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## The Ceratioid Anglerfishes of Australia

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**ABSTRACT.** Ceratioid anglerfishes recently collected from Australian waters and primarily housed at the Australian Museum, Sydney, represent eight of the 11 recognized families of the suborder, including 12 genera and 15 species, one of which is here described as new. These are listed below together with all additional records of ceratioids from Australian waters. Revised and supplemental diagnostic and descriptive data as well as notes on geographic distribution are included. Pending the chance of subsequent discovery of any as yet unrecorded ceratioids from Australian waters, diagnoses of all families of the Ceratioidei and references to all recent family revisions are provided.

BERTELSEN, E., & T.W. PIETSCH, 1983. The ceratioid anglerfishes of Australia. Records of the Australian Museum 35(2): 77-99.

Mid-water trawling off eastern Australia in the last ten years has amassed a collection of ceratioid anglerfishes housed at the Australian Museum in Sydney that represents eight of the 11 recognized families of the suborder, 12 genera and 15 species, one of which is here described as new. These are listed below together with all additional records of ceratioids from Australian waters. Keys, revised and supplemental diagnostic and descriptive data as well as notes on geographic distribution are also provided. Since most of the approximately 130 recognized species of the Ceratioidei appear to be very widely distributed, diagnoses and key to all families of the Ceratioidei are provided on the plausible chance that representatives will turn up in Australian waters.

### Methods and Materials

Australian waters are defined as that area lying within 200 miles of the Australian continent.

Standard lengths (SL) are used throughout. Terms are defined as follows: *illicium*: the first dorsal spine that bears a terminal bait; *esca*: the fleshy bait at the tip of the first dorsal spine; *denticular*: small, tooth-bearing ossification present in the skin of the snout above the symphysis of the premaxillae and at the tip of the lower jaw of male ceratioids (Bertelsen, 1951); *caruncle*: fleshy, club-shaped light-organ situated on the dorsal mid-line just anterior to the soft dorsal fin of females of the Ceratiidae. Methods for taking counts and measurements, and terminology used in describing esca morphology, follow Pietsch (1974, fig. 60).

Only material in the collections of the Australian Museum, Sydney (AMS) and the Western Australian Museum, Perth (WAM), is listed. All specimens were collected by the Fisheries Research Vessel "Kapala" with an Engel Midwater Trawl, unless otherwise indicated. Material from other sources referred to in the descriptions is catalogued in the following institutions:

BMNH: British Museum (Natural History), London

IOAN: Institution of Oceanology, Academy of Sciences of the USSR, Moscow

ISH: Institut für Seefischerei, Hamburg

LACM: Natural History Museum of Los Angeles County

USNM: National Museum of Natural History, Washington DC

ZMB: Zoologisches Museum der Humboldt-Universität zu Berlin

ZMUC: Zoological Museum, University of Copenhagen

All material is female unless otherwise indicated.

### Suborder CERATIOIDEI

**Diagnosis.** Most distinctly differing from other suborders of Lophiiformes in being bathy- and mesopelagic, lacking pelvic fins (except in larval and newly metamorphosed *Caulophryne*) and having extreme sexual dimorphism. Most females have a single external cephalic fin-ray, illicium with esca photophore (illicium absent in *Neoceratias* and esca bulb and photophore lacking in *Caulophrynidae* and *Rhynchactis*; an external second cephalic ray present in juvenile *Diceratiidae* and *Ceratiidae*). Males are

dwarfed, much smaller than the adult females; they lack esca and external illicium, have enlarged eyes and/or olfactory organs, and have pincer-like jaws with hooked denticular teeth, assumed to be used for attachment to

the females; in some families and genera this attachment becomes parasitic through fusion of male and female tissue.

#### Key to the Families of the Ceratioidei

1. Illicium absent ..... 2
- Illicium present; females ..... 3
2. Long hooked teeth on outer sides of jaws ..... females of Neoceratiidae, p.93
- No teeth on outer sides of jaws (males of all families) ..... 14
3. No bulbous light organ on tip of illicium ..... 4
- A bulbous light organ on tip of illicium ..... 5
4. Longest rays of dorsal and anal fin greater than 60% of SL; body short ..... Caulophrynidae, p.79
- Longest rays of dorsal and anal fin much less than 60% SL; body elongate ..... *Rhynchactis* of Gigantactinidae
5. More than 11 dorsal rays ..... Melanocetidae, p.80
- Fewer than 11 dorsal rays ..... 6
6. Two or three caruncles on dorsal midline; cleft of mouth vertical to strongly oblique ..... Ceratiidae, p.89
- No caruncles on dorsal midline; cleft of mouth nearly horizontal ..... 7
7. A second cephalic ray present immediately posterior to base of illicium, bearing a distal luminous gland (withdrawn beneath skin in larger specimens, its presence indicated by small pore) ..... Diceratiidae, p.83
- A second cephalic ray absent ..... 8
8. Upper jaw extending anteriorly far beyond lower jaw; esca with 1-3 denticles ..... Thaumatoichthyidae, p.89
- Jaws equal anteriorly; esca without denticles ..... 9
9. Illicium emerging on tip of snout, length of head less than 35% of SL, length of caudal peduncle more than 20% of SL; 5 pectoral radials ..... *Gigantactis* of Gigantactinidae, p.91
- Illicium emerging behind tip of snout; length of head more than 35% of SL; caudal peduncle less than 20% of SL; 3-4 pectoral radials ..... 10
10. Dermal spines or plates present ..... 11
- Skin naked (although microscopic spinules may be present, skin appears naked and smooth) ..... 12
11. Skin with some large, bony plates, each bearing a median spine ..... specimens larger than 30-40 mm of Himantolophidae, p.82
- Skin with numerous, close-set spines ..... Centrophrynidae, p.89
12. Four to five branchiostegal rays; D.3 (very rarely 2 or 4); A.3 (rarely 2 or 4) ..... Linophrynidae, p.94
- Six branchiostegal rays; D. more than 4; A. 4-7 ..... 13

- 13. Snout and chin more or less pointed ..... Oneirodidae, p.83
- Snout and chin very blunt ..... specimens of less than 30–40 mm of Himantolophidae, p.82
- 14. Upper denticular teeth absent; A. more than 9 ..... 15
- Upper denticular teeth present; A. less than 9 ..... 16
- 15. Lower denticular with approximately 9 teeth; young specimens with ventral fins; D. 14–22; A. 13–19 ..... Caulophrynidae<sup>1</sup>, p.79
- Lower denticular trifurcated, each branch with a double hook; D.11–13; A.10–13 ..... Neoceratiidae, p.93
- 16. Olfactory organs small; eyes large, bowl-shaped; D.3–5; A.3–5 ..... Ceratiidae, p.89
- Olfactory organs large; eyes not bowl-shaped ..... 17
- 17. More than 11 dorsal rays ..... Melanocetidae, p.80
- Fewer than 11 dorsal rays ..... 18
- 18. Fewer than 5 dorsal rays ..... 19
- 5–8 dorsal rays ..... 20
- 19. Eyes large, slightly tubular, directed more or less anteriorly; D.3, rarely 2 or 4; A.3, rarely 2 or 4 ..... Linophrynidae, p.94
- Eyes spherical, directed laterally; D.4; A.4, rarely 3 ..... *Rhynchactis* of Gigantactinidae
- 20. Eyes small, diameter 5% of SL or less ..... 21
- Eyes large, diameter greater than 5% SL ..... 22
- 21. A small digitiform hyoid barbel, 6 branchiostegal rays ..... Centrophrynidae, p.89
- No hyoid barbel; 5 branchiostegal rays ..... Gigantactinidae, p.89
- 22. Skin completely covered with well developed spines; anterior nostrils opening laterally ..... 23
- Skin spines absent or small and scattered; anterior nostrils opening forward near end of snout ..... 24
- 23. Several (more than 10) upper denticular teeth, all fused at base ..... Himantolophidae, p.82
- Two separate upper denticular teeth ..... Diceratiidae, p.83
- 24. Small, but distinct spines scattered in skin of body ..... Thaumatchthyidae<sup>2</sup>, p.89
- Skin spines absent or microscopic in size ..... Oneirodidae<sup>3</sup>, p.83

**Notes:** <sup>1</sup>Males of the caulophrynid genus *Robia*, which has D.6, A.5, are unknown.  
<sup>2</sup>Males of the thaumatchthyid genus *Lasiognathus*, in which the females have naked skin, are unknown.  
<sup>3</sup>Males of 8 of the 15 recognized oneirodid genera are unknown, including *Spiniphryne* in which the females have spiny skin.

**Family CAULOPHRYNIDAE**

**Diagnosis.** Females are distinguished from those of other ceratioid families by having extremely elongate dorsal and anal rays; eight caudal rays; neuromasts of the acoustico-lateralis system located at the tips of

extremely elongate filaments; two pectoral radials; escal bulb absent.

Males become parasitic; free-living stages are distinguished from those of other ceratioid families by the absence of an upper denticular; lower denticular unbranched bearing approximately nine teeth; ventral

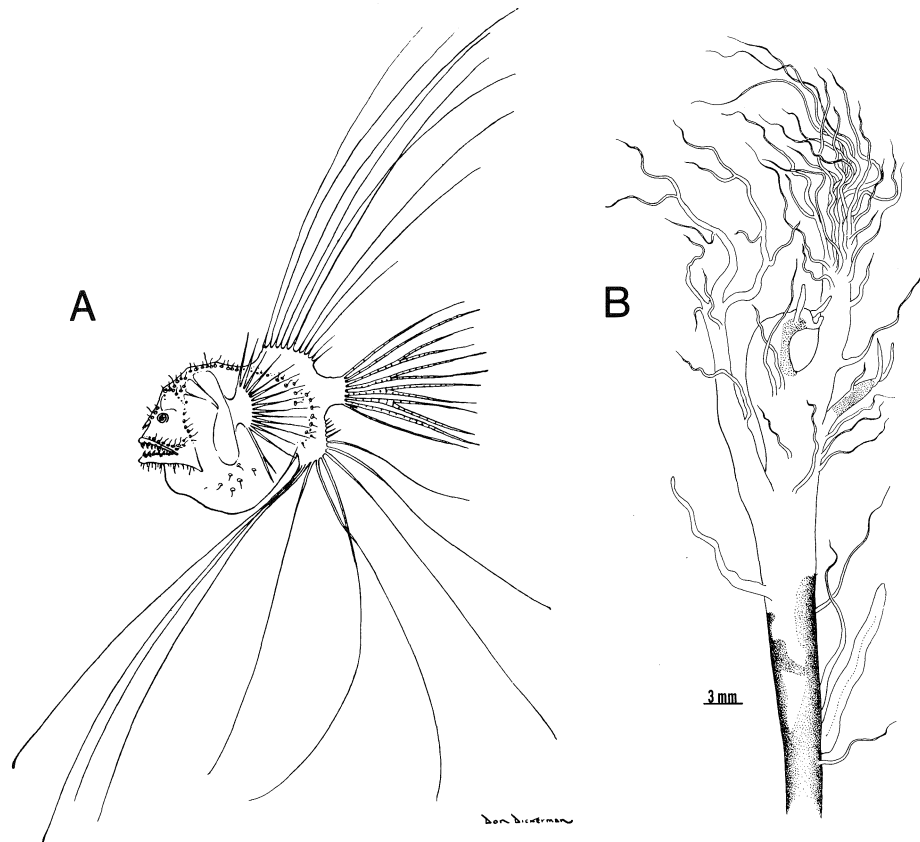


Fig. 1. *Caulophryne jordani* Goode and Bean, 1896. A, after Beebe and Rose (1926). B, esca in left lateral view, LACM 33924-1, 54 mm SL; after Pietsch (1979).

fins present in younger stages.

Two genera, one recorded from eastern Australian waters.

*Caulophryne* Goode and Bean, 1896

For synonymy see Pietsch, 1979.

**Diagnosis.** Males and females are distinguished from those of *Robia* (the only other genus of the family) in having D. 14-22 and A. 12-19. Females are further distinguished in having a considerably shorter illicium (less than 50% SL).

Three species, one recorded from eastern Australian waters.

*Caulophryne jordani* Goode and Bean, 1896

Fig. 1

*Caulophryne jordani* Goode and Bean, 1896:26, 496, 541, fig. 409 (original description, single specimen off Long Island, New York, holotype USNM 39265).—Pietsch, 1979:12, 15-16, figs 1-13, 16, 18, 19, 24 (family review based on all known material).

For complete synonymy see Pietsch, 1979.

**Material.** A single female: AMS 1.20314-017, 64.5 mm SL, east of Broken Bay, N.S.W., 33° 28'S, 152°33'E, 0-900 m over 2400 m, 14 December 1977.

*Caulophryne jordani* was previously known from eleven specimens collected from widely separated stations in all three major oceans (Pietsch, 1979, fig. 24). Although represented by a single specimen from the Pacific Sector of the Southern Ocean (at approximately 39°58'S, 160° 34'E, the individual recorded here is the first record of a metamorphosed caulophrynid from Australian waters. However, a single larval specimen (ZMUC P92202) tentatively referred to *C. jordani* was recorded from this area (33° 33'S, 154° 04'E) by Bertelsen (1951:34).

Two additional caulophrynids are known from the Indo-Australian Archipelago: *Robia legula*, represented only by the holotype (LACM 36024-1) collected in the Banda Sea, and *Caulophryne pelagica*, a single specimen (LACM 36023-1) from the Halmahera Sea.

**Family MELANOCETIDAE**

**Diagnosis.** Males and females are distinguished from those of other ceratioid families by having D. 12-17 and A.4 (rarely 3 or 5). Females are further distinguished by the absence of sphenotic spines and skin spines (although spines are present microscopically, the skin appears naked and smooth).

Males are non-parasitic with skin spinulose or naked; upper denticular teeth with 2–3 semicircular series of strong, recurved denticles, fused with a median series of 3–9 enlarged dermal spines that articulate with the pterygiophore of the illicium; lower denticular with 10–23 recurved denticles, fused into a median and two lateral groups; eyes and nostrils lateral; nasal area unpigmented, inflated.

A single genus.

*Melanocetus* Günther, 1864

For synonymy see Pietsch and Van Duzer, 1980. With the characters of the family. Five species, two recorded from Australian waters.

**Key to Females of Species of *Melanocetus* Recorded from Australian Waters**

- 1. Anterior margin of vomer nearly straight; esca bulb with compressed posterior and (usually) anterior crests; width of esca bulb 3.8–8.6% of SL ..... *Melanocetus johnsoni* Günther, 1864
- Anterior margin of vomer deeply concave; esca bulb without posterior and anterior crests; width of esca bulb 1.9–5.1% of SL ..... *Melanocetus murrayi* Günther, 1887

**Key to Males of Species of *Melanocetus* Recorded from Australian Waters**

- 1. A median series of 11 or more denticular teeth on snout; 12–24 denticular teeth on lower jaw; D. 13–15; P. 17–21 ..... *Melanocetus johnsoni* Günther, 1864
- A median series of 3–5 denticular teeth on snout; 10–13 denticular teeth on lower jaw; D. 12–14; P. 15–18 ..... *Melanocetus murrayi* Günther, 1887

*Melanocetus johnsoni* Günther, 1864

Fig. 2

*Melanocetus johnsoni* Günther, 1864: 301–303, pl. 25 (original description, single specimen from Madeira, holotype BMNH 1864.7.18.6.—Pietsch and Van Duzer, 1980:59–87 (family review based on all known material).

For complete synonymy see Pietsch and Van Duzer, 1980.

**Material.** Sixty-six females, 4–88 mm SL: AMS I.16162–019, 6 (12–26 mm SL), E of Sydney, N.S.W., 34°05'S, 151°55'E, 0–950 m over 1920–2830 m, 25 March 1971. AMS I.19562–041, 4 (4–9 mm SL), E of Port Hacking, N.S.W. 34°09'S, 152°07'E, 0–550 m over 1890 m, 23 March 1971. AMS I.19601–036, 25 (5–11 mm SL), E of Sydney, N.S.W., 34°10'S, 151°59'E, 0–75 m over 1810–2470 m, 24 March 1971. AMS I.19608–026, 4 (4–8 mm SL), off Sydney, N.S.W., 34°05'S, 151°56'E, 0–800 m over 2410–2920 m, 23 March 1971. AMS I.20064–029, 21.5 mm SL, off Sydney, N.S.W., 34°10'S, 152°04'E, 0–660 m over 2500 m, 26 October 1977. AMS I.20066–002, 5 (11–22.5 mm SL), E of

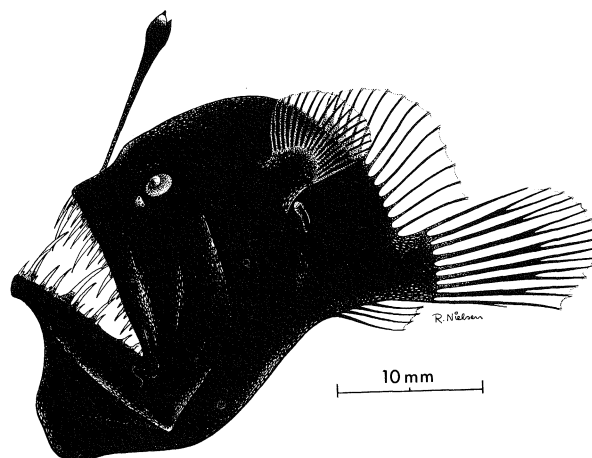


Fig. 2. *Melanocetus johnsoni* Günther, 1864, 25 mm SL, ZMUC P92373. Drawn by R. Nielsen.

Brush Island, N.S.W., 35°36'S, 150°55'E, 0–650 m over 2000 m, 27 October 1977. AMS I.20070–008, 32 mm SL, NE of Cape Howe, N.S.W., 37°24'S, 150°30'E, 0–540 m over 3600 m, 1 November 1977. AMS I.20306–006, 38 mm SL, E of Broken Bay, N.S.W., 33°31'S, 152°20'E, 0–900 m over 1800–2900 m, 12 December 1977. AMS I.20307–012, 2 (17–29 mm SL), E of Broken Bay, N.S.W., 33°28'S, 152°25'E, 0–900 m over 1830–2800 m, 13 December 1977. AMS I.20313–004, 2 (17–26.5 mm SL), E of Tuggerah Lakes, N.S.W., 33°20'S, 152°32'E, 0–450 m over 2400 m, 14 December 1977. AMS I.20314–012, 13 (14–52 mm SL), E of Broken Bay, N.S.W. 33°28'S, 152°33'E, 0–900 m over 4200 m, 14 December 1977. AMS I.20315–008, 12.5 mm SL, E of Sydney, N.S.W., 33°53'S, 152°02'E, 0–900 m over 1800 m, 14 December 1977. AMS I.20410–006, 88 mm SL, E of Wollongong, N.S.W., 34°27'S, 151°38'E, 0–600 m over 2000–2200 m, 23 May 1978.

Sixty-six specimens of *Melanocetus johnsoni* have been collected over the past ten years off the east coast of Australia. The only previous record from this area was a single larval specimen (ZMUC P92307) listed by Bertelsen (1951:263). This species has a wide geographic distribution in tropical and subtropical waters of all three major oceans of the world (Pietsch and Van Duzer, 1980).

*Melanocetus murrayi* Günther, 1887

Fig. 3

*Melanocetus murrayi* Günther, 1887:57, pl. 11, fig. A (original description, single specimen from central Atlantic, lectotype BMNH 1887.12.7.17).—Pietsch and Van Duzer, 1980: 59–87 (family review based on all known material). For complete synonymy see Pietsch and Van Duzer, 1980.

Although several records are known from Indonesian waters (Pietsch and Van Duzer, 1980, fig. 30), *Melanocetus murrayi* is represented in Australian waters by a single metamorphosed female (BMNH 1932.5.3.1) collected at approximately 33°33'S, 154°04'E (Regan and Trewavas, 1932:50), and a larval specimen (ZMUC P92438) recorded by Bertelsen (1951:263).

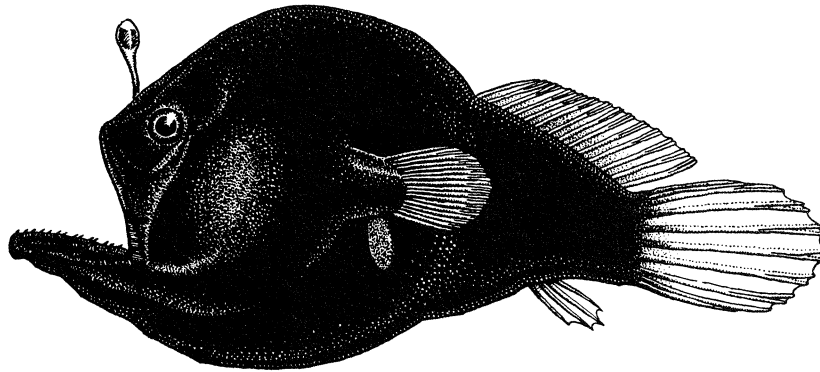


Fig. 3. *Melanocetus murrayi* Günther, 1887, 15 mm SL, BOC 2032. After Parr (1927).

### Family HIMANTOLOPHIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families by having large, bony plates embedded in the skin, each bearing a median spine; snout and anterior surface of lower jaw with low, rounded, dermal papillae (spines and papillae absent in juveniles less than approximately 30 mm SL); lower jaw very robust, projecting slightly beyond upper; esca bulb large bearing stout, tentacular appendages.

Males are non-parasitic with skin spinulose; upper and lower denticular teeth in 2–3 transverse series fused at the base; eyes and nostrils lateral; nasal area pigmented, not inflated.

A single genus.

#### *Himantolophus* Reinhardt, 1837

A complete family review is in preparation by Bertelsen and Krefft.

With the characters of the family.

Fifteen species recognized, one recorded from Australian waters in addition to several unidentifiable specimens.

#### *Himantolophus appellii* (Clarke, 1878)

Fig. 4

*Aegoeonichthys appellii* Clarke, 1878:145, pl.6 (original description, single specimen from off New Zealand, holotype not preserved).—Waite, 1912:194–197, pl.10 (description of an additional specimen from off New Zealand).

*Himantolophus appellii*.—Regan, 1926: 41–42 (*Aegoeonichthys*, a synonym of *Himantolophus* Reinhardt); Bertelsen, 1952: 60, 66 (family review based on all known material).

**Diagnosis.** Females are distinguished from those of other members of the genus in having transparent swellings of the distal part of esca bulb surrounding a pair of darkly pigmented appendages; a second pair of tentacular appendages situated posterior to swellings, approximately twice as long as the first pair, and divided into three or more branches; in specimens greater than

approximately 30 mm SL, two to five shorter, bifurcated or unbranched tentacular appendages behind and below posterior distal pair (Fig. 4A).

**Material.** 17 females, 20–270 mm SL: AMS I.16162–018, 39 mm SL, E of Sydney, N.S.W., 34°05'S, 151°55'E, 0–950 m over 1920–2830 m, 25 March 1971. AMS I.17868–005, 32 mm SL, E of Sydney, N.S.W., 33°40'S, 151°56'E, otter trawl, 0–425 m, 6 December 1972. AMS I.20071–003, 24 mm SL, E of Kiama, N.S.W., 34°40'S, 151°15'E, 0–548 m over 3290 m, 3 November 1977. AMS I.20314–013, 38 mm SL, E of Broken Bay, N.S.W., 33°28'S, 152°33'E, 0–900 m over 4200 m, 14 December 1977. AMS I.20410–007, 4, 20–62 mm SL, off Wollongong, N.S.W., 0–600 m over 2000–2200 m, 23 May 1978. AMS I.21365–009, 28 mm SL, off Newcastle, N.S.W., 33°09'S, 153°05'E, 0–750 m over 1500 m, 28 November 1979. AMS I.21411–001, 24.5 mm SL, E of Port Kembla, N.S.W., 34°33'–34'S, 153°42'E, 26 September 1979. AMS I.22648–001, c. 165 mm, off Albany, W.A., 28 November 1974. AMS I.22649–001, off Albany, W.A., 3 April 1974. WAM P 15746, 163 mm SL, off Albany, W.A., June 1964. WAM P 15747, 270 mm SL, 35°16'S, 118°40'E, 1 November 1966. WAM P 15748, 167 mm SL, 35°21'S, 118°30'E, 13 October 1965. WAM P 15749, 190 mm SL, 35°10'S, 118°36'E, 29 August 1964. WAM P 15750, 174 mm, 35°24'S, 118°30'E, 22 September 1964. (All WAM specimens from stomachs of sperm whales.)

*Tentatively referred specimens.* One female, two males and two larval females: AMS I. 16494–043, 14 mm SL larval female, E of Sydney, N.S.W., 34°02'S, 152°12'E, 0–600 m over 2395–2830 m, 25 March 1971. AMS I.17887–005, 15 mm SL larval female, E of Port Hacking, N.S.W., 34°13'S, 150°22'E, 0–146 m over 165 m, 6 May 1974. AMS I.20305–003, 51 mm SL female, E of Broken Bay, N.S.W., 33°33'S, 152°18'E, 0–170 m over 2000 m, 12 December 1977. AMS I.20307–013, 2 males (23.5–27 mm SL), 70 km E of Broken Bay, N.S.W., 33°28'S, 152°25'E, 0–900 m over 1830–2800 m, 13 December 1977.

Besides the 17 specimens listed above only a single specimen caught off Tasmania (IOAN 40510, 225 mm SL) is known from Australian waters. The holotype and four additional specimens are recorded from off New Zealand and six additional specimens have been caught in the Atlantic and Indian Oceans. All the records are within a narrow zone between 32°S and 43°S from the

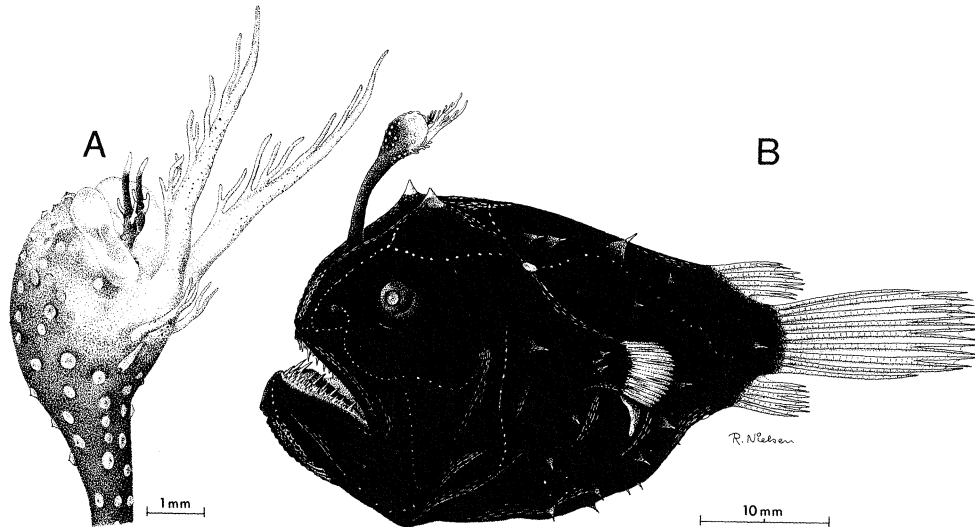


Fig. 4. *Himantolophus appellii* (Clarke, 1878) A, esca in left lateral view, 39 mm SL, AMS I.16162-018. B, 38 mm SL, AMS I.20314-013. Drawn by R. Nielsen.

east coast of South America to New Zealand. As no other species of *Himantolophus* has been reported from similar southern latitudes, the eight larvae (3-6 mm total length, ZMUC P92661-92663) previously recorded from this area by Bertelsen (1951:263), as well as the 5 tentatively referred specimens listed above, most probably represent this species. Among the latter the 51 mm SL female has lost the esca, but in all other characters it is quite similar to the material of *H. appellii* described above.

The two metamorphosed males (23.5-27 mm SL) have 15-18 upper and lower denticular teeth in 2-3 irregular series; 10-12 olfactory lamellae; posterior nostril nearly as large as, and well separated from, eye. To what extent *Himantolophus* males may show specific differences in these characters is unknown.

The two larval females (14-15 mm SL) are in good agreement with *Himantolophus* larvae of similar size described by Bertelsen (1951:61-63) and Maul (1962:11-12). The inflated transparent skin has no dorsal pigment spot, but several melanophores are present, scattered below and in front of the gill opening.

#### Family DICERATIIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families by having a second cephalic ray bearing a distal luminous gland, in young specimens appearing as a club-shaped ray immediately behind the illicium, in larger specimens withdrawn beneath skin, its presence indicated by a small pore. They may further be distinguished by the following combination of characters: opercle bifurcate; subopercle with well-developed anterior spine; sphenotic spines present; hyomandibular with double head; three pectoral radials;

microscopic dermal spines present; D.5-7; A.4; P.13-16. Males probably non-parasitic; skin spinulose; two denticular teeth on snout and two transverse series each of 4-5 on lower jaw, all separate; eyes and nostrils lateral (Bertelsen, 1983).

No member of the family Diceratiidae has been recorded from eastern Australia. Two species, however, are known from adjacent Indonesian waters: *Diceratias bispinosus* (Paxton and Lavenberg, 1973) and *Phrynichthys thele*. For a complete family review see Uwate (1979).

#### Family ONEIRODIDAE

**Diagnosis.** The numerous and variously specialized genera of the Oneirodidae have few common features that distinguish them from other ceratioid families. Although not characteristic of all genera, the following features are useful in differentiating Australian oneirodids: opercle bifurcate; three pectoral radials; hyomandibular with a double head (single head in *Bertella*); anterior subopercular spine usually absent (blunt projection present in most specimens of *Chaenophryne*, adolescent females of *Lopholodops* and some larvae and males of *Dolophichthys* and *Pentherichthys*); skin spines absent (microscopic dermal spines present in *Oneirodes*); D.4-8, A.4-7, P.14-30.

Males are non-parasitic with skin naked; posterior end of upper denticular remote from anterior end of pterygiophore of illicium; eyes and posterior nostrils lateral, anterior nostrils close together and directed anteriorly; olfactory organs large; nasal area with or without pigment.

Fifteen genera (see Pietsch, 1974, 1978), only three recorded from Australian waters.



**Key to Females of Genera and Species of the  
Oneirodidae Recorded from Australian Waters**

1. Sphenotic spines present; opercle deeply notched posteriorly; pelvic bones rod-shaped, not expanded or only slightly expanded distally ..... 2
- Sphenotic spines absent; opercle not deeply notched posteriorly; pelvic bones widely expanded distally, occasionally triradiate ..... *Chaenophryne draco* Beebe, 1932, p.88
2. Caudal fin not covered by black skin except at base; anal fin rays 4, rarely 5; subopercle short and broad, lower part nearly circular (*Oneirodes*) ..... 3
- Caudal fin covered by black skin for some distance beyond fin base; anal fin rays 5, rarely 4; subopercle long and narrow, lower part strongly oval ..... *Dolopichthys pullatus* Regan and Trewavas, 1932, p.87
3. Esca with two or three medial filaments more than six times length of esca bulb (Fig. 5) ..... *Oneirodes kreffti* Pietsch, 1974, p.84
- Esca without elongate medial appendages ..... 4
4. Anterior esca appendage laterally compressed; posterior esca appendage less than half length of esca bulb (Fig. 6) ..... *Oneirodes sabex* Pietsch and Seigel, 1980, p.85
- Anterior esca appendage cylindrical; posterior esca appendage considerably longer than length of esca bulb; lateral esca appendage present (Fig. 7) ..... *Oneirodes whitleyi* n.sp., p.85

*Oneirodes* Lütken, 1871

For synonymy see Pietsch, 1974.

**Diagnosis.** Males and females are distinguished from those of other oneirodid genera in having the subopercle short and broad, lower part (and upper part in males) semicircular; A.4, very rarely 5. Females are further distinguished by having sphenotic spines; dorsal margin of frontal bone strongly curved; pigmented skin not extending beyond base of caudal fin.

Males are further distinguished by having skin between the nostrils unpigmented; inner surface of subopercle unpigmented; caudal peduncle without subdermal pigment; 7–13 lower denticular teeth.

Approximately 33 species, three recorded from eastern Australian waters.

*Oneirodes kreffti* Pietsch, 1974

Fig. 5

*Oneirodes kreffti* Pietsch, 1974: 57, figs 60B, 75, 76, 107, tables 1, 12 (original description, 3 specimens from eastern South Atlantic and Indian Ocean, holotype, ISH 1536/71).

**Material.** A single female, 50 mm SL: AMS I.16162–020, Tasman Sea, off Sydney, N.S.W., 34°05'S, 151°55'E, 0–950 m over 1922–2836 m, 25 March 1971.

This specimen represents the first record of *O. kreffti* since the original description (Pietsch, 1974), and extends the known geographic range of the species into



**Fig. 5.** Esca of *Oneirodes kreffti* Pietsch, 1974, holotype, 50 mm SL, ISH 1536–7. **A**, anterolateral view. **B**, posterolateral view, anterior appendage not shown. After Pietsch (1974).

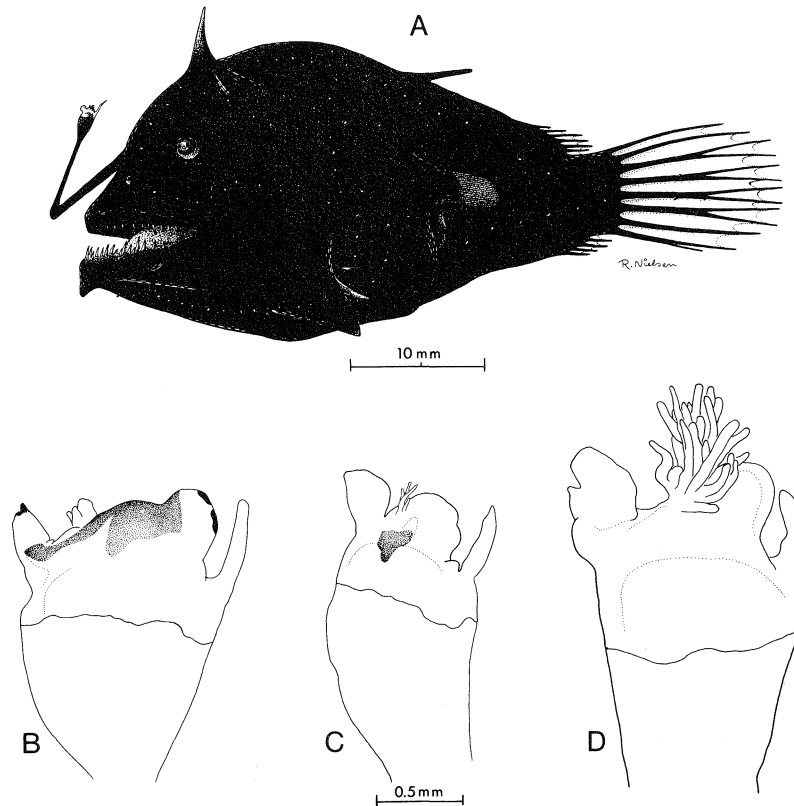


Fig. 6. *Oneirodes sabex* Pietsch and Seigel, 1980. **A**, paratype, 39 mm SL, AMS I.20314-016. Drawn by R. Nielsen. **B-D**, escae in left lateral views, after Pietsch and Seigel (1980). **B**, paratype, 17 mm SL, LACM 36089-4; **C**, paratype, 26.5 mm SL, LACM 36087-4; **D**, holotype, 46 mm SL, LACM 36116-3.

the western South Pacific Ocean. Although the esca of this new specimen is somewhat damaged, it compares very well with the type material.

***Oneirodes sabex* Pietsch and Seigel, 1980**

Fig. 6

*Oneirodes sabex* Pietsch and Seigel, 1980: 387, figs 9, 10 table 3 (original description, 14 specimens from off Luzon, Philippines, Banda Sea and off Sydney, Australia, holotype LACM 36116-3).

**Material.** Four metamorphosed females (12.5–50 mm SL): AMS I.16162-055, 12.5 mm SL, 72.5 km E of Sydney, N.S.W., 34°05'S, 151°55'E, 0–950 m over 1922–2836 m, 25 March 1971. AMS I.20314-016, paratype, 39 mm SL, E of Broken Bay, N.S.W., 33°28'S, 152°33'E, 0–900 m over 4200 m, 14 December 1977. AMS I.20315-010, paratype, 32.5 mm SL, E of Sydney, N.S.W., 33°53'S, 152°02'E, 0–900 m over 1800 m, 14 December 1977. AMS I.21368-008, 50 mm SL, off Newcastle, N.S.W., 33°04'S, 153°08'E, 0–750 m over +1500 m, 28 November 1979.

The original description of *O. sabex* was based on 14 metamorphosed females collected from south-east Asian and eastern Australian waters (Pietsch and Seigel, 1980). In addition to the two paratypes listed above, two more specimens (12.5–50 mm SL) have been deposited in collections of the Australian Museum.

***Oneirodes whitleyi* n.sp.**

Fig. 7, Table 1

**Material.** Three metamorphosed females, 11–30 mm SL.

**Holotype.** AMS I.20066-003, 30 mm SL, east of Brush Island, N.S.W., 35°36'S, 150°55'E, 0–650 m over 2000 m, 27 October 1977.

**Paratypes.** AMS I.19608-045, 11 mm SL, off Sydney, N.S.W., 34°05'S, 151°56'E, 0–800 m over 2410–2920 m, 23 March 1971. AMS I.20066-070, 22 mm SL, data as for holotype.

**Diagnosis.** A species of *Oneirodes* differing from all previously described species in the morphology of the esca: anterior appendage cylindrical with a darkly pigmented internal tube and conical distal tip, bearing from 3 to 5 short, lateral filaments; a pair of highly branched medial appendages; posterior appendage cylindrical, unpigmented, approximately one and one-half times length of escal bulb; a cylindrical, lateral appendage on each side, bifurcated distally and bearing 0–1 small, lateral filament (Fig. 7B, C).

**Description.** Escal appendage pattern B (Pietsch, 1974, fig. 60B); except for tiny differences in numbers and size of filaments quite similar in the three specimens. Subopercle short, upper end rounded, or tapering to a point (in holotype), with slightly concave posterior

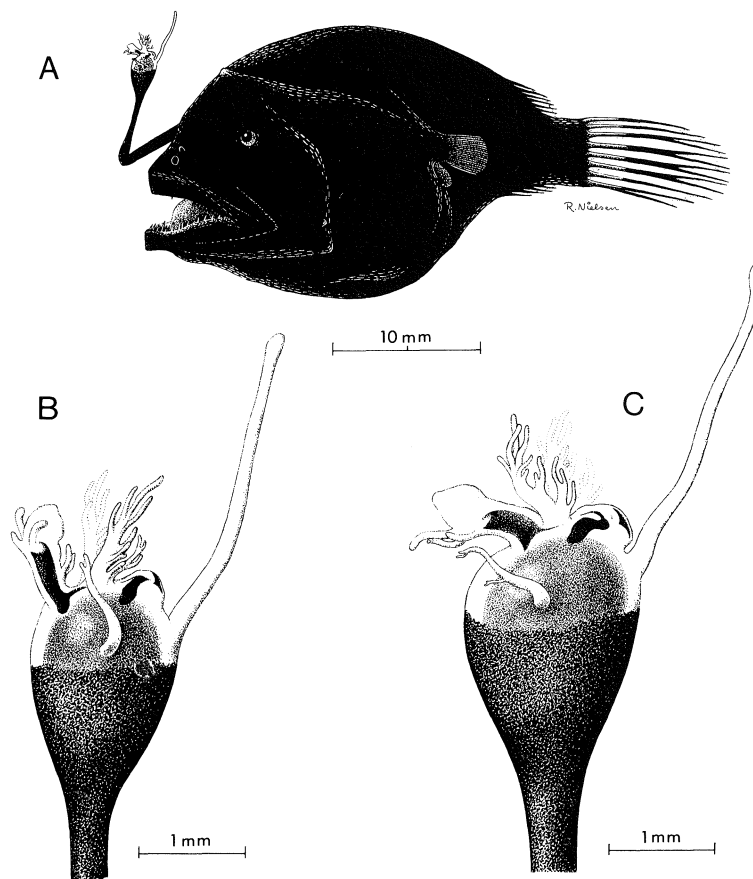


Fig. 7. *Oneirodes whitleyi* new species. A, holotype, 30 mm SL, AMS I.20066-003. B-C, escae in left lateral views. B, paratype, 22 mm SL, AMS I.20066-070; C, holotype, 30 mm SL, AMS I.20066-003. Drawn by R. Nielsen.

Table 1. Counts and measurements of *Oneirodes whitleyi*. Measurements expressed in per cent of SL.

	Paratype AMS I.19068-045	Paratype AMS I.20066-070	Holotype AMS I.20066-003
Standard Length (mm)	11	22	30
Length			
Head	45	50	47
Lower jaw	50	50	47
Premaxilla	33	30	35
Illicium	27	25	25
Head depth	49	48	48
Teeth			
Vomer	2 + 2	3 + 2	4 + 4
Upper jaw	8 + 8	13 + 12	23 + 21
Lower jaw	12 + 12	18 + 18	20 + 20
Dorsal fin rays	6	6	6
Anal fin rays	4	4	4
Pectoral fin rays	16-16	16-16	16-16

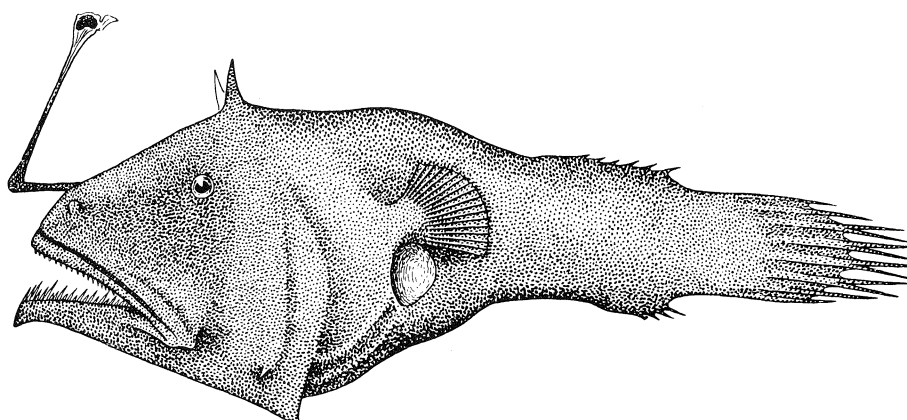


Fig. 8. *Dolopichthys pullatus* Regan and Trewavas, 1932, 32 mm SL, ZMUC P92101. After Regan and Trewavas (1932).

margin; length of lower fork of opercle 30% of SL; ratio of lengths of upper and lower forks of opercle 0.47–0.50. Epibranchial teeth absent; teeth present on pharyngobranchial II.

Counts and measurements in Table 1.

**Distribution.** *Oneiroides whitleyi* is known only from three metamorphosed females collected from eastern Australian waters, between the surface and approximately 800 m.

**Etymology.** This new form is named in honour of the late Gilbert P. Whitley in recognition of his contribution to Australian ichthyology.

#### *Oneiroides* sp.

**Material.** AMS I.20070–005, 33.5 mm SL, NE of Cape Howe, N.S.W., 37°24'S, 150°30'E, 0–540 m over 3600 m, 1 November 1977.

Since the esca of this metamorphosed female is badly desiccated, the specimen cannot be identified to species.

#### *Oneiroides* sp. larvae

**Material.** AMS I.19608–019, 4 (7–7.5 mm SL), off Sydney, N.S.W., 34°05'S, 151°56'E, 0–800 m over 2410–2920 m, 23 March 1971.

As is the case with nearly all larvae except those of monotypic ceratioid genera, these four small specimens cannot be identified to species.

#### Other Species of *Oneiroides*

A considerable number of additional species of *Oneiroides* have been collected from adjacent South-east Asian waters. Any or all of these might be expected to occur off Australia as well (see Pietsch, 1974, and Pietsch and Seigel, 1980):

*Oneiroides alius* Seigel and Pietsch, 1978

*Oneiroides carlsbergi* (Regan and Trewavas, 1932)

*Oneiroides cristatus* (Regan and Trewavas, 1932)

*Oneiroides eschrichtii* Lütken, 1871

*Oneiroides flagellifer* (Regan and Trewavas, 1932)

*Oneiroides melanocauda* Bertelsen, 1951

*Oneiroides micronema* Grobecker, 1978

*Oneiroides plagionema* Pietsch and Seigel, 1980

*Oneiroides pterurus* Pietsch and Seigel, 1980

*Oneiroides schistonema* Pietsch and Seigel, 1980

*Oneiroides schmidti* (Regan and Trewavas, 1932)

*Oneiroides thysanema* Pietsch and Seigel, 1980

#### *Dolopichthys* Garman, 1899

For synonymy see Pietsch, 1972b.

**Diagnosis.** Males and females are distinguished from those of other oneirodid genera in having the opercle deeply notched posteriorly; subopercle long and narrow, the upper part tapering to a point; A.5, rarely 4. Females are further distinguished by having sphenotic spines; dorsal margin of the frontals bones nearly straight; pigmented skin extending well beyond base of caudal fin.

Males are further distinguished by having nasal area pigmented; posterior nostril contiguous with eye; 4–10 lower denticular teeth.

Six species, only one recorded from eastern Australian waters.

#### *Dolopichthys pullatus* Regan and Trewavas, 1932

Fig. 8

*Dolopichthys pullatus* Regan and Trewavas, 1932:79, fig. 123, pl. 3, fig. 1 (original description, single specimen from the Molucca Sea, holotype ZMUC P92101).—Pietsch, 1972b: 7–12, figs 1–4, 11, 12, tables 1–3 (review based on all known material).

For complete synonymy see Pietsch, 1972b.

**Material.** Four females, 14–73 mm SL: AMS I.20066–001, 27 mm SL, E of Brush Island, N.S.W., 35°36'S, 150°55'E,

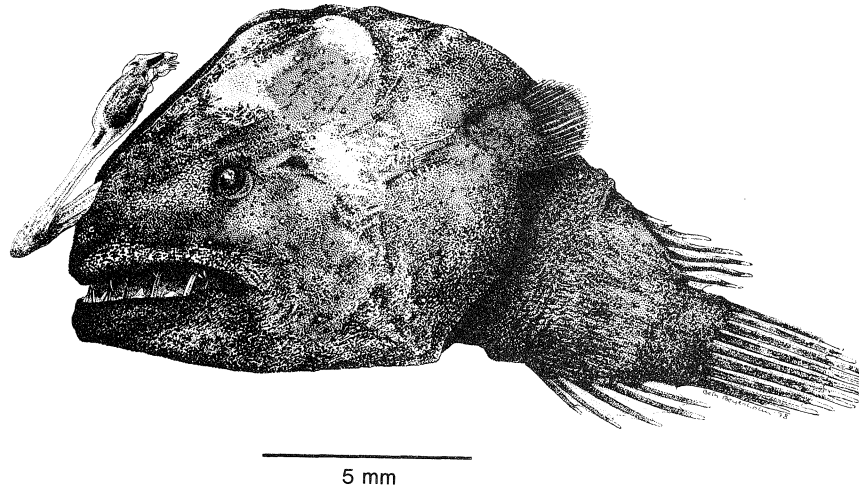


Fig. 9. *Chaenophryne draco* Beebe, 1932. After Munk and Bertelsen (1980).

0–650 m over 2000 m, 27 October 1977. AMS I.20315–011, 26.5 mm SL, E of Sydney, N.S.W., 33°53'S, 152°02'E, 0–900 m over 1800 m, 14 December 1977. AMS I.20410–010, 73 mm SL, E of Wollongong, N.S.W., 34°27'S, 151°38'E, 0–600 m over 2000–2200 m, 23 May 1978. AMS I.21365–010, 14 mm SL, off Newcastle, N.S.W., 33°09'S, 153°05'E, 0–750 m over +1500 m, 28 November 1979.

Four specimens of *Dolopichthys pullatus* are in the collections of the Australian Museum, Sydney. Although more than 30 individuals have been reported from localities in the Atlantic, Gulf of Mexico, eastern Pacific and Indian oceans (Pietsch, 1972b), this species was previously represented in the western Pacific by only the holotype from the Molucca Sea, and by a second specimen (LACM 36116–2) collected in the Banda Sea (Pietsch and Seigel, 1980).

The closely related species *Dolopichthys longicornis* is known from 19 metamorphosed females. Two of these were taken in waters adjacent to Australia: the holotype of *Dolopichthys mucronatus* (ZMUC P92100, = *D. longicornis*) from the South China Sea, and a second specimen from the Banda Sea (Pietsch and Seigel, 1980).

#### *Chaenophryne* Regan, 1925b

For synonymy see Pietsch, 1975.

**Diagnosis.** Males and females are distinguished from other oneirodid genera in having the subopercle long and narrow, the upper end tapering to a point; posterior margin of opercle only slightly concave; A.5, rarely 4. Females are further distinguished by the

absence of sphenotic spines (blunt ridges present on parietals and posttemporals); dorsal margin of frontal strongly curved; pigmented skin extending well beyond base of caudal fin.

Males are further distinguished by having nasal area pigmented; posterior nostril not contiguous with eye; 17–27 lower denticular teeth.

Four species, only one recorded from eastern Australian waters.

#### *Chaenophryne draco* Beebe, 1932

Fig. 9.

*Chaenophryne draco* Beebe, 1932:84, fig. 22 (original description, single specimen from off Bermuda, holotype USNM 170943).—Pietsch, 1975:87–90, figs 1B, 2A, 3–5, 8, 11, 12, tables 1–3, 5 (review based on all known material); Munk and Bertelsen, 1980: 103–129, figs 1–20 (esca morphology). For complete synonymy see Pietsch, 1975.

**Material.** Two females, 14–52 mm SL: AMS I.20064–005, 52 mm SL, off Sydney, N.S.W., 34°10'S, 152°04'E, 0–660 m over 2500 m, 26 October 1977. AMS I.20314–021, 14 mm SL, E of Broken Bay, N.S.W., 33°28'S, 152°33'E, 0–900 m over 4200 m, 14 December 1977.

*Chaenophryne draco* has a wide distribution, occurring in all three major oceans (Pietsch, 1975). Although it is known from two metamorphosed females collected in the Banda Sea (Pietsch and Seigel, 1980), the specimens reported here are the first records from Australian waters.

Although relatively common in other parts of the world, the closely related *Chaenophryne longiceps* is represented in the western Pacific by a single

metamorphosed male from the Banda Sea (Pietsch and Seigel, 1980). It is conceivable that this form inhabits eastern Australian waters as well.

#### Other Oneirodids

A number of additional oneirodids have been collected from adjacent, south-east Asian localities. Any or all of these forms might be expected to occur off Australia as well (see Pietsch, 1974, and Pietsch and Seigel, 1980):

- Danaphryne nigrifilis* Regan and Trewavas, 1932
- Microlophichthys microlophus* Regan, 1925
- Chiroptryne xenolophus* Regan and Trewavas, 1932
- Pentherichthys* sp.
- Lophodolos indicus* Lloyd, 1909

#### Family THAUMATICHTHYIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families by having upper jaw extending far beyond lower jaw, anteriorly separated, only connected by an elastic membrane; long, hooked premaxillary teeth and 1–3 hooked denticles on esca.

Two genera, *Lasiognathus* and *Thaumatichthys*.

Males only known in the latter genus; distinct from males of other families by having 4 separate, hooked denticles arranged in two pairs above each other on tip of snout and 7 denticles arranged in two transverse series on tip of lower jaw; dermal spines present on body.

No member of the family Thaumatichthyidae has been recorded from Australia. The holotype of *Thaumatichthys pagidostomus* (USNM 72952), however, was collected in adjacent south-east Asian waters off Sulawesi, Celebes (Smith and Radcliffe, 1912); for a complete review see Bertelsen and Struhsaker, 1977.

#### Family CENTROPHRYNIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families by the following combination of characters: opercle bifurcate; suboperculum with anterior spine (reduced in large specimens); four pectoral radials (fusing to 3 in specimens larger than 150 mm); hyomandibular with double head gill teeth present on epibranchial I and ceratobranchials I–IV; esca with a laterally compressed fan-shaped appendage; escal filaments absent. Larvae, males and juvenile females with a short, simple hyoid barbel.

Males probably non-parasitic; upper denticular with 3 teeth, the lower with 4; eyes lateral, less than 5% SL in diameter; anterior nostrils opening anteriorly; skin naked.

A single genus.

No member of the Centrophrynidae has been recorded from eastern Australia. The lectotype of *Centrophryne spinulosa* (ZMUC P92122), however, was captured off the northern coast of New Guinea (Regan and Trewavas, 1932); for a complete review see Pietsch, 1972a.

#### Family CERATIIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families in having two or three caruncles on the dorsal midline just anterior to the soft dorsal fin; sphenotic spines absent; posterior end of pterygiophore of illicium emerging from the dorsal midline anterior to caruncles; cleft of mouth vertical to strongly oblique; skin covered with close-set dermal spines; D.4–5; A.4–5.

Males parasitic; free-living stages with a pair of large denticular teeth on snout, fused at base and articulating with pterygiophore of illicium; two pairs of denticular teeth on tip of lower jaw; eyes large, bowl-shaped; olfactory organs minute.

Two monotypic genera.

#### Key to Females of Genera and Species of Ceratiidae

1. Illicium long, much longer than bulb of esca; 2 caruncles on dorsal midline; subopercle without spine on anterior margin . . . . . *Ceratias holboelli* Kröyer, 1845, p.89
- Illicium short, nearly completely enveloped by bulb of esca; 3 caruncles on dorsal midline; subopercle with spine on anterior margin . . . . . *Cryptopsaras couesi* Gill, 1883, p.91

#### Key to Males of Genera and Species of Ceratiidae

1. Body without subdermal pigment . . . . . *Ceratias holboelli* Kröyer, 1845, p.89
- Body with subdermal pigment on gill-cover, back and caudal peduncle . . . . . *Cryptopsaras couesi* Gill, 1883, p.91

#### *Ceratias* Kröyer, 1845

For synonymy see Bertelsen, 1951.

**Diagnosis.** Females are distinguished from those of *Cryptopsaras* in having two club-shaped caruncles on the dorsal midline just anterior to the soft dorsal fin (minute in specimens greater than 400 mm SL); illicium long, 19–25% of SL.

Males are distinguished by having two pairs of lower denticular teeth of nearly equal size. Larvae, males and juvenile females without subdermal pigment.

A single species (but see comments below).

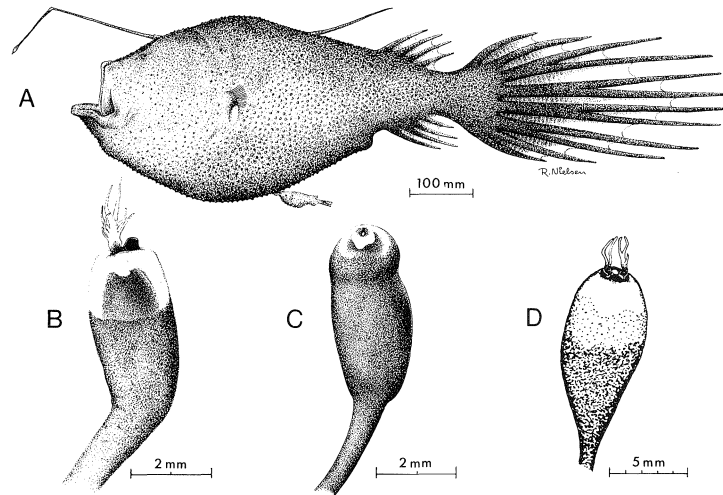
#### *Ceratias holboelli* Kröyer, 1845

Fig. 10

*Ceratias holboelli* Kröyer, 1845: 638 (original description, single specimen from southern Greenland, holotype ZMUC P61).—Bertelsen, 1951:133–318, figs 90–92 (revision based on all known material).

For complete synonymy see Bertelsen, 1951.

**Material.** Five metamorphosed females, 22–570 mm SL: AMS I.19562–042, 22 mm SL, E of Port Hacking, N.S.W., 34°09'S, 152°07'E, 0–550 m over 1890 m, 23 March 1971. AMS I.20307–014, 2 (135–168 mm SL), E of Broken Bay, N.S.W., 33°28'S, 152°25'E, 0–900 m over 1830–2800 m, 13



**Fig. 10.** *Ceratias holboelli* Kröyer, 1845. **A**, female c.650 mm SL, with parasitic male c.80 mm SL. After Bertelsen (1951). **B-D**, escae: **B**, left lateral view, 168 mm SL, AMS I.20307-014, drawn by R. Nielsen. **C**, posterior view, 135 mm SL, AMS I.20307-014, drawn by R. Nielsen. **D**, left lateral view, 340 mm SL, BMNH 1949, 11.3.2, after Clarke (1950).

December 1977. WAM P4266, 480 mm SL, 35°34'S, 117°36'E, from stomach of sperm whale, 31 August 1957. WAM P27143-001, 570 mm SL, 35°24'S, 118°30'E, from stomach of sperm whale, 22 September 1964.

*Ceratias holboelli* has broad distribution in all three major oceans of the world. The holotype of *Mancalias bifilis* Regan and Trewavas, 1932 (referred to *C. holboelli* by Bertelsen, 1951) was collected east of New Zealand (46°43'S, 176°09'E). More recently 14 juvenile females were collected in the Banda, Celebes, Ceram and Halmahera seas (Pietsch and Seigel, 1980). With the exception of the large female (480 mm, WAM P4266) reported by Bowen (1963) and a single larval specimen (5 mm total length, ZMUC P921185) collected at approximately 29°37.5'S, 156°46'E (Bertelsen, 1951:271), the four specimens recorded here are the first from Australian waters.

As noted by Bowen (1963) the esca of the 480 mm SL specimen is damaged and in the 570 mm SL specimen (WAM P27143-001) the illicium is lost. In both of these adult females the skin of the body is complete and shows no sign of male attachment. Both have immature but relatively large ovaries measuring in the 480 mm SL specimen (left ovary) 80 mm in length and 25 mm in width with oocysts of about 0.2 mm in diameter. In the 570 mm SL specimen the respective measurements are 100 × 60 mm with oocysts of 0.2-0.3 mm.

In the smallest (22 mm SL) of the three specimens in the collection of the Australian Museum illicium and esca are damaged.

In the 135 mm SL specimen the illicium measures 17.5% SL, the exerted portion of the pterygiophore, 70% of SL. The esca bulb is oval in shape, pigmented except at the distal tip, and terminates without filaments and without any elevation of the small pigment spot that

surrounds the esca pore. A slight constriction of the bulb below the distally placed photophore may be due to shrinkage in preservation (Fig. 10C).

In the 168 mm SL specimen the length of the illicium is 31% of SL, the total length of the pterygiophore of the illicium is 113% of SL. The esca bulb is somewhat pear-shaped, the proximal two-thirds darkly pigmented. The esca pore is raised on a pigmented tube. A stout filament is present just anterior to the esca pore, its length approximately 75% of the diameter of the esca bulb, bearing three short filaments on each side (Fig. 10A).

Since Kröyer's (1845) original description, material of this genus has been described under nine generic and 13 specific names. More recently (Clarke, 1950; Bertelsen, 1951; Penrith, 1967), however, only the type species has been recognized, but doubt remains as to whether the existing material represents one or more species. Bertelsen (1951:133) found no esca filaments in specimens less than about 75 mm SL. However, in the relatively few larger specimens available with well-preserved escae, those from the North Atlantic (four specimens) had a single distal esca filament, while those from the southern hemisphere (three specimens) had a pair of distal filaments (Fig. 10D). For this reason, Bertelsen (1951) recommended that until further material becomes available, two subspecies should be recognized: a northern *Ceratias h. holboelli* and a southern *Ceratias h. tentaculatus*. Penrith (1967:185) reported a specimen with a distal pair of esca filaments from off Cape Town, and although additional material now available to us (Bertelsen and Pietsch, manuscript) seems to further confirm the existence of a separate southern species, some uncertainty remains. The additional material described here provides nothing to reduce this uncertainty.

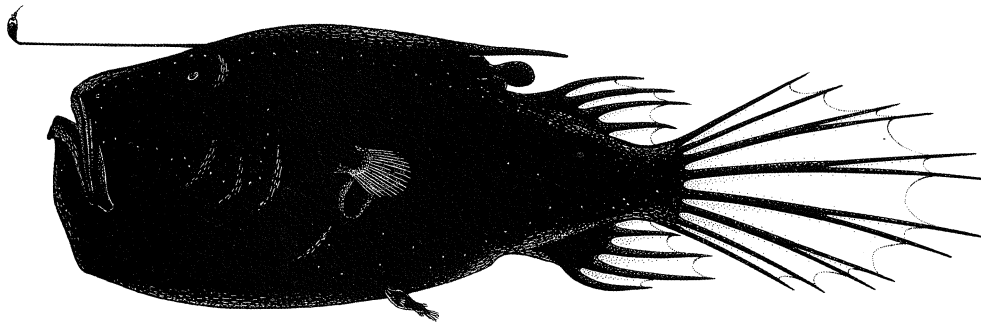


Fig. 11. *Cryptopsaras couesi* Gill, 1883, 290 mm SL. Redrawn after Tanaka (1911).

If *Ceratias tentaculatus* (originally described by Norman, 1930, from a single specimen collected from the Atlantic sector of the Southern Ocean) is resurrected and its distribution shown to be restricted by the Subtropical Convergence, there is still a question as to whether the remaining material from other parts of the world represents one or two species. The 168 mm SL specimen described here with a single escal filament, apparently a typical specimen of *C. holboelli* from eastern Australian waters, indicates a worldwide distribution for this species. On the other hand, additional material is needed to show whether the 135 mm specimen without an escal filament represents merely intraspecific variation or an additional third species.

#### *Cryptopsaras* Gill, 1883

For synonymy see Bertelsen, 1951.

**Diagnosis.** Females are distinguished from those of *Ceratias* in having three club-shaped caruncles on the dorsal midline just anterior to the soft dorsal fin; illicium extremely short, nearly completely enveloped by the escal bulb.

Males are distinguished by having two pairs of lower denticular teeth, the posterior pair considerably shorter than the anterior pair; subdermal pigment present on gill-cover, back and caudal peduncle.

A single species.

#### *Cryptopsaras couesi* Gill, 1883

Fig 11

*Cryptopsaras couesi* Gill, 1883:284 (original description, single specimen from off Long Island, New York, holotype USNM 33558).—Bertelsen, 1951:139-145, figs 93-97, table 29 (review based on all known material).

For complete synonymy see Bertelsen, 1951.

**Material.** Four females, 8–152 mm SL: AMS I.19601–037, 8 mm SL, E of Sydney, N.S.W., 34°10'S, 151°59'E, 0–75 m over 1810–2470 m, 24 March 1971. AMS I.19608–021, 9 mm SL, off Sydney, N.S.W., 34°05'S, 151°56'E, 0–800 m over 2410–2920 m, 23 March 1971. AMS I.20305–002, 73 mm SL, E of Broken Bay, N.S.W., 33°33'S, 152°18'E, 0–170 m over

2000 m, 12 December 1977. AMS I.20410–008, 152 mm SL, E of Wollongong, N.S.W., 34°27'S, 151°38'E, 0–600 m over 2000–2200 m, 23 May 1978.

*Cryptopsaras couesi* has a cosmopolitan distribution in all three major oceans of the world (Bertelsen, 1951). Three females from localities off New Zealand and in the Tasman Sea were described by Regan and Trewavas (1932:8). Bertelsen (1951:272) recorded 12 larvae and three free-living, metamorphosed males from eastern Australian waters, in addition to a number of specimens from adjacent south-east Asian waters. An 11 mm SL female collected off Western Australia in 1965 (no other data available) is present in the collections of the Western Australian Museum, Perth (WAM P26831–001). Finally, 50 specimens of this species were reported by Pietsch and Seigel (1980) from collections made in the Banda, Celebes, Halmahera, Sulu and Timor Seas.

#### Family GIGANTACTINIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families by having an elongate body, head less than 35% of SL, caudal peduncle length greater than 20% of SL; sphenotic spines absent; caudal fin with nine rays, but ventralmost ray reduced and embedded giving the appearance of only eight rays; five pectoral radials; skin spinulose.

Males non-parasitic with eyes minute; olfactory organs large; anterior nostrils close together and opening anteriorly; denticular teeth all or nearly all mutually free; upper denticular teeth 3–6 (rarely 2), not connected to pterygiophore of illicium; lower denticular teeth 4–7 (rarely 3).

Two genera, one recorded from eastern Australian waters.

#### *Gigantactis* Brauer, 1902

For synonymy see Bertelsen *et al.*, 1981.

**Diagnosis.** Females are distinguished from those of *Rhynchactis* (the only other genus of the family) in having the lower jaw teeth well developed in several series; D.5–9 (rarely 4 or 10); A.4–7 (rarely 8); escal bulb present.



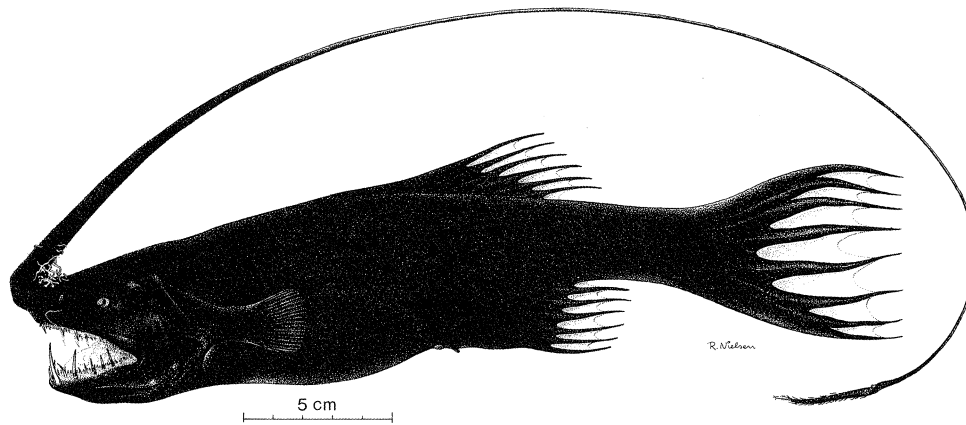


Fig. 12. *Gigantactis paxtoni* Bertelsen, Pietsch and Lavenberg, 1980, holotype, 232 mm SL, AMS I.20314-018, after Bertelsen *et al.* (1980).



Fig. 13. *Gigantactis paxtoni* Bertelsen, Pietsch and Lavenberg, 1980. Escae: **A**, left lateral view, holotype, 232 mm SL, AMS I.20314-018; **B**, Left posterolateral view, paratype, 50 mm SL, IOAN uncatalogued. After Bertelsen *et al.* (1980).

Males are distinguished from those of *Rhynchactis* in having upper denticular teeth 3, lower denticular teeth 4; D.5-9 (rarely 4 or 10); A.4-7 (rarely 8); skin spinulose in some species.

Seventeen species, only one recorded from Australia (Bertelsen *et al.*, 1981), in addition to three *Gigantactis* larvae not identifiable to species (ZMUC P921628-921629, Bertelsen, 1951:274).

*Gigantactis paxtoni* Bertelsen, Pietsch  
and Lavenberg, 1981  
Figs 12, 13

*Gigantactis* "sp.1" Parin *et al.*, 1977:156 (single specimen).  
*Gigantactis paxtoni* Bertelsen, Pietsch and Lavenberg  
1981:39-41, figs 36, 37, 38, 64, tables 1, 2, 9 (original  
description, eight specimens. Holotype AMS I.20314-018,  
232 mm SL).

**Material.** Seven metamorphosed females 50-232 mm SL:  
AMS I.20070-016, paratype, 124 mm SL, NE of Cape Howe,  
N.S.W., 37°24'S, 150°30'E, 0-540 m over 3600 m, 1  
November 1977. AMS I.20306-007, paratype, 142 mm SL,  
65 km E of Broken Bay, N.S.W., 33°31'S, 152°20'E,  
0-900 m over 1800-2900 m, 12 December 1977. AMS  
I.20314-018, holotype, 232 mm SL, 100 km E of Broken Bay,  
N.S.W., 33°28'S, 152°33'E, 0-900 m over 4200 m, 14  
December 1977. AMS I.20314-060, 2 paratypes, 218-228 mm  
SL, same data as holotype. AMS I.21365-007, 134 mm SL,  
off Newcastle, N.S.W., 33°09'S, 153°05'E, 0-750 m over  
1500 m, 28 November 1979. ZMUC P921988, paratype,  
175 mm SL, same data as holotype.

The original description of *G. paxtoni* was based on 8 metamorphosed females, 6 from the south-east coast of Australia, one from the north-west coast of New Guinea and one from western South Indian Ocean. In addition to the holotype and paratypes listed above, one female, 134 mm SL (AMS I.21365-007) has been obtained. The characters of this new specimen are in full agreement with those of the type material.

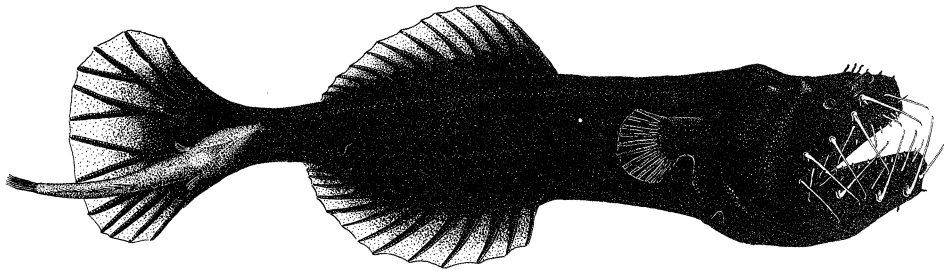


Fig. 14. *Neoceratias spinifer* Pappenheim, 1914, female, 52 mm SL, with parasitic male, 15.5 mm SL, ZMUC P921726. After Bertelsen (1951).

**Comments.** The closely related species, *Gigantactis vanhoefeni*, is well represented in adjacent Indonesian waters; seven females were recently collected in the Banda Sea (Pietsch and Seigel, 1980). Its presence off Australia is thus a distinct possibility.

**Family NEOCERATIIDAE**

**Diagnosis.** Females are distinguished from those of other ceratioid families by the absence of the illicium and esca; body elongate, head less than 30% of SL; a large nasal papilla on each side of snout; long, hooked teeth situated outside of the mouth, movably attached to conical, bony outgrowths of the jaws; caudal fin broad, fan-shaped; skin naked; D.11-13; A.10-13.

Males are parasitic with no upper denticular; lower denticular with three projections each ending in a double hook (Bertelsen, 1951:161, fig. 105B); eyes and olfactory organs degenerate; skin naked. Free-living stages unknown.

A single genus.

*Neoceratias* Pappenheim, 1914

With the characters of the family.

A single species.

*Neoceratias spinifer* Pappenheim, 1914

Figs 14, 15

*Neoceratias spinifer* Pappenheim, 1914:198, fig. 10 (original description, single specimen from the south Atlantic at approximately 12°11'S, 6°16'W, holotype ZMB 19383).—Bertelsen, 1951:158-161, figs 105, 106, tables 35, 36 (review based on all known material, osteology, parasitic male and larvae); Pietsch, 1976:789, fig. 8 (additional material, reproduction).

With the characters of the family.

**Material.** AMS I.20908-002, a female (77 mm SL) with parasitic male (12.5 mm SL), off Cape York Peninsula, Queensland, 14°30'S, 145°42'E, Tucker trawl, 0-1200 m, 1 February 1979, R/V 'Lady Basten'.

The number of known specimens of this species has now been brought to 28. Eleven of these are larvae and

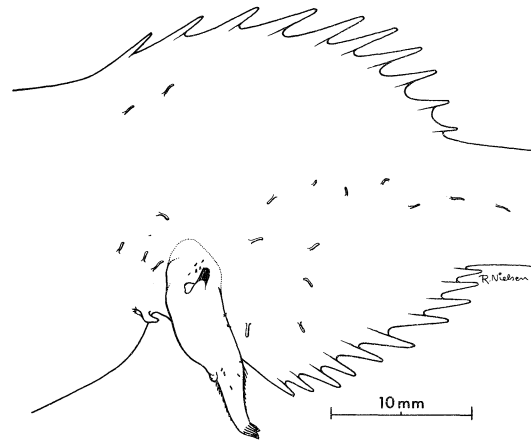


Fig. 15. *Neoceratias spinifer* Pappenheim, 1914, parasitic male, 12.5 mm SL, with head partly embedded in body of female, 77 mm SL, AMS I.20908-002. Drawn by R. Nielsen.

12 are metamorphosed females (17-108.5 mm SL), five of which carry a single parasitic male (Bertelsen, 1951; Pietsch, 1976). Although this material comes from widely scattered localities in the warmer latitudes of the Atlantic, Indian and Pacific oceans, the parasitized female reported here is the first record from Australia.

The specimen in the collections of the Australian Museum agrees in all respects with the description provided by Bertelsen (1951). The ovaries are approximately 11 mm (about 14% of SL) in length and contain numerous immature eggs, the largest of which measures approximately 0.15 mm in diameter. The male is attached anteriorly on the left side of the base of the anal fin (Fig. 15). The testes are large. The head is nearly completely embedded in the tissue of the female with the mouth fully occluded. Two of the four previously described parasitic males of *Neoceratias* have similarly closed mouth openings, in contrast to all the approximately 60 known cases of parasitism in other ceratioid species. In these, more or less distinct lateral openings remain at the corners of the mouth that perhaps permit a normal direction of the respiratory current. Since the gills of the *Neoceratias* males with

occluded mouths are normally developed, it may be assumed that water for respiration is pumped in and out through the opercular opening (Pietsch, 1976:790).

### Family LINOPHRYNIDAE

**Diagnosis.** Females are distinguished from those of other ceratioid families in having 3 (very rarely 2 or 4) dorsal and anal fin rays; skin naked; anus sinistral, 5 branchiostegal rays.

Males become parasitic; free-living stages with eyes large, somewhat tubular, and more or less directed anteriorly.

Five genera (see Bertelsen, 1951), two recorded from Australian waters.

#### Key to Females of Genera of Linophryinidae Recorded from Australian Waters

1. Skin darkly pigmented, opaque; hyoid barbel present; teeth few and strong ..... *Linophryne*
- Skin unpigmented, transparent; hyoid barbel absent; teeth small, numerous ..... *Haplophryne*

#### Key to Males of Genera of Linophryinidae Recorded from Australian Waters

1. Skin pigmented; denticular teeth strong; pre-maxillae and larval teeth degenerating with growth ..... *Linophryne*
- Skin unpigmented; denticular teeth weak; pre-maxillae and larval teeth retained with growth ..... *Haplophryne*

#### *Linophryne* Collett, 1886

For synonymy see Bertelsen, 1951 and 1982.

**Diagnosis.** Females are distinguished from those of other linophrynid genera in having a well-developed hyoid barbel, bearing small, globular photophores; gape of mouth large with few teeth, some of which are extremely long; sphenotic spines well developed; preopercular spine simple.

Free-living males with skin darkly pigmented; subdermal pigment present; premaxillae degenerate; jaw teeth few to absent; upper and lower denticular teeth well developed.

Twenty-one species (Bertelsen, 1982), only one recorded from Australian waters (plus one poorly preserved and unidentifiable specimen).

#### *Linophryne densiramus* Imai, 1941 Fig. 16

*Linophryne densiramus* Imai, 1941:247–250, figs 14–17, table 7 (original description, single specimen from Japan, holotype uncatalogued).—Bertelsen, 1980: 55–59, figs 11, 12, 17, tables 1, 2, 4 (resurrection from synonymy of *Linophryne arborifera*, 12 new records).

*Linophryne arborifera*.—Bertelsen, 1951: 178–183 (in part; *Linophryne densiramus* regarded as a synonym); Parin

*et al.*, 1977: (in part; additional specimen from the Banda Sea; misidentification after Bertelsen, 1951).

**Material.** AMS I.20314–015, 42 mm SL, 100 km E of Broken Bay, N.S.W., 33°28'S, 152°33'E, 0–900 m over 4200 m, 14 December 1977.

Fourteen females of *Linophryne densiramus* are known, one of them with a parasitic male. They were collected from scattered localities in the western Atlantic, Gulf of Mexico, Banda Sea and Pacific Ocean. The Australian Museum specimen (Bertelsen, 1980:58, fig. 12H) is the first record from the Australian coast; it is in full agreement with the specimens from other areas.

#### *Linophryne* sp.

**Material.** AMS I.20070–006, 24 mm SL, NE of Cape Howe, N.S.W., 37°24'S, 150°30'E, 0–540 m over 3600 m, 1 November 1977.

Specific identification of this specimen is impossible because of the loss of both the esca and barbel. By means of other morphological characters, however, a number of the recognized species of the genus can be excluded. According to subdermal pigmentation it does not represent *L. densiramus*, but most probably *Linophryne* subgenus *Linophryne* Bertelsen, 1982.

#### Other Species of *Linophryne*

Two additional species of *Linophryne* were recently collected in nearby Indonesian waters (Bertelsen, 1978, 1981, Pietsch and Seigel, 1980). These are *Linophryne indica* (Brauer, 1902) and *Linophryne trewavasae* Bertelsen, 1978. Either one or both of these forms might be expected to occur in Australian waters as well.

The *Aceratias indicus* recorded from Australian waters by Regan and Trewavas (1932) and Whitley (1964) is based upon male *Linophryne* unidentifiable to species.

#### *Haplophryne* Regan, 1912

For synonymy see Bertelsen, 1951 and Munk and Bertelsen, 1983.

**Diagnosis.** Females are distinguished from those of other linophrynid genera by the absence of a hyoid barbel; numerous, relatively small jaw teeth in 3–4 rows; large frontal spines present; preopercle with a large compressed spine terminating in 2–5 radiating cusps; esca sessile on snout; skin naked without pigment.

Males parasitic; free-living stages with well-developed jaw teeth; denticular teeth feeble; skin unpigmented.

A single species.

#### *Haplophryne mollis* (Brauer, 1902) Figs 17–18

*Aceratias mollis* Brauer, figs 17, 18 (original description, single male from Indian Ocean, holotype ZMB 17713).

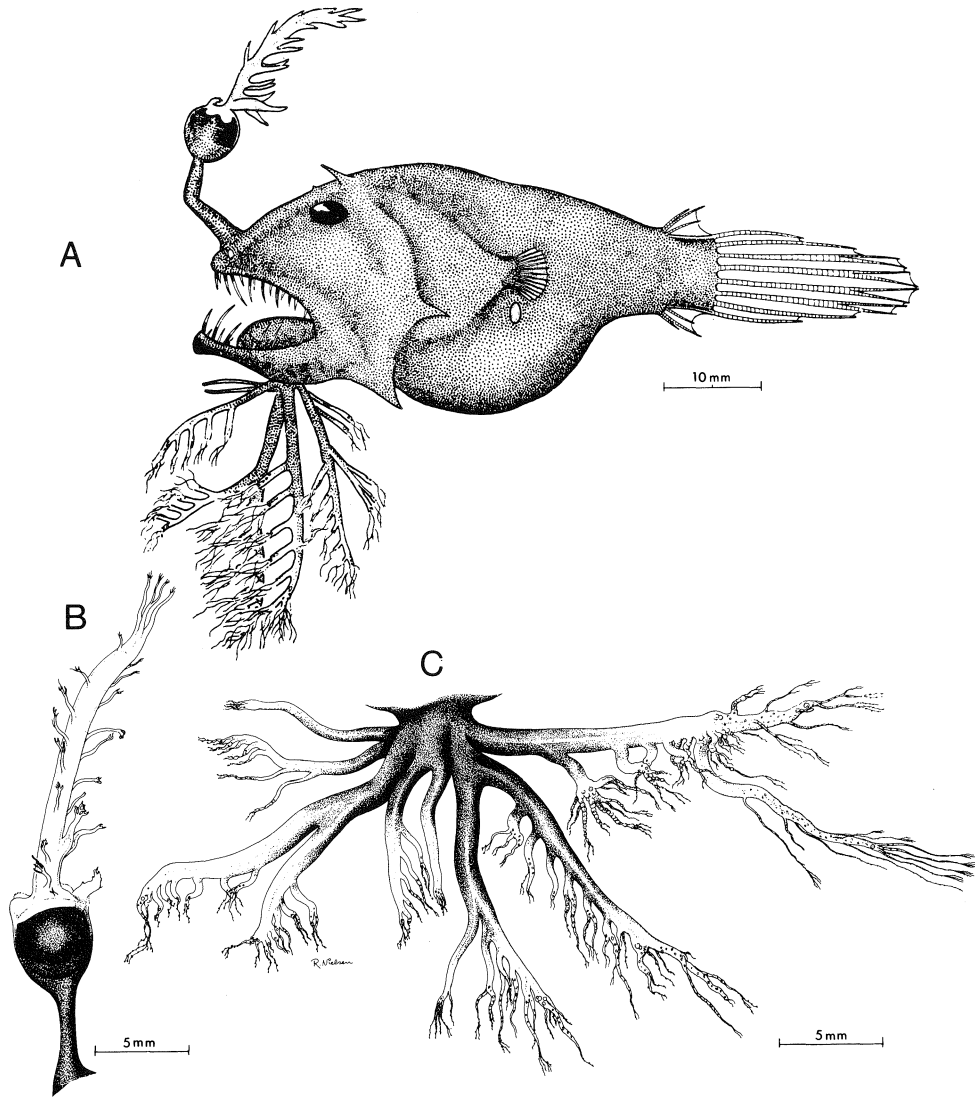


Fig. 16. *Linophryne densiramus* Imai, 1941. A, holotype, 50 mm SL, after Imai, 1941. B, and C, left lateral view of esca and barbel, 43.5 mm SL, LACM 38440-1. After Bertelsen (1980).

*Haplophryne mollis*.—Regan, 1912:289 (gen. nov.); Munk and Bertelsen, 1982: (*Haplophryne mollis* (Brauer, 1902), a senior synonym for *Edriolychnus schmidti* Regan, 1925).

*Edriolychnus schmidti* Regan, 1925:398, figs 8, 9 (original description, single specimen, parasitized female from the Caribbean Sea, holotype ZMUC P92135).—Bertelsen, 1951:168–172, figs 111A, B, 112–115, tables 38–40 (revision based on all known material).

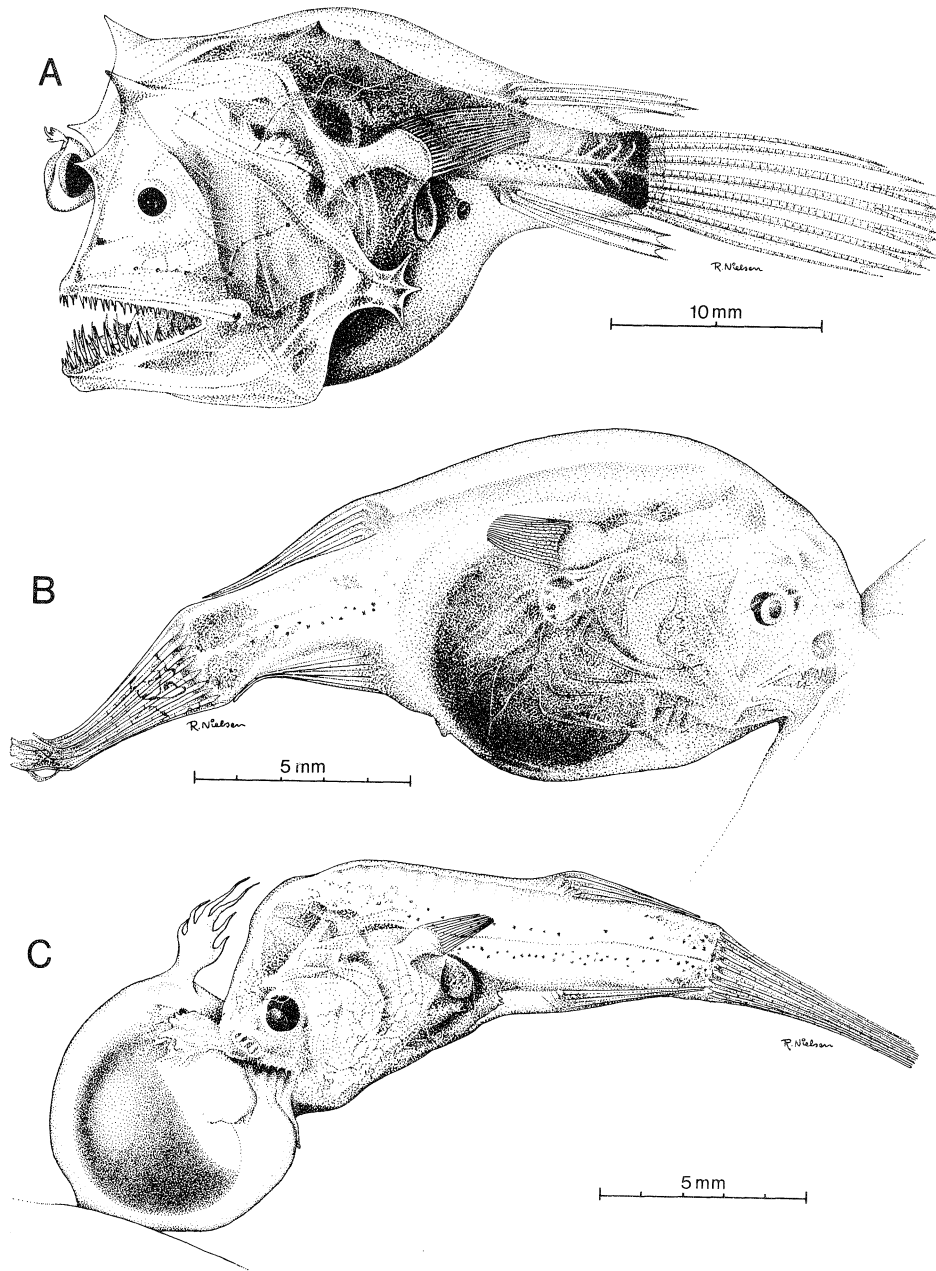
For additional synonymy see Bertelsen, 1951.

With the characters of the genus.

**Material.** Seven females (29–62 mm SL), five (39–62 mm SL) with parasitic males (10.5–15 mm SL): AMS I.20070–002, 32 mm SL, NE of Cape Howe, N.S.W., 37°24'S, 150°30'E, 0–540 m over 3600 m, 1 November 1977. AMS I.20071–001, female (52.5 mm SL) with 2 parasitic males (11.5–12 mm SL), E of Kiama, N.S.W., 34°40'S, 151°15'E, 0–548 m over 3300 m, 3 November 1977. AMS I.20314–014, 2 females

(29 mm SL without male; 46 mm SL with parasitic male, 11 mm SL), 100 km E of Broken Bay, N.S.W., 33°28'S, 152°33'E, 0–900 m over 4200 m, 14 December 1977. AMS I.20315–009, female (39 mm SL) with parasitic male (12.5 mm SL), 65 km E of Sydney, N.S.W., 33°53'S, 152°02'E, 0–900 m over 1800 m, 14 December 1977. AMS I.21364–003, female (48 mm SL) with 2 parasitic males (10.5–12 mm SL), off Newcastle, N.S.W., 33°01'S, 153°01'E, 0–750 m over +1500 m, 27 November 1979. AMS I.21365–008, female (62 mm SL) with 2 parasitic males (12–15 mm SL), off Newcastle, N.S.W., 33°09'S, 153°05'E, 0–750 m over +1500 m, 28 November 1979.

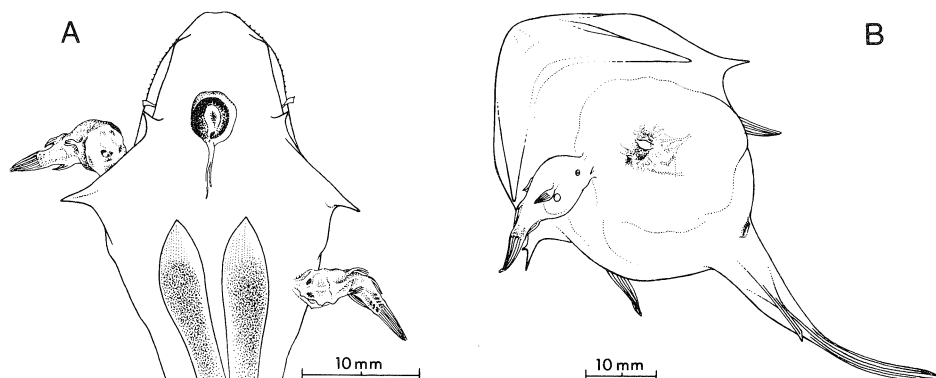
A total of approximately 35 females and free-living males have been reported from scattered positions in the warmer latitudes of all major oceans. The material recorded here constitutes the first occurrence of this species in Australian waters.



**Fig. 17.** *Haplophryne mollis* (Brauer, 1902). **A**, female, 29 mm SL, AMS I.20314-014. **B**, male, 15 mm SL, parasitically attached to belly of 62 mm SL female, AMS I.21365-008. **C**, male, 12 mm SL, parasitically attached to the distal surface of the esca of 62 mm SL female, AMS I.21365-008. Drawn by R. Nielsen.

The seven females in the collections of the Australian Museum are very similar and agree in all respects with previous descriptions. As shown by Bertelsen (1951:170-171), the shape of the preopercular spines varies: in four of the specimens both spines are tricuspid; they are broken in AMS I.20070-002; the left is tricuspid while the right has only two cusps in AMS I.21364-003; the left is undivided, the right bicuspid in AMS I.21365-008. The escae, decreasing in diameter from 12 to 10 per cent of SL with increasing standard length,

bear a compressed posterior appendage with 2-6 distal filaments. The skin is totally unpigmented except for a dark spot surrounding the sinistral anus, and a similar pigment spot surrounding the gill opening in the two smallest females (29-32 mm SL). Secondary subdermal pigmentation increased in distribution and density with increasing standard length. In the smallest female (29 mm SL), secondary subdermal pigment covers only the posterior-most myomeres of the caudal peduncle (Fig. 17); in the larger specimens this pigment has spread



**Fig. 18.** *Haplophryne mollis* (Brauer, 1902). **A**, dorsal view of female, 52.5 mm SL, AMS I.20071-001, with two parasitic males, 11.5–12 mm SL. **B**, ventral view of female, 62 mm SL, AMS I.21365-008, showing parasitic male and scar left by another parasitic male. Drawn by R. Nielsen.

anteriorly, gradually covering the larval series of large melanophores along the sides of the body.

All of the females are immature with small ovaries containing eggs of less than 0.1 mm in diameter.

Five of the seven females are sexually parasitized. The two smaller (29–32 mm) are without males, each of the two next largest (39–46 mm) carries a single male, while each of the three largest females (48–62 mm) has two attached males and an additional scar with remains of the jaw bones of a lost male. The eight males represent somewhat different development stages. Seven of them are of about the same length (10.5–12.5 mm SL) as the largest known free-living *Haplophryne* males, but differ in development of subdermal pigmentation and testes. The 11.5 mm male of AMS I.20071-001 (Fig. 18) and the 12 mm male of AMS I.21365-008 (Fig. 17) appear to be the youngest, having very little secondary subdermal pigment on the caudal peduncle and without any trace of eye degeneration or distinct enlargement of gonads. The 12.5 mm male of AMS I.20315-009 and especially the 15 mm male of AMS I.21365-008 (Fig. 17) are in more advanced stages with secondary pigment completely covering the larval series of large melanophores along the sides of the body, with somewhat shrunken eyes and the belly greatly inflated with enlarged testes. The latter is the first record of a parasitic *Haplophryne* male that is distinctly longer and more voluminous than the largest known free-living males of the genus, thus representing the first evidence of growth based on true parasitism in this genus. In two of the females (AMS I.23364-003 and AMS I.23365-008) the scar, which indicates the position of a lost parasitic male, has a small central papilla and, on each side of this, remains of jaw bones with teeth embedded in the skin. In both specimens numerous radiating blood vessels are distinct in the tissue surrounding the scar. In AMS I.20071-001 the scar is indistinct and only remains of the jaw bones of the male are left. While the scars and three of the parasitic males were placed on the belly of the females, the remaining five males were attached in various places on the head.

Especially remarkable is the position of the smaller male of AMS I.21365-008, attached to the distal surface of esca of the female (Fig. 17).

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