

CARL CHUN

THE CEPHALOPODA

PART I: OEGOPSIDA
PART II: MYOPSIDA, OCTOPODA

ATLAS

NOTE TO PLATE LXVIII

Figure 7 should read Figure 8

Figure 9 should read Figure 7

CARL CHUN

THE CEPHALOPODA

GERMAN DEEPSEA EXPEDITION 1898-1899. VOL. XVIII

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SCIENTIFIC RESULTS OF THE GERMAN DEEPSEA EXPEDITION
ON BOARD THE STEAMSHIP "VALDIVIA" 1898-1899

Volume Eighteen

UNDER THE AUSPICES OF THE GERMAN MINISTRY OF THE INTERIOR

Supervised by CARL CHUN, Director of the Expedition

Professor of Zoology, Leipzig.

After 1914 continued by

AUGUST BRAUER

Professor of Zoology, Berlin

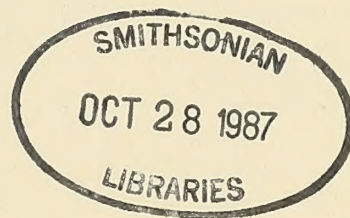
CARL CHUN

THE CEPHALOPODA

PART I: OEGOPSIDA

PART II: MYOPSIDA, OCTOPODA

ATLAS



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Since the study of the Cephalopoda is a very specialized field with a unique and specific terminology and phraseology, it was necessary to edit the translation in a technical sense to insure that as accurate and meaningful a representation of Chun's original work as possible would be achieved. We hope to have accomplished this responsibility.

Clyde F. E. Roper and Ingrid H. Roper
Technical Editors

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List of Plates

- I *Thaumatolampas diadema*
n.gen.n.sp. 50
- II *Thaumatolampas diadema*
CH. 50
- III *Thaumatolampas diadema*
CH. 50
- IV *Thaumatolampas diadema*,
luminous organs 61
- V *Abraliopsis morisii* VÉR.
64
- VI *Abraliopsis morisii* VÉR.,
male and juvenile stages
64
- VII Young larvae of
Abraliopsis 80
Young larvae of
Thelidioteuthis
alessandrinii VÉR. 83
Indeterminable larvae of
Enoploteuthidae 82
- VIII *Abraliopsis morisii* VÉR.,
arm apparatus and
buccal funnel 68
- IX *Abraliopsis morisii* VÉR.,
mantle complex and
genitalia 73
Abralia veranyi RÜPP.,
mantle complex and
genitalia 76
- X *Abraliopsis morisii* VÉR.,
hectocotylus, genitalia,
luminous organs 67
- XI *Pyroteuthis margaritifera*
VÉR. 106
Enoploteuthis leptura
D'ORB. 86
- XII *Pterygioteuthis giardi*
FISCHER, males and
juvenile forms 87
- XIII *Pterygioteuthis giardi*, *Pt.*
gemmata, arm, buccal
funnel, larvae 87
Pyroteuthis margaritifera
90
Indeterminable larvae of
Enoploteuthidae 85
- XIV *Pterygioteuthis giardi*, *Pt.*
gemmata, arrangement
of luminous organs 95
Pyroteuthis margaritifera
106
- XV *Pterygioteuthis giardi*, *Pt.*
gemmata, hectocotylus
and genitalia 93
- XVI *Pterygioteuthis giardi*, *Pt.*
gemmata, luminous
organs 96
- XVII *Octopodoteuthis* RÜPPEL
(*Veranya* KROHN),
larvae 109
- XVIII *Calliteuthis hoylei*
GOODRICH 133
Calliteuthis reversa 136
Histioteuthis 138
- XIX *Histioteuthis* 138, 139
Calliteuthis hoylei
GOODRICH 133
Calliteuthis reversa 136
- XX *Calliteuthis hoylei*
GOODRICH 118, 124,
133
Calliteuthis reversa 136
Calliteuthis ocellata 128,
130
- XXI *Histioteuthis ruppellii*
130, 138
- XXII *Teleoteuthis caribaea*
LESUEUR 141, 142
- XXIII Larvae of Onychoteuthidae
143
Teleoteuthis caribaea,
clubs 141
- XXIV *Benthoteuthis megalops*
VERRILL (*Bathyteuthis*
abyssicola HOYLE)
145
- XXV *Benthoteuthis megalops*
VERRILL, arm
apparatus 145, 151–
152
- XXVI *Benthoteuthis megalops*
VERRILL, intestinal
tract, vascular system
145, 152
- XXVII *Benthoteuthis megalops*
VERRILL, eye and
luminous organ 145
- XXVIII *Rhynchoteuthis*, larvae
157–160
- XXIX *Rhynchoteuthis*, larvae
157–160
Brachioteuthis, larvae 166
Brachioteuthis picta
CHUN 162
- XXX *Brachioteuthis*, juvenile
166
Brachioteuthis picta 162
- XXXI *Brachioteuthis picta* n.sp.
162
Juvenile *Brachioteuthis*,
gladius and arm
apparatus 166
- XXXII *Brachioteuthis picta* n.sp.,
head, intestinal tract,
vascular system 162
- XXXIII *Mastigoteuthis glaukopsis*
n.sp. 184
M. flammea n.sp. 181
- XXXIV *Mastigoteuthis cordiformis*
n.sp. 177
- XXXV *Mastigoteuthis* VERRILL,
gladius, cartilage, arm
apparatus
M. cordiformis n.sp. 177
M. glaukopsis n.sp. 184
M. flammea 181
- XXXVI *Mastigoteuthis*, anatomy
M. flammea 181
M. cordiformis 177
- XXXVII *Mastigoteuthis*, luminous
organs
M. glaukopsis 184
M. flammea 181
M. cordiformis 177
- XXXVIII *Chiroteuthis* (*Chirotauma*)
imperator n.sp. 189
- XXXIX *Chiroteuthis imperator*
189
Doratopsis exophthalmica
228
D. lippula 229
D. sagitta 227

C. CHUN

- XL *Chiroteuthis veranyi*
FÉRUSSAC 221
Chiroteuthis imperator
189
Ch. picteti 192
- XLI *Chiroteuthis imperator*,
nervous system, gladius,
viscera 201, 207
- XLII *Chiroteuthis*, mantle
complex, intestinal tract
Ch. imperator 189
Ch. veranyi 221
- XLIII *Chiroteuthis imperator*
189
- XLIV *Chiroteuthis*, luminous
organs, glandular knobs
Ch. veranyi 221
Ch. imperator 189
- XLV *Doratopsis sagitta* n.sp.
227
D. lippula n.sp. 229
- XLVI *Doratopsis exophthalmica*
n.sp. 228
D. lippula n.sp. 229
- XLVII *Doratopsis*, anatomy
D. sagitta 227
D. exophthalmica 228
D. vermicularis RÜPPELL
231
- XLVIII *Cranchia scabra* LEACH
257
Liocranchia valdiviae n.sp.
264
- XLIX *Cranchia scabra* LEACH
257
- L *Cranchia scabra*, anatomy
257
- LI *Liocranchia* anatomy,
juvenile forms
L. reinhardtii 269
L. valdiviae 264
- LII *Euzygaena pacifica* ISSEL
279
Leachia eschscholtzii
RATHKE 271
- LIII *Desmoteuthis pellucida*
CHUN 278
Crystalloteuthis glacialis
n.gen.n.sp. 290
- LIV *Desmoteuthis pellucida*,
anatomy 278
Crystalloteuthis glacialis,
anatomy 290
- LV *Corynomma speculator*
n.gen.n.sp. 286
- LVI *Teuthowenia antarctica*
n.sp. 293
Sandalops melancholis
n.gen.n.sp. 295
Bathothauma 242
Toxeuma belone 296
- LVII *Bathothauma* 250
Teuthowenia antarctica n.
sp. 293
- LVIII *Toxeuma belone* n.gen.n.sp.
296
Bathothauma lyromma
n.gen.n.sp. 303
- LIX *Galiteuthis (Taonidium)*
suhmii HOYLE 297
- LX Luminous organs of
Cranchiidae
Cranchia scabra 268
Liocranchia valdiviae 268
Leachia eschscholtzii 275
Corynomma speculator
289
Desmoteuthis pellucida
283
Bathothauma lyromma
303
- LXI Larvae of Cranchiidae 304
- LXII *Rossia mastigophora* n.sp.
311
- LXIII *Rossia mastigophora*, arm
apparatus, mantle
complex 314
- LXIV *Spirula australis* LAM.
319
- LXV *Spirula australis* LAM.,
mantle complex, arm
apparatus 325
- LXVI *Spirula australis* 319
- LXVII *Spirula australis* 319
- LXVIII *Spirula australis*, intestinal
tract 343
- LXIX *Spirula australis*, nervous
system, sensory organs
346
- LXX *Spirula australis*, vascular
system, oviducts,
luminous organs 351
- LXXI Larvae of *Spirula* 361
- LXXII *Spirula australis*, shell
332
- LXXIII *Spirula australis*, larva and
shell 332
- LXXIV *Argonauta* 369
- LXXV *Velodona togata*, n.gen.n.
sp. 373
- LXXVI *Velodona togata* n.gen.n.sp.
373
- LXXVII *Tremoctopus hyalinus*
RANG, juvenile 371
Polypus, juvenile 378
- LXXVIII Larvae of bristle bearing
Octopoda 381
- LXXIX *Polypus levis* HOYLE 380
- LXXX *Polypus valdiviae* 378
- LXXXI *Eledonella pygmaea*
VERR. 383
- LXXXII *Bolitaena diaphana*
STEENSTR. 385
- LXXXIII *Bolitaena diaphana*
STEENSTR., juvenile
385
- LXXXIV *Bolitaena* 385
- LXXXV *Bolitaena diaphana*,
Eledonella pygmaea,
nervous system 392
- LXXXVI *Bolitaena diaphana*,
Eledonella pygmaea,
static organs,
osphradium 405
- LXXXVII *Bolitaena diaphana*,
intestinal tract, male
genitalia 410
- LXXXVIII *Bolitaena*, development of
chromatophores 398
- LXXXIX *Bolitaena diaphana*,
chromatophores,
musculature, nervous
network, structure of
bristle tufts 389
- XC *Vampyroteuthis infernalis*
n.gen.n.sp. 419
- XCI *Vampyroteuthis infernalis*
n.gen.n.sp. 419
Amphitretus pelagicus
HOYLE 415
- XCII *Cirrothauma murrayi*
CHUN 422
- XCIII *Cirrothauma murrayi*
CHUN 422
- XCIV *Opisthoteuthis medusoides*
n.sp. 422
Opisthoteuthis extensa n.sp.
421
- XCV *Opisthoteuthis medusoides*
s.sp. 422
Opisthoteuthis extensa s.sp.
421

CARL CHUN

THE CEPHALOPODA

PART I: OEGOPSIDA

ATLAS

GERMAN DEEPSEA EXPEDITION 1898-1899. VOL. XVIII, PART I

WISSENSCHAFTLICHE ERGEBNISSE
DER
DEUTSCHEN TIEFSEE-EXPEDITION

AUF DEM DAMPFER „VALDIVIA“ 1898-1899

IM AUFTRAGE DES REICHSAMTES DES INNERN

HERAUSGEGEBEN VON

CARL CHUN

PROFESSOR DER ZOOLOGIE IN LEIPZIG

LEITER DER EXPEDITION

ACHTZEHNTER BAND

CARL CHUN

DIE CEPHALOPODEN

I. TEIL: OEGOPSIDA

ATLAS



JENA
VERLAG VON GUSTAV FISCHER
1910

Eingegangen den 15. November 1909, C. Chun

PLATES

Plate I

Thaumatolampas diadema n. gen. n. sp.

- Figure 1. Specimen from Station 89, southern part of the Benguela Current. Left side. $\times 2.5$
Figure 2. Same, ventral side. The ventral luminous organs are visible through the mantle.
Figure 3. Specimen from Station 118; West Wind Drift, south of Cape Province. Chromatophores on mantle were abraded; the light-colored gills and branchial hearts and the brown-red stomach are visible through the mantle. $\times 2.5$

Figures are based on color sketches of the live animal.

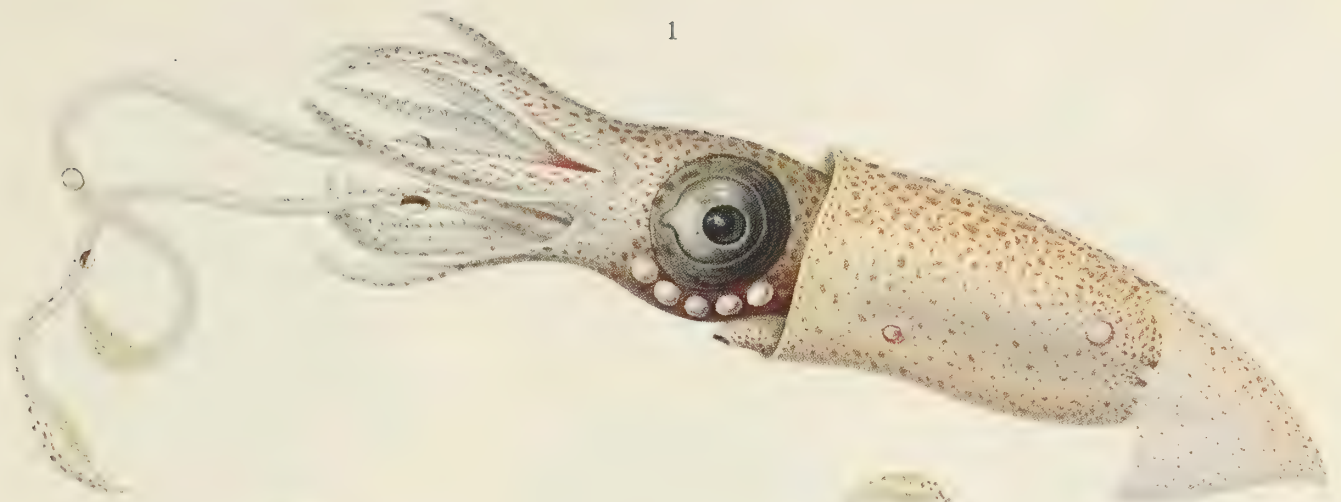


Plate II

Thaumatolampas diadema CH.

- Figure 1. Luminous organs of specimen from Station 118
Drawing based on a photograph of the live animal
- Figure 2. Head and funnel of specimen from Station 89, diagonally from the right. $\times 5$.
- Figure 3. Specimen from Station 118, with opened mantle cavity. $\times 2.5$
- Figure 4. Specimen from Station 89. Funnel opened to show the funnel organ, the middle part of which is situated before the anus with the two and appendages. Anal organs red
- Figure 5. Mantle complex of specimen from Station 89. Right anal organ (red) covered by vena cava
- Figure 6. Buccal funnel of specimen from Station 89, ventral Attachment to ventral arms has been cut, and ventral arms and tentacles bent down.
1, 2, 3, 4—points of buccal funnel
- Figure 7. Deep attachment of 3rd and 4th arms.
- Figure 8. Central and two adjacent eye organs.
Drawn after the preserved specimen.

ABBREVIATIONS

- | | | |
|--|--|--|
| <i>a. post.</i> — posterior artery | <i>luc. br.</i> — branchial organ | <i>mu. r. abd.</i> — musculus rectus abdominis |
| <i>br. 3</i> —3rd arm | <i>luc. tent.</i> — organ of tentacle | <i>nid.</i> — nidamental gland |
| <i>br. 4</i> — 4th arm | <i>luc. v.</i> — median ventral organ | <i>s.</i> — knob on 3rd buccal pillar |
| <i>c. br.</i> — branchial heart | <i>luc. v. a.</i> — median ventral organ | <i>tent.</i> — tentacle |
| <i>col. bucc. 3</i> —3rd buccal pillar | <i>luc. v. lat.</i> — lateral ventral organ | <i>tub. olf.</i> — olfactory tubercle |
| <i>fun. br. 4</i> — attachment of 4th arm | <i>luc. v. p.</i> — posterior ventral organ | <i>ur.</i> — papilla of renal sac |
| <i>funic. t.</i> — muscular attachment of tentacle | <i>mu. depr. inf.</i> — funnel depressor | <i>v. abd.</i> — abdominal vein |
| <i>lam. tect.</i> — protective membrane | <i>mu. obl. 3</i> —deep attachment from 3rd to 4th arm | <i>v. branch.</i> —branchial vein |
| <i>luc. an</i> — anal luminous organ | <i>mu. obl. 4</i> —deep attachment from 4th to 3rd arm | <i>v. c.</i> —vena cava |
| | | <i>valv.</i> — funnel valve |

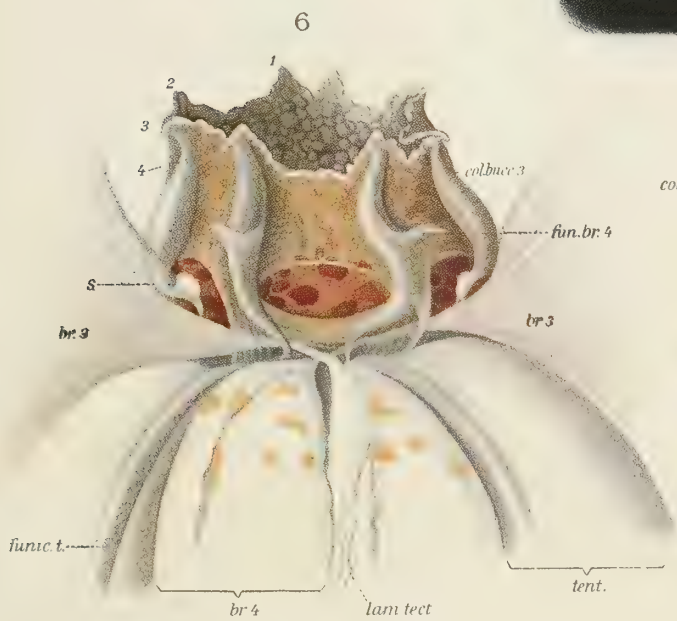
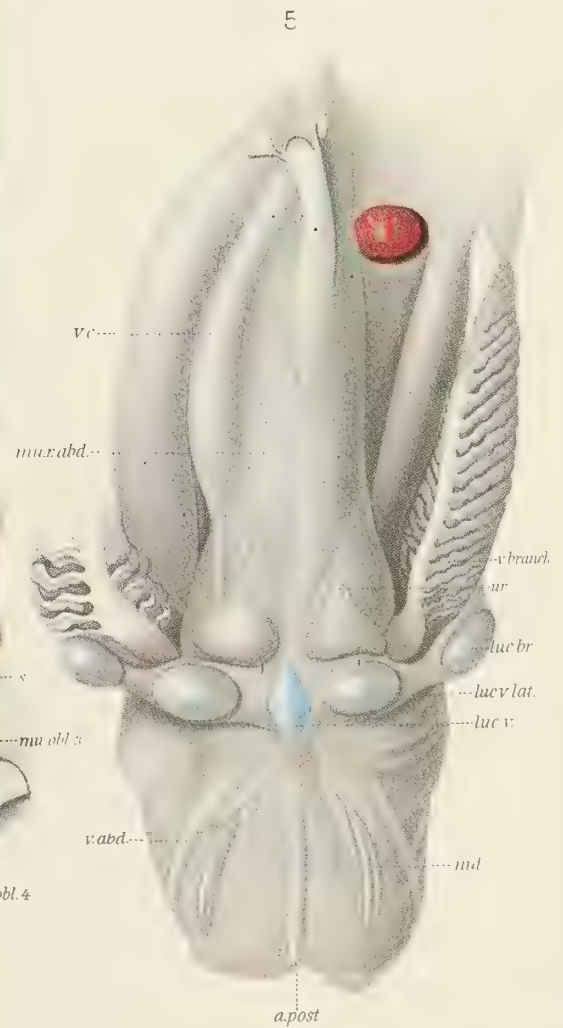
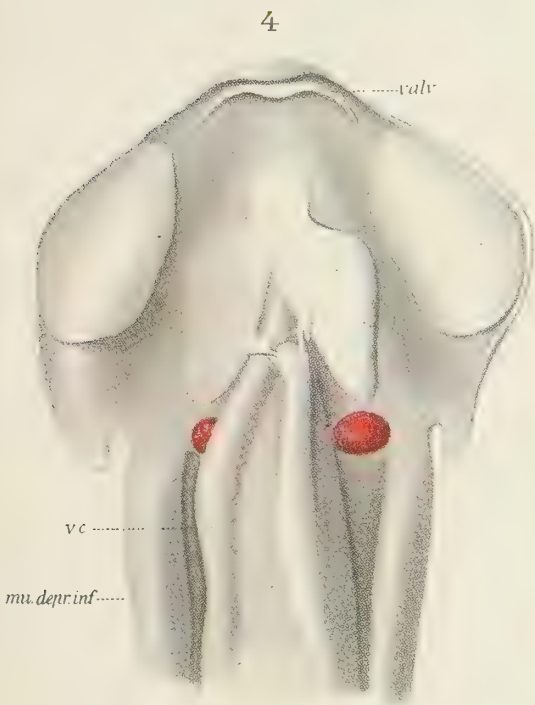
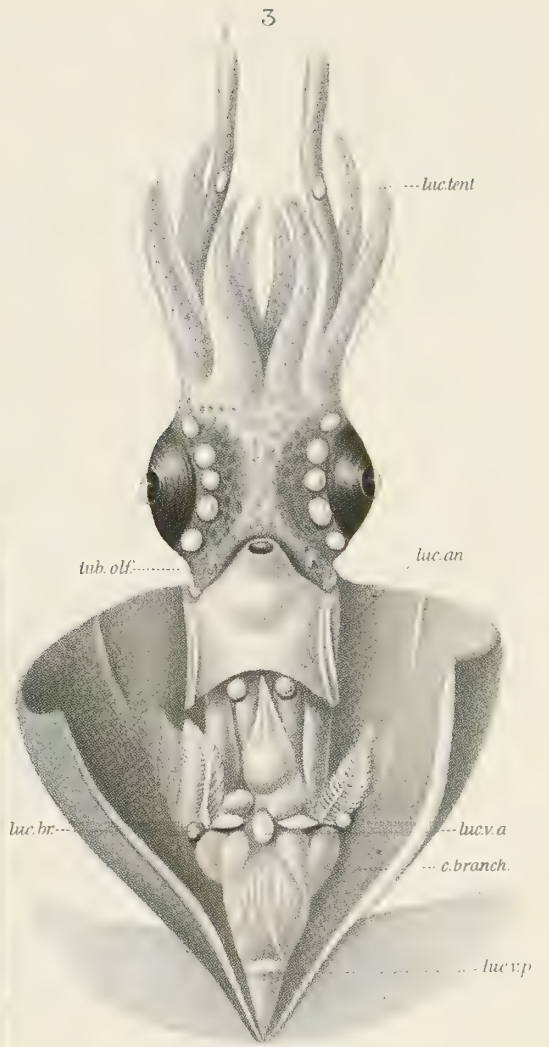
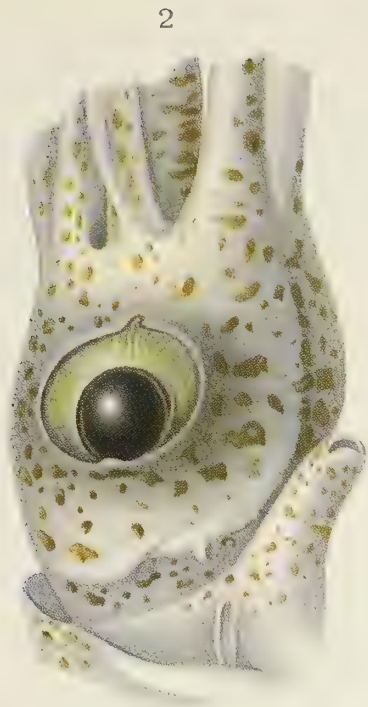


Plate III

Thaumatolampas diadema CH.

- Figure 1. Specimen from Station 89. Arm apparatus and buccal funnel. Appr. $\times 4$
Figure 2. Specimen from Station 89. Right tentacle club
Figure 3. Upper jaw, lateral. Station 118
Figure 4. Lower jaw, lateral.
Figure 5. Lower jaw, viewed from below.
Figure 6. Gladius, ventral. $\times 3.5$. Specimen from Station 118
Figure 7. Same, lateral. $\times 7$
Figure 8. Posterior end of gladius. $\times 12$
Figure 9. Neck cartilage. $\times 6$. Specimen from Station 89
Figure 10. Sucker of ventral arm. Station 118
Figure 11. Sucker of ventral arm in longitudinal section.
Figure 12. Sucker of tentacle club. Chitinous ring, seen from above. Specimen from Station 118
Figure 13. Denticles of tentacle suckers, lateral.
Figure 14. Outer denticle of tentacle suckers, lateral.
Figure 15 a, b. Radula. Specimen from Station 118
Figure 16. Longitudinal (radial) section of buccal pillar and buccal lips. $\times 55$. Hemalum. Station 118
Figure 17. Longitudinal section of knob of 3rd buccal pillar. Hemalum. Station 118
Figure 18. Right branchial area and adjacent organs of specimen from Station 118.
Figure 19. Right oviduct of specimen from Station 89. $\times 30$

ABBREVIATIONS

a. gul.—gular lamella of lower jaw
a. pal.—palatine lamella of upper jaw
a. r.—rostral wings
ann.—ring of suckers
app. c.—appendages of branchial heart
app. ren.—venous appendage of renal sac
c. br.—branchial heart
ch.—chitinous ring of sucker
chr.—chromatophores
d.—inner teeth of suckers

d'.—outer teeth of suckers
ga.—ganglionic layer in sensory knob
gl. nid.—nidamental gland
gl. ovd.—oviduct gland
lb. ext.—outer buccal lip
lb. i.—inner buccal lip
lig. br.—branchial ligament
m. depr. inf.—funnel depressor
ma.—matrix of chitinous ring
n.—nerve

ovd.—oviduct
p.—muscular pad of sucker
ped.—stalk of sucker
pil.—buccal pillar
r.—rostrum
v.—vein
v. abd. d.—right abdominal vein
v. br.—branchial vein
v. p. d.—right pallial vein
vill.—buccal villi

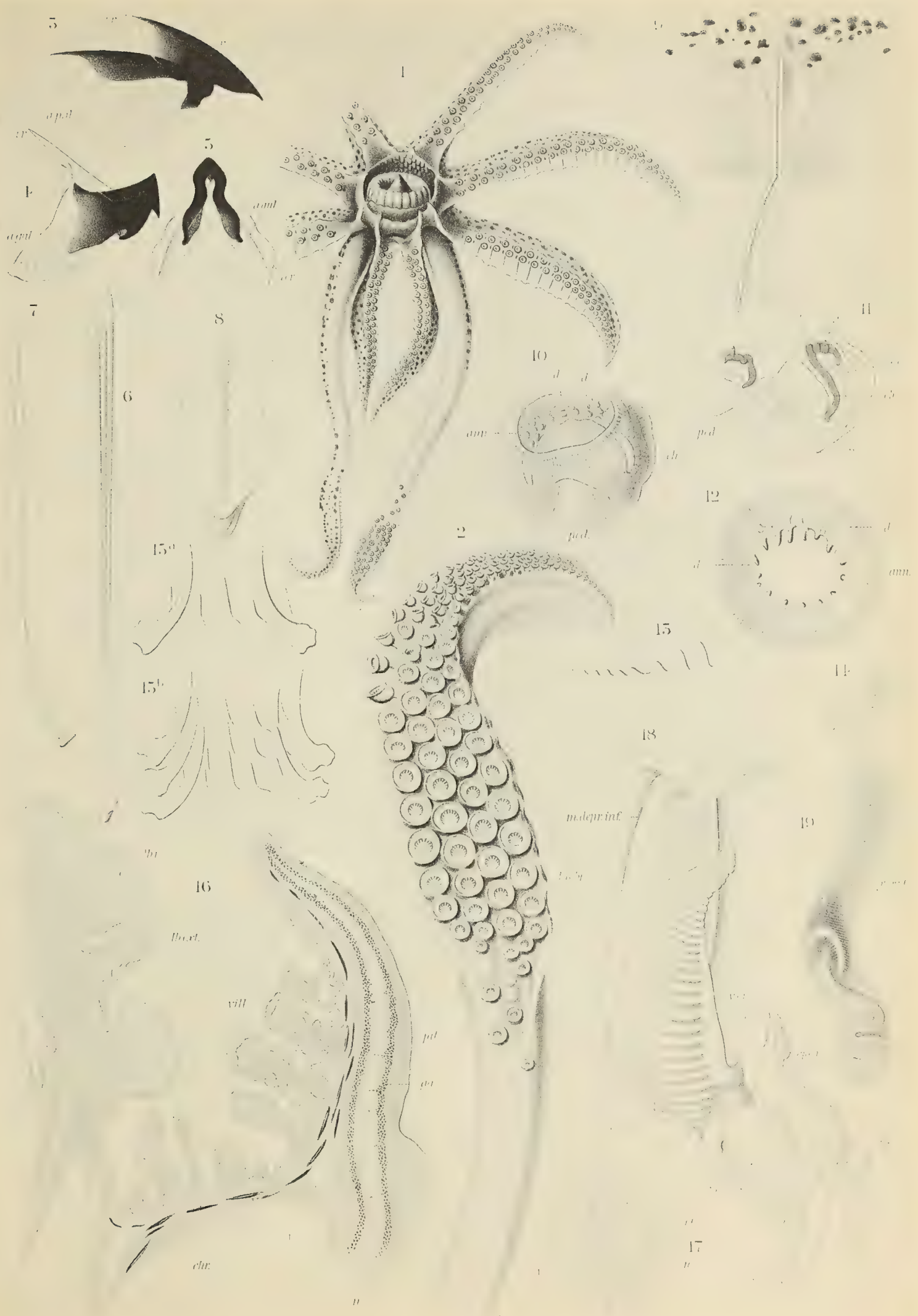


Plate IV

Luminous organs of *Thaumatolampas diadema* after preservation in formol-alcohol

- Figure 1. Transverse section of distal tentacle organ (double organ).
 Figure 2. Branching of nerve in luminous body of central tentacle organ. Zeiss F. 2
 Figure 3. Section of middle and two lateral organs of eye.
 Figure 4. The small double organ of the marginal organ of the eye. Hemalum. $\times 350$
 Figure 5. Lateral luminous cells of middle organ of eye. Hemalum. Zeiss F. 2
 Figure 6. Luminous cells from center of middle organ of eye and capillary network. Hemalum. Zeiss F. 2
 Figure 7. Squamous cells of middle organ of eye. Hemalum. Zeiss F. 2
 Figure 8. Squamous cells seen from the surface. Hemalum. Zeiss F. 2
 Figure 9. Median section of anal organ. Hemalum
 Figure 10. Marginal cells of tapetum of base of anal organ. Hemalum. Zeiss F. 2
 Figure 11. Tapetal cell of inner surface of anal organ. Hemalum. Zeiss F. 2
 Figure 12. Branching of nerve radiating into luminous body of anal organ. Iron-hematoxylin. Zeiss F. 2
 Figure 13. Section through fibrous squamous cell of anal organ. Hemalum. Zeiss F. 2
 Figure 14. Marginal nerve fibers of anal organ, joined arcade-like below the squamous cells. Hemalum. Zeiss F. 2
 Figure 15. Median and right ventral organ viewed from inner side, under magnifying lens.
 Figure 16. Lateral view of large posterior ventral organ. $\times 72$
 Cleared in oil of cloves.
 Figure 17. Lateral view of right branchial organ. $\times 72$
 Cleared in oil of cloves.
 Figure 18. Longitudinal section through middle and lateral ventral organ. A few details were copied from adjacent sections. Picrocarmine. $\times 60$
 Figure 19. Luminous cells and capillary network of lateral ventral organ. Picrocarmine. Zeiss F. 2
 Figure 20. Fibrous cells of reflector of lateral ventral organ. Picrocarmine. Zeiss F. 2
 Figure 21. Epithelial cells of renal sac, bordering on ventral organ. Hemalum. Zeiss F. 2
 Figure 22. Silken-sheeny fiber in upper distal organ of tentacle. Hemalum. Zeiss F. 2

ABBREVIATIONS

<i>a.</i> —pad of fibrous cells	<i>luc. oc. 4.</i> —4th eye organ	<i>phot.</i> —luminous body
<i>art.</i> —artery	<i>luc. oc. 5.</i> —5th eye organ	<i>phot. ext.</i> —luminous body of outer organ
<i>c. sq.</i> —squamous cells	<i>m.</i> —envelope (ventral organ)	<i>phot. int.</i> —luminous body of inner organ
<i>c. sq. ext.</i> —outer squamous cells	<i>mu.</i> —muscle fibers	<i>str.</i> —silken-sheeny fibers
<i>c. sq. int.</i> —inner squamous cells	<i>mu. long.</i> —longitudinal muscles	<i>str. ext.</i> —outer fibers
<i>cap.</i> —capillaries	<i>mu. rect. abd.</i> —musculus rectus abdominis	<i>str. int.</i> —inner fibers
<i>ep. neph.</i> —epithelium of renal sac	<i>n.</i> —nerves	<i>tap.</i> —tapetum
<i>fibr.</i> —fibrous connective tissue	<i>n. tent.</i> —nerve of tentacle	<i>tap. ext.</i> —outer tapetum
<i>lam.</i> —fine lamellae (anal organ)	<i>neph.</i> —renal sac	<i>tap. int.</i> —inner tapetum
<i>luc. centr.</i> —central luminous body (of tentacle organ)	<i>nu.</i> —nuclei	<i>v.</i> —vein or vessel, resp.
<i>luc. ext.</i> —peripheral luminous body	<i>nu. cap.</i> —nuclei of capillaries	<i>v. c.</i> —branches of vena cava
<i>luc. inf.</i> —inner organ of eye	<i>pall.</i> —mantle	<i>ven.</i> —vein
<i>luc. oc. 3.</i> —3rd eye organ	<i>pg.</i> —pigment	

Plate V

Abraliopsis morisii VÉR.

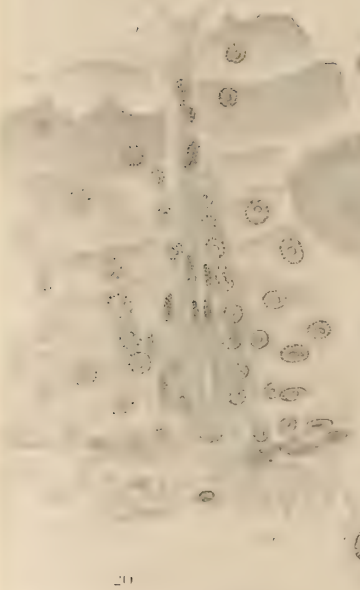
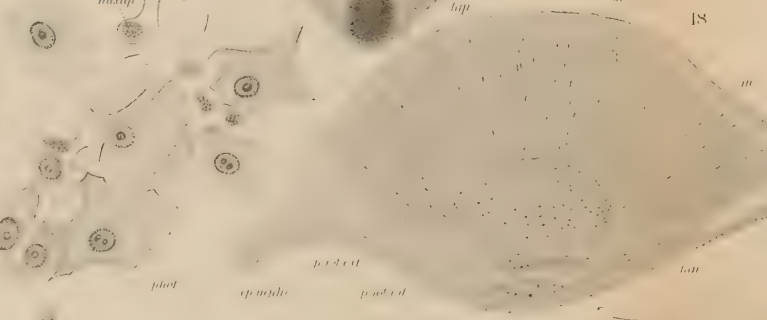
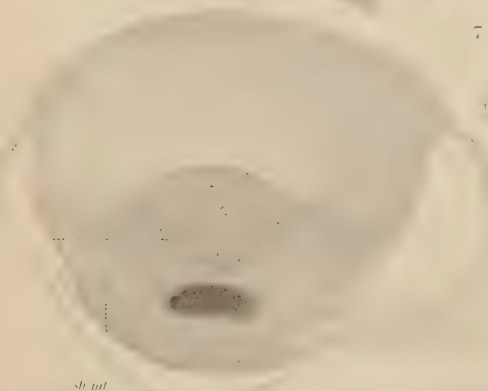
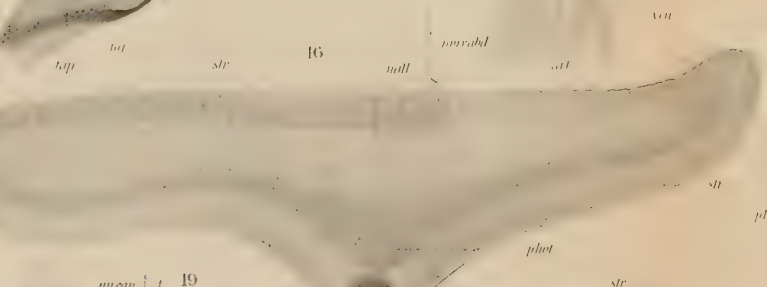
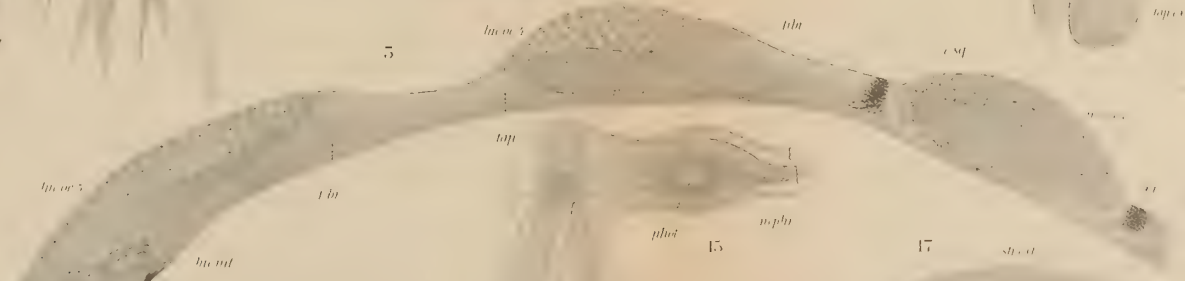
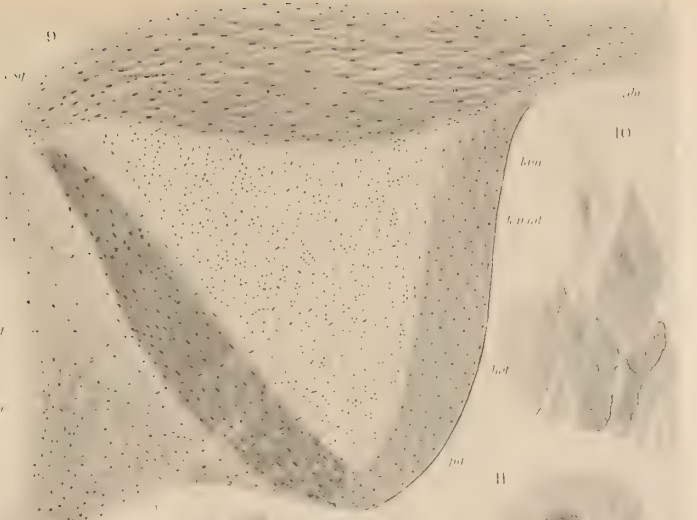
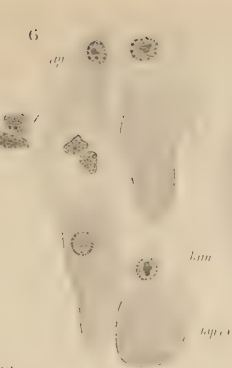
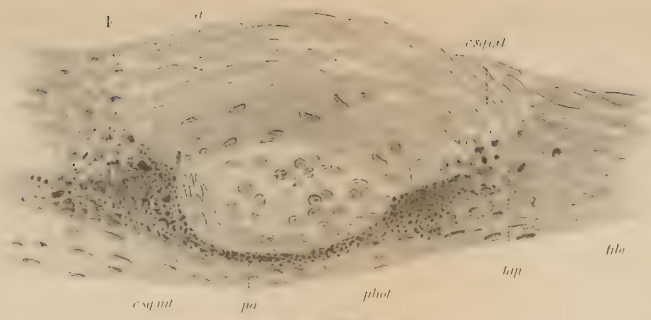
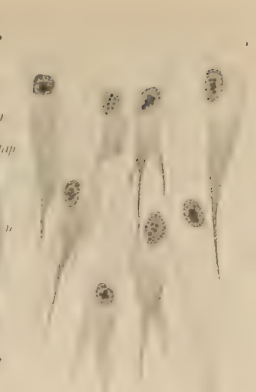
Mature female from Station 256 in Indian North Equatorial Current. $\times 2$.

After color sketches of the live animal

Figure 1. Left side.

Figure 2. Ventral

Figure 3. Dorsal.





1



2



3

Plate VI

Abraliopsis morisii VÉR. Male and juvenile stages

- Figure 1. Male with hectocotylized left ventral arm. Station 54, Guinea Current. $\times 3$. After color sketch of the live animal
- Figure 2. Older juvenile stage from Station 54, Guinea Current. Ventral view (*Micrabralia* PFEFFER). $\times 6$
- Figure 3. Juvenile stage from Station 323, Indian Countercurrent. Ventral (*Compsoteuthis* PFEFFER)
- Figure 4. Same, left side.
- Figure 5. Juvenile stage from Atlantic South Equatorial Current. Right side (*Compsoteuthis* PFEFFER)
- Figure 6. Same, ventral.

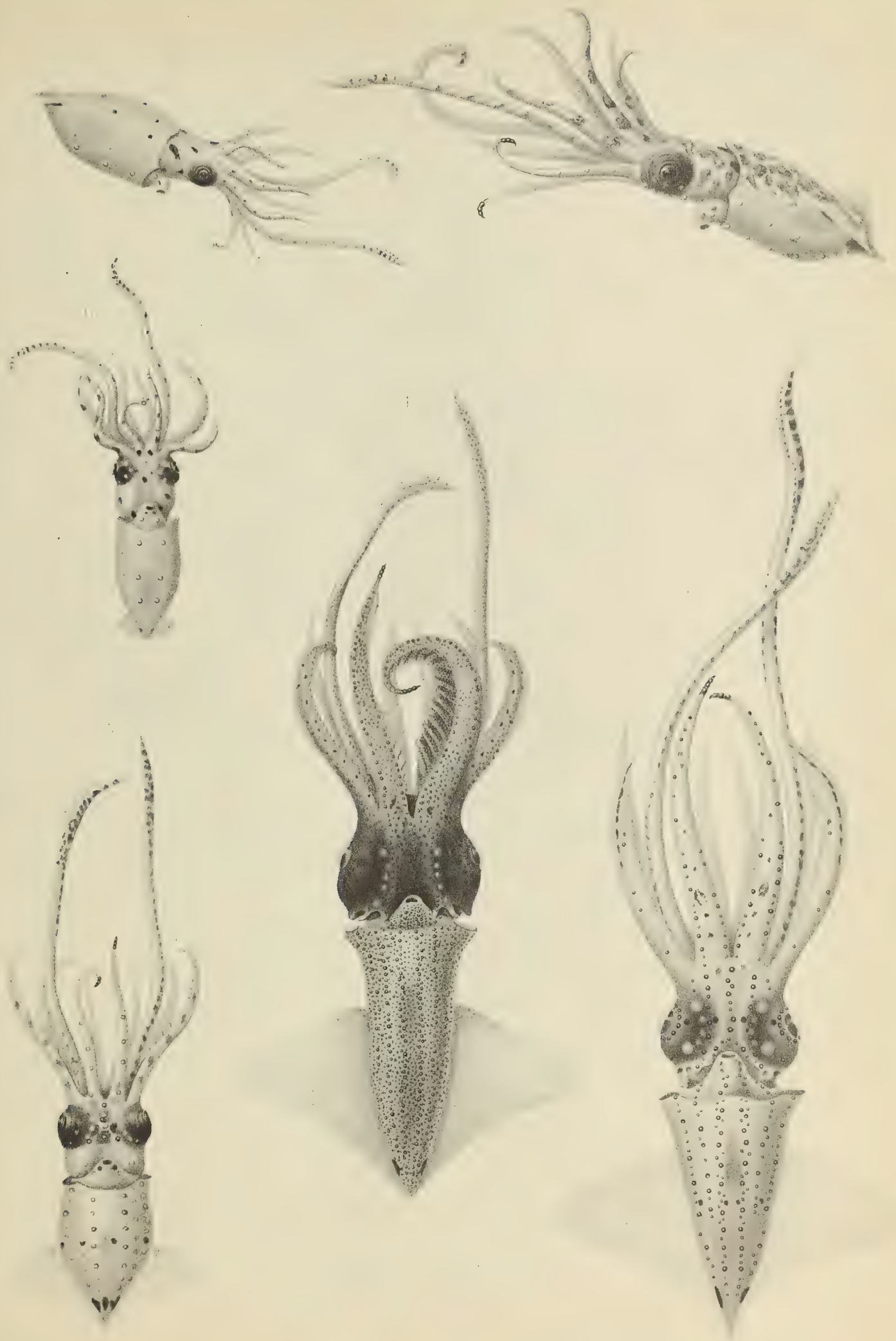


Plate VII

Young larvae of *Abraliopsis*, *Thelidoteuthis*, and of *Enoploteuthidae*

Figures 1–8. Larvae of *Abraliopsis*

- Figure 1. Larva of *Abraliopsis*, Indian Countercurrent, Station 228. $\times 6$. (*Compsoteuthis* PFEFFER)
Figure 2. Left tentacle club of same larva.
Figure 3. Larva from Indian Countercurrent, Station 231. Dorsal. $\times 6$
Figure 4. Same larva. Ventral. $\times 6$
Figure 5. Tentacle club of same larva.
Figure 6. Younger larva from Indian Countercurrent. Ventral. $\times 6$
Figure 7. Youngest larva, ventral. Indian Countercurrent. Station 228. $\times 6$
Figure 8. Left tentacle club of same larva.

Figures 9–13. Youngest larvae, probably belonging to the development cycle of *Abraliopsis*

- Figure 9. Larva from Indian North Equatorial Current, Station 217. $\times 6$
Figure 10. Tentacle club of larva of Figure 11.
Figure 11. Youngest larva from Station 217, lateral. $\times 7.3$
Figure 12. Youngest larva. Guinea Current, Station 43. $\times 22$
Figure 13. Tentacle of same larva.

Figures 14–19. Larvae of *Thelidoteuthis alessandrinii* VÉR. and similar younger larvae

- Figure 14. Larva from Indian North Equatorial Current, Station 218. $\times 10$
Figure 15. Tentacle club of same larva. Appr. $\times 40$
Figure 16. Older larva of *Thelidoteuthis* from Indian South Equatorial Current, Station 235. Ventral. $\times 6$
Figure 17. Tentacle club of same larva. Appr. $\times 24$
Figure 18. Larva from Indian Countercurrent, Station 223. Ventral
Figure 19. Tentacle club of same larva. Appr. $\times 50$

Figures 20–23. Larvae that perhaps belong to *Enoploteuthis*

- Figure 20. Larva from Indian North Equatorial Current, Station 218. Ventral. $\times 7$
Figure 21. Dorsal view of same larva. $\times 7$
Figure 22. Tentacle club of same larva.
Figure 23. Smaller larva of same species from Indian North Equatorial Current, Station 218. $\times 6$
Figure 24. Larva from Guinea Current. Station 54. $\times 10$
Figure 25. Tentacle club of same larva. $\times 50$

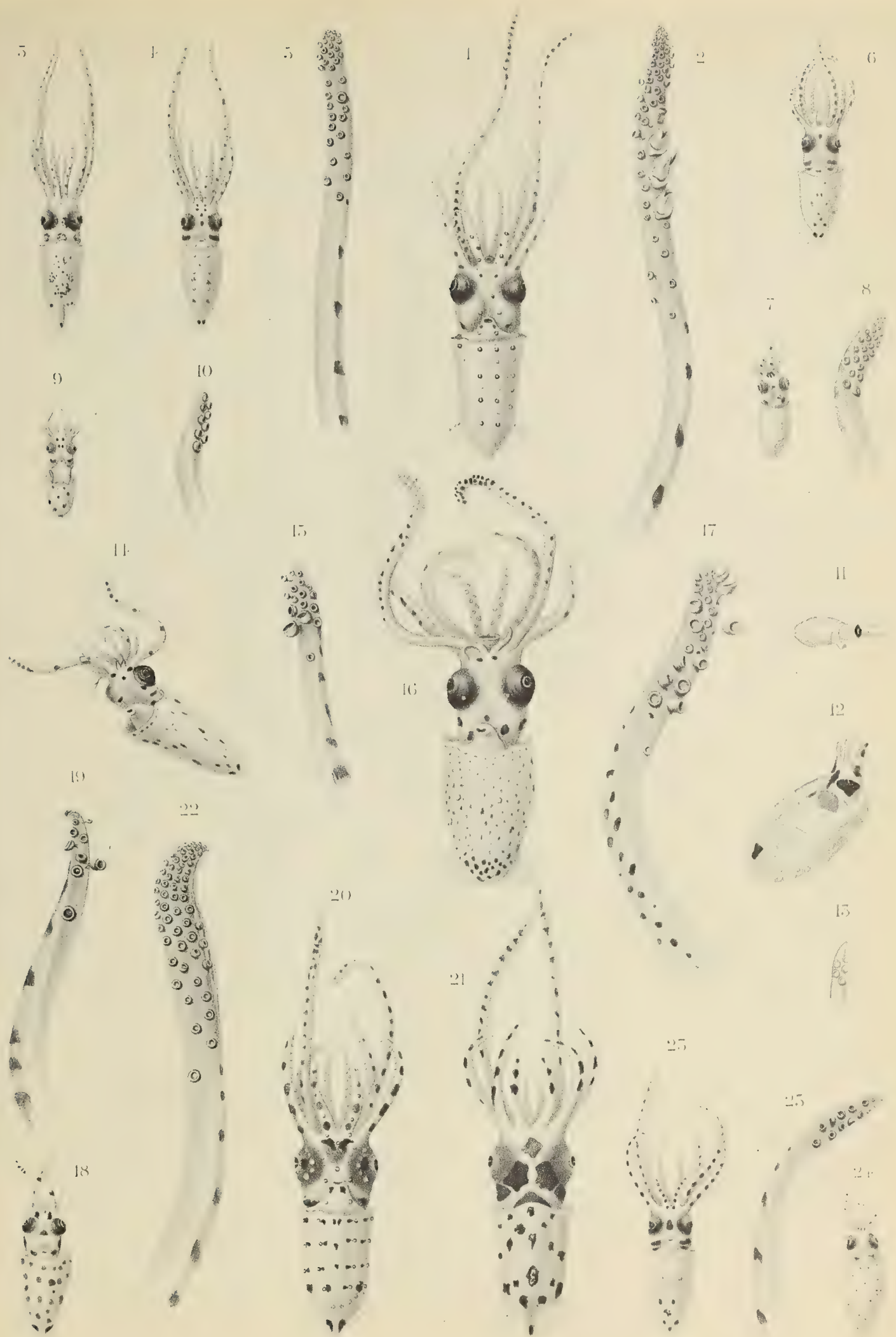


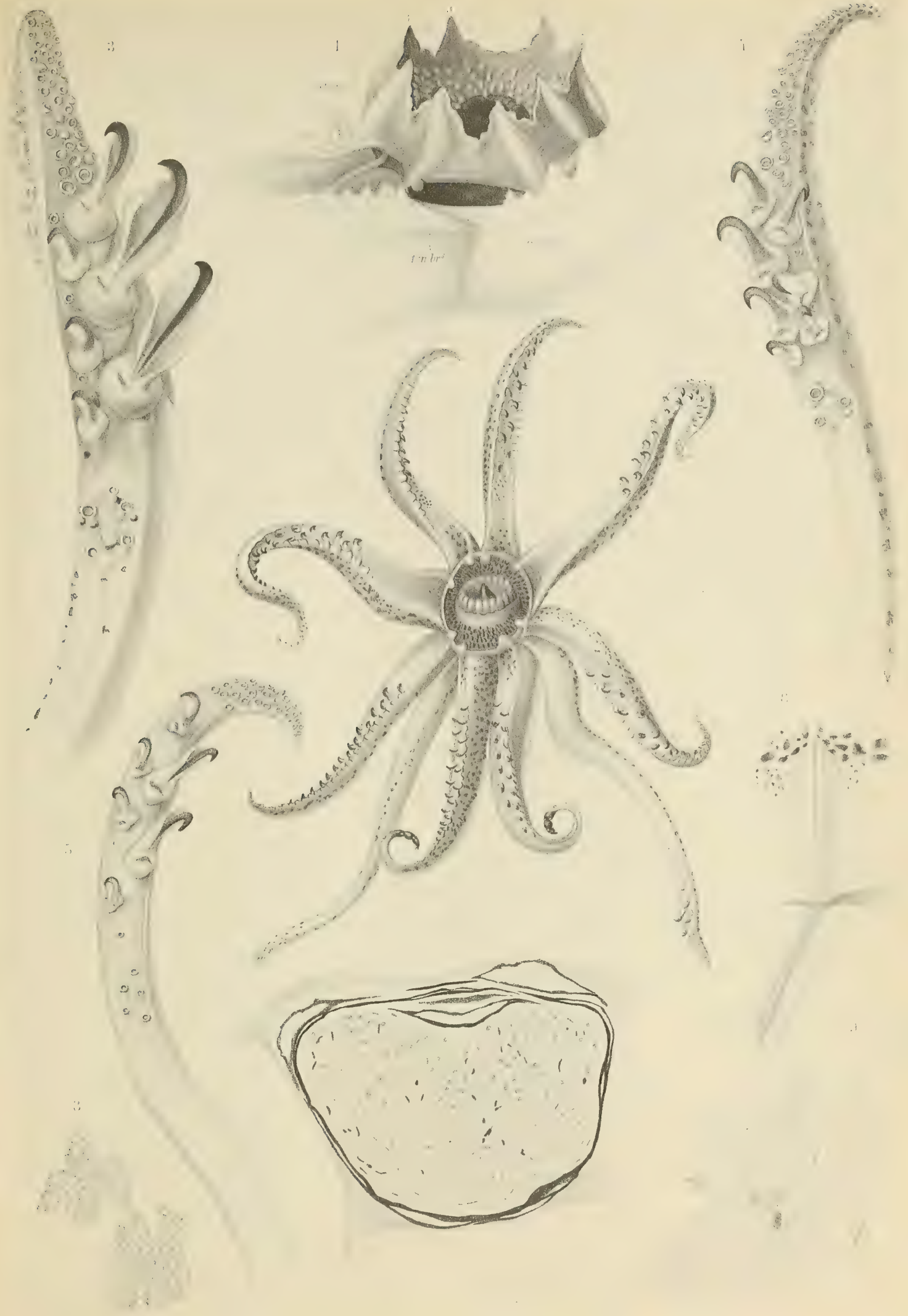
Plate VIII

Abraliopsis morisii VÉR. Arm apparatus and buccal funnel

- Figure 1. *Abraliopsis morisii*, male. Buccal funnel viewed diagonally from the side. The 2nd and 3rd left arms are spread to show the deeper attachments: 1—dorsal, 2—dorsolateral, 3—ventrolateral, 4—ventral buccal peak
- Figure 2. Arm apparatus and buccal funnel (Station 254), seen from above. $\times 4$
- Figure 3. Left tentacle club of a male. Station 256. $\times 15$
- Figure 4. Right tentacle club of a male. Station 254. $\times 20$
- Figure 5. Left tentacle club of adult male. Station 54. $\times 20$
- Figure 6. Neck cartilage. Station 254. $\times 9$
- Figure 7. Knob of ventral arm, longitudinal section of the arm.
- Figure 8. Granulate cells of knob tissue. Zeiss F. 2 Pr
- Figure 9. Granulate cells of knob, with capillaries (*cap.*). Zeiss F. 2 Pr

ABBREVIATIONS

- cap.*—capillaries
fun. br. 2—deep attachment from
2nd to 3rd arm
fun. br. 3—deep attachment from
3rd to 2nd arm
fun. tent.—muscle of attachment
of tentacle



Embry

Plate IX

Abraliopsis, Abralia. Mantle complex and genitalia

Figures 1–5. *Abraliopsis morisii* VÉR.

- Figure 1. Opened mantle cavity of male. Spermatophore sac filled with spermatophores. Station 254, Indian Ocean. Appr. $\times 4$
- Figure 2. Opened mantle cavity of an Atlantic male with markedly swollen testes and far projecting end of spermatophore sac. Appr. $\times 4$
- Figure 3. Opened mantle cavity of large female from Station 256 (Indian Ocean), with ripe eggs and markedly swollen oviduct glands. $\times 4$
- Figure 4. Oviduct glands and adjacent organs of same female, diagonally viewed from the right. $\times 4$
- Figure 5. Male gonoducts, dorsal. Station 254, cf. Figure 1. $\times 9$

Figures 6 and 7. *Abralia owenii* VÉR.

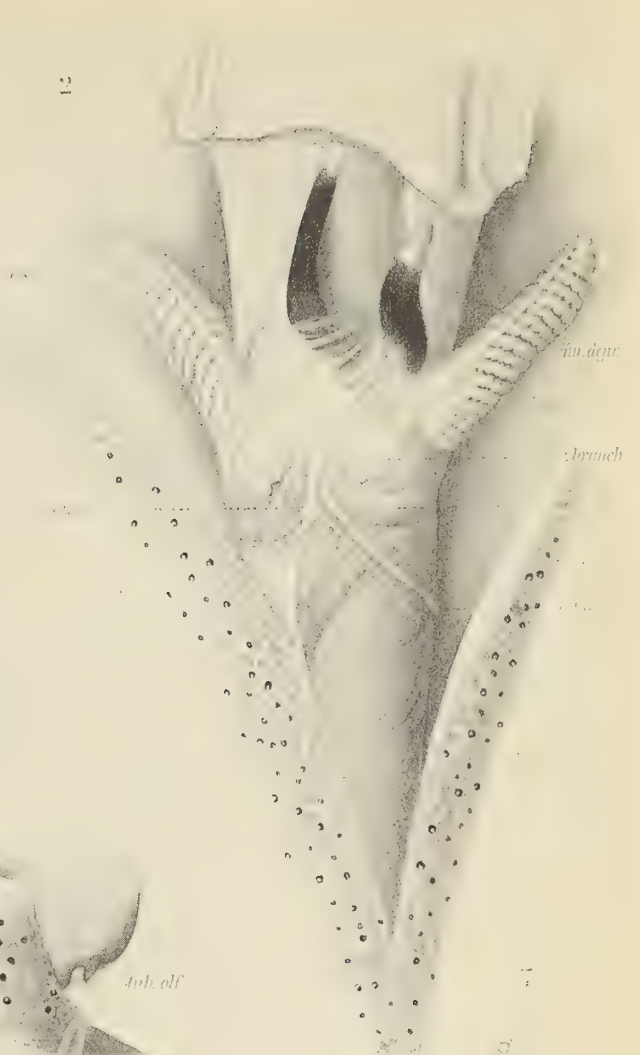
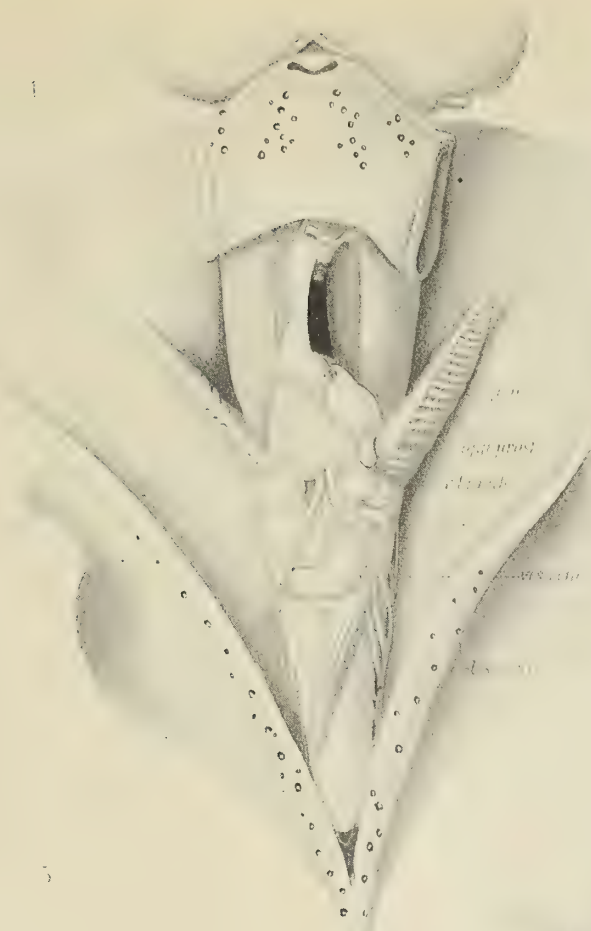
- Figure 6. Left oviduct of young female from Nice (dorsal length of mantle—22 mm), natural position, ventral
- Figure 7. Same oviduct, exposed.

ABBREVIATIONS

<i>a.</i> —artery	<i>gl. od. i.</i> —lower half of oviduct gland	<i>sept.</i> —mantle septum
<i>a. pinn.</i> —artery of fins	<i>gl. od. s.</i> —upper half of oviduct gland	<i>susp.</i> —branchial ligament
<i>a. post.</i> —posterior artery	<i>mu. depr. inf.</i> —funnel depressor	<i>test.</i> —testis
<i>amp.</i> —opening of vas deferens	<i>neph.</i> —renal sac	<i>tub. olf.</i> —olfactory tubercle
<i>app. c.</i> —appendage of branchial heart	<i>or. od.</i> —opening of oviduct	<i>v.</i> —vein
<i>app. prost.</i> —appendage of prostate	<i>ov.</i> —ovary	<i>v. abd.</i> —abdominal vein
<i>b. sperm.</i> —Needham's sac (spermatophore sac)	<i>pen.</i> —terminal part of spermatophore sac	<i>v. def.</i> —vas deferens
<i>c. branch.</i> —branchial heart	<i>prost.</i> —prostate	<i>ves. sem.</i> —seminal vesicle
		<i>ves. sem. 3</i> —3rd part of seminal vesicle

1

12



5

11

epi. pros.

sub. dl'

sub. dl'

l. sp. m.

6
or. od.

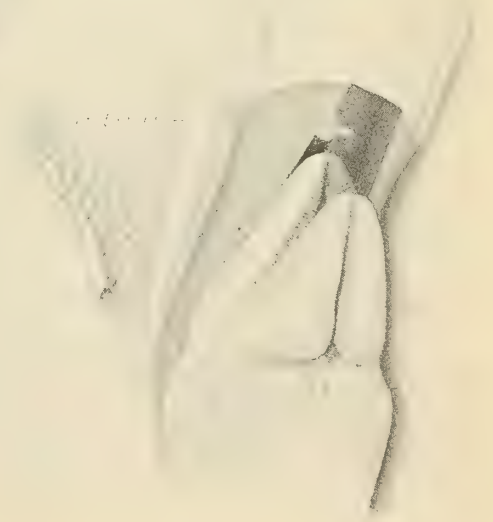


Plate X

Abraliopsis morisii VÉR. Hectocotylus, genitalia, luminous organs

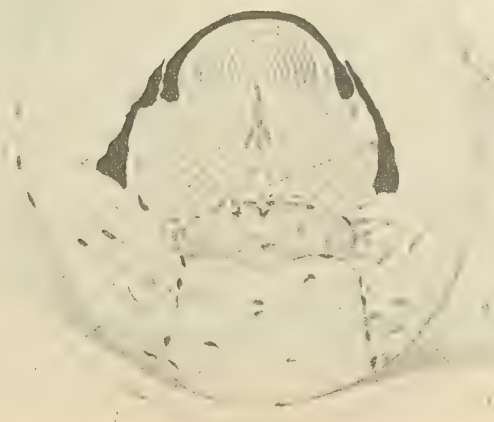
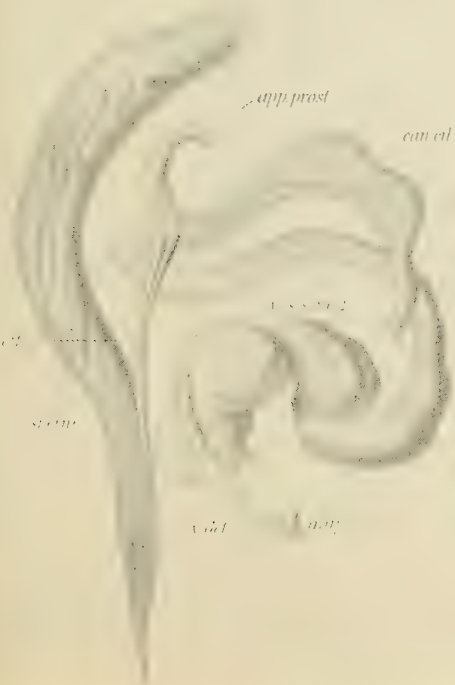
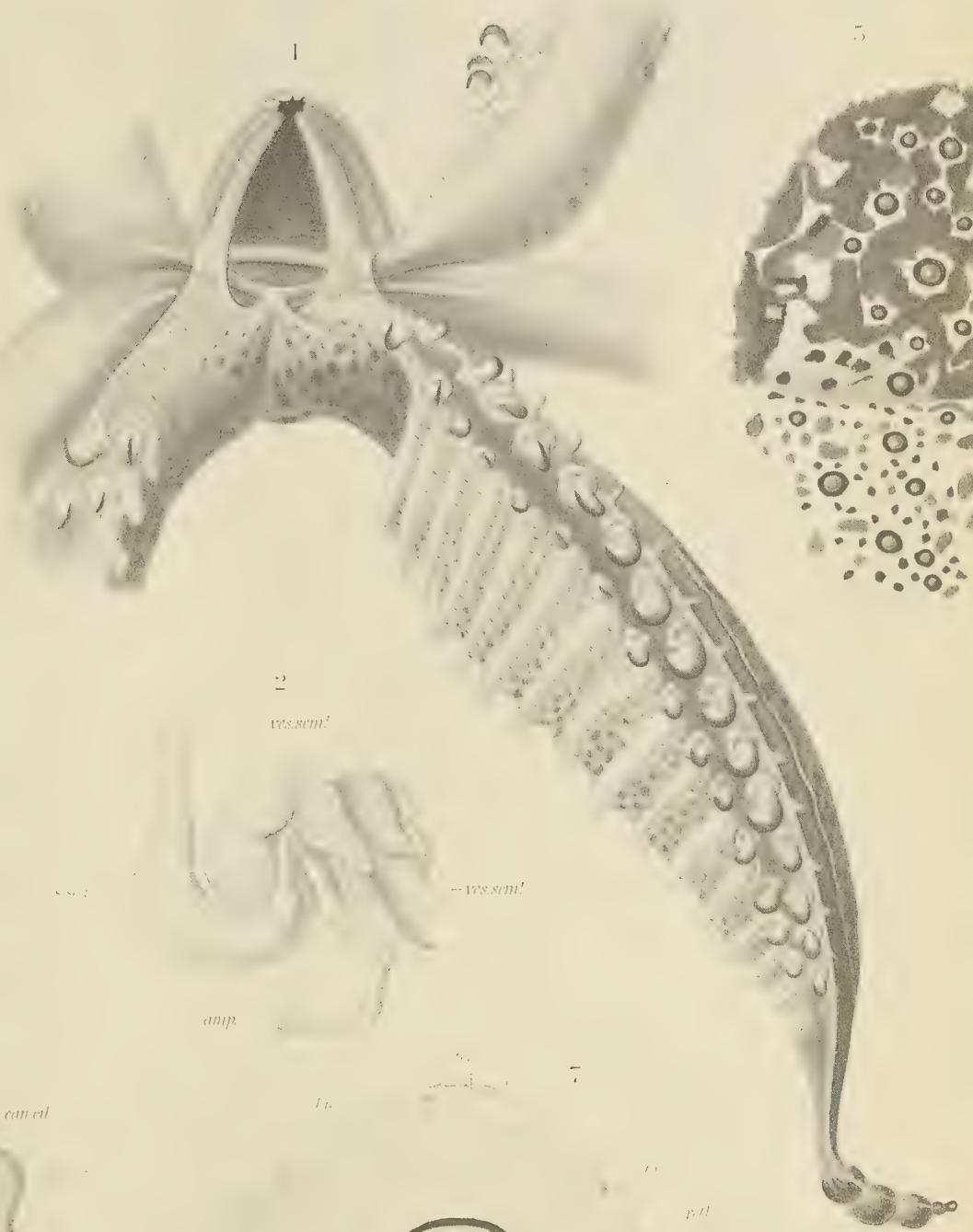
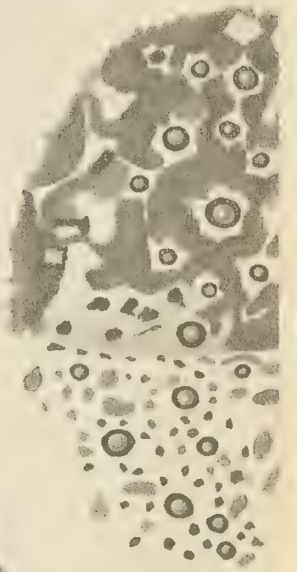
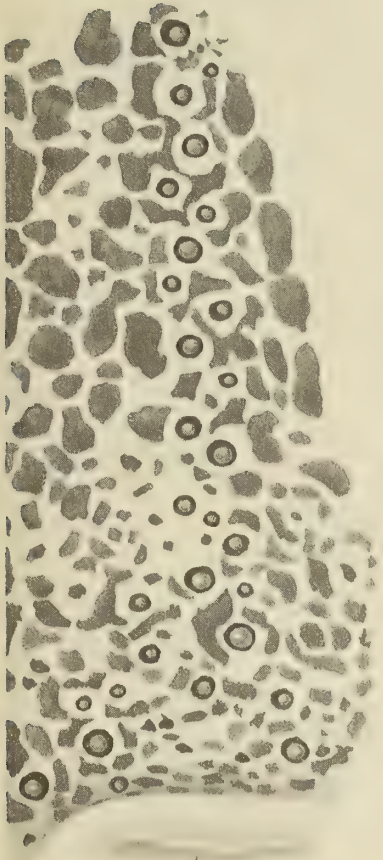
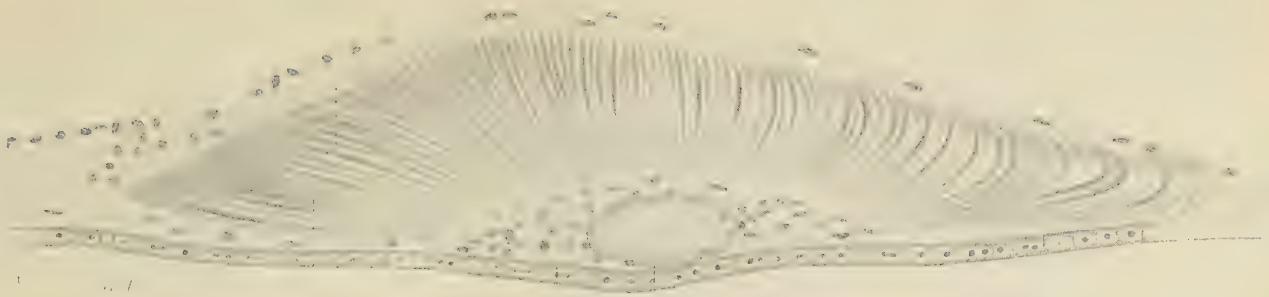
- Figure 1. Hectocotylus, buccal funnel and attachment of adjacent arms, ventral. Male from Station 54. $\times 12$
- Figure 2. Male gonoducts, ventral. Specimen from Station 254
- Figure 3. Gonoducts of male from Station 254, dissected out.
- Figure 4. Skin with luminous organs, directly anterior to funnel. Station 256
- Figure 5. Part of mantle and funnel with luminous organs. Station 256
- Figure 6. Median section of a large luminous organ of the eye. Zeiss C. 2. Station 254. $\times 224$
- Figure 7. Section through fully developed organ of mantle. Station 254

ABBREVIATIONS

amp.—opening of vas deferens
app. prost.—appendage of prostate
b. sperm.—spermatophore sac
(Needham's sac)
c.—central luminous cells
can. cil.—ciliated canal
cart.—cartilage of eye
chr.—chromatophores

co.—outer sheath of luminous organ
f.—bars of connective tissue
fibr.—fibers of connective tissue
l.—lens
lac.—lacuna
nu.—nuclei
or. cil.—opening of ciliated canal
phot.—luminous body

prost.—prostate
*refl.*¹—cuppola of reflector
*refl.*²—lateral parts of reflector
str.—fibrous cells of eye organ
v.—vessel
v. def.—vas deferens
v. eff.—vas efferens
ves. sem. 1, 2, 3—1st, 2nd and 3rd
part of seminal vesicle



phot.

Plate XI

Figures 1–4. *Pyroteuthis margaritifera* VÉR.

- Figure 1. Male from Messina. Ventral view with ventral luminous organs. $\times 2$
- Figure 2. Hectocotylus with large lobes, lateral. Appr. $\times 6$
- Figure 3. Same, inner side. Appr. $\times 6$
- Figure 4. Right tentacle of female. Appr. $\times 18$

Figures 5 and 6. *Enoploteuthis leptura* D'ORB.

- Figure 5. Young male from Atlantic South Equatorial Current. $\times 2.5$
- Figure 6. Tentacle club. Appr. $\times 12$.

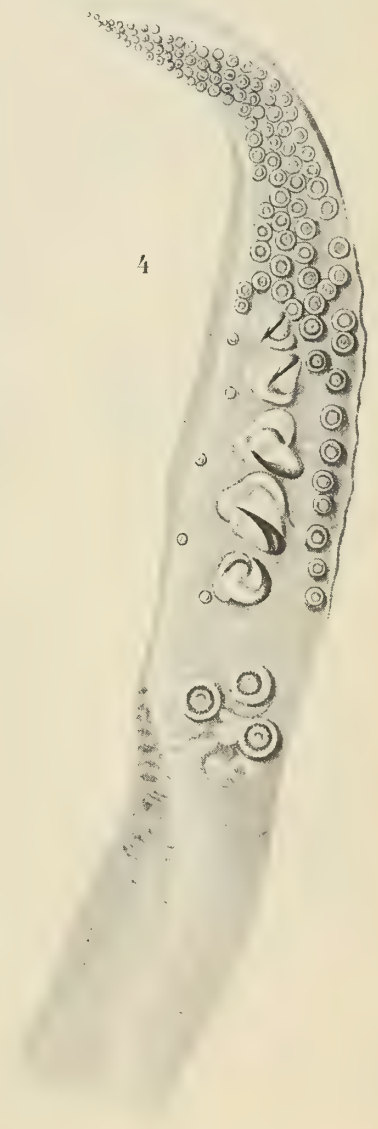
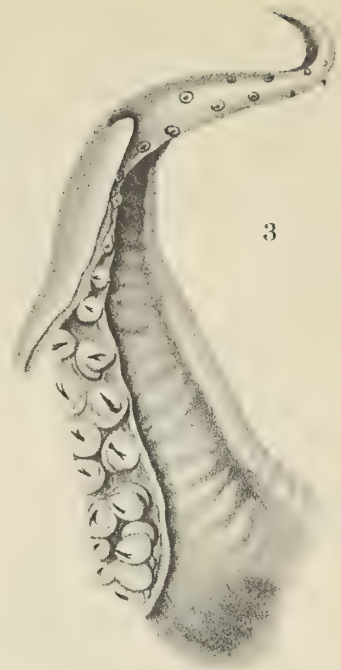
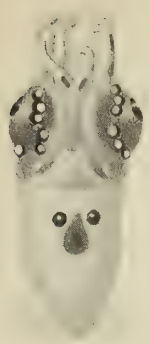


Plate XII

Pterygioteuthis giardi FISCHER. Males and juvenile forms

- Figure 1. Medium-sized male from Station 217, Indian North Equatorial Current. Dorsal view. Color sketch of live animal. $\times 5$
- Figure 2. Same, ventral.
- Figure 3. Small male from Station 215, Indian North Equatorial Current. Right side. Color sketch of live animal. $\times 5.5$
- Figure 4. Same, ventral.
- Figure 5. Older juvenile stage from Station 117, Agulhas Current. Ventral
- Figure 6. Older juvenile stage from Station 66, South Equatorial Current. Ventral. $\times 7.5$
- Figure 7. Larva from South Equatorial Current. Ventral. $\times 7.5$
- Figure 8. Larva from South Atlantic. Ventral
- Figure 9. Larva from Atlantic South Equatorial Current. Dorsal. $\times 7.5$
- Figure 10. Same, ventral.
- Figure 11. Same, left side.
- Figure 12. Larva from Station 231, Indian Countercurrent. Left side. $\times 7.3$
- Figure 13. Youngest larva from South Atlantic. Right side. $\times 7.3$
- Figure 14. Youngest larva from Station 214, Indian North Equatorial Current. Left side. $\times 7.3$
- Figure 15. Same larva, ventral diagonal. $\times 25$

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9



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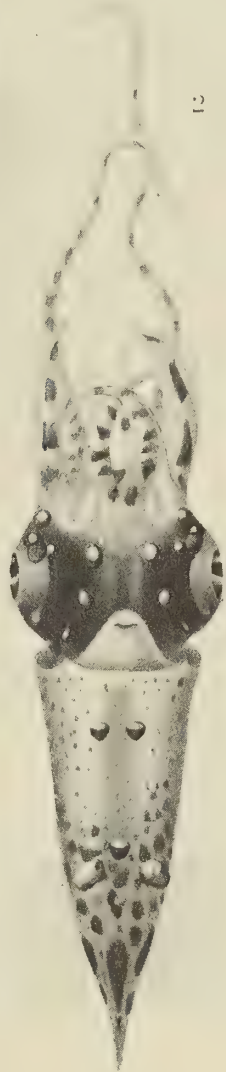
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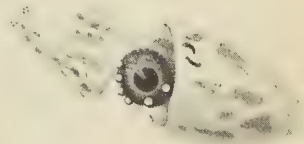
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6



5



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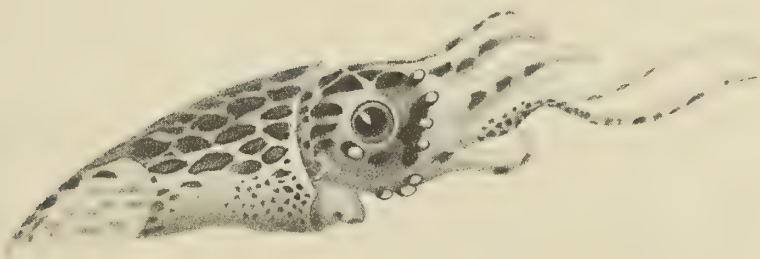


Plate XIII

Pterygioteuthis, arm apparatus and buccal funnel; larvae of Enoploteuthidae

- Figure 1. *Pterygioteuthis giardi*. Young male from Indian North Equatorial Current, Station 217 (Plate XII, Figures 1, 2). Buccal funnel, ventral. Ventral arms bent downward, their attachment cut. $\times 8$
- Figure 2. Same specimen, arms and buccal funnel dissected out. Appr. $\times 8$
- Figure 3. *Pt. gemmata*, female. Attachment of ventral arms and tentacle, left side. The thin, long muscle of attachment of the tentacle passes below the deep attachment of the 3rd arm to the base of the tentacle. Porus aquiferus present between chocolate-brown buccal funnel and deep attachment
- Figure 4. Tentacle club of young male of *Pt. giardi* from Station 217 (Plate XII, Figures 1, 2)
- Figure 5. *Pt. giardi*. Young male from Station 215. Sail-shaped connection of dorsal arms seen from the outside
- Figure 6. *Pyroteuthis margaritifera*, female. Attachment between 2nd and 3rd arm on the right side
- Figure 7. *Pterygioteuthis giardi*. Young male from Station 215. Buccal funnel viewed from the ventral diagonal. Ventral arms (not drawn) bent down
- Figure 8. *Pt. giardi*. Neck cartilage of male from Station 217.

Figures 9–12. Larvae of *Pterygioteuthis*

- Figure 9. Tentacle of youngest larva from Station 214 (Plate XII, Figure 14), anterior and lateral. Appr. $\times 50$
- Figure 10. Posterior end of body of same larva, dorsal.
- Figure 11. Tentacle of larva from Station 231 (Plate XII, Figure 12).
- Figure 12. Tentacle of larva from Station 46 (Plate XII, Figure 13).

Figures 13–23. Larvae of Enoploteuthidae

- Figure 13. Larva from southern part of Benguela Current. Station 91. $\times 6$
- Figure 14. Left tentacle club of same larva. $\times 30$
- Figure 15. Younger larva from Station 91, southern part of Benguela Current. $\times 10$
- Figure 16. Tentacle club of same larva. Appr. $\times 20$
- Figure 17. Young larva from Station 102, Agulhas Bank. $\times 10$
- Figure 18. Tentacle club of same larva. Appr. $\times 30$
- Figure 19. Younger larva, same stage as in Figure 17, ventral. Station 102, Agulhas Bank. $\times 10$
- Figure 20. Younger larva, same stage, lateral. Station 102, Agulhas Bank. $\times 10$
- Figure 21. Tentacle club of same larva. Appr. $\times 30$
- Figure 22. Youngest larva from Station 102, Agulhas Bank.
- Figure 23. Arm apparatus of same larva.

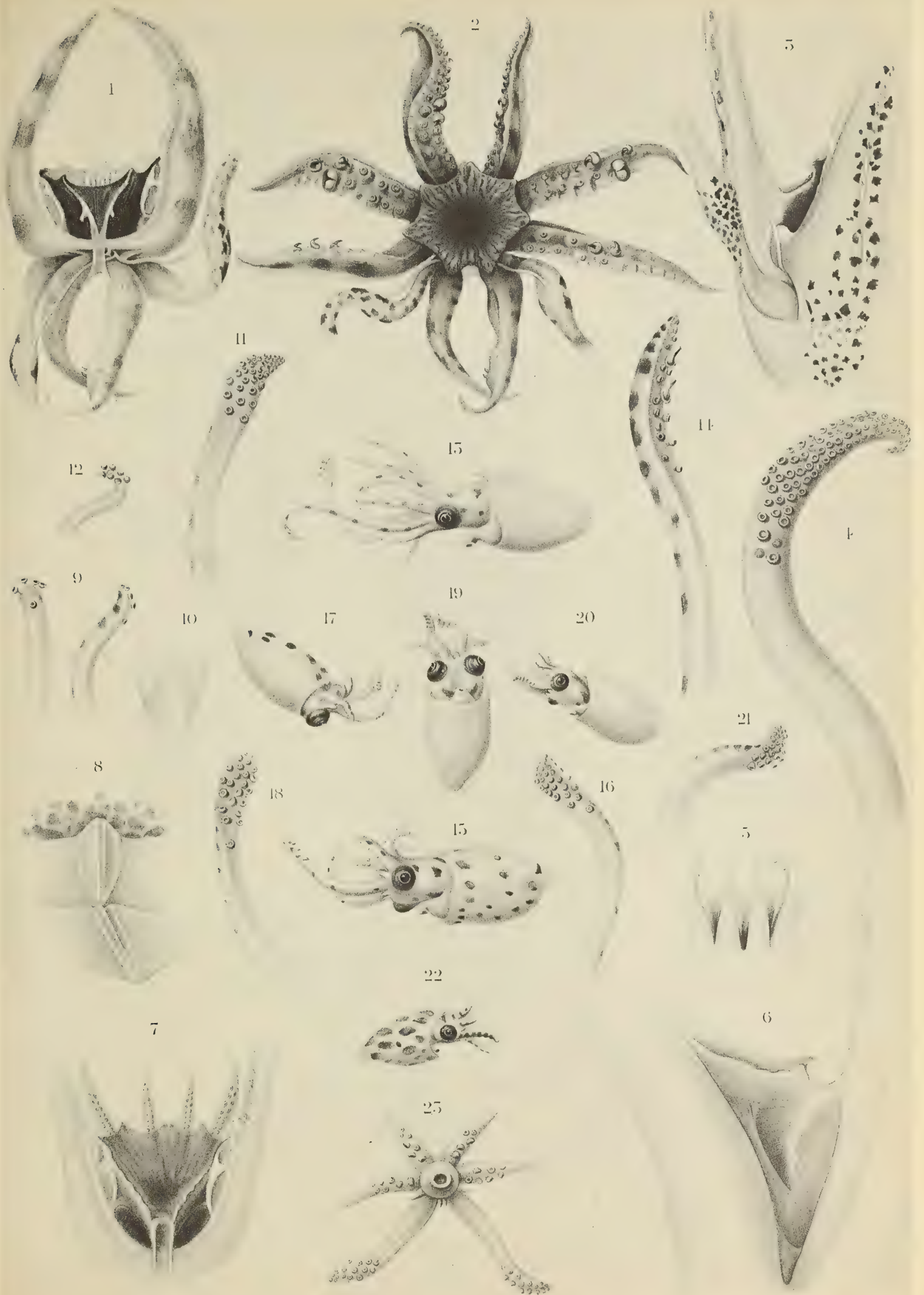


Plate XIV

Pterygioteuthis. Arrangement of luminous organs

- Figure 1. Adult of *Pterygioteuthis giardi* with opened mantle cavity. Station 218, Indian North Equatorial Current. $\times 5.2$
- Figure 2. Slightly younger male of *Pt. giardi* from Indian North Equatorial Current, Station 217 (Plate XII, Figure 11. Mantle cavity and funnel opened. $\times 6$
- Figure 3. Young male of *Pt. giardi* from Indian North Equatorial Current (Plate XII, Figure 4). Abdominal wall opened to show testis. δ —male gonoducts
- Figure 4. Mantle organs of male of *Pt. gemmata*.
Drawn after a specimen fixed in formol by VANHÖFFEN. North of Tristan da Cunha
- Figure 5. Eye organs of female of *Pt. gemmata*. Right eye. Eyeball turned slightly down, so that organ No. 10 is not visible
- Figure 6. Eye organs of adult male of *Pt. giardi* (Figure 1). Right eye
- Figure 7. Eye organ No. 10 of *Pt. giardi*, exterior surface, with pigment cup and lens.
- Figure 8. Eye organs of *Pyroteuthis margaritifera* (Messina). Left eye turned slightly outward to show the small organs
- Figure 9. Left anal organ of male of *Pt. gemmata* (cf. Figure 4). Lateral view

ABBREVIATIONS

an.—anus

app. prost.—appendage of prostate

luc. an.—anal organ

luc. branch.—branchial organ

l. br.—dto.

luc. v. 1.—first ventral organ

luc. v. 2.—2nd ventral organ

luc. v. 3.—3rd ventral organ

luc. v. 4.—4th ventral organ

pen.—terminus of spermatophore sac

ur.—papilla or renal sac

v. abd.—abdominal vein

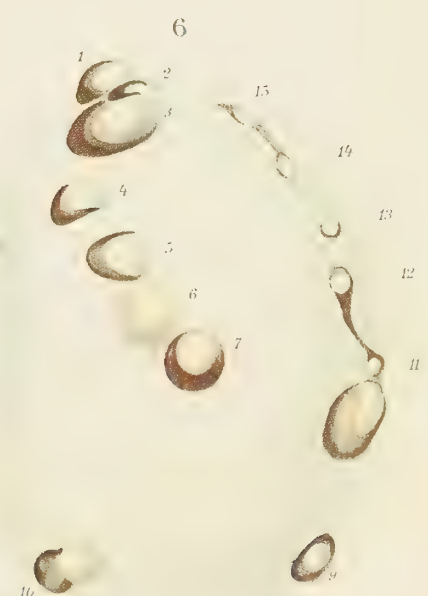
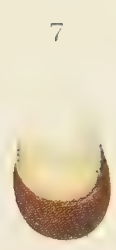
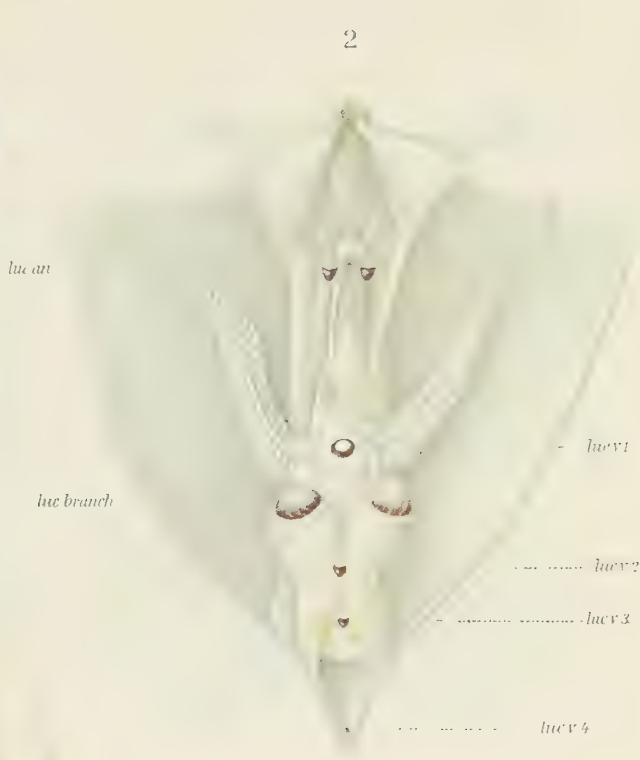


Plate XV

Pterygioteuthis. Hectocotylus and genitalia

- Figure 1. Hectocotylus of adult male of *Pterygioteuthis giardi*, inner surface (cf. Plate XIV, Figure 1)
- Figure 2. Hectocotylus of adult male of *Pt. gemmata* n. sp. Surface facing median plane
- Figure 3. Same hectocotylus of *Pt. gemmata*, inner surface.
- Figure 4. Tooth plate and lamellar region of the gland of the hectocotylus of *Pt. giardi* shown in Figure 1, outer surface.
- Figure 5. Tooth plate and lamellar region of gland of younger male of *Pt. giardi* (Plate XII, Figure 2). Hectocotylus, outer side
- Figure 6. Longitudinal section of distal half of hectocotylus and glandular swelling of *Pt. gemmata*. Hemalum. Zeiss A. 0
- Figure 7. Cross section through hectocotylus of *Pt. gemmata* between the two glandular swellings. Hemalum. Zeiss A. 0
- Figure 8. Cross section through hectocotylus of *Pt. gemmata* at level of proximal glandular swelling. Hemalum. Zeiss A. 0
- Figure 9. Male genitalia of *Pt. gemmata*.
- Figure 10. Ciliated funnel of ciliated canal of *Pt. gemmata*, longitudinal section. Formol-alcohol. Iron-hematoxylin. Zeiss F. 0
- Figure 11. Slightly oblique transverse section of end of ciliated duct of *Pt. gemmata*. Iron-hematoxylin. Zeiss F. 0
- Figure 12. Gland cells of first part of seminal vesicle of *Pt. gemmata*. Formol-alcohol. Hemalum. Zeiss F. 2

ABBREVIATIONS

<i>amp.</i> —opening of vas deferens in body cavity	<i>gl. str.</i> —glandular grooves of hectocotylus	<i>prost.</i> —accessory gland (prostate)
<i>app. prost.</i> —appendage of distal vas deferens	<i>lam. dent.</i> —toothed lamella of hectocotylus	<i>v. d.</i> —vas deferens
<i>b. sperm.</i> —spermatophore sac (Needham's sac)	<i>lam. nat.</i> —swimming membrane	<i>v. eff.</i> —vas efferens
<i>can. cil.</i> —ciliated canal	<i>m. brach.</i> —arm musculature	<i>ves. sem. 1</i> —1st part of seminal vesicle (spermatophore gland)
<i>gl.</i> —glandular sacs of hectocotylus	<i>n.</i> —arm nerve	<i>ves. sem. 2</i> —2nd part of spermatophore gland
<i>gl. dist.</i> —distal glandular pad	<i>n'.</i> —lateral branches of arm nerve	<i>vas. sem. 3</i> —3rd part of spermatophore gland
<i>gl. prox.</i> —proximal glandular pad	<i>or. cil.</i> —ciliated funnel of ciliated canal	α, β, γ —the 3 subdivisions of the 3rd part
	<i>or. gl.</i> —opening of glandular sac	

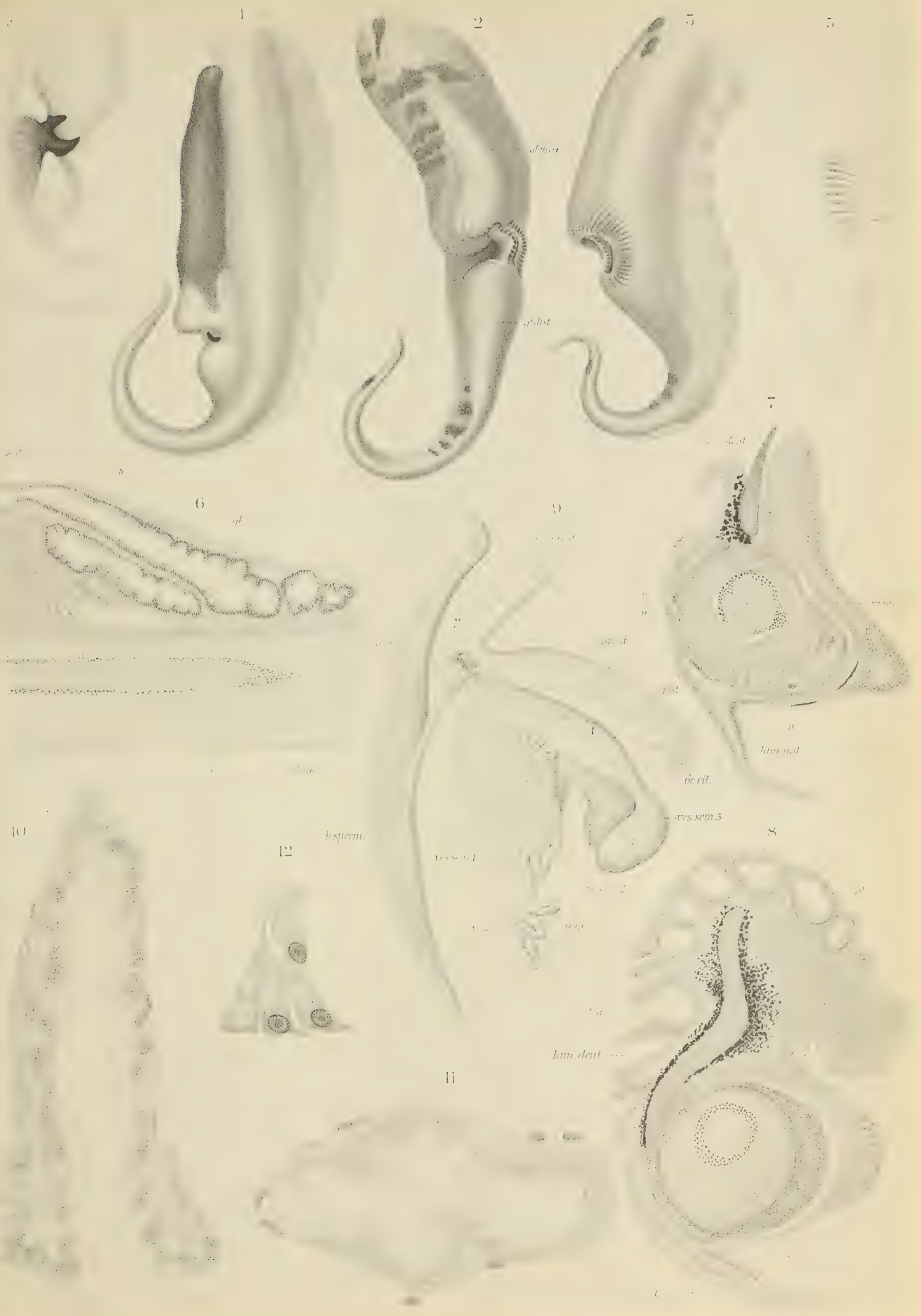


Plate XVI

Luminous organs of *Pterygioteuthis*

Preparations were made from specimens fixed in formol. All outlines were drawn using prism

- Figure 1. *Pt. gemmata*, male. Section of eye organ No. 1. Hemalum. $\times 135$
Figure 2. *Pt. gemmata*, male. Organ No. 10. $\times 133$
Figure 3. *Pt. giardi*, Station 217. Median section of organ No. 10. Hemalum
Figure 4. *Pt. giardi*, male. Station 218. Organ No. 10. $\times 53$
Figure 5. *Pt. gemmata*, male. Organ No. 6. $\times 133$
Figure 6. *Pt. giardi*, male. Organ No. 6. $\times 53$
Figure 7. *Pt. gemmata*, male. Organ No. 6. $\times 53$
Figure 8. *Pt. gemmata*, male. Small organ No. 11, with lens. $\times 133$
Figure 9. *Pt. gemmata*, male. Small organ No. 12. $\times 133$
Figure 10. *Pt. gemmata*, male. Large anterior abdominal organ. Iron-hematoxylin. Section is transverse to longitudinal axis of body. $\times 133$
Figure 11. *Pt. gemmata*, male. Second abdominal organ. Median section. $\times 133$
Figure 12. *Pt. gemmata*, male. Left anal organ. Hemalum. $\times 133$
Figure 13. *Pt. gemmata*, male. Median section of the right branchial organ. Hemalum. $\times 133$
Figure 14. *Pt. gemmata*. Part of luminous body of right branchial organ. Zeiss, homog. immersion
Figure 15. *Pt. gemmata*. Part of eye organ No. 3; lamella of inner reflector with nerves and vessels penetrating the lamella. Zeiss F. 0
Figure 16. *Pt. gemmata*. Squamous cell from eye organ No. 3, surface view
Figure 17. *Pt. gemmata*, female. Large anterior eye organ. Fixed in sublimate; nerves entering luminous body stained black with iron-hematoxylin. Zeiss, homog. immersion
Figure 18. Same object as in Figure 17. Bundle with 3 nerve fibers radiating into it
Figure 19. Part of branchial organ of *Pt. gemmata*; nerve bundles entering luminous body.

ABBREVIATIONS

cap.—capillaries
cart.—cartilage of eye
coll.—marginal lamellae of anal organ
cps.—outer sheath of ventral organs
fibr.—layer of connective tissue
l.—lens
l.'—granulate cells of lens of eye organs
l."—homogeneous cells of lens of eye organs
l. sq.—squamous cells of lens

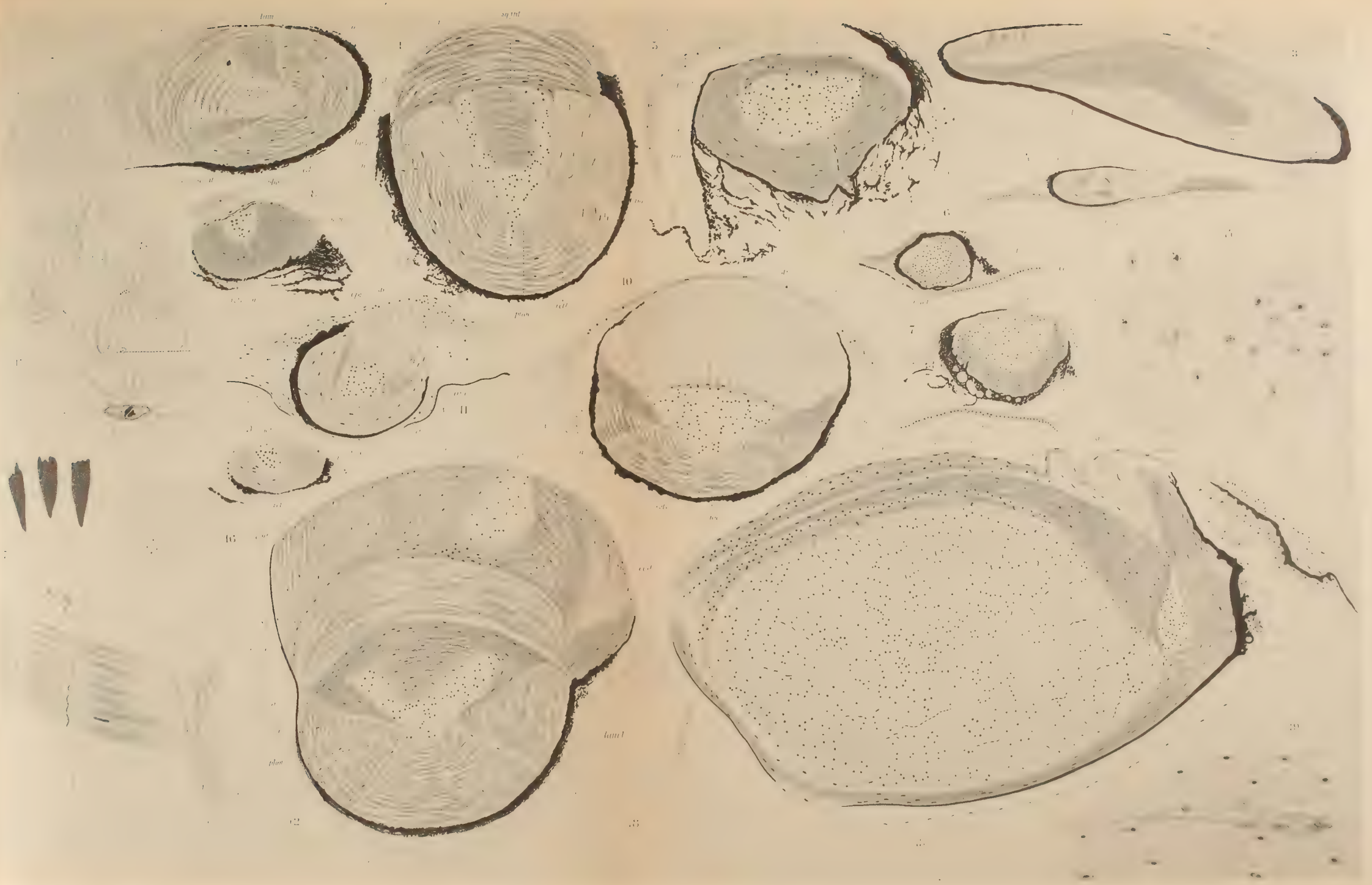
lam.—system of lamellae
lam. l.—lateral system of lamellae
lam. ext.—outer system of lamellae
lam. int.—inner system of lamellae
n.—nerves
n.'—nerve layer of branchial organ
nu. l.—nuclei of lens cells
nu. lam.—nuclei of lamellae
mu.—muscle fibers
mu. l.—longitudinal muscles

pg.—pigment
phot.—luminous body
phot.'—luminous body of the double organ
refl.—reflector
sq.—squamous cells
sq. int.—inner squamous cells
str.—fibers of lens
v.—vessel
ven.—vein

Plate XVII

Octopodoteuthis RÜPPELL (*Veranya* KROHN). Larvae from Indian Ocean

- Figure 1. Oldest larva. Station 271, Gulf of Aden. Ventral. $\times 6$
Figure 2. Same larva, dorsal.
Figure 3. Larva from Station 102, Agulhas Current. Ventral. $\times 6$
Figure 4. Same larva, dorsal. $\times 6$
Figure 5. Younger larva from Station 102, Agulhas Current. Anterior region, ventral. Appr. $\times 28$
Figure 6. Same larva. Anterior region, dorsal. Appr. $\times 28$
Figure 7. Tentacle club of oldest larva. Lateral. Appr. $\times 40$
Figure 8. Same club, broad side. Appr. $\times 40$
Figure 9. Arm apparatus of larva from Station 102 (cf. Figure 3).
Figure 10. Arm- and buccal apparatus of oldest larva from Station 271 (cf. Figure 1).
Figure 11. Anterior region of youngest larva. Station 215. Indian North Equatorial Current. Appr. $\times 32$
Figure 12. Tentacle club of youngest larva. Station 215. Appr. $\times 90$



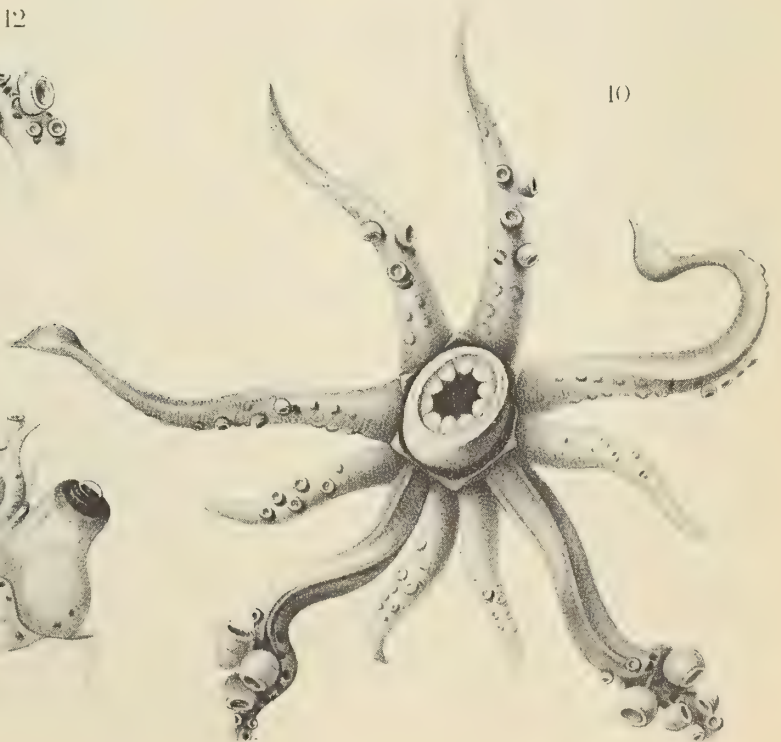
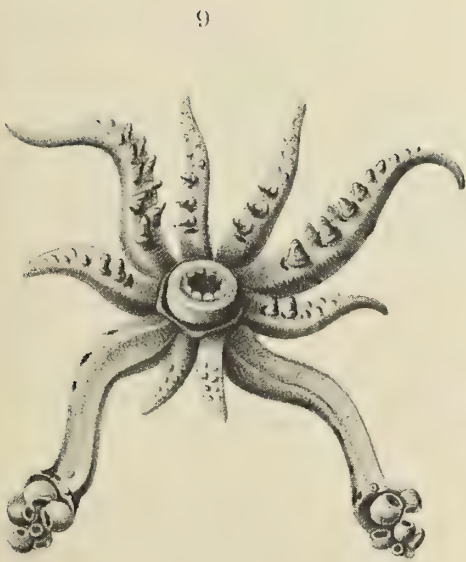
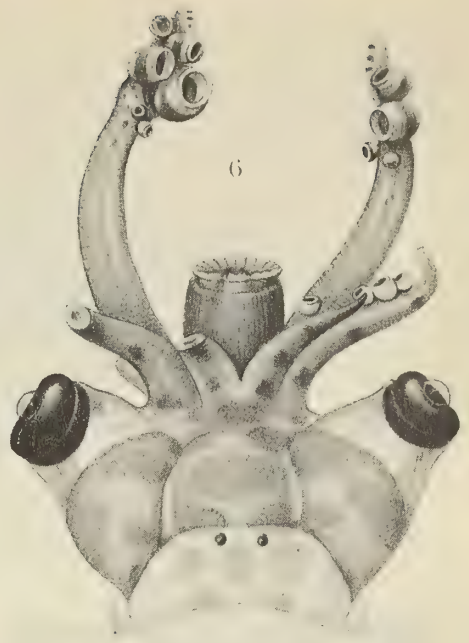
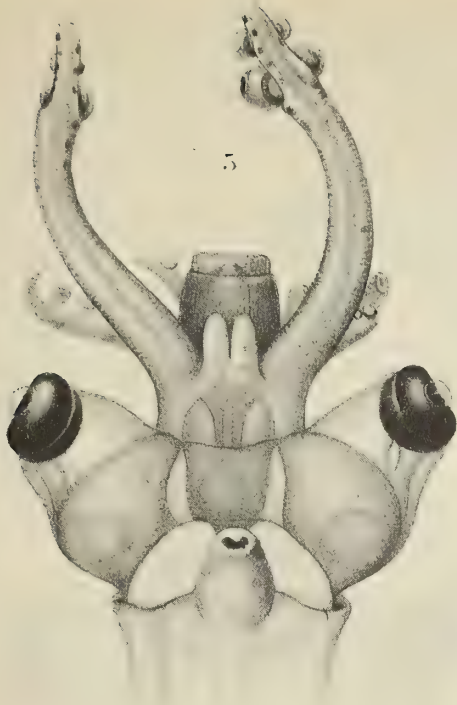


Plate XVIII

Calliteuthis, Histioteuthis juv.

- Figure 1. *Calliteuthis hoylei* GOODRICH. Station 235, Indian South Equatorial Current near the Amirantes. Ventral. $\times 2$
Color sketch of the live animal.
- Figures 2, 3, 4. *Calliteuthis reversa*. Station 223, Indian Countercurrent near Chagos Archipelago
Color sketch of the live animal.
- Figure 2. Dorsal. $\times 2$
- Figure 3. Ventral. $\times 2$
- Figure 4. Left side. $\times 2$
- Figure 5. *Calliteuthis*. Juvenile form from Station 112, southern part of Aqulhas Bank.
Ventral. $\times 8$
- Figure 6. *Histioteuthis*. Juvenile form. Deepwater catch near Villefranche. Right side. $\times 7$
- Figure 7. Same, ventral. $\times 7$



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Plate XIX

Histioteuthis juv., *Calliteuthis*

- Figure 1. Juvenile form of *Histioteuthis*, ventral. Messina. Appr. $\times 7$
Figure 2. Right club of same specimen. Appr. $\times 20$
Figure 3. Juvenile form of *Histioteuthis*, left side. Station 73, Benguela Current. Appr. $\times 8$
Figure 4. Right club of same specimen.
Figure 5. Right club of *Calliteuthis reversa*. Station 223 (cf. Plate XVIII, Figures 2-4). Appr.
 $\times 16$
Figure 6. Right club of *Calliteuthis hoylei*. Station 235 (cf. Plate XVIII, Figure 1). Appr.
 $\times 16$

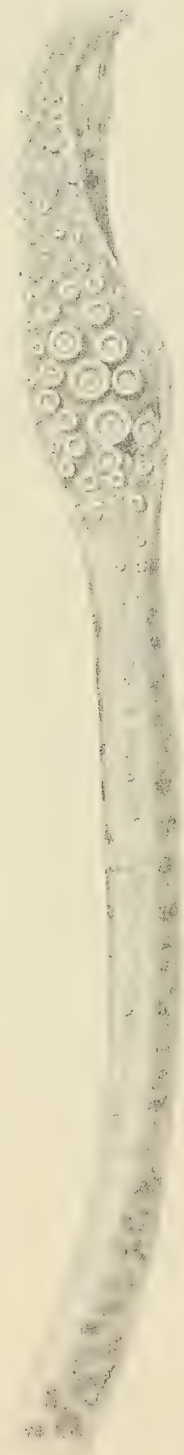
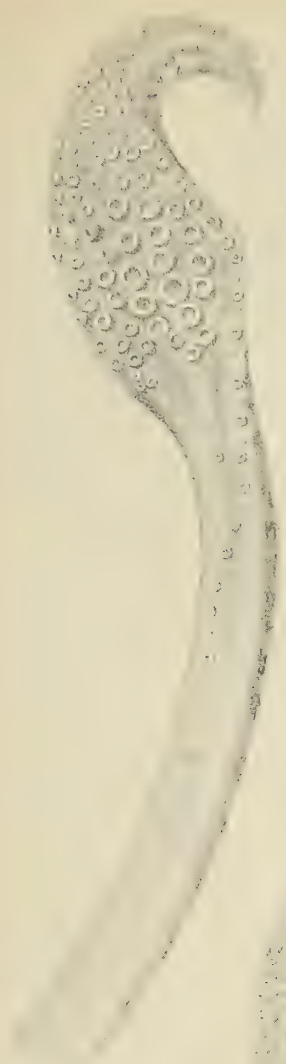


Plate XX

Anatomy of *Calliteuthis*

- Figure 1. *Calliteuthis hoylei*. Station 235. Left eye, lateral. $\times 6$
Figure 2. *C. hoylei*. Station 235. Neck cartilage. $\times 8$
Figure 3. *C. reversa*. Station 223. Buccal funnel and attachment. $\times 4$
Figure 4. *C. reversa*. Station 223. Neck cartilage. $\times 8$
Figure 5. *C. hoylei*. Station 235, young female. Mantle complex. $\times 7$
Figure 6. *C. reversa*. Station 223, young female. Mantle complex. Appr. $\times 4$
Figure 7. *C. ocellata*. Sagami Bay (Japan). The double genitalia of the mature male. Natural size
Figure 8. *C. ocellata*. Sagami Bay. Spermatophore
Figure 9. *C. ocellata*. Oral end of spermatophore tube
Figure 10. *C. hoylei*. Anal appendage. $\times 30$
Figure 11. *C. reversa*. Anal appendage. $\times 30$
Figure 12. *C. hoylei*. Longitudinal section of luminous organ. Formol-alcohol. Hemalum
Figure 13. *C. reversa*. Squamous cell of reflector, surface view. Formol-alcohol; homog. imm. 1/12
Figure 14. *C. reversa*. Luminous cells; homog. imm. 1/12

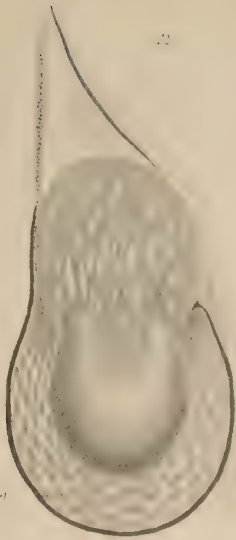
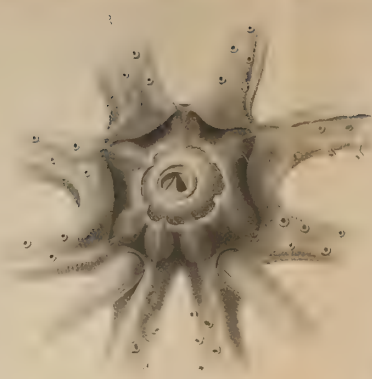
ABBREVIATIONS

- | | | |
|--|---|---|
| <i>a. pall.</i> —pallial artery | <i>g. opt.</i> —optic ganglion | <i>sacc. ven.</i> —venous sac |
| <i>a. pinn.</i> —artery of fins | <i>glut.</i> —adhesive pad | <i>sp.</i> —sperm |
| <i>a. post.</i> —posterior artery | <i>inf.</i> —ciliated funnel | <i>spec.</i> —mirror |
| <i>amp.</i> —opening of vas deferens | <i>l.</i> —lens | <i>spec.'</i> —mirror of posterior organ |
| <i>app. prost.</i> —appendage of prostate | <i>l'</i> —inner fibers of lens | <i>sperm.</i> —spermatophores |
| <i>b. sperm. d.</i> —right spermatophore sac | <i>mu. depr. inf.</i> —funnel depressor | <i>stom.</i> —stomach |
| <i>b. sperm. s.</i> —left spermatophore sac | <i>n.</i> —nerve | <i>test.</i> —testis |
| <i>c. alb.</i> —white body | <i>nid.</i> —nidamental gland | <i>ur.</i> —papilla of renal sac |
| <i>c. branch.</i> —branchial heart | <i>od.</i> —oviduct | <i>v. abd.</i> —abdominal vein |
| <i>c. cil. s.</i> —left ciliated canal | <i>or.</i> —opening of projectile tube | <i>v. def. d.</i> —right vas deferens |
| <i>c. sq.</i> —squamous cells | <i>pg.</i> —pigment | <i>v. def. s.</i> —left vas deferens |
| <i>chr.</i> —chromatophores | <i>proj.</i> —projectile tube | <i>ves. sem. 1</i> —1st part of seminal vesicle |
| <i>cil.</i> —ciliated body | <i>prost. d.</i> —right prostate | <i>ves. sem. 2</i> —2nd part of seminal vesicle |
| <i>coll.</i> —swelling substance | <i>prost. s.</i> —left prostate | <i>ves. sem. 3</i> —3rd part of seminal vesicle |
| <i>fil.</i> —terminal filament | <i>refl.</i> —reflector | <i>x</i> —cord of connective tissue |

Plate XXI

Histioteuthis rüppellii VÉRANY

Large male from Nice with both dorsal arms hectocotylized. Two-thirds natural size



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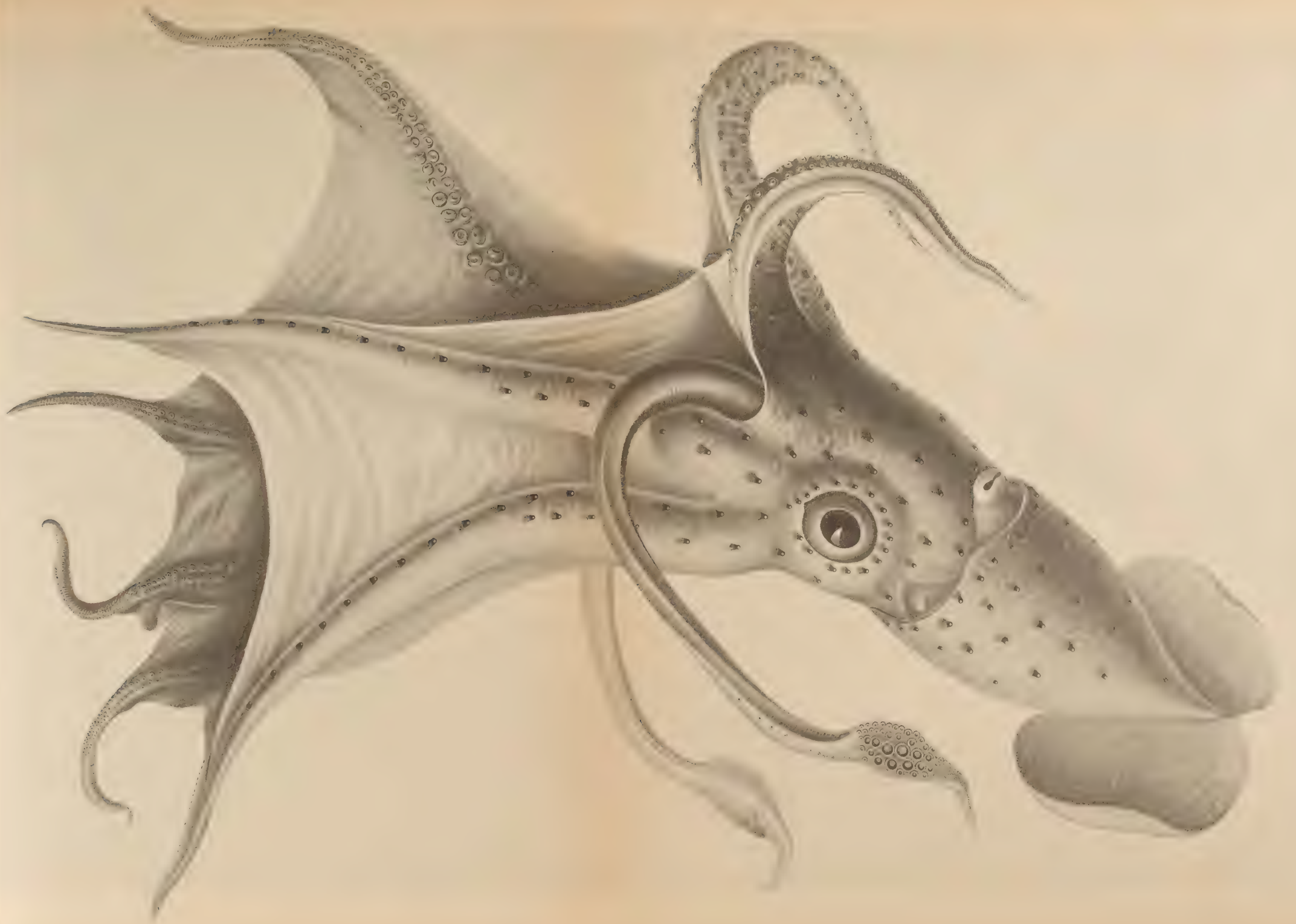
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Plate XXII

Teleoteuthis caribaea LESUEUR

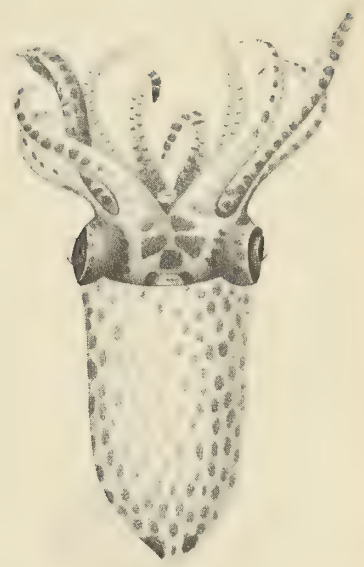
Juvenile stages from Station 49, Atlantic South Equatorial Current, surface

- Figure 1. Youngest stage, ventral. $\times 4$
- Figure 2. Same stage, dorsal. $\times 4$
- Figure 3. Slightly older stage, dorsal. $\times 4$
- Figure 4. Same, ventral.
- Figure 5. Intermediate stage, dorsal. $\times 4$
- Figure 6. Same, ventral. $\times 4$
- Figure 7. Oldest stage, dorsal. $\times 3$
- Figure 8. Same, ventral. $\times 3$





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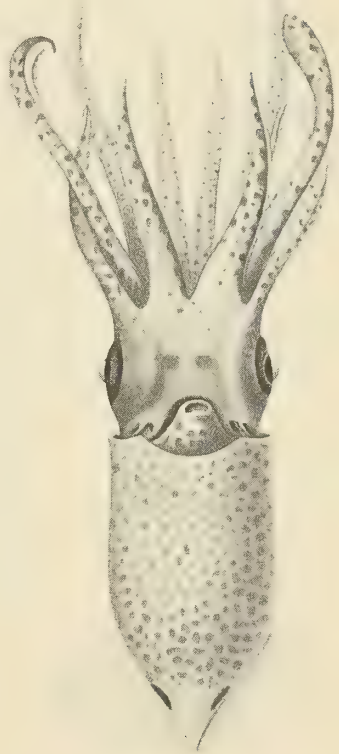


Plate XXIII

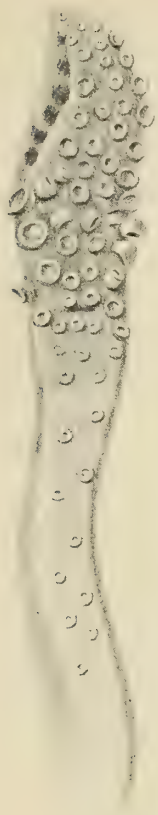
Larvae of Onychoteuthidae, clubs of *Teleoteuthis caribaea*

- Figure 1. Youngest larva, right side. Station 218, Bay of Bengal. $\times 10$
Figure 2. Arms of same larva, seen from above.
Figure 3. Young larva, right side. Station 172, southern part of Indian Ocean. $\times 10$
Figure 4. Arms of same larva.
Figure 5. Young larva, left side. Station 48, Atlantic South Equatorial Current. $\times 10$
Figure 6. Arms of same larva.
Figure 7. Older larva, left side. Station 218, Bay of Bengal. $\times 10$
Figure 8. Arms of same larva.
Figure 9. Oldest larva, left side. Station 74, Benguela Current. $\times 10$
Figure 10. Arms of same larva.

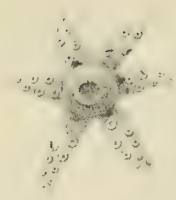
Figures 11–14. Clubs of juvenile stages of *Teleoteuthis caribaea*. Station 49

- Figure 11. Club of youngest stage (cf. Plate XXII, Figures 1, 2). Appr. $\times 30$
Figure 12. Club of young stage (cf. Plate XXII, Figures 3, 4). Appr. $\times 30$
Figure 13. Club of intermediate stage (cf. Plate XXII, Figures 5, 6). Appr. $\times 18$
Figure 14. Club of oldest stage (cf. Plate XXII, Figures 7, 8). Appr. $\times 18$

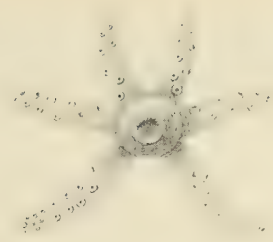
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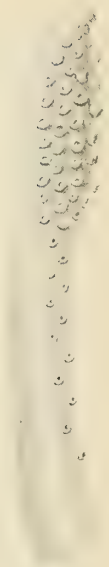
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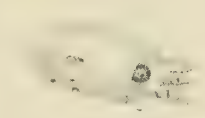
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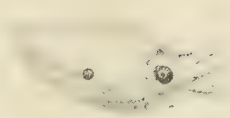
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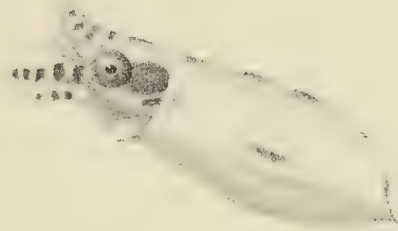
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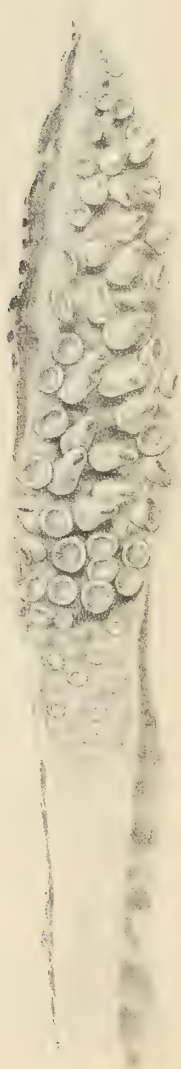
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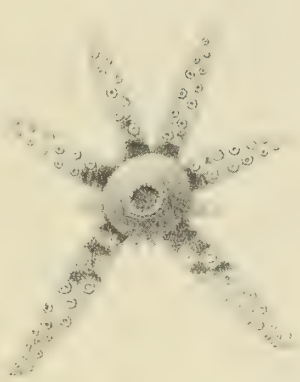
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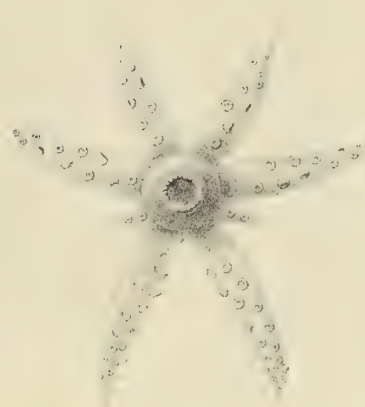
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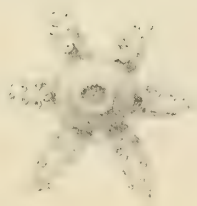


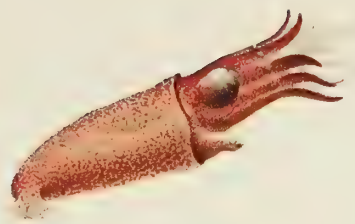
Plate XXIV

Benthoteuthis megalops VERRILL (*Bathyteuthis abyssicola* HOYLE)

Based on color sketches of live animals

- Figure 1. Largest specimen, dorsal. Station 221, Indian Countercurrent near Chagos Archipelago. × 3
- Figure 2. Same specimen, ventral. × 3
- Figure 3. Medium-sized specimen, dorsal. Station 217, Indian North Equatorial Current. × 3
- Figure 4. Medium-sized specimen, ventral. Station 115, Benguela Current South of Cape of Good Hope. × 3
- Figure 5. Same, right side. × 3
- Figure 6. Small specimen, left side. Station 207, Indian Ocean (Surat passage). × 3
- Figure 7. Head of medium-sized specimen, ventral. × 6
- Figure 8. Head of same specimen, obliquely from left side. × 6

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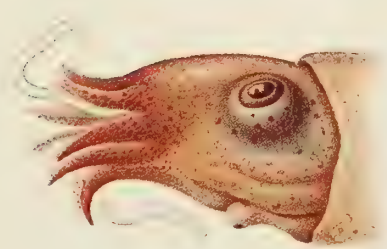


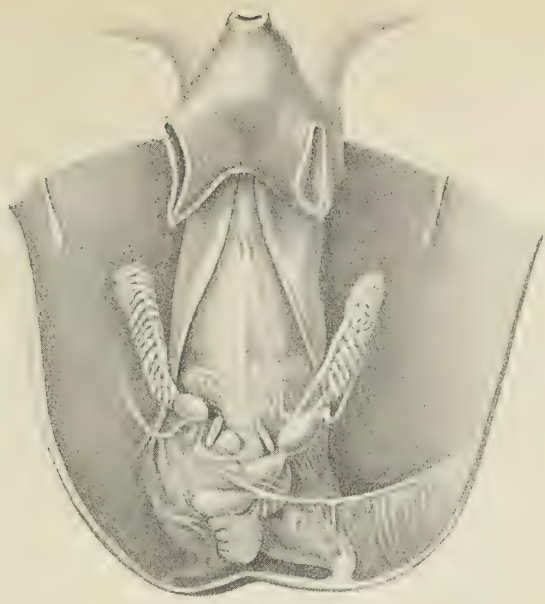
Plate XXV

Benthoteuthis megalops VERRILL. Arm apparatus, mantle complex

- Figure 1. Mantle complex of large specimen, Station 221. Appr. \times 4
- Figure 2. Arm apparatus, diagonally dorsal. Small specimen, Station 115. Appr. \times 15
- Figure 3. Arm apparatus, diagonally ventral. Large specimen, Station 221
- Figure 4. Club of the large specimen from Station 221. Appr. \times 30
- Figure 5. Club of small specimen from Station 115. Appr. \times 30
- Figure 6. Funnel organ of the large specimen from Station 221. \times 8
- Figure 7. Neck cartilage of same specimen. Appr. \times 10



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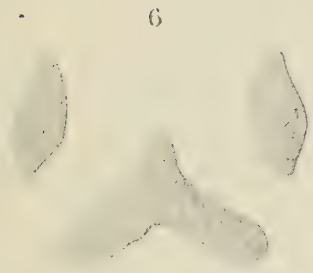
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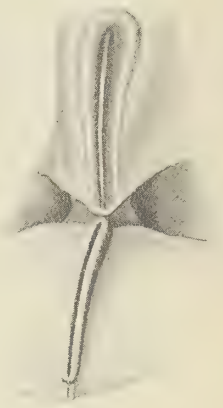
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Plate XXVI

Benthoteuthis megalops VERRILL. Intestinal tract, vascular system. Large specimen from Station 221

Figure 1. Mantle complex, ventral. Abdominal wall with heart and vessels removed. $\times 10$

Figure 2. Intestinal tract, left side. $\times 10$

Figure 3. Intestinal tract, dorsal. $\times 10$

Figure 4. Mantle complex with intestinal tract, vascular system, and female genitalia, ventral.
 $\times 10$

Figure 5. Vascular system, nidamental glands and oviduct, dorsal. $\times 10$

ABBREVIATIONS

a. branch.—branchial artery

a. ceph.—cephalic aorta

a. post.—posterior aorta

an.—anus

ao.—cephalic aorta

app. c.—appendage or branchial heart

atr.—ink sac

branch.—gill

c.—heart

c. branch.—branchial heart

d. coel.—coelomic duct to renal sac

d. hep.—hepatic duct

hep.—liver

hep.¹—anterior part of liver

lig. an.—anal ligament

lig. g. g.—gastro-genital ligament

mu. depr. inf.—funnel depressor

mu. retr. cap. lat.—musculus retractor
capitis lateralis

neph.—renal sac

nid.—nidamental gland

od. s.—left oviduct

oes.—esophagus

o. st.—opening of stomach

ov.—ovary

ovid.—oviduct

pancr. d.—right pancreas

pancr. s.—left pancreas

rect.—rectum

s. ven.—venous sac

s. ven. hep.—venous sac of liver

saliv. post.—posterior salivary gland

st.—stomach

st.¹—anterior part of stomach

st. coec.—caecum

ur.—papilla of renal sac

v. abd.—abdominal vein

v. branch.—branchial vein

v. c.—vena cava

v. hep.—hepatic vein

v. hep. pancr.—hepato-pancreatic vein

v. pall.—pallial vein

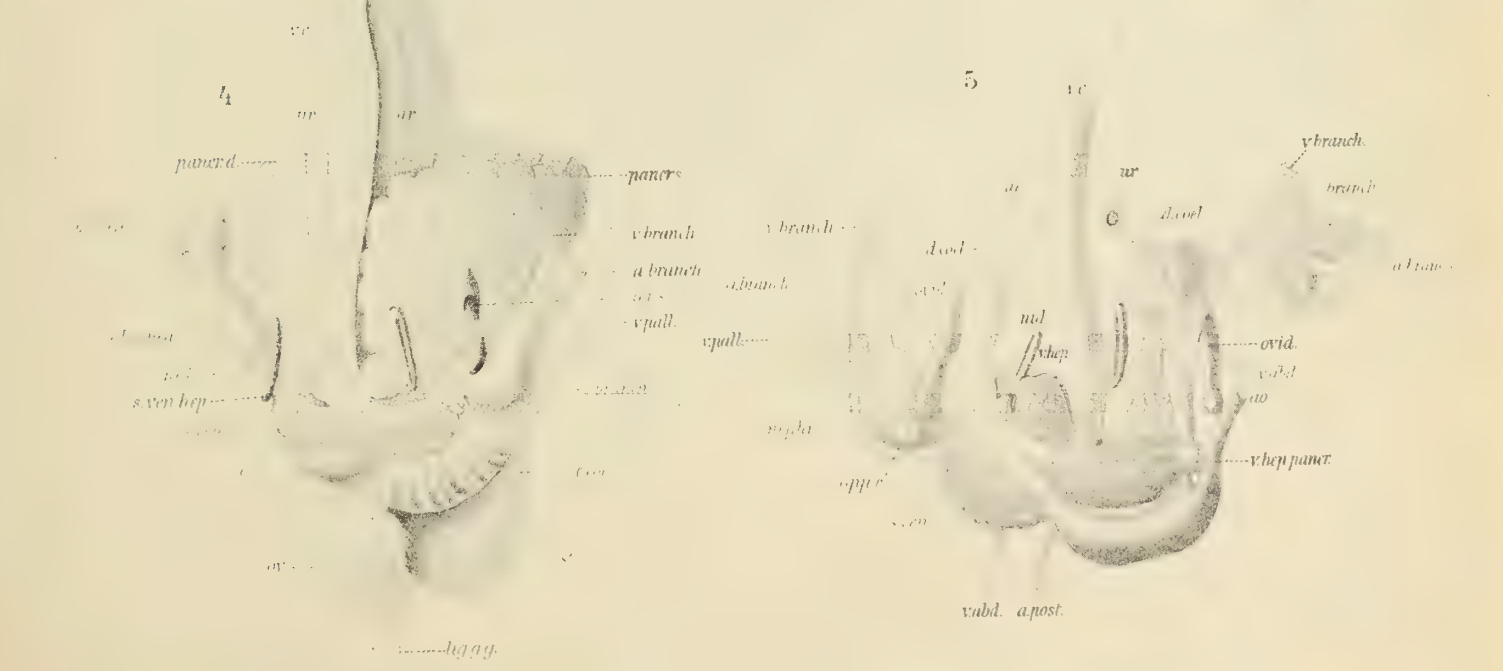
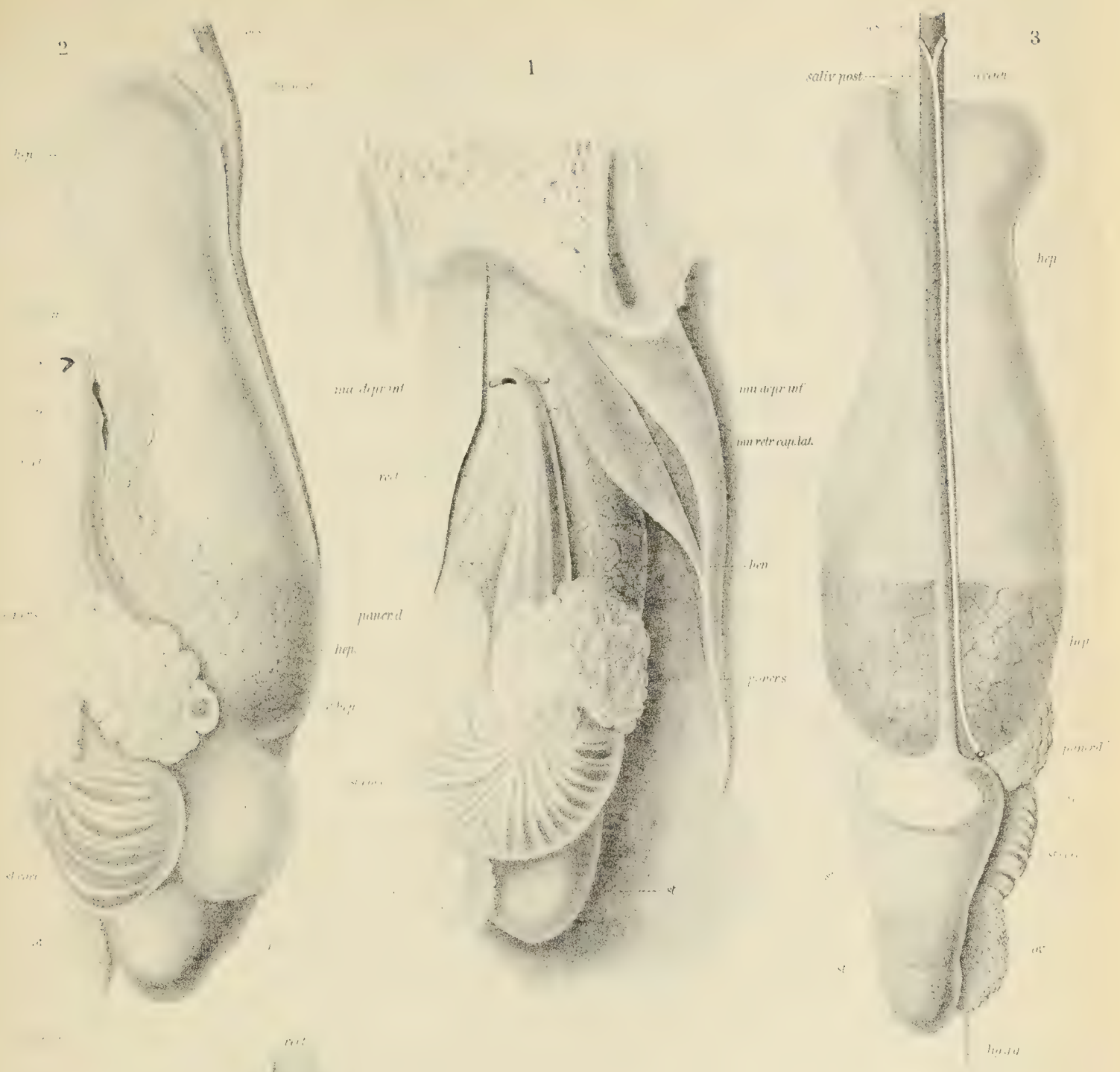


Plate XXVII

Figures 1-8. *Benthoteuthis megalops* VERRILL. Eye and luminous organ
Fixation in formol (eye) and osmic acid (lum. organ)

Figures 9-11. *Ctenopteryx* juv.

- Figure 1. Left eye of large specimen of *Benthoteuthis megalops* from Station 221. Right side.
Appr. $\times 12$
- Figure 2. Same, ventral. Appr. $\times 12$
- Figure 3. Median section through eye of large specimen from Station 221.
- Figure 4. Section through fovea of same eye. $\times 195$
- Figure 5. Posterior margin and fovea of same eye after clearing in oil of cloves. $\times 23$
- Figure 6. Marginal part of retina of same eye. $\times 195$
- Figure 7. Vascular whorl near fovea.
- Figure 8. Longitudinal section of luminous organ of a medium-sized specimen. $\times 400$
- Figure 9. Juvenile form of *Ctenopteryx* sp., dorsal. South Atlantic Benguela Current. Station
86. $\times 6$
- Figure 10. Same, ventral. $\times 6$
- Figure 11. Right fin of same specimen, lateral. Appr. $\times 25$

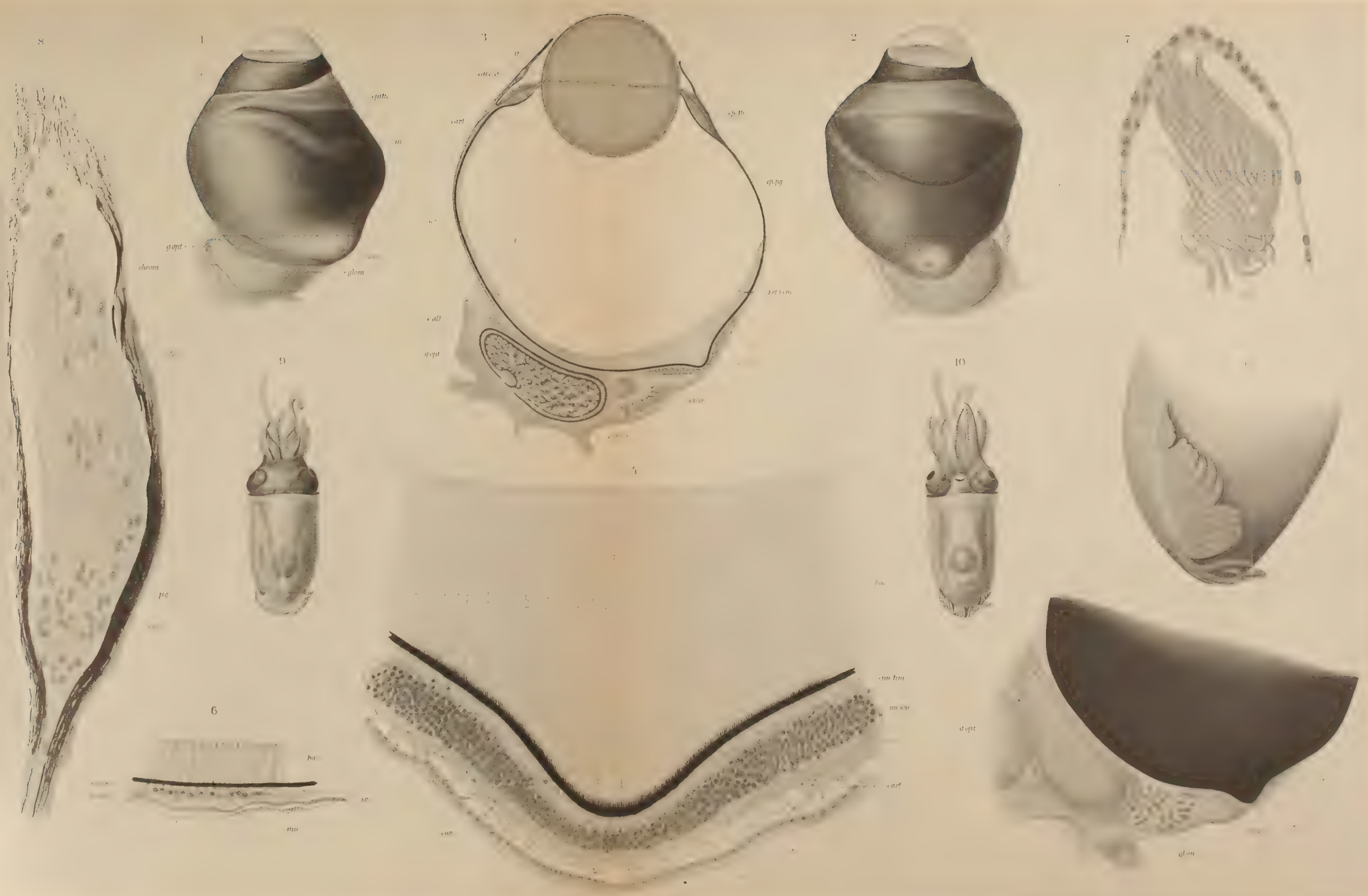
ABBREVIATIONS

<i>bac.</i> —rods	<i>ep. pg.</i> —pigmented epithelium	<i>n.</i> —nerve
<i>bg.</i> —connective tissue	<i>fovea</i> —fovea of retina	<i>nu. lim.</i> —nuclei of cells of membrana limitans
<i>c. alb.</i> —white body	<i>g. opt.</i> —optio ganglion	<i>nu. sens.</i> —nuclei of sensory cells
<i>c. epith.</i> —epithelial (ciliated) body	<i>glom.</i> —glomerulus	<i>pg.</i> —pigment
<i>cap.</i> —capillaries	<i>ir.</i> —iris	<i>phot.</i> —luminous body
<i>cart.</i> —cartilage of eye	<i>lim.</i> —membrana limitans of rod layer	<i>ret. dors.</i> —dorsal retina
<i>cart. cr.</i> —cartilage of cranium	<i>m.</i> —margin of retina	<i>ret. ventr.</i> —ventral retina
<i>cart. ir.</i> —cartilage of iris	<i>mu.</i> —muscle fibers	<i>scl.</i> —sclera of eyeball
<i>chrom.</i> —chromatophores	<i>mu. l.</i> —longitudinal muscles	

Plate XXVIII

Rhynchoteuthis, larvae of Ommatostrephidae. $\times 10$

- Figure 1. Youngest larva, ventral. Station 215, Bay of Bengal
- Figure 2. Young larva, ventral. Station 64, southern Atlantic near São Tomé Island
- Figure 3. Young larva, right side. Station 64
- Figure 4. Intermediate larva, ventral. Station 41, Guinea Current
- Figure 5. Intermediate larva, right side. Station 41, Guinea Current
- Figure 6. Intermediate larva, right side. Station 236, Indian Ocean near Seychelles
- Figure 7. Intermediate larva, left side. Station 173, southern Indian Ocean
- Figure 8. Young larva, ventral. Station 64, Atlantic Ocean near São Tomé Island
- Figure 9. Intermediate larva, ventral. Station 173, southern Indian Ocean
- Figure 10. Young larva, left side. Station 125, Indian North Equatorial Current
- Figure 11. Older larva, ventral. Station 175, Indian South Equatorial Current
- Figure 12. Older larva, ventral. Station 90, South Atlantic Benguela Current
- Figure 13. Oldest larva, left side. Station 228, Indian Countercurrent
- Figure 14. Same, dorsal.
- Figure 15. Same, ventral.



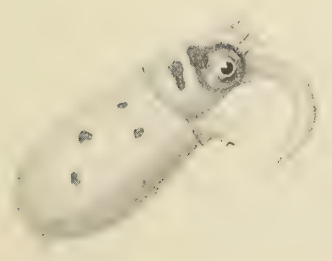
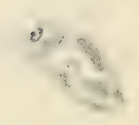
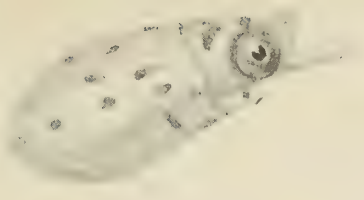


Plate XXIX

Figures 1–9. *Rhynchoteuthis*

Figures 9–11. *Brachioteuthis* (*Tracheloteuthis*)

Figures 12, 13. Larva caught in locking net

- Figure 1. *Rhynchoteuthis*. Head and arms of intermediate larva, seen from above. Station 175. Appr. $\times 18$
- Figure 2. Head and arms of oldest larva (cf. Plate XXVIII, Figure 14), seen from above. Station 228. Appr. $\times 18$
- Figure 3. Neck cartilage of oldest larva. Station 228. Appr. $\times 20$
- Figure 4. Mantle complex of oldest larva. Station 228. Appr. $\times 20$
- Figure 5. Eye of young larva, lateral. Station 64
- Figure 6. End of fused tentacles of young larva. Station 55, Guinea Current
- Figure 7. Anal appendage of older larva. Station 90, southern Atlantic. Appr. $\times 50$
- Figure 8. Anal appendage of oldest larva. Station 228. Appr. $\times 50$
- Figure 9. *Brachioteuthis*, youngest larva, left side. Station 237. Indian South Equatorial Current. $\times 8$
- Figure 10. Head of same larva, dorsal. Appr. $\times 20$
- Figure 11. *Brachioteuthis picta* n.sp. Buccal funnel and attachment of arms, seen from above. Station 67, northern branch of Benguela Current. Appr. $\times 10$
- Figure 12. Larva caught in locking net at 1,500–2,000 m, right side. Station 120, West Wind Drift. $\times 10$
- Figure 13. Same larva, ventral. $\times 10$

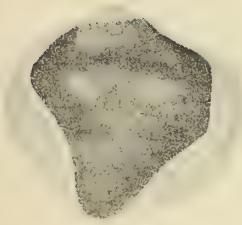


Plate XXX

Figures 1-3. *Brachioteuthis (Tracheloteuthis)* juv.

Figures 4, 5. *Brachioteuthis picta* n. sp.

- Figure 1. Juvenile form of *Brachioteuthis*, probably belonging to *Br. riisei*. STEENSTR., left side. Station 66, northern branch of Benguela Current. $\times 8$
- Figure 2. *Brachioteuthis* juv., dorsal. Station 236, Indian South Equatorial Current near Amirantes. Appr. $\times 8$
- Figure 3. Same larva, ventral. Appr. $\times 8$
- Figure 4. *Brachioteuthis picta* n. sp., dorsal. Station 67, northern branch of Benguela Current. $\times 2$
- Figure 5. Same specimen, ventral. $\times 2$

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Plate XXXI

Figures 1, 2, 3, 5, 7, 8. *Brachioteuthis picta* n. sp.

Figures 4, 6. Juvenile forms of *Brachioteuthis* (*Tracheloteuthis*). Gladius and arm apparatus

- Figure 1. *Brachioteuthis picta* CH. Gladius, ventral $\times 5$
- Figure 2. *Br. picta*. Left club, outer surface. $\times 10$
- Figure 3. Same, inner surface.
- Figure 4. Club of juvenile form from Station 236 (cf. Plate XXX, Figures 2, 3)
- Figure 5. Large sucker of club of *Br. picta*.
- Figure 6. Club of juvenile form from Station 66 (cf. Plate XXX, Figure 1). Appr. $\times 20$
- Figure 7. Row of suckers in middle of 3rd arm of *Brachioteuthis picta*, ventral. Appr. $\times 18$
- Figure 8. Same, dorsal. Appr. $\times 18$



Plate XXXII

Brachioteuthis (Tracheloteuthis) picta n.sp. Head, intestinal tract, and vascular system

- Figure 1. Mantle complex. Funnel slightly displaced. $\times 4$
Figure 2. Head with neck folds, olfactory tubercle, and funnel, left side. $\times 10$
Figure 3. Visceral complex, right side. $\times 11$
Figure 4. Intestinal tract, left side. $\times 11$
Figure 5. Neck cartilage. $\times 8$
Figure 6. Vascular system, dorsal. $\times 11$

ABBREVIATIONS

a. branch.—branchial artery
a. ceph.—cephalic aorta
a. pall.—pallial artery
a. post.—posterior artery
app. an.—anal appendages
app. c.—appendage of branchial
heart
atr.—ink sac
c.—heart
c. branch.—branchial heart
hep.—liver

int.—mid-intestine
lig. g. g.—gastro-genital ligament
mu. depr. inf.—funnel depressor
n. visc.—visceral nerve
oes.—esophagus
pancr.—pancreas
pancr.¹—anterior lobe of pan-
creas
rect.—rectum
sacc. v.—venous sac
sacc. v.¹—anterior venous sac

sacc. v.²—posterior venous sac
sin. st.—sinus of stomach
st.—stomach
st. coec.—caecum
st. coec.¹—hood of caecum
test.—testis
v. abd.—abdominal vein
v. branch.—branchial vein
v. c.—vena cava
v. hep.—hepatic vein
v. pall.—pallial vein

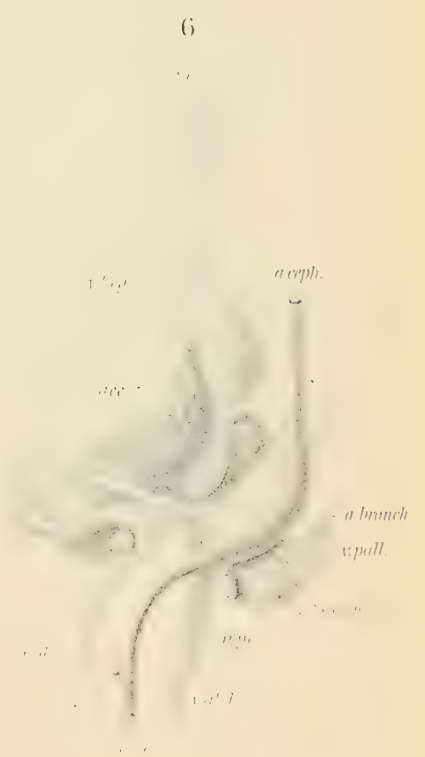
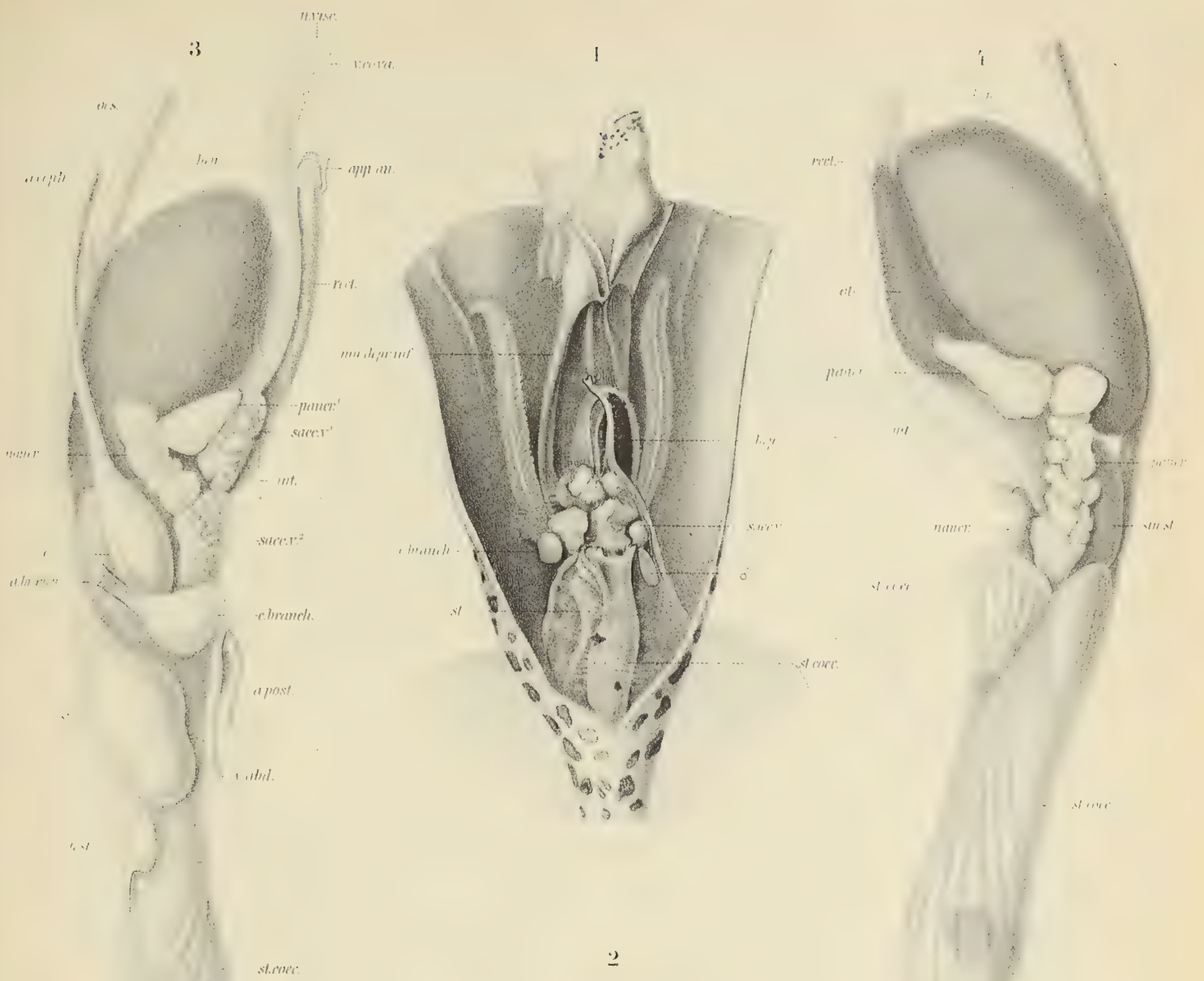


Plate XXXIII

Figures 1-2. *Mastigoteuthis glaukopsis* n. sp.

Figure 1. *M. glaukopsis*, left side. Station 261, Indian South Equatorial Current near East Africa. $\times 2$

Figure 2. Same, ventral.

Figures 3, 4. *M. flammea* n. sp.

Figure 3. *M. flammea*, dorsal. Station 64, near São Tomé Island in the South Atlantic. $\times 2$

Figure 4. Same, ventral. $\times 2$



Plate XXXIV

Mastigoteuthis cordiformis n. sp.

Figure 1. *M. cordiformis*, dorsal. Station 194, Indian Countercurrent near Nias. Natural size

Figure 2. Same, ventral.

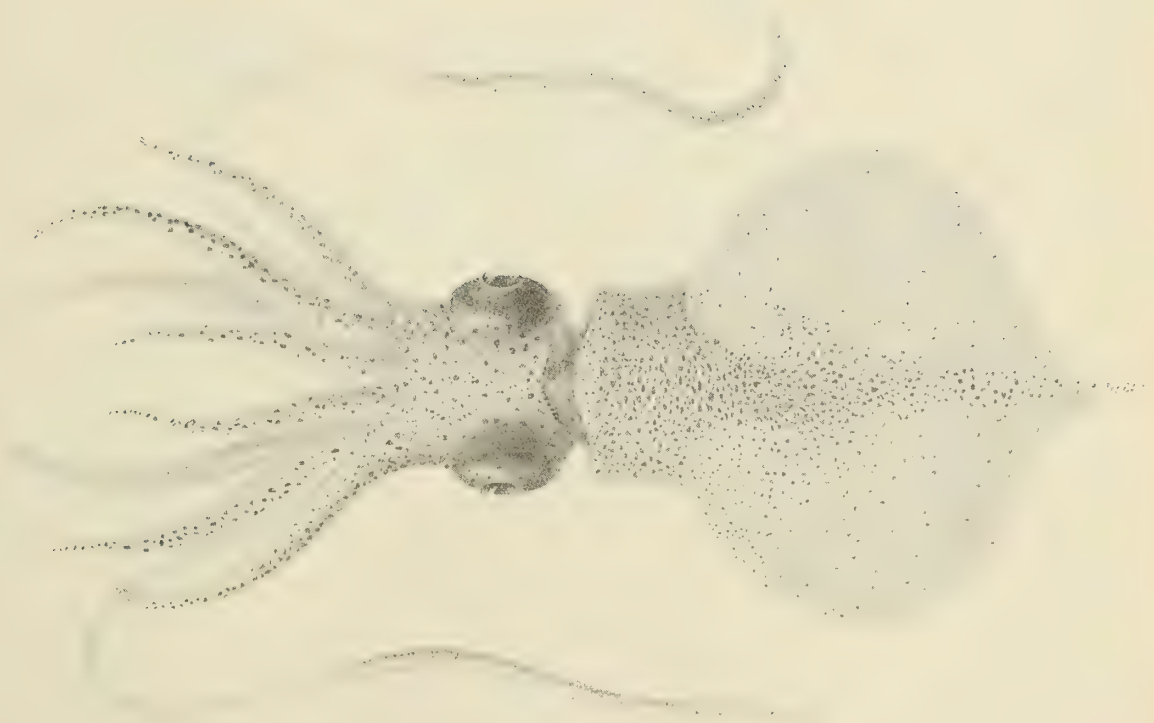
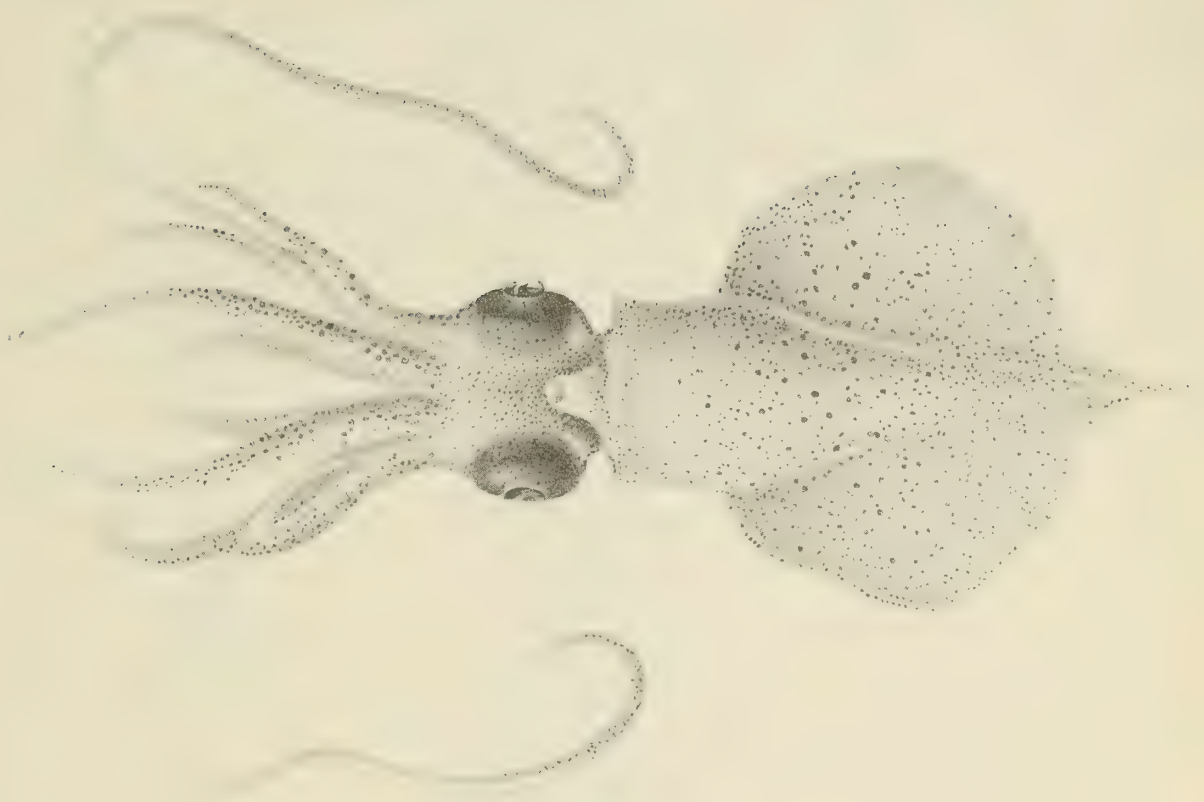


Plate XXXV

Mastigoteuthis VERRILL. Gladius, cartilage, and arm apparatus

- Figure 1. *Mastigoteuthis cordiformis* n. sp. Right funnel cartilage. Station 194
- Figure 2. *M. glaukopsis* n. sp. Right funnel cartilage. Station 261
- Figure 3. *M. flammea*. Right funnel cartilage. Station 53
- Figure 4. *M. flammea*. Right funnel cartilage. Station 64
- Figure 5. *M. cordiformis*. Gladius, ventral. $\times 2$
- Figure 6. Same, right side. $\times 2$
- Figure 7. Neck cartilage of *M. flammea*. Station 64
- Figure 8. Bases of arms, buccal funnel, and tentacles of *M. cordiformis*, seen from above. $\times 2$
- Figure 9. Buccal funnel and its attachment, *M. flammea*. Station 64
- Figure 10. Proximal part of club of *M. cordiformis*.
- Figure 11. Tentacle sucker of *M. cordiformis*, lateral.
- Figure 12. Tentacle sucker of *M. cordiformis*, seen from above.
- Figure 13. Arm sucker of *M. cordiformis*, lateral.
- Figure 14. Arm sucker of *M. cordiformis*, seen from the opening.
- Figure 15. Tentacle of *M. glaukopsis*. Station 261. Appr. $\times 2.5$
- Figure 16. Part of club of *M. glaukopsis*, outer side. Appr. $\times 20$

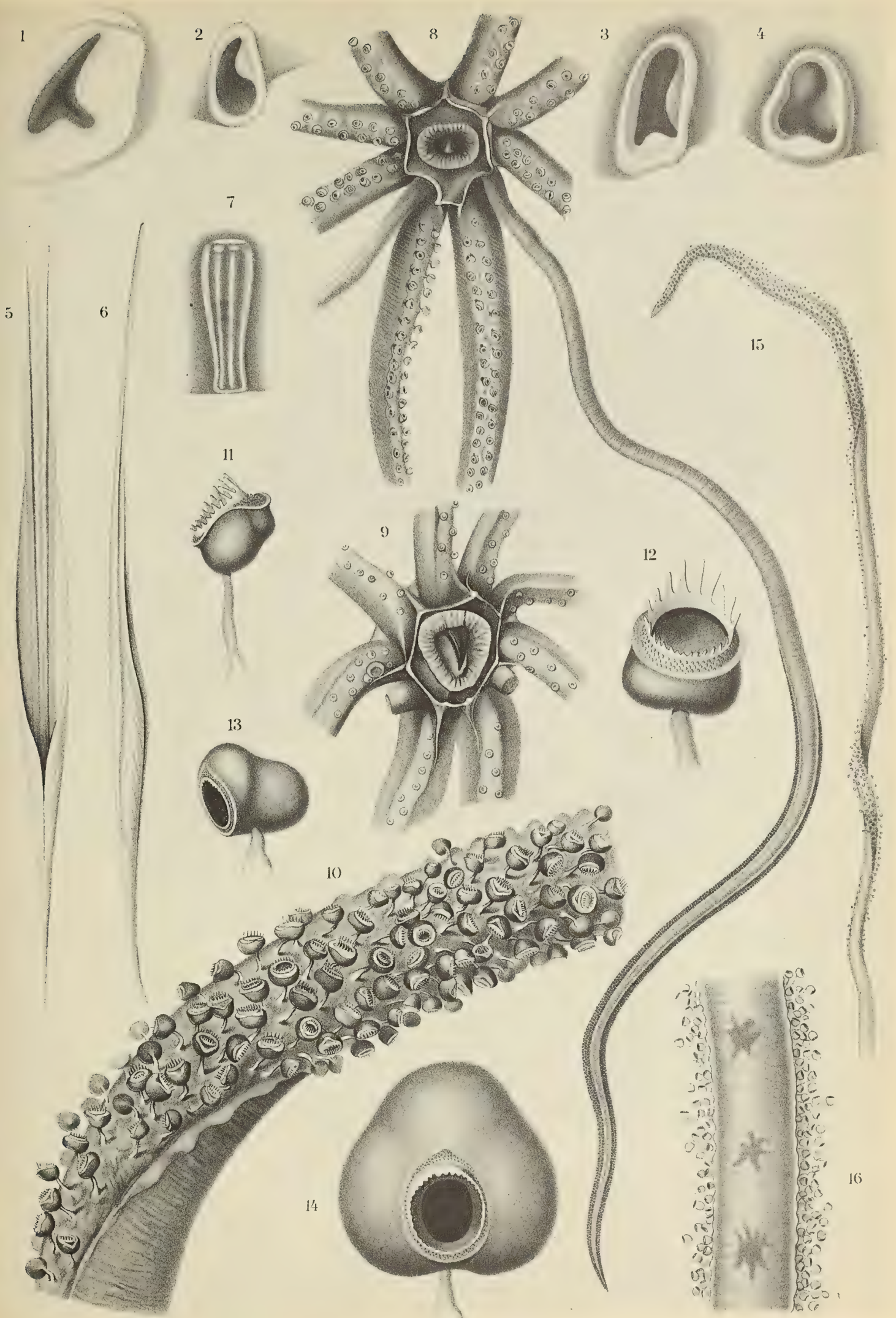


Plate XXXVI

Mastigoteuthis. Anatomy

- Figure 1. *Mastigoteuthis flammea*. Mantle complex, ventral. Station 64. Left gill cut at base of branchial heart and folded aside. Abdominal wall removed on left side
- Figure 2. *Mastigoteuthis flammea*. Mantle complex of specimen from Station 53, ventral
- Figure 3. *Mastigoteuthis cordiformis*. Mantle complex, ventral
- Figure 4. *Mastigoteuthis cordiformis*. Stomach and caecum with gastric ganglion and veins. Ventral
- Figure 5. *Mastigoteuthis cordiformis*. Neck cartilage. $\times 3.5$

ABBREVIATIONS

a. branch.—branchial artery
a. post.—posterior artery
app. c.—appendage of branchial heart
c.—heart
c. branch.—branchial heart
g. gastr.—gastric ganglion
g. stell.—stellate ganglion
hep.—liver
int. mid-intestine
lig. g. g.—gastro-genital ligament

luc.—luminous organ
mu. coll.—collaris
mu. depr. inf.—funnel depressor
n. pall.—pallial nerve
nid.—nidamental gland
oes.—esophagus
ov.—ovary
pancr.—pancreas
rad.—spiral folds
sacc.—abdominal wall
sacc. v.—venous sac

st.—stomach
*st.*¹—tip of stomach
st. coec.—caecum
susp.—ligament of gills
tub. olf.—olfactory tubercle
ur.—papilla of renal sac
v. abd.—abdominal vein
v. branch.—branchial vein
v. c.—vena cava
v. g.—gastric vein
v. pall.—pallial vein



Plate XXXVII

Mastigoteuthis. Luminous organs

- Figure 1. *Mastigoteuthis glaukopsis* n. sp., Station 261. Longitudinal section of organ of left eye.
Formol, alcohol-hemalum. $\times 130$
- Figure 2. *M. flammea* n. sp., Station 64. Section through mantle organ. Formol, alcohol-hemalum
- Figure 3. *M. flammea*, Station 64. Section through mantle organ.
- Figure 4. Mantle organs of *M. flammea*, surface view. Under magnifying glass
- Figure 5. *M. cordiformis* n. sp. Section through conical tubercle (luminous organ?) of skin

ABBREVIATIONS

- chr.*—chromatophores
ep.—epithelium
gel.—gelatinous connective tissue
mu.—muscle fibers
phot.—luminous body
v.—vessel
x.—central cord of cells

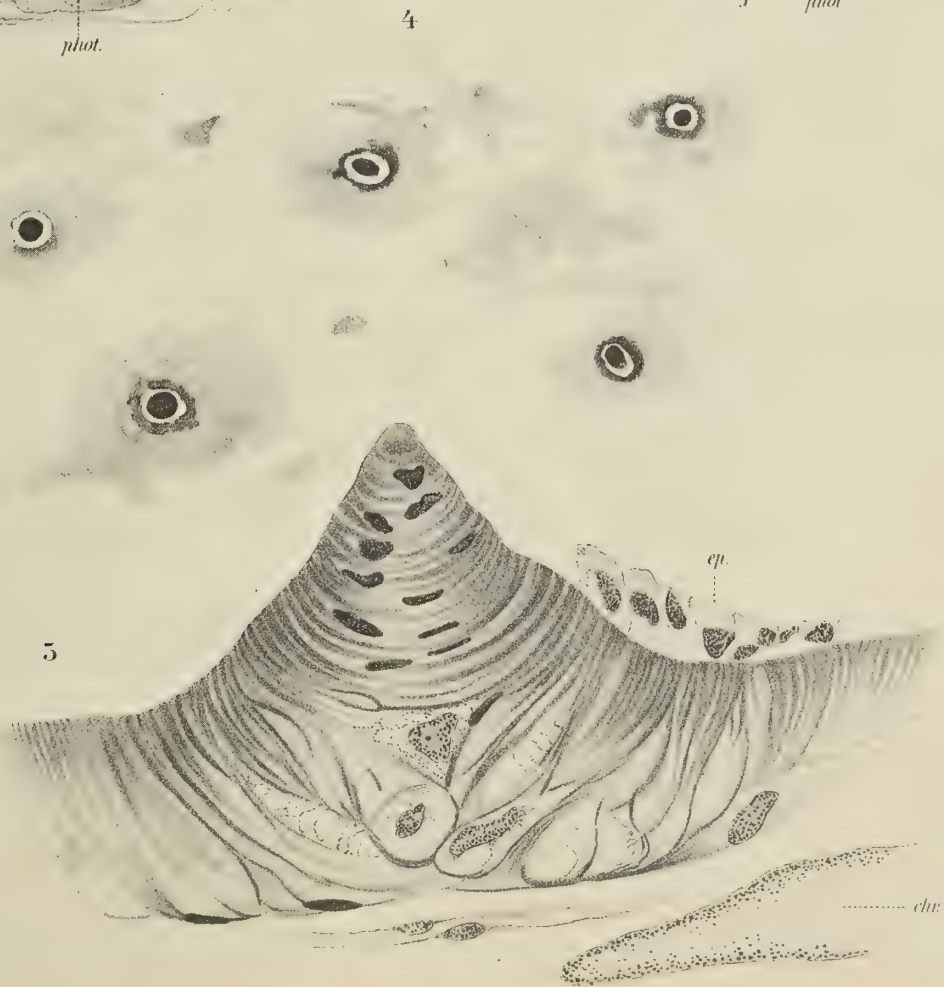
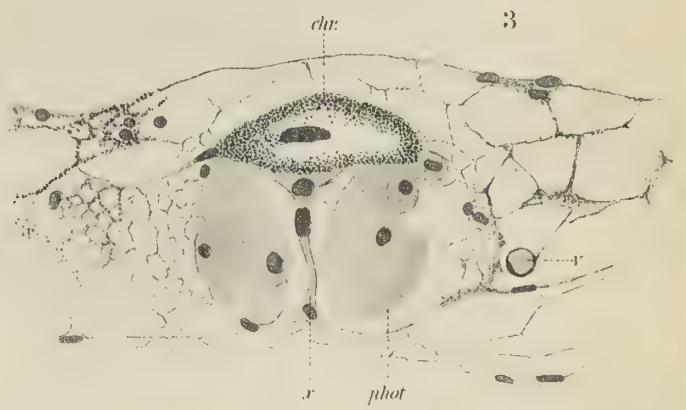
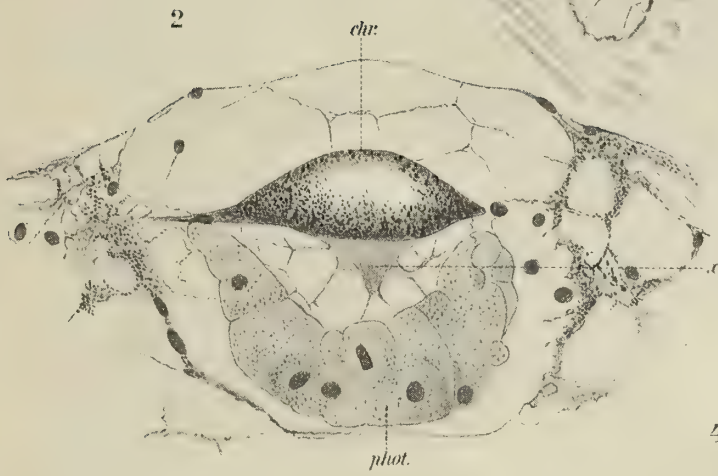


Plate XXXVIII

Chiroteuthis (Chirotauma) imperator n. sp.

Specimen from Station 194, South Channel of Nias. Natural size

Figure 1. Right side.

Figure 2. Dorsal.

Plate XXXIX

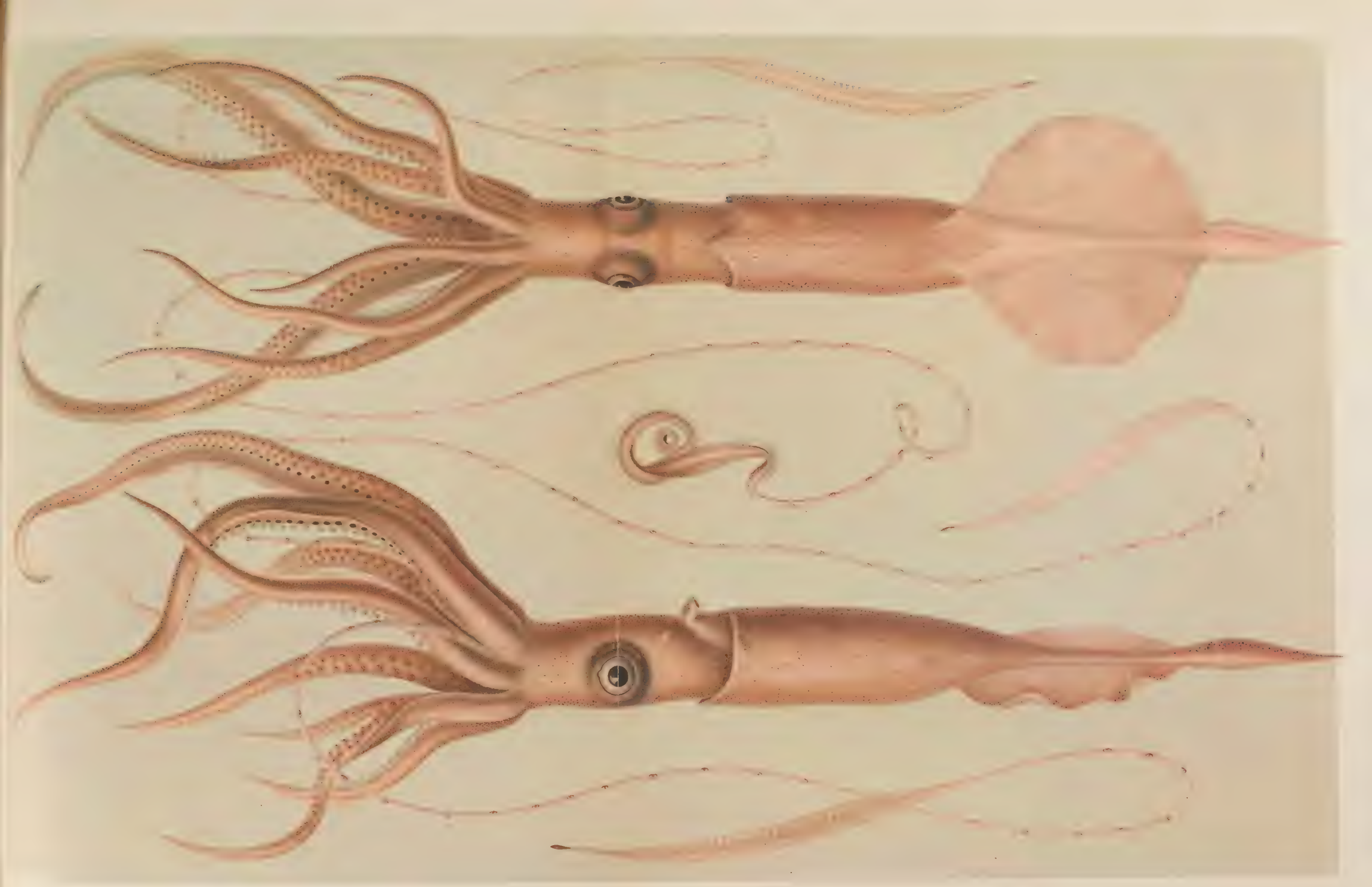
Chiroteuthis, Doratopsis

Figures 1–10. *Ch. imperator*. Station 194, Indian Countercurrent, near Nias

- Figure 1. Neck cartilage and opposite cartilage. Natural size
- Figure 2. Buccal funnel with attachments and arm bases, seen from above.
- Figure 3. Buccal funnel, ventral surface, lateral.
- Figure 4. Arm suckers, lateral.
- Figure 5. Arm suckers, seen from the opening.
- Figure 6. Tentacle suckers, seen from the opening.
- Figure 7. Tentacle suckers, lateral.
- Figure 8. Left funnel cartilage. $\times 5$
- Figure 9. Right funnel cartilage. $\times 5$
- Figure 10. Opposite cartilage of mantle. $\times 5$

Figures 11–15. *Doratopsis*

- Figure 11. Tentacle of *D. exophthalmica*, Station 169.
- Figure 12. Tentacle club of *D. lippula*, Station 74.
- Figure 13. Tentacle club of *D. exophthalmica*, Station 26.
- Figure 14. Base of large ventral arm of *D. exophthalmica*, Station 169.
- Figure 15. Base of large ventral arm of *D. sagitta*, Station 39.



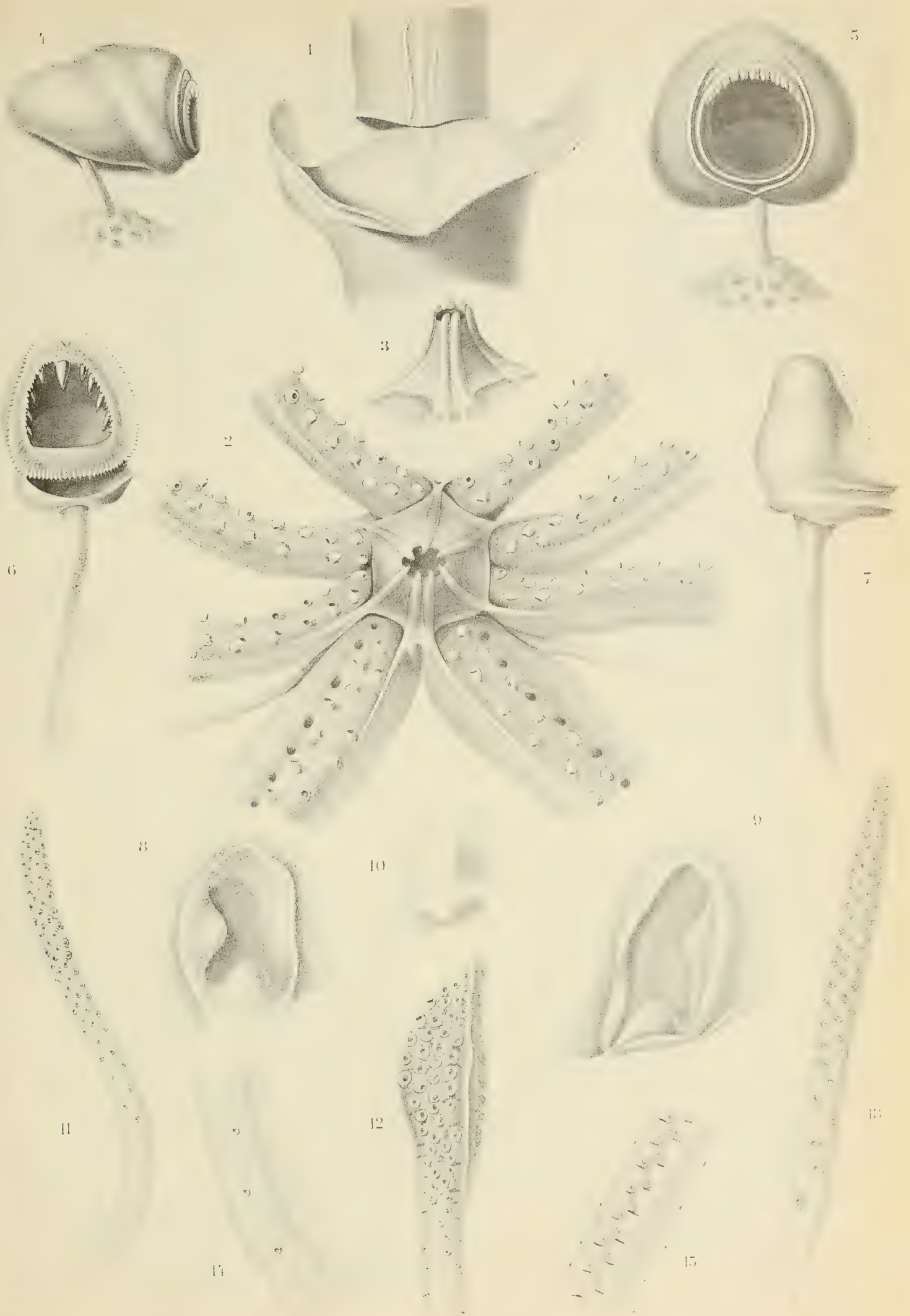


Plate XL

Chiroteuthis

Figure 1. *Ch. veranyi* FÉRUSAC. Adult male, natural size, ventral. Mantle was opened and the right eye exposed to show the luminous stripes

Figures 2-7. *Ch. imperator*

Figure 2. End of tentacle club with glandular knob, lateral. Station 194. Appr. $\times 20$

Figure 3. Glandular knob on club tip, external surface.

Figure 4. Part from middle of tentacle club. Specimen from Sagami Bay

Figure 5. Olfactory tubercle, diagonally lateral. Station 194

Figure 6. Left eye of *Ch. picteti*, after JOUBIN's description of original specimen

Figure 7. *Ch. imperator*. Mantle complex of younger male with both ventral luminous organs. Renal sac opened. Sagami Bay

ABBREVIATIONS

luc.—ventral luminous organs

ur.—papilla of renal sac

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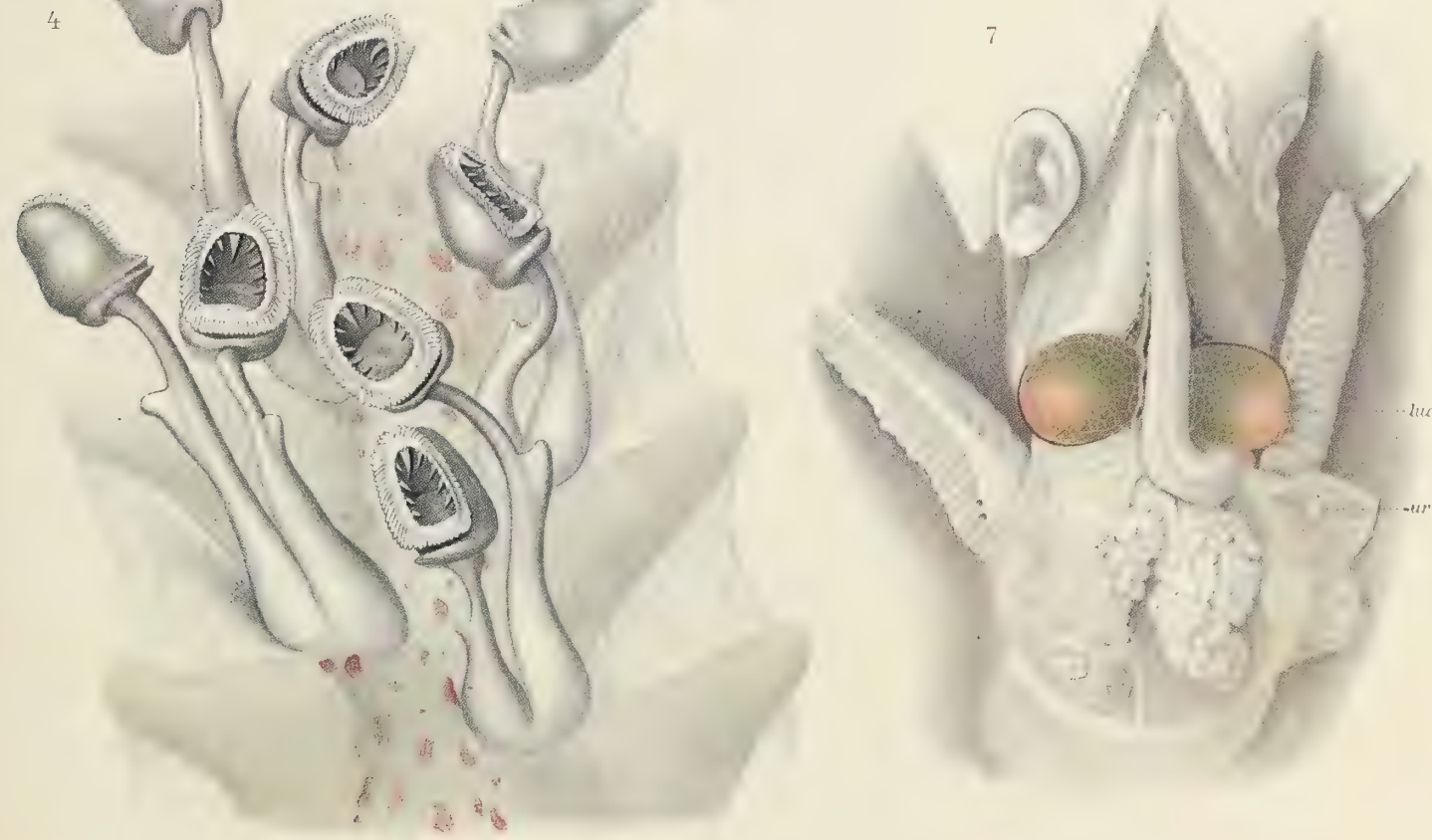
5

6



4

7



luc
ur

Plate XLI

Chiroteuthis imperator. Nervous system, gladius, viscera

- Figure 1. Nervous system of medium-sized specimen, dorsal. Visceral nerve and its branches was slightly displaced to the right
- Figure 2. Inferior buccal ganglion with adjacent anterior salivary glands and branches of buccal artery.
- Figure 3. Stellate ganglia and commissure of medium-sized specimen.
- Figure 4. Right orbit after removal of eye, with parts of central nervous system shining through. $\times 5.2$
- Figure 5. Central nervous system and thicker nerves of large specimen from Station 194. Left side. Cartilage of static organ cut open. Larger arteries and veins also indicated. Of the intestinal tract, course of esophagus and position of posterior salivary gland is indicated. $\times 4.7$
- Figure 6. Gastric ganglion with nerves.
- Figure 7. Heart, branchial hearts with efferent vessels and left oviduct of medium-sized specimen. Dorsal diagonal view. Oviduct not presented in right half of figure. $\times 4.2$
- Figure 8. Opening of right oviduct near branchial ganglion, ventral surface.
- Figure 9. Vena cava and appendage below point of entrance into cranium, with funnel nerves and adjacent muscle part. Lateral
- Figure 10. Gladius of medium-sized specimen, dorsal surface. Natural size
- Figure 10a, b, c. Slightly enlarged cross sections of gladius at level indicated by dotted lines.
- Figure 11. Same gladius, right side.
- Figure 12. Initial part of cone, ventral, under the magnifying glass.
- Figure 13. Posterior tip of gladius, lateral, showing also end of gelatinous tube and the delicate septa. $\times 14$
- Figure 14. Initial part of cone of large specimen from Station 194, with projecting gelatinous pad and end of gastro-genital ligament. Viewed diagonally from the right
- Figure 15. Section from posterior half of body, dissected out to show initial part of cone and adjacent organs, ventral
- Figure 16. Same preparation, left side.
- Figure 17. Male gonoducts of younger specimen, dorsal. $\times 6$
- Figure 18. Same, ventral. $\times 6$
- Figure 19. Testis of young male, ventral surface.
- Figure 20. Same, lateral, with posterior end of stomach and gastro-genital ligament.

ABBREVIATIONS

- | | | |
|---|---|---|
| <i>a. brach.</i> —brachial artery | <i>g. cer.</i> —cerebral ganglion | <i>n. s. phar.</i> —nerves of supraesophageal ganglion |
| <i>a. branch.</i> —branchial artery | <i>g. gastr.</i> —gastric ganglion | <i>n. stat.</i> —static nerve |
| <i>a. ceph.</i> —cephalic aorta | <i>g. ped.</i> —pedal ganglion | <i>n. symp.</i> —sympathetic nerve |
| <i>a. ophth.</i> —ophthalmic artery | <i>g. spl.</i> —splanchnic ganglion | <i>n. tent.</i> —nerve of tentacle |
| <i>a. pancr.</i> —pancreatic artery | <i>g. stell.</i> —stellate ganglion | <i>n. visc.</i> —visceral nerve |
| <i>a. phar.</i> —pharyngeal artery | <i>g. visc.</i> —visceral ganglion | <i>o. stat.</i> —static organ |
| <i>a. pinn.</i> —fin artery | <i>glad.</i> —gladius | <i>oes.</i> —esophagus |
| <i>a. post.</i> —posterior artery | <i>gl. od.</i> —oviduct gland | <i>od.</i> —oviduct |
| <i>a. saliv.</i> —salivary artery | <i>lig. g. g.</i> —gastro-genital ligament | <i>pen.</i> —end of spermatophore sac |
| <i>add. inf.</i> —funnel adductor | <i>m. cr.</i> —cranial ridge | <i>prost.</i> —prostate |
| <i>alb.</i> —white body | <i>mu.</i> —muscle | <i>r.</i> —nerve branch |
| <i>amp.</i> —opening of vas deferens | <i>mu. flab.</i> —fan-shaped muscle | <i>r. d. hep.</i> —nerve branch to hepatic duct |
| <i>app. c.</i> —appendage of branchial heart | <i>mu. pall.</i> —mantle musculature | <i>r. pancr.</i> —nerve branch to pancreas |
| <i>app. prost.</i> —appendage of prostate | <i>n. a. o. i.</i> —inferior antorbital nerve | <i>r. stom.</i> —nerve branch to stomach |
| <i>b. sperm.</i> —spermatophore sac (Needham's sac) | <i>n. a. o. s.</i> —superior antorbital nerve | <i>r. stom. coec.</i> —nerve branch to caecum |
| <i>c.</i> —heart | <i>n. atr.</i> —nerve to ink sac | <i>sacc. glad.</i> —shell gland |
| <i>c. b. s. i.</i> —commissure of buccal ganglia | <i>n. brach.</i> —brachial nerve | <i>sacc. v.</i> —venous sac |
| <i>c. brach. b.</i> —brachio-buccal commissure | <i>n. brach. 1, 2, 3, 4.</i> —branches of brachial nerve to 1st, 2nd, 3rd, 4th arms | <i>saliv. a.</i> —anterior salivary gland |
| <i>c. branch.</i> —branchial heart | <i>n. branch.</i> —branchial nerve | <i>saliv. p.</i> —posterior salivary gland |
| <i>c. cer. b.</i> —cerebro-buccal commissure | <i>n. c. branch.</i> —nerve of branchial heart | <i>sept.</i> —septae of cone |
| <i>c. cer. br.</i> —cerebro-brachial commissure | <i>n. inf.</i> —funnel nerve | <i>stom.</i> —stomach |
| <i>c. cer. ped.</i> —cerebro-pedal commissure | <i>n. inf. orb.</i> —orbital branch of funnel nerve | <i>test.</i> —testis |
| <i>c. cil.</i> —ciliated canal | <i>n. i. phar.</i> —nerves of inferior buccal ganglion | <i>v.</i> —vein |
| <i>c. visc. a.</i> —anterior visceral commissure | <i>n. o. m.</i> } oculomotor nerve | <i>v. abd.</i> —abdominal vein |
| <i>c. visc. p.</i> —posterior visceral commissure | <i>n. o. mot.</i> } oculomotor nerve | <i>v. branch.</i> —branchial vein |
| <i>coec. v. c.</i> —appendage of vena cava | <i>n. olf.</i> —olfactory nerve | <i>v. c.</i> —vena cava |
| <i>con.</i> —cone of gladius | <i>n. ophth. i.</i> —inferior ophthalmic nerve | <i>v. cr.</i> —cranial vein |
| <i>d. saliv.</i> —duct of posterior salivary gland | <i>n. ophth. s.</i> —superior ophthalmic nerve | <i>v. def.</i> —vas deferens |
| <i>div. oes.</i> —diverticulum of esophagus | <i>n. opt.</i> —optic nerve | <i>v. eff.</i> —vas efferens |
| <i>g. brach.</i> —brachial ganglion | <i>n. p. orb.</i> —postorbital nerve | <i>v. lien.</i> —splenic vein |
| <i>g. branch.</i> —branchial ganglion | <i>n. pall.</i> —pallial nerve | <i>v. saliv.</i> —salivary vein |
| <i>g. bucc. inf.</i> —inferior buccal ganglion | | <i>ves. sem. 1, ves. sem. 2, ves. sem. 3.</i> —1st, 2nd and 3rd part of seminal vesicle |
| <i>g. bucc. sup.</i> —superior buccal ganglion | | <i>x.</i> —gelatinous swelling of cone |

Plate XLII

Chiroteuthis. Mantle complex and intestinal tract

Figures 1-4. *Ch. imperator*

- Figure 1. Mantle complex of specimen from Station 194, ventral. Funnel opened
Figure 2. Intestinal tract of younger female, left side.
Figure 3. Viscera of same specimen, right side, with ovary situated on them.
Figure 4. Intestinal tract of young male, ventral. Mid-intestine cut at exit from stomach; dots indicate its position. $\times 3$
Figure 5. *Chiroteuthis veranyi* FÉRUS. Mantle complex of adult male from Messina. Ventral surface, viewed slightly diagonally from the left

ABBREVIATIONS

<i>a. post.</i> .—posterior artery	<i>mu. coll.</i> .—collaris	<i>rect.</i> .—rectum
<i>atr.</i> .—ink sac	<i>mu. depr. inf.</i> .—funnel depressor	<i>sacc. v.</i> .—venous sac
<i>b. sperm.</i> .—spermatophore sac	<i>mu. st.</i> .—muscular ridge of stomach	<i>sept.</i> .—mantle septum
<i>c. branch.</i> .—branchial heart	<i>n. pall.</i> .—mantle nerve	<i>st.</i> .—stomach
<i>cart. pall.</i> .—mantle cartilage	<i>n. symp.</i> .—sympathetic nerve	<i>st.</i> ¹ .—appendage of stomach
<i>d. hep.</i> .—hepatic duct	<i>nid.</i> .—nidamental gland	<i>st. coec.</i> .—caecum
<i>d. hep. pancr.</i> .—hepato-pancreatic duct	<i>oes.</i> .—esophagus	<i>susp. branch.</i> .—branchial ligament
<i>g. gastr.</i> .—gastric ganglion	<i>org. inf.</i> ¹ .—median funnel organ	<i>test.</i> .—testis
<i>hep.</i> .—liver	<i>org. inf.</i> ² .—lateral funnel organ	<i>v. abd.</i> .—abdominal vein
<i>int.</i> .—mid-intestine	<i>ov.</i> .—ovary	<i>v. c.</i> .—vena cava
<i>lig. g. g.</i> .—gastro-genital ligament	<i>pancr.</i> .—pancreas	<i>valv.</i> .—funnel valve
<i>luc.</i> .—ventral luminous organ	<i>pen.</i> .—end of spermatophore sac	<i>ves. sem.</i> .—seminal vesicle



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apha

solu u

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v. apd
v. apd
v. apd
v. apd
v. apd

v. m. abh

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v. m. abh

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20

v. m. abh

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v. m. abh

6

v. m. abh

10^a

10^b

10

10

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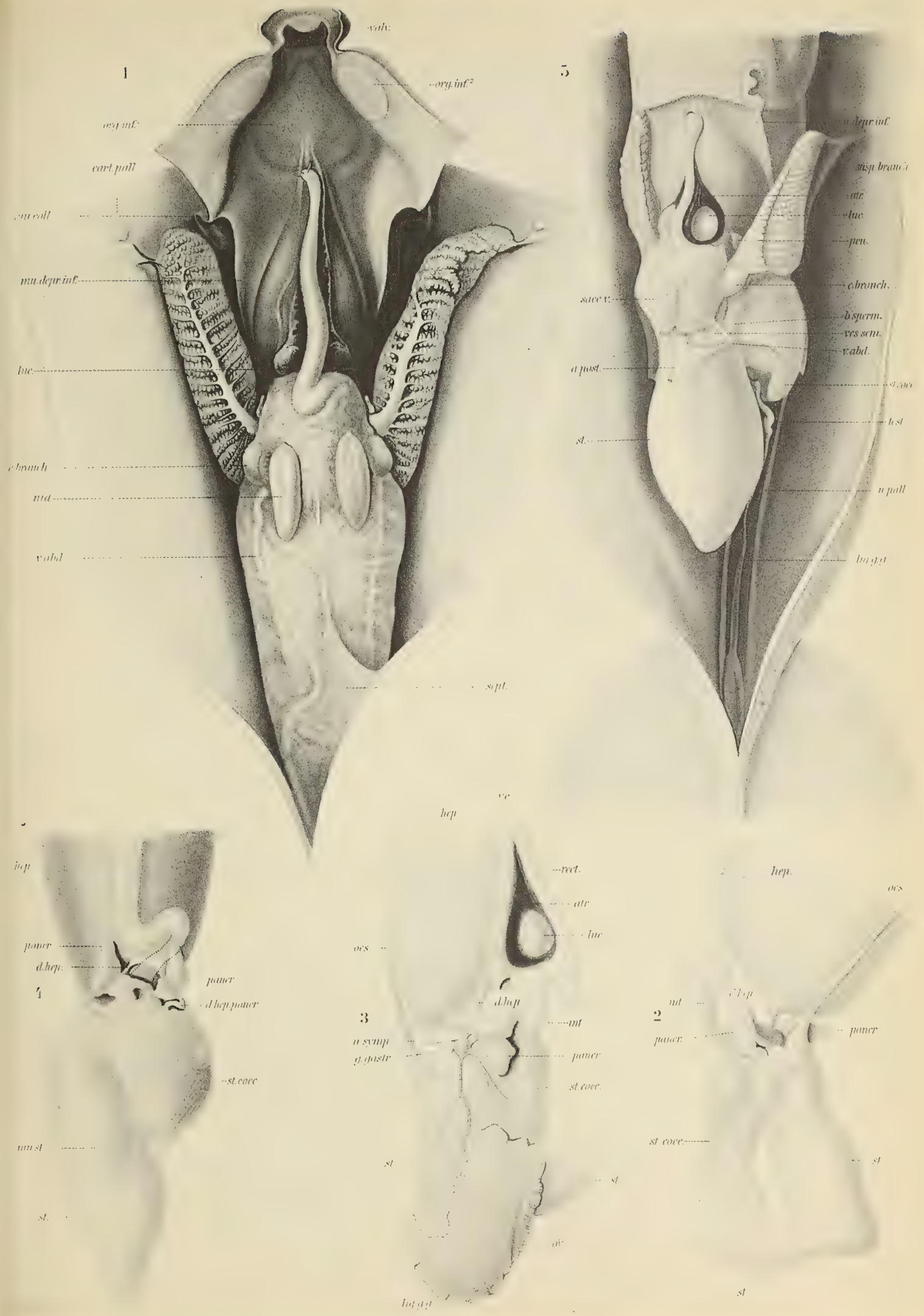
v. m. abh

v. m. abh

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volv

org inf?

org inf

cart pall

mu coll

mu depr inf

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c branch

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Plate XLIII

Chiroteuthis imperator

- Figure 1. Mantle complex of specimen from Station 194, ventral.
Figure 2. Specimen from Sagami Bay. Head viewed from the ventral side, to show the luminous organs of the eye and the nerves and vessels that extend from base of cranium
Figure 3. Dorsal view of head, showing cranial capsule and organs situated outside it. Sagami Bay
Figure 4. Same specimen as in Figure 3; with cranial capsule and anterior nerves removed.

ABBREVIATIONS

- | | |
|---|--|
| <i>a. ceph.</i> —cephalic aorta | <i>m. bucc.</i> —buccal membrane |
| <i>a. ophth.</i> —ophthalmic artery | <i>mu. depr. inf.</i> —funnel depressor |
| <i>atr.</i> —ink sac | <i>mu. palp.</i> —muscular mass of lid |
| <i>b. cran.</i> —base of cranium | <i>n. brach. 1, n. brach. 2, n. brach. 3,</i> |
| <i>brach. IV</i> —4th arm | <i>n. brach. 4</i> —nerves to 1st, 2nd, 3rd, |
| <i>c. alb.</i> —white body | 4th arms, respectively |
| <i>c. branch.</i> —branchial heart | <i>n. inf.</i> —funnel nerve |
| <i>cart. inf.</i> —funnel cartilage | <i>n. ophth. sup.</i> —superior ophthalmic |
| <i>cart. nuch.</i> —neck cartilage | nerve |
| <i>cart. pall.</i> —mantle cartilage | <i>n. pall.</i> —pallial nerve |
| <i>comm. b. s. i.</i> —commissure between | <i>n. pall. d.</i> —right pallial nerve |
| superior and inferior buccal | <i>n. s. phar.</i> —nerves of supraesophageal |
| ganglion | ganglion |
| <i>comm. cer. b.</i> —cerebro-buccal commissure | <i>n. symp.</i> —sympathetic nerve |
| <i>con.</i> —cone of gladius | <i>n. tent.</i> —nerve of tentacle |
| <i>cran.</i> —cranium | <i>nid.</i> —nidamental gland |
| <i>g. brach.</i> —brachial ganglion | <i>oes.</i> —esophagus |
| <i>g. bucc. inf.</i> —inferior buccal ganglion | <i>ov.</i> —ovary |
| <i>g. bucc. sup.</i> —superior buccal ganglion | <i>phar.</i> —pharynx |
| <i>g. cer.</i> —cerebral ganglion | <i>rect.</i> —rectum |
| <i>g. opt.</i> —optic ganglion | <i>sacc.</i> —abdominal wall |
| <i>gel.</i> —gelatinous tissue | <i>sacc.¹</i> —right abdominal wall |
| <i>gel. con.</i> —gelatinous swelling of cone | <i>saliv. ant.</i> —anterior salivary gland |
| <i>gel. pall.</i> —gelatinous tissue of mantle | <i>saliv. post.</i> —posterior salivary gland |
| <i>inf.</i> —funnel | <i>s. v. c.</i> —appendix of vena cava |
| <i>luc.</i> —luminous organ | <i>s. ven.</i> —venous sacs |
| <i>luc.¹</i> —outer row of eye organ | <i>st.</i> —stomach |
| <i>luc.²</i> —middle row of eye organs | <i>v. abd.</i> —abdominal vein |
| <i>luc.³</i> —inner row of eye organs | <i>v. c.</i> —vena cava |

Plate XLIV

Chiroteuthis. Luminous organs and glandular knobs

- Figure 1. *Chiroteuthis veranyi* FÉRUS., Messina. Luminous organ on ventral arm, longitudinal section. Formol, alcohol, hemalum. $\times 110$
- Figure 2. *Ch. veranyi*. Longitudinal section of ventral organ
- Figure 3. *Ch. imperator*. Part of luminous body of ventral organ; homog. imm. 1/12 (reduced). Formol, alcohol, hemalum
- Figure 4. *Ch. veranyi*. Confluence of several septa in gelatinous body of ventral organ; homog. imm. 1/12 (reduced)
- Figure 5. *Ch. veranyi*. Thick nerve extending along anterior dorsal surface of ventral organ; homog. imm. 1/12 (reduced)
- Figure 6. *Ch. imperator*. Longitudinal section through eye organ. Formol, alcohol, hemalum
- Figure 7. *Ch. imperator*. Part of luminous body of eye organ. Formol-alcohol, hemalum; homog. imm. 1/12
- Figure 8. *Ch. imperator*. Vessel entering eye organ; homog. imm. 1/12 (reduced)
- Figure 9. *Ch. imperator*. Fibers of lens of eye organ:
a) longitudinally, b) cross section.
Homog. imm. 1/12. Formol, alcohol, hemalum
- Figure 10. *Ch. imperator*. Horizontal section of glandular knob at end of tentacle club. Formol, alcohol, acid carmine
- Figure 11. *Ch. imperator*. Longitudinal section of glandular knob at end of club. Formol, alcohol, acid carmine
- Figure 12. *Ch. imperator*. Cross section of tentacle stalk of younger specimen, with glandular knob situated on top
- Figure 13. *Ch. imperator*. Basal part of glandular knob of tentacle club. Horizontal section. Formol, alcohol, hemalum; homog. imm. 1/12 (reduced)
- Figure 14. *Ch. imperator*. Basal part of gland lamella. Longitudinal section of luminous organ of tentacle club; homog. imm. 1/12 (reduced)
- Figure 15. *Ch. imperator*. Basal part of organ of tentacle club. Longitudinal section; homog. imm. 1/12 (reduced)
- Figure 16. *Ch. imperator*. Cross section of distal region of gland lamellae. Organ of tentacle club

ABBREVIATIONS

<i>art.</i> —artery	<i>gel.</i> —gelatinous tissue	<i>nu.</i> —nuclei
<i>atr.</i> —ink sac	<i>gel. cut.</i> —gelatinous tissue of skin	<i>nu. cap.</i> —nuclei of capillaries
<i>bg.</i> —connective tissue	<i>hom.</i> —gelatinous mass of gland lamellae	<i>nu. phot.</i> —nuclei of luminous body
<i>cap.</i> —capillaries	<i>l.</i> —lens	<i>phot.</i> —luminous body
<i>chr.</i> —chromatophores	<i>l.¹</i> —lens fibers, cut	<i>plica</i> —skin fold
<i>chr. pg.</i> —chromatophores of arm organ	<i>lam.</i> —gland lamellae	<i>refl.</i> —reflector
<i>cps.</i> —sheath of arm organ	<i>mu.</i> —musculature	<i>ret.</i> —knots of meshes of connective tissue
<i>cut.</i> —skin	<i>mu. circ.</i> —circular muscle fibers	<i>sang.</i> —blood corpuscles
<i>ep.</i> —epithelium	<i>mu. tent.</i> —musculature of tentacle	<i>secr.</i> —secretion
<i>fibr.</i> —fibrous cords of reflector	<i>n.</i> —nerve	<i>v.</i> —vessel
	<i>n. tent.</i> —nerve of tentacle	



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Plate XLV

Doratopsis DE ROCHEBRUNE

Figures 1-5. *Doratopsis sagitta* n. sp.

- Figure 1. *Doratopsis sagitta*, dorsal. Station 172, South Indian doldrum belt. $\times 3$
Figure 2. Same, ventral surface. $\times 3$
Figure 3. *D. sagitta*, dorsal surface. Station 39, Guinea Current. $\times 3$
Figure 4. Same, ventral surface.
Figure 5. *D. sagitta*. Head of specimen from Station 39, lateral. $\times 12$

Figures 6-7. *Doratopsis lippula* n. sp.

- Figure 6. *D. lippula*, dorsal surface. South Equatorial Current
Figure 7. Same, ventral surface.



Plate XLVI

Doratopsis DE ROCHEBRUNE

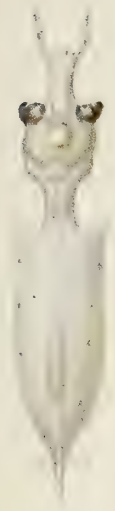
Figures 1-5. *Doratopsis exophthalmica* n.sp.

- Figure 1. *D. exophthalmica*. Station 26, Canaries Current. $\times 3$
- Figure 2. Same, ventral. $\times 3$
- Figure 3. *D. exophthalmica* from Station 169, South Indian doldrum belt. Left side. $\times 3$
- Figure 4. Same, dorsal surface. $\times 3$
- Figure 5. Head of specimen from Station 169, lateral. $\times 15$

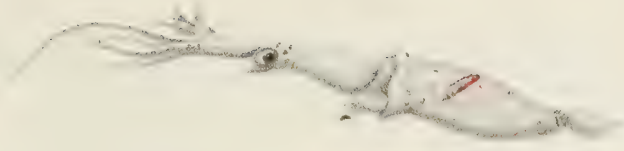
Figures 6-7. *Doratopsis lippula* n.sp.

- Figure 6. Anterior part of body of *D. lippula*. Station 74, Benguela Current. $\times 3$
- Figure 7. Head of specimen from Station 74, lateral.
- Figure 8. Youngest larva of *Doratopsis*. Station 228, Indian Countercurrent. $\times 3$
- Figure 9. Same larva, dorsal surface. $\times 3$
- Figure 10. Same larva, ventral surface. $\times 8$

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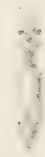
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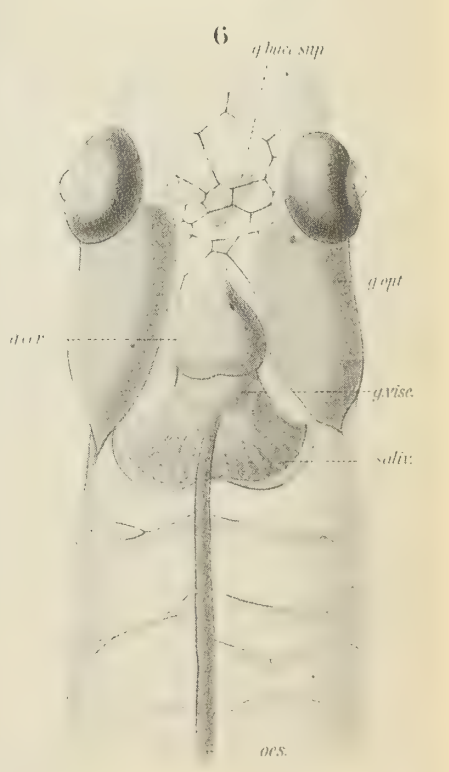
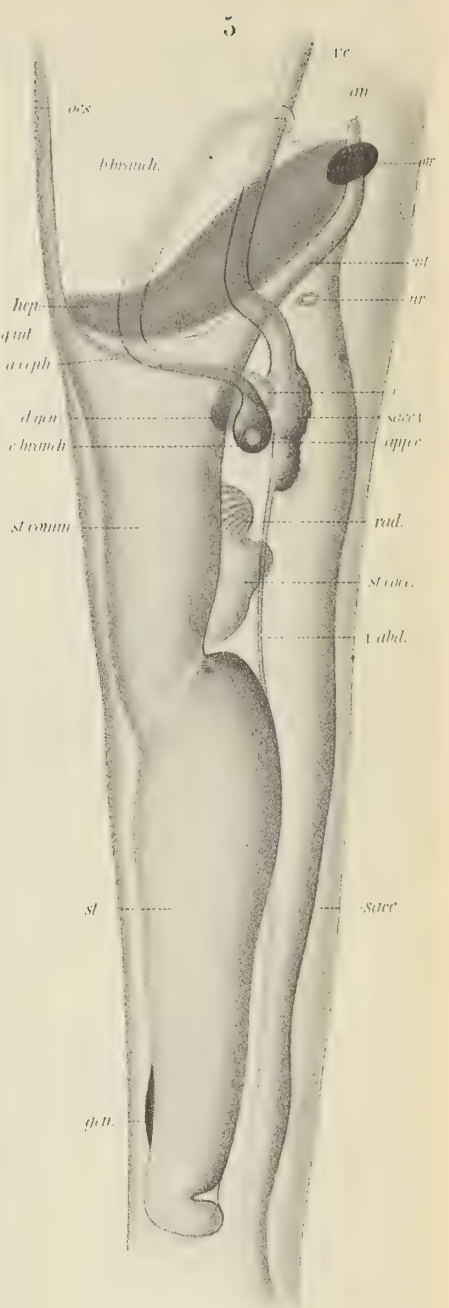
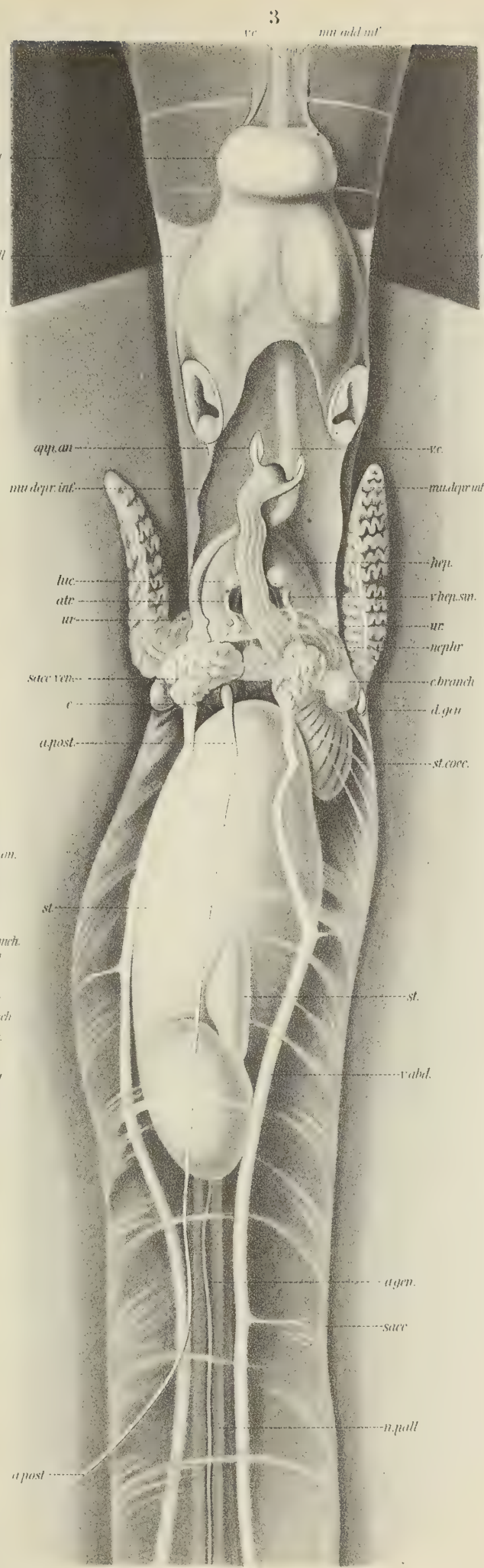
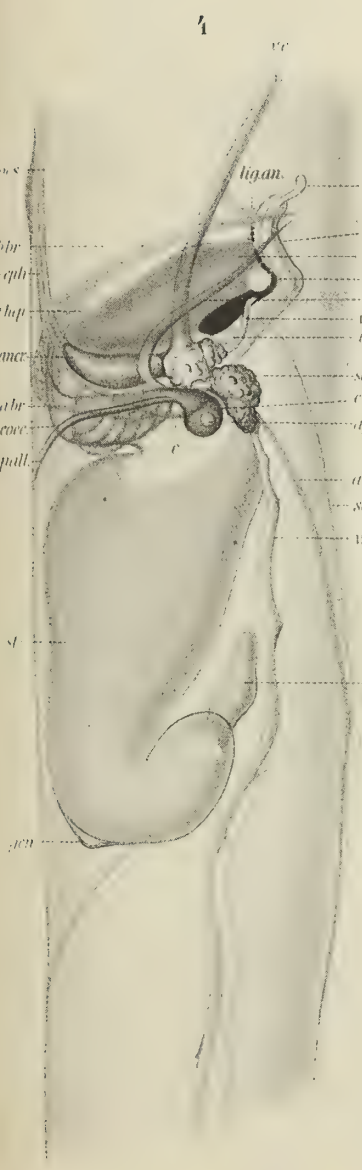
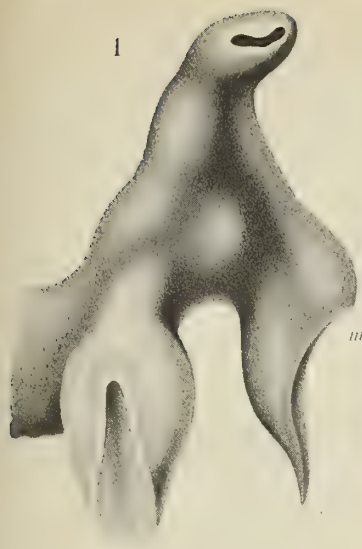
Plate XLVII

Anatomy of *Doratopsis*

- Figure 1. Funnel and funnel cartilage of *D. sagitta*, Station 172.
Figure 2. Left funnel cartilage and antitragus of *D. exophthalmica*, Station 26.
Figure 3. Mantle complex of *D. vermicularis* RÜPPELL from Messina, ventral.
Figure 4. Visceral complex of same larva, right side. $\times 12$. (Only basal part of gill—i.e. the branchial gland—shown)
Figure 5. Visceral complex of *D. sagitta*, right side. Station 172. (Only the branchial gland shows the position of the gill)
Figure 6. *D. sagitta*. Head of specimen from Station 172, dorsal. $\times 12$

ABBREVIATIONS

- | | | |
|---|---|--|
| <i>a. br.</i> —branchial artery | <i>g. cer.</i> —cerebral ganglion | <i>pancr.</i> —pancreas |
| <i>a. ceph.</i> —cephalic aorta | <i>g. opt.</i> —optic ganglion | <i>rad.</i> —spiral folds |
| <i>a. gen.</i> —artery of gastro-genital ligament | <i>g. visc.</i> —visceral ganglion | <i>rect.</i> —rectum |
| <i>a. hep.</i> —hepatic artery | <i>gen.</i> —genital gland | <i>sacc.</i> —visceral sac |
| <i>a. post.</i> —posterior artery | <i>hep.</i> —liver | <i>sacc. v.</i> —venous sac |
| <i>an.</i> —anus | <i>inf.</i> —funnel | <i>saliv.</i> —posterior salivary gland |
| <i>app. an.</i> —anal appendage | <i>int.</i> —mid-intestine | <i>st.</i> —stomach |
| <i>app. c.</i> —appendage of branchial heart | <i>lig. an.</i> —anal ligament | <i>st.¹</i> —appendage of stomach |
| <i>atr.</i> —ink sac | <i>luc.</i> —luminous organ | <i>st. coec.</i> —caecum |
| <i>b. br.</i> } gill base (branchial gland) | <i>m.</i> —margin of mantle | <i>st. comm.</i> —sinus of stomach |
| <i>b. branch.</i> } | <i>mu. add. inf.</i> —funnel adductors | <i>ur.</i> —papilla of renal sac |
| <i>c.</i> —heart | <i>mu. coll.</i> —collaris | <i>v. abd.</i> —abdominal vein |
| <i>c. branch.</i> —branchial heart | <i>mu. depr. inf.</i> —funnel depressor | <i>v. branch.</i> —branchial vein |
| <i>d. gen.</i> —“anlage” of gonoducts | <i>n. pall.</i> —pallial nerve | <i>v. c.</i> —vena cava |
| <i>g. bucc. sup.</i> —superior buccal ganglion | <i>neph.</i> —renal sac | <i>v. hep.</i> —hepatic vein |
| | <i>oes.</i> —esophagus | <i>v. hep. sin.</i> —left hepatic vein |
| | <i>org. inf.</i> —funnel organ | <i>v. pall.</i> —pallial vein |



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Plate XLVIII

Cranchia LEACH, *Liocranchia* PFEFFER

- Figure 1. *Cranchia scabra* LEACH. Large male from South Equatorial Current, Station 49
Drawn from a live specimen after a photograph and color sketch. Natural size
- Figure 2. Same specimen, dorsal. Natural size
- Figure 3. *Liocranchia valdiviae* n.sp. Adult male, dorsal. Indian North Equatorial Current
near coast of East Africa. Station 258. $\times 2$
- Figure 4. Same specimen, ventral.



Plate XLIX

Cranchia scabra LEACH

Figures 1-6. *Cranchia scabra*. Juvenile specimen from Indian North Equatorial Current (Station 217)

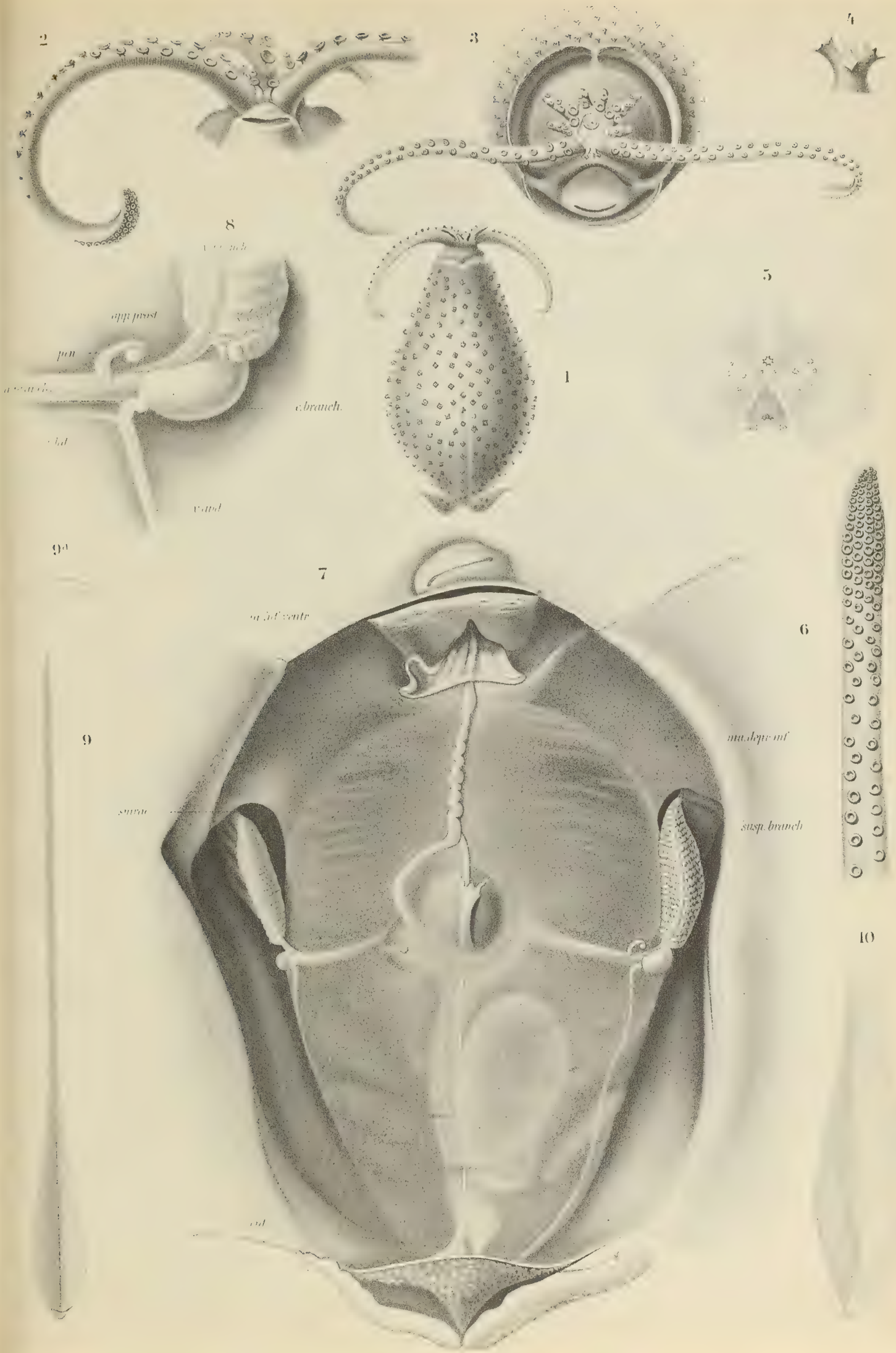
- Figure 1. Dorsal view. $\times 5$
Figure 2. Arms, ventral. Appr. $\times 20$
Figure 3. Anterior part of body, showing the arms and the 3 points of fusion on mantle. Appr. $\times 12$
Figure 4. Cartilaginous tubercle of mantle.
Figure 5. Posterior end of body with fins.
Figure 6. End of tentacle with club. Appr. $\times 30$
Figure 7. Opened mantle cavity of large male of *Cranchia scabra* (cf. Plate XLVIII, Figures 1, 2).

The projecting liver is in the middle, rectum and anal appendages are situated on it. A ligament extends from the vena cava toward the anus. The vena cava circumscribes the liver on its right side in a wide curve. On each side behind the liver are the openings of the renal sacs. Gills and branchial hearts are situated at a large distance; they are surrounded anteriorly by the curved margin of the musculus depressor infundibuli (funnel depressor), which is transformed into a septum. The large branchial arteries and the abdominal veins extend toward the branchial hearts, the latter approaching them from behind. The opening of the male genitalia is situated in front of the left branchial heart (Figure 8). The funnel organ is folded, due to the strong contraction caused by preservation; the ventral wall of the funnel is displaced upward. In the posterior half of the body, the large caecum and, behind it, the stomach and the esophagus, which enters it, as well as the hepato-pancreatic duct are visible through the abdominal integument. The posterior artery passes over the middle of the abdominal wall; the very short mantle septum is attached to this artery.

- Figure 8. Base of left gill of large male, showing branchial heart, veins and opening of genitalia. $\times 6$
Figure 9. Gladius of medium-sized female of *Cranchia scabra*, ventral. $\times 3$
Figure 9a. Cross section through anterior half of gladius.
Figure 10. Posterior end of same gladius, viewed diagonally from the side.

ABBREVIATIONS

<i>a. branch.</i> —branchial artery	<i>sept.</i> —mantle septum
<i>app. prost.</i> —appendage of prostate	<i>susp. branch.</i> —branchial ligament
<i>c. branch.</i> —branchial heart	<i>v. abd.</i> —abdominal vein
<i>m. inf. ventr.</i> —ventral lamella of funnel	<i>v. branch.</i> —branchial vein
<i>mu. depr. inf.</i> —funnel depressor	<i>v. lat.</i> —lateral vein, opening into abdominal vein
<i>pen.</i> —penis (distal part of Needham's sac)	



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Plate L

Anatomy of *Cranchia scabra*

- Figure 1. Buccal funnel and arm apparatus, inner side. Large male from Station 49 with hectocotylized ventral arm. $\times 4$
- Figure 2. Outer side of tentacle club. Large male. $\times 4$
- Figure 3. Head and arms, right side (Based on the preserved large male). Eye completely covered by contracted lid membrane. $\times 3$
- Figure 4. Right eye with the 13 luminous organs (1 . . . 13), after removal of lid membrane. Large male. $\times 2.3$
- Figure 5. Right eye of medium-sized female with the 13 luminous organs (1 . . . 13). $\times 10$
- Figure 6. Intestinal tract, vascular system, gills and developing genitalia of medium-sized female, ventral surface. Liver and adjacent organs folded over upward, toward the front. $\times 7$
- Figure 7. Intestinal tract and vascular system of medium-sized female, right side. $\times 7$
- Figure 8. Dorsal half of liver and adjacent organs of the medium-sized female. Left side. $\times 7$
- Figure 9. Brain and eyes of medium-sized female, dorsal.
- Figure 10. Stomach and ovary of medium-sized female, dorsal surface. $\times 7$
- Figure 11. Same as Figure 10, left side. $\times 7$
- Figure 12. Swellings and spiral folds of caecum, right side. Large male
- Figure 13. Stomach and caecum, and adjacent gonad, of the large male, left side.
- Figure 14. Posterior surface of liver with venous sacs, pancreas, and rectum. Medium-sized female. $\times 7$
- Figure 15. Gonoducts of large male, ventral surface. $\times 14$
- Figure 16. Same, dorsal surface. $\times 14$

ABBREVIATIONS

- | | | |
|--|---|---|
| <i>a. branch.</i> —branchial artery | <i>ir.</i> —iris | <i>sacc. v. hep. post.</i> —posterior sac of hepatic vein |
| <i>a. ceph.</i> —cephalic aorta | <i>lam. ext.</i> —outer membrane | <i>st.</i> —stomach |
| <i>a. dors.</i> —dorsal artery | <i>lig. an.</i> —anal ligament | <i>st. coec.</i> —caecum |
| <i>a. hep.</i> —hepatic artery | <i>lig. g. g.</i> —gastro-genital ligament | <i>sulc.</i> —groove of intestine |
| <i>a. post.</i> —posterior artery | <i>n. ophth. sup.</i> —superior ophthalmic nerve | <i>test.</i> —testis |
| <i>amp.</i> —ampulla of cephalic vein | <i>n. pall.</i> —pallial nerve | <i>tub. olf.</i> —olfactory tubercle |
| <i>app. an.</i> —anal appendage | <i>nid.</i> —nidamental gland | <i>ur.</i> —papilla of renal sac |
| <i>app. prost.</i> —appendage of prostate | <i>oes.</i> —esophagus | <i>v. abd.</i> —abdominal vein |
| <i>b. sperm.</i> —spermatophore sac | <i>ovd.</i> —oviduct | <i>v. branch.</i> —branchial vein |
| <i>c. branch.</i> —branchial heart | <i>pancr.</i> —pancreas | <i>v. c.</i> —vena cava |
| <i>d. hep.</i> —hepatic duct | <i>pen.</i> —end of spermatophore sac | <i>v. def.</i> —vas deferens |
| <i>d. hep. pancr.</i> —hepato-pancreatic duct | <i>prost.</i> —prostate | <i>v. dors.</i> —dorsal vein |
| <i>diaphr.</i> —diaphragm | <i>rad.</i> —spiral folds | <i>v. g. g.</i> —gastric vein |
| <i>g. bucc. sup.</i> —superior buccal ganglion | <i>rect.</i> —rectum | <i>v. pall.</i> —pallial vein |
| <i>g. opt.</i> —optic ganglion | <i>sacc.</i> —sheath of male gonoducts | <i>vel.</i> —sail-shaped stomach fold |
| <i>g. pall.</i> —pallial ganglion | <i>sacc. v. hep.</i> —sac of hepatic vein | <i>ves. sem. 1, ves. sem. 2, ves. sem. 3</i> —1st, 2nd, and 3rd part of seminal vesicle, respectively |
| <i>hect.</i> —hectocotylus | <i>sacc. v. hep. ant.</i> —anterior sac of hepatic vein | |
| <i>hep.</i> —liver | | |
| <i>inf.</i> —funnel | | |
| <i>int.</i> —mid-intestine | | |

Plate LI

Liocranchia. Anatomy and juvenile forms

- Figure 1. Young larva, length 5.5 mm. Dorsal view of anterior half of head, Station 54, Guinea Current. $\times 20$
- Figure 2. Same larva, ventral. $\times 20$
- Figure 3. Head of youngest larva, length 4.5 mm, lateral. Station 226, central Indian Ocean. $\times 45$
- Figure 4. Youngest larva of *Cranchia scabra*. Anterior part of body, lateral. Station 54, Guinea Current. $\times 20$
- Figure 5. *Liocranchia reinhardtii*. Head of juvenile specimen, ventral. Total length: 20 mm (dorsal mantle length: 15 mm). The lid membrane forms a sac. Station 54, Guinea Current. $\times 15$
- Figure 6. *L. reinhardtii*. Arms of larva whose dorsal mantle length measures 7 mm. Station 64, near São Tomé. $\times 25$
- Figure 7. *L. reinhardtii*. Arm apparatus of medium-sized larva which measures 9 mm dorsal mantle length. Station 215, Bay of Bengal. $\times 18$
- Figure 8. *L. valdiviae*. Ventral arms of male from Station 239; dorsal mantle length 25 mm. Left ventral arm hectocotylized. Indian Countercurrent. $\times 15$
- Figure 9. *L. valdiviae*. Ventral arms of large male; dorsal mantle length 40 mm (cf. Plate XLVIII, Figures 3 and 4). Left ventral arm hectocotylized. Station 258, East African coast. $\times 15$
- Figure 10. *L. valdiviae*. Arm apparatus of male measuring 22 mm dorsal mantle length. Station 182, Indian South Equatorial Current. $\times 10$
- Figure 11. *L. valdiviae*. Club of large male, outer surface. Station 258. $\times 18$
- Figure 12. *L. valdiviae*. Tentacle of large male. Station 258. $\times 12$
- Figure 13. *L. valdiviae*. Inner organs of the large male from Station 258, ventral. $\times 8$
- Figure 14. *L. valdiviae*. Stomach with opened caecum. Station 258

ABBREVIATIONS

<i>a. branch.</i> —branchial artery	<i>sacc. v. hep. p.</i> —posterior sac of hepatic vein
<i>a. ceph.</i> —cephalic aorta	<i>spir.</i> —spiral winding of esophagus, intestine and hepato-pancreatic duct
<i>an.</i> —anus	<i>st.</i> —stomach
<i>c. branch.</i> —branchial heart	<i>st. coec.</i> —caecum
<i>hect.</i> —hectocotylus	<i>sulc.</i> —groove to caecum
<i>hep.</i> —liver	<i>ur.</i> —papilla of renal sac
<i>lig. g. g.</i> —gastro-genital ligament	<i>v. c.</i> —vena cava
<i>oes.</i> —esophagus	<i>vel.</i> —stomach sail
<i>pancr.</i> —pancreas	<i>ves. sem.</i> —seminal vesicle
<i>pen.</i> —end of spermatophore sac (penis)	
<i>sacc. v. hep. a.</i> —anterior sac of hepatic vein	

Plate LII

Euzygaena, Leachia

Figures 1-3. *Euzygaena pacifica* ISS., male

- Figure 1. Ventral. Sagami Bay. $\times 2$
Figure 2. Right club. $\times 17$
Figure 3. Ventral arms. Right ventral arm hectocotylized. $\times 25$

Figures 4-7. *Leachia eschscholtzii* RATHKE. Near Borneo

- Figure 4. Mature female. Mantle complex. $\times 4$
Figure 5. *Leachia eschscholtzii* RATHKE, female. Anatomy of the internal organs, ventral
Figure 6. Openings of stomach and caecum with pancreas, ventral
Figure 7. Cap of caecum and pancreas.

ABBREVIATIONS

a. branch.—branchial vein
a. dors.—dorsal artery
a. g. g.—gastric artery
a. hep.—hepatic artery
a. post.—posterior artery
an.—anus
app. an.—anal appendages
branch.—gill
d. hep. c.—single hepatic duct
d. hep. d.—right hepatic duct
d. pancr.—pancreatic ducts

g. visc.—gastric ganglion
gl. od. d.—right oviduct gland
gl. od. s.—left oviduct gland
hep.—liver
int.—intestine
lig. an.—anal ligament
lig. g. g.—gastro-genital ligament
nid. d.—right nidamental gland
nid. s.—left nidamental gland
oes.—esophagus
ov.—ovary

or. od.—opening of oviduct gland
pancr.—pancreas
rad.—spiral folds
rect.—rectum
st.—stomach
st.'—narrowed part of stomach
st. coec.—caecum
sulc.—groove to caecum
ur.—papilla of renal sac
v. c.—vena cava
vel.—stomach sail



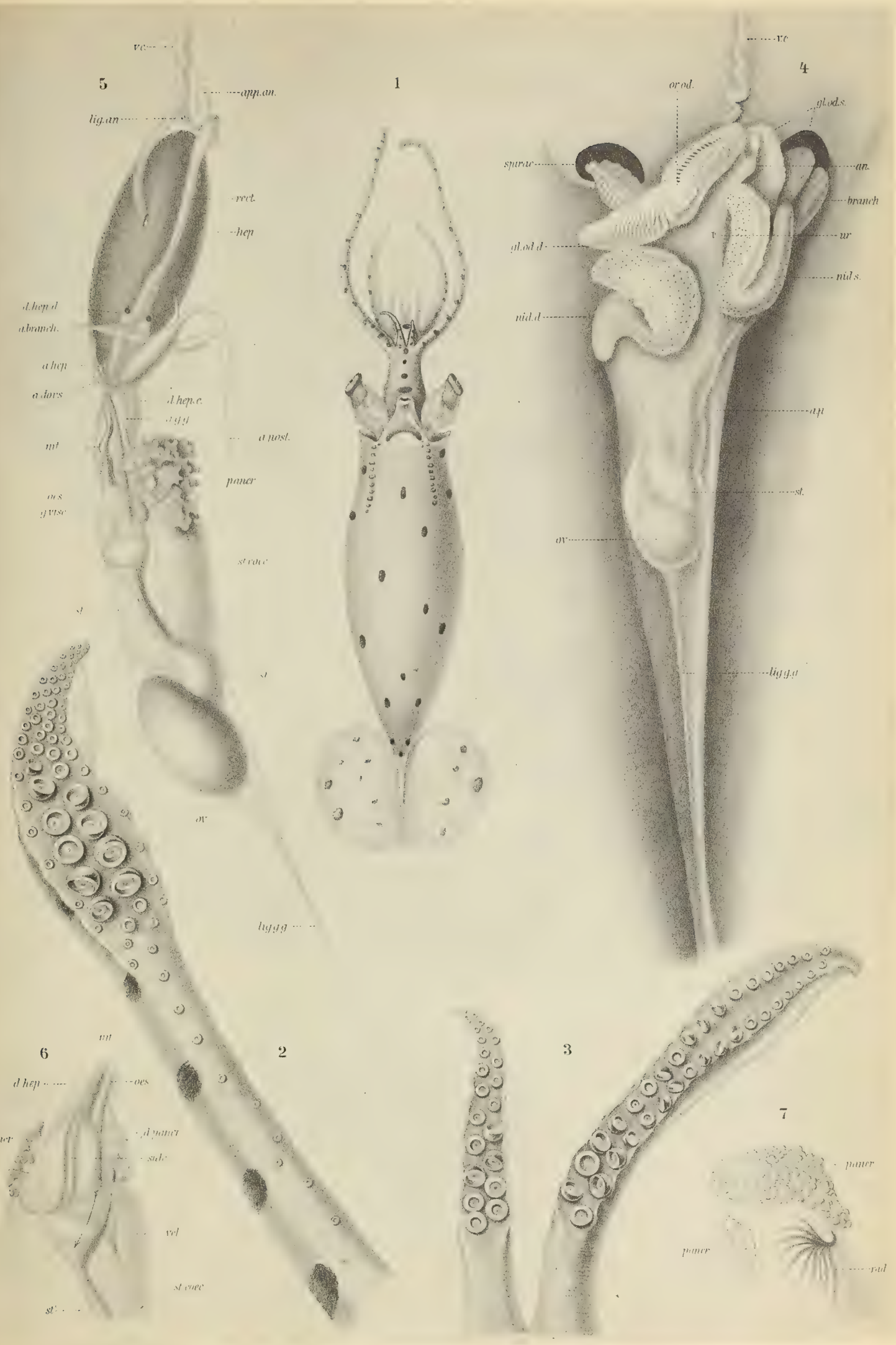


Plate LIII

Desmoteuthis, Crystalloteuthis n.gen.

Figure 1. *Desmoteuthis pellucida* CHUN. Drawn after the live animal. Station 90, Benguela Current. Natural size

Figures 2-9. *Crystalloteuthis glacialis* n.gen. n.sp. Station 145, Antarctic Ocean

Figure 2. *Cryst. glacialis*. Drawn after the live animal. Dorsal. $\times 2$

Figure 3. Same, ventral. Drawn after the preserved specimen. $\times 2$

Figure 4. Arms, dorsal. $\times 12$

Figure 5. Outer side of tentacle. $\times 10$

Figure 6. Inner side of tentacle. $\times 10$

Figure 7. Head and funnel, ventral. Lid membrane of right eye removed. Mantle opened

Figure 8. Left ventral tubercle.

Figure 9. Dorsal tubercle.

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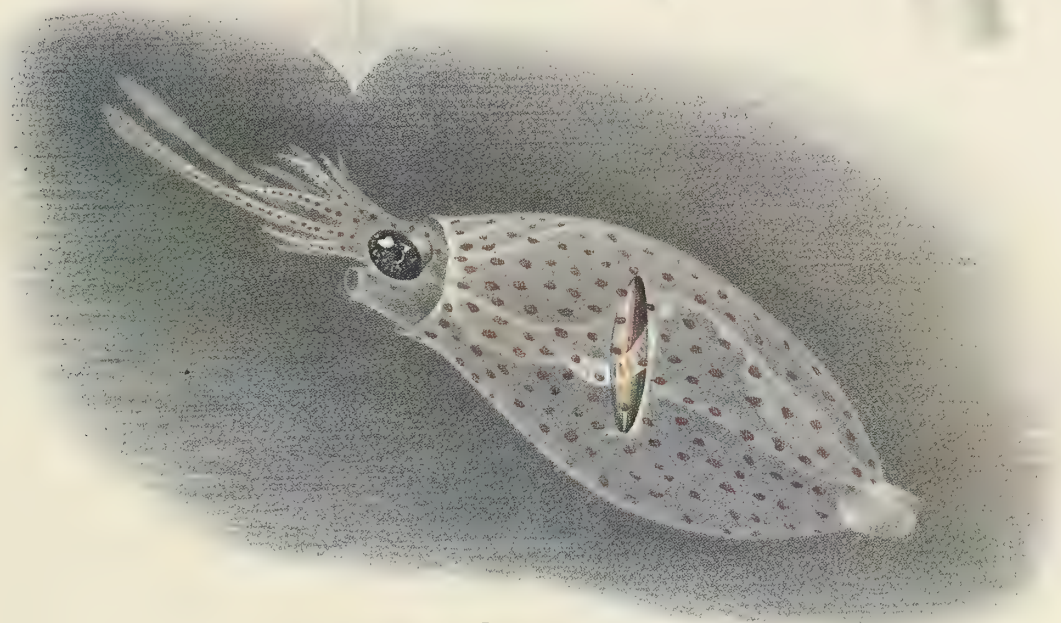
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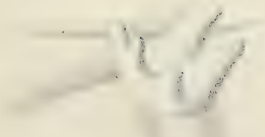


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Plate LIV

Desmoteuthis and *Crystalloteuthis*. Anatomy

Figures 1–17. *Desmoteuthis pellucida*

- Figure 1. Arm apparatus and buccal funnel, viewed from above. $\times 3$
Figure 2. Outer side of club of tentacle with protective membranes and swimming membrane.
 $\times 9$
Figure 3. Head and arms of the preserved specimen, diagonally from above. $\times 4.5$
Figure 4. Larger sucker of tentacle club.
Figure 5. Larger sucker of arm, dried out.
The whitish, calcified indentations of the margin and the plates of the inner chitinous layer are distinct
Figure 6. Olfactory tubercle, in profile.
Figure 7. Right eye. Ventral view, showing both luminous organs. $\times 4.5$
Figure 8. Same eye, broad side. Lid fold contracted to form a slit
Figure 9. Cross section of mantle, showing musculature: homog. imm. 1/12, ocular No. 2.
Figure 10. Longitudinal section of mantle; homog. imm. 1/12, ocular No. 2.
Figure 11. Nuclei of outer epithelium of mantle: homog. imm. 1/12, ocular No. 2.
Figure 12. Visceral complex and vascular system, right side.
Figure 13. Cross section of viscera anterior to caecum (in direction of arrow, Figure 12).
Figure 14. Viscera, heart, and large vessels, viewed from posterior side of liver.
Figure 15. Same preparation as in Figure 14; heart and right pancreatic duct removed.
Figure 16. Caecum with opening of pancreatic duct, left side.
Figure 17. Stomach, caecum, and adjacent parts opened.
Figure 18. *Crystalloteuthis glacialis*. Viscera, heart, and large vessels, right side

ABBREVIATIONS

a. branch.—branchial artery
a. ceph.—cephalic aorta
a. dors.—dorsal artery
a. hep.—hepatic artery
a. pancr.—pancreatic artery
a. post.—posterior artery
amp. v.—ampulla of cephalic vein
an.—anus
app. an.—anal appendages
atr.—ink sac
bg.—connective tissue of cutis
c.—heart
d. hep. pancr.—hepato-pancreatic duct
diaphr.—diaphragm
ek.—ectoderm
g. gastr.—gastric ganglion
gen.—gonad
hep.—liver

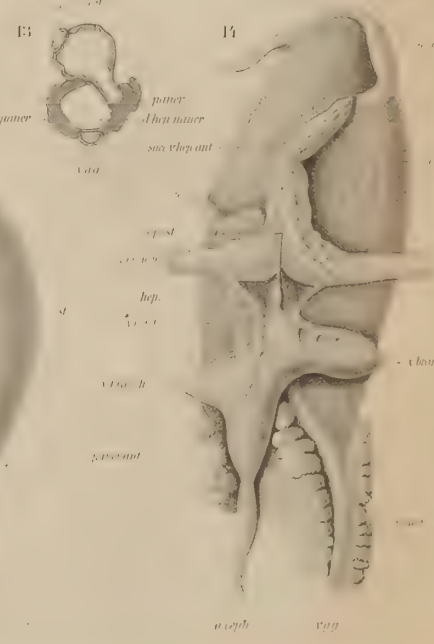
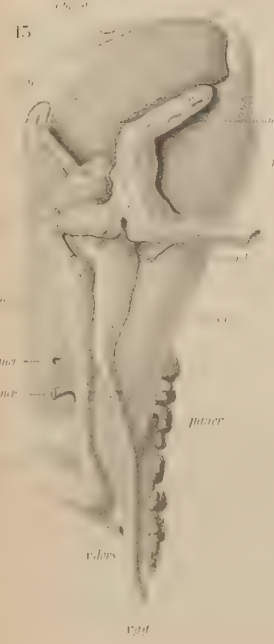
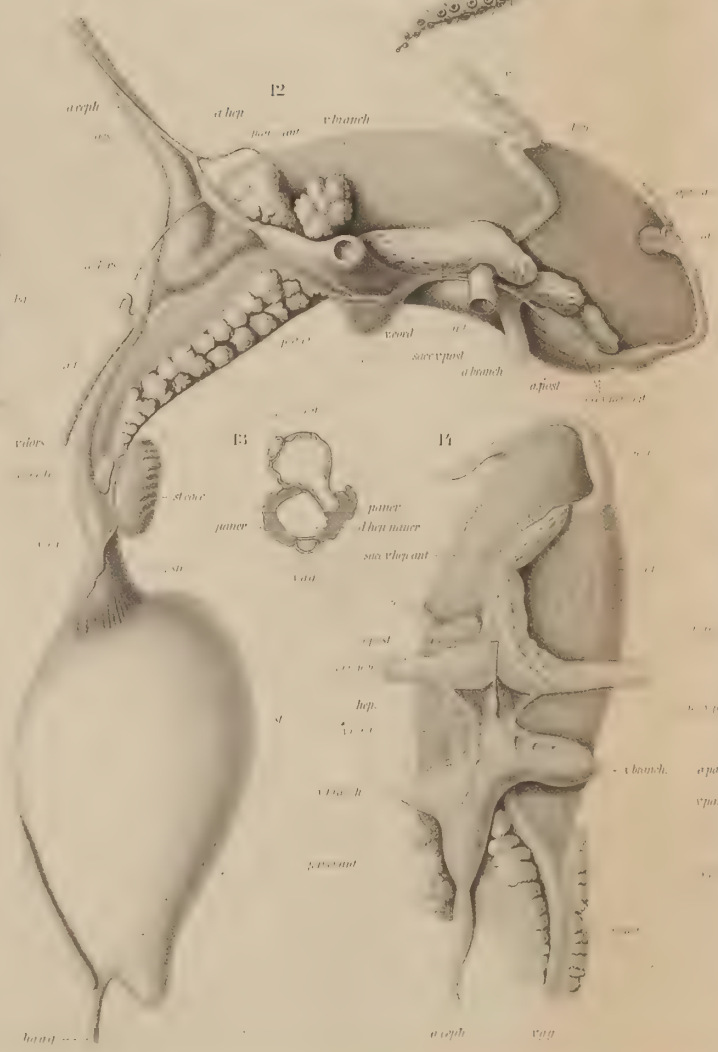
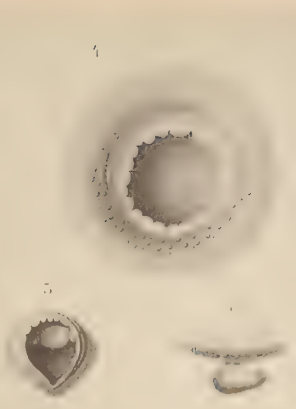
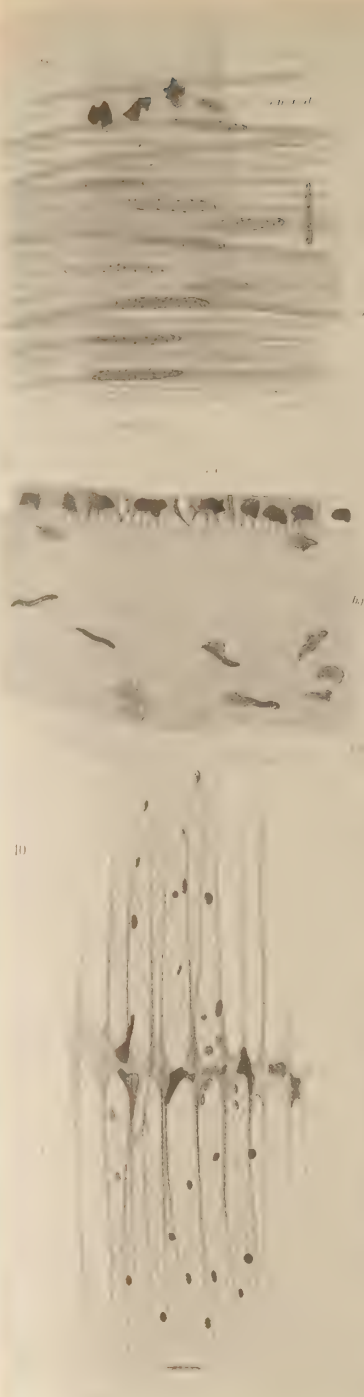
inf.—funnel
int.—mid-intestine
lam. int.—inner marginal lamella of mantle
lam. rad.—lamella of radial fibers
lig. an.—anal ligament
lig. g. g.—gastro-gential ligament
luc. ant.—anterior luminous organ
luc. post.—posterior luminous organ
mu. circ.—ring muscles
mu. rad.—radial muscles
nu. circ.—nuclei of ring muscles
nu. rad.—nuclei of radial muscles
oes.—esophagus
ov.—ovary
p. inf.—inner funnel of renal sac
pancr.—pancreas
rect.—rectum

sacc. v. ant.—anterior venous sac
sacc. v. g. g.—sac of gastric vein
sacc. v. hep.—sac of hepatic vein
sacc. v. post.—posterior venous sac
st.—stomach
st. coec.—caecum
st. str.—striated part of stomach
str.¹—larger swellings
sulc.—groove to caecum
tub. olf.—olfactory tubercle
ur.—papilla of renal sac
v.—vein of caecum
v. branch.—branchial vein
v. c.—vena cava
v. ceph.—cephalic vein
v. cord.—cardiac vein
v. dors.—dorsal vein
v. g. g.—gastric vein
v. pancr.—pancreatic vein

Plate LV

Corynomma speculator n. gen. n. sp

- Figure 1. Specimen from Station 237, Indian South Equatorial Current. Dorsal, $\times 3$
- Figure 2. Same specimen, ventral. $\times 3$
- Figure 3. Head and arms, dorsal. Appr. $\times 11$
- Figure 4. Arms, viewed diagonally from above. Appr. $\times 15$
- Figure 5. Eye, lateral. $\times 15$
- Figure 6. Eye, diagonally dorsal. $\times 15$
- Figure 7. Tentacle, inner surface. Appr. $\times 28$
- Figure 8. Tentacle, outer surface.
- Figure 9. Tentacle of older specimen from Atlantic South Equatorial Current. Appr. $\times 12$.



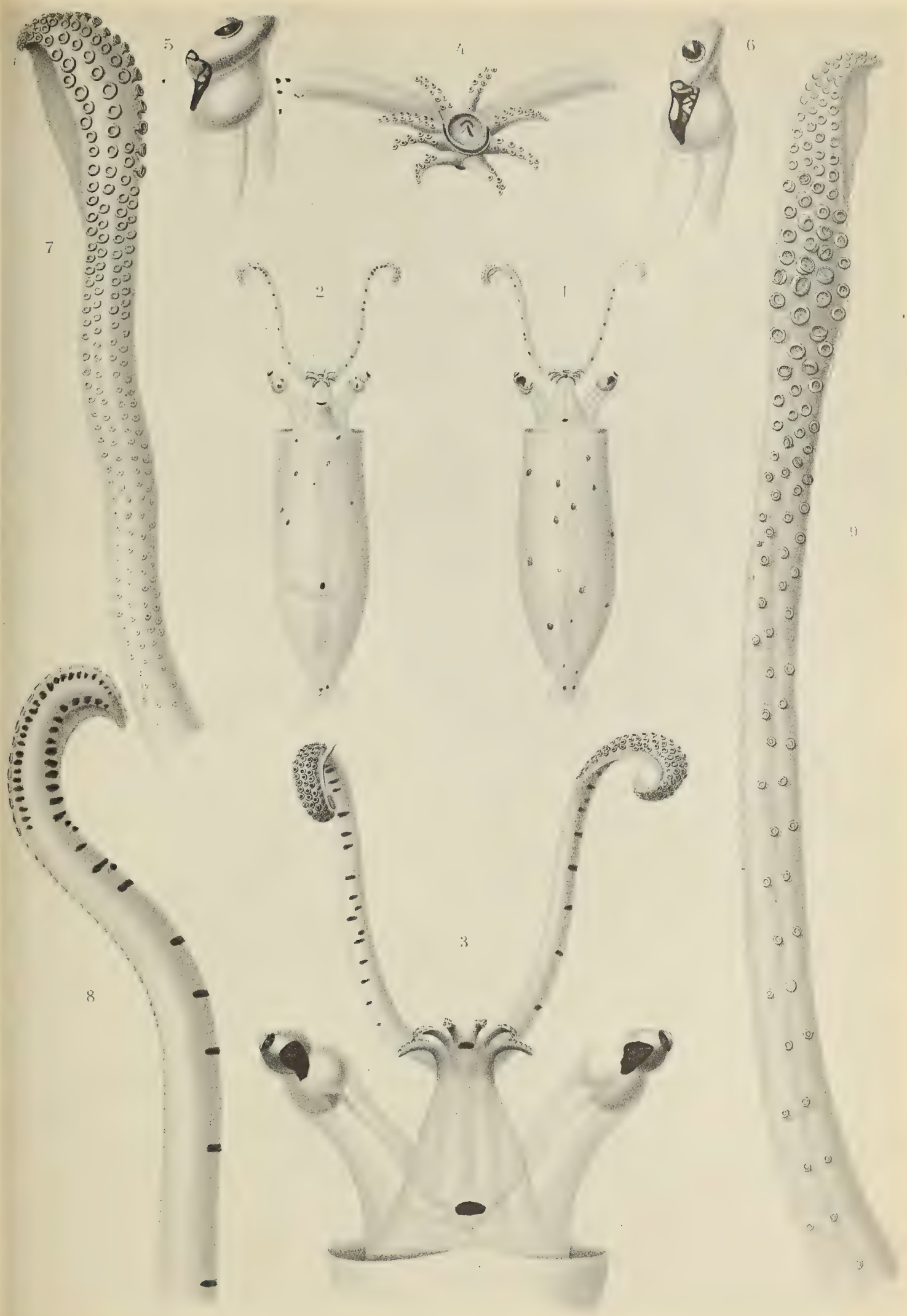


Plate LVI

Teuthowenia, Sandalops, Toxeuma, Bathothauma

Figures 1–5. *Teuthowenia antarctica* n. sp.

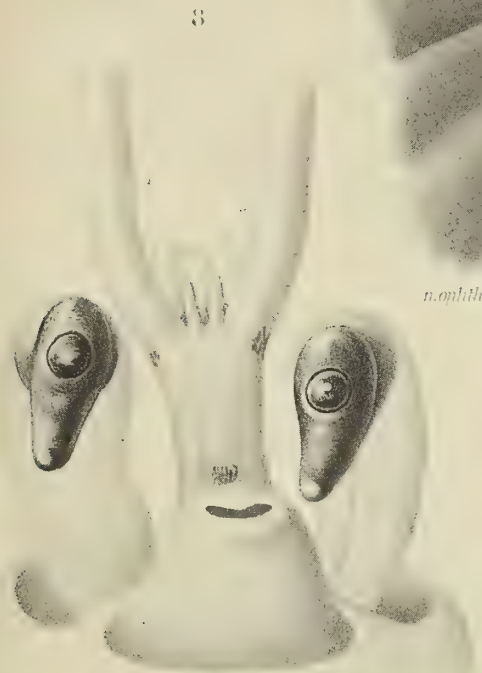
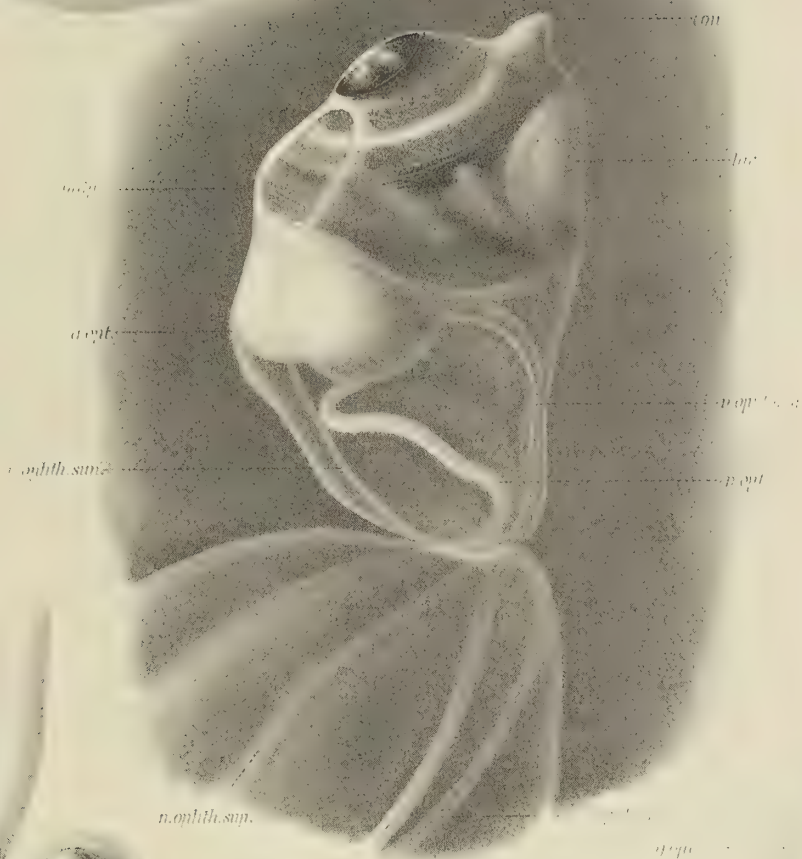
- Figure 1. Dorsal view of specimen from Station 136. Antarctic Ocean. $\times 4$
Figure 2. Same specimen, ventral. $\times 4$
Figure 3. Anterior part of body, ventral. $\times 14$
Figure 4. Eye, viewed diagonally from above. $\times 14$
Figure 5. Left eye, precisely lateral. $\times 17$

Figures 6–8. *Sandalops melancholicus* n. gen. n. sp.

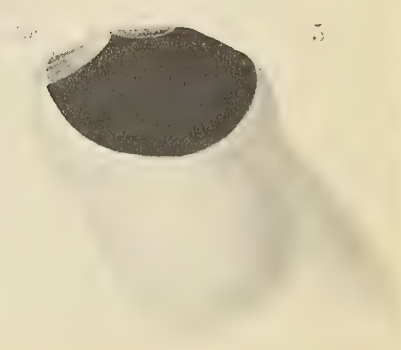
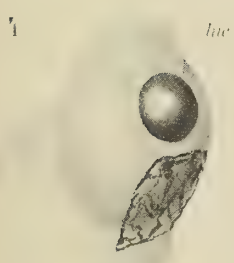
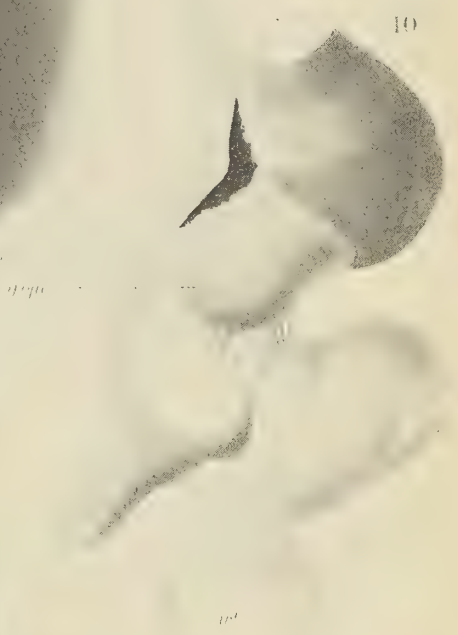
- Figure 6. *Sandalops melancholicus*, right side. Southern Atlantic. $\times 8$
Figure 7. Posterior end of body with fins. Appr. $\times 10$
Figure 8. Anterior part of the body, ventral. Appr. $\times 16$
Figure 9. Left eye of *Bathothauma*, diagonally lateral. Eye stalk constricted by preservation.
 $\times 7$
Figure 10. Right eye of *Toxeuma*, lateral. $\times 9$

ABBREVIATIONS

cart.—cartilage of ventral corner of
mantle
con.—conus of eyeball
g. opt.—optic ganglion
inf.—funnel
luc.—luminous organ
n. ophth. inf.—inferior ophthalmic nerve
n. ophth. sup.—superior ophthalmic
nerve
n. opt.—optic nerve



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opt

opt. sup.

n. opt. sup.

9

ant

opt

opt. sup.

opt

opt

opt

inc

inc

5

Plate LVII

Bathothauma, Teuthowenia

Figure 1. *Bathothauma lyromma* n. gen. n. sp. Mantle complex, ventral. $\times 4.5$

Figure 2. *Bathothauma*. Heart, major vessels and adjacent organs. $\times 8$.
Liver displaced forward

Figures 3–7. *Teuthowenia antarctica* n. sp. Station 137, Antarctic Ocean

Figure 3. Tentacle, lateral. $\times 15$

Figure 4. Tentacle, inner surface. $\times 15$

Figure 5. Arms and buccal funnel. $\times 20$

Figure 6. Mantle complex, left side (after clearing in oil of cloves).

Figure 7. Mantle complex and left gill, ventral surface.

ABBREVIATIONS

a. branch.—branchial artery

a. post.—posterior artery

an.—anus

app. an.—anal appendages

atr.—ink sac

c.—heart

c. branch.—branchial heart

cer.—brain

d. coel.—inner funnel of renal sac

d. hep. pancr.—hepato-pancreatic
duct

g. opt.—optic ganglion

g. stell.—stellate ganglion

hep.—liver

inf.—funnel

int.—mid-intestine

lig.—ligament of liver

luc.—luminous organ

neph.—renal sac

oes.—esophagus

org. inf.—funnel organ

ov.—ovary

pancr.—pancreas

sacc.—visceral sac

sacc. ven.—venous sac

saliv.—posterior salivary
gland

spirac.—spiraculum

st.—stomach

*st.*¹—anterior part of stomach

*st.*²—middle part of stomach

*st.*³—end part of stomach

st. coec.—caecum

stat.—static organ

susp. branch.—branchial ligament

ur.—papilla of renal sac

v. branch.—branchial vein

v. c.—vena cava

v. hep.—hepatic vein

v. pall.—pallial vein

y.—narrow part of viscera sac with
posterior end of stomach

Plate LVIII

Toxeuma, Bathothauma

Figures 1-5. *Toxeuma belone* n.gen. n.sp.

- Figure 1. *Toxeuma belone*. Station 182, Indian South Equatorial Current. $\times 2$
Figure 2. Same specimen, ventral. $\times 2$
Figure 3. Anterior part of body, ventral. Appr. $\times 8$
Figure 4. Tentacle club, outer surface. $\times 25$
Figure 5. Tentacle club, inner surface. $\times 25$

Figures 6, 7. *Bathothauma lyromma* n.gen. n.sp.

- Figure 6. *Bathothauma lyromma*, female. Natural size. Atlantic North Equatorial Current.
Ventral. Eye stalks presented are constricted by preservation
Figure 7. Same specimen, dorsal. Natural size. Eye stalks drawn after another specimen—
extended

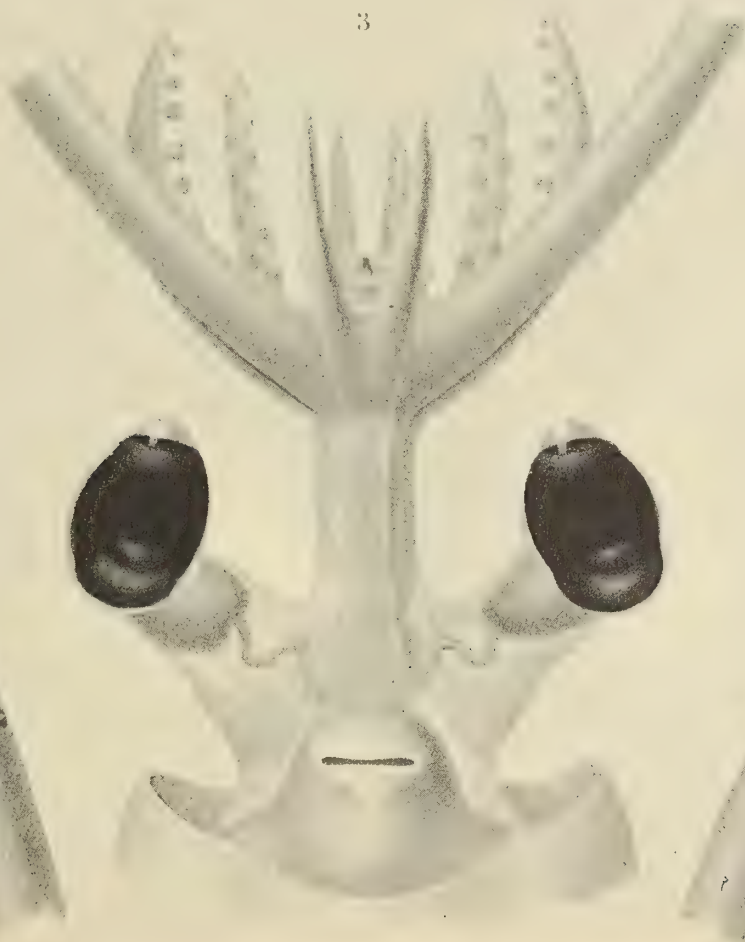


Plate LIX

Galiteuthis (Taonidium)

- Figure 1. *Galiteuthis suhmii* HOYLE (*G. armata* JOUBIN), dorsal. Station 51, Guinea Current.
Natural size
- Figure 2. Same specimen, ventral.
- Figure 3. *Galiteuthis (Taonidium) suhmii*. Juvenile form, dorsal. Station 43, Guinea Current.
× 2
- Figure 4. Same specimen, ventral.
- Figure 5. Right club of adult specimen. Appr. × 20
- Figure 6. Right club of juvenile form (*Taonidium*). × 15
- Figure 7. Club of juvenile form, lateral.
- Figure 8. Third and 4th arm of juvenile form, and base of tentacle, left side. Appr. × 24
- Figure 9. Arms and buccal funnel of juvenile form. Appr. × 24
- Figure 10. Arms and buccal funnel of adult. × 2
- Figure 11. Eye of adult specimen, ventral, showing luminous organ (*luc.*) and olfactory tubercle.

Plate LX

Luminous organs of the Cranchiidae

Figures 1-6. *Cranchia scabra*

- Figure 1. Median section through organ No. 3 (cf. Plate L, Figure 5). Sublimate, iron-hematoxylin. $\times 120$
Figure 2. Median section through organ No. 11. $\times 120$
Figure 3. Median section through organ No. 12. $\times 120$
Figure 4. Part of luminous body of organ No. 3. Homog. imm. 1/12, ocular No. 2, prism
Figure 5. Transition of the luminous body of organ No. 2 into the body epithelium. Homog. imm. 1/12
Figure 6. Cell from bottom of reflector.

Figures 7-11. *Liocranchia valdiviae*

- Figure 7. Eye with the 4 organs, lateral. Lid fold removed, but olfactory tubercle situated outside the lid fold is shown. $\times 12$
Figure 8. Median section of a luminous organ. $\times 100$
Figure 9. Luminous body: transition of the finely granulate cells into the pale, vacuolated cells. Homog. imm., ocular No. 2, prism
Figure 10. Concentrically stratified luminous cells from bottom of luminous body. Homog. imm. 1/12, ocular No. 2, prism. Acid carmine
Figure 11. Transition of the luminous cells into the body epithelium. Homog. imm. 1/12, ocular No. 2, prism

Figure 12. *Leachia eschscholtzii*

- Figure 12. Median section of organ No. 2.

Figures 13-17. *Corynomma speculator*

- Figure 13. The two organs on the ink sac; rectum and adjacent region.
Figure 14. Longitudinal section through an organ (parallel to median plane). $\times 120$
Figure 15. Cross section of ink sac and luminous organ situated on it. Posterior region
Figure 16. Same series of cross sections as in Figure 15, anterior region. Ocular No. 2, prism
Figure 17. Luminous cells and capillaries. Homog. imm. 1/12, ocular, prism

Figures 18-24. *Desmoteuthis pellucida*

- Figure 18. Median section through double organ of eye, with marginal part of retina and the epithelial body. Formol, hemalum
Figure 19. Border zone between cells of luminous body and fibrous cells of lens. Homog. imm. 1/12, ocular No. 2, prism
Figure 20. Luminous cells after staining with iron-hematoxylin. Homog. imm. 1/12, ocular No. 2, prism
Figure 21. Cells of luminous body and capillaries. Hemalum

Figure 22. *Bathothauma lyromma*

- Figure 22. Median section through luminous organ of *Bathothauma*. $\times 72$
In the course of preservation, the luminous organ detached itself from eyeball and bent outward; in life it is convex and adheres closely to the eyeball.

ABBREVIATIONS

a. post.—posterior artery
an.—anus
atr.—ink sac
bg.—connective tissue
branch—gill
c. cil.—ciliated body
c. hep.—capsule of connective tissue of liver
cap.—capillaries
cart.—eye cartilage
ek.—ectoderm
fibr.—fibers of connective tissue
gel.—gelatinous body

hep.—liver
ir.—iris
lim.—cells of membrana limitans
luc. ant.—anterior luminous organ
luc. post.—posterior luminous organ
m. l.—membrana limitans
mu. cil.—ciliary muscle
nu. cap.—nuclei of capillaries
nu. phot.—nuclei of luminous cells
nu. str.—nuclei of lens fibers
phot.—luminous body
phot. centr.—central luminous cell

pulv.—pad
refl.—reflector
res.—reservoir of ink sac
s. ven.—marginal vein
s. z.—cells of retina
spec.—mirror
st.—rods
str.—fibers of lens
tub. olf.—olfactory tubercle
ur.—papilla of renal sac
v.—vessels
ven.—vein

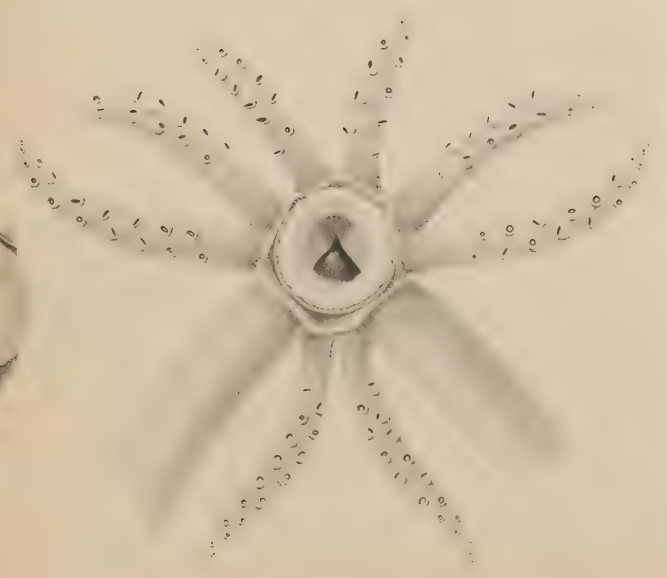
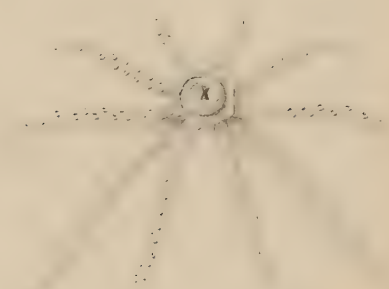
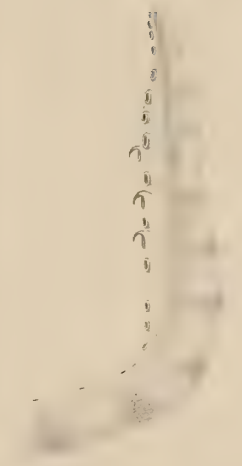
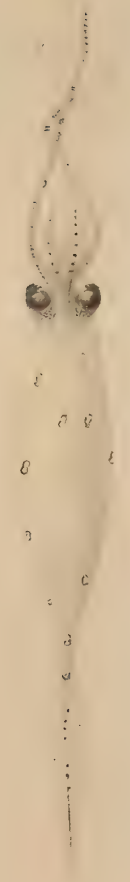
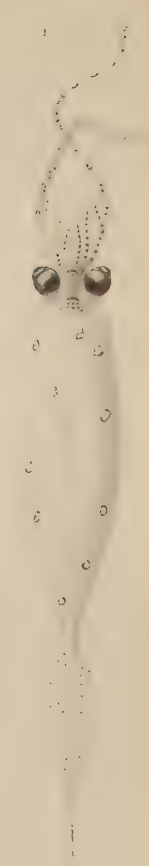
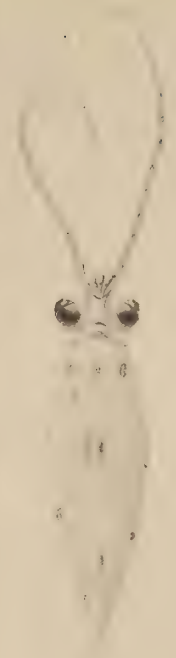
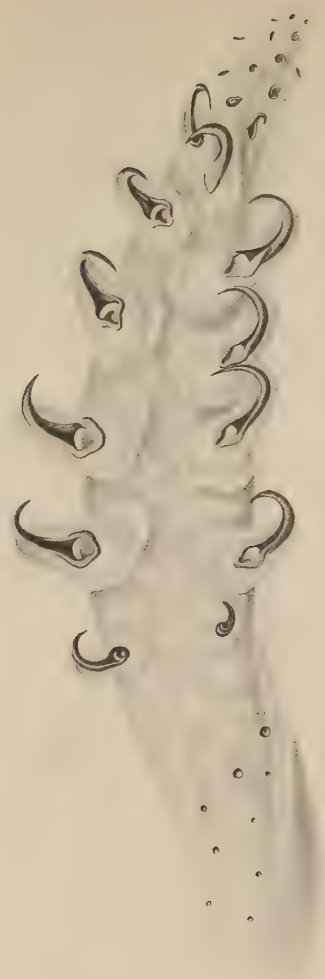


Plate LXI

Larvae of Cranchiidae

Figure 1. Juvenile larva from Station 102 (Agulhas Current). Ventral. $\times 10$

Figure 2. Same larva, lateral. $\times 10$

Figures 3-5. Juvenile larva from Guinea Current, Station 41 (*Euzygaena?*)

Figure 3. Lateral. $\times 10$

Figure 4. Ventral. $\times 10$

Figure 5. Head, dorsal. Appr. $\times 30$

Figure 6. Larva of *Corynomma*, caught in locking net at 100-200 m. Station 143, Antarctic Drift Current. Ventral. $\times 10$

Figure 7. Larva of *Teuthowenia antarctica*. Station 135, Antarctic Drift Current. Diagonally ventral. $\times 10$

Figure 8. Tentacle of the larva from Station 135 (Figure 7). Appr. $\times 40$

Figure 9. Older larva of *Taonidium (Galiteuthis)*. Station 64, Atlantic Ocean, near São Tomé. $\times 6$

Figure 10. Tentacle of the larva from Station 64 (Figure 9). Appr. $\times 20$

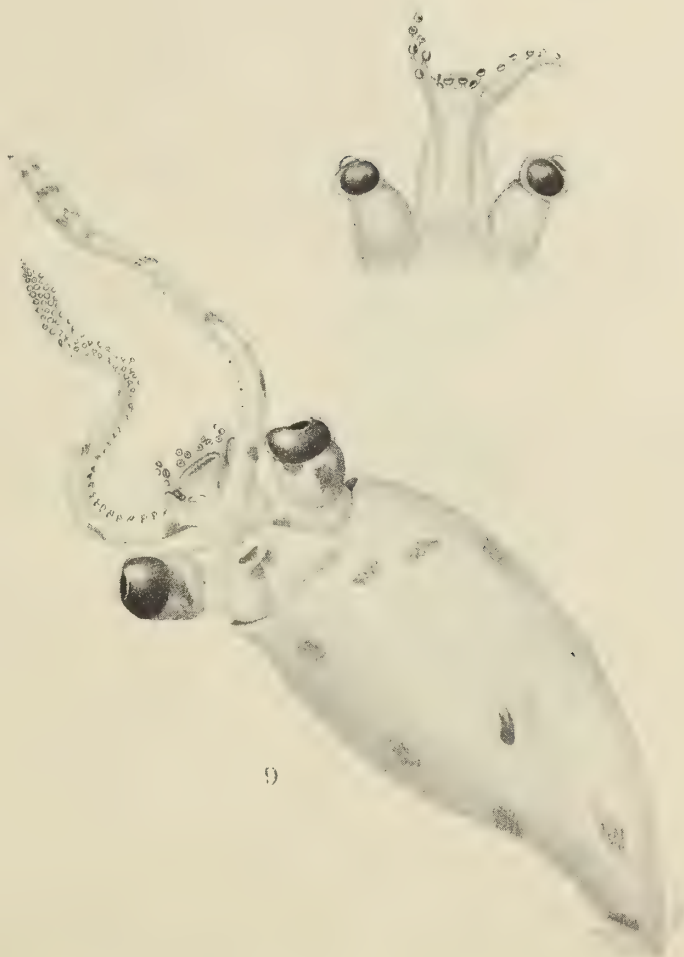




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CARL CHUN

THE CEPHALOPODA
PART II: MYOPSIDA, OCTOPODA
ATLAS

GERMAN DEEPSEA EXPEDITION 1898-1899. VOL. XVIII, PART II

WISSENSCHAFTLICHE ERGEBNISSE
DER
DEUTSCHEN TIEFSEE-EXPEDITION

AUF DEM DAMPFER „VALDIVIA“ 1898-1899

IM AUFTRAGE DES REICHSAMTES DES INNERN

HERAUSGEGEBEN VON

CARL CHUN

PROFESSOR DER ZOOLOGIE IN LEIPZIG, LEITER DER EXPEDITION

UND NACH SEINEM TODE FORTGESETZT VON

AUGUST BRAUER

PROFESSOR DER ZOOLOGIE IN BERLIN

ACHTZEHNTER BAND

CARL CHUN

DIE CEPHALOPODEN

II. TEIL:

MYOPSIDA. OCTOPODA

MIT 39 ABBILDUNGEN IM TEXT UND 34 TAFELN



JENA
VERLAG VON GUSTAV FISCHER
1915

Eingegangen im März 1914, C. Chun

PLATES

Plate LXII

Rossia mastigophora n. sp.

Station 253. Indian North Equatorial Current near the East African coast. Trawl, 638 m

- Figure 1. Female, dorsal view. Natural size
- Figure 2. Same, ventral view. Natural size
- Figure 3. Same, diagonally from the left. Natural size

From color sketches of the live animal

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Plate LXIII

Rossia mastigophora n. sp.

Station 253

Arm Apparatus and Mantle Complex

- Figure 1. Arm apparatus of male. $\times 3$. *I* — dorsal arms; *IV* — ventral arms; *t* — cut tentacle.
Suckers partly lost
- Figure 2. Club of female. $\times 5$
- Figure 3. Neck cartilage and left eye of female; collaris folded at right of neck cartilage.
- Figure 4. Mantle complex of male.
- Figure 5. Mantle complex of female.
- Figure 6. Funnel cartilage and mantle complex of female.

ABBREVIATIONS

depr. inf. — funnel depressors
gl.', gl." — glands of unknown nature
in the mantle cavity
nid. — nidamental gland
nid. acc. — accessory nidamental gland
olf. — olfactory organ
org. inf. — funnel organ
ov. — ovary
pen. — penis
sept. — mantle septum
t — tentacle
ur. — renal papilla

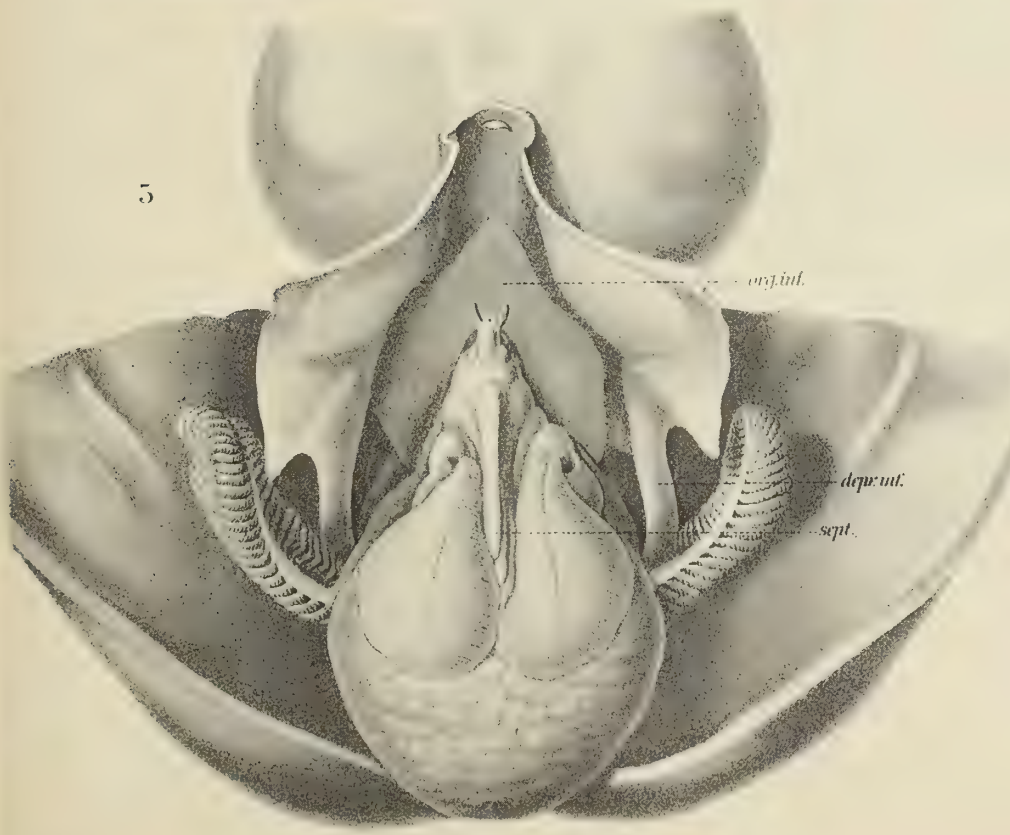
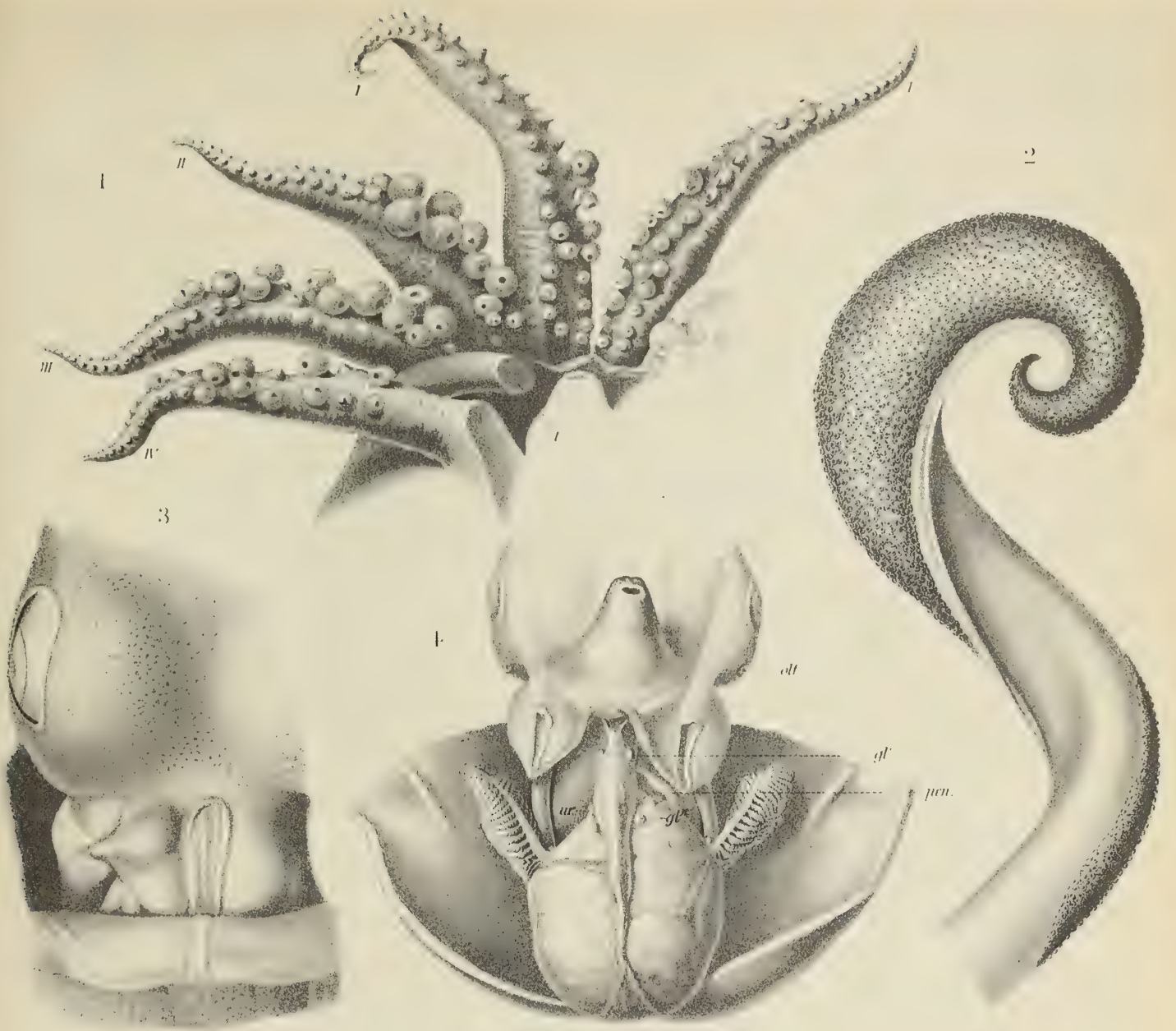


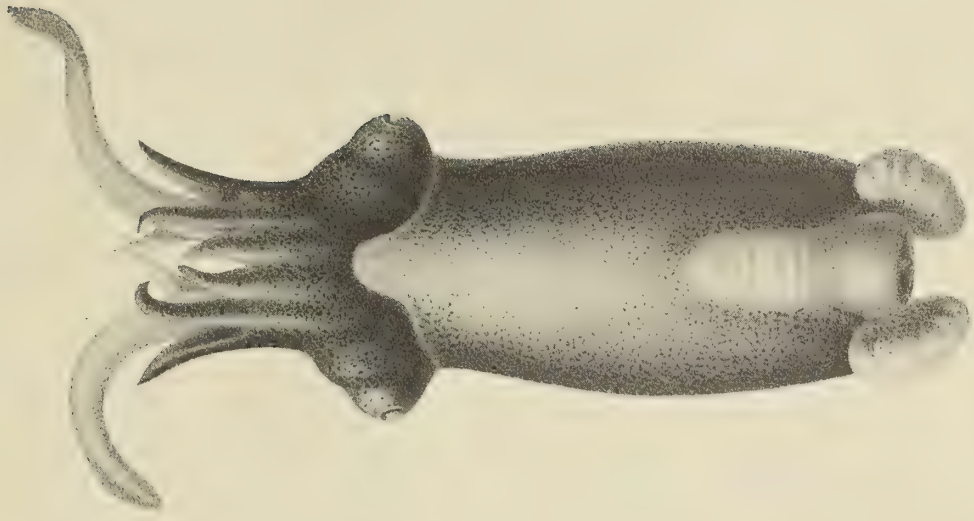
Plate LXIV

Spirula australis LAM.

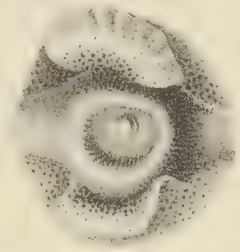
Station 195. Nias South Canal

- Figure 1. Female, diagonally from the ventral side. $\times 2$. Color sketch after the live animal; chromatophores on mantle chafed off by the trawl.
- Figure 2. Same, dorsal view. $\times 2$. Coloration of mantle completed
- Figure 3. Terminal disc with fins. $\times 2$

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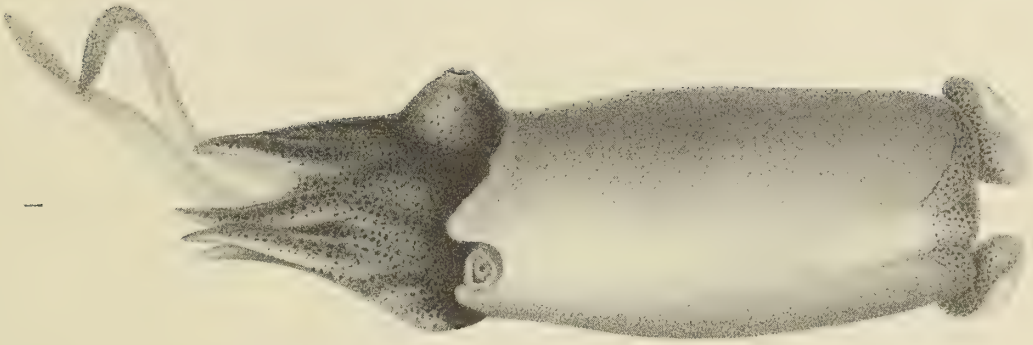


Plate LXV

Spirula australis LAM.

Station 195

Mantle Complex and Arm Apparatus

- Figure 1. Female with opened mantle cavity. $\times 2$
Figure 2. Mantle complex obliquely from the left; left nidamental glands removed. $\times 2$
Figure 3. Neck cartilage; dorsal corner of mantle folded back. $\times 3$
Figure 4. Funnel (opened) with funnel organ. $\times 3$
Figure 5. Inner view of spread arms and tentacles.
Figure 6. Left club.

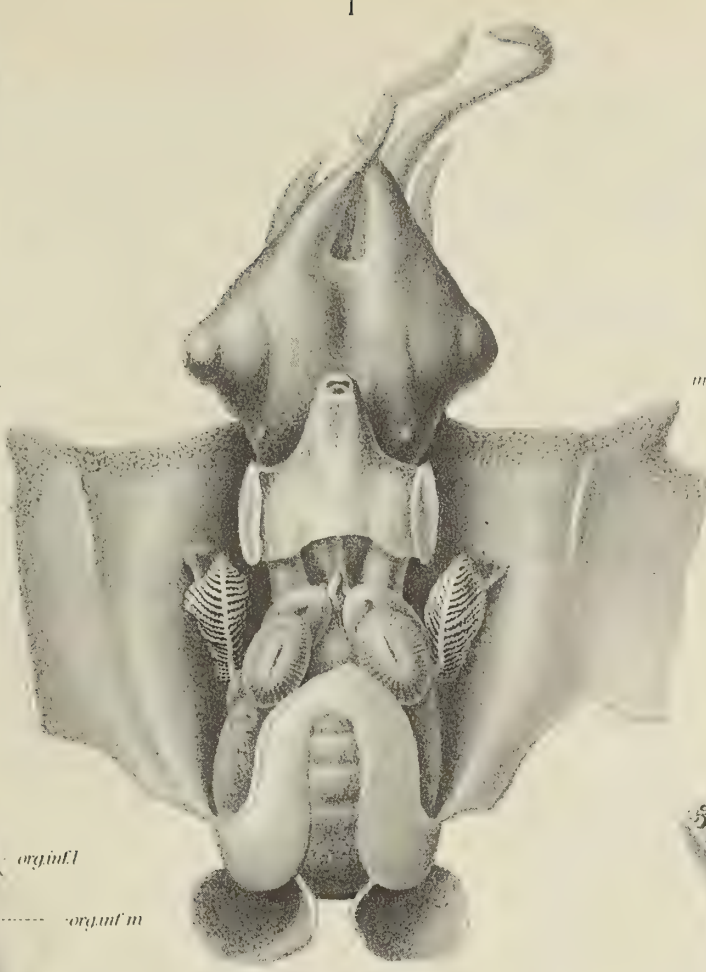
ABBREVIATIONS

depr. inf. — funnel depressors
nid. acc. — accessory nidamental gland
olf. — olfactory organ
org. inf. funnel organ
ov. — ovary
ovd. — oviduct
rect. — rectum
ur. — renal papilla

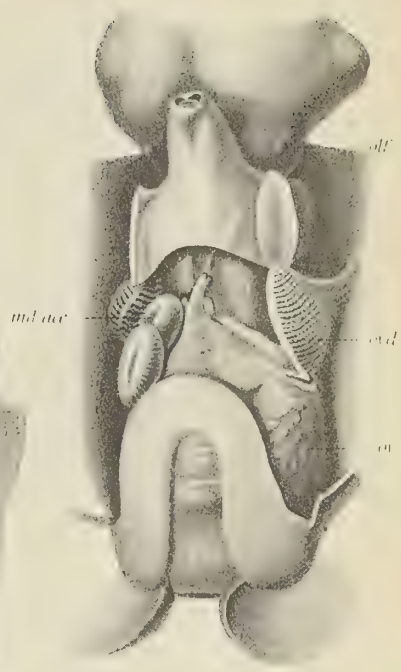
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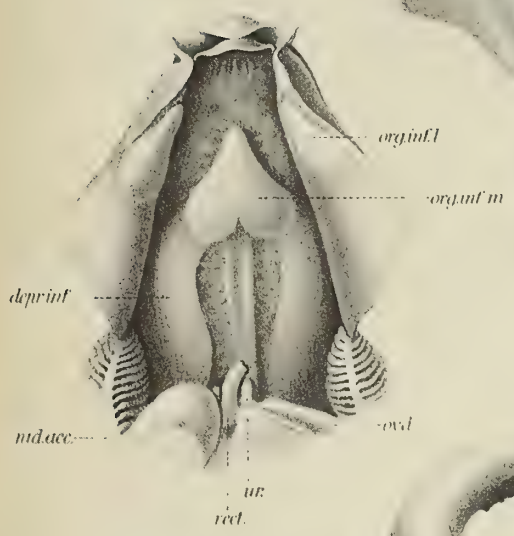
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Plate LXVI

Spirula australis

(Printed from photographs)

Figure 1. *Spirula*, dorsal view.

Figure 2. *Spirula*, right side.

Figure 3. Opened mantle cavity. Left nidamental glands removed and left posterior part of mantle folded down. Shell opened to show siphonal necks. Ventral view.

Figure 4. Mantle complex, slightly diagonally from the left. Left nidamental gland removed



Plate LXVII

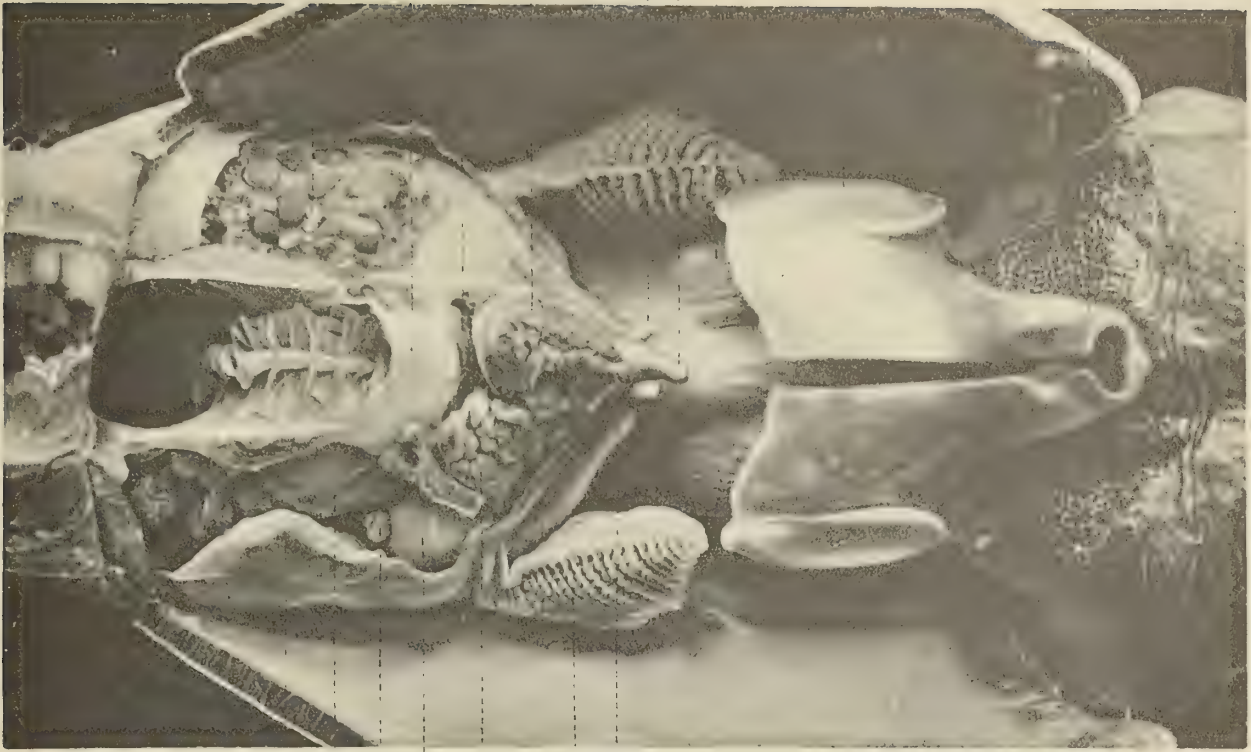
Spirula australis

(Printed from photographs)

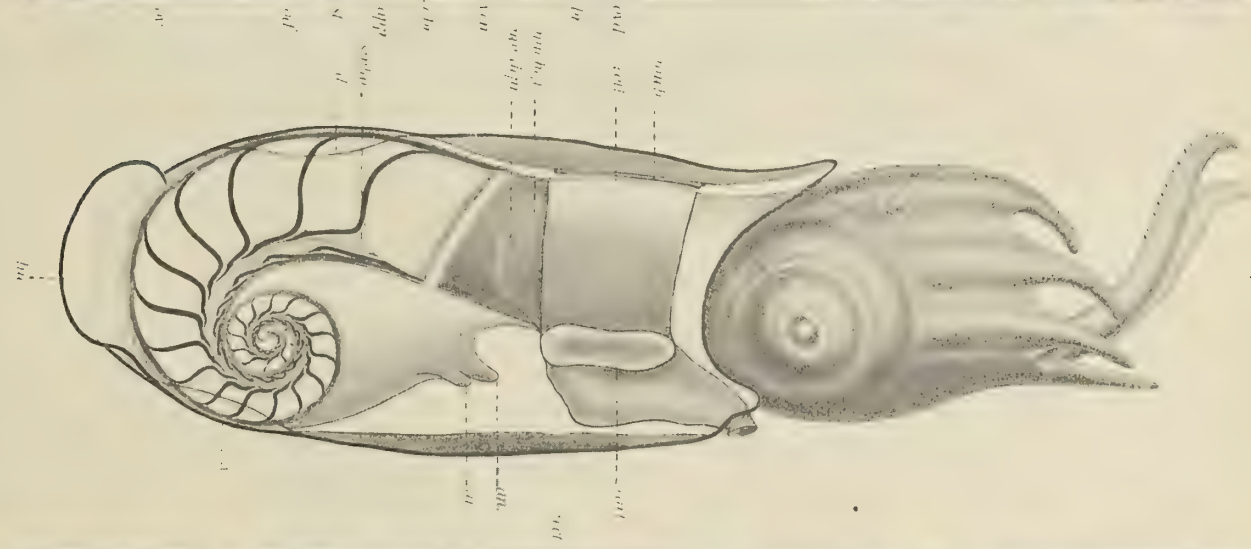
- Figure 1. Semidiagrammatic presentation of *Spirula*, from the right. Mantle and shell cut in half; posterior end of body, which is shown transparent, covered by right fin. Extent of dorsal and ventral ovals indicated by fine contours (*d.*, *v.*)
- Figure 2. Mantle complex, ventral view. Shell opened to show siphonal necks; nidamental glands removed and funnel opened by longitudinal cut. Abdominal wall removed above intestine and right half of visceral sac
- Figure 3. Mantle complex after removal of renal sac and vascular system.

ABBREVIATIONS

<i>an.</i> — anus	<i>nuch.</i> — neck cartilage
<i>app.</i> — appendage of branchial heart	<i>ov.</i> — ovary with eggs at different stages of development
<i>br.</i> — gills	<i>ov.'</i> — right lobe of ovary behind stomach
<i>cart.</i> — funnel cartilage	<i>ovd.</i> , <i>ovd.'</i> — oviduct
<i>cbr.</i> — branchial heart	<i>rect.</i> — rectum
<i>coll.</i> — collaris	<i>sacc.</i> — shell sac
<i>d.</i> — contours of dorsal oval	<i>sacc.st.</i> — sac of caecum
<i>inf.</i> — funnel	<i>sipho</i> — siphuncle
<i>luc.</i> — luminous organ	<i>st.</i> — richly vascularized envelope of caecum (spiral stomach)
<i>mu.depr.</i> — musculi depressores infundibuli	<i>ur.</i> — renal papilla
<i>mu.hep.</i> — muscular capsule of liver	<i>v.</i> — contours of ventral oval
<i>nephr.</i> — communication between the two renal sacs behind intestine	<i>ven.</i> — venous appendages



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abymit

Plate LXVIII

Spirula australis

Intestinal Tract

- Figure 1. Liver, stomach, rectum and ovary, ventral. Caecum and pancreas with their envelope
Figure 2. Liver, pancreas and rectum diagonally from the left side. Envelope of caecum and pancreas cut open
Figure 3. Upper view of transversely cut muscular envelope of liver and living chamber.
Figure 4. Halves of liver, spread to show esophagus and aorta. Caecum and pancreas shown with their envelope. Dorsal view
Figure 5. Intestinal tract in a cleared preparation, ventral view; liver folded aside.
Figure 6. Unpaired part of pancreas with collecting duct.
Figure 7. Posterior salivary gland, from the posterior; cross sections of salivary duct, esophagus and aorta shown in the dorsal groove.
Figure 9. Upper (*a*) and lower (*b*) jaw, lateral view; *c* — lower jaw, upper view. $\times 5.5$.

ABBREVIATIONS

a. ceph. — arteria cephalica

atr. — ink sac

d. hep. pancr. — hepatic duct

d. saliv. — duct of salivary gland

g. gastr. — gastric ganglion

hep. — liver

int. — mid-intestine

lig. g. g. — gastro-genital ligament

oes. — esophagus

ov. — ovary

pancr. — pancreas

rect. — rectum

s. st. coec. — sac of caecum

st. — stomach

x — constriction

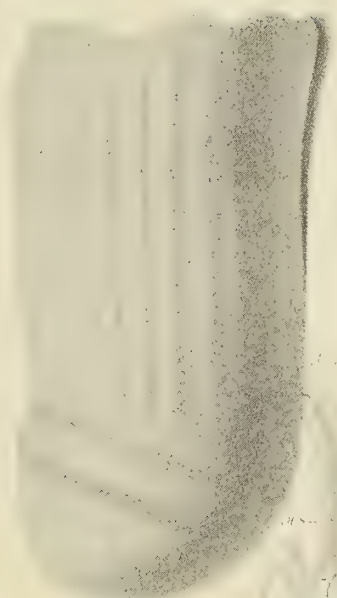
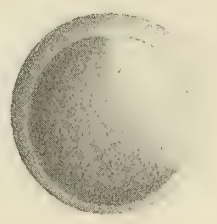
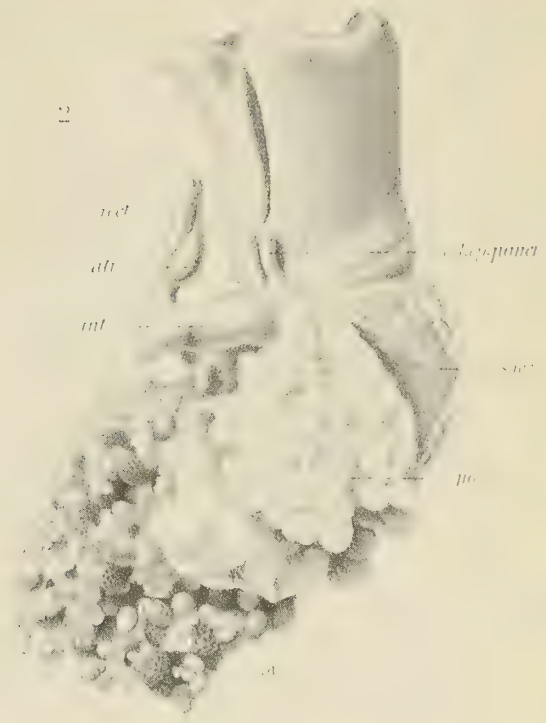


Plate LXIX

Spirula australis LAM.

Nervous System and Sensory Organs

- Figure 1. Anterior part of body, from the right. Mantle folded dorsally and separated by a cut from the shell sac. Only penultimate septa of shell exposed; rest of shell removed. Eyelid cut and folded back in 4 corners
- Figure 2. Longitudinal section through eye with adjacent optic ganglion.
- Figure 3. Section through retina with adjacent cartilage.
- Figure 4. Brain with nerves from the right.
- Figure 5. Supraesophageal ganglion.
- Figure 6. Right supra- and infraesophageal ganglia, lateral view.
- Figure 7. Statolith, from the broad and from the narrow side.

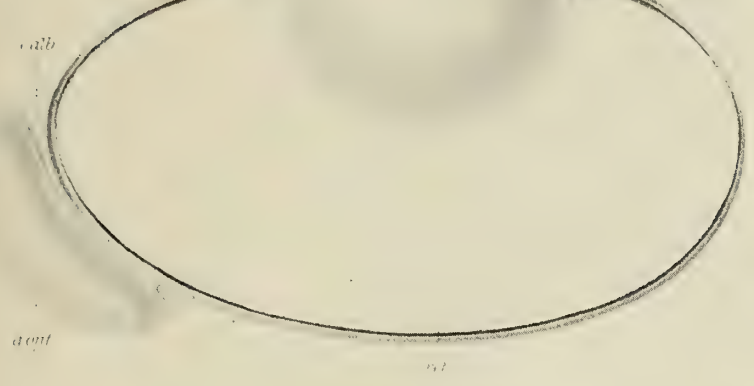
ABBREVIATIONS

c. alb. — white body
cam. — chamber
cart. — cartilage
c. brach. — commissura brachialis
c. cil. — ciliary body
c. cer. b. — commissura cerebr.
 buccale
coll. — collaris
depr. inf. — musculi depressores
 infundibuli
g. brach. — ganglion brachiale
g. bucc. inf. — ganglion buccale
 inferius
g. bucc. sup. — ganglion buccale
 superius
g. cer. — ganglion cerebrale

g. opt. — ganglion opticum
g. ped. — ganglion pedale
g. st. — ganglion stellatum
g. visc. — ganglion viscerale
ir. — iris
lim. — membrana limitans
mu. hep. — muscular sheath of liver
n. a. o. inf. — nervus antorbitalis
 inferior
n. a. o. s. — nervus antorbitalis
 superior
n. coll. — nervus collaris
n. inf. — nervus infundibuli anterior
n. olf. — nervus olfactorius
n. ophth. s. — nervus ophthalmicus
 superior

n. opt. — nervus opticus
n. pall. — nervus pallialis
n. pinn. — nervus pinnalis
n. p. o. — nervus postorbitalis
n. retr. cap. a. — nervus retractor
 capitis anterior
n. stat. — nervus staticus
n. tent. — nervus tentacularis
n. visc. — nervus visceralis
olf. — olfactory tubercle
pall. — mantle
pg. — pigment layer
ret. — retina
s. — layer of sensory cells
sacc. conch. — shell sac
st. — rods

12



3

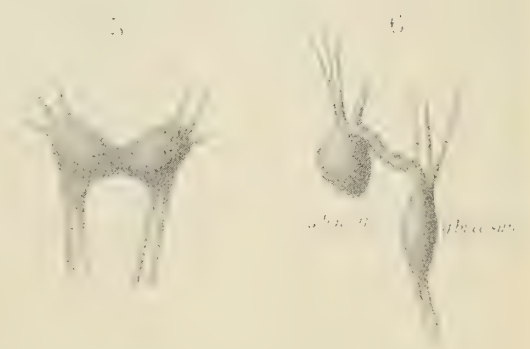
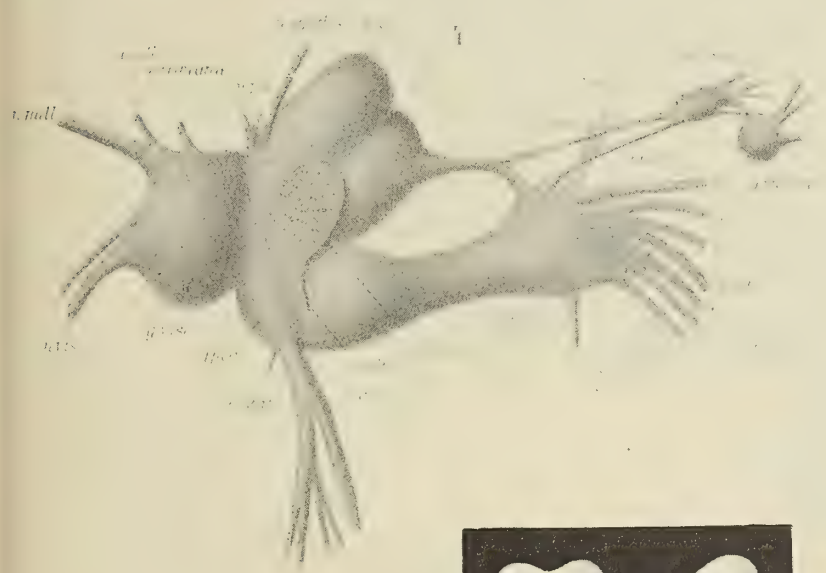
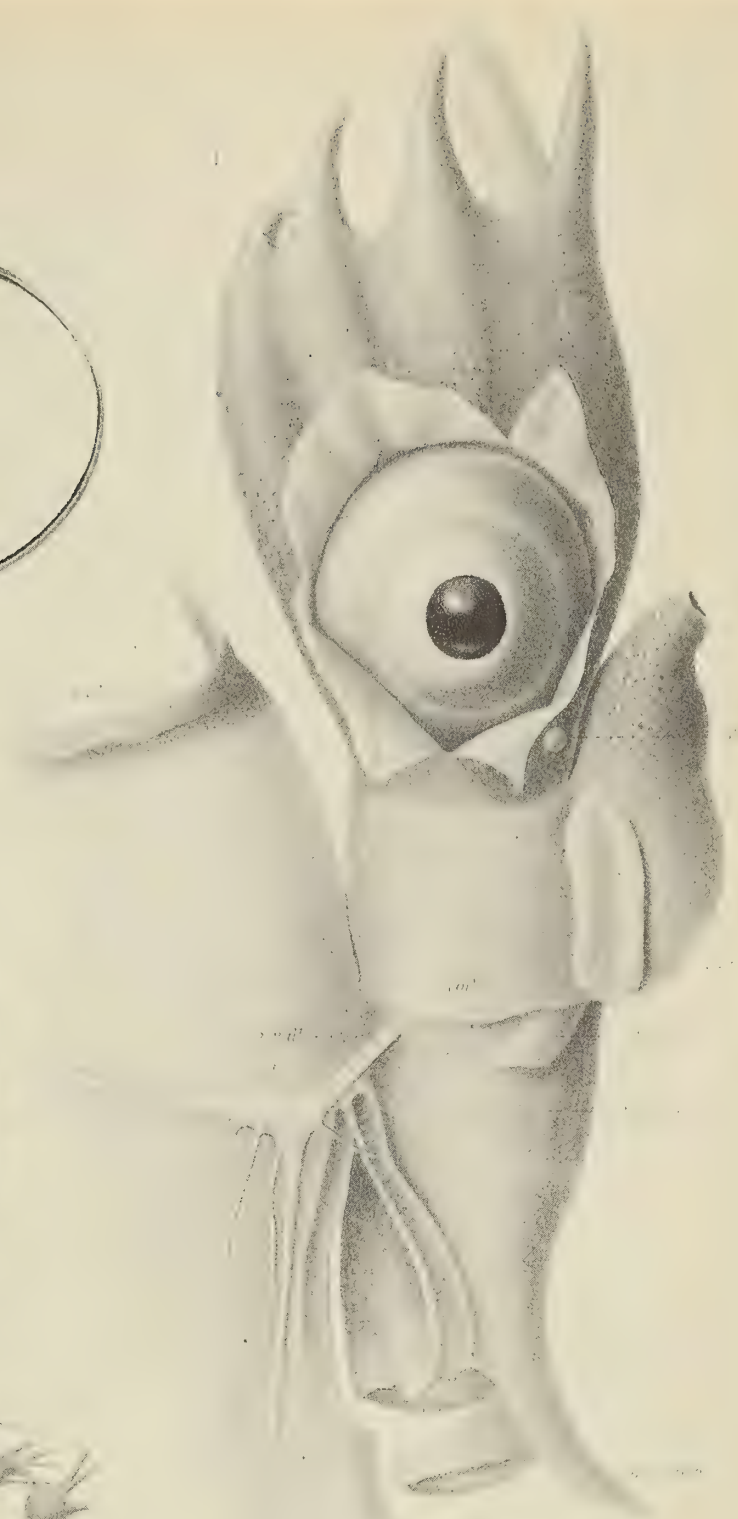
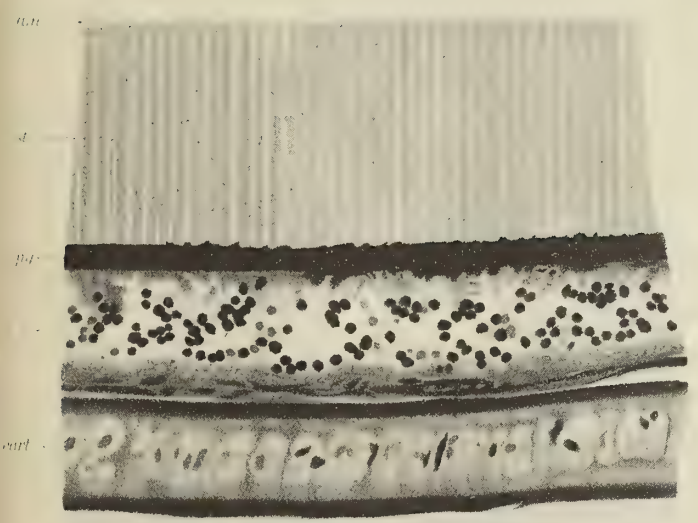


Plate LXX

Spirula australis LAM.

Vascular System, Oviducts, Luminous Organs

- Figure 1. Oviducts, renal sac and vascular system, dorsal view.
Figure 2. Branching of arteria posterior and arteria recurrens, ventral view. Intestine shown by dotted line.
Figure 3. Capillary vessel with blood corpuscles from the luminous body.
Figure 4. Cross section of vena genitalis anterior to its entrance into the renal sac.
Figure 5. Radial section of terminal disc with the luminous organ.
Figure 6. Luminous body.
Figure 7. Nerve from luminous body. Fibrils stained with iron hematoxylin. Zeiss, homogeneous immersion
Figure 8. Nerve branching in luminous body, with thicker and finer fibrils. Iron hematoxylin. Zeiss, homogeneous immersion
Figure 9. Large nerve radiating into luminous body, with nuclei and stained efferent fibrils. Iron hematoxylin. Zeiss, homogeneous immersion
Figure 10. Glandular epithelium of terminal disc. Zeiss, homogeneous immersion.
Figure 11. Lens tissue from vicinity of luminous body. Zeiss, homogeneous immersion
Figure 12. Lens tissue from periphery. Zeiss, homogeneous immersion
Figure 13. Tissue of bars of reflector. Zeiss, homogeneous immersion
Figure 14. Cells with pigment clusters, from cutis of terminal disc. Zeiss, homogeneous immersion.

ABBREVIATIONS

<i>a. branch.</i> — arteria branchialis	<i>c. branch.</i> — branchial heart	<i>ov. od.</i> — opening of oviduct
<i>a. ceph.</i> — aorta cephalica	<i>chr.</i> — chromatophores	<i>phot.</i> — central body of luminous body
<i>a. g.</i> — branch of arteria recurrens to intestine	<i>ep. gl.</i> — epithelium of body	<i>refl.</i> — reflector
<i>a. gastr.</i> — arteria gastrica	<i>ep. sacc.</i> — epithelium of shell sac	<i>sacc.</i> — shell sac
<i>a. gen.</i> — arteria genitalis	<i>gl. od.</i> — oviduct gland	<i>sang.</i> — blood corpuscles
<i>a. n.</i> — branches to renal sacs	<i>l</i> — terminal knob	<i>sin.</i> — blood sinus
<i>a. post.</i> — aorta posterior	<i>lam. refl.</i> — layer of reflector	<i>ur.</i> — renal papilla
<i>a. pp.</i> — appendages of branchial hearts	<i>mu.</i> — muscles	<i>v. abd.</i> — vena abdominalis
<i>a. rec.</i> — arteria recurrens	<i>neph.</i> — renal sacs	<i>v. branch.</i> — vena branchialis
<i>a. sacc.</i> — branch to shell sac	<i>nu. cap.</i> — nuclei of capillaries	<i>v. c.</i> — vena cava
<i>atr.</i> — ink sac	<i>nu. phot.</i> — nuclei of central body of luminous organ	<i>v. hep.</i> — vena hepatica
	<i>od.</i> — oviduct	<i>v. od.</i> — vein of oviduct
		<i>v. pall.</i> — vena pallialis

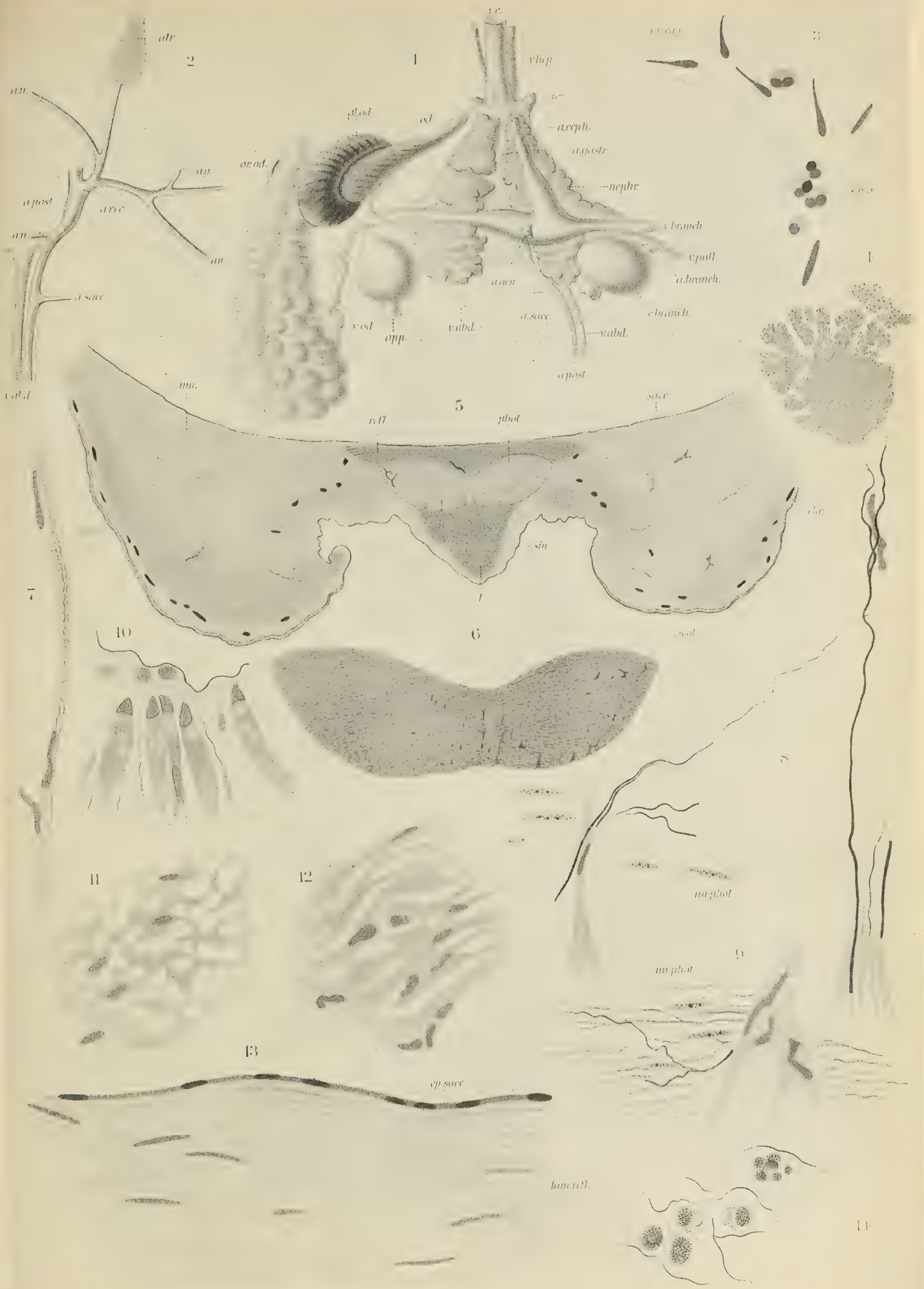


Plate LXXI

Larvae of *Spirula*

Figures 1-8. Copies of Figures 1-6 of Plate 1, and Figures 2, 3 of Plate 2, from CHUN: "Cephalopoda".
Rep. Scient. Res. "Michael Sars" North Atl. Exp., 1910, Vol. 3, Part 1.

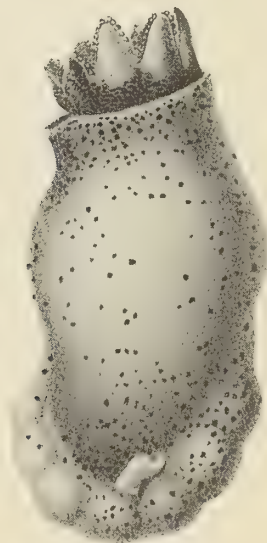
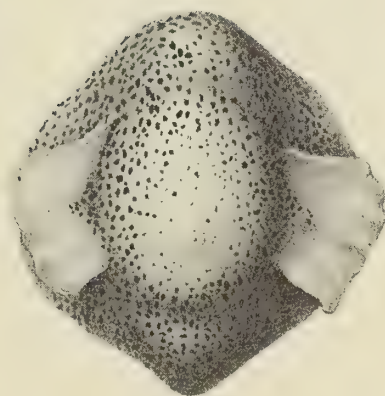
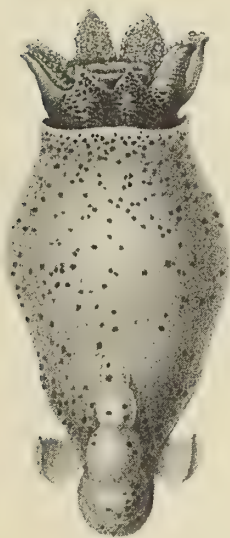


Plate LXXII

Spirula australis LAM.

Shell

- Figure 1. Initial chamber and siphuncle, median longitudinal section. Zeiss 8 mm, ocular 2. *a.p'* and *i.p'*—outer and inner plates of the adjacent shell wall (9th, 10th and 11th chamber); *ch*—chitinized boat-shaped lamella with remnants of epithelium; *sept*¹—septal neck of initial chamber, *sept*², *sept*³—septal necks of 2nd and 3rd chamber; *pros*—prosiphuncle; *pil*—pillar substance; *pil'*—assumed pillar substance forming end of initial chamber; *sacc*—thickened part of shell sac, continued in the umbilicus (*umb*)
- Figure 2. Initial part of shell sac occupying umbilicus (*umb*). Zeiss A 4. *v*—branched capillaries; 1...8—region of 1st–8th chambers; *umb*—connective tissue of umbilicus
- Figure 3. Longitudinal section through dorsal margin of living chamber. Inner plate (*i.p.*) of shell wall detached from the epithelium
- Figure 4. Opening of siphuncle into the living chamber. Zeiss A 4. *a*—plug of connective tissue cells (*ep*) situated on matrix of siphonal neck; *amp.v*—ampulla-shaped dilatation of venous stems; *coel*—coelom; *h*—envelope of liver; *ep'*—torn epithelial cord providing connection with epithelium of siphuncle

ABBREVIATIONS

<i>a</i> — plug of connective tissue	<i>i.p</i> — inner plate
<i>amp</i> — ampulla of blood vessels	<i>ir</i> — iridocytes
<i>a.p</i> — outer plate	<i>mu</i> — musculature
<i>art</i> — artery	<i>mu.hep</i> — muscular sheath of liver
<i>cart</i> — cartilage	<i>pil</i> — pillar
<i>ch</i> — chitinous lamella	<i>pros</i> — prosiphuncle
<i>coel</i> — coelom	<i>sacc</i> — shell sac
<i>cut</i> — cutis	<i>sept</i> — septal funnel
<i>ek</i> — ectoderm	<i>umb</i> — umbilicus
<i>ep</i> — epithelium	<i>v</i> — vessel
<i>h</i> — envelope of liver	



2



Plate LXXIII

Spirula australis

Larva and Shell

- Figure 1. Median section of youngest larva (Plate LXXI, Figures 1, 2). A few adjacent parts are included; stomach shown by thin line, caecum by dotted line. Shell chambers, slightly shrunk, drawn after the cleared specimen
- Figure 2. Cross section of siphuncle of adult animal. Zeiss 8 mm, ocular 2
- Figure 3. Part of cross section of siphuncle, with adjacent pillar and septal funnel. Zeiss, hom. immersion, 2 mm. Oc. 2
- Figure 4. Nuclei of epithelium of shell sac in area of umbilicus.
- Figure 5. Longitudinal section of ventral wall of shell sac at level of the 3rd from last chamber. Zeiss 8 mm, oc. 2
- Figure 6. Longitudinal section of folded shell sac in area of 4th saddle. Zeiss 8 mm, oc. 4
- Figure 7. Longitudinal section of folded shell sac in area of 6th saddle. Zeiss 8 mm, oc. 4

ABBREVIATIONS

<i>a.</i> — thickening of larval shell sac	<i>g. bucc. i</i> — ganglion buccale inferius	<i>n'</i> — nerve of dorsal arm
<i>an</i> — anus	<i>g. bucc. s</i> — ganglion buccale superius	<i>neph</i> — kidney
<i>a. p</i> — outer plate	<i>g. cer</i> — ganglion cerebrale	<i>o</i> — mouth
<i>art</i> — artery	<i>g. gastr</i> — ganglion gastricum	<i>o. inf. d</i> — dorsal funnel organ
<i>atr</i> — ink sac	<i>g. ped</i> — ganglion pedale	<i>o. inf. v</i> — ventral funnel organ
<i>bg</i> — connective tissue	<i>g. visc</i> — ganglion viscerale	<i>oes</i> — esophagus
<i>c</i> — heart	<i>ga</i> — gelatinous connective tissue	<i>p'</i> — dorsal arm
<i>ch</i> — chitinous lamella	<i>gl. sal. a</i> — anterior salivary gland	<i>pall. e</i> — outer layer of mantle
<i>chr</i> — chromatophore	<i>gl. sal. p</i> — posterior salivary gland	<i>pall. i</i> — inner layer of mantle
<i>coel. si</i> — coelomic tube of siphuncle	<i>gl. submx</i> — submaxillary gland	<i>pall. m</i> — middle layer of mantle
<i>coll</i> — collaris	<i>go</i> — gonad	<i>pil</i> — pillar
<i>cut</i> — cutis	<i>hep</i> — liver	<i>pros</i> — prosiphuncle
<i>d. hep. pancr</i> — ductus hepato-pancreaticus	<i>inf</i> — funnel	<i>sept</i> — septal funnel
<i>d. sal. p</i> — efferent duct of posterior salivary gland	<i>i. p</i> — inner plate	<i>st</i> — stomach
<i>ep</i> — epithelium	<i>mu</i> — musculature	<i>stat</i> — static organ
<i>ep. s</i> — siphonal epithelium	<i>mu'</i> — musculature of body wall	<i>v</i> — vessel
<i>g. brach</i> — ganglion brachiale	<i>mu. umb</i> — muscle inside umbilicus	<i>valv</i> — funnel valve
	<i>mx. inf</i> — lower jaw	<i>x</i> — space enlarged by detachment of liver
	<i>mx. sup</i> — upper jaw	2, 3, 4, 5, 6 — 2nd to 6th chambers

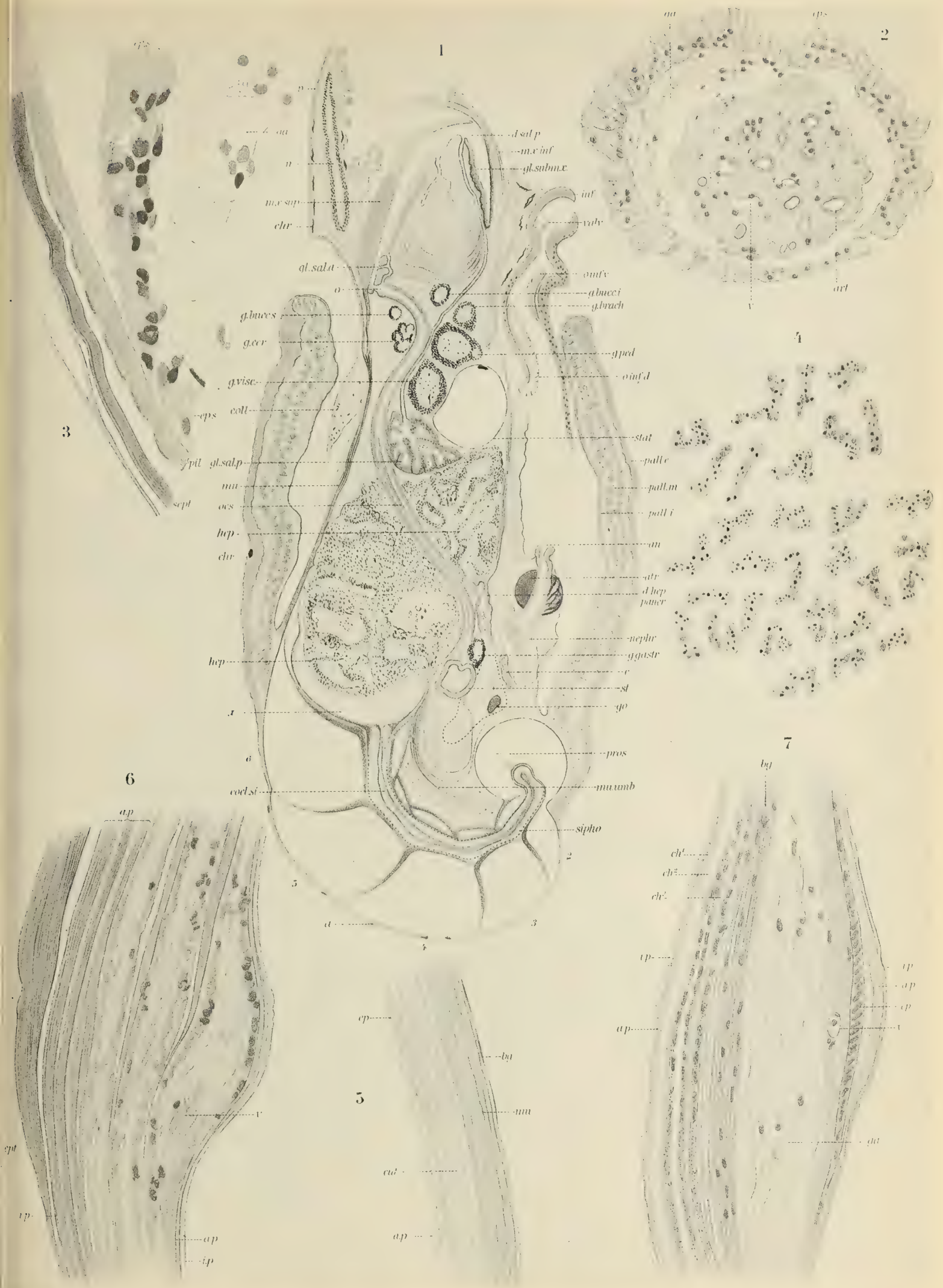


Plate LXXIV

Argonauta

- Figure 1. *Argonauta hians* SOLANDER, male; Station 50, South Equatorial Current. $\times 6$
Figure 2. *Argonauta hians* SOLANDER, female; Station 50, South Equatorial Current. $\times 6$
Figure 3. *Argonauta* sp., juvenile female; Station 263. Indian North Equatorial Current. $\times 6$
Figure 4. *Argonauta hians*, male; Station 50. Funnel and mantle cartilage. Appr. $\times 20$
Figure 5. *Argonauta hians*, male; Station 50. Arm apparatus. Appr. $\times 12$
Figure 6. *Argonauta hians*, female; Station 50. Funnel and mantle cartilages

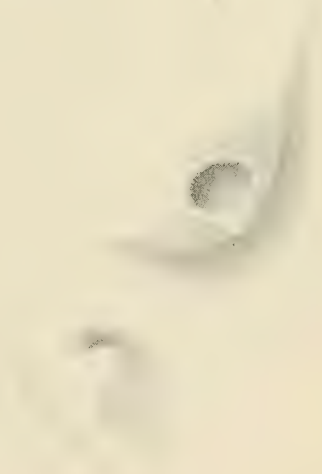
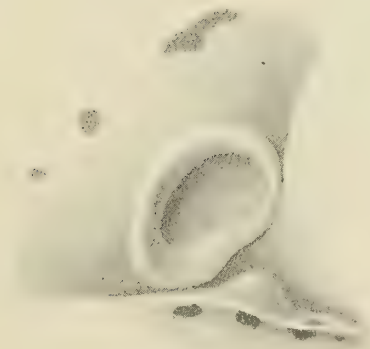
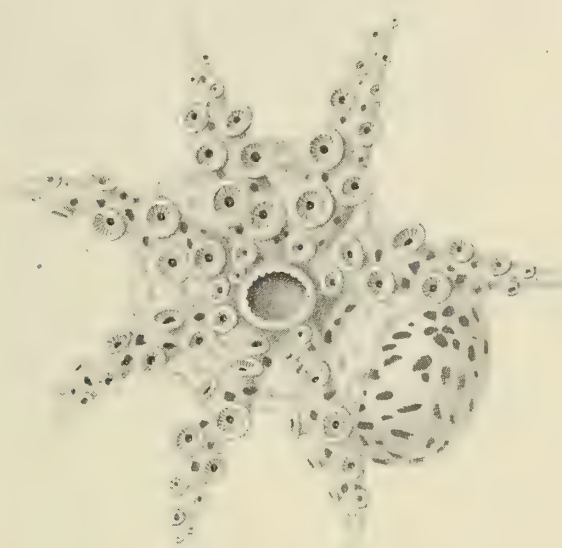
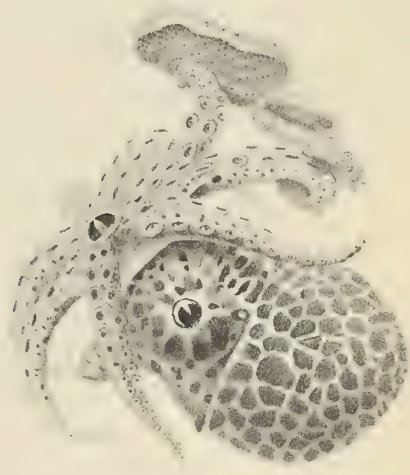
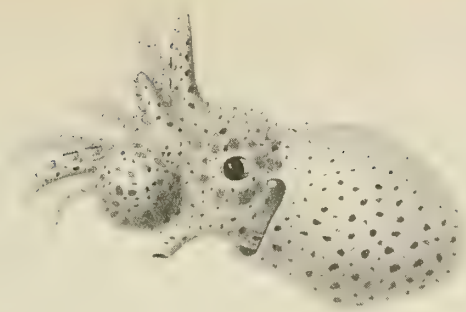


Plate LXXV

Velodona togata n. gen., n. sp.

Right side. Natural size. Drawn from color sketch of the live animal. Station 249. Trawl, 749 m.
Near the Somali coast

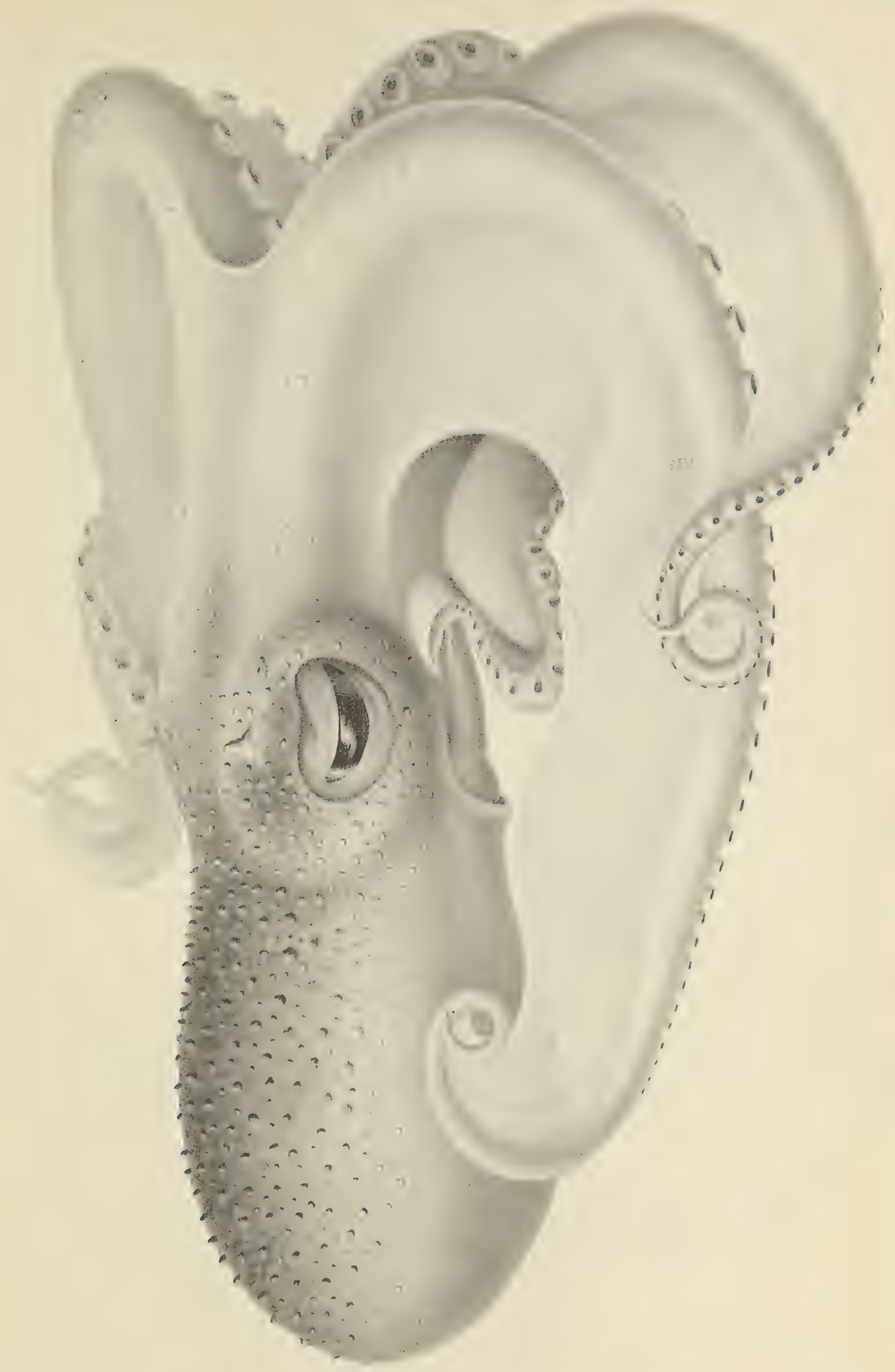


Plate LXXVI

Velodona togata n. gen., n. sp.

Dorsal view. Drawn from color sketch of the live animal. Station 249. Trawl, 749 m. Near the Somali coast



Plate LXXVII

Tremoctopus hyalinus RANG, juv. (Figures 1, 4, 5, 6); *Polypus* juv. (Figures 2, 3, 7).

- Figure 1. *Tremoctopus hyalinus* RANG, juv., Station 49, South Equatorial Current. $\times 6$
- Figure 2. *Polypus* juv., Station 244, Zanzibar Canal. $\times 6$
- Figure 3. *Polypus* (*brevipes* D'ORB.?) juv., Station 207, Indian North Equatorial Current, Surat Passage. $\times 6$
- Figure 4. Thickened right margin of mantle of *Tremoctopus*, Station 49.
- Figure 5. Funnel, mantle margin and anus of *Tremoctopus*, Station 49. Appr. $\times 18$
- Figure 6. *Tremoctopus hyalinus* juv., Station 49. Arm apparatus. $\times 12$
- Figure 7. *Polypus* juv., Station 244. Arm apparatus. $\times 12$

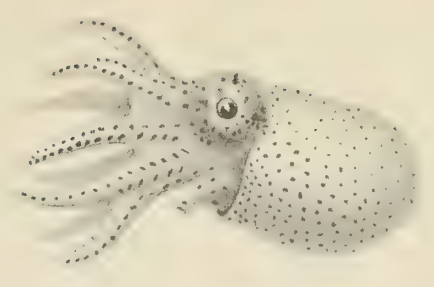
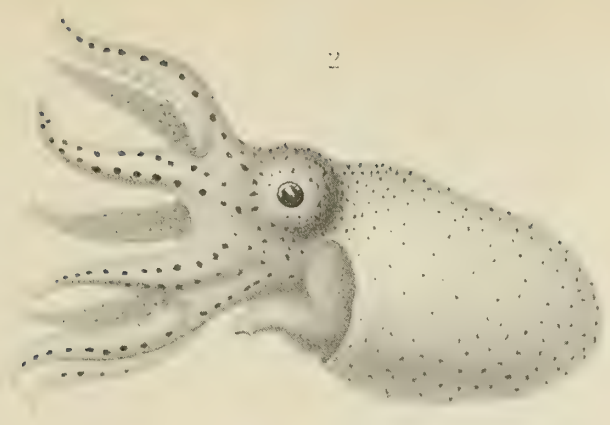


Plate LXXVIII

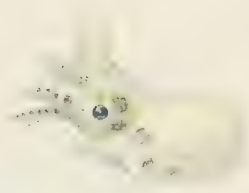
Larvae of Bristle Bearing Octopoda

- Figure 1. Larva of Octopoda with bristles, Station 223, Indian Countercurrent. $\times 6$
- Figure 2. Larva of Octopoda with bristles, Station 41, Guinea Current. $\times 6$
- Figure 3. Same larva, higher magnification, $\times 30$
- Figure 4. Arm apparatus of larva from Station 223. Appr. $\times 12$
- Figure 5. Arm apparatus of larva from Station 41. $\times 12$

1



2



3



4



5

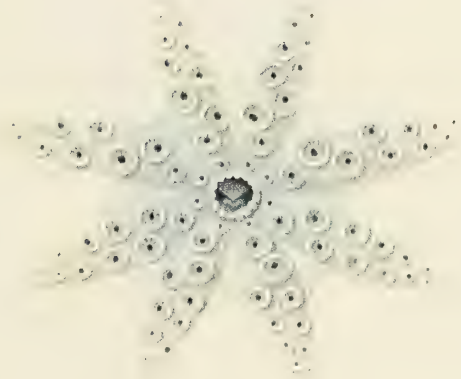


Plate LXXIX

Polypus levis HOYLE, male

Station 160, Port Gazelle, Kerguelen.



Plate LXXX

Polypus valdiviae. Station 103, Agulhas Bank

Figure 4. Hectocotylus.

Figure 5. Young male?

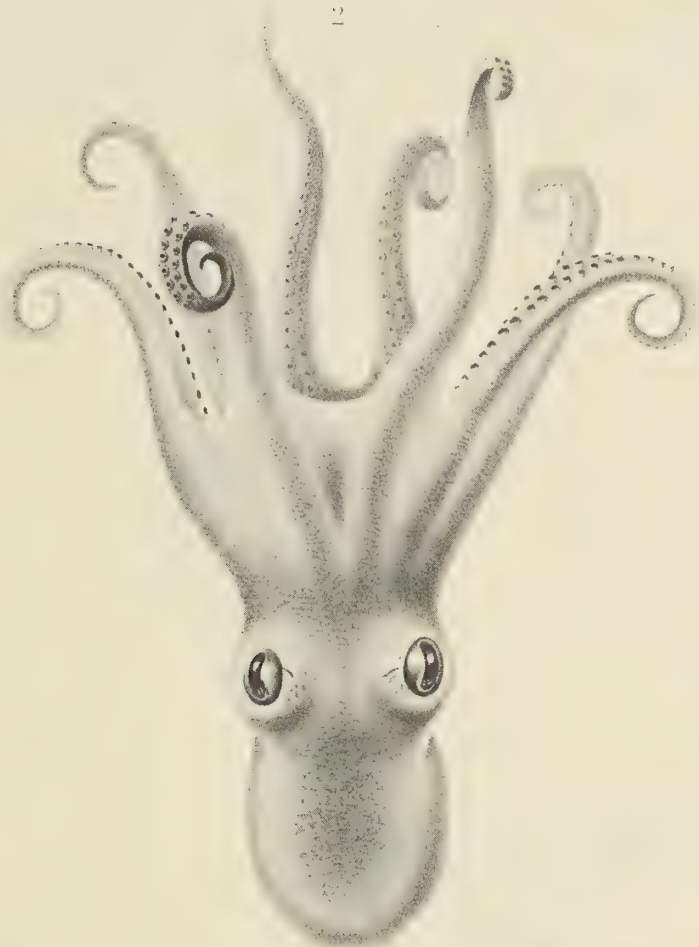


Plate LXXXI

Eledonella pygmaea VERR.

Figures 1-2. Young females.

Figure 3. Male, probably from the material of the *Michael Sars* Expedition.

Figure 4. Hectocotylus of younger male.

Figure 5. Female. Station 53. Gulf of Guinea

1



2



3



4



5



Plate LXXXII

Bolitaena diaphana STEENSTR.

Figures 1 and 4. Station 66b, northeast of S. Thomé.

Figures 2 and 3. Station 50, Gulf of Guinea.

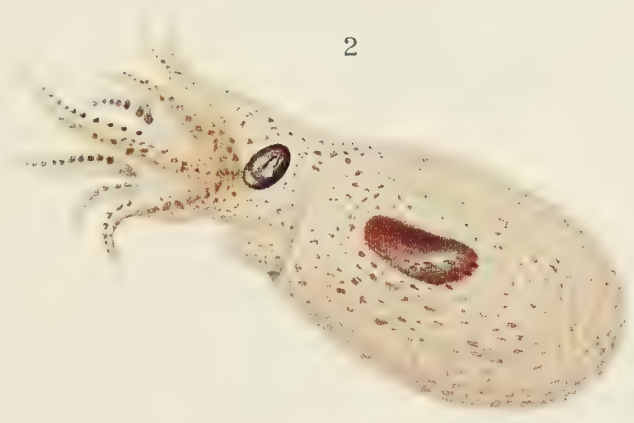
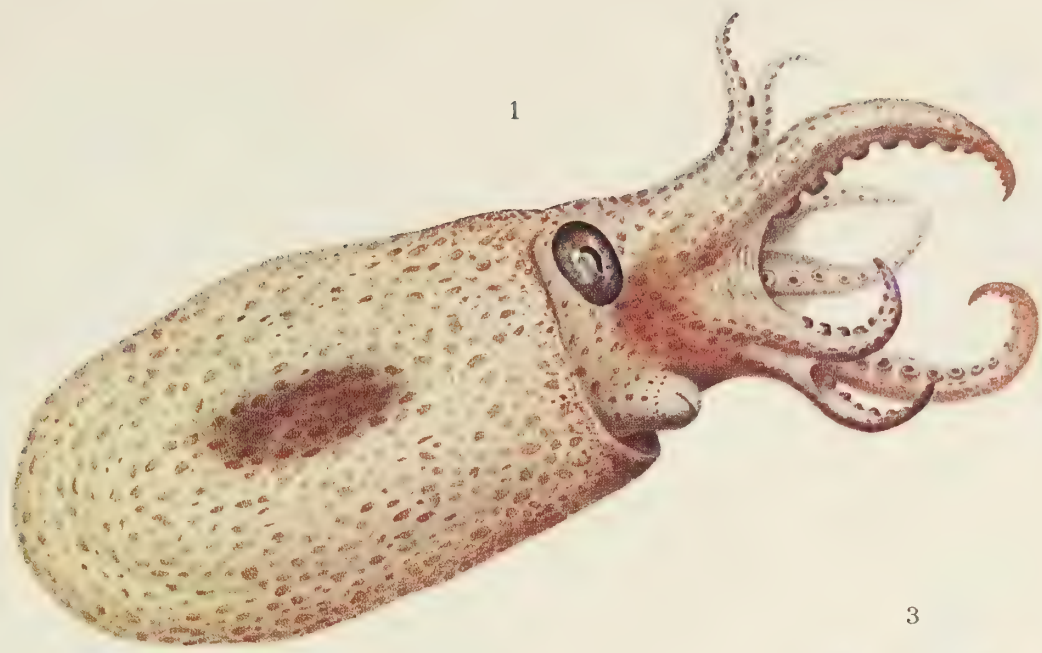


Plate LXXXIII

Bolitaena diaphana STEENSTR., juv.

Figure 1. Station 190, near Sumatra.

Figures 2 and 6. Station 217, southwest of Ceylon.

Figures 3, 4, 5, 7, 8. Station 44, south of Sierra Leone.

Figures 9 and 10. Station 66b, northeast of S. Thomé.

ABBREVIATIONS

c.branch. — branchial heart

g.stell. — ganglion stellatum

sept. — mantle septum

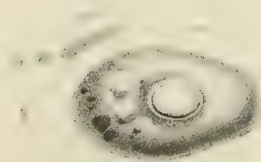
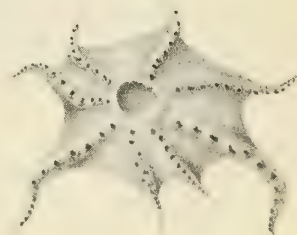
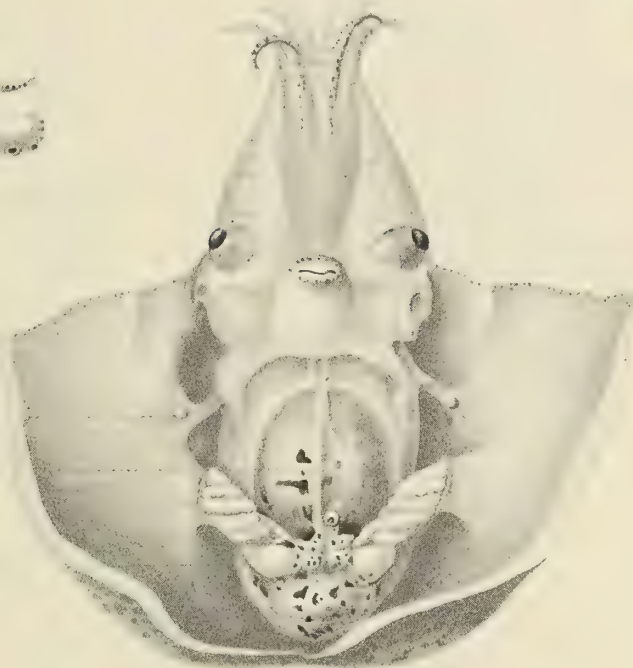
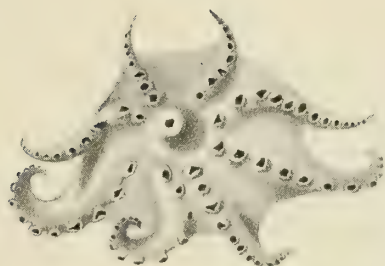
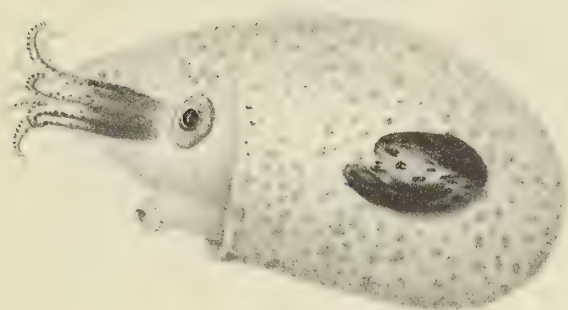
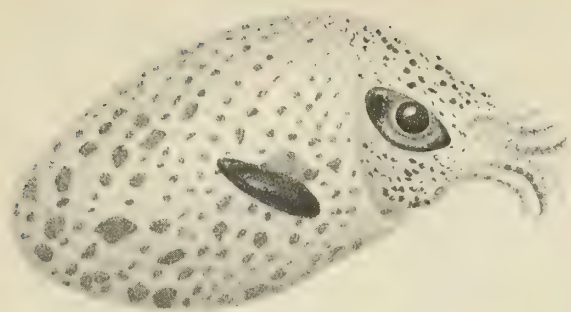


Plate LXXXIV

Figure 1. *Bolitaena*, ventral view, with opened gelatinous mantle. Mantle septum, strongly pigmented visceral sac and right gill visible. The larger arm (3rd right arm), which faces the observer, is hectocotylized

ABBREVIATIONS

c. branch. — branchial heart
org. infund. — funnel organ
pen. — penis
sept. — mantle septum
test. — testis

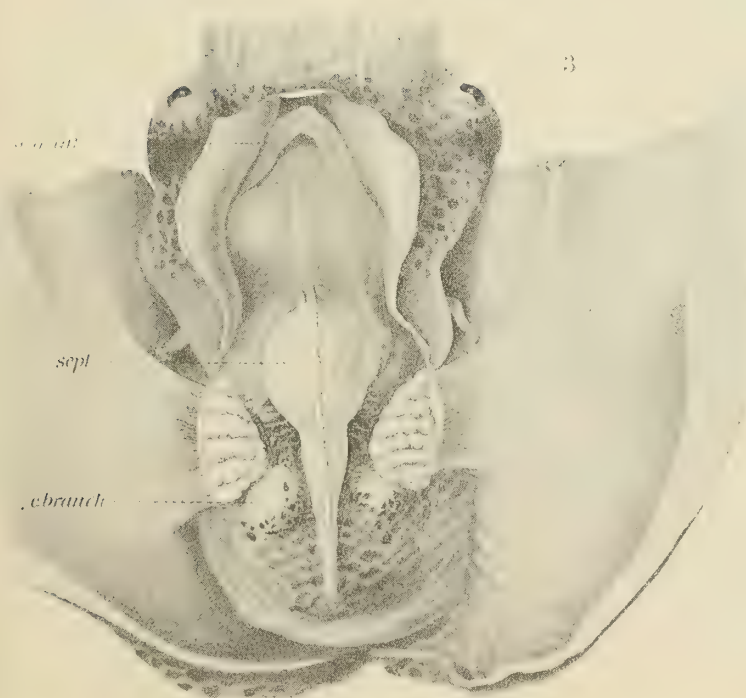
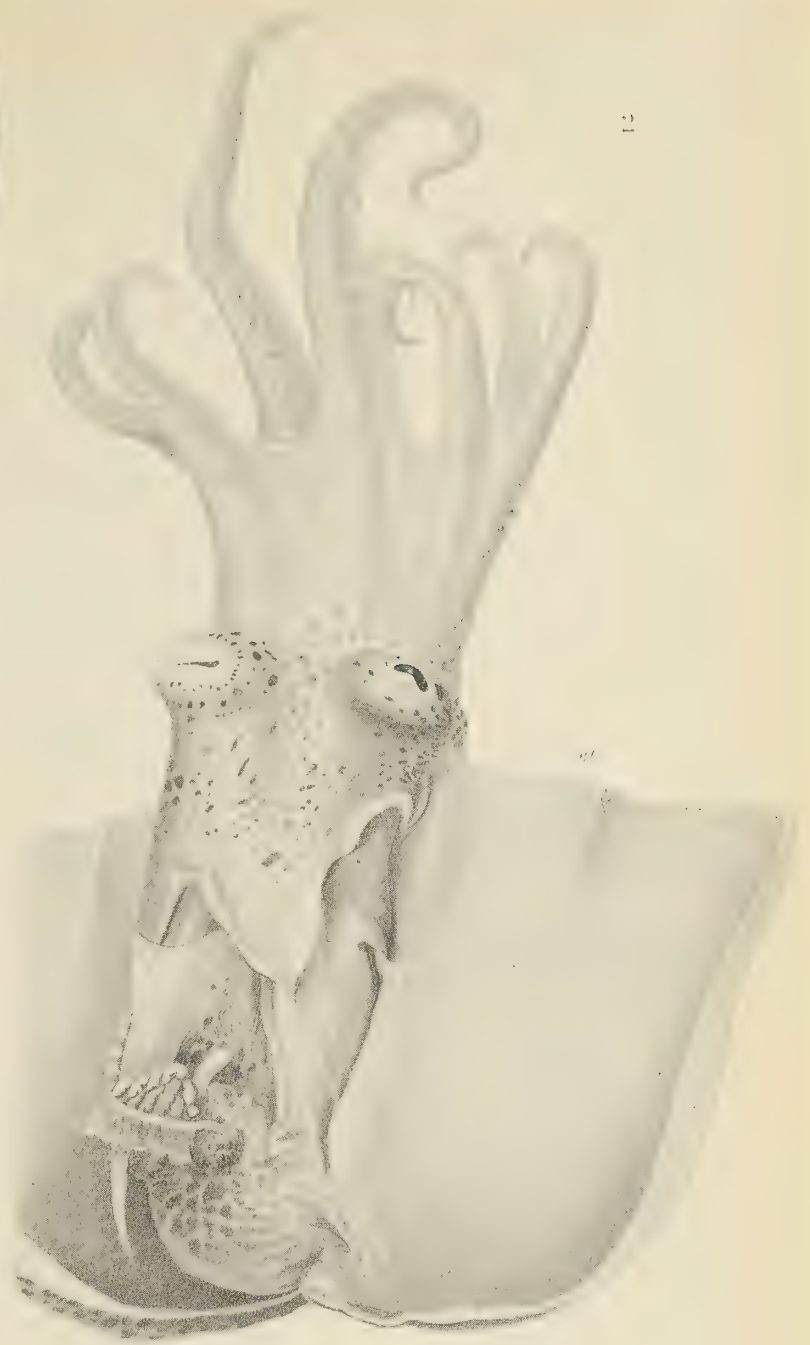
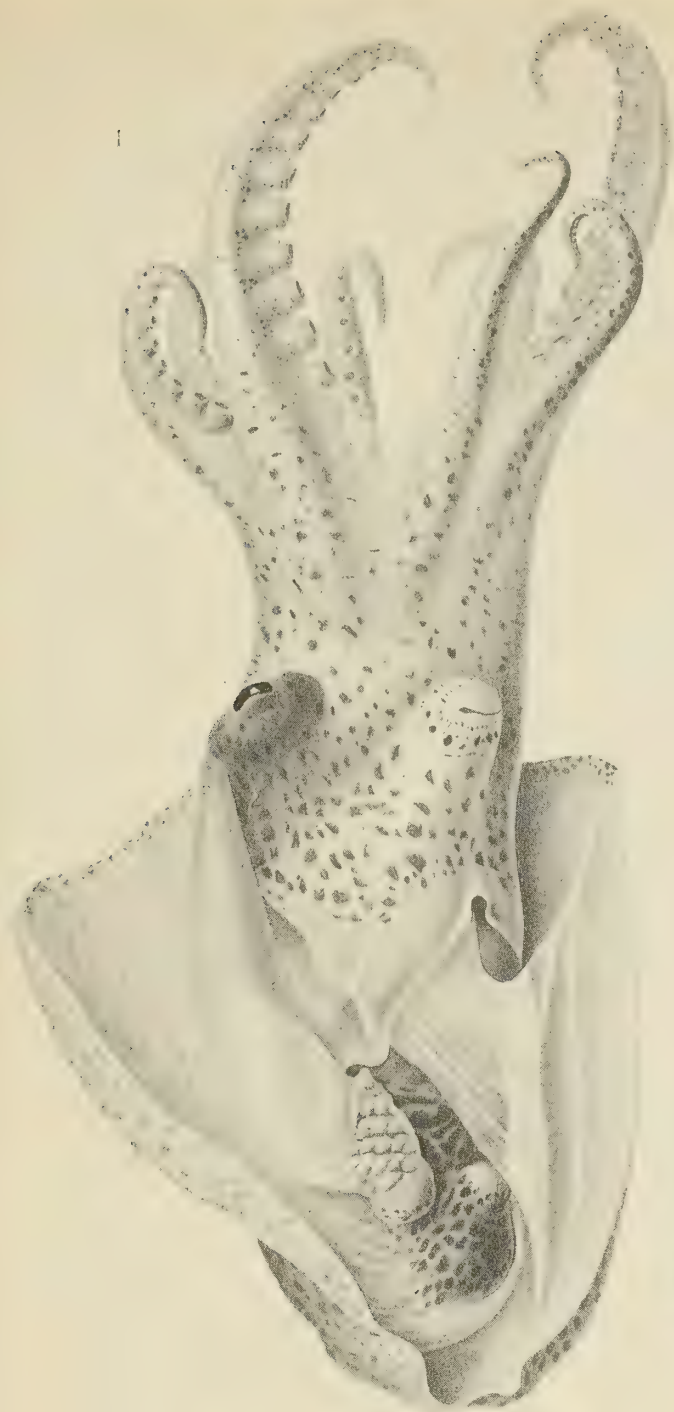


Plate LXXXV

Bolitaena, Eledonella; Nervous System

Figures 1–5. *Bolitaena diaphana* STEENSTR. Station 50

- Figure 1. Central nervous system with adjacent organs of medium-sized specimen. Dorsal view
Figure 2. Central nervous system of same specimen, ventral view.
Figure 3. Central nervous system and nerves of arms of same specimen. Ventral view. Arms obliquely cut open, to show transverse lamellae in the gelatinous substance and nerves shining through
Figure 4. Ganglia of visceral nerves at level of anus.
Figure 5. Infraesophageal ganglion.
Figure 6. *Bolitaena*, Station 66. Gastric ganglion

Figures 7, 8. *Eledonella pygmaea*. Experimental Station 53

- Figure 7. Central nervous system, ventral view. $\times 20$
Figure 8. Central nervous system, dorsal view. $\times 20$

ABBREVIATIONS

- | | | |
|---|---|---|
| <i>a. brach</i> — arteria brachialis | <i>g. bucc. s</i> — ganglion buccale superius | <i>n. inf. p.</i> — nervus infundibuli posterior |
| <i>a. bucc</i> — arteria buccalis | <i>g. cer</i> — ganglion cerebrale | <i>n. lab</i> — nervus labialis |
| <i>a. ceph</i> — arteria cephalica | <i>g. gast</i> — ganglion gastricum | <i>n. oc. i.</i> — nervus oculomotorius inferior |
| <i>a. inf</i> — arteria infundibuli | <i>g. n. o. i.</i> — ganglion nervi ophthalmii inferior | <i>n. olf</i> — nervus olfactorius |
| <i>an</i> — anus | <i>g. n. visc</i> — ganglion nervi visceralis | <i>n. opt.</i> — nervus opticus |
| <i>a. ophth</i> — arteria ophthalmica | <i>g. opt</i> — ganglion opticum | <i>n. ophth. a.</i> — nervus ophthalmicus anterior |
| <i>a. saliv</i> — artery to salivary glands | <i>g. ped</i> — ganglion pedale | <i>n. ophth. i.</i> — nervus ophthalmicus inferior |
| <i>a. stat</i> — artery to static organ | <i>g. pedunc</i> — ganglion pedunculi | <i>n. ophth. p.</i> — nervus ophthalmicus posterior |
| <i>c. alb</i> — white body | <i>g. visc</i> — ganglion viscerale | <i>n. pall</i> — nervus pallialis |
| <i>c. brach. b.</i> — commissura brachio-buccalis | <i>g. saliv. a.</i> — anterior salivary gland | <i>n. symp</i> — nervus sympaticus |
| <i>c. b. s. i.</i> — commissura supraesophagea–infraesophagea | <i>n. abd</i> — nervus abdominalis | <i>n. visc</i> — nervus visceralis |
| <i>com. brach</i> — commissura brachialis | <i>n. acc. olf</i> — nervus accessorius olfactorii | <i>oes</i> — esophagus |
| <i>d. saliv. p.</i> — efferent duct of posterior salivary gland | <i>n. add. inf</i> — nervus adductor infundibuli | <i>opt</i> — optic nerve |
| <i>g</i> ¹ — ganglionic swelling of the optic nerve | <i>n. ant</i> — nervus anterior | <i>rect</i> — rectum |
| <i>g. brach</i> — ganglion brachiale | <i>n. a. o. s</i> — nervus antorbitalis superior | <i>stat</i> — nervus staticus |
| <i>g. bucc. i.</i> — ganglion buccale inferius | <i>n. brach</i> — nervus brachialis | <i>v. c</i> — vena cava |
| | <i>n. inf. a.</i> — nervus infundibuli anterior | |

Plate LXXXVI

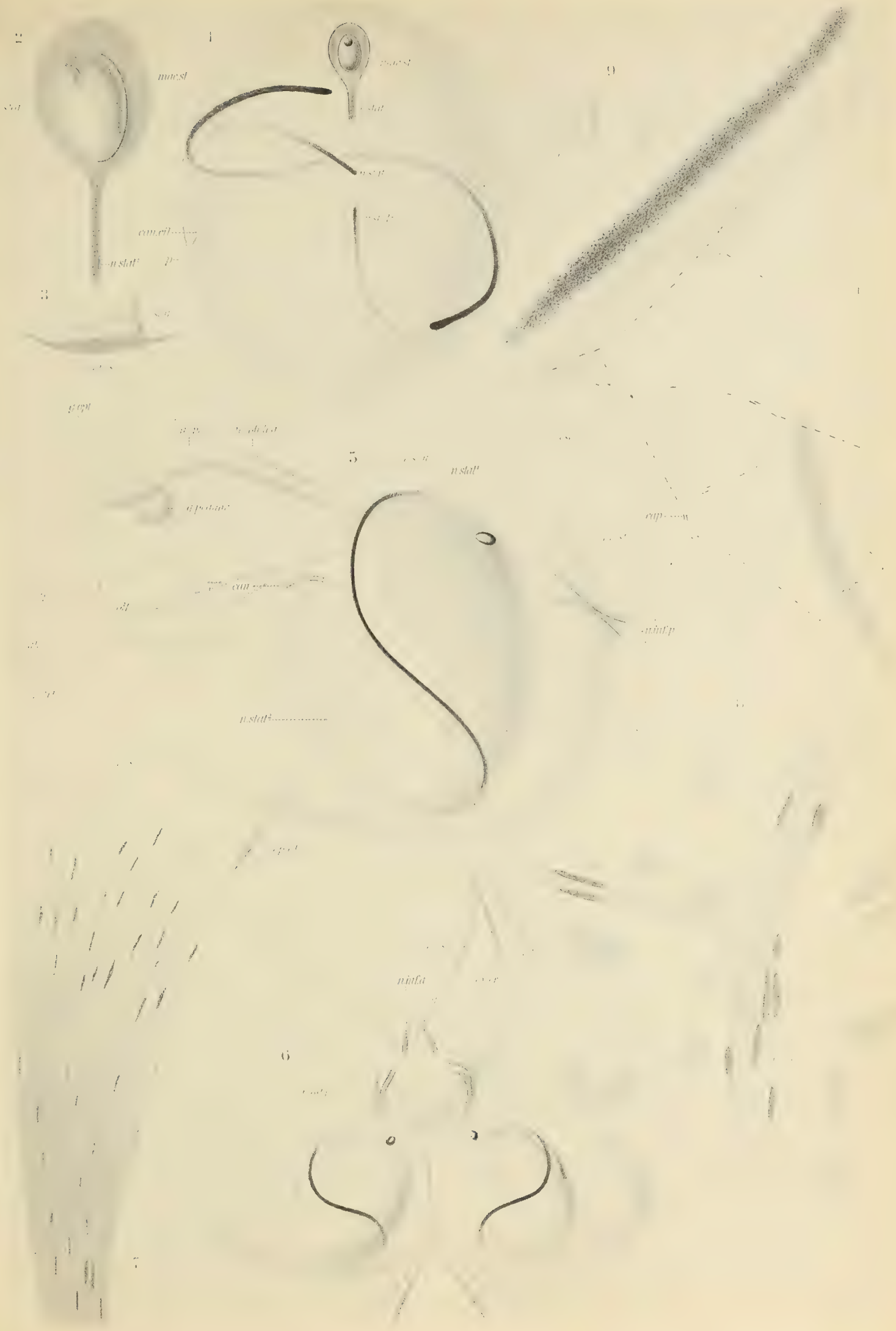
Bolitaena, Eledonella

Figures 1-8, Static Organs; Figure 9, Osphradium

- Figure 1. *Bolitaena*. Station 50. Static organ, dorsal view
Figure 2. *Eledonella*. Macula statica princeps with statoliths, seen from above
Figure 3. Same, lateral view.
Figure 4. *Bolitaena*. Station 50. Ciliated canal with adjacent parts: *a*—nonciliated distal part
Figure 5. *Eledonella*. Station 49. Right static organ with brain and cerebral nerves showing through, ventral view
Figure 6. *Bolitaena*. Station 50. Both static organs with their capsules, ventral view. Arms of vena cava and adjacent nerves indicated
Figure 7. *Bolitaena*. Terminal branching of 3rd static nerve
Figure 8. *Bolitaena*. Nuclei of the inner wall of static organ and capillaries
Figure 9. Osphradium (tuberculum olfactorium) of *Bolitaena*. Station 66. *a*—lateral view, *b*—seen from above

ABBREVIATIONS

- | | | |
|--|---|---|
| <i>can. cil</i> — ciliated canal | <i>n. inf. a</i> — nervus infundibuli anterior | <i>n. stat</i> ¹ —nervus staticus, branch to macula princeps |
| <i>a</i> — distal end of ciliated canal | <i>n. inf. p</i> — nervus infundibuli posterior | <i>n. stat</i> ² —nervus staticus, branch to distal part of crista |
| <i>cap</i> — capillary vessels | <i>n. olf</i> —nervus olfactorius, sensory branch | <i>n. stat</i> ³ —nervus staticus, branch to proximal part of crista |
| <i>caps</i> — capsules of static organs | <i>n. olf</i> ¹ , <i>n. olf</i> ² —nervus olfactorius, motor branches | <i>n. v. c</i> — nerve of vena cava |
| <i>c. v. br.</i> —arms of vena cava (circulus venous brachialis) | <i>n. ophth. a</i> —nervus ophthalmicus anterior | <i>n. visc</i> — nervus visceralis |
| <i>cr. st</i> — crista statica | <i>n. ophth. i</i> —nervus ophthalmicus inferior | <i>nu</i> — nuclei |
| <i>g. opt</i> — ganglion opticum | <i>n. opt</i> — nervus opticus | <i>p</i> — pore of ciliated canal |
| <i>g. ped</i> — ganglion pedunculi | <i>n. pall</i> — nervus pallialis | <i>stat</i> — statolith |
| <i>mac. st</i> —sensory pad (macula statica princeps) | | <i>v. inf</i> — funnel vein |
| <i>n. abd</i> — nervus abdominalis | | |



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Plate LXXXVII

Bolitaena

Figures 1–3, Intestinal Tract; Figures 4–9, Male Genitalia

- Figure 1. *Bolitaena diaphana*. Station 50. Intestinal tract, right side; pharynx and brain, dorsal view. $\times 5$
- Figure 2. Same, ventral view. $\times 5$
- Figure 3. Same, diagonally from the dorsal view, with layer of neighboring chromatophores. *a*—sickle-shaped muscular pad; *b*—connecting cord; *c*—lateral pad; *d*—terminal dome
- Figure 4–9. Male genitalia of *Bolitaena diaphana*. Stations 66 and 50
- Figure 4. Testis, gonoducts and adjacent organs in situ. Station 50. Younger specimen
- Figure 5. Gonoducts of older specimen from Station 66 (spread).
- Figure 6. Same, natural position, viewed from the outside (cf. Plate LXXXIV, Figure 4).
- Figure 7. Initial part of gonoducts viewed from the inside.
- Figure 8. Penis with diverticulum in optical longitudinal section. $\times 7$
- Figure 9. Aciniform gland of appendix.

ABBREVIATIONS

<i>amp</i> — ampulla	<i>gl. sal. a</i> — anterior salivary gland
<i>an</i> — anus	<i>gl. sal. p</i> — posterior salivary gland
<i>app</i> — appendix	<i>hep</i> — liver
<i>app. an</i> — anal appendages	<i>ingl</i> — crop
<i>atr</i> — ink sac	<i>int</i> — intestine
<i>b. sperm</i> — spermatophore sac	<i>n. pall</i> — pallial nerve
<i>branch</i> — gill	<i>oes</i> — esophagus
<i>c. alb</i> — white body	<i>pancr</i> — pancreas
<i>c. branch</i> — branchial heart	<i>pen</i> — penis
<i>caps</i> — capsule of testis	<i>ph</i> — pharynx
<i>cer</i> — cerebral ganglion	<i>prost</i> — prostate
<i>coll. p</i> — cervix of penis	<i>prost</i> ¹ — end of prostate
<i>coec</i> — evagination of appendix	<i>rect</i> — rectum
<i>d. hep. pancr</i> — ductus hepato-pancreaticus	<i>st</i> — stomach
<i>d. sal</i> — salivary duct	<i>st. coec</i> — caecum
<i>div. pen</i> — diverticulum of penis	<i>test</i> — testis
<i>g. gastr</i> — ganglion gastricum	<i>v. def</i> — vas deferens
<i>g. opt</i> — ganglion opticum	<i>v. eff</i> — vas efferens
<i>g. ped</i> — ganglion pedale	<i>ves. sem</i> ¹ } 1st, 2nd and 3rd part of
<i>gl</i> — gland	<i>ves. sem</i> ² } vesicula seminalis
<i>gl. ac</i> — aciniform gland	<i>ves. sem</i> ³ }

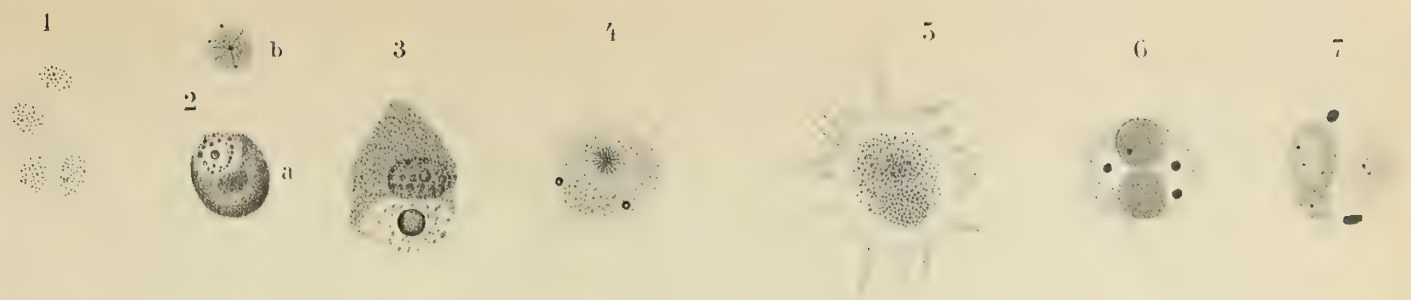
Plate LXXXVIII

Bolitaena. Development of Chromatophores

Preparations made from mantle of two young specimens fixed with chrome-osmium acid (Fleming's solution). The specimens are 25 mm (Station 190) and 24 mm (Station 232) long and have a mantle length of 16 and 14 mm, respectively. Dye: iron hematoxylin, Heidenhain method. One specimen (Station 190) illustrated on Plate LXXXVIII, Figure 1.

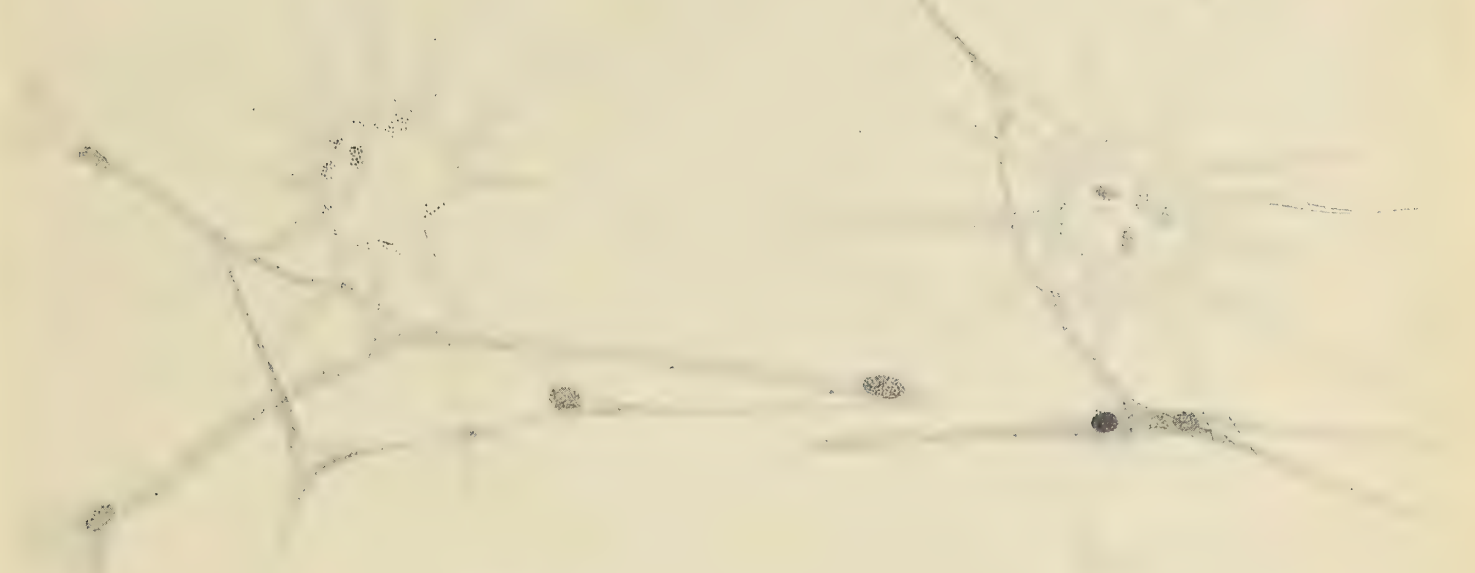
Drawings with Zeiss Apochromat homogeneous immersion 1/12 and oculars 0, 2, 4. Muscle processes stained blue, nerves brownish.

- Figure 1. Nest of connective tissue cells from the gelatinous substance.
- Figure 2a. Youngest stage of the chromatophore, with sphere.
- Figure 2b. Sphere with central granule and radial fibers.
- Figure 3. Cell with coarsely granulate nucleus and light-colored secretory vacuole that contains a spherical mass of secretion.
- Figure 4. Young mononuclear chromatophore with sphere and radial pseudopodium-like processes.
- Figure 5. Slightly older stage with light-colored ectoplasm that has radial processes.
- Figure 6. Binuclear cell with short processes.
- Figure 7. Binuclear cell with sphere and two secretory masses, without processes.
- Figure 8. Young binuclear chromatophore with radial muscular processes of which 3 are innervated.
- Figure 9. Young chromatophore with 4 nuclei, two of which are homogeneous, and the other two finely granulated. The ring-shaped arrangement of the contractile substance between the processes is distinct
- Figure 10. Young chromatophore with 5 nuclei, lateral view. The outward-facing hood-like dome is filled with flakes of secretion
- Figure 11. Chromatophore with 5 nuclei and its nervous network.
- Figure 12. Chromatophore with 8 deeply situated nuclei which are covered by the hood-shaped dome. Mononuclear youngest stage shown situated nearby
- Figure 13. Chromatophore with 16 nuclei which are still situated centrally.



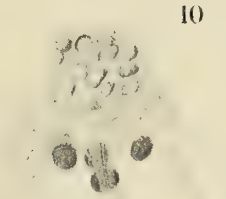
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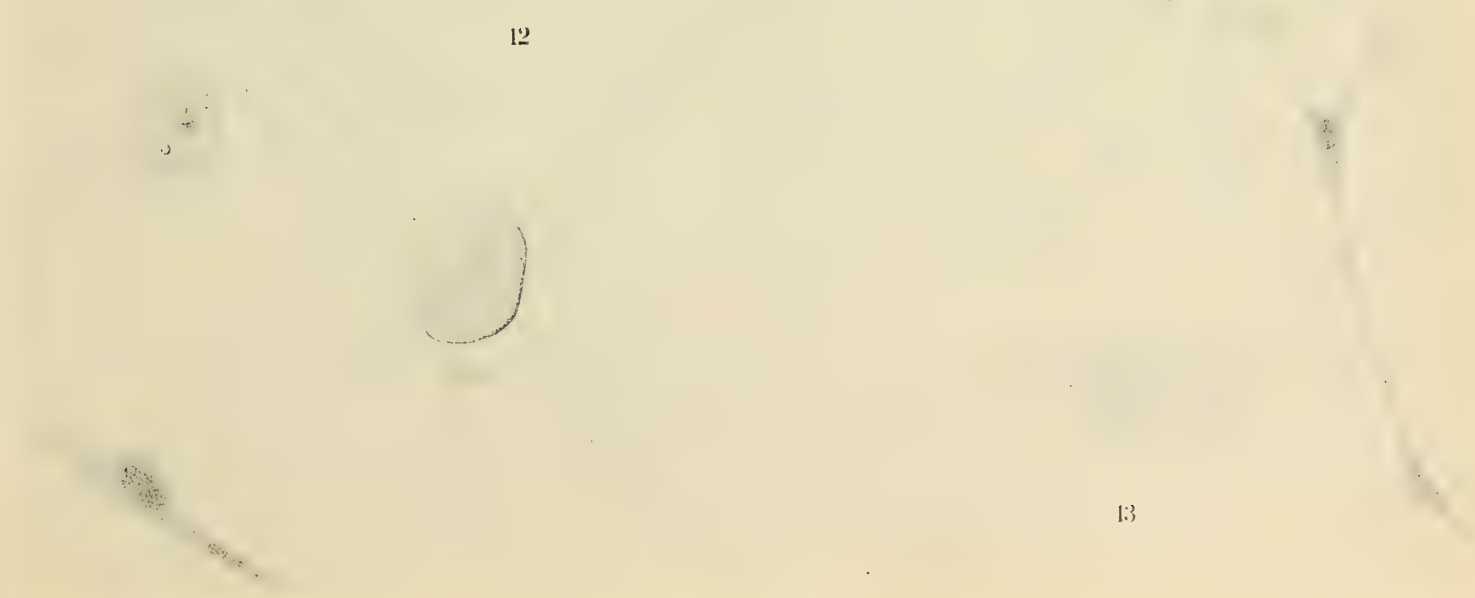


Plate LXXXIX

Bolitaena diaphana

Chromatophores, Musculature, Nervous Network, and Structure of Bristle Tufts

Preparations of mantle of two specimens (Stations 190 and 232) fixed with chrome-osmium acid. Musculature stained bluish, nervous network brownish. Dye: iron hematoxylin. Heidenhain method.

n — nerve *nu* — nucleus *v* — vessel

- Figure 1. Surface preparation showing the deeply situated branched musculature, the network of nerve endings and two contracted, developed chromatophores; also visible are two young stages of chromatophores. Network of nerve endings examined with homogeneous immersion 1/12. $\times 165$
- Figure 2. Branched musculature and contracted chromatophores from ventral margin of mantle. $\times 100$
- Figure 3. Expanded chromatophores with nervous network and branched musculature. Main nucleus of chromatophore, surrounded by a halo in center of large vacuole (situated on stem of longitudinal muscles). $\times 100$
- Figure 4 a, b, c. Base of the muscular processes of developed chromatophores.
- Figure 5. Young chromatophore with a central main nucleus surrounded by a honeycomb-like plasma and with peripheral nuclei displaced to the base of the muscular processes. Specimen from Station 65; fixation with sublimate and acid carmine. Homogeneous immersion 1/12
- Figure 6. Young chromatophore after staining with osmium (Station 190). The cap-shaped apex (Plate LXXXVIII, Figure 10) has become flattened and has filled with light-brown pigment granules. The main nucleus is stained black by osmium; the other nuclei have moved to the base of the muscular processes
- Figure 7. Division site of a nerve, with two granulate nerve nuclei and a homogeneous sheath nucleus.
- Figure 8. Division site of a nerve with two homogeneous nuclei and one granulate nerve nucleus.
- Figure 9. Ventral surface of specimen from Station 190, showing osmium-stained superficial longitudinal and transverse muscle fibers; chromatophores situated mainly along muscle fibers. The upper margin corresponds to the mantle margin at the level of the funnel. $\times 8$
- Figures 10–13. Development and structure of bristle tufts (specimen from Station 232). Hom. immersion 1/12
- Figure 10. Ectodermal cell plug with finely striated cone and basal cell situated below it.
- Figure 11. Developed tuft of bristles. Two smaller nuclei are seen persisting near the large basal nucleus
- Figure 12. Tuft of bristles seen from above, with basal nucleus and peripheral muscular processes.
- Figure 13. Chitinous cup with thin bristle tuft.

Plate XC

Vampyroteuthis infernalis n. gen., n. sp.

Specimen from Station 65 (Latitude of Cape Verde)

Vertical Net to 1,200 m

- Figure 1. Right side. $\times 3.5$
- Figure 2. Dorsal view. $\times 3.5$
- Figure 3. Arms with umbrella. $\times 4.5$



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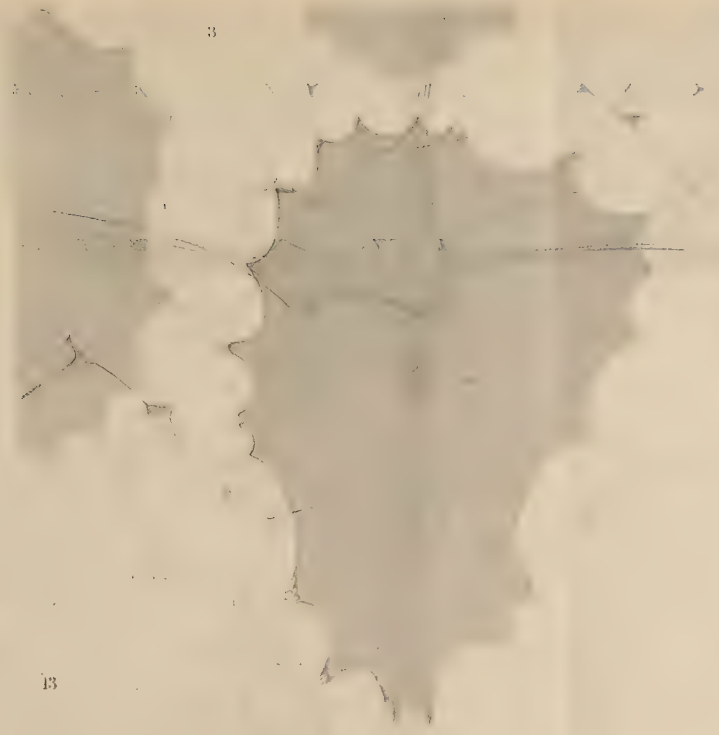
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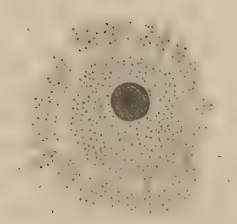
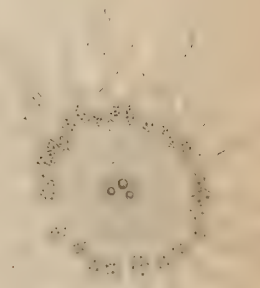


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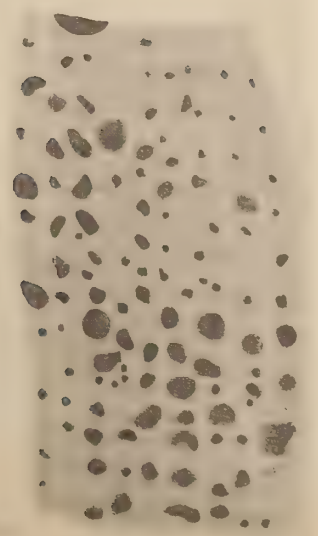
4'

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Plate XCI

Vampyroteuthis, Amphitretus

Figures 1–5. *Vampyroteuthis infernalis* n.g. and sp.

- Figure 1. Specimen from Station 65. Ventral view of mantle complex. $\times 3.5$. Notable are the blackish stained rectum, the renal papillae, the branchial hearts (*c. branch.*), and the gonad (*go.*) which is light-colored and shines through above the stomach
- Figure 2. Youngest specimen, ventral view, with spread umbrella.
- Figure 3. Young specimen from Station 85 (Benguela Current), left side. Muscular bands of mantle gaping open on dorsal side. $\times 3$
- Figure 4. Left eye of specimen from Station 65. Eye protruding from lid fold. $\times 4.5$

tub. olf. — olfactory tubercle *c. alb.* — white body

- Figure 5. Right eye of same specimen. Eye covered by lid fold. Brownish iris visible through pupil. $\times 4.5$

Figures 6–10. *Amphitretus pelagicus* HOYLE

- Figure 6. *Amphitretus pelagicus* HOYLE, left side. Station 102, Agulhas Current. Vertical net to 1,800 m. $\times 2$. Specimen is damaged: gelatinous skin and funnel chafed off
- Figure 7. Eyes, dorsal view. Color sketch from the live animal
- Figure 8. Right eye, lateral view.
- Figure 9. Median section through right eye (in direction of cross section of whole animal).

ABBREVIATIONS

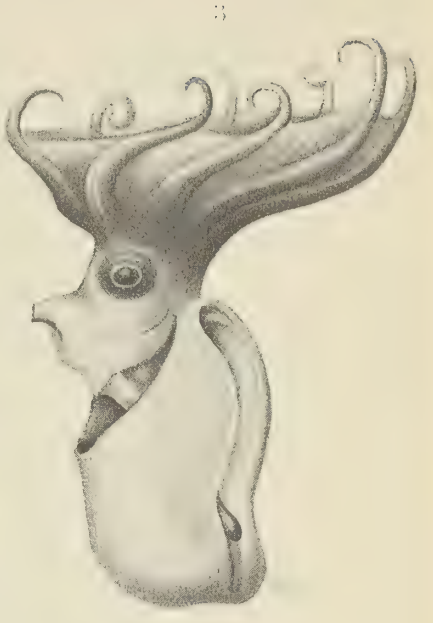
<i>c. alb.</i> — white body	<i>fov.</i> — pitlike depression of retina on outer side of eyeball
<i>cart.</i> — cartilaginous ring at root of iris and epithelial body	<i>g. opt.</i> — optic ganglion
<i>c. epith.</i> — epithelial (ciliary) body	<i>ir.</i> — iris
<i>ep. pg.</i> — pigmented epithelium	<i>ret.</i> — retina

- Figure 10. Retina of *Amphitretus*. Drawn after microphotograph

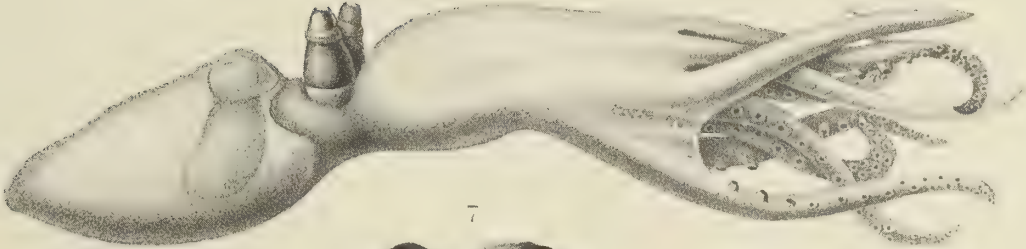
ABBREVIATIONS

<i>g. opt.</i> ¹ — peripheral ganglionic layer of optic ganglion	<i>m.</i> — membrane between cells of limitans and sensory cells
<i>g. opt.</i> ² — granulate layer	<i>m. h.</i> — limiting membrane toward vitreous body
<i>g. opt.</i> ³ — central ganglionic layer	<i>n. opt.</i> — fiber layer of optic nerve
<i>gr.</i> — granulate layer beneath sensory cells	<i>sens.</i> — pad of sensory cells
<i>lim.</i> — multiply layered cells of limitans	<i>st.</i> — rods

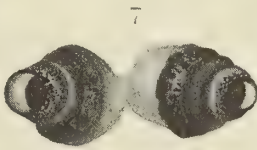
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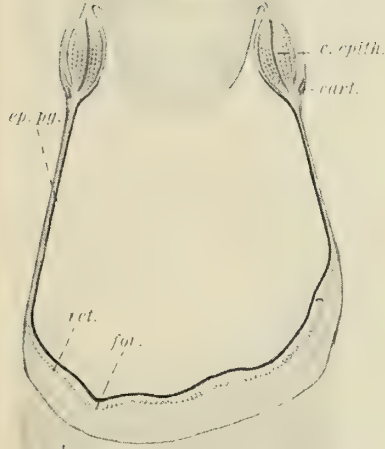


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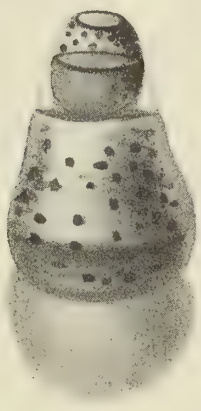
m. h.

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c. alb.

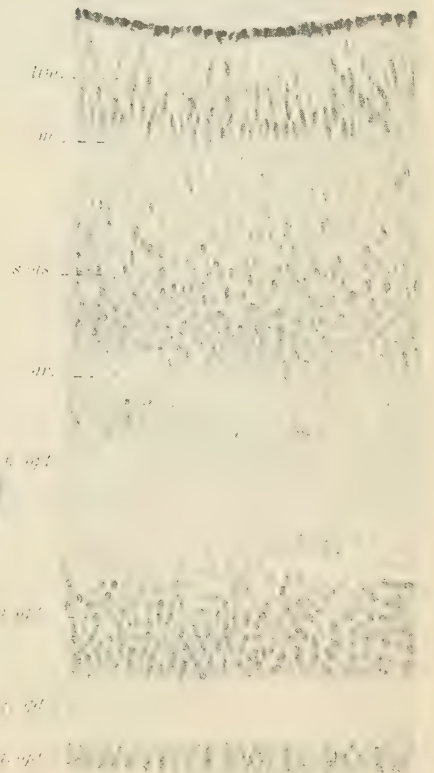
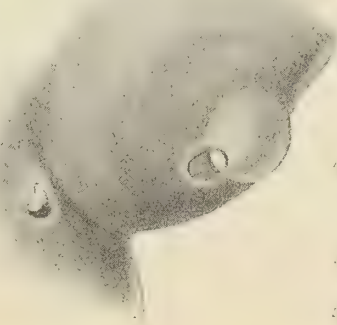


Plate XCII

Cirrothauma murrayi CHUN

Ventral view. Station 82 of the *Michael Sars* Expedition



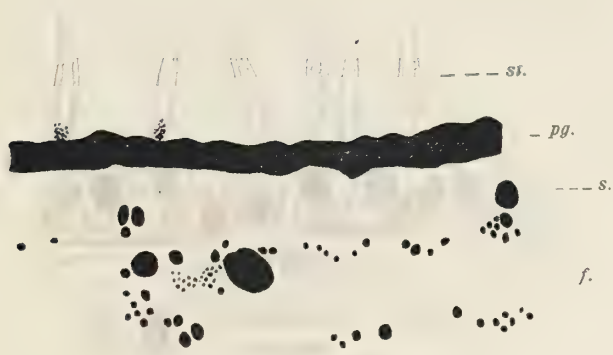
Plate XCIII

Cirrothauma murrayi CHUN

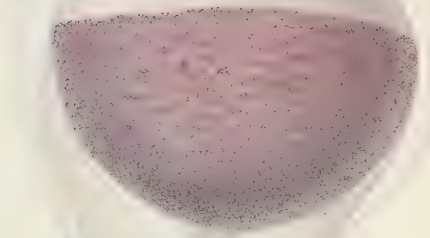
- Figure 1. View from mouth. Basal parts of the 8 arms visible
Figure 2. Rudimentary eye.
Figure 3. Retina.

ABBREVIATIONS

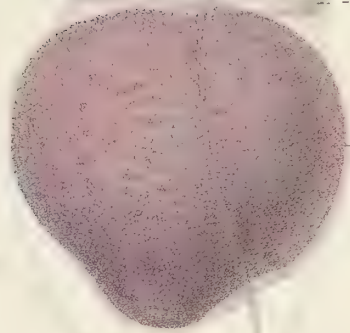
a.—outer space surrounding eyeball
alb.—white body
f.—fiber layer
ophth. i. — nervus ophthalmicus inferior
ophth. s. — nervus ophthalmicus superior
opt. — nervus opticus
pg. — pigment of retina
s. — sensory cells
sin. v. — sinus venosus
st. — rods
v. ophth. — vena ophthalmica



a.-



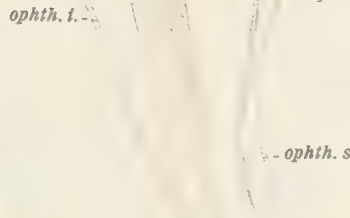
alb.



sin. r.

ophth. l.

opt.



ophth. s.

v. ophth.

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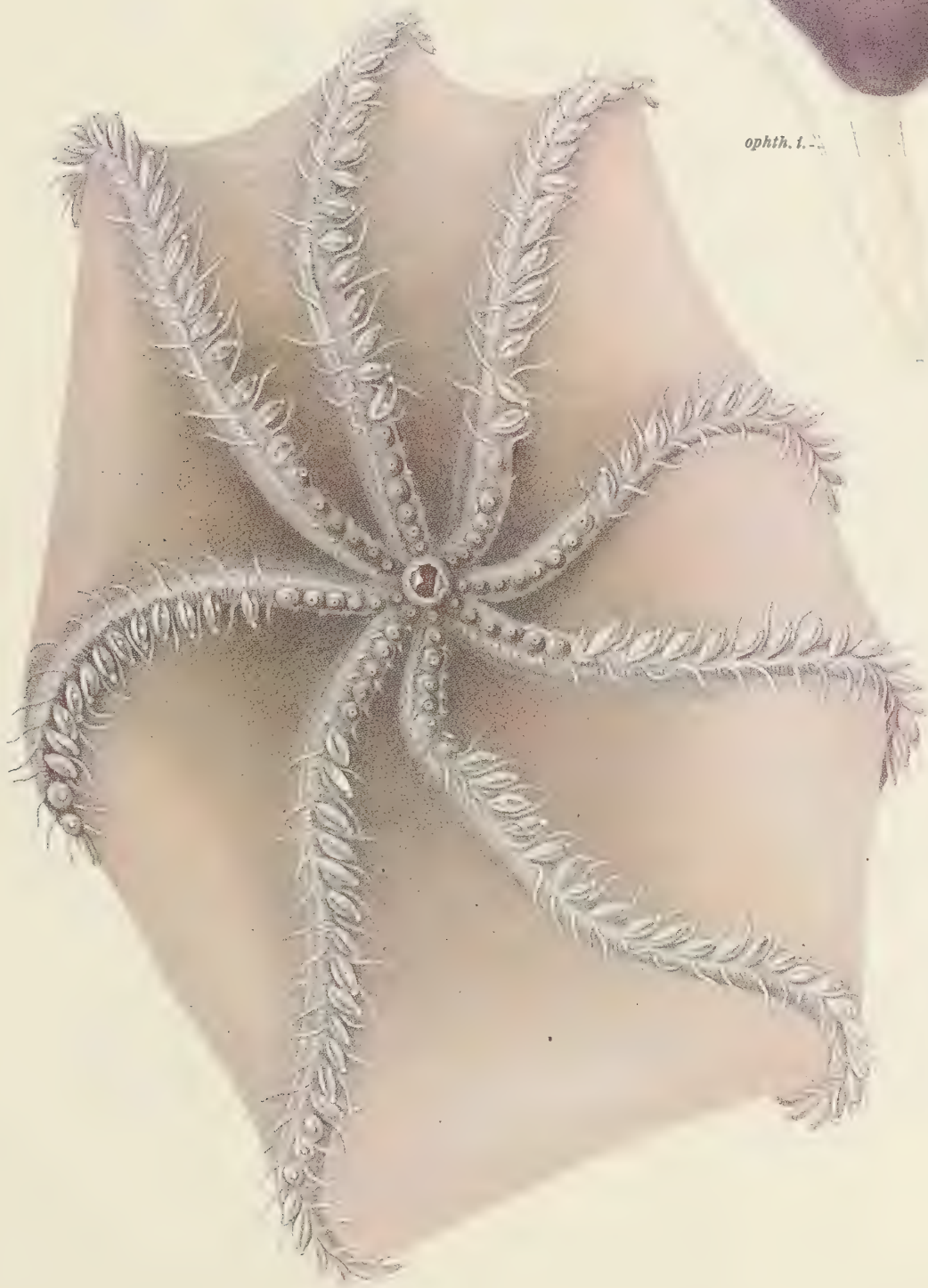


Plate XCIV

Opisthoteuthis VERRILL

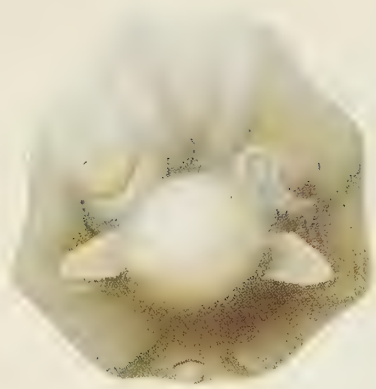
Figures 1 and 2. *Opisthoteuthis medusoides* n.sp., Station 243, near Dar es Salaam

Figure 1. Posterior view.

Figure 2. Lateral view.

Figure 3. *Opisthoteuthis extensa* n.sp., Station 189, Mentawai Basin. Posterior view

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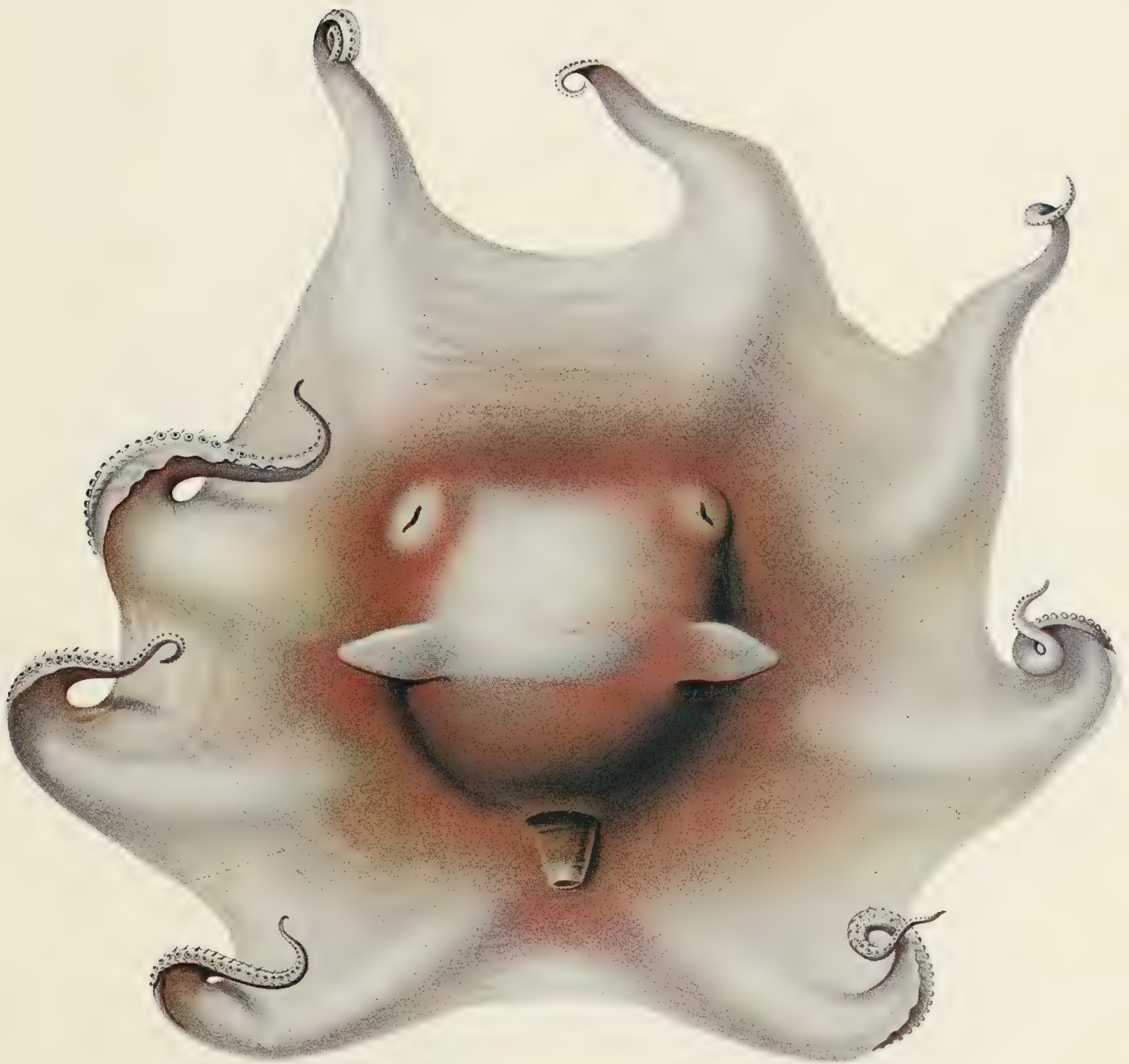


Plate XCV

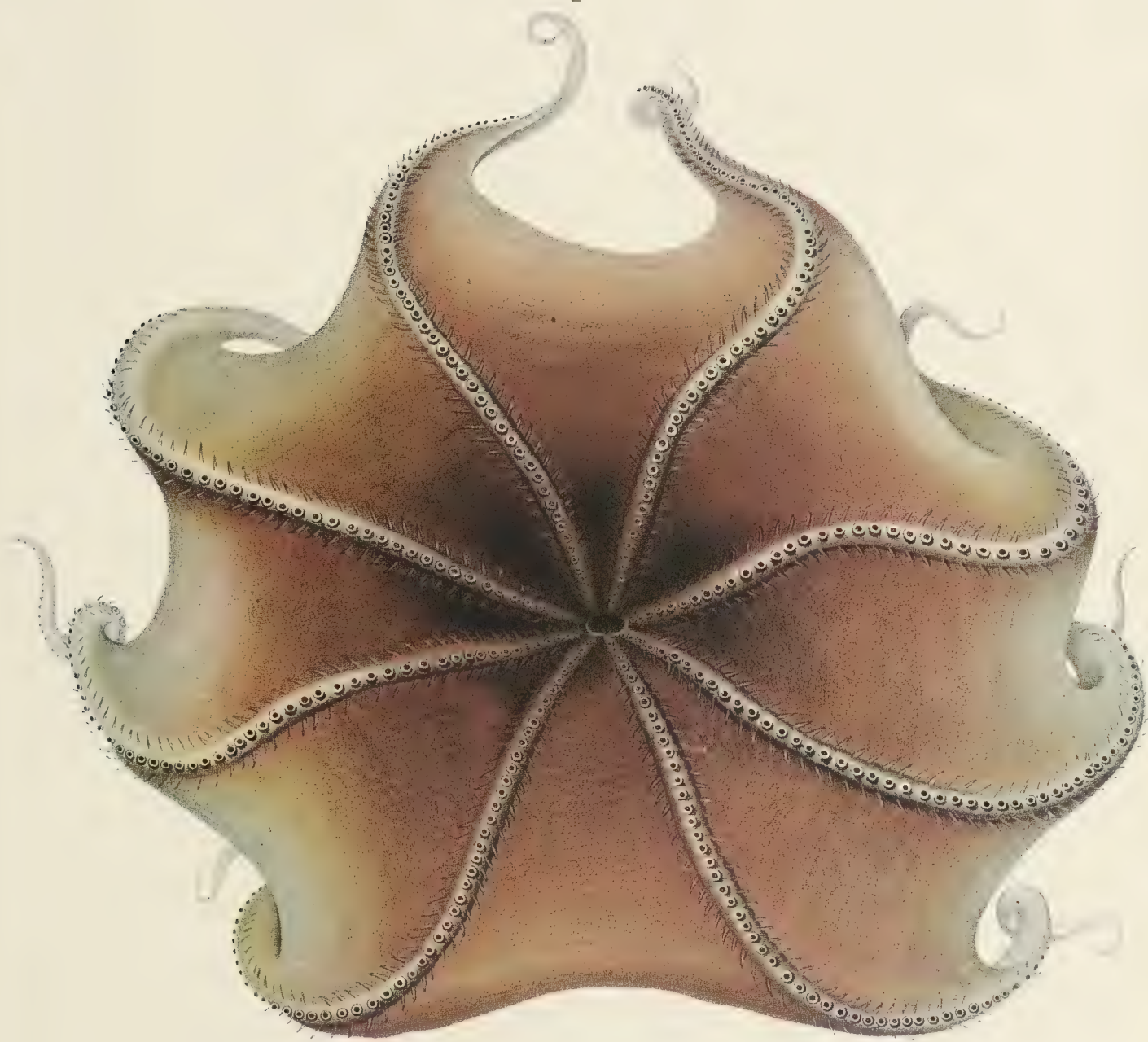
Opisthoteuthis VERRILL

- Figure 1. *Opisthoteuthis medusoides* n.sp. Anterior view
Figure 2. *Opisthoteuthis extensa* n.sp. Anterior view

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