A list of the specimens of Chimaeriformes (Holocephali) in the Department of Zoology, The University Museum, The University of Tokyo

Akinori Teramura[1*], Keita Koeda[2,3*], Masahiro Aizawa[2], Kazuo Sakamoto[2,4], Rei Ueshima[2,5]

[1]Fisheries Laboratory, Graduate School of Agricultural and Life Sciences, The University of Tokyo, 2971-4, Bentenjima, Nishi, Maisaka, Hamamatsu, Shizuoka 431-0214, Japan
[2]The University Museum, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
[3]Faculty of Science, University of the Ryukyus, 1 Senbaru, Nishihara, Okinawa 902-0213, Japan
[4]Fish Information Center and Museum, 6-6 Toyosu, Koto-ku, Tokyo 135-0061, Japan
[5]Department of Biological Sciences, Graduate School of Science, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

*Corresponding author: E-mail: akifishes@yahoo.co.jp

Abstract

A detailed investigation of the specimens of Chimaeriformes (Holocephali) deposited in the Department of Zoology, The University Museum, The University of Tokyo (ZUMT) found 26 specimens including six egg capsule specimens. However, all of the following type specimens of Chimaeriformes cataloged in ZUMT, were not found: ZUMT 915, *Chimaera jordani* Tanaka, 1905; ZUMT 916 *Chimaera owstoni* Tanaka, 1905; ZUMT 961, *Chimaera spilota* Tanaka (1908); ZUMT 1457, *Chimaera mitsukurii* Dean, 1904a; ZUMT 2155, *Anteliochimaera chaetirhamphus* Tanaka, 1909; ZUMT 1453, *Rhinochimaera pacifica* (Mitsukuri, 1895). This report provides information on accessible specimens with some comments on the morphology of the egg capsules of Japanese chimaeras including the egg capsule specimens.

Introduction

Chimaeriformes “chimaeras” inhabit deep-sea waters worldwide, and three families, six genera and 57 species are regarded as valid (Weigmann 2016; Fricke et al. 2022). Especially, chimaeriformes are represented by 12 species across two families (Chimaeridae and Rhinochimaeridae) in the Japanese waters (Nakabo 2013a, b; Motomura 2020) and five of these species are endemic to Japan. Before the ZUMT collection started on 1904, Kakichi Mitsukuri described a new species *Rhinochimaera pacifica* (Mitsukuri, 1895) which was the first new fish species described by Japanese (Koeda et al. 2022). Secondly, Shigeho Tanaka (pupil of Mitsukuri) who built up the fish collection, started his ichthyological research on Chimaeriformes, and described two chimaeras, *Chimaera jordani* Tanaka, 1905 and *Chimaera owstoni* Tanaka, 1905 in the early history of ZUMT. Three years later, Tanaka described one more new species, *Chimaera spilota* Tanaka, 1908. However, the type specimens of these four species deposited in ZUMT, are presently regarded as “lost” (Fricke et al. 2022). Therefore, all specimens of chimaeras deposited in ZUMT were reidentified in this study, and listed below.

Materials and Methods

The specimens of Chimaeriformes in ZUMT were re-identified by the first author in the present study, generally following Dean (1904ab), Dider et al. (2012), Kokuho et al. (2003), and Nakabo et al. (2013a). Body length (BDL) and total length (TL) were measured for all specimens and egg capsules, respectively, following Dider et al. (2012) and Chembian (2007). Although some of the ZUMT specimens collected by Dr. Abe had not been formally cataloged into the ZUMT collection (and the data of some specimens not retained), such specimens which can recognize by having underbar with the number on the accompanying label, are listed herein with the number ZUMT ABE XXXX, due to the possibility of future discovery of Dr. Abe's remaining catalog books with collection data. Specimens with the same collection locality and date are listed together. Local and personal names are given in Japanese (in parentheses) for specimens thus treated in Japanese in the specimen ledger. The collection year and collector for some specimens was estimated by following Koeda et al. (2022). The list includes collection locality, ZUMT number with number of specimens in parentheses when two or more, size, collection date, collector or donator and affiliation, and remarks when available. Catalog numbers after ZUMT 62000 are newly given during this study.

Collection of Chimaeriformes in ZUMT

The following holotype specimens of Chimaeriformes should be deposited in ZUMT, but unfortunately all of them could not find during the present study: *C. jordani* ジョルダンギンザメ, ZUMT 915 (Tanaka 1905); *C. owstoni* シロブチギンザメ, ZUMT 916 (Tanaka 1905); *C. spilota* (regarded as junior synonym of *H. barbouri*) ココノホシギンザメ, ZUMT 961 (Tanaka 1908); *C. mitsukurii* アカギンザメ, ZUMT 1457 (Dean 1904a); *Anteliochimaera chaetirhamphus* アズマギンザメ, ZUMT 2155 (Tanaka, 1909); *R. pacifica* テングギンザメ, ZUMT 1453 (Mitsukuri 1895). For details on the type specimens, refer to Aizawa et al. (2022). Although Dean (1904a) showed egg capsule specimens of *C. phantasma*, *H. mitsukurii* and *R. pacifica* collected from Misaki, Kanagawa Prefecture were deposited in ZUMT, egg capsule specimens of *H. mitsukurii* were not found during the survey. Several notable specimens especially for egg capsules were found from the collection, e.g., ZUMT 1456 which is *C. phantasma* specimen immediately after description and some egg capsule specimens. Although egg capsules of Chimaeridae is rarely available, they are known to have morphological differences among species, which can contribute to species distributional records. Therefore, the egg capsule specimens in ZUMT should be a valuable resource for future taxonomic studies on chimaeras, and some comments on the morphology of the egg capsules of Japanese chimaeras are given in the remarks.

Chimaeridae ギンザメ科

Chimaera Linnaeus, 1758 ギンザメ属

Chimaera phantasma Jordan & Snyder, 1900 ギンザメ

ZUMT 1456: 270.4 mm BDL, male, Misaki, Miura City, Kanagawa Pref., June 1901, B. Dean.

ZUMT 20359: 227.9 mm BDL, female, Kii-Tanabe (currently Tanabe City), Wakayama Pref., before 1930, N. Ui（宇井縫蔵）.

ZUMT 24105: 321.8 mm BDL, male, Naya (currently Nakamachi and Kinsei-cho), Kagoshima City, Kagoshima Pref.

ZUMT 44101: 383.7 mm BDL, male, Hachijo-jima Island, Feb. 1922, M. Uchiyama (内山操).

ZUMT 51079: 128.8 mm BDL, female, East China Sea, 2 Feb. 1960.

ZUMT 51380: 293.8 mm BDL, female; **ZUMT 51381**: 181.6 mm BDL, female; **ZUMT 51382**: 165.7 mm BDL, male; **ZUMT 51383**: 107.6 mm BDL, female, East China Sea, purchased at Fukuoka Fish Market, 12 Aug. 1959, Y. Tominaga（富永義昭）.

ZUMT 53479: 95.1 mm BDL, male, Ishigaki-jima Island.

Remarks: This specimen represents the first record of *C. phantasma* from the Ishigaki-jima Island.

ZUMT 54900: 246.7 mm BDL, female, Sagami Bay, 1938, Mitsui Institute of Marine Biology (三井海洋生物研究所).

ZUMT 63371: 341.3 mm BDL, female; **ZUMT 63372**: 166.3 mm BDL, female, no data.

ZUMT 63377: 355.6 mm BDL, female, Nagasaki Pref., Apr. 1910, Nagasaki Prefecture Normal School (長崎師範学校).

Hydrolagus Gill, 1862　アカギンザメ属

Hydrolagus mitsukurii (Jordan & Snyder, 1904)　アカギンザメ

ZUMT ABE 18209: 375.5 mm BDL, female, off Inubozaki Cape, Chiba Pref., 15 June 1978, T. Abe (阿部宗明).

Remarks: Tanaka (1913) shown the identification key of this species as a Japanese name “Mitsukuri-ginzame ミツクリギンザメ”.

Hydrolagus barbouri (Garman,1908)　ココノホシギンザメ

ZUMT 25605: 115.9 mm BDL, female; **ZUMT 25606**: 143.6 mm BDL, male, off Onahama, Fukushima Pref., 400–500 m depth, before 1933, H. Tsunoda (角田春彦).

ZUMT 31680: 98.8 mm BDL, male, Ibaraki Pref., before 1936, K. Tashiro (田代清友).

ZUMT 63373: 180.1 mm BDL, male; **ZUMT 63374**: 199.0 mm BDL, male; **ZUMT 63375**: 182 mm BDL, no data.

-Egg capsules-

Chimaeridae　ギンザメ科

Chimaera Linnaeus, 1758　ギンザメ属

Chimaera phantasma Jordan & Snyder, 1900　ギンザメ

ZUMT 37987 (2): 233.2 mm TL, 112.5+ mm TL, no data.

ZUMT 63401 (Fig.1): 232.4 mm TL, Tokyo Market, Tokyo Met.

ZUMT 63409 (2): 251.3 mm TL, 262.9 mm TL, probably Sagami Bay, 450 m depth, collected on 8 Mar. 1901, K. Aoki (青木熊吉).

Hydrolagus Gill, 1862 アカギンザメ属
Hydrolagus barbouri (Garman, 1908) ココノホシギンザメ

ZUMT 63402 (Fig. 2): 121.5 mm TL, Ishinomaki City, Miyagi Pref., Y. Wakiya (脇谷洋次郎).

Remarks: These specimens were identified as egg capsules of Chimaeridae based on the following characteristics: teardrop shape with small lateral flanges; dorsal surface with raised keel along the middle (Ebert and Dand 2020). The egg capsule of three Japanese chimaeras can be identified by the following characteristics: *C. phantasma* (n=4; Fig. 1): narrow end of egg capsule (tail sheath) extended (capsule width more than 12.6% total length), the apex of the larger end flat; *H. mitsukurii*: narrow end of egg capsule extended (capsule width12.3% total length), the apex of the larger end constricted; *H. barbouri* (n=1; Kokuho et al. 2003, Fig. 2): narrow end of egg capsule shortened (capsule width 25.8% total length), the apex of the larger end flat (Dean 1904a).

Rhinochimaeridae テングギンザメ科
Rhinochimaera Garman, 1901 テングギンザメ属
Rhinochimaera pacifica (Mitsukuri, 1895) テングギンザメ

ZUMT 1498 (Fig. 3): 168.3 mm TL, Misaki, Miura City, Kanagawa Pref., 4 Mar. 1898, K. Aoki.

ZUMT 3212: 185.3 mm TL, probably Okinose, Tokyo Bay, 1050 m depth, Feb. 1908, K. Aoki.

ZUMT 63410 (2): 173.3 mm TL, 212.7 mm TL, off Atami City, Shizuoka Pref., Sagami Bay, 22 June 1906, A. Owston (deposited by K. Aoki).

Remarks: These specimens were identified as Rhinochimaeridae egg capsules based on the following characteristics: wide ribbed lateral flanges with central spindle; dorsal surface without raised keel (Fig.3) (Ebert and Dand 2020). In the Japanese waters, following four species of Rhinochimaeridae are recorded: *R. pacifica*; *Rhinochimaera africana* Compagno, Stehmann & Ebert, 1990（クロテングギンザメ）; *Harriotta raleighana* Goode & Bean, 1895（ヨミノツカイ）; *Harriotta chaetirhampha* (Tanaka, 1909)（アズマギンザメ）(Nakabo et al. 2013b; Nakayama 2020; Motomura 2020). Although Dean (1904b) reported egg capsules of *R. pacifica* on the basis of the specimens ranged 16.5 or 26 cm deposited in ZUMT, these specimens were not found during the present study. The three egg capsule specimens of Rhinochimaeridae deposited in ZUMT found in the present study are identified as *R. pacifica*, because the shapes of the egg capsules are similar to those of *R. pacifica* shown by Dean (1904b), and *R. pacifica* is only the species of *Rhinochimaera* has been recorded from southern Japan (vs. *R. africana* known south to Iwate Pref. in Pacific coast of Japanese waters)(Nakabo 2013b).

Acknowledgements

We are deeply grateful to the late Y. Tominaga for his dedication and efforts to the ZUMT collection. We are also grateful to H. Hata (National Museum of Nature and Science), H. Wada (Kanagawa Prefectural Museum of Natural History), I. Abe, S. Fujiwara, A. Iinuma, M. Saito, A. Takahashi (Tokyo University of Marine Science and Technology), and M. Fukatani, S. Ito (University of Tokyo), H. Ogata (ZUMT) for curatorial assistance. We also thank K. Kikuchi and S. Hirase (Fisheries Laboratory) for supporting the investigation. The present study was supported in part by Grant-in-Aid from JSPS Fellows (DC1 202022659) for the first author, JSPS KAKENHI 21K06313 JP and the Sasakawa Scientific Research Grant from The Japan Science Society (2021-4064) to the second author.

References

Aizawa, M., Koeda, K., Hata, H., Aizawa, M., Sakamoto, K. and Ueshima, R. 2022. Fish types deposited in the Department of Zoology, The University Museum, The University of Tokyo - Part 2: Myxiniformes to Acipenseriformes. The University Museum, The University of Tokyo Material Reports, 129: 189−217.

Chembian, A. J. 2007. New record of *Rhinochimaera atlantica* (Chimaeriformes: Rhinochimaeridae) spawning ground in the Gulf of Mannar along the south-east coast of India. Indian Journal of Fisheries, 54: 345–350.

Dean, B. 1904a. Notes on *Chimaera*. Two Japanese species, *C. phantasma* Jordan and Snyder and *C. mitsukurii* n. s., and their egg cases. Journal of the College of Science, Imperial University of Tokyo, 19 (3): 1–9.

Dean, B. 1904b. Notes on the Long-Snouted Chimaeroid of Japan, *Rhinochimaera* (*Harriotta*) *Pacifica* (Garman) Mitsukuri. Journal of the College of Science. Imperial University of Tokyo, 19 (4): 1–20, 2 pls.

Didier, D. A., Kemper, J. M. and Ebert, D. A. 2012. Phylogeny, biology and classification of extant holocephalans. Pp. 97–122. In: Carrier, J. C., Musick, J. A., Heithaus, M. R. (eds) Biology of sharks and their relatives, 2nd edition. CRC Press, Boca Raton.

Ebert, D. A. and Dando, M. 2020. Field guide to sharks, rays, and chimaeras of Europe and the Mediterranean. Princeton University Press, New Jersey. 383 pp.

Fricke, R., Eschmeyer, W. N. and van der Laan, R. (eds). 2021. Eschmeyer's catalog of fishes: genera, species, references. Electronic version.

https://researcharchive.calacademy.org/research/ichthyology/catalog/getref.asp?id=20773. Accessed 6 April 2022

Koeda, K., Hata, H., Aizawa, M., Sakamoto, K. and Ueshima, R. 2022. History of the fish collection of the Department of Zoology, The University Museum, The University of Tokyo. The University Museum, The University of Tokyo Material Reports, 129: 1−24. (In Japanese)

Kokuho, T., Nakaya, K. and Kitagawa, D. 2003. Distribution and reproductive biology of the Nine-spot Ratfish *Hydrolagus barbouri* (Holocephali; Chimaeridae). Memoirs of the Graduate School of Fisheries Science, Hokkaido University, 50 (2): 63–87.

Tanaka, S. 1905. On two new species of *Chimaera*. Journal of the College Science Imperial University of Tokyo 20 (11): 1–14, pls. 1–2.

Tanaka, S. 1908. Notes on some Japanese fishes, with descriptions of fourteen new species. Journal of the College of Science, Imperial University, Tokyo, 23 (7): 1–54, pls. 1–4.

Tanaka, S. 1909. Descriptions of one new genus and ten new species of Japanese fishes. Journal of the College of Science. Imperial University of Tokyo, 27 (8): 1–27, pl. 1.

Tanaka, S. 1913. Simple identificational keys to fishes, vol. 2. The Ichtyological Journal, 1 (6): 154–156.

Mitsukuri, K. 1895. On a new genus of the chimaeroid group *Harriotta*. Zoological Magazine, 7 (80): 97–98, pl. 16. (In Japanese)

Motomura, H. 2020. List of Japan's all fish species. Current standard Japanese and scientific names of all fish species recorded from Japanese waters. The Kagoshima University Museum, Kagoshima. 560 pp.

Nakabo, T., Yagishita, N. and Yamaguchi, A. 2013a. Chimaeridae. Pp. 146–147, 1755. In: Nakabo T. (ed) Fishes of Japan with pictorial keys to the species, third edition. Tokai University Press, Hadano. (In Japanese)

Nakabo, T., Yagishita, N. and Yamaguchi, A. 2013b. Rhinochimaeridae. Pp. 148–149, 1755. In: Nakabo T. (ed) Fishes of Japan with pictorial keys to the species, third edition. Tokai University Press, Hadano. (In Japanese)

Nakayama, N., Matsunuma, M. and Endo, H. 2020. A preliminary review and in situ observations of the spookfish genus *Harriotta* (Holocephali: Rhinochimaeridae). Ichthyological Research, 67: 82–91.

Weigmann, S. 2016. Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the world, with a focus on biogeographical diversity. Journal of Fish Biology, 88: 837–1037.

Figure 1. Egg capsule of *Chimaera phantasma*: ZUMT 63401, 232.4 mm TL, Tokyo Market, Tokyo Met.

Figure 2. Egg capsule of *Hydrolagus barbouri*: ZUMT 63402, 121.5 mm TL, Ishinomaki City, Miyagi Pref., Y. Wakiya.

Figure 3. Egg capsule of *Rhinochimaera pacifica*: ZUMT 1498, 168.3 mm TL, Misaki, Miura City, Kanagawa Pref., 4 Mar. 1898, K. Aoki.