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Species Description and Distribution of *Strombus* (Mollusca: Strombidae) in Johor Straits and its Surrounding Areas

(Pemerihalan Spesies dan Taburan *Strombus* (Mollusca: Strombidae) di Selat Johor dan Kawasan Sekitarnya)

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ABSTRACT

A total of 230 individuals of Strombus *were sampled at various locations along the Johor Straits, Malaysia. Four species of* Strombus were *present in the study areas i.e.* Strombus canarium *Linnaeus, 1758;* Strombus urceus *Linnaeus, 1758;* Strombus marginatus *subspecies* succinctus *Linnaeus, 1767;* Strombus marginatus *subspecies* robustus *Sowerby, 1874; and* Strombus vittatus *subspecies* vittatus *Linnaeus, 1758*. Strombus canarium *was the most common, widely distributed and most abundant, followed by* S. urceus*, while the others were only rarely found. Among the species sampled,* Strombus marginatus *and* Strombus vittatus *were two new distribution records for the Johor Straits. Since all* Strombus *were traditionally harvested and consumed by the locals since long ago, further studies are needed particularly regarding the population dynamics and fishery of the harvested species.*

Keywords: Conch; distribution; Johor Straits; Strombidae; taxonomy

ABSTRAK

Sebanyak 230 individu Strombus *telah berjaya disampel di beberapa lokasi sepanjang Selat Johor, Malaysia. Terdapat empat spesis yang dikenal pasti iaitu* Strombus canarium *Linnaeus, 1758;* Strombus urceus *Linnaeus, 1758;* Strombus marginatus *subspesis* succinctus *Linnaeus, 1767;* Strombus marginatus *subspesis* robustus *Sowerby, 1874; dan* Strombus vittatus *subspesis* vittatus *Linnaeus, 1758*. S. canarium *adalah yang paling biasa ditemui, diikuti dengan* S. urceus*, sementara yang lain amat jarang ditemui. Antara spesis yang disampel,* S. marginatus *dan* S. vittatus *merupakan dua rekod baru bagi kawasan kajian. Memandangkan ia adalah makanan yang digemari oleh penduduk tempatan dan aktiviti penangkapan telah dijalankan sejak dahulu lagi, kajian lanjut amat diperlukan terutamanya berkenaan kedinamikan populasi dan aspek perikanan siput* Strombus.

Kata kunci: Siput gonggong; taburan; Selat Johor; Strombidae; taksonomi

INTRODUCTION

The genus *Strombus* is a world wide tropical group of mesogastropods species, within the family Strombidae. The living *Strombus* contains about 50 full species, where 38 of them occurred within the Indo-Pacific region (Abbott 1960). The Indo-Malayan waters contain about 23 races while in the Philippines there are about 26 races. This region was considered as centre of species occurrence for the *Strombus* (Abbott 1960). Although most information regarding the genus in this region has been dealt with great extends by Abbott (1960), information regarding the species in Malaysian waters is however very limited. Chuang (1973) reported two species present in sandy shores around Singapore i.e. *S. isabella* and *S. urceus*. Purchon and Purchon (1981) recorded 11 species in coastal waters of Malaysia Peninsula, namely *S. aurisdiane aurisdiane* Linnaeus, 1758; *S. canarium* Linnaeus, 1758; *S. decorus decorus* (Roding 1798); *S. dilatatus dilatatus* Swainson, 1821; *S. epidromis* Linnaeus, 1758; *S. luhuanus* Linnaeus, 1758; *S. marginatus marginatus* Linnaeus, 1758; *S. marginatus robustus* Sowerby, 1874; *S. urceus* Linnaeus, 1758; *S. variabilis variabilis* Swainson, 1820; and *S. vittatus vittatus* Linnaeus, 1758.

In many parts of Southeast Asia, *Strombus canarium*, which was abundant within seagrass beds, constituted important food staples especially for those living along the shore (Amini 1986; Purchon & Purchon 1981; Amornjaruchit 1988; Poutiers 1998). They are largely collected for their meat, apart from the shell which also has considerable ornamental value (Poutiers 1998). Within the Johor Straits only two species have been reported earlier i.e. *S. canarium* and *S. urceus* (Chuang 1961, 1973; Purchon & Purchon 1981; Zaidi et al. 2005). The aim of this study was to generate specific information on the taxonomy and distribution of *Strombus* in various locations along the Johor Straits, particularly within seagrass ecosystem, which normally preferred by this herbivorous gastropod.

Materials and Method

Specimens were manually collected from Merambong Shoal (1º 19.55' N, 103º 35.57' E), Tanjung Adang Shoal (1º 19.48' N, 103º 33.59' E), Merambong Island (1º 18' 54.83 N, 103º 36.33' E) and Tanjung Bin (1º 19.385' N, 103º 32.065' E), in the west; and Tanjung Surat (1º 29.170' N, 104º 02.651' E) and Pasir Gogok (1º 26.229' N, 104º 05.644' E) in the east of the Johor Straits (Figure 1). *Enhalus acoroides* and *Halophila ovalis* complex dominate the seagrass meadow at most of the sampling sites. Surveys were also extended to the coasts of Melaka and Negeri Sembilan, and few islands off the eastern coast of Johor i.e. the Pulau Tinggi archipelago. The identification of species was based on earlier descriptions by Abbott (1960), Walls (1980) and Poutiers (1998), and were redescribed to represent the local population.

Result and Discussion

A total of 230 individuals of *Strombus* were sampled and analyzed for taxonomic identification. There were four species of *Strombus* present in the study areas i.e. *Strombus canarium* Linnaeus, 1758; *Strombus urceus* Linnaeus, 1758; *Strombus marginatus* subspecies *succinctus* Linnaeus, 1767; *Strombus marginatus* subspecies *robustus* Sowerby, 1874; and *Strombus vittatus* subspecies *vittatus* Linnaeus, 1758.

Strombus canarium Linnaeus, 1758

Remark: This species was the most abundance and was highly associated with seagrass bed. It is known as 'siput gonggong' among the locals and was traditionally harvested, with good market value (Zaidi et al. 2005; Japar

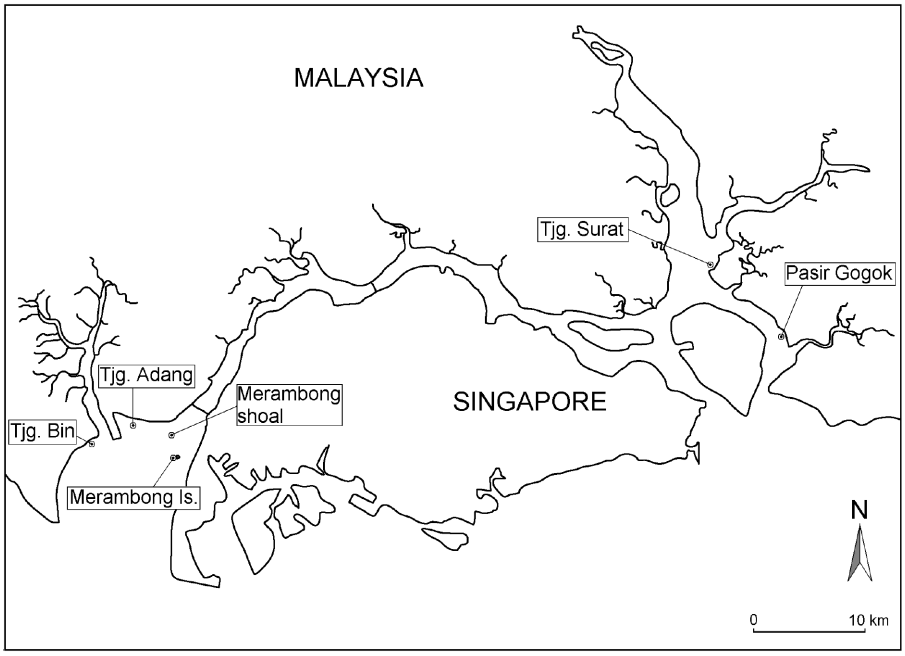

FIGURE 1. Location of the study sites

TABLE 1. Shell meristic measurements of adult *S. canarium* (N = 136)

Characters	Measurement (mm) ± S.E.	Range (mm)	Measurement by other authors
Total shell length	55.24 ± 0.32	46.53 – 64.92	31 – 97 mm* 65 mm** 36 – 72 mm***
Shell width	35.13 ± 0.19	29.44 – 41.90	
Shell Depth	25.47 ± 0.16	21.52 – 29.40	
Body whorl length	43.82 ± 0.24	37.33 – 51.74	
Spire length	11.49 ± 0.11	8.23 – 15.93	
Aperture length	45.85 ± 0.27	38.36 – 54.74	
Shell outer lip thickness	3.26 ± 0.11	0.79 – 6.55	
Number of whorls	10 – 11	–	

* From Abbott (1960).

** From Poutiers (1998) (average value)

*** From Amini (1986)

Sidik et al. 2006). They preferred areas with soft or muddy sediment, often in colonies and within areas of low to medium seagrass densities.

Material Examined: Number of specimens examined 136, with shell length ranged from 46.53 to 64.92 mm (Table 1).

Description: The shell generally solid, heavy, globose, with smooth texture. The general outline of the shell was broad spindle-shaped. Outer shell was lightly leathery in live specimen. Spire with at least five whorls, with very distinct sutures. Nuclear whorls three, rounded, smooth and translucent white. Postnuclear whorls brownish and moderately rounded, with either spiral cords or incised lines. Numerous axial riblets present to form a gross reticulate pattern (Figure 2(a)). By the second or third whorl only incised lines are present, and the remaining whorls are smooth, except for six to 15 weak spiral threads or incised lines at the base (anterior) of the shell. The penultimate whorl flat, rounded, barely angular. Last whorl (body whorl) roundly swollen at shoulder. Dorsum of body whorl with small hump or knob, normally smooth (absent) in very old specimen.

Color of shell uniform light yellow-brown type i.e. form *turturella* (Roding 1798), and rarely covered with a fine, zig-zag network of darker brown (netted form). Columella straight, swollen, smooth, enamel-white, and highly glazed in older specimen. The outer lip was greatly expanded, thickened and rounded, with its upper end projecting slightly upward. The aperture long, only a little shorter than the length of body whorl. Siphonal canal short and stromboid notch very shallow. Periostracum rather thick, reticulated, yellow brown and fimbriated at the sutures. Posterior canal is also shallow and short, adhering to one or two whorls up the spire. The operculum stromboid, dark brown and slightly arching, with seven to eight weak serrations (Figure 2(f)). Verge with broad swollen distal end, consists of keel, accessory pad and auxiliary prong (Figure 2(e)). Radula with a formula of: 3-1-3 or 4-1-4; 1-5 (plus peg) or 1-6 (Plus peg); 6; 6.

Records: This species was recorded from Tanjung Adang Shoal, Merambong Shoal, Tanjung Bin, Tanjung Surat and Pasir Gogok in the Johor Straits; from Pulau Tinggi, Pulau Besar and Pulau Sibu in eastern Johor, and Port Dickson and Teluk Kemang in Negeri Sembilan. Previously

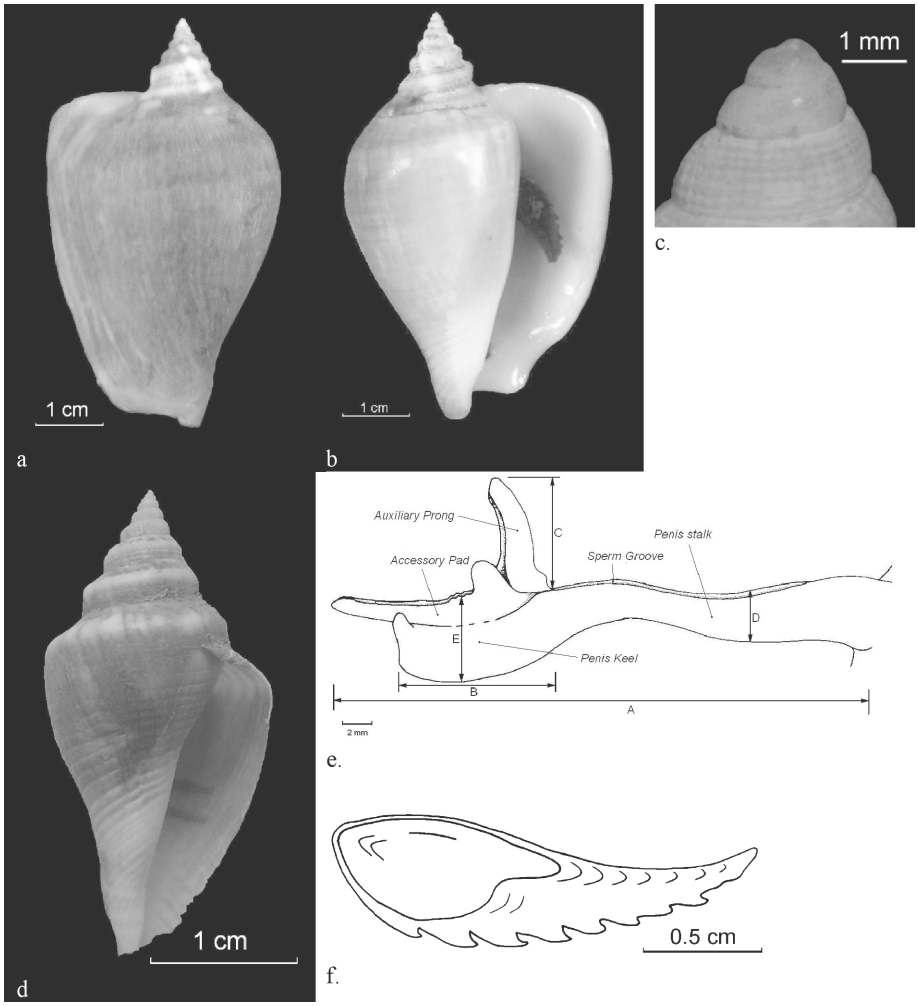

FIGURE 2. *Strombus canarium* Linnaeus, 1758. Adult shells (a,b), protoconch (apex) (c), juvenile shell (d), schematic drawings of male's verge (e) and adult operculum (f)

reported from Pulau Pangkor, Pulau Langkawi, Cape Rachado, Kilat, and western Johor Straits (Chuang 1961, 1973; Purchon & Purchon 1981; Zaidi et al. 2005). Regionally, the species range extends from Southern India to Australia and Melanesia, and North to Japan (Abbott 1960; Poutiers 1998). It was also abundant in coastal areas of Indonesia (Amini 1986; Amini & Pralampita 1987; Erlambang & Siregar 1995; Erlambang 1996), Thailand (Tantanasiriwong 1978; Amornjaruchit 1988) and Vietnam (Lauranceau 2001).

Synonyms: *Laevistrombus turturella* Roding (1798): p. 65, no. 833, fig. 817; *Strombus isabella* Lamarck (1822): p. 207, fig. 817; *Strombus vanikorensis* Quoy and Gaimard (1834): p. 73, pl. 51, figs. 7-9; *Strombus taeniatus* Quoy and Gaimard (1834): p. 75, pl. 51, figs. 14-15; *Strombus gibbus* 'Martini' Issel and T. -Canefri (1876): p. 344; R. Bergh (1895): pp. 359-362, pl. 23, figs. 50-53; *Strombus vanicorensis* Quoy (1885): p. 110.

STROMBUS URCEUS LINNAEUS, 1758

Remark: The species collected was form *ustulatus* Schumacher (1817), i.e. with black colored columella and aperture. Normally present together with *S. canarium*, thus known as 'gonggong jantan' (or male conch) by the locals. They preferred areas with soft or muddy sediment, often in colonies and within areas of low to medium seagrass densities.

Material Examined: Number of specimens examined 78, with total shell length ranged between 51.2 to 61.82 mm (Table 2).

Decription: Shell varied from solid, smooth, to axially nodulated. Elongate or slender in appearance with low degree of shell-outer lip flaring. Whorls either rounded or, especially the spire, squarish (Figure 3(c)-(d)). Nuclear whorls three, bulimoid, glossy, smooth, translucent-tan or bluish-black and rarely colorless (Figure 3(a)). First post-nuclear whorl with eight to ten microscopic incised lines. Subsequent whorls shouldered and with 11 to 17 small axial riblets per whorl, usually knobbed or beaded. Last whorl has three to eight low knobs at shoulder, with the one on dorsum being the largest. Axial plications normally absent on the parietal area. Base of shell with eight to ten incised lines; or low, flat cords. Shell color range from brown, whitish, cream, or with greenish, yellow brown maculations, with flecks of broken bands and axial streaks.

The columella was smooth, except for six to 15 raised spiral lirae at the top third and one to eight distinct lirae at the lower fourth; and set almost at right angle to the axis of the columella. Columella all black in adult, but yellowish-orange with black rim in newly matured individuals. Siphonal canal almost always tipped with bluish-black within and without. The siphonal canal somewhat elongated, slightly reflected upward and moderately twisted. Stromboid notch shallows. Periostracum thin and smooth, and translucent grayish to yellow. Periostracum is usually worn-out at body whorl. Posterior canal short, adhering to less than one whorl in the spire. Operculum stromboid, not arching, brown, and with about 12 fine, sharp serrations (Figure 3(f)). Verge simple, with broad distal end, variegated (spotted, multicolored) with white and red embedded granules (Figure 3(e)). Radula with formula of 2-1-2; 1-3 (plus peg); 4; 5.

Records: The species was recorded from Merambong Shoal, Tanjung Adang Shoal, Tanjung Bin and Tanjung Surat in Johor Straits; and Port Dickson, Negeri Sembilan; Pulau Tinggi and Pulau Sibu. Previously it has been reported from Pulau Perhentian, Terengganu; from Pulau Tinggi, Pulau Sibu and Pulau Besar, Johor; Pulau Pangkor, Perak; Kilat and Cape Rachado, Negeri Sembilan, and within Singapore waters (Purchon & Purchon 1981). Regionally *urceus* distribution range extends from the Ryukyu Islands (Japan) in the north to Australia and Melanesia (Abbott 1960; Poutiers 1998).

Synonyms: *Lambis reticulata* Link (1807): p. 109, fig. 806; *Canarium ustulatum* Schumacher (1817): p. 219, figs. 803 and 805; *Strombus incisus* Wood (1828): p. 14, pl. 4, fig. 12; *Strombus anatellus* Duclos (1844): vol. 2, pl. 4, figs. 11 and 12, pl. 21, figs. 8 and 9; *Strombus crassilabrum*

TABLE 2. Shell meristic measurements of adult *S. urceus* (N = 27)

Characters	Measurement (mm) ± S.E.	Range (mm)	Measurement by other authors
Total shell length	56.62 ± 0.60	51.20 – 61.82	19 – 61 mm* 50 mm**
Shell width	24.53 ± 0.37	21.40 – 27.40	
Shell Depth	20.21 ± 0.43	17.10 – 22.86	
Body whorl length	41.21 ± 0.44	36.84 – 44.51	
Spire length	15.61 ± 0.22	14.23 – 17.31	
Shell outer lip thickness	2.74 ± 0.13	1.50 – 3.86	
Number of whorls	8 to 9	–	

* From Abbott (1960).

** From Poutiers (1998) (average value)

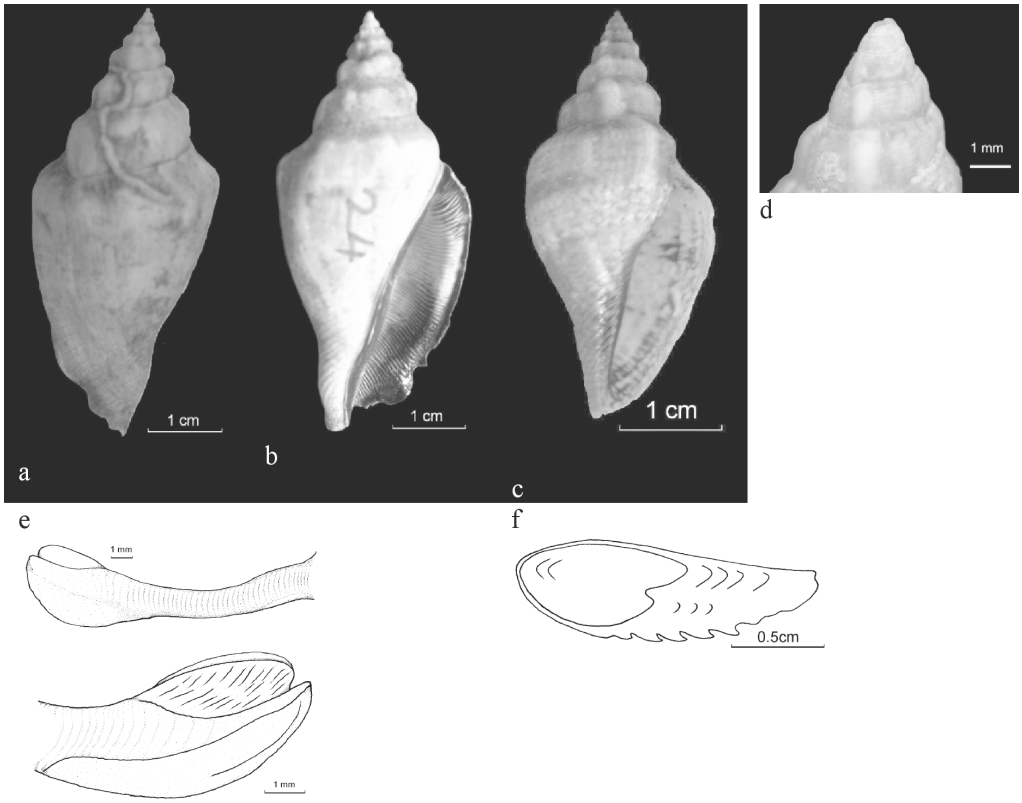

FIGURE 3. *Strombus urceus* form *ustulatus* Schumacher, 1817. Adult shells (a, b), juvenile shell (c), protoconch (d), schematic drawings of male's verge (e) and adult operculum (f)

Anton (1839): p. 87, no. 2820; *Strombus (Canarium) muricatus* 'Martini' Watson (1885): p. 417, Schepman (1909): p. 151; *Strombus (Canarium) plicatus* Lamarck, Adam & Leloup (1938): p. 112, pl. 1, fig. 8 (d & e); *Strombus ustulatus* form *laevis* Dodge (1946): pp. 2 & 7, figs. 1 & 6; *Strombus (Canarium) gendinganensis* Martin (1946): p. 61, pl. 4, fig. 27.

STROMBUS MARGINATUS SUBSPECIES *SUCCINCTUS* LINNAEUS, 1767

Remark: A new distribution record for the study area. Previously reported in non-coralline waters of Ceylon and the southeast end of India. This species still remain in puzzle since not much material has been collected and studied (Abbott 1960). There are four subspecies currently accepted: *marginatus* Linne, 1758; *succinctus* Linne (1767); *robustus* Sowerby (1874); *septimus* Duclos (1844). They preferred areas with soft or muddy sediment, often solitary or in pairs and within areas of low to medium seagrass densities.

Material examined: Number of specimens examined 4, with total shell length ranged from 45.14 to 51.01 mm (Table 3).

Description: Shell smooth and moderately elongate. Adults normally have ten complete whorls. Nuclear whorls $2^1/_2$,

TABLE 3. Shell meristic measurements of adult *S. marginatus succinctus* (N = 4)

Characters	Measurement (mm) ± S.E.	Range (mm)	Measurement by other authors
Total shell length	48.44 ± 1.32	45.14 – 51.01	40 – 53 mm * 50 mm**
Shell width	24.66 ± 0.43	23.70 – 25.52	
Shell Depth	20.12 ± 0.42	19.43 – 21.21	
Body whorl length	38.69 ± 0.77	36.62 – 40.00	
Spire length	9.76 ± 0.56	8.52 – 11.01	
Number of whorls	10	–	

* From Abbott (1960).

** From Poutiers (1998) (average value)

small, glossy and translucent-white. Apical whorls (spire) have numerous axial riblets, which are crossed by few microscopic spiral threads. The first three of nuclear whorls bear a total of four to eight swollen, rounded, former varices. The suture minutely indented. In the first to the third whorl, it is bordered below by a distinct spiral, striated cord. In the third to the last whorl, it is commonly bordered above by small beads or nodules (Figure 4(c) & (d)). Body whorl smooth, with few weak spiral threads at the top and 10 to 14 incised lines at the base. The ventral side of body whorl smooth and flattened. The dorsal side near the shoulder, may has one small but prominent, rounded, low nodule.

Outer shell is light yellow-brown. Body whorl bears four to five spiral white bands, which were sparsely overlaid with very fine reticulated and arrow-shaped brown lines. Aperture elongates, whitish and spirally striated within. Parietal callus white, slightly swollen and weakly wrinkled at the top. Outer lip sinuate, sharp, its edge curling inward slightly; posterior canal long, adhering to two or three whorls in the spire (arching up over one to three sutures), extending straight up (Figure 4(c)) and may arch over to the left (Figure 4(d)). Stromboid notch shallows. Periostracum thin, varnish-like and transparent. Operculum stromboid, dark brown, slightly arching, with seven to eight weak serrations (Figure 4(g)). Proboscis and eye peduncles were brownish maroon with numerous white spots. Sides of foot weakly immersed with brown. Tentacles rather short (relative to body length) compared with *canarium* and *urceus*. Verge stout, with a broad 'heeled' distal blade (Figure 4(f)), and the stalk dusted with brownish orange and small white spots.

Records: The specimens in this study were only found from Merambong Shoal, which was a new distribution record for the Johor Straits area. Regionally, it was abundant in muddy bottom, from Ceylon to Madras, India (Abbott, 1960).

Synonyms: *Strombus accinctus* Linne (1767): p. 1212; Iredale (1958): p. 61; Born (1778): p. 280.

STROMBUS VITTATUS SUBSPECIES *VITTATUS* LINNAEUS, 1758

Remark: A very polytypic and highly variable *Strombus* species. There are three geographically distinct subspecies: in the northern parts of its range is the *japonicus* Reeve from Japan, within the southeastern and Melanesia is the typical subspecies *vittatus*, and the *campbelli*, which is confined to the Australian waters (Abbott, 1960). This species preferred areas with soft or sandy-mud sediment, rarely in colonies and within areas of low to medium seagrass densities.

Material Examined: Number of specimens examined 5, shell length ranged between 88.65 – 90.01 mm (Table 4).

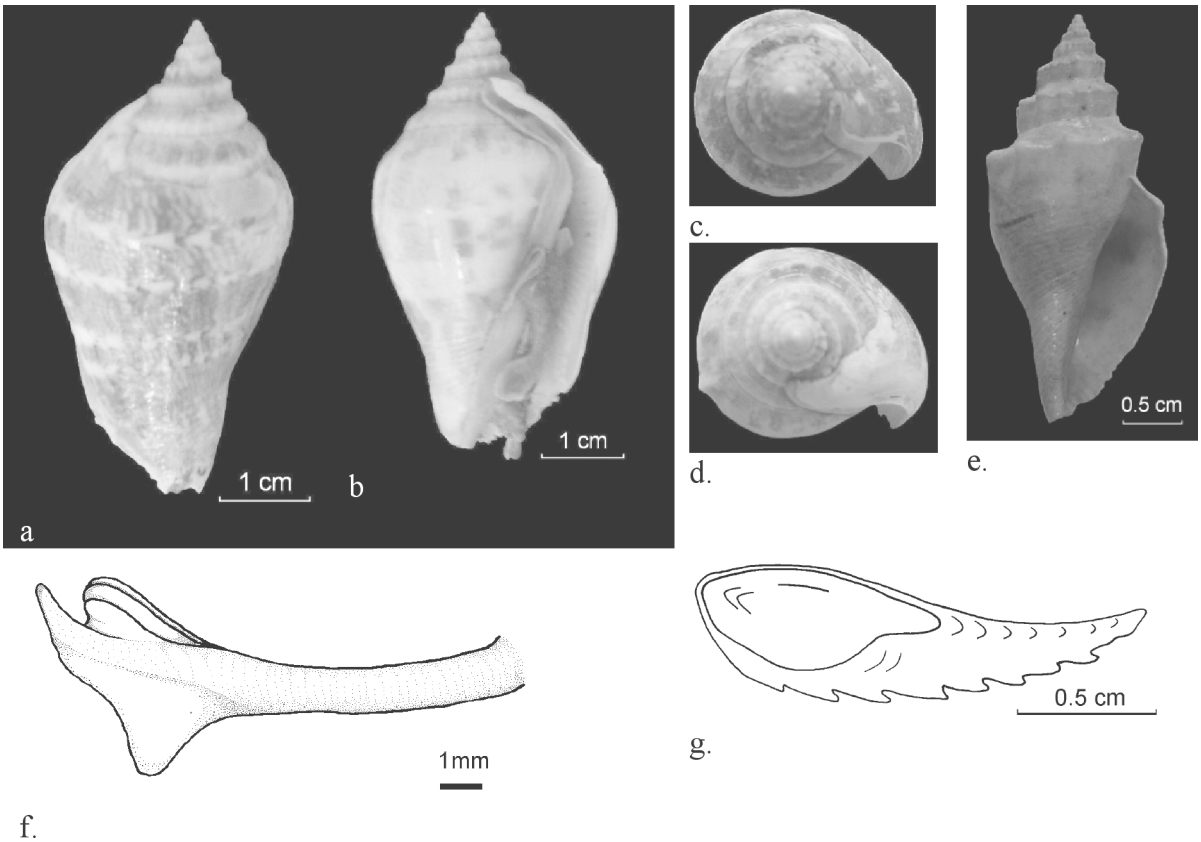

FIGURE 4. Strombus marginatus subspecies succinctus Linnaeus, 1967. Adult shells (a,b), apical view of adult shells (c, d), juvenile shell (e), schematic drawing of male's verge (f) and adult operculum (g)

TABLE 4. Shell meristic measurements of adult *S. vittatus vittatus* (N = 5)

Characters	Measurement (mm) ± S.E.	Range (mm)	Measurement by other author
Total shell length	83.74 ± 5.6	72.57 – 90.01	40 – 66 mm*
Shell width	25.53 ± 3.38	18.79 – 29.25	
Shell Depth	20.10 ± 0.70	18.71 – 20.90	
Body whorl length	45.52 ± 2.65	40.24 – 48.51	
Spire length	38.22 ± 2.95	32.33 – 41.50	
Aperture length	42.04 ± 4.78	32.48 – 46.84	
Number of whorls	14 – 15	14 – 15	

* From Abbott (1960)

Description: Shell rather elongated and thin but strong, with a long and well-produced spire and a winged outer-lip (Figure 6). Shell brownish-yellow, leathery in fresh specimens. Total number of whorls 15, with 4 translucent white, glossy nuclear whorls (Figure 6(f)). The first nuclear whorl was relatively very small. First post-nuclear whorl glistening, with one to three spiral incised scratches, then with glossy, crowded, rather neat, axial riblets (15 to 22 riblets per whorl). In subsequent whorls the spirally incised lines were limited to three to six of the lower half of the whorl. The shouldered axial riblets do not invade the area just below the suture where there may be a smooth concave area or a series of one to four spiral threads. Base of the shell has 15 to 20 low, flat-topped, spiral cords. Center of body whorl usually smooth, but may have a single low knob on the dorsum just below the suture. The axial riblets may sometimes absent on the last two whorls.

Columella slightly arching, enamel-white, its left side sometimes bordered by a longitudinal chink, smooth in the center, but above with a dozen very weak spiral rugae and at the base sometimes with 2 to 3 very weak lirae. Posterior canal is narrow and extending to the suture above. Wing of outer lip is tongue-like and curled slightly inward. Interior of body whorl glossy white, with a series of tiny, irregular and low spiral lirae. Stromboid notch weakly developed. Anterior siphonal canal short, not recurved nor twisted. Periostracum thin, transparent and usually being worn off. Operculum stromboid, light-brown, slightly arching and moderately thin, with few weak serrations in worn specimen (Figure 6(h)). Verge simple, with a well-developed laminated pad, which is mottled (Figure 6(g)). Radula with moderately strong teeth, 9 mm in length with only 25 to 26 rows. The marginal tooth was thick with few denticles and the peg

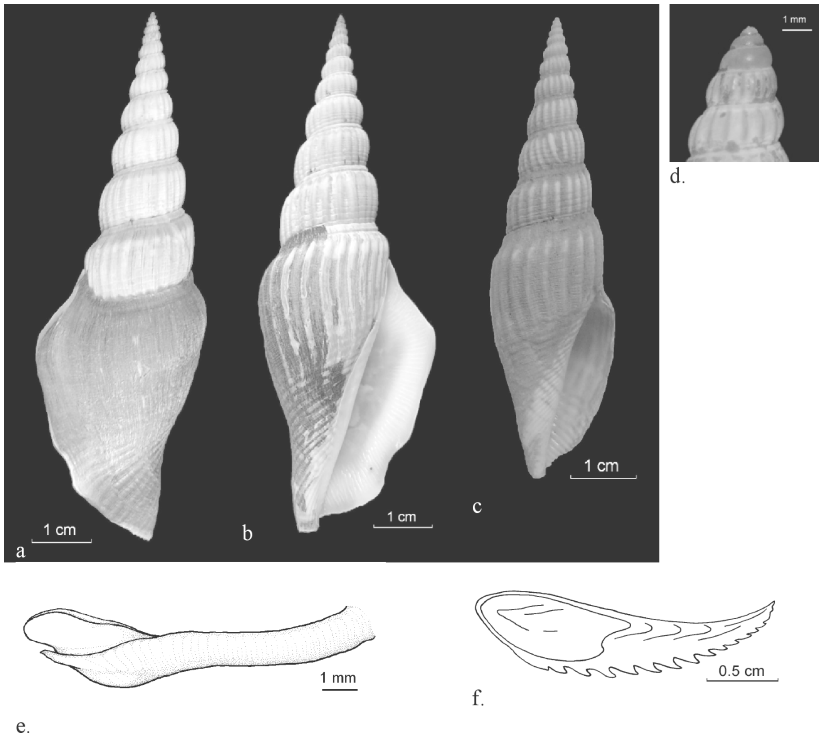

FIGURE 5. *Strombus vittatus* subspecies *vittatus* Linnaeus, 1978. Adult shells (a, b), juvenile shell (c), spire of juvenile shell (d), schematic drawing of male's verge (e) and adult operculum (f)

on the lateral tooth is quite reduced. The radula formula is: 3-1-3; 1-2; 2; 5.

Records: The specimens were collected from Merambong shoal and Tanjung Adang Shoal, which were new distribution records. The species was previously recorded from Kota Bharu, Kelantan; Pulau Perhentian and Marang, Terengganu; Kuantan, Pahang; and Endau and Mersing, Johor (Purchon & Purchon 1981). Regionally the species was widely distributed within the South China Sea, to Southern half of Japan (Abbott 1960).

Synonyms: *Lambis vittatus* Gmelin (1798): p. 66, no. 838; *Strombus sulcatus* Holsten (1802): p. 56, no. 735; Dillwyn (1823): p. 38; *Strombus australis* Schroter (1805): p. 93; *Strombus turritus* Lamarck (1822): p. 212; *Strombus (Doxander) vittatus* Gmelin (1950): p. 245.

CONCLUSION

It can be concluded that Merambong Shoal, Tanjung Adang Shoals and Merambong Island provided suitable natural habitat for *Strombus* where they formed the most abundant gastropods, particularly the *S. canarium* and *S. urceus*. A total of four full species of *Strombus* were found at the study sites, favouring areas with soft sediment and low to medium seagrass density. *Strombus marginatus* and *Strombus vittatus* were two new distribution records for western Johor coast, Malaysia.

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