PROCEEDINGS

OF THE

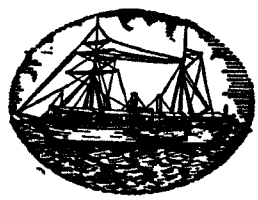
SYMPOSIUM ON MOLLUSCA

HELD AT

COCHIN

FROM JANUARY 12 TO 16, 1968

PART III



SYMPOSIUM SERIES 3

MARINE BIOLOGICAL ASSOCIATION OF INDIA

MARINE FISHERIES P.O., MANDAPAM CAMP

INDIA

ON THE STRUCTURE AND LIFE-HISTORY OF A NEW AEOLID, *FAVORINUS ARGENTIMACULATUS* FROM PALK BAY*

K. VIRABHADRA RAO

Central Marine Fisheries Research Institute, Mandapam Camp, India

ABSTRACT

A tiny nudibranch mollusc collected from the shallow waters of the Palk Bay in the vicinity of Mandapam has been ascribed to a new species of *Favorinus*, viz., *F. argentimaculatus* of the family Favorinidae. The species differs from the members of the genus in the presence of silvery spots all over the integument and also in the general arrangement of the cerata. Its structure, feeding habits, spawn, early development, and larval and post-larval stages have been described.

INTRODUCTION

ON the 8th of July 1962 when a few seaweeds firmly attached to submerged rocks in the shallow waters of the Palk Bay in the proximity to the fish farm of the Central Marine Fisheries Research Institute at Mandapam Camp were collected and kept in the laboratory aquaria for a study of the nudibranch molluscs which fairly abounded in the region, the author noticed for the first time a few tiny naked slugs, now referred to the genus *Favorinus* and described as belonging to a species new to science. Subsequently till September 1962 and in the following year of 1963 in the first four months, a few more individual members of the species were collected off and on. These when noticed were removed in pairs into clean finger-bowls containing sea-water to watch their feeding and spawning habits and also to trace their developmental stages. Some of the internal structures of the adults were studied by dissections under the magnification of stereoscopic microscope and also by the examination of stained serial microtome sections.

EXTERNAL CHARACTERS

The body which is elegant in appearance is about 1·5 cm. long from the tips of the oral tentacles to the tip of the tail. The oral tentacles are smooth, slender and tapering to fine points at their free ends, but a little broader at their bases close to the head. The dorsal tentacles or the rhinophores are a little shorter and arise mid-dorsally from the head. Distally each rhinophore bears a prominent button-like or bulbose enlargement, beyond which it ends abruptly in a sharp point. The basal regions of the two rhinophores meet dorsally on the head, behind which through the transparent integument, are visible two dark pigmented eyes, one on each side, as also the contours of the cerebropleural ganglia. The width of the back is about the same as that of the foot. Anteriorly the foot is finely arched and continued into a tapering process on either side so as to give the appearance of yet another pair of tentacles. The slender long foot terminates behind in a filamentous tail. Viewed from the ventral surface, the head in front of the foot presents a semicircular appearance bearing the mouth opening in the middle (Fig. 1, *a*, *b*).

The cerata or the branchial papillae are long, slender, slightly arched, more or less fusiform, and arranged in seven to eight groups dorsolaterally on either side. The first two groups of each side are rather very close. The distance between the second and the third groups is much greater than between any other two adjacent groups. Dorsolaterally the origin of the cerata suggests a

* Published with the permission of the Director, Central Marine Fisheries Research Institute, Mandapam Camp.

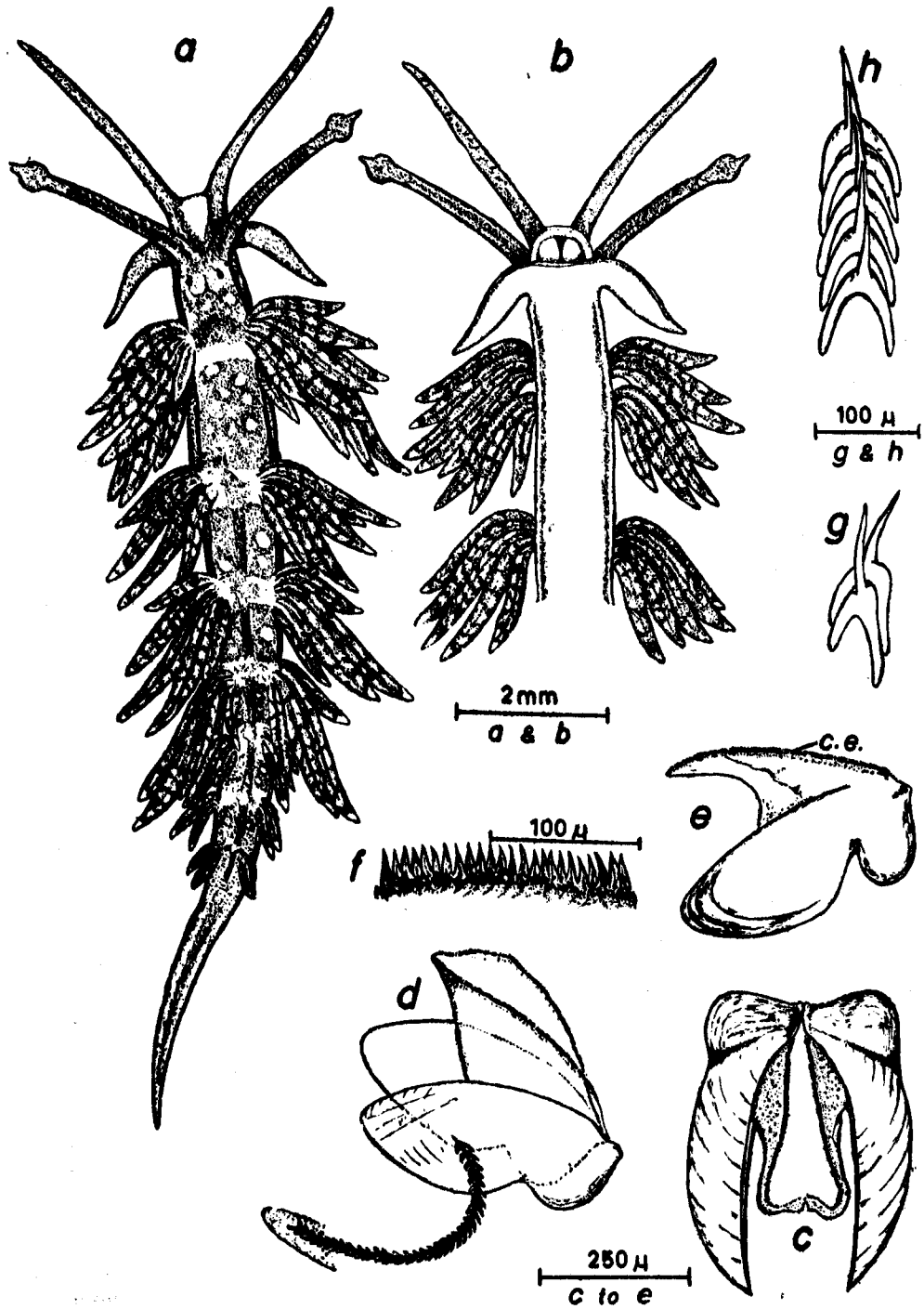


FIG. 1. *Favorinus argentimaculatus* sp. nov. *a*, Dorsal view of the animal; *b*, ventral view of the anterior region of the same; *c* to *e*, different views of the jaws; *f*, cutting edge of jaw magnified; *g* and *h*, radular teeth.

distinct horse-shoe arrangement in the first five groups. The genital orifice is within the second horse-shoe of the right side. The anus and the nephroproct are close to each other in the proximity of the third horse-shoe of the same side. In each of the first four groups, the cerata are larger in size and five to six in numbers, but in the posterior ones, gradually of diminishing size and smaller in number.

The general colouration is pale white and slightly yellowish. There is a light greyish tinge irregularly spread and is particularly prominent in the major portion of the rhinophores, the basal regions of the oral tentacles, across the back and the sides. Over the cerata the greyish colouration extends as irregular bands. Very conspicuous are certain silvery white blotches over the head, the back and the cerata. Viewed under the stereoscopic microscope with strong rays of light falling on the body, the characteristic silvery white spots are resplendent, hence the specific name *argentimaculatus*. The body as it creeps, waving the tentacles, dragging the filamentous tail and carrying the cerata in gentle motion, is extremely graceful.

INTERNAL ORGANS

The mouth leads into a buccal mass provided with a pair of serrated jaws and a uniseriate radula having about thirty minute teeth of which nine are under formation within the radular sac (Fig. 1, *c, d, e*). The serrations on the cutting edges of the jaws are in two close set linear rows, one row having prominent sharp elongated denticles and a second row of very minute, rather inconspicuous denticles at the base of the former row (Fig. 1, *f*). The radular teeth are roughly horse-shoe-shaped, each with a single median, much elongated, spine-like cusp (Fig. 1, *g, h*). There are no lateral denticles which are present in some species under the genus. The radular formula is $30 \times 0.1.0$.

Racemose salivary glands open on the roof of the buccal mass. The oesophagus (*oe.*, Fig. 2, *a*), which follows the buccal mass, leads into an enlarged stomach (*st.*, Fig. 2, *b, c*). The hepatic diverticula are in communication with the stomach as in other members of the genus. The posterior hepatic diverticulum (Fig. 2, *e*; *p.h.d.*) runs beneath the body wall giving off paired lateral branches (Fig. 2, *f*; *l.hep.d.*) to the third and the following posterior groups of cerata. The hepatic diverticulum (Fig. 2, *b*; *hep.d.*) extending into each of the cerata is unbranched. The intestine (Fig. 2, *d*; *nt.*) communicating with the stomach is followed by the rectum which opens out by the anus along with the nephroproct close to the third horse-shoe of cerata of the right side, as stated earlier.

The creatures were actively moving and depositing their spawn mostly at night time. When they were observed to devour their own eggs in captivity, they were thereafter fed regularly on the spawn of another nudibranch, *Discodoris* sp., which occurred common in the shallow water environs of the Palk Bay.

The heart (Fig. 2, *d, e*; *ht.*) lying within the pericardium (Fig. 2, *d, e, f*; *p.c.*) behind the region of the stomach consists of an anteriorly placed ventricle and a posteriorly situated auricle, the pulsations of which are clearly noticeable when the animals are watched under the magnification of the microscope. Postero-ventrally to the heart is the saccular kidney (Fig. 2, *c, k.*) giving off a diverticulum which opens by a ciliated passage, the reno-pericardial passage into the pericardium (Fig. 2 *c*; *r.p.p.*).

The bulk of the body space is occupied by the reproductive organs, *viz.*, the anterior genital complex (Fig. 2, *a, b, c*; *ant.ge.*) in front and the hermaphrodite follicles behind (Fig. 2 *f*, *her.gl.*). The protrusible penis, enclosed in the penis sheath (Fig. 2 *c*; *p.sh.*), is without a penial stylet.

The central nervous system is of the aeolidian type with paired cerebropleural ganglia (Fig. 2, *a*; *c.pl.g.*) and the pedal ganglia (*ped.g.*). Associated with the cerebropleural ganglia are the rhinophoral ganglia (Fig. 2, *a*; *rh.g.*). There is also a pair of buccal ganglia connected with the cerebropleural ganglia by long buccal commissures. Paired eyes and statocysts are also associated with the central nervous system as in all aeolids.

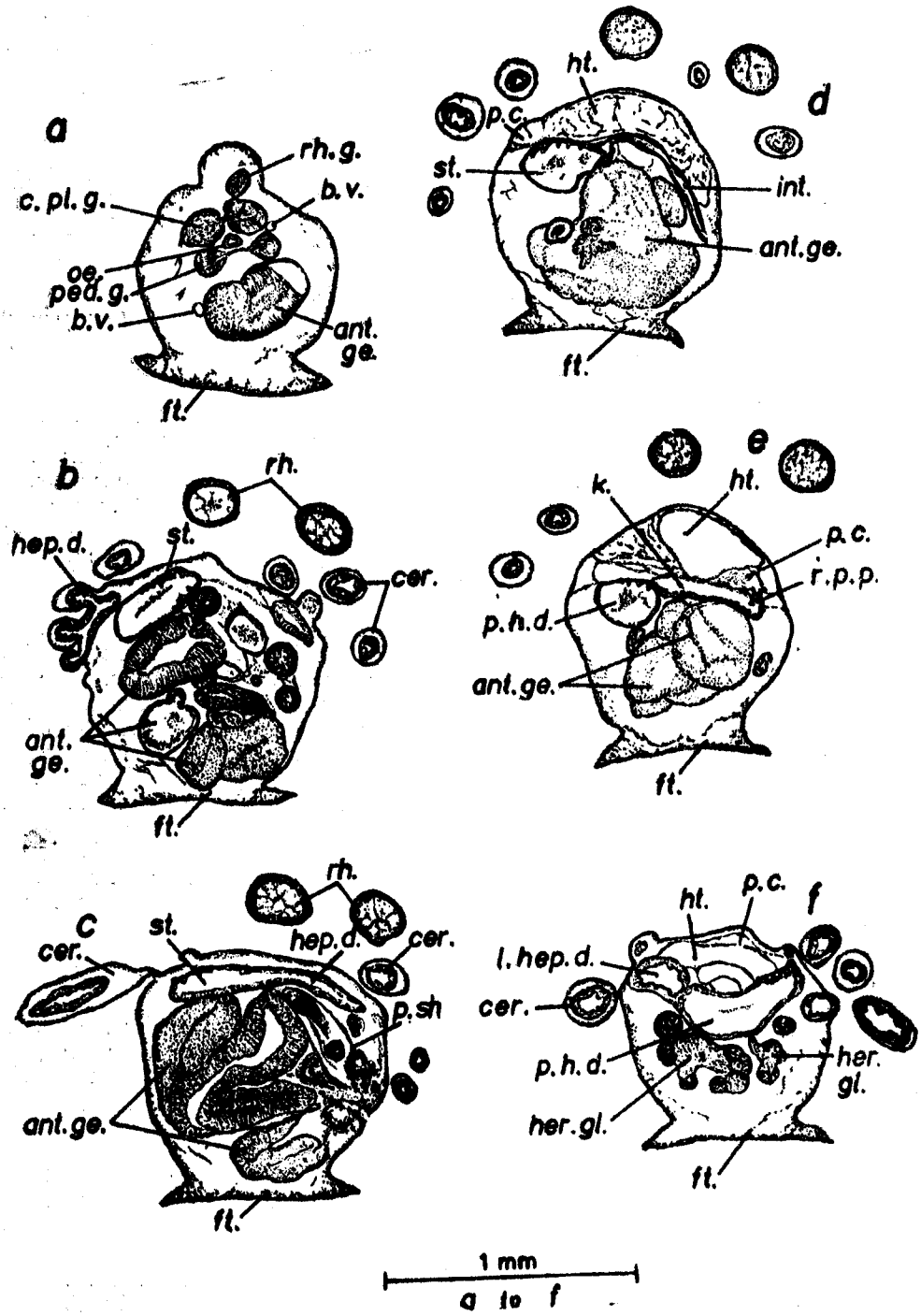


FIG. 2. *F. argentimaculatus* sp. nov. *a* to *f*, Transverse sections of the body passing through different regions (*see* key to lettering)

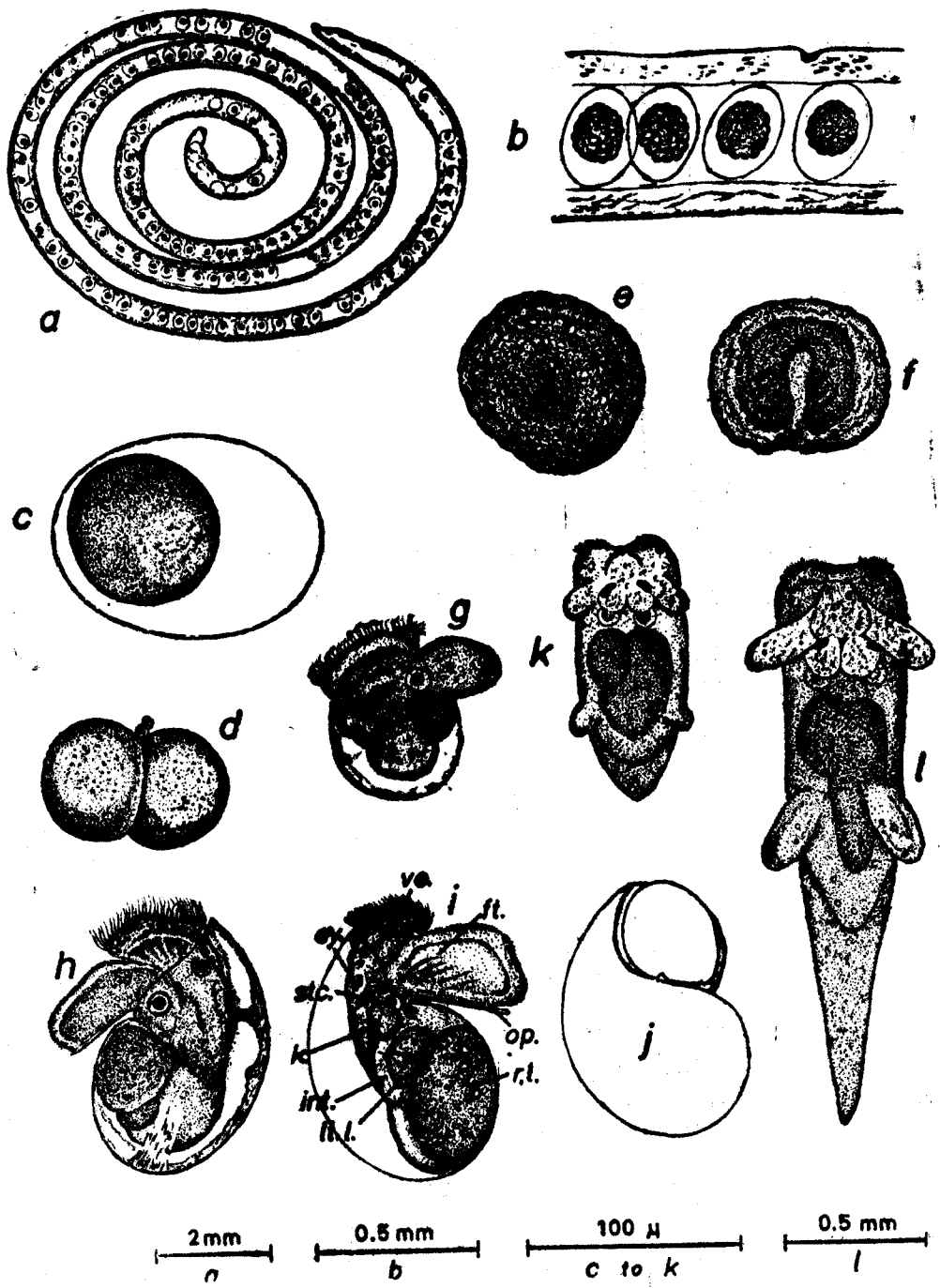


FIG. 3. *F. argentimaculatus* sp. nov.—*a*, Spawn; *b*, bit of sprawn magnified; *c*, egg within capsule; *d*, two-cell-stage; *e* and *f*, different views of gastrula; *g*, early veliger stage; *h* and *i*, different views of fully formed veligner (*see* key to lettering); *j*, empty larval shell; *k*, early post-larva; *l*, late post-larva.

Spawning and Developmental Stages

F. argentimaculatus, in all months when obtained, were found to copulate and deposit their spawn. There appears to be no particular breeding period for this species in this locality as in the allied species, *F. branchialis* which is known to breed round the year in the Copenhagen harbour (Rasmussen, 1951).

The fertilized eggs laden with yellowish yolk granules, surrounded by colorless albumen and enclosed in transparent membraneous egg capsules, extrude out along with mucus during oviposition. The mucus hardens on exposure fixing the eggs to the wall of the finger-bowl or to some weed and the spawn takes the form of a coil after the manner of a watch-spring when the oviposition is completed. The spawn (Fig. 3, *a*, *b*) occupies a diameter of about 8 mm. when it is in three coils. Often the coils may be one less or one more, when the total diameter varies accordingly. The eggs have always been found to be arranged in a single linear series in this species, as contrasted with those in *Favorinus alba* of Alder and Hancock (1845), in which they are laid 3 or 4 abreast the entire length of the spawn string which takes 7 to 8 coils. The egg ribbon of *F. branchialis* described by Rasmussen (*loc. cit.*) is similar to that of *F. alba*. The deposition of the spawn in the form of a watch-spring appears to be characteristic of the members of the genus.

The salinity of the water in the finger-bowls was 32·96‰ and the temperature range was 27·4° C. to 29·0° C. when the development was traced. Some particulars of the developmental stages studied are given below:

Date	*Time*	*Stages of development, length of time after spawning and remarks*
2-8-1962	0720 hrs.	Fertilized egg from freshly laid spawn, yolky part measuring 70 μ and the capsule in long axis about 130 μ (Fig. 3, *c*).
2-8-1962	0745 ,,	The two polar bodies have been extruded, 25 minutes after deposition of spawn.
2-8-1962	0825 ,,	The first cleavage which is vertical has been completed when it is 1 hour and 5 minutes old (Fig. 3, *d*).
2-8-1962	0910 ,,	The second cleavage which is also vertical has been completed when 1 hour and 50 minutes old.
2-8-1962	1015 ,,	The third cleavage which is horizontal results in the four small upper and four large lower cells when 2 hours and 55 minutes old.
2-8-1962	1520 ,,	Blastula formed when 8 hours old.
2-8-1962	1930 ,,	Gastrulation commenced when 12 hours 10 minutes old.
3-8-1962	0830 ,,	Gastrulation is completed and the blastopore is being reduced to a crescentric slit when 25 hours and 10 minutes old (Fig. 3, *e*, 3 *f*).
3-8-1962	1430 ,,	Velar lobes, foot, shell gland and statocyst are being formed when 31 hours and 10 minutes old.
3-8-1962	2200 ,,	The early veliger stage is formed, the embryo vigorously rotating in the egg capsule; velar lobes, foot, statocysts and stomodaeum well developed and the shell has assumed a cup shape when 38 hours and 40 minutes old.
4-8-1962	0900 ,,	Veliger fully formed with well-developed velar lobes (*ve.*), foot (*ft.*), paired eyes (*ey.*), paired statocysts (*st.c.*), unequal right and left liver lobes (*lt.l.* and *r.l.*), mouth, oesophagus, stomach, intestine (*int.*), excretory organ (*k.*) close to the anal opening, all enclosed in a spirally coiled shell with an operculum (Fig. 3, *h*, *i* and *j*). The veligers are seen actively moving within the egg capsule in rotatory motion with jerks as the velar cilia lashed. They are 49 hours 40 minutes old.
5-8-1962	1730 ,,	The fully formed veligers are still not liberated free from the capsules and are exhibiting the same kind of movement as before when 82 hours and 10 minutes old.
6-8-1962	1530 ,,	Some of the veligers liberated free from the capsules were found swimming in the water contained in the finger-bowl when examined under the binocular microscope. They were liberated free 104 hours and 10 minutes after the spawn was deposited

Date	*Time*	*Stages of development, length of time after spawning and remarks*
7-8-1962	1100 ,,	Almost all veligers have been liberated by 123 hours 40 minutes after oviposition.
7-8-1962	1100 ,,	A few empty shells (Fig. 3, *i*) are noticed and one post-larva after discarding the larval shell and operculum has been found creeping rather slowly, having an elongate form, reduced velar lobes, paired eyes, paired statocysts, enlarged liver lobes, distinct ganglia in the central nervous system and rudiments of rhinophores and cerata (Fig. 3, *k*).
9-8-1962	0900 ,,	An advanced creeping post-larval form with elongated body about 2 mm. long with structures described in the earlier stage better developed (169 hours and 40 minutes after the deposition of spawn). By this time numerous ciliates developed in the finger-bowls have attacked destroying the post-larval stages.

Systematic Position

The genus *Favorinus* Gray as described by Eliot (1910) is characterised by the presence of an elongated body, long, smooth oral tentacles, a foot anterolaterally drawn out into tentacle-like processes, rhinophores not perfoliate but with one or more bulbous swellings below tips, cerata arranged in clusters, jaws with serrated edges and a radula which is uniseriate with teeth having only a prominent long central cups (rarely with minute lateral denticles at the base).

The members of the genus are widely spread over the coasts of Atlantic, Mediterranean, Indian and the Pacific Oceans.

The present form possesses all the generic characters. The specific characters of *F. argenimaculatus* are as follows: Oral tentacles smooth and long; rhinophores with bulbous enlargements one on each, below the tips; cerata in seven to eight clusters on each side, with the first five clusters showing a horse-shoe arrangement; genital orifice close within the second horse-shoe of the right-side; anus and nephroproct close to the third horse-shoe of the right side; cutting edges of jaws with a double row of denticles; radula uniseriate with teeth having each a prominent central cusp and no lateral denticles; foot with anterolateral corners drawn out into long processes and posteriorly terminating in a filamentous tail; colouration pale yellowish-white with a greyish tinge irregularly spread all over and silvery white shining spots over the back, cerata and sides; spawn coiled like a watch-spring with a single linear row of eggs.

Locality.—Palk Bay shallow waters in the vicinity of Mandapam.

Habitat.—Among the weeds on submerged rocks, bearing sponges and other sedentary organisms.

Favorinus (= *Eolis*) *alba* of the British coasts (Alder and Hancock, 1845) differs from the present species in the arrangement of the cerata and the general colouration. In the former, the cerata are in five or six clusters, the first two clusters being at considerable distance from each other and are composed of two transverse rows each and in the other clusters the cerata being in a single series each; there is a distinct arrangement of opaque white patches over the head and the dorsum. As stated earlier there is also a difference between *F. alba* and the present species in the arrangement of eggs in the spawn. *F. alba* and *F. branchialis* are considered synonymous (Odhner, 1939). In *F. japonicus* from Sagami Bay, Japan (Baba, 1949) the branchial papillae are red and minutely nodulose unlike those of the present species. In *F. perfoliatus* (Baba, *loc. cit.*) also from the same region, the branchial papillae are rose red and the rhinophores are perfoliated, a characteristic which is unusual in the genus. In *F. japonicus* referred to above and *F. horridus* (Macnae, 1954), there are two distinct enlargements in each rhinophore, whereas in the present species a single enlargement only. In *F. horridus* sub.-sp. *brevitentaculatus* (Engel and van Eken, 1962) from the Red Sea the tentacles are short instead of being long and slender. The little known *Eolis nodulosa* Kelart (Eliot, 1906) in having three enlargements on its rhinophores has some resemblance to *F. auritulus* from Brazil described in detail by Marcus [Boletin 207, *Univ. Sao Paulo, Zool.* (20)], pp. 89–200). *F. auritulus* has much longer rhinophores than in the former species.

SUMMARY

Favorinus argentimaculatus sp. nov. collected from the sea-weeds in shallow waters of the Palk Bay in the south-eastern coast of India is characterised by the presence of silvery white spots over the back, sides and the cerata. The rhinophores have each a single bulbous enlargement. The radular formula is $30 \times 0.1.0$ and the teeth have each a single spine-like central cusp and no lateral denticles. The spawn is watch-spring-like with a single linear series of eggs. Fully formed veligers are set free from the capsules in about 100 hours after the deposition of the spawn. The duration of the free swimming larval life seem to be extremely short. Some post-larval stages have been described.

LITERATURE CITED

ALDER, J. AND A. HANCOCK 1845–1855. *A Monograph of the British Nudibranchiate Mollusca*, Parts 1–7, The Ray Society, London.

BABA, K. 1949. *Opisthobranchia of Sagami Bay*. Iwanami Shoten, Tokyo.

ELIOT, C. 1906. On the Nudibranchs of the Southern India and Ceylon, with special reference to the Drawings made by Kelaart and the Collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne. *Proc. Zool. Soc., London*, pp. 636–691.

———. 1910. *A Monograph of the British Nudibranchiate Mollusca*, Part 8. Supplementary, The Ray Society, London.

ENGEL, H. AND C. J. VAN EKEN 1962. Red Sea Opisthobranchia from the coasts of Israel and Sinai. *Bull. Min. Agri., Div. Fisheries, Sea Fish. Res. Stn. Contr.*, **22**: 15–37.

MACNAE, W. 1954. On some Eolidian Nudibranchiate Molluscs from South Africa. *Ann. Natl. Mus.*, **13** (1): 1–50.

ODHNER, N. H. 1939. Opisthobranchiate Mollusca from the Western and Northern waters of Norway. *Kgl. Norse, Vid. Sclgk.*, Skr. (1): 1–92.

RAO, K. VIRABHADRA 1952. *Cuthona adyarensis*, a new Nudibranch (Mollusca: Gastropoda) from Madras. *J. Zool. Soc., India*, **3**: 229–238.

———. 1961. Development and life-history of a nudibranchiate gastropod *Cuthona adyarensis* Rao. *J. Mar. biol. Ass. India*, **3**: 186–197.

RAO, K. VIRABHADRA AND K. ALAGARSWAMI 1960. An account of the structure and early development of a new species of a nudibranchiate gastropod, *Eolidina (Eolidina) mannarensis*. *Ibid.*, **2**: 6–16.

RASMUSSEN, E. 1951. Faunistic biological notes on marine invertebrates. II. The eggs and larvae of some Danish marine gastropods. *Vidensk. Medd. fra. Dansk. naturh. Foren.*, **113**: 201–249.

KEY TO LETTERING

ant. ge., anterior genitalia; *b.v.*, blood vessel; *c.e.*, cutting edge; *c. pl.g.*, cerebropleural ganglion; *cer.*, cerata; *ey.*, eye; *ft.*, foot; *hep. d.*, hepatic diverticulum; *her. gl.*, hermaphrodite follicles; *ht.*, heart; *int.*, intestine; *k.*, kidney; *l. hep. d.*, lateral hepatic diverticulum; *lt. l.*, left liver lobe; *oe.*, oesophagus; *op.*, operculum; *p.c.*, pericardium; *ped.g.*, pedal ganglion; *p.h.d.*, posterior hepatic diverticulum; *p. sh.*, penis sheath; *rh.*, rhinophores; *rh.g.*, rhinophoral ganglion; *r.l.*, right liver lobe; *r.p.p.*, renopericardial passage; *st.*, stomach; *stc.*, statocyst; *ve.*, velar lobe.