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Anchovies from the Ryukyu Islands

Shinsho NISHISHIMAMOTO

Abstract

No taxonomic study on the anchovies (family Engraulidae) of the Ryukyu Islands, referred to the former Okinawa Prefecture of Japan including three groups of islands of Okinawa, Miyako and Yaeyama in this paper, is hitherto made, although a certain species is a very important bait fish for the local skipjack fishery. Three species of the genus *Stolephorus*, namely *Stolephorus zollingeri* (BLEEKER), *S. pseudoheterolobus* HARDENBERG and *S. indicus* (VAN HASSELT), are recorded and described.

Introduction

Occurrence of an anchovy (family Engraulidae) called "mizushuren" in the waters adjacent to Amami Oshima and in the Ryukyu Islands was reported, although the specific name was not indicated, by the Japanese Agriculture Bureau¹⁾ and by KISHINOUE²⁾. SCHMIDT³⁾ recorded *Stolephorus indicus* (VAN HASSELT) from Kominato, Amami Oshima. Recently HAYASHI and TADOKORO⁴⁾ reported the occurrence of *Stolephorus zollingeri* (BLEEKER) along the Pacific coast from the southern Kyushu to the middle part of Japan, and suggested the probable identity of the anchovy called "mizushuren" with the species. No taxonomic study, however, has been made on the anchovies of the Ryukyu Islands which is referred, in this paper, to the former Okinawa Prefecture of Japan including the three groups of islands of Okinawa, Miyako and Yaeyama.

While working in an investigation on the bait fishes for the skipjack fishery of the Ryukyu Islands, the author collected, from various parts of Okinawa-Jima, a number of specimens of an engraulid fish called "mizu-sururu" by the local people, which was a very important bait fish for the local skipjack fishermen. Examination of the specimens indicated that they were *Stolephorus pseudoheterolobus* HARDENBERG. Along with two samples of the species were collected two specimen of *Stolephorus indicus* (VAN HASSELT). The author also collected a postlarva of *Stolephorus zollingeri* (BLEEKER) at Iriomote-jima, and three specimens of the species were given by KAWAKAMI of the Aburatsu Fishing Co, who obtained them at the same island from a fishermen's collection.

In this paper, the above-mentioned three species of the genus *Stolephorus* are recorded and described. So far, no other species or genera of the family have been found in the Ryukyu Islands.

The sincere acknowledgement is made to Mr. JENKURO KAWAKAMI of the Aburatsu Fishing Co., Miyazaki, Japan, who gave a valuable collection of *S. zollingeri* to the author. Many thanks are due to the fishermen who cooperated in collecting specimens.

Key to the Species of *Stolephorus* from Ryukyu Islands

- 1a. Maxillary short, truncated or broadly rounded posteriorly, not reaching joint of mandible, never to preopercle; distance from tip of snout to rear end of maxillary 5.6-5.9 in standard length. Mandible reaching quite beyond a vertical line through front of anterior nostril; distance from tip of snout to tip of lower jaw when mouth closed 9.6-11.1 in head length. Origin of anal far behind base of dorsal, generally under or slightly before tips of dorsal rays when depressed; length of anal base about 6.5 in length. *Stolephorus zollingeri* (BLEEKER)
- 1b. Maxillary longer, pointed posteriorly, reaching to or past rear end of mandibular joint or to lower anterior margin of preopercle.
- 2a. Origin of anal fin slightly behind base of dorsal or under bases of last three dorsal rays; length of anal base 5.5-6.1 in length. Mandible ending far behind upper edge of gill-opening, anteriorly reaching only to a vertical line through posterior nostril; distance from tip of snout to tip of lower jaw when mouth closed 4.5-5.8 in head. Distal margin of dorsal truncate; when the fin depressed, its first rays reaching to or past tips of last rays, ending generally above bases of 3rd to 5th branched anal rays. Distance from tip of snout to rear end of maxillary 4.2-5.1 in length. *Stolephorus pseudoheterolobus* HARDENBERG
- 2b. Origin of anal fin under base of 10th or 11th branched dorsal ray; length of anal base 6.3-6.4 in standard length. Mandible ending slightly before a vertical line through upper edge of gill opening, reaching nearly to a vertical line through front of anterior nostril; distance from tip of snout to tip of lower jaw when mouth closed 8.2-8.5 in head. Distal margin of dorsal fin a little concave; when the fin depressed, its first rays reaching only to or slightly past end of the fin base, last three rays reaching more behind, last one ending above bases of 6th to 10th branched anal rays. Distance from tip of snout to rear end of maxillary 5.2-5.6 in length. *Stolephorus indicus* (VAN HASSELT)

STOLEPHORUS ZOLLINGERI (BLEEKER)

Japanese name: "Taiwan-Ainoko"

Fig. 1

Engraulis zollingeri BLEEKER, Jour. Indian Arch., vol.3, p.73, 1849 (type locality: Macassar, Celebes).

Stolephorus zollingeri BLEEKER, Atlas Ichth. Ind., Neerland., vol.6, p.126, pl.226, fig.2, 1866-72 (Java; Sumatra; Bali; Celebes; Amboina).

Anchovia zollingeri FOWLER and BEAN, Proc. U. S. Nat. Mus., vol.62, p.2, 1922 (Takao, Formosa).

Anchoviella zollingeri FOWLER, Proc. Acad. Nat. Sci. Philadelphia, vol.86, p.69, fig.4, 1934 (Bali).

1. Specimens Studied

Funauki-Wan, Iriomote-Jima; a postlarva, caught by S. NISHISHIMOTO with a dip net and a light at night, Oct. 26, 1959.

Funaura, Iriomote-Jima; three specimens, 40.7, 39.5 and 39.0 mm. in standard length, from a fishermen in Ishigaki-Jima, given by J. KAWAKAMI of Abratsu Fishing Co., Miyazaki, Japan, caught in a summer month of 1958.

The description is based on the three larger specimens, and the postlarva was used only for making counts. Only one specimen was dissected for counting

number of vertebrae.

2. Description

Certain counts and measurements were made on the three larger specimens and the postlarva (counts only), and ranges of the counts and those of the measurements expressed in standard length are shown in table I and table II, respectively, along with similar data on the other species.

Body elongate, moderately compressed, its ventral profile a little more convex than the dorsal. Depth of head at midend of occiput nearly equal to the greatest depth of body. Snout bluntly pointed, projecting less than one-third its length beyond tip of lower jaw, remarkably shorter than eye, a little longer than pupil, and 5.15-5.5 in head length. Distance from midtip of snout to tip of lower jaw when mouth closed 9.6-11.1 in head. Horizontal diameter of eye 3.4-3.7 in head. Maxillary short and truncated or broadly rounded posteriorly, its upper free margin short and nearly horizontal, not reaching front of joint of mandible, never to preopercle. Distance from tip of snout to rear end of maxillary 1.47-1.57 in head. Mandible reaching to or past a vertical line through midpoint between tip of snout and front of anterior nostril, ending slightly behind lower anterior margin of preopercle and slightly before a vertical line through upper edge of gill opening. Distance from tip of lower jaw to rear end of mandible 1.34-1.55 in head.

Distal margin of dorsal truncate; when the fin depressed, its first rays reaching to or slightly past the tips of last rays ending above origin of anal or above bases of unbranched rays of anal. Origin of anal far behind dorsal base, distal margin of anal fin concave, the first to 7th branched rays of the fin reaching base of 10th branched ray when depressed. Pectoral fin reaching beyond two-third way to pelvic insertion. Insertion of pelvic fin midway between pectoral insertion and anal origin, or nearer to pectoral, reaching a vertical line through base of 3rd or 4th branched dorsal ray. Caudal fin deeply forked, lower lobe slightly longer than upper one.

Scales deciduous. The last abdominal scute at a distance longer than snout from pelvic insertion. Nearly matured ova elliptic in shape, an ovum from a specimen, 39.5 mm in standard length, measured 0.4×0.2 mm. Difference between the numbers of precaudal and caudal vertebrae 7.

Colour in formalin brown above, grayish white below, with lateral dark brown bands on sides. A black spot on occiput. Tip and back of snout, tip of lower jaw, dorsal fin and caudal powdered with black. Lower fins hyaline. A pigmented line from end of anal base to caudal. Small black dots along the sides of anal base. Gill rakers and intestine brownish.

3. Remarks

The specimens from Iriomote-Jima agree with the descriptions of the anchovy presented by HAYASHI and TADOKORO⁴⁾, SHEN⁵⁾, FOWLER⁶⁾, and HARDENBERG⁷⁾, although there are some disagreements in the descriptions. The anchovy is easily

distinguished from the other species found in the Ryukyu Islands by the key presented.

The fish has been known from Madagascar, East Indies, Philippines, Tropical Pacific Islands, Taiwan, Miyazaki and Wakayama in Japan, and is now made known from the Ryukyu Islands.

HAYASHI and TADOKORO⁸⁾ reported that the catch of postlarvae of the species on the Pacific coast of Wakayama Prefecture during the period from April 1958 to 1959 was estimated at 148 tons. In the Ryukyu Islands, the fish is not usually caught by the fishermen.

Table I. Ranges of certain counts made on the species of *Stolephorus* from Ryukyu Islands with numbers of specimens examined in parentheses

Characters	zollingeri	pseudoheterolobus	indicus
Standard length in millimeters	31.0-40.7	44.0-61.5	83.7-89.0
Dorsal rays	13-14 (4)	13-16 (34)	16 (2)
Anal rays	14-17 (4)	14-19 (34)	18 (2)
Pectoral rays	15 (4)	13-16 (34)	14 (2)
Gill rakers:			
Upper limb	15-16 (3)	21-26 (20)	14-15 (2)
Lower limb	23-25 (3)	27-30 (20)	20 (2)
Vertebrae:			
Precaudal	24 (1)	21-24 (20)	21 (1)
Caudal	17 (1)	19-21 (20)	21 (1)
Total	41 (1)	41-44 (20)	42 (1)
Abdominal scutes	3-5 (3)	5-7 (28)	5 (1)

Table II. Ranges of measurements made on species of *Stolephorus* from Ryukyu Islands and recorded in standard length, along with numbers of specimens measured in parentheses

Characters	zollingeri	pseudoheterolobus	indicus
Standard length in millimeters	39.0-40.7 (3)	44.0-61.5 (44)	83.7-89.0 (2)
Length of head	3.7-3.9 (3)	3.7-4.1 (44)	4.1-4.2 (2)
Greatest depth of body	5.9-6.2 (3)	5.7-6.7 (31)	5.3 (1)
Head depth at end of occiput	5.7-6.3 (3)	7.0-7.5 (10)	6.9-7.0 (2)
Length of snout	19.8-20.5 (3)	15.8-19.2 (34)	17.8 (1)
Diameter of eye	13.4-13.6 (3)	13.2-16.5 (34)	14.0 (1)
Maxillary length (from snout tip) ..	5.6-5.9 (3)	4.2-5.1 (34)	5.2-5.6 (2)
Length of mandible	5.1-6.0 (3)	5.5-6.8 (34)	6.4-6.5 (2)
Width of bony interorbital space ..	21.2-26.7 (3)	15.9-18.2 (10)	15.2-18.5 (2)
Postorbital length of head	7.1-7.7 (3)	7.5-7.8 (10)	7.6-8.3 (2)
Tip of snout to tip of lower jaw (when mouth closed)	36.7-40.1 (3)	19.0-23.0 (10)	33.5-35.6 (2)
Length of longest fin ray of:			
Dorsal	6.3-6.9 (3)	6.7-7.7 (10)	7.7 (1)
Anal	9.0-10.2 (3)	9.0-9.6 (10)	8.9-9.1 (2)
Pectoral	7.1-7.4 (3)	7.8-8.6 (9)	8.0 (1)
Length of midcaudal fin ray	10.0-10.3 (2)	10.2-13.4 (10)	12.7-13.9 (2)
Length of base of dorsal fin	7.2-7.8 (3)	7.4-8.2 (10)	6.9-7.3 (2)
Length of base of anal fin	6.5 (3)	5.6-6.1 (10)	6.3-6.4 (2)
Snout tip to dorsal origin	1.9-2.1 (3)	1.8-2.0 (34)	1.82 (1)
Snout tip to anal origin	1.5 (3)	1.5-1.6 (34)	1.60 (1)
Snout tip to pelvic insertion	2.2 (3)	2.1-2.3 (34)	2.3 (1)
Pelvic insertion to anal origin	4.4-5.1 (3)	4.9-5.8 (34)	5.3 (1)
Pectoral insertion to pelvic	4.8-5.1 (3)	4.8-5.5 (34)	5.3 (1)
Least depth of caudal peduncle	10.9-11.5 (3)	11.4-12.3 (10)	11.2-11.4 (2)
Length of caudal peduncle	4.8-5.3 (3)	4.5-5.1 (10)	4.1 (1)

STOLEPHORUS PSEUDOHETEROLOBUS HARDENBERG

Okinawan name: "mizusururu"

Fig. 2

Stolephorus pseudoheterolobus HARDENBERG, Nat. Tijdsch. Ned. Indie, vol. 93, pt. 2, p. 261, 1933 (type locality: Riouw and Lingga Archipelago; Molucas). ... SHEN, Inst. Fishr. Biol., Min. Eco. Aff. Nat. Taiwan Univ., vol.1, no.3, p. 30, pl. 2, fig. 4, 1959 (Tamsui and Pescadore Islands, Taiwan).

Anchoviella pseudoheteroloba FOWLER, U. S. Nat. Mus., Bull. 100, vol. 13, pp. 697-698, 1941 (compiled).

1. Specimens Studied

Motobu, Okinawa-Jima; 95 specimens, 39 to 63 mm. in standard length, provided from fishermen's catch by a driving into net, Aug. 5, 1959.

Chujo-Wan, Okinawa-Jima; 71 specimens, 32 to 60 mm. in standard length, provided from fishermen's catch by a lift net and underwater fish-lamps, at night, Sept. 10, 1959.

Unten, Okinawa-Jima; 84 specimens, 39 to 52 mm. in standard length, caught by S. NISHISHIMAMOTO with a dip net and a underwater fish-lamp at night, Sept. 10, 1959.

Kantena-Wan, Okinawa-Jima; 643 specimens, 43 to 60 mm. in standard length, caught by S. NISHISHIMAMOTO and a party of fishermen with dip nets, a lift net and underwater fish-lamps at night, May. 18, 1961.

Ishikawa, Okinawa-Jima; 182 specimens, 25 to 48 mm. in standard length, caught by S. NISHISHIMAMOTO with a dip net and underwater lamp at night, May 4, 1962.

Shioya-Wan, Okinawa-Jima; 55 specimens, 30 to 60 mm. in standard length, caught by S. NISHISHIMAMOTO with dip net and underwater fish-lamp at night, Mar. 24, 1962.

Most of the specimens used in the study were caught at night with a dip net or a lift net and underwater lamps at certain bays and inlets ("Wan" in Japanese) in Okinawa-Jima. Some postlarvae were collected along with larger specimens, but they are not used for the description in the study.

2. Description

Certain counts and measurements were made on variable number of specimens depending on the character used (table I and table II).

Body elongate, moderately compressed, its dorsal profile as convex as the ventral. Depth of head at midend of occiput shorter than the greatest depth of body. Snout blunt, projecting more than half or in some cases about half its length beyond tip of lower jaw, a little shorter than eye, and 4.0-5.0 in head. Distance from midtip of snout to tip of lower jaw when mouth closed 4.5-5.8 in head. Horizontal diameter of eye 3.5-4.3 in head. Maxillary long and pointed posteriorly, its upper free margin oblique, a little convex or nearly truncate, generally reaching well beyond joint of mandible and quite to or a little past lower anterior margin of preopercle. Distance from tip of snout to rear end of maxillary 1.14-1.29 in head. Mandible reaching a vertical line through rear nostril, ending under lower anterior margin of preopercle and entirely behind upper edge of gill opening. Distance from tip of lower jaw to rear end of mandible 1.47-1.65 in head.

Distal margin of dorsal fin truncate; when the fin depressed, its first rays reaching to or a little past tips of last rays, ending above the bases of 3rd to 6th branched anal rays. Anal origin slightly behind dorsal base or under bases of last three dorsal rays; distal margin of anal concave, its first to 6th or 7th branched rays reaching the base of the 10th or 11th branched rays when depressed. Pectoral fin reaching not quite two-third way to pelvic insertion. Insertion of pelvic fin midway between pectoral insertion and anal origin, reaching a vertical line through the bases of unbranched rays or first two branched rays of dorsal fin. Caudal fin deeply forked, lower lobe somewhat longer than the upper one.

Nearly matured ova elliptic in shape, an ovum from a specimen of 57.5 mm. in standard length, caught at Kantena-wan on May 18, 1961, measured 0.5 mm. \times 0.3 mm. Scales deciduous; the last abdominal scute at a distance from tip of its spine to pelvic insertion nearly equal to snout length or less, depending on number of scutes present. Difference between the numbers of precaudal and caudal vertebrae 0-5, usually 3-4.

Colour hyaline with a silvery lateral band from head to caudal. A black spot on occiput. Tip and back of snout and caudal fin powdered with black, other fins hyaline. Small dots along the sides of anal base, and a pigmented line from end of the fin base to caudal. Gill rakers and intestine black. The Okinawan local name "mizusururu" is referred to the hyaline coloration.

3. Ecological Note

The species was found along the coast of Okinawa-Jima, being especially abundant in bays and inlets. During the skipjack fishing season from April to September, the fish is intensively caught by the local bait fishermen with a kind of lift net and underwater fish-lamps at night. There is considerable fluctuation in annual catch, which affects directly the fishing activities and the catch of skipjack.

When the anchovies were attracted by a bright light at night, it was observed that they gathered at the surface around the light when school was small, but usually remained at a depth of about one meter or more, swimming around the light, when the school was large. Postlarvae were found generally at the surface close to the light.

The postlarval fish occurred throughout the fishing season, being especially abundant in early months of the season. This indicates the occurrence of a height of spawning season in winter months, although spawning may take place all the year round.

4. Remarks

Identification of the specimens was made by comparing with the descriptions of the species presented by HARDENBERG⁷⁾ and by SHEN⁸⁾. They agree with the descriptions in all respects except in the counts of gill rakers, being greater in numbers.

The anchovy had been known from East Indies and Taiwan, and is now made

known from the Ryukyu Islands.

STOLEPHORUS INDICUS (VAN HASSELT)

Japanese name: "Indo-Ainoko"

Fig. 3

- Engraulis indica* VAN HASSELT, *Algemein Konst-Letterbode*, p.329, 1823 (type locality: Java).
Stolephorus indicus BLEEKER, *Atlas Ichth. Ind. Neerland.*, vol. 6, p. 127, pl. 259, fig.2, 1866-72 (East Indies).
Anchovia indica JORDAN and EVERMANN, *Proc. U. S. Nat. Mus.*, vol.25, p.328, 1902 (Formosa)... Schmidt, *Trans. Pacific Comm. Acad. Sci. U. S. S. R.*, vol. 11, p. 177, 1931 (Kominato, Amami Oshima).
Anchoviella indica FOWLER, *Proc. Acad. Sci. Philadelphia*, vol.86, p.69, 1934 (Saneer; Bale).

1. Specimens Studied

- Motobu, Okinawa-Jima; one specimens damaged, 89.0 in standard length, provided from fishermen's catch by a driving into net, Aug. 5, 1959.
 Chujo-Wan, Okinawa-Jima; one specimens, 83.7 mm. in standard length, provided from fishermen's catch by a lift net and underwater fish-lamps at night, Sept. 3, 1959.

One of the specimens was damaged, so that number of measurements was limited. Only the damaged specimen was dissected for counting number of vertebrae.

2. Description

Certain measurements were made on the two specimens, and ranges of the counts and those of the measurements expressed in standard length are shown in table I and table II, respectively.

Body elongate, slightly compressed, its ventral profile a little more convex than the dorsal. Depth of head at midend of occiput considerably smaller than the greatest depth of body. Snout bluntly rounded, projecting about one-third its length beyond tip of lower jaw, shorter than eye, and about 4.4 in head length. Distance from midtip of snout to tip of lower jaw when mouth closed 8.2-8.5 in head. Horizontal diameter of eye 3.4 in head. Maxillary long and bluntly pointed posteriorly, its upper free margin broadly rounded, reaching end of joint of mandible and to lower anterior margin of preopercle. Distance from tip of snout to rear end of maxillary 1.28-1.33 in head. Mandible reaching nearly to a vertical line through the front margin of anterior nostril, ending under lower anterior margin of preopercle and slightly before a vertical line through upper edge of gill opening. Distance from tip of lower jaw to rear end of mandible 1.57-1.58 in head.

The distal margin of dorsal fin somewhat concave; when the fin depressed, its first branched rays reaching to or a little past end of the fin base, last three rays reaching more behind, last one ending above the bases of 6th to 10th branched anal rays. Origin of anal under the base of 10th or 11th branched dorsal rays; distal margin of anal fin concave, its first to 6th or 7th branched rays

reaching the bases of 10th or 11th branched ray when depressed. Pelvic fin reaching nearly two-third way to pelvic insertion. Insertion of pelvic fin midway between pectoral insertion and anal origin, reaching not quite to a vertical line through origin of dorsal fin. Caudal fin deeply forked, lower lobe a little longer than the upper one.

Scales deciduous, 40 in median lateral series, 9 transversely, 19 predorsal in a specimen. The last abdominal scute at a distance from tip of its spine to pelvic insertion less than snout length. One specimen dissected showed no difference between the numbers of precaudal and caudal vertebrae.

Colour of the specimens preserved in formalin changed so that the lateral bands were only traced on sides. Black spots on and behind occiput. Tip and back of snout, middorsal line and caudal powdered with black. Inner side of operculum brownish. Gill rakers somewhat pigmented.

3. Remarks

The two specimens agree with the descriptions made by JORDAN and SEAL⁹⁾, HARDENBERG⁷⁾, ROXAS¹⁰⁾, FOWLER⁶⁾, and SHEN⁵⁾. They differ from the specimens reported by SCHMIDT³⁾ from Amami Oshima, according to his description, in the origin of anal fin, being under the dorsal base instead of being entirely behind the dorsal base. He suggested that his specimens probably represented a northern subspecies or race. It is also possible that his specimens are *S. pseudoheterolobus* HARDENBERG rather than *S. indicus*, since the former species was not yet established at the time of his report. HAYASHI and TADOKORO⁴⁾ considered that *S. indicus* from Kochi, first erroneously reported as *Anchoviella pseudoheteroloba* (HARDENBERG) and later the speciation was corrected by KAMOHARA^{11, 12)}, was a synonym of *S. zollingeri*. Additional investigations are needed for further discussions.

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Plate



Fig. 1. *Stolephorus zollingeri* (Bleeker), 40.7 mm. in standard length, partly stained.

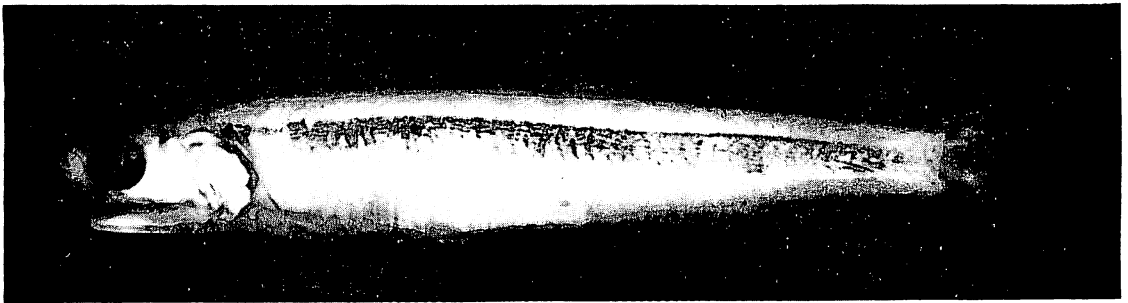


Fig. 2. *Stolephorus pseudoheterolobus* Hardenberg, 59 mm. in standard length.

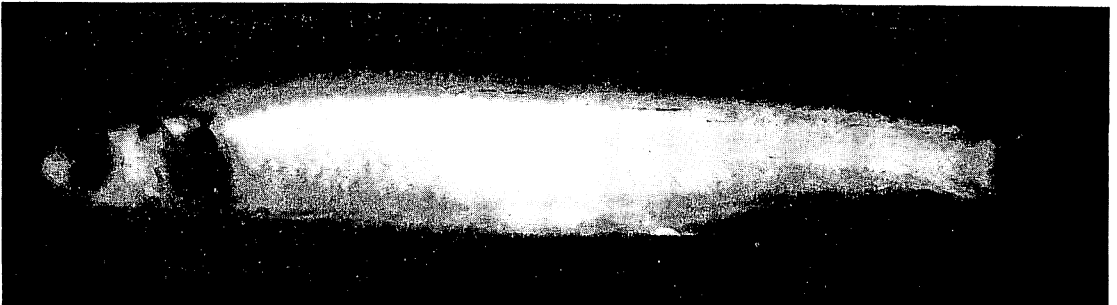


Fig. 3. *Stolephorus indicus* (Van Hasselt), 83.7 mm. in standard length.