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Cephalopod Paralarvae (Excluding Ommastrephidae) Collected from Western Japan Sea and Northern Sector of the East China Sea during 1987-1988: Preliminary Classification and Distribution

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Abstract

Classification and distribution of cephalopod paralarvae in the western Japan Sea and northern sector of the East China Sea were studied. The materials were collected by the R/V *Mizuho-Maru* and T/V *Mizunagi* during mid-October to late November, 1987 and 1988. A total of 1128 paralarvae, excluding those of the Ommastrephidae, were examined and classified into 13 species of eight families except for the unclassified Octopodidae. The distribution charts of each species were prepared.

Key Words Cephalopoda, paralarva, Japan Sea, classification, distribution

Introduction

The Japan Sea National Fisheries Research Institute has been conducting survey on the distributional and environment of the paralarvae of Japanese common squid, *Todarodes pacificus* Steenstrup in the Tsushima Warm Current area since 1972 (JAPAN SEA REGIONAL FISHERIES RESEARCH LABORATORY, 1973-1988). This paper reports the classification and distribution of cephalopod paralarvae (excluding the Ommastrephidae) collected during four cruises in 1987 and 1988, among collections of a lengthy series of cruises.

The cephalopod paralarvae in the Japanese waters were studied by OKUTANI (1966, 1968, 1969) and YAMAMOTO and OKUTANI (1975) in the offshore areas of Pacific coast, by SATO and SAWADA (1974) in the nearshore area of Izu Peninsula, and by KUBODERA and OKUTANI (1981) and KUBODERA and JEFFERTS (1984a, b) in the Subarctic Pacific areas. Only SHIMOMURA and FUKATAKI (1957) reported on cephalopod eggs in the Japan Sea but there

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have been no reports on the relationships between cephalopod paralarval fauna except a series of quantitative data on *T. pacificus* (JAPAN SEA REGIONAL FISHERIES RESEARCH LABORATORY, 1973–1988).

Before going further, we wish to extend our thanks to Mr. S. HASEGAWA, Dr. Y. HIROTA, Mr. Y. HIYAMA, Mr. H. NISHIDA, and Mr. N. KAWAKAMI, the Japan Sea National Fisheries Research Institute for their help on board and laboratory in sampling and sorting the specimens under study. Thanks are also due to the captains and crew of the R/V *Mizuho-Maru* and T/V *Mizunagi* for the effort sampling on the sea. We send our gratitude to Dr. Takashi OKUTANI, Professor of Tokyo University of Fisheries, for his constant guidance and criticism during the course of this study.

Materials and Methods

The materials examined in this study was collected from the western Japan Sea and northern part of the East China Sea during mid-October to late November in the years of 1987 and 1988 by the T/V *Mizunagi* (148.0 t) and R/V *Mizuho-Maru* (150.44 t) at 256 stations in total for these two years (Fig. 1, Table 1).

The sampling was made with oblique haul from a depth of 75 m by a cylinder-cone ring net (80 cm in mouth diameter, 3.2 m in lateral length, 0.58 mm in mesh). All samples were fixed by 5% neutralized formalin seawater on board, and later cephalopod paralarvae were sorted out in the laboratory.

In this study, ML means the ventral mantle length in the genus *Sepiola* and Octopoda and the dorsal mantle length in all other groups.

Results

The cephalopod paralarvae (excluding the Ommastrephidae) in the present collection were identified as 13 species of eight families, except for the unclassified Octopodidae.

Family **Sepiolidae**

Sepiola birostrata SASAKI, 1918

(Figs. 2, 3)

Observation: The mantle is globular with a round posterior end. The anterodorsal margin of the mantle is fused with the dorsal region of the head by integument. The fins are broad and round. The funnel cartilage is lanceolate with a simple straight groove. The arms are short and robust with biserial suckers. Arm formula is III, II, IV, I. The

Table 1. Date, vessel and number of stations by cruise.

Year	Period	Vessel	No. of stations
1987	10/13–10/31	*Mizunagi*	44
	10/21–11/18	*Mizuho-Maru*	67
1988	10/12–10/31	*Mizunagi*	78
	10/21–11/18	*Mizuho-Maru*	67

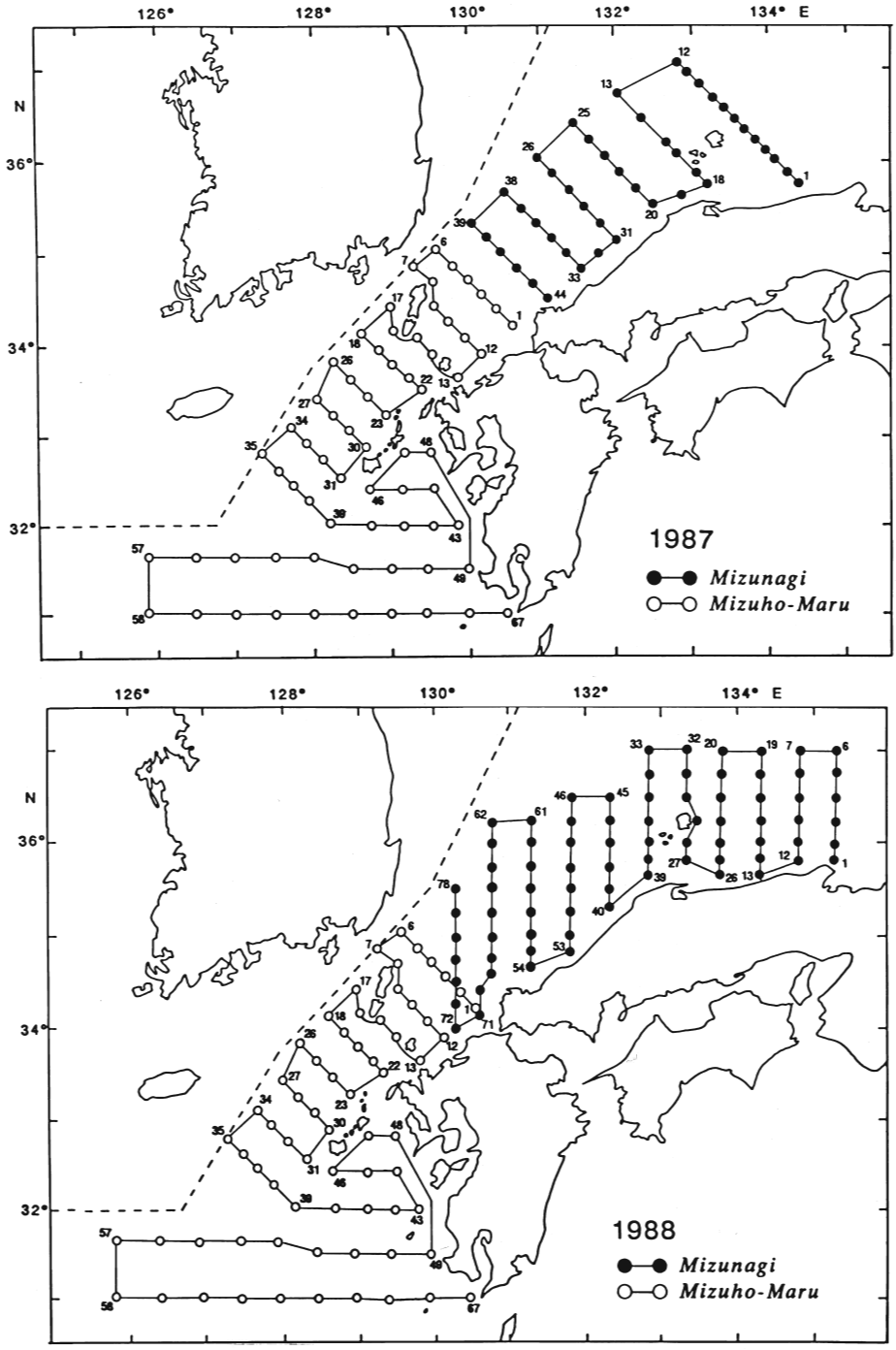

Fig. 1. Station plan of the 1987 and 1988 cruises. Solid circles are the stations occupied by the T/V *Mizunagi* and open circles by the R/V *Mizuho-Maru*.

interbrachial membrane of both Arms I is over 50 % of arm length. The tentacular club of specimen of about 1.5 mm ML is lanceolate with only nine suckers, of which the proximal one is extremely large in size. In a specimen of 2 mm ML, about 32 suckers are arranged in four rows on the semicircular club. A reniform, white silver and transparent light organ is present on the dorsal side of rectum.

Chromatophores on the mantle are arranged rather irregularly, but densely on the ventral side. The fins are devoid of chromatophores. On the dorsal head, four or five chromatophores are arranged in an inverse V-shape. A single chromatophore exists just in front of the eyeball. On the ventral head, a pair of chromatophores are situated at the base of the funnel. One or two quadrate chromatophores are present on the Arms II and III, while they are absent on the Arms I and IV.

Occurrence: 29 specimens from 26 stations (Fig. 3).

Remarks: The present specimens were identified to belong to the family Sepiolidae by possession of the unfused mantle-funnel connectives and absence of shell.

Only one species of the subfamily Heteroteuthinae is known from the Japanese waters, namely, *Sepiolina nipponensis* (BERRY, 1911), which is characterized in the adult stage as having biserial suckers on the arms, a deep interbrachial membrane, and a distinct iridescent band along the ventral mantle. The paralarval stage of this species has never been described, but it is possible to distinguish from the present specimen by the form of the light organ (oval in *S. nipponensis* versus reniform in this specimens).

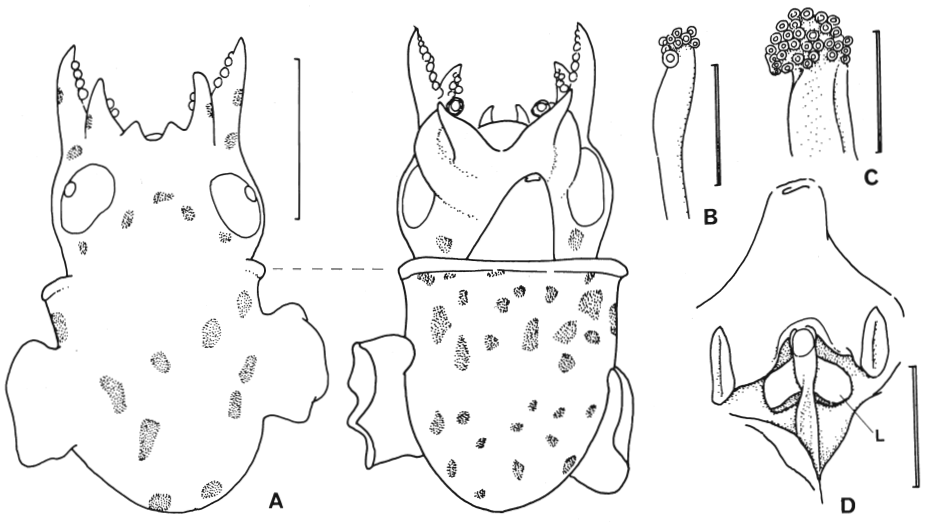

Fig. 2. *Sepiola birostrata*. (A): Dorsal and ventral views of a 1.6 mm ML specimen from *Mizuho-Maru* St. 9 (1988). (B): Right tentacular club of a 1.2 mm ML specimen from *Mizuho-Maru* St. 18 (1988). (C): Right tentacular club of a 2.0 mm ML specimen from *Mizuho-Maru* St. 19 (1988). (D): Mantle cavity of the same. L indicates the light organ. [Scale: single bar = 1 mm; double bar = 0.5 mm]

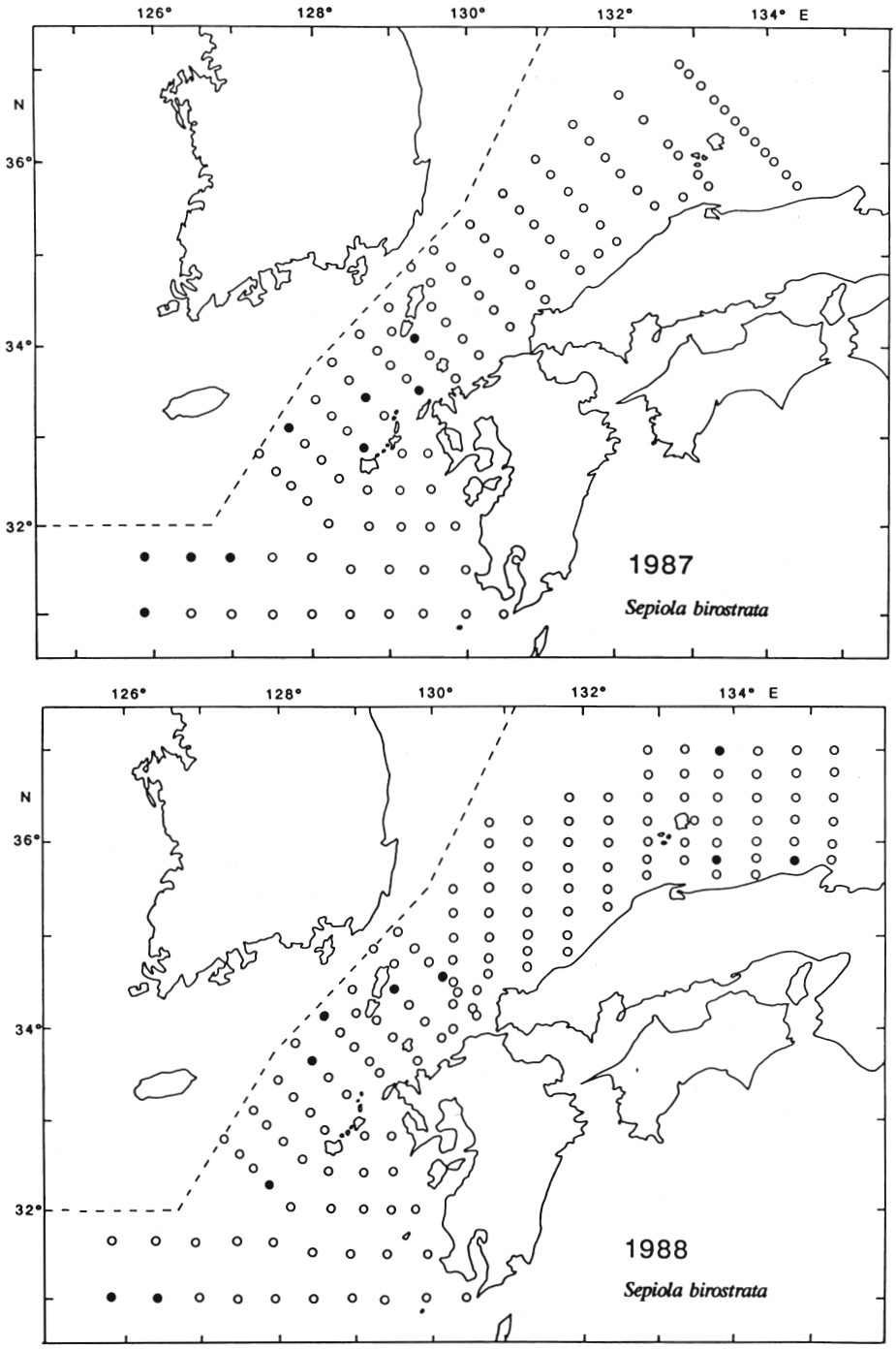

Fig. 3. Distribution of *Sepiola birostrata*. Solid circles indicate positive stations.

In the subfamily Sepiolinae, three genera are known from the Japanese waters, namely, *Euprymna, Sepiola* and *Inioteuthis* (OKUTANI, 1979).

In the genus *Euprymna*, the arm sucker arrangement is quadriserial even in the hatchling, and easily separable from the present specimens (ALLAN, 1945).

The present specimens are easily separable from *Inioteuthis* by the presence of an intestinal light organ, but it will match in characters of the genus *Sepiola* in having biserial arm suckers and characteristic light organ. In the Japanese waters, two species of *Sepiola* are known, namely, *S. birostrata* SASAKI, 1918 and *S. parva* SASAKI, 1914. *S. birostrata* seems to be more common than the other particularly in sandy-muddy flats such as in the East China Sea. Thus the present specimens were identified to be *S. birostrata*.

Family **Idiosepiidae**

Idiosepius paradoxus (ORTMANN, 1881)

(Fig. 4. A)

Observation: The mantle is globular with a thin and weak integument. The fins are semicircular in outline and situated slightly anterior to the mantle end. The funnel cartilage is oval. The arms are short and robust with biserial suckers. The arm formula is II, III, I, IV. The tentacle is never prominent.

On the dorsal mantle only about ten chromatophores are scattered on the posterior half. The ventral mantle and funnel are devoid of chromatophores. The dorsal and ventral head have two pairs of chromatophores on each side. Arms II and III have three to four chromatophores on the aboral side.

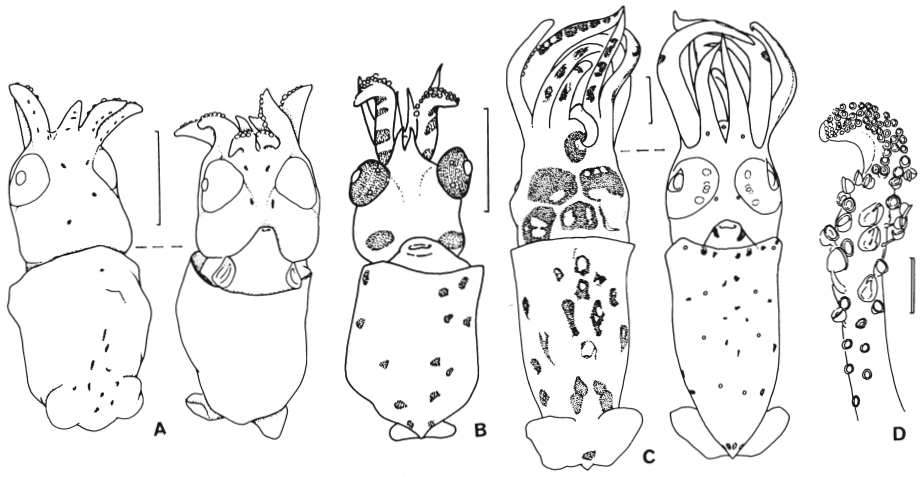

Fig. 4. **(A).** *Idiosepius paradoxus*. Dorsal and ventral views of a 1.9 mm ML specimen from *Mizuho-Maru* St. 22 (1987).
(B)-(D). *Enoploteuthis chuni*. (B): Ventral view of a 2.0 mm ML specimen from *Mizuho-Maru* St. 17 (1988). (C): Dorsal and ventral views of a 5.2 mm ML specimen from *Mizuho-Maru* St. 54 (1988). (D): Left tentacular club of a 5.0 mm ML specimen from *Mizuho-Maru* St. 61 (1988). [Scale: single bar=1 mm; double bar=0.5 mm]

Occurrence: A single specimen from 1987 *Mizuho-Maru* St. 22.

Remarks: The present specimen is characterized by a myopsid eye, fins situated slightly anterior, and undifferentiated tentacles.

Family **Enoploteuthidae**

Enoploteuthis chuni ISHIKAWA, 1914

(Figs. 4. B–D, 5)

Observation: Arms are rather short and weak with biserial suckers, and the formula is II, III, I, IV. The longest arm attains about 75% of ML. The tentacular club has four rows of suckers that become biserial and are rather sparse proximally. In a specimen of 5.0 mm ML, two hooks develop in the inner ventral sucker row of the manus.

On the ventral mantle, a pair of photophores is prominent at the anterior one-fourth in the specimen of 4.0 mm ML. Subsequently, a pair of photophores just behind the lateral angle of anteroventral margin, and a pair of photophores at the proximal of the first pair differentiate at 5.0 mm ML. On the funnel, a pair of photophores is evident at 5.0 mm ML. On the ventral head, a pair of photophores is prominent between the eyes at 3.2 mm ML. A pair of lateral funnel and two mid-ventral photophores differentiate at 5.6 mm ML. Two pairs of photophores are prominent on the orbit at 3.2 mm ML. On the Arm IV, a pair of photophores is recognized at 4.0 mm ML.

A single subocular photophore appears rather posteriorly at 2.3 mm ML, and soon another one develops. A small interposed photophore becomes prominent at 4.0 mm ML. At 5.6 mm ML, 5 or 6 subocular photophores are already present.

Occurrence: 80 specimens from 52 stations (Fig. 5)

Remarks: Eighty specimens ranging from 2.5 to 5.8 mm ML are easily separable from the other enoploteuthid paralarvae larger than 2.5 mm ML in the present collection. The prominencies of subocular and cephalic photophores are different from those in *Abralia*. The first subocular photophores appears rather posteriorly in *E. chuni*, but at the mid-ventral periphery of the eyes in *Abralia*. In *E. chuni*, a pair of photophores is first prominent on the ventral head, in contrast to single center one in *Abralia* species (YOUNG & HARMAN, 1985). The paralarvae of *Watasenia scintillans* has long and weak arms and a peculiar photophore on the Arm IV larger than about 3 mm ML.

The paralarvae of this species were first described by OKUTANI (1968).

Abralia ? multihamata SASAKI, 1929

(Figs. 6. A, 7)

Observation: The mantle is rather long and conicocylindrical. The arms are short and robust with biserial suckers, and the formula is III, II, I, IV. The Arms I to III have a narrow aboral keel. The tentacle is short and robust with quadriserial suckers on the club.

On the ventral mantle, two pairs of photophores are present at 4 mm ML. On the ventral head, a single photophore is prominent between both eyes at 4 mm ML. Three monotypic subocular photophores are evident at 2.9 mm ML. At 4 mm ML, there are five

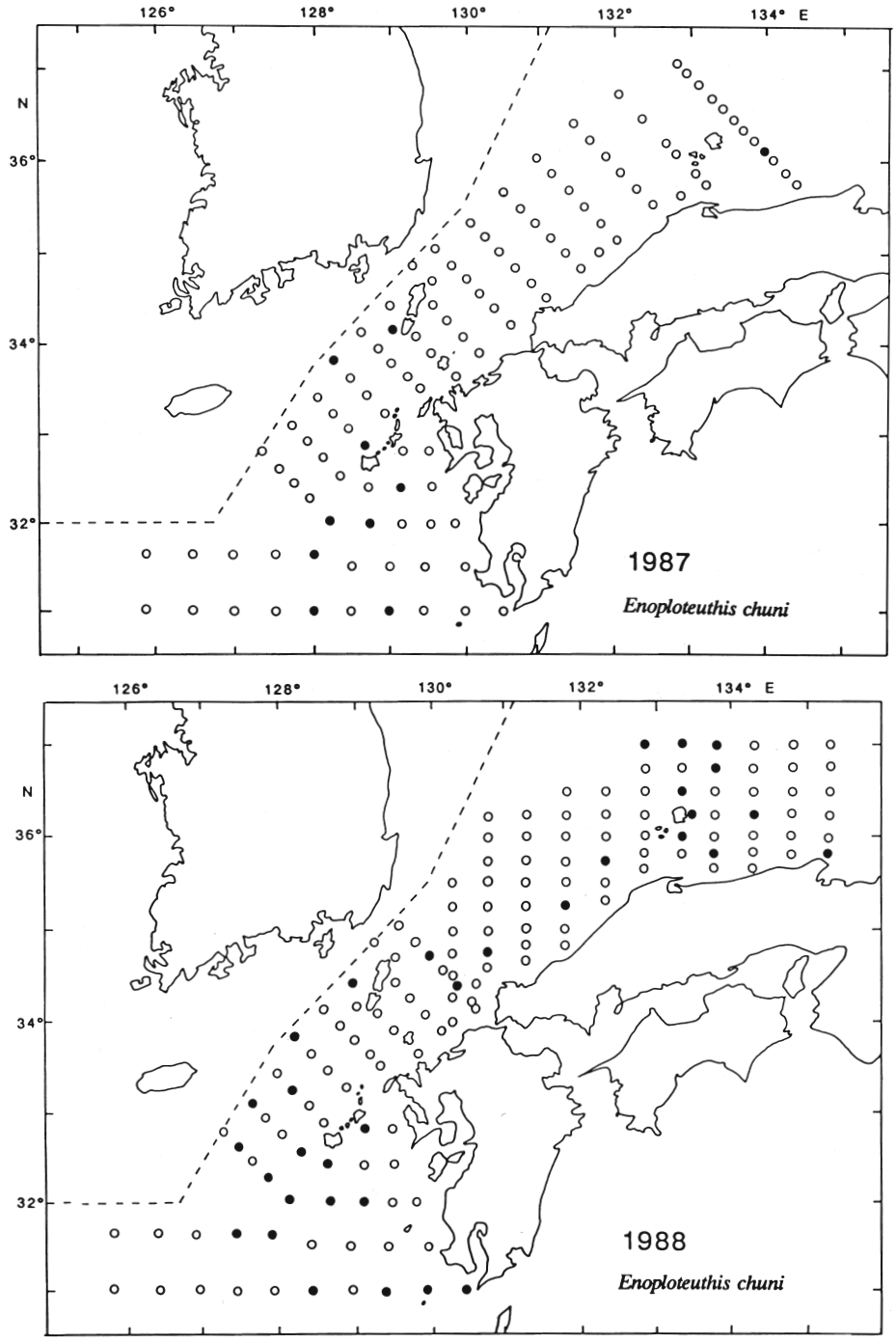

Fig. 5. Distribution of *Enoploteuthis chuni*. Solid circles indicate positive stations.

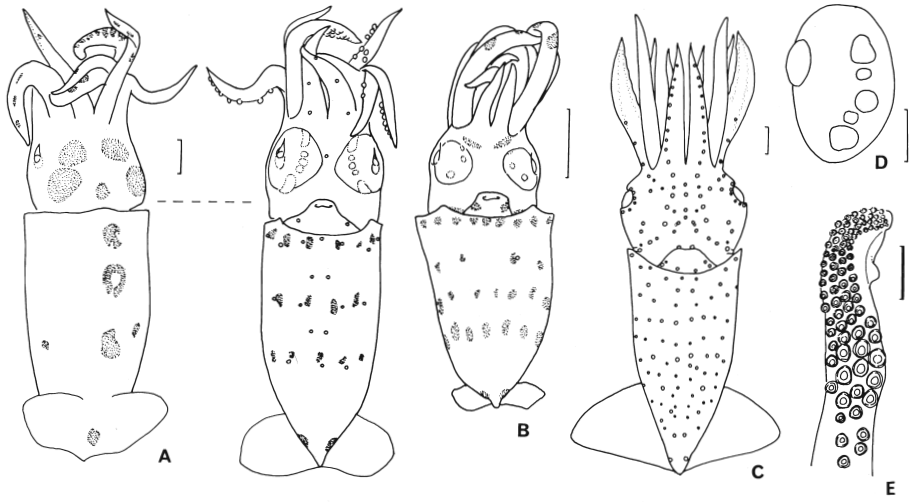

Fig. 6. (A). *Abralia multihamata*. Dorsal and ventral views of a 7.8 mm ML specimen from *Mizuho-Maru* St. 57 (1988). (B)-(E). *Abralia andamanica*. (B): Ventral view of a 3.0 mm ML specimen from *Mizuho-Maru* St. 17 (1988). (C): Ventral view of a 9.2 mm ML specimen from *Mizuho-Maru* St. 72. (1988). (D): Left eyeball of the same. (E): Left tentacular club of the same. [Scale: single bar=1 mm; double bar=0.5 mm.]

subocular photophores, of which the terminal two are modified to be large and opaque.

On the dorsal surface of mantle, three chromatophores are arranged along the mid-dorsal line in a 4 mm ML specimen. On the dorsal head, five chromatophores are arranged dorsally and posterodorsally to the eyes, and anteriorly to the nuchal cartilage.

Occurrence: Eleven specimens from nine stations (Fig. 7).

Remarks: In the Japanese water, there are two *Abralia* species having two types of photophores on the eyeball, namely, *A. multihamata* and *A. andamanica*. The present paralarvae are separable from those of *A. andamanica* by the characteristic of a smaller number of chromatophores on a more elongated mantle at the same size.

The adult specimen of *A. multihamata* was originally described from Formosan waters (SASAKI, 1929), but it occurs in both Suruga Bay and Sagami Bay (TSUCHIYA, MS).

Abralia andamanica (GOODRICH, 1896)
(Figs. 6. B-E, 8)

Observation: The mantle is globular to conico-cylindrical. The arms are short and robust with biserial suckers, and formula is II, III, IV, I. The tentacle is also short and robust with quadriserial suckers on the club.

The specimen of 2.9 mm ML lacks the tegumental photophore. At 4.9 mm ML, two pairs of photophores are present on the ventral mantle. A pair of funnel photophores is observed at 4.9 mm ML. On the ventral head, a single photophore first differentiates between both eyes at 4 mm ML. Three monotypic subocular photophores are evident at

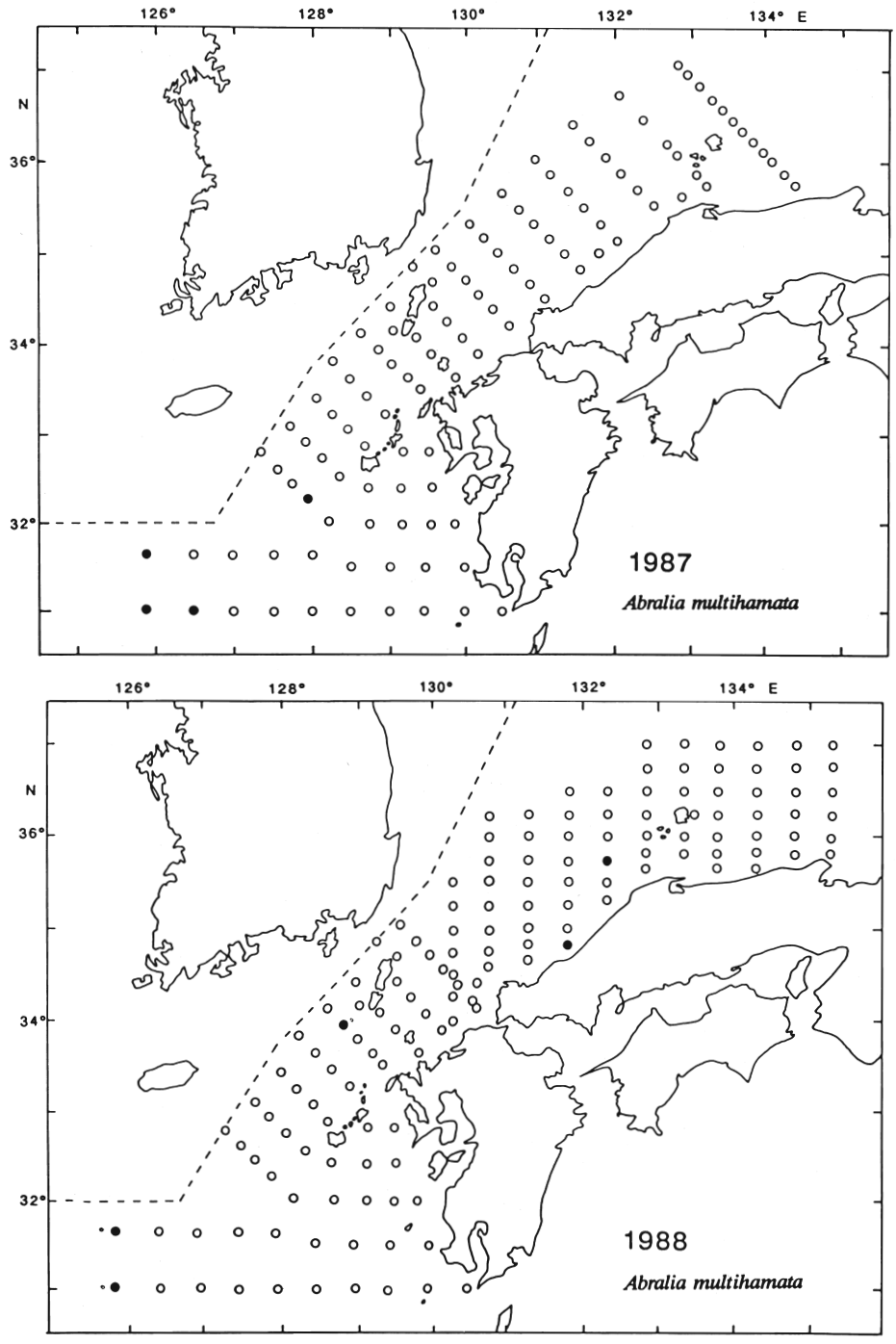

Fig. 7. Distribution of *Abralia multihamata*. Solid circles indicate positive stations.

2.9 mm ML. At 5.7 mm ML, five subocular photophores are completed, of which the terminal two are enlarged and opaque.

Occurrence: 45 specimens from 33 stations (Fig. 8).

Remarks: This species is characterized by having two types of subocular photophores. OKUTANI (1974) described an advanced stage of *A. andamanica* from the eastern Pacific. The largest specimen in our material (9.2 mm ML) is similar to OKUTANI's.

The present occurrence is the first record of this species in the Japan Sea, although TAKI and IGARASHI (1967) identified an intermediate form of *A. andamanica* and *A. multihamata* from off Namerikawa, Toyama Prefecture.

Abralia astrosticta BERRY, 1909
(Fig. 9. A)

Observation: One specimen, 2.5 mm ML was available in the present collection. The mantle is long conico-cylindrical. The head is proportionally elongate cubic. The arms are short and robust with biserial suckers. The arm formula is III, II, I, IV. The tentacle is short and robust with quadriserial suckers on the club.

A pair of large integumental photophores is located near the posterior end of mantle, but other integumental photophores are not prominent. On the eyeball, a single central photophore is present.

Occurrence: A single specimen from *Mizuho-Maru* St. 65 (1988).

Remarks: The present specimen belongs to *Abralia (Astrabralia)*, characterized by the presence of a pair of caudal photophores. This paralarva agrees with that of *A. astrosticta* described by YOUNG & HARMAN (1985) in body proportion, chromatophore arrangement and presence of the caudal photophores.

Watasenia scintillans (BERRY, 1911)
(Figs. 9. B–D, 10)

Observation: The mantle is rather thin. The arms are long and weak with sparsely arranged biserial suckers. The arm formula is II, III, I, IV. The longest arm attains about the same as ML. The tentacle is long and weak with quadriserial suckers on the club. At about 5 mm ML, two hooks are differentiated on the club.

The distal photophores on the Arm IV are apparent in specimens over 3 mm ML. At about 5 mm ML, three subocular photophores are prominent.

Occurrence: 47 specimens from 27 stations (Fig. 10).

Remarks: Paralarval specimens are characterized by the presence of the terminal photophores of the Arm IV over 3 mm ML. The presence of these photophores on the Arm IV is also shared with the genera *Watasenia* and *Abraliopsis*. As a few species of *Abraliopsis* are known from the Japanese waters (TSUCHIYA & OKUTANI, 1988, 1990), it is rather difficult to separate paralarvae of two genera. KUBODERA and OKUTANI (1981) stated that the terminal photophores of Arm IV in this species appeared in the specimen at about 4 mm ML. The smallest specimen with these photophores among the present material is about only 3 mm ML, and its photophores are still weak, transparent, and

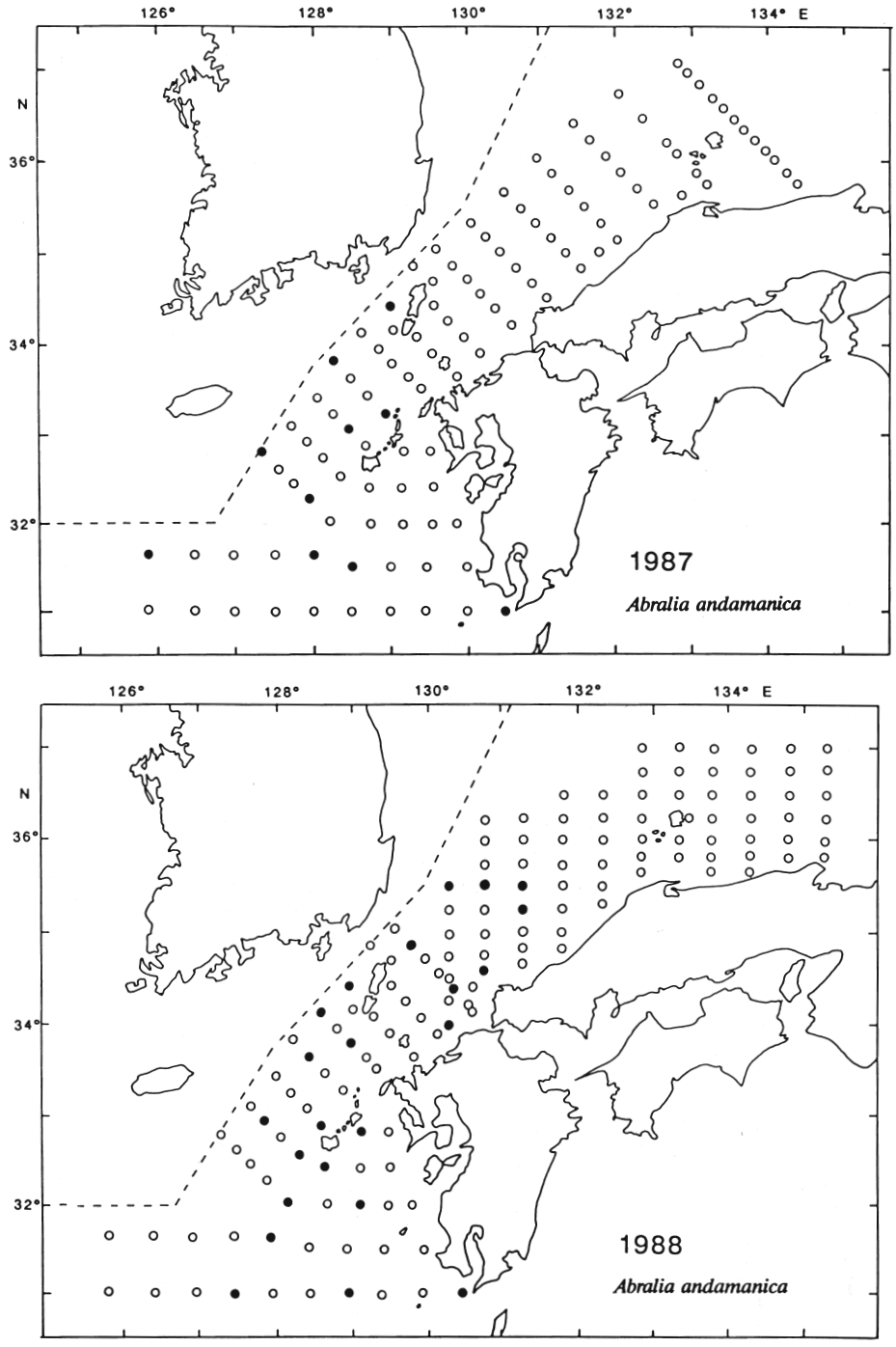

Fig. 8. Distribution of *Abralia andamanica*. Solid circles indicate positive stations.

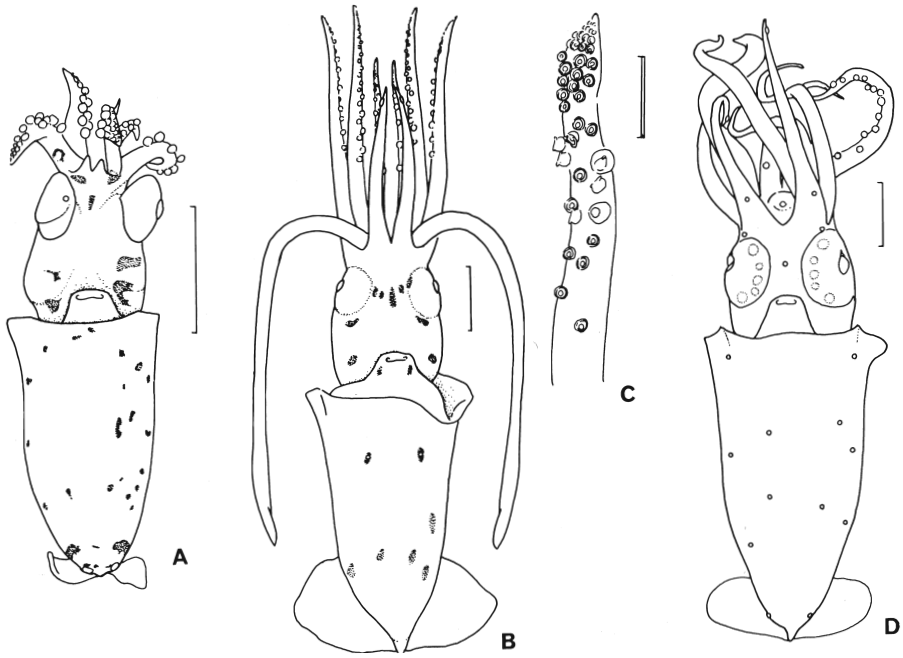

Fig. 9. *Abralia astrosticta* and *Watasenia scintillans*. (A). *Abralia astrosticta*. Ventral view of a 2.5 mm ML specimen from *Mizuho-Maru* St. 65 (1988). (B)-(D). *Watasenia scintillans*. (B): Ventral view of a 4.5 mm ML specimen from *Mizunagi* St. 36 (1988). (C): Left tentacular club of the same. (D): Ventral view of a 5.2 mm ML specimen from *Mizunagi* St. 11 (1987). [Scale: single bar=1 mm; double bar=0.5 mm]

almost unrecognizable.

The development of subocular photophores is rather slower in *Watasenia* than the other genera. Two or three photophores are prominent about 6 mm ML in *W. scintillans*, while located at about 2 to 2.3 mm in other species.

Family **Onychoteuthidae**

Onychoteuthis sp.

(Fig. 11. A)

Observation: A single specimen of 3.5 mm ML is available in the present material. The mantle is muscular, conico-cylindrical, terminating posteriorly to the acute end solidified by the gladius. Arms are short and robust with biserial suckers, and the formula is II, I, III, IV. The tentacle is also short and robust with the club bearing quadriserial suckers.

On the mid-dorsal mantle, five chromatophores are arranged in a longitudinal row. There are seven chromatophores on the anteroventral margin of the mantle. At the middle of the ventral mantle, there are 20 crowded chromatophores. A pair of large

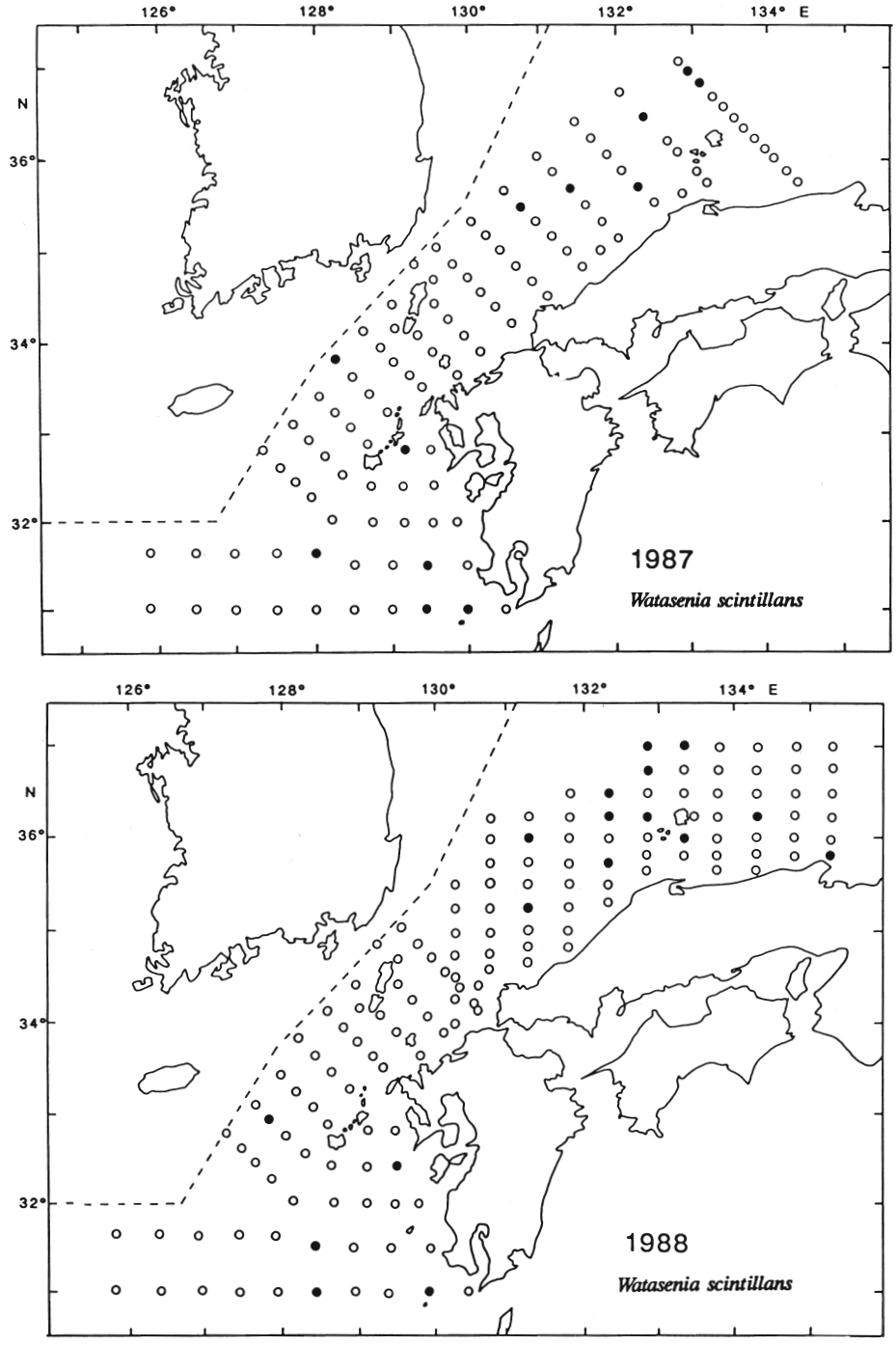

Fig. 10. Distribution of paralarvae of *Watasenia scintillans*. Solid circles indicate positive stations.

chromatophores is situated on the lateral side of the posterior mantle. On the dorsal head, seven large chromatophores are present. A pair of chromatophores is situated on the outer side of proximal Arm IV.

Occurrence: A single specimen from *Mizuho-Maru* St. 65 (1988).

Remarks: From the Japanese waters, one nominal species belonging to the genus *Onychoteuthis* is known, namely, *O. borealijaponica*. OKUTANI (1968) and OKUTANI and MCGOWAN (1969) described paralarvae of *O. borealijaponica* under the name of *O. banksi* (YOUNG, 1972). Compared to Okutani's paralarvae, our specimen differs in the chromatophore arrangement of the mantle, and may not be *O. borealijaponica*. The present paralarva is identifiable to be *Onychoteuthis* sp. B of YOUNG & HARMAN (1987).

Onykia sp.
(Fig. 11. B)

Observation: The mantle is globular with the posterior end solidified by the endcone of the gladius. The fins are paddle-shaped. The arms are very short and robust with biserial suckers. The arm formula is II, I, III, IV. The tentacle is also short and robust with quadriserial suckers on the club.

Nine large chromatophores are present on the mid-dorsal mantle. Three pairs of small chromatophores are arranged on the lateral side of the above-mentioned row. There are 25 crowded chromatophores on the anteroventral mantle. A pair of large chromatophores is present on the lateral side of the posterior mantle. On the dorsal head, 17 large chromatophores are arranged symmetrically. The ventral head, arms and tentacles are all devoid of chromatophores.

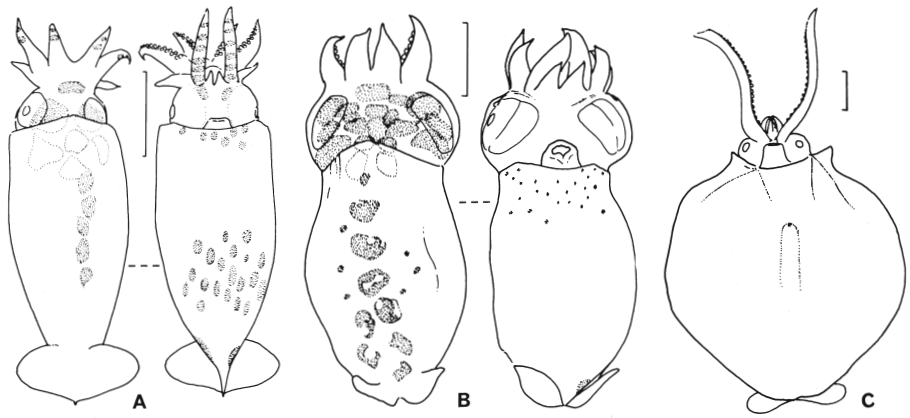

Fig. 11. *Onychoteuthis* sp., *Onykia* sp. and *Liocranchia reinhardti*. (A): *Onychoteuthis* sp. Dorsal and ventral views of a 3.5 mm ML specimen from *Mizuho-Maru* St. 65 (1988). (B): *Onykia* sp. Dorsal and ventral views of a 3.5 mm ML specimen from *Mizuho-Maru* St. 64 (1988). (C): *Liocranchia reinhardti*. Ventral view of a 6.0 mm ML specimen from *Mizuho-Maru* St. 29 (1987). [Scale bar: 1 mm]

Occurrence: A single specimen from *Mizuho-Maru* St. 64 (1988).

Remarks: *Onykia* species is one of the commonest paralarvae in the surface sample of warm temperate to tropical waters. Recently, it has been reported that the genus *Onykia* represents a juvenile form of the genus *Moroteuthis* (TSUCHIYA & OKUTANI, in press). Two species of *Moroteuthis* are known in the Northwest Pacific, namely, *M. robusta* and *M. loennbergi*. However, ecological information that might be useful for identification of their paralarvae is very scarce.

The present specimen is different from similar sized specimens described by YAMAMOTO & OKUTANI (1975, Fig. 13b) in respect to the chromatophore arrangement. Our specimen has a smaller number of chromatophores on the dorsal mantle (15 versus 27 in YAMAMOTO and OKUTANI's). In contrast, chromatophores on the dorsal head are larger in number (17 versus 5). Their specimen has chromatophores on the arms. The observed smaller number of chromatophores may mean that our specimen represents an earlier stage of development, and thus the smaller number of chromatophores in the same size suggest that the animal grows larger in the adult stage.

Family **Cranchiidae**

Liocranchia reinhardti (STEENSTRUP, 1856)

(Fig. 11. C)

Observation: The mantle is thin and spherical with an acute posterior end. At the mantle-funnel fusions, inverted V-shaped cartilageous ridges are present. The tentacle is long with four rows of suckers on almost the entire oral surface. There are three to four photophores on the eyeball.

Occurrence: A single specimen from *Mizuho-Maru* St. 29 (1987).

Remarks: This paralarva is characterized and distinguished from other genera of Cranchiidae by the presence of inverted V-shaped cartilageous ridges.

Family **Octopodidae**

Octopodidae spp. paralarvae

(Figs. 12. A–C, 13)

Occurrence: 181 specimens from 83 stations (Fig. 13).

Remarks: YOUNG, HARMAN and HOCHBERG (1989) studied octopodid paralarvae in the Hawaiian waters and classified them into eleven types based on the chromatophore pattern.

There are several types of octopodid paralarvae in the present material. However, it is difficult to classify them because of the discoloration of chromatophores. Several types of paralarvae are presented for illustration only (Fig. 12. A–C).

In the Japanese waters, at least 39 species are known, but the paralarvae are known for only few species, and no criteria have been established to identify the paralarvae from the planktonic sample (OKUTANI, 1984, 1985).

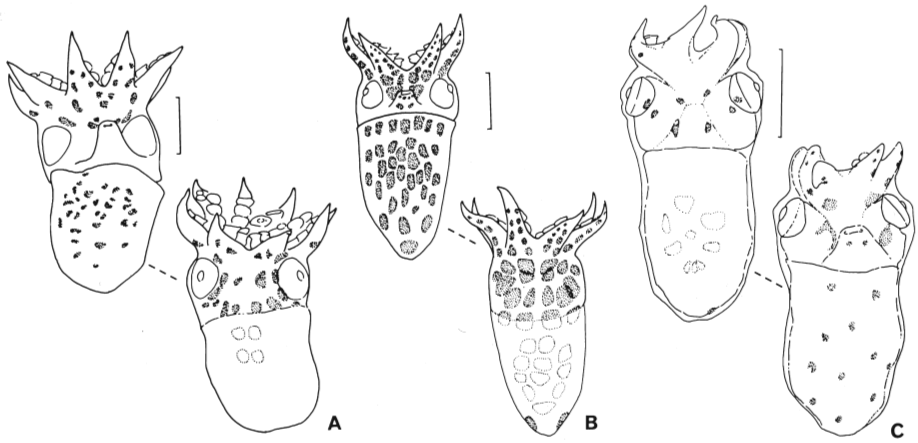

Fig. 12. Unidentified octopodid paralarvae. Dorsal and ventral views. (A): 2.2 mm ML specimen from *Mizuho-Maru* St. 27 (1987). (B): 2.7 mm ML specimen from *Mizunagi* St. 54 (1988). (C): 1. 9 mm ML specimen from *Mizuho-Maru* St. 43 (1988). [Scale bar: 1 mm.]

Family **Tremoctopodidae**

Tremoctopus violaceus gracialis (EYDOUX & SOULEYET, 1852)

(Fig. 14. A)

Observation: The mantle is globular with a thin and tight integument. The arms are short and unequal in length. Arm I is distinctly long with a distinctly large sucker.

Occurrence: Two specimens from *Mizuho-Maru* St. 4 and St. 12 (1987).

Remarks: The paralarvae of this species is characterized by an elongate Arm I with an extra-large sucker. The hatchling of this species is about 1 mm ML (NAEF, 1923; HAMABE, 1973).

Family **Argonautidae**

Argonauta sp.

(Figs. 14B, 15)

Observation: The mantle is conical to globular. The integument of the mantle is thick, weak and gelatinous. The arm is short and subequal in length, while Arm I is slightly longer than the others, and it is covered in half its length by a thick gelatinous epidermis. In the male, left Arm III is hectocotylized at about 1 mm ML. The hectocotylized arm is elongate and curled orally and ensheathed in a spherical tunic.

Occurrence: 209 specimens from 48 stations (Fig. 15).

Remarks: This species is characterized by a short conical mantle, subequal arms, and hectocotylization of the left Arm III in males larger than 1 mm ML. The embryonic development and paralarvae of *Argonauta argo* were described by NAEF (1923). The paralarvae of the present species is separable from those of octopodid species under study by the presence of marginal chromatophores along the ventral margin of the mantle.

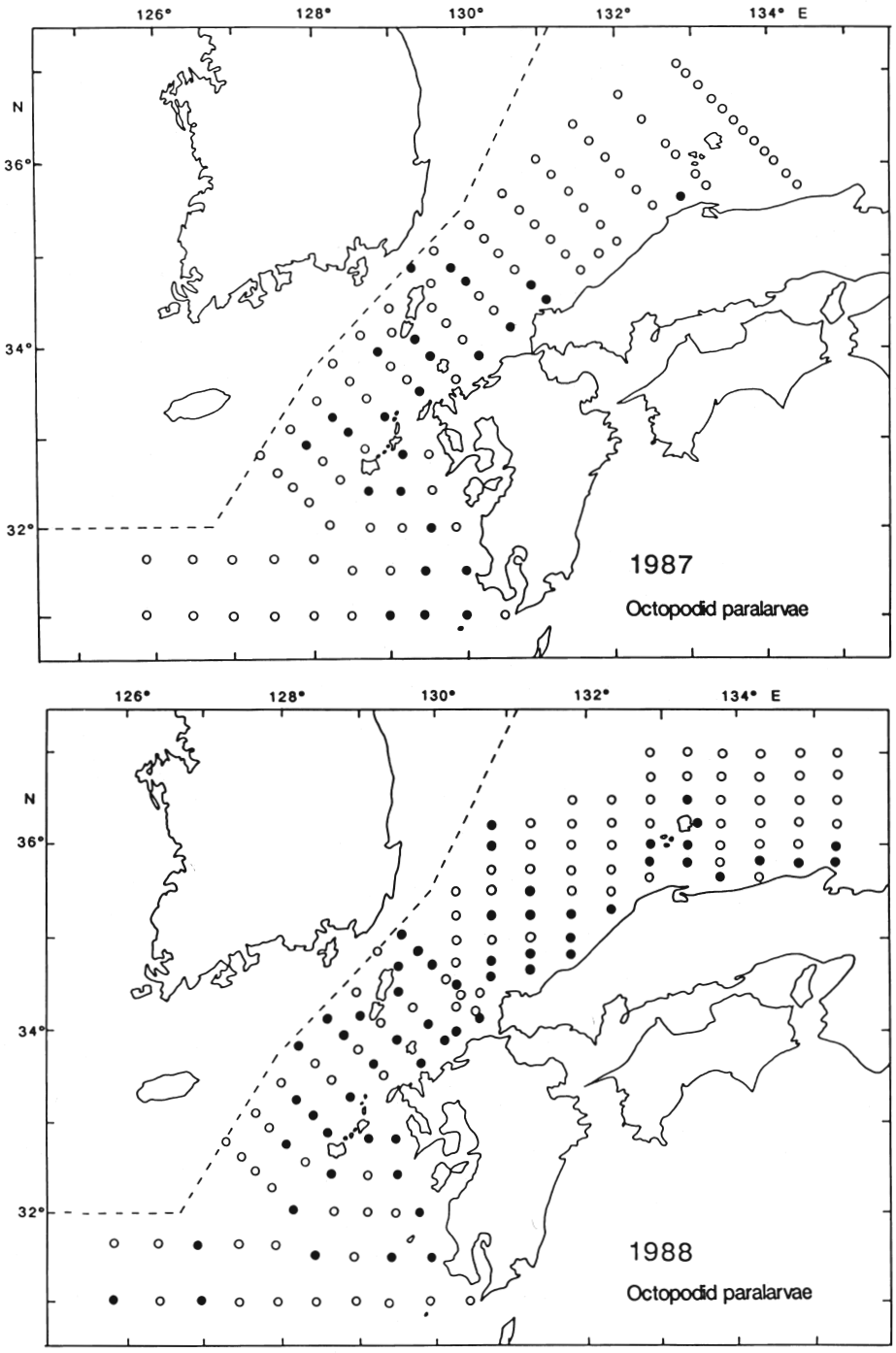

Fig. 13. Distribution of unidentified octopodid paralarvae. Solid circles indicate positive stations.

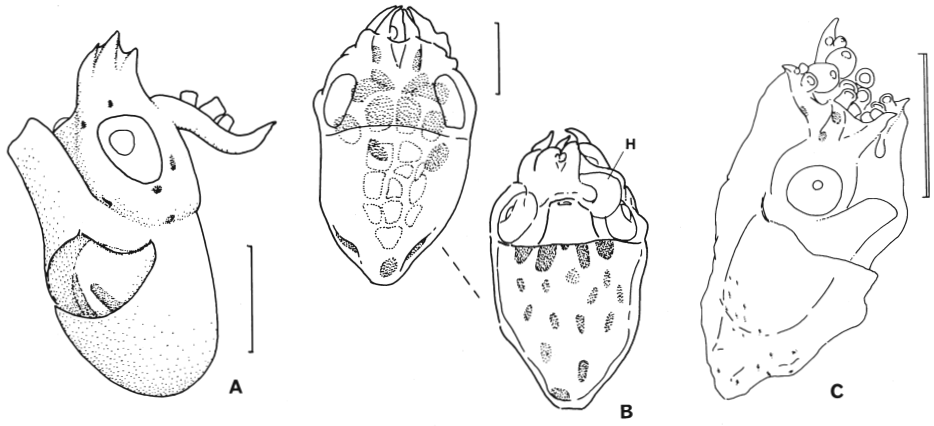

Fig. 14. *Tremoctopus violaceus gracialis. Argonauta* sp. and *Alloposus mollis*. (A): *Tremoctopus violaceus gracialis*. Lateral view of a 1.2 mm ML specimen from *Mizuho-Maru* St. 4 (1987). (B): *Argonauta* sp. Dorsal and ventral views of a 2.8 mm ML specimen from *Mizuho-Maru* St. 8 (1988). H indicates the ensheathed hectocotylus. (C): *Alloposus mollis*, Lateral view of a 2.1 mm ML specimen from *Mizunagi* St. 36 (1988). [Scale: single bar=1 mm; double bar=0.5 mm.]

From the Japan Sea, another species of *Argonauta* have been also recorded, namely, *A. hians* (NISHIMURA, 1968; HONMA et al., 1983), from which it is impossible to separate species during such a small size range.

Family **Alloposidae**

? Alloposus mollis VERRILL, 1880

(Fig. 14. C)

Observation: The whole body surface is covered by a thick and gelatinous integument. The mantle is short and conical. The funnel is large but weak. The head is hemispherical with large eyes. The optic lobe and cephalic pillar are clearly visible through the skin. Arm I is distinctly long with an extra-large globular sucker. The interbrachial web is deep except between both Arm I limbs. The small chromatophores are scattered on the dorsal mantle.

Occurrence: A single specimen from *Mizunagi* St. 36 (1988).

Remarks: The paralarvae of *Alloposus mollis* was illustrated by only NESIS (1979). This paralarva is characterized by a thick gelatinous integument and long Arm I with an extremely large sucker, and it is separable from those of the genera *Argonauta, Ocythoe* and *Tremoctopus* by the pronounced development of the gelatinous integument (NESIS, 1979).

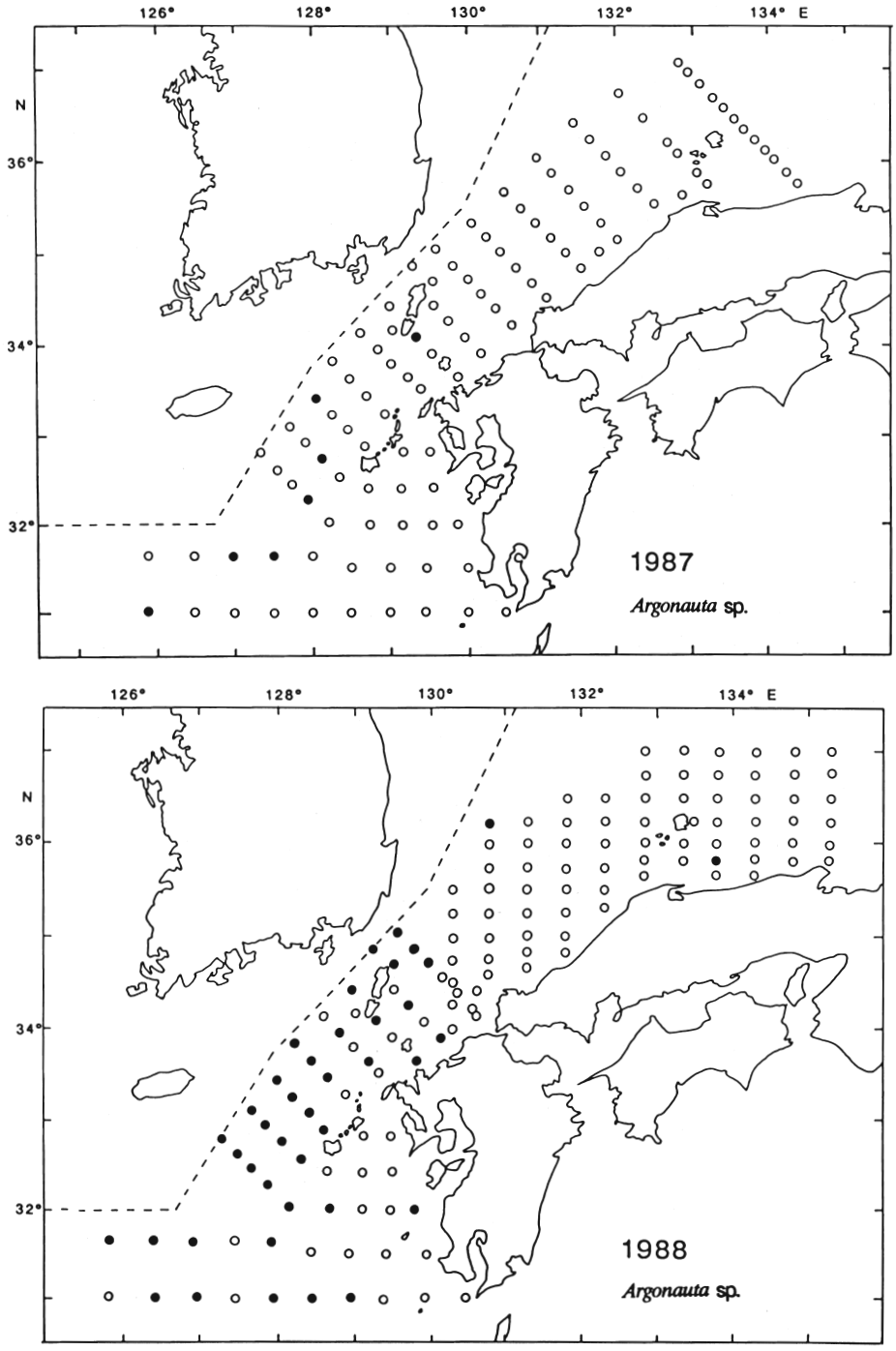

Fig. 15. Distribution of *Argonauta* sp. Solid circles indicate positive stations.

Remarks on distribution

The major species which were collected in this study may be divisible into two types according to the distribution patterns.

The first group is the species widely distributed in the whole study area: *Sepiola birostrata, Enoploteuthis chuni* and *Watasenia scintillans*. They are suboceanic or neritic species that are mostly endemic to the Japanese waters.

In contrast, those of the second group are distributed mainly in the south of the Tsushima Strait or the northern sector of the East China Sea: *Abralia andamanica, Abralia multihamata* and *Argonauta* sp. These species are distributed in warm oceanic waters to the tropical Indo-Pacific.

In the west off Kyushu, some species that are distributed mainly in the warm temperate or tropical waters were sporadically collected, namely, *Onykia* sp., *Onychoteuthis* sp., and *Liocranchia reinhardti*. The former two are distributed mainly in the tropical waters in juvenile stages but usual extend their habitat into the cool temperate waters as they growth.

Abralia astrosticta was originally described from the Hawaiian waters (BERRY, 1909), but it is distributed throughout the oceanic waters of tropical Pacific including the Kuroshio region (NESIS, 1982).

Tremoctopus violaceus gracialis is a tropical Indo-Pacific species, while this octopod has occasionally appeared in the Japan Sea (NISHIMURA, 1968).

Alloposus mollis is a cosmopolitan octopod in the oceanic waters, and it also occasionally enters into the neritic waters of the Japan Sea (NISHIMURA, 1968).

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1987-1988年に西部日本海および北部東シナ海から採集された頭足類稚仔（アカイカ科を除く）：分類と分布

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西部日本海および北部東シナ海から採集された頭足類稚仔についての分類および分布に関する研究を行った．本研究に用いた材料は1987年および1988年の10月中旬から11月下旬にかけて日本海区水産研究所が2隻の調査船で行った80cmリングネット傾斜びき採集によって得られた標本から，アカイカ科を除く頭足類稚仔のみを選別したものである．標本個体数は1128個体でマダコ科を除く頭足類は8科13種であった．これらの稚仔について分類および分布の情報を整理した．ただし，マダコ科については十分な分類学的検討は行われなかった．これらのうち，ナンヨウホタルイカ *Abralia andamanica* は日本海から初めて記録された．

APPENDIX TABLE

Occurrence of cephalopod paralarvae by cruise and by station

Code for species name:

SB:	*Sepiola birostrara*	ON:	*Onychoteuthis* sp.
IP:	*Idiosepius paradoxus*	OK:	*Onykia* sp.
EC:	*Enoploteuthis chuni*	LR:	*Liocranchia reinhardti*
AM:	*Abralia multihamata*	OC:	Unidentified OCTOPODIDS
AA:	*Abralia andamanica*	TV:	*Tremoctopus violaceus gracialis*
AS:	*Abralia astrosticta*	AR:	*Argonauta* sp.
WS:	*Watasenia scintillans*	AL:	*Alloposus mollis*
EN:	Unidentified ENOPLOTEUTHIDS	OT:	Unidentified

Appendix I-1. 1987 *Mizunagi*

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
1	10/25	34°47.0′	134°24.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2		35°54.0′	134°14.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3		36°00.0′	134°06.0′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
4		36°07.0′	133°58.0′	–	–	1	–	–	–	–	2	–	–	–	–	–	–	–	–
5		36°13.8′	133°50.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6		36°20.7′	133°41.3′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7		36°27.9′	133°32.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8		36°35.6′	133°24.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	10/26	36°42.2′	133°15.3′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10		36°49.0′	133°06.1′	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
11		36°55.1′	132°58.1′	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
12		37°02.2′	132°48.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
13		36°43.1′	132°05.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14		36°30.0′	132°22.2′	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
15		36°16.0′	132°40.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16		36°09.1′	132°48.0′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
17		35°54.0′	133°06.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18		35°46.0′	133°16.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19		35°40.1′	132°53.3′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
20		35°33.8′	132°28.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21		35°44.0′	132°16.5′	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
22	10/27	35°54.0′	132°04.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23		36°04.1′	131°50.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
24		36°14.0′	131°38.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25		36°23.7′	131°25.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26	10/28	36°04.0′	130°58.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
27		35°54.0′	131°11.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
28		35°44.0′	131°24.0′	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–
29		35°33.1′	131°36.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
30		35°22.4′	131°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
31		35°12.4′	132°04.4′	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
32		35°01.0′	131°51.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
33		34°50.0′	131°37.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
34		35°01.0′	131°24.9′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
35		35°11.8′	131°12.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
36		35°21.9′	131°00.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Appendix I-2. 1987 *Mizunagi* (continued)

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
37		35°31.6′	130°48.2′	–	–	–	–	–	–	1	1	–	–	–	–	–	–	–	–
38		35°41.5′	130°34.5′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
39	10/29	35°23.0′	130°10.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
40		35°12.3′	130°20.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
41		35°02.0′	130°34.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
42		34°51.3′	130°47.9′	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–
43		34°41.4′	130°59.6′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
44		34°34.1′	131°08.6′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–

Appendix II-1. 1987 *Mizuho-Maru.*

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
1	10/23	34°16.1′	130°30.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2		34°23.8′	130°25.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3		34°35.9′	130°13.9′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
4		34°45.9′	130°00.0′	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–
5		34°55.0′	129°50.0′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
6	10/24	35°06.0′	129°36.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7		34°53.0′	129°22.0′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
8		34°42.8′	129°39.5′	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9		34°27.9′	129°34.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10		34°16.9′	129°46.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11		34°07.0′	129°58.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
12		33°57.0′	130°10.9′	–	–	–	–	–	–	–	–	–	–	–	2	1	–	–	–
13		33°43.0′	130°00.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
14		33°57.8′	129°37.9′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
15		34°07.0′	129°26.0′	2	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
16	10/25	34°10.2′	129°04.0′	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
17		34°25.6′	129°00.4′	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–
18		34°08.1′	128°40.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19		33°58.0′	128°51.1′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
20		33°48.0′	129°03.8′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
21		33°39.1′	129°15.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22		33°32.3′	129°24.4′	1	1	–	–	–	–	–	–	–	–	–	2	–	–	–	–
23	10/28	33°17.0′	128°56.2′	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–
24		33°27.9′	128°46.0′	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
25		33°38.0′	128°32.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
26		33°50.1′	128°20.0′	–	–	2	–	3	–	1	–	–	–	–	–	–	–	–	–
27	10/29	33°26.7′	128°04.7′	1	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–
28		33°15.9′	128°16.3′	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
29		33°05.9′	128°29.8′	–	–	–	–	1	–	–	–	–	–	1	4	–	–	–	–
30		32°55.9′	128°41.9′	1	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–
31		32°36.0′	128°20.0′	–	–	–	–	–	–	–	6	–	–	–	–	–	–	–	–
32		32°47.1′	128°06.8′	–	–	–	–	–	?1	–	2	–	–	–	–	–	1	–	–
33		32°58.0′	127°55.0′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
34		33°07.6′	127°42.3′	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
35		32°50.0′	127°22.0′	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–
36		32°40.1′	127°34.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
37		32°30.1′	127°46.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–

Appendix II-2. 1987 *Mizuho-Maru* (continued)

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
38	10/30	32°20.0′	128°00.0′	–	–	–	2	6	–	–	13	–	–	–	–	–	1	–	–
39		32°00.0′	128°05.1′	–	–	2	–	–	–	–	4	–	–	–	–	–	–	–	–
40		32°00.0′	128°44.9′	–	–	1	–	–	–	–	6	–	–	–	–	–	–	–	–
41		32°00.0′	129°10.0′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
42		32°00.0′	129°35.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
43		32°00.3′	129°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
44		32°24.8′	129°34.9′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
45		32°24.9′	129°10.0′	–	–	1	–	–	–	–	1	–	–	–	4	–	–	–	–
46		32°24.9′	128°45.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
47	10/31	32°49.8′	129°14.9′	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–
48		32°49.7′	129°29.5′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
49	11/4	31°29.9′	130°00.0′	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
50		31°29.6′	129°29.8′	–	–	–	–	–	–	2	–	–	–	–	1	–	–	–	–
51	11/6	31°29.8′	129°00.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
52		31°30.3′	128°30.2′	–	–	–	–	1	–	–	10	–	–	–	–	–	–	–	–
53		31°40.0′	127°30.0′	–	–	1	–	1	–	1	–	–	–	–	–	–	–	–	–
54		31°40.0′	127°30.0′	1	–	–	–	–	–	–	1	–	–	–	–	–	2	–	–
55		31°40.1′	126°59.3′	4	–	–	–	–	–	–	3	–	–	–	–	–	2	–	–
56		31°39.9′	126°29.9′	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
57		31°39.9′	125°55.0′	1	–	–	2	1	–	–	2	–	–	–	–	–	–	–	–
58		31°00.2′	125°56.9′	4	–	–	1	–	–	–	4	–	–	–	–	–	–	–	–
59	11/7	31°00.4′	126°29.9′	–	–	–	2	–	–	–	32	–	–	–	–	–	?1	–	–
60		31°00.0′	126°59.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
61		31°00.0′	127°30.6′	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
62		31°00.0′	128°00.0′	–	–	1	–	–	–	–	26	–	–	–	1	–	–	–	–
63		31°00.0′	128°29.9′	–	–	–	–	–	–	–	33	–	–	–	–	–	–	–	–
64		30°59.8′	129°00.0′	–	–	3	–	–	–	–	3	–	–	–	1	–	1	–	–
65		31°00.0′	129°30.0′	–	–	–	–	–	–	1	3	–	–	–	1	–	–	–	–
66		30°59.2′	130°00.0′	–	–	–	–	–	–	6	–	–	–	–	1	–	–	–	–
67		31°00.5′	130°30.3′	–	–	–	–	2	–	–	2	–	–	–	–	–	–	–	–

Appendix III-1. 1988 *Mizunagi*.

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
1	10/16	35°50.0′	135°20.0′	–	–	1	–	–	–	1	–	–	–	–	1	–	–	–	–
2	10/17	35°59.9′	135°20.0′	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
3		36°15.0′	135°20.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4		36°30.3′	135°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
5		36°45.0′	135°20.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6		37°00.0′	135°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7		37°00.0′	134°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
8		36°45.3′	134°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
9		36°30.1′	134°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10		36°15.2′	134°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
11		35°59.9′	134°50.0′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
12		35°50.1′	134°50.1′	1	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
13		35°40.1′	134°19.9′	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
14		35°50.0′	134°20.0′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
15	10/18	35°59.9′	134°20.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Appendix III-2. 1988 *Mizunagi*.

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
16		36°14.8′	134°20.1′	–	–	1	–	–	–	1	–	–	–	–	1	–	–	–	–
17		36°30.0′	134°20.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18		36°45.0′	134°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
19		37°00.0′	134°20.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20		37°00.0′	133°50.0′	1	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–
21		36°45.0′	133°50.0′	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–
22		36°30.2′	133°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
23		36°15.1′	133°50.0′	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
24		36°00.0′	133°50.0′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
25		35°50.0′	133°50.1′	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
26		35°40.0′	133°50.0′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
27		35°45.1′	133°19.9′	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
28	10/19	35°59.8′	133°20.1′	–	–	3	–	–	–	3	–	–	–	–	4	–	–	–	–
29		36°15.0′	133°29.7′	–	–	2	–	–	–	–	–	–	–	–	1	–	–	–	–
30		36°29.9′	133°20.1′	–	–	6	–	–	–	–	4	–	–	–	1	–	–	–	–
31		36°45.0′	133°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
32		37°00.0′	133°20.0′	–	–	1	–	–	–	3	–	–	–	–	–	–	–	–	–
33		37°00.0′	132°49.8′	–	–	4	–	–	–	3	–	–	–	–	–	–	–	–	–
34		36°45.2′	132°50.0′	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
35		36°30.2′	132°50.1′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
36		36°15.2′	132°50.1′	–	–	–	–	–	–	3	–	–	–	–	–	–	–	1	–
37		36°00.2′	132°50.1′	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–
38		35°50.0′	132°50.0′	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
39		35°40.0′	132°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
40		35°20.1′	132°19.9′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
41	10/20	35°29.9′	132°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
42		35°44.9	132°20.1′	–	–	1	1	–	–	2	–	–	–	–	–	–	–	–	–
43		35°59.9′	132°20.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
44		36°15.0′	132°20.0′	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–
45		36°30.0′	132°20.0′	–	–	–	–	–	–	1	3	–	–	–	–	–	–	–	–
46		36°30.0′	131°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
47		36°15.0′	131°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
48		36°00.2′	131°50.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
49		35°45.2′	131°50.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
50		35°30.3′	131°50.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
51		35°15.1′	131°50.0′	–	–	2	–	–	–	–	–	–	–	–	2	–	–	–	–
52		35°00.0′	131°50.0′	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
53		34°50.0′	131°49.6′	–	–	–	1	–	–	–	–	–	–	–	8	–	–	–	–
54	10/22	34°40.0′	131°20.0′	–	–	–	–	–	–	–	–	–	–	–	4	2	–	–	–
55		34°50.1′	131°20.0′	1	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–
56		35°00.0′	131°19.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
57		35°15.1′	131°20.0′	–	–	–	–	1	–	2	11	–	–	–	2	–	–	–	–
58	10/23	35°29.9′	131°20.0′	–	–	–	–	1	–	–	2	–	–	–	1	–	–	–	–
59		35°44.8′	131°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
60		36°00.0′	131°20.1′	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
61		36°15.0′	131°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
62		36°15.1′	130°50.0′	–	–	–	–	–	–	–	5	–	–	–	1	–	1	–	–
63		36°00.1′	130°50.0′	–	–	–	–	–	–	–	17	–	–	–	–	–	–	–	1
64		35°45.2′	130°50.0′	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–

Appendix III-3. 1988 *Mizunagi* (continued).

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
65		35°30.2′	130°50.1′	–	–	–	–	2	–	–	3	–	–	–	–	–	–	–	–
66		35°15.3′	130°50.0′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
67		35°00.1′	130°50.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
68		34°45.1′	130°50.0′	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–	–
69		34°34.9′	130°50.1′	–	–	–	–	1	–	–	1	–	–	–	1	–	–	–	–
70		34°25.1′	130°40.1′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
71		34°10.1′	130°40.0′	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–
72	10/24	34°00.1′	130°20.1′	–	–	–	–	1	–	–	–	–	–	–	34	–	–	–	–
73		34°14.9′	130°20.1′	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
74		34°29.9′	130°20.1′	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–
75		34°45.0′	130°20.0′	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–
76		35°00.0′	130°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
77		35°10.0′	130°20.0′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
78		35°29.8′	130°20.1′	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–

Appendix IV-1. 1988 *Mizuho-Maru*.

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
1	10/23	34°16.8′	130°36.7′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
2		34°24.9′	130°25.8′	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–
3		34°36.4′	130°13.2′	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
4		34°46.5′	129°59.9′	1	–	1	–	–	–	–	–	–	–	–	1	–	1	–	–
5		34°55.4′	129°49.2′	–	–	–	–	1	–	–	2	–	–	–	1	–	1	–	–
6	10/24	35°06.0′	129°35.8′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
7		34°53.6′	129°21.0′	–	–	–	–	–	–	–	5	–	–	–	–	–	1	–	–
8		34°43.3′	129°39.2′	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–
9		34°28.5′	129°33.8′	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
10		34°16.7′	129°45.2′	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
11		34°07.0′	129°57.5′	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	–
12		33°57.3′	130°10.5′	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	–
13		33°43.9′	129°57.3′	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–
14		33°59.1′	129°39.7′	–	–	–	–	–	–	–	1	–	–	–	3	–	–	–	–
15		34°08.2	129°28.0′	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–
16		34°10.2′	129°04.0′	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
17	10/25	34°25.7′	129°00.1′	–	–	3	–	1	–	–	60	–	–	–	–	–	1	–	–
18		34°09.7′	128°40.4′	2	–	–	–	1	–	–	–	–	–	–	3	–	–	–	–
19		33°58.0′	128°51.0′	2	–	–	?1	–	–	–	–	–	–	–	1	–	1	–	–
20		33°48.5′	129°03.8′	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–
21		33°39.3′	129°15.8′	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–
22		33°31.9′	129°23.8′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
23		33°17.4′	128°56.2′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
24		33°28.3′	128°45.5′	–	–	–	–	–	–	–	1	–	–	–	–	–	2	–	–
25		33°38.3′	128°32.6′	–	–	–	–	1	–	–	85	–	–	–	–	–	13	–	–
26		33°50.5′	128°20.0′	–	–	1	–	–	–	–	4	–	–	–	2	–	24	–	–
27		33°27.5′	128°04.1′	–	–	–	–	–	–	–	3	–	–	–	–	–	1	–	–
28		33°16.4′	128°15.7′	–	–	5	–	–	–	–	1	–	–	–	2	–	4	–	–
29	10/26	33°06.8′	128°29.3′	–	–	–	–	–	–	–	1	–	–	–	3	–	2	–	–
30		32°56.8′	128°41.5′	–	–	–	–	1	–	–	–	–	–	–	4	–	1	–	2
31	10/30	32°37.0′	128°20.0′	–	–	3	–	1	–	–	–	–	–	–	–	–	9	–	–

Appendix IV-2. 1988 *Mizuho-Maru* (continued).

St.	date	Lat. (N)	long. (E)	SB	IP	EC	AM	AA	AS	WS	EN	ON	OK	LR	OC	TV	AR	AL	OT
32	10/31	32°47.2′	128°06.8′	–	–	–	–	–	–	–	1	–	–	–	1	–	1	–	–
33		32°58.2′	127°54.5′	–	–	–	–	1	–	1	3	–	–	–	–	–	5	–	–
34		33°08.5′	127°41.8′	–	–	1	–	–	–	–	–	–	–	–	–	–	3	–	–
35		32°51.3′	127°21.5′	–	–	–	–	–	–	–	2	–	–	–	–	–	14	–	–
36		32°40.1′	127°33.5′	–	–	2	–	–	–	–	6	–	–	–	–	–	12	–	–
37		32°30.2′	127°45.7′	1	–	–	–	–	–	–	–	–	–	–	–	–	22	–	–
38		32°20.6′	127°59.6′	–	–	1	–	–	–	–	4	–	–	–	–	–	31	–	–
39		32°00.8′	128°03.9′	–	–	1	–	1	–	–	4	–	–	–	1	–	6	–	–
40	11/7	32°00.0′	128°44.9′	–	–	1	–	–	–	–	7	–	–	–	–	–	3	–	–
41		32°00.5′	129°09.1′	–	–	1	–	1	–	–	4	–	–	–	–	–	2	–	–
42		32°00.6′	129°35.0′	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–
43		32°00.6′	129°50.0′	–	–	–	–	–	–	–	–	–	–	–	2	–	1	–	–
44	10/26	32°25.6′	129°34.7′	–	–	–	–	–	–	1	5	–	–	–	1	–	–	–	–
45		32°24.7′	129°09.5′	–	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–
46		32°25.7′	128°44.5′	–	–	1	–	1	–	–	7	–	–	–	3	–	–	–	–
47		32°50.3′	129°15.7′	–	–	2	–	1	–	–	–	–	–	–	3	–	–	–	–
48		32°50.3′	129°29.6′	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
49	11/6	31°30.7′	130°00.4′	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–
50		31°31.5′	129°29.6′	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–
51		31°33.0′	128°57.9′	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
52		31°31.3′	128°29.3′	–	–	–	–	–	–	1	3	–	–	–	–	–	4	–	–
53	10/31	31°40.6′	127°58.9′	–	–	2	–	1	–	–	4	–	–	–	–	–	4	–	–
54		31°40.6′	127°29.4′	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
55		31°40.4′	126°59.7′	–	–	–	–	–	–	–	2	–	–	–	1	–	1	–	–
56	11/1	31°40.1′	126°29.3′	–	–	–	–	–	–	–	–	–	–	–	–	–	12	–	–
57		31°40.7′	125°54.6′	–	–	–	1	–	–	–	3	–	–	–	–	–	17	–	–
58		31°00.4′	125°53.7′	4	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–
59		31°00.4′	126°29.5′	5	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–
60		30°59.4′	126°58.7′	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–
61		30°59.5′	127°28.9′	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–
62		31°00.7′	127°59.7′	–	–	–	–	–	–	–	7	–	–	–	–	–	1	–	–
63		31°00.2′	128°28.9′	–	–	2	–	–	–	1	2	–	–	–	–	–	1	–	–
64	11/2	31°00.3′	128°59.0′	–	–	–	–	1	–	–	–	–	1	–	–	–	2	–	–
65		31°00.6′	129°29.5′	–	–	2	–	–	1	–	3	1	–	–	1	–	–	–	–
66		31°00.2′	129°59.3′	–	–	1	–	–	–	1	9	–	–	–	–	–	–	–	–
67		31°00.8′	130°29.7′	–	–	1	–	2	–	–	4	–	–	–	–	–	–	–	–