



Two new deep-sea anglerfishes (Oneirodidae and Gigantactidae) from Taiwan, with synopsis of Taiwanese ceratioids

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Abstract

Two new species of deep-sea anglerfishes are described on the basis of specimens collected from off northeastern Taiwan. *Oneirodes formosanus* **sp. nov.**, based on one adult female, differs from its congeners in having a deep caudal peduncle (15.4% SL) and esca with a single simple, elongate, unbranched, internally pigmented, anterior esca appendage; a simple, elongate, posterior esca appendage; an elongate terminal esca papilla; and no medial and lateral esca appendages. *Gigantactis cheni* **sp. nov.**, based on three adult females, differs from its congeners in having a series of unpigmented filaments at base of illicium; a black terminal elongated esca bearing numerous dermal spinules; relatively more jaws teeth with the outermost ones relatively short. A synopsis of Taiwanese species of the suborder Ceratioidei is provided.

Keywords: Lophiiformes, *Oneirodes formosanus* **sp. nov.**, *Gigantactis cheni* **sp. nov.**, deep-sea fish, Taiwan

Introduction

Deep-sea anglerfishes (suborder Ceratioidei) from Taiwanese waters were poorly known until deep-sea biodiversity surveys were made in recent two decades. Kuroda (1951) first recorded *Cryptopsaras couesii* Gill, 1883 based on a female specimen collected from the southern Taiwan. A specimen of *Neoceratias spinifer* Pappenheim, 1914 reported by Bertelsen (1951) represented the second record in Taiwan. Chen *et al.* (1967) recorded a female specimen of *Himantolophus groenlandicus* Reinhardt, 1837 from off Dong-gang, and Lee (1988) and Shen *et al.* (1993) also followed Chen *et al.* (1967) in reporting *H. groenlandicus* in their publications. However, the specimen has been lost (Bertelsen & Krefft, 1988:39) and was probably misidentified (Pietsch, 2009:336).

During the Deep-sea Biodiversity Survey Project (2001 to 2008), many deep-sea fishes were collected by using the commercial fishing boats and research vessels and previously collected specimens in the museums were re-identified. Among them, the lophiiform anglerfishes represent a high diversity group in Taiwan with many new species and new records found (Ho & Shao, 2004; Pietsch *et al.*, 2004; Ho & Shao, 2007a, b, 2008a b; Ho *et al.*, 2008 a, b; Ho & Shao, 2010), including several new species: *Bufoceratias shaoi* Pietsch, Ho & Chen and *Oneirodes pietschi* Ho & Shao, *Halieutopsis margaretae* Ho & Shao, *Halicmetus niger* Ho, Endo & Sakamaki, and *Malthopsis gigas* Ho & Shao.

In his master thesis, the first author (HCH) studied 91 specimens of deep-sea anglerfishes collected from Taiwan and recognized 7 families with 19 species, including 5 undescribed species. About the same number of specimens were collected subsequent to the thesis. As a consequence, a total of 17 genera and 27 nominal species in all 11 families of the suborder Ceratioidei were recognized. In addition, there are still unidentified specimens due to taxonomy uncertainty, damaged or in younger stages. Pietsch (2009) included most of this information in his comprehensive book on deep-sea anglerfishes of the world.

Here we formally described two species new to science, and provide a synopsis of ceratioid fishes of Taiwan.

Materials and Methods

Standard length (SL) is used throughout. Terminology and methods used for making counts and measurements follow Pietsch (1974). The type series of new species were collected by commercial fishing boats from off Daxi, Yilan in NE Taiwan (ca. 24°50'N, 122°00'E) in about 400–500 m by using bottom trawler. Specimens were deposited at Biodiversity Research Center, Academia Sinica, Taipei, Taiwan (ASIZP), National Museum of Nature Science, Taichong, Taiwan (NMNSF), National Museum of Marine Biology & Aquarium, Pingtung, Taiwan (NMMB-P), Fishery Research Institute, COA, Keelung, Taiwan (TFRI) and Zoologisk Museum, Københavns Universitet, Copenhagen, Denmark (ZMUC). Comparatively data for *Gigantactis* species are those given in the original description or collected by the first author. Original descriptions of these species listed in Table 1 are not cited.

Family Oneirodidae

Oneirodes Lütken, 1871

Oneirodes formosanus sp. nov.

Formosa dreamer

Figs. 1A–B, 2A–B

Holotype. ASIZP 59950, adult female, 92.6 mm SL, off Daxi, Yilan, NE Taiwan, ca. 24°53.63' N, 122°03.49'E, ca. 400–600 m, bottom trawl, 20 Mar. 1998, from bycatch.

Diagnosis. A species of *Oneirodes* with metamorphosed female differing from congeners in having an elongated terminal papilla on esca; a deep caudal peduncle (15.4% SL); a single simple, elongate, unbranched anterior escal appendages, with internal pigmentation; no medial and lateral escal appendages; a simple, elongate, posterior escal appendage, tapering distally, without internal pigmentation; terminal escal papilla elongated and cylindrical, internally pigmented, without distal pigment spots (Fig. 2).

Description. Dorsal-fin rays 6; pectoral-fin rays 16; anal-fin rays 4; caudal-fin rays 9. Premaxillary teeth 23; dentary teeth 22; vomerine teeth 4. Measurements in % SL: illicial length 25.5; head length 35.1; head depth 39.7; premaxillary length 28.9; lower jaw length 42.4; caudal-peduncle depth 15.4.

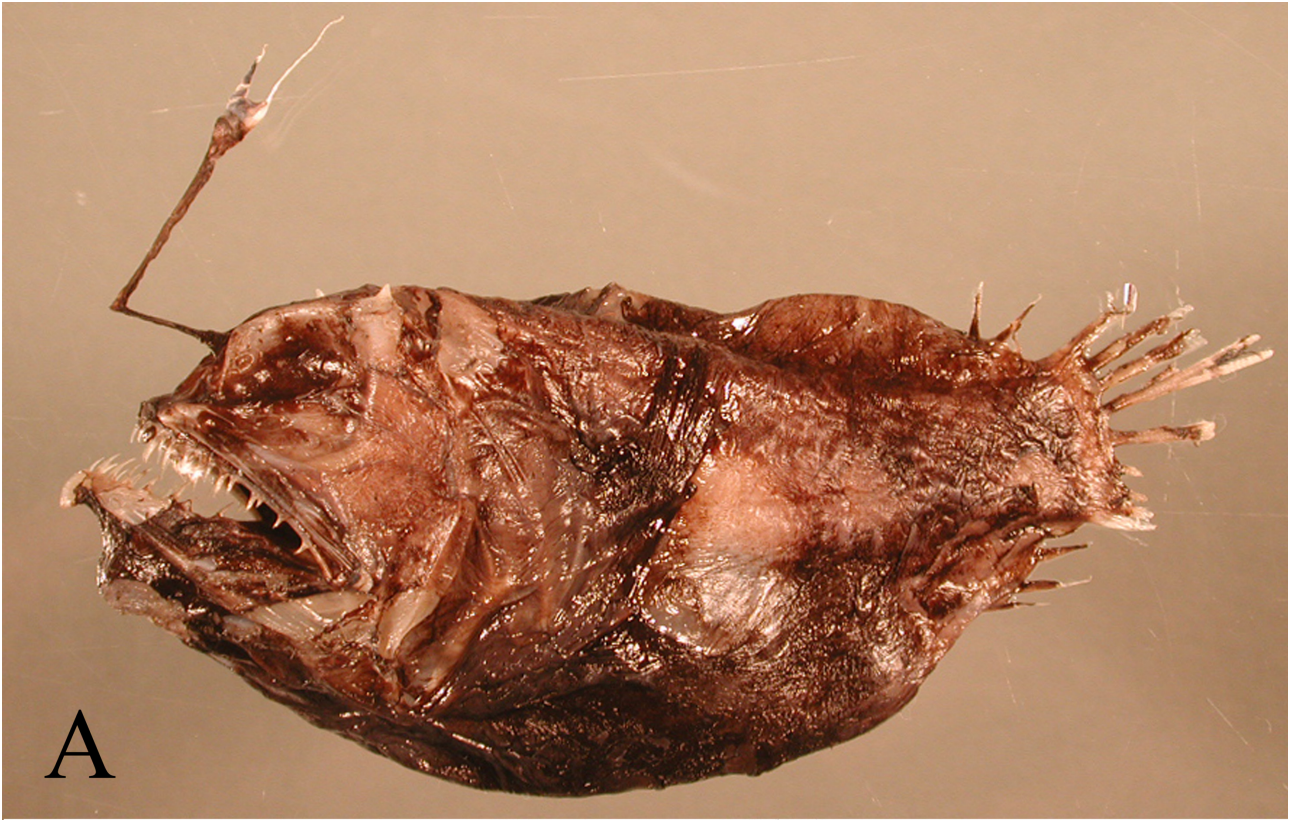
Escal appendage pattern B (Pietsch, 1974a: 34, fig. 60B): anterior escal appendage cylindrical, elongated, tapering, unbranched, about twice escal height, with internal pigmentation; medial and lateral escal appendages absent; posterior escal appendage slender, about four times escal height, without internal pigment; escal pore relatively large, lying between terminal escal papillae and base of posterior escal appendage; terminal papilla elongated, cylindrical, with internal pigmentation, as long as the esca (Fig. 2A).

Opercle bifurcate, upper fork narrow, pointed distally, lower fork slender and slightly curved; length of lower fork of opercle 26.3% SL; ratio of lengths of upper and lower forks of opercle 0.5; subopercle relatively long and narrow, without indentation on posterodorsal margin, upper part tapering to a point, lower part broad and rounded (Fig. 2B). Pharyngobranchials II and III with well-developed teeth; epibranchial teeth absent.

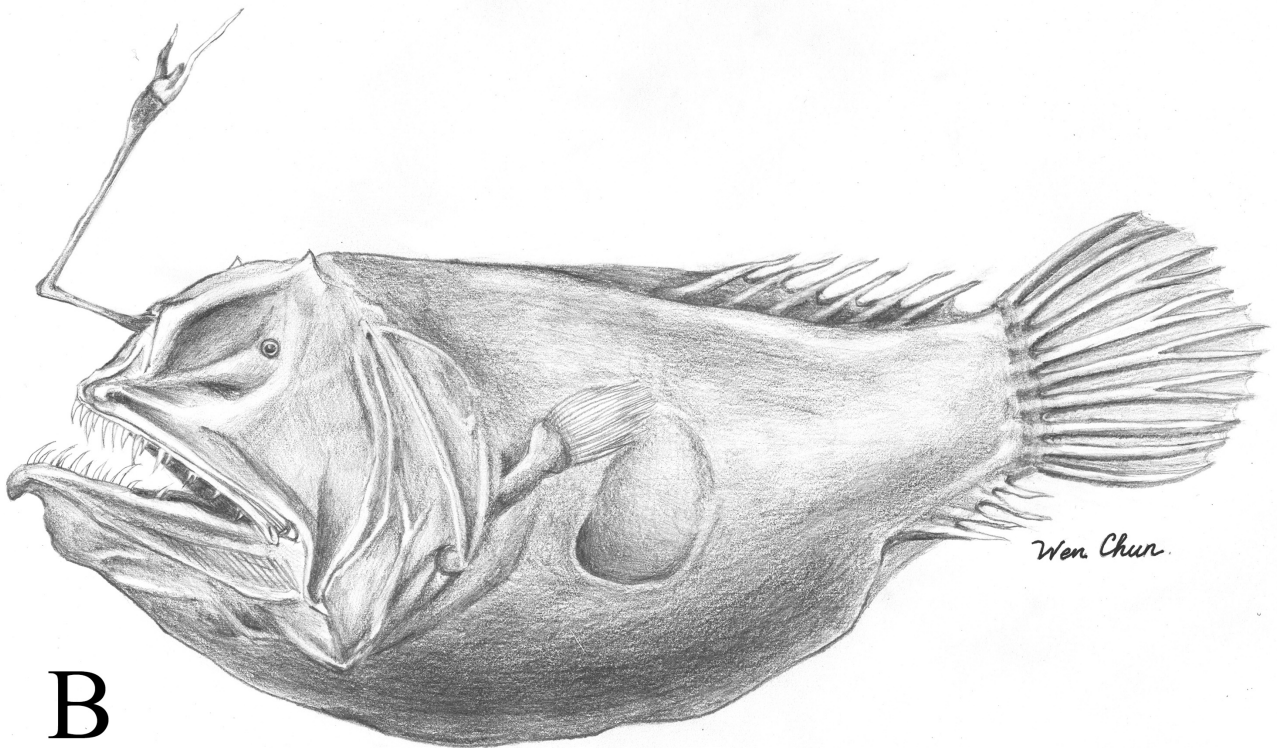
Distribution. The *Oneirodes formosanus* is known only from the holotype collected from northeastern Taiwan off Daxi at depth ca. 400–500 m.

Etymology. Named for the type locality, Formosa, an old name of Taiwan meaning the beautiful island.

Remarks. The relatively simple escal structure, deep caudal peduncle, and elongate terminal papilla can separate *Oneirodes formosanus* sp. nov. from congeners sharing the same escal pattern B. Of the congeners, it is most similar to *O. eschrichtii* Lütken, 1871 and *O. bulbosus* Chapman, 1939, but can be distinguished by lacking median and anterolateral appendages and having an unbranched anterior appendage. It is more or less similar to *O. thompsoni* (Schultz, 1934), *O. flagellifer* (Regan & Trewavas, 1932) and *O. bradburyae* Grey, 1957, but can be distinguished by lacking filaments on the anterior appendage and having an elongated terminal papilla and slender and unbranched subopercle.



A



B

FIGURE 1. Drawing of *Oneiroides formosanus* sp. nov., ASIZP 59950, holotype, 92.6 mm SL. A. Preserved specimen. B. Drawing of holotype.

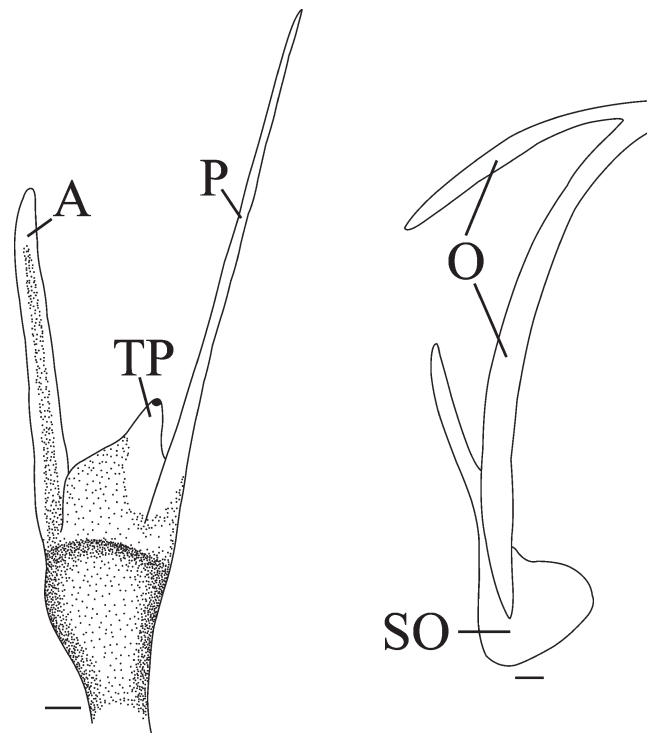


FIGURE 2. Esca (left) and operculum (right) of *Oneirodes formosanus* **sp. nov.**, from the holotype. A, anterior appendage; P, posterior appendage; TP, terminal papilla; O, opercle; SO, subopercle. Scale bar is 1 mm.

Family GIGANTACTINIDAE

Gigantactis Brauer, 1902

Gigantactis cheni **sp. nov.**

Hairy whipnose

Figs. 3A–C

Holotype. ASIZP 62947, female, 385 mm SL, off Daxi, Yilan, northeast Taiwan, ca. 24°50' N, 122°00' E, ca. 400–500 m, bottom trawl, Oct. 2001, bycatch, coll. D.-M. Chen.

Paratype. ASIZP 61823, female, 340 mm SL, May 2002; NMMB-P006230, female, 325 mm SL, Nov. 8, 2007; both collected from near the type locality by D.-M. Chen.

Diagnosis. A member of the *Gigantactis vanhoeffeni* species group differing from congeners in having a single row of 8–15 unpigmented filaments present on posterior margin of basal one-third of illicium; illicial length 145.5–172.1% SL; esca elongated, tapering into a conical shape, with numerous spinules, and darkly pigmented; distal prolongation length 10.6–12.6% SL; dentary teeth 66–70 on each side, arranged in 5 longitudinal series; dentary teeth relative long, 2.5–3.4% SL; caudal fin rays short, 25.5–30.6% SL; and caudal fin deeply forked.

Description. Dorsal-fin rays 6, anal-fin rays 6, pectoral-fin rays 17, caudal-fin rays 9. Dentary teeth 66–70 on each side, 136 (136–140) in total; premaxillary teeth 26–32 on each side; lower jaw with five series of teeth, two inner rows, one middle row, and 2 outer rows (Fig. 3C). Head length 19.7–21.5% SL; head depth 10.6–12.4% SL.

Body laterally compressed; caudal peduncle elongate; head short; dermal spinules present on entire body surface except lips; illicium emerging from stout tip, 15 (8–12 in paratypes) unpigmented filaments along posterior margin of basal one-third of illicial stem, 10 (5–8) on dorsal surface of head just behind the base of illicium; illicium relative long, 145.5–172.1% SL. Papilliform gland present inside of upper oral cavity.

Escal bulb tapering, with a long black-pigmented prolongation, 10.6–12.6% SL; surface spinulose except the escal pore; short filaments present on prolongation and the terminal tip.

Distribution. *Gigantactis cheni* is represented by the type series collected from northeastern Taiwan off Daxi at depth ca. 400–500 m.

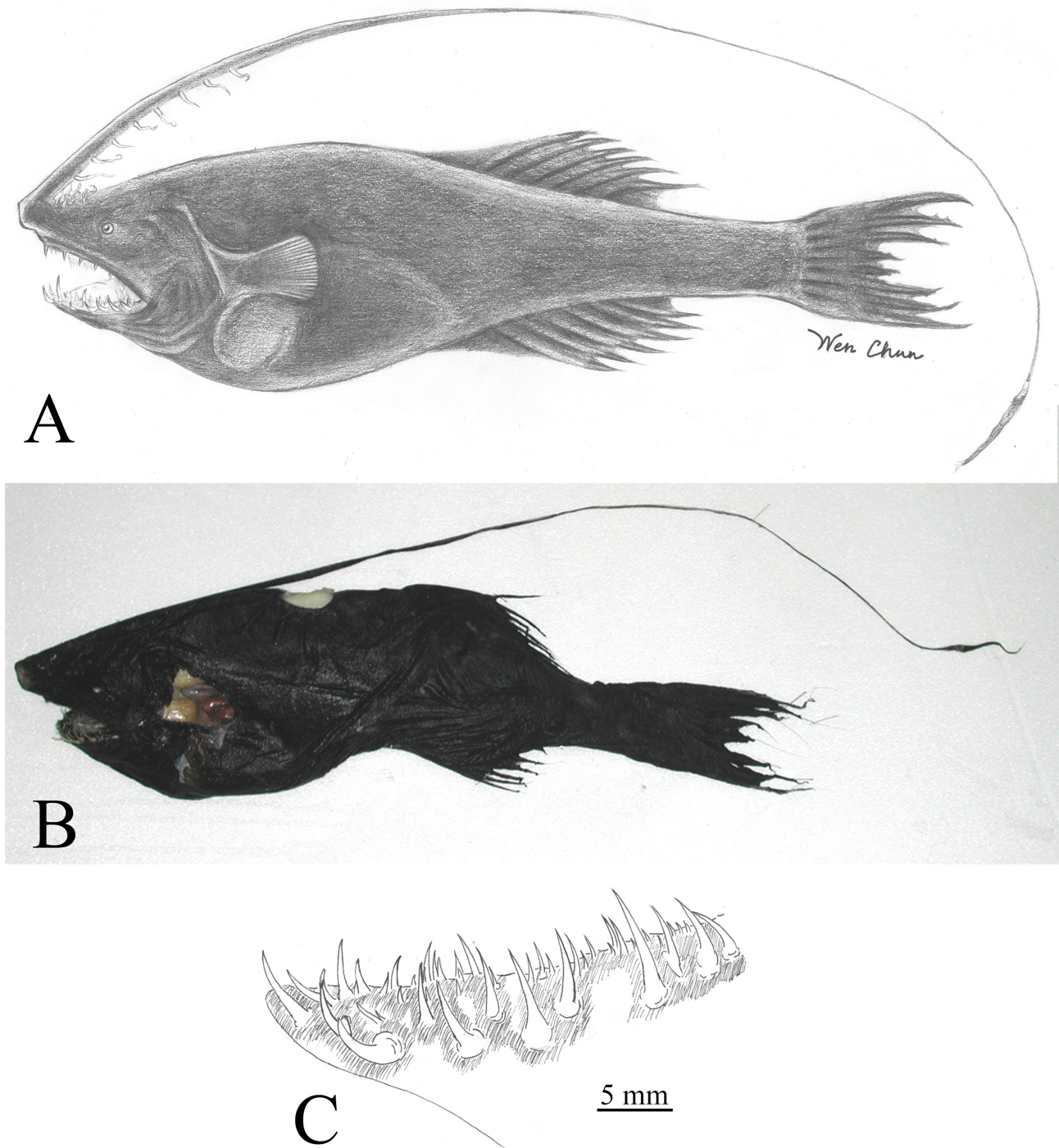


FIGURE 3. *Gigantactis cheni* **sp. nov.** A. Drawing of holotype, ASIZP 62947, 385 mm SL, not all cirri were shown. B. Fresh caught paratype, ASIZP 61823, 340 mm SL. C. Teeth on left side of lower jaw, from the holotype.

Etymology. *Gigantactis cheni* is named for Mr. Din-Moo Chen, an excellent fisherman who collected most samples for our studies, including the type series of both new species in present work.

Remarks. *Gigantactis cheni* **sp. nov.** belongs to the *G. vanhoeffeni* species group (Bertelsen *et al.*, 1981) and differs from all other members of this group in having a considerably longer illicium and a longer distal prolongation of the esca bulb. It is most similar to *G. paxtoni* Bertelsen, Pietsch & Lavenberg, 1981 which also has unpigmented filaments on illicium. However, the new species differs in having relatively more total jaws teeth (136–140, vs. 10–55), relatively short outermost teeth (2.5–3.4%, vs. 3.4–7.1% SL); slightly shorter illicium (145.5–172.1%,

vs. 168.0–198.0% SL); a relatively short esca prolongation (10.6–12.4%, vs. 12.0–28.0% SL); a relatively short caudal fin (25.5–30.6%, vs. 27.5–35.0% SL); and caudal fin deeply forked (vs. nearly truncate). Also, the filaments on the head are distributed on the posterior illicium for about one-third its length, whereas those on *G. paxtoni* are restricted to the basal region of illicium.

Gigantactis cheni **sp. nov.** is also similar to *G. meadi* Bertelsen, Pietsch & Lavenberg, 1981, but differs in having a relatively long illicium (145.5–172.1%, vs. 72–96% SL), a relatively elongated esca (vs. short), caudal fin deeply forked (Fig. 3A, vs. slightly concaved).

TABLE 1. List of all ceratioid species and specimens collected from Taiwan. All specimens are females unless otherwise indicated.

Taxon	Specimens (SL, in mm)	Remarks
Family Caulophrynidae		
<i>Caulophryne pelagica</i> (Brauer)	TFRI-P3032 (80.0)	South China Sea
Family Melanocetidae		
<i>Melanocetus johnsonii</i> Günther	ASIZP 59765 (102.0), ASIZP 64426 (21.0), NMMB-P23715 (83.8)	NE, SW Taiwan
<i>Melanocetus murrayi</i> Günther	32 lots in ASIZP. NMMB-P11268 (94.0), NMMB-P17750 (65.0).	NE, SE & SW Taiwan
Family Himantolophidae		
<i>Himantolophus melanolophus</i> Bertelsen & Krefft	NMNST 0993 (41.0)	SW Taiwan
<i>Himantolophus</i> sp.	ASIZP 61805 (30.0, ♂)	
Family Diceratiidae		
<i>Diceratias bispinosus</i> (Günther)	ASIZP 57321 (28.0), NMMB-P26660 (43.0).	SW Taiwan
<i>Bufoceratias shaoi</i> Pietsch, Ho & Chen	3 lots of type series in ASIZP. NMMB- P11269 (102.0), NMMB-P29085 (49.9).	NE & SW Taiwan
<i>Bufoceratias thele</i> (Uwate)	ASIZP 63075 (200.0), ASIZP 70166 (190.0), ASIZP 74365 (95.0), ASIZP 76179 (180.0).	NE Taiwan
Family Oneirodidae		
<i>Oneirodes carlsbergi</i> (Regan & Trewavas)	ASIZP 66385 (35.3)	NE Taiwan
<i>Oneirodes formosanus</i> sp. nov.	ASIZP 59950 (92.6), holotype.	NE Taiwan
<i>Oneirodes pietschi</i> Ho & Shao	ASIZP 61821 (46.0), ASIZP 61822 (100.0), holotype.	NE Taiwan, South China Sea
<i>Oneirodes sabex</i> Pietsch & Seigel	ASIZP 61818 (189.0), ASIZP 61819 (107.0).	NE Taiwan
<i>Oneirodes</i> sp. 1	ASIZP 62952 (292.0).	NE Taiwan
<i>Oneirodes</i> spp.	ASIZP 61817 (13.0), ASIZP 62878 (72.0), ASIZP 64403 (12.0).	Unidentified specimens.
<i>Tyrannophryne pugnax</i> Regan & Trewavas	ASIZP 66384 (47.0).	NE Taiwan
<i>Lophodolos indicus</i> Lloyd	ASIZP 61820 (53.0).	NE Taiwan
<i>Spiniphryne gladisfenae</i> (Beebe)	NMMB-P009031 (126.0).	NE Taiwan
<i>Dolopichthys pullatus</i> Regan & Trewavas	ASIZP 59951 (112.0), ASIZP 62879 (83.0).	NE Taiwan
Family Thaumatoichthyidae		
<i>Thaumatoichthys pagidostomus</i> Smith & Radcliffe	ASIZP 63971 (239.0), ASIZP 66381 (148.0).	NE Taiwan
<i>Lasiognathus</i> sp.	NMMB-P009034 (140.0).	NE Taiwan

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TABLE 1. (Continued)

Taxon	Specimens (SL, in mm)	Remarks
Family Centrophryidae		
<i>Centrophryne spinulosa</i> Regan & Trewavas	ASIZP 59902 (247.0), ASIZP 61793 (135.0), ASIZP 61794 (92.1), ASIZP 62881 (125.0), ASIZP 62948 (240.0), ASIZP 63268 (122.0), NMMB-P009367 (121.0).	NE Taiwan
Family Neoceratiidae		
<i>Neoceratias spinifer</i> Pappenheim	ZMUC P921721 (52.0)	E Taiwan
Family Ceratiidae		
<i>Ceratias holboelli</i> Krøyer	ASIZP 57172 (170.0).	South China Sea
<i>Ceratias</i> sp.	ASIZP 61795 (10.0), ASIZP 66387 (14.0), ASIZP 66388, 2 (26.4–44.9)	Unidentified specimens.
<i>Cryptosaras couesii</i> Gill	ASIZP 57160 (38.0), ASIZP 66323 (169.0), ASIZP 65680 (48.0), NMMB-P007507 (44.0), NMMB-P28978 (50.3), ZMUC P921367.	NE, E & SW Taiwan
Family Gigantactinidae		
<i>Gigantactis cheni</i> sp. nov.	ASIZP 62947 (385.0), holotype, ASIZP 61823 (340.0), paratype, NMMB-P006230 (325.0), paratype.	NE Taiwan
<i>Gigantactis vanhoeffeni</i> Brauer	ASIZP 59903 (355.0), ASIZP 60136 (420.0), ASIZP 61798 (356.0), ASIZP 61799 (370.0), ASIZP 65446 (210.0), NMMB-P006229 (360.0), NMMB-P10546 (345.0), NMMB-P10862 (360.0), NMMB-P10863 (380.0),	NE Taiwan
<i>Gigantactis elsmanni</i> Bertelsen, Pietsch & Lavenberg	SIZP 61800 (396.0), ASIZP 65436 (390.0),	NE Taiwan
<i>Gigantactis gargantua</i> Bertelsen, Pietsch & Lavenberg	ASIZP 60277 (320.0), ASIZP 59883 (2, 268.0–270.0), ASIZP 65437 (272.0).	NE Taiwan
<i>Rhynchactis leptonema</i> Regan	ASIZP 59916 (139.0), ASIZP 61803 (141.0), ASIZP 62954 (88.0).	NE Taiwan
<i>Rhynchactis macrothrix</i> Bertelsen & Pietsch	ASIZP 61797 (116.0), ASIZP 61801 (152.0), ASIZP 61804 (126.0), ASIZP 62880 (70.0), ASIZP 63267 (143.0), ASIZP 65431 (148.0).	NE Taiwan
Family Linophryidae		
<i>Linophryne indica</i> (Brauer)	ASIZP 61806 (18.0, ♂)	SW Taiwan
<i>Linophryne</i> sp. 1	ASIZP 62942 (38.0)	NE Taiwan
<i>Linophryne</i> sp. 2	ASIZP 66386 (39.5, ♀+♂)	South China Sea

Synopsis of deep-sea anglerfishes of Taiwan

Table 1 lists all ceratioid species and specimens collected from Taiwan.

Four species have been described as new: *Oneirodes pietschi* and *Bufoceratias shaoi*, and two described herein, *O. formosanus* **sp. nov.** and *Gigantactis cheni* **sp. nov.** Among these species, our specimen of *Himantolophus melanolophus* is the only known record in the Pacific Ocean, whereas these of *Spiniphryne gladisfenae*, *Oneirodes carlsbergi*, *Centrophryne spinulosa* and *Rhynchactis macrothrix* represent the first records from the northwestern Pacific Ocean. *Linophryne indica* was represented by a male specimen, however, this species was commonly recorded in western Pacific. The specimen of *Lasiognathus* sp. with a missing illicium and can not be identified to the species level.

There are three unidentified females (*Oneirodes* sp. 1, *Linophryne* sp. 1 and *Linophryne* sp. 2) that are unlikely identical to any currently recognized species but more specimens are needed for further studies.

In addition, there is one unidentified male of *Himantolophus* sp. belonging to the *Himantolophus rostratus* species group of Bertelsen & Krefft (1988:77), and many unidentified females of *Oneirodes* spp. and juveniles of *Ceratias* spp. with under developed esca or metamorphosed females with broken esca that cannot be identified to the species level.

In summary, the diversity of deep-sea anglerfishes from Taiwan is relatively high, including all 11 families, 18 out of 35 genera (51.4%) and 30 out of 170 species (17.6%). Ho *et al.* (2018) estimated that the eel species in Taiwan represent about 23.3% of the world diversity which may suggest that the current diversity of deep-sea anglerfishes is lower than expected. More investigations may increase the numbers in the future.

Comparative materials. *Gigantactis paxtoni*: Holotype: AMS I.20314-018. Paratypes: AMS I.20070-016 (1), AMS I.20306-007 (1), AMS I.20314-060 (3), CSIRO H4586-01 (1), CSIRO H3280-01 (1), CSIRO H6177-01 (1), all from Australia. *Gigantactis meadi*: CSIRO H2511-02 (1), CSIRO H4841-01 (1), CSIRO H4154-01 (1), CSIRO H3852-01 (1), all from Australia.

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