Title	SUPPLEMENTARY NOTES ON THE ANATOMY OF METARUNCINA SETOENSIS (BABA, 1954), (N. G.) (OPISTHOBRANCHIA-CEPHALASPIDEA)
Author(s)	Baba, Kikutaro
Citation	PUBLICATIONS OF THE SETO MARINE BIOLOGICAL LABORATORY (1967), 15(3): 185-197
Issue Date	1967-10-30
URL	http://hdl.handle.net/2433/175467
Right	
Type	Departmental Bulletin Paper
Textversion	publisher

SUPPLEMENTARY NOTES ON THE ANATOMY OF *METARUNCINA SETOENSIS* (BABA, 1954), (N.G.) (OPISTHOBRANCHIA-CEPHALASPIDEA)[1]

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With Plates II–V

The species which forms the subject of this paper was originally reported by me as *Runcina setoensis* BABA, 1954. After that paper was published, there was found in the years 1955～1959 a great increase in the population of *Runcina* around the type locality, and part of them were used as the material for the studies of their spawn and developing embryos in the laboratory (BABA and HAMATANI, 1959). With this advantage of having abundant material at my disposal, I decided to go further to make more detailed accounts of the species on the basis of a microscopic study of the animals.

In the beginning of October, 1963, I had fortunately chances to discuss with Dr. M.T. GHISELIN, who was at Seto at that time, about the phylogeny of the Runcinidae. His ingenious ways of research on *Runcina* brought him successful results (GHISELIN, 1963) and stimulated me as valuable suggestions for my subsequent works. Before going to summarize my studies, I have to mention that I was affected partly by Mr. R. BURN (1963): he showed his talent in the systematic classification of *Runcina* and its allies.

Metaruncina BABA, n. g.

Most closely allied to *Ildica* BERGH, 1889 (type: *I. nana* BERGH, 1889.—Mauritius) in the possession of a single cephalaspidean gill on the right posterior side of body, but differentiated from it in having a greatly degraded radula which remains in a triseriate type (1.1.1.) in *Ildica*. Shell posterior, terminal, internal in *Metaruncina*, and external (?) in *Ildica*. Genitalia without a spermatheca (bursa copulatrix).

Type: *Runcina setoensis* BABA, 1954.

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Publ. Seto Mar. Biol. Lab., XV (3), 185-197, 1967. (Article 11)

Metaruncina setoensis (BABA, 1954)

Runcina setoensis BABA, 1954, pp. 373–374, text-fig. 1.—Seto, Kii; BABA & HAMATANI, 1959, pp. 281–290, pl. 22, figs. 1–19; pl. 23, figs. 1–10; pl. 24, figs. 1–7 (direct development).—Seto, Kii.

Dissection work under a binocular microscope was made usually on live specimens taken from the sea. For histological examination eighteen specimens listed below were used in serial preparations.

Sp. Nos. 1–4.	Oct. 12, 1958. (H.S.)	Sp. Nos. 9–12.	Oct. 4, 1959. (L.S.)
Sp. Nos. 5–7.	Oct. 5, 1959. (H.S.)	Sp. Nos. 13–14.	Oct. 12, 1958. (T.S.)
Sp. No. 8.	Oct. 12, 1958. (L.S.)	Sp. Nos. 15–18.	Oct. 4, 1959. (T.S.)

They were all in a matured state each. The fixative in general use was that of BOUIN; only the specimens Nos. 5 to 7 were fixed with NAVASHIN's fluid. The dyes for many of the preparations were DELAFIELD's haematoxylin and eosin; a selective mucus staining by toluidine blue was applied to a single case of the specimen No. 4.

Externals: The general body-form and colours were approximately as shown previously (BABA, 1954; BABA & HAMATANI, 1959). The gill in this species was rightly discussed by GHISELIN (1963, pp. 391–392). It is single, attached to the right posterior side of body, and freely projecting behind. The pinnae, 4–6 in number on each side of the rachis, are arranged alternately. The first rudiment of the gill is to be seen on a young individual immediately after hatching (BABA & HAMATANI, 1959, text-fig. 1A). It is notable that such a cephalaspidean gill is possessed in common only by two of the different genera, *Ildica* and *Metaruncina* (cf. BURN, 1963, p. 19). In *Runcina* (in a restricted sense) the gill is right posterior in position, but it consists of 2–3, paucipinnate plumes (cf. BURN, 1963, pp. 20, 21). In the genera *Runcinida* and *Runcinella* the gill is formed of 4–5, paucipinnate plumes which are set in a semi-circle round the anus (cf. BURN, 1963, p. 21). The anus is posterior and median as usual. In *Metaruncina* the opening of the opaline gland lies just to the left of the anus (in *Runcinida* this opening is low down the level of anus, on the left of the median line). From the opening of the opaline gland there occurs an occasional jet of colourless, hyaline mucous matter which encloses whitish grains as the products of the opaline gland proper (cf. GHISELIN, 1963, p. 390).

In *Metaruncina* the common genital orifice lies moderately apart from the gill (in *Runcinida* and *Runcinella* it is found rather closely in front of the gill). The copulatory behavior (including the act of transmission of spermatophores) stated by GHISELIN (1963, pp. 394–395) has repeatedly been confirmed by me. The male orifice opens on the right side of the mouth (in *Runcinida* it comes more closely to the mouth). The external seminal groove and the foldings of the HANCOCK's organs are as shown by GHISELIN.

The shell of *Metaruncina* varies greatly in form according to specimens. Typically it is of an elongated haliotiform, highly flattened, more or less widened in front but narrowed to a produced rostrum behind, and marked on the surface with fine growthlines; in consistency it is calcareous, opaque and whitish. The total length of the shell ranges from 0.2 mm to 0.4 mm. As was reported previously (BABA & HAMATANI, 1959, p. 284), the shell of *Metaruncina* begins to develop within the mantle-tissue at an early stage of intra-capsular veliger, and is kept as a complete internal shell throughout the life of the animal. Hence there is no formation of a protoconch on the rostrum of the shell in question. The external (?) shell of *Ildica* needs to be re-examined on fresh material. *Ildica divae* of MARCUS & MARCUS, 1963 has a true nautiloid shell.

The whole outer surface of the body including the mantle, sides, gill and sole is covered with fine cilia.

Internals: The jaw-plates and radula are nearly as given before (BABA, 1954, p. 373; see also GHISELIN, 1963, p. 391). The paired salivary glands are long, band-like and colourless. The alimentary canal (oesophagus and intestine) is yellow-pigmented, its lumen having a strong ciliary current in a fresh state. The oesophageal diverticulum lies a short distance in front of the gizzard. It appears to be a simple blind sac without a secretory structure. It is only slightly ciliated internally. The gizzard plates, colourless when fresh, show each a series of 11–12, acutely pointed laminae in side view. The stomach does not form a well defined chamber. It is accompanied by paired liver-lobes which are symmetrical in the intra-capsular veliger stage (BABA & HAMATANI, 1959, p. 284), but later these structures acquire an asymmetry. Thus in the adult the right liver which is the smaller of the two takes an antero-ventral position; the left liver is decidedly larger than the right one and lies postero-dorsal to the stomach. The oesophagus passes into the stomach at its antero-ventral corner on the left side; the intestine leaves the antero-dorsal corner of the stomach, and runs down as far as to the postero-median anus. The intestine has an internal longitudinal fold at its origin from the stomach. The liver-mass in fresh is generally of an ashy yellowish brown. Under the microscope the liver cells appear to take different facies as follows: (1) some are filled with clear and colourless granules which tend to be easily destroyed in the sectioned material; (2) some are packed with mostly fine granules of a dull colour, and (3) others contain coaser, yellow-tinted granules. The contents of the cell-types (2) and (3) may remain as they were before on mounted sections.

The opaline gland consists of a moderate number of compound glandules intermingled with smaller mucous cells. In a fresh state each of the compound glandules is formed of cells full of whitish grains (these latter, however, may easily be destroyed by a fixing fluid). Externally it is covered by a muscular layer which apparently controlls the contraction of the body of the glandule. The whole organ of the opaline gland has a common lumen which opens to the exterior through a small pore. An actual case of secretion from the opaline gland was already noted before. Lying just below the shell and located above the rectum there is a small compound gland of unknown function. Its duct opens at a point immediately above the posterior insertion of the gill, and so this gland is named tentatively as a supra-branchial gland.

The central nervous system of *Metaruncina* was studied and discussed with some reservations by GHISELIN (1963, pp. 392–393). Unfortunately I have not been able to prepare much informations of this system on the basis of my own research material. The primitively cephalaspidean character of the central nervous system of the runcinid is shown by the possession of strongly ganglionated nerves (labial and olfactory nerves) supplied from the cerebro-pleural (here identified as such by the presence of the pleural nerves) ganglia to the HANCOCK's organ on either side of the head (cf. GUIART, 1901, fig. 55.—*Scaphander*). A tendency of great shortening of the visceral loop occurs in some small-sized forms (*Philinoglossa*, etc.) of the Opisthobranchia (GHISELIN, 1963, p. 395). It seems likely that the ganglionic mass (RP+ of GHISELIN, 1963) just behind the right cerebro-pleural ganglion consists mainly of the supra-intestinal elements. It takes its position on the dorsal side of the oesophagus. The ganglionic mass (LP+ of GHISELIN) immediately behind the left cerebro-pleural ganglion may be presumed as having been formed by the union of the infra-intestinal and the visceral ganglia. This mass is as large as the right-sided partner, and lies below the oesophagus. Only it must be remarked that the fine nerves from the visceral loop remained undetermined on the microscopic preparations. The statocysts contain each a single statolith. There is no formation of an osphradium.

The heart occupies its position in the right posterior part of the haemocoele (cf. *Pluscula* of MARCUS, 1953, and *Philinoglossa*). The auricle receives blood from the lacunar system of the gill. On the serial preparations the aorta appears to pass forward to open directly into the haemocoele. The kidney is a spacious sac lying to the left side of the vascular system. It is combined with the pericardium by a simple reno-pericardial canal. The nephroproct is found just below the anterior insertion of the gill. There occur abundant plasma cells wandering about in the lacunose subepithelial connective tissue and in the haemocoele. Amoebocytes were found gathered especially within the lacunae of the gill.

The gonad is seen at about the middle of the body and located to the right of the median line. It consists of a single elongated testis accompanied on the periphery by a moderate number of ovarian follicles. These follicles may assume each a rusty brown tint owing to the eggs matured within. Posteriorly the gonad passes to form a slightly bulged sac (ampulla) for keeping endogenous sperms. Then follows the pallial part of gonoduct with an accessory female gland mass filling the hindmost lumen of the haemocoele. The details of the pallial gonoduct, however, could not satisfactorily be analized from the viewpoint of functional anatomy (cf. GHISELIN, 1963, p. 394). Distally the seemingly monaulic canal of the pallial gonoduct in *Metaruncina* has no formation of a spermatheca (bursa copulatrix) for the reception of introduced spermatophores (a stalked spermatheca is clearly present in *Runcinida*). The male copulatory organ consists of three parts: the penis sac, the prostate, and the spermatic bulb (GHISELIN, 1963, p. 394). In a live animal the whole organ is greatly extensible or contractile owing to the muscular covering containing circular and longitudinal fibres. The everted penis sac acts as a temporary penis. The prostate is yellow-pigmented, and the spermatic bulb has a melanin-black epithelium. It is to be added that a spermatic bulb is present also in the copulatory apparatus of *Runcinida.*

Systematical Notes

When making a general survey of the genera and species of the Runcinoidea, it was felt necessary to pay a special attention to the nautiloid shell possessed by *Ildica divae* MARCUS & MARCUS, 1963 from Curaçao. The external (?) shell of the digested animal of *Ildica nana* BERGH, 1889 cannot rightly be accepted. It is very unfortunate that the type of *Runcina* FORBES, 1851 has long been left without being anatomized exactly by later investigators. The sole external feature to be found in this type concerns the gill. So I am going to prepare below a re-arrangement of all the genera of the Runcinoidea on the basis mainly of the comparison of their gill characters. This does not mean, however, to neglect the systematic classification of the Runcinoidea advanced by BURN (1963, pp. 19–22).

Superfamily Runcinoidea

Family Runcinidae. Shell reduced to a non-convoluted internal shell, or it may be missing altogether.

A. A single cephalaspidean gill on the right posterior body-side.
   1. *Ildica* Bergh, 1889. Type: *Ildica nana* BERGH, 1889.—Mauritius. Radula 1.1.1. Shell posterior, terminal, and external (?).
   2. *Metaruncina* BABA, n.g. Type: *Runcina setoensis* BABA, 1954.—Seto, Kii. Radula greatly reduced, not in distinct rows. Shell posterior, terminal, and completely internal in formation.

B. Gill formed of 2–3 separate plumes, these being right posterior in position.
   1. *Runcina* FORBES, 1851. Type: *Runcina hancocki* FORBES, 1851=*Pelta coronata* QUATREFAGES, 1844.—England. Radula and shell unknown. Several species have hitherto been referred provisionally to this genus.

C. Gill formed of 4–5 separate plumes set in a semi-circle round the posterior median anus. A shell absent.
   1. *Runcinella* ODHNER, 1924. Type: *Runcinella zelandica* ODHNER, 1924.—New Zealand. Radula 2.1.2.
   2. *Runcinida* BURN, 1963. Type: *Runcina elioti* BABA, 1937.—Amakusa. Radula 1.1.1.

D. Gill missing.
   1. *Ilbia* BURN, 1963. Type: *Ilbia ilbi* BURN, 1963.—Victoria. No shell. Radula 1.1.1.

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BOETTGER, C.R. 1955. Die Systematik der euthyneuren Schnecken. Zool. Anz., Suppl., Bd. 18. (Runcinidae)

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CRAWFORD, T. 1965. Some molluscs associated with *Posidonia* weed at Flinders, Victoria. Australian Newsletter, vol. 13, no. 50. (*Ilbia ilbi*)

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FORBES, E. 1851. In: A history of British molluscs and their shells. vol. 3. (*Runcina hancocki,* not directly referred to)

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——— 1963. Opisthobranchs from the Lesser Antilles. Studies on the fauna of Curaçao and other Caribbean islands, vol. 19. (*Ildica divae*)

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MÖRCH, M.O.A.L. 1863. Contributions à la faune malacologique des Antilles danoises. Journ. Conchylio., vol. 11. (*Pelta prasina*)

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Postscript

1. Additional specimens of *Runcinida elioti* (BABA, 1937) have been collected from several stations of our seas. Anatomical notes of this species will be prepared in a separate paper.

2. In my report of *Volvatella* of July, 1966, I could not refer to *V. ficula* BURN, 1966, a species which had been recorded from Fiji. Some of the southern Pacific species of *Volvatella* will tentatively be taken up as below: (i) *V. fragilis* PEASE, 1860 (Hawaii; live animal white); (ii) *V. evansi* (KAY, 1961) (Hawaii; live animal orange); (iii) *V. ficula* BURN, 1966 (Fiji; live animal creamy white); (iv) *V. vigourouxi* (MONTROUZIER, 1861) (New Caledonia; shell only); and (v) *V. kawamurai* HABE, 1946 (Okinawa and Amami Groups; colour of live animal unknown).

Literature: BURN, R. 1966. The opisthobranchs of a caulerpan microfauna from Fiji. (*Volvatella ficula*); KAY, A. 1961. A new opisthobranch mollusc from Hawaii. Pac. Sci., vol. 15, no. 1. (*Arthessa evansi*)

3. Two of the latest works by BURN (1965 and 1966) have given us solid grounds for establishing advanced taxonomy of the recent taxa of the bivalved sacoglossans. Privately I am going to agree with him, and *Edenttellina*, *Tamanovalva* and *Midorigai* are accepted as distinct from one another either conchologically or anatomically. Now the specific name *T. limax* KAWAGUTI & BABA, 1959 stands as it was first pub-

lished. *Tamanovalva* comprises also a number of exotic species such as *T. corallensis* (HEDLEY, 1920) (Australia), *T. babai* BURN, 1965 (=*Berthelinia typica* BURN, 1960) (Australia), *T. fijiensis* BURN, 1966 (Fiji), *T. chloris* (DALL, 1918) (Baja California), and some others. *Berthelinia*, (?) *Anomalomya* and *Cossmannella* (=*Ludovicia*) are fossil genera, the first of these being based on an undifferentiated larval shell.

Literature: BURN, R. 1965. Rediscovery and taxonomy of *Edenttellina typica* GATLIFF and GABRIEL. Nature, vol. 206, no. 4985;———1966. The opisthobranchs of a caulerpan microfauna from Fiji. (*Tamanovalva fijiensis*)

4. In response to the suggestion by BURN, 1966, it was decided to create a new genus as follows: *Embletoniella* BABA, n. g. Type: *Embletonia paucipapillata* BABA & HAMATANI, 1963. This new genus is distinguished from *Embletonia* ALDER & HANCOCK, 1851 by the branchial papillae which are marked each with four apical twigs, and by having a prostatic and unarmed penis. *Embletonia gracilis* of RISBEC, 1928 belongs to this new genus, but it was not satisfactorily anatomized. Now the two species of *Embletoniella* are shown thus: (i) *E. paucipapillata* (BABA & HAMATANI, 1963) (Japan) and (ii) *E. gracilis* (RISBEC, 1928) (New Caledonia, Australia, and Japan).

Literature: BABA, K. 1959. A new record of an interesting species, *Embletonia gracile* RISBEC, from Japan (Nudibranchia-Eolidacea). Publ. Seto Mar. Biol. Lab., vol. 7, no. 3; BABA, K. & HAMATANI, I. 1963. Anatomy of *Embletonia gracilis paucipapillata* n. ssp. from Osaka Bay, Japan (Nudibranchia-Eolidoidea). Publ. Seto Mar. Biol. Lab., vol. 11, no. 2; BURN, R. 1966. Descriptions of Australian Eolidacea (Mollusca: Opisthobranchia). 3. Journ. malac. Soc. Australia, no. 9. (*Embletonia gracilis*); LEMCHE, H. 1964. *Embletonia* ALDER & HANCOCK, 1851 (Gastropoda): proposed validation under the plenary powers. Z.N. (S.) 1100. Bull. zool. Nomencl., vol. 21, pt. 2.

5. Some of the species of the Aeolidiidae from our seas will provisionally be designated as below:

(i) *Berghia amakusana* (BABA, 1937) =*Baeolidia major amakusana* BABA, 1937. This name change follows MARCUS', 1958. *Baeolidia major* ELIOT, 1903, from the sea round its type locality Zanzibar, is hoped to be revised. Recently the species *amakusana* was found from the Gulf of California (FARMER, 1966). (ii) *Berghia japonica* (BABA, 1937) =*Baeolidia japonica* BABA, 1937. This name change follows MARCUS', 1958. I have a plan to make a complete anatomy of this species at any chance in future. (iii) *Limenandra fusiformis* (BABA, 1949) =*Baeolidia fusiformis* BABA, 1949. This name change was suggested by HAEFELFINGER & STAMM, 1959. Specimens of this species will also be revised by me in the future.

Literature: FARMER, W. 1966. Range extension of *Berghia amakusana* (BABA) to the east Pacific. Veliger, vol. 9, no. 2; HAEFELFINGER, H.R. & STAMM, R.A. 1959. *Limenandra nodosa* gen. et sp. nov., un opisthobranche nouveau de la Méditerranée. Vie et Milieu, tom. 9, fasc. 4; MARCUS, Er. 1958. On western Atlantic opisthobranchiate gastropods. Amer. Mus. Novitates, no. 1906. (*Baeolidia*)

EXPLANATION OF PLATES II-V

Metaruncina setoensis. All the specimens for this study were collected from the shores around the Seto Marine Biological Laboratory, Seto, Kii, Middle Japan, during the years 1951–65.

PLATE II

Fig. 1. Matured specimen in an actively crawling position (Aug. 1, 1963). Measurements (after the Codes in Dorids): total body-length from head to tail-tip (Code A) 6 mm; mantle-length (Code Am) 4 mm; mantle-width (Code M) 1 mm; mantle-height (Code H) 1 mm; tail-length (Code C) 2 mm; sole-width (Code B) 1 mm; gill-length 0.8 mm. Mantle truncated or shallowly sinuated in front, obtuse behind, lateral margins parallel, tail projecting. General ground-colour above ashy yellow, wholly sprinkled with chocolate-brown spots, the melanin-black pigment prevailing at the centre of mantle, on mantle-margin, on sides, on foot-margin, and on median line of tail. Paired eyes shining through, the internal shell usually not visible from outside. Gill deep black. a. cluster of chocolate-brown pigment cells, b. rachis of gill, c. lateral pinnae of gill, d. anus.

Fig. 2. The same animal in a resting position. b. male genital orifice (actually this is more close to mouth), c. external seminal groove, d. common genital orifice, e. spermatophores (1–2) erroneously planted near the genital orifice, f. gill, g. anus, h. opening of opaline gland, i. position of internal shell. The spermatophores are papilliform, and opaque white in appearance.

Fig. 3. A resting animal from right side (Oct. 6, 1963). a. everted penis sac forming a whitish cone of temporary penis, b. feeble foldings of HANCOCK's organ visible on under side of mantle-margin, c. external seminal groove, d. common genital orifice, e. nephroproct (secured by serial sections), f. gill, g. anus, i. secretion from the opening (h) of opaline gland, j. isolated epithelial cells with melanin pigment.

Fig. 4. The same animal from ventral side. Sole ashy yellow covered with chocolate-brown spots as above. a. external seminal groove, b. male genital orifice, c. mouth-slit. There is no formation of oral tentacles.

Fig. 5. The same animal as above. a. appearance of a temporary penis.

Fig. 6. Some of the differently shaped shells (×45). Fresh material. a-b (Aug. 1, 1963); c-d (Oct. 6, 1963).

Fig. 7. Pharyngeal bulb from above. Fresh material (Aug. 1, 1963). a. paired jaw-plates covered with spiny denticles (×130), b. group of rudimentary radula teeth (×180).

Fig. 8. General view of the central nervous system (×50). Fresh material (Oct. 6, 1963). Details supplemented by observation of serial preparations (Sp. No. 1 and others). a. buccal ganglion, b. cerebro-pleural ganglion, c. pedal ganglion,

d. supra-intestinal ganglion, e. infra-intestinal ganglion (plus visceral ganglion), f. nerve to buccal region, g. optic nerve (origin?), h. labial nerve (?=n. 3 of *Elysia*), i. olfactory (or tentacular) nerve (?=n. 1 of *Elysia*), j. visceral loop, k. statocyst, l. pleural nerves (?=n. 6 and n. 7 of *Elysia*), m. nerves from supra- and infra-intestinal ganglia (?=n. 8 of *Elysia*), n. nerve from visceral loop (?= visceral nerve of *Elysia*). Each of the pedal ganglia has 3 nerves (anterior, middle and posterior).

PLATE III

Fig. 1. Digestive system, diagrammatic. Main material: Sp. Nos. 1 and 6. a. small eosinophile glands opening into the mouth, b. HANCOCK's organ supplied with ganglionated nerves, c. cluster of large compound mucous glands opening ventrally into the mouth, d. salivary gland, e. right liver (right ventral in position), f. origin of intestine (dorsal to stomach), g. aorta, h. heart, i. reno-pericardial canal, j. nephroproct (situated below anterior insertion of gill), k. supra-branchial gland (opening just above the posterior insertion of gill), l. anus, m. internal shell, n. opening of opaline gland, o. kidney, p. accessory female gland mass (cup-shaped, slightly yellowish when fresh), q. left liver (left dorsal in position), r. lumen of stomach, s. gizzard, t. central nervous system, u. pharyngeal bulb.

Fig. 2. Cross section of body on level of stomach (×20). Material: Sp. No. 13. a. origin of intestine, b. testis part of gonad, c. ovarian follicles, d. external seminal groove, e. right liver, f. spermatic bulb, g. second part of oesophagus passing into stomach (i), h. left liver.

Fig. 3. Horizontal section of head region (×40). Material: Sp. No. 5. a. mouth opening, b. male genital orifice, c. group of rudimentary radula teeth, d. penis sac, e. odontophore, f. jaw-plates and their spiny denticles, g. branches of ganglionated nerves to HANCOCK's organ.

Fig. 4. Horizontal section of part of the alimentary canal (×25). Material: Sp. No. 1. a. first part of oesophagus, b. second part of oesophagus, c. muscular part of gizzard, d. gizzard plates, e. oesophageal diverticulum.

Fig. 5. Oesophageal epithelium containing yellow pigment granules (×270). Fresh material (Oct. 6, 1963).

Fig. 6. Cross-section of muscular part of gizzard (×35). Material: Sp. No. 10. Showing position of 4 gizzard plates.

Fig. 7. A gizzard plate (×50). Fresh material (Aug. 1, 1963).

Fig. 8. Isolated liver cells (×400). Fresh material (Oct. 6, 1963). a. liver cells with colourless granules, b. liver cells with dull-coloured granules, c. liver cells with yellow-tinted granules.

Fig. 9. Part of liver epithelium (×90). Material: Sp. No. 2. Letters as in Fig. 8.

Fig. 10. Part of liver epithelium (×100). Material: Sp. No. 1. Under higher

magnification the yellow-tinted granules may be seen included each within a vacuole. Letters as in Fig. 8.

Fig. 11. Cross section of intestine (a) and rectum (b) (×90). Material: Sp. No. 14. The excrement consists of fine granules of unknown nature.

Fig. 12. Intestinal epithelium containing yellow pigment granules (×270). Fresh material (Oct. 6, 1963).

Fig. 13. Horizontal section of opaline gland (×100). Material: Sp. No. 6. a. compound glandules, b. opening of opaline gland, c. common lumen of opaline gland, d. mucous cells, e. invaginated epithelium.

Fig. 14. Part of opaline gland (×150). Material: Sp. No. 1. a. external muscular layer, b. individual gland cells filled with eosinophile grains, c. lumen of the individual glandule, d. mucous cells.

Fig. 15. Individual glandule in the isolated state (×150). Fresh material (Oct. 6, 1963). b. individual gland cells filled with whitish grains. These gland cells may sometimes contain traces of yellow pigment.

Fig. 16. Cross section of opaline gland (×80). Material: Sp. No. 13. a. showing destruction of secretory grains into finer granulations, b. lumen of an individual glandule.

Plate IV

Fig. 1. Horizontal section of the right posterior part of body on level of the heart (×35). Material: Sp. No. 6. a. intestine, b. aorta, c. ventricle, d. auricle, e. reno-pericardial canal, f. nephroproct (situated below anterior insertion of gill), g. gill, h. anus, i. opening of opaline gland (j), k. rectum, l. lumen of kidney, m. left liver, n. testis part of gonad.

Fig. 2. Median longitudinal section of head region (×35). Material: Sp. No. 8. a. ovarian follicles, b. supra-intestinal ganglion, c. cerebro-pleural ganglion, d. oesophagus, e. buccal ganglion, f. branches of ganglionated nerves to Hancock's organ, g. pharynx, h. spiny denticles of jaw-plate, i. cuticular lining, j. mouth opening, k. pedal ganglion, l. cluster of large compound mucous glands, m. prostatic part of male copulatory organ, n. right liver, o. left liver.

Fig. 3. Submedian longitudinal section of posterior part of body (×35). Material: Sp. No. 8. a. left liver, b. gland C (?=mucous gland) of the accessory female gland mass, c. gland A (?=albumen gland) of the same, d. opening of opaline gland.

Fig. 4. Median longitudinal section of posterior part of body (×35). Material: Sp. No. 10. a. shell within a shell sac, b. supra-branchial gland, c. anus guarded by small eosinophile glands.

Fig. 5. Longitudinal section of posterior part of body, passing through heart (×35). Material: Sp. No. 11. a. testis, b. ovarian follicles, c. common gonoduct, d. lumen

of kidney, e. pedal epithelium with compound mucous glands, f. tail epithelium (melanin-pigmented), g. gill epithelium (melanin-pigmented), h. nephroproct (situated below anterior insertion of gill), i. venous blood vessel between gill and auricle (k), j. reno-pericardial canal, l. ventricle, m. aorta, n. intestine. There are muscle fibres within the tissue of the gill.

Fig. 6. Cross section of body on level of heart (×20). Sp. No. 13. a. ovarian follicles, b. testis, c. ventricle, d. intestine, e. kidney, f. common gonoduct, g. gland B (?=membrane gland) of accessory female gland mass, h. gland A (?=albumen gland) of the same, i. gland C (?=mucous gland) of the same, j. left liver.

Fig. 7. Cross section of body on level of posterior insertion of gill (×20). Material: Sp. No. 18. a. shell within a shell sac, b. supra-branchial gland, c. gill, d. rectum, e. opaline gland.

Fig. 8. Same as the structures a and b in Fig. 7 (×85).

Fig. 9. Differently shaped plasma cells each having eosinophile granules (×200). Material: Sp. No. 2.

Fig. 10. Amoebocytes in the lacunae of gill (×200). Material: Sp. No. 11.

Fig. 11. Epithelial cells of kidney, each containing a yellow concretion within a distal vacuole (×180). Material: Sp. No. 1.

PLATE V

Fig. 1. Genital system, diagrammatic. Main material: Sp. No. 1. a. everted penis sac acting as temporary penis, b. male genital orifice, c. normal position of penis sac, d. gonad consisting of a central testis and peripheral ovarian follicles, e. external seminal groove, f. common genital orifice, g. spermatophores erroneously planted near the genital orifice, h. accessory female gland mass, i. left liver, j. cluster of large compound mucous glands opening ventrally into mouth.

Fig. 2. General view of the male copulatory organ in an extended position. Fresh material (Oct. 6, 1963). a. male genital orifice, b. penis sac, c. prostate, d. spermatic bulb.

Fig. 3. Dissection of the male copulatory organ (×30). Main material: Sp. No. 1. a. low epithelium of penis sac, b. glandular epithelium of prostate, individual gland cells having eosinophile granules, c. freshly isolated gland cell having yellow pigment granules in addition to colourless secretory ones, d. cross section of spermatic bulb, e. muscular covering, f. melanin-pigmented epithelium, g. motionless sperms stored within.

Fig. 4. Male copulatory organ in a greatly contracted position. Fresh material (Aug. 1, 1963).

Fig. 5. A spermatophore showing sperms and prostate granules that are pressed out under microscope (×65). Fresh material (Oct. 6, 1963).

Fig. 6. Longitudinal section of body passing through the common genital opening (×35). Seen from right side. Material: Sp. No. 8. a. three spermatophores about to pass simultaneously into the common gonoduct (b).

Fig. 7. Horizontal section along the length of the gonad (×15). Sp. No. 1. a. testis (accumulation of melanin pigment granules occurs in the outer wall of testis), b. hermaphrodite duct (=preampullar portion of coelomic gonoduct), c. ampulla, d. ovarian follicles.

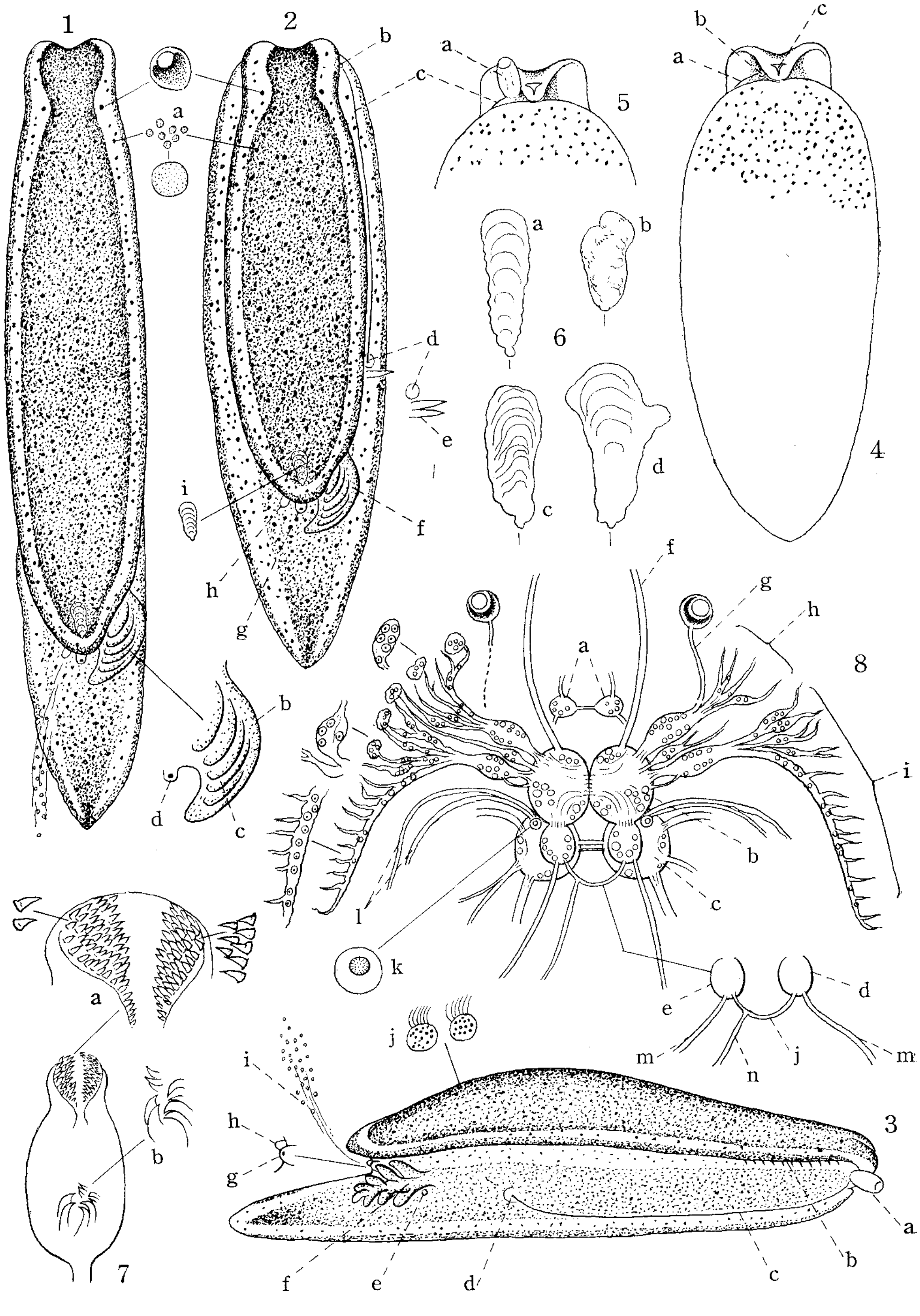
Fig. 8. Enlarged figure of ovarian follicle (a) and part of testis (b) (×60). Material: Sp. No. 18.

Fig. 9. Reconstructed genital organs from above, diagrammatic (×35). Main material: Sp. No. 1. a. spermatophore passing into common genital orifice (b), c. common gonoduct (=distal canal of pallial gonoduct), d. testis part of gonad, e. hermaphrodite duct, f. a small ganglion present near the genital complex, g. area of gland A (?=albumen gland), h. area of gland C (?=mucous gland), i. area of gland B (?=membrane gland).

Fig. 10. Analysis of various parts of genital organs shown in Fig. 9. a. hermaphrodite duct, b. ampulla, c. straight canal with strong cilia, d. ciliated chamber, e. connecting canal to gland C (f), g. connecting canal to gland A (h), i. communication centre between 3 different canals, j. gland B.

The secretory granules in gland A are coarse and eosinophile. This gland was identified as an albumen gland. From special staining reaction (from e to f) to toluidine blue solution the gland C was determined as a mucous gland. The secretory granules of gland B are finer than in gland A, and eosinophile. This gland was referred to a membrane gland with many questions. No further histo-chemical examination of these glands was possible for me. The above analysis was made certain on some other series of sections (Sp. Nos. 2–7, 13, 16, and 18), but actual ways of transporting sexual elements (eggs, endogenous sperms, and exogenous ones) to their respective destination could not be understood by this study. Moreover, the positional arrangement of these glandular areas from A, C to B seems to be different from the order of substances attached to the periphery of each of the oviposited eggs.

Fig. 11. Egg-cell in a newly laid egg-band (×40). Fresh material (Oct. 6, 1963). a. opaque, whitish fluid (? albumen), b. soft, colourless substance (mucus), c. colourless membrane of egg, d. animal pole. The egg-cell itself is of a deep orange-yellow, being somewhat paler towards the animal pole.



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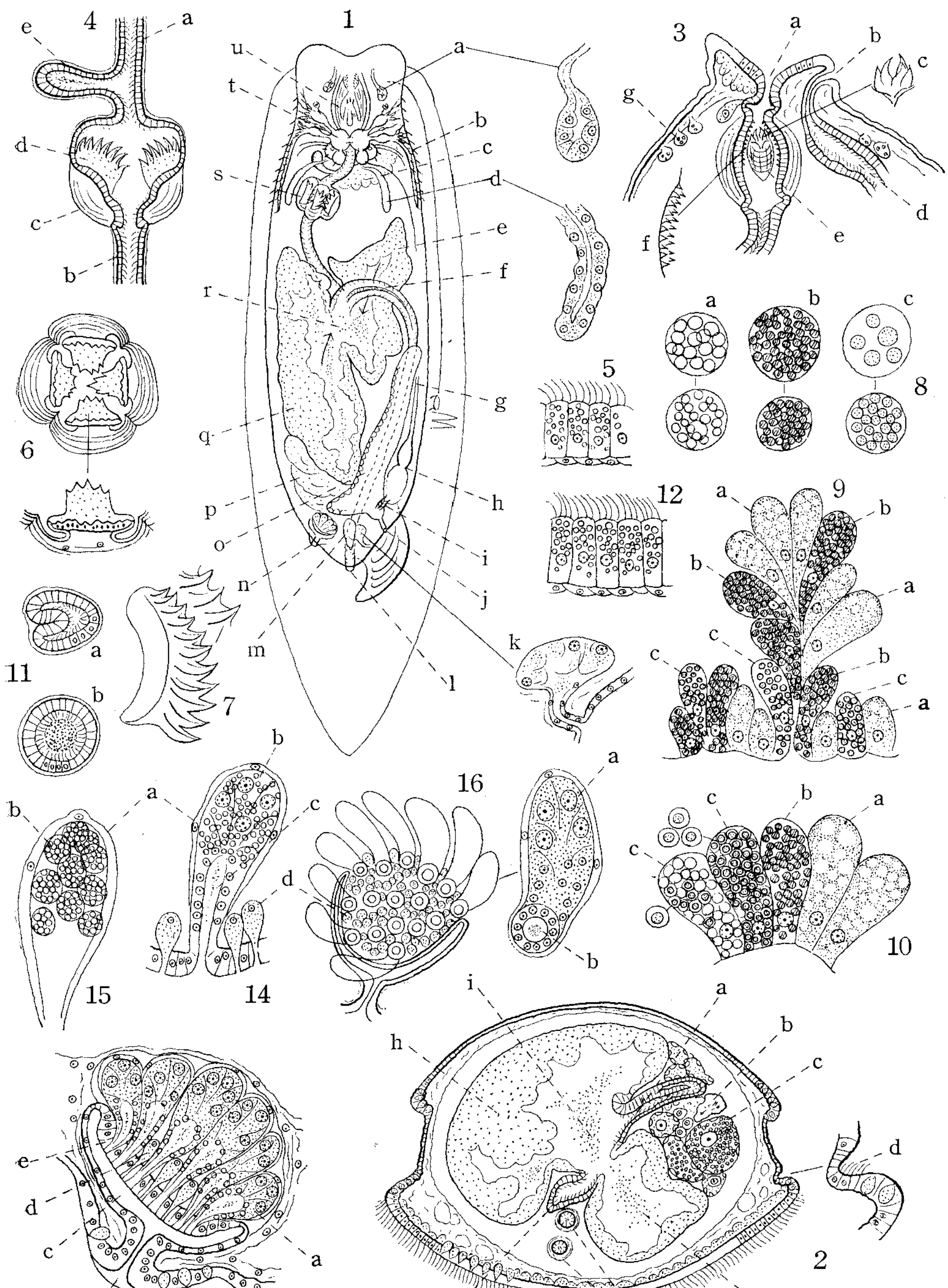

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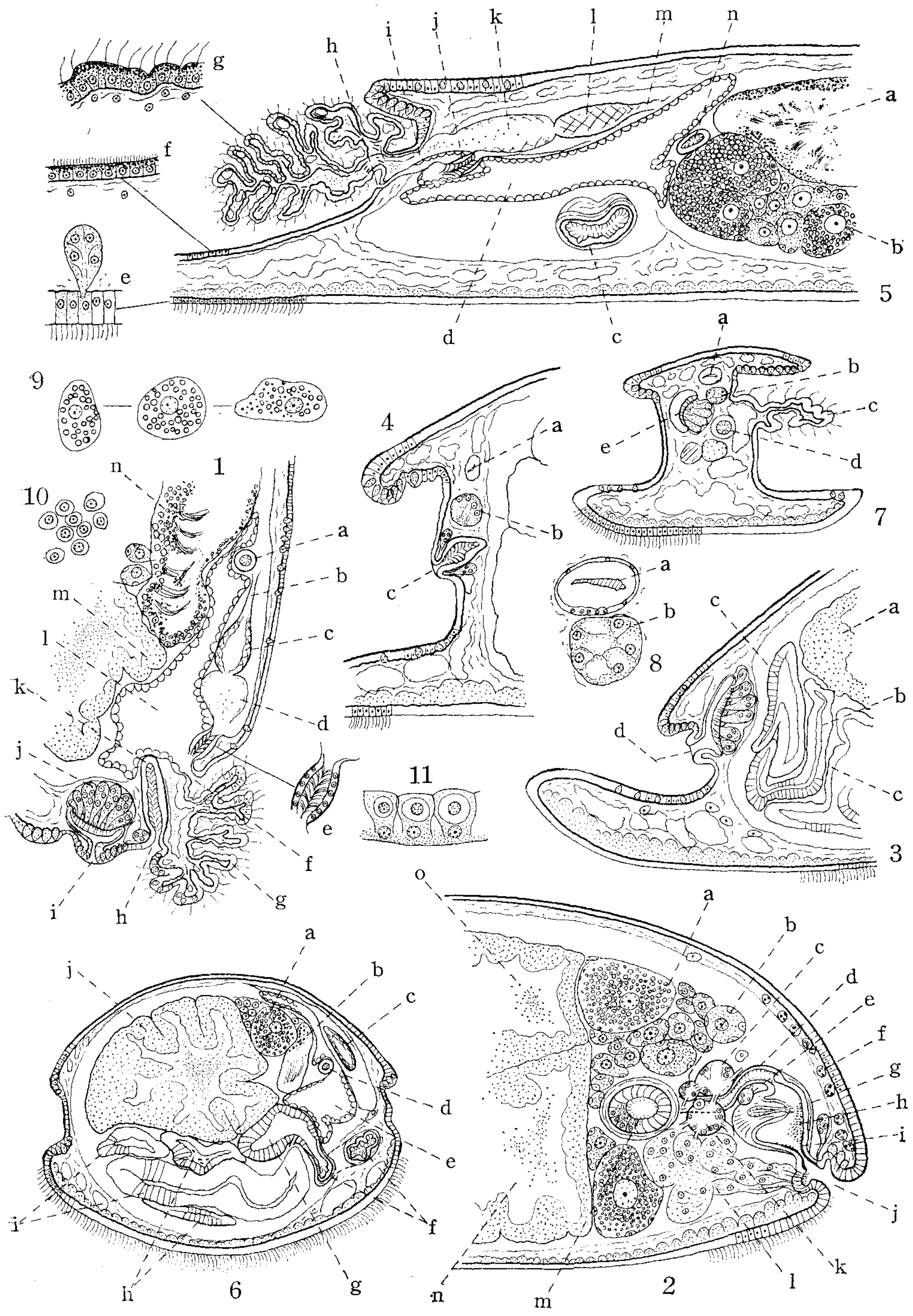

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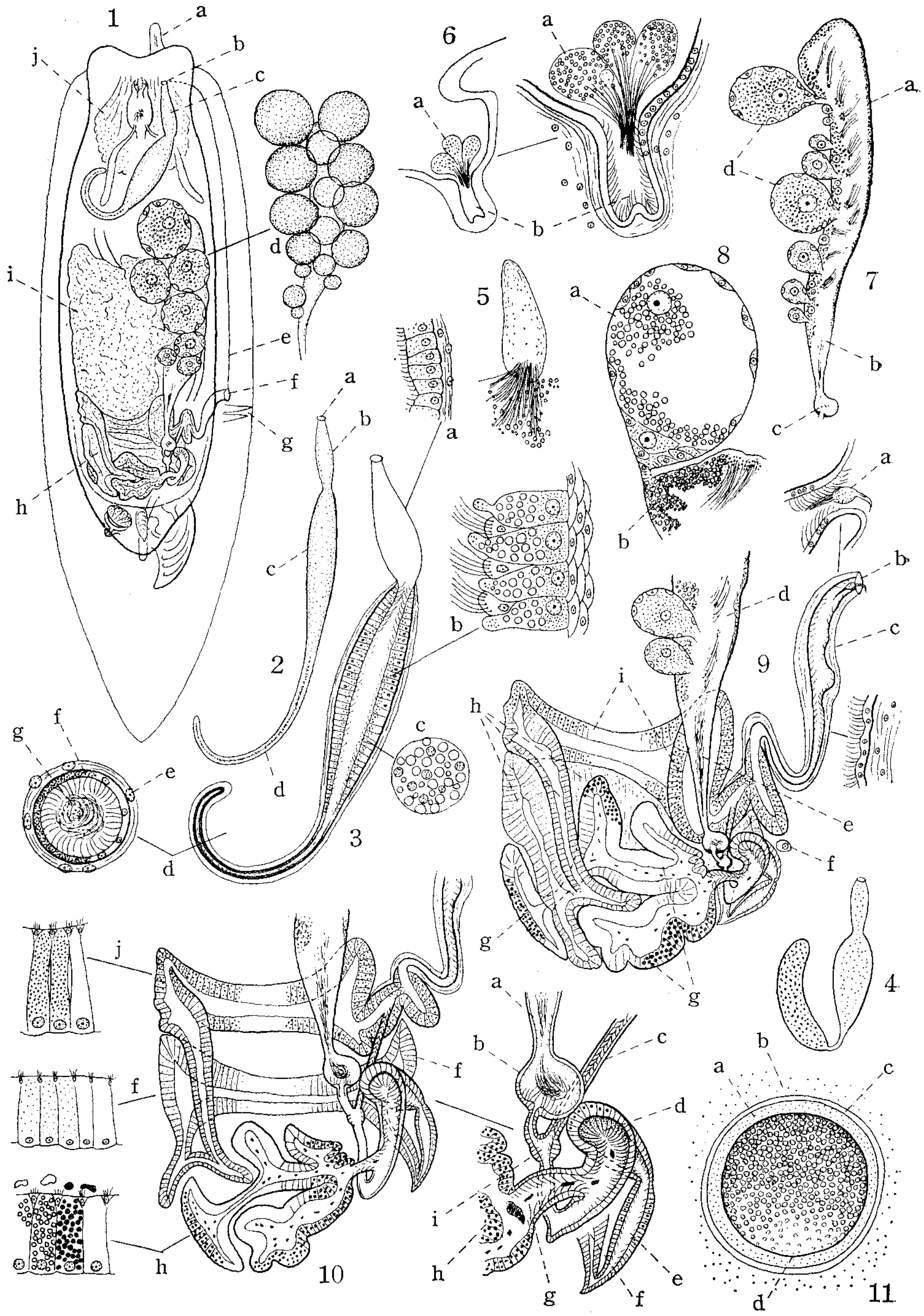

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