EGG CAPSULES AND YOUNG OF THE GASTROPOD *PYRULOFUSUS DEFORMIS* (NEPTUNEIDAE) AT BARROW, ALASKA*

The first specimens of the arctic prosobranch gastropod, *Pyrulofusus deformis* (Reeve 1847) taken from an Alaskan locality north of the Arctic Circle were the two live and two dead specimens collected by G. E. MacGinitie in 1948 and 1949[1] at Barrow, Alaska (70°20′N.156°41′W.). These four individuals and other specimens from the Bering Sea and Gulf of Alaska were reported by N. MacGinitie[2]. This distinctive sinistral species can be identified readily from her figures and account (Ref. 2, p. 114; Pl. 13, Figs. 3-5). A characteristic of this large snail is the size of the protoconch (larval shell) part of the apex of the shell. The large size of this indicates that the larvae must be very large and that intracapsular life is probably rather long.

During the summer of 1963 collections of benthic invertebrates were made by dredge and beam trawl in the waters of the Arctic Ocean near Pt. Barrow, Alaska from the reseasch vessels of the Arctic Research Laboratory (ONR), Barrow, Alaska.

On August 16, 1963 a dredge haul over very rocky ground at 176 m. at 71°34′N.-155°50′W. brought up a boulder of about 0.1 m.[3] size on which was found a single large snail egg capsule. An identical capsule was found loose among the stones and rubble of the dredge haul. Another dredge haul in the area at 165 m. at 71°33′N.155°53′W. contained two small male individuals of *Pyrulofusus deformis* whose shells were in excellent condition and free of incrustations. Three small snails that were later found on one of the capsules were readily identified by comparision with these sub-adults.

The egg capsule of this snail does not appear to have been described and as it indicates considerable specialization of the reproductive biology of the species for life in the Arctic, the small amount of material found is described here.

One of the capsules was collected intact but without identifiable embryos. It contained a colorless, thick, jelly-like material in the basal portion and some soft yellowish material above this. No structure could be discerned in the latter, which was apparently the remains of eggs or embryos. There was some indication that the capsule contents had been attacked by micro-organisms. The other capsule, which had been slightly damaged in the dredge, contained three small snails, which virtually filled the inside. There was no other material in the capsule.

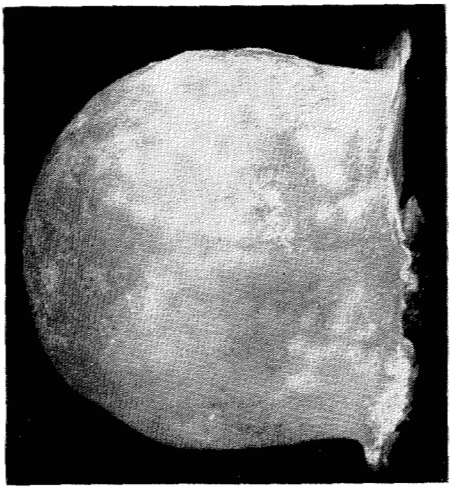

Fig. 1. Egg capsule of *Pyrulofusus deformis* containing three juvenile snails when found. Side view. Actual diameter 27 mm.

These egg capsules are large, coriaceous hemispheres with a flat base firmly cemented to the substratum. The rounded capsules (Fig. 1) are almost spherical in shape, as they have a height only a few millimetres smaller than the diameter. The globular appearance is accentuated by a slight constriction at the base. There are neither preformed exit holes nor seams. The capsule that contained the three small snails is 24 mm. high and has a maximum diameter of 27 mm. The other capsule measures

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21 mm. high and 24 mm. in diameter. The capsules are light in colour with the domed top a darker brown than the tan sides. The paper-thin capsule wall is tough, stiff, and has a smooth parchment-like texture both externally and

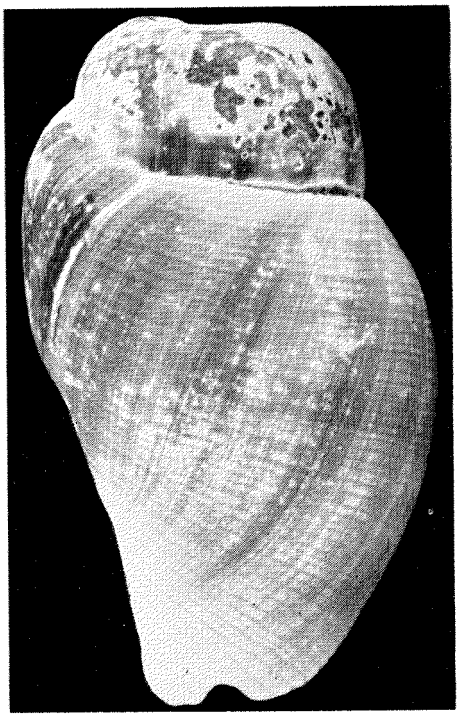

Fig. 2. Shell of young *P. deformis* from capsule. Dorsal view. Actual length 16.8 mm.

internally. The wall of the capsule with the young snails is thinner and more brittle than the other, probably in relation to the advanced state of development of the contents. The capsule wall has no sculpture or ornamentation. At the attachment line, the capsules have a flat, narrow (3 to 5 mm.) rim cemented to the substrate. The attached base of the capsule is continuous with the walls and differs from them only in being rather hyaline and soft. This membranous bottom permits the capsule to be peeled off the substrate intact.

The shells of the juveniles taken from the capsule show two complete whorls (Fig. 2, dorsal view; Fig. 3, aperture view). The angle of coiling of the first complete (nuclear) whorl is small, producing a slightly umbilicate apex. The sides of the first whorl are rather flat and show no sculpture. At the beginning of the second whorl, there is an abrupt transition to an inflated convex body whorl formed at a greater angle of coiling, leaving most of the nuclear whorl

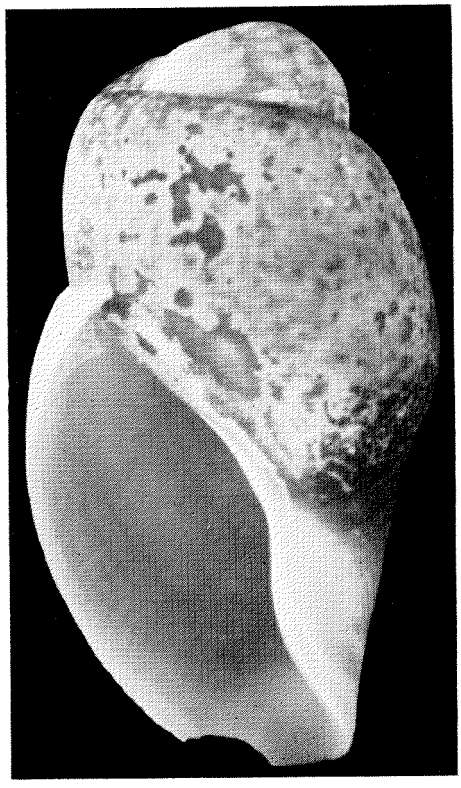

Fig. 3. Shell of young *P. deformis* from capsule. Aperture view. Actual length 16.8 mm.

exposed as a high, straight-sided apex in the older shell. The aperture length greatly increases with the formation of the siphonal canal in the second whorl. Fine, flat spiral cords intersected by the increment lines appear on the second whorl and are continued as the adult sculpture. The first whorl is dark reddish brown and the second is a lighter tan color, with the siphonal canal white

on the aperture face and lighter than the rest of the shell when seen from above. The colour of the second whorl is maintained in the development of subsequent whorls in the adult.

The available shell measurements of *Pyrulofusus deformis* specimens from Pt. Barrow are given in Table 1. Included are data from the three capsule juveniles and two free subadults collected in this study and measurements of two of the MacGinitie specimens on loan from the U.S. National Museum. The data illustrate several features of growth and development of this species.

Comparison of the nuclear whorl measurements of the large specimens from Barrow with similar measurements of the capsule young indicate that these three juveniles are not unusually large for this population. It may be concluded that this species normally attains a relatively large size and two shell coils while still in the egg capsule.

The data indicate that the body whorl of a subadult animal may form more than 80 per cent of the total shell length. Adults have few coils and increase in shell volume is attained in this species by relatively great elongation of the aperture and great expansion with each coil attained. This growth characteristic is achieved very early in the capsule young. The single nuclear whorl is rather tightly coiled, and is flat to involute in some specimens. The measurements given indicate that the characteristic large, elongate aperture is achieved immediately at the start of the second coil while the small snail is still in the capsule and is thereafter maintained. Length of shell is more than doubled by the time the third coil is attained in the free subadult.

Descriptions of both *Pyrulofusus deformis* and *P. harpa* (Mörch) often emphasize the presence of obliquely longitudinal costae (ribs) in large shells. There is considerable individual variation in the prominence of these costae in *P. deformis*[2], and the available material of juvenile individuals indicates that this character is a development of later growth. No colabrial costae can be detected in the three capsule juveniles and only a vague indication of them is present in the subadults collected at Barrow. One of the latter specimens, 39.6 mm. in height, has several vague longitudinally disposed swellings on the shoulder of the third whorl that represent the earliest appearance of this character during development that could be noted in the present sample.

Two of the capsule young were dissected and compared with dissections of the two sub-adults available. The foot, operculum, tentacles, and gill were identical with those of the adult. The proboscis was completely developed and the radulae consisted of many rows of

Table 1. Shell dimensions in mm. of *Pyrulofusus deformis* from Pt. Barrow.

Dimension	*Capsule juveniles*			*Free subadults*			*Adults*		
Shell length	17.8	16.8	16.8	36.5	39.6	44.2	73	83.5*	142*
Maximum diameter of body whorl	12	10.5	10.6	22	24.6	27	43	42*	83*
Aperture length	15	13.3	13	25.6	28.1	32.7	46		
Height, last whorl				29.3	32.7	38.7	58		
Diameter, 1st whorl	8	8.4	7.8	7.8	8.3	8.1	9.2		
Height, 1st whorl	4.8	4.8	4.5	5	6	4.7	6.6		
Number of whorls	2	2	2	3	3	3 1/5	4¼	4*	5*

* Adapted from Ref. 2.

teeth with the same morphology as those in the radulae of the subadults examined. The conditions of these structures indicated that development was complete and that the young snails were ready to emerge from the capsule.

In all the East Greenland prosobranch, the larval development of which could be determined, Thorson[3] found pelagic larval stages lacking, and rather large larvae were found to develop in capsules and then pass directly into the free bottom stage. Furthermore, Thorson[4] found during his extensive studies that 95 per cent of all the bottom invertebrates of that area do not have planktonic larvae. He concluded that this might be considered an adaptation to life in the Arctic because of the correlation of this habit with numerous special ecological factors related to pelagic development in the cold seas. The precise method of development of *Pyrulofusus deformis* is still unknown; i.e., whether the eggs are large and yolky or whether the material to sustain intracapsular growth to such an advanced stage is provided by nurse eggs in the capsule. But in the light of Thorson's findings indicated above, the large egg capsules and few, large, non-pelagic young that develop therein can be interpreted as an especially well-developed adaptation for reproduction in the Arctic seas.

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[1]MacGinitie, G. E. 1955. Distribution and ecology of the marine invertebrates of Point Barrow, Alaska. Smithsonian Misc. Collections 128:1-201.

[2]MacGinitie, Nettie. 1959. Marine mollusca of Pt. Barrow, Alaska. Proc. U.S. Natl. Mus. 109:59-208.

[3]Thorson, Gunnar. 1935. Studies on the egg capsules and development of arctic marine prosobranchs. Medd. Grønl. 100(5):1-71.

[4]Thorson, Gunnar. 1936. The larval development, growth, and metabolism of arctic marine bottom invertebrates, compared with those of other seas. Medd. Grønl. 100(6):1-155.

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BREEDING SUCCESS OF THE COMMON TERN ON THE NORTH SHORE OF THE GULF OF ST. LAWRENCE IN 1961 AND 1962

Colonies of the comomn tern, *Sterna hirundo,* occur on many of the small islands off the north shore of the Gulf of St. Lawrence[1]. In 1961 and 1962 the author had the opportunity to observe a number of colonies near the mouth of the Nabisipi River, 50°14′N.62°13′W. It was evident that breeding success in the colonies can change greatly from year to year. The breeding in 1962 was an almost complete failure and contrasted sharply with that in 1961. Annual recruitment in the tern colonies is very much influenced by weather and perhaps also by egg collecting.

Egg collecting

Along the north shore of the Gulf of St. Lawrence, and indeed along all the remote eastern coastal regions of Canada, there has been a long and unfortunate history of egg collecting. Comeau[2] mentioned egg collecting in the 1800's when the principal harvest consisted of the eggs of puffins and eiders. Palmer[3] stated that in the 1940's eggs of the common tern were gathered in Labrador, Europe, and elsewhere and that in some places they were a valued article of diet. Wetherbee[4] gave a specific example from the Labrador coast. Local residents at Muddy Bay made annual egg depredations on the common tern colony of Green Island and have always done so during living memory. Nowadays, because the numbers of eiders, murres, and puffins have been reduced, the principal victims of the egg collectors are terns, and to a much smaller extent gulls. This is largely because the eggs of these species are readily available. Egg collecting is prompted by the economic conditions in the region. As far as could be ascertained the average earned income of a family in Aguanish was around $1,200 in 1960-61. In an average family there were between eight and ten children. Family allowances supplement the earned income, but unfortunately many bread winners are unemployed. In Aguanish perhaps