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A NEW SPECIES OF *THAIS* (GASTROPODA: MURICIDAE) FROM SINGAPORE AND PENINSULAR MALAYSIA

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ABSTRACT. - *Thais jubilaea,* new species (Mollusca: Neogastropoda: Muricidae) which is common on rocky shores of Singapore and West Malaysia is described. The species has probably been overlooked and mistaken for *Thais clavigera* (Küster, 1858) and/or *Thais undata* (Lamarck, 1822) in the past but can now be separated from them using the shell, radula, body colour and form of penis.

INTRODUCTION

The genus *Thais* comprises a large number of species of predatory gastropods common on rocky shores around the world, and the intertidal rocky shores of Singapore and peninsular Malaysia are no exception. This group of snails prey mainly on barnacles, oysters and other molluscs. Although they are conspicuous and fairly abundant, the identification of the various species is difficult. Many of the species resemble each other, and intraspecific variations of shell morphology, such as sculpture and colour, due to environmental or age-related factors can in some cases exceed interspecific variation. The fact that considerable variability in shell morphology is known to exist in some species has led people to expect that such variability is a general rule in many species of *Thais*. Reliance on shell characters alone has resulted in the inability to recognise different species with very similar shells. This has probably been the case for the new species described here, which is very similar to *Thais clavigera* (Küster, 1858), *Thais undata* (Lamarck, 1822), *Thais kieneri* (Deshayes, 1844) and to a lesser extent, *Thais bitubercularis* (Lamarck, 1822) and *Thais luteostoma* (Holten, 1802). The availability of live specimens has allowed us to use characters other than the shell that are useful for identification. In this paper, we have used the shell, radula, body colour and penial morphology of the new species. The new species is also compared with *Thais clavigera* and *Thais undata.* Confusion already exists as to the identity of *Thais undata, Thais kieneri, Thais luteostoma* and *Thais bitubercularis,* which may perhaps all be the same species, but this will not be discussed here.

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MATERIALS AND METHODS

Shells were collected from various natural and man-made `rocky' shores of Singapore and peninsular Malaysia. Shell descriptions are given for both dry and wet specimens, since the colour of the external surface is dependent on whether they are dry (as in museum collections) or wet (as encountered in the field). The snails were relaxed in 7.5% magnesium chloride solution in seawater (1:1 v/v) overnight, and the soft parts were examined under a stereoscopic microscope using a colour-corrected light source (Schott KL 1500 fitted with 15V 150W Philips 6423 bulb). Radulae were extracted in 1M potassium hydroxide solution, washed in distilled water and their lengths measured. They were then mounted flat on aluminium or brass stubs with double-sided tape, coated with gold and examined under a JEOL JSM T220-A scanning electron microscope. Photographs were taken from two perspectives: perpendicular and at an angle of 45 degrees towards the posterior end (i.e., in the direction of nascent rows). Radulae were also viewed under the light microscope. They were either viewed as they were after dissection or processed according to Verdcourt (1948) and teased apart in mountant to show individual teeth. Terminology used for the description of radulae follows that of Fujioka (1985) and Kool (1987).

Type specimens are deposited in the Zoological Reference Collection (ZRC) at the National University of Singapore. Voucher specimens (including paratypes) will be sent to other institutions at a later date.

TAXONOMY

Thais jubilaea, new species
(Colour plate 19I: A, D, G, H; Figs.1, 2)

Etymology.- The species is named in celebration of the 40th anniversary of the Department of Zoology; the year 1990 is also the 25th anniversary (silver jubilee) of independence for the Republic of Singapore, and the 10th anniversary of the National University of Singapore at Kent Ridge.

Diagnosis.- **Shell**: Tubercles are reduced to mere undulations on last whorl; spiral cords bear dashes of brown pigment separated by shorter yellowish-white dashes or spots, which are not always axially aligned with the pigmentation of the two spiral rows of tubercles. This is usually more apparent on the apertural (less worn) side of the shell. The edge of the outer lip traces a relatively smooth arc that is not angulate at the position of the first row of tubercles. **Body**: Subcutaneous white pigment spots present on sides of foot with little or no subcutaneous yellow spots; penial flagellum is barbed, resembling a harpoon.

Material examined.- Holotype- male, (ZRC.1990.13650), Tuas, Singapore, collected 30 March 1990, K.S.Tan.

Paratypes (ZRC.1990.13651-13659, 13809-13818) were collected from the following places: Singapore: East Coast Park granite bunds (4 specimens); Marina South granite bunds (2 specimens); Tuas, rocky shore off Tuas Road (7 specimens). Peninsular Malaysia, east coast: Tanjong Tembeling near Kuantan, Pahang, on granite boulders (4 specimens); peninsular Malaysia, west coast: Tanjong Bidara, off Tanjong Bidara Beach Re-

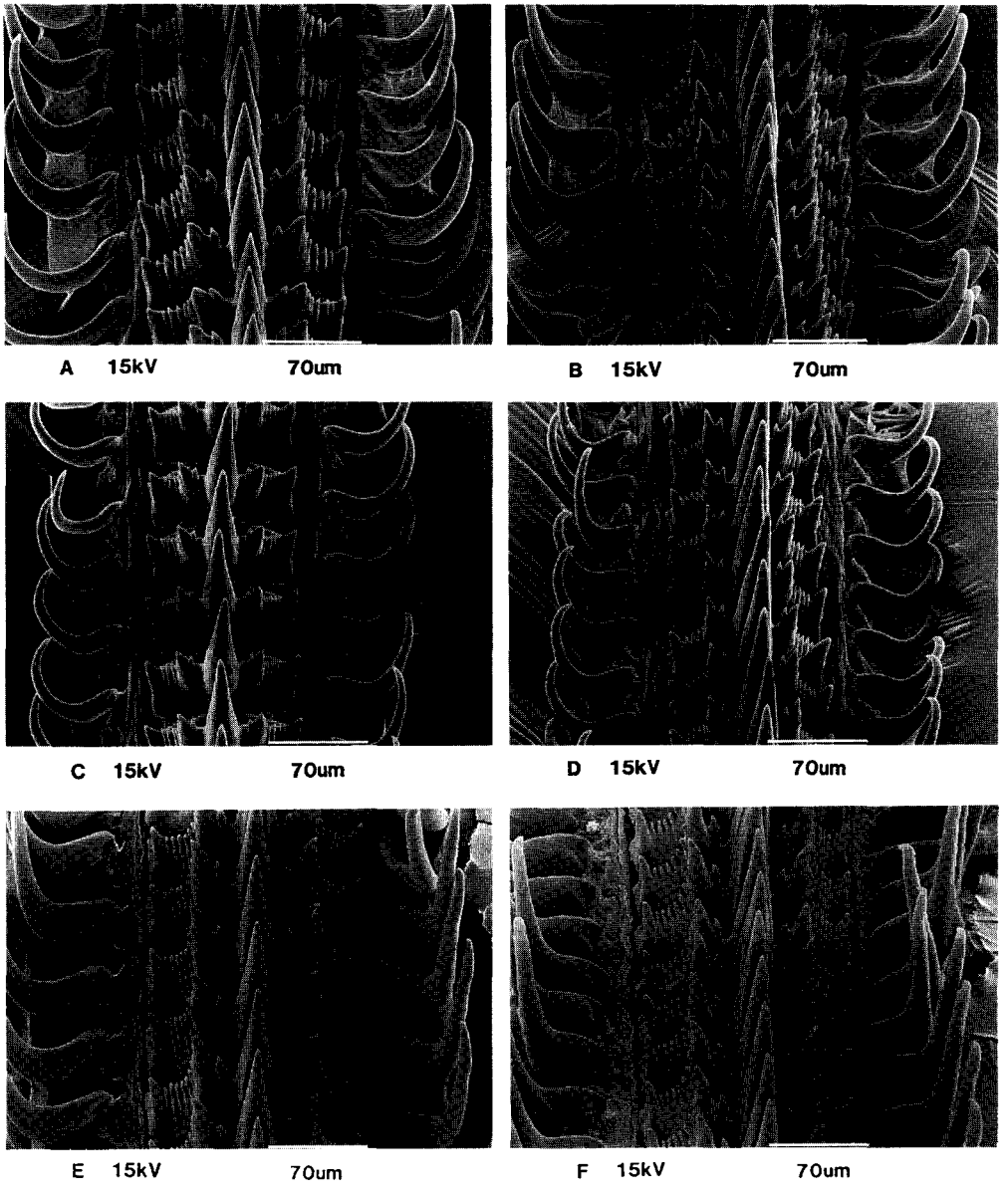

Fig. 1. SEM of *Thais* radulae: (A) *Thais jubilaea,* new species. Holotype, male, Tuas, Singapore; perpendicular view. Shell height 33.8mm, radula length 9.2mm; (B) Same as (A), 45° view; (C) *Thais clavigera,* male, Tanjong Balau, Johore, peninsular Malaysia; perpendicular view. Shell height 30.9mm, radula length 10.6mm; (D) Same as (C), 45° view; (E) *Thais undata,* male, Tanah Merah, Singapore; perpendicular view. Shell height 34.3mm, radula length 10.0mm; (F) Same as (E), 45° view.

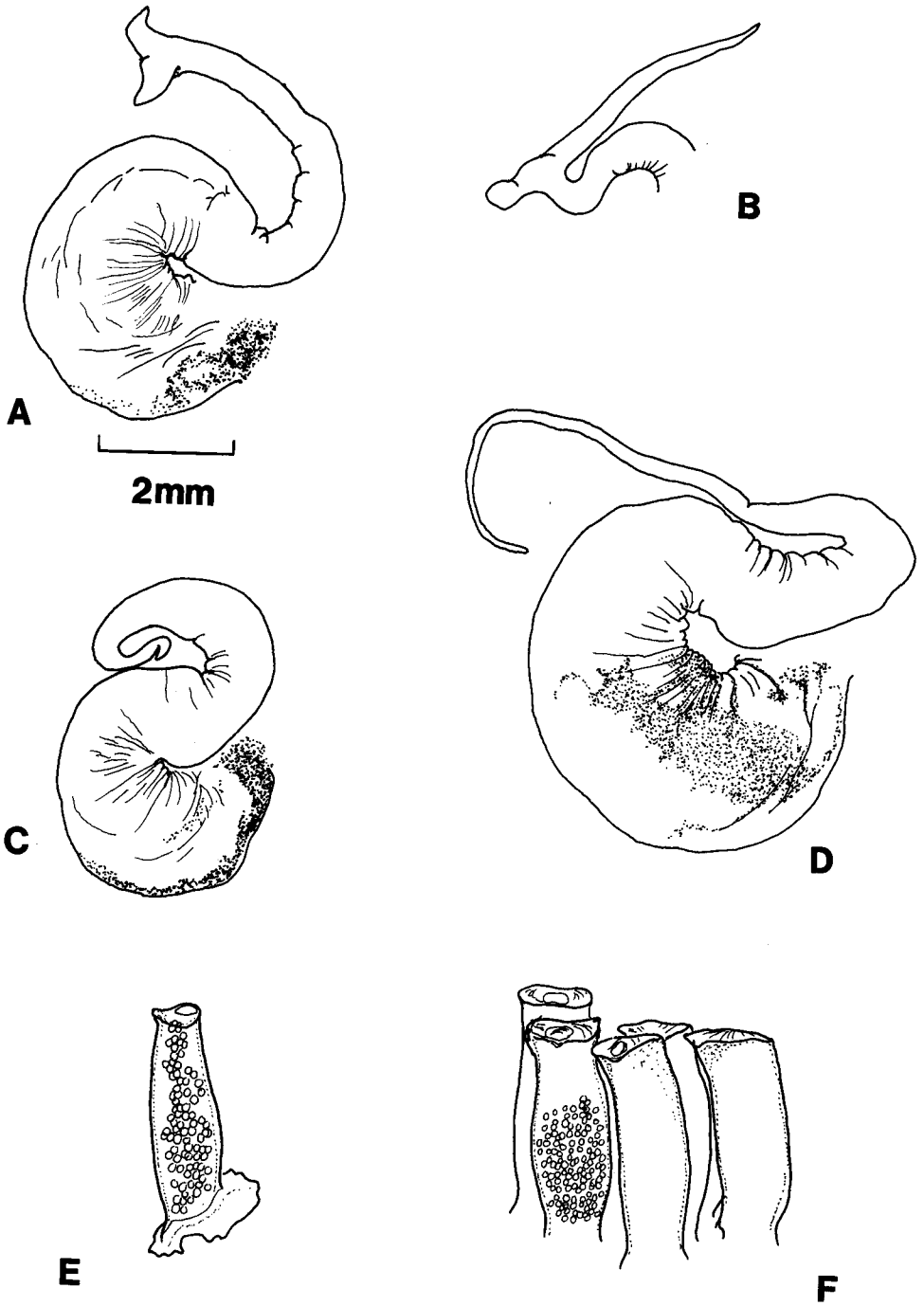

Fig. 2. Camera lucida drawings of penes and egg capsules of *Thais* spp. (Scale bar for A-D is 2mm, as shown): (A) Penis, *Thais jubilaea*, holotype; (B) Distal end of penial flagellum, *Thais jubilaea*, Tanjong Tembeling, Pahang, peninsular Malaysia; (C) Penis, *Thais clavigera*, Tuas, Singapore; (D) Penis, *Thais undata*, Tanah Merah, Singapore; (E) Egg capsule, *Thais jubilaea*; capsule height = 4mm; (F) Egg capsules, *Thais undata*; capsule height = 5mm.

sort, between Tanjong Kling and Cape Rachado, Malacca, on granite boulders (3 specimens).

Description.- **Shell**: *External features*: Height 25-38mm., fusiform, spire tall, entire external shell surface more or less lirate on unworn specimens. The last whorl bears two spiral rows of 8-9 very low tubercles; further abapically, two spiral rows of cords are present. Each cord consists of 2-3 spiral lirae which are wider than those found between the spiral rows. When the shell is dry, it is generally greyish-white with brown axially aligned markings corresponding to the positions of the tubercles. In worn, dry specimens, the brown markings are darkest at the tubercles; in unworn dry specimens, the markings may also be present between the adjacent spiral rows of tubercles. On wetted shells and on some unworn specimens, brown-black discontinuous dashes separated by shorter white or cream spots on the spiral cords can be seen. These dashes stand out since they are not always axially aligned with the pigmentation on the tubercles (see Colour Plate 19I, figs. G, H). *Aperture:* Edge of outer lip usually crenate, forming a relatively smooth arc that is not angulate at the first row of tubercles. The inner edge of the outer lip bears 3-5 denticles which may either appear papillate or drawn out to form spiral ridges towards the inside of the aperture. The region between the row of denticles and the edge of the outer lip is dark brown or black in specimens where the lip is not thickened, whereas it may be greyish-yellow in those with a thickened lip. The interior appears spirally banded if enamel deposition is not complete, with the darker bands corresponding to the space between the spiral rows of tubercles. Otherwise, the interior is yellow-orange. The columella is broad, generally yellow-orange in colour and the columellar lip is concave.

Body colour: Sole of foot beige to almost white, sometimes with white subcutaneous pigment spots distributed throughout; edge of sole with high density of subcutaneous white pigment spots; sides of foot mottled black on the surface with subcutaneous white pigment spots. No differences were found between males and females.

Penis: (Fig.2, A,B) Muscular, flagellate; flagellum is barbed at the distal end, resembling a harpoon.

Egg capsules: Indistinguishable from those of *Thais clavigera*;(see Fig.2E). Colour of eggs in the capsules may vary from yellow to cream when freshly laid.

Radula: (Fig.1, A,B) Radula length 8.6-12.1mm (shell height 28-37mm); rachidian width 130 μm. Ratio of shell height to radula length = 3.22 ± 0.090 SE (n=12); radula length is independent of sex, but may vary according to age. Rachidian: central cusp medium-sized, slender; lateral cusps point outwards; there are 3 marginal denticles and 3 lateral cusp serrations; marginal cusps prominent, sharp, pointing outwards.

The ratio of shell height to radula length for *Thais clavigera* and *Thais undata* are 2.70 ± 0.010 (n=12) and 3.71 ± 0.118 (n=12) respectively. Analysis of variance showed that the ratios among the three species were significantly different.

Habitat.- Although no quantitative survey was done, the new species (and *Thais clavigera*) prefer wave-splashed regions between the middle and lower limits of the barnacle belt (usually of *Balanus* spp.) or just below the oyster belt (mainly *Saccostrea cucullata*), and seems to be more or less clear water species, avoiding silty conditions. *Thais undata*, on the other hand, are found between the middle and upper limits of the

barnacle belt, and are usually associated with areas of silt-laden water (e.g., rocky shores adjacent to mangroves and even on outlying mangrove trees fringing the sea) although all three species can be found together (e.g., on granite bunds along the east coast of Singapore).

DISCUSSION

The species described here has probably been confused with *Thais clavigera*, with which the new species is usually found in Singapore and peninsular Malaysia. It may also have been confused with *Thais undata*, which can occur in the same habitat. Identification based on the shell alone may present some difficulty, but with experience, the low tubercles, the smooth arc traced by the edge of the outer lip which is not angulate at the position of the first row of tubercles, and the pattern of brownish-black dashes on the spiral cords of the last whorl can be used to distinguish this species from *Thais clavigera* and *Thais undata*. In *Thais clavigera*, the tubercles tend to be pyramidal in shape with a rectangular base, as illustrated in Küster (1858) (species 95, plate 31a, fig.1, which is based on the type specimen from Singapore) and just below the suture separating the last whorl from the penultimate whorl there is a nodose cord that is absent in *Thais jubilaea*. In *Thais undata*, the tubercles are compressed in a plane perpendicular to the shell axis, and in some specimens they may be slightly curved towards the apex. In contrast, the tubercles of *Thais jubilaea*, if present, are never as prominent. The outer lip of the shell of *Thais clavigera* and *Thais undata* are angulate at the first row of tubercles, but not in *Thais jubilaea* (see Colour plate 19I, A-F). A further distinction between the three species is that in unworn shells of *Thais jubilaea* the spiral cords bear alternating brown and yellowish-white dashes that are not axially aligned (see Colour plate 19I, G, H), while in *Thais clavigera* and *Thais undata* the tubercles are usually brown or black and they appear as broad axial markings when the shells are wet.

The radula of *Thais jubilaea* also differs from those of *Thais clavigera* and *Thais undata* (see Fig.1). *Thais clavigera* has fewer marginal denticles present on the rachidian teeth (three to four, compared to four to six in *Thais jubilaea*), and the central cusp is slender and long compared to that of the new species. The rachidian teeth of *Thais undata* have a greater number of marginal denticles (six, excluding lateral cusp serrations), and the central cusp is shorter. As already stated above, the ratio of shell height to radular length is lower in *Thais clavigera* and higher in *Thais undata*.

In living specimens of *Thais jubilaea*, white subcutaneous pigment spots are distributed throughout the sides of the foot whereas yellow subcutaneous pigment spots predominate in *Thais clavigera* and *Thais undata* and white spots are indistinct.

The harpoon-like penis of *Thais jubilaea* is distinctly different from those of *Thais clavigera* and *Thais undata*. The flagellum of *Thais clavigera* is always reflexed at the tip (Fig.2C) whereas *Thais undata* has an extremely long flagellum that is never reflexed at the tip (Fig.2D). These differences are also constant in pseudopenes of females of the three species showing effects of 'imposex' due to organotin pollution.

The egg capsules of *Thais jubilaea* and *Thais clavigera* are identical, but those of *Thais undata* differ in not tapering towards the top and therefore have a larger 'lid' (see Fig. 2 E,F).

Habitat requirements for these three species seem to be very similar in many respects. They are usually found together, although at Tanjong Bidara (Malacca, peninisular Malaysia), a monospecies population of *Thais jubilaea* was found on granite boulders spatially segregated from the more common *Thais undata*.

Museum collections have not been examined in detail, but it is likely that specimens of *Thais jubilaea* are identified as *Thais clavigera, Thais kieneri, Thais undata,* or *Thais luteostoma*. We are in possession of a photograph taken by Professor D. V. Ellis (University of Victoria, British Columbia, Canada) of specimens in the British Museum (Natural History) identified as *Thais clavigera* (Acc.no. 2264, 'intertidal rocks, Pulau Pinang, west coast Malaya'). Some of the specimens in the photograph are clearly *Thais jubilaea*. *Purpura fasciata* Reeve in Reeve (1846) (species 45, plate IX) is superficially similar to the new species, and although the habitat is unknown, and the description of the aperture as being 'short and almost rounded' agrees with *Thais jubilaea*, he further states of the aperture: 'the purplish-white tinge of the aperture, in which there is no indication of yellow or orange-red'. This is not so for *Thais jubilaea*. *Purpura fasciata* is also illustrated in Küster (1858) (species 37, plate 23, figs.6,7). The specimen described is from the Antilles. The three yellow bands on the last whorl and the violet colour of the anterior siphonal end of the columella as described by Küster are not present in the new species. Cooke (1919) described the rachidian tooth of *Purpura fasciata* from Ascension Island; the two specimens examined by him had different numbers of blunt outer denticles (three and five respectively); the present species described has five to six sharp outer denticles, but since no illustrations are given, an objective comparison is impossible.

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