Journal of Marine Science and Technology

Volume 21
Issue 7 *Vol 22, Supplemental*

Article 21

TAXONOMIC STUDY OF PIKE CONGERS (ANGUILLIFORMES: MURAENESOCIDAE) WITH IDENTIFICATION OF MURAENESOCID COLLECTIONS IN TAIWAN

James Lin
Department of Aquaculture, National Taiwan Ocean University, Keelung, Taiwan, R.O.C. Biodiversity Research Center, Academia Sinica, Nankang, Taipei, R.O.C.

Kwang-Tsao Shao
Biodiversity Research Center, Academia Sinica, Nankang, Taipei, R.O.C.

Hong-Ming Chen
Department of Aquaculture, National Taiwan Ocean University, Keelung, Taiwan, R.O.C. Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung, Taiwan, R.O.C., hmchen@mail.ntou.edu.tw

Recommended Citation

Lin, James; Shao, Kwang-Tsao; and Chen, Hong-Ming (2013) "TAXONOMIC STUDY OF PIKE CONGERS (ANGUILLIFORMES: MURAENESOCIDAE) WITH IDENTIFICATION OF MURAENESOCID COLLECTIONS IN TAIWAN," *Journal of Marine Science and Technology*: Vol. 21: Iss. 7, Article 21.
DOI: 10.6119/JMST-013-1220-6
Available at: https://jmstt.ntou.edu.tw/journal/vol21/iss7/21

TAXONOMIC STUDY OF PIKE CONGERS (ANGUILLIFORMES: MURAENESOCIDAE) WITH IDENTIFICATION OF MURAENESOCID COLLECTIONS IN TAIWAN

Acknowledgements

We are grateful to Pei-Li Lin (Biodiversity Research Center, Academia Sinica, Taiwan, BRCAS), Hsuan-Ching Ho (National Museum of Marine Biology and Aquarium, Taiwan, NMMBA), Chuan-Chen Wu (Fisheries Research Institute, FRI, COA), Jian-Neng Fang (National Taiwan Museum, NTM), Shen-Chih Wang (National Museum of Marine Science and Technology, NMMST), and Kao-Yi Wu (National Taiwan University, NTU) for their kindness in lending the specimens. We also thank the colleagues in the Laboratory of Aquatic Ecology, National Taiwan Ocean University, for their assistance in collecting, measuring and photographing of the specimens in this study. We also want to thank Abbie Chulin for her assistance in the revision of this paper in relation to its English writing.

Journal of Marine Science and Technology, Vol. 21, Suppl., pp. 166-174 (2013)
DOI: 10.6119/JMST-013-1220-6

TAXONOMIC STUDY OF PIKE CONGERS (ANGUILLIFORMES: MURAENESOCIDAE) WITH IDENTIFICATION OF MURAENESOCID COLLECTIONS IN TAIWAN

James Lin[1, 2], Kwang-Tsao Shao[2], and Hong-Ming Chen[1, 3]

Key words: taxonomy, pike conger, Muraenesocidae, Taiwan.

ABSTRACT

During the past years, we collected and studied on the Anguilliformes fishes, and described some new genera and new species of eels. We noticed that there are some misidentified species or invalid junior synonym in Muraenesocidae specimens. Considering how limited this family is known in Taiwan, we would like to revise the species of pike congers here. We collected muraenesocid specimens around Taiwan from fish markets, fishery harbors, fishermen, and also examined the specimens from other Taiwanese museum collections. Comparing to the past literature of Muraenesocidae, we found that the species *Congresox talabon* was misreported previously, and there is not any specimen of *C. talabon* found in Taiwan to date. We also confirmed that *Gavialiceps taiwanensis* is a valid species, not a synonym of *G. taeniola*. In this study, we revised the current taxonomic status of Muraenesocidae species, providing the correct species identification for the museum deposited specimens. We also provided the diagnostic key, fresh specimen photographs, precise dentition drawings for the muraenesocids in Taiwan.

I. INTRODUCTION

Canned stewed eel is a very common and famous food in Taiwan. Perhaps, only a few people can realize which eel species were used [22]. So far, it was still little-known on the eel family Muraenesocidae and its species composition in Taiwan. However, only the genus *Muraenesox* are commercial species in the family, and the other two genera, *Gavialiceps* and *Oxyconger*, are used for the raw material of fish meal [33].

Like most Anguilliformes fishes, Muraenesocidae is characterized by elongated and cylindrical body, scale absent, no spine, dorsal fin confluent with caudal fin and anal fin, pelvic fin absent, metamorphosis through the leptocephalus larval stage [26].

The English common name, pike conger, refers to its elongated shape head and triangular enlarged vomer teeth while the Taiwanese common name, ho mua, denotes its tiger-like teeth. Both names refer to Muraenesocidae eel has enlarged, pointed and very dangerous fang-like teeth [15, 9]. They are demersal fishes inhabiting tropical and subtropical offshore waters of the continental shelf and continental slope worldwide.

The first muraenesocid species reported from Taiwan was *Muraenesox arabicus* (=*Muraenesox cinereus*) by Chen [7]. Followed by Li [23], who had reported two species: *Muraenesox talabon* (=*Congresox talabon*) and *Oxyconger leptognathus*, but without a correct specimen record of *M. talabon*. Chen and Weng [8] reported *Muraenesox yamaguchiensis* (=*Muraenesox bagio* [9]), and described a new species *Chlopsis taiwanensis* (=*Gavialiceps taiwanensis*), which had been recognized as a synonym of *Gavialiceps taeniola* many times [5, 10, 30], but re-clarified its validity by Karmovskaya [19], who revised the genus *Gavialiceps* around Indo-Western Pacific.

In this paper, we examined specimens of the family Muraenesocidae from Taiwan, clarify the validity of species composition and the correct species identification of muraenesocid specimens from Pisces collections in Taiwan.

II. MATERIALS AND METHODS

The specimens reported here were collected by commercial fishing trawlers and bottom long-line in Taiwanese waters at depths of 50~400 m. Measurements were conducted as a straight line (point to point), and dial calipers were used to record to the nearest 0.1 mm. The morphological measure-

Paper submitted 10/31/13; revised 12/14/13; accepted 12/20/13. Author for correspondence: Hong-Ming Chen (e-mail: hmchen@mail.ntou.edu.tw).
[1] *Department of Aquaculture, National Taiwan Ocean University, Keelung, Taiwan, R.O.C.*
[2] *Biodiversity Research Center, Academia Sinica, Nankang, Taipei, R.O.C.*
[3] *Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung, Taiwan, R.O.C.*

ments and meristic counts were utilized as presented by Böhlke [4] while the vertebral counts are from radiographs.

The following measurement abbreviations are used: TL = total length, PAL = preanal length, TR = trunk length, PDL = predorsal length, HL = head length, DGO = body depth at gill opening, GO = gill opening depth, IOW = interorbital width, UJ = length of upper jaw, LJ = length of lower jaw, E = diameter of eye, S = snout length, P = pectoral fin length, VG = ventral width between gill openings, PDLL = lateral-line pores before dorsal fin origin, PALL = lateral-line pores before anus, PADR = preanal dorsal fin rays, PR = pectoral fin rays, TV= total vertebrae, PAV = preanal vertebrae, PDV = predorsal vertebrae, PCV = precaudal vertebrae, MVF = mean vertebrae formula.

Specimens are deposited in the following museums: ASIZP (Academia Sinica, Biodiversity Research Center, Taipei, Taiwan), NMMSTP (Pisces Collection, National Museum of Marine Science and Technology, Keelung, Taiwan), TOU-AE (National Taiwan Ocean University, Laboratory of Aquatic Ecology, Department of Aquaculture, Keelung, Taiwan), NMMBP (Pisces Collection, National Museum of Marine Biology and Aquarium, Pingtung, Taiwan), NTUM (National Taiwan University, Institute of Zoology, Taipei, Taiwan), NTM (National Taiwan Museum, Taipei, Taiwan), FRIP (Fisheries Research Institute, Keelung, Taiwan).

Drawings and photographs were made by James Lin. The nomenclatural details were consulted from Eschmeyer [12], the online catalog of fishes.

III. RESULTS

Family Muraenesocidae

Body and head are elongate, it is cylindrical in front and compressed posteriorly, it is tapering and with a flexible tail. Dorsal fin is well developed and it is confluent with caudal fin and anal fin; the dorsal fin originates slightly before or above the gill opening. It has a pointed snout which is slightly narrow and contains a fleshy tip; the upper jaw is curved, and the rictus is behind the posterior eye margin. The Gill opening slit is large, and located on the lower side, its height almost reaches half of the body depth. The eye is well developed. The anterior nostril is tubular, laterally and located middle from the snout tip to the posterior nostril. The posterior nostril is elliptical and located in front of the eye at the mid-eye level. The Lateral-line is complete and scale is absent. The premaxillary teeth and anterior part of mandibular teeth are pointed. The vomer contains 2 or 3 rows of sharp, fang-like teeth. The total vertebrae count of Muraenesocidae species in Taiwan ranges between 114~239 while the preanal lateral-line pores ranges between 35~55. Three genera and four species of Muraenesocidae are recorded here in Taiwan.

Key to the genera and species of Muraenesocidae from Taiwan

1a. Pectoral fin absent, TV 237~239 ····· *Gavialiceps taiwanensis*
1b. Pectoral fin present, TV 114~155 ····· 2
2a. Anus is behind the mid-body; vomer teeth has 2 rows without enlarged mid-row vomer teeth····· *Oxyconger leptognathus*
2b. Anus is before the mid-body; vomer teeth has 3 rows with mid-row of enlarged, triangle-like teeth ·····*Muraenesox*
3a. PALL 35~37; PADR 50~54; TV 137~138; snout is acute ····· *Muraenesox bagio*
3b. PALL 40~46; PADR 66~80; TV 149~155; snout is broad ····· *Muraenesox cinereus*

Genus *Gavialiceps* Alcock, 1889

Gavialiceps Alcock, 1889: 460 [1] (type species *Gavialiceps taeniola* Alcock,1889); Castle, 1977 [5]; Talwar and Kacker, 1984: 234 [34]; Masuda *et al*., 1985: 32 [24]; Karmovskaya, 1994: 742 [19]; Smith in Carpenter and Niem, 1999: 1683 [33]; Hatooka in Nakabo, 2000: 235 [17]; Shen *et al*., 2004: 280 [30]; Thankappan *et al*., 2007 [35]; Ho *et al*., 2010 [18]; Zhang *et al*., 2010: 300 [36]; Shen and Wu, 2011: 135 [31].

1. Diagnosis

It has a slender body that is flexible and slightly compressed and with a hair-like tail that is extremely thin and tender. Anus is before mid-body. Gill opening slit is large. Snout is elongated, crocodile-like and a little flat. Anterior nostril is tubular and located middle from the upper jaw tip to the posterior nostril. Posterior nostril is located in front of the eye at the mid-eye level. Supraorbital pores are slit-like. Vomer plate is elongated with enlarge mid-row teeth. Maxillary teeth series with an inner row separate from the outers. Pectoral fin is absent. Dorsal fin is confluent with caudal fin and anal fin. Scale is absent. Lateral-line is complete. Now, the genus contains 5 species in the world with 1 species reported from Taiwan.

2. Etymology

Derived from the Latin *Gavial* (the crocodile), and *ceps* (the head) which is in reference to the depressed, crocodile-like head shape.

3. Distribution

In tropical and subtropical seas around Indo-Western Pacific.

Gavialiceps taiwanensis (Chen and Weng, 1967)

Figs. 1, 2

Chlopsis taiwanensis Chen and Weng, 1967: 81, fig. 61 [8] (Donggang, southwestern Taiwan, Lectotype: NMMBP 1405 [formerly type THUP 2671]); Shen, 1984: 114 [29]; Chen and Yu, 1986: 255, fig. 6-64 left [9].

Fig. 1. ***Gavialiceps taiwanensis*, TOU-AE5531, 480 mm TL, May 2010, Daxi, Yilan. Top, lateral view of whole body. Bottom, lateral view of head.**

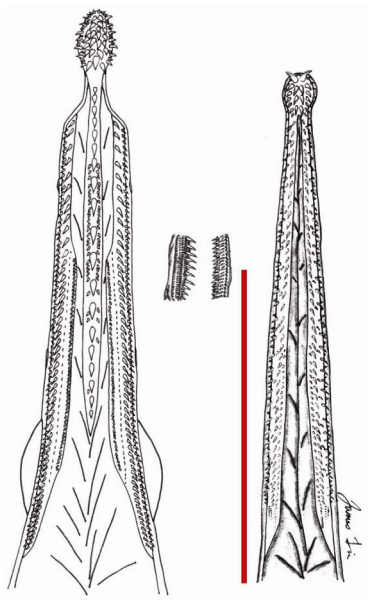

Fig. 2. Dentition of *Gavialiceps taiwanensis*, TOU-AE5531, 480 mm TL, May 2010, Daxi, Yilan. Scale = 10 mm.

Gavialiceps taeniola (not Alcock, 1889): Shen *et al*., 2004: 280 [30]; Zhang *et al*., 2010: 300 [36].

Gavialiceps taiwanensis: Karmovskaya, 1994: 742 [19]; Ho *et al*., 2010 [18]; Shen and Wu, 2011: 135 [31].

1. Specimens examined

NMMBP 1405, Lectotype, 1 specimen, 564 mm TL, Donggang, Pingtung, January 1965; NMMBP 1360, Paralectotypes, 26 specimens, 310~610 mm TL, Donggang, Pingtung, March 1965; NMMBP 1410, Paralectotype, 1 specimen, 595 mm TL, Donggang, Pingtung, March 1965; TOU-AE 5483~5484, 5490~5495, 5524, 5531~5536, 5613~5624, 5800, 5845~5854, 5872~5876, 5880~5881, 5895, 46 specimens, 130~689 mm TL, Daxi, Yilan; TOU-AE 5796~5797, 5816~5820, 7 specimens, 277~450 mm TL, Donggang, Pingtung; ASIZP 0061770, 1 specimen, 455 mm TL, Daxi, Yilan; NTM 1130, 12 specimens, 530 mm TL, Daxi, Yilan; NMMSTP 00911, 1 specimen, 610 mm TL, Dongsha; NMMSTP 01579, 1 specimen, 257 mm TL, Daxi, Yilan; FRIP 00243, 12 specimens, 163~437 mm TL, Daxi, Yilan; NMMBP 374, 376, 526, 911, 2814, 3210~3211, 3509, 3535, 3703, 7216, 7480, 7597, 7961, 8382, 9187, 9221, 9315~9316, 10067~10068, 25 specimens, 320~763 mm TL, Donggang, Pingtung; NMMBP 1752~1753, 1820, 3003~3004, 6213, 7438, 9146, 9187, 9 specimens, 670 mm TL, Daxi, Yilan.

2. Diagnosis

MVF 7-50-238; PDV 6~10; PAV 49~53; TV 237~239; PCV 68~70. PDLL 5~6; PALL 42~55. PADR 70~80. % of TL: PAL 31.31~31.88; Tail 68.13~68.69; TR 21.92~23.96; PDL 8.37~9.92; HL 8.58~9.08; DGO 1.31~1.58. % of HL: IOW 2.85~12.81; UJ 46.89~65; LJ 42.57~60.54; E 5.88~11.05; S 38.91~49.5.

Body is elongated, slightly compressed with a flexible tail and tender. Anus is located before midway of body. Pectoral fin is absent. Dorsal fin is confluent with caudal and anal fins. Dorsal fin originates above the gill opening. Gill openings are large and located somewhat ventrally, almost connected together on the ventral side. Snout is elongated, pointed, crocodile-like and a little flat. Upper jaw with the premaxilla plate projects beyond the lower jaw. Eye is round. Rictus extends beyond the posterior margin of eye. Anterior nostril is tubular and located midway from the upper jaw tip to posterior nostril. Posterior nostril is located in front of the eye. Teeth number is abundant, conical-granular, direct backward and exposed when mouth is closed. Vomer teeth are in three rows with enlarged and fangs-like mid-row teeth. Maxillary teeth series with an inner row clearly separated from the outers.

3. Coloration

When fresh the body is semi-transparent, the head is yellow to orange color with many melanophores spread on the body. Gill opening is black. Anus has a black spot. Fin with no color anteriorly but changes to a black color near the tail tip. Peritoneum is black. In formalin the body is a cream color. In alcohol the body is a beige color.

4. Etymology

Named from the type locality—Taiwan.

5. Distribution

Western to northern Pacific regions, known from South

China Sea to East China Sea, Taiwan, China to southern part of Japan. Widely distributed around Taiwan at depths of > 300 m.

Genus *Muraenesox* McClelland, 1844

Muraenesox McClelland, 1844: 408 [25] (type species *Muraenesox hamiltonii* McClelland, 1844); Day, 1878: 661 [11]; Gill, 1890: 234 [14]; Li, 1960: 84 [23]; Castle and Williamson, 1975 [6]; Sainsbury *et al*., 1985: 58 [27]; Chen and Yu, 1986 [9]; Talwar and Kacker, 1984: 237 [32]; Shen, 1984: 114 [29]; Masuda *et al*., 1985: 32 [24]; Smith in Carpenter and Niem, 1999: 1675 [33]; Hatooka in Nakabo, 2000: 235 [17]; Shen *et al*., 2004: 281 [30]; Zhang *et al*., 2010: 290 [36]; Shen and Wu, 2011: 135 [31].

1. Diagnosis

A muraenesocid eel genus has moderate large to large body and relatively more heavy body. Body is moderately elongate, the anus is located before midway of body, and it is cylindrical anteriorly but becomes more compressed posteriorly, with a tapering tail. It has a large gill opening slit. Head is acute, snout is elongate, and rictus extends beyond the posterior margin of the eye. Anterior nostril is tubular and located in the middle between the upper jaw tip and posterior nostril.

Posterior nostril is located in front of the eye, on the mid-eye level. Vomer teeth plate is elongated with three rows; the middle row is enlarged, blade-like, sharp teeth which has a thicker base. Pectoral fins are well developed. Dorsal fin is confluent with the caudal fin and anal fin. Scale is absent. Lateral-line is complete. Now, the genus contains 2 species in the world, both species have been reported from Taiwan.

2. Etymology

Derived from the Latin *Muraena* (eel), and *esox* (from the pike fish genus *Esox*), in reference to the elongated and sharp head shape and the pointed teeth.

3. Distribution

Both species had been reported from the Indian Ocean to north western Pacific in tropical and subtropical offshore waters, but most common in western Pacific.

Muraenesox bagio (Hamilton, 1822)

Figs. 3, 4

Muraena bagio Hamilton, 1822: 21, 364 [16] (Ganges River estuaries, India. No types known).

Muraenesox yamaguchiensis Katayama and Takai, 1954: 97, Figs. 1-2 [21] (Yamaguchi Prefecture, Japan. Holotype: Katayama's Fish Coll. 1764); Zhang *et al*., 2010: 294, fig. 171 [36].

Muraenesox bagio: Castle and Williamson, 1975: 4 [6]; Talwar and Kacker, 1984: 238, fig. 100 [34]; Shen, 1984: 114 [29]; Masuda *et al*., 1985: 32, fig. B [24]; Chen and Yu, 1986: 254 [9]; Smith in Carpenter and Niem, 1999: 1676 [33]; Hatooka in Nakabo, 2000: 235 [17]; Shen *et al*., 2004: 281 [30]; Shen and Wu, 2011: 135 [31].

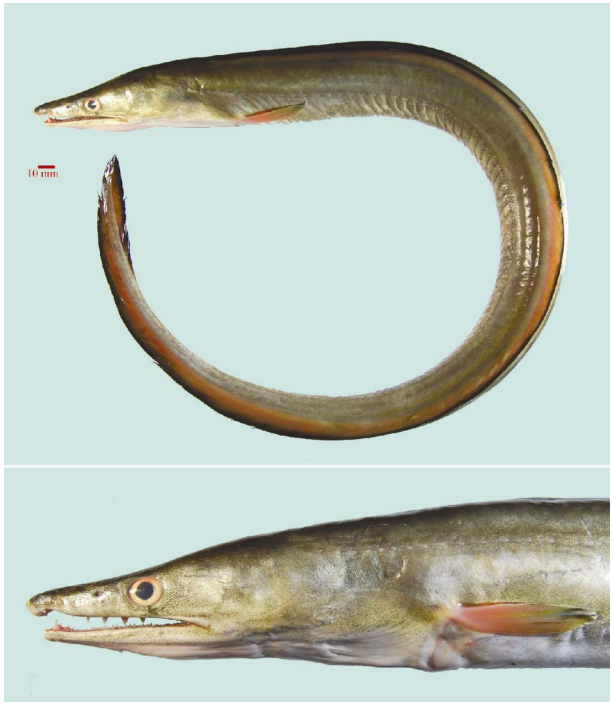

Fig. 3. ***Muraenesox bagio*, TOU-AE 6956, 855 mm TL, Jul. 2013, Budai harbor, Chiayi. Top, lateral view of whole body. Bottom, lateral view of head.**

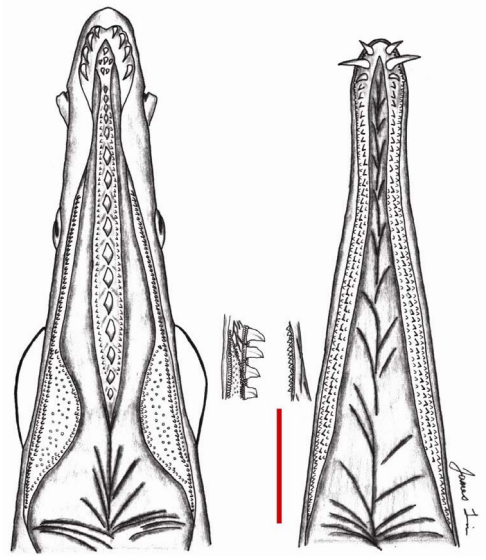

Fig. 4. Dentition of *Muraenesox bagio*, ASIZP0064688, 683 mm TL, Aug. 2004, Dapeng Bay, Pingtung. Scale = 10 mm.

1. Specimens examined

TOU-AE 6956, July 2013, 1 specimen, 855 mm TL, Budai harbor, Chiayi; ASIZP 0064688, August 2004, 1 specimen, 683 mm TL, Dapeng Bay, Pingtung; NMMBP 6817, 7736,

2 specimens 526~543 mm TL, Kaohsiung ; NMMBP 2986, 2002~2003, 3 specimens, 383~543 mm TL, Donggang, Pingtung.

2. Diagnosis

MVF 9-38-138; PDV 8~9; PAV 37~38; TV 137~138; PCV 56~58. PDLL 6~7; PALL 35~37. PADR 50~54. PR 12. % of TL: PAL 36.55~42.78; Tail 57.22~63.45; TR 22.99~23.94; PDL 14.06~14.36; HL 14.06~14.62; DGO 4.62~5.06. % of HL: IOW 9.23~10; UJ 48.87~49.99; LJ 44~45.94; E 11.33~13.21; S 26.07~29.23; P 29.82~35.73.

Body is elongated, it is cylindrical anteriorly but compressed posteriorly, it has a tapering tail. Anus is located about two fifth of the body. Pectoral fin is well developed. Dorsal fin is confluent with the caudal and anal fins. Dorsal fin origin-nates right above the gill opening. Gill opening is slit-like, large, located somewhat ventrally, and nearly meeting on the end of each side. It has a fleshy snout that is moderately elongated, slightly acute, and a little narrow. Upper jaw projects beyond the lower jaw with the premaxilla level. Eye is ellipse. Rictus extends beyond the posterior margin of the eye. Anterior nostril is tubular and located midway from upper jaw tip to the posterior nostril. Posterior nostril is located two thirds in front of the eye. Teeth numbers are abundant, conical-granular and hidden when mouth is closed. Vomer teeth are in three rows, with enlarged, compressed and blade-like mid-row teeth which have a wider base. Maxillary teeth with several rows extend inward on the eye level.

3. Coloration

When fresh the body is pale yellow to yellow with it being darker above and pale below. It is pale to pale yellow on the ventral side and on the abdomen. Pale yellow to yellow on the pectoral fins. Dorsal fin is pale yellow with a black edge. Lateral-line pores are white in color. In formalin and alcohol the body is brown to dark brown.

4. Etymology

Named from the Latin *brunne* (brown), and *gilv* (pale yellow), in reference to the pale brownish coloration.

5. Distribution

Distributed in the Red Sea and from the Indian Ocean to the northwestern and southwestern Pacific. Rare species in Taiwan are mainly distributed in the southwestern Taiwan: off the coast of Chiayi, Kaohsiung and Pingtung, with a depth of up to 200m.

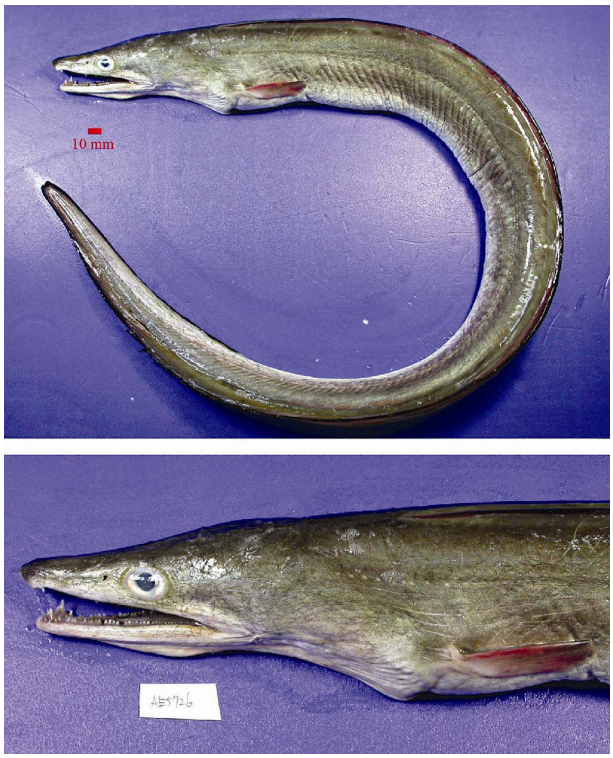

Fig. 5. ***Muraenesox cinereus*, TOU-AE 5726, 960 mm TL, Nov. 2010, Keelung. Top, lateral view of whole body. Bottom, lateral view of head.**

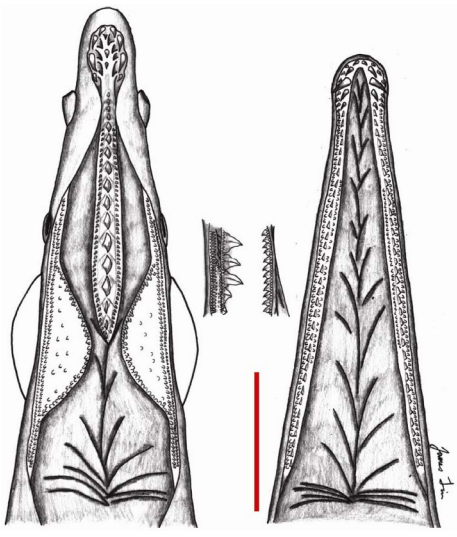

Fig. 6. Dentition of *Muraenesox cinereus*, TOU-AE5721, 497 mm TL, Jul. 2008, Daxi, Yilan. Scale = 10 mm.

Muraenesox cinereus (Forsskål, 1775)

Figs. 5, 6

Muraena cinerea Forsskål, 1775: 22, 364 [13] (Jeddah, Saudi Arabia, Red Sea. Holotype: ZMUC P31250, a dry skin).

Muraenesox arabicus (not Bloch and Schneider, 1801): Chen, 1954 [7].

Muraenesox cinereus: Day, 1878: 662, plate 18, fig. 4 [11]; Li, 1960: 84 [23]; Castle and Williamson, 1975: 4 [6]; Talwar and Kacker, 1984: 239, fig. 101 [34]; Shen, 1984: 114 [29]; Sainsbury *et al*., 1985: 58 [27]; Masuda *et al*., 1985: 32, fig. A [24]; Chen and Yu, 1986: 254, fig. 6-63 left [9]; Smith in Carpenter and Niem, 1999: 1677 [33];

Hatooka in Nakabo, 2000: 235 [17]; Zhang *et al*., 2010: 290, fig. 170A [36]; Shen and Wu, 2011: 135 [31].

1. Specimens examined

TOU-AE 5396~5398, 5537~5538, 5655~5662, 5716~5724, 5734~5735, 5799, 5834~5840, 5866, 5868~5871, 37 specimens, 446~854 mm TL, Daxi, Yilan; TOU-AE 5486, 5863~5865, 4 specimens, 562~705 mm TL, Shi-ti, Hualien; TOU-AE 5598, 1 specimen, 1005 mm TL, Changbin, Taitung; TOU-AE 5725~5732, 8 specimens, 686~960 mm TL, Keelung; TOU-AE 5740~5741, 5856, 3 specimens, 494~651 mm TL, Nanfangao, Yilan; ASIZP 0058376, 1 specimen, 436 mm TL, Xingda harbor, Kaohsiung; NTUM 00327, 2 specimens, 679 mm TL, Keelung; NTUM 02068, 1 specimen, 165 mm TL, Kinmen; NTUM 07613, 1 specimen, 399 mm TL, Daxi, Yilan; NMMSTP 01503, 01684, 2 specimens, 552~643 mm TL, Daxi, Yilan; FRIP 020007, 3 specimens, 197 mm TL, northern waters of Taiwan; NMMBP 3648, 3654, 3681, 9077, 9090, 7 specimens, 491~623 mm TL, Donggang, Pingtung; NMMBP 6681, 7542, 2 specimens, 555~666 mm TL, Kaohsiung; NMMBP 6675, 1 specimen, 561 mm TL, Tainan; NMMBP 6651, 6676, 2 specimens, 591~683 mm TL, Taichung. Other material. FRIP 01350, 1 specimen, 587 mm TL, northern waters of Australia.

2. Diagnosis

MVF 8-45-151; PDV 7~10; PAV 43~48; TV 149~155; PCV 64~66. PDLL 4~8; PALL 40~46. PADR 66~80. PR 15~18. % of TL: PAL 36.21~46.92; Tail 55.68~63.92; TR 19.22~29.27; PDL 12.01~15.28; HL 12.84~16.53; DGO 3.96~7.28. % of HL: IOW 11.39~20.37; UJ 46.04~55.41; LJ 39.73~52.43; E 9.99~15.54; S 26.96~32.83; P 30.13~44.03.

Body is elongated, it is cylindrical anteriorly and compressed posteriorly, with a tapering tail. Anus is located before mid-body. Pectoral fin is well developed. Dorsal fin is confluent with caudal and anal fins. Dorsal fin originates above or slightly before the gill opening. Gill openings are large, located ventrally and nearly meet on the ventral side. It has a fleshy snout that is broader, moderately elongated and slightly acute. Isthmus is wide. Upper jaw projects beyond the lower jaw with the premaxilla level. Eye is ellipse. Rictus extends beyond posterior margin of the eye. Anterior nostril is tubular and located midway from upper jaw tip to posterior nostril. Posterior nostril located two thirds in front of the eye. Teeth are abundant in number, conical-granular and hidden when mouth is closed. Vomer teeth have three rows with enlarged, compressed and blade-like mid-row teeth that have a wider base. Maxillary teeth with several rows extend inward on the eye level.

3. Coloration

When fresh it is light gray to light brown, comes gray, with a deep color above and pale white below. Light brown to red color on the pectoral fins. Dorsal fin is gray with obvious black edge. Lateral-line pores with white color. In formalin and alcohol, body gray brown to dark brown, yellow or brown on ventral side.

4. Etymology

Named from the Latin *cinere* (ashen) this is in reference to the gray body coloration.

5. Distribution

This species had been widely reported from Red Sea, Indian Ocean to northwestern and southwestern Pacific. It is one of the most common eel species in Taiwan and usually used for canned stewed eel and red yeast eel, it widely distributed in Taiwanese sea waters including all islands with a depth of up to 400 m.

Genus *Oxyconger* Bleeker, 1864

Oxyconger Bleeker, 1864: 19 [3] (type species *Conger leptognathus* Bleeker, 1858 [2]); Li, 1960: 85 [23]; Shen, 1984: 113 [29]; Sainsbury *et al*., 1985: 57 [27]; Masuda *et al*., 1985: 32 [24]; Lee, 1985: 43 [22]; Smith in Carpenter and Niem, 1999: 1674 [33]; Hatooka in Nakabo, 2000: 235 [17]; Shen *et al*., 2004: 282 [30]; Zhang *et al*., 2010: 298 [36]; Shen and Wu, 2011: 136 [31].

1. Diagnosis

Relatively short body within the family and with a short tail; anus is located behind midway of the body near the tail tip rather than the snout tip. Gill opening is moderated. Head pointed and the snout is moderately elongate, rictus is slightly behind posterior margin of the eye. Anterior nostril is tubular and located two thirds between upper jaw tip to the posterior nostril. Posterior nostril is located in front of the eye. It is without the mid-row enlarged vomer teeth, however, there are two separate plates with moderate sized teeth on vomer. Maxillary teeth are in two rows, with inner row with enlarged, sharp and fangs-like teeth. Pectoral fins are well developed. Caudal fin is reduced. Scale is absent. Lateral-line is complete. Only one species within this genus, *Oxyconger leptognathus*, and it was also reported from Taiwan.

2. Etymology

Derived from the Greek "*Oxy*"(sharp) and the Latin "*conger*" (an eel), in reference to the acute head shape.

3. Distribution

O. leptognathus had been reported from western, northern Pacific and from east Australia with it being most common in western Pacific.

Oxyconger leptognathus (Bleeker, 1858)

Figs. 7, 8

Conger leptognathus Bleeker, 1858: 27 [2] (Nagasaki, Japan. Holotype: BMNH 1867.11.28.295).

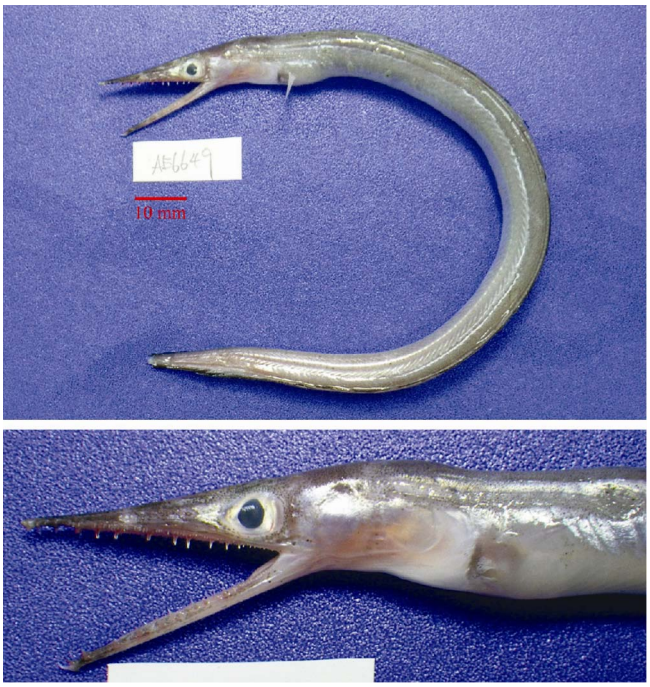

Fig. 7. ***Oxyconger leptognathus*****, TOU-AE 6649, 250 mm TL, Oct. 2012, Daxi, Yilan. Top, lateral view of whole body. Bottom, lateral view of head.**

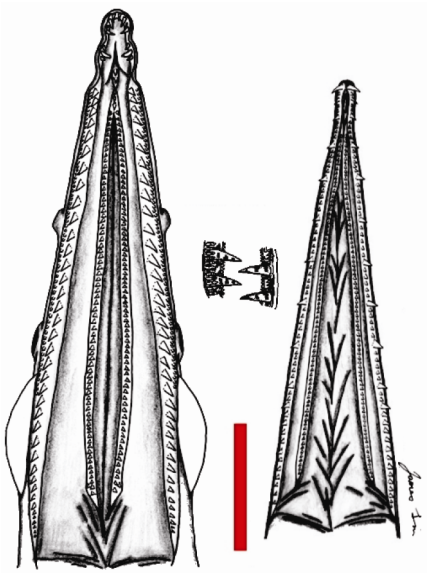

Fig. 8. Dentition of *Oxyconger leptognathus*, ASIZP0066667, 423 mm TL, Oct. 2005, Daxi, Yilan. Scale = 10 mm.

Oxyconger leptognathus: Li, 1960: 85 [23]; Shen, 1984:113 [29]; Sainsbury *et al*., 1985: 57 [27]; Masuda *et al*., 1985: 32, fig. C [24]; Lee, 1985: 43, fig. 043 [22]; Chen and Yu, 1986: 254, fig. 6-63 left [9]; Smith in Carpenter and Niem, 1999: 1677 [33]; Hatooka in Nakabo, 2000: 235 [17]; Shen *et al*., 2004:282 [30]; Zhang *et al*., 2010: 298, fig. 174 [36]; Shen and Wu, 2011:136 [31].

1. Specimens examined

TOU-AE 6649, 1 specimen, 250 mm TL, Daxi, Yilan; ASIZP006082, 1 specimen, 147 mm TL, Donggang, Pingtung; ASIZP 0066667, 1 specimen, 423 mm TL, Daxi, Yilan; NTUM 04348, 06975, 2 specimens, 194~264 mm TL, Magong, Penghu; NTMP 1131, 1 specimen, 349 mm TL, Daxi, Yilan; FRIP 00771, 1 specimen, 213 mm TL, northeastern Taiwanese waters; NMMBP 1462, 4586, 8813, 3 specimens, 257~344 mm TL, Magong, Penghu; NMMBP 3006, 4589, 5208, 3 specimens, 202~283 mm TL, Donggang, Pingtung; NMMBP 4587, 1 specimen, 283 mm TL, Tidal land, Chiayi; NMMBP 4588, 1 specimen, 245 mm TL, Xiaoliuqiu, Pingtung.

2. Diagnosis

MVF 7-52-117; PDV 5~7; PAV 50~54; TV 114~119; PCV 51~54. PDLL 3~5; PALL 49~54. PADR 100~110. PR 10~11. % of TL: PAL 55.1~61.8; Tail 39.24~44.9; TR 37.11~42.98; PDL 17.19~20.62; HL 17.26~20.19; DGO 3.53~6.56. % of HL: IOW 5.38~9.85; UJ 59.18~66.73; LJ 57.29~65.71; E 13.26~16.22; S 40.61~46.4; P 24.44~29.82.

Body is short and compressed; it has a tapering tail. Anus is located posterior, behind the mid-body. Pectoral fins are well developed. Dorsal, caudal and anal fin are confluent; caudal fin is reduced. Dorsal fin originates above the gill opening. Gill openings are large and located ventrally, and almost meet on the ventral side. Snout is acute, sharp and moderately elongated. Isthmus is narrow. Upper jaw, a premaxilla plate projects beyond the lower. Eye is round to ellipse. Rictus slightly extend beyond the posterior margin of the eye. Anterior nostril is tubular and located halfway between the upper jaw tip and anterior margin of the eye. Posterior nostril is in front of the eye and located between anterior nostril and anterior eye. Teeth are pointed and conical; it is exposed when mouth is closed. Vomer teeth are in two rows without the enlarged mid-row teeth. Maxillary teeth are in two rows with the inner row having enlarged sharp teeth. Dentary teeth are in two rows with the outer row having several enlarged teeth with about five small teeth between each two enlarged teeth.

3. Coloration

When fresh the body is light gray to silver. It has a silver band on the mid body and from posterior eye to tail tip. It has transparent white pectoral fins. Dorsal fin is gray with a black edge. The female specimen TOU-AE 6649 had transparent ripe eggs (egg diameter 1~2 mm). Peritoneum is black. In formalin and alcohol the body is creamy pale to brown.

4. Etymology

Named from the Greek "*lepto*" (slender) and "*gnathus*" (the jaw) and this is in reference to the acute, slender jaw and head.

5. Distribution

From south-western Japan to Taiwan and occasionally seen in non-target fishes by bottom trawl. Depth of up to 300 m.

Table 1. Mean morphological proportions and counts of the specimens of four Muraenesocidae species in Taiwan.

	Gavialiceps taiwanensis	*Muraenesox bagio*	*Muraenesox cinereus*	*Oxyconger leptognathus*
% of TL				
PAL	31.4	39.5	38.7	59.2
Tail	68.6	60.5	61.3	40.8
TR	23.3	23.5	25.2	40
PDL	8.8	14.2	14	18.4
HL	8.6	14.3	14.6	18.5
DGO	1.4	4.8	5.6	4.5
DA	2.2	4.9	5.8	4.5
% of PAL				
TR	75.4	59.6	65.1	67.7
PDL	26.8	36	36.1	31.1
HL	26.7	36.4	37.8	31.3
DGO	5.4	12.2	14.6	7.6
DA	7.7	12.5	14.9	7.7
% of HL				
IOW	5.4	9.6	14.1	7.5
UJ	56.2	49.2	49.8	66.3
LJ	51.9	45.1	45.1	63.1
E	7.7	12.1	12	14.4
S	45.4	28	28.8	46.8
VG	3.4	10.6	8.6	4.8
P	-	33.4	37.8	28
% of DGO				
GO	56.4	37.9	45.4	50
Counts				
PDLL	5	7	6	5
PALL	50	35	42	51
PADR	75	52	76	100
PDV	7	9	8	7
PAV	50	38	45	52
TV	238	138	151	117
PCV	69	57	65	53

IV. DISCUSSION

In the past, it was hard to gather or exchange the relative scientific literature from foreign countries, even in the taxonomy of Muraenesocidae, which led to many synonyms, misidentified or invalid species recorded in the local fish collections. In this study, we gave the mean morphological proportions and counts of the specimens of four Muraenesocidae species in Taiwan (Table 1), and examined most of the Muraenesocidae relative specimens from Taiwanese fish collections and provided the correct species identification for the specimens (Table 2). As shown in the results, the specimen NTUM 04348 which had been reported as *Congresox talabon* in Li [23] were misidentified specimens, there were two

Table 2. Identification correction for Taiwanese Muraenesocidae collections.

Catalog no.	Original identified name	Correct scientific name
NTM 1130	*Saurenchelys fierasfer*	*Gavialiceps taiwanensis*
NTUM 04348	*Congresox talabon*	*Oxyconger leptognathus*
NTUM 07613	*Muraenesox bagio*	*Muraenesox cinereus*
NMMSTP 00911	*Saurenchelys taiwanensis*	*Gavialiceps taiwanensis*
FRIP 000243	*Saurenchelys fierasfer*	*Gavialiceps taiwanensis*
FRIP 001350	*Muraenesox yamaguchiensis*	*Muraenesox cinereus*
FRIP 020007	*Muraenesox bagio*	*Muraenesox cinereus*
NMMBP 02986	*Muraenesox cinereus*	*Muraenesox bagio*
NMMBP 09077	*Muraenesox bagio*	*Muraenesox cinereus*
NMMBP 09090	*Muraenesox bagio*	*Muraenesox cinereus*

Oxyconger leptognathus inside and after we examined the correct *Congresox talabon* specimen TOU-AE 5867 (814 mm TL, Oct. 2011, Kuala Selangor, Malaysia, collected by Dr. Kar-Hoe Loh), we subsequently found out that there was no actual *Congresox talabon* specimen caught from Taiwan. *C. talabon* is distributed around the Indian Ocean to Java Sea and Central-western Pacific [33] and it probably will be found from southwestern Taiwan. Li [23] wrote a reasonable description of the *C. talabon*, but he did not clearly record the examined specimen information. He guessed National Taiwan University had *C. talabon* specimens and did not even list the cataloged number of the specimen. Based on this reason, a formal taxonomic report should stand with clear description, cataloged specimen and figure evidence. Unfortunately, there was not any real record of *C. talabon* in Taiwan.

Within the family Muraenesocidae, genera *Gavialiceps* and *Oxyconger* remain with an uncertain classification status; in particular the knowledge of the latter is so few that it still lacks more related information, especially on the osteology study. It will need further study to clarify their relationship. *Gavialiceps* had a complete study on its osteology and compared with the other similar genera groups, was considered as a genus including *Rhynchoconger-Uroconger* group within family Congridae [20, 32]. Because its sibling genus *Xenomystax* also shared the characteristics such as having the elongated ethmovomer, enlarged teeth on the mid-row of vomer, form of the lateral-line ossicles, and the inner row of maxillary teeth separated from the outers. Smith [32] believed that the *Xenomystax* stand as a bridge between Congridae and Nettastomatidae, and *Gavialiceps* display a taxonomic relationship (the elongated ethmovomer, lateral-line ossicles, elongated vomerine, no pectoral fin…etc.) closer to Nettastomatidae than Congridae or Muraenesocidae. Consequently, we think *Gavialiceps* should belong to Nettastomatidae but considering the purpose of this study, we follow the classification of Muraenesocidae from the previous Taiwanese literature and the fish database of Taiwan [28] at this stage, and clarify the correct species identification for the past cataloged Taiwanese specimens.

ACKNOWLEDGMENTS

We are grateful to Pei-Li Lin (Biodiversity Research Center, Academia Sinica, Taiwan, BRCAS), Hsuan-Ching Ho (National Museum of Marine Biology and Aquarium, Taiwan, NMMBA), Chuan-Chen Wu (Fisheries Research Institute, FRI, COA), Jian-Neng Fang (National Taiwan Museum, NTM), Shen-Chih Wang (National Museum of Marine Science and Technology, NMMST), and Kao-Yi Wu (National Taiwan University, NTU) for their kindness in lending the specimens. We also thank the colleagues in the Laboratory of Aquatic Ecology, National Taiwan Ocean University, for their assistance in collecting, measuring and photographing of the specimens in this study. We also want to thank Abbie Chulin for her assistance in the revision of this paper in relation to its English writing.

REFERENCES

1. Alcock, A. W., "Natural history notes from H. M. Indian marine survey steamer 'Investigator,' Commander Alfred Carpenter, R. N., D. S. O., commanding.–No. 13. On the bathybial fishes of the Bay of Bengal and neighbouring waters, obtained during the seasons 1885-1889," *Annals and Magazine of Natural History*, Series 6, Vol. 4, No. 24, pp. 450-461 (1889).
2. Bleeker, P., *Vierde Bijdrage tot de Kennis der Ichthyologische Fauna van Japan*, Vol. 3, No. 10, pp. 1-46, pls. 1-4 (1858).
3. Bleeker, P., "Atlas ichthyologique des Indes Orientales Néêrlandaises, publié sous les auspices du Gouvernement colonial néêrlandaises," *Tome IV. Murènes, Synbranches, Leptocéphales*, Vol. 4, pp. 1-150, pls. 145-193 (1864).
4. Böhlke, E. B., "Methods and Terminology," in: Böhlke, E. B. (Ed.), *Fishes of the Western North Atlantic*, Memoir Sears Foundation for Marine Research, New Haven, Vol. 1, No. 9. pp. 1-7 (1989).
5. Castle, P. H. J., "Leptocephalus of the muraenesocid eel *Gavialiceps taeniola*," Copeia, Vol. 1977, No. 3, pp. 488-492 (1977).
6. Castle, P. H. J. and Williamson, G. R., "Systematics and distribution of eels of the Muraenesox group (Anguilliformes, Muraenesocidae), a preliminary report and key," *J. L. B. Smith Institute of Ichthyology*, Rhodes University, Grahamstown, South Africa, Special publication, No. 15, pp. 1-9 (1975).
7. Chen, J. T. F., *Synopsis of Fishes of Taiwan*, Bank of Taiwan, Taipei, pp. 1-122 (1954). (in Chinese)
8. Chen, J. T. F. and Weng, H. T. C., "A review of the apodal fishes of Taiwan," *Biological Bulletin Tunghai University, Ichthyology Series*, Vol. 6, No. 32, pp. 1-86 (1967).
9. Chen, J. T. F. and Yu, M. J., *A Synopsis of the Vertebrates of Taiwan*, Second Edition, The Commercial Press, Ltd, Taipei, Vol. 1, pp. 1-442 (1986).
10. Chen, Y.Y., *Taxonomy, Distribution and Reproduction of Deep-Sea Eels in Taiwan Waters and the Phylogeny of Anguilliformes and Congroidei (Elopomorpha: Teleostei)*, Master Thesis, Institute of Marine Biology, National Sun Yat-Sen University, Kaohsiung, Taiwan (2002). (in Chinese)
11. Day, F., *The Fishes of India; Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon*, Part 4, pp. i-xx + 553-779, pls. 139-195 (1878).
12. Eschmeyer, W. N. (Ed.), *Catalog of Fishes*, California Academy of Sciences, http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp, Electronic version accessed 27 March 2013 (2013).
13. Forsskål, P. S., *Descriptiones Animalium Avium, Amphibiorum, Piscium, Insectorum, Vermium; Quae in Itinere Orientali Observavit*, Post mortem auctoris edidit Carsten Niebuhr, Hauniae, pp. i-xxxiv + 1-164 (1775).
14. Gill, T. N., "Osteological characteristics of the family Muraenesocidae," *Proceedings of the United States National Museum*, Vol. 13, No. 815, pp. 231-234 (1890).
15. Grant, E., *Fishes of Australia*, E. M. Grant Pty Limited, Queensland, Australia, pp. 1-457 (1995).
16. Hamilton, F., *An Account of the Fishes Found in the River Ganges and Its Branches*, Edinburgh and London, pp. i-vii + 1-405, pls. 1-39 (1822).
17. Hatooka, K., "Muraenesocidae," in: Nakabo, T. (Ed.), *Fishes of Japan with Pictorial Keys to the Species Second Edition*, Tokai university press, Tokyo, Vol. 1, pp. 235 (2000). (in Japanese)
18. Ho, H. C., Smith, D. G., Wang, S. I., Shao, K. T., Ju, Y. M., and Chang, C. W., "Specimen catalog of Pisces collection of National Museum of Marine Biology and Aquarium transferred from Tunghi University and Aquarium, (II) Order Anguilliformes," *Platax*, Vol. 7, pp. 13-34 (2010).
19. Karmovskaya, E. S., "Systematics and distribution of the eel genus *Gavialiceps* (Congridae) in the Indo-West Pacific," *Journal of Ichthyology*, Vol. 34, No. 3, pp. 73-89 (1994).
20. Karmovskaya, E. S., "Benthopelagic bathyal conger eels of families Congridae and Nettastomatidae from the western tropical Pacific, with descriptions of ten new species," *Journal of Ichthyology*, Vol. 44, Suppl. 1, pp. S1-S32 (2004).
21. Katayama, M. and Takai, T., "A new conger-like eel, *Muraenesox yamaguchiensis*, from the Inland Sea of Japan," *Journal of Ichthyology*, Vol. 3, pp. 97-101 (1954).
22. Lee, J. L., *Atlas of Common Fishes from Taiwan, Volume 2, Deep Sea Fishes*, Angling Magazine Press, Taipei, pp. 1-255 (1985). (in Chinese)
23. Li, L. K., "Additions to the apodal ichthyfauna of Taiwan (Formosa)," *Journal of Taiwan Museum*, Vol. 13, No. 1-2, pp. 83-89 (1960).
24. Masuda, H., Araga, C., and Yoshino, T., *Coastal Fishes of Southern Japan*, Tokai University Press, Tokyo, pp. 1-379 (1985). (in Japanese)
25. McClelland, J., "Description of a collection of fishes made at Chusan and Ningpo in China, by Dr. G. R. Playfair, Surgeon of the Phlegethon, war steamer, during the late military operations in that country," *Calcutta Journal of Natural History*, Vol. 4, No. 4, pp. 390-413, pls. 21-25 (1844).
26. Nelson, J. S., *Fishes of the World, 4th Edition*, John Wiley & Sons, Inc., Hoboken, New Jersey, pp. 1-601 (2006).
27. Sainsbury, K. J., Kailola, P. J., and Leyland, G. G., *Continental Shelf Fishes of Northern and North-Western Australia*, CSIRO Division of Fishes Research. Canberra, Australia, pp. 1-375 (1985).
28. Shao, K. T., *Taiwan Fish Database*, WWW Web Electronic Publication, http://fishdb.sinica.edu.tw (2013-10-31).
29. Shen, S. C., *Synopsis of Fishes of Taiwan*, Southern Materials Center, Inc., Taipei, pp. 1-533 (1984). (in Chinese)
30. Shen, S. C., Wang, D. M., Lee, S. C., Shao, K. T., Mok, H. K., Joung, S. J., Chen, J. P., Chen, C. H., Chen, Y. Y., and Liu, C. H., *Encyclopaedia of Vertebrata -- Fish, Volume 1*, National Institute for Compilation and Translation, Taipei, pp. 1-452 (2004). (in Chinese)
31. Shen, S. C. and Wu, K. Y., *Fishes of Taiwan*, National Museum of Marine Biology and Aquarium, Pingtung, pp. 1-896 (2011). (in Chinese)
32. Smith, D. G., "Family Nettastomatidae," in: Böhlke, E. B. (Ed.), *Fishes of the Western North Atlantic*, Memoir Sears Foundation for Marine Research, New Haven, Vol. 1, No. 9, pp. 568-612 (1989).
33. Smith, D. G., "Muraenesocidae," in: Carpenter, K. E. and Niem, V. H. (Eds.), *FAO Species Identification Guide for Fishery Purposes - The Living Marine Resources of the Western Central Pacific, Volume 3, Batoid Fishes, Chimaeras and Bony Fishes Part 1 (Elopidae to Linophrynidae)*, FAO, Rome, pp. 1673-1677 (1999).
34. Talwar, P. K. and Kacker, R. K., *Commercial Sea Fishes of India*, zoological survey of India Calcutta, pp. 1-997 (1984).
35. Thankappan, D., Manjebrayakath, H., and Jayaprakash, A. A., "Distribution and biology of the deep-sea eel, *Gavialiceps taeniola* along the continental slope off Indian EEZ," *Journal of the Marine Biological Association of India*, Vol. 49, No. 1, pp. 81-85 (2007).
36. Zhang, C. G., Tang, W. Q., Liu, D., Zhang, Z. L., and Zhang, S. Y., *Fauna Sinica. Osteichthyes, Anguilliformes, Notacanthiformes*, Science Press, Beijing, pp. i-x + 1-453, pls. 1.1, 1.2, 2-3 (2010). (in Chinese)