

Three species of *Siphonalia* Adams, 1863 (Gastropoda, Buccinidae) from China seas, with descriptions of two new species*

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Abstract Three species of *Siphonalia* A. Adams, 1863 collected from the East and South China Seas are described and illustrated. Species were identified during re-sorting of the Buccinidae collection in the Marine Biological Museum, Chinese Academy of Sciences, Qingdao. *Siphonalia marybethi* Parth, 1996, from South China Sea, is recorded from the coast of China for the first time. *Siphonalia leei* sp. nov., from off Kueishan Island, Taiwan Island, most closely resembles *S. fusoides* (Reeve, 1846), but differs from it in having a relatively small spire with a flattened profile, more recurved siphonal canal and much smaller adult shell size. In shape and sculpture *S. nanshaensis* sp. nov., from the Nansha Islands (Spratly Islands), is most similar to *S. mikado* Melvill, 1888, but that species differs from it in having a more angulate teleoconch whorl with irregularly spaced spiral cords, less constricted shell base, and small parietal tooth on the inner lip.

Keyword: Gastropoda; Buccinidae; *Siphonalia*; taxonomy; China

1 INTRODUCTION

The genus *Siphonalia* was originally established by Adams (1863) to accommodate several new species, and taxa previously described by Reeve (1846–1847). This genus currently includes more than 20 valid Recent species (see MolluscaBase, 2018), the majority of which occur along the coast of southern Japan (14 species, see Okutani, 2000) and five species from Chinese waters: *S. cassidariaeformis* (Reeve, 1846), *S. callizona* Kuroda & Habe, 1961 and *S. nigrobrunnea* Lee & Chen, 2010 from Taiwan Island; *S. fusoides* (Reeve, 1846) from the East China Sea and Taiwan Island; and *S. spadicea* (Reeve, 1847) from the Yellow and East China Seas (Wu and Lee, 2005; Zhang, 2008; Lee and Chen, 2010).

Recently, examination of *Siphonalia* specimens in collections of the Marine Biological Museum, Chinese Academy of Sciences, revealed three species, two of which proved undescribed, and one a new distribution record. Herein we describe and illustrate these species, increasing the recognized richness of *Siphonalia* taxa known from Chinese waters.

2 MATERIAL AND METHOD

Specimens were collected from China seas (Fig.1). Shell morphology was observed by stereomicroscope. A radula was extracted and cleaned with 10% NaOH at 60°C for 4–5 h, washed in distilled water, air dried, and then coated with gold for examination by scanning electron microscopy. Specimens have been deposited at the Marine Biological Museum, Chinese Academy of Sciences (MBMCAS).

Abbreviation: MBM: Marine Biological Museum; RN: registration number; coll: collector; spm(s): specimen(s); stn: station.

3 RESULT

Systematics

Class Gastropoda Cuvier, 1797
Order Neogastropoda Wenz, 1938
Family Buccinidae Rafinesque, 1815

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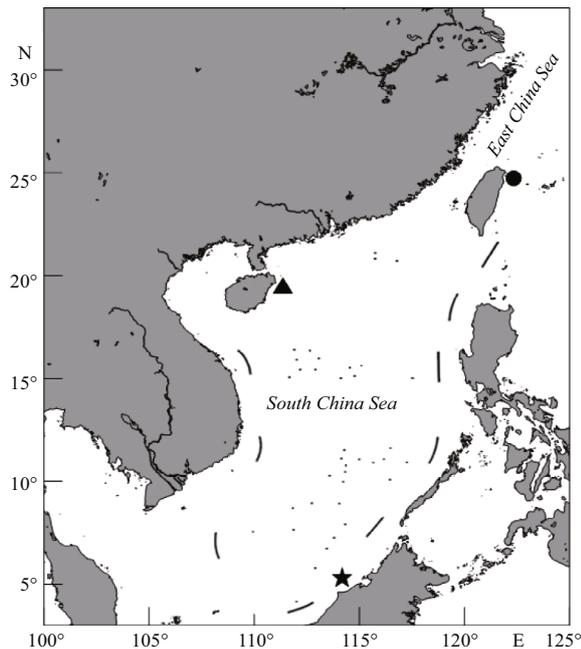


Fig.1 Distribution of *Siphonalia* species in present study

Triangle: *Siphonalia marybethi* Parth, 1996; solid circle: *Siphonalia leei* sp. nov.; star: *Siphonalia nanshaensis* sp. nov.

Genus *Siphonalia* A. Adams, 1863

Diagnosis. Species with moderate-sized, ovately fusiform shell; teleoconch whorls usually shouldered, sculptured with axial ribs and spiral cords; spire acute, body whorl ventricose; aperture ovate, siphonal canal recurved; operculum ovate with apical nucleus; radula formula 1+1+1, with tricuspid central tooth and lateral tooth with 3 or 4 cusps.

3.1 *Siphonalia marybethi* Parth, 1996 (Fig.2)

Siphonalia marybethi Parth, 1996: 302, figs. 1, 2; Thach, 2005: 139, pl. 39, figs. 11, 16.

Distribution and habitat: Vietnam (Vung Tau); China (South China Sea), live at depths to 80 m, on sandy to muddy sediments.

Description: Shell (Figs.2a-d) height to 46.7 mm, very thick, biconical, with acuminate spire; siphonal canal very short, slightly recurved. Protoconch of 1.5 smooth whorls; teleoconch to 6 evenly convex whorls. Body whorl rounded, large, occupying 3/4 of total shell length. Suture narrow, slightly channeled. Spiral sculpture of strong, raised cords, the subsutural one strongest; axial sculpture of prominent ribs, limited to spire whorl. Aperture ovate, outer lip internally crenulated. Columella weakly calloused, sigmoid. Anal canal present. Operculum ovate, with anterior nucleus. Shell color uniformly yellow, covered with thick, brown periostracum.

Preserved animal (Fig.2e, g) yellowish. Tentacles

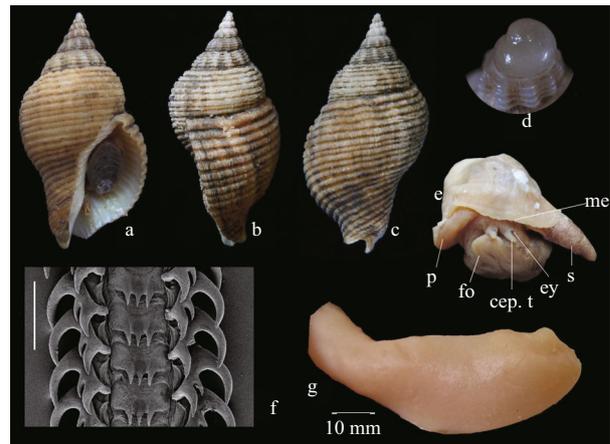


Fig.2 *Siphonalia marybethi* Parth, 1996

a–c. apertural, lateral (right) and dorsal views of shell, respectively, 46.7 mm; d. enlargement of protoconch; e. anterior view of animal; f. Radula, scale bar=200 µm; g. penis. cep.t: cephalic tentacle; ey: eye; fo: foot; me: mantle edge; p: penis; s: siphon.

short, stout, with near-centrally located eyes on outer margin. Siphon short, thick. Foot broad. Penis large, distal end with a conical seminal papilla.

Radula (Fig.2f) rachiglossate. Central tooth nearly rectangular, posterior margin with three equal-sized cusps; lateral teeth with three large cusps, innermost short, wide, central smallest, outermost largest.

Remarks: Parth (1996) described this species on the basis of two empty shells from the South China Sea off Vung Tau, Vietnam. Our specimens from Hainan Island increase the recognized distribution of this species.

3.2 *Siphonalia leei* sp. nov. (Fig.3a–d)

Type specimens: Holotype, RN: MBM283602, Kueishan Island, Taiwan Island, China, on sandy bottom. Paratypes, three shells, RN: MBM283603, collected with holotype at type locality.

Type locality: Kueishan Island, Taiwan Island, China.

Etymology: The new species is named after Mr. Chin-Yeh Lee, who collected the type specimens.

Description: Shell (Fig.3a–d) of medium size for genus, height to 35.1 mm, very thick, solid, with small, conical spire (spire angle ~50°) comprising about 1/3 total shell length. Body whorl very large, rounded, occupying 2/3 of total shell length. Protoconch rounded (maximum diameter 1.2 mm), of 1.5 smooth whorls, with indistinct transition to teleoconch, followed by initial axial ribs that become stronger and more regularly spaced after 1/4 whorl. Suture adpressed, slightly undulant. Teleoconch with up to 5 flattened whorls with distinct shoulder angulation. Spiral sculpture of 4 or 5 cords on first teleoconch

Table 1 Collection data of *Siphonalia marybethi* Parth, 1996

	Registration number	Latitude	Longitude	Stn	Depth (m)	Bottom	Collection year	Coll.
1	MBM027465	19°45'N	111°15'E	6132	77	Sandy and muddy	Oct. 1959	Zhican TANG
2	MBM115955	19°45'N	111°15'E	6132	70	Sandy and muddy	Feb. 1959	Ruiyu LIU
3	MBM259827	-	-	-	-	-	Jun. 1975	Xiutong MA
4	MBM259895	-	-	-	70	Sandy and muddy	-	-

- means no data.



Fig.3 *Siphonalia leei* sp. nov. (a–d); *Siphonalia nanshaensis* sp. nov. (e, f)

a–b. holotype, 35.1 mm; c–d. paratype 1, 30.7 mm; e–f. holotype, 45.5 mm.

whorl, and 7 or 8 on second whorl, without intercalated cords. Third and subsequent whorls with thin secondary peripheral spiral cord, developing into 5 cords on body whorl. Spiral cords raised, with flattened top, with moderately rectangular cross-section.

Axial ribs on spire whorls only, extending from suture to suture on earlier whorls, becoming broad and widely spaced toward the shell base, forming strong, rounded knobs on whorl periphery. First to fourth teleoconch whorls with 10 or 11, and penultimate whorl with 12 axial ribs, with microscopic incremental lines, forming fine axial grooves and ridges between spiral interspaces.

Aperture large, ovate, whitish within, offset from coiling axis by $\sim 20^\circ$. Siphonal canal long, broad, open, deflected dorsally and adaxially, with prominent fascioles along its length. Outer lip slightly expanded, internally with 17 ridges of varied strength; columella lip smooth, with thick callus. Shell base color uniformly white under thick, brown periostracum. Operculum ovate, with apical nucleus.

Radula and soft parts unknown.

Remarks: *Siphonalia leei* sp. nov. is most similar to *S. fusoides* (Reeve, 1846–1847) and *S. trochulus* (Reeve, 1843) in general shape (see Reeve, 1846–1847; Okutani, 2000). From *S. fusoides* it differs in having a relatively small spire with flattened profile, more recurved siphonal canal, and much smaller adult shell size, and from *S. trochulus* (Reeve, 1843) it differs in having angulate rather than rounded spire whorls, and a less ventricose body whorl.

3.3 *Siphonalia nanshaensis* sp. nov. (Fig.3e, f)

Type specimen: Holotype, RN: MBM116671, Nansha Islands (Spratly Islands): $5^\circ 16'N$, $114^\circ 10'E$, 173 m, on sandy bottom, 9 May, 1987.

Type locality: Nansha Islands (Spratly Islands), China.

Etymology: The name refers to its type locality, Nansha Islands.

Description: Shell (Fig.3e, f) medium sized for genus, 45.5 mm long and 21.0 mm wide, very thick, solid, with tall, acute spire (spire angle $\sim 40^\circ$) comprising 2/5 total shell length. Body whorl rounded, occupying 3/5 of total length, shell base abruptly constricted. Protoconch rounded (maximum diameter 1.0 mm), of 1.5 smooth whorls; transition to teleoconch indistinct, followed by indistinct axial ribs that become stronger and more regularly spaced after 1/5 whorl. Suture adpressed, undulant. Teleoconch with 7 convex whorls, sculptured with spiral cords and axial ribs. Spiral cords slightly undulant, rather raised, with flattened top and moderately rectangular cross-section, overriding but not nodulating the thick axial ribs. First, second and penultimate teleoconch whorls with 5, 7 or 8, and 10 spiral cords, respectively; body whorl with about 25 spiral cords; with occasional secondary spiral cords on periphery of the penultimate and body whorl.

Axial ribs extend from suture to suture on spire, becoming obsolete on lower part of body whorl. First teleoconch whorl with 10, and penultimate and body whorls each with 12 axial ribs. Incremental lines very weak, forming small axial grooves on spiral cords and weak ridges between spiral interspaces, giving shell surface a rough appearance.

Aperture ovate, yellowish within, offset from coiling axis by $\sim 15^\circ$. Anal canal distinct, 2.5 mm in length. Outer lip thickened, with 14 ridges of varied strength, strongest posteriorly, becoming shorter and more rounded anteriorly; columellar lip smooth, moderately calloused. Siphonal canal long, narrow, open, strongly deflected dorsally and adaxially, with prominent fascioles along its length. Shell base color yellowish.

Radula and soft parts unknown.

Remarks: *Siphonalia nanshaensis* sp. nov. is most similar to *S. mikado* Melvill, 1888, but that species can be differentiated from it by having a more angulate teleoconch whorl with irregularly spaced spiral cords, less constricted shell base, and inner-lip with parietal teeth.

4 DISCUSSION

Although the taxonomy of *Siphonalia* species has been well studied, systematic relationships between species would benefit from further revision. Descriptions of most species have been based on hard-part conchological features, without descriptions of radular and anatomical characters, or molecular data. The shape and arrangement of radular teeth (e.g. Cernohorsky, 1971; Bouchet and Warén, 1985), and anatomy of the male reproductive system (e.g. Golikov, 1963; Kosyan and Kantor, 2014, 2016), have proven useful in buccinid taxonomy. Various buccinid groups have also been classified based on the basis of mitochondrial and nuclear gene data (e.g. Hayashi, 2005; Nakano et al., 2010; Hou et al., 2013). Unfortunately, detailed information of anatomy and radular features, and molecular data are not available for the two new species described herein. To determine robust systematic relationships between species in this genus, further studies, which include examination of soft tissue at both morphological and molecular level, are needed.

5 DATA AVAILABILITY STATEMENT

The authors declare that all the data supporting the findings of this study are available within the article.

6 ACKNOWLEDGEMENT

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References

- Adams A. 1863. On the Japanese species of *Siphonalia*, a proposed new genus of Gasteropodous Mollusca. *Annals and Magazine of Natural History*, **11**(63): 202-206.
- Bouchet P, Warén A. 1985. Mollusca Gastropoda: taxonomical notes on tropical deep water buccinidae with descriptions of new taxa. In: Forest J ed. Résultats des Campagnes MUSORSTOM I et II Philippines (1976, 1980). Tome 2. Mémoires du Muséum National d'Histoire Naturelle, Paris, Série A, Zoologie, **133**: 457-499.
- Cernohorsky W O. 1971. Indo-pacific pisaniniinae (Mollusca: gastropoda) and related buccinid genera. *Records of the Auckland Institute and Museum*, **8**: 137-167.
- Golikov A.N. 1963. Gastropod mollusks of the genus *Neptunea* Bolten. Fauna of the USSR, Mollusks. *USSR Academy of Science*, **5**(1): 1-183.
- Hayashi S. 2005. The molecular phylogeny of the Buccinidae (Caenogastropoda: neogastropoda) as inferred from the complete mitochondrial 16S rRNA gene sequences of selected representatives. *Molluscan Research*, **25**(2): 85-98.
- Hou L, Dahms H U, Dong C Y, Chen Y F, Hou H C, Yang W X, Zou X Y. 2013. Phylogenetic positions of some genera and species of the family Buccinidae (Gastropoda: Mollusca) from China based on ribosomal RNA and COI sequences. *Chinese Science Bulletin*, **58**(19): 2 315-2 322.
- Kosyan A R, Kantor Y I. 2014. Revision of the genus *Retifusus* Dall, 1916 (Gastropoda: buccinidae). *Ruthenica*, **24**(2): 123-166.
- Kosyan A R, Kantor Y I. 2016. Revision of the genus *Retimohnia* McLean, 1995 (Gastropoda: buccinidae). *Ruthenica*, **26**(2): 85-121.
- Lee C Y, Chen C L. 2010. A new *Siphonalia* in the family Buccinidae from northeast Taiwan. *Bulletin of Malacology, Taiwan*, 45-48.
- Melvill J C. 1888. Two new siphonaliae from Japan. *Journal of Conchology*, **5**: 348-349.
- MolluscaBase (2018). *Siphonalia* A. Adams, 1863. World Register of Marine Species, <http://marinespecies.org/aphia.php?p=taxdetails&id=456518>, accessed on 2018-03-22.
- Nakano T, Kurihara Y, Miyoshi H, Higuchi S. 2010. Molecular phylogeny of *Neptunea* (Gastropoda: Buccinidae) inferred from mitochondrial DNA Sequences, with description of a new species. *Venus*, **68**(3-4): 121-137.
- Okutani T. 2000. Marine Mollusks in Japan. University of Tokai Press, Tokyo. 1 224p.
- Parth M. 1996. Description of a new buccinid species from Vietnam (Mollusca, Gastropoda, Buccinidae). *Spixiana*, **19**(3): 301-302.
- Reeve L A. 1846-1847. Monograph of the Genus *Buccinum*. In: Reeve L ed. Conchologia iconica: or, Illustrations of the Shells of Molluscos Animals. Reeve Bros, London.
- Wu W L, Lee Y C. 2005. The Taiwan Common Mollusks in Color. Taiwan Forestry Bureau, Council of Agriculture, Taipei, China. 294p.
- Zhang S P. 2008. Family Buccinidae Rafinesque, 1815. In: Liu J Y ed. Checklist of Marine Biota of China Seas. Science Press, Beijing. p.501-503. (in Chinese)