Occurrence of Brachyuran Larvae in the Surf Zone of Fukiage Beach, Kagoshima Prefecture, Japan

I. Families Grapsidae and Ocypodidae

MOHAMAD ISMID, HIROSHI SUZUKI and TOSHIO SAISHO
Laboratory of Marine Biology, Faculty of Fisheries, Kagoshima University

Abstract


This paper deals with brachyuran larvae of the families Grapsidae and Ocypodidae collected from the surf zone of Fukiage beach, Kagoshima Prefecture. Descriptions are given of zoea I-II of Hemigrapsus sanguineus, zoea I of Sesarminae sp., zoea I-IV of Scopimera globosa, zoea I-IV of Ilyoplax pusilla, and zoea I of Macrophthalmus sp. Seasonal abundance of these zoeae throughout the 18-month study period showed high concentrations during the summer months (June to August) followed by a steady decline in autumn. The occurrences of successive intermediate zoeal stages of S. globosa and I. pusilla suggest that the surf zone is a part of nursery ground for the larvae of these two species.

Introduction

Studies dealing with the ecology of brachyuran larvae have been conducted in various aquatic habitat ranging from rivers or estuaries (BOICOURT, 1982; CRONIN, 1982; LAMBERT & EPIFANIO, 1982; EPIFANIO, 1987; PAULA, 1989) to coastal bays and offshore waters (BROOKINS & EPIFANIO, 1985; JOHNSON, 1985; LINDLEY, 1986; SHANKS, 1986; DITTEL & EPIFANIO, 1982). However, the occurrence of the larvae in beach areas and surf zones have so far been neglected.

Most of the previous studies regarding the surf zone focused mainly on benthic fauna (ANSELL et al., 1972; MCLACHLAN et al., 1979; DEXTER, 1989), ecology of fish larvae (SENTA &
HIRAI, 1981; LASIAK, 1981; SENTA & KINOSHITA, 1983, 1985; BENNET, 1989; KINOSHITA & FUJITA, 1988; WHITFIELD, 1989) and ecology of Mysidacea (WOOLDRIDGE, 1981; COCKCROFT et al., 1988). As many brachyuran species inhabit sandy beaches and adjacent waters along the beach line, the role of the surf zone in the ecological study of brachyuran larvae should also be included.

This paper presents descriptions of larvae as well as discusses larval occurrences of the families Grapsidae and Ocypodidae collected from Fukiage Beach in Kagoshima Prefecture, Japan.

Materials and Methods

Samplings were conducted monthly from June 1990 to December 1991 in the surf zone of Fukiage Beach, Kagoshima Prefecture (Fig. 1). Larval collections were made by the use of 2 small size plankton nets (aperture 10cm X 20cm; mesh size 300 μ) positioned vertically at surface and bottom of the water column. The bottom net was fixed on sledges and stainless plate to prevent clogging, while a small buoy was attached to the surface net to maintain its vertical position. These nets were towed along a distance of 20m parallel to the shore line at 3 stations located near the estuary of Izaku River. Samplings were conducted during low tide and high tide at depths not exceeding 1.5m. Collected larvae were first fixed in 5% formalin with sea water, and then transferred into 70% ethanol.

The larval counts were converted to number of larvae per cubic meter based on the towing distance and aperture size of the nets. Drawings and measurements were made with the aid of a drawing apparatus and ocular micrometer. The length of zoea (T.T) were taken from tip of the rostral spine to tip of the dorsal spine; the length of dorsal spine (D.L), from a transverse line across distal extremities of carapace to tip of the spine; and the length of rostral spine (R.L), from tip of the rostrum to anterior border of the ocular eave.

Descriptions

All larval assignments are tentative and designated with a letter and number following the

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Fig. 1 Location of study area and sampling stations at Fukiage Beach (Solid circles indicate sampling stations).
Brachyuran larvae in the surf zone (I)

Fig. 2 *Hemigrapsus sanguineus*, (SZ-A1). (a) lateral view, zoea I; (b) abdomen and telson, zoea I; (c) antenna, zoea I; (d) lateral view, zoea II; (e) abdomen and telson, zoea II; (f) antenna, zoea II. All scale bars represent 0.1mm.

prefix "SZ" (for surf zone).

**Grapsidae**

Species SZ-A1, *Hemigrapsus sanguineus* DE HAAN, 1835 (Fig. 2)

Zoea I (Fig. 2a-c) and II (Fig. 2d-f)

Dimensions: Zoea I - T. T 0.76mm, D. L 0.20mm, R. L 0.25mm; Zoea II - T. T 0.80mm, D. L 0.22mm, R. L 0.28mm.

Carapace: Dorsal, rostral and lateral spines present, but indistinct. Dorsal spine slightly shorter than rostral spine.

Abdomen: 5 somites plus telson. Lateral knobs on somite 2 and 3.

Telson: Bifurcate, with a row of small spinules on inner border of furca. Inner arch of telson with 3 pairs of serrated setae separated by a median cleft.

Antenna: Tapered exopod about 1/2 of protopod and bearing a small medial seta. Protopod slightly shorter than carapace rostral spine.

The combination of having indistinct carapace spines, tapering antennal exopod and unarmed telson places SZ-A1 zoea in the Grapsidae. Rice (1980) categorized several grapsid genera relative to the presence of the lateral carapace spine. Among these genera, SZ-A1 zoea bears the closest resemblance to the genus *Hemigrapsus*. Accounts of this genus have been given by Aikawa (1929) and Kurata (1968). *Hemigrapsus zoea* are commonly known to have a tapering antennal exopod and indistinct...
carapace spines as observed in SZ-A1 zoea. Within this genus, SZ-A1 zoea closely resembles *Hemigrapsus sanguineus* described by Kurata (1968).

Species SZ-E2, Sesarminae sp. (Fig. 3)
Zoea I
Dimensions: T.T 0.60mm, D.L 0.13mm, R.L 0.14mm.
Carapace: Dorsal and rostral spines present, but indistinct. Lateral spine absent.
Abdomen: 5 somites plus telson. Small lateral knobs on somite 2 and 3.
Telson: Bifurcate. Telsonal furca slender and straight with a row of small spinules on inner border. 3 pairs of serrated setae on inner arch of telson separated by a median cleft.
Antenna: Exopod slightly less than 1/2 of protopod with 2 unequal terminal setae. Tapered protopod almost as long as carapace rostral spine and with 2 rows of spinules.

The absence of the carapace lateral spine and presence of 2 unequal terminal setae on the antennal exopod clearly indicate that this grapsid zoea belongs to the subfamily Sesarminae. Fukuda & Baba (1976), Terada (1976), and Muraoka (1979) have made notable accounts of the Sesarminae. Within Sesarminae, the genera recorded as lacking carapace lateral spine are Sesarma, Metasesarma, Aratus, and Chiromantes (Terada, 1976; Rice, 1980).

However, distinguishing characters among the larvae of these genera remains unknown. The distinguishable characters like the carapace spines, antenna and telson are still unclear, thus making it difficult to establish with certainty the generic placement of SZ-E2 within the Sesarminae.

**Ocypodidae**

Species SZ-C3, *Scopimera ?globosa* De Haan, 1835 (Figs. 4 and 5)
Zoea I (Fig. 4a-c), II (Fig. 4d-f), III (Fig. 5a-c), and IV (Fig. 5d-f)
Dimensions: Zoea I - T.T 1.91mm, D.L 0.63mm, R.L 0.93mm; Zoea II - T.T 2.20mm, D.L 0.70mm, R.L 1.02 mm; Zoea III - T.T 2.67mm, D.L 0.83mm, R.L 1.23mm; Zoea IV - T.T 2.92mm, D.L 0.94mm, R.L 1.27mm.
Carapace: Dorsal, rostral and lateral spines present. Dorsal and rostral spines long and well-developed, their length increasing continuously in successive stages.
Abdomen: Long and slender, with 5 somites plus telson in zoea I - III. Somites 2 and 3 with small lateral knobs. Biramous pleopod buds and somite 6 appeared in stage IV.
Telson: Bifurcate. Telsonal furca long, slender and armed with 1 dorsal spine. 3 pairs of serrated setae on inner arch of telson separated by a median cleft.
Antenna: Tapered and long protopod with small spinules on distal surface. Exopod absent. Endopod bud appearing in zoea IV at less than 1/4 of protopod.

Having well-developed, long dorsal and rostral spines, and lacking the antennal exopod strongly indicate that this zoea belongs to the subfamily Scopimerinae. The presence of the outer dorsal spine on the telsonal furca indicates...
Brachyuran larvae in the surf zone (I)

Fig. 4 Scopimera ?globosa, (SZ-C3). (a) lateral view, zoea I; (b) abdomen and telson, zoea I; (c) antenna, zoea I; (d) lateral view, zoea II; (e) abdomen and telson, zoea II; (f) antenna, zoea II. All scale bars represent 0.1mm.

Further its attribution to the genus Scopimera. Scopimera larvae as a whole are poorly known. Previous accounts of this genus are given of the first stage zoea of S. crabicauda Alcock, life history of S. globosa De Haan, and larval development of S. inflata H. Milne Edwards, by Rice (1976), Terada (1976), and Fielder & Greenwood (1985), respectively. SZ-C3 zoea bears close resemblance to S. globosa as described by Terada (1979). Further resemblance
Fig. 5 *Scopimera ?globosa*, (SZ-C3). (a) lateral view, zoea III; (b) abdomen and telson, zoea III; (c) antenna, zoea III; (d) lateral view, zoea IV; (e) abdomen and telson, zoea IV; (f) antenna, zoea IV. All scale bars represent 0.1mm.

is found in the successive stages on the appearance of the antennal endopod bud and the 6th abdominal somite in zoea IV.

Species SZ-B4, *Ilyoplax ?pusilla* De Haan, 1835 (Figs. 6 and 7)
Zoea I (Fig. 6a-c), II (Fig. 6d-f), III (Fig. 7a-c), and IV (Fig. 7d-f)
Brachyuran larvae in the surf zone (1)

Fig. 6 *Ilyoplax pusilla*, (SZ-B4). (a) lateral view, zoea I; (b) abdomen and telson, zoea I; (c) antenna, zoea I; (d) lateral view, zoea II; (e) abdomen and telson, zoea II; (f) antenna, zoea II. All scale bars represent 0.1mm.

Fig. 7 *Ilyoplax pusilla*, (SZ-B4). (a) lateral view, zoea III; (b) abdomen and telson, zoea III; (c) antenna, zoea III; (d) lateral view, zoea IV; (e) abdomen and telson, zoea IV; (f) antenna, zoea IV. All scale bars represent 0.1mm.
Dimensions: Zoea I - T.T 1.05mm, D.L 0.32mm, R.L 0.46mm; Zoea II - T.T 1.92mm, D.L 0.60mm, R.L 0.90 mm; Zoea III - T.T 2.91mm, D.L 0.95mm, R.L 1.30mm; Zoea IV - T.T 3.50mm, D.L 0.97mm, R.L 1.62mm.

Carapace: Dorsal, rostral and lateral spines present. Dorsal and rostral spines well-developed and distinctively long, length increasing in successive stages.

Abdomen: Long and slender with 5 somites in zoea I - III. Somite 6 separated from telson in zoea IV. Somites 2 and 3 with 2 lateral knobs. Biramous pleopod on somites 2-5 well-developed in zoea IV.

Telson: Bifurcate. Telsonal furca long and slender, size increasing continuously in successive stages. All stages bearing 3 pairs of serrated setae on inner arch of telson.

Antenna: Well-developed; long protopod with spinules and 2 small proximal seta. Exopod absent. Small endopod bud (about 1/4 of protopod) appeared in zoea IV.

As in SZ-C3 zoea, SZ-B4 zoea bears distinctive character of the subfamily Scopimerinae. With the absence of outer spine on the telson, this zoea appears closer to the genus Ilyoplax. Accounts of the Ilyoplax pusilla have been made by AIKAWA (1929), TERADA (1976), and MURAOKA (1980). Based on their descriptions, the antenna of SZ-B4 zoea are similar to those described by TERADA (1976) and MURAOKA (1980), in which 2 small proximal seta on the protopod were recorded. Although TERADA (1976) described the presence of a small outer lateral seta on the telsonal furca, MURAOKA (1980) described the telson unarmed as in SZ-B4 zoea.

Species SZ-N5, Macrophthalmus sp. (Fig. 8)

Zoea I.

Dimensions: T.T 0.48mm, D.L 0.08mm, R.L 0.13mm.

Carapace: Smooth, with small dorsal and rostral spines. Lateral spine absent.

Abdomen: 5 somites plus telson. Somites 2 and 3 with small lateral knobs.

Telson: Bifurcate. Inner border of furca with a row of very small spinules. 3 pairs of serrated setae on inner arch of telson separated by a small median cleft.

Antenna: Protopod almost as long as carapace; rostral spine with small spinules on distal half. Tapered exopod about 1/2 protopod.

The combined characters of lacking the carapace lateral spine, with tapered antennal exopod, and without outer spine on the telson fit the present zoea to the general description of the Macrophthalminae provided by RICE (1980). The characteristic features of the antennal exopod and telson are reminiscent of Macrophthalmus depressus RUPPELL and Macrophthalmus dilatatus De HAAN described by RICE (1975) and TERADA (1979), respectively. Macrophthalmus crabs are relatively common in Japanese waters with a total of 14 known species (MIYAKE, 1983). However, the morphology of its zoea are poorly known and available information are insufficient for making a definitive assignment.

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Seasonal Abundance

In this 18-month study on the seasonal abundance of brachyuran larvae, the larvae of both Grapsidae and Ocypodidae were consistently found with high concentration during the summer months, followed by a relatively sharp decline in early autumn.

Zoea I of *Hemigrapsus sanguineus* (SZ-A1) showed maximum numbers in August in both years, with 170.0 larvae/m³ in 1990, and 125.0 larvae/m³ in 1991 (Fig. 9a). As sampling in 1990 began in June, the abundance of this zoea prior to that month is unknown. However, the data of 1991 shows that this larva appeared in small number in March before the commence of increase and reaching its peak in August. Thereafter, a steep decline appeared and was not recorded in November. Disappearance of zoea was also recorded in the following winter months in both years. Zoea II was collected only in 1990, and showed the maximum number of 12.5 larvae/m³ in August (Fig. 9b).

Sesarminae sp. zoea (SZ-E2) was represented only by zoea I in the surf zone with the maximum number of 150.0 larvae/m³ appeared in July of 1990, and 136.6 larvae/m³ in August of 1991 (Fig. 10). The earliest appearance of this zoea in 1991 was recorded in April at 5.0 larvae/m³, followed by a decrease in March, and a subsequent increase before reaching its peak in August. Thereafter, the number showed a rapid decline till October.

The maximum numbers for zoea I of *Scopimera globosa* (SZ-C3) were recorded at 137.5 larvae/m³ in June of 1990, and 129.2 larvae/m³ in July of 1991 (Fig. 11a). Appearance in 1991 lasted from May to September. This zoea also assumes a rapid decline after attaining its maximum number in both years. Other stages of this zoea also appeared during the summer and early autumn, but in much smaller number than zoea I (Figs. 11b, c, and d).

Zoea I of *Ilyoplax pusilla* (SZ-B4) appeared in the surf zone in June with maximum number of 152.5 larvae/m³ in 1990, and 121.2 larvae/m³ in 1990 (Fig. 12a). This zoea also appeared in small number of 2.5 larvae/m³ in December of 1990. However, this winter appearance was not repeated in the following year.
where larval appearance ended in September. Other stages of this zoea appeared in smaller numbers than zoea I between June and October (Figs. 12b, c, and d).

Zoea I of *Macrophthalmus* sp. (SZ-N5) was present in the surf zone from spring to autumn (Fig. 13). In 1991, this zoea appeared in small number of 2.5 larvae/m³ in March, decreasing in April before going into a gradual increase and reaching its peak of 104.2 larvae/m³ in August. The maximum numbers of 125.0 larvae/m³ was also recorded in August of 1990. Abundance after peak concentration went into a declining pattern which lasted till November in 1990, and till October in 1991.

![Fig. 10 Seasonal abundance of Sesarminae sp., (SZ-E2), zoea I.](image)

![Fig. 11 Seasonal abundance of *Scopimera globosa*, (SZ-C3). (a) zoea I; (b) zoea II; (c) zoea III; (d) zoea IV.](image)
Brachyuran larvae in the surf zone (1)

Several previous studies suggested the surf zone as a nursery ground for fish larvae (SENTA & HIRAI, 1981; SENTA & KINOSHITA, 1985; BENNET, 1989). WHITFIELD (1989) attributed the abundance of zooplankton to be an important factor in enhancing the surf zone as a nursery ground for fish larvae. This study revealed that brachyuran larvae in the surf zone comprising a part of the zooplankton community. Thus, they would be vulnerable to predation by fish larvae.

The larvae of Sesarminae (SZ-E2) and Macrophthalmus (SZ-N5) were represented only by zoea I. Zoea II of Hemigrapsus sanguineus (SZ-A1) also occurred in the surf zone. Since no

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Fig. 12 Seasonal abundance of Ilyoplax pusilla, (SZ-B4). (a) zoea I; (b) zoea II; (c) zoea III; (d) zoea IV.

Fig. 13 Seasonal abundance of Macrophthalmus sp., (SZ-N5), zoea I.

Discussion

Several previous studies suggested the surf zone as a nursery ground for fish larvae (SENTA & HIRAI, 1981; SENTA & KINOSHITA, 1985; BENNET, 1989). WHITFIELD (1989) attributed the abundance of zooplankton to be an important factor in enhancing the surf zone as a nursery ground for fish larvae. This study revealed that brachyuran larvae in the surf zone comprising a part of the zooplankton community. Thus, they would be vulnerable to predation by fish larvae.

The larvae of Sesarminae (SZ-E2) and Macrophthalmus (SZ-N5) were represented only by zoea I. Zoea II of Hemigrapsus sanguineus (SZ-A1) also occurred in the surf zone. Since no
other stages were found, it is possible that the larvae of these species were only transitory in the surf zone before being transported elsewhere for further development. Such larval transportation may also assist in avoiding larval predation. In such a case the surf zone would constitute only as a passway of minor importance for the larvae.

On the other hand, the occurrence of successive zoeal stages of *Scopimera globosa* (SZ-C3) and *Ilyoplax pusilla* (SZ-B4) in the surf zone would indicate a different situation. The adults of these two species are generally known to inhabit restricted areas such as estuaries and mud flats (SAKAI, 1976). According to SANDIFER (1975), McCONAUGHA (1988) and SUZUKI & KIKUCHI (1990), larvae of many estuarine species are found in close vicinity to their adult habitat. Therefore the larvae of these two ocypodid species would remain close to the estuary of Izaku River and the adjacent surf zone during larval development. Thus, it is probable that the surf zone serves as a part of the nursery ground for larvae of these species.

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References


Brachyuran larvae in the surf zone (1)


MOHAMAD ISMID and HIROSHI SUZUKI
Laboratory of Marine Biology, Faculty of Fisheries, Kagoshima University, Kagoshima City 890, Japan.

鹿児島県吹上浜の砂浜帯における短尾類幼生の出現（I）イワガニ科およびスナガニ科

モハマド イスミド・鈴木廣志・税所俊郎

本研究は砂浜帯における短尾類幼生の出現を明らかにし、短尾類幼生の生態における砂浜帯の役割を検討するために行なわれた。イワガニ科およびスナガニ科に属する種類では *Hemigrapsus sanguineus* の第I - II期ゾエア、*Sesarminae* sp. の第I期ゾエア、*Scopimera globosa* および *Ilyoplax pusilla* の第I - IV期ゾエア。そして *Macrophthalmus* sp. の第I期ゾエアが採集され、それぞれの形態を記載した。これらのゾエア幼生は主に夏期の6月 - 8月に多く出現する傾向がみられた。*S. globosa* や *I. pusilla* のように第1からIV期にわたってのゾエア幼生が砂浜帯で見られ、かつ限られた生息地を持つ種にとっては、砂浜帯がその幼生にとって nursery ground の一部となっていることが示唆される。

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