On the Eggs and Early Life Histories of Pyrenidae (Columbellidae) in Marine Gastropods※

By

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It has been generally known that larvae of marine gastropods are important elements among planktons and serve as foods to other marine animals living along the coast.

In this connection many studies have been done on the development of the eggs and larvae of marine gastropods.

THORSON (1940) described several forms of the egg-capsules found in the family of *Columbellidae* and the development of *Columbella blanda*. Recently, in comparison with that described by FRANC (1943), KNUDSEN (1950) illustrated that there might be perhaps two different types of the egg-capsules and the hatched larvae of *C. rustica*. HABE (1944) observed the planktonic post larva and its metamorphosis of *Pyrene sp.* sampled from the adjacent waters of Japan.

The present paper embodies the observation on two different types of the egg-capsules and the larval forms in Pyrenidae taken from the coast of Yoshimi, Yamaguchi Prefecture.

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Pyrene misera (SOWERBY)

This species is commonly seen in tide-pools or between tidal marks along the coast of Yoshimi. In summer many milkish white egg-capsules are found laid on algae along with mother mollusks. Usually 5 to 12 egg-capsules are connected with each other by means of marginal edge of adhesion disk which is oval-shaped and nearly 2 mm in long diameter (Fig. 1. a, b). A dome-shaped wall, which is about 1 mm in height and comparatively thick and tough because of its fibrous reticulation, rises from this adhesion disk (Fig. 1. c). At the top of this translucent dome-shaped wall there is an elliptical origin of exit hole (0.8×0.6mm) between two indistinct keels. The inner capsule, which is enclosed by the dome-shaped wall mentioned above, is formed of very thin, smooth and transparent membrane and it appears that on the upper surface of this inner capsule there is a stripe like

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a rib and a somewhat thickened margin having the shape of an elongated ellipse——perhaps the origin of exit hole (Fig. 1. d). 4 to 6 eggs are enclosed with the colloidal substance in the inner capsule, and the newly laid egg has a diameter of 0.315 mm and is light yellow in colour.

After the egg-capsules were separated from its attached face with caution not to be wounded, the states of egg-capsules were observed and the process of egg development was traced through the transparent membrane bordering the dome-shaped wall from the attached surface. Consequently, the author found that the development of each egg was unequal even in one capsule and the number of the micromeres increased largely with time on and became to surround the macromeres. Before long, a large micromere projected out from each side of embryo and about the half of each large micromere protruded beyond the surface of the ectoderm (Fig. 1. e). In about ten days after having laid the embryo developed into the stage of veliger, and was whirling in the capsule. It seemed that this type of cleavage was almost analogous to that was found in *Cypraea*, *Conus* and *Mitra* by OSTERGAARD (1950).

The veliger has two-lobed velum with rudimental cilia, two tentacles, two eyes, two otocysts and one foot with a round posterior margin. The shell of veliger is transparent and the fore part of body is colorless, but its liver is colored yellow.

In about ten days, embryos in the veliger stage develop into the creeping stage, in which embryos lose the velum and have long tentacles and 3 or 4 individuals leave from each capsule by rasping the exit hole at the top or even at the lateral wall. Thus, it seems to take for the embryo more than 20 days to hatch in the capsule. An instance having a long incubation period could be observed in the embryo that was not hatched nearly a month in the water of glass dish. Each hatched larva has a well-developed foot which has a somewhat sharp posterior end and a small elliptical operculum. The shell is 0.8 mm to 1 mm in height (0.93 mm on the average), has about 1½ whorls and is colored milkish white, but the color of body is grey (Fig. 1. f). The hatched larva preys often on other eggs of the same species by the radula in the elongated proboscis. Sometimes, the author observed many fragments of embryonic shells or only one abnormally large embryonic shell (1.4 mm in shell height and 2¼ whorls, Fig. 1. g), remaining in the capsules from which the larvae have already hatched. Moreover, the number of hatched larvae is usually fewer than the number of eggs. These facts coincide with the description of THORSON (1940) on this family, and it can be presumed that the larvae feed on eggs or get grown through cannibalism.

Here and there the margin of shell aperture is tinged with dark brown soon after the hatch, and this pattern becomes to form some intermittent latitudinal stripes as the shell grows, and simultaneously, the dull longitudinal ribs become to appear on the body whorl.

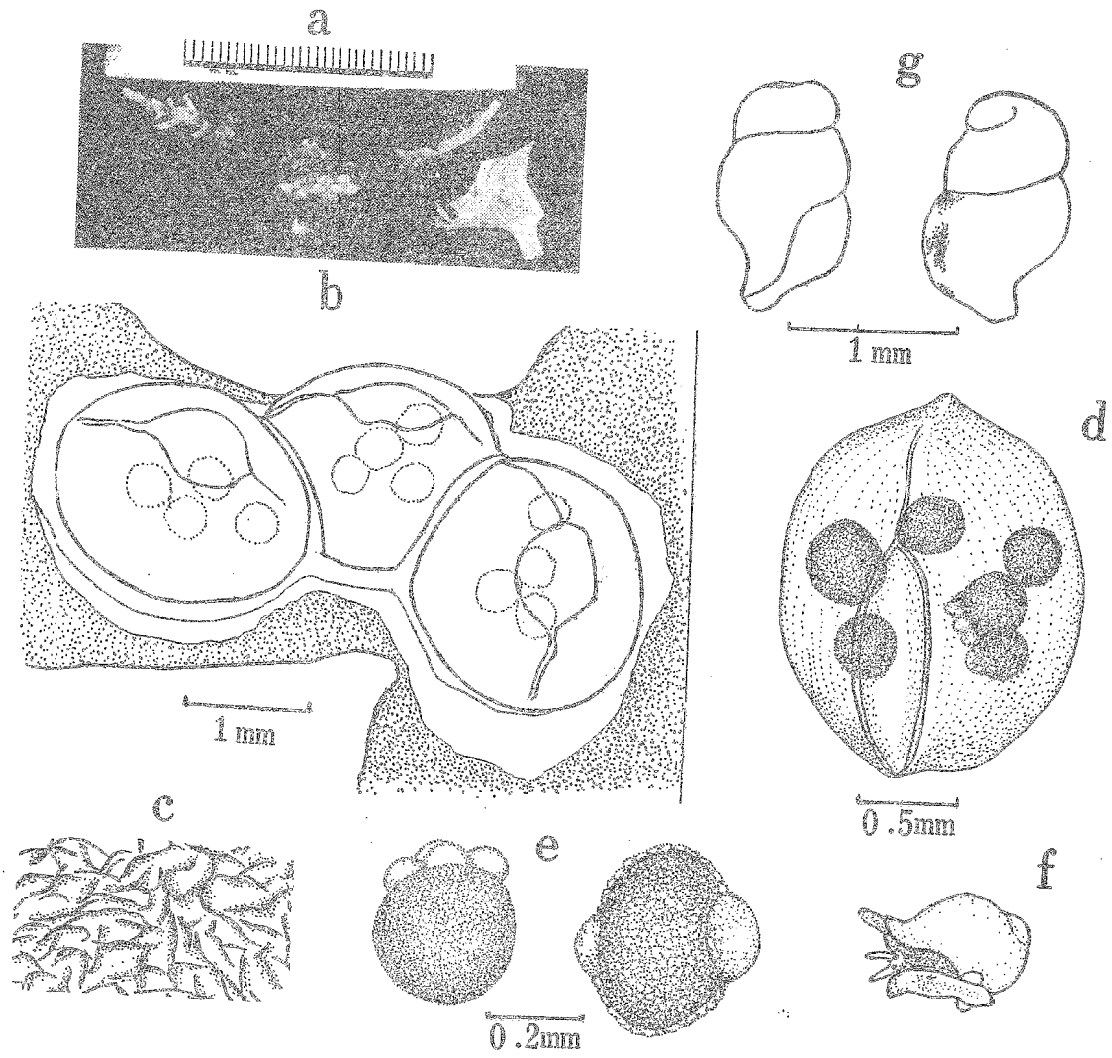

Fig. 1. *Pyrene misera* (SOWERBY). a, Egg-capsules attached to algae ; b, enlarged egg capsules; c, magnifed fibrous reticulation of outer wall of egg-capsule ; d, enlarged inner egg capsule and embryos ; e, zygotes in cleavage stages ; f, newly hatched larva 0.88mm in height ; g, abnormally large embryonic shell remained in egg capsule.

The early young mollusk secretes from the posterior parts of foot somewhat elongated mucus substance, which serves as a float or a means of cohesion, and the mollusk attaches to the under water surface from which it hangs down or attaches to the substratum from which it can not be detached by any conside rable strength of water disturbance. It may be considered as the function of the mucus substance that the young mollusk removes with tidal current or supports its habitat as well as the mucus substance of *Meretrix lusoria* (UCHIDA ,1941) or as the byssus of *Venerupis semidecussata* (YOSHIDA ,1953), both bivalves being common in Japan.

Having passed through 50 days from the hatch, the reared larval shell is about 1.7 mm in height and has about 4 whorls, and simultaneously, at the region of the anterior aperture, several latitudinal ribs become to be recognized clearly. In

August, many young shells of 1.3 mm to 2.4 mm in height can be collected from the tidal zone on the rocky coast.

Early in October, these young shells grow 4.5 mm in height and have about 6 whorls, and then almost all show the adult feature and live among the seaweeds (Fig. 1. h).

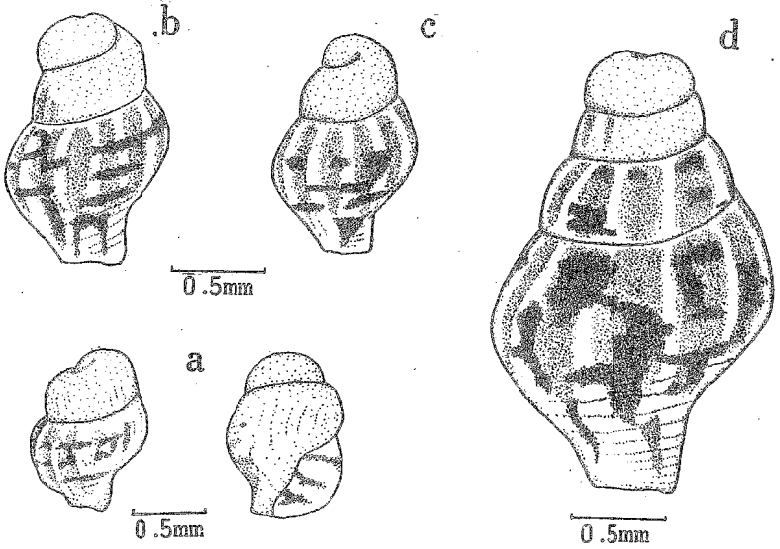

Fig. 2. *Pyrene misera* (SOWERBY) .a, larval shell (1.1 mm in height) after 10 days of hatch ; b, larval shell (1.68 mm in height) after 47 days of hatch ; c,d, larval shell (1.23 mm and 2.42 mm in height)collected at rocky coast in August.

Columbella (*? versicolor* SOWERBY)

Many egg-capsules are taken from the surface of shell (*Pinctada martensi*) or various fucus (for instance, *Padina*) from the middle decade of February to early decade of May. The group, which consists of 26 to 42 egg capsules, is laid (Fig. 2. a) and every capsule is connected by the marginal edge of its adhesion disk.

The capsule is like an upset wine-cup in feature (Fig. 2. b) ; the main portion of capsule, shaped of small trunk which is constructed of a transparent and thin wall and is 1.7 mm in diameter and 0.7 mm in height, rises from the adhesion disk and the roundish flattened area (0.6 mm in diameter) exists on the narrowed top of this trunk. This is the origin of exit hole on which there are 15 to 20 setae surrounded by the collar-like membrane (about 0.5 mm in height). Also, under above-mentioned membrane, another collar-like membrane (about 0.3 mm in height) rises from a portion which is about 0.5 mm above the substratum. The form of egg-capsule should be placed within the type of *Columbella* (*Pyrene*) *rosacea* described by THORSON (1940), with the exception of the setae on the origin of exit hole. The main part of egg-capsule also almost resembles the egg-capsule of *Columbella rustica* (KNUDSEN, 1950), but has more advanced protectors, in the vicinity of exit hole. The newly laid spherical ova (0.14 mm in diameter) are tinged with pale yellow and 38 to 57 eggs are recognized in one capsule (Fig. 2. c).

The process of egg cleavage is perceived the same as that of *P. misera*, however, in the single capsule enclosing about 20 to 30 large embryos 3 to 14 small embryos are recognized among them and the size of small embryo is half or less as much as that of the large embryo, and both embryos are whirling (Fig. 3. d). On the other hand, in the egg-capsule having no small embryo, there are 15 or 17 large embryos with similar size of 0.27 mm, and the number of them does not appear to reduce.

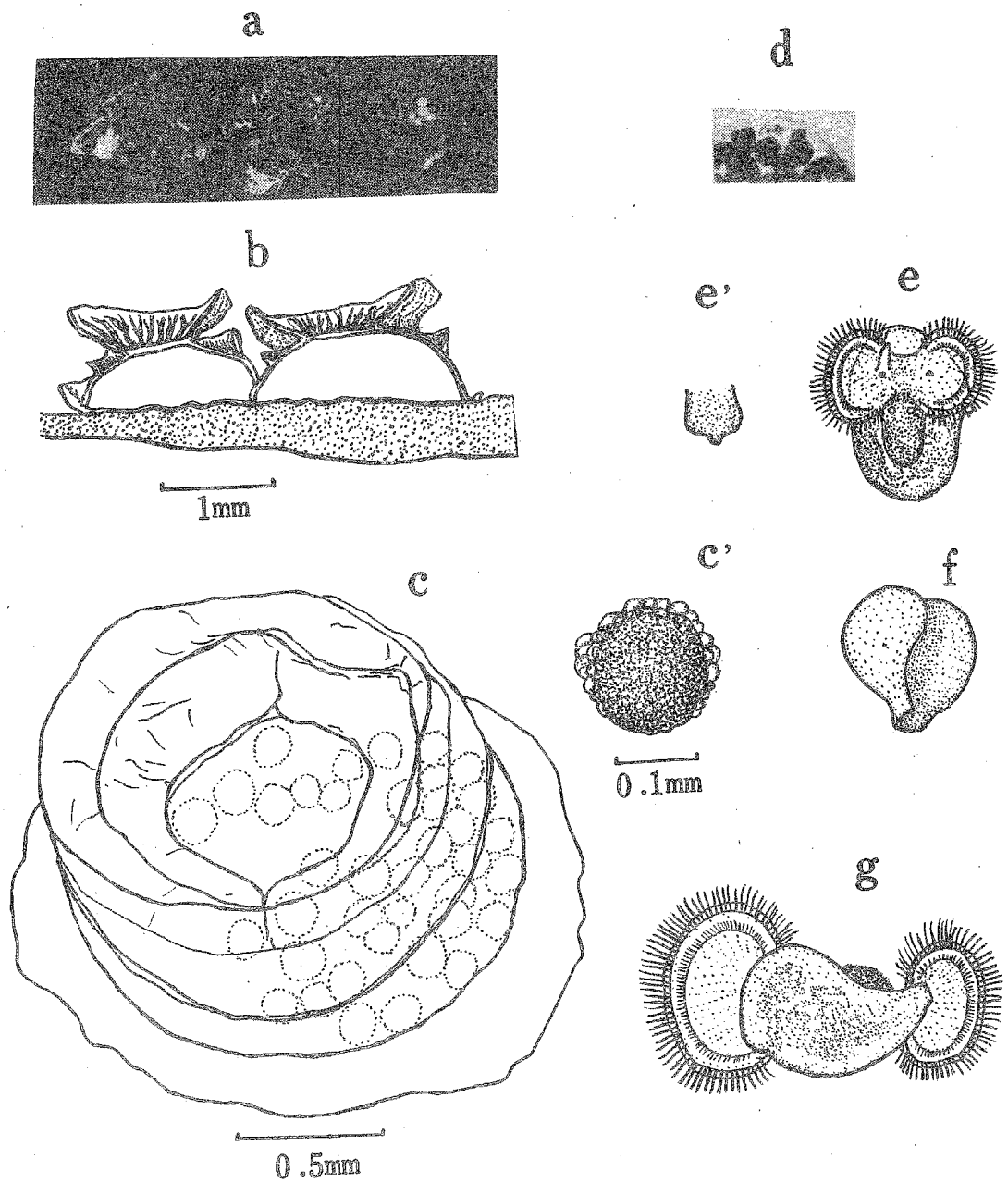

Fig. 3. ***Columbella*** (? ***versicolor*** SOWERBY). a, Egg-capsules attached to shells and fucus ; b. magnified sections of egg capsules ; c,c′ enlarged egg-capsule seen from upper surface and zygote in cleavage stage ; d, magnified large and small embryos in egg-capsule ; e,e′ elongated free-swimming veliger newly hatched and foot of rather developed veliger ; f,larval shell 0.32 mm in height ; g, free-swimming veliger after 18 days of hatch 0.42 mm in shell height.

The hatched free-swimming veliger has a shell height of 0.27 mm to 0.32 mm. The fact that the number of normally developed embryos reduces below that of eggs and undeveloped embryos come out in process of development of those embyos, is not so remarkable as in the same state of *C. blanda* (THORSON, 1940), but it seems that this fact is an analogous form of cannibalism to that phenomenon observed in *Tethys grandis* (OSTERGAARD, 1950) in which the stronger and more developed embryos knock the weaker to pieces and consume them.

The veliger (Fig. 2. e) has already an undeveloped siphon and shows a fine granulation at the surface of its shell when it hatches. The liver is brownish orange in color and the remaining part of body is pale greenish yellow. The velum is bilobed with double circulated cilia of which the outer-side cilia are longer and the inner-side cilia are shorter. The tentacle is observed only at the right side in this stage and another tentacle becomes to come out on the left side before long. Mouth part is tinged somewhat black and, like the foot, has the roundish posterior margin. In 18 days after the hatch, the veliger (0.42 mm in height and has about 2 whorls) has a large aperture and a somewhat short and wide siphon too. The right lobe of velum is significantly larger than the left. The foot having a projected posterior edge, has a thin and elliptical small operculum on the back side. Even for 23 days the larvae do not still metamorphose and yet keep their free-swimming life. From this fact, it is supposed that the larvae have considerablly long free-swimming life and go down to the bottom in the well-developed form.

This veliger resembles that of *Pyrene sp.* (HABE, 1944) in the feature of velum and, on the other hand, the feature and size of embryonic shell bear a remarkable resemblance to those of *C. rustica* (KNUDSEN, 1950). From consideration of all characteristics mentioned above, it can be deduced that this species belongs surely to *Pyrenidae* and is the same species as *Columbella versicolor* because many *C. versicolor* are taken from the neighbourhood of group of the egg-capsules mentioned above. However, it appears that there is a considerable difference between the egg-capsule described in this paper and that of *C. versicolor* described by RISBEC (1929, '31)

Comparisons and Discussions

It is common to the two species written in this paper that both species are inferred to have the characters of cannibalism in the stage when the embryos exist in the egg-capsules, and this fact coincides with the opinion given to some species of this family by THORSON (1940). The double-constructed egg-capsule as found in *P. misera* has never been reported in this family. And then, on the outer wall of capsule in *P. misera*, the tough and reticular fibrous structure develops remarkably in compensation for the degenerated keels, but, *C. versicolor*

has two collar-like membranes which appear to be transformed from the keels because of the thinner and weaker wall than the former species. The setae on the origin of exit hole in latter species have also remarkable characteristics that have never been observed in this family. As regards the problem whether a free-swimming form or a creeping one is perceived in the type of larval life at the hatch, THORSON (1940) related that a large percentage of species has a pelagic development in the warmer waters than in the colder waters and, on the other hand, a large percentage of species having non-pelagic development is more frequently found in tidal zone than in shelves from the results of his investigations on many species of marine prosobranchs in several regions all over the world.

However, illustrating the various instances in adjacent waters of Plymouth, LEBOUR (1937) pointed out the point that the position of dweller lies whether in the tidal zone or not not to be essential factor for the development of larvae which hatched whether in the free-swimming stage or in the crawling stage. On this subject KNUDSEN (1950) also explained that the temperature would not be an important element on the Tropical West Africa fauna.

From the above-mentioned discussions, *P. misera* lays eggs on the place exposed at ebb tide or on tide-pools at the time of higher water temperature (27~30°C) in the mid-summer, and on the contrary, *C. versicolor* lays eggs on the place not almost exposed in the season of lower water temperature (16°C or thereabout). And the former hatches in the creeping stage, and the latter hatches in the free-swimming stage.

It can be understood that *P. misera* has a rather longer incubation period than that of the latter and can remain in the egg-capsule till the more developed form of crawling stage, because it has a higher ability of protecting and fostering for the reason that it has the stonger wall of egg-capsule, and the larger ovum and still fewer ova per the capacity of capsule than the latter. However, the author thinks that much considerations should be paid to the effects of various environmental factors on the larva after the hatch from the egg-capsule.

References

HABE, T. : 1944. Studies on the eggs and larvae of the Japanese gastropods (1), Jour. Conch. **13**, 188—194.

KNUDSEN, J. : 1950. Egg capsules and development of some marine Prosobranchs from Tropical West Africa. Sci. Res. Dan. Exp. Coast of Trop. West Africa. Atlantide Rep. **1**. 85—128.

LEBOUR, V. M. : 1937. The egg larvae of the British Prosobranchs with special reference to those living in the plankton. Jour. Mar. Biol. Assoc. United Kingdom. **22**, 105—166.

OSTERGAARD, J. M. : 1950. Spawing and development of some Hawaiian marine Gastropods. Pac. Sci. **4** (2), 75—115.

THORSON,G. : 1935. Studies on the egg-capsules and development of Arctic marine Prosobranchs. Medd. Grønland. **100** (5), 1—71.

——— : 1940. Studies on the egg mass and larval development of Gastropoda from the Iranian Gulf. Dan. Sci. Inv. Iran. Pt. 2, 159—238.

YOSHIDA, H. : 1953. Studies on larvae and young shells of industrial bivalves in Japan. Jour. Shimonoseki Coll. Fish. **3** (1), 1—106.