STUDIES ON THE MOLLUSCAN FAECES (IV)[1]

KOHMAN Y. ARAKAWA

Hiroshima Fisheries Experimental Station, Ondo, Aki-gun, Hiroshima, Japan

With 2 Text-figures

In the present paper, further observations on faecal pellets from twenty-five gastropods and one bivalve are recorded, together with supplementary notes on some molluscs referred to already in my previous paper.

Before going further, I would like to thank Mr. Iwao HAMATANI for identifying opisthobranchs and Prof. Akihiko INABA for providing laboratory facilities at the Mukaishima Marine Biological Station. Special appreciation is extended to Dr. Hiroshi ITAGAKI and Mr. Takashi MASUDA for some freshwater and terrestrial snails. Thanks are also due to Dr. Takasi TOKIOKA for his editorial advices.

MATERIALS

	Species	Locality
GASTROPODA		
Trochidae	1. *Umbonium (Sachium) moniliferum* (LAM.) キサゴ	Tomioka, Kumamoto Pref.
Bithynidae	2. *Parafossarulus manchouricus* (BOURGIUGNAT) マメタニシ	?
Thiaridae	3. *Semisulcospira bensoni* (PHILIPPI) カワニナ	Tamayu-machi, Shimane Pref.
	4. *S. b. reiniana* (BROT) チリメンカワニナ	Iwakuni, Yamaguchi Pref.
	5. *S. b. trachea* (WESTERLUND) ヒタチチリメンカワニナ	,, ,,
	6. *S.* sp. シリキレカワニナ	Iwakuni, Yamaguchi Pref.
Naticidae	7. *Naticarius concinnus* (DUNKER) フロガイダマシ	Mukaishima, Hiroshima Pref.
	8. *Eunaticina papilla* (GMELIN) ネコガイ	?

1) Contributions from the Mukaishima Marine Biological Station, No. 110.

Ovulidae 9. *Primovula rhodia* (A. ADAMS) ツグチガイ
Mukaishima, Hiroshima Pref.

Cymatiidae 10. *Apollon natator* (RÖDING) ウネボラ（アラレボラ）
〃 〃

Pyrenidae 11. *Indomitrella lischkei* (SMITH) シラゲガイ
?

Buccinidae 12. *Cantharus cecillei* (PHILIPPI) オガイ
Mukaishima, Hiroshima Pref.

13. *Siphonalia cassidariaeformis* (REEVE) ミクリガイ
〃 〃

Turridae 14. *Inquisitor jeffreysi* (SMITH)モミジボラ
〃 〃

Conidae 15. *Virroconus fulgetrum* (SOWERBY) サヤガタイモ
Shirahama, Wakayama Pref.

16. *Chelyconus fulmen* (RVE.) ベッコウイモ
〃 〃

Hydatinidae 17. *Hydatina physis* (L.) ミスガイ
〃 〃

Atycidae 18. *Liola laeta* (GOULD) カイコガイダマシ
Mukaishima, Hiroshima Pref.

Aplysiidae 19. *Aplysia (Varria) oculifera* AD. & RVE. ミドリアメフラシ
Shirahama, Wakayama Pref.

20. *A.* sp. アメフラシの１種
Arasaki, Kanagawa Pref.

21. *Notarchus (Bursatella) leachi leachi* var. *freeri* (GRIFFIN) フレリトゲアメフラシ
Ondo, Hiroshima Pref.

Doriidae 22. *Dendrodoris (D.) nigra* (STIMPSON) クロシタナシウミウシ
Mukaishima, Hiroshima Pref.

Physidae 23. *Physa acuta* (DRAPARNAUD) サカマキガイ
Arasaki, Kanagawa Pref.

Clausiliidae 24. *Phaedusa (Euphaedusa) digonoptix comes* (PILSBRY) ヒメコギセル
?

25. *Tyrannophaedusa (Decoliphaedusa) bilabrata* (SMITH) シリオレギセル
?

BIVALVIA

Hiatellidae 26. *Panope japonica* A. AD. ナミガイ
Mukaishima, Hiroshima Pref.

DESCRIPTIONS

1) *Umbonium (Sachium) moniliferum* (LAMARCK) The form of faeces is quite indefinable as they are shed usually in loose mucoid masses containing some sand grains and well-digested food particles.

2) *Parafossarulus manchouricus* (BOURGIUGNAT) Faecal pellets are ellipsoidal, but, occasionally fusiform, or rarely flocculent. They are somewhat coarse in consistency and contain a considerable amount of gelatinous matters mixed with undigested fragments. The colour is greyish green.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size					
		Breadth (B) mm		Length (L) mm		Ratio (L/B)	
		Range	Mean	Range	Mean	Range	Mean
?	18	0.08–0.18	0.13	0.28–0.62	0.43	2.33–4.50	3.47

3) *Semisulcospira bensoni* (PHILIPPI) (Fig. 1-13) Pellets are roughly cigar-shaped, with bluntly pointed ends and uneven surface; coarse in texture, somewhat sandy in appearance, and yellowish brown in colour.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size					
		Breadth (B) mm		Length (L) mm		Ratio (L/B)	
		Range	Mean	Range	Mean	Range	Mean
9×19	3	0.28–0.42	0.34	1.80–1.94	1.86	4.29–6.93	5.66

4) *Semisulcospira bensoni reiniana* (BROT) (Fig. 1-2) Pellets are elongate and ellipsoidal in form and with four or five weak compressions on the surface. They are bluntly pointed at each end, but frequently one end may be pointed more acutely. Colour varies from dark green to greenish brown or greyish brown, with the nature of pellets. The darkly coloured pellets are uniform in shape, with no surface sculptures, and fine and firm in consistency, while the lightly coloured ones are somewhat irregular in outline, with faint compressions on the surface, and coarse and soft in consistency.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size					
		Breadth (B) mm		Length (L) mm		Ratio (L/B)	
		Range	Mean	Range	Mean	Range	Mean
22.5+(shell alt.)	6	0.30–0.40	0.33	1.40–2.00	1.70	4.50–6.33	5.14
10.0+(")	2	0.26–0.30	0.28	1.00–1.20	1.10	3.33–4.62	3.98
9.5+(")	6	0.23–0.26	0.25	0.90–1.22	1.01	3.60–4.87	4.06
				Average mean ratio			4.51

5) *Semisulcospira bensoni trachea* (WESTERLUND) (Fig. 1-4) Pellets are generally cigar-shaped and with uneven surface. The pellets coloured dark green are rather uniform in shape, with several weak compressions on the surface, fine in texture and firm in consistency; while those coloured grey brown are somewhat flocculent, no compressions on the surface, coarse in texture and soft in consistency.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size					
		Breadth (B) mm		Length (L) mm		Ratio (L/B)	
		Range	Mean	Range	Mean	Range	Mean
?	6	0.24–0.51	0.35	1.38–2.32	1.80	3.80–9.67	5.50

6) *Semisulcospira* sp. (Fig. 1-14) Pellets are cigar-shaped, with bluntly pointed ends. The surface is uneven and chapped by occasional clefts, texture is rather coarse and colour brownish.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size		
		Breadth (B) mm	Length (L) mm	Ratio (L/B)
28.5 (shell alt.)	1	0.60	3.15	5.25

7) *Naticarius concinnus* (DUNKER) (Fig. 1-5) Faeces are usually shed as indefinite mucoid masses which are composed of a large quantity of mucus mixed with well-digested food particles, shell pieces of bivalves, some sand grains and other skeletal matters. The colour is grey yellow. Rarely, however, ovoid pellets, measureing about 0.6 mm × 0.8 mm and with fine texture may be produced.

8) *Eunaticina papilla* (GMELIN) Faeces are dark grey and quite indefinite in shape. They are composed almost of food particles laden with mucus and mixed with partially digested fragments and some sand grains.

9) *Primovula rhodia* (A. ADAMS) (Fig. 1-3) Pellets are normally oval and with fine texture, but sometimes may be ellipsoidal or droplet-shaped. They are coloured black, this is appearantly due to their peculiar food, polyps of a gorgonid, *Euplexaura crassa* KÜKENTHAL, on which the present snail is living parasitically.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size				
		Breadth (B) mm	Length (L) mm		Ratio(L/B)	
			Range	Mean	Range	Mean
10.5(shell alt.)	2	0.17	0.40–0.43	0.42	2.35–2.53	2.44
12.5(")	3	0.21	0.45–0.50	0.48	2.14–2.38	2.27
			Average mean ratio			2.34

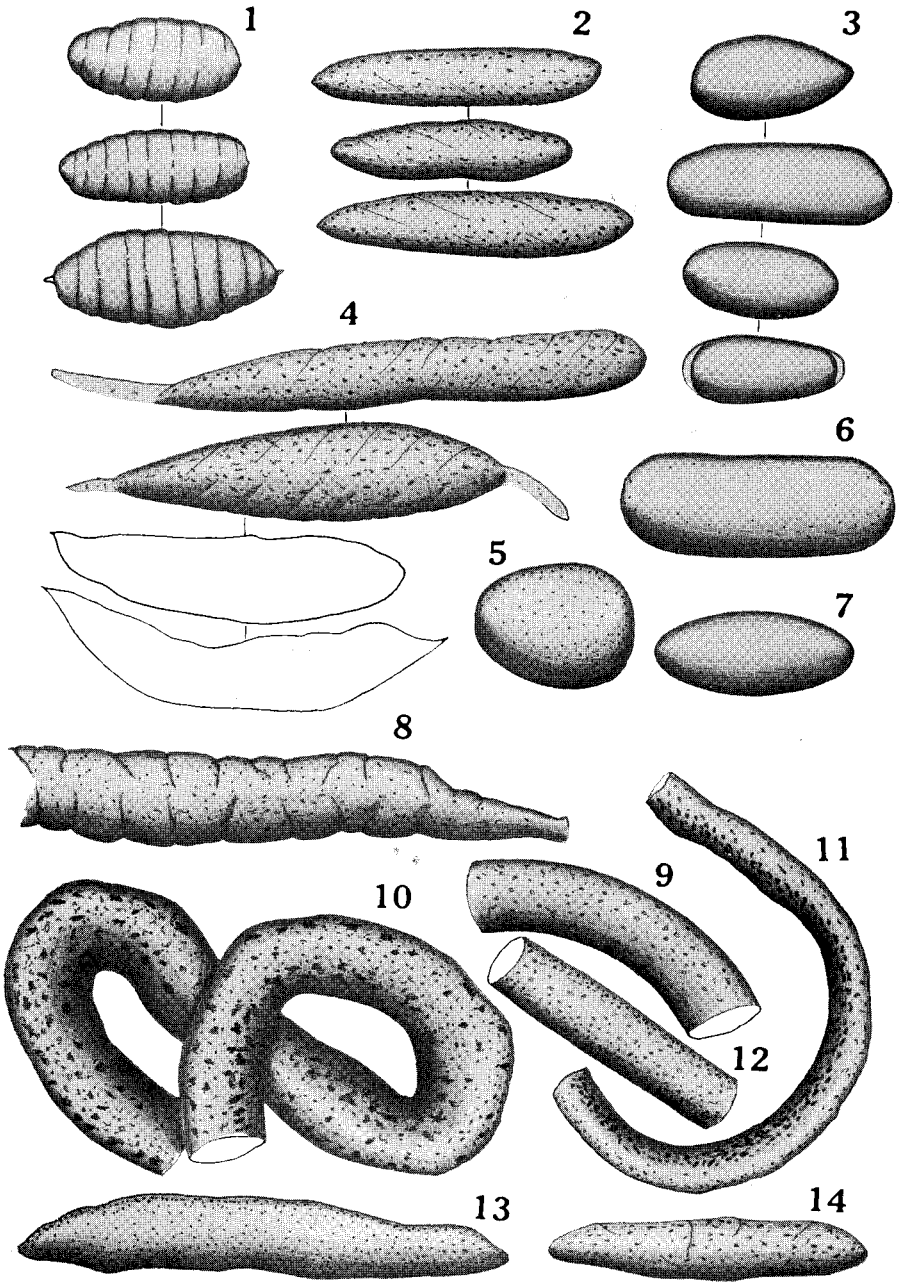

Fig. 1. Faecal pellets of: 1. *Apollon natator* 2. *Semisulcospira bensoni reiniana* 3. *Primovula rhodia* 4. *Semisulcospira bensoni trachea* 5. *Naticarius concinnus* 6. *Cantharus cecillei* 7. *Inquisitor jeffreysi* 8. *Siphonalia cassidariaeformis* 9. *Physa acuta* 10. *Phaedusa digonoptix comes* 11. *Tyrannophaedusa bilabrata* 12. *Liola laeta* 13. *Semisulcospira bensoni* 14. *S.* sp.

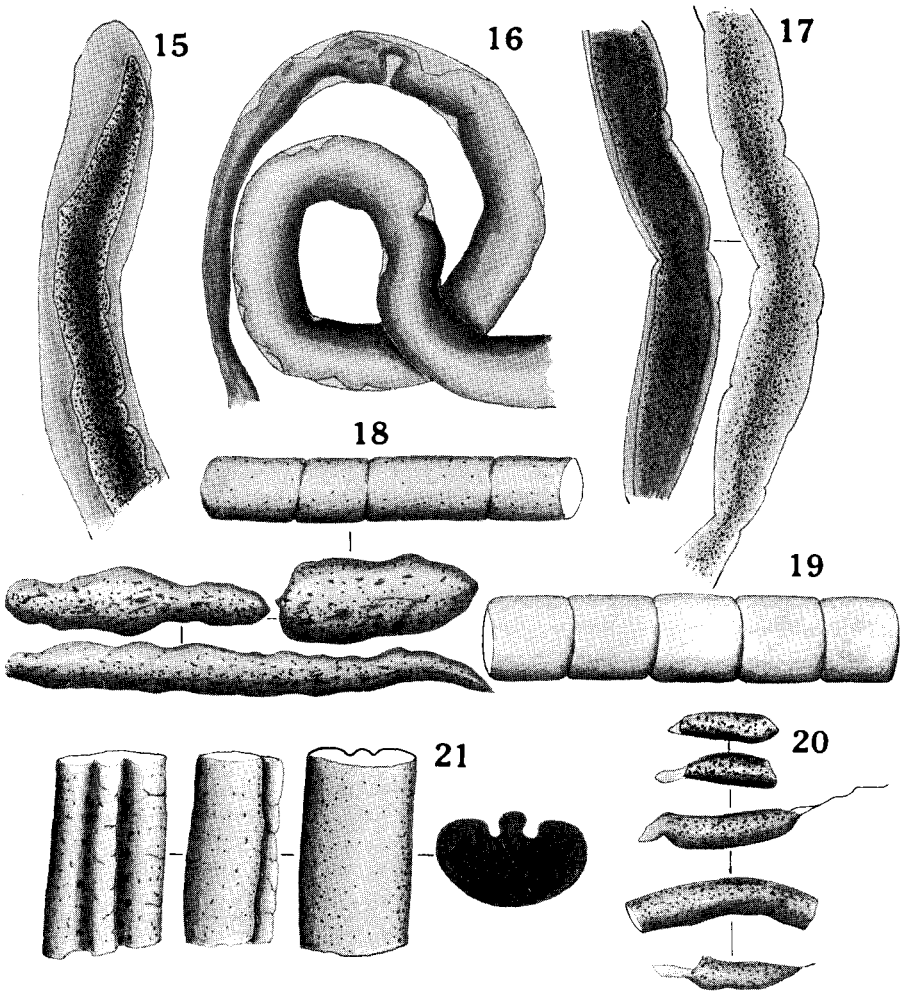

Fig. 2. Faecal pellets of: 15. *Hydatina physis* 16. *Notarchus leachi leachi* var. *freeri* 17. *Aplysia oculifera* 18. *Dendrodoris nigra* 19. *Panope japonica* 20. *Macroschisma dilatata* 21. *Stomatella lintricula* (left to right: ventral, lateral, dorsal side and cross section)

10) *Apollon natator* (RÖDING) (Fig. 1-1) Pellets are ellipsoidal or sometimes oval and annulated with nine to twelve faint compressions which give them an appearance of a shrinked bag-worm. They are rather fine in texture and grey green in colour.

Measurements:

Size of producer mm	Number of pellets examined	Pellet-size				
		Breadth (B) mm	Length (L) mm		Ratio (L/B)	
			Range	Mean	Range	Mean
38.0(shell alt.)	4	0.60	0.91–1.40	1.21	1.52–2.33	2.02

The ends are normally rounded, but occasionally less rounded or beset with a small process.

11) *Indomitrella lischkei* (SMITH) This snail produces flocculent pellets which are composed almost entirely of mucoid materials mingled with well-digested fine food particles.

12) *Cantharus cecillei* (PHILIPPI) (Fig. 1-6) Faeces are released as indefinite mucoid masses, or sometimes as ellipsoidal pellets with rounded ends. They are coarse in texture and brownish grey in colour.

Measurements:

Size of producer mm	Pellet-size		
	Breadth (B) mm	Length (L) mm	Ratio(L /B)
29.0(shell alt.)	0.60	1.60	2.67

13) *Siphonalia cassidariaeformis* (REEVE) (Fig. 1-8) Faecal rods from this snail are irregular in thickness, even in the same rod, and with the surface uneven, and marked with many occasional transverse clefts. They are coarse in texture, sandy in appearance, and dark brown in colour, variegated with white and grey patches.

Measurements:

Size of producer mm	Breadth of faecal rod mm
39.0(shell alt.)	0.45–1.64

14) *Inquisitor jeffreysi* (SMITH) (Fig. 1-7) This snail discharges indefinite faecal masses embedded in a large amount of mucoid matter, which occasionally may take an ovoid form with fine surface-texture.

Measurements:

Size of producer mm	Pellet-size		
	Breadth (B) mm	Length (L) mm	Ratio (L/B)
49.0(shell alt.)	0.22	0.45	2.05

15) *Virroconus fulgetrum* (SOWERBY) This conid snail produces indefinite mucoid faecal masses which are composed mainly of well-digested fine particles.

16) *Chelyconus fulmen* (REEVE) Faeces are voided as quite irregular mucoid masses which are composed of well-digested fine materials as in the preceding species.

17) *Hydatina physis* (LINNÉ) (Fig. 2-15) Faecal rods are irregularly shaped and usually shed in a large quantity of mucus. They are dark green in colour and very soft in consistency.

Measurements:

Size of producer mm	Breadth of faecal rod mm
21.0(shell alt.)	0.22–0.30

18) *Liola laeta* (GOULD) (Fig. 1-12) Faeces are simple rods, coarse in texture, sandy in appearance, and greenish grey in colour.

Measurements:

Size of producer mm	Breadth of faecal rod mm
15.0(shell alt.)	0.59

19) *Aplysia (Varria) oculifera* ADAMS & REEVE (Fig. 2-17) Faecal rods are rather irregular in breadth, translucent and yellowish grey in colour. They are composed almost of a large amount of gelatinous matters mixed with well-digested particulate materials.

Measurements:

Size of producer mm	Breadth of faecal rod mm
?	0.18–0.37

20) *Aplysia* sp. Faecal rods are constricted at irregular intervals. They are dark green and composed of well-digested fine materials mixed with a considerable amount of gelatinous substance.

Measurements:

Size of producer mm	Pellet-size				
	Breadth (B) mm	Interval of constrictions (C) mm		Ratio (C/B)	
		Range	Mean	Range	Mean
?	0.26	0.36–1.08	0.64	1.39–4.15	2.45

21) *Notarchus (Bursatella) leachi leachi* var. *freeri* (GRIFFIN) (Fig. 2-16) Faecal rods are very irregular in breadth, translucent and deep green to greyish white in colour.

Measurements:

Size of producer mm	Breadth of faecal rod mm
?	0.30–1.50

22) *Dendrodoris (D.) nigra* (STIMPSON) (Fig. 2-18) Faecal rods from this nudibranch are rather variable in form. They are normally simple rods plainly surfaced, occasionally, however they are constricted or twisted, or rarely cut into ellipsoids of varying lengths; fine but not homogeneous in texture, khaki yellow or chocolate grey in colour.

Measurements:

Size of producer mm	Pellet-size					
	Breadth (B) mm		Interval of constrictions (C) mm		Ratio (C/B)	
	Range	Mean	Range	Mean	Range	Mean
35.0(body length)	0.16–0.23	—	—	—	—	—
42.0(»)	0.45–0.90	0.61	2.10–5.00	2.84	2.33–10.00	5.10

23) *Physa acuta* (DRAPARNAUD) (Fig. 1-9) Faeces are simple rods surfaced plainly and usually shed broken in small lengths, rather coarse and not homogeneous in surface-texture.

Measurements:

Size of producer mm	Breadth of faecal rod mm
11.0(shell alt.)	0.60
14.0(»)	0.75

24) *Phaedusa (Euphaedusa) digonoptix comes* (PILSBRY) (Fig. 1-10) Rods are composed of partially digested vegetable fragments and other indigested materials and vary **in** colour from dark brown to green with the nature of food taken. Their surface is plain and very coarse in texture.

Measurements:

Size of producer mm	Breadth of faecal rod mm
12.0(shell alt.)	0.16

25) *Tyrannophaedusa (Decoliphaedusa) bilabrata* (SMITH) (Fig. 1-11) Faecal rods are simple, composed of vegetable fragments and other indigested food, and coloured green; the surface is uneven and coarse in texture.

Measurements:

Size of producer mm	Breadth of faecal rod mm
26.0(shell alt.)	0.45

26) *Panope japonica* A. ADAMS (Fig. 2-19) Faecal rods are constricted at regular intervals and occasionally shed broken in ovoid pieces. They are soft in consistency, very fine and homogeneous in surface-texture.

Measurements:

Size of producer mm	Pellet-size		
	Breadth (B) mm	Interval of constrictions (C) mm	Ratio (C/B)
58.0(shell alt.)	0.80	1.30	0.62

SUPPLEMENTARY NOTES

1. *Macroschisma dilatata* A. ADAMS Faeces were described as plain rods with circular section (ARAKAWA, 1968: p. 129). Further observations upon the specimens collected from Habu-shima Island, the Inland Sea of Japan, showed that faeces are shed in short rods with ends variable in structure: simply broken, pointed, protruded out, or sometimes with hairy appendage (Fig. 2-20), according to the kind and amount of food taken.

2. *Murexsul cirrosus* (HINDS) The faecal pellets ever described for *Latiaxis pagodus* (A. ADAMS) (ARAKAWA, 1968: p. 135) should be for *Murexsul cirrosus*. My misidentification was pointed out by Dr. Katura OYAMA, to whom my thanks are due.

3. *Stomatella lintricula* (A. ADAMA) The faecal pellets from the specimens taken from the depth of 40 m off Tomioka, Chijiwa Bay were described as of the typical trochid type (ARAKAWA, 1968: p. 130). Further examination upon the material collected on the shore of Habu-shima Island, the Inland Sea of Japan revealed that the pellets can be somewhat aberrant, missing the elaborate superficial lateral scultpure which is regarded as one of the remarkable faecal characteristics of this group (Fig. 2-21). MOORE (1932) has already recorded a phenomenon similar to this in several species of British trochids, such as *Gibbula cineraria* (L.), *G. magus* (L.) and *Calliostoma zizyphinum* (L.), stating"—the surface of pellets of animals collected in deep water is usually rougher than that of specimens from the littoral zone." To clarify what the cause was, he made a simple experiment with *G. cineraria* by feeding it with a pure algal culture, but he could not gain any positive results.

REFERENCES

ARAKAWA, K. Y. (1968): Studies on the Molluscan Faeces (III). Publ. Seto Mar. Biol. Lab., XVI (2), 127–139.

ITAGAKI, H. (1960): Anatomy of *Semisulcospira bensoni*, a Freshwater Gastropod. Jap. Jour. Malac., The Venus, 21 (1), 41–50.

———— (1965): Anatomy of *Parafossarulus manchouricus* BOURGUINAT (Bithyniidae). Ibid. 24 (3), 169–180.

MOORE, H. B. (1932): The Faecal Pellets of Trochidae. Jour. Mar. Biol. Ass. U. K., 18 (1), 235–242.