



A new genus and species of the cod fish family Moridae (Order Gadiiformes) from southwestern Taiwan

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Abstract

Pterophycis spatium **gen. nov. et sp. nov.** is described on the basis of two specimens collected from shallow waters of southwestern Taiwan. The new genus can be distinguished from other genera in the family in having genital papilla separated from anus by several small scales, all rays on pelvic fin elongate, and the following combination of characters: light organ present; snout broad and rounded, without shelf-like plate; teeth absent from palatines and vomer; swimbladder with anterior elongate projections that attached to openings at rear of the skull; pelvic fin with 7 rays; first dorsal fin short-based, with 8 rays; and second dorsal and anal fins long-based, their margins not indented.

Key words: Pisces, ichthyology, taxonomy, *Pterophycis spatium*, Bigfin mora

Introduction

The gadiform fishes are mostly demersal which inhabits in shallow to deep water of depths greater than 1,000 m. A few species of the family Gadidae can grow up to 2 m, whereas codlets of the family Bregmaceridae are less than 10 cm long in general. Some families (i.e. Gadidae and Merlucciidae) include target species of very large-scale fisheries have been operating since the last century, while more than half of them live in the deep sea beyond commercial fishing depth (Cohen *et al.*, 1990).

The Moridae is currently the second largest family of gadiforms comprising 19 genera with about 107 species (Fricke *et al.*, 2019). However, most members are poorly known and there is no substantial agreement to identify how many genera recognized in this family. They are relative to elongate fishes, many with a narrow and distinct caudal peduncle and caudal fin. Most species are of rather small size, live in fairly deep water over hard bottom, and apparently do not dense aggregations (Cohen *et al.*, 1990).

The Moridae have been taxonomically reviewed by many researchers: the Pacific Ocean by Rass (1954); New Zealand region by Paulin (1983); and New Caledonia by Paulin & Roberts (1997). Regional or generic revision were made through the previous few decades (Small, 1981; Trunov, 1989, 1990, 1991, 1992a, b; Shcherbachev, 1993; Meléndez & Markle, 1997; Sazonov & Shcherbachev, 2000) and new genera or species were described (i.e. Paulin, 1986, 1987, 1989b, 1991; Sazonov, 1986, 2001; Markle & Meléndez, 1988; Parin & Sazonov, 1990; Anderson & Tweddle, 2002). No new taxon was described since 2002, except for one (González *et al.*, 2018). They are found throughout the world in tropical and temperate seas and occurred at depths ranging from 2–3 m to over 1500 m (Cohen *et al.*, 1990).

In Taiwan, Yu & Ho (2012) studied the taxonomy of Moridae and recognized 6 genera with 11 species, including one unidentified specimen. The specimen was tentatively identified as *Physiculus* sp. although it was likely an undescribed species. However, with a damaged tail and incomplete lateral line it was set aside and waiting for more suitable material. The second specimen of same species was recently collected from southwestern Taiwan and recognized as a new genus and species together with the previous specimen. In order to establish the new genus and species, a detailed description is provided here.

Methods and materials

Standard length (SL) and head length (HL) were measured from upper jaw symphysis to base of caudal fin, and to posterior end of opercle, respectively. Predorsal, prepectoral, prepelvic and preanal lengths, measured from upper jaw symphysis to origin of each fin; body depth at origin of dorsal fin; body width at base of pectoral fin; snout length from upper jaw symphysis to anterior margin of orbit; eye diameter length of longest horizontal distance of bony margin; interorbital width least distance between upper bony margins of orbit; post-orbital length from posterior bony margin to posterior end of opercle; upper-jaw length from upper jaw symphysis to posterior end of maxilla; pelvic-fin length from origin of fin to tip of longest ray; barbel length from its base to tip; first dorsal-fin height length of longest ray. Measurements of light organ length (LO), and interventral line to light organ (InV-LO), to anus (InV-anus), and to origin of anal fin (InV-af), followed Paulin (1989b).

Morphometric data were taken to nearest 0.1 mm using digital calipers, except for SL which was to nearest 1 mm. Specimens examined in the present study were deposited in the fish collection of Biodiversity Research Museum, Academia Sinica, Taiwan (ASIZP), Muséum national d'Histoire naturelle, France (MNHN) and National Museum of Marine Biology & Aquarium, Taiwan (NMMB-P).

Pterophycis gen. nov.

Type species. *Pterophycis spatium* Ho, **sp. nov.** (by monotypy), as described below.

Diagnosis. A genus of Moridae with a ventral light organ and differs from all other genera by having genital papilla separated from anus by several small scales, a large pelvic fin with all rays elongated (Fig. 1A), and the following combination of characters: snout broad and rounded, not shelf-like; palatines and vomer toothless; swim-bladder with elongate projections that attached to openings at rear of the skull (Fig. 2); pelvic fin with 7 rays; first dorsal fin short-based, with 8 rays; second dorsal and anal fins long-based, their margins not indented.

Etymology. From Latin *pter* means fin and *phycis*, a cod, in referring to the diagnostic large pelvic fin of the genus.

Relationship. The presence of the light organ and two dorsal fins suggest that *Pterophycis* **gen. nov.** is closely related to *Physiculus*, *Gadella* and *Salilota* belong to “*Physiculus*” subgroup (*sensu* Paulin, 1989a), which also includes *Tripterothycis* that has a light organ and three dorsal fins. It apparently shares many characters with the most specious genus *Physiculus* by the absence of vomerine teeth and similar fin elements and position. However, two diagnostic characters that distinguish these two genera are the large pelvic fins with all rays elongate and the position of genital papilla (Figs. 1A, vs. 1B, C).

In addition to these two diagnostic characters mentioned above, it can be further distinguished from the monotypic genus *Salilota*, restricted in southern America, by lacking tooth patch on vomer (vs. small tooth patch on vomer in *Salilota*) and 8 first dorsal-fin rays (vs. 9–12); and from the worldwide distributed genus *Gadella*, with 12 species currently, by having chin barbel (vs. absent in *Gadella*) and origin of anal fin slightly behind a vertical of that of second dorsal fin (vs. origin of anal fin well behind that of second dorsal fin). Members of *Tripterothycis*, with 2 species restricted in the Southern Hemisphere, have their light organs situated at around the anus and three well-separated dorsal fins which can be easily distinguished from those of other genera.

Pterophycis spatium sp. nov.

New English name: Bigfin mora

New Chinese name: 大鰭稚鱈 (Da-chi-zhi-shue)

Figs. 1A, 2A, 3A–C, 4A–B

Holotype. NMMB-P22891 (243 mm SL), Ke-tzu-liao, Kaohsiung, southwestern Taiwan, western Taiwan Strait, purchased from fish market, collected by local bottom trawl, 4 May 2015.

Paratype. ASIZP 58039 (1, 210+ mm SL), Chong-chou, Kaohsiung, southwestern Taiwan, 1 Dec. 1985.

Diagnosis. As given for the genus.

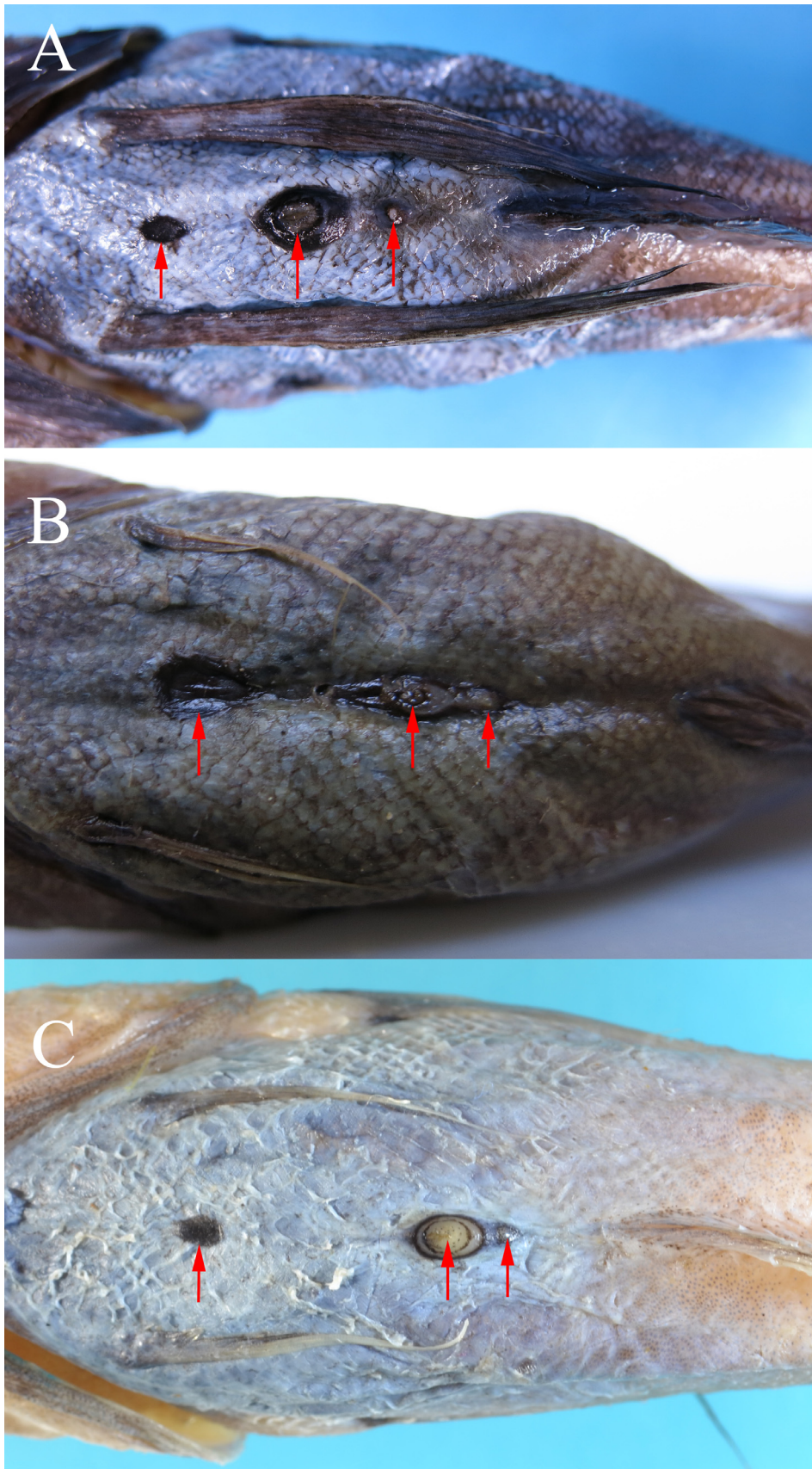


FIGURE 1. Ventral view of abdominal region comparing with the pelvic fins, light organ (left arrow), anus (middle arrow) and genital papilla (right arrow). A. *Pterophyscis* **gen. nov.**, NMMB-P22891. B. Holotype of *Physiculus dalwigkii*, type species of *Physiculus*, MNHN 1996-1380, 190 mm SL. C. *Physiculus chigodarana*, NMMB-P16401, 118 mm SL.

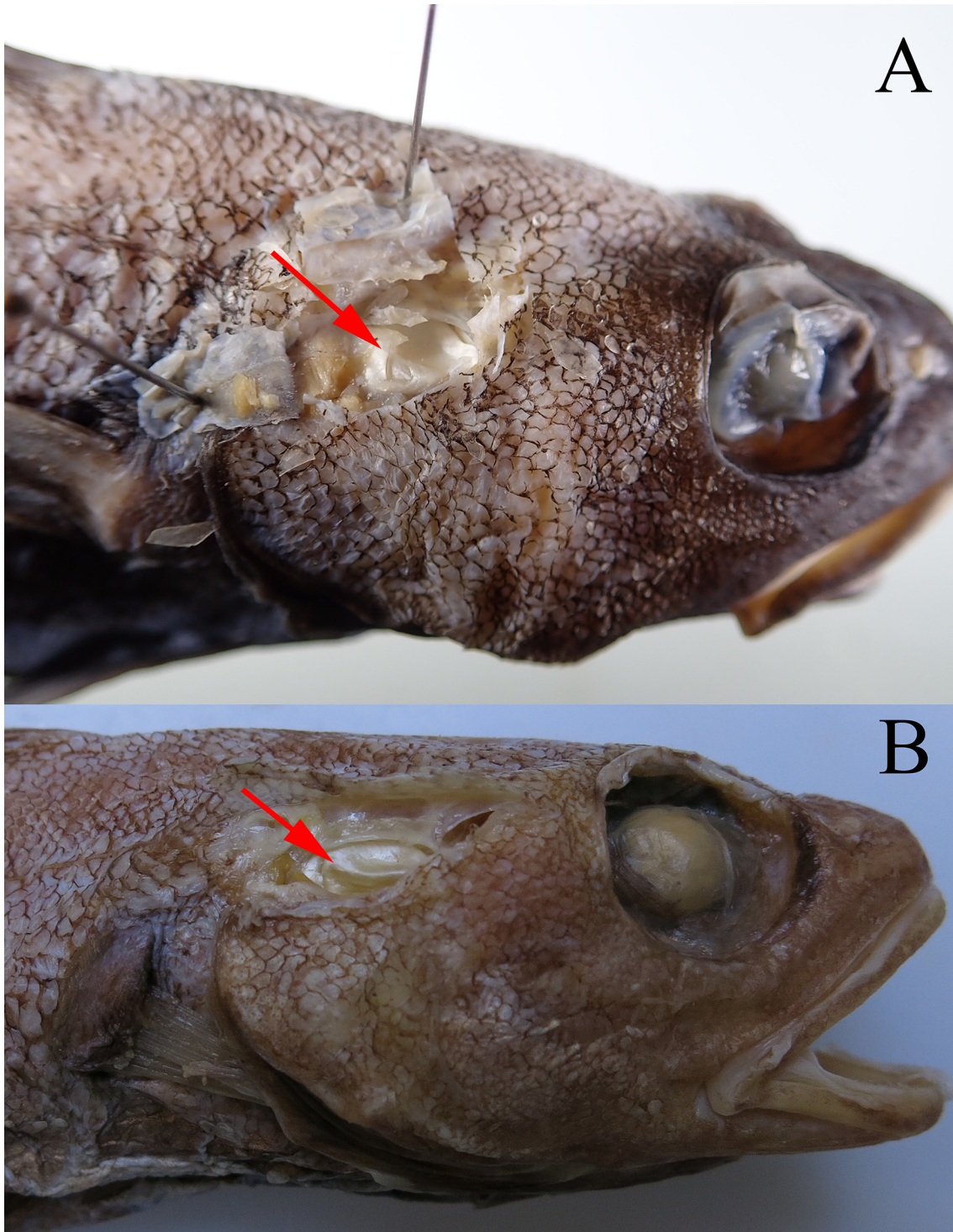


FIGURE 2. Dorsolateral view of head showing the anterior extension of swimbladder (arrowed). A. *Pterophycis* **gen. nov.**, NMMB-P22891. B. *Physiculus dalwigkii*, type species of *Physiculus*, MNHN A.4502, 197 mm SL.

Description. The following data are given for the holotype, followed by the value of paratype in parentheses, when available. Characters given in the diagnosis of the genus are not repeated.

First dorsal-fin rays 8 (8), second dorsal-fin rays 67 (47+); pectoral-fin rays 27 (29); anal-fin rays 71 (47+); pelvic-fin rays 7 (7/5); scales in longitudinal series ca. 125 (ca. 105+); scale rows between first dorsal-fin base and lateral line 12 (11); gill rakers 3+8=11 (3+4=7); vertebrae 15+40=55.



FIGURE 3. *Pterophycis spatium* **sp. nov.**, holotype, NMMB-P22891, 243 mm SL. A. Lateral view. B. Ventral view of head. C. Lateral view of head.



FIGURE 4. Paratype of *Pterophyscis spatium* **sp. nov.**, ASIZP 58039, 210+ mm SL. A. lateral view (reversed). B. Ventral view of anterior body.

Head length 4.0 times in SL; predorsal length 3.3; prepectoral length 3.7; prepelvic length 4.2; preanal length 2.7; dorsal-fin base 1.5; anal-fin base 1.5; pectoral-fin length 6.0; pelvic-fin length 4.1. Snout 3.3 (3.1) times in head length; eye diameter 4.0 (3.9); interorbital width 4.5 (4.3); upper-jaw length 2.2 (2.1); post-orbital length 1.9 (2.0); barbel 6.6 (6.5); longest first dorsal-fin ray 2.8 (2.8); longest second dorsal-fin ray 2.8; caudal-peduncle length 6.5; caudal-peduncle height 8.5.

Body moderately elongate, robust anteriorly, gradually compressed and narrowing to a narrow caudal peduncle and caudal fin. Head large and broadly rounded, slightly depressed anteriorly; snout wide with a round anterior outline; eye large, its diameter slightly wider than interorbital space. Mouth large and terminal; maxilla extends to a vertical near the posterior margin of eye; upper jaw slightly overhanging the lower jaw. Gill slit wide. Teeth villiform, in wide band on both jaws; vomerine and palatine toothless. Chin barbel present, its length shorter than eye diameter.

Two dorsal fins. Origin of first dorsal fin clearly behind a vertical of insertion of pectoral fin; origin of anal fin slightly behind a vertical of that of second dorsal fin; pectoral fin with broad base, rounded posteriorly, with lower rays gradually shorter; pelvic fin thoracic, extremely large, inserting slightly anterior to pectoral fin, when appressed, its tip extends to base of 15th (21st) ray of anal fin, all rays elongate, subequal in length; caudal fin small, well separated from dorsal and anal fins, rounded and symmetrical posteriorly. Caudal peduncle short, its length less than eye diameter.

Scales cycloid, small, oval-shaped; scale patch extends to anterior nostril and below middle of eye; naked area on snout large, not reaching to middle of eye. Gular region and branchiostegal membrane naked. Scales in front of pelvic-fin base gradually smaller anteriorly.

Luminous organ large, distance between its anterior and posterior margins 12.7% (22.0%) of distance between interventral line and origin of anal fin (InV-af); its locality closer to interventral line than anus (at middle point of interventral line and anus in paratype), distance between interventral line and anterior margin of light organ (InV-LO) 21.7% (29.8%) of InV-af; anus large and rounded, circled by black naked skin, situating slightly closer to interventral line than origin of anal fin (at middle point of interventral line and origin of anal fin in paratype); genital papilla separated posteriorly from anus by several small scales.

Coloration. When fresh body reddish brown and trunk blue-tan; branchiostegal membrane black; first dorsal fin and pectoral- and pelvic- fin bases darker; second dorsal and anal fins with indistinct black margins. The preserved holotype is darker than its fresh condition overall. The long-term preserved paratype lost most of its coloration; head light brown; gular region, branchiostegal membranes, naked area of snout and outer margins of dorsal and anal fins deep brownish, with all other portions of body creamy white.

Distribution. Only known from the shallow waters (less than 100 m) in southwestern Taiwan off Kaohsiung, western Taiwan Strait, southwestern Taiwan.

Etymology. The specific name *spatium*, means distance in Latin, is referred to the clear gape between the anus and genital papilla, which is unique for the family.

TABLE 1. Morphometric data of the holotype and paratype of *Pterophycis spatium* sp. nov.

	Holotype				Paratype	
	243 mm SL				210+ mm SL	
	%SL	in SL	%HL	in HL	%HL	in HL
Head length	25.3	4.0	-	-	-	-
Predorsal length	30.1	3.3	-	-	-	-
Prepectoral length	27.0	3.7	-	-	-	-
Prepelvic length	23.9	4.2	-	-	-	-
Preanal length	37.7	2.7	-	-	-	-
Anal-fin base	57.4	1.7	-	-	-	-
Dorsal-fin base	65.2	1.5	-	-	-	-
Longest caudal-fin ray	8.3	12.0	32.8	3.0	-	-
Pectoral-fin length	16.6	6.0	65.5	1.5	-	-
Pelvic-fin length	24.7	4.1	97.4	1.0	109.1	0.9
Snout length	7.7	12.9	30.6	3.3	31.8	3.1
Upper-jaw length	11.5	8.7	45.4	2.2	48.3	2.1
Eye diameter	6.4	15.7	25.2	4.0	25.5	3.9
Interorbital width	5.6	17.7	22.3	4.5	23	4.3
Post-orbital length	13.3	7.5	52.4	1.9	50.8	2.0
Barbel length	3.8	26.1	15.1	6.6	15.4	6.5
Longest 1st dorsal-fin ray	8.9	11.2	35.3	2.8	35.4	2.8
Longest 2nd dorsal-fin ray	9.1	10.9	36.1	2.8	-	-
Caudal-peduncle length	3.9	25.9	15.3	6.5	-	-
Caudal-peduncle depth	3.0	33.8	11.7	8.5	-	-
	%InV-af				%InV-af	
InV-LO	21.7				29.8	
LO	12.7				22.0	
InV-anus	72.4				87.3	

Discussion

These two specimens of *Pterophycis spatium* were identified as member of Moridae because of both having elongate anterior projections of the swimbladder attached to openings at rear of the skull just above the gill openings and a narrow caudal peduncle. As mentioned about, four genera with the ventral light organ were recognized in the family Moridae as “*Physiculus*” subgroup by Paulin (1989a), here we add one new genus into the subgroup (see a key to these genera below).

The positions of light organ and anus are quite variable in most gadiform fishes, especially in Moridae and Macrourinae (Cohen *et al.*, 1990, Shcherbachev, 1993). The light organ is located at well before pelvic fin (ex. *Coelorinchus*, in part), interventral space (*Salilota*, *Coelorinchus*, in part), vary in abdomen region (*Physiculus*), or immediately before anus (*Tripterocephalus*, *Coelorinchus*, in part). The anus is located at interventral space (ex. *Nezumia*), vary in abdomen region (*Physiculus* and most species in Macrourinae), or immediately in front of anal-fin origin (*Hymenocephalus* and *Coelorinchus*, in part). However, their genital papillae or genital openings are always close to the anus, either closely attached or restricted in a naked region around the anus (ex. *Mataeocephalus*, *Trachonurus*, *Ventrifossa*) (Cohen *et al.*, 1990). As a consequence, *Pterophycis spatium* is the only species with genital papilla away from the anus, separated by scales, and is unique for the entire order.

Key to genera with light organ on abdomen in Moridae (subgroup *Physiculus*)

- 1A. Light organ restricted to an area around anus, not clearly separated from anus; three dorsal fins *Tripterocephalus*
- 1B. Light organ a scaleless fossa, well in advance of anus; two dorsal fins 2
- 2A. No barbel on tip of lower jaw *Gadella*
- 2B. Barbel present on tip of lower jaw 3
- 3A. Teeth present on vomer *Salilota*
- 3B. Teeth absent from vomer 4
- 4A. Pelvic fin large, all rays elongate and subequal in length; genital papilla separated from anus by scales *Pterophycis* **new genus**
- 4B. Pelvic fin thin or slender, only 2 outermost rays elongate; genital papilla and anus restricted to an naked area *Physiculus*

Comparative materials. *Physiculus dalwigkii* (type species of *Physiculus*): MNHN 1996-1380, 190 mm SL, holotype, no locality, probably Mediterranean; MNHN 1898-0929, 203 mm SL, off Nice, France, Mediterranean Ocean, 1898; MNHN A.4502, 197 mm SL, off Nice, France, Mediterranean, 1881. Other specimens are as listed in Yu & Ho (2012).

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