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EGG CAPSULES AND DEVELOPMÉNT OF THAIS SAVIGNYI DÉSHAYÉS

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INTRODUCTION AND HISTORICAL

Thais savignyi is a predator shell driller gastropod on other economic species ; and thus the study of its life history is important. Also, the identification of Prosobranch's larvae that form a part of the temporary plankton of the Red Sea can help in studying the feeding habits of the economic pelagic fishes.

Species of family Thaididae (or Purpuridae) were previously included under family Muricidae of which only the development of three species from the Red Sea (namely *Murex* (*Phyllonatus*) *incarnatus* Roding, *Murex ramosus* Linne and *Jopas francolinum* Bruguiere) were described (Gohar and Eisawy, 1967). In the present work the biology and life-history of the oyster driller *Thais* (=*Purpura*) *savignyi* Deshayes are througly studied.

From scattered literatures one can mention the important works as following : a spawn firstly described by Ellis (1756) under the name of *Cyathus marinus* was found to belong to *Purpura* (*Nucella*) *lapillus* (Jeffreys, 1867 ; Lamy, 1929 ; Lebour, 1937 and others). Carpenters (1855) was the first who studied the embryology of *P. lapillus*. Other studies on the spawn and development of this species were made by Koren & Danielssen (1857), Selenka (1872), Mac Murrich (1887) and Pelseneer (1905 & 1911). Portmann (1925 & 1930) studying the egg capsules and development of this species, suggested that the presence of nurse eggs were the result of fertilization with apryene spermatozoa. In the same species, Risbec (1937) summarized the typical aspects of development, Lebour (1937) described the capsules ; Ankel (1937) studied the structure of the capsules, giving an account on the hatching process ; and Thorson (1946) described the egg capsule and the hatching larva.

Esper (1830) described the spawn which was attributed by him to a *Natica* species, but Lamy (1928) stated that it was similar to that of *P. chocolatum* which had been described by d'Orbigny (1846) from Bolivia and Peru.

d'Orbigny (loc. cit.) also described the spawn of *P.* (*Stramontia*) *haemastoma* = *Thais haemastoma* from Rio Janeriro. The egg capsules of the same species which are yellowish to rose-coloured were studied from the Gulf of Mexico by Burkenroad (1931), its development was studied by St. Amant (1938 & 1957), the formation of the capsules by Franc (1941), its breeding habitat, egg-capsules, developmental rate and larva by Butler (1954).

Galtsoff (1964) in studying the predator of *Crassostrea virginica* made some observation on its breeding habit. The recent work was done on a variety of this species (*T. haemastoma floridana*) by D'Asaro (1966) who studied the egg capsules, embryogenesis and organogensis.

Very similar spawns of those of *T. haemastoma* were produced by *P. (Cuma) carnifera* = *Thais carnifera* (Annandale & Kemp, 1961 from the Chilka Lake in India ; and Thorson (1940) from the Iranian Gulf), and *T. javanica* (Molur, 1933).

Hedely (1905) described the spawn of *P. (Trochia) succinata* from Australia.

In addition to the above mentioned spawn, (Thorson, loc. cit.) studied the egg-capsules and larvae of *Thais hippocastineum* from the same locality. Its capsule is a vase-tshaped with a short stalk and nurse eggs. He also found that the larvae which are in the crawling stage emerged through a hole at the side wall and they did not use the normal exit hole of the capsule.

Lebour (1945) described the egg capsules of *T. fasciata* from Bermuda.

Knudsen (1950) described and figured the egg capsules and the early veligers of *T. cronata* from West Africa.

Natarajan (1957) recorded the breeding habit and the capsules of *T. bufo, T. tissoti* and three unidentified thaidid species.

Amio (1963) described the egg capsules and the newly hatched veligers of two Japanese species *P. clavigera* and *P. borni.*

HABITAT, MATERIAL AND METHODS

Thais savignyi is one of the most common carnivorous gastropods, living in the tidal zone around the Marine Biological Station at Al Ghrdaqa, preferring the more shallower areas and sometimes it is exposed to air at low tide. It crawls on the bottom of the sea by its mascular foot, but when kept in cement aquarium it lives near the water surface at the areas where the water is supplied.

This oyster driller was observed in the aquarium of the Station attacking some gastropods (such as *Turbo radiatus, Strombus gibberulus, S. fasciatus* and others) and some lamellibranchs such as *Ostrea forskali, Circe arabica, Mytilus variabilis, Pecten* sp., and others). The animal attacks the

victem by boring a hole in the shell and eating the meat by inserting its probscis. The mechanism of this process was studied by several biologists as Dubois (1909), Carriker (1943 & 1961) and others.

As in most species of Thaididae, when the animal is disturbed it secretes a small amount of purple fluid in the surrounding water. This fluid may be of protecting significance. Allen (1950) said that this fluid together with that of *Murex* shells give the Tryian dye used by the ancients for colouring robes, parchments and other articles for royal use.

The collected specimens were kept in the vivaria where they lived in a good condition all the year round.

The identification of *Thais* was somewhat difficult from the available literature and Museum specimens. Prof. G. Thorson and Dr. Knudsen (Kobenhagen Museum) were kind enough to mention that this species is either *Thais hippocastaneum Lamarck* or *T. distinguenda* Dunker & Zelebor. But as the egg capsules of this species differ greatly from those of *T. hippocastaneum* from the Iranian Gulf (Thorson, 1940), and its structure slightly differs from that of the Japanese driller *T. distinguenda* (Kira, 1962) it appears to be another species. By thorough examination of previous literature, especially Savigny's plates (1872) and others it can be concluded that the present specimens are *Thais savignyi* Deshayes which confuse greatly with the above mentioned two species.

The spawning was keenly observed in the laboratory and similar egg-capsules were also collected from the sea.

Rearing and preservation of embryos and larvae as well as microscopic drawings were followed as in the previously described prosobranch species (Gohar & Eisawy, 1967 a & b, Eisawy and Sorial, 1968 & 1973, and Eisawy, 1970).

SPAWNING AND EGG CAPSULES

The spawning season of *T. savignyi* is rather long, extending from August till November at a water temperature ranging between 21° and 30°C. The difference in temperature during this period affects greatly the rate of development of the embryos as described later.

Spawning is usually proceeded by copulation. The female lays its eggs in capsules which are deposited in shallow nitches in a solid substratum of dead corals or empty shells. In all cases the capsules are fixed to the

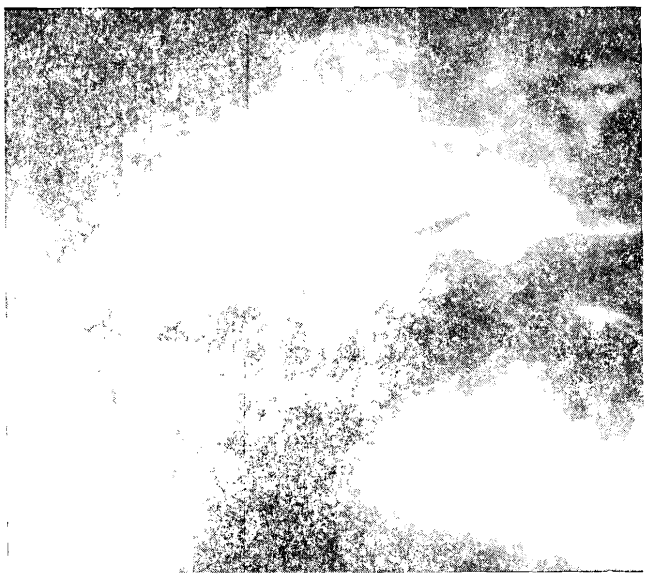
lower surface of the substratum where they are exposed only to diffuse sunlight. In in-door aquarium, the capsules are also laid at the lower surface of shells, especially *Ostrea forskali*. If the latter is absent the capsules are deposited on the walls of the aquarium near the water level.

The egg capsules are separate when freshly laid, standing side by side but their bases are confluent forming a continuous thin membrane covering the substratum (Fig. 1). Then further deposited capsules are attached to the tops of older ones (Fig. 2) and thus a cluster of capsules is formed. The animal takes about 15 minutes to produce each egg capsule during August and about 20 minutes in November. The size of the capsule coincides with that of the parent animal, usually small individuals lay smaller capsules. The number of capsules which are laid by single animal ranges between 16 and 30. It had been observed that when one individual started to spawn in a locality others followed laying their capsules in the same area. So large groups of capsules (120 to 230) which are present in a place may belong to a number of individuals.

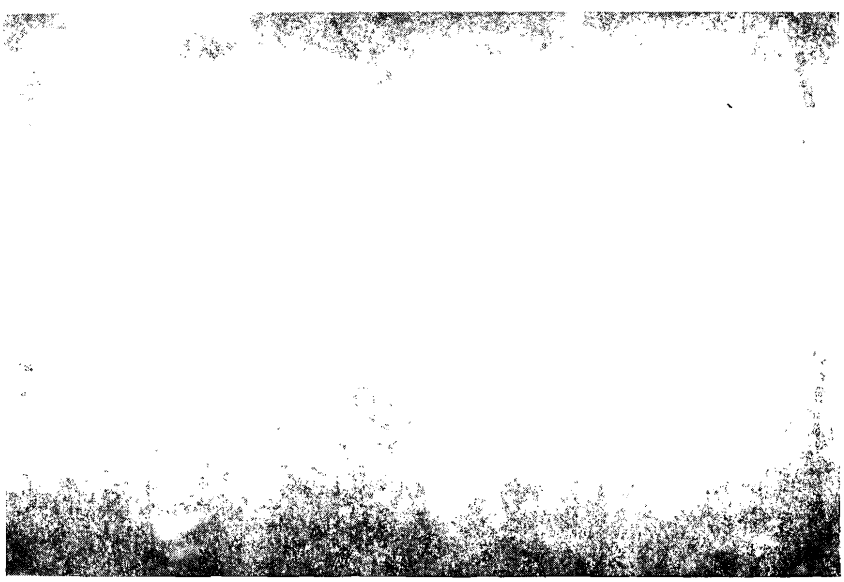
The egg capsule (Figs. 3 to 5) is a broad flattened vase-shaped without a stalk, and measures about 3.5-3.7 mms long, 3-3.2 mms. wide and 0.5 mm thick. It is fixed to the substratum by a rather broad base with a thin membrane to which is attached the neighbouring capsules. At one broad side there is a circular concavity (about 2 mms. in diameter), in the middle of which a wide circular exit hole (about 700 μ in diameter) is present. The exit hole is covered with a comparatively transparent membrane through which eggs or embryos could be easily seen. The other broad side of the capsule is convex with a median longitudinal ridge (about 1.9 mms. long) behind the concavity. The narrow sides and the top of the capsule are convex.

The egg capsule is semi-transparent and colourless when freshly deposited and becomes light horn-coloured as development proceeds. In few clusters some capsules may contain dark purple fluid and dead embryos. It was found that on piercing or rupturing any normal capsule ; its internal transparent mucus becomes gradually dark purple when comes in contact with sea water and then the embryos die. So the presence of such coloured capsules may be due to external damage in nature.

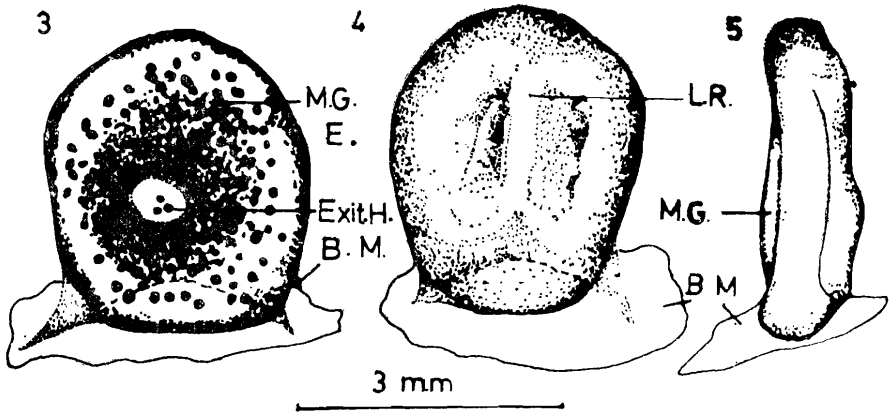
The number of contained eggs depends on size of the capsule and varies between 250 and 500 in each. The eggs are embedded in mucous substance which fills nearly all the cavity of the capsule.



Thais savignyi. Fig. 1. A photo of separate egg-capsules.



T, savignyi, Fig. 2. A photo of a cluster of egg-capsules.



Thais (*Purpura*) *savignyi*, Text-figs. 3–5. A single egg-capsule, seen from the ventral, dorsal and lateral sides.

The undeveloped eggs (Fig. 6) is yellowish in colour, coarsly granulated, spherical in shape and measures about 185 to 190 μ in diameter. It possesses a comparatively large, clear, less-granulated, lens- shaped apical area in which the nucleus is situated. Nearly all eggs develop into embryos and thus nurse cells are completely absent in this species.

DEVELOPMENT

The development of this species proceeds slowly and takes 30 to 60 days from spawning to hatching. This great difference in the embryonic period is due to difference in water temperature during the spawning season. The following table shows the relation between the duration of the embryonic life and the average water temperature during the breeding season.

Time of Spawning	Avg. Water Temp.	Embryonic Period
August	28°C	30 32 days
September	26°C	38 days
October	24.2°C	45 days
November . .	21°C	60 days

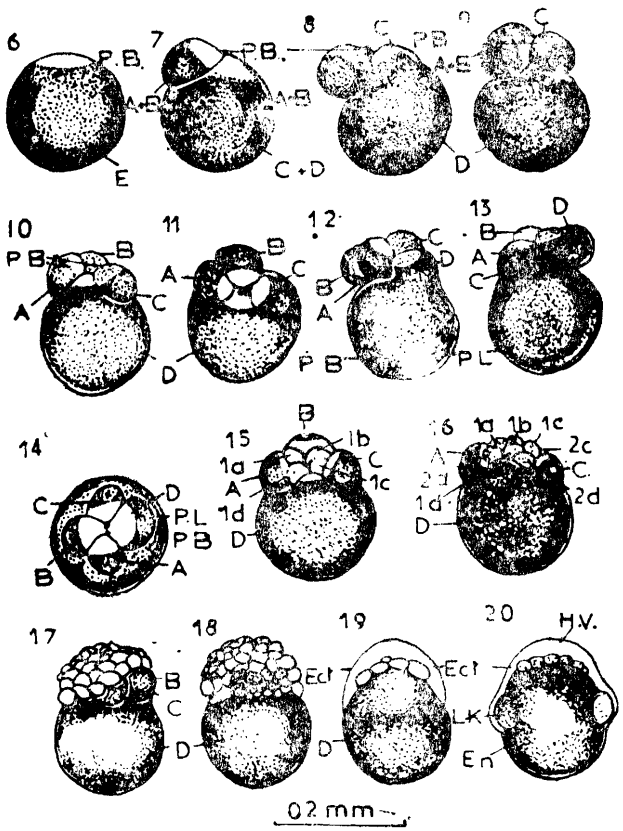
It appears from that table, that the lower the temperature the longer the embryonic life of the species.

The following description of the developmental stages corresponds to a spawn which was laid at the begining of the breeding season (4th of August) and hatched at 5th of September.

The two polar bedies appear after about 12 hours from spawning (Fig. 6). The first cleavage is terminal, resulting in dividing the egg into two unequal blastomeres, one small (A + B) and the other very large (C + D), Fig. 7. Each of these two cells include nearly half the clear apical area. Then after 3 to 4 hours the large cell divides into two unequal macromeres which are a small "C" and a large "D" (Figs. 8 & 9). This is followed after another four hours by the division of the small cell "A + B" into two nearly equal macromeres of which "A" is slightly smaller than "B" and nearly equals cell "C" in size (Figs. 10 & 11). At this stage, the clear apical area is represented in the four blastomeres of which the three small A, B and C are situated at the tip of the very large cell D. Normally near the clear area of the latter cell there is a slightly raised cone which shows no constriction between it and the lower larger part. In very rare cases, this stage is followed by the appearance of a distinct constriction in the upper part of the cell D, but the small portion remains connected with the larger one (polar lobe), Figs. 12 to 14. These abnormal stages resemble the normal ones of *T. haemastoma floridana* (D'Asaro, 1966). In the present species, the abnormal stages were not observed proceeding in further development, while the above described ones develop until hatching out of larvae.

The first quartette in normal stages is formed after 24 hours from spawning, when four small micromeres are cut off into a dextral position at the animal pole between the three small macromeres and above the large fourth one (Fig. 15). The second quartette, which is sinistral, occurs after 6 hours from the last stage and thus another four small micromeres are produced (Fig. 16). The third and fourth quartettes could not be observed owing to the multiplication of micromeres of the first two quartettes (Fig. 17). The multiplied micromeres grow gradually over the macromeres, covering firstly the three small, A,B,C cells and the fourth quartette, and then extending over the large one D (Figs. 18 & 19). During this overgrowth two large larval kidneys are formed, one on each side of the embryo, and the thin transparent ectoderm is completely surrounding the macromeres after 8 days from spawning (Fig. 20). In this stage, which represents the gastrula, the original macromeres and the micromeres of the fourth quartette arrange themselves to form the

mesoderm of the embryo, with the large cell D forming the nutritive visceral mass. It is clear that gastrulation takes place completely by epiboly without any sign of invagination.



Thais savignyi (Cont.), Text-figs. 6–20. 6. Undeveloped egg, 7 : 2-blastomere stage 8 and 9 : 3-blastomere stage, 10 and 11 : 4-blastomere stage, 12–14 : 4-blastomere stage, with abnormal constriction of D cell, 15 : 8-cell stage, 16 : 12-cell stage, 17–19 : An embryo, showing multiplication of micromeres and overgrowth of ectoderm, 20 : The gastrula stage.

After two days of gastrulation (10 days from spawning),the embryo, which measures about 220 μ in length, is provided with some newly formed organs (Figs. 21 & 22). These are : an upper ventral ciliated circular mouth and a lower ventral ciliated protrusion which represents the premordium of the foot (about 36μ long) ; and the apical area which gives rise to the mitvelar cone is (about 36 long) ; and the apical area which gives rise to the mitvelar cone is ciliated. The two larval kidneys increase in size, move slightly towards the

ventral side and are placed in a line just below the foot. The embryo now starts very slow rotatory movement inside the egg-capsule by the cilia of the mit-velar cone and the foot.

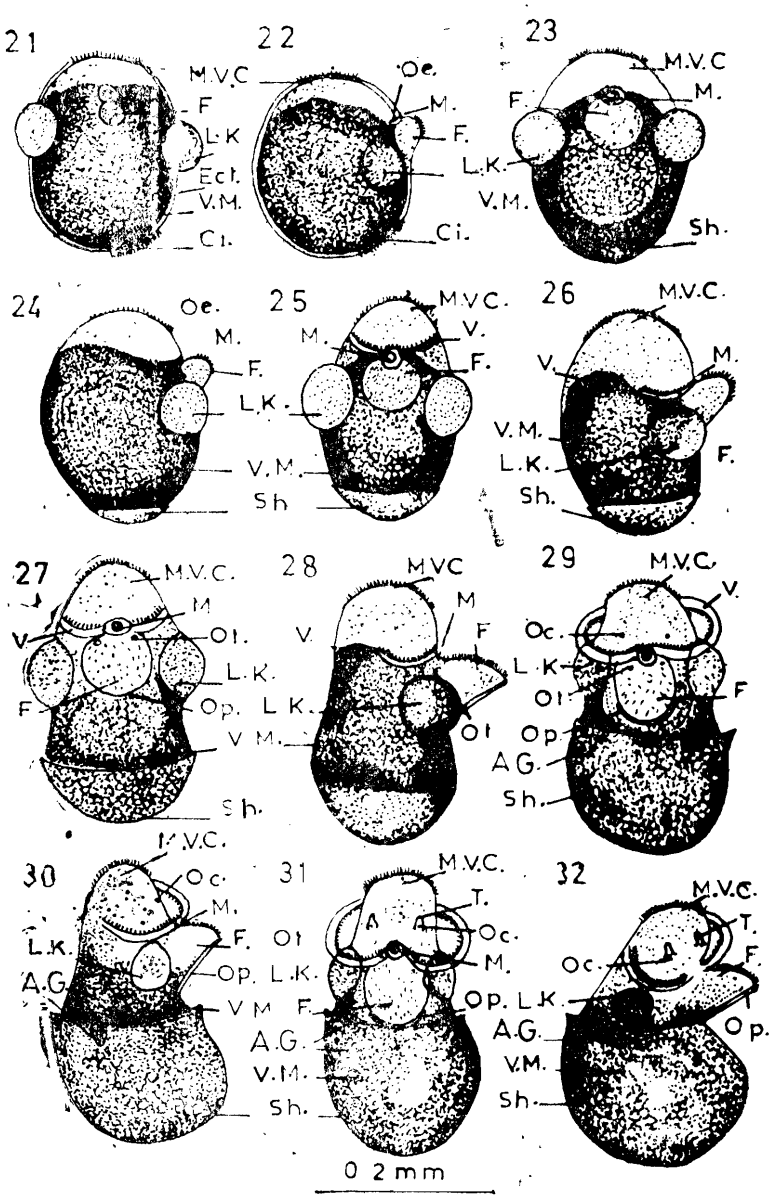
The embryo of 11 days old increases gradually in size and measures about 228 μ in length (Figs. 23 & 24). This stage is characterised by the formation of a basal disk-like transparent shell which is about 20 μ long. The foot grows greatly, becoming triangular in shape and measures about 56 μ long.

As development proceeds gradually, the embryo which is about 12 days old, measures about 240 μ long (Figs. 25 & 26). At this stage two velar lobes are newly formed on either sides of the mit-velar cone which is slightly elongated. The other organs increase in size, especially the foot which is now 64 μ long, and the shell is about 32 μ in length and slightly surrounds the basal part. The rotatory movement of the embryo increases gradually.

After 14 days from spawning, an elongated embryo, measuring about 200 μ long, is obtained (Figs. 27 & 28). Two symmetrical octocysts and a small transparent operculum, projecting a little beyond the foot, are newly developed. The two velar lobes increase in size, projecting slightly out of the body with their cilia becoming longer. The foot grows rapidly, measuring about 80 μ in length. The larval kidneys increase in size and are still situated at the sides of the large foot and below the velar lobes. The shell grows more (about 60μ long), becoming cup-shaped and surrounding the lower part of the body.

After 16 days from spawning, the embryo grows more and measures about 300 μ long (Figs. 29 & 30). In this stage, two violet eye spots (ocelli), oesophagus, and the anal gland are newly formed. The other organs, previously present, increase in size, except the mitvelar cone and the larval kidneys which are slightly absorbed. The kidney move upwards occupying a position just below the velum and on the sides of the foot. The velum protrudes greatly from the body, with elongated cilia, and thus the movement of the embryo fastens. The foot enlarges more, measuring about 88 μ long, and its operculum becomes larger and protruding. The shell enlarges, measuring about 120 μ long and enclosing the major part of the visceral mass.

The 18 days old embryo measures about 312 μ long (Figs. 31 & 32). It is characterised by the development of two small tentacles on the eye spots. The velum projects more out of the body, and the foot is still oval, measuring 92 μ long with the operculum projecting beyond it. The two larval kidneys and the mit-velar cone are more absorbed. The shell, which is about one whorl, grows more, measuring about 148 μ long and is characterised by the appearance of dark brownish spots which are scattered on the basal part.



Thais savignyi (Cont.), Text-figs. 21–32 ; 21 and 22 : 10-day embryo, 23 and 24 : 11-day embryo, 25 and 26 : 12-day embryo, 27 and 28 : 14-day embryo, 29–30: 16-day embryo, 31 and 32: 18-day embryo (All stages from ventral and right sides).

After 20 days from spawning, the embryo (Figs. 33 & 34) is characterized by the development of a mantle fold which extends dorsally, and a subvelum

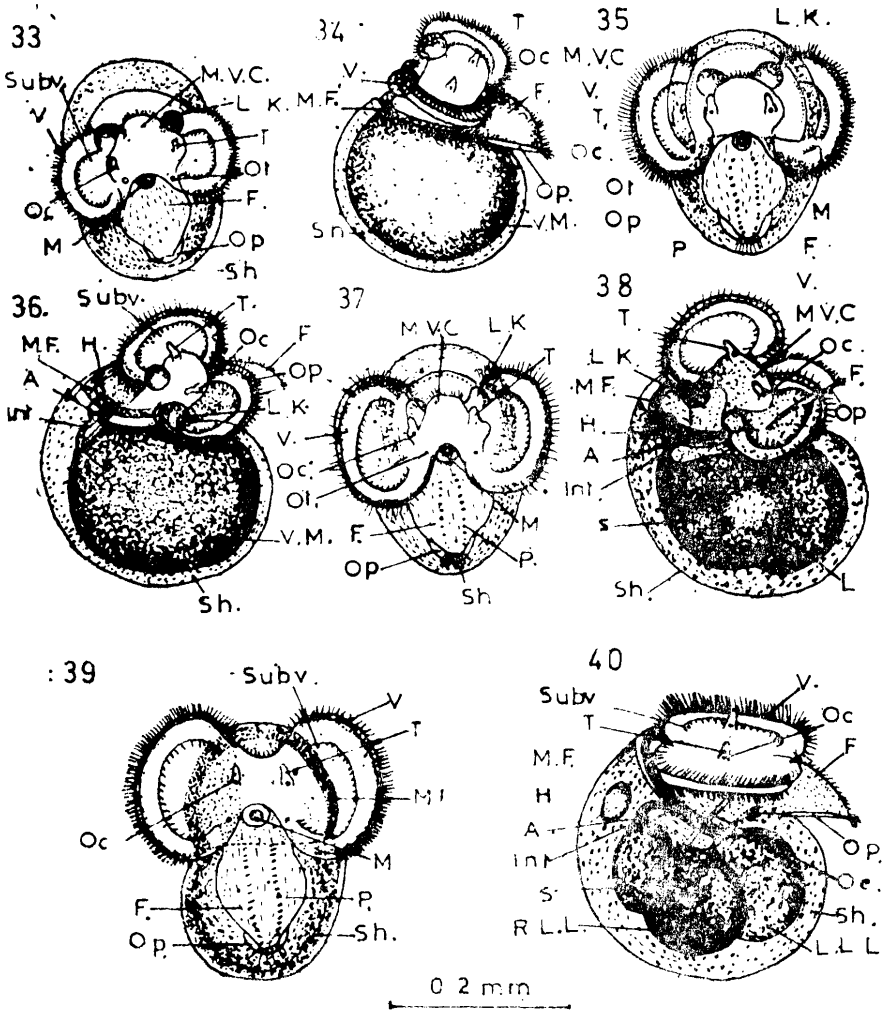
with short cilia below the enlarged original velum. The latter is also coloured with yellow pigments which are scattered irregularly on its upper surface near the outer margin, and each velar lobe is oval in shape and measures about 100 μ long. The larval kidneys reduce more in size and move dorsally below the velar lobes. With the exception of the mit-velar cone, all other organs increase in size, especially the foot, operculum, tentacles and shell. The foot becomes triangular in shape, measuring about 100 μ in length and 80 μ in the greatest breadth. The shell which is slightly more than one whorl measures about 168 μ, surrounding completely the visceral mass and is more coloured by the brownish spots.

The 22 days old embryo (Figs. 35 & 36) is characterized by the development of the anus, instestine and the heart which is a simple pulsating organ on the dorsal side. The other organs are more developed but the mit-velar cone and larval kidneys are more reduced in size. The oval velar lobe has long cilia, surrounds completely the mit-velar cone and measures about 132 μ in length. The mantle fold grows more, reflecting over the dorsal surface of the embryo, and is coloured with yellowish white spots. The foot which is now about 108 μ long and 88 μ in the greatest depth, possesses a tuft of cilia at its end in addition to short cilia covering its surface. Also two parallel rows of dark orange pigments appear on its ventral surface. The tentacles are longer and become ciliated at the tips. The shell, which measures about 240 μ long, is more twisted with more condensed brownish spots.

The development of the embryo proceeds further, and after 24 days from spawning, the visceral mass begins to show a slight differentiation into its parts, starting with its left liver lobe (Figs. 37 & 38). The foot is about 120 μ in length and 92 μ in breadth and the velar lobe is about 140 μ in length. All other organs increase in size except the mit-velar cone which nearly disappears, and the two more absorbed larval kidney which are situated below the dorsal sides of the velar lobes.

The 26 days old embryo (4-5 days before hatching) assumes the general shape of typical veliger larva (Figs. 39 & 40). It is very active moving always towards the exit hole of the egg capsule. The most striking features of the embryo at this stage are the complete disapearance of both mit-velar cone, larval kidneys and the differentiation of visceral mass into stomach, two large slightly asymmetrical liver lobes. The yellowish mantale fold becomes ornamented with orange patches which are evently scattered on its surface except the right side where they are more condensed. The other organs are more advanced in development ; the oval velar lobe is 160 μ in length and 120 μ in greatest breadth, the foot is more powerful measuring about

144 μ in length and 122 μ in greatest breadth, and the shell is little more than one whorl and is about 288 μ in length and 260 μ in breadth. The dark brown spots of the shell are more condensed and accordingly the egg capsules which are slightly swelled exhibit the dark brownish white colour.



Thais savignyi (Cont.), Text-figs. 33-40. 33 and 34 : 20-day embryo, 35 and 36 : 22-day embryo, 37 and 38 : 24-day embryo, 39 and 40 : 26-day embryo (All stages seen from top and right views).

HATCHING AND GROWTH OF THE VELIGER

After about 30 - 32 days from spawning, the veliger larva is hatched out (Figs. 41 & 42). It escapes from the capsule through the thin membrane of the exit hole. During this process the larva comes out contaminated with mucus. The larvae remain for a while at the bottom, then free from the mucus move actively towards the more lighted area of the rearing aquarium.

The veliger is provided with a bilobed velum, below which there is a well marked ciliated subvelum with shorter cilia than those of the former. The two velar lobes are oval in shape, and are slightly unequal in size. The larger right lobe is about 180 μ in length and 124 μ in greatest breadth, while the smaller left one measures about 160 μ long and 120 μ in breadth. Each lobe possesses yellow pigments which are irregularly scattered near its border and more concentrated on the ventral side. The two dark violet eye spots are situated at the bases of the two small tentacles whose surfaces are covered with minute cilia which are larger near the tips. The mantle fold is thick, faint yellow coloured with orange patches scattering on its surface, and at its right side opens the anus. The foot is comparatively large, stout club-shaped, bordered and covered with minute cilia, and possesses a tuft of longer cilia projecting at its posterior end. Also dark orange pigments are irregularly and faintly scattered on its surface. These pigments are more concentrated and arranged into two median parallel rows on the ventral side. Below the foot there is an oval tranparent operculum which is slightly protruded out. There are two small symmetrical otocysts which are embedded near the broad base of the attachment of the foot to the body wall.

The larva is also provided with a circular ciliated mouth on the thickened area between the velar lobes. The mouth leads to the oesophagus which opens in a fusiform stomach. The latter opens to the outside by the anus through a short intestine, and is attached to two slightly symmetrical liver lobes. The visceral mass is yellowish to organe in colour due to the residual embryonic yolk particles left unused by the embryo, and it is hardly seen from the dark brown shell. The heart could be seen at the dorsal side of the larva as a pulsating organ with a single chamber. The larva is provided with a shell ornamented with scattered dark brownish spots which are more accumulated near the apex of the body whorl. It is a little more than one whorl and measures about 300 μ in length and 264 μ in the greatest breadth.

The newly hatched veliger of this species passes through distinct planktonic stages in which the velum as well as other organs enlarge before beginning of metamorphosis.

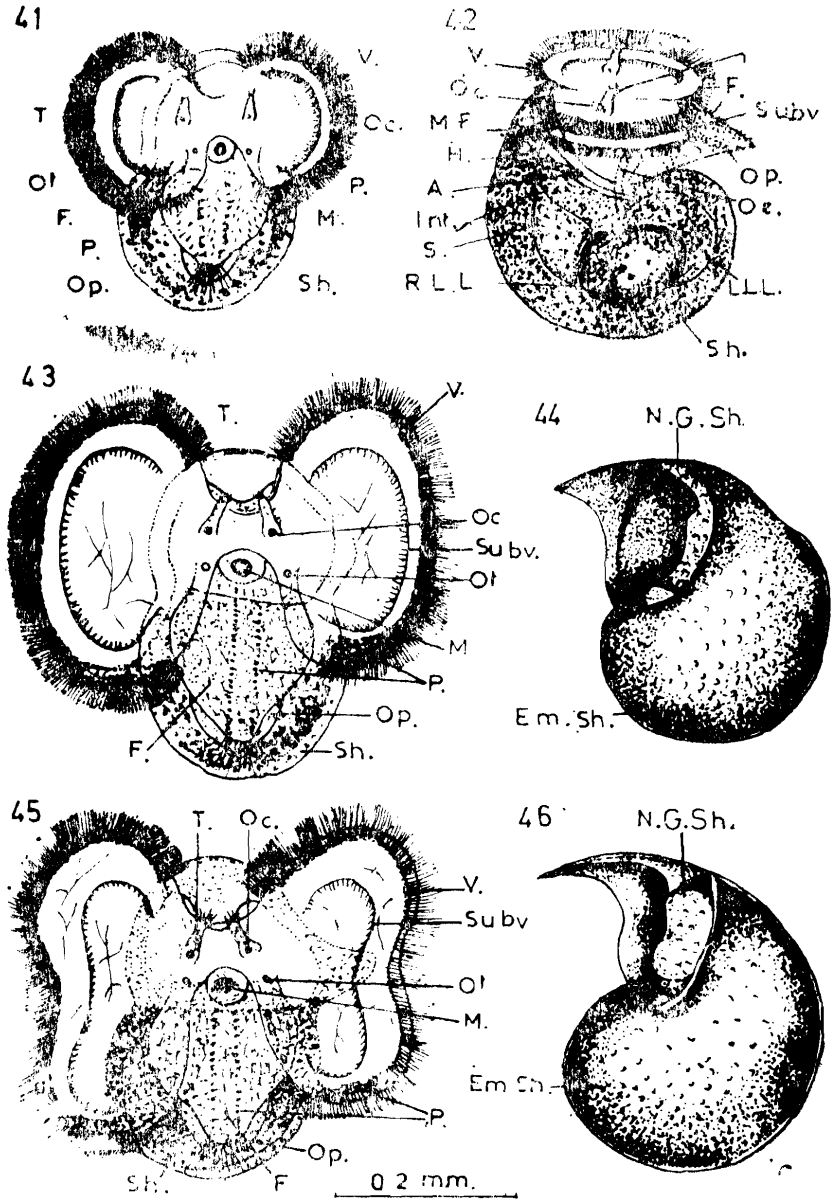
The larva grows quickly, and after 6 days of swimming all organs increase in size especially the velum, foot and shell (Figs. 43 & 44). The oval right velar lobe becomes elongated and measures about 300 μ long and 200 μ in greatest breadth while the left one is 280 μ long and 184 μ in breadth. The dark yellow pigments appear clearly on their surfaces, and are more concentrated into large spots at their borders. The foot is enlarged, still ciliated, club-shaped, clearly pigmented and measures about 196 μ in length and 160 μ breadth. The shell twists a little dextrally and becomes keeled dorsally with a left finger-like process. It is about 340 μ long and 272 μ wide, and aquires more dark brown spots and loses some of its transparency. The mantle fold becomes more thick, more pigmented and appears clearly from the opening of the shell. The other organs, such as tentacles, oesophagus, intestine and heart increase in size. At this stage, the larva is still moving towards the more lighted area of the rearing basin.

After 12 days of swimming, another advanced and distinct stage is obtained (Figs. 45 & 46). In this stage, the two velar lobes, which measures about 340 μ long in the right one and about 300 μ in the left one, increase in size and each shows a secondary division, and thus the velum becomes nearly fourlobed. The foot is about 200 μ in length and 160 μ in breadth. The shell (360 μ long and 280 μ wide) is more keeled dorsally with the left finger-like process more developed and protruded. The other organs are developed more and the characteristic colouration is still clear.

Unfortunately, after this stage the larvae died out gradually and their metamorphosis could not be followed. From the continuous great growth of the velum with its long cilia, and the gradual growth of the foot and the shell, one can expect that the larvae may spend longer time in the planktonic life before transforming to the creeping young.

DISCUSSION

Thais savignyi lays its eggs in capsules which differ from those previously described species of family Thaididae in some specific structures as size, colour, number of eggs and shape of capsules. The general shape of capsules in different species is either vase-shaped as in *T. lapillus, T. hippocastaneum,* or pillar shaped as in *T. caranifera, T. haemastoma, T. clavigera, T. broni*



Thais savignyi (Cont.), Text-figs. 41–46. 41 and 42 : Newly hatched veliger larva, top and right views, 43 : 6-day veliger larva, top view, 44 : Shell of previous stage, 45 : 12-day veliger larva, top view, 46 : Shell of previous stage.

and others. In all cases the exit hole is located at the top of the capsule. In our species, the capsule is broad flattened oval vase-shaped with an exit hole at the middle of the concave side. The second difference is that the

other species lay adherent capsules which are arranged side by side on a common basal membrane, while in our species the firstly laid capsules are separate and adherent but the further deposited ones are standing on the tops of the older ones forming a coherent cluster. Another important difference lies in the nurse cells which are present in some species as in *T. lapillus* (Pelseneer, 1905 & 1911, Portmann, 1925 & 1930, Thorson, 1946 and others), *T. hippocastaneum* (Thorson, 1940) and *T. clavigera* (Amio, 1963), are completely absent in our species and all eggs develop into larvae, and this agrees with other species of *Thais.* (*T. carinifera,* Thorson 1940, *T. haemastoma floridana,* D'Asaro 1966 and others). The early cleavages are not proceeding in the same manner in different species of the family. Pelseneer (1911) had listed three types for the early cleavage in *T. lapillus;* the first is the trifoil type, the other cleavage include AB ooccurs first followed by CD cleavage, and vice versa. In *T. haemastoma floridana* (D'Asaro 1966) CD cleavage is prior to that of AB with the formation of the polar lobe which is connected to the small D. In our species, CD cleavage occurs first followed by AB, but the 4 cell stage agrees in very few abnormal embryos with those described by D'Asaro, while the normal arrangement is the presence of three small macromeres (A, B & C) on the top of the large fourth cell D.

The larvae of *T. savignyi* hatch out as typical veligers from the normal exit holes. They do not swim directly after their dischargement as in other species, but remain for a while contaminated with the mucous substance emerging with them from the capsule, and then are liberated in the surrounding water after dissolving of this substance. The planktonic larva of this species passes through 3 characteristic stages : the newly hatched veliger with an oval bilobed velum possessing yellow pinments scattering in its surfaces and with semi-transparent shell. The advanced larva has greatly elongated velum (with its pigments) and a shell which is slightly opaque due to the condensation of dark brown spots and has a dorsal blunt beek and a left finger-like siphon; in the more advanced stage the velum is nearly four-lobed and the shell becomes completely opaque and possesses the other characteristic features.

SUMMARY

Thais savignyi lays its yellow eggs (200 μ) in broad flattened vase shaped stalkless capsules which are firstly arranged in adherent mass, then form coherent cluster with the deposition of new ones. Each capsule contains 250 to 500 eggs, all of which develop into embryos. The first two

cleavages are unequal. The development proceeds slowly, the gastrula is attained after 8 days and the free swimming larva hatches after 30 to 32 days of spawning. The veliger possesses an oval bilobed velum (160 - 180 x 120 - 124 μ) with yellow pigments on its surface ; a stout club-shaped ciliated foot with tuft of long cilia and two parallel rows of dark orange pigments on its ventral side; and a shell (slightly more than one whorl, (300 x 264 μ) coloured with dark brown spots. It passes through planktonic stages before beginning of metamorphosis, the velum becomes elongated then four-lobed. The aperture of the shell is formed into a beak projecting between the dorsal velar lobes and a left siphon.

LIST OF ABBREVIATIONS

A.	Anus
A.G.	Anal gland
Bl.	Blastopore
B.M.	Basal membrane
Ci.	Cilia
E.	Egg
E.C.	Egg capsule
Ec.	Ectoderm
Em.Sh.	Embryonic shell
F.	Foot
H.	Heart
Int.	Intestine
L.G.	Longitudinal groove
L.K.	Larval kidney
L.L.L.	Left liver lobe
L.R.	Longitudinal ridge
M.	Mouth
Met.	Metapodium
M.V.C.	Mit-velar cone
N.G.Sh.	New growth of shell
Oc.	Ocellus (Eye spot)
Oe.	Oesophagus

Op.	Operculum
Ot.	Otocyst
P.	Pigment
R.L.L.	Right liver lobe
S.	Stomach
Sh.	Shell
Subv.	Subvelum
T.	Tentacle
V.	Velum
V.M.	Visceral mass

A, B, C, and D are the first 4 blastomeres or macromeres. 1a, 2a, 3a, 4a, 1b ..... 4d are the micromeres of the 4 quartettes.

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