

The Fæcal Pellets of the Trochidæ.

By

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With 12 Figures in the Text.

FÆCAL PELLETS of the following species are described :—

Gibbula cineraria (Linn.).

G. umbilicalis (Da Costa).

G. tumida (Montagu).

G. magus (Linn.).

Cantharus (Jujubinus) clelandi (Wood).

Calliostoma zizyphinum (Linn.).

Of the various molluscan fæcal pellets so far described, none have shown a very high degree either of internal differentiation, or of external sculpturing. In the latter respect the most complicated are perhaps those of the Nuculidæ (Moore, 1) and the Pectinidæ (Moore, 2). In neither of these groups is there any trace of internal localisation of different types of material, but in the Mytilidæ (Moore, 2) there is, in some species, a sorting of the finer material to the lateral regions of the fæcal ribbon, and of the courser material to the centre. There is not however any clear-cut line of demarcation between the two regions.

In the present group there is, in all the species described except *Calliostoma zizyphinum*, a localisation of the constituent materials according to their grade into certain definite regions of the pellet; and there is further, in all except *Calliostoma*, a very complex system of surface sculpturing.

The pellets of *Gibbula umbilicalis* and *G. cineraria* may frequently be seen on the shore, where their peculiar shape makes them easily recognisable. Moorhouse (3), speaking of *Trochus niloticus* from Low Isles, on the Great Barrier Reef, says: "Feeding appears to proceed at every opportunity, so that the amount of fæcal matter deposited is very great. This fæcal track has often been the means of tracing an animal that was

otherwise hidden." He does not however give any description of the fæces.

The methods used for collecting, and preparing sections of the pellets, have already been given in a previous paper (Moore, 2). There is one potential source of error which calls for special comment. When a pellet contains an area in which are deposited any large mineral particles occurring in the food material, a section in which such large particles occur is very liable to be damaged in cutting. At the same time, a section of the same pellet through an area where there do not happen to be any large particles, is more likely to remain intact. And, since it is generally the case that only a certain proportion of the sections cut are undamaged, an examination of the most perfect sections is apt to give the erroneous impression that there is no localisation of the different types of material. This can only be avoided by correlation of the results from sectioning, with an examination of dissected specimens; and in this particular group the pellets can quite easily be dissected with a needle.

Unless otherwise stated, the localities given for the various species refer to specimens collected between tide marks and, except where stated, the pellets from a considerable number of specimens have been examined. I am indebted to Dr. E. J. Allen for the material from Plymouth; and to Miss M. W. Parke for the material from Loch Hine, in Ireland; also to the Editor of *Nature* for permission to reproduce Figure 10.

Gibbula cineraria (Linn.). [= *Trochus cinerarius* of Forbes & Hanley.]

Localities: Plymouth; Loch Hine, Ireland; Port Erin; littoral, and from 5 to 20 fathoms.

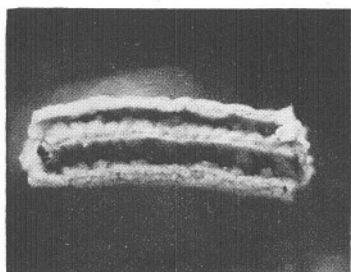
G. umbilicalis (Da Costa). [= *Trochus umbilicatus* of Forbes & Hanley.]

Localities: Plymouth; Port Erin.

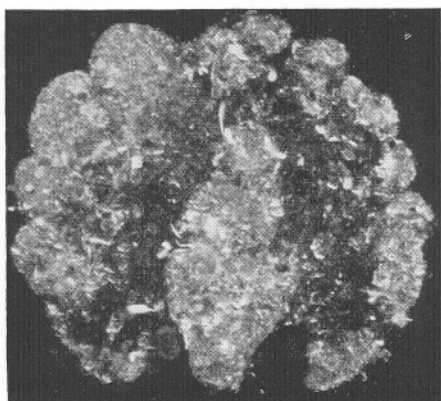
The pellets of these two species are so alike that it has not been possible to differentiate between them. They are shed in the form of a rod, which breaks into lengths of three to five times the diameter. They are usually brown and sandy in appearance, although both these characters are variable according to the nature of the food eaten: when the animal has been feeding mainly on algæ, more or less translucent pellets may be found.

In the case of *G. cineraria*, an animal with a shell 1.5 cm. in diameter, forms pellets with an average diameter of 0.6 mm.

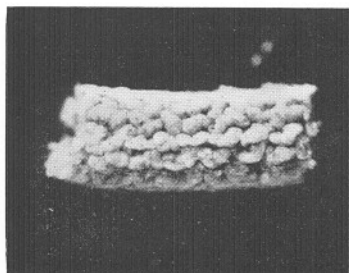
The pellets are roughly circular in section, but on the ventral side there are two deep V-shaped longitudinal grooves, with an upstanding ridge between them. This ridge is supported on either side by a series of rounded buttresses, which constitute the internal walls of the ventral grooves, and are separated from one another by deep, narrow clefts. These buttresses can be seen in Figures 1 and 3. The crest of the mid-ventral



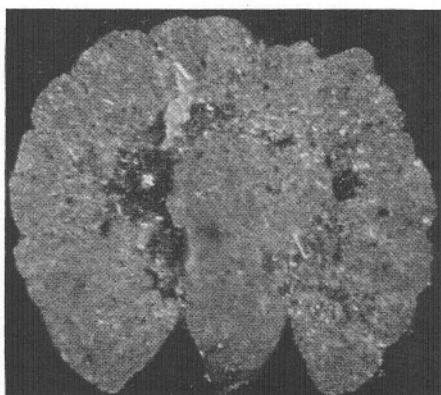
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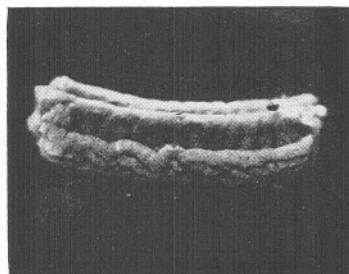
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Gibbula umbilicaris.

- FIG. 1.—Ventral view.
 „ 2.—Dorsal view,
 „ 3.—Ventro-lateral view.
 „ 4.—
 „ 5.— } Transverse sections.
 „ 6.— }

ridge may be either rounded or flattened, and in some cases it appears to be of a gelatinous consistency, and can be dissected away unbroken from the rest of the pellet with a needle.

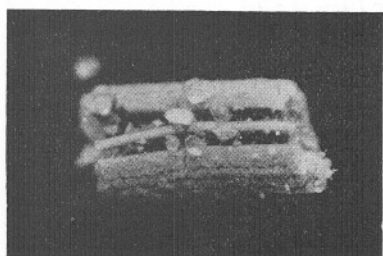
The ventro-lateral lips bounding the ventral grooves are usually smooth, but the rest of the dorsal and lateral regions of the surface of the pellet are cut by deep grooves into about ten rounded longitudinal ridges, and these ridges are thrown into tightly packed lateral undulations. In the pellets of specimens collected from the littoral zone of the shore these undulations are usually of a rather irregular nature, and the loops of neighbouring ridges do not lie opposite one another on successive ridges. In specimens of *G. cineraria* taken at a depth of from 5 to 20 fathoms, off Port Erin, the ridges on the pellets tended to be more compact, and their undulations more regular, although never attaining the regularity of certain allied species. This tendency towards the formation of more regular pellets by specimens from deep water, as compared with those occurring on the shore, is found also in *G. magus*, and it would be interesting to know whether a similar phenomenon is found in other animals also, and if so, what is its significance.

In an experiment, *G. cineraria* was fed on a pure algal culture, containing no gritty matter, but the pellets retained their typical form, although of a very loose consistency. Under natural conditions, extraneous particles tend to adhere to the pellets, so that the fine details of their sculpture may be obscured.

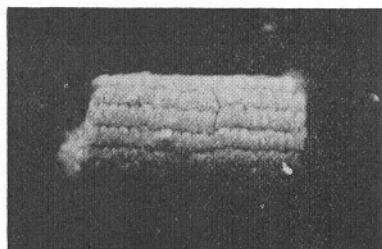
In transverse section the pellet shows two distinct types of material, in regions more or less sharply marked off from one another. In one of these there are only fine particles, and these are fairly firmly bound together—presumably by some material like mucus—so that if the pellet is crushed, the regions composed of this material tend to remain intact. The mid-ventral ridge, and a central region attached to, and forming a base to this ridge, are formed of this fine material, as is the whole of the region comprising and underlying the dorsal and lateral ridges. These two regions meet near the bottoms of the ventral grooves.

Between these two areas of fine material there is a region of variable extent, in which are found any coarse particles such as shell fragments, or large sand grains, which the pellet contains. Although this region is not clearly defined in all pellets, it is typically present, and may include large empty cavities between the individual particles.

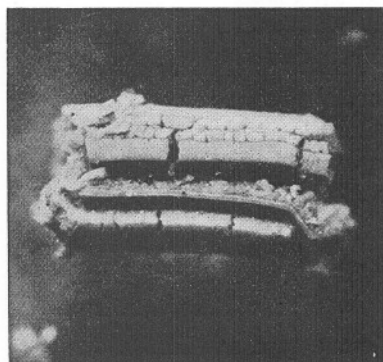
Owing to the difficulty of cutting such sandy material, it is not possible to show a single section which will illustrate all these points, but a general idea of the structure of the pellet may be obtained from a comparison of those shown in Figures 4–6, with the photographs of entire pellets in Figures 1–3.



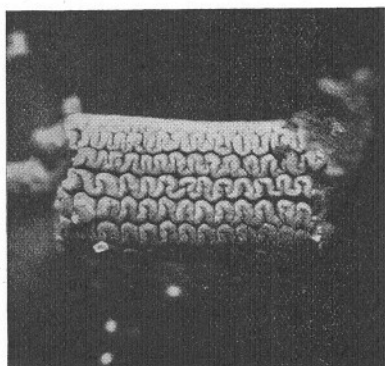
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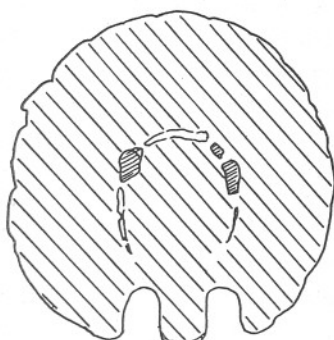
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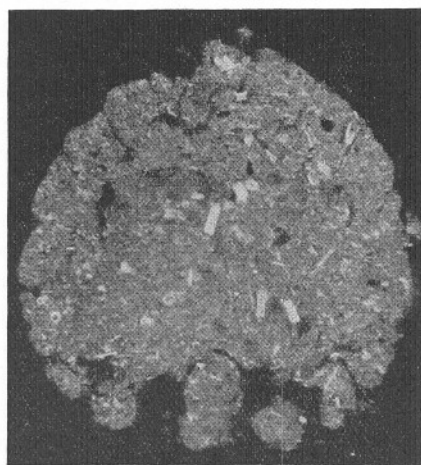
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FIG. 7.—*Cantharus clelandi*, ventral view.
 „ 8.— „ „ dorsal view.
 „ 9.—*Gibbula magus*, ventral view.
 „ 10.— „ „ dorsal view.
 „ 11.— } „ „ Transverse sections.
 „ 12.— }

Gibbula tumida (Montagu). [= *Trochus tumidus* of Forbes & Hanley.]

Locality: Port Erin, 5 to 20 fathoms.

The pellets of this species are of a similar type to those described above, but with the sculpturing of a more regular pattern. The ventral grooves and ridge are similar, with the exception of the buttresses, which are much narrower in this species, and may even be absent altogether. The mid-ventral ridge also may be narrower in this species. The dorsal and lateral system of ridges is of the same type as in the previous species, except that here there are more numerous ridges, and the undulations in them are considerably more regular. The ridges, being more numerous, are also thinner, and the undulations are of a finer pattern than those of *G. cineraria*. They tend also to lie opposite one another on successive ridges, and may even be almost as regularly arranged as they are in *G. magus*. The grooves which separate these ridges are deeply cut, but their distinctness is obscured by the small size of the pellets, and the relative coarseness of the sand of which they are composed. In transverse section the pellets show the same type of localisation of the coarse and fine grade materials as do those of *G. cineraria*.

Gibbula magus (Linn.). [= *Trochus magus* of Forbes & Hanley.] Localities:

Port Erin, littoral (one specimen only), and from 5 to 20 fathoms.

The pellets of this species are of the same type as those of the preceding, but of an even more regular pattern. The ventral grooves occupy a relatively smaller area of the surface of the pellet, and the buttresses of the mid-ventral ridge are inconspicuous from the surface, although clearly visible if the pellet is dissected. The gelatinous tip to the mid-ventral ridge is usually prominent, and can be clearly seen in Figure 9. The dorsal and lateral system of ridges are generally deeply cut and clearly defined; the ridges are more numerous than in *G. cineraria*, and their undulations are usually very regular, as seen in the example shown in Figure 10. There may sometimes, however, be a system of secondary undulations superimposed on the first, and giving rise to a more complex pattern. It is noteworthy that the pellets of a single specimen which was found on the shore between tide marks were of a very much less regular type than is usual in those from deeper water.

In transverse section the localisation of material seen in the preceding species is much less noticeable, so that the region of coarse grade material may appear to be altogether absent, as in the section shown in Figure 12; but dissection of the pellet generally shows a certain amount of coarse grade material around the central core. The rest of the pellet consists of fine material, and frequently contains numerous diatom tests.

From an animal with a shell 3.0 cm. in diameter, the pellets average 1.4 mm. in diameter.

Cantharus (Jujubinus) clelandi (Wood). [= *Trochus millegranus* of Forbes & Hanley.] Localities: Port Erin, littoral (one specimen only), and from 5 to 20 fathoms.

The pellets are very similar to those of *Gibbula magus*, except that the sculpturing of the dorsal and lateral surfaces is not so deeply cut. This may be associated, as in *G. tumida*, with the small size of the animal and its pellets, and the relative coarseness of the sand of which the latter are composed. (Figs. 7 and 8.)

The undulations of the ridges, as in *G. magus*, are very regularly disposed, and the ventral grooves are restricted, as in that species, to a relatively small area of the ventral surface. The mid-ventral ridge is thin, and its buttresses are reduced or absent. As in *G. magus*, there is not much coarse material in the pellet, so that a transverse section shows little localisation of material, but coarse particles may be found in the usual region if the pellet is dissected.

From an animal with a shell 1.0 cm. in diameter, the pellets average 0.4 mm. in diameter.

Calliostoma zizyphinum (Linn.). [= *Trochus zizyphinus* of Forbes & Hanley.] Localities: Plymouth; Port Erin, littoral, and from 5 to 20 fathoms.

The pellets, in marked contradistinction to those so far described, are in the form of rods, circular in section, but devoid of any surface sculpturing, and with no localisation of the materials inside. They are of a rather loose, sandy consistency, and the surface of pellets of animals collected in deep water is usually rougher than that of specimens from the littoral zone. The pellets of var. *lyonsii* do not differ from those of the typical form from the same ground. In general the pellets do not contain any material as coarse as the larger particles found in *Gibbula* and *Cantharus*, but it is an interesting fact that the pellets of many individuals collected on the shore are composed almost entirely of sponge spicules.

From an animal with a shell 2.0 cm. in diameter, the pellets average 0.75 mm. in diameter.

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