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ON THE REPRODUCTION OF PERIWINKLES,
LITTORINIDAE, GASTROPODA¹⁾

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Observations on the reproduction and breeding habits of the Littorinidae have been dealt with by Baster (1762), Pelseneer (1911), Sewell (1924), Lebour (1935, '37, '45), Ostergaard (1950), Tokioka and Habe (1953), Habe (1955, '56), Kojima (1957, '58a, b, c, d, e, f, '59) and others. The reproduction of the Littorinidae are of two different types, viviparous type and oviparous type. The majority of the oviparous type species have characteristic floating egg capsules which are the specific characters. Winckworth (1922) stated that Littorinidae were sufficiently distinct in the method of reproduction to merit separation into distinct genera and classified the British Littorinidae based mainly on their reproductive type. Tokioka and Habe (1953) classified morphologically the floating egg capsules of the Littorinidae into three types, and Kojima (1958c) added a new type of symmetrical shape. Tokioka and Habe (1953) and Abbott (1954) described that the floating egg capsules are important taxonomical characters for the identification of Littorinidae. Habe (1958) classified the Japanese Littorinidae based mainly on the reproductive types. The writer studied on the breeding of some Japanese species of Littorinidae and the results are reviewed in this paper.

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Reproductive type of Littorinidae: The reproductive type of Littorinidae are classified into following groups: I. Viviparous type, *Littorina saxatilis* (Olivi) (Pelseneer 1911), *Littorina scabra* L. (Sewell 1924), *Littorina angulifera* Lam. (Lebour 1945). II. Oviparous type, A. Egg-masses type, *Littorina obtusata* (L.)

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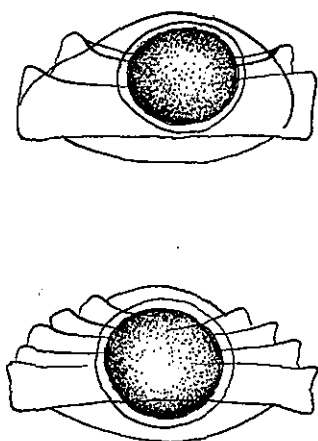


Fig. 1. Side views of the egg capsules of *Nodilittorina granulatis* (Gray), showing the two types of variation of the shape. $\times 200$

(Baster 1762), *Littorina saxatilis* (Olivi) (Seshappa 1947), *Littorivaga atkana* (Dall) (Kojima 1958a, d), B. Floating egg capsule type, 1. Helmet type, *Littorina littorea* L. (Lebour 1935), *Littorina pintado* Wood (Ostergaard 1950), *Littorivaga brevicula* (Philippi) (Kojima 1957), *Littorivaga mandschurica* (Schrenck) (Kojima 1958f). 2. Simple-drum type, *Littorina (Melarhaphé) neritoides* (Montagu) (Lebour 1935), *Tectarius muricatus* L. (Lebour 1945). 3. Drum type, *Littorina zigzac* Dillw. (Lebour 1945), *Echinella trochiformis* Dillw. (Lebour 1945), *Nodilittorina pyramidalis* (Quoy et Gaimard) (Habe 1956, Kojima 1958 c), *Nodilittorina granulatis* (Gray) (Habe 1955, '56, Kojima Fig. 1), *Nodilittorina picta* (Philippi) (Habe 1956), *Peasiella roepstorffiana* Nevill (Habe 1956). 4. Disk type (Symmetrical type), *Littorina squalida* Broderip et Sowerby (Kojima 1958 c,e), *Littoraria strigata* (Lischke) (Kojima 1958 f). *Melarhaphé (Littorinopsis) scabra* (Linnaeus) liberates the elongate-oval shaped egg capsules including the veliger stage larva at Palao (Abe 1936, '39), *Littorina scabra* (Linne) is viviparous species (Bequaert 1943, Habe 1956). Thorson (1946) described that *Littorina saxatilis* (Olivi) var. *tenebrosa* Maton is a viviparous species, on the other hand many other investigators described that this species is viviparous, but Seshappa (1947) observed that this species liberated the deposited egg-masses.

Habe (1958) revised the taxonomical position of some Japanese species of Littorinidae based mainly on the reproductive types as follow: *Littorivaga brevicula* (Philippi) to *Littorina brevicula* (Philippi), *Littorivaga mandschurica* (Schrenck) to *Littorina mandschurica* Schrenck, *Littorivaga atkana* (Dall) to *Neritrema sitkana* (Philippi), *Littorina squalida* Broderip et Sowerby to *Ezolittorina squalida* (Broderip et Sowerby).

Breeding season of Littorinidae: The breeding season of the species of Littorinidae in Japan is as follows: *Littorina brevicula* and *Littorina mandschurica* are from February to April, *Nodilittorina granulatis* from July to August, *Peasiella roepstorffiana* from May to September at Asamushi. *Neritrema sitkana* is from January to February at Hakodate, Hokkaido, *Ezolittorina squalida* in July at Akkeshi, Hokkaido. *Nodilittorina pyramidalis*, *Nodilittorina granulatis*, *Nodilittorina picta* and *Peasiella roepstorffiana* are from July to August at Shirahama, Wakayama Prefecture (Tokioka, 1950, Tokioka and Habe 1953, Habe 1955, '56, Kojima 1958c).

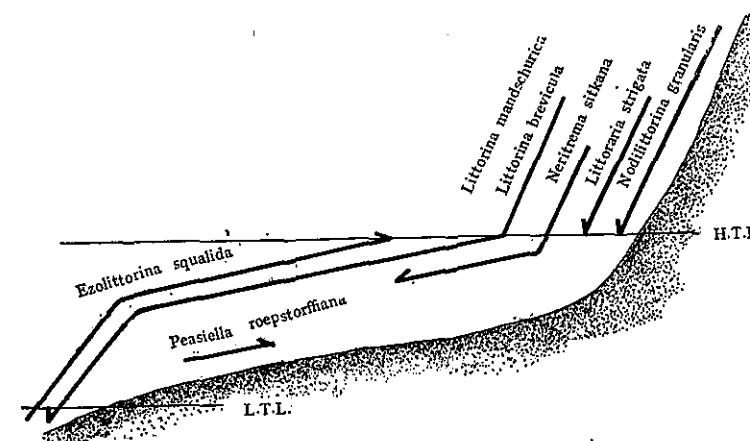


Fig. 2. Seasonal migration in the breeding season of Littorinidae.
H.T.L. High tide level. L.T.L. Low tide level.

Littoraria strigata in August at Amakusa, Kumamoto Prefecture, and *Melarhaphé (Littorinopsis) scabra* (= *Littoraria scabra*) in August at Palao (Abe 1936, '39).

Migration and breeding: *Littorina neritoides* (Lebour 1935), *Littorina zigzac*, *Tectarius muricatus*, *Echinella trochiformis* (Lebour 1945) and *Nodilittorina granulatis* (Kojima 1958b), *Nodilittorina pyramidalis*, *Littoraria strigata* live on the rocks or breakwater above high tide level and they approach the water in the breeding season. *Melarhaphé (Littorinopsis) scabra* (= *Littoraria scabra*) (Abe 1936, '39) and *Littorina angulifera* (Lebour 1945) live on the branches of the mangrove-tree in the breeding season, usually on those overhanging or near the water, and in the other seasons they are often found higher up on the denser branches. *Littorina brevicula* (Kojima 1957, '59) and *Littorina mandschurica* (Kojima 1958f) lives in the sea water near the low tide level in the breeding season, and in other seasons on the rocks or breakwater above high tide level. The relation between the breeding season and migration of some Japanese species of Littorinidae are shown in Fig. 2. In the breeding season, *Ezolittorina squalida* and *Peasiella roepstorffiana* are of the upward type and migrate to high tide level from the low tide level (Kojima 1959), on the other hand all of the other species are of the downward type and they migrate to the sea water or lower level from high tide level.

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