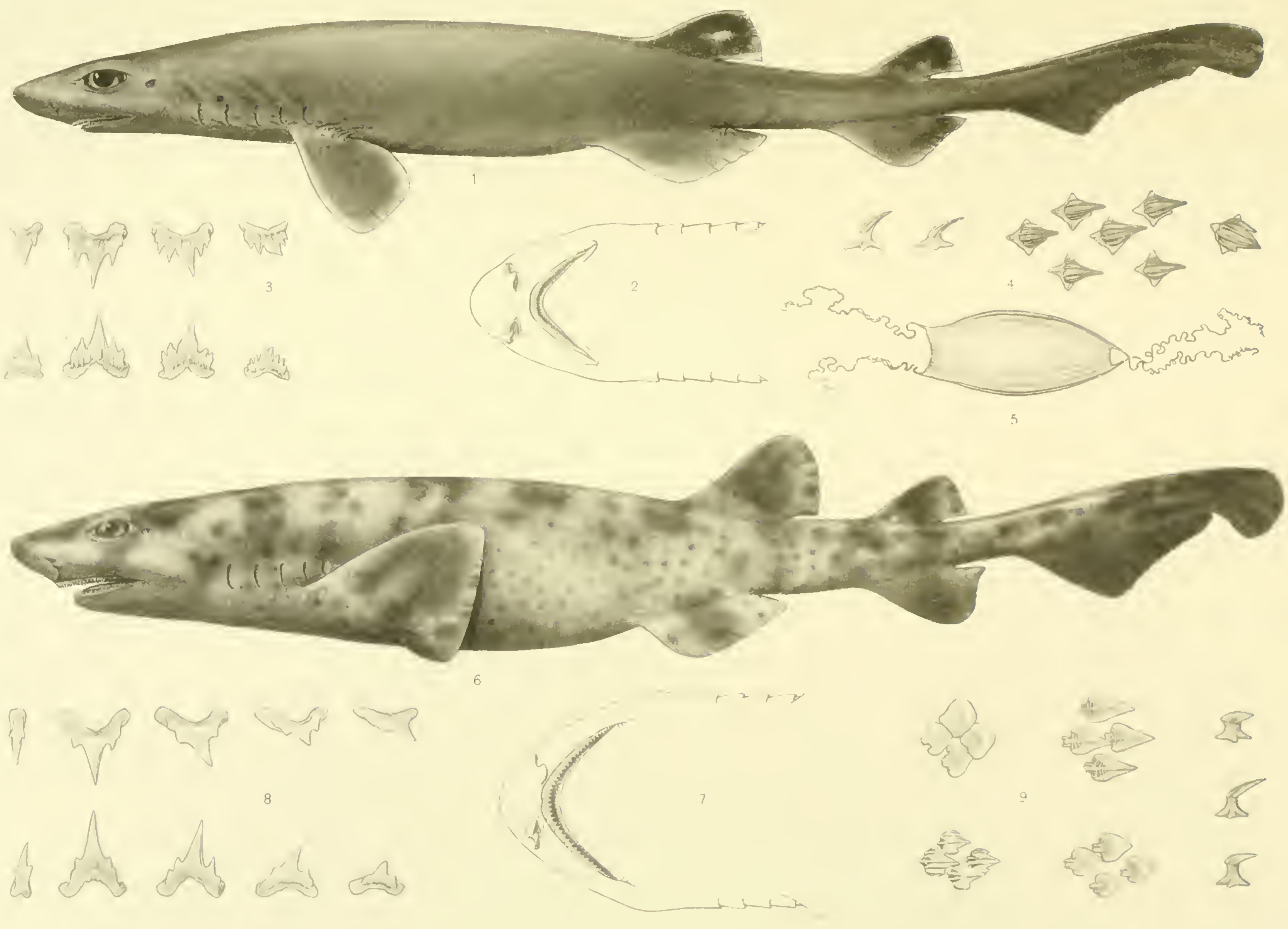
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PLATE 10.

SQUALIDAE.

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6. Teeth from near the front end of the jaw.
7. Head from below.
8. Scales from near the middle of the flank.

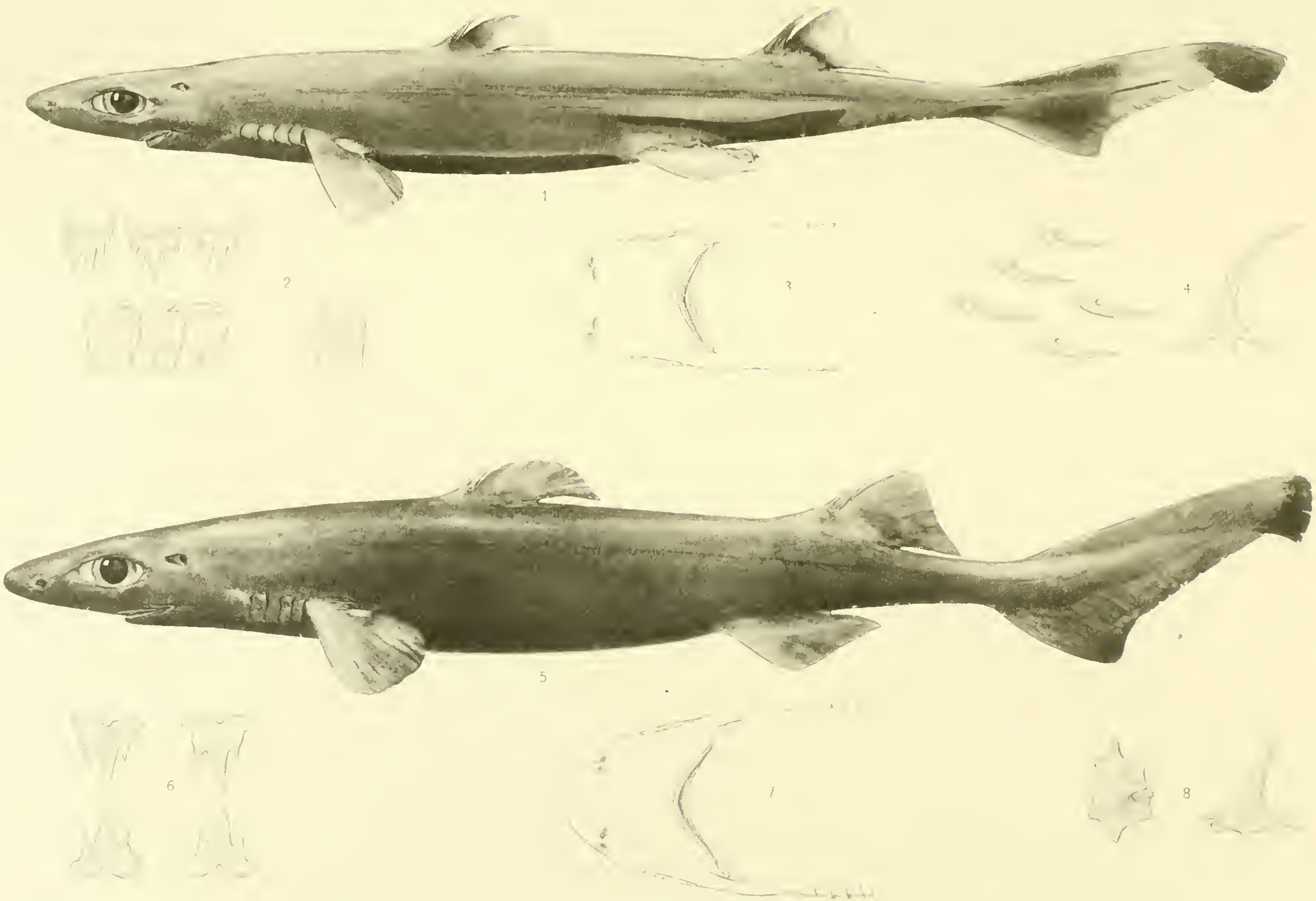
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PLATE 11.

SQUALIDAE.

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6. Head from below.
7. Teeth from the front end of the jaw.
8. Scales from near the middle of the flank.

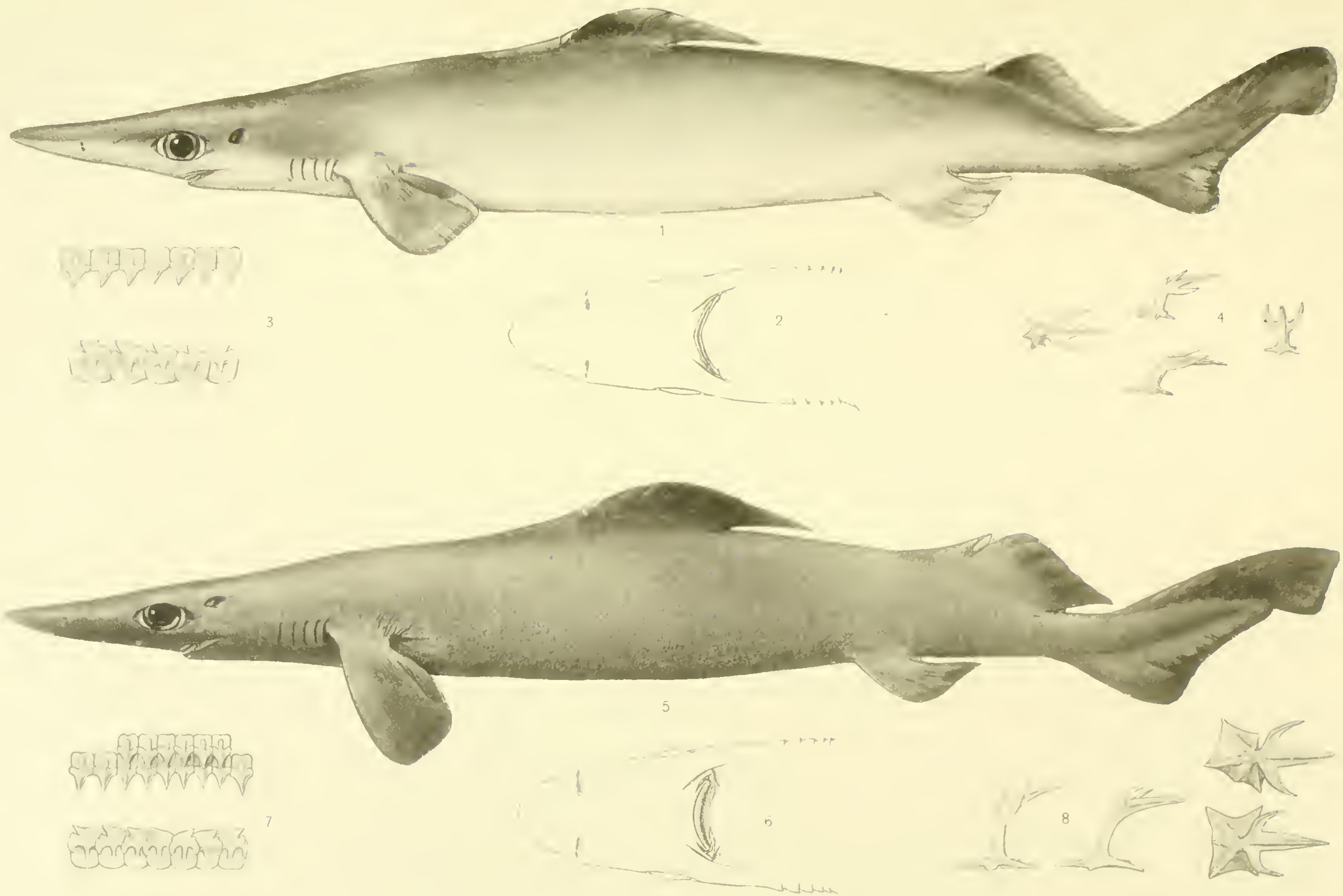
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PLATE 12.

PLATE 12.

SQUALIDAE.

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3. Head from below.
4. Scales from the middle of the flank.
5. Lateral view of a specimen $32\frac{1}{4}$ inches long.
6. Teeth from the front end of the jaw.
7. Head from below.
8. Scales from near the middle of the flank.

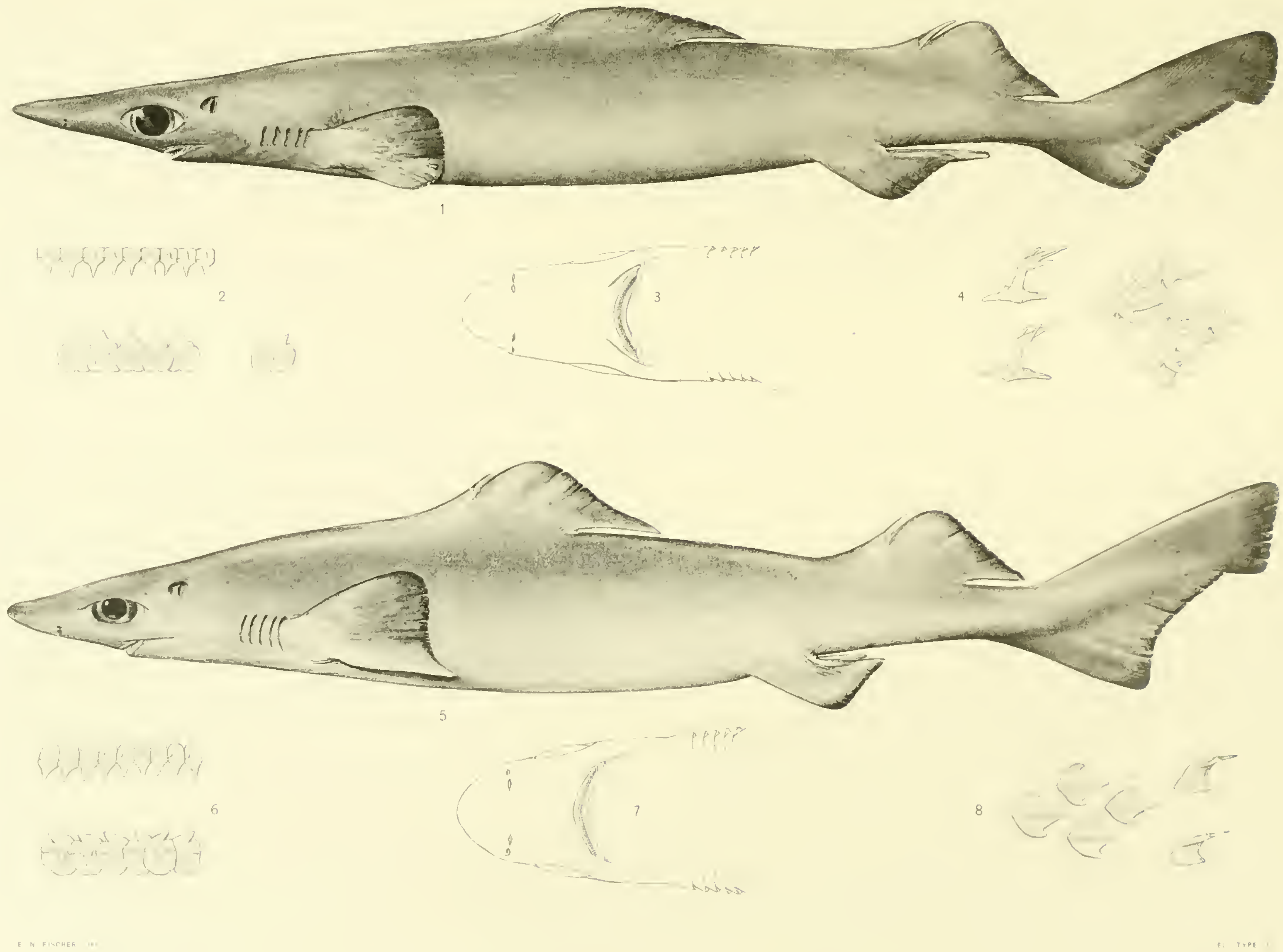
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PLATE 13

PLATE 13.

SQUALIDAE.

Fig. 1–4. CENTROPHORUS ATROMARGINATUS (Page 200). Fig. 5–8. CENTROSCYMNUS OWSTONII (Page 205).

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6. Teeth from the front end of the jaw.
7. Head from below.
8. Scales from near the middle of the flank.

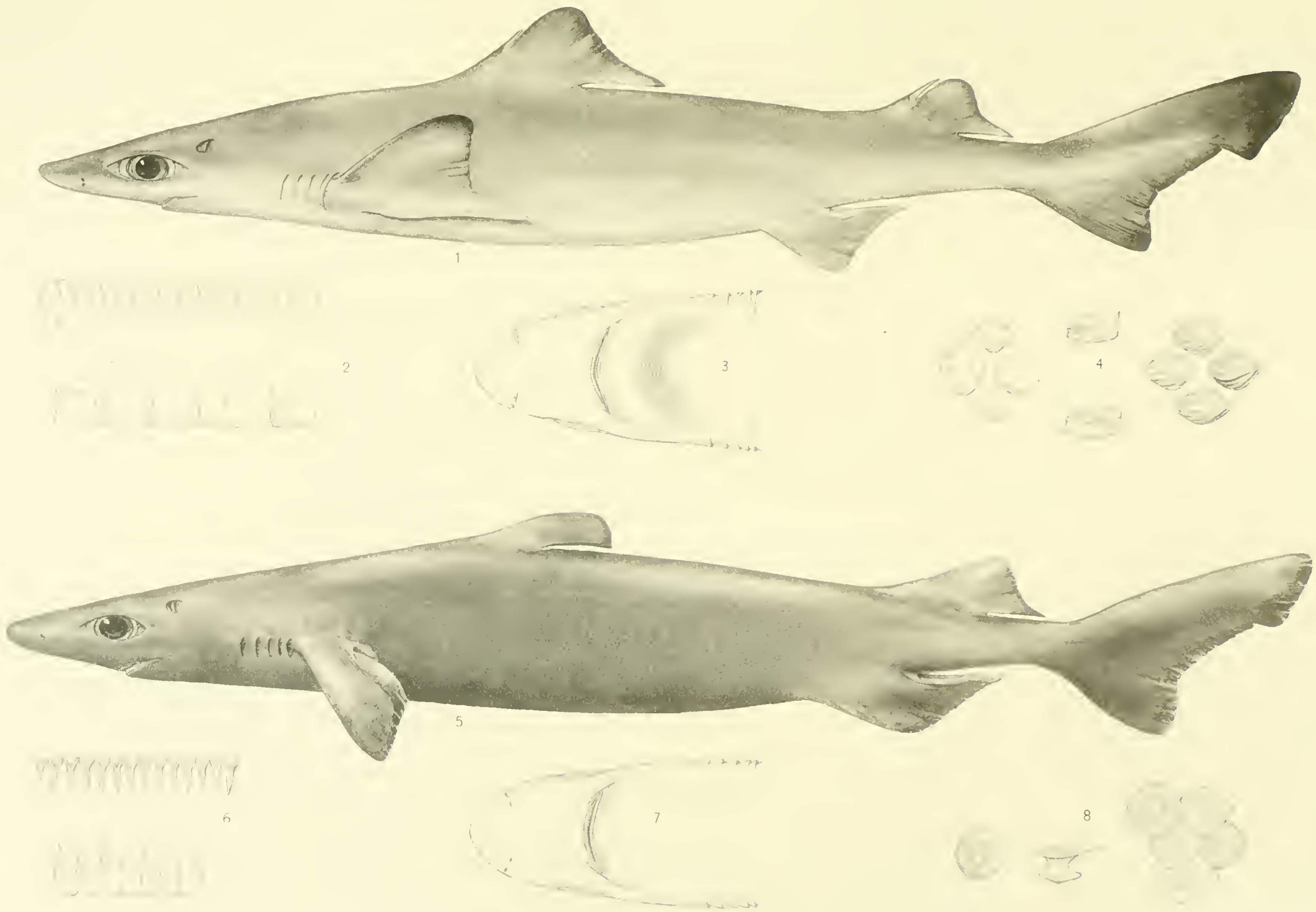
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PLATE 14.

SQUALIDAE.

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6. Teeth from near the front end of the jaw.
7. Head from below.
8. Scales from the middle of the flank.

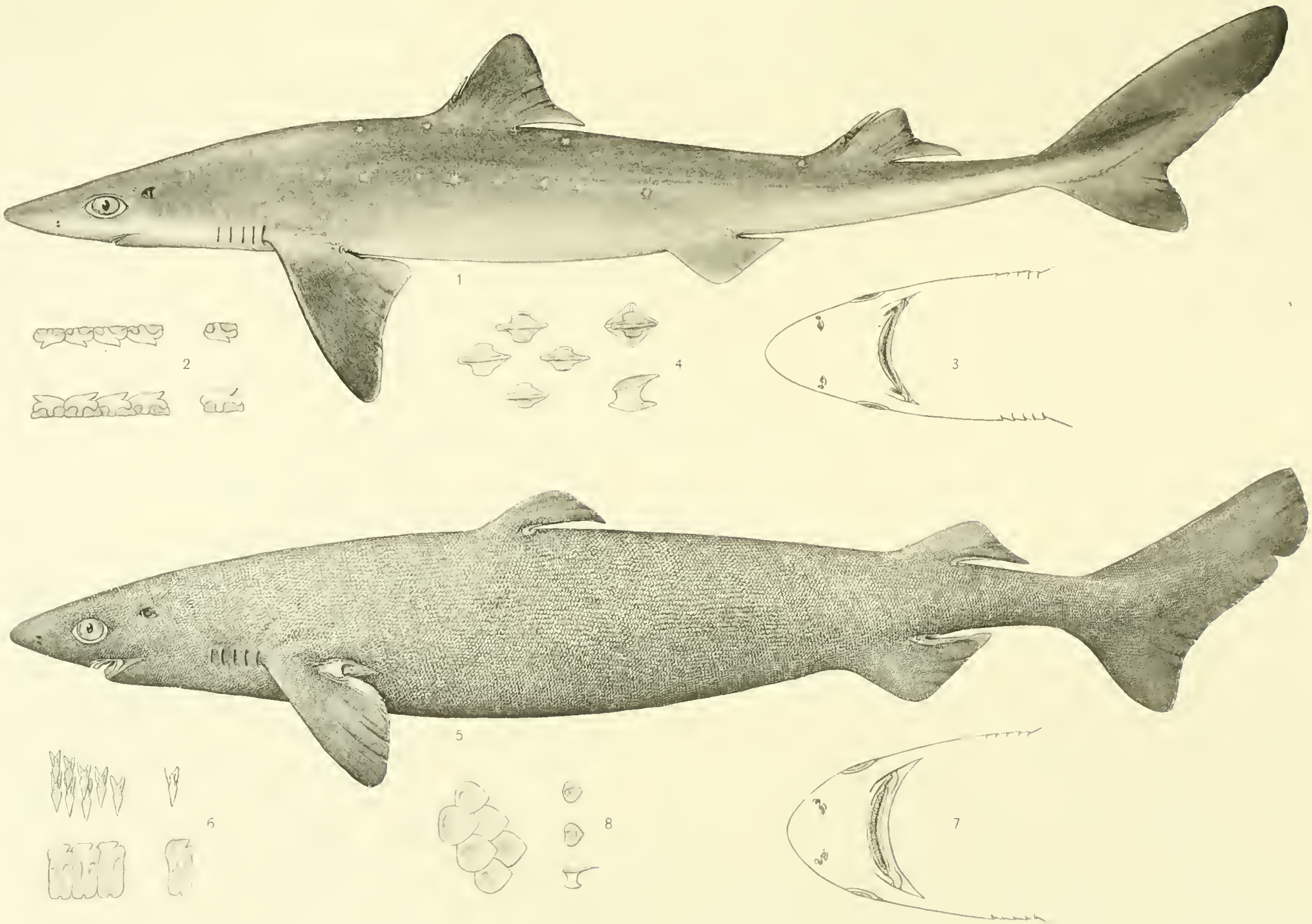
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PLATE 15.

PLATE 15.

SCYMNORHINIDAE.

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3. Scales from the middle of the flank.
4. Lateral view of a specimen 106 inches long.
5. Teeth from near the front end of the jaw.
6. Scales from the middle of the flank.

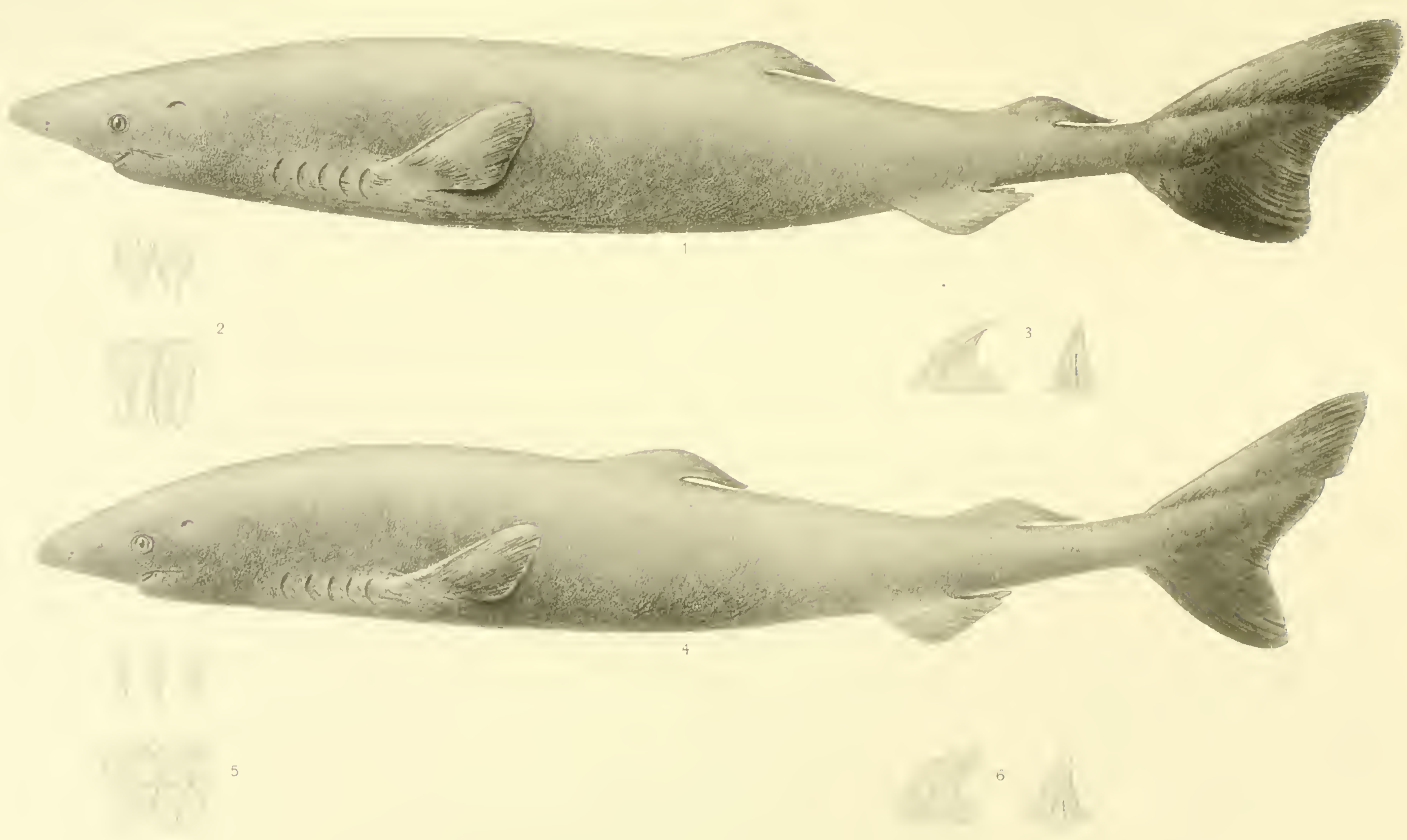

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PLATE 16.

PLATE 16.

RHINIDAE and PRISTIDAE.

Fig. 1–4. RHINA CALIFORNICA (Page 253). Fig. 5–7. PRISTIS CLAVATA (Page 263).

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3. Teeth.
4. Scales from the middle of the body.
5. Dorsal view of a specimen $24\frac{3}{8}$ inches long.
6. Forward teeth.
7. Scales from near the middle of the body.

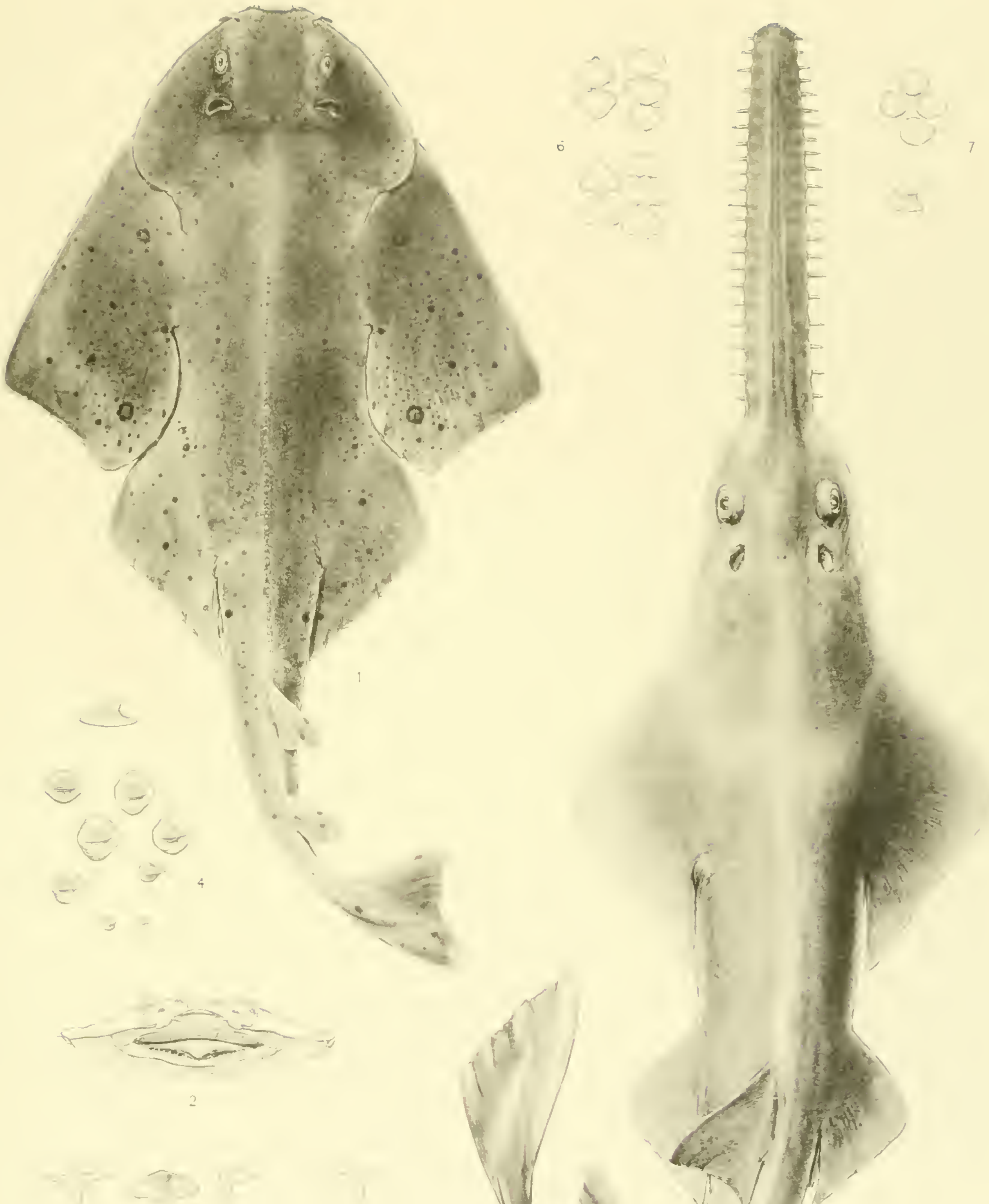
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PLATE 17.

PLATE 17.

RHINOBATIDAE.

Fig. 1–2. Rhinobatus lentiginosus (Page 279).

1. Dorsal view of a specimen $22\frac{3}{4}$ inches long.
2. Ventral view.

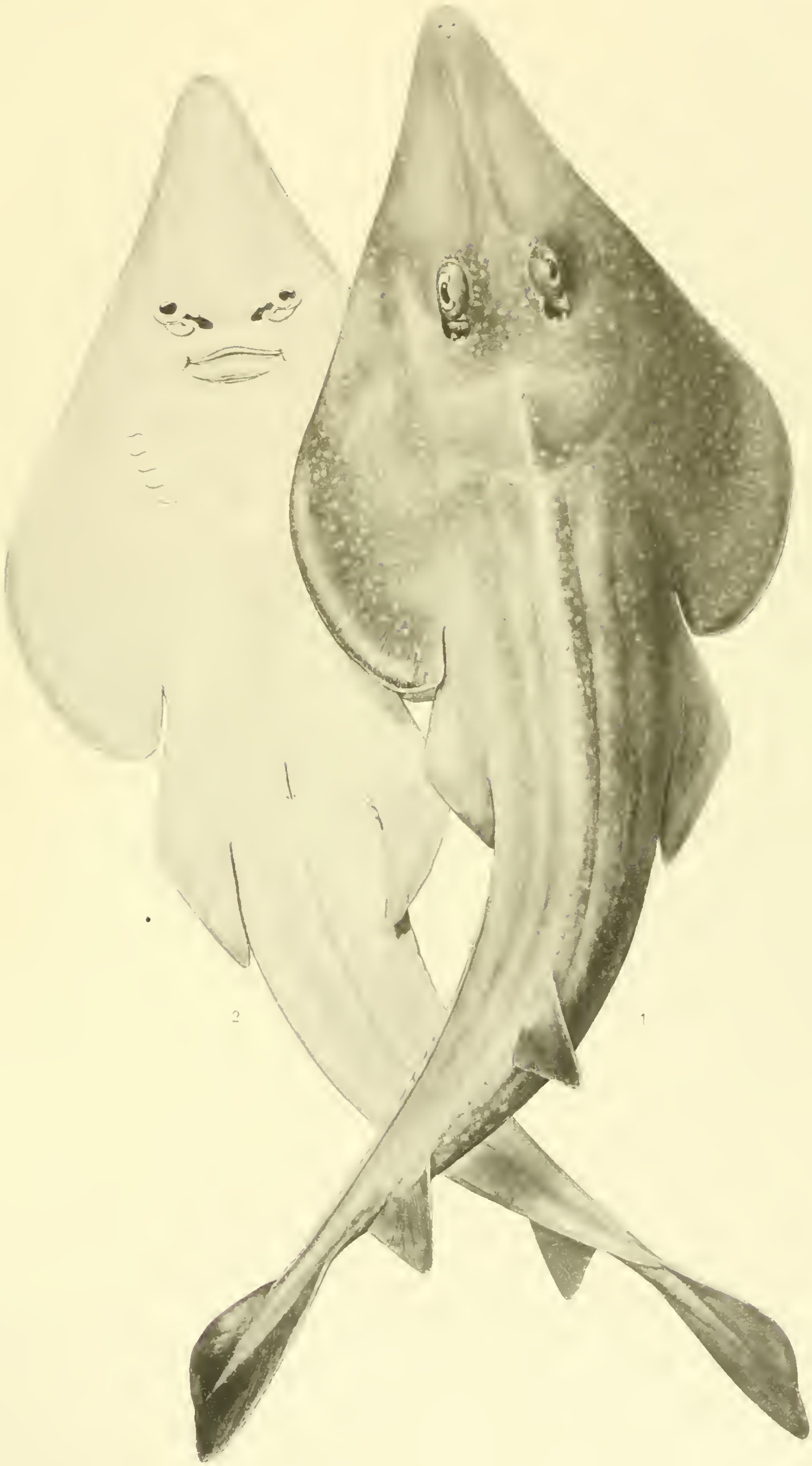

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PLATE 17[a].

PLATE 17a.

RHINOBATIDAE.

Fig. 1–2. Rhinobatus rasus (Page 270). Fig. 3–4. Rhinobatus planiceps (Page 283).

1. Dorsal view of a specimen $14\frac{7}{8}$ inches long.
2. Head from below.
3. Dorsal view of a specimen $17\frac{7}{8}$ inches long.
4. Head from below.

E. N. Fischer, del. Heliotype Co.

PLATE 17b.

PLATE 17b.

RHINOBATIDAE and RAIIDAE.

Fig. 1–2. Rhinobatus acutus (Page 273). Fig. 3. Raia kincaidii (Page 343).

1. Dorsal view of a specimen $13\frac{7}{16}$ inches long.
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3. Dorsal view of a specimen 12 inches long.

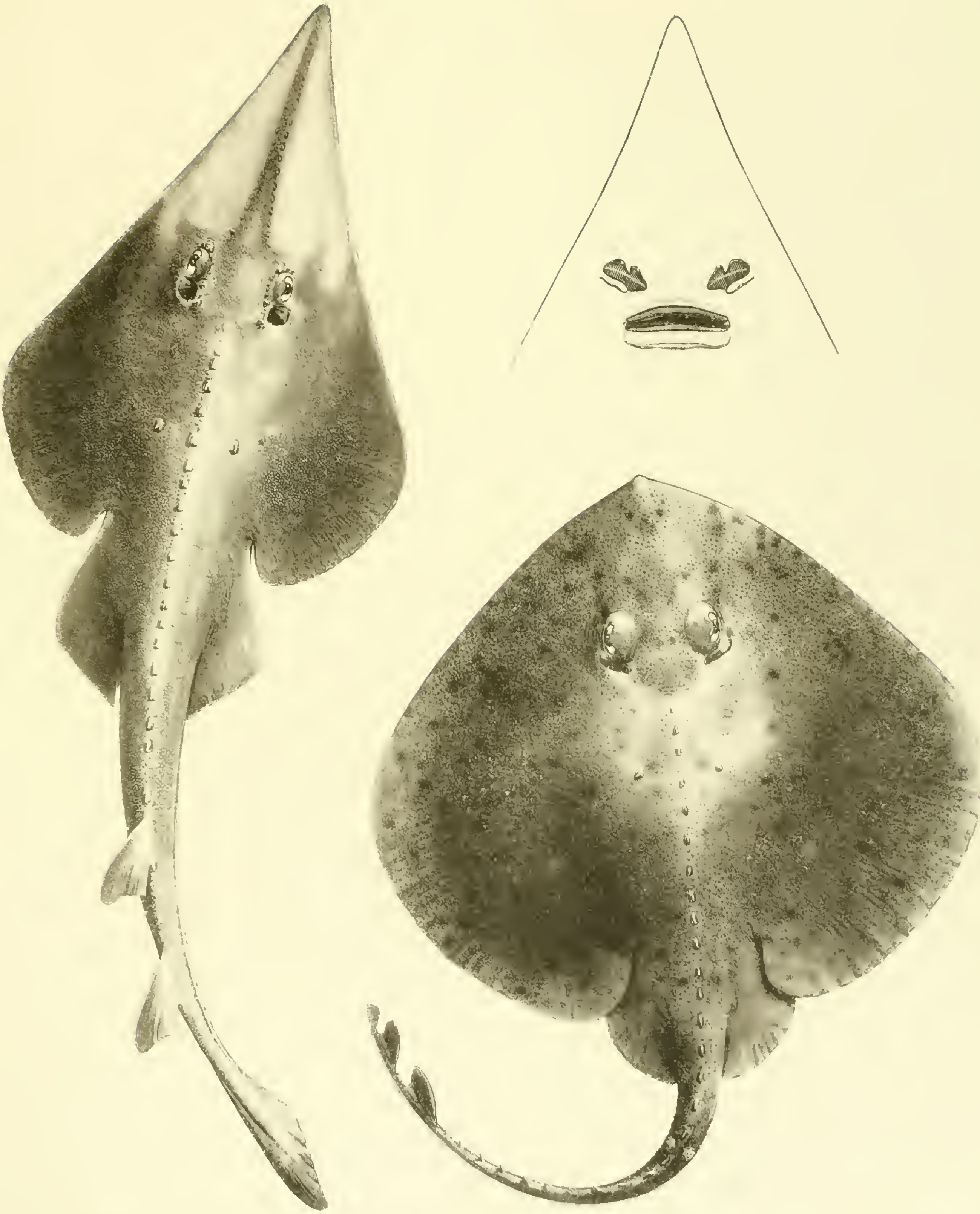

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PLATE 18.

RAIIDAE.

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1. Dorsal view of a specimen $9\frac{5}{8}$ inches long.
2. Dorsal view of a specimen $6\frac{1}{2}$ inches long.

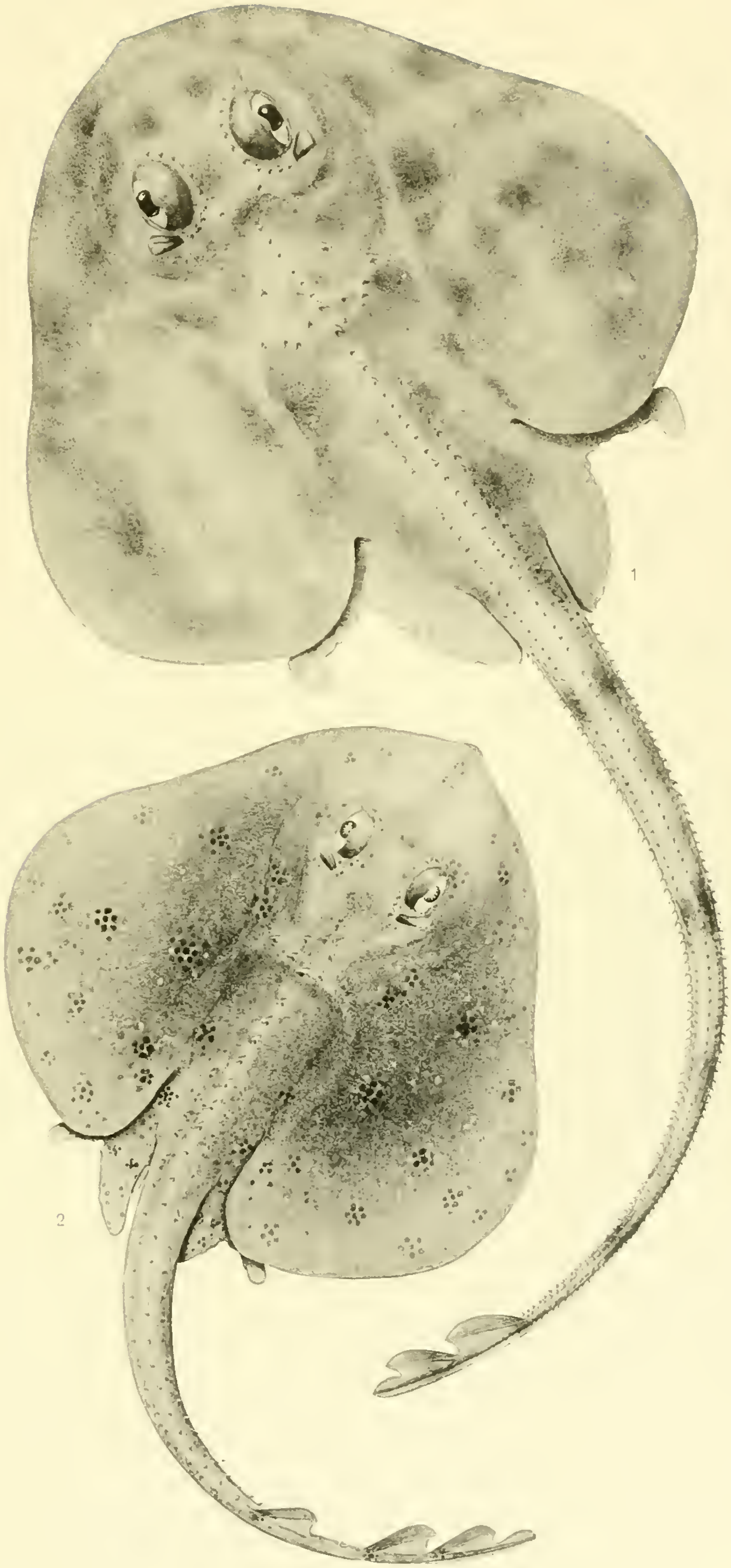
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PLATE 19.

PLATE 19.

RAIIDAE.

Fig. 1–2. RAIA ACKLEYI (Page 336).

1. Dorsal view.
2. Head from below.


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PLATE 20.

PLATE 20.

RAIIDAE.

Fig. 1–2. RAIA ERINACEA (Page 337).

1. Dorsal view of a specimen 19½ inches long.
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PLATE 21

PLATE 21.

RAIIDAE.

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1. Dorsal view of a specimen $14\frac{1}{8}$ inches long. M. C. Z. 365.
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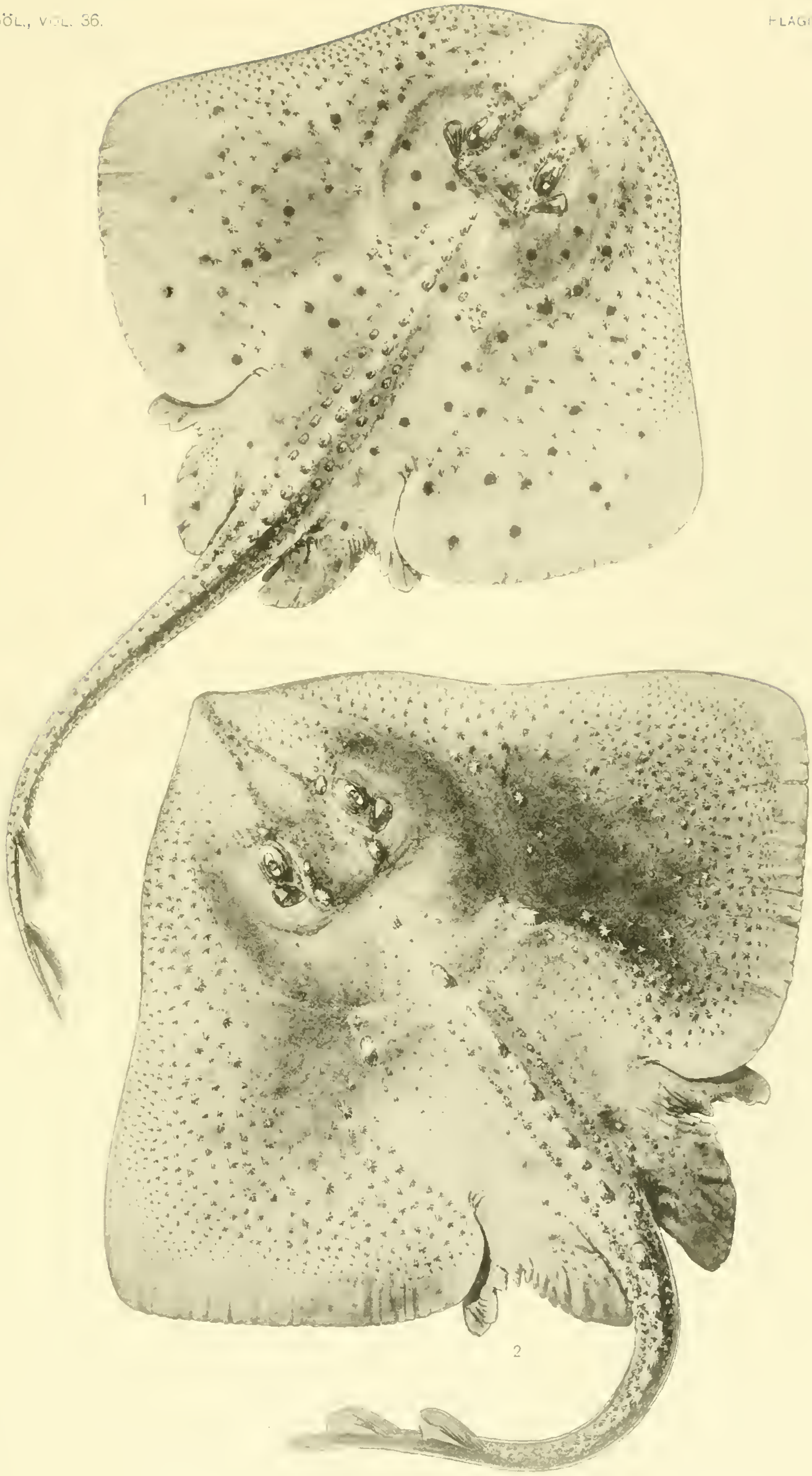

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PLATE 22.

PLATE 22.

RAIIDAE.

Fig. 1. Raia diaphanes (Page 339). Fig. 2. Raia stabuliforis (Page 341)

1. Dorsal view of a specimen $36\frac{1}{4}$ inches long. M. C. Z. 1136.
2. Dorsal view of a specimen $47\frac{1}{2}$ inches long. M. C. Z. 1138.

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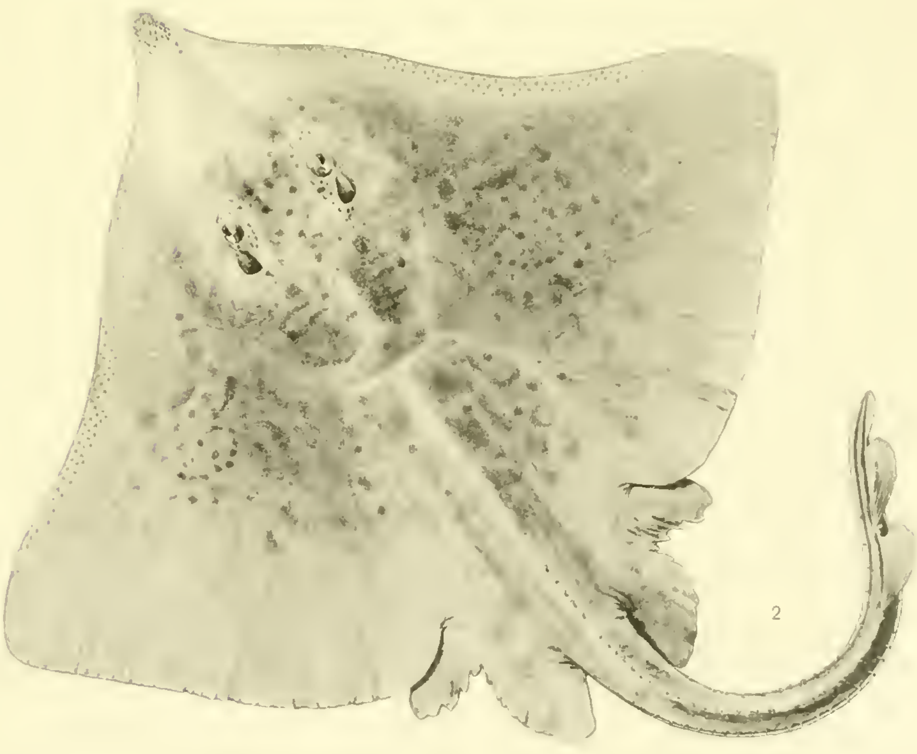

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PLATE 23.

PLATE 23.

RAIIDAE.

Fig. 1–2. RAIA EGLANTERIA (Page 341).

1. Dorsal view of a specimen 21 inches long. M. C. Z. 878.
2. Head from below.

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HELIOTYPE

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PLATE 24.

RAIIDAE and NARCACIONTIDAE.

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PLATE 25.

PLATE 25.

RAIIDAE and NARCACIONTIDAE.

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1. Dorsal view of a specimen $22\frac{1}{2}$ inches long. M. C. Z. 250.
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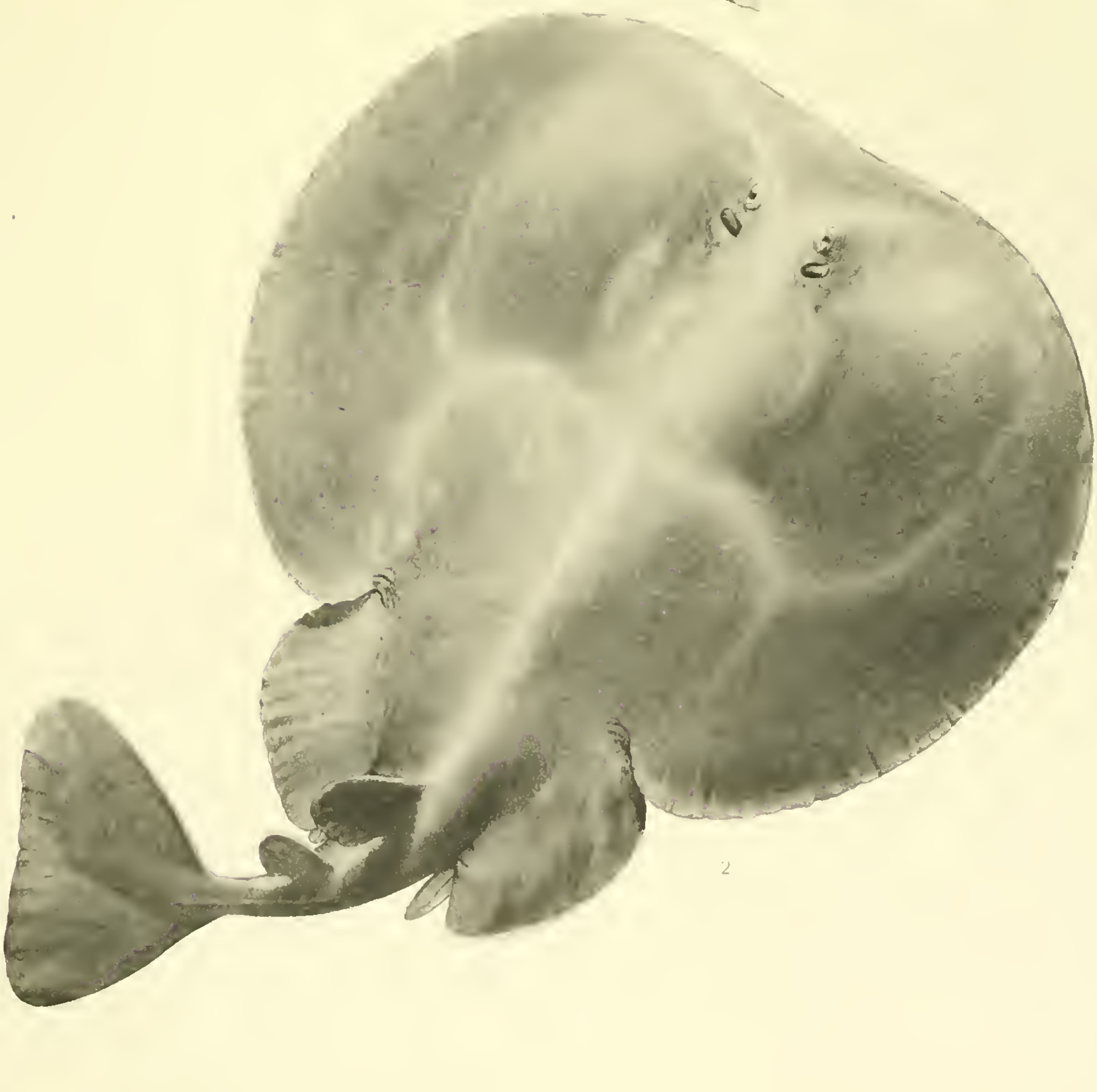

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PLATE 26.

PLATE 26.

NARCACIONTIDAE.

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2. Dorsal view of a specimen $9\frac{1}{5}$ inches long. M. C. Z. 752.
3. Dorsal view of a specimen $7\frac{7}{8}$ inches long. M. C. Z. 44.

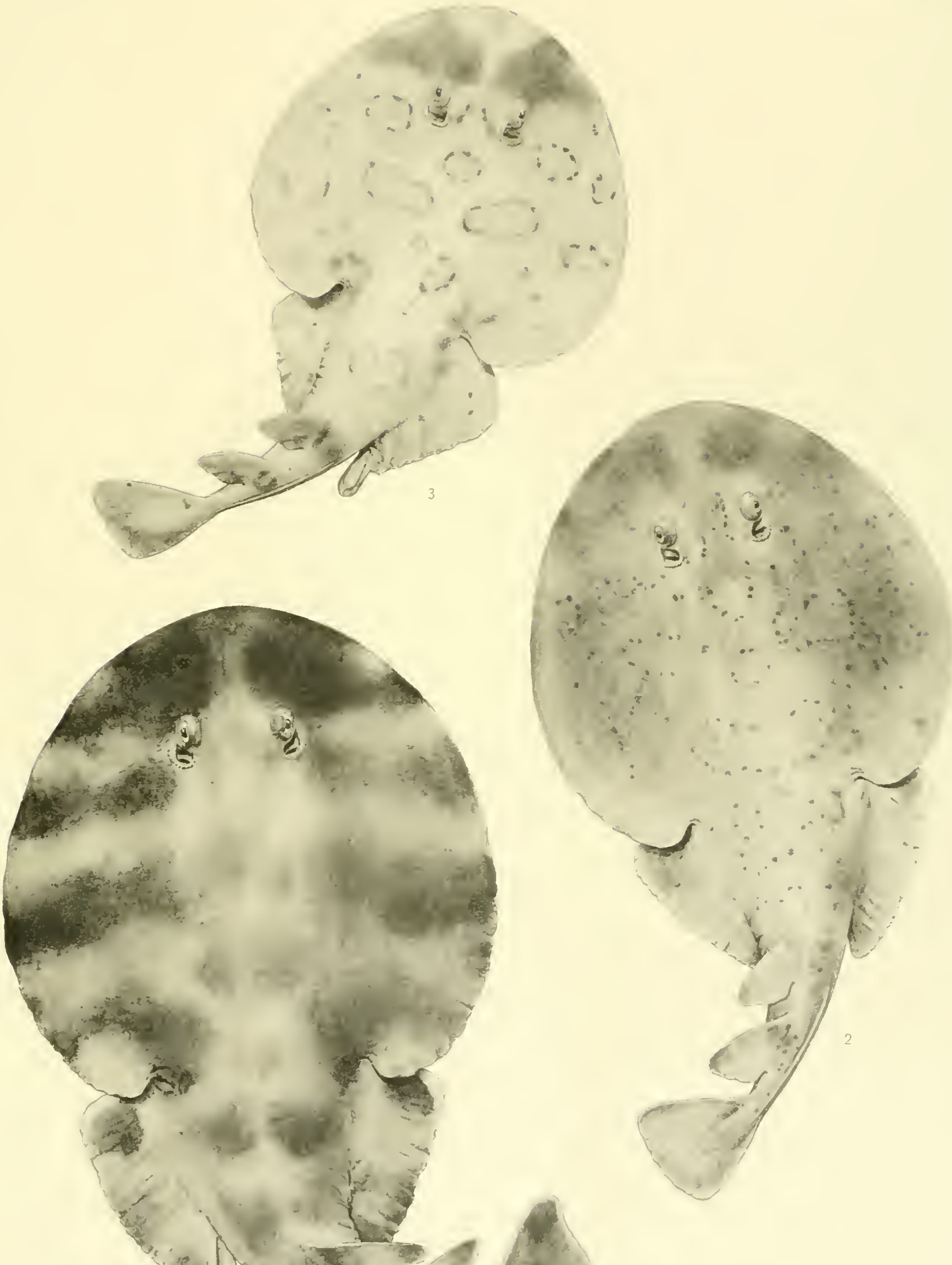
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PLATE 27.

PLATE 27.

RAIIDAE.

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1. Dorsal view of a specimen 13¼ inches long. M. C. Z. 632.
2. Ventral view of the anterior half of disk.
3. Dorsal view of a specimen 14¾ inches long. M. C. Z. 226.
4. Ventral view of the anterior part of disk.
5. Dorsal and lateral views of the produced end of the snout.

PLATE 28.

PLATE 28.

DASYBATIDAE.

Fig. 1–3. UROBATIS SLOANI. (Page 402).

1. Dorsal view.
2. Lateral view of young from oviduct.
3. Ventral view of young from oviduct.

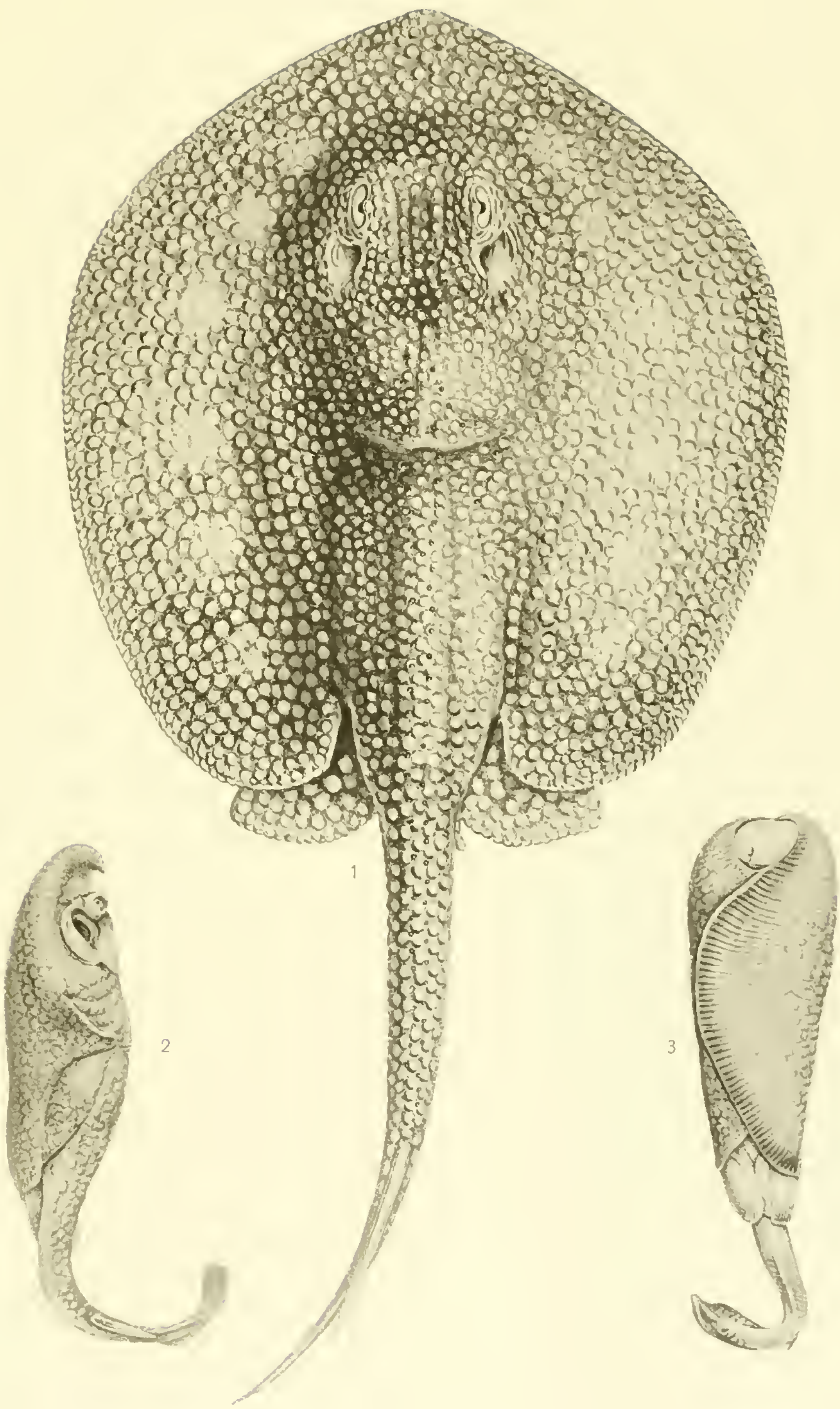
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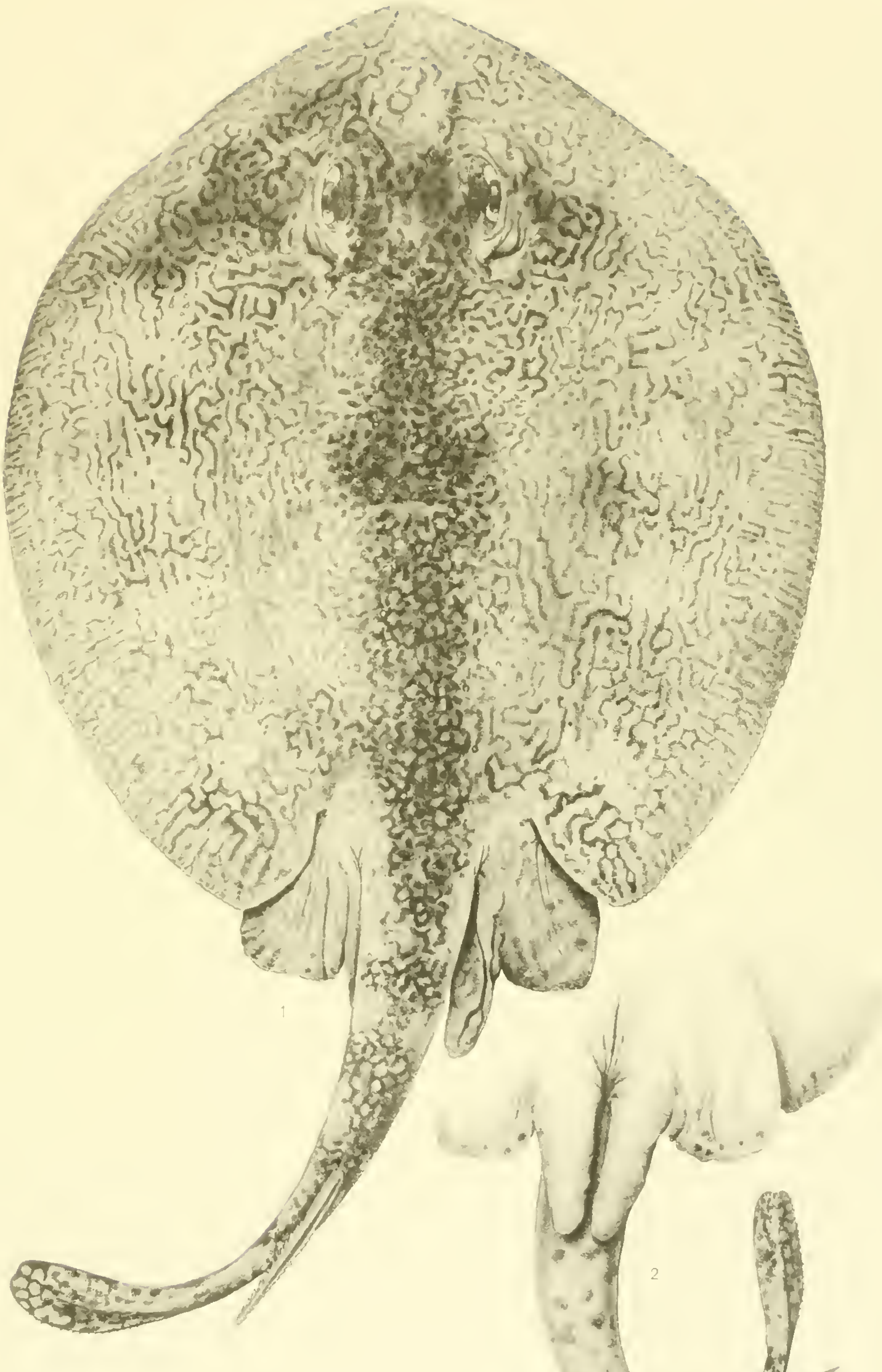
PLATE 29.

PLATE 29.

DASYBATIDAE.

Fig. 1–2. Urobatis vermiculatus (Page 402).

1. Dorsal view. M. C. Z. 1055.
2. Ventral fins and tail from below.



E. N. F[illegible]her, del.

PLATE 30.

PLATE 30.

DASYBATIDAE.

Fig. 1–2. UROTRYGON MUNDUS (Page 406).

1. Dorsal view of a specimen $8\frac{1}{4}$ inches long. M. C. Z. 831.
2. Ventral view.

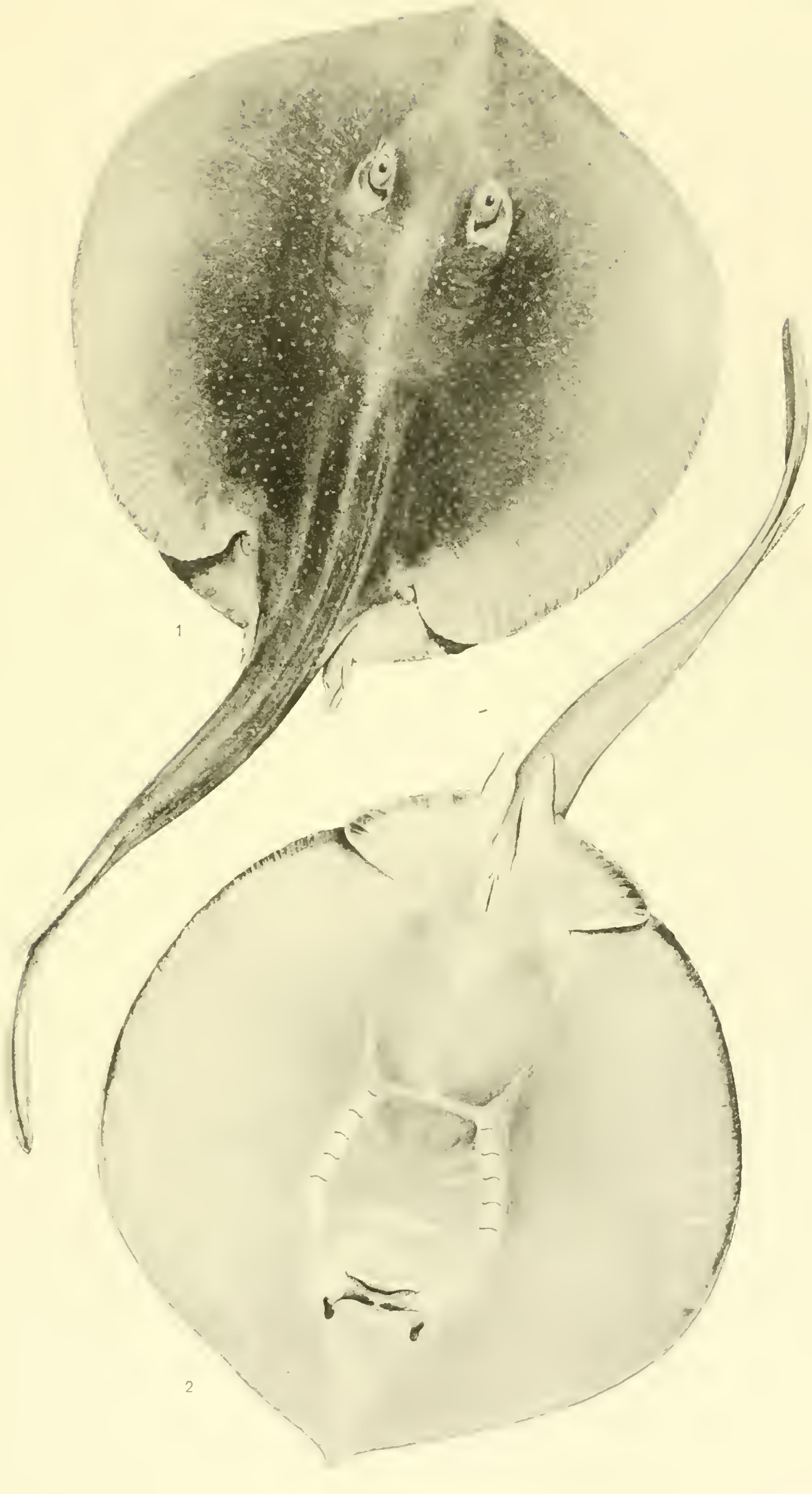

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PLATE 31.

PLATE 31.

POTAMOTRYGONIDAE.

Fig. 1–2. Potamotrygon circularis (Page 419). Fig. 3–4. Potamotrygon laticeps (Page 417).

1. Dorsal view. Disk $15\frac{1}{4}$ inches long. M. C. Z. 291.
2. Mouth and nostrils.
3. Dorsal view. Disk 16 inches long. M. C. Z. 605.
4. Mouth and nostrils.


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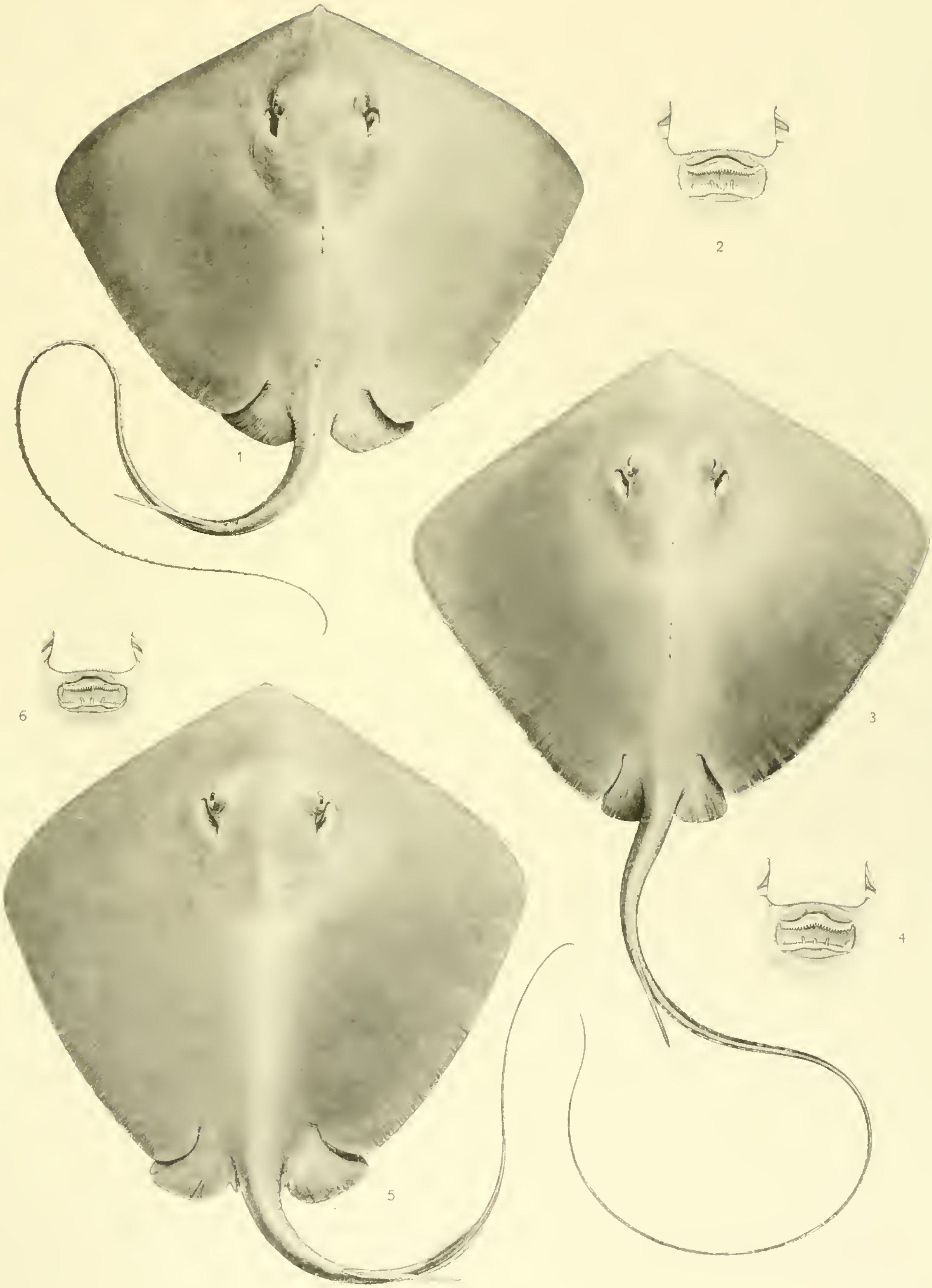
PLATE 32.

PLATE 32.

DASYBATIDAE.

Fig. 1–2. Dasybatus latus (Page 383). Fig. 3–4. Dasybatus longus (Page 390). Fig. 5-6. Dasybatus brevis (Page 396).

1. Dorsal view of a specimen 51 inches long. M. C. Z. 129.
2. Mouth and nostrils.
3. Dorsal view of a specimen $39\frac{1}{4}$ inches long. M. C. Z. 126.
4. Mouth and nostrils.
5. Dorsal view of a specimen $30\frac{7}{8}$ inches long. M. C. Z. 371.
6. Mouth and nostrils.



E. N. FISCHER, DEL. HELIOTYPE

PLATE 33.

PLATE 33.

DASYBATIDAE.

Fig. 1–2. Dasybatus marinus (Page 382). Fig. 3–4. Pteroplatea micrura (Page 414).

1. Dorsal view of a specimen 106 inches long. M. C. Z. 990.
2. Mouth and nostrils.
3. Dorsal view of a specimen $11\frac{1}{2}$ inches long. M. C. Z. 95.
4. Head from below.

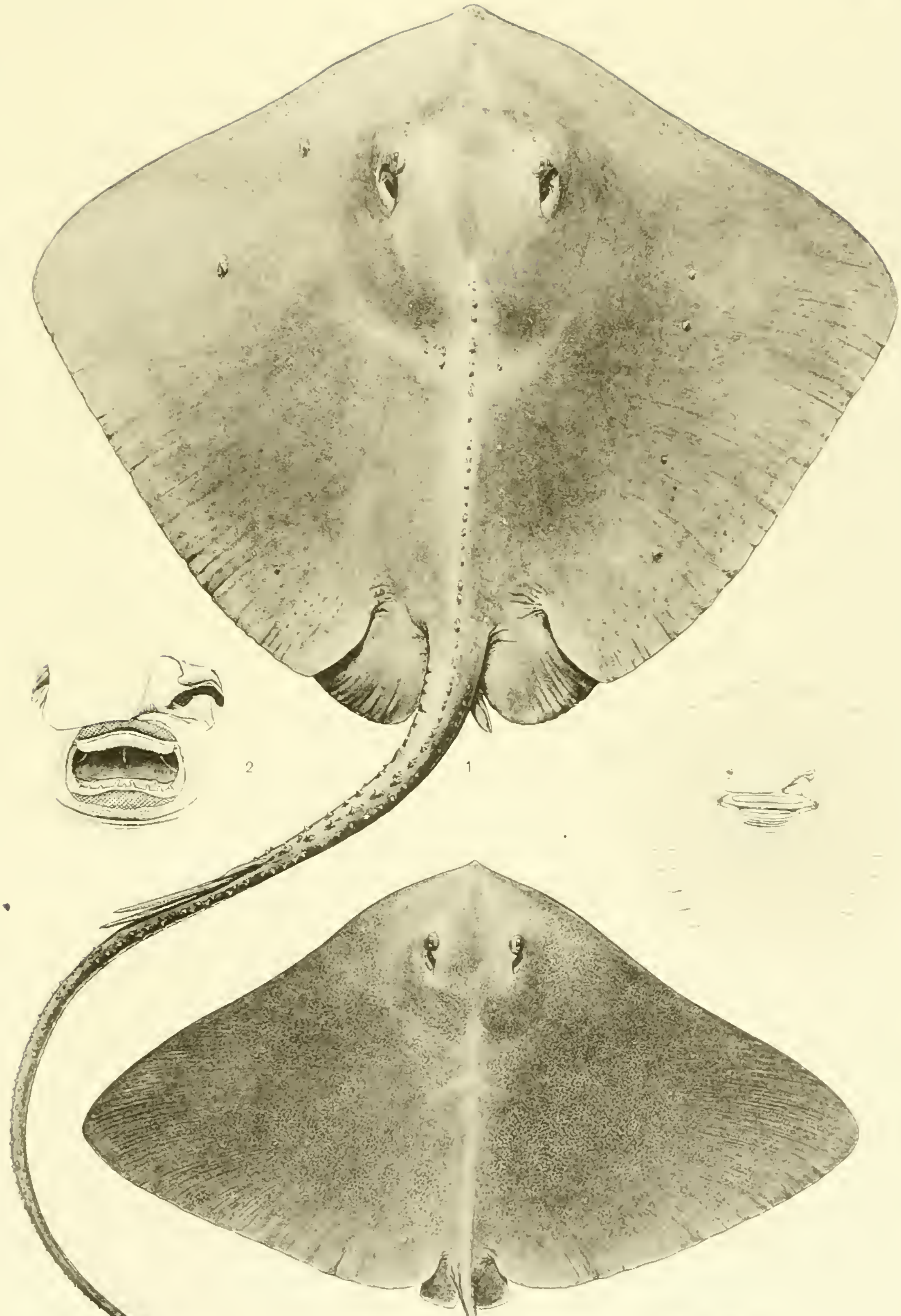

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PLATE 34.

PLATE 34.

POTAMOTRYGONIDAE.

Fig. 1–3. DISCEUS THAYERI (Page 426).

1. Dorsal view. Disk $12\frac{7}{8}$ inches long. M. C. Z. 563.
2. Mouth and nostrils.
3. Teeth from near the front end of the jaw.


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PLATE 35.

PLATE 35.

MYLIOBATIDAE.

Fig. 1–4. MYLIOBATIS FREMINVILLII (Page 432).

1. Dorsal view of a specimen $46\frac{1}{8}$ inches long. M. C. Z. 992.
2. Frontal view.
3. Ventral view.
4. Teeth from upper and lower jaws.

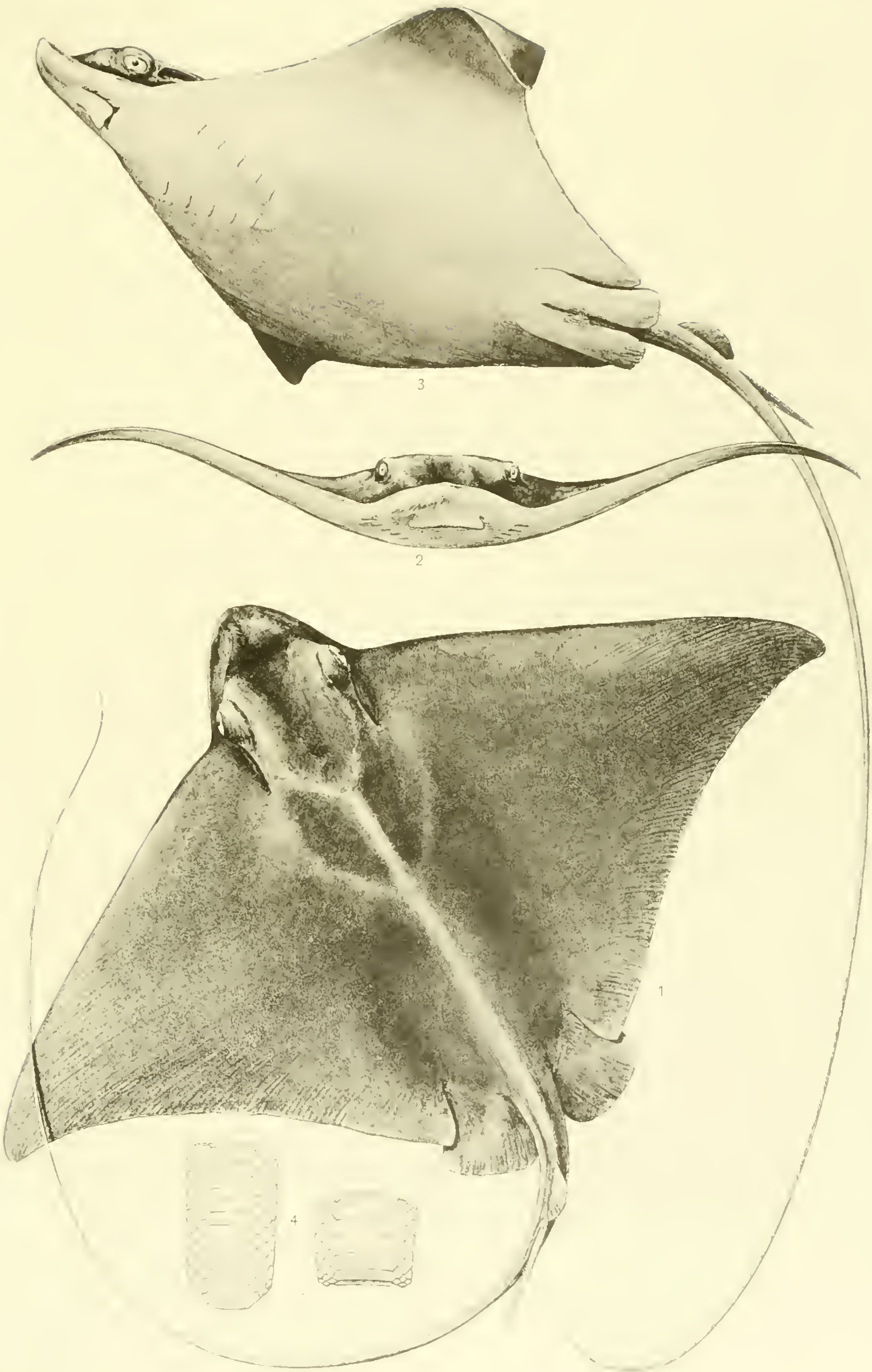
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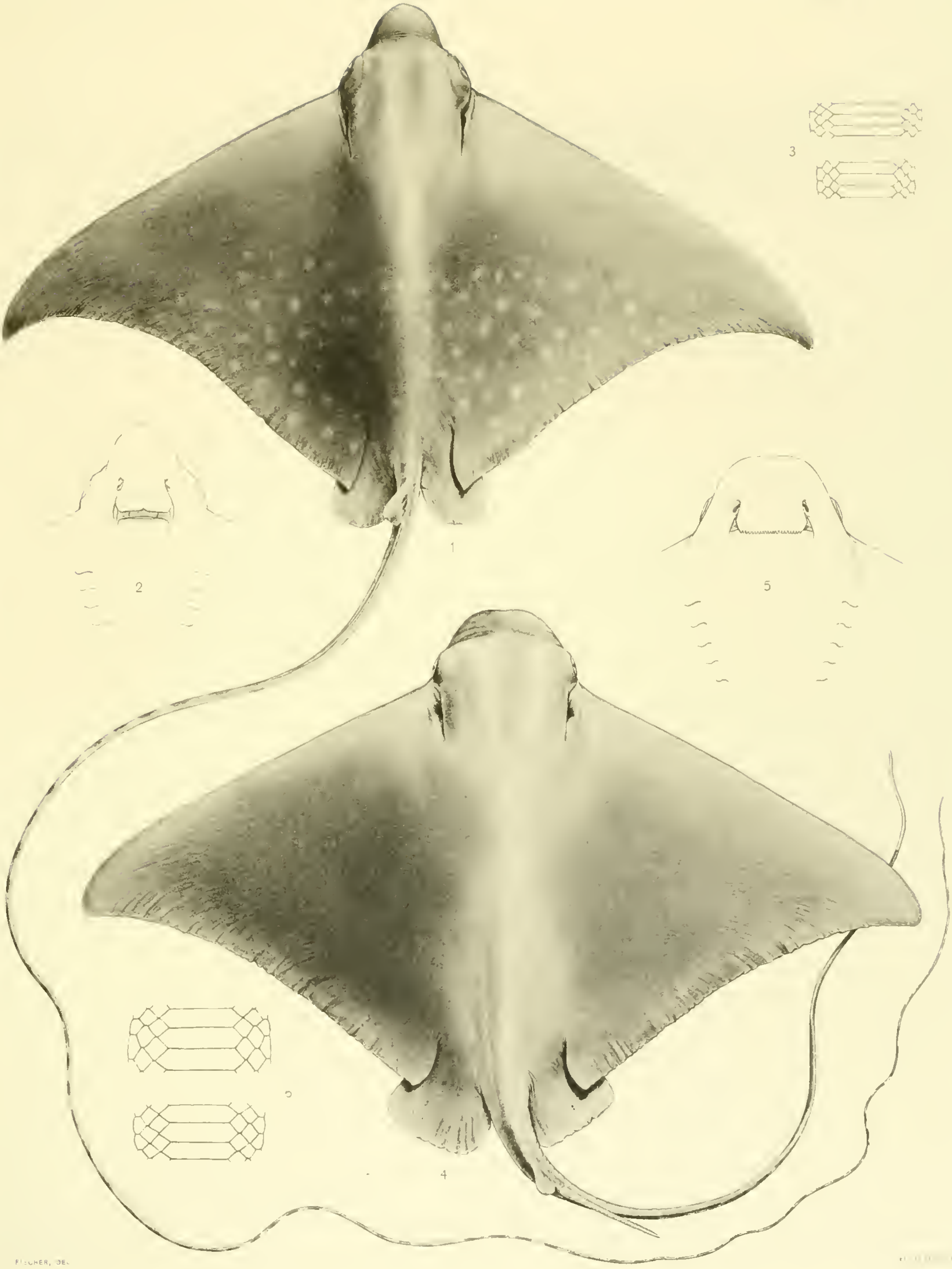
PLATE 36.

PLATE 36.

MYLIOBATIDAE.

Fig. 1–3. AETOMYLAEUS MACULATUS (Page 435). Fig. 4–6. MYLIOBATIS PERUVIANUS (Page 430).

1. Dorsal view of a specimen $28\frac{1}{2}$ inches long. M. C. Z. 106.
2. Head from below.
3. Teeth from upper and lower jaws.
4. Dorsal view of a specimen $23\frac{5}{8}$ inches long. M. C. Z. 636.
5. Head from below.
6. Teeth from upper and lower jaws.



E. Fischer, del.

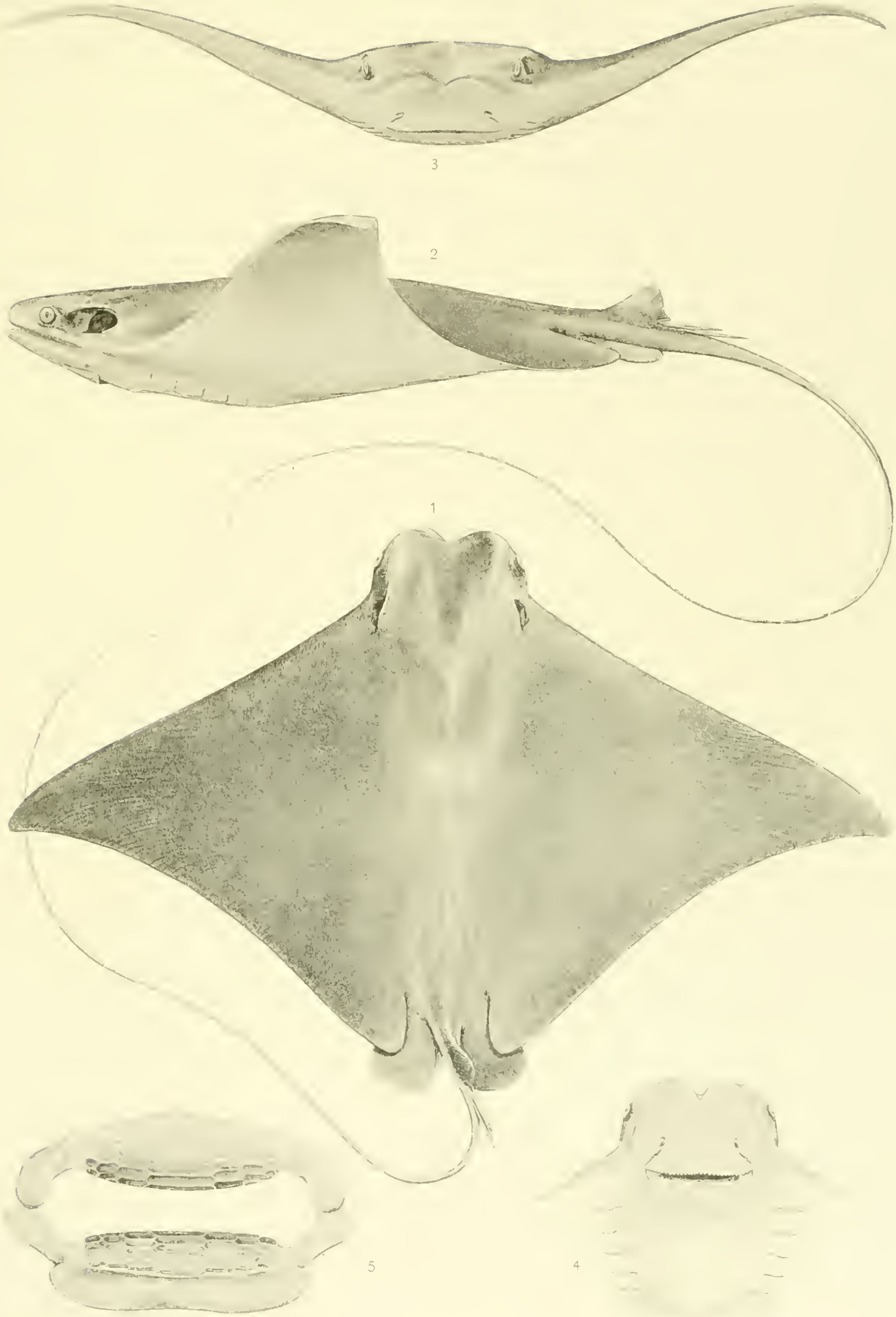
PLATE 37.

PLATE 37.

RHINOPTERIDAE.

Fig. 1–3. Rhinoptera quadriloba (Page 444).

1. Dorsal view of a specimen $38\frac{1}{2}$ inches long. M. C. Z. 746.
2. Lateral view.
3. Frontal view.



E. N. Fischer, del.

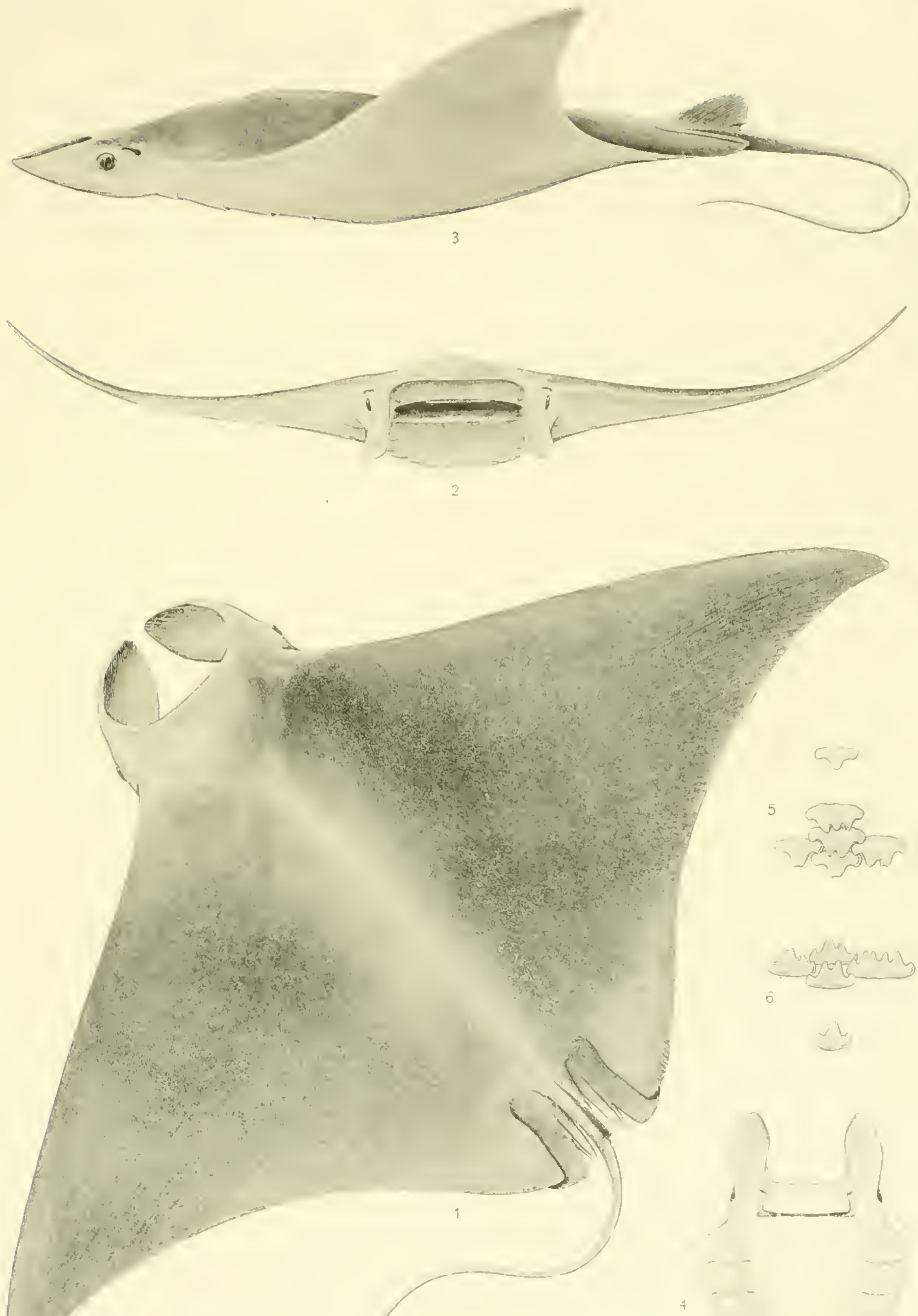
PLATE 38.

PLATE 38.

MOBULIDAE.

Fig. 1–6. MOBULA HYPOSTOMA (Page 453).

1. Dorsal view of a specimen 39 inches long. M. C. Z. 683.
2. Frontal view.
3. Lateral view.
4. Head and gill openings from below.
5. Teeth from upper jaw.
6. Teeth from lower jaw.



E. N. F[illegible]HER, DEL. [illegible]

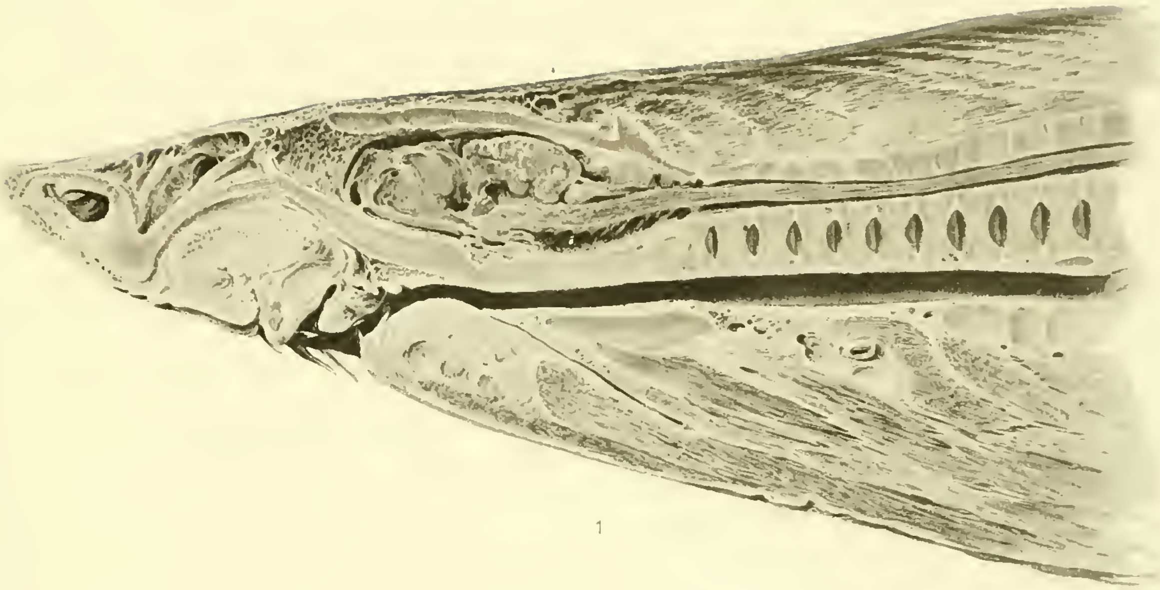
PLATE 39.

PLATE 39.

CARCHARIDAE and MYLIOBATIDAE.

Fig. 1. CARCHARIAS TAURUS (Page 25). Fig. 2. MYLIOBATIS FREMINVILLII (Page 432).

These longitudinal sections of the head and anterior part of the body contrast the conditions in one of the lower of the Antacea with those in one of the most specialized of the Platosomia. The sections show the cartilages of the skull, those of the forward portion of the vertebral column, and in part those of the branchial apparatus; they show the brain, its chamber, the celular cavities of the head, the mouth cavities from the lips to the stomach, the jaws, the teeth, the pads protecting the roof of the mouth, and the arrangement of the muscles.



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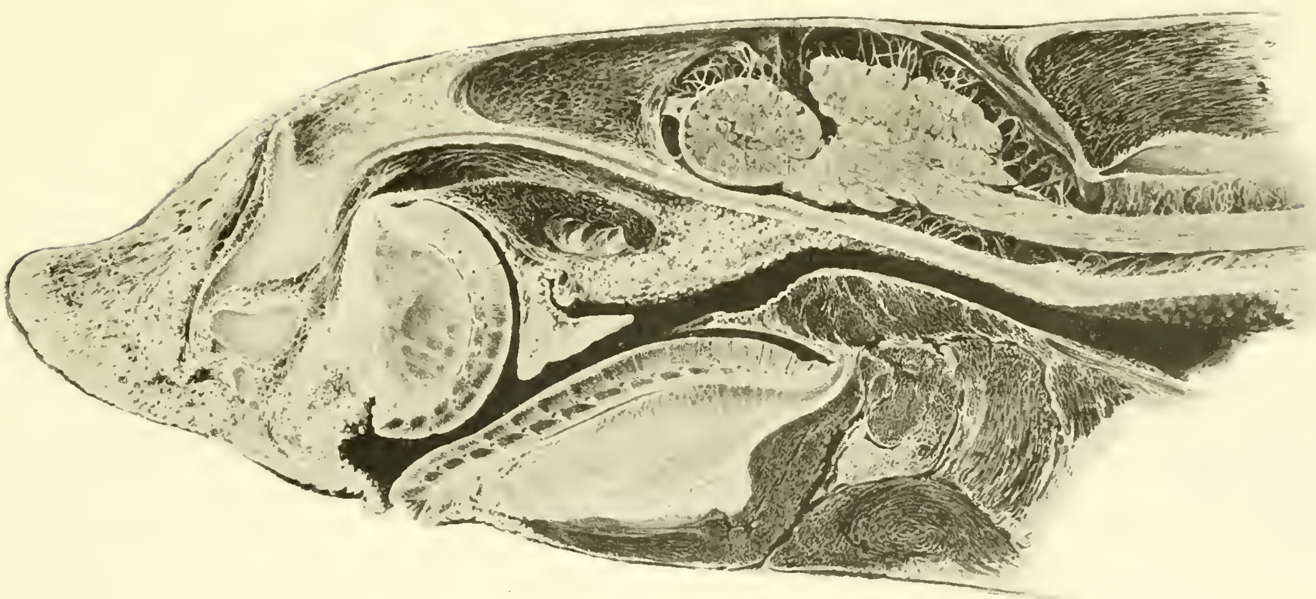

PLATE 40.

PLATE 40.

CARCHARIDAE.

Fig. 1–3. SCAPANORHYNCHUS OWSTONI. M. C. Z. 1048 (Page 28).

1. Brain from above.
2. Brain from the side.
3. Brain from below.

Comparison of the brain of this species with that of *Carcharias taurus*, Plate **41**, proves that Scapanorhynchus is the more primitive of the two genera and conversely that Carcharias is much the more advanced.

E. N. F...HER, DEL.

PLATE 41.

PLATE **41**.

CARCHARIDAE.

Fig. 1–3. CARCHARIAS TAURUS (Page 25).

1. Upper surfaces of the brain.
2. Brain from the side.
3. Brain from below.

Though not of as high a type as that of Vulpecula, Plate **42**, and greatly outranked by the brains of the Carcharinidae and Cestraciontidae, Plate **43**, fig. 1–4, the brain of *Carcharias taurus* makes a considerable advance from that of Scapanorhynchus, Plate **40**.

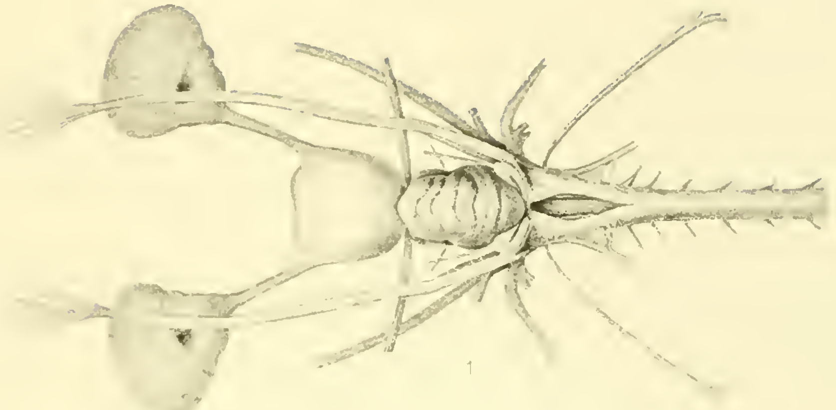

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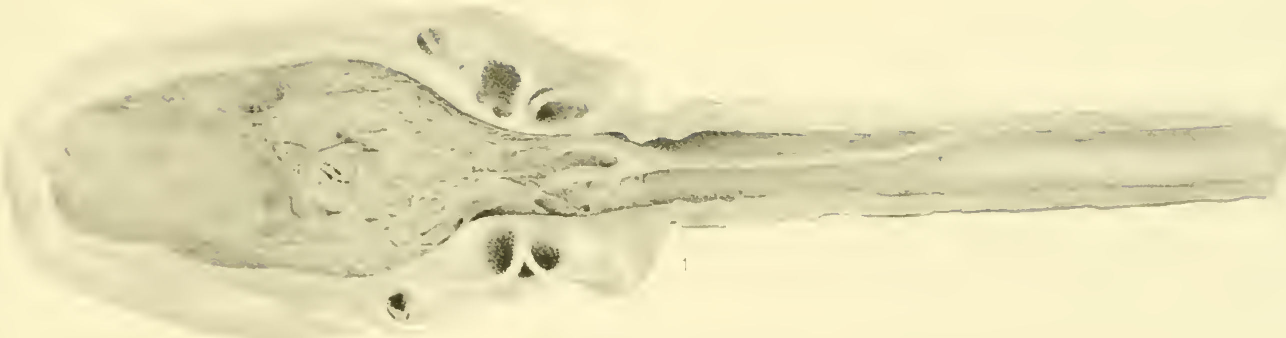
PLATE 42.

PLATE 42.

VULPECULIDAE.

Fig. 1–5. Vulpecula marina (Page 30).

1. Brain after removal of the cartilage above it.
2. Brain after partial removal of the vessels and envelopes.
3. Lower surface of the brain removed from its chamber.
4. Brain from above.
5. Brain from the side.



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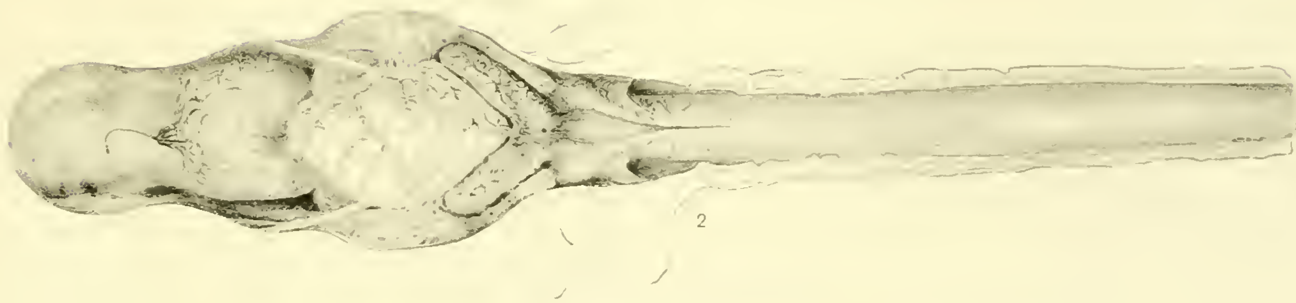

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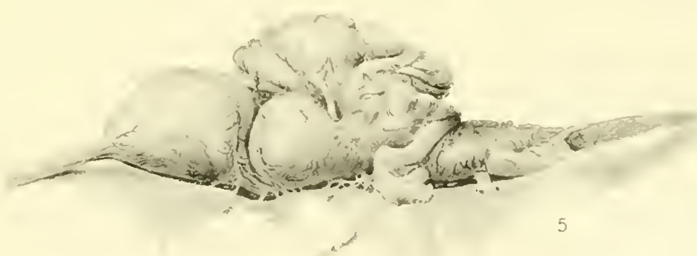

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PLATE 43.

PLATE 43.

CESTRACIONTIDAE, CARCHARINIDAE, and SQUALIDAE.

Fig. 1. CESTRACION TIBURO (Page 160). Fig. 2–3. CESTRACION ZYGAENA (Page 157). Fig. 4–5. CARCHARINUS PLATYODON (Page 126). Fig. 6–8. GALEOCERDO ARCTICUS (Page 118). Fig. 9–10. SQUALUS ACANTHIAS (Page 192).

1. Dorsal view of brain. M. C. Z. 1292.
2. Dorsal view of brain. M. C. Z. 1291.
3. Ventral view of brain.
4. Dorsal view of brain.
5. Nasal sac, bisected.
6. Dorsal view of brain. M. C. Z. 1288.
7. Ventral view of brain.
8. Lateral view of brain.
9. Dorsal view of brain. M. C. Z. 1298.
10. Ventral view of brain.

From the brain of the Carcharidae, Plates **40** and **41**, there was in the Vulpeculidae, Plate **42**, a marked increase in the plication of the hind brain with a less considerable one in the size of the fore brain. In Plate **43**, the much greater advance of the Cestraciontidae is seen both in the volume of the fore brain and the complexity of the hind brain; these are more advanced in the Cestraciontidae than in the Carcharinidae, the nearest allies, for instances see fig. 4, *Carcharinus platyodon*, and figs. 6–8, *Galeocerdo arcticus*. That the archaic family Squalidae is much lower in rank is indicated by the smooth hind brain and the smaller amount of the fore brain.

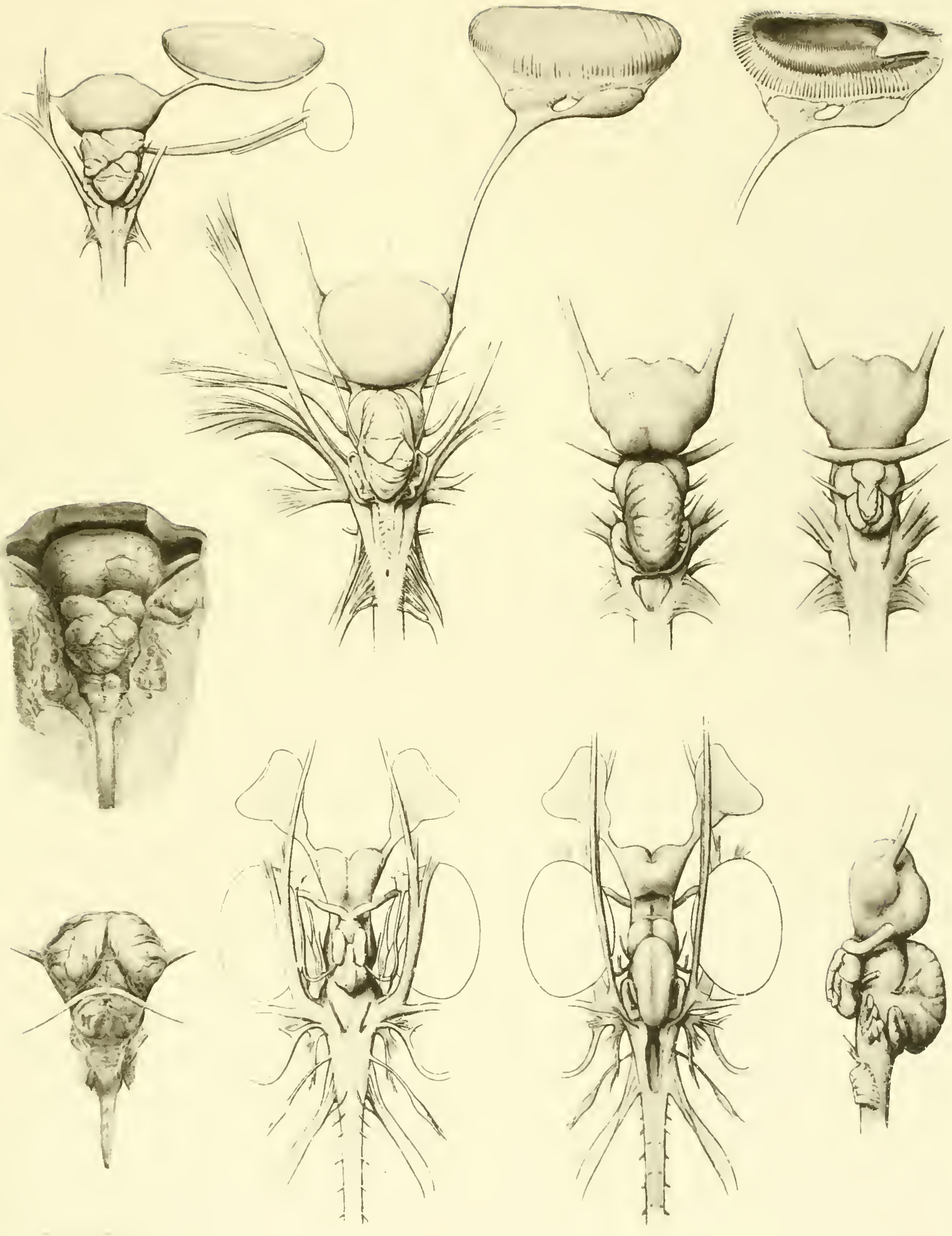

PLATE 44.

PLATE 44.

RAIIDAE and DASYBATIDAE.

Fig. 1–3. RAIA SCABRATA (Page 340). Fig. 4–6. RAIA STABULIFORIS (Page 341). Fig. 7. DASYBATUS MARINUS (Page 382).

1. Brain from above. M. C. Z. 1289.
2. Brain from the side.
3. Brain from below.
4. Brain from above. M. C. Z. 1294.
5. Ear from the side.
6. Brain from below.
7. Brain from above. M. C. Z. 1287.

The comparative amount of the brain is much the same in these families but the higher rank of the Dasybatidae is plainly indicated in the greater complexity of the hind brain.

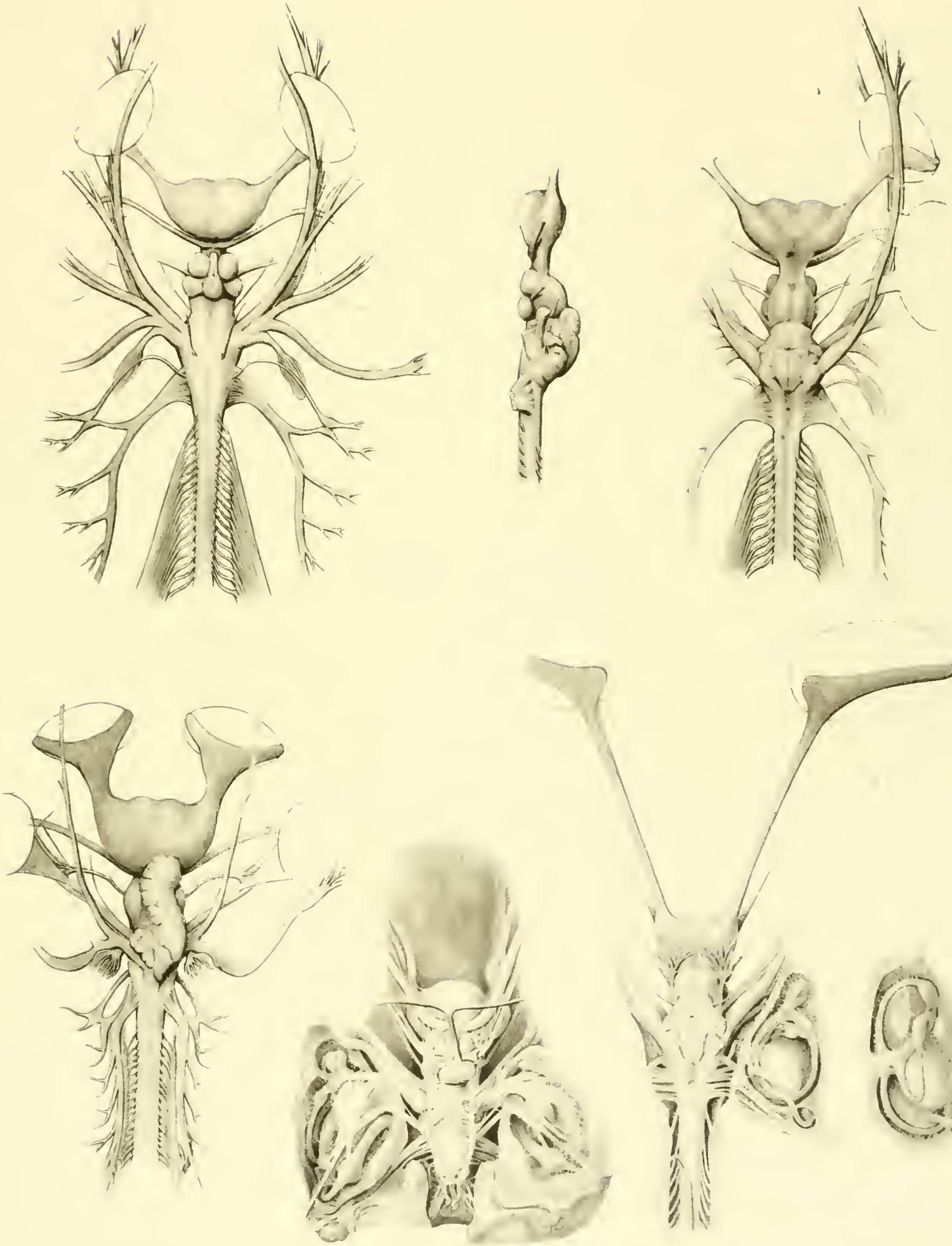

PLATE 45.

PLATE 45.

CENTRACIONTIDAE.

Fig. 1–6. Centracion francisci (Page 186).

1. Teeth and jaws of a very young specimen.
2. Upper jaws and teeth of the same.
3. Lower jaws and teeth of the same.
4. Jaws and teeth of a larger specimen.
5. Upper jaws and teeth of the same.
6. Lower jaws and teeth of the same.

The teeth of the very young Centracion are all raptorial; they attest a soft-bodied food at this stage, and a probable ancestry in forms with cuspidate teeth. The larger specimen shows the widening of the hindmost teeth in preparation for the development of the grinders.

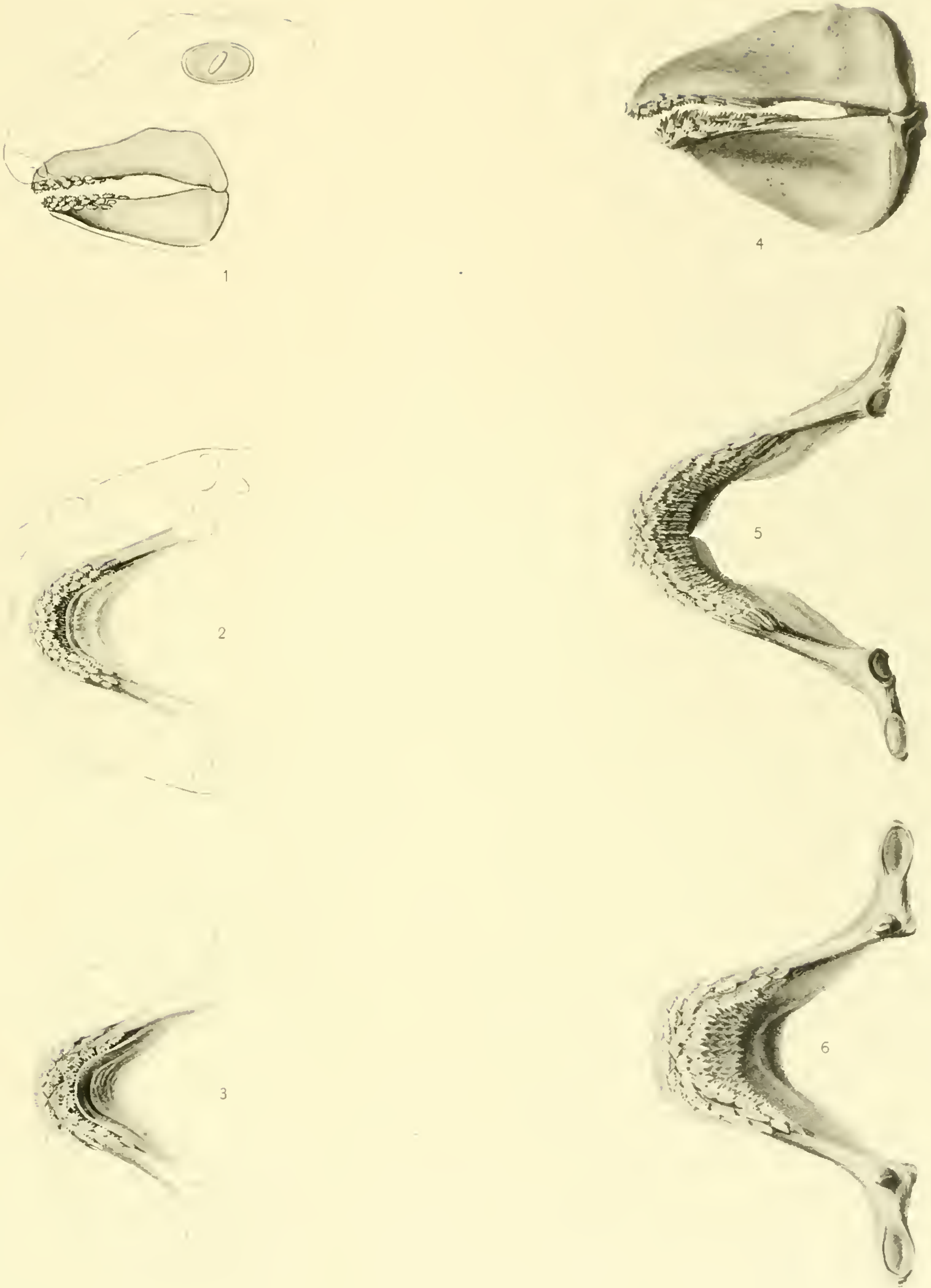
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PLATE 46.

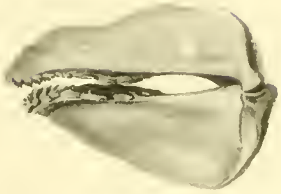
PLATE 46.

CENTRACIONTIDAE.

Fig. 1–6. CENTRACION FRANCISCI (Page 186).

1. Jaws of a specimen of medium size.
2. Upper jaws and teeth of the same.
3. Lower jaws and teeth of the same.
4. Jaws of an old individual.
5. Upper jaws and teeth of the same.
6. Lower jaws and teeth of the same.

These figures are from older specimens than those shown on Plate **45**. They indicate the decided change that takes place in the feeding habits. The hinder teeth are all molars, with a low ridge instead of cusps, and are much wider and more swollen than the front teeth, some of the hindmost of which apparently have been succeeded, when renewed, by molars in their particular rows.



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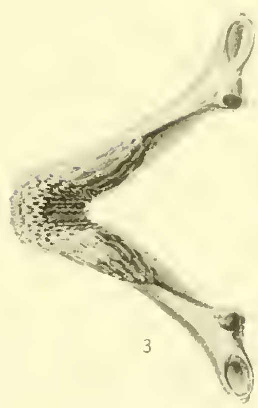

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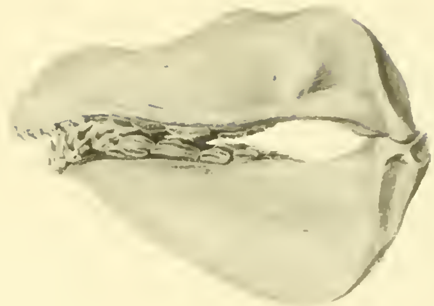

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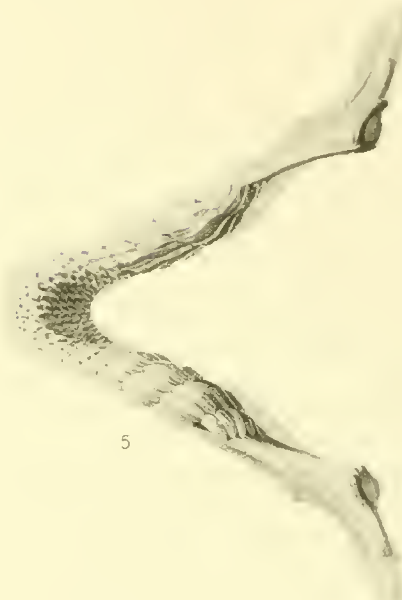

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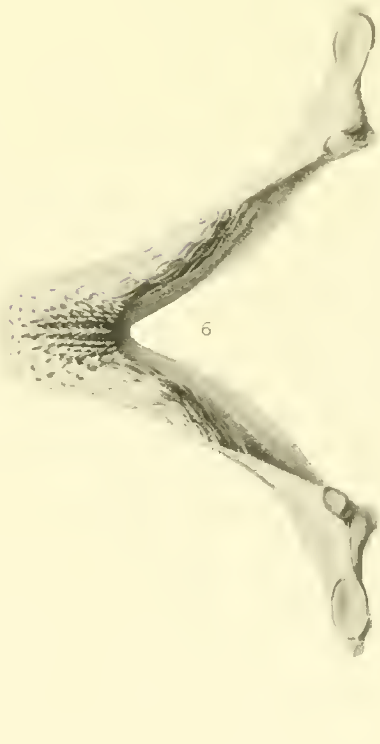

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E. Konopicky, del.

Heliotype

PLATE 47.

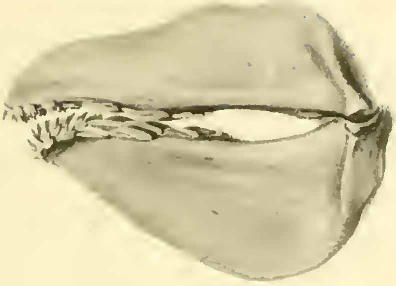
PLATE 47.

CENTRACIONTIDAE.

Fig. 1–3. Centracion quoyi (Page 187). Fig. 4–6. Centracion philippi (Page 182).

1. Lateral view of jaws and teeth.
2. Upper teeth and jaws from below.
3. Lower teeth and jaws from above.
4. Lateral view of jaws and teeth.
5. Upper teeth and jaws from below.
6. Lower teeth and jaws from above.

The ridges on the molars of younger specimens become less prominent with age and use. The harder the food in particular localities the more faint the ridges appear.



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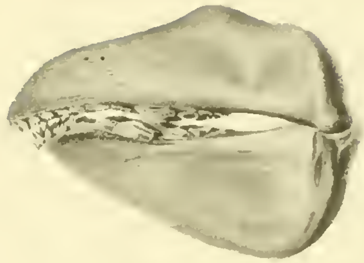

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PLATE 48.

PLATE 48.

RHINOPTERIDAE.

Fig. 1–3. Rhinoptera jussieui (Page 447). Fig. 4. Rhinoptera marginata (Page 445). Fig. 5–6. Rhinoptera lalandii (Page 445).

1. Teeth from a very young specimen. M. C. Z. 311.
2. Teeth from a larger specimen. M. C. Z. 316.
3. Teeth from a large specimen. M. C. Z. 535.
4. Jaws and primary dentition. M. C. Z. 631.
5. Teeth from a medium sized specimen. M. C. Z. 534.
6. Teeth from a large specimen. M. C. Z. 534.

Figures 1, 2, and 4 illustrate the changes in dentition during the period of rapid growth from very young stages. The small round primary teeth in front of the pavements suggest derivation from ancestral forms with dentition resembling that of some Dasybatidae. In fig. 3 and 6 are shown the teeth of large specimens. Figures 3 and 5 show dentition that have been much affected by individual variation.

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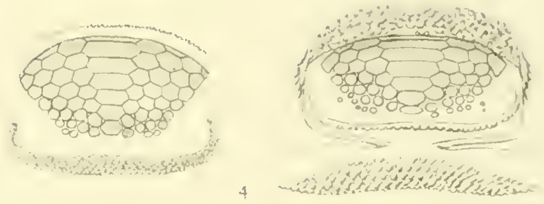

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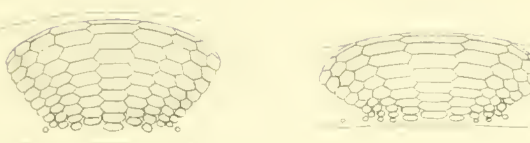

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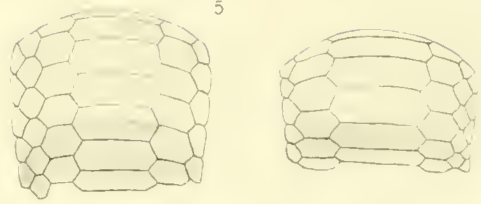

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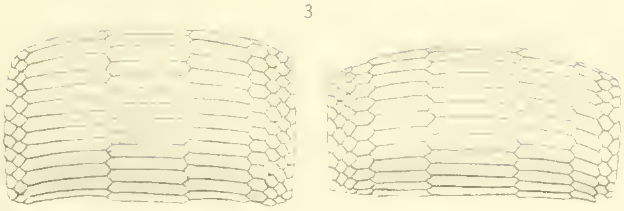

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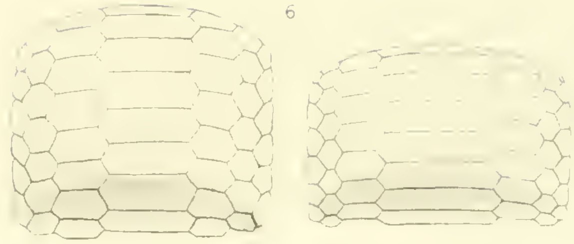

E. N. Fischer, del.

PLATE 49.

PLATE 49.

MYLIOBATIDAE.

Fig. 1–3. AËTOBATUS NARINARI (Page 441). Fig. 4–6. MYLIOBATIS CALIFORNICUS (Page 429).

1. Dentition of a very young specimen. M. C. Z. 1079.
2. Dentition of a young specimen, larger than that shown in fig. 1. M. C. Z. 1070.
3. Teeth of a large specimen. M. C. Z. 865.
4. Dentition of a very young specimen. M. C. Z. 348.
5. Dentition of a larger specimen. M. C. Z. 395.
6. Dentition of a specimen beyond the age of rapid growth. M. C. Z. 424.

In the youngest specimens of Aëtobatus examined there are two rows of upper and two rows of lower teeth, fig. 1 and 2, each two quickly broadening and being succeeded by the broad teeth of the single row retained through life. Possibly a still earlier stage may show a dentition more like that of Rhinoptera in its primary features. The earliest stage of Myliobatis figured has six rounded teeth in front of the pavement, another has seven, thus accounting for all the rows of later stages, the median one only becoming broad. It is to be expected that younger specimens will show dentitions more in accord with that of fig. 1, Plate 48, in Rhinoptera.


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PLATE 50.

PLATE **50**.

ANTACEA.

Fig. 1, 6, 8. GALEORHINUS LAEVIS (Page 176). Fig. 2. PARMATURUS PILOSUS (Page 89). Fig. 3. TRIAENODON OBESUS (Page 163). Fig. 4. CARCHARINUS MILBERTI (Page 133). Fig. 5, 11, 12. TRIAKIS SEMIFASCIATA (Page 165). Fig. 7. TRIAKIS HENLEI (Page 168). Fig. 9. HEMIGALEUS PECTORALIS (Page 150). Fig. 10. EUGALEUS GALEUS (Page 153). Fig. 13–16. SCOLIODON LONGURIO (Page 114).

The nictitating membrane in its early stages is merely a longitudinal fold in the lower eyelid, not reaching the edges of the lid, fig. 1 and 2. This is the case in the very young of *Galeorhinus laevis*, fig. 1; in older specimens of this species the fold reaches the edge of the lid at one end, as in fig. 6, but in large ones the fold reaches the edge of the lid at both ends, fig. 8, and in transverse section its outlines resemble those of Triakis, fig. 12. The membrane attains its greatest perfection and more nearly covers the eye-ball in the Cestraciontidae (Hammer Heads) and in the Carcharinidae, fig. 4, 13–16. In the Galeorhinidae it is better described as a fold instead of as a membrane. In all cases it is likely that only with some aid by muscular retraction of the ball can it be made to entirely cover the eye. Plate **50** indicates some of the variations in the pupil of the eye. The oblique pupil of the Centraciontidae (Port Jackson Sharks) is shown on Plate **45**, fig. 1.

N. ...HER, DEL.

PLATE 51.

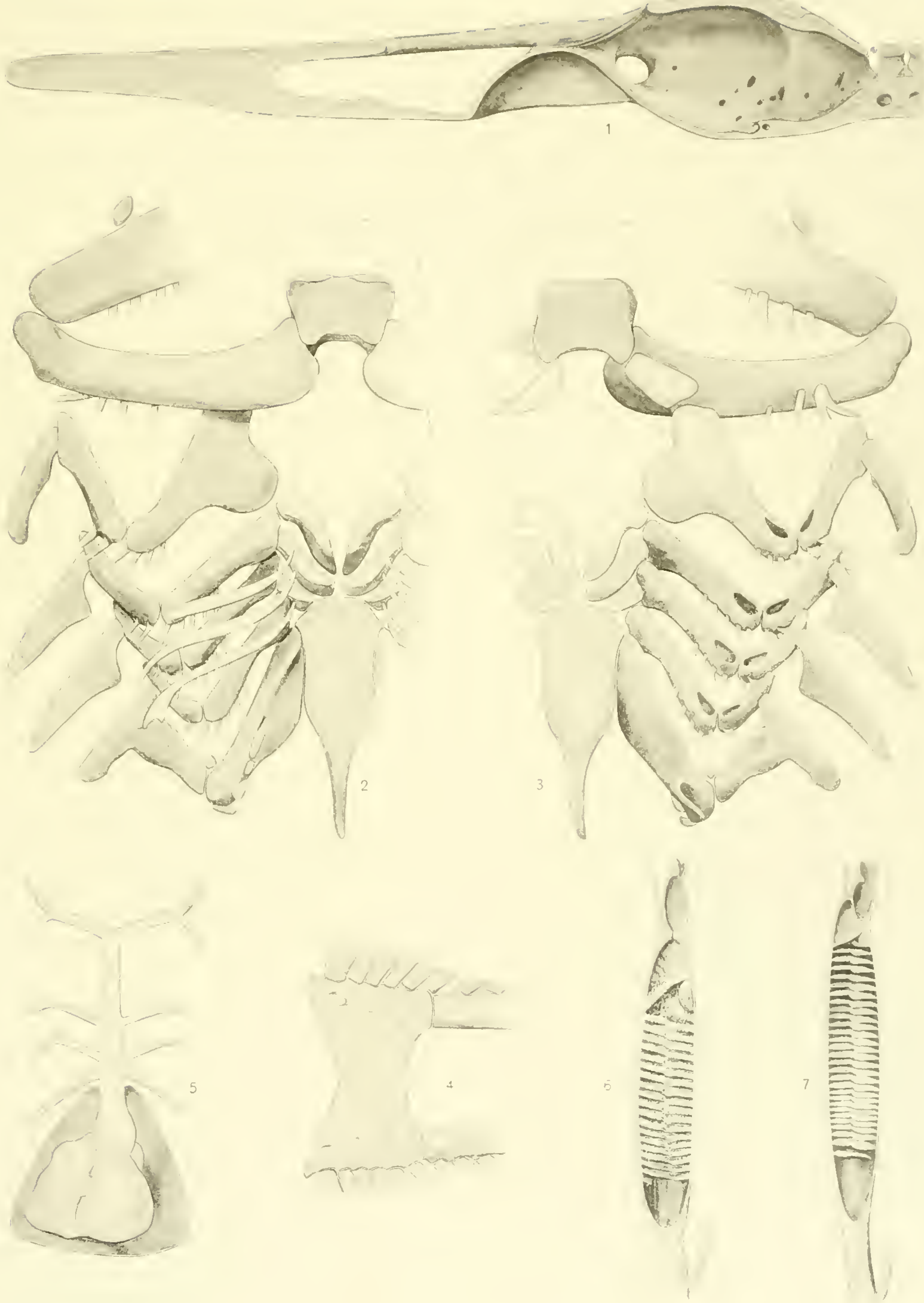
PLATE 51.

CARCHARIDAE.

Fig. 1–6. SCAPANORHYNCHUS OWSTONI. M. C. Z. 1048 (Page 28). Fig. 7. CARCHARIAS TAURUS. M. C. Z. 210 (Page 25).

1. Skull in longitudinal section.
2. Branchial skeleton from below.
3. Branchial skeleton from above.
4. Pelvis and radials.
5. Heart, conus, and arteries.
6. Intestine with spiral folds.
7. Intestine.

In most features the structure of Scapanorhynchus is closely allied to that of Carcharias. This is very evident in the parts of the anatomy given on this plate but not previously figured. At first sight the snout appears to present most divergence but most of this disappears on closer comparison of the long snout with the short one. The large cartilage in fig. 3 behind the copula, glossohyal, between it and the first ceratobranchial, is the first hypobranchial; it is present also in Carcharias, see Fürbringer, 1903, Morph. jahrb., **31**, pl. 17, f. 20 *x*. Three extrabranchials are shown in fig. 2 of Plate **51**, a slender rudiment of a fourth was present. As in most other items, the intestines of these genera, fig. 6, 7, have much in common.



E. FISCHER, DEL.

PLATE 52.

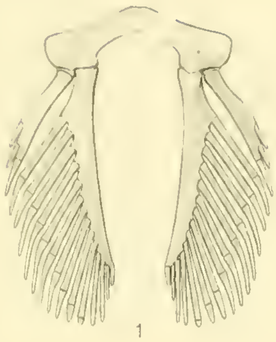
PLATE 52.

Pelvis of ANTACEA and DIPNOI.

Fig. 1. Scoliodon longurio. M. C. Z. 694 (Page 114). Fig. 2. Hemigaleus pectoralis. M. C. Z. 847 (Page 150). Fig. 3. Pristiophorus japonicus. M. C. Z. 1045 (Page 246). Fig. 4. Protopterus annectens. M. C. Z. 8964. Fig. 5–7. Ceratodus forsteri. M. C. Z. 9827.

1–5. Lower view.
6. Upper view.
7. Lateral view.

The pelvis of the Antacea, fig. 1–3, is radically different from that of the Dipnoi, fig. 4–7. The differences are of such characters that no evidences of close relationships are evident. The structure in the sharks, the Antacea, is farther than that in certain of the more specialized of the Platosomia, the Potamotrygons, for instance, Plate **54**, fig. 1–2, from that in these Dipnoi; yet undoubtedly such resemblances as exist between the pelvis of the Lung Fishes and that of the River Trygons, in the median propelvic cartilage, is due to similarity of conditions and habits and not to inheritance from common ancestors. The pelvis of Polypterus is still more remote, nearer to that of bony fishes.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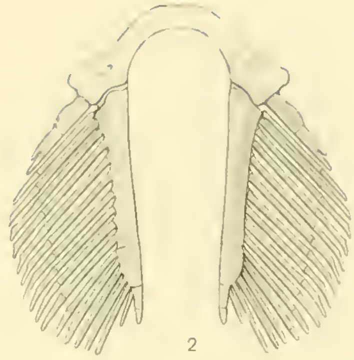
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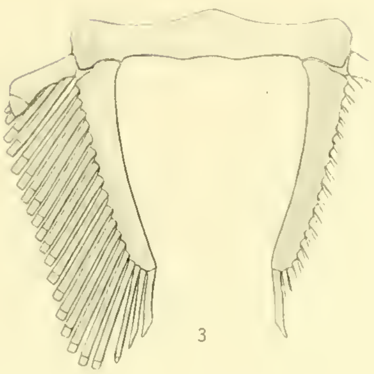
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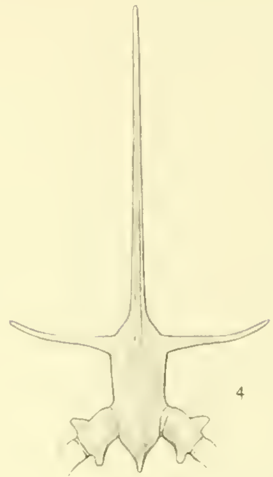
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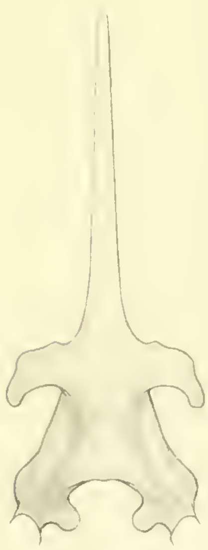
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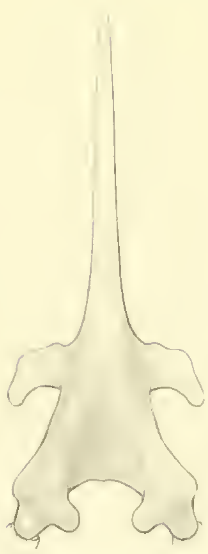
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PLATE 53.

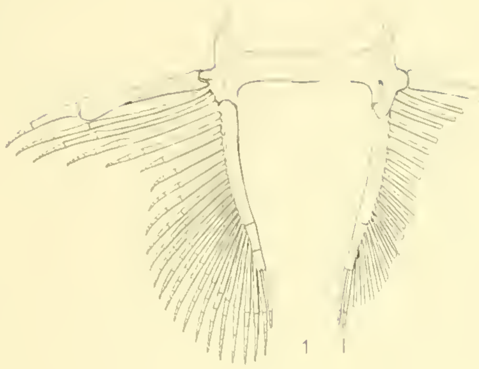
PLATE 53.

Pelvis of PLATOSOMIA.

Upper and lower surface.

Fig. 1. Uraptera agassizii. M. C. Z. 549 (Page 367).
Fig. 2. Narcacion californicus. M. C. Z. 43 (Page 311).
Fig. 3. Urobatis sloani. M. C. Z. 35 (Page 402).
Fig. 4. Taeniura lymma. M. C. Z. 23 (Page 399).
Fig. 5. Dasybatus marinus. M. C. Z. 641 (Page 382).
Fig. 6. Pteroplatea altavela. M. C. Z. 386 (Page 415).

The pelvis of the Raiidae, fig. 1, with the lateral prepelvic processes, recalls that of Cyclobatis, a fossil genus. The pelvis of Narcacion, fig. 2, is raioid, but is more arched backward in the middle. Figures 3–6 represent the Dasybatidae, in which family the organ is more like that of the Antacea, which have neither lateral nor median processes in front of the pelvis.



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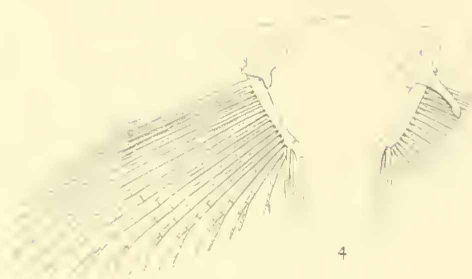

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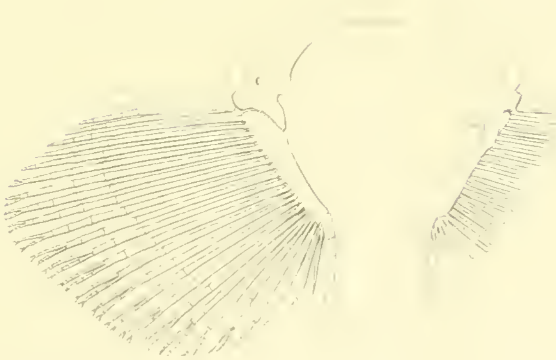

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PLATE 54.

PLATE 54.

Pelvis of PLATOSOMIA.

Fig. 1. Potamotrygon circularis. M. C. Z. 296 (Page 419).
Fig. 2. Disceus thayeri. M. C. Z. 606 (Page 426).
Fig. 3. Myliobatis freminvillii. M. C. Z. 1160 (Page 432).
Fig. 4. Aëtobatus narinari. M. C. Z. 389 (Page 441).
Fig. 5. Rhinoptera jussieui. M. C. Z. 863 (Page 447).
Fig. 6. Mobula hypostoma. M. C. Z. 683 (Page 453).

The figures on this plate are from a group of the Platosomia characterized by a median process in front of the pelvis, among other features. The process is shortest in the Myliobatidae, fig. 3–4, longer in the Mobulidae, fig. 6 and longest in the Potamotrygonidae. Its presence has no bearing on a question of affinity with Dipnoi, Plate **52**, fig. 4–7.

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PLATE 55.

PLATE 55.

ANTERIOR VERTEBRAE.

Fig. 1. Callorhynchus tritoris. M. C. Z. 173. Fig. 2. Chimaera monstrosa. M. C. Z. 326. Fig. 3. Pristis microdon. M. C. Z. 302 (Page 265). Fig. 4. Rhinobatus percellens. M. C. Z. 430 (Page 278). Fig. 5. Raja erinacea. M. C. Z. 358 (Page 337). Fig. 6. Potamotrygon laticeps. M. C. Z. 290 (Page 417). Fig. 7. Taeniura lymma. M. C. Z. 620 (Page 399). Fig. 8. Myliobatis californicus. M. C. Z. 636 (Page 429). Fig. 9. Aëtobatus narinari. M. C. Z. 677 (Page 441). Fig. 10. Rhinoptera jussieui. M. C. Z. 863 (Page 447).

Figures 1 and 2 show the condition of the vertebrae in the Chismopnea, how few of them are included in the consolidation, the articulation of the erectile spine, and the condition of the notochord, without rings in Callorhynchus, fig. 1, with rings in Chimaera, fig. 2. Figures 3–10 are from among the lowest to the highest of the Platosomia. They indicate the gradually increasing number of the vertebrae taking part in the anchylosis, with the decrease in size and withdrawal backward of the lateral wings or stays so prominent in the Pristidae, fig. 3, the scapulary attachment of the shoulder girdle superior in Pristidae and Rhinobatidae, fig. 3–4, inferior in the Raiae, fig. 5, and a lateral articulation in Dasybatidae, fig. 7, Potamotrygonidae, fig. 6, Myliobatidae, fig. 8, Rhinopteridae, fig. 10 and the Mobulidae. The different styles of attachment of the shoulder girdle apparently divide the Platosomia into groups. A considerable increase in irregularity of vertebrae and processes obtains as the most specialized genera are approached.

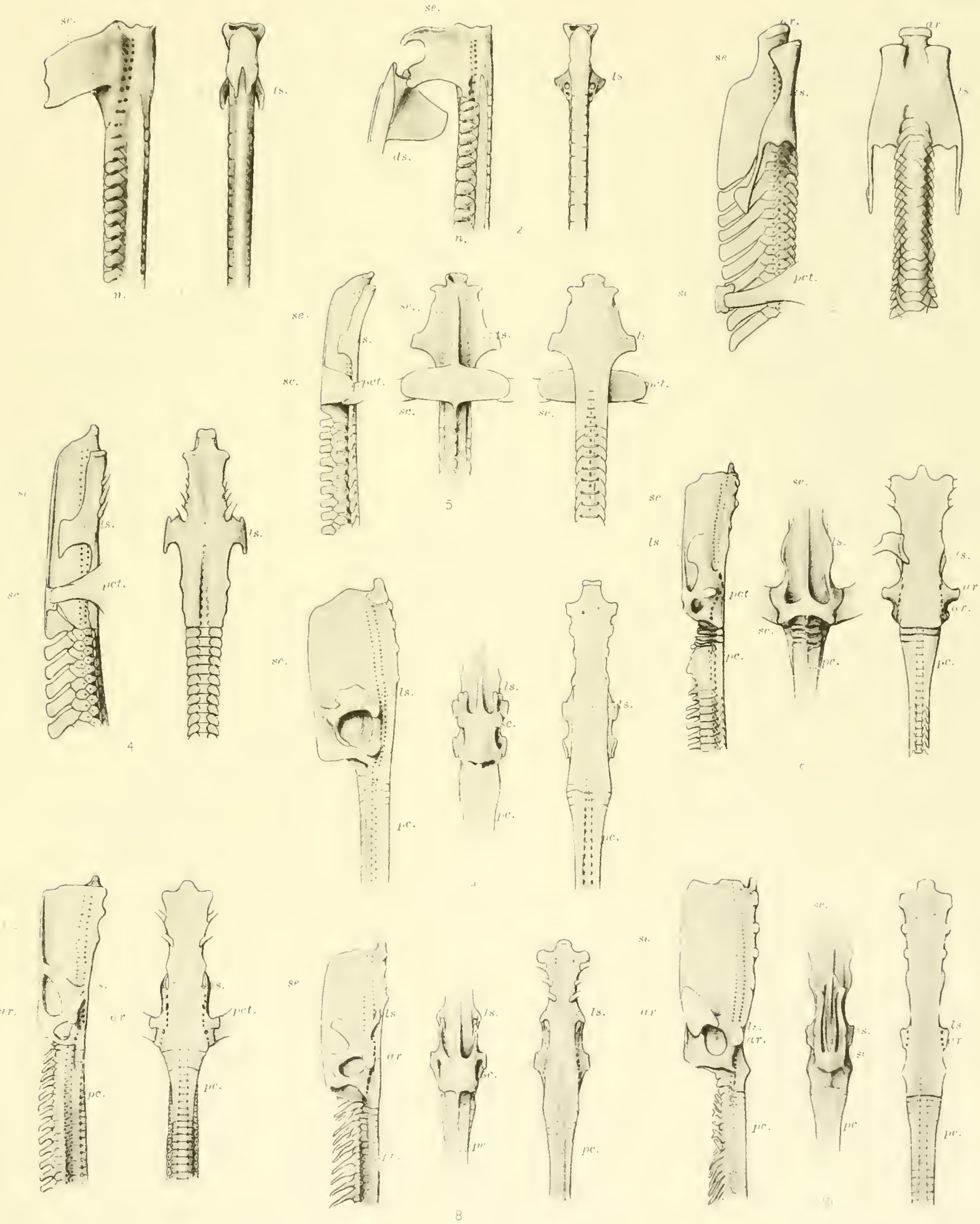
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PLATE 56

PLATE 56.

HEART.

Fig. 1. Heptranchias perlo. M. C. Z. 945 (Page 21). Fig. 2. Scaphanorhynchus owstoni. M. C. Z. 1048 (Page 28). Fig. 3. Orectolobus japonicus. M. C. Z. 1038 (Page 50). Fig. 4. Cephaloscyllium umbratile. M. C. Z. 1041 (Page 80). Fig. 5. Isurus punctatus. M. C. Z. 1249 (Page 36). Fig. 6. Pristiophorus japonicus. M. C. Z. 1045 (Page 246). Fig. 7. Rhinobatus percellens. M. C. Z. 430 (Page 278). Fig. 8. Discobatus sinensis. M. C. Z. 1120 (Page 289). Fig. 9. Narcacion marmoratus. M. C. Z. 42 (Page 305). Fig. 10. Narke japonica. M. C. Z. 1114 (Page 314).

Rather generally the number of rows of valves in the conus of the Antacea decreases with advance in rank, with increase in specialization. For proof of this compare Heptranchias, fig. 1, Scaphanorhynchus, fig. 2, Isurus, fig. 5, and Pristiophorus, fig. 6, with Orectolobus, fig. 3, and Cephaloscyllium, fig. 4. In the Platosomia the rule does not hold so well, as is shown by comparing Rhinobatus, fig. 7, of this Plate with greatly specialized types, Plate **57**, fig. 1–6.

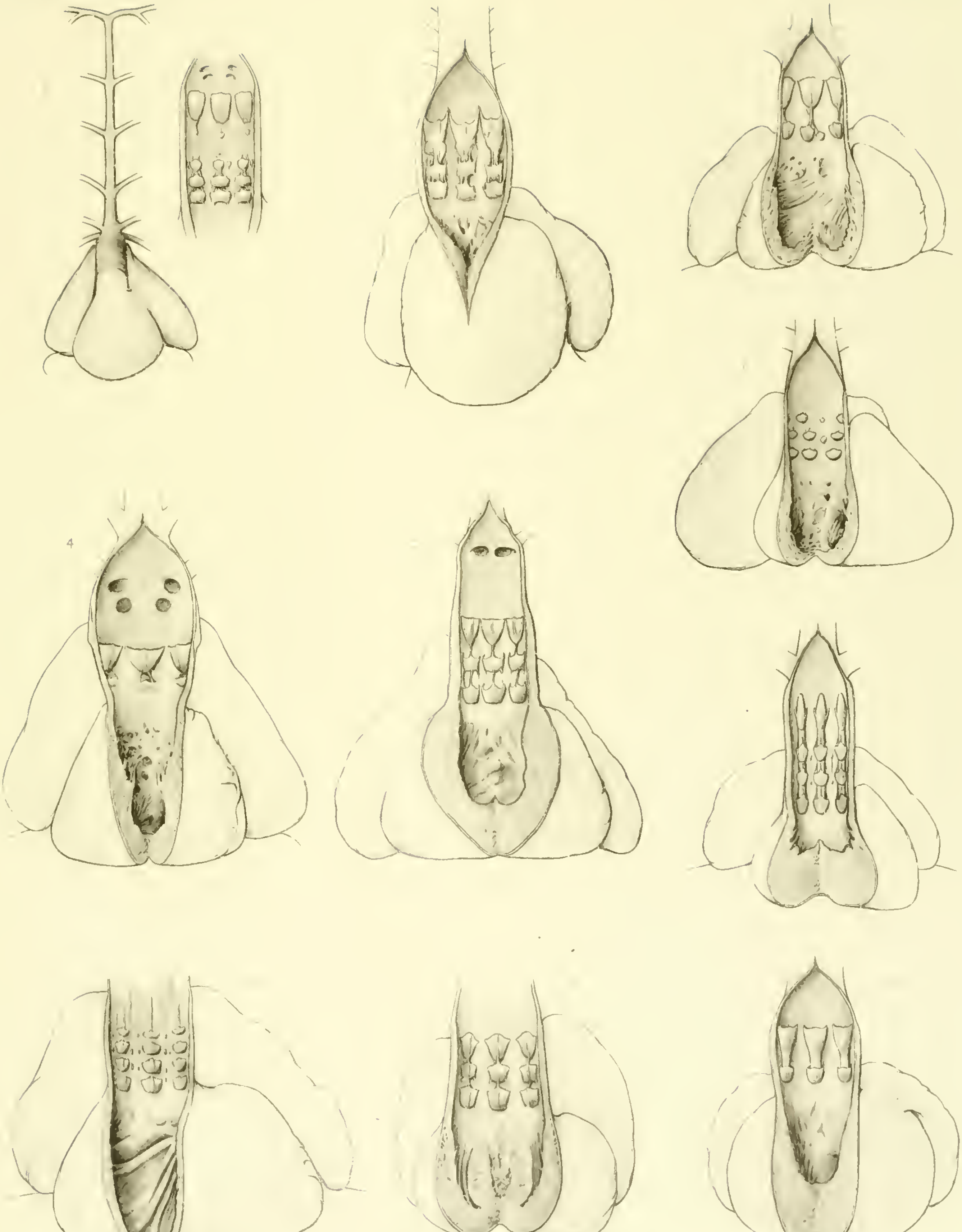
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PLATE 57.

PLATE 57.

HEART.

Fig. 1. Sympterygia acuta. M. C. Z. 632 (Page 370). Fig. 2. Disceus thayeri. M. C. Z. 297 (Page 426). Fig. 3. Pteroplatea altavela. M. C. Z. 336 (Page 415). Fig. 4. Aëtobatus narinari. M. C. Z. 677 (Page 441). Fig. 5. Rhinoptera jussieui. M. C. Z. 863 (Page 447). Fig. 6. Mobula hypostoma. M. C. Z. 683 (Page 453). Fig. 7–10. Ceratodus forsteri. M. C. Z. 9827.

The majority of the more differentiated of the families of the Platosomia have a larger number of rows of valves in the conus than others commonly accepted as much lower in rank; that is, with increase in specialization decrease in the number of valves does not obtain as regularly as in the Antacea. This is substantiated by contrast of Rhinobatus, Plate **56**, fig. 6, with Aëtobatus, fig. 4, Rhinoptera, fig. 5, and Mobula, fig. 6, of Plate **57.**

Figures 7–10 represent the heart of Ceratodus.

For fig. 7 the pericardium was slit longitudinally and turned to the sides; for fig. 8 both conus and ventricle were opened, showing the upper end of the so-called spiral valve in the passage from the ventricle into the conus, the lower end of the passage with the end of the hinder one of a series of large thick-walled valves of the aditus, and the chamber of the ventricle with the basal, posterior, fibrous pad. The conus is thrown open in fig. 9 disclosing the transverse series of large valves immediately behind the arteries, and behind that series another transverse series of smaller valves; this figure also shows the somewhat spiral course of the opening from the ventricle, in dotted lines, with the end of a large valve at its origin, and the fibrous pad at the side of which is a large opening controlled by muscles into the ventricle. The inner two of the dotted lines roughly indicate the position of a longitudinal series of large valves laid bare in fig. 10 which shows one of the transverse series of large valves in front cut open to prove that this series originated from one of the hinder of several transverse series, the smaller valves of the anterior series being included by the larger valves; this figure also shows a longitudinal series in the aditus of large valves one of which was formed from each of the transverse series of small valves, at its left in the figure.

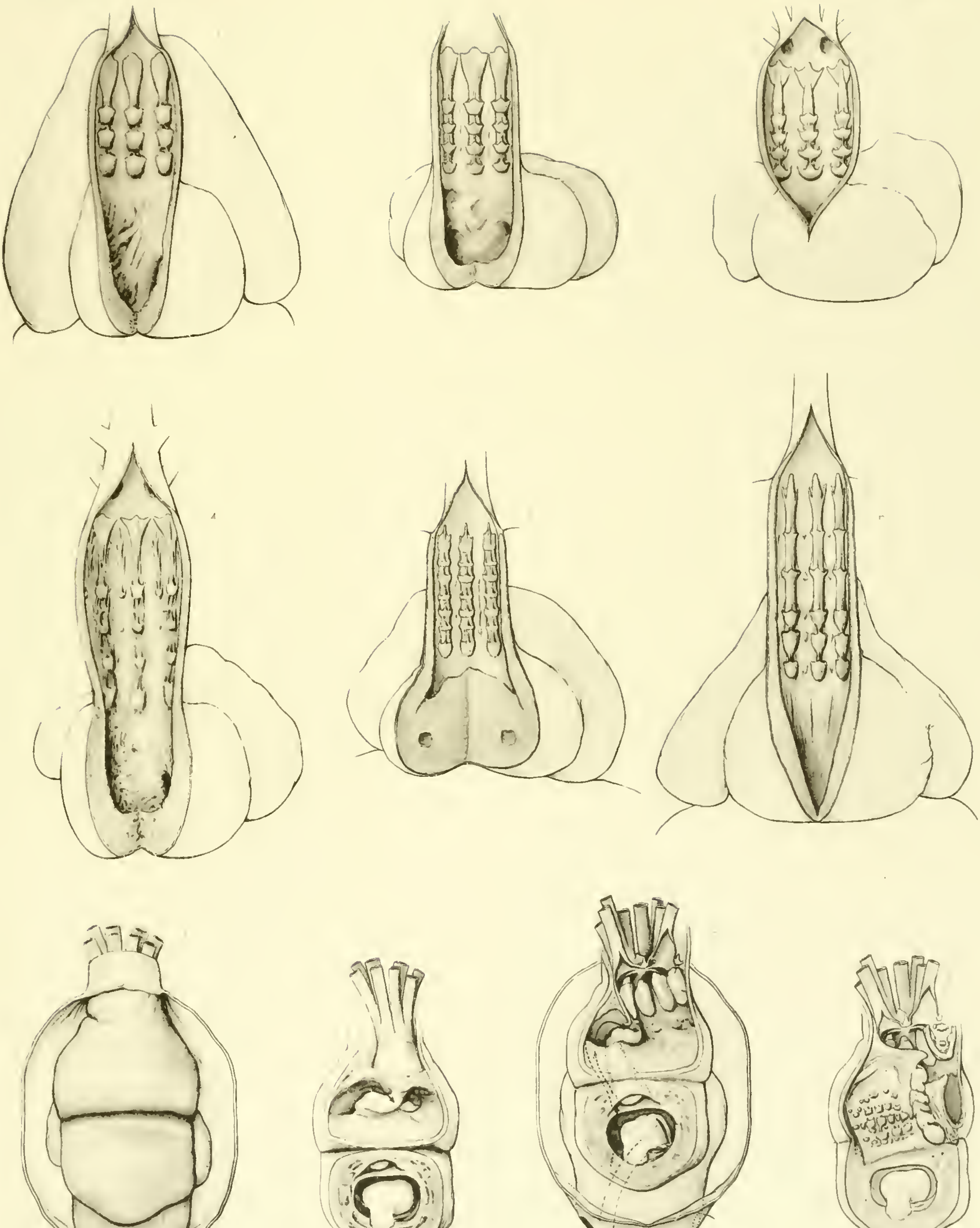

PLATE 58.

PLATE 58.

Intestines of ANTACEA and CERATODUS.

Fig. 1. Heptranchias perlo. M. C. Z. 945 (Page 21). Fig. 2. Cephaloscyllium umbratile. M. C. Z. 1044 (Page 80). Fig. 3. Isurus punctatus. M. C. Z. 1249 (Page 36). Fig. 4. Hemigaleus pectoralis. M. C. Z. 847 (Page 150). Fig. 5. Pristiophorus japonicus. M. C. Z. 1045 (Page 246). Fig. 6. Ceratodus fosteri. M. C. Z. 9827.

There are marked differences between the intestine of the Plagiostomia and that of Ceratodus. The stomach of the former is distinctly separated from the spiral intestine, while that of the latter is a continuation forward of the spiral itself. The stomach and intestine of Ceratodus, fig. 6, form a continuous spiral the characters of the inner surfaces of which change from the villous of the stomach proper to the absobent of the intestine in a single turn of the winding course. The number of turns in Ceratodus is nine or ten; the axis of the spiral is firm and muscular. The number of turns in the intestinal spiral of the Plagiostomia varies in those dissected here from four in Hemigaleus, fig. 4, to thirty-nine in Isurus, fig. 3.

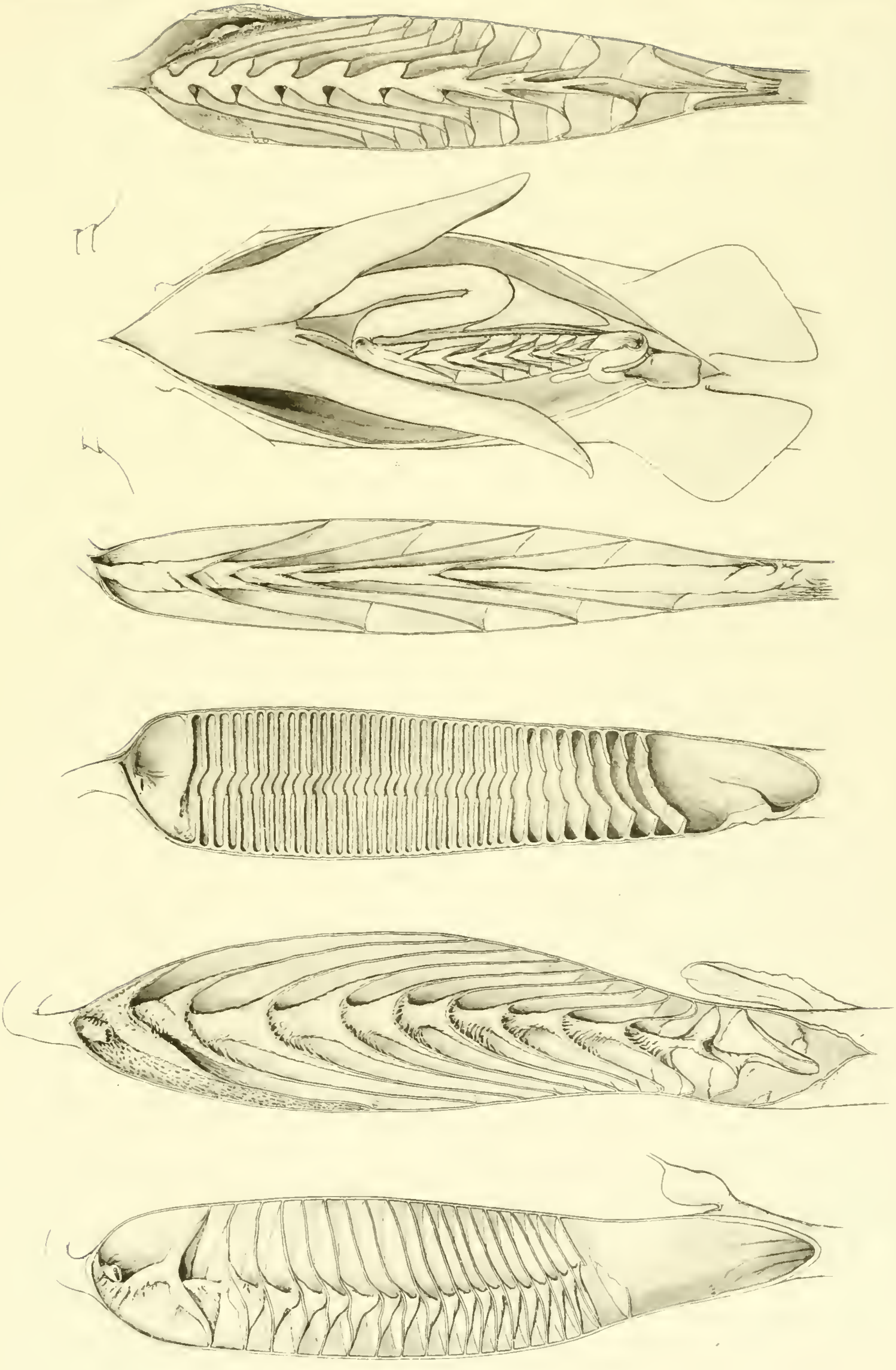

PLATE 59.

PLATE 59.

Fig. 1–2. SQUALUS ACANTHIAS. M. C. Z. 35 (Page 192). Fig. 3. GINGLYMOSTOMA CIRRATUM. M. C. Z. 819 (Page 54). Fig. 4–6. CHLAMYDOSELACHUS ANGUINEUS. M. C. Z. 1247, 1285 (Page 14). Fig. 7–8. MOBULA HYPOSTOMA. M. C. Z. 683 (Page 453). Fig. 9–10. RHINOPTERA JUSSIEUI. M. C. Z. 863 (Page 447).

Figure 1, $\frac{4}{7}$ natural size, and fig. 2, natural size, exhibit the outer and the internal yolk-sac, the heart with arteries, the liver, the stomach, and the intestine. Figure 3, $\frac{7}{12}$ natural length, is the egg of Ginglymostoma, the embryo showing through the shell. Figure 4–5, $\frac{5}{7}$ nat., show the egg with the embryo of Chlamydoselachus. Fig. 7–8 show the appearance of the gill plates of Mobula, and fig. 9–10 those of Rhinoptera. There is in the latter a longitudinal division of the plates into upper and lower parts, in fig. 9 there are also seen modifications to some extent intermediate in character between the plates in fig. 10 and those of Mobula.

Figure 6, of Chlamydoselachus, was made for comparison with the type and with figures in more recent articles by Fürbringer and Goodey. In a number of points it is at variance with the figures mentioned and agrees more nearly with the type. There is no point behind the middle of the first basihyal, as in Fürbringer, 1903, Morph. jahrb. **31**, pl. 27, f. 18 or in Goodey, 1910, Proc. Zool. soc. Lond., pl. 43, f. 6 "bbr. 1 (?)." The basibranchials are more numerous and regular than in either of the mentioned figures. The hypobranchials are present in five pairs, the hindmost pair being displaced and resting below the junction of the sixth ceratobranchial and the basibranchial; these cartilages are those figured as the vestigial seventh arch, Goodey, *loc. cit.*, pl. 43, fig. 6, "b a 7 (?)." The seventh arch was discovered and figured by Fürbringer, 1903, as an "eventuel Rudiment einer siebenten Kiemenbogens"; it is of much greater development in this Plate than in either of the other figures.

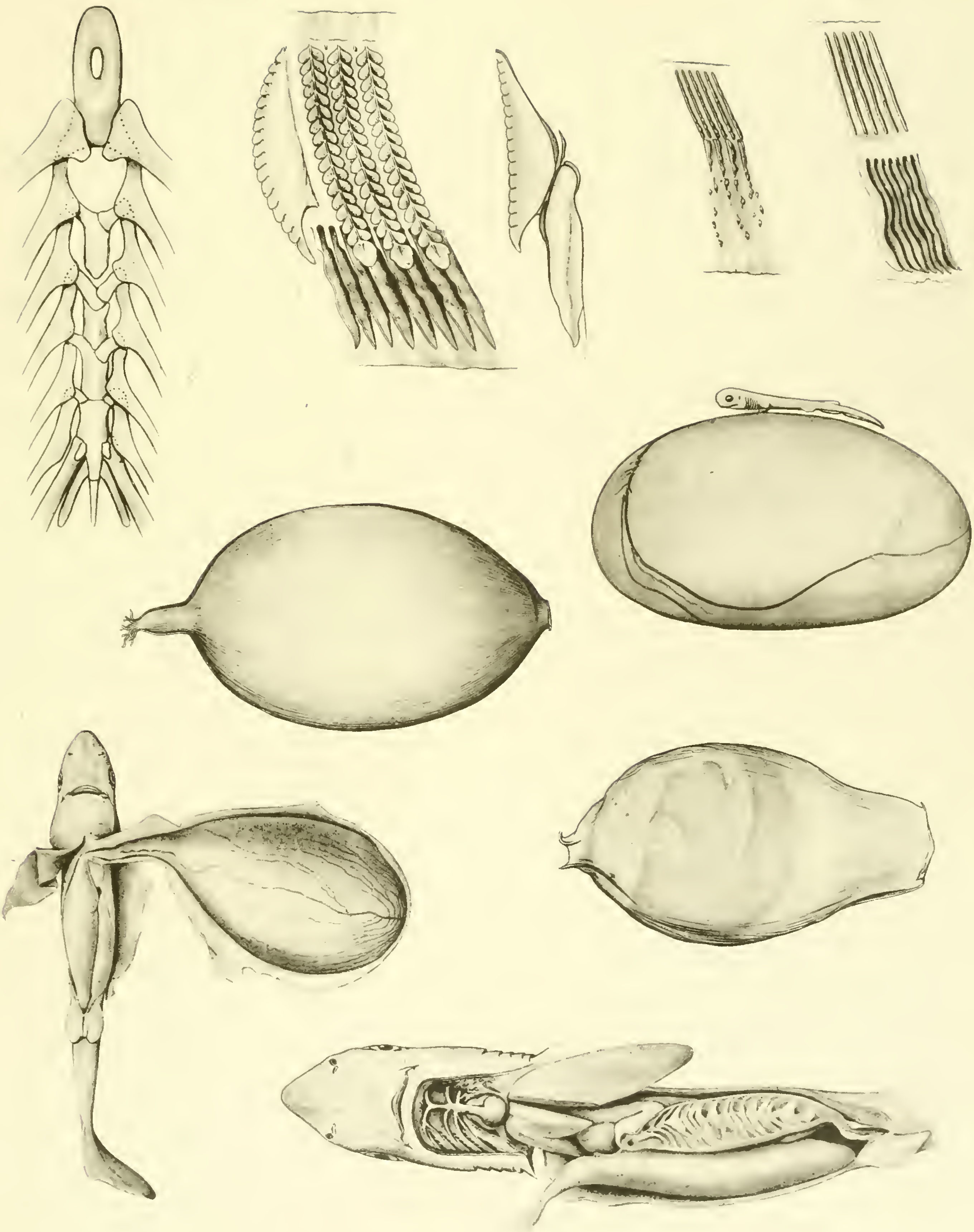

PLATE 60.

PLATE 60.

ANTACEA.

Fig. 1–4. GALEORHINUS LAEVIS (Page 176). Fig. 5–9. SQUALUS ACANTHIAS (Page 192).

1. Nearly natural length. M. C. Z. 1301.
2–3. Nearly natural length. M. C. Z. 1304.
4. Nearly natural length. M. C. Z. 1303.
5. Two thirds natural length.
6. Twice natural length.
7–9. Natural size.
5–9. M. C. Z. 1305.

Figure 1 represents the egg in its membranous envelope before the appearance of the embryo. Figures 2–4 show the embryo with the egg near the time the latter attaches itself to the wall of the oviduct, the attachment being a consequence of active development of the blood vessels and rapid depletion of the nutriment of the egg. Partially attached eggs, before entire disappearance, are considerably modified on the side in contact with the wall to which after the egg is absorbed the embryo remains attached by the cord. The egg of Squalus, fig. 5 and 7, is one that carries a sufficient amount of nutriment for the development and growth of the embryo without attachment to the surrounding walls. The distribution of the blood vessels over the yolk differs much from that in fig. 2–4.

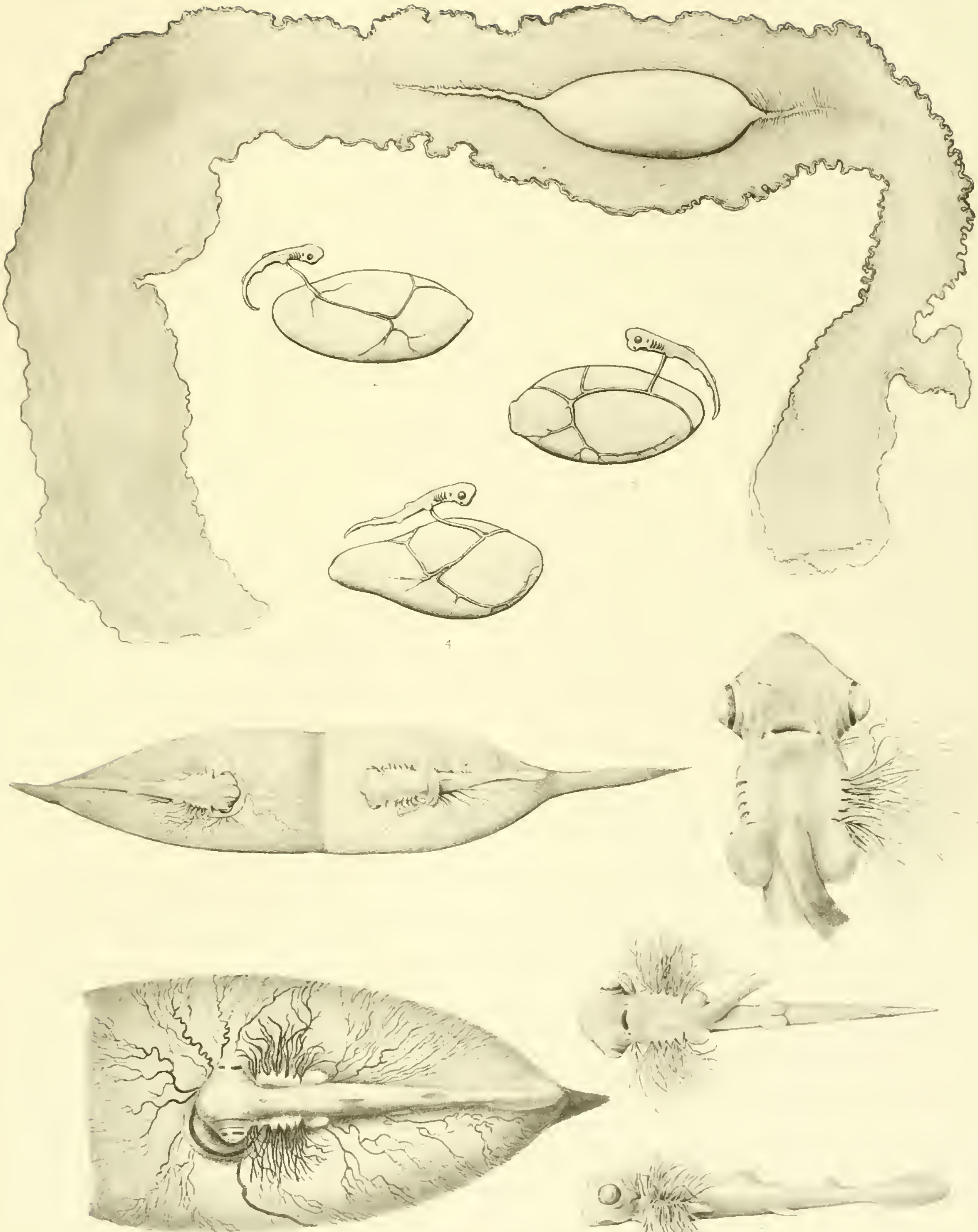

PLATE 61.

PLATE 61.

PLATOSOMIA and ANTACEA.

Fig. 1–3. Narcacion marmoratus (Page 305). Fig. 4–5. Narcacion nobilianus (Page 310). Fig. 6. Narcine timlei (Page 300). Fig. 7–8. Chlamydoselachus anguineus (Page 14). Fig. 9–11. Rhina californica (Page 253).

1–3. Various stages from De Sanctis, 1872.
4–5. Four fifths and natural length. M. C. Z. 1016.
6. One and two thirds natural length.
7–8. One and three fourths natural length. M. C. Z. 1285.
9–10. Five sixths natural length. M. C. Z. 916.
11. Two and two thirds natural length. M. C. Z. 916.

The first three figures illustrate the squaliform raiiform and torpediform stages socalled by De Sanctis (1872, Atti Reale accad., **5**, pl. 1, fig. 3, 6, 9.) In fig. 3 the forward extension of the pectorals, at the sides of the batteries, is strongly marked while the lateral growth of the antorbital process ultimately forming the front of the disk has hardly begun; at this stage the latter merely forms a pad in front of the head. Figures 4 and 5 from a specimen off the coast of New England illustrate the lateral growth of the antorbital portions of the disk to meet the forward extensions of the pectorals and, with the obliteration of the notch opposite each eye, complete the disk. See the skeleton of *N. marmoratus* on Plate **67**, *ao*. The batteries are well developed and the disk completely outlined at a very small stage of *Narcine timlei*, fig. 6. In connection with fig. 7–8, showing the young Chlamydoselachus with well differentiated fins and external gills, see also fig. 4–5, Plate **59**. The embryo of *Rhina californica*, fig. 9, was attached to an enormous mass of yolk, longer and many times the weight of the little shark. Figures 10 and 11 show the intestines and their connection with this yolk, the dotted lines indicating the entrance in front of the spiral folds.

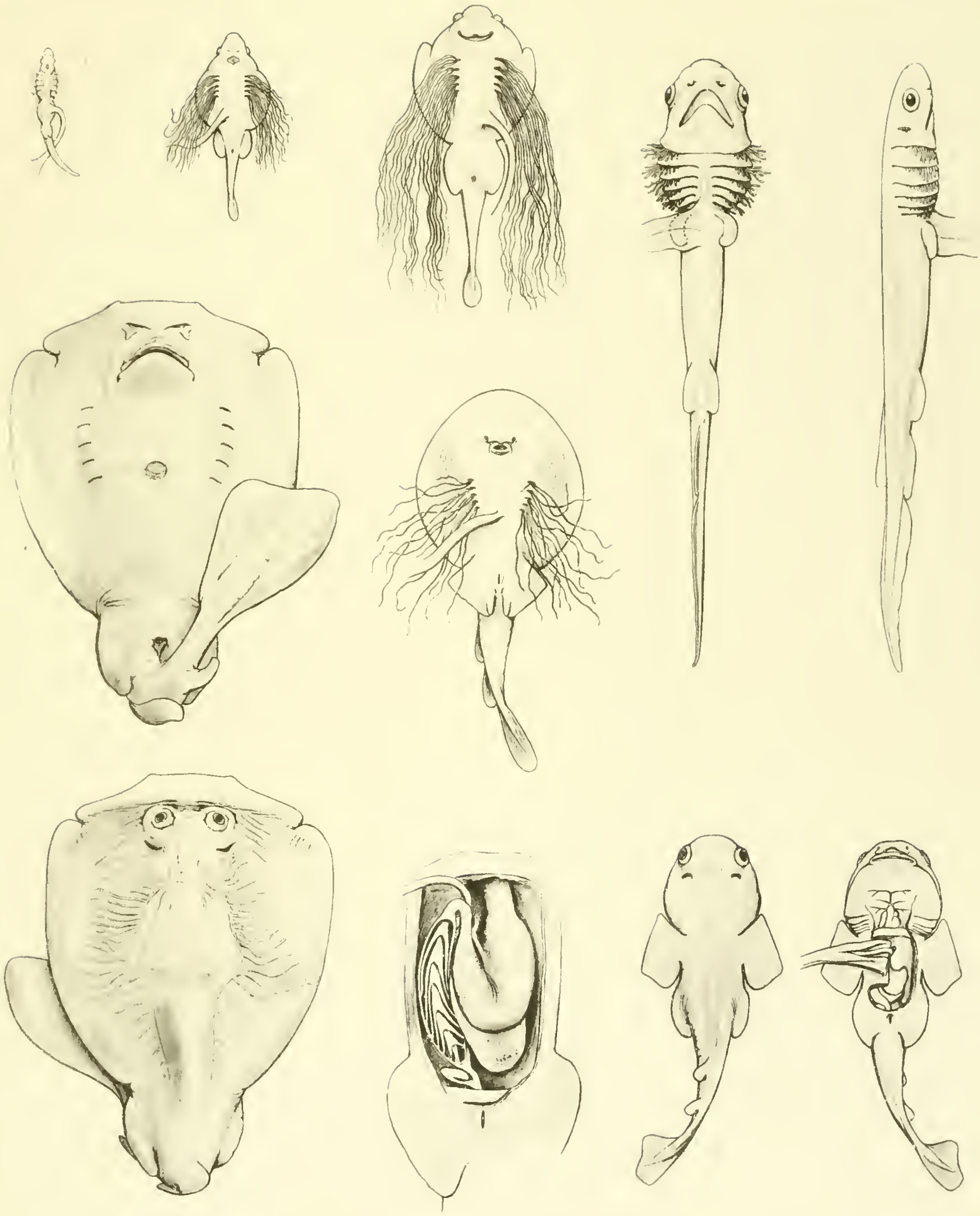

PLATE 62.

PLATE 62.

ISURIDAE.

Fig. 1–3. Isurus punctatus (Page 36).

1. Dorsal view of the skull, vertebrae, branchial cartilages, and shoulder girdle.
2. Lateral view of the skull, jaws, teeth, branchial cartilages, and shoulder girdle.
3. Ventral view of the skull, jaws, teeth, branchial cartilages, vertebrae, and shoulder girdle.

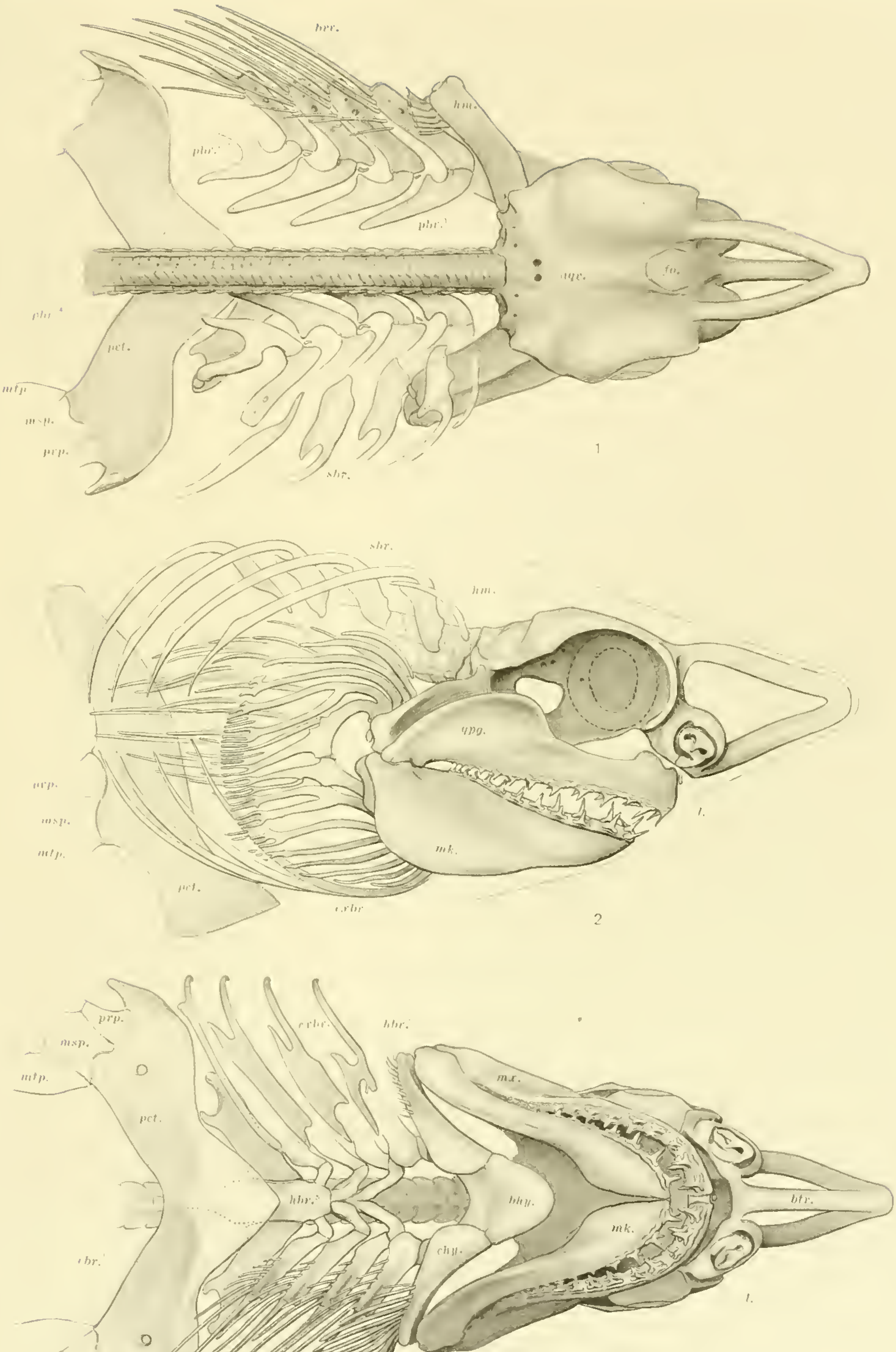
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PLATE 63.

PLATE 63.

ISURIDAE.

Fig. 1–6. Isurus punctatus (Page 36).

1. Pectoral fin.
2. Pelvis and ventral or pelvic fins.
3. Vertebral column, second dorsal fin, and the anal fin.
4. First dorsal fin.
5. Caudal fins and vertebrae.
6. Scales from near the middle of the flank.

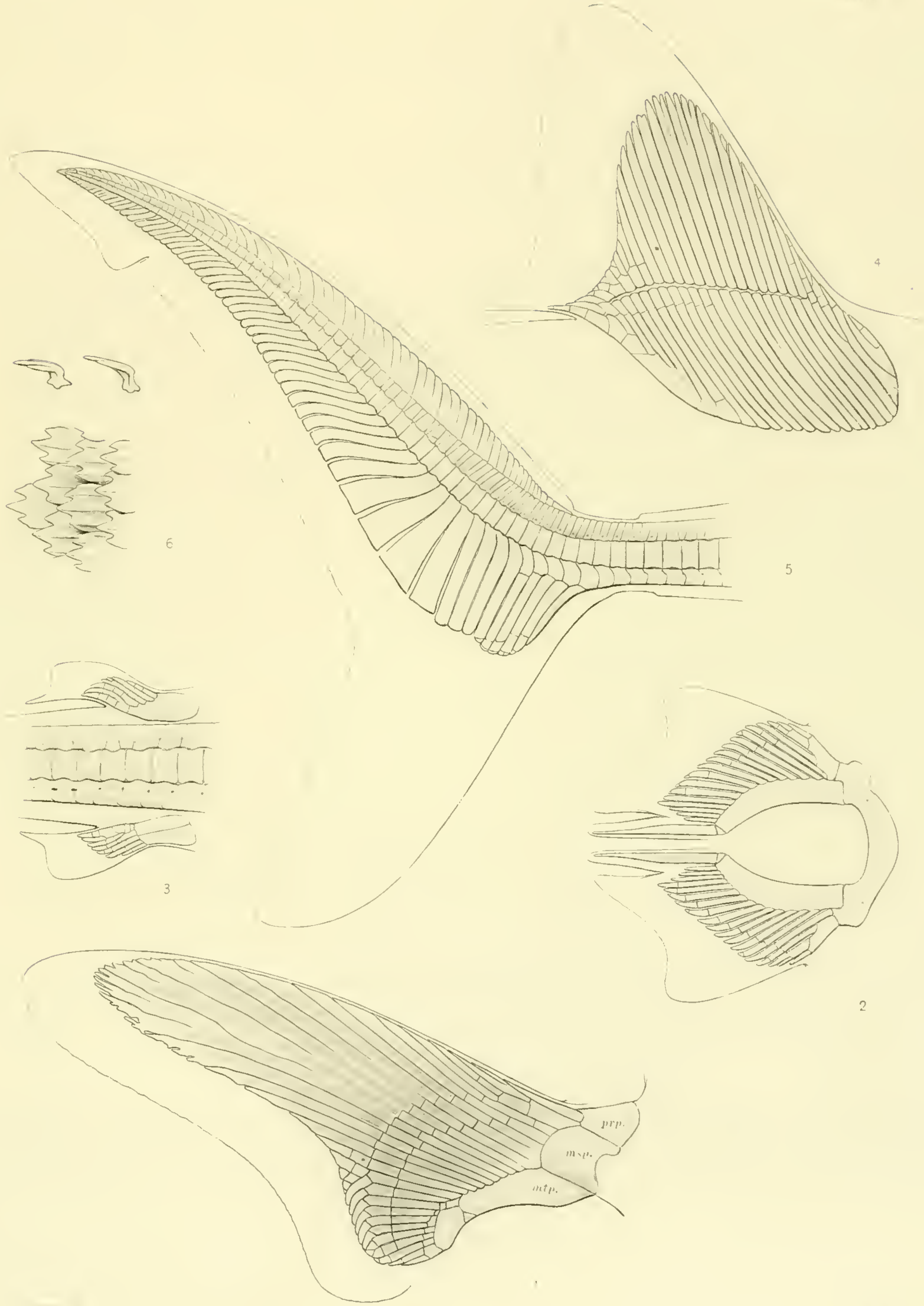

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PLATE 64.

PLATE 64.

PRISTIOPHORIDAE and PRISTIDAE.

Fig. 1. PRISTIOPHORUS JAPONICUS (Page 246). Fig. 2–3. PRISTIS MICRODON (Page 265).

1. Dorsal view. M. C. Z. 1045.
2. Dorsal view. M. C. Z. 302.
3. Ventral view. M. C. Z. 302.

A species of the Antacea is placed by the side of one of the Platosomia to give prominence to differences between the two groups, which appear especially, among others, in the jaws, the branchial skeleton, the shoulder girdle and the pectoral fins. The girdle of the shark, fig. 1, is remotely attached to the vertebrae in its scapulary extensions; it is considerably arched and the fins are placed rather behind its transverse axis. In the ray, fig. 2, the girdle is firmly and superiorly attached to the vertebrae by means of a scapular element and the fins are lateral and forward of the articulations as well as behind them. The copula, *bhy*, is divided into sections, segmented, and distinct from the cartilages behind it; in the ray it is unsegmented and is attached to the ceratohyals, *chy* (*ehy* in Plate). Strong cartilages appear in the gill covers of the ray, *sp*. The postbranchial stay, *pbs*, has its greatest development in Pristis and, as shown in the following plates, dwindles in approaching the rays of highest rank.

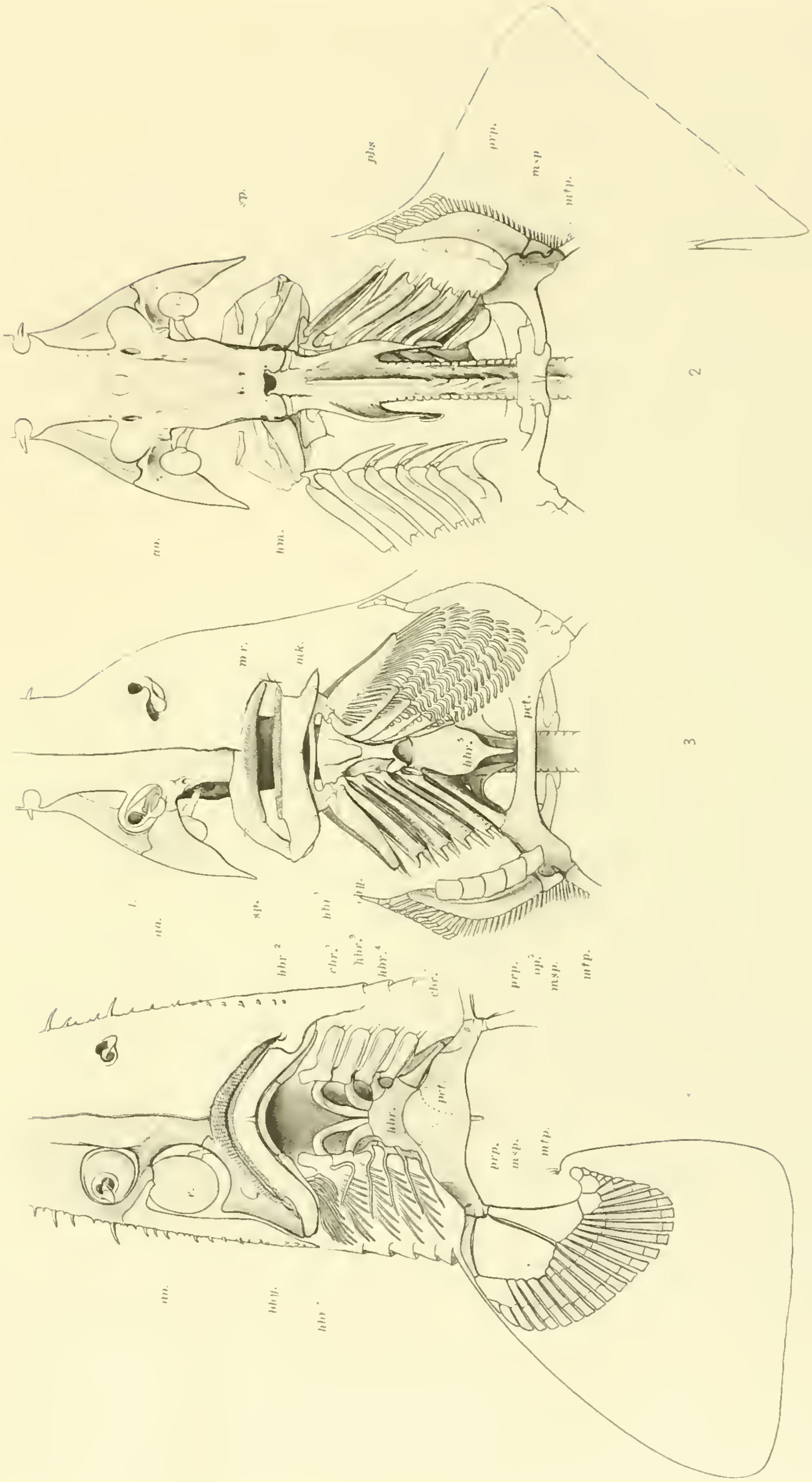
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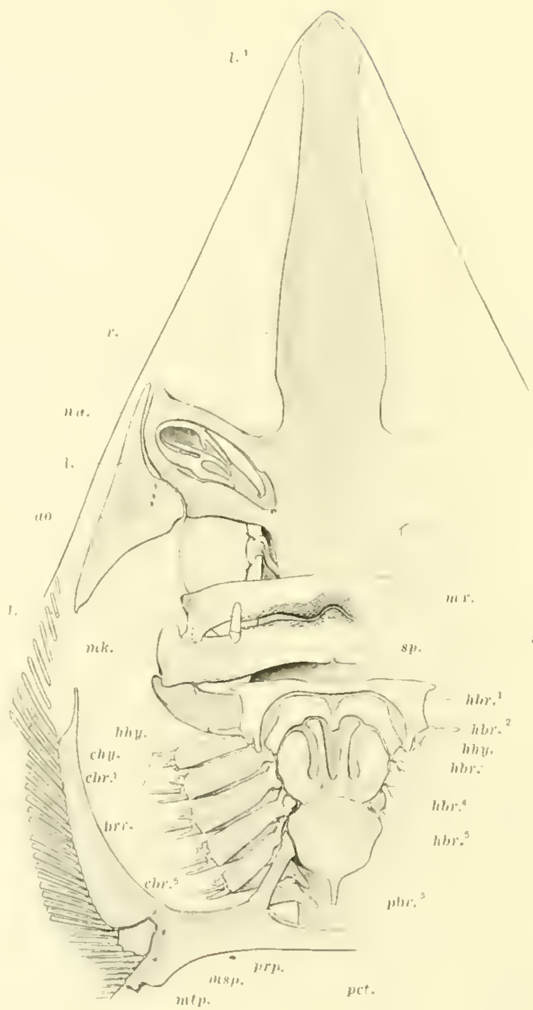
PLATE 65.

PLATE 65.

RHINOBATIDAE.

Fig. 1. Rhynchobatus djiddensis. M. C. Z. 806 (Page 268). Fig. 2. Rhinobatus percellens. M. C. Z. 435 (Page 278). Fig. 3. Syrrhina brevirostris (Page 285).

The skeleton of the Rhinobatidae is closely allied to that of the Pristidae. The copula, *hbr* 1, is unsegmented, the other basibranchials are broadened fused and contorted, the antorbital, *ao*, is extended farther outward from the skull and the shoulder girdle is much widened. The basibranchials are sketched from young individuals and must of course differ considerably from those of larger or adult specimens.



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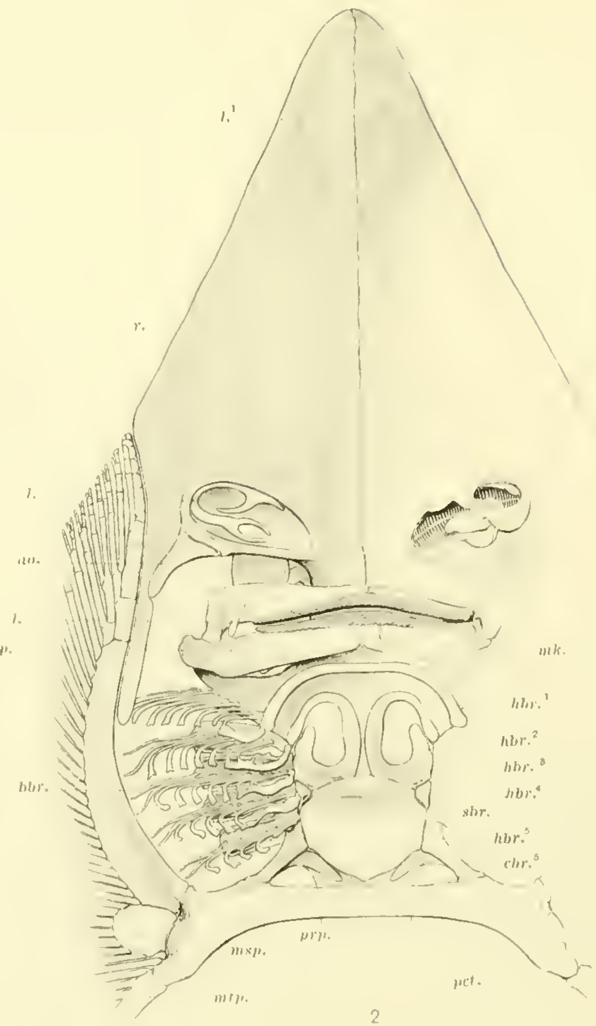

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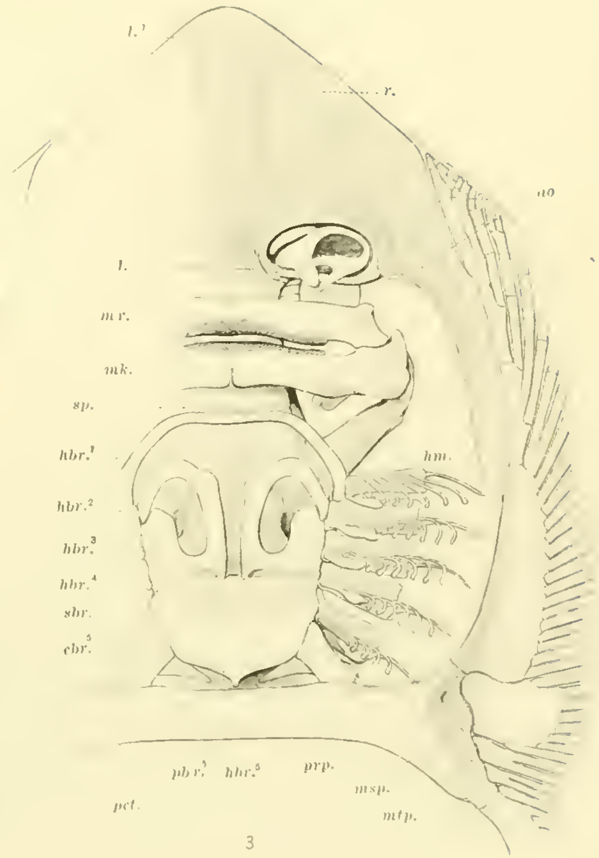

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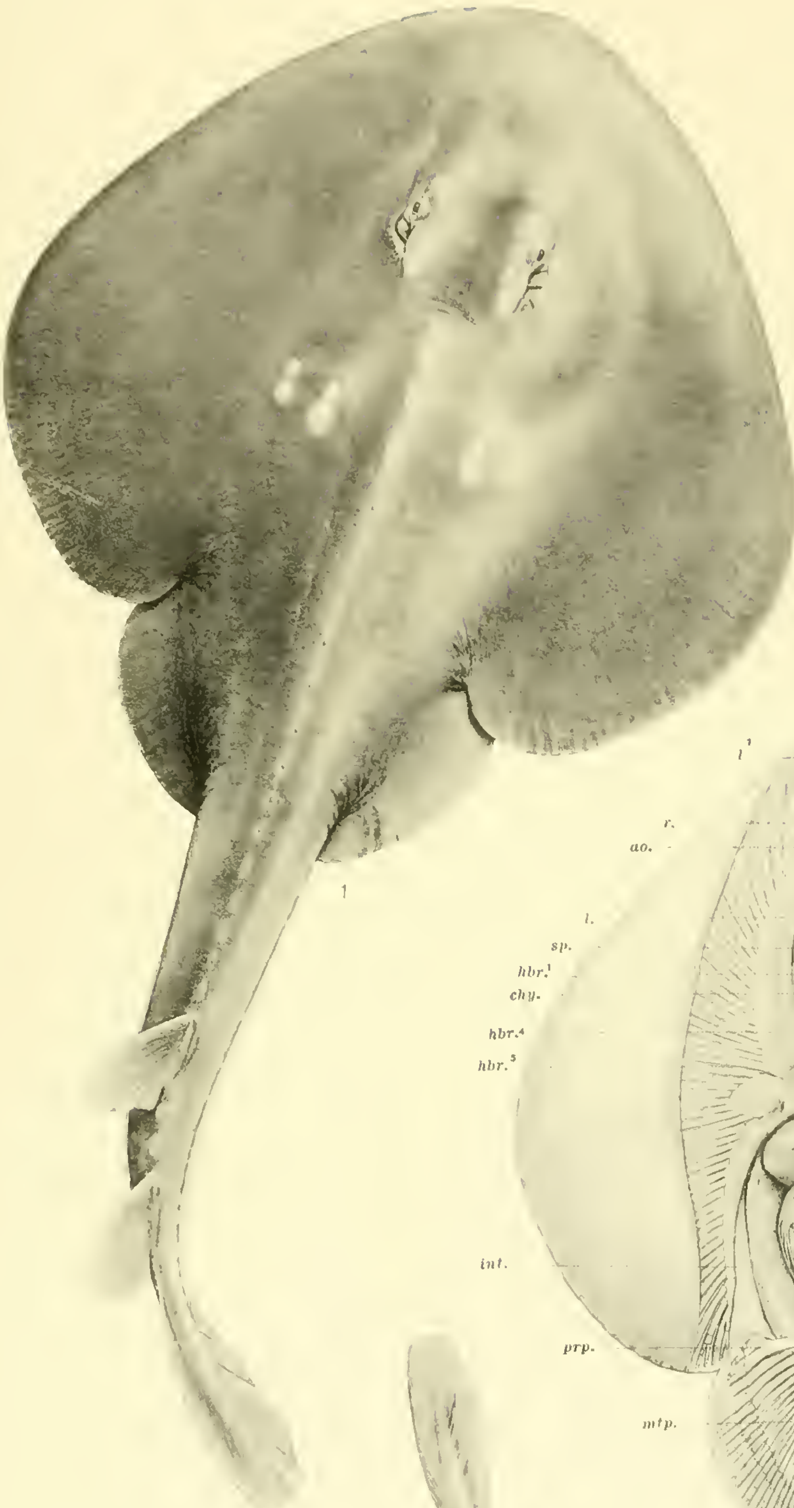
PLATE 66.

PLATE 66.

DISCOBATIDAE.

Fig. 1–3. Discobatus sinensis (Page 289).

The figures are taken from a female twenty-five and one fourth inches in length. The lower surface, fig. 2, has been dissected out so as to show the skeleton and the viscera. The mouth, fig. 3, was drawn as it appeared before dissection. Attention is directed to several features in which Discobatus to some extent approaches the Narcaciontidae. The rostral cartilage, *r*, ends abruptly a short distance in front of the skull and is supplemented by soft flexible branched extensions somewhat like those of Narcine. The antorbital, *ao*, has greatly extended forward and outward. The branchial rays are expanded at their outer extremities. There is a triangular group of ampullae, an incipient battery, opposite the end of each lower jaw. The copula, *h br'*, is unsegmented. The pelvis is very wide; it is provided with a slight anterior process at each end. The propterygium of the ventrals is considerably branched at its distal end. With the exception of the liver, which is indicated by dotted lines, the viscera are shown in position.



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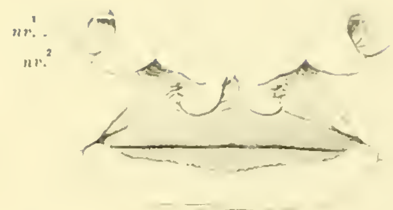

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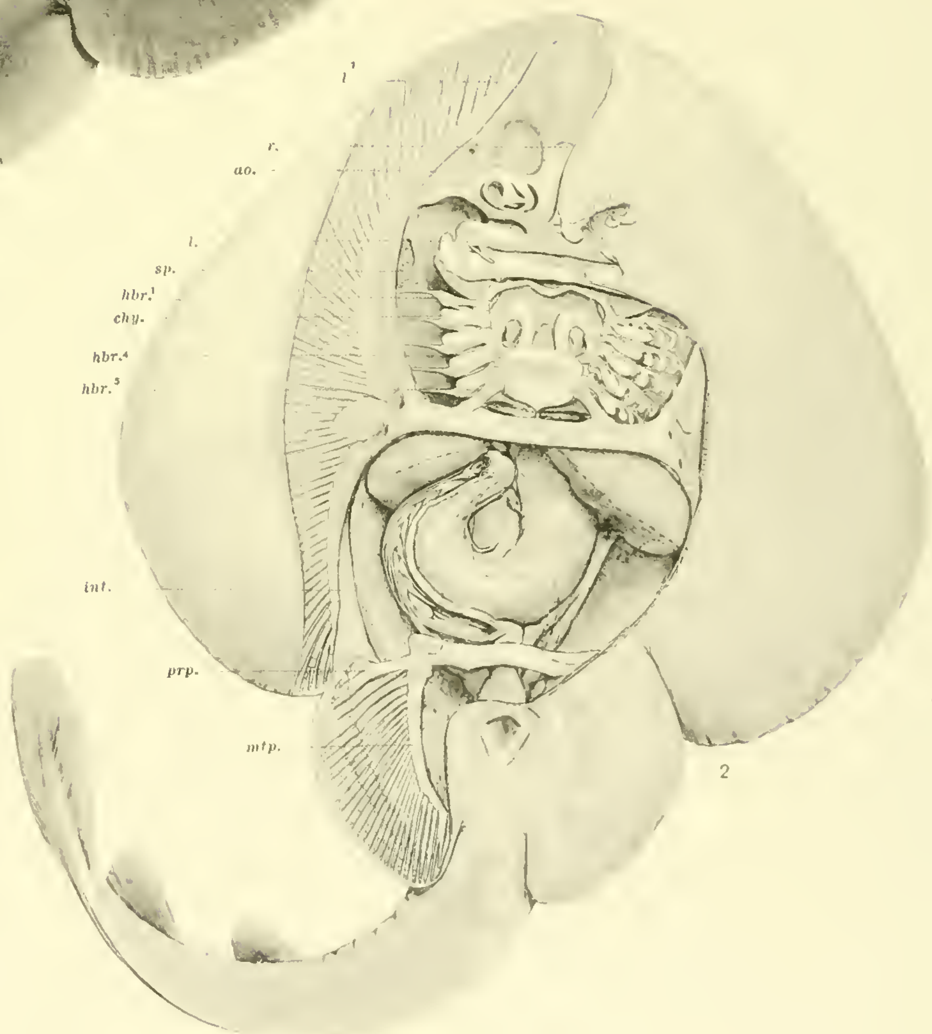

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PLATE 67.

PLATE 67.

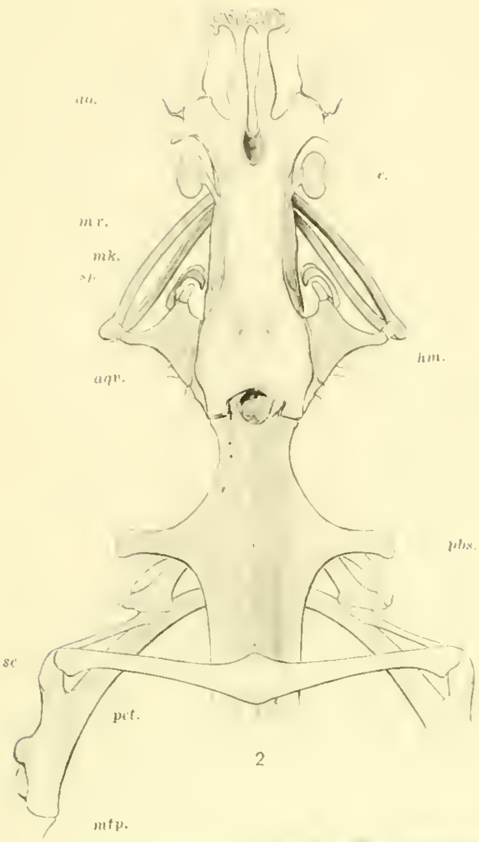
NARCACIONTIDAE.

Shoulder girdle to snout.

Fig. 1–2. NARCACION MARMORATUS. M. C. Z. 42 (Page 305). Fig. 3–4. NARKE JAPONICA. M. C. Z. 1114 (Page 314).

1, 3. Ventral view.
2, 4. Dorsal view.

The Torpedoes form the most distinct group of the Platosomia. Aside from the electric apparatus their skeletons would serve to place the family at a distance from the other families. The shoulder girdle, the antorbital and its function in the forward part of the disk, the peculiar rostral cartilages, the spiracular cartilages and their supplementals, and the slender branchial rays with their rounded plate-like extremities are very different from the same parts in the framework of the nearest allies. The incomplete copula, *co*, *cp*, and the arrangement of the joints of the propterygial basalia of the pectoral fins also illustrate this; and at the same time the genera of the Narcaciontidae differ widely from one another: — compare the elongate skull, long rostral cartilages, the anteriorly much dissected antorbitals, the wide postbranchial stays, *pbs*, the arrangement of the propterygial joints of the pectoral basalia, and the regularly articulated branchihyals of *Narcacion marmoratus* with the short skull, short rostral cartilage, the slightly dissected antorbitals, the narrow extent of the postbranchial stays, the labial cartilages, and the consolidated branchihyals of *Narke japonica.*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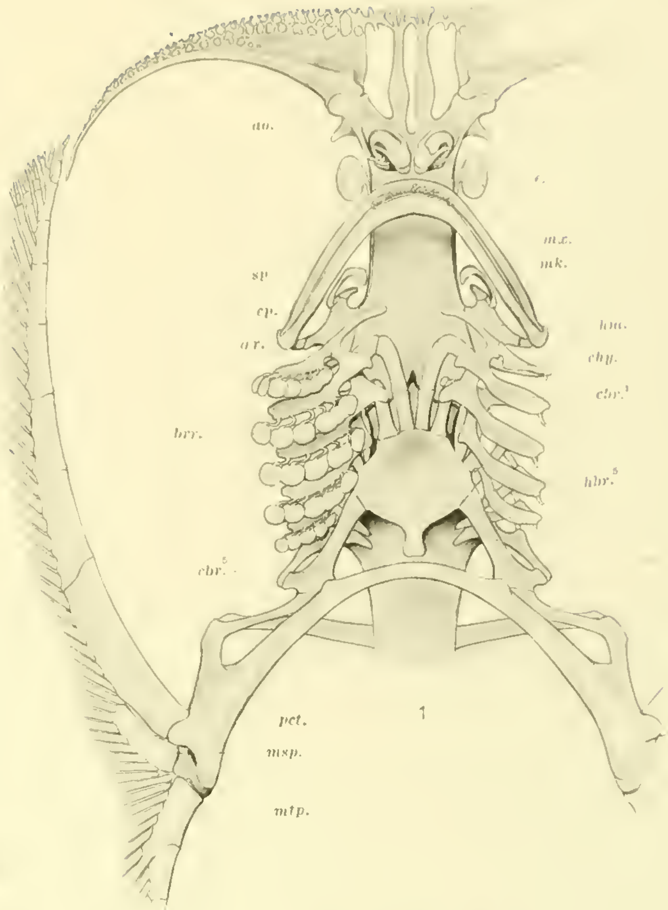
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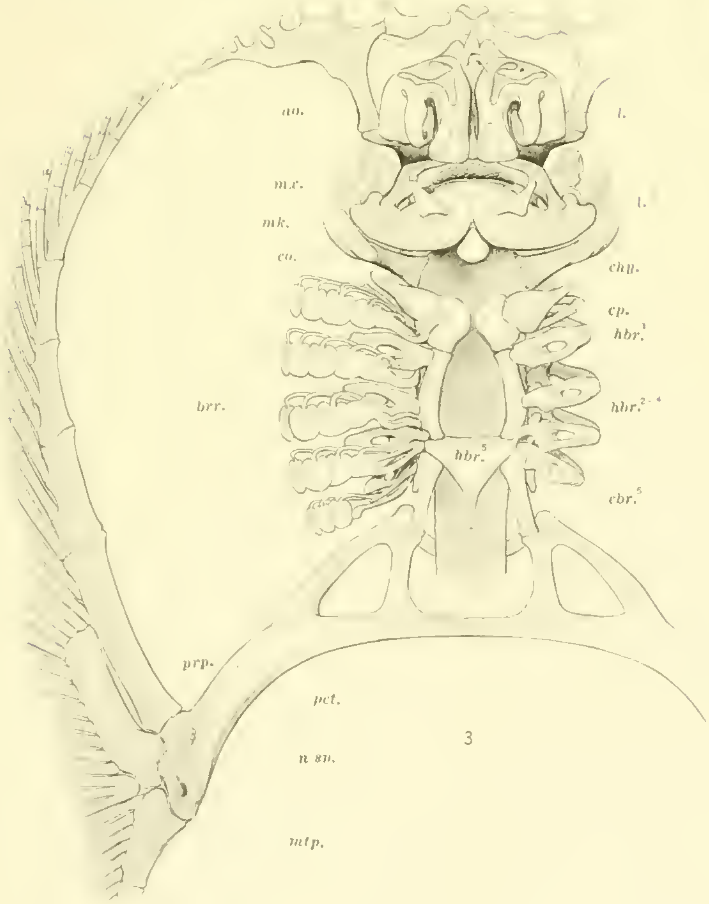
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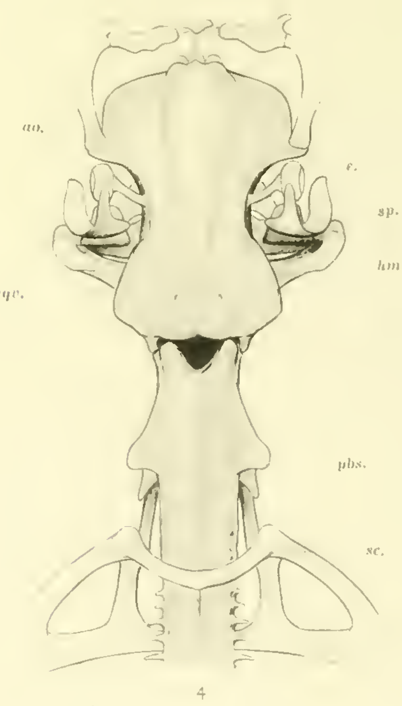
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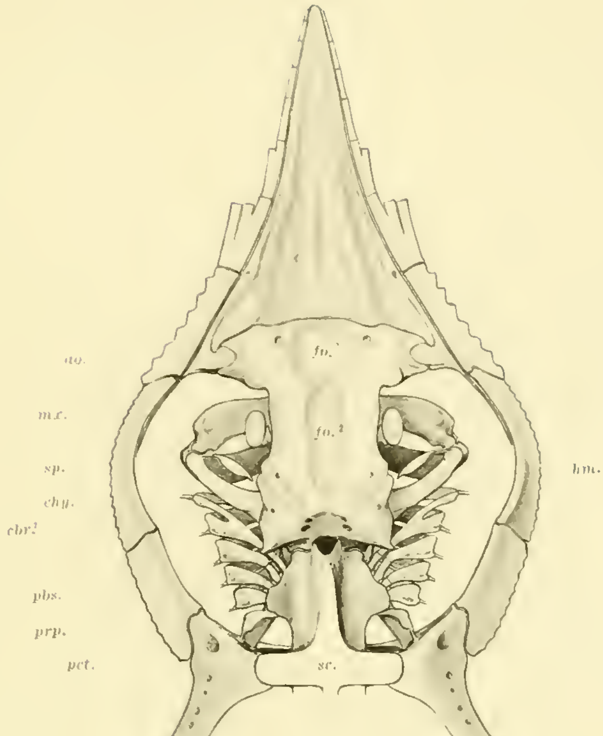
PLATE 68.

PLATE 68.

RAIIDAE.

Fig. 1. Raia erinacea. M. C. Z. 358 (Page 337). Fig. 2. Uraptera agassizii. M. C. Z. 549, (Page 367). Fig. 3–4. Sympterygia acuta. M. C. Z. 632 (Page 370).

The proterygial basalia of the pectoral fins of the Narcaciontidae have numerous joints between the antorbital, *ao*, and the pectoral arch, *pct;* the Raiidae have comparatively few, most often but a single one, that is two segments in the pectoral base opposite the gills, an arrangement gaining in firmness of the disk along the sides of the branchial chamber. Marked variations occur among the genera of Raiidae. In Sympterygia, fig. 3 a semicartilaginous mass in front of the skull displaces the rostral cartilage; in Malacorhina the rostral cartilage is lacking and the forward part of the skull is much like that of the Dasybatidae. In general the hyobranchials are reduced, but the copula, *hbr'*, is complete and not segmented as in Dasybatidae nor divided as in Narcaciontidae. The scapular, *sc*, overlaps the girdle. The prominent lateral prepelvic processes recall similar ones on the fossil genus Cyclobatis.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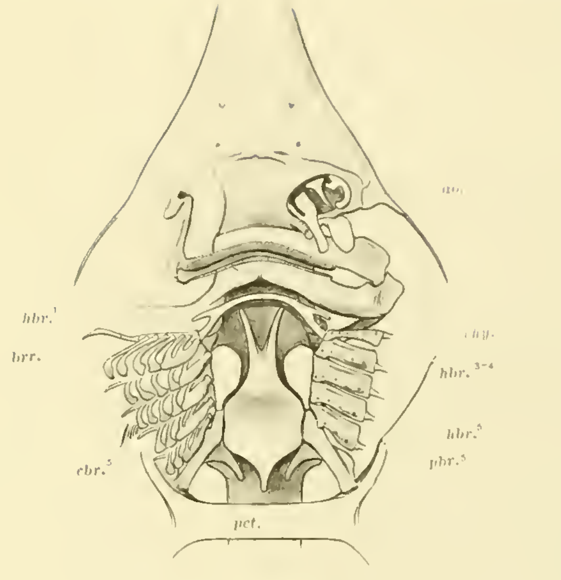
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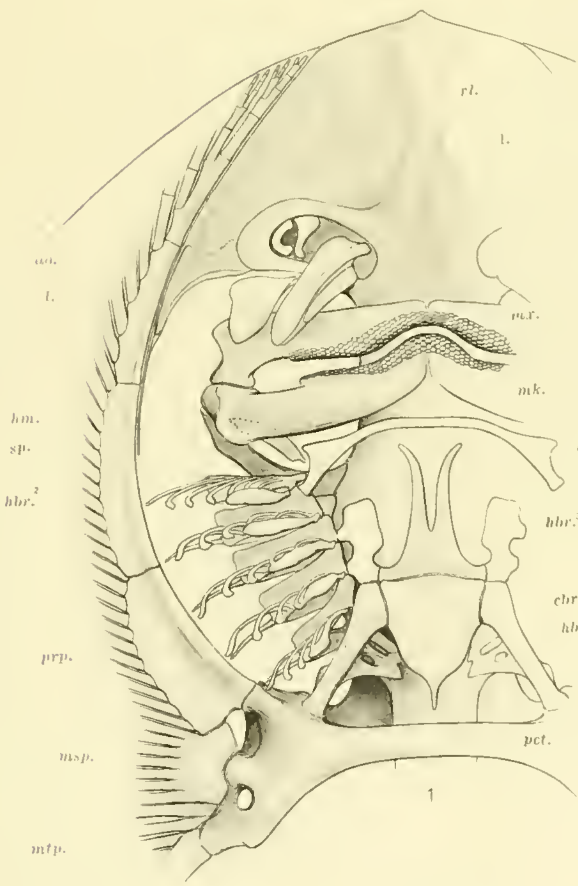
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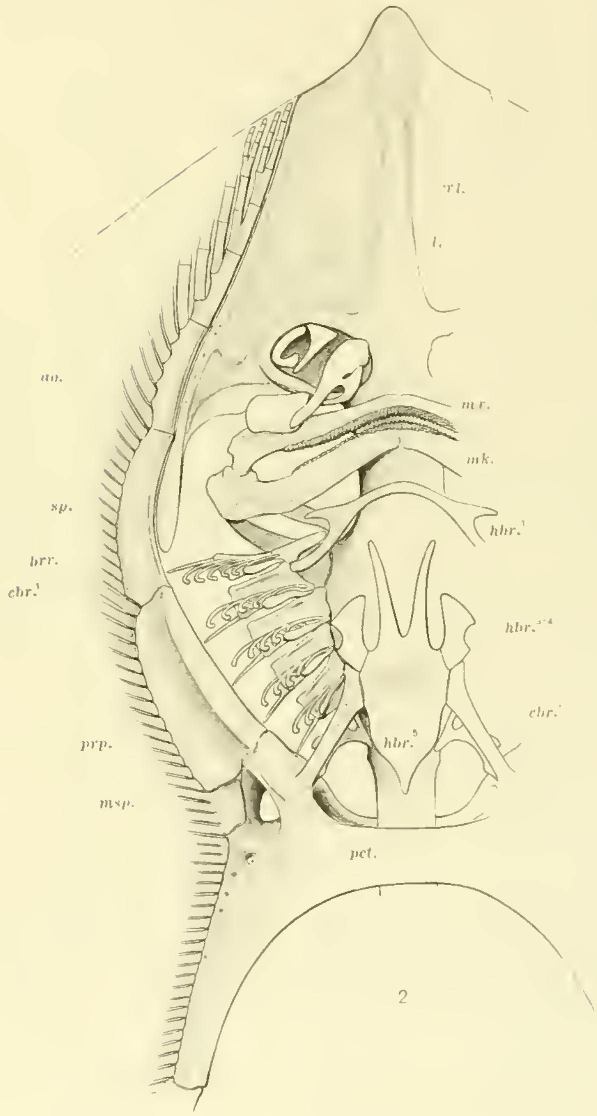
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PLATE 69.

PLATE 69.

RAIIDAE and DASYBATIDAE.

Fig. 1–2. MALACORHINA MIRA. M. C. Z. 226 (Page 372). Fig. 3. UROTRYGON ASPIDURUS. M. C. Z. 555 (Page 405). Fig. 4–5. UROBATIS SLOANI (Page 402).

A peculiarity of Malacorhina is the absence of a rostral cartilage, the front of the skull in consequence resembling that of Dasybatus. The scapular attachment overlaps the girdle as in the other Raiidae. A feature not noticed in the others is a small movable cartilage, *x*, resting above the base of the suspensorium, a rudiment perhaps of a sometime complete arch which included the spiracular cartilages and the pterygoquadrates, the upper jaws. The copula is unsegmented and the joints in the bases of the pectorals opposite the gills are like those of the family in general.

Urotrygon, fig. 3, and Urobatis, fig. 4–5, agree in most respects with other Dasybatidae; they have no rostral cartilage, there is no joint in the pectoral base opposite the gills and the scapular articulations are against the ends of the scapula, *sc.* not above the girdle as in the Raiidae. Urotrygon, fig. 3, apparently lacks the median segment of the copula, as in the Torpedoes. In Urobatis there is a slender elongate supraspiracular cartilage.

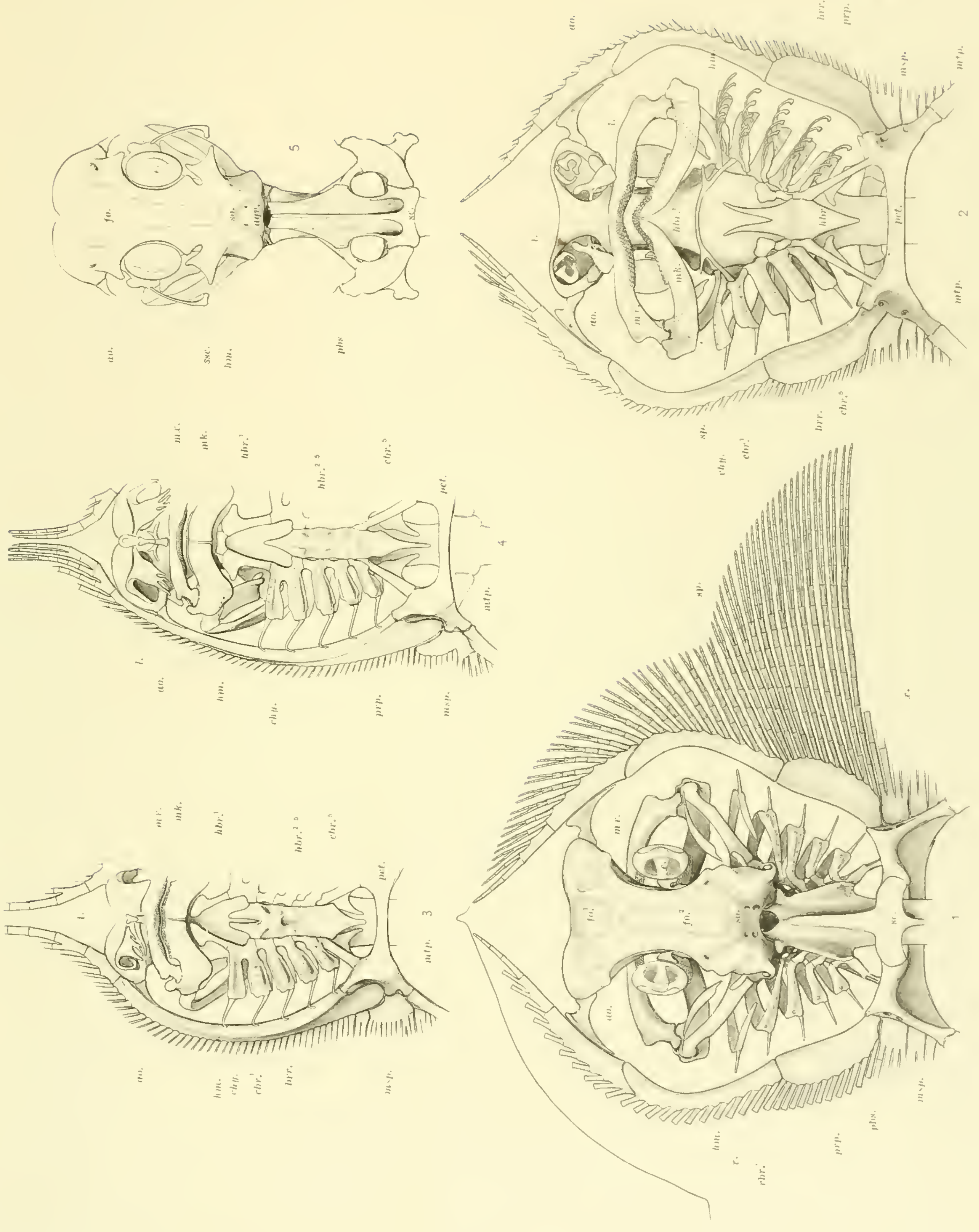

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PLATE 70.

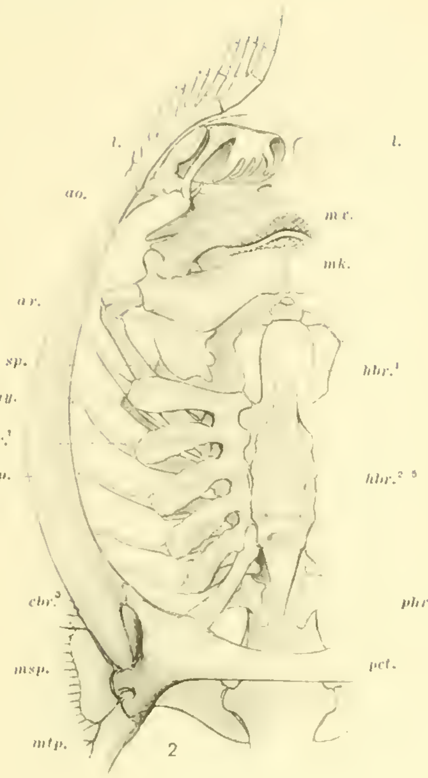
PLATE 70.

POTAMOTRYGONIDAE.

Fig. 1–2. Potamotrygon circularis. M. C. Z. 295 (Page 419). Fig. 3–4. Disceus thayeri. M. C. Z. 606 (Page 426).

1, 3. Dorsal view.
2, 4. Ventral view.

The River Trygons are close allies of the Dasybatidae. They have no rostral cartilage from the skull forward, the copula, *hbr′*, is segmented, the propterygial basalia of the pectoral fins, *pap*, are strong and in a single piece between the antorbital and the shoulder girdles, and the postbranchial stay, *pbs*, is reduced. Disceus, fig. 3, has a small hardly distinct antorbital cartilage, *ro*, a broad postspiracular *psp*, a wide bar in the shoulder girdle and short orbital processes; Potamotrygon, fig. 1, has a larger antorbital, a narrow and elongate postspiracular, a narrower bar in the girdle and longer orbital processes. In both genera the ceratobranchials are more or less solidly anchylosed. Disceus has elongate narrow opercular cartilages, *op* 1–5.



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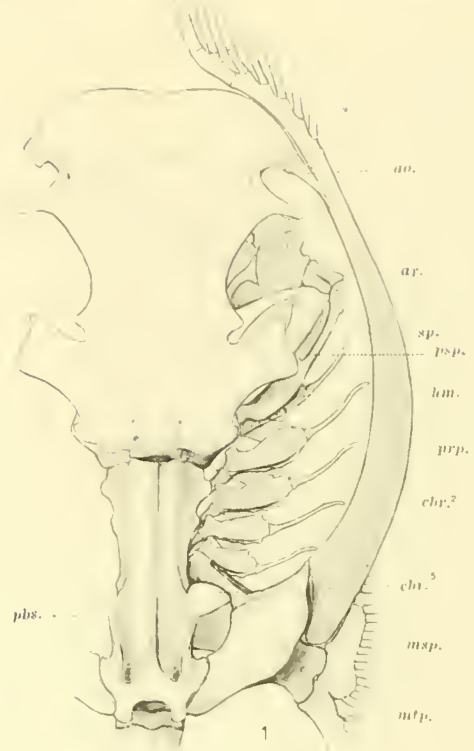

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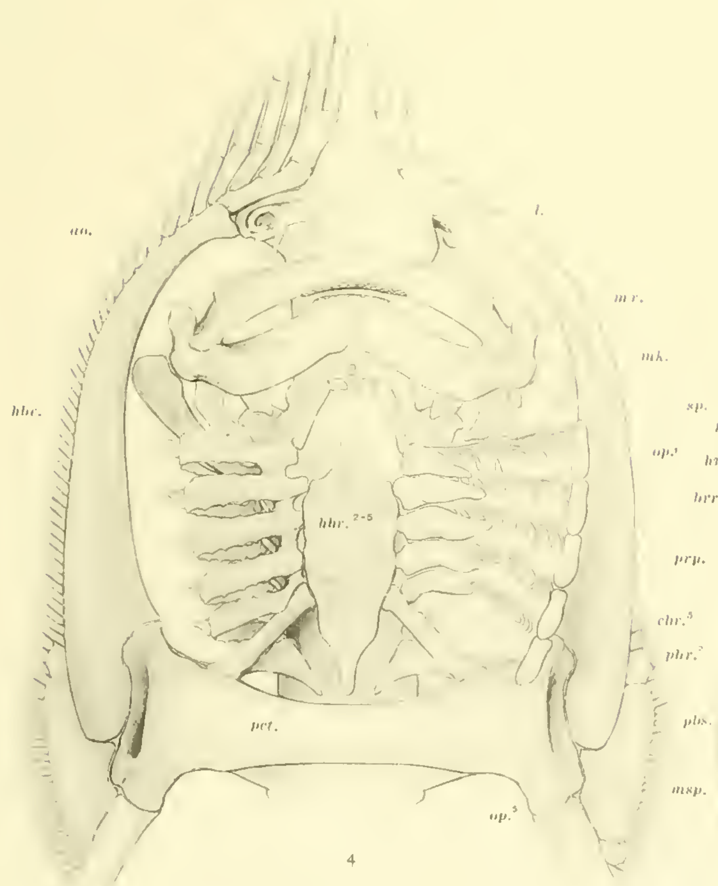

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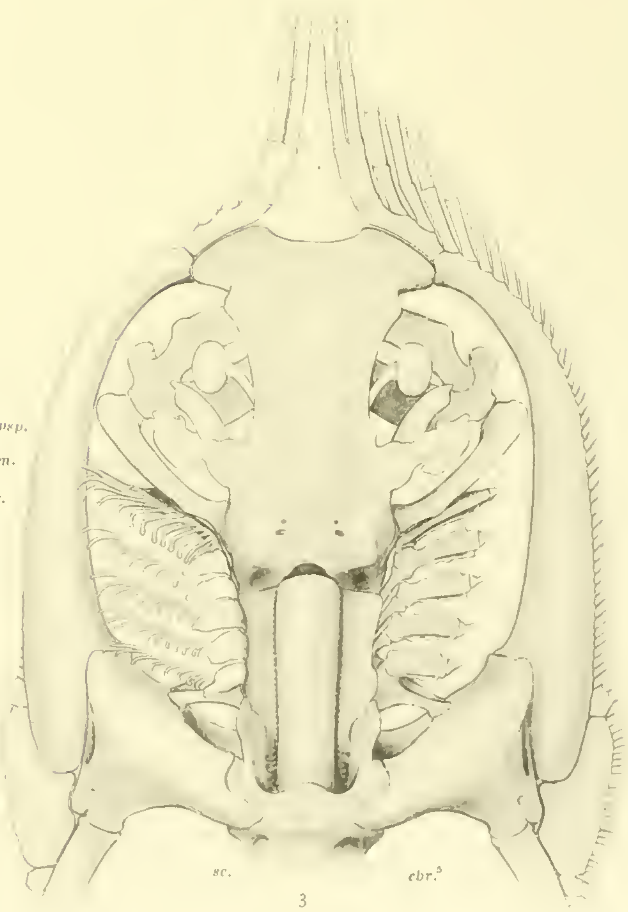

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PLATE 71.

PLATE 71.

DASYBATIDAE.

Fig. 1–2. Dasybatus guttatus. M. C. Z. 639 (Page 391). Fig. 3. Dasybatus zugei. M. C. Z. 23 (Page 398). Fig. 4–5. Taeniura lymma. M. C. Z. 620 (Page 399).

1, 3, 4. Dorsal view.
2, 5. Ventral view.

Rigidity of the disk around the head and the branchial chamber is secured by the elongation and firmness of the propterygial segment of the pectoral base. The copula, *hbr'*, unlike that of the Raiidae, is segmented; anteriorly, in the basibranchial portion, it broadens toward the suspensorium, hyomandibular, *hm*. The ceratobranchials are more or less consolidated and enlarged, as also the basihyals. The branchial ray, or rays, at the outer ends of the ceratohyals and ceratobranchials are attached to the bases of the pectoral at their outer ends but are not modified.

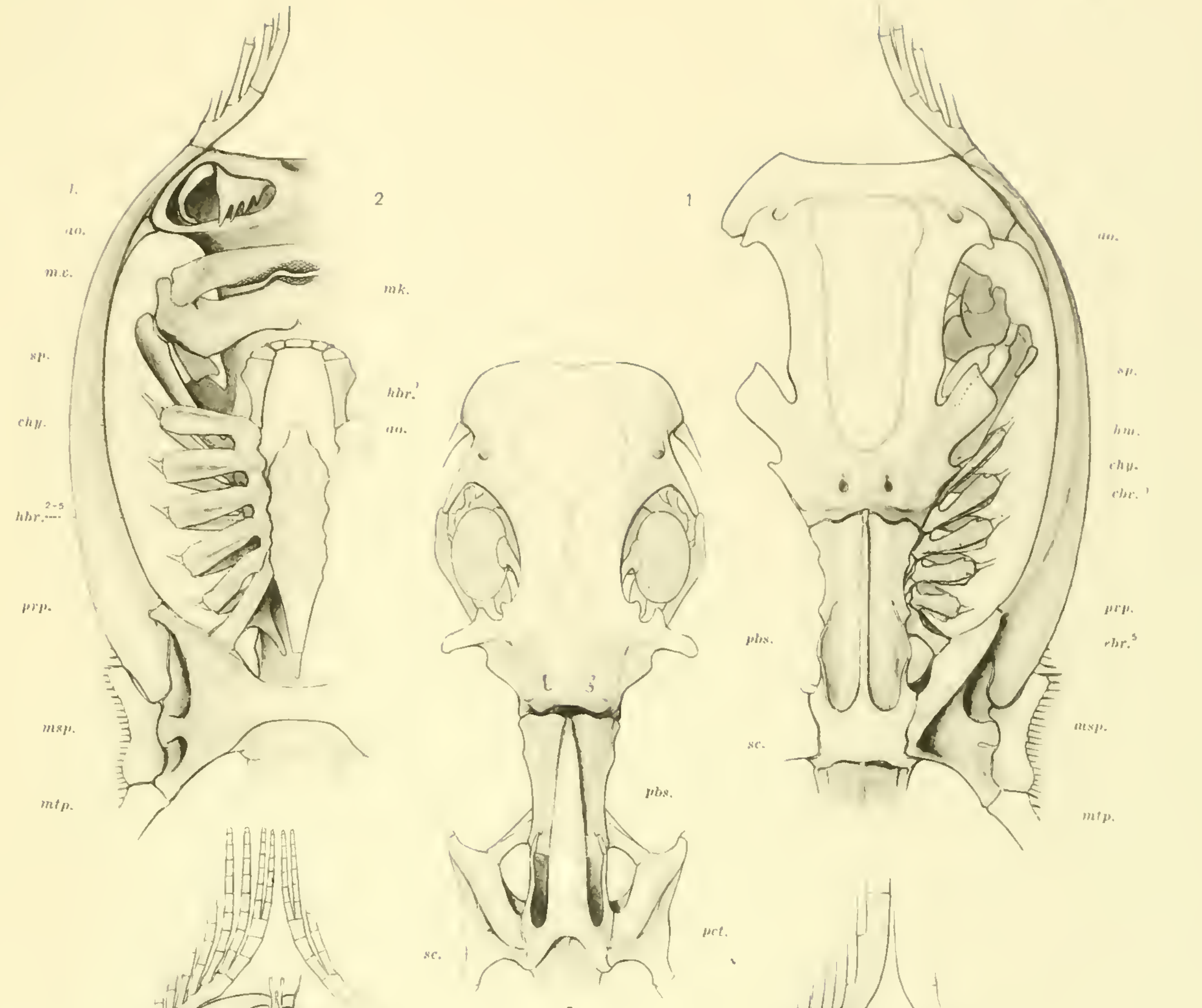

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PLATE 72.

PLATE 72.

Fig. 1–2. Pteroplatea altavela. (Page 415).

Except in what is more directly affected by the broadening of the body and the pectorals this genus exhibits no great departure from the other Dasybatidae. The copula is segmented, the propterygial segment of the pectoral base is strong and elongate and reaches slightly beyond the antorbital, the ceratobranchials, *cbr*, are fused at their inward ends, and the basihyals form a large broad shield-like plate. The shoulder girdle has been modified in several particulars; the pectoral bar, *pct*, has widened and the scapular braces to the pro- meso- and metapterygia have elongated, though the scapula, *sc*, from which they extend outward, is comparatively little changed.

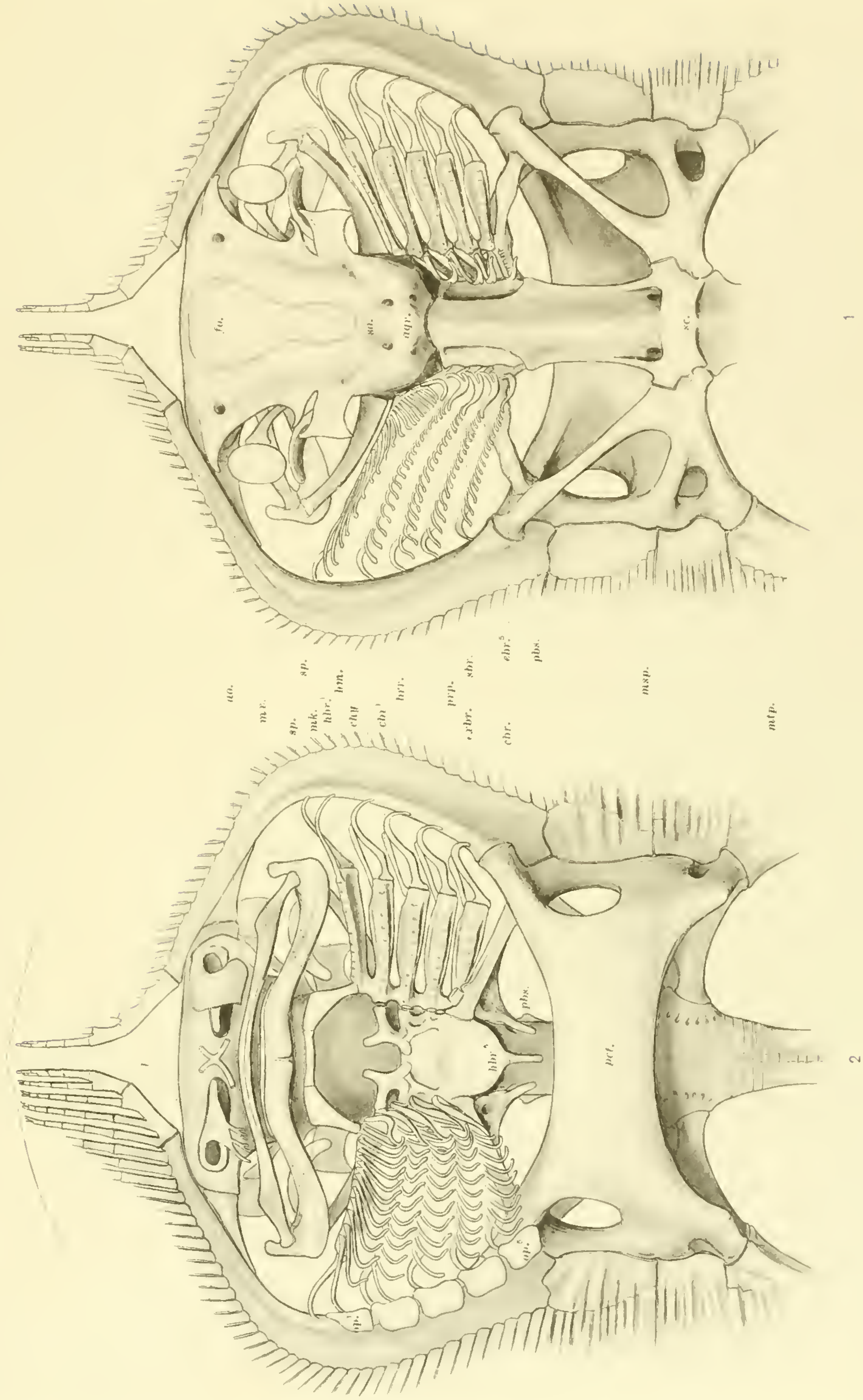
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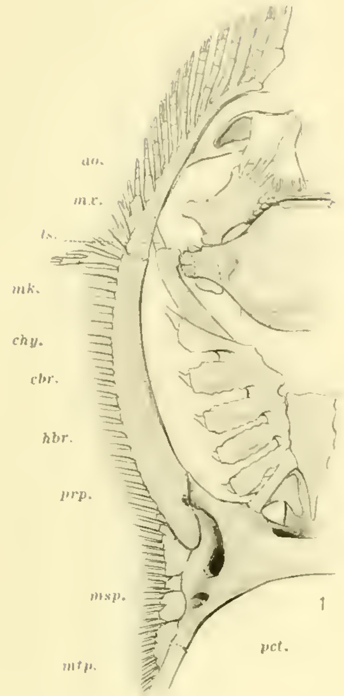
PLATE 73

PLATE 73.

MYLIOBATIDAE.

Fig. 1. Myliobatis aquila. M. C. Z. 623 (Page 431). Fig. 2. Myliobatis peruvianus. M. C. Z. 636 (Page 430). Fig. 3. Aetomylaeus maculatus. M. C. Z. 106 (Page 435). Fig. 4. Aëtobatus narinari. M. C. Z. 677 (Page 441).

Three of the genera of the Myliobatidae are figured here. The fourth, Pteromylaeus, stands between Aëtomylaeus and Aëtobatus; it has the narrowed head and the separation of the pectorals as in the latter, but has a different dentition. Myliobatis, fig. 1, differs from the rest of the family in possessing a continuous pectoral along the side of the head, and in absence of the modification of the pectoral rays opposite the lower jaw. In all the genera the propterygial segment of the base of the pectoral extends beyond the antorbital, that is beyond the head. In the very young this section of the base appears to be somewhat irregularly segmented, but these indications are transitory, probably ancestral tokens. The branchial ray at the outer end of the ceratobranchial is slightly modified at its point of attachment to the pectoral base. The extra series of cartilages, *cvs*, in front of the branchial rays along the ceratobranchials and epibranchials are more developed than in preceding families. The extrabranchials, *sbr*, above and below, are well developed; they are modified branchial rays. The opercular cartilages, *op* 1–5, are fringed. Extra cartilages, *cvs*, appear upon or along the bands of the gill lamellae; these may be called epitropeal, the upper ones being supratropeals, the lower subtropeals.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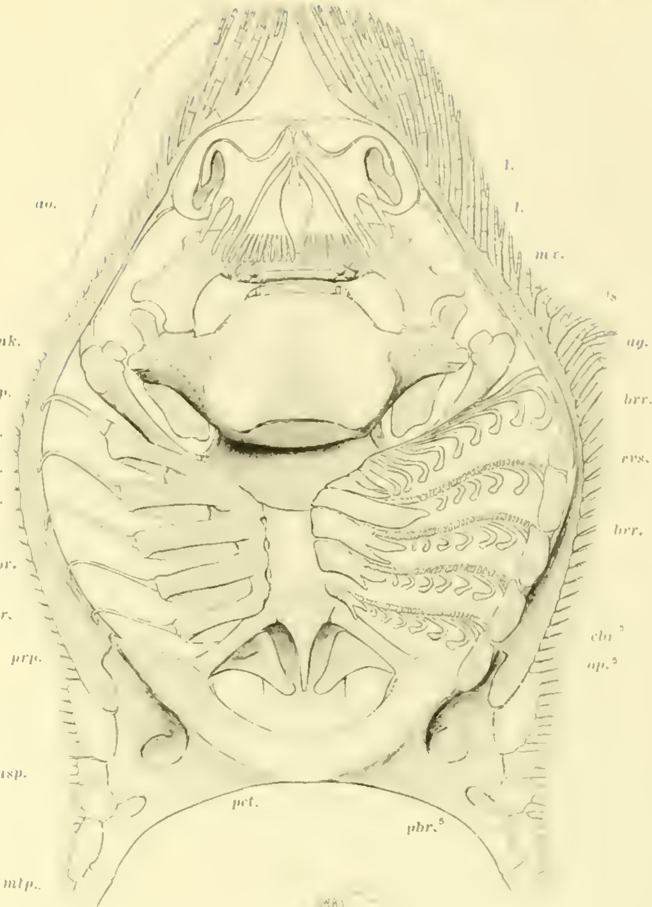
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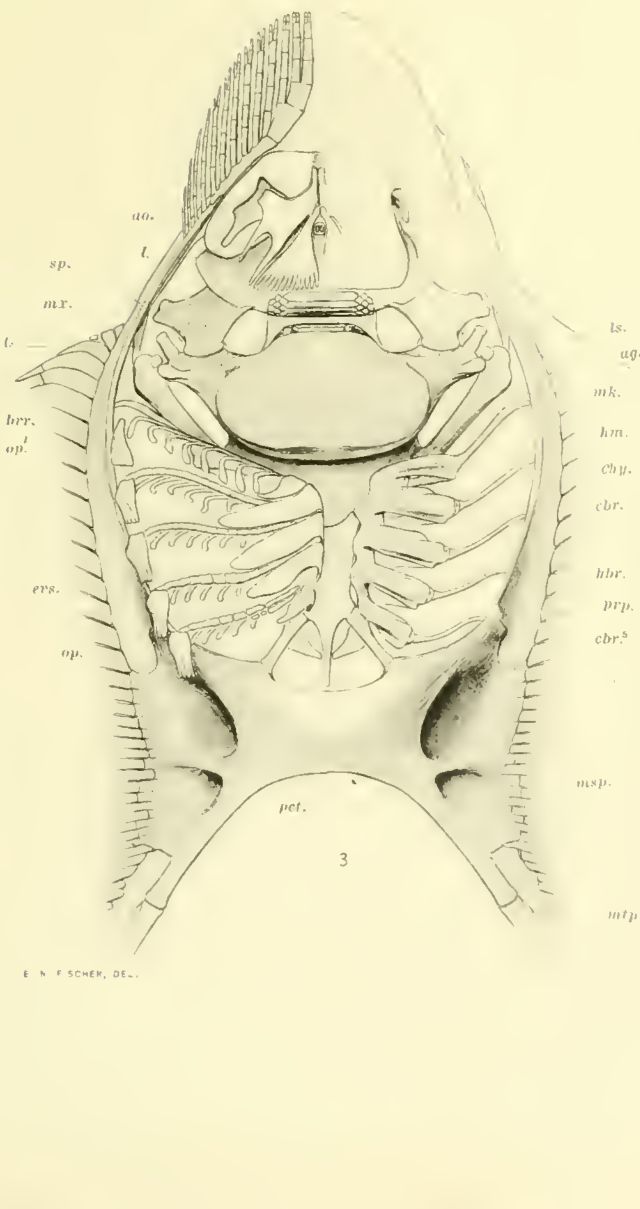
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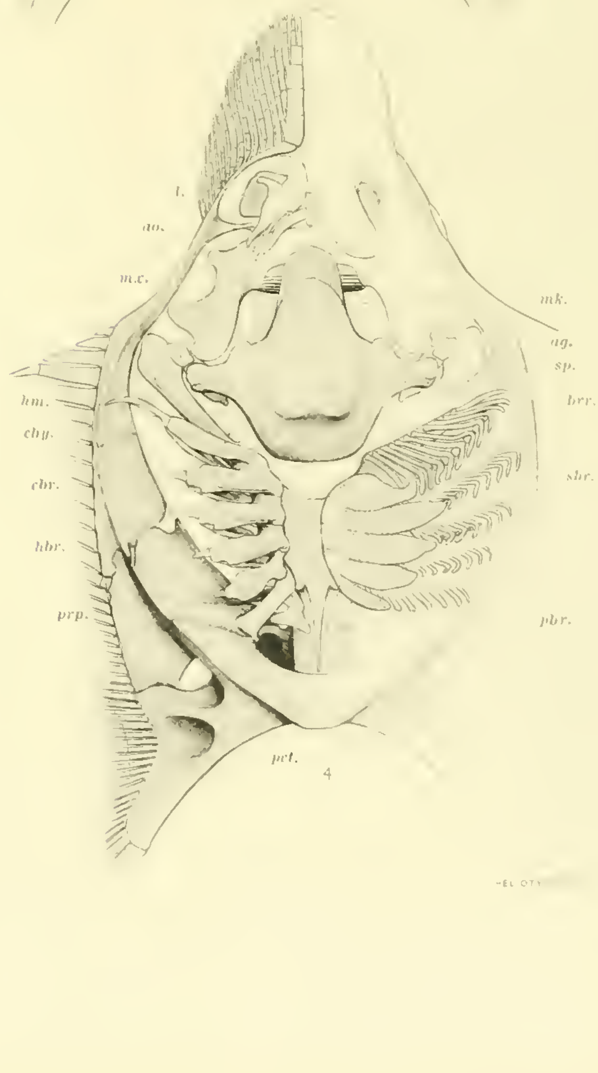
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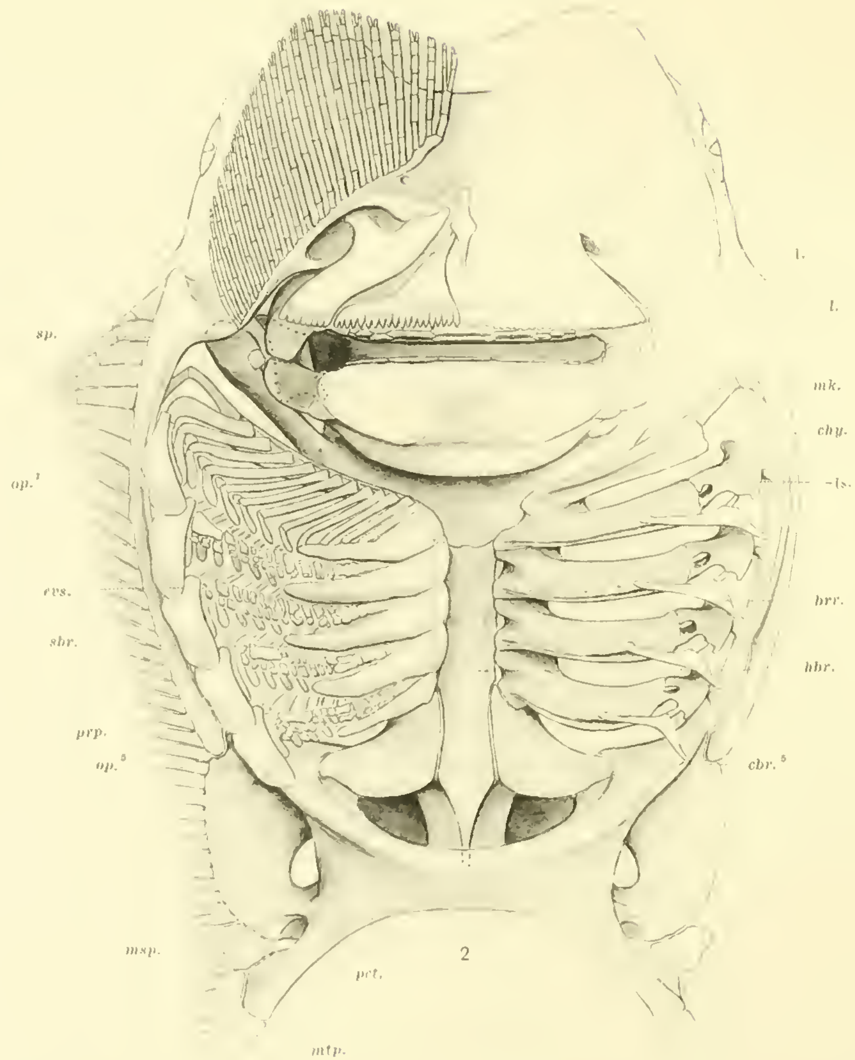
PLATE **74**.

PLATE **74**.

RHINOPTERIDAE.

Fig. 1–2. Rhinoptera jussieui. M. C. Z. 863 (Page 447).

The skull of the Rhinopteridae is short, broad, and somewhat indented in front. The cephalic fins are quite distinct from the pectorals, are situated at a lower level, and are not widely separated from one another in front of the mouth. The mouth is widened and the jaws are broadened, the narial cartilages are long and broad. The propterygial bases of the pectorals are unsegmented at the sides of the gill chambers, unless it be in very young stages, they are enlarged and strengthened, and to further conduce to stability and firmness the lateral stays, *ls*, *bra*, *bre*, are so greatly modified as to be hardly recognizable as gill rays; the anterior, *ls*, is directed forward over the antorbital, *ao*, as a single elongate cartilage; the second, *brr*, fig. 1, is directed outward, segmented and turned back in its outer segment; the third, *bra*, and the following show the outer segment firmly attached to the base of the pectoral while the inner segment of the ray, *bre*, is broadened and enlarged into a sort of hammer-shape, solidly attached to the ceratobranchial and the epibranchial at their junction, and also to the outer stay or segment, *bra*. The epitropeal cartilages, supratropeal and subtropeal, *evs*, form regular series above the arches, and irregular ones below them. The extrabranchials, *sbr*, supra and sub are large. The mesopterygia are much reduced or fused with the girdle, *pct*. The anterior *hm*, in fig. 1, should be *sp*. Changes in the structure of the gills leading towards Mobula are seen in the Rhinopteridae; the inward section of each lamina takes on more of the functions of protection and of propelling the food toward the stomach while the outer section is more concerned in purifying the blood, see Plate **59**, fig. 9–10.



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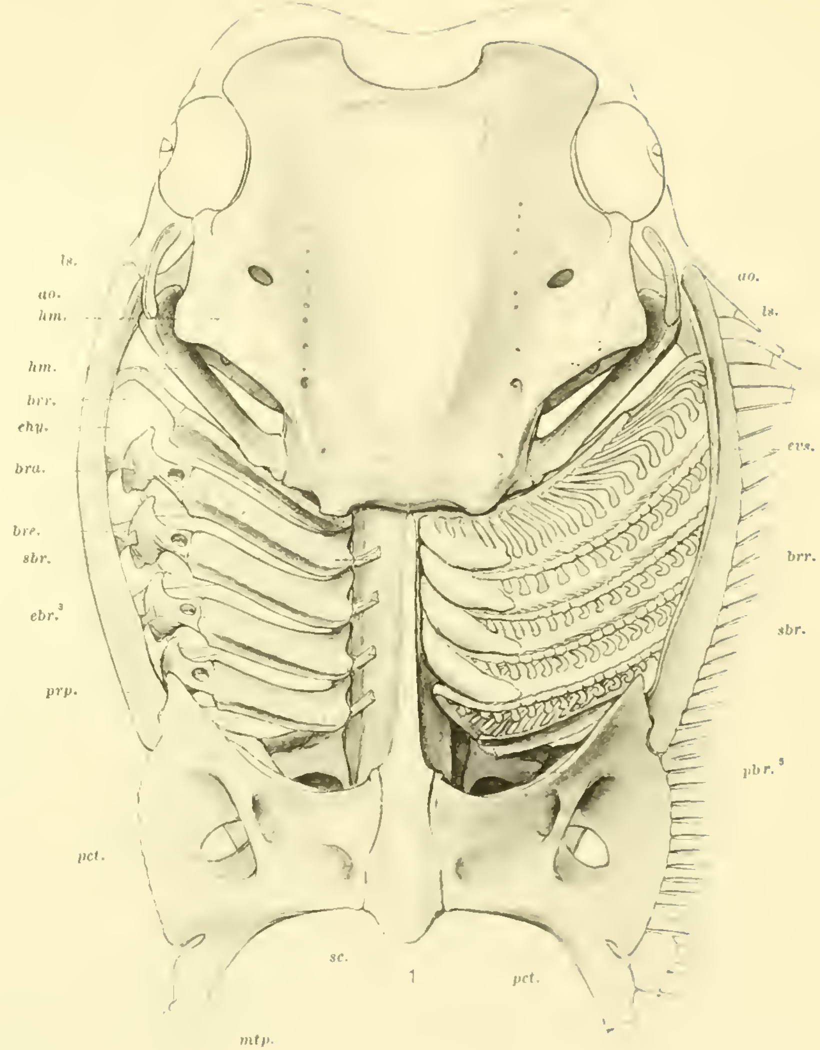

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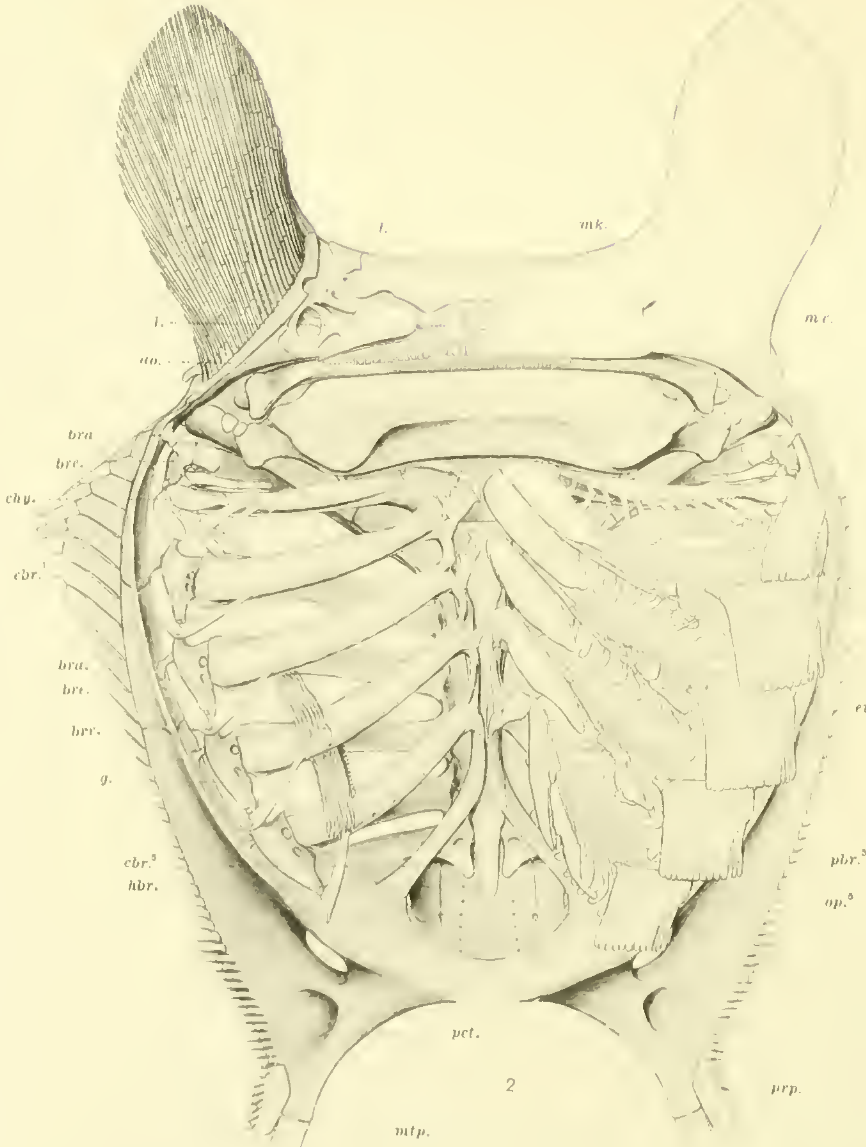
PLATE 75.

PLATE 75.

MOBULIDAE.

Fig. 1–2. MOBULA HYPOSTOMA (Page 453).

A course of evolution resembling the actual course traversed by Mobula from an ancestral form like the Dasybati may be traced through Myliobatis, Aetomylaeus, and Rhinoptera by means of the pectoral and the cephalic fins — connected and meeting in front of the head and lacking the modified radials opposite the gills in Myliobatis, disconnected at the sides but still meeting in front and possessed of the modified radials in Aetomylaeus and Rhinoptera — or by means of the propterygial bases of the pectorals, or even by means of the outer branchial rays their attachments and their transformations quite as readily as by means of the dentition, the narial cartilages, or the skull itself. The cranium of Mobula is broader and more indented in the forehead than that of Rhinoptera. The cephalic fins are distant from one another in front of the head; they are radically separated from the pectorals, the anterior rays of which latter have undergone considerable changes of form. The mouth is widened; the jaws are elongate. The outer branchial rays are transformed into braces or stays, *ls*, *bra*, *brc*, in a more firm attachment of the gill arches. The extrabranchials, *sbr*, are highly developed; originally they were branchial rays, and they do not closely correspond with the extrabranchials seen, on Plate **51**, fig. 2, or on Plate **62**, *exbr* and *sbr*, in the shark. The stays *ls*, *bra*, *brc* originated as noted under Plate **74** for those in Rhinoptera. The second ray from the outer stay is lengthened, wider outward, and has a slender curved extremity; it also serves as a brace. Nearly all of the rays on the ceratohyals, *chy*, are segmented and more or less changed in form. The long strips of cartilage, *evs*, first appearing as small lumps and later fusing, upon the bends in the gill lamellae, parallel with the gill arches, are adventitious and are first noted in Myliobatidae, Plate **73**; they are named *epitropeal* cartilages, the upper *supratropeal*, the lower *subtropeal*. The opercular cartilages, *op* 1–5 attain their maximum development in this family.



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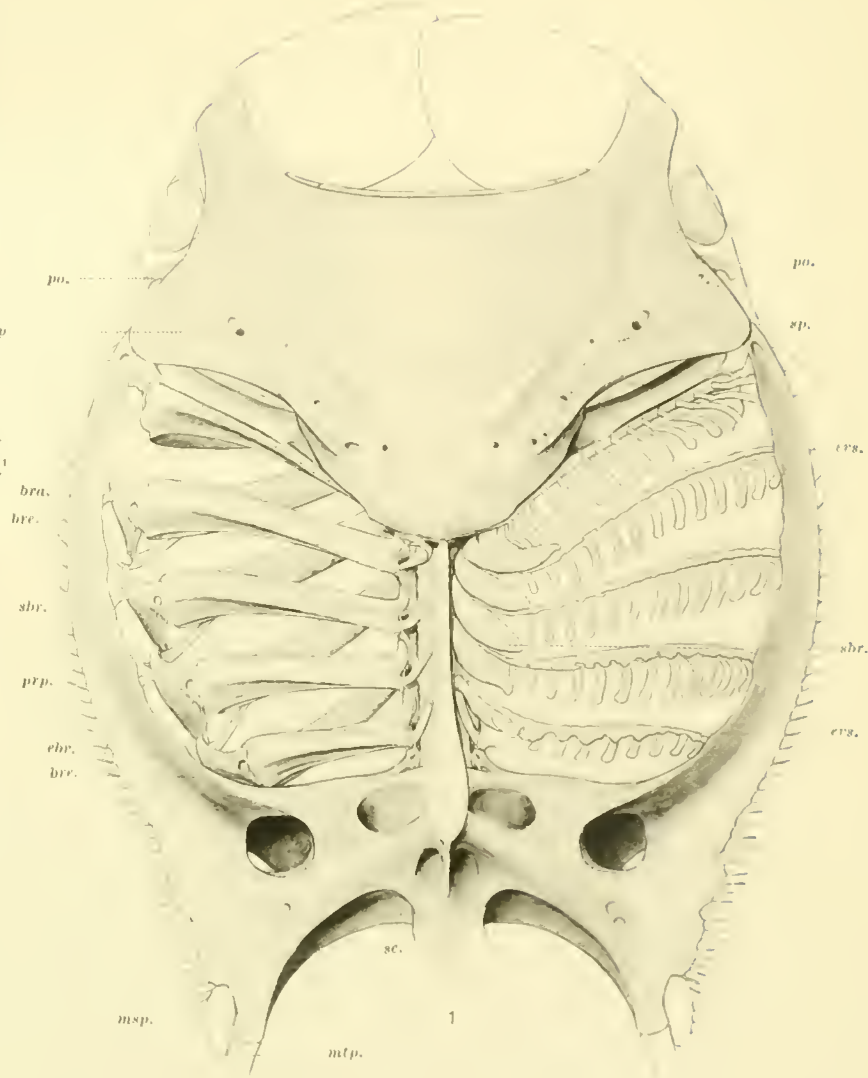

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