

Egg Capsule of *Hongoe koreana* (Chondrichthyes: Rajiformes: Rajidae)

By Choong-Hoon Jeong* and Jin-Koo Kim¹

Research Center for Coastal Environments of Yellow Sea, Inha University, Incheon 402-751, Korea

¹Department of Marine Biology, Pukyong National University, Busan 608-737, Korea

ABSTRACT The egg capsule of *Hongoe koreana* is newly described based on two egg capsules extracted from the uterus of a female collected near the type locality, the southwestern coast of the Korean Peninsula. The egg capsule of *H. koreana* has the following characters: medium sized, measuring 124.5~133.7 mm in total length including horns, 102.8~109.4 mm in length excluding horns, and 41.0~42.2 mm in maximum width; asymmetrical, with the egg capsule more convex ventrally in lateral view; the surface relatively smooth, with longitudinal striations distinct, and covered with masses of sticky silky fibers; anterior and posterior aprons distinct; all four horns short, tube-like in shape, elliptical in cross section, anterior horns recurved inwardly; respiratory fissure present at tip of each of the four horns. The color of the fresh capsule is bright brown.

Key words : *Hongoe koreana*, egg capsule, cartilage fish, reproduction, taxonomy, biology

INTRODUCTION

Skates (Rajidae *sensu* McEachran and Dunn, 1998, and Jeong and Nakabo, 2009) are oviparous, and their eggs are encased with a thick leathery membrane, i.e., the egg capsule (or egg case), which is laid in an early stage of development (Ishiyama, 1958a; Musick and Ellis, 2005). Embryonic development is completed within the egg capsule (Wourms, 1977), and the egg capsule provides protection for the embryo during its long developmental period, usually lasting several months (Carrier *et al.*, 2004). The egg capsule of skates is usually quadrangular in shape with horn-like processes at each corner, and the dorsal surface is usually arched while the ventral surface is flattened. Morphological differences in egg capsules among skates may provide useful taxonomic characters and reflect phylogenetic relationships. Differences may be associated with environmental adaptations and reproductive biology (Ishiyama, 1958a, b; Hubbs and Ishiyama, 1968; Ishihara *et al.*, 2005).

Hongoe koreana (Jeong and Nakabo, 1997) was described as a new species based on single adult female specimen collected from off the southwestern coast of the

Korean Peninsula (Jeong and Nakabo, 1997). Recently, the new genus *Hongoe* was erected for the species (Jeong and Nakabo, 2009), based on phylogenetic analysis for the 29 rajid genera plus 3 outgroups, and because of having several unique characters not shared with any other supraspecific taxa of Rajidae (*sensu* McEachran and Dunn, 1998; equal to Rajoidei of Compagno, 2005, and Ebert and Compagno, 2007).

During research on the reproductive biology of *Hongoe koreana* (Kim *et al.*, 2005), four egg capsules were collected from two female's uteri, but the egg capsules of the species were not described by them. The morphology of the egg capsule of *H. koreana* is newly described here from single recently collected female.

MATERIALS AND METHODS

One female (FSIU 333-1, 747 mm TL, 522 mm DW) of *Hongoe koreana* was collected on 17 May 2003 from near the type locality, off the southwestern coast of the Korean Peninsula, at approximately 34° 10'N, 126° 20'E. The egg capsules, FSIU 333-2, 333-3 from this female were too damaged for examination. A second female (FSIU 334-1, 715 mm TL, 504 mm DW) of *H. koreana* was collected on 25 October 2005 in same area. Two

*Corresponding author: Choong-Hoon Jeong Tel: 82-070-8822-2072,
Fax: 82-32-876-7710, E-mail: chjeongfish@korea.com, chjeong@inha.ac.kr

Table 1. Dimensions in mm of two *Hongeo koreana* egg capsules (FSIU 334-2, 334-3), expressed as average of each values

Characters	Left	Center	Right	Mean	Range
Length excluding horns	107.8	103.1	108.8	106.6	102.8~109.4
Total length including horns	128.9	—	133.2	131.0	124.5~133.7
Width (maximum)	—	—	—	41.6	41.0~42.2
Height (maximum)	—	—	—	21.5	21.5~21.5
Anterior horn length	44.0	—	44.5	44.3	41.3~46.7
Posterior horn length	41.1	—	40.5	40.8	39.1~43.0
Anterior apron width	—	—	—	31.2	31.1~31.3
Anterior apron length	—	—	—	22.7	21.3~24.1
Posterior apron width	—	—	—	28.8	28.5~29.0
Posterior apron length	—	—	—	25.8	25.5~26.0
Lateral keel width	1.8	—	1.7	1.8	1.6~1.8
Lateral keel thickness	1.5	—	1.5	1.5	1.4~1.5

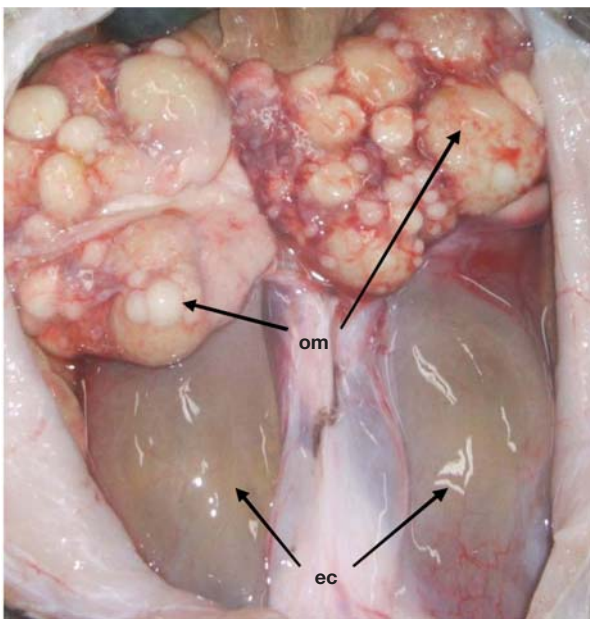


Fig. 1. A part of posterior oviducts (uteri) and egg capsules (FSIU 334-2, 334-3) of female *Hongeo koreana* (FSIU 334-1). Egg capsules were enveloped by uteri. ec, egg capsule; om, ovum.

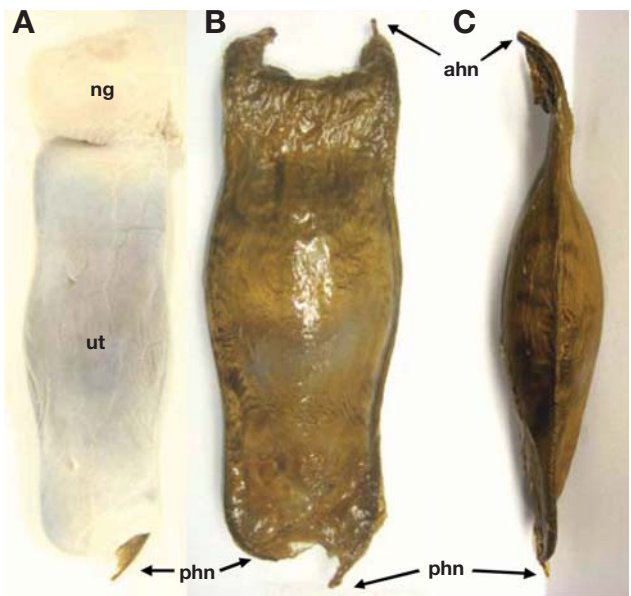


Fig. 2. Oviduct and egg capsule of *Hongeo koreana* (FSIU 334-3). Complete posterior oviduct bearing term egg capsule (A); egg capsule entirely wrapped by silky fibers in dorsal (B) and lateral (C) views. ahn, anterior horns; ng, nidamental gland; phn, posterior horns; ut, uterus.

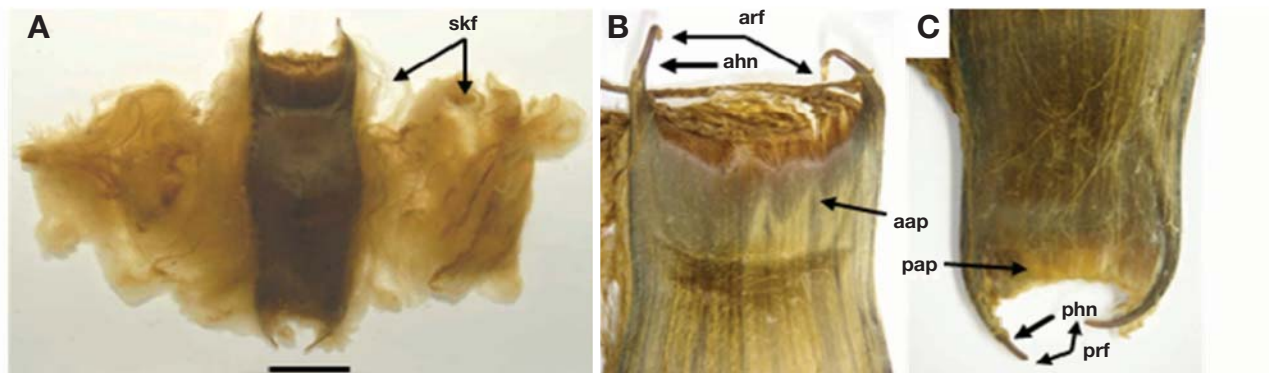


Fig. 3. Dorsal egg capsule (FSIU 334-3) of *Hongeo koreana*, wrapped by silky fibers in 70% ethanol (A); dry egg capsule, close-up of surface structure at anterior (B) and posterior (C) region. aap, anterior apron; ahn, anterior horns; arf, anterior respiratory fissure; pap, posterior apron; phn, posterior horns; prf, posterior respiratory fissure; skf, silky fibers. Black bar indicates 3 cm.

egg capsules were directly extracted from the uterus of this female, thus we here describe based on two egg capsules of FSIU 334-2, 334-3 (Figs. 1, 2 and 3; Table 1). All specimens collected, two females and four egg capsules, were preserved and curated at FSIU (Laboratory of Fisheries, Department of Oceanography, College of Natural Science, Inha University, Korea).

Methods for measurements and terminology of the egg capsule followed Hubbs and Ishiyama (1968), and Ishiyama and Ishihara (1977). The egg capsule is covered by thin fibers, which are named "silky fibers" by Ishihara *et al.* (2005). Total length including horns follows Stehmann and Merrett (2001), and the width and depth of nidamental glands (=shell glands) measure the greatest dimensions. The dimensions of the egg capsule are given in Table 1.

RESULTS AND DISCUSSION

Description. Nidamental glands kidney-shaped, maximum width 41.1 mm, maximum depth 27.2 mm (Figs. 1, 2). Egg capsule covered with masses of sticky, silky fibers, except at the tips of the four horns (Figs. 2, 3). In dorsal view, egg capsule rectangular in shape and slightly convex laterally. In lateral view, egg capsule more convex ventrally. Both dorsal and ventral surfaces relatively smooth, but with distinct longitudinal striations. Respiratory fissure present at tip of each of the four horns. Both anterior and posterior aprons very distinct, anterior apron slightly wider than posterior. Egg capsule medium sized, measuring 124.5~133.7 mm in total length including horns, 102.8~109.4 mm in length excluding horns, and 41.0~42.2 mm in maximum width. Length as long as about 2.6 times maximum width. Horns short, tapered towards the tips, tube-like in shape, elliptical in cross section; anterior horns about 1.1 times the length of the posterior horns. Posterior horns shorter than anterior horns, length 38.3% capsule length. Anterior horns recurved inwardly at level of tips, length 41.5% capsule length. Anterior apron almost straight; posterior apron concave. Width and length of anterior apron almost equal to posterior apron. Lateral keels narrow, 4.2% maximum egg capsule width. Capsule bright brown when fresh, dark brown in ethanol. Capsule covered with shiny yellow silky fibers. Intra-uterine color bright brown.

Remarks. Among East Asian rajid fishes, the northern forms (i.e., species of the genera *Bathyraja* and *Rhinoraja*) have egg capsules that are somewhat rough, with minute prickles or tubercles, over the entire surface of the main portion. On the other hand, the egg capsules of the southern forms (i.e., species of the genera *Dipturus*, *Okamejei* and "*Raja* North Pacific Assemblage" *sensu* McEachran and Dunn, 1998) are generally smooth (Ishiyama, 1958a, b; Ishihara *et al.*, 2005). The surface of the

egg capsule of *Hongoe koreana* resembles some species of the *Bathyraja*, *Rhinoraja*, and "*Raja* N. Pac. Assemblage" in being rather rough (Fig. 3B, C). The main portion of the egg capsules of most species of the tribe Rajini (*sensu* McEachran and Dunn, 1998) from the North Pacific has a very smooth surface (Ishiyama, 1950, 1958a, b; Ishihara, 1987; Ishihara *et al.*, 2005). The masses of sticky, silky fibers of *H. koreana* (Figs. 2B, 2C, 3A) have not been found in species of the tribe Rajini from the North Pacific reported by several authors (Ishiyama, 1950, 1958a, b, 1967; Ishiyama and Ishihara, 1977; Ishihara and Ishiyama, 1985; Ishihara, 1987; Ishihara *et al.*, 2005). The characters of horns elliptical in cross section, anterior horns recurved inwardly at the tips, and anterior and posterior aprons well developed appear to be unique among species of the tribe Rajini from the North Pacific.

ACKNOWLEDGMENTS

We wish to express our sincere thanks to Prof. Tetsuji Nakabo (The Kyoto University Museum, Kyoto University, Japan) and Dr. James W. Orr (NMFS, NOAA, USA) for their critical comments and English corrections. Our thanks go to Late Prof. Reizo Ishiyama (formerly MTUF, Japan), Dr. Hajime Ishihara (W & I Associates Corporation, Japan) and Dr. Matthias F.W. Stehmann (ICHTHYS, Germany) for their valuable comments on the egg capsules of skates and/or providing references.

REFERENCES

- Carrier, J.C., H.L. Pratt Jr. and J.I. Castro. 2004. Reproductive biology of elasmobranchs. In: Carrier, J.C., J.A. Musick and M.R. Heithaus (eds.), *Biology of sharks and their relatives*, CRC Press, Boca Raton, pp. 269-286.
- Compagno, L.J.V. 2005. Checklist of living Chondrichthyes. In: Hamlett, W.C. (ed.), *Reproductive biology and phylogeny of Chondrichthyes: sharks, batoids and chimaeras*. Science Publishers, Enfield, NH, pp. 503-548.
- Ebert, D.A. and L.J.V. Compagno. 2007. Biodiversity and systematics of skates (Chondrichthyes: Rajiformes: Rajoidei). *Environ. Biol. Fish.*, 80: 111-124.
- Hubbs, C.L. and R. Ishiyama. 1968. Methods for the taxonomic study and description of skates (Rajidae). *Copeia*, pp. 483-491.
- Ishihara, H. 1987. Revision of the Western North Pacific species of the genus *Raja*. *Japan. J. Ichthyol.*, 34: 241-285.
- Ishihara, H., K. Homma and C.-H. Jeong. 2005. Comparative morphological study of the egg capsules of skates

- (Pisces: Rajiformes). J. Japan. Drift. Soc., 3: 31-41. (in Japanese)
- Ishihara, H. and R. Ishiyama. 1985. Two new North Pacific skates (Rajidae) and revised key to *Bathyraja* in the area. Japan. J. Ichthyol., 32: 143-179.
- Ishiyama, R. 1950. Studies on the rays and skates belonging to the family Rajidae, found in Japan and adjacent regions. 1. Egg-capsules of ten species. Japan. J. Ichthyol., 1: 30-36.
- Ishiyama, R. 1958a. Observations on the egg capsules of skates of the family Rajidae, found in Japan and adjacent waters. Bull. Mus. Comp. Zool., Harvard Coll., 118: 1-24.
- Ishiyama, R. 1958b. Studies on the rajid fishes (Rajidae) found in the waters around Japan. J. Shimonoseki Coll. Fish., 7: 193-394.
- Ishiyama, R. 1967. Fauna Japonica: Rajidae (Pisces). Biogeogr. Soc. Japan., Tokyo, vi+84pp., 32pls.
- Ishiyama, R. and H. Ishihara. 1977. Five new species of skates in the genus *Bathyraja* from the Western North Pacific, with reference to their interspecific relationships. Japan. J. Ichthyol., 24: 71-90.
- Jeong, C.H. and T. Nakabo. 1997. *Raja koreana*, a new species of skate (Elasmobranchii, Rajoidei) from Korea. Ichthyol. Res., 44: 413-420.
- Jeong, C.H. and T. Nakabo. 2009. *Hongoe*, a new skate genus (Chondrichthyes: Rajidae), with redescription of the type species. Ichthyol. Res., 56: 140-155.
- Kim, J.K., D.S. Sim and S.D. Jeong. 2005. Sexual maturity of *Raja koreana* (Elasmobranchii, Rajoidei). Korea. J. Ichthyol., 14: 229-235.
- McEachran, J.D. and K.A. Dunn. 1998. Phylogenetic analysis of skates, a morphologically conservative clade of elasmobranchs (Chondrichthyes: Rajidae). Copeia, pp. 271-290.
- Musick, J.A. and J.K. Ellis. 2005. Reproductive evolution of Chondrichthyes. In: Hamlett, W.C. (ed.), Reproductive biology and phylogeny of Chondrichthyes: sharks, batoids and chimaeras. Science Publishers, Enfield, NH, pp. 45-79.
- Stehmann, M.F.W. and N.R. Merrett. 2001. First records of advanced embryos and egg capsules of *Bathyraja* skates from the deep north-eastern Atlantic. J. Fish. Biol., 59: 338-349.
- Wourms, J.P. 1977. Reproduction and development in chondrichthyan fishes. Amer. Zool., 17: 379-410.

고려홍어 *Hongoe koreana*의 난각(연골어강: 홍어목: 홍어과)

정충훈 · 김진구¹

인하대학교 서해연안환경연구센터, ¹부경대학교 자원생물학과

요 약 : 고려홍어의 모식산지인 한반도 남서해안에서 포획한 암컷개체의 자궁에서 직접 적출한 난각 2개를 새롭게 기재하였다. 본종의 난각은 다른 종과 비교하여 보통 크기이고, 뿔(horn)을 포함한 전장은 124.5~133.7 mm, 뿔을 제외한 주부(main portion)의 체장은 102.8~109.4 mm, 최대폭은 41.0~42.2 mm이다. 측면에서 볼 때 배쪽으로 불룩한 비대칭이고, 표면은 비교적 부드러운 편이지만 세로로 미세한 고랑(longitudinal striations)은 뚜렷하고, 매우 발달한 섬유다발(絹狀絲 silky fibers)로 덮혀 있다. 앞뒤의 apron은 뚜렷하며, 네 뿔은 짧고 튜브모양이고 그 횡단면은 타원형이고, 앞쪽 뿔은 안쪽으로 심하게 구부러져 있으며, 호흡공(respiratory fissure)은 네 뿔의 끝부분에 위치한다. 신선한 상태에서 밝은 갈색이다.

찾아보기 낱말 : 고려홍어, 난각, 연골어류, 홍어과, 생식, 분류