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A Review of Lanternfishes (Families: Myctophidae and Neoscopelidae) and Their Distributions around Taiwan and the Tungsha Islands with Notes on Seventeen New Records

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John Ta-Ming Wang and Che-Tsung Chen (2001) A review of lanternfishes (Families: Myctophidae and Neoscopelidae) and their distributions around Taiwan and the Tungsha Islands with notes on seventeen new records. *Zoological Studies* **40**(2): 103-126. Lanternfishes collected during 9 cruises from 1991 to 1997 were studied. The area sampled lies between 19°N and 25°N and 114°E and 123°E. The specimens collected in this area comprise 40 species belong to 16 genera, among which 17 species are first records. These first record species include *Benthosema fibulatum*, *Bolinichthys supralateralis*, *Electrona risso*, *Hygophum proximum*, *H. reinhardtii*, *Lampadena anomala*, *Lobianchia gemellarii*, *Lampanyctus niger*, *L. turneri*, *L. tenuiformis*, *Myctophum asperum*, *M. aurolaternatum*, *M. nitidulum*, *M. spinosum*, *Notolychnus valdiviae*, *Notoscopelus caudispinosus*, and *N. resplendens*. Among these, six species, *Bolinichthys supralateralis*, *Electrona risso*, *Lampanyctus turneri*, *Lampadena anomala*, *Notolychnus valdiviae*, and *Notoscopelus caudispinosus*, are first records for the South China Sea, and the species, *Lampadena anomala* is a new record for Asian oceans (Table 1). Four species (*Triphoturus microchir*, *Diaphus diadematus*, *D. latus*, and *D. taaningi*) were controversial in previous reports, so they are discussed in this study. Geographic distributions and localities of catches of all lanternfish species are shown on the maps (Figs. 3-8).

Key words: Myctophidae, Neoscopelidae, Fish fauna, Deep-sea fishes.

Lanternfishes (Families: Myctophidae and Neoscopelidae) are ubiquitous and speciose, with approximately 240 species in 30 genera, (Nafpaktitis 1978, Hulley et al. 1995). Up to half of fish larvae collected in the open ocean are myctophid fishes (Moser et al. 1974), and myctophids may have the greatest biomass of any vertebrate family (Ahlstrom et al. 1976). It is well known that myctophids are often one of the major elements in the deep scattering layer (Barham 1966, Pearcy and Mesecar 1971), and also are key members of the oceanic food web. Among the commercially important and protected marine vertebrates known to prey on them are salmon (Shimada 1948, Manzer 1968), tuna (Alverson 1963, Pinkas et al. 1971), rockfish (Pereyra et al. 1969), fur seals (Mead and Taylor 1953), and cetaceans (Fitch and Brownell 1968). Most myctophid fishes exhibit a diel vertical migration between the mesopelagic and epipelagic zones to feed on zooplankton in the upper 200-m depth.

In earlier synopses of the fishes of Taiwan, only 3 myctophid species in 3 genera were recorded (Chen 1969, Shen 1984). One species was added in 1986 (Chen and Yu 1986). The most recent review of lanternfishes from Taiwan lists 2 families, six genera, and 12 species (Shen et al. 1993), so lanternfishes in Taiwan were not divided into 2 families until Shen et al. (1993). Kao and Shao (1996) published 5 new records in the genus *Diaphus*, so the lanternfishes around Taiwan increased to a total of 17 species in 6 genera.

There is no doubt that body photophore patterns on myctophids and neoscopelids are of taxonomic importance, so most researchers often classify them according to their body photophore patterns. But not all body photophores, such as the AO photophores,

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are stable as a taxonomic character (Fraser-Brunner 1949). Some myctophids (especially in the genus *Diaphus*) with very similar body photophore patterns are quite different species (such as *D. coeruleus* and *D. watasei*), and many species possess sexual dimorphism (especially in the genus *Diaphus*), so it is very easy to misidentify them and even separate members of the same species. To date, about 340 nominal myctophid species have been described under the 56 genera. However, according to current estimates, approximately 240 species in not more than 30 genera are generally recognized (Nafpaktitis 1978, Paxton 1979). So, many lanternfish species in previous reports from Taiwan deserve further detailed revision.

Meanwhile, Chen (1983) reported 11 genera and 25 species in the central waters of the South China Sea, whereas Huang and Yang (1983) recorded 13 genera and 31 species from the waters adjacent to the Tungsha Islands in the South China Sea. Yang et al. (1996) reported 2 families, 16 genera, and 54 species from the Nansha Islands in the northeastern part of the South China Sea. Ni and Kwok (1999) listed only 1 species in Hong Kong waters.

Seventeen species belonging to 10 genera presented in this paper are first records for the northern South China Sea and the waters around Taiwan (Fig. 1), and the total number of lanternfishes from Taiwan has increased to 41 species (although *Diaphus taaningi* is absent from our collection) in 16 genera. Until now, there have been no detailed distribution data for each lanternfish around this area. This study lists 40 species, and their distributions are shown on maps (Figs. 3-8).

MATERIALS AND METHODS

Most of the materials used in this study were collected on 6 cruises of the *Fishery Researcher* 1 of the Taiwan Fisheries Research Institute from 1994 to 1997, during which 184 samplings including 1622 lanternfish specimens were obtained (among them, just 107 specimens are new records and are examined in this study). Another 35 specimens were obtained on 4 cruises of the *Ocean Researcher* III of National Sun Yat-sen University in 1991, 1994, and 1995. The specimens were collected either by a 15-foot or 6-foot IKMT (Issac-Kidd Midwater Trawl) or by bottom trawls (Table 2). IKMT collections (including 117 samplings) were conducted as oblique tows (with net depths ranging from 50 to 1500 m) at 117 sampling stations. Net depth and width were monitored with Scanmar 400 or Simrad ITI acoustic sensors. A further 55 bottom trawl samplings were conducted at depths ranging from 336 to 1521 m. In addition, a few specimens were collected at the Tahsi and Tungkang fish markets. All specimens have been deposited at the Laboratory of Fisheries Science Department of National Taiwan Ocean University (NTOU).

Table 1. New record species in this study and with the comparison between mainland China and Japan

	Mainland China				Japan			
Species	Chen[a]	Huang[b]	Huang[c]	Yang	Kawaguchi	Uyeno	Nakabo	Masuda
Benthosema fibulatum	+		+		+		+	+
Bolinichthys supralateralis						+		
Electrona risso					+	+	+	
Hygophum proximum	+		+	+	+		+	+
Hygophum reinhardtii				+	+		+	+
Lampadena anomala								
Lampanyctus niger	+	+	+	+	+			+
Lampanyctus tenuiformis			+	+	+	+	+	+
Lampanyctus turneri							+	+
Lobianchia gemellarii					+			+
Myctophum asperum	+	+	+	+	+		+	+
Myctophum aurolaternatum	+	+	+	+	+		+	+
Myctophum nitidulum	+		+	+	+	+	+	+
Myctophum spinosum				+	+		+	+
Notolychnus valdiviae					+		+	+
Notoscopelus caudispinosus					+		+	
Notoscopelus resplendens		+	+	+	+		+	

[a]Chen 1983; [b]Huang 1983; [c]Huang 1994.

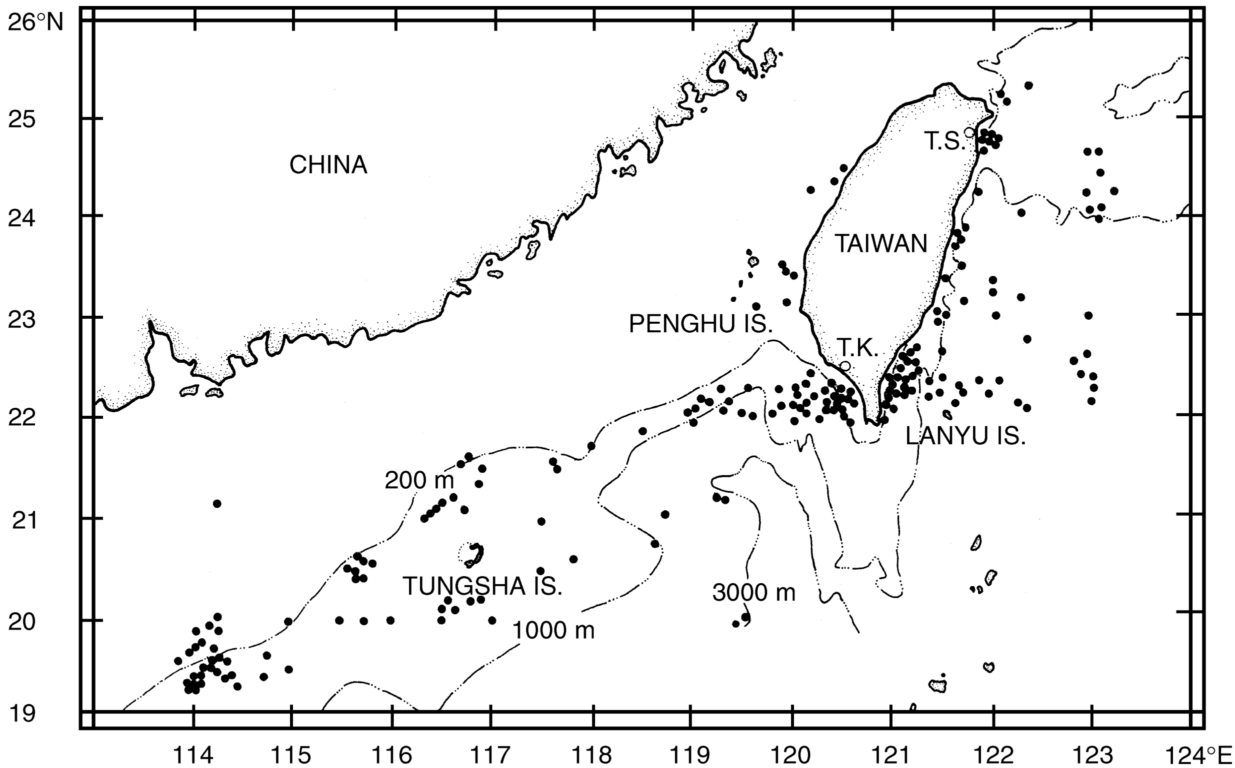

Fig. 1. Localities of sampling stations (T.K. = Tungkang; T.S. = Tashi).

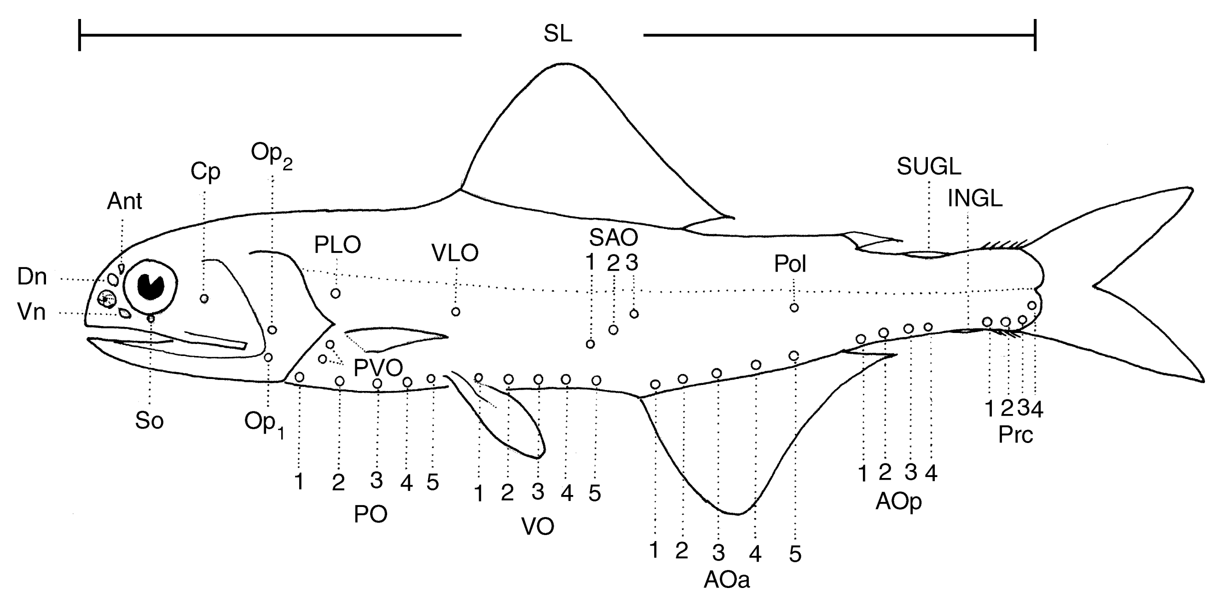

Fig. 2. General distribution of luminous organs and their abbreviated terminology in the family Myctophidae.
Dn = Dorsonasal organ; Vn = Ventronasal organ; So = Suborbital organ; Ant = Antorbital organ; Op = Opercular organs; Cp = Cheek photophore; PO = Thoracic organs; PVO = Subpectoral organs; PLO = Suprapectoral organ; VO = Ventral organs; VLO = Supraventral organ; SUGL = Supracaudal gland; SAO = Supra-anal organs; AOa = Anterior anal organs; AOp = Posterior anal organs; Pol = Postero-lateral organs; Prc = Precaudal organs; INGL = Infracaudal gland; SL = Standard length.

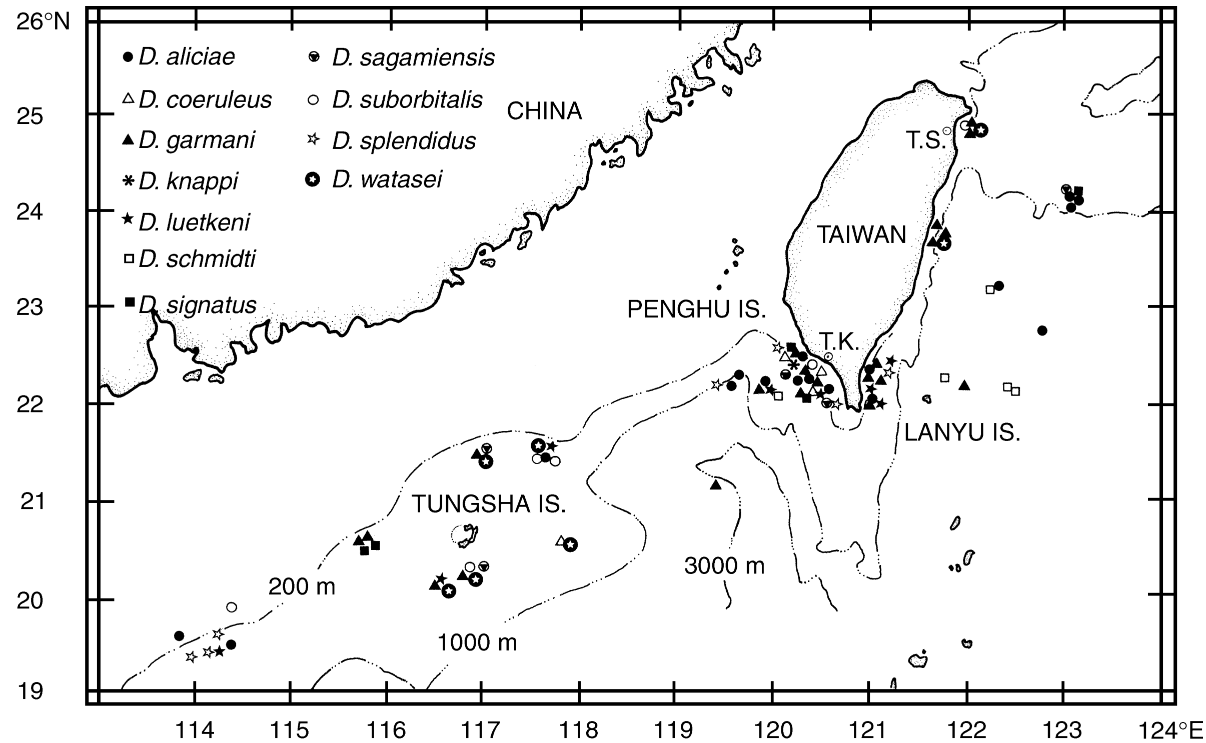

Fig. 3. Distribution of the genus *Diaphus* (T.K. = Tungkang; T.S. = Tashi).

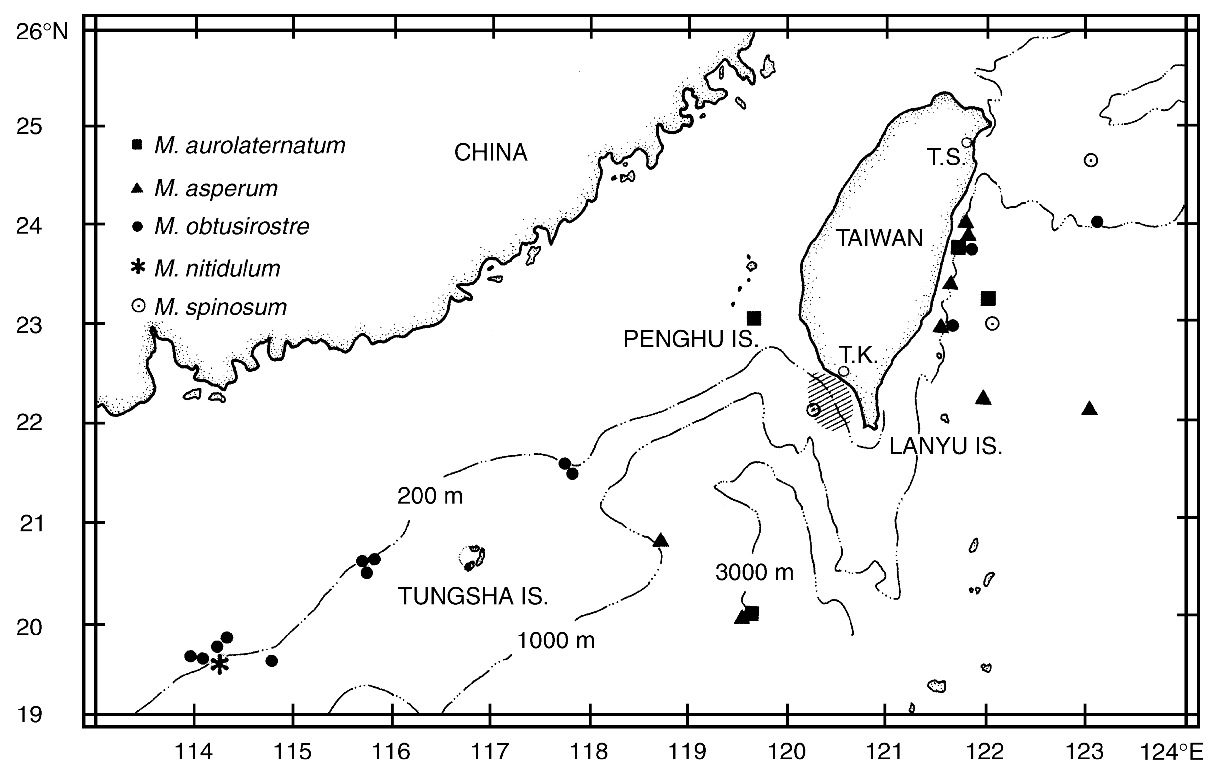

Fig. 4. Distribution of the genus *Myctophum* (shaded area indicates where *M. obtusirostre* is very abundant; T.K. = Tungkang; T.S. = Tashi).

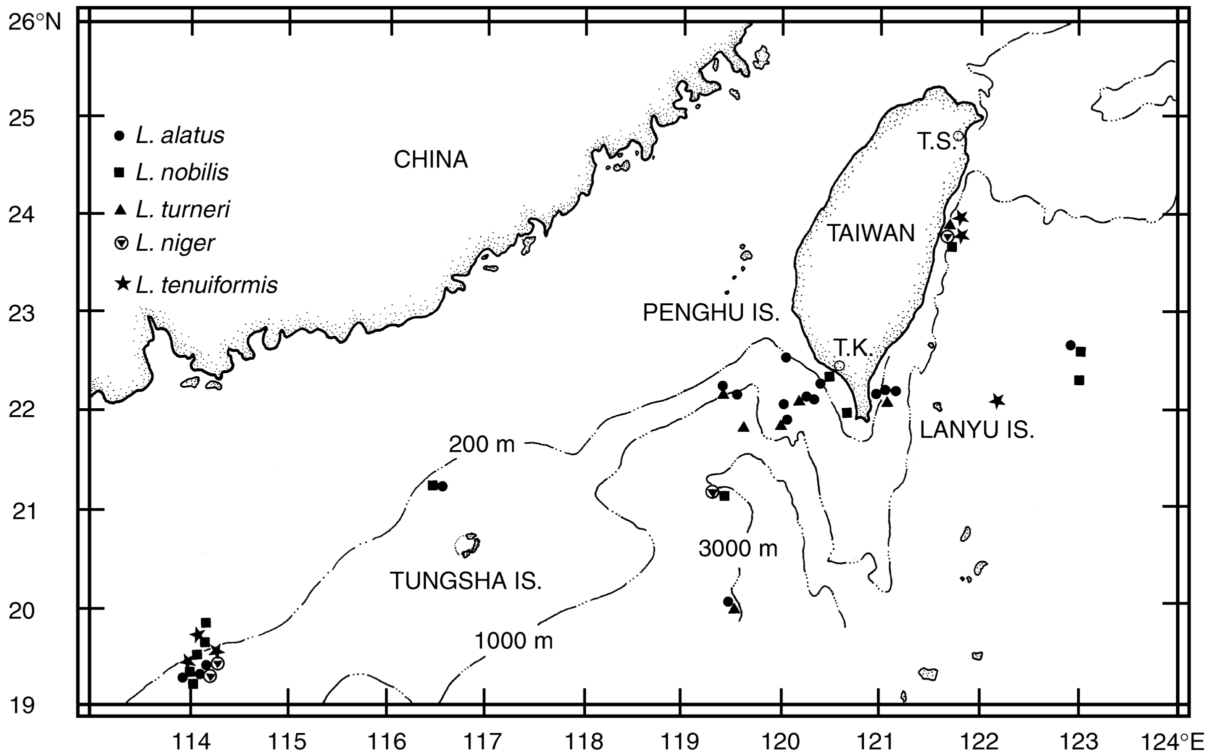

Fig. 5. Distribution of the genus *Lampanyctus* (T.K. = Tungkang; T.S. = Tashi).

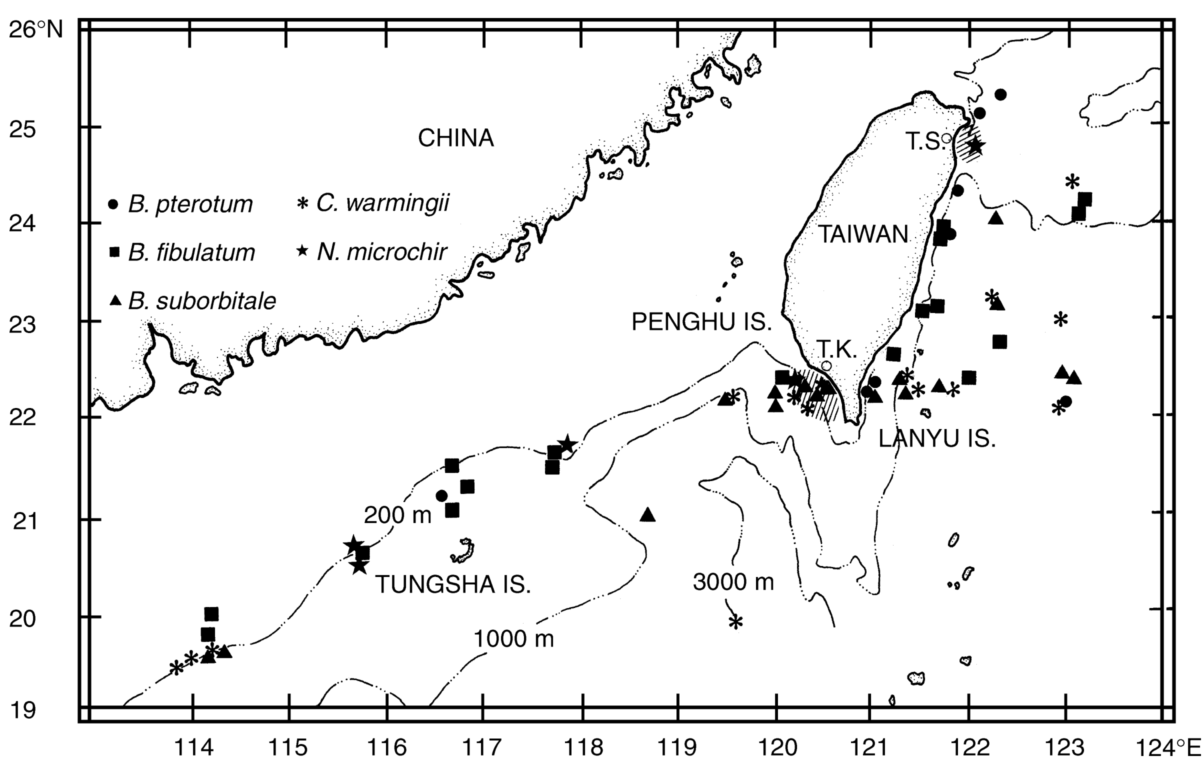

Fig. 6. Distribution of the fishes of the genera *Benthosema*, *Ceratoscopelus*, and *Neoscopelus* (family: Neoscopelidae) (shaded areas represent where *B. pterotum* is very abundant; T.K. = Tungkang; T.S. = Tashi).

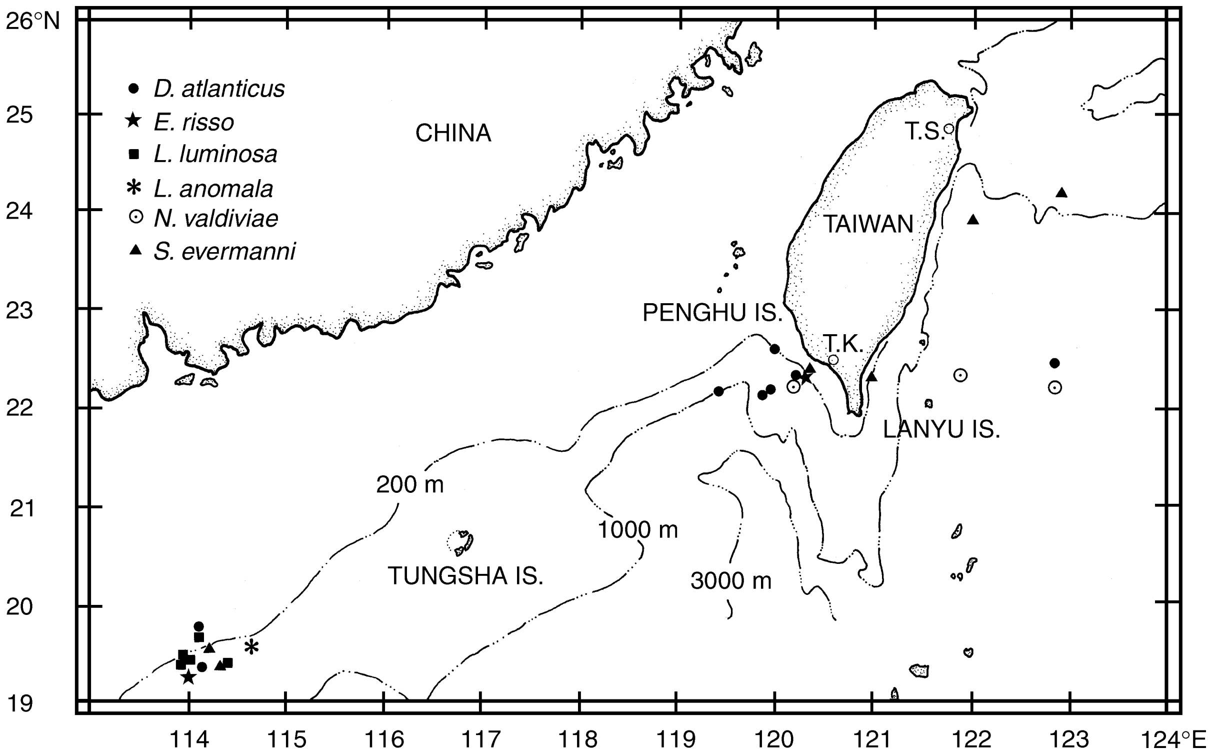

Fig. 7. Distribution of the fishes of the genera *Diogenichthys*, *Electrona*, *Lampadena*, *Notolychnus*, and *Symbolophorus* (T.K. = Tungkang; T.S. = Tashi).

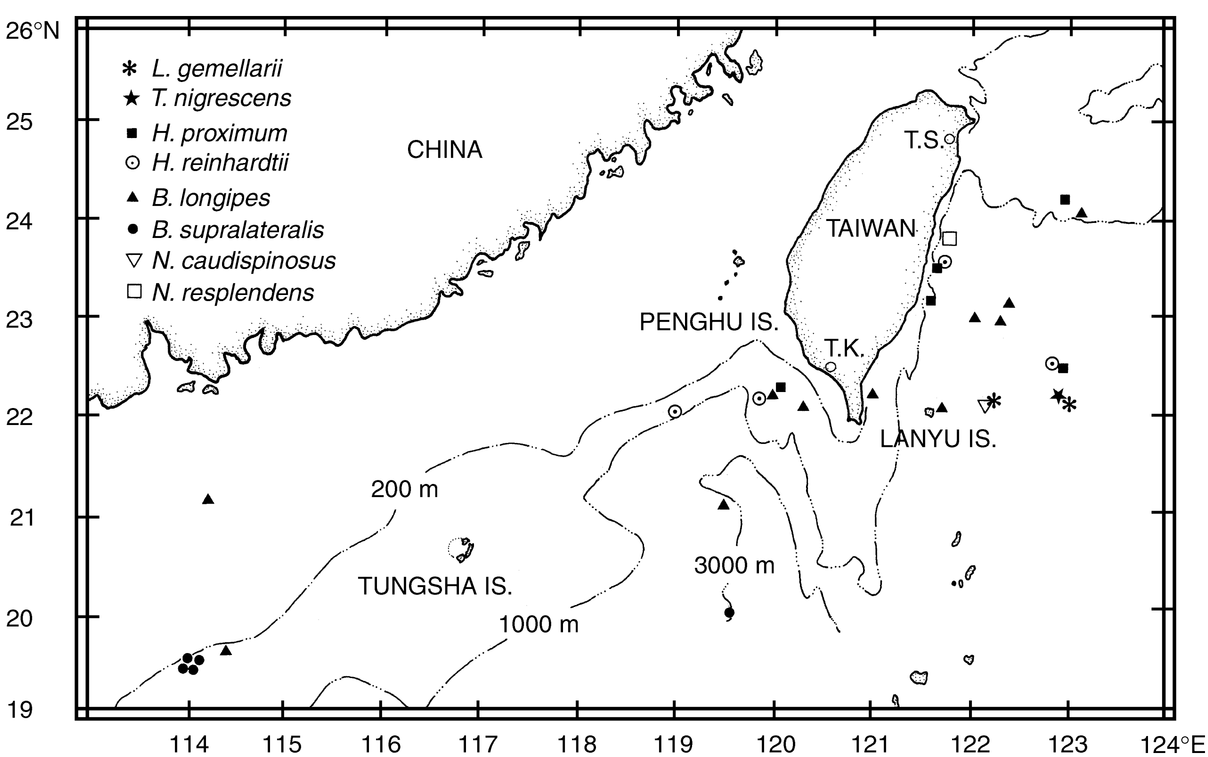

Fig. 8. Distribution of the fishes of the genera *Bolinichthys*, *Hygophum*, *Lobianchia*, *Notoscopelus*, and *Triphoturus* (T.K. = Tungkang; T.S. = Tashi).

The sampling localities of the specimens examined are shown in figure 1.

The similarity index used in this study follows that of Odum (1983) and Kerb (1994), that is, the similarity index equals 2**C** / (**A** + **B**); where **A** is the number of species in sample (or community) **A**; **B** is the number of species in sample (or community) **B**; and **C** is the number of species occurring in both samples (or communities). This index ranges from 0 to 1.0 to quantify the range from no similarity to complete similarity, respectively.

Methods of measuring and counting followed Nafpaktitis (1969), while photophore groupings and their abbreviations are in accordance with Parr (1929) and Nafpaktitis (1969) (Fig. 2).

RESULTS

Key to lanternfishes in the waters around Taiwan (where an asterisk (*) indicates a 1st record in figure 1; characters in brackets can readily distinguish the species from other congeneric species. G.R., gill rakers; LL, lateral line; BD, body depth; P., pectoral fin; V., ventral fin; A., anal fin. Other abbreviations in this key are explained in figure 2)

1a. Photophores present midventrally from the end of head to beginning of the caudal fin, [G.R. 10-12] **(Family: Neoscopelidae)** .... *Neoscopelus microchir*

Table 2. Lanternfishes in Tungsha, southwestern Taiwan, and eastern Taiwan (+, rare; ++, many; +++, abundant)

Species	Chinese name	Tungsha Islands	Southwestern Taiwan	Eastern Taiwan
Benthosema fibulatum	帶底燈魚	+++	+	+
Benthosema pterotum	七星底燈魚	+	+++	+++
Benthosema suborbitale	耀眼底燈魚	+	+	+
Bolinichthys longipes	長鰭虹燈魚	+	+	++
Bolinichthys supralateralis	側上虹燈魚	+++		
Ceratoscopelus warmingii	瓦氏角燈魚	++	+	+++
Diaphus aliciae	長距眶燈魚	++	++	+++
Diaphus coeruleus	藍光眶燈魚	++	+++	
Diaphus garmani	亮胸眶燈魚	+++	+++	+++
Diaphus knappi	奈氏眶燈魚		+	
Diaphus luetkeni	呂氏眶燈魚	++	++	+++
Diaphus sagamiensis	相模眶燈魚	+++	+++	+
Diaphus schmidti	史氏眶燈魚		+	++
Diaphus signatus	后光眶燈魚		+	+
Diaphus splendidus	亮眶燈魚	++	++	+
Diaphus suborbitalis	光腺眶燈魚	+++	+	++
Diaphus watasei	渡瀨眶燈魚	+++	+	++
Diogenichthys atlanticus	西明燈魚		+	+
Electrona risso	高體電燈魚	+	+	
Hygophum proximum	近壯燈魚			+
Hygophum reinhardtii	萊氏壯燈魚			+
Lampadena anomala	糙炬燈魚	+		
Lampadena luminosa	發光炬燈魚	+++		
Lampanyctus alatus	細斑珍燈魚	+	++	++
Lampanyctus niger	黑體珍燈魚	++	+	+
Lampanyctus nobilis	名珍燈魚	+++	++	+++
Lampanyctus turneri	圖氏珍燈魚	+	++	
Lampanyctus tenuiformis	天紐珍燈魚	+		+
Lobianchia gemellarii	日本葉燈魚			+
Myctophum asperum	暗色燈籠魚	+		+
Myctophum aurolaternatum	金焰燈籠魚	+		+
Myctophum nitidulum	閃光燈籠魚	+		
Myctophum obtusirostre	鈍吻燈籠魚	+++	++	++
Myctophum spinosum	櫛棘燈籠魚		+	+
Neoscopelus microchir	短鰭新燈魚	+++	+++	++
Notolychnus valdiviae	尖吻背燈魚		+	+
Notoscopelus caudispinosus	尾棘背燈魚			+
Notoscopelus resplendens	閃光背燈魚			+
Symbolophorus evermanni	埃氏標燈魚	+	+	+
Triphoturus nigrescens	黑尾燈魚			+

1b. Photophores absent on midventral part of body **(Family: Myctophidae)** 2
2a. 2 Prc 3
2b. More than 2 Prc 16
3a. Prc_2 well above horizontal septum; VLO, SAO_3, and Pol very close to dorsal contour of body ...... *Notolychnus valdiviae**
3b. Prc_2 below horizontal septum; VLO, SAO_3 and Pol below (or near) LL 4
4a. Pol absent; AO continuous [BD > 1/3 SL] ..... *Electrona risso**
4b. Pol present; AO series dividing into AOa and AOp 5
5a. 2 Pol 6
5b. 1 Pol 7
6a. Origin of the upper edge of pectoral fin below level of center of eye; anal fin rays fewer than 22 ..... *Hygophum proximum**
6b. Origin of upper edge of pectoral fin on or above level of center of eye; anal fin rays more than 22 .... *Hygophum reinhardii**
7a. PVO series horizontal, VO_2 elevated 8
7b. PVO series on an inclined line, VO series level 11
8a. Prc_2 much higher than Prc_1 9
8b. Prc horizontal .... *Diogenichthys atlanticus*
9a. So present; G.R. 13-15 .... *Benthosema suborbitale*
9b. So absent; G.R. 20-29 10
10a. SAO_1 well below line connecting VLO with SAO_2; OP_2 on level of ventral margin of orbit ...... *Benthosema fibulatum**
10b. SAO_1 on line connecting VLO with SAO_2; OP_2 well above level of ventral margin of orbit .... *Benthosema pterotum*
11a. SAO series strongly angulate, (1st AOp above on A. base) .... *Symbolophorus evermanni*
11b. SAO series in a straight (or slightly angulate) line 12
12a. Scales cycloid 13
12b. Scales ctenoid 15
13a. Posterodorsal margin of operculum sharply angulate .... *Myctophum nitidulum**
13b. Posterodorsal margin of operculum evenly rounded 14
14a. Pol well in advance of vertical at origin of adipose fin base .... *Myctophum aurolaternatum**
14b. Pol on or slightly behind vertical at origin of adipose fin base .... *Myctophum obtusirostre*
15a. SAO series strongly angulate, G.R. 13-17 .... *Myctophum asperum**
15b. SAO series slightly angulate, ctenoid scales along anal fin base bearing 1-3 elongated posteriorly directed spines, G.R. 18-25 .... *Myctophum spinosum**
16a. 3 Prc 17
16b. 4 Prc 23
17a. Crescentic whitish tissue on posterior 1/2 of iris; [3 SAO] 18
17b. No crescentic whitish tissue on posterior 1/2 of iris 19
18a. VLO at LL; [INGL not reaching last AOp] .... *Bolinichthys longipes*
18b. VLO about midway between ventral fin and LL; [G.R. 19-22] .... *Bolinichthys supralateralis**
19a. 1 Pol; SUGL and INGL large, singular and bordered by heavy black pigment 20
19b. 2 Pol; SUGL and INGL consisting of several patches of luminous tissues, not bordered by heavy black pigment 21
20a. PO_4 highly elevated .... *Lampadena luminosa*
20b. PO on a level line; [VO plus SAO 5-6; AOa 3-4] .... *Lampadena anomala**

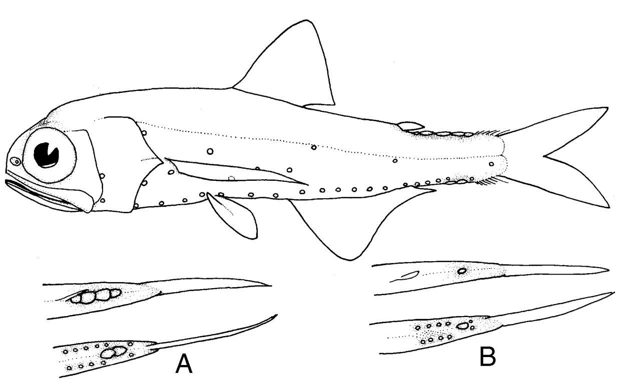

Fig. 9. *Benthosema fibulatum*, ♂, NTOU 11601, 62.7 mm SL. (A) SUGL (top) and INGL (bottom) of the same specimen. (B) SUGL (top) and INGL (bottom) of female, NTOU 11505, 62.0 mm SL.

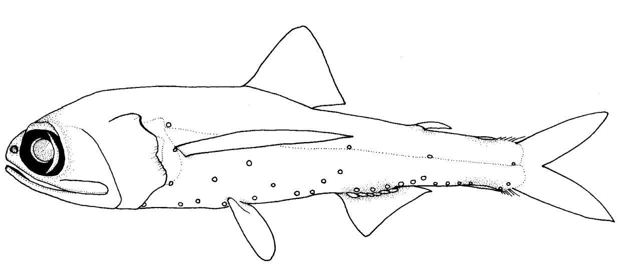

Fig. 10. *Bolinichthys supralateralis*, NTOU 15601, 78.1 mm SL.

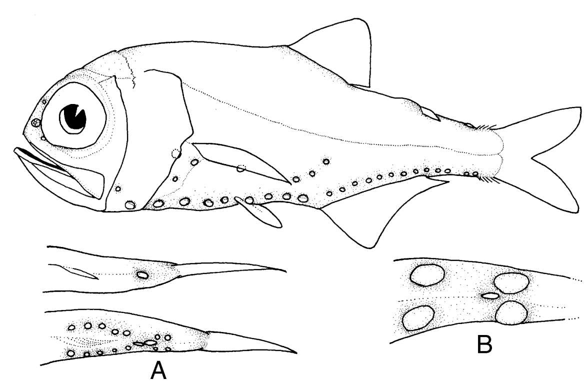

Fig. 11. *Electrona risso*, ♂, NTOU 18501, 65.9 mm SL. (A) SUGL (top) and INGL (bottom) of the same specimen. (B) INGL of female, NTOU 18502, 45.5 mm SL.

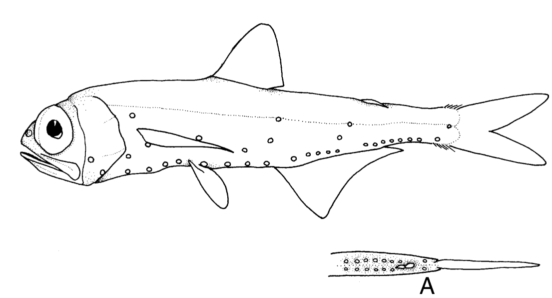

Fig. 12. *Hygophum proximum*, ♀, NTOU 19401, 39.4 mm SL. (A) INGL of the same specimen.

21a. 2 Pol on a horizontal line 22
21b. 2 Pol not on horizontal line .... *Triphoturus nigrescens*
22a. G.R. 19-22 .... *Notoscopelus resplendens**
22b. G.R. fewer than 15 .... *Notoscopelus caudispinosus**
23a. PO_1, PVO_1, PVO_2 and VO_1, VO_2, VO_3 on 2 straight ascending lines 29
23b. PO_1, PVO_1, PVO_2 and VO_1, VO_2, VO_3 not on straight ascending lines 24
24a. PO_4 not elevated; luminous scalelike structures midventrally between V. base and anus .... *Ceratoscopelus warmingii*
24b. PO_4 highly elevated; no luminous scale-like structures midventrally between V. base and anus 25
25a. VO_2 elevated and anterior to VO_1 ... *Lampanyctus turneri**
25b. VO_2 not anterior to VO_1 26
26a. P. absent or weakly developed .... *Lampanyctus niger**
26b. P. extending at least to origin of anal fin base 27
27a. Cp present; luminous gland present at adipose fin base ... . *Lampanyctus alatus*
27b. Cp absent; no luminous gland at adipose fin base 28
28a. Prc_{1-3} level, Prc_4 much higher near LL .... *Lampanyctus tenuiformis**
28b. Prc_{1-2} level, Prc_{2-4} forming a straight ascending line .... *Lampanyctus nobilis*
29a. Male with SUGL; female with INGL [Prc evenly spaced] ... . *Lobianchia gemellari**
29b. SUGL and INGL absent 30
30a. So present, [SAO_{1-3} and VO_5 forming an almost straight line] .... *Diaphus aliciae*
30b. So absent 31
31a. Ant present 32
31b. Ant absent 34
32a. Vn extending posteriorly along ventral margin of pupil, usually reaching vertical through posterior margin of pupil .... *Diaphus sagamiensis*
32b. Vn not reaching vertical through center of pupil 33
33a. SAO_3 and Pol about 3 photophore diameters below LL .... *Diaphus watasei*
33b. SAO_3 and Pol almost contacting with LL, [VLO closer to V. base than to LL] .... *Diaphus knappi*
34a. Vn widely separated from Dn 35
34b. Vn confluent or contiguous with Dn 37
35a. Vn long, extending along most of ventral margin of orbit; small, round, budlike projection present on dorsal margin of Vn .... *Diaphus luetkeni*
35b. Vn short, without small, round, and budlike projection on dorsal margin 36
36a. Vn under posterior 1/2 of pupil, [G.R. 26-30; luminous scales present at PLO, VLO, SAO_3, and Prc_4] ....

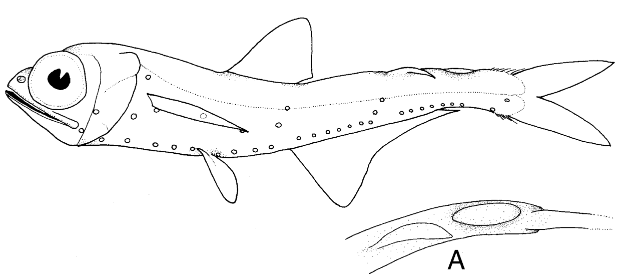

Fig. 13. *Hygophum reinhardtii*, NTOU 20401, 29.3 mm SL. (A) SUGL of the same specimen.

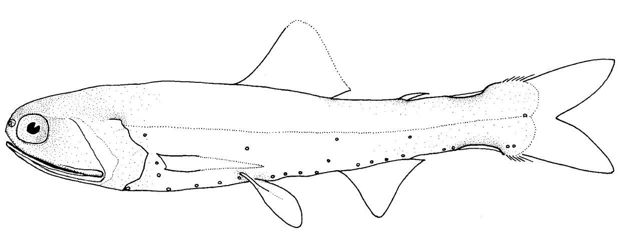

Fig. 14. *Lampadena anomala*, NTOU 27601, 137.3 mm SL.

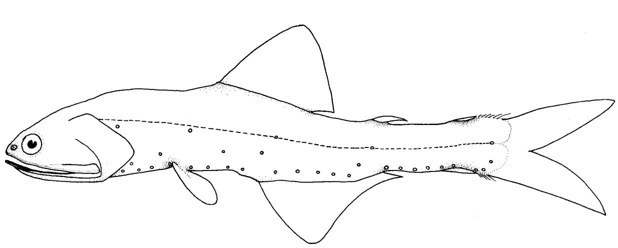

Fig. 15. *Lampanyctus niger*, NTOU 22505, 78.3 mm SL.

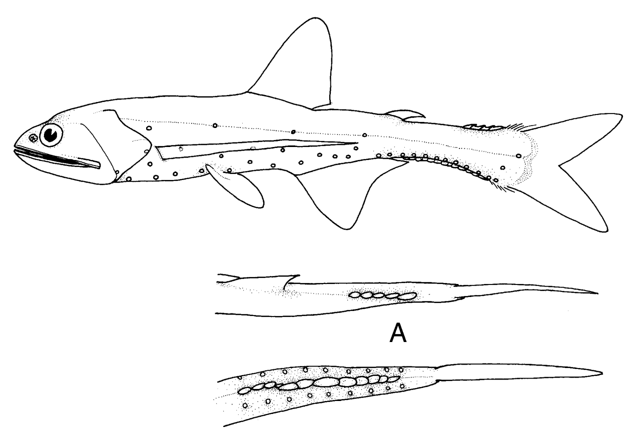

Fig. 16. *Lampanyctus turneri*, NTOU 25402, 41.8 mm SL. (A) SUGL (top) and INGL (bottom) of the same specimen.

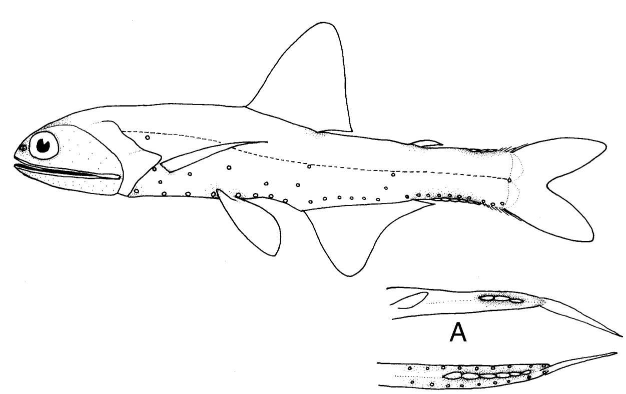

Fig. 17. *Lampanyctus tenuiformis*, NTOU 24501, 106.5 mm SL. (A) SUGL (top) and INGL (bottom) of the same specimen.

.... *Diaphua suborbitalis*
36b. Vn on anterior-ventral margin of orbit, [G.R. 20-22; luminous scale only at PLO] .... *Diaphus taaningi*
37a. SAO_3 and Pol about 3 photophore diameters below LL .... *Diaphus coeruleus*
37b. SAO_3 and Pol almost contacting LL 38
38a. AOa_1 behind (or right above) AOa_2 .... *Diaphus signatus*
38b. AOa_1 in front of AOa_2 39
39a. PLO slight lower than VLO .... *Diaphus splendidus*
39b. PLO higher than VLO 40
40a. Luminous scale of PLO slightly larger than that of PLO .... *Diaphus schmidti*
40b. Luminous scale of PLO 2 or 3 times larger than that of PLO .... *Diaphus garmani*

SYSTEMATICS

Benthosema fibulatum (Gilbert and Cramer, 1897)
(Figs. 6, 9, 26)

Myctophum fibulatum Gilbert and Cramer, 1897. Proc. U.S. Natn. Mus., 19(1114): 411-412, pl. 38, fig. 2 (Kaiwi Channel, Hawaii).

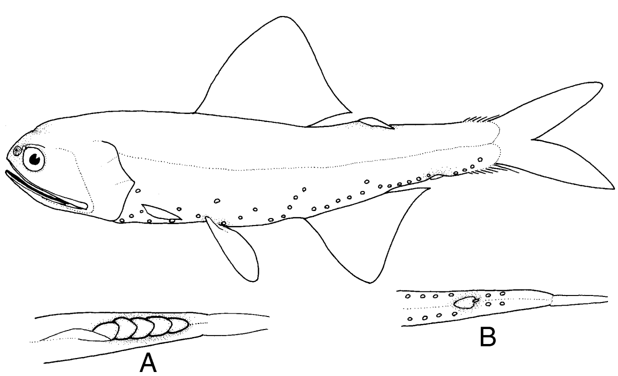

Fig. 18. *Lobianchia gemellarii*, ♀, NTOU 28602, 50.3 mm SL. (A) SUGL of male, collected at 10°18.7'N, 131°09.1'E, 52.7 mm SL. (B) INGL of NTOU 28602.

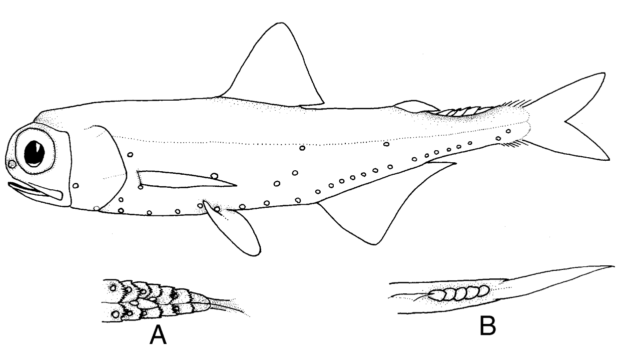

Fig. 19. *Myctophum asperum*, ♂, NTOU 29402, 72.0 mm SL. (A) INGL of female, NTOU 29501, 69.6 mm SL. (B) SUGL of same male.

Materials: 14 specimens, 19.7-69.2 mm SL. NTOU 11401, 1 (44.5 mm), 23°06.6'N, 121°30.3'E, 8 Sept. 1994, 2127 h, 6-ft IKMT, 0-200 m; NTOU 11402, 1 (19.7 mm), 24°06.6'N, 121°30.3'E, 6 Sept. 1994, 1800 h, 6-ft IKMT, 400 m wire out; NTOU 11501, 1 (21.6 mm), 22°40.0'N, 122°25.0'E, 11 Dec. 1995, 1800 h, 15-ft IKMT, 1000 m wire out; NTOU 11502, ♂ (63.8 mm), 21°35.5'N, 117°39.7'E, 16 Apr. 1995, 1530-1725 h, bottom trawl, sampling depth 502-520 m; NTOU 11503, ♂ (57.8 mm), 21° 36.5'N, 117°45.1'E, 17 Apr. 1995, 1023-1211 h, bottom trawl, sampling depth 458-520 m; NTOU 11504, ♀ (65.0 mm), 20°35.5'N, 115°44.8'E, 19 Apr. 1995, 1012-1141 h, bottom trawl, sampling depth 418-441 m; NTOU 11505, ♂ (60.4 mm), ♀ (62.0 mm), 21°12.6'N, 116°34.0'E, 18 Apr. 1995, 1200-1321h, bottom trawl, sampling depth 335-337 m; NTOU 11506, ♀ (67.4 mm), 21°19.9'N, 116°48.6'E, 17 Apr. 1995, 1625-1808 h, bottom trawl, sampling depth 354-361 m; NTOU 11507, ♀ (69.2 mm), 23°53.8'N, 121°41.3'E, 29 Apr. 1995, 2315-2350 h, 15-ft IKMT, sampling depth 0-150 m; NTOU 11601, 2 ♂♂ (60.4-62.7 mm), 1 ♀ (61.9 mm), 19°49.2'N, 114°09.3'E, 23 Apr. 1996, 0745-1005 h, bottom trawl, sampling depth 475-512 m; NTOU 11602, 1 (29.4 mm), 22°24.8'N, 122°00.5'E, 30 Apr. 1996, 1335-1425 h, 15-ft IKMT, sampling depth 0-1000 m.

Diagnosis: D. 13(12-14); A. 19(18-20); P. 15(14-16); AO 6 + 4(5), total 10(11); G.R. 6(7) + 1 + 15, total 22-23. Mature males have large 3 to 5 translucent SUGL and smaller INGL; mature females have small SUGL and much smaller INGL patches.

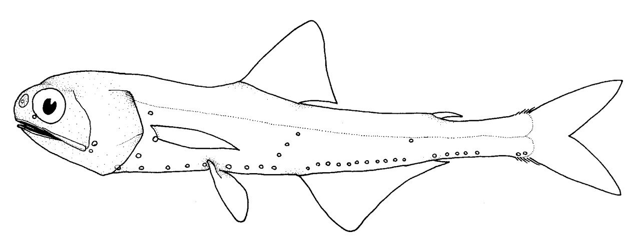

Fig. 20. *Myctophum aurolaternatum*, NTOU 30502, 28.5 mm SL.

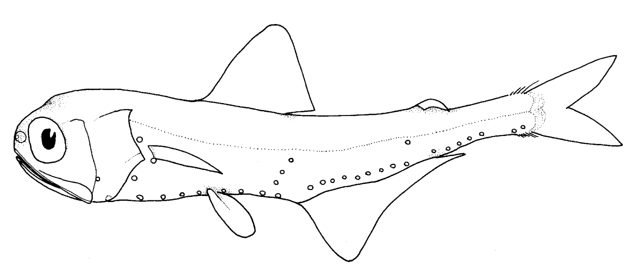

Fig. 21. *Myctophum nitidulum*, NTOU 31601, 27.8 mm SL.

Remarks: *Benthosema fibulatum* is the largest species in the genus reaching 90 mm SL (Wisner 1976).

Distribution: *B. fibulatum* appears in Hawaiian waters, north of New Guinea, off Japan, and the Indian Ocean off South Africa (Wisner 1976). This species is distributed in the waters off the eastern through the southwestern coasts of Taiwan and the Tungsha Islands.

Bolinichthys supralateralis **(Parr, 1928)**
(Figs. 8, 10, 30)

Lampanyctus supralateralis Parr, 1928. Bull. Bingham Oceanogr. Coll. 3(3): 94, fig. 12 (23°42'N, 76°43'W).

Materials: 25 specimens, 64.0-98.3 mm SL. NTOU 15401, 2 (71.3-87.0 mm), 20°53.9'N, 118°37.3'E, 1 May 1994, 0827-1000 h, 6-ft IKMT, 3500 m wire out; NTOU 15501, 1 (66.7 mm), 21°36.5'N, 117°45.1'E, 17 Apr. 1995, 1023-1211 h, bottom trawl, sampling depth 458-520 m; NTOU 15502, 4 (71.9-88.4 mm), 19°26.8'N, 114°01.8'E, 22 Apr. 1995, 1034-1225 h, bottom trawl, sampling depth 660-663 m; NTOU 15503, 5 (64.0-87.3 mm), 19°32.0'N, 114°E, 21 Apr. 1995, 1403-1545 h, bottom trawl, sampling depth 569-611 m; NTOU 15504, 7 (81.2-98.3 mm), 19°24.9'N, 114°04.5'E, 23 Apr. 1995, 0753-0950 h, bottom trawl, sampling depth 716-726 m; NTOU 15505, 1 (79.6 mm), 19°29.9'N, 114°03.8'E, 22 Apr. 1995, 0753-0947 h, bottom trawl, sampling depth 650 m; NTOU 15506, 3 (87.7-93.2 mm), 19°30.1'N, 114°09.8'E, 23 Apr. 1995, 1045-1235 h, bottom trawl, sampling depth 754-767 m; NTOU 15601, 2 (78.1-81.6 mm), 19°49.2'N, 114°09.3'E, 23 Apr. 1996, 0810-1030 h, bottom trawl, sampling depth 475-512 m.

Diagnosis: D. 12-14; A. 13-15; P. 12-13; AO 5(4) + 3-4, total 8-10; G.R. 6(5) + 1 + 14(12-14), total 19-21. Three to 6 small elongate patches of luminous tissue along base of anal fin which originate at the 4th ray. SUGL short, with 2 to 3 scales, INGL with 3 to 5 scales reaching below last or next to last AOp.

Remarks: Uyeno (1983) recorded 4 specimens of *B. supralateralis* from 830- to 850-m depth around Japan. *Bolinichthys supralateralis* is abundant from Tungsha Island, usually collected at depths from 458 to 754 m. The shallowest capture was 350 m in equatorial regions, while the record in the South Atlantic was 700 m (Hulley 1981).

Distribution: *Bolinichthys supralateralis* appears in the Atlantic (40°N-02°S and 32°-40°S), Indian Ocean (21°-30°S), west coast of Australia, and near Hawaii (Smith 1986). Nafpaktitis (1977) reported this tropical-subtropical species from the Pacific near Hawaii, and also from 36°S, 125°W. There are also records from the east coast of Australia. Wisner (1976) reported the distribution of this species in the eastern Pacific Ocean, northeastern tip of Luzon, Philippines, and from about 10°S, 96°E in the Indian Ocean. This species also appears in the waters near

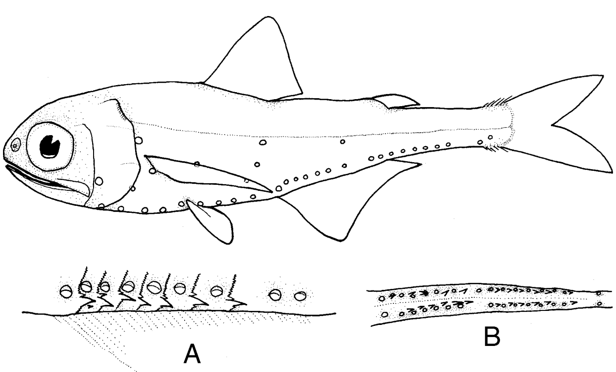

Fig. 22. *Myctophum spinosum*, NTOU 33101, 54.8 mm SL. (A) arrangement of spine-bearing scales along base of anal fin. (B) ventral view of same specimen.

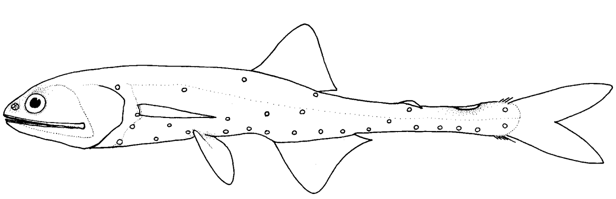

Fig. 23. *Notolychnus valdiviae*, NTOU 34602, 21.9 mm SL.

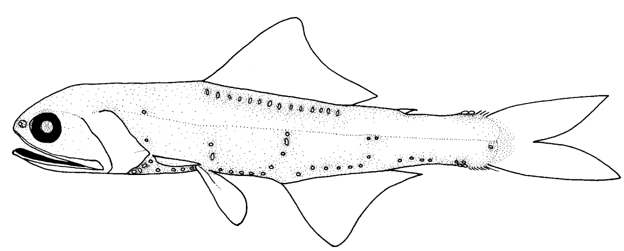

Fig. 24. *Notoscopelus caudispinosus*, NTOU 35601, 47.5 mm SL.

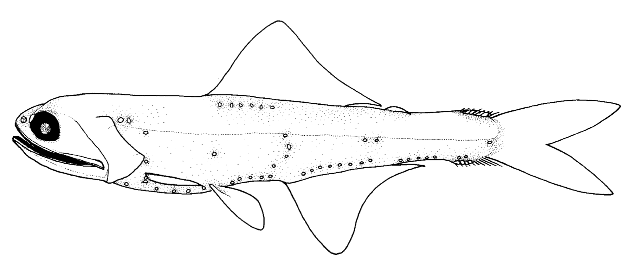

Fig. 25. *Notoscopelus resplendens*, NTOU 36501, 40.5 mm SL.

the Tungsha Islands.

Electrona risso (Cocco, 1829)
(Figs. 7, 11, 44)

Scopelus risso Cocco, 1829. Gior. Sci. Lett. Art. Sicilia 26 (77): 144 (Messina).

Materials: 5 specimens, 45.5-67.8 mm SL. NTOU 18501, ♂ (65.9 mm), 22°23.0'N, 120°20.0'E, 5 Feb. 1995, 1000-1300 h, by sergestid fishing boat, sampling depth about 200 m; NTOU 18502, 2 ♀♀ (45.5-60.3 mm), 19°24.9'N, 114°04.5'E, 23 Apr. 1995, 0753-0950 h, bottom trawl, sampling depth 716-726 m; NTOU 18601, 2 ♀♀ (64.0-67.8 mm), 19°35.6'N, 114°11.7'E, 23 Apr. 1996, 1506-1700 h, bottom trawl, sampling depth 700-728 m.

Diagnosis: D. 13-15; A. 19(18); P. 15(14-16); AO 11, G.R. 8 + 1 + 17-18, total 26-27. Body short and deep, its depth slightly greater than 1/3 of SL; SAO series often on a nearly straight line.

Distribution: *Electrona risso* appears in the northern and northwestern Pacific Ocean, Mediterranean Sea, northwestern Atlantic Ocean, South Africa, and tropical Indian Ocean. It also occurs in the waters off Tungkang and the Tungsha Islands.

Hygophum proximum Becker, 1965
(Figs. 8, 12, 45)

Hygophum proximum Becker, 1965. Tr. Inst. Okean. Acad. Sci. USSR 80: 81, figs. 6-9 (00°58'S, 82°53'E).

Materials: 4 specimens, 18.1-39.4 mm SL. NTOU 19401, ♀ (39.4 mm), 23°12.4'N, 122°18.7'E, 9 Sept. 1994; NTOU 19402, 1 (21.6 mm), 24°04.2'N, 123°06.9'E, 6 Sept. 1994, 2359 h; NTOU 19403, 2 (18.1-27.2 mm), 17 Oct. 1994, 2120 h, 6-ft IKMT; NTOU 19601, 1 (35.9 mm), 22°25.1'N, 122°59.8'E, 30 Apr. 1996, 0735-0826 h, 15 ft-IKMT, sampling depth 0-1000 m.

Diagnosis: D. 12-13; A. 17-21; P. 13-14, AO 5 + 7, total 12; G.R. 4 + 1 + 11-13, total 16-18. Mature males with large, single, black-edged SUGL, filling 3/4 or more of the supracaudal space; mature females with 2 IUGL.

Remarks: *Hygophum proximum* has a larger SUGL than any other species of the genus.

Distribution: *H. proximum* is widespread in warmer waters of the Pacific and Indian Oceans. It has not been reported from the Atlantic Ocean (Wisner 1976). This species usually occurs in eastern Taiwan and occasionally near Tungkang.

Hygophum reinhardtii (Lütken, 1982)
(Figs. 8, 13, 46)

Scopelus reinhardtii Lütken, 1982. Danske Vidensk. Selsk. Skrifter, 7(6): 237, 256 (*partim*), fig. 16 (34°22'N, 18°10'W).

Materials: 7 specimens, 20.5-49.1 mm SL. NTOU 20401, 1 (29.3 mm), 22°N, 119°E, 18 Oct. 1994, 1900 h, 6-ft IKMT; NTOU 20402, 1 (19.4 mm), 23°12.4'N, 122°15.4'E, 9 Sept. 1994, 6-ft IKMT; NTOU 20601, 2 (29.0-43.8 mm), 22°09.8'N, 122°19.9'E, 29 Apr. 1996, 1805-1857 h, 15-ft IKMT, sampling depth 0-700 m; NTOU 20602, 2 (20.5-21.1 mm), 22°25.1'N, 122°59.8'E, 30 Apr. 1996, 0735-0826 h, 15-ft IKMT, sampling depth 0-1000 m; NTOU 20603, 1 (49.1 mm), 22°11.4'N, 119°25.4'E, 27 Apr. 1996, 0840-0950 h, 15-ft IKMT, sampling depth 0-1000 m.

Diagnosis: D. 13-14; A. 21-23; P. 13-14; AO 7 + 7-8, total 14-15; G.R. 4 + 1 + 12-13, total 17-18. Males with single SUGL filling about 1/2 the supracaudal space, females with 3 coalesced INGL patches, sometimes separate.

Remarks: The longer and more slender caudal peduncle and the higher number of anal rays separate this species from all other species of the genus.

Distribution: *Hygophum reinhardtii* appears in the southern Indian Ocean, and in the temperate Atlantic and Pacific Oceans, but is absent from equatorial waters (Smith 1986). It is occasionally found in eastern and southwestern Taiwanese waters.

Lampadena anomala Parr, 1928
(Figs. 7, 14, 47)

Lampadena anomala Parr, 1928. Bull. Bingham Oceanogr. Coll. 3(3): 150, fig. 35 (32°24'N, 64°29'W).

Material: 1 specimen, 137.3 mm SL. NTOU 27601, 1 (137.3 mm), 19°38.0'N, 114°48.7'E, 25 Apr. 1996, 1545-1700 h, bottom trawl, sampling depth 1493-1549 m.

Diagnosis: D. 13; A. 13; P. 16; AO 4 + 2, total 6; G.R. 5 + 1 + 11, total 17. Photophores smaller than in other species of the genus. VLO nearer to lateral line than to pelvic base. Three VO, 3 SAO, and 3 AOa, widely separated, 2 AOp and the last over anterior margin of INGL. Three Prc, the first 2 very close together, the 3rd far distant at end of lateral line. SAO_3 and Pol about their respective diameters below lateral line. SUGL slightly shorter than INGL.

Remarks: *Lampadena anomala* is newly recorded from Asia (Table 1), and it appeared just once in the 6 cruises. Nafpaktitis (1969) reported a damaged specimen taken in the east-central Pacific Ocean at about 5°S, 135°W. Clarke (1973) reported 3 specimens collected from 32°24'N, 64°29'W, and Nafpaktitis and Paxton (1968) reported specimens from 13°12'N, 72°47'W and from near Bermuda.

Nafpaktitis and Paxton (1968) also mentioned that *L. anomala* appears to occur at greater depths than the rest of its congeners. Hulley (1981) reported that *L. anomala* appears to occur more deeply than the rest of its congeners. Krefft (1970) reported on 2 specimens collected at about 2000 m in daytime. The *L. anomala* specimen we had was caught at about 1549 m, the deepest fishing depth by bottom trawls made around the Tungsha Islands.

Distribution: *L. anomala* occurs in the Atlantic (32°N to 39°S) and near Hawaii (Smith 1986). This species has only been caught in waters southwest of Tungsha Island.

Lampanyctus niger **(Günther, 1887)**
(Figs. 5, 15, 51)

Nannobrochium nigrum Günther, 1887. "Challenger" Rep. 22 (57): 199, L I, fig. B.

Materials: 16 specimens, 18.5-98.4 mm SL. NTOU 22501, 1 (18.5 mm), 22°14.7'N, 120°55.3'E, 27 Apr. 1995, 1905-1933 h, 15-ft IKMT, 100 m wire out; NTOU 22502, 5 (20.8-65.0 mm), 23°53.8'N, 121°41.3'E, 29 Apr. 1995, 2315-2350 h, 15-ft IKMT, 300 m wire out; NTOU 22503, 1 (68.7 mm), 23°51.0'N, 121°40.0'E, 29 Apr. 1995, 2212-2250 h, 15-ft IKMT, 500 m wire out; NTOU 22504, 1 (87.9 mm), 19°38.5'N, 114°23.1'E, 23 Apr. 1995, 1636-2000 h, bottom trawl, sampling depth 990-1015 m; NTOU 22505, 8 (73.8-98.4 mm), 19°24.9'N, 114°04.5'E, 23 Apr. 1995, 0753-0950 h, bottom trawl, sampling depth 716-726 m.

Diagnosis: D. 13-15, A. 17-18, AO 5-6 + 6-7, total 11-13; G.R. 4-5 + 1 + 10-11, total 15-17.

Remarks: Pectoral fin absent or weakly developed and VLO elevated to close lateral line which easily distinguish *L. niger* from other species of the genus.

Distribution: *L. niger* occurs in the Pacific warm waters. It often occurs in the waters near the Tungsha Islands; off the eastern and southwestern Taiwan.

Lampanyctus turneri **(Fowler, 1934)**
(Figs. 5, 16, 52)

Serpa turneri Fowler, 1934. Proc. Acad. Nat. Sci. Philad. 85: 285 (Leyte-Mindanao, Philippines).

Materials: 8 specimens, 28.6-44.7 mm SL. NTOU 25401, 1 (38.3 mm), 22°N, 119°02.7'E, 31 July 1994, 2015-2245 h, 6-ft IKMT, 2000 m wire out; NTOU 25402, 2 (28.6-43.7 mm), 22°N, 120°30.2'E, 1 Aug. 1994, 1355 h; NTOU 25403, 1 (41.8 mm), 20°53.9'N, 118°37.3'E, 1 May 1994, 0827-1000 h, 6-ft IKMT, 3500 m wire out; NTOU 25501, 1 (43.2 mm), 23°51.0'N, 121°40.0'E, 29 Apr. 1995, 2212-2250 h, 15-ft IKMT, 500 m wire out; NTOU 25502, 1 (35.0 mm), 23°53.8'N, 121°41.3'E, 29 Apr. 1995, 2315-2350 h, 15-ft IKMT, 300 m wire out; NTOU 25601, 2 (33.8-44.7 mm), 22°11.4'N, 119°25.4'E, 27 Apr. 1996, 0840-0950 h, 15-ft IKMT, sampling depth 0-1000 m.

Diagnosis: D. 12-13; A. 17(16-18); P. 12(11); AO 4-5 + 8-9, total 13-14; G.R. 3 + 1 + 9-10, total 13-14.

Remarks: The elevated, anteriorly displaced VO_2 (anterior of the vertical from VO_1) and the low AO and G.R. counts easily separate it from all other congeners.

Distribution: *L. turneri* is a tropical species known from the Indo-Pacific between the South China Sea and the western South Indian Ocean (Wisner 1974). It also appears in eastern and southwestern Taiwanese waters.

Lampanyctus tenuiformis **(Brauer, 1906)**
(Figs. 5, 17, 53)

Myctophum (*Lampanyctus*) *tenuiformis* Brauer, 1906. Wiss. Ergebn. dt. Tiefsee-Exped. "Valdivia", 15: 243, fig. 160 (4°34'S, 53°42'E)

Materials: 3 specimens, 25.8-106.5 mm SL. NTOU 24501, 1 (106.5 mm), 19°24.9'N, 114°04.5'E, 23 Apr. 1995, 0753-0950 h, bottom trawl, sampling depth 716-726 m; NTOU 24601, 1 (28.6 mm), 19°32.0'N, 114°11.0'E, 22 Apr. 1996, 1830-1720 h, 15-ft IKMT; NTOU 24602, 1 (25.8 mm), 22°09.8'N, 122°19.9'E, 29 Apr. 1996, 1805-1857 h, 15-ft IKMT, sampling depth 0-700 m.

Diagnosis: D. 13-14; A. 17-18; P. 14-15; AO 5-6 + 6-8, total 12-13; G.R. 4 + 1 + 9-11, total 14-16.

Distribution: *L. tenuiformis* was also reported from the tropical Indian Ocean (Nafpaktitis 1969), and tropical Pacific (Nafpaktitis et al. 1977). It occurs in eastern Taiwan and southwestern waters around the Tungsha Islands.

Lobianchia gemellarii **(Cocco, 1838)**
(Figs. 8, 18, 54)

Myctophum gemellarii Cocco, 1838. Nuov. Ann. Sci. Nat. Bologna 2(9): 186, pl. VII, fig. 9 (Messina).

Materials: 2 specimens, 30.4-50.3 mm SL. NTOU 28601, 1 (30.4 mm), 22°09.9'N, 120°56.7'E, 29 Apr. 1996, 0840-0920 h, 15-ft IKMT, sampling depth 414-521 m; NTOU 28602, 1 ♀ (50.3 mm), 22°09.8'N, 122°19.9'E, 29 Apr. 1996, 1805-1857 h, 15-ft IKMT, sampling depth 0-700 m.

Diagnosis: D. 17; A. 13-15; P. 11; AO 5 + 5-6, total 10-11; G.R. 4-5 + 1 + 11, total 16-17. Mature males have an SUGL consisting of a series of 6 large, well-defined scalelike structures flanked by 5 pairs of smaller, triangular ones. The INGL of mature females consists of 2 heart-shaped scales, flanked by smaller, triangular luminous scales.

Remarks: The genus *Lobianchia* is very similar to the genus *Diaphus* in appearance, but *Lobianchia* has SUGL or INGL, while they are absent in *Diaphus*.

Distribution: *L. gemellarii* is quite common in the western Indian Ocean, tropical and subtropical Atlantic Ocean, Mediterranean Sea, and the tropical and subtropical Pacific (Nafpaktitis 1978). This species also occurs off eastern Taiwan.

Myctophum asperum **Richardson, 1845**
(Figs. 4, 19, 55)

Myctophum asperum Richardson, 1845. Zool. Voy. 'Erebus' 'Terror', 2: 41.

Materials: 4 specimens, 20.2-72.0 mm SL. NTOU 29401, 1 (21.3 mm), 23°06.6'N, 121°30.4'E, 8 Sept. 1994, 2127 h, 6-ft IKMT; NTOU 29402, ♂ (72.0 mm), 20°00.7'N, 119°33.8'E, 1 May 1994, 1925-2220 h, 6-ft IKMT, 3500 m wire out; NTOU 29501, ♀ (69.6 mm), 20°29.7'N, 115°38.7'E, 19 Apr. 1995, 1712-1847 h, bottom trawl, sampling depth 442 m; NTOU 29601, 1 (20.2 mm), 22°09.9'N, 122°59.5'E, 29 Apr. 1996, 2225-2310 h, 15-ft IKMT, sampling depth 0-500 m.

Diagnosis: D. 12; A. 19; P. 13-14; AO 7 + 6-7, total 13-14; G.R. 4 + 1 + 10, total 15. Males bear 5 luminous scales in SUGL, and females bear 1 to 4 scales in INGL.

Remarks: The presence of 4 upper rakers is one of the most useful characters to distinguish *M. asperum* from the other 5 species (Nafpaktitis 1969), since this is the lowest number.

Distribution: *M. asperum* occurs in the North and South Equatorial Currents and the Equatorial Countercurrent of the Pacific and Indian Oceans (Kawaguchi et al. 1972). It also appears off eastern and southwestern Taiwan.

Myctophum aurolaternatum **Garman, 1899**
(Figs. 4, 20, 56)

Myctophum aurolaternatum Garman, 1899. Mem. Mus. Comp. Zool. Harv. 24: 264, pl. 55, fig. 3.

Materials: 3 specimens, 28.5-44.8 mm SL. NTOU 30401, 1 (44.8 mm), 20°00.7'N, 119°33.8'E, 1 May 1994, 1925-2220 h, 6-ft IKMT, 3500 m wire out; NTOU 30501, 1 (30.8 mm), 22°14.7'N, 121°54.7'E, 28 Apr. 1995, 0055-0130 h, 15-ft IKMT, 90 m wire out; NTOU 30502, 1 (28.5 mm), 23°53.8'N, 121°41.3'E, 29 Apr. 1995, 2315-2350 h, 15-ft IKMT, 300 m wire out.

Diagnosis: D. 13-14; A. 23-24; P. 14; AO 10-11 + 6-7, total 17; G.R. 4-5 + 1 + 11-12, total 17. SUGL of males with 6 to 9 triangular, overlapping scales; INGL of females with 3 to 7 rounded, usually contiguous luminous scales.

Remarks: High counts of AOa (10 to 11) and total AO (16 to 19) easily distinguish this species from other *Myctophum* species.

Distribution: *M. aurolaternatum* is widely distributed from about 25°N to 17°S in the eastern Pacific Ocean. It is also common in the Indo-Pacific region and Indian Ocean (Wisner 1976). This species occurs off eastern and southwestern Taiwan.

Myctophum nitidulum **Garman, 1899**
(Figs. 4, 21, 57)

Myctophum nitidulum Garman, 1899. Mem. Mus. Comp. Zool. Harv. 24: 266, pl. 56, fig. 3. (27°50'N, 145°45'W).

Material: 1 specimen, 27.8 mm SL. NTOU 31601, 1 (27.8 mm), 19°32.0'N, 114°11.0'E, 22 Apr. 1996, 1830-1720 h, 15-ft IKMT.

Diagnosis: D. 13; A. 19; P. 14; AO 9 + 5, total 14; G.R. 5 + 1 + 14, total 20. Male SUGL has 5 to 8 (3-6), female INGL with 2 to 6 small, round to oblong spots, respectively (Wisner 1976).

Remarks: *M. nitidulum* may be distinguished from all other *Myctophum* possessing cycloid scales by its angulate, non-serrate, posterodorsal margin of the operculum.

Distribution: *M. nitidulum* is widespread throughout the warmer waters of the Pacific Ocean (Wisner 1976). It appears in southwestern Taiwan.

Myctophum spinosum **(Steindachner, 1867)**
(Figs. 4, 22, 59)

Scopelus spinosum Steindachner, 1867. Sitz. Akad. Wiss. Wien 55: 711, pl. 3, fig. 4, 4a (China).

Materials: 3 specimens, 16.6-54.8 mm SL. NTOU 33101, 1 (54.8 mm), 24°40'N, 123°E, 14 Mar. 1991, 0319 h; NTOU 33401, 1 (31.7 mm), 23°N, 122°E, 7 Sept. 1994, 2300 h, 6-ft IKMT; NTOU 33701, 1 (16.6 mm), 22°11.1'N, 120°17.4'E, 24 May 1997, 1325-1410 h, 15-ft IKMT, sampling depth 0-605 m.

Diagnosis: D. 12-13; A. 18-19; P. 15; AO 7 + 6-8, total 13-15; G.R. 6 + 1 + 13-15, total 20-23. Males have 6 luminous scales in the SUGL, and females have 1 to 4 smaller scales in the INGL.

Remarks: Ctenoid scales on the anal fin base possess 1-2 posteriorly-directed spines, and Pol is

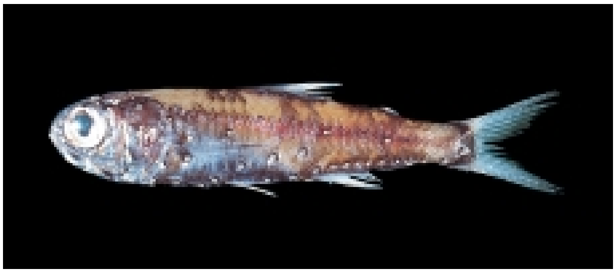

Fig. 26. *Benthosema fibulatum* 62 mm SL.

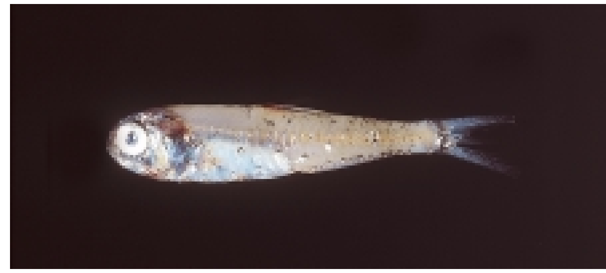

Fig. 27. *Benthosema pterotum* 43.5 mm SL.

Fig. 28. *Benthosema suborbitale* 25.9 mm SL.

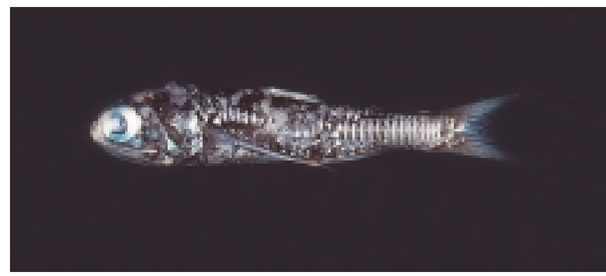

Fig. 29. *Bolinichthys longipes* 39.2 mm SL.

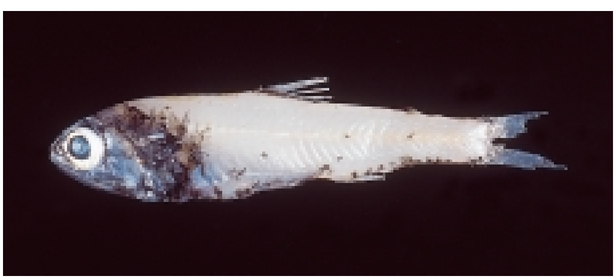

Fig. 30. *Bolinichthys supralateralis* 66.7 mm SL.

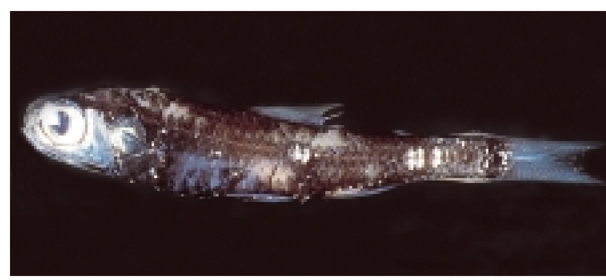

Fig. 31. *Ceratoscopelus warmingii* 52.5 mm SL.

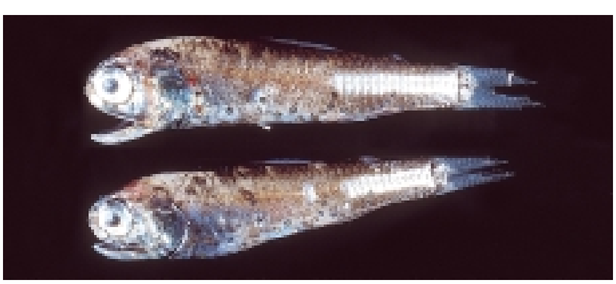

Fig. 32. *Diaphus aliciae* 39.7 mm SL and 37.5 mm SL.

Fig. 33. *Diaphus coeruleus* 107.8 mm SL.

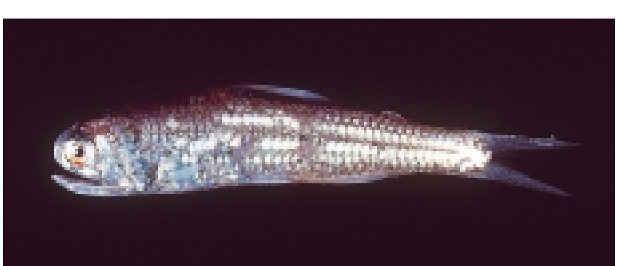

Fig. 34. *Diaphus garmani* 37.5 mm SL.

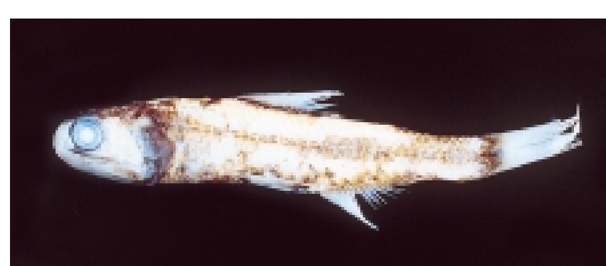

Fig. 35. *Diaphus knappi* 65.7 mm SL.

Fig. 36. *Diaphus luetkeni* 57.5 mm SL.

Fig. 37. *Diaphus sagamiensis* 86.7 mm SL.

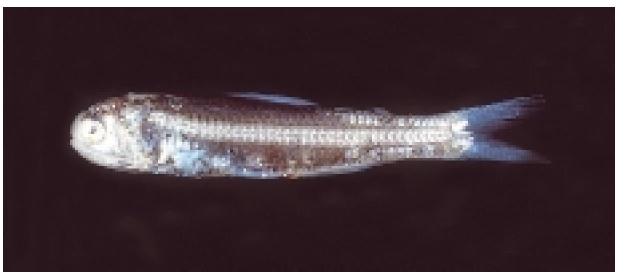

Fig. 38. *Diaphus schmidti* 38.6 mm SL.

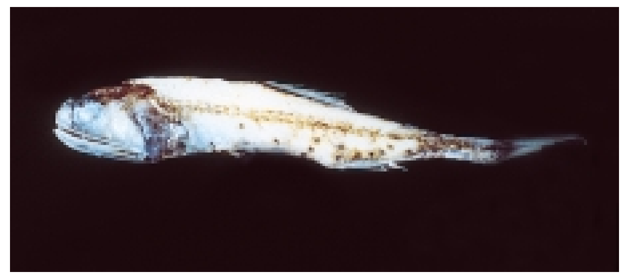

Fig. 39. *Diaphus signatus* 57.5 mm SL.

Fig. 40. *Diaphus splendidus* 55.8 mm SL.

Fig. 41. *Diaphus suborbitalis* 68.6 mm SL.

Fig. 42. *Diaphus watasei* 115.3 mm SL.

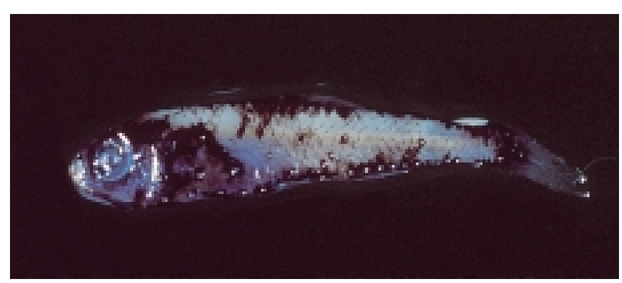

Fig. 43. *Diogenichthys atlanticus* 18.2 mm SL.

Fig. 44. *Electrona risso* 67.8 mm SL.

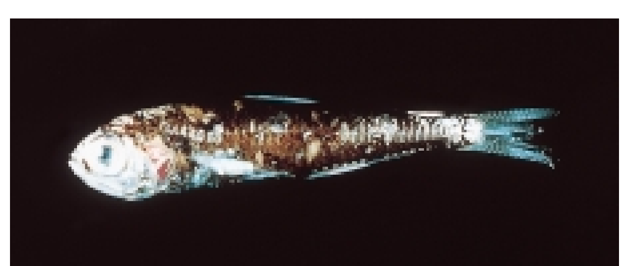

Fig. 45. *Hygophum proximum* 35.9 mm SL.

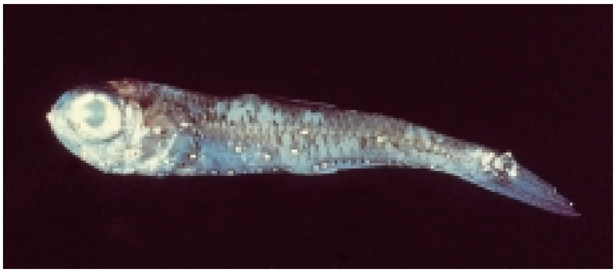

Fig. 46. *Hygophum reinhardtii* 43.8 mm SL.

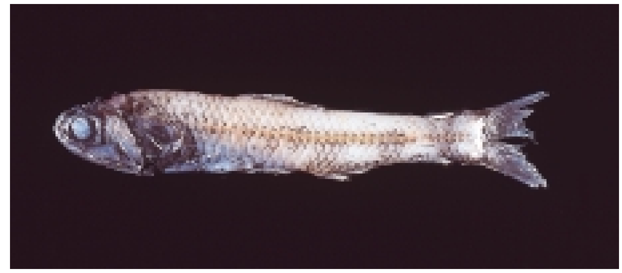

Fig. 47. *Lampadena anomala* 137.3 mm SL.

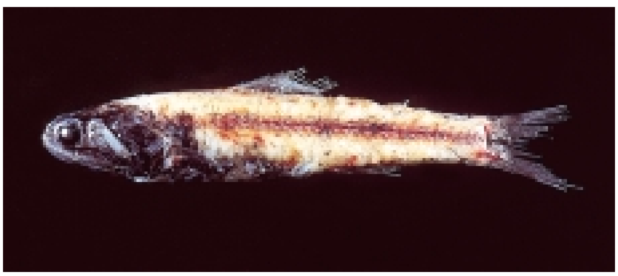

Fig. 48. *Lampadena luminosa* 92.9 mm SL.

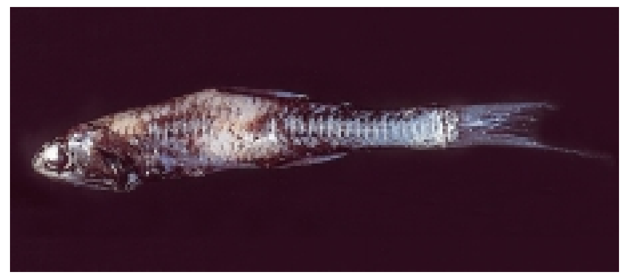

Fig. 49. *Lampanyctus alatus* 47.5 mm SL.

Fig. 50. *Lampanyctus nobilis* 87.5 mm SL.

Fig. 51. *Lampanyctus niger* 65 mm SL.

Fig. 52. *Lampanyctus turneri* 43.2 mm SL.

Fig. 53. *Lampanyctus tenuiformis* 106.5 mm SL.

Fig. 54. *Lobianchia gemellarii* 50.3 mm SL.

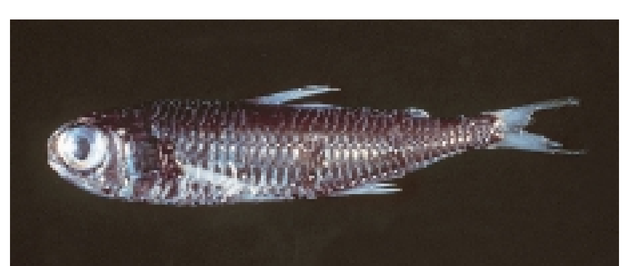

Fig. 55. *Myctophum asperum* 69.6 mm SL.

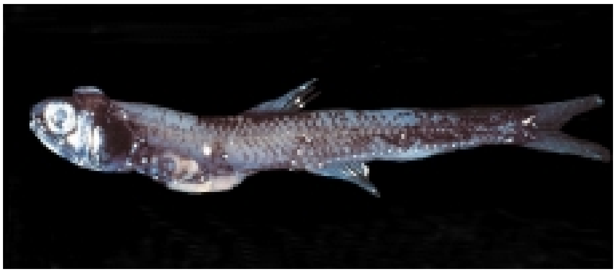

Fig. 56. *Myctophum aurolaternatum* 30.8 mm SL.

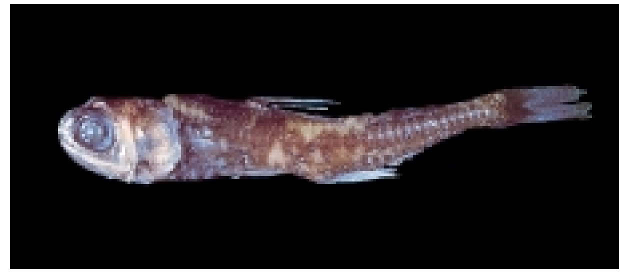

Fig. 57. *Myctophum nitidulum* 27.8 mm SL.

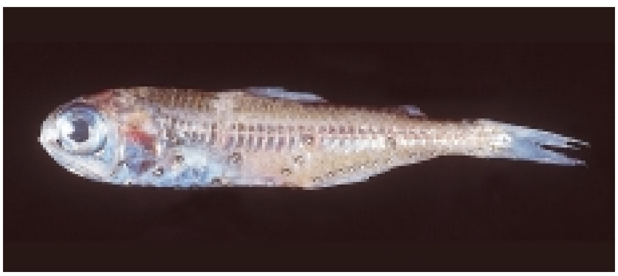

Fig. 58. *Myctophum obtusirostre* 62.5 mm SL.

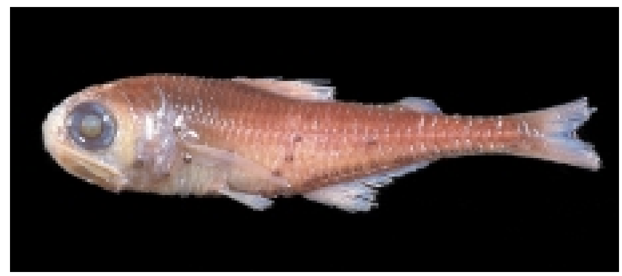

Fig. 59. *Myctophum spinosum* 54.8 mm SL.

Fig. 60. *Notolychnus valdiviae* 21.9 mm SL.

Fig. 61. *Notoscopelus caudispinosus* 47.5 mm SL.

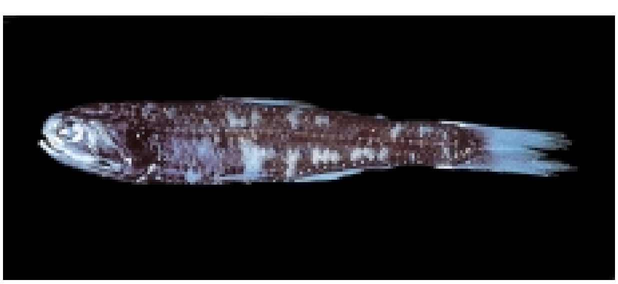

Fig. 62. *Notoscopelus resplendens* 40.5 mm SL.

Fig. 63. *Symbolophorus evermanni* 40.4 mm SL.

FIg. 64. *Triphoturus nigrescens* 31.4 mm SL.

Fig. 65. *Neoscopelus microchir* 115.5 mm SL.

well in advance of origin of adipose fin base, which separate *M. spinosum* from other species of the genus.

Distribution: *M. spinosum* is widely distributed in the tropical waters of the Pacific, Indo-Pacific, Indian, and possibly Atlantic Oceans (Wisner 1976). It appears off eastern Taiwan.

Notolychnus valdiviae **(Brauer, 1904)**
(Figs. 7, 23, 60)

Myctophum valdiviae Brauer,1904. Zool. Anz. 28: 398, fig. 6, 1906, Wiss. Ergebn. dt. Tiefsee-Exped. 'Validivia' 15: 206, fig. 127 (no type locality given).

Materials: 8 specimens, 19.7-23.0 mm SL. NTOU 34501, 1 (19.7 mm), 22°24.4'N, 120°18.8'E, 7 Feb. 1995, 1634-1647 h; NTOU 34601, 4 (20.6-23.0 mm), 22°24.8'N, 122°00.5'E, 30 Apr. 1996, 1335-1425 h, 15-ft IKMT, sampling depth 0-1000 m; NTOU 34602, 3 (20.0-21.9 mm), 22°09.9'N, 122°59.5'E, 29 Apr. 1996, 2225-2310 h, 15-ft IKMT, sampling depth 0-500 m.

Diagnosis: D. 10-11; A. 12-13; P. 11-13; V. 6; AO 4 + 4, total 8; G.R. 2 + 1 + 7, total 10. A single deeply set translucent SUGL present in both sexes, but no INGL. Males have much larger eyes and a longer SUGL than those of females.

Remarks: The monotypic genus *Notolychnus* can be distinguished from all other genera by the high positions of VLO, SAO_3, and Pol, all of which lie close to the dorsal contour of the body, and by the location of Prc_2 well above the lateral line and also directly above Prc_1.

Distribution: *N. valdiviae* occurs in the tropical and temperate waters of the Pacific, Atlantic, and Indian oceans (Bolin 1959). It occurs in southeastern and southwestern Taiwanese waters.

Notoscopelus caudispinosus **(Johnson, 1863)**
(Figs. 8, 24, 61)

Scopelus caudispinosus Johnson, 1863. Proc. Zool. Soc. Lond. 33: 42 (off Madeira).

Materials: 2 specimens, 47.5-79.6 mm SL. NTOU 35401, 1 (79.6 mm), 23°09.8'N, 122°15.4'E, 9 Sept. 1994, 2100-2123 h, 6-ft IKMT; NTOU 35601, 1 (47.5 mm), 22°09.8'N, 122°19.9'E, 29 Apr. 1996, 1805-1857 h, 15-ft IKMT, sampling depth 0-700 m.

Diagnosis: D. 27; A. 19; P. 12; AO 7 + 4, total 11; G.R. 4 + 1 + 8-9, total 13-14.

Remarks: *N. caudispinosus* can be easily separated from *N. resplendens* by its higher number of dorsal fin rays and fewer gill rakers (13-14 vs. 19-23).

Distribution: *N. caudispinosus* is distributed broadly in the tropical Atlantic and Indian Oceans, and Southeast Asian and Hawaiian waters (Smith 1986). It also appears in southeastern Taiwanese waters.

Notoscopelus resplendens **(Richardson, 1845)**
(Figs. 8, 25, 62)

Lampanyctus resplendens Richardson, 1845. Zool. Voy. 'Erebus' 'Terror' 2: 42, pl. 27, figs. 16-18 (no type locality given).

Material: 1 specimen, 40.5 mm SL. NTOU 36501, 1 (40.5 mm), 23°53.8'N, 121°41.3'E, 29 Apr. 1995, 2315-2350 h, 15-ft IKMT, 300 m wire out.

Diagnosis: D. 22; A. 19; P. 12; AO 8 + 5, total 13; G.R. 6 + 1 + 14, total 21.

Remarks: *N. resplendens* can be easily distinguished from other species of the genus by its gill raker count (19-23).

Distribution: *N. resplendens* occurs in the Atlantic (47°N- subtropical convergence), Indian (24°-30°S), and Pacific (35°N-34°S) Oceans (Smith 1986). It also appears in southeastern Taiwanese waters.

DISTRIBUTION

The lanternfishes caught from the 3 study regions, namely, waters around Tungsha Islands, off southwestern Taiwan, and eastern Taiwan, are listed in table 2. Distribution of the *Diaphus* species is shown in figure 3. *Diaphus garmani* and *D. aliciae* were dominant species in the genus and are abundant in the 3 areas. They often appear with sergestid shrimp *Sergia* spp., marine hatchetfishes *Argyropelecus* spp., and *Polyipus* spp. *D. coeruleus*, very abundant in southwestern Taiwan near Tungkang, is the only lanternfish species with commercial value in Taiwan. It is often sold in the Tungkang fish market. *D. coeruleus* usually feeds mostly on sergestid shrimp (with high commercial value in Tungkang) throughout the year (Omori 1969) and other small lanternfishes (such as *Benthosema pterotum*, etc.) occasionally. So it occupies an important niche in the waters near Tungkang. *D. luetkeni* and *D. splendidus* were common in the 3 areas. *D. sagamiensis*, *D. watasei*, and *D. suborbitalis* were abundantly caught by bottom trawl. *D. suborbitalis* occurred in the 3 areas. However, *D. watasei* usually appeared in eastern Taiwanese waters and around Tungsha Islands, while *D. sagamiensis* often appeared in waters off southern Taiwan and around Tungsha Islands. *D. knappi* appeared only in the waters off south-western Taiwan.

The *Myctophum* species were mostly collected off eastern Taiwan and in Tungsha waters (Fig. 4). The most abundant species was *M. obtusirostre* found mainly off Tungkang area (Fig. 4) and around Tungsha Islands. *M. asperum* usually appeared off eastern Taiwan. *M. spinosum* and *M. aurolaternatum* were caught around Taiwan. Other *Myctophum* species were rare, e.g., *M. nitidulum* appeared at only 1 station in Tungsha area.

Distributions of the *Lampanyctus* species are shown in figure 5. *L. alatus* and *L. nobilis* were dominant species; the former often appeared off southwestern Taiwan and Tungsha Islands. *L. nobilis* occurred more evenly in all 3 areas. *L. niger* and *L. tenuiformis* usually appeared around the Tungsha Islands and off eastern Taiwan. *L. turneri* was often caught off southern Taiwan.

Distributions of *Benthosema*, *Ceratoscopelus*, and *Neoscopelus* species are shown in figure 6. *N. microchir* often appeared off the Tungkang, Tashi, and Tungsha areas. Although *C. warmingii* occurred in all 3 areas, it was more often found off eastern Taiwan. The 3 species of *Benthosema* were distributed in all 3 areas. With the exception of *B. pterotum*, the dominant species in this genus usually appeared abundantly in Tungkang and Tashi; *B. fibulatum* often appeared in eastern Taiwan and in Tungsha.

Distributions of *Diogenichthys*, *Electrona*, *Lampadena*, *Notolychnus*, and *Symbolophorus* species are shown in figure 7. *D. atlanticus* and *E. risso* occurred around Tungsha Islands and off southwestern Taiwan. The 2 species of *Lampadena* were confined to waters southeast of Tungsha Islands; *N. valdiviae* appeared in the waters off southern Taiwan. *S. evermanni* occurred in all 3 areas.

Distributions of the species in other genera (*Lobianchia*, *Triphoturus*, *Hygophum*, *Bolinichthys*, and *Notoscoplus*) are shown in figure 8. *B. longipes* appeared in all the 3 areas, but *B. supralateralis* was confined to around Tungsha area. *Lobianchia* spp., *Triphoturus* spp., and *Notoscoplus* spp. were caught off eastern Taiwan, and *Hygophum* off southwestern and eastern Taiwan.

Lanternfishes caught only by IKMT in these 3 areas are shown in table 3. There were 18 species from the 12 samplings around Tungsha Islands; nineteen species from the 38 samplings in the southwestern Taiwan; and 31 species from the 67 samplings off eastern Taiwan.

The similarity index (Odum 1983, Kreb 1994) of lanternfish species composition between the southwestern and eastern waters of Taiwan is 0.78; and 0.76 between southwestern Taiwan and Tungsha Islands (Table 3). The similarity index between Tungsha Islands and eastern Taiwan is 0.70. The similarity index of the lanternfish fauna off southwestern and eastern Taiwan shows the highest similarity among these 3 regions; this may be caused by the Kuroshio current passing along the east coast and its branch passing off southwestern Taiwan.

DISCUSSION

Lanternfishes studied here comprise the 2 families, Neoscopelidae and Myctophidae. There are 3 genera with 6 species in the Neoscopelidae (Nelson 1994); however, just 1 species, *Neoscopelus microchir*, appears in our area. This species was first reported by Chen (1969), and then by Shen (1984a b), Chen and Yu (1986), and Shen (1993). Unfortunately, they all put this species in the family Myctophidae except for Shen et al. (1993). Shen (1984b) listed its specific name as *Triphoturus microchir* (Gilbert 1913). According to the photograph in Shen (1984b) and Shen et al. (1993), its scientific name should be removed to *Neoscopelus microchir* Matsubara 1943.

Benthosema pterotum and *Diaphus latus* were also first reported by Chen (1969). *B. pterotum*, the dominant lanternfish around Taiwan, usually appears abundantly in Tungkang and Tashi fish markets (Fig. 5), however, Shen (1984a) described it as very rare. *D. garmani* is also a very common species around Taiwan. Shen (1984a) considered *D. latus* and *D. garmani* to be synonymous, and mentioned that *D. latus* occurred in southwestern Taiwan. Although Kawaguchi (1978) synonymized these 2 species, Paxton (1979) still considered them as 2 different species. Nafpaktitis (1968, p.73) pointed out that “*D. garmani* shows a noticeable geographic variation reflected mainly in the number of gill rakers and the total number of AO”. And there are no other reports of *D. latus*, including Nafpaktitis (1968 1977), Wisner (1981), Hulley (1981), Smith (1986), Bekker (1983), Kao (1996), and Shen et al. (1993). Furthermore, we have not seen *D. latus* in southwestern Taiwan for many years.

Diaphus diadematus reported by Shen (1984b) was doubted by Chen (1986). Shen (1993) and Kao (1996) did not list this species in their reports. According to the 2 photographs and capture locality described in Shen (1984b), one is thought to be *D. suborbitalis* (because of the VLO in *D. diadematus* is much lower than that of *D. suborbitalis*), and the other seems to be *D. watasei*.

Diaphus taaningi was recorded from Taiwan by Shen et al. (1993), however, the collection locality was not mentioned. Although Bekker (1983) described its distribution from southwestern and eastern Africa to northern Philippines on the map, this species had not been reported in mainland China (Yang 1996), Japan (Kawaguchi 1978, Masuda et al. 1984, Nakabo 1993), or eastern Pacific (Wisner 1976). Furthermore, we have not collected any specimen in many years of trawling or found it in any Taiwanese fish markets.

The most controversial identifications in previous reports from Taiwan occur in the genus *Diaphus*, which may be because *Diaphus* is the largest and most complicated genus of lanternfishes, and includes over 70 species worldwide (Nafpaktitis 1978). Luminous organs on the head and the body photophores are 2 important characters for identification; especially the former are usually crucial for identification. Taking *D. watasei* and *D. coeruleus* for instance, although these 2 species are easily separated from other congeneric species by their lower Pol, SAO_3 (3 photophores below the lateral line), and longer standard length (reaching about 150 mm SL), the body photophore patterns are almost identical. However, the luminous organs on the head of those 2 species differ greatly from each other (Kawaguchi 1978, Nafpaktitis 1978, Kao and Shao 1996). *D. watasei* possesses an Ant, while *D. coeruleus* does not (Nafpaktitis 1978, Kao and Shao 1996). Wisner

Table 3. Lanternfishes caught by IKMT from Tungsha, southwestern Taiwan, and eastern Taiwan (○, sampling in the day; ●, sampling at night)

Species	Tungsha Islands	Southwestern Taiwan	Eastern Taiwan
Benthosema fibulatum			●
Benthosema pterotum		○ ●	○ ●
Benthosema suborbitale	○	○	○ ●
Bolinichthys longipes	○	●	○ ●
Bolinichthys supralateralis	○		
Ceratoscopelus warmingii	○	○ ●	○ ●
Diaphus aliciae	○ ●	○ ●	○ ●
Diaphus coeruleus		○	
Diaphus garmani	○	○ ●	○ ●
Diaphus knappi			
Diaphus luetkeni	○ ●	○	○
Diaphus sagamiensis			●
Diaphus schmidti			○ ●
Diaphus signatus			●
Diaphus splendidus		○	
Diaphus suborbitalis			
Diaphus watasei			●
Diogenichthys atlanticus	○ ●	○	○
Electrona risso		○	
Hygophum proximum			○ ●
Hygophum reinhardtii		●	○ ●
Lampadena luminosa			
Lampadena anomala			
Lobianchia gemellarii			●
Lampanyctus alatus	○	○ ●	○ ●
Lampanyctus niger	○	○	●
Lampanyctus nobilis	○ ●	○ ●	○ ●
Lampanyctus turneri	○	○ ●	●
Lampanyctus tenuiformis	○		●
Myctophum asperum	○		●
Myctophum aurolaternatum	○		●
Myctophum nitidulum	○		
Myctophum obtusirostre	○ ●	○ ●	●
Myctophum spinosum		○	●
Neoscopelus microchir			●
Notolychnus valdiviae		○	○
Notoscopelus caudispinosus			●
Notoscopelus resplendens			●
Symbolophorus evermanni	○		○ ●
Triphoturus nigrescens			○

(1976) reported that *D. coeruleus* possesses an Ant. Yang et al. (1996) also mentioned in the key to the genus *Diaphus* that this species has an Ant present, but Yang et al. (1996) examined 10 specimens (110 to 143 mm SL, all in the mature stage), and did not report the Ant of *D. coeruleus* in the species description. Although *D. coeruleus* was first identified by Klunzinger (1871), Kawaguchi and Nafpaktitis thought the original paper did not describe it clearly (pers. comm. with K. Kawaguchi). So the original description of *D. coeruleus* refers to Fraser-Brunner (1949) in this study. Fraser-Brunner (1949, p. 1070), Nafpaktitis (1978, p. 10) and Kao and Shao (1996, p. 4) reported that *D. coeruleus* lacks an Ant. Moreover, the Ant is absent from many specimens of *D. coeruleus* (collected around Tungsha Islands and in Tungkang fish market) examined in this study. On the other hand, there is no dispute about *D. watasei* possessing an Ant. Other characters of the head also contribute to separating those 2 species, such as Vn. The Vn on *D. watasei* is triangular, and terminates at or behind a vertical through the anterior margin of the pupil; however, that of *D. coeruleus* is crescent-shaped, and terminates in advance of a vertical through the anterior margin of the pupil. Moreover, in most cases, the luminous organs on the head in the genus *Diaphus* are sexually dimorphic, and those on young individuals may differ from those of mature fish (Nafpaktitis 1968).

Lampanyctus nobilis, a very common lanternfish species in the waters around Taiwan, is very similar to another congeneric species, *L. macropterus* (Nafpaktitis 1969, Wisner 1976). But we still can separate those 2 species easily by the SAO and VO series. Both the VO and AOa series are arched with SAO_2 higher than SAO_1 in *L. nobilis*, and VO_2 (always noticeably behind VO_1) abruptly elevated above VO_1. Also SAO_1 and SAO_2 are on the same level in *L. macropterus*.

Forty lanternfish species in 16 genera were collected in the 3 areas of Taiwanese waters. Differences in the total number of species and species composition among the 3 areas may have been partially affected by the uneven fishing efforts made and different gears used in these study areas. Two kinds of fishing gears were used in this study (bottom trawl, 55 samples and IKMT, 117 samples). The lanternfish species collected by these 2 type of gears were quite different. The genera in bottom trawl samples included *Diaphus*, *Bolinichthys*, *Lampanyctus*, *Lampadena*, *Myctophum*, and *Ceratoscopelus*. Those in IKMT samples included *Diaphus*, *Lampanyctus*, *Benthosema*, *Myctophum*, *Ceratoscopelus*, and *Bolinichthys*. *Lampadena* and *Electrona* were not collected with IKMT, whereas *Notoscopelus*, *Lobianchia*, *Hygophum*, *Symbolophorus*, *Diogenichthys*, *Notolychnus*, and *Triphoturus* were absent from bottom trawl samples. *Bolinichthys* and *Ceratoscopelus* were taken with both types of gear. The former genus was collected with bottom trawls, but *Ceratoscopelus* was more likely to be captured by IKMT. In terms of species, *Bolinichthys supralateralis*, *Electrona risso*, *Lampadena luminosa*, and *L. anomala* were caught only by bottom trawls, while *Triphoturus nigrescens*, *Notolychnus valdiviae*, *Notoscopelus caudispinosus*, *Diogenichthys atlanticus*, *Hygophum proximum*, and *H. reinhardtii* were caught only by IKMT. Others could be found in samples of both gears.

Seven of the 17 first records in this study, i.e., *Bolinichthys supralateralis*, *Electrona risso*, *Lampanyctus turneri*, *Lobianchia gemellarii*, *Lampadena anomala*, *Notolychnus valdiviae*, and *Notoscopelus caudispinosus* had not previously been known from South China Sea to East China Sea (Table 1). Chen (1983), Huang and Yang (1983), and Yang (1996) studied the myctophids in South and East China Seas with either plankton nets or mid-water trawls. As *B. supralateralis*, *E. risso*, and *L. anomala* were caught only by bottom trawl, the absence of these species from South and East China Sea could be a result of not using bottom trawls. The other 4 species were caught by IKMT in this study. The absence of the above-mentioned species may also be due to differences in depth between these 2 geographical regions.

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臺灣及東沙島周邊水域燈籠魚之整理及其分布並兼記十七種新記錄

王大明　陳哲聰

本文係報導臺灣及東沙島周邊海域之燈籠魚目(Myctophidae and Neoscopelidae)魚類，標本大部份採自1991至1997年九個航次，由水試一號以底拖網或IKMT共作業184網次，作業範圍自北緯19至25度，東經114至123度。燈籠魚標本共有四十種分屬於十六屬，其中十七種在該海域為首次記錄。首次記錄之燈籠魚為帶底燈魚(*Benthosema fibulatum*)、側上虹燈魚(*Bolinichthys supralateralis*)、高體電燈魚(*Electrona risso*)、近壯燈魚(*Hygophum proximum*)、萊氏壯燈魚(*H. reinhardtii*)、糙炬燈魚(*Lampadena anomala*)、日本葉燈魚(*Lobianchia gemellarii*)、黑體珍燈魚(*Lampanyctus niger*)、圖氏珍燈魚(*L. turneri*)、天紐珍燈魚(*L. tenuiformis*)、暗色燈籠魚(*Myctophum asperum*)、金焰燈籠魚(*M. aurolaternatum*)、閃光燈籠魚(*M. nitidulum*)、櫛棘燈籠魚(*M. spinosum*)、尖吻背燈魚(*Notolychnus valdiviae*)、尾棘背燈魚(*Notoscopelus caudispinosus*) 及閃光背燈魚(*N. resplendens*)，共十屬十七種。其中側上虹燈魚(*B. supralateralis*)、高體電燈魚(*E. risso*)、圖氏珍燈魚(*L. turneri*)、糙炬燈魚(*L. anomala*)、尖吻背燈魚(*N. valdiviae*)及尾棘背燈魚(*N. caudispinosus*) 六種在南海也是新記錄種；而糙炬燈魚 (*L. anomala*) 更是全亞洲海域的新記錄種。此外，本省曾經發表的燈籠魚報告中，其中短臂尾燈魚(*Triphoturus microchir*)、冠眶燈魚(*Diaphus diadematus*)、寬眶燈魚(*D. latus*) 及譚氏眶燈魚 (*D. taaningi*) 四種燈籠魚曾被鑑定錯誤，在本報告中已予以更正。文中除簡述各新記錄種之關鍵特徵外，另備臺灣及東沙島海域所有燈籠之檢索表、分布圖及彩色標本照片等，以利學者參考。

關鍵詞：燈籠魚科，新燈籠魚科，魚類相，深海魚類。

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