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THE FRESHWATER SNAIL GENUS *SULCOSPIRA* TROSCHEL, 1857 FROM JAVA, WITH DESCRIPTION OF A NEW SPECIES FROM TASIKMALAYA, WEST JAVA, INDONESIA (MOLLUSCA: GASTROPODA: PACHYCHILIDAE)

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ABSTRACT. — Members of the viviparous freshwater snail genus *Sulcospira* Troschel, 1858 occur in lotic habitats in Southeast Asia. Three species have been reported from Java, two of which (*Sulcospira sulcospira* and *S. pisum*) may have become extinct, while *S. testudinaria* is fairly common. Based on recent collections, here we describe a new species, *Sulcospira kawaluensis*, from Tasikmalaya, West Java. Shell, embryonic shell, and radula characters of the new species clearly differ from those in *S. testudinaria. Sulcospira kawaluensis* new species has a rather restricted occurrence near Tasikmalaya in West Java.

KEY WORDS. — Indonesia, Java, Gastropoda, Pachychilidae, *Sulcospira kawaluensis*

INTRODUCTION

The freshwater snail genus *Sulcospira* Troschel, 1858 is found in Sundaland, Indochina, and southern China, and its members usually occur in relatively fast running waters, such as rivers and streams or creeks (Köhler & Dames, 2009). Three species of *Sulcospira* have been recorded from Java: the type species of the genus, *S. sulcospira* (Mousson, 1848), as well as *S. pisum* (Brot, 1868) and *S. testudinaria* (von dem Busch, 1842) (van Benthem-Jutting, 1956; Köhler & Glaubrecht, 2005; Köhler et al., 2008). Earlier authors, including Morrison (1954) and van Benthem-Jutting (1956), referred the genus *Sulcospira* to the family Thiaridae and recognised only one species in Java, *Sulcospira sulcospira*. Morrison (1954:381) stated that the shell of *S. sulcospira* appears to be similar to certain species of *Brotia, Tylomelania*, and to immature individuals of *Balanocochlis.* van Benthem-Jutting (1956) described the shell of *S. sulcospira* and cited Troschel's (1858) remark that the animal of *S. sulcospira* contained numerous shelled juveniles, each with a shell of two whorls. Another species with a turreted but more slender shell than *S. sulcospira* is traditionally attributed to *Brotia testudinaria* (von dem Busch, 1842), while specimens with a broad shell shape and a short spire are identified as *Balanocochlis pisum*. These three species were placed in the family Thiaridae by van Benthem-Jutting (1956; see also Wenz, 1938; Morrison, 1954).

The nomenclature and systematics of the genus *Sulcospira* were recently examined by Köhler & Glaubrecht (2005) in the light of recent molecular studies (Lydeard et al., 2002; Köhler et al., 2004), which have demonstrated that members of *Sulcospira* are not closely related to thiarids but in fact belong to the Pachychilidae. Using several morphological characters, Köhler & Glaubrecht (2005:24) compared *S. sulcospira* and the so-called *S. martini* from Java. They stated that the morphology of the protoconch of so-called *S. martini* does not resemble either of the known pachychilid genera very closely, including that of *S. sulcospira*, and it could be deduced that *S. martini* might be a representative of a yet undescribed genus. However, their study also revealed clearly that *Sulcospira* exhibits a peculiar protoconch morphology, which differs from that of other pachychilids, such as *Brotia* and *Tylomelania* (Köhler & Glaubrecht, 2001, 2006; von Rintelen & Glaubrecht, 2003). Subsequently, Köhler et al. (2008) used the same characters to transfer *Balanocochlis pisum* from the Thiaridae to the pachychilid genus *Sulcospira*, thus reporting the third species of *Sulcospira* from Java.

Based on molecular phylogenetic and anatomical evidence, Köhler & Dames (2009) suggested placement of ten species from the Southeast Asian mainland and Borneo within the genus *Sulcospira*.

According to Köhler & Glaubrecht (2005) *Sulcospira* is a poorly known genus amongst Southeast Asian Pachychilidae. In Java no information on the habitat, ecology, and precise distribution of *S. sulcospira* and *S. pisum* is available, except that they were described from "Java" (Thiele, 1931; Wenz, 1938; Köhler & Glaubrecht, 2005). The occurence of *S. testudinaria* and its habitat has been studied by Isnaningsih & Listiawan (2011) who collected the species from five rivers in Pegunungan Sewu, Central Java, and also listed by Wowor (unpublished data) who collected from six streams and rivers along Bogor and Jakarta, West Java (see Fig. 8).

During extended field work on Java (Marwoto, unpublished data; Köhler & von Rintelen, unpublished data), *Sulcospira testudinaria* was found at many localities in West, Central and East Java. However, neither *S. sulcospira* nor *S. pisum* has been seen since their original descriptions dating back to the 19th century. In order to evaluate the diversity, habitat and distribution of *Sulcospira* in Java, pachychilid snails were collected from rivers and streams in the karst area of Pegunungan Sewu, Central Java, and in rivers in East and West Java between 2006 and 2009.

MATERIAL AND METHODS

The study is based on ethanol-preserved specimens from West, Central and East Java. Morphological investigations were carried out by dissecting and drawing the animals using a stereomicroscope with a camera lucida (Nikon SMZ 800). Radulae and embryonic shells were extracted and prepared for SEM by using a proteinase K protocol (Holznagel, 1998) for cleaning. They were subsequently observed using a JEOL Type JSM-5310LV SEM. Midgut anatomy was documented through photography by use of a digital camera (Olympus E330 ADU) and Olympus SZX7 dissecting microscope. Shell parameters were measured to the nearest 0.1 mm with a calliper. All specimens have been deposited at the Museum Zoologicum Bogoriense, Research Center for Biology in Cibinong (MZB).

RESULTS

Sulcospira testudinaria was very common in rivers and creeks, and occurred also in irrigation canals of rice fields (see below for locality details). However we also found a new species of *Sulcospira* from West Java. This new species occurs only near Tasikmalaya and is described below and compared with its congeners from Java, including *S. sulcospira*, *S. pisum*, and *S. testudinaria* . The distribution of *S. testudinaria* and *S. kawaluensis* new species in Java is presented on the map (Fig. 8).

SYSTEMATIC DESCRIPTION: PACHYCHILIDAE FISCHER & CROSSE, 1892

Sulcospira Troschel, 1858

Sulcospira: Troschel, 1858: 117–118; Thiele, 1931: 190; Wenz, 1938: 688; Morrison, 1954: 357; van Benthem Jutting 1956: 378; Köhler & Glaubrecht 2005: 16–26; Köhler, et al., 2008: 331–339; Köhler et al., 2009: 127–141; Köhler & Dames, 2009: 679–699.

Adamietta: Brandt, 1974: 171 (type species *Melania housei* I. Lea, 1856).

Type species. — *Sulcospira typica* Troschel, 1885 (= *Melania sulcospira* Mousson, 1849), by original designation.

Diagnosis. — Shell rather conical, with spiral lirae but lacking axial lirae. Operculum with 4–6 whorls. Protoconch smooth and inflated, with up to two whorls possessing a fine granular texture or faint growth lines.

Sulcospira sulcospira (Mousson, 1849)

(Fig. 1A)

Melania sulcospira: Mousson, 1849 [1848]: 269; Mousson 1849b; 68, pl. 9, Fig. 3.

Sulcospira sulcospira: Morrison, 1954: 381; van Benthem-Jutting, 1956: 368, 378. Fig. 77; Köhler & Glaubrecht, 2002b: 149, Fig. 3L; Köhler & Glaubrecht, 2005: 18, Figs. 3–5.

Diagnosis. — Shell small (holotype up to 23.2 mm), ovoid-conical, apex eroded and up to six flattened whorls. Suture narrow. Shell yellowish to olive with brown vertical flames. Sculptured with spiral lirae that are more prominent at the base of body whorl. Aperture oval, slightly produced at the base. Operculum with four whorls regularly increasing in diameter with a sub-central nuleus. A more detailed description of the shell, operculum, protoconch, and radula is provided by Köhler & Glaubrecht (2005: 18).

Distribution. — Known only from the type locality "Java"

Sulcospira pisum (Brot, 1868)

(Fig. 1B, C)

Melania pisum: Brot, 1868: 54–55, pl. 2, Fig. 5; Brot, 1874:18, in: Martini & Chemnitz.

Balanocochlis pisum: van Benthem-Jutting, 1956: 384–385.

Balanocochlis gland: [partim] Köhler & Glaubrecht, 2002b: 124.

Sulcospira pisum: Köhler, et al., 2008: 331–339.

Diagnosis. — Shell small (lectotype up to 14.2 mm), globular, apex always truncated with less than three remaining whorls. Sculptured only with growth lines. Colour dark chestnut or olive-brown, sometimes with darker vertical flames. Aperture oval, pointed above, rounded at the base, columella thick. Operculum ovate with an almost central nucleus. A detailed description of shell, operculum, embryonic shell, radula, and soft body anatomy is provided by Köhler et al., 2008: 331–339.

Distribution. — Known only from the type locality "Java".

Sulcospira testudinaria (von dem Busch, 1842)

(Fig. 1D–F)

Melania testudinaria: von dem Busch, 1842, in: Philippi,1842: 3, pl. 1, Fig. 14; Mousson, 1849: 66, pl. 11, Figs. 1–3.

Brotia testudinaria: van Benthem-Jutting, 1956: 368, Figs. 69, 70, 74; Köhler & Glaubrecht, 2001: 301, Figs. 1F, 3D, 14A–D; Köhler & Glaubrecht, 2002b: 150; Köhler & Glaubrecht, 2002a: 357.

Sulcospira testudinaria: Köhler & Dames, 2009: 681, Figs. 4I–K, 5D, 6F, 12C.

Diagnosis. — Shell variable, turreted or elongately conic, solid, medium to large (22–40 mm), spire angle about 30°. Apex eroded, only 7–9 flattened whorls remain. Shell dark brown to black, or yellowish to brown, with brownish flames. Sculpture consists only of 2–3 spiral lirae near the suture, and 3–6 prominent spirals lirae at the base of the body whorl. Suture narrow and shallow. Aperture oval, outer lip straight. Columella not thickened. Operculum oval with 3–4 whorls increasing in diameter, with a sub-central nucleus. Shell dimensions from Tasikmalaya are given in Table 1.

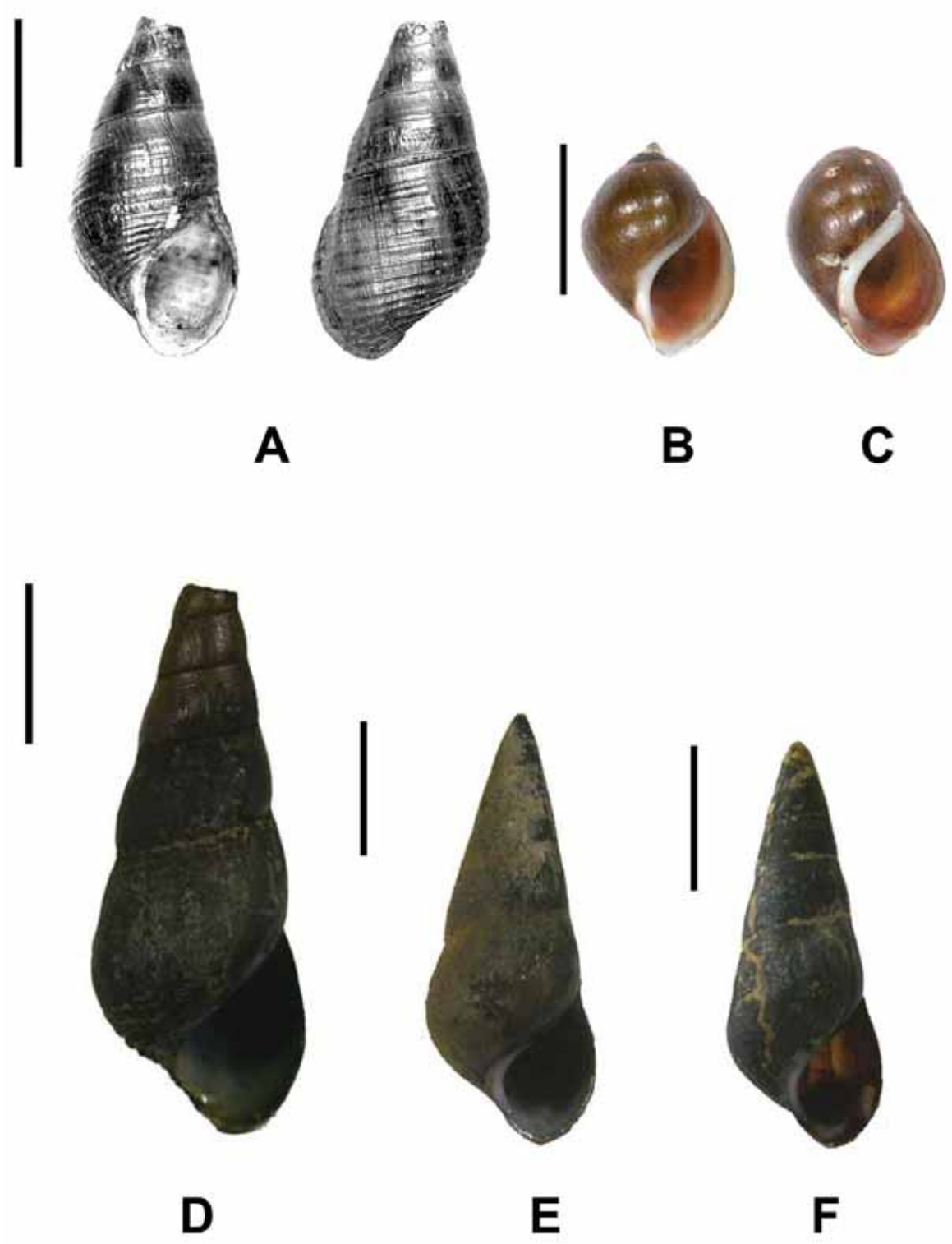

Fig. 1. Shell morphology of *Sulcospira sulcospira*, *S. pisum*, and *S. testudinaria*: A, holotype *S. sulcospira* (ZMZ 522306); B, lectotype of *Melania pisum* MHNG, Brot collection (Java); C, paralectotype of *M. pisum,* MHNG, Brot collection (Java); D–F, *S. testudinaria*: (D, MZB Gst.15.062; E, MZB.Gst.15.479; F, MZB Gst.15.481). Abbreviations: ZMZ, Zoologiches Museum der Universität Zürich; MHNG, Muséum d'Histoire Naturelle, Genève. Scale bar = 10 mm.

Table 1. Measurements (in mm) *S.testudinaria* from Tasikmalaya

Parameter		Range	Mean	SD	n
Shell	Height	16.99–34.80	27.01	4.60	22
	Width	8.06–13.65	11.19	1.61	22
Bodywhorl		10.98–21.81	16.58	2.93	22
Aperture	Length	6.01–13.85	9.91	1.78	22
	Width	3.88–7.58	5.66	0.92	22
Embryo	Length	1.00; 1.45	—	—	2

External and internal morphology. — Head foot dark grey to black, mantle edge straight, dark grey or palely pigmented. Body coiled in 2.5 whorls, mantle cavity about 1.5 whorls. Head, tentacle, and neck pigmented dark grey to black. Stomach has a simple sorting area formed by two transverse folds and crescent-shaped thickening. Inner crescent fold undulated, gastric pad thick and large supporting a thin cuticular gastric shield (see also Köhler & Dames, 2009).

Radula (Fig. 4C, D). — Taeniglossate with 90–160 rows, 9.98–16.11 mm long (n = 4). Central tooth with large, pronounced median denticle, accompanied by two smaller denticles at each side. Lateral teeth with enlarged pointed major denticles and two much smaller denticles on each side as well. The inner and outer marginal teeth each possess one large median denticle and there are two much smaller denticles at the inner side.

Reproductive biology. — Females contain 100–156 similarly sized embryonic shells (n = 6) with a shell height of c. 1 mm or less.

Embryonic shell (Fig. 6C, D). — Conical, dome-shaped, apex inflated and smooth with fine granular texture.

Distribution. — Throughout Java, Indonesia.

Material examined. — West Java: 88 ex. (MZB Gst.15.615), Desa [= Village]. Picung Cimari, Cikoneng, Tasikmalaya, coll. Simon, Ristiyanti & A. Munandar, 9 Aug.2006; 65 ex. (MZB Gst.15.616), Cikukulu Cisaat, coll. Simon, Ristiyanti & A. Munandar, 8 Aug.2006; 8 ex. (MZB Gst.15.062), River Cibangbay (07°25'14.7"S, 108°11'34.9"E), Kawalu subdistrict, coll. Heryanto & Nova, 21 Oct.2009; 10 ex. (MZB Gst.15.165), River Cibangbay (07°25'14.7"S, 108°11'34.9"E) Kawalu subdistrict, coll. Heryanto & Nova, 21 Oct.2009; 4 ex. (MZB Gst.15.166), Village Salebu, Mangunrejo subdistrict, coll. Heryanto & Nova, 23 Oct.2009.

Central Java: 182 ex. (MZB Gst.15.479, MZB Gst.15.484), River Kalisuci, Semanu subdistrict, Gunung Kidul, Yogyakarta, coll. N. R. Isnaningsih, Riena & A. L. Dwi, 29 Aug.2006; 599 ex. (MZB Gst.15.481), S. Gua Gremeng, Ponjong subdistrict, Gunung Kidul , Yogyakarta, coll. N. R. Isnaningsih, Riena & A. L. Dwi, 6 Aug.2006; 584 ex. (MZB Gst.15.480, MZB Gst.15.482, MZB Gst.15.489), River Beton, Ponjong subdistrict, Gunung Kidul,Yogyakarta, coll. N. R. Isnaningsih, Riena, A. L. Dwi & K. H. Renny, 5 Aug.2006, 28 Aug.2008, 2 Jul.2009; 116 ex. (MZB Gst.15.478), River Prambutan, Playen subdistrict, Gunung Kidul,Yogyakarta, coll. N. R. Isnaningsih, Riena & A. L. Dwi, 7 Aug.2006; 60 ex. (MZB Gst.15.486), River Belikwatu, Wonogiri, coll. Adi & Anto, 24 Jul.2008; 82 ex. (MZB Gst.15.485), River Prapatan Pakis, Klaten, coll. Simon & N. R. Isnaningsih, 13 Aug.2006.

East Java: 23 ex. (MZB Gst.15.248), Semanding subdistrict, Tuban, coll. K. H. Renny, 5 Aug.2010; 86 ex. (MZB Gst.15.477), River Bekti, Bektiharjo, Tuban, coll. Heryanto, N. R. Isnaningsih & Alfiah, 5 Jul.2006; 132 ex. (MZB Gst.15.483), River Gua Ngerong, Tuban, coll. Heryanto, N. R. Isnaningsih & Alfiah, 5 Jul.2006; 13 ex. (MZB Gst.15.252), Perhutani, Plumpang subdistrict, Tuban, coll. K. H. Renny, 6 Aug.2010; 17 ex. (MZB Gst.15.250), Sendang Joko Tarub, Plumpang subdistrict, Tuban, coll. K. H. Renny, 4 Aug.2010; 26 ex. (MZB Gst.15.251), River Gua Srenggo, Montong subdistrict, Tuban, coll. K. H. Renny, 6 Aug.2010.

Sulcospira kawaluensis, new species

(Fig. 2A–G)

Material examined. — Holotype: 1 ex. (MZB Gst.15.059), on sandy and rocky substrate, water depth <0.4 m, in River Cibangbay (07°25'14.7"S, 108°11'34.9"E), Kawalu subdistrict, Tasikmalaya, West Java, Indonesia, coll. Heryanto & Nova, 21 Oct.2009.

Paratypes: 35 ex. (MZB Gst.15.060), same habitat and locality as holotype; 16 ex (MZB Gst.15.061), Mangunrejo subdistrict (07°22'05.2"S, 108°05'22.8"E) Tasikmalaya, West Java, Indonesia, coll. Heryanto & Nova, 23 Oct.2009; 18 ex. (MZB Gst.8545), small Cisereuh River, Kawalu subdistrict, Tasikmalaya, W. Java, Indonesia, coll. M. Djajasasmita, 26 Oct.1980.

Description. — Shell medium sized, thick, ovately conic, olive brown or dark brown to black. Usually with dark brown flames at the body whorl. Earlier whorls in adult specimens almost always corroded, with only four to six flattened whorls remaining. Suture not deep. Shell smooth, without spiral lirae, except for three to seven at the base of body whorls. Spire angle about 60°. Aperture widely ovate, somewhat expanded at the base; inner part white to brownish. Peristome sharp; columella thickened. Operculum oval with three whorls increasing in diameter, and a sub-central nucleus (Fig. 2D). Shell dimensions are given in Table 2.

External and internal morphology (Figs. 3A, 5A). Head foot dark grey to black, mantle edge straight, dark grey or pale pigmented. Body coiled in 2.5 whorls, mantle cavity

Table 2. Measurements (in mm) of the holotype and paratypes of *Sulcospira kawaluensis* new species.

Parameter		Holotype (n = 1)	Paratypes			
			Range	Mean	SD	n
Shell	Height	22.14	10.45–27.90	19.17	3.50	35
	Width	13.22	7.02–14.78	10.46	1.69	35
Bodywhorl		17.11	8.51–20.60	15.59	2.74	35
Aperture	Length	10.54	5.95–13.97	10.46	1.79	35
	Width	6.41	3.44–8.48	6.62	1.12	35
Embryo	Length	—	1.43; 1.47	—	—	2

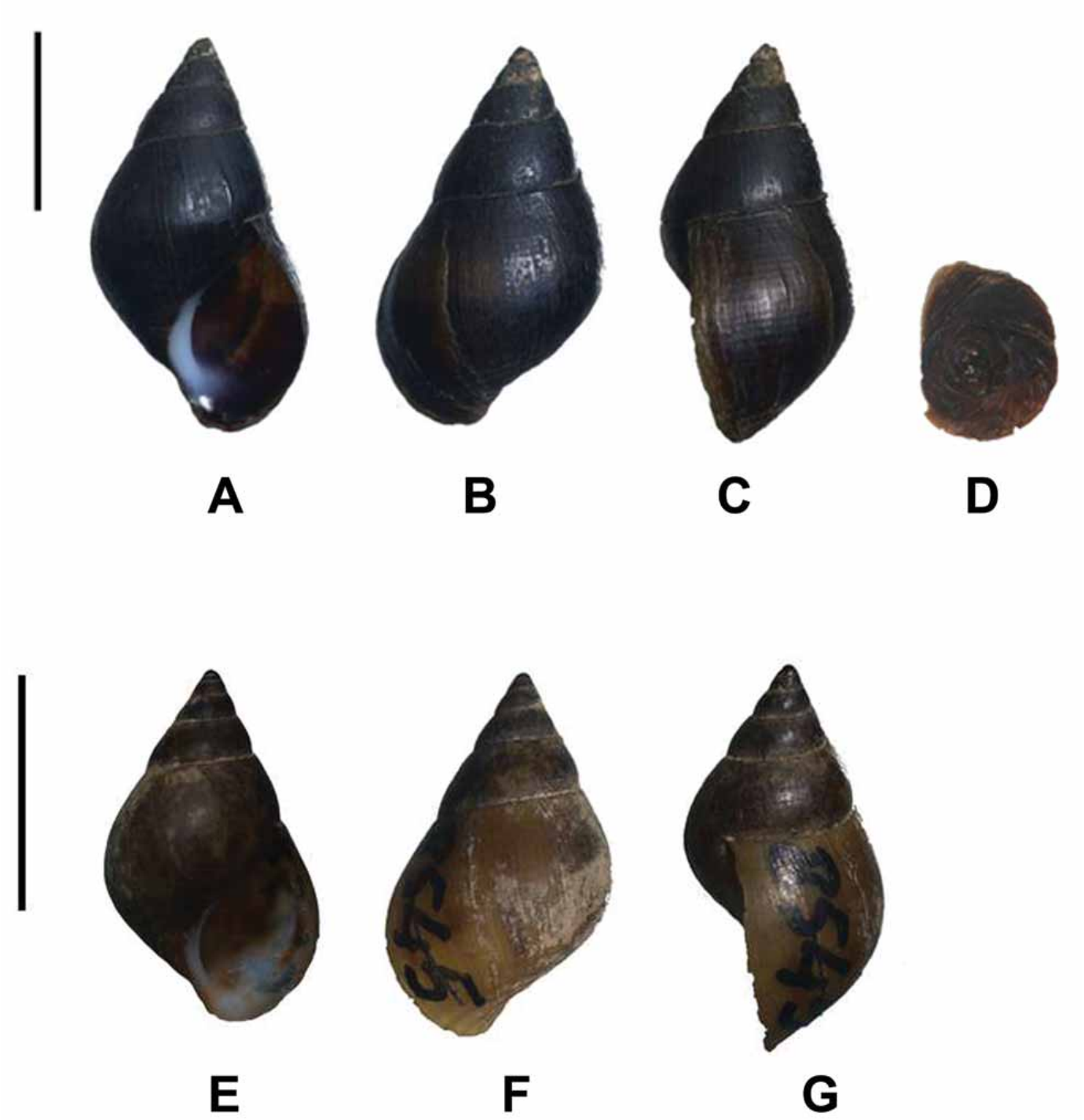

Fig. 2. Shell and operculum of *S. kawaluensis* new species: A–C, holotype (MZB Gst.15.059); D, operculum of a paratype; E–G, paratypes (MZB Gst.8.545). Scale bar = 10 mm.

about 1.5 whorls. Head, tentacle, and neck pigmented dark grey to black. Hypobranchial gland visible, ctenidium long (>7 mm length), osphradium simple, pale, about half of the ctenidium length. Stomach has a simple sorting area formed by two transverse folds and crescent-shaped thickening. Inner crescent fold undulated, gastric pad thick and large supporting a thin cuticular gastric shield (Fig. 3B).

Radula (Fig. 4A, B). — Taeniglossate with 190 rows, 21.20–23.14 mm long (n = 3). Central tooth with very large, almost triangle- shaped pointed major denticle, accompanied by two very much smaller denticles at each side. Glabella broad and the basal margin slightly rounded. Lateral teeth with enlarged, pointed major denticles and two much smaller denticles on each side as well. Marginal teeth slightly concave, tips curved and comparatively long, with two denticles each, the outermost ones are much enlarged.

Reproductive system (Fig. 5A, B). — Female with subhaemocoelic brood pouch located well behind buccal mass, occupying very large part of visceral cavity. Females containing 77–108 embryonic shelled (n of adult female = 6) all in similar size, about 1.45 mm height. Pallial oviduct about 7 mm long. A free medial lamina supports two sperm gutters, a spermatophore bursa, and a seminal receptacle.

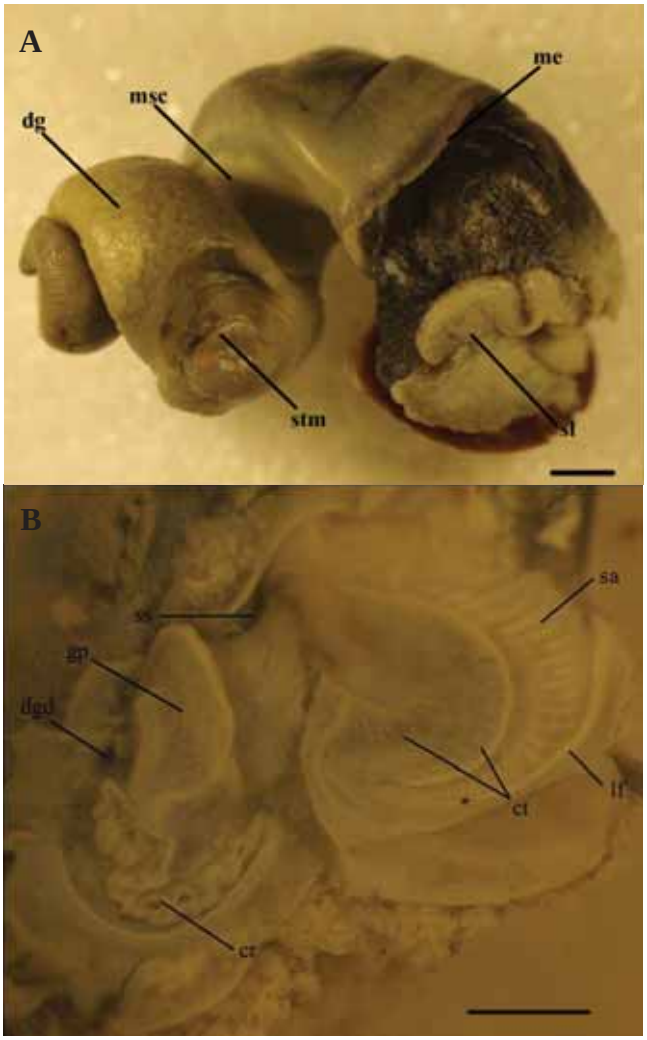

Fig. 3. External and internal morphology of *S. kawaluensis* new species: A, coiling animal; B, detail stomach. Abbreviations: cr, crescent folds; ct, crescent thickenings;dg, digestive gland; dgd, digestive gland duct; gp, gastric pad; lf, lateral fold; me, mantle edge; msc, columella muscle; sa, sorting area; sl, sole; ss, opening to style sac; stm, stomach. Scale bar = 1 mm.

Embryonic shell (Fig. 6A, B). — Conical, dome-shaped, with two whorls; protoconch smooth with fine granular texture. Second whorl with faint spiral lirae. Height of shell 1.45 mm, diameter of protoconch 0.5 mm.

Distribution. — Only known from Kawalu subdistrict at Tasikmalaya, West Java.

Etymology. — The specific name *kawaluensis* is an adjective referring to the name of the sub district Kawalu at Tasikmalaya, where the River Cibangbay is situated; of female gender.

DISCUSSION

Morphology. — The new species *S. kawaluensis* exhibits typical pachychilid characters (von Rintelen & Glaubrecht, 2003; Köhler & Glaubrecht, 2001, 2005) such as a multispiral operculum and a very long taenioglossate radula (>150 rows) with pronounced central teeth.

Köhler & Dames (2009: 697) suggested an embryonic shell with a smooth and inflated apical whorl, and a pallial oviduct with a seminal receptacle as diagnostic morphological features of *Sulcospira*. The new species also shares those features with *S. testudinaria,* the more common pachychilid snail in Java examined in detail by Köhler & Glaubrecht, 2001.

Adults of *S. kawaluensis* new species can easily be distinguished from the type species of *S. sulcospira* by having fewer (4–6) and less prominent spiral lirae at the base of the body whorl (see Köhler & Glaubrecht, 2005), and from *S testudinaria* by their conical shape (as opposed to a turreted shell in *S. testudinaria*) and smaller size (Tables 1–3; Fig. 7). In addition, *S. kawaluensis* new species has fewer but larger embryonic shells in the broad pouch (Table 3). The new species differs from *S. pisum* in having more whorls and an oval operculum (see Köhler et al., 2008; Table 3). The radula of *S. kawaluensis* new species also differs from *S. testudinaria* and *S. pisum* by having larger central denticles on the central and lateral teeth with much smaller denticles at each side of the central denticles, and the base of the central tooth is rounded (Fig. 4A–D; also see Köhler & Glaubrecht, 2001; Köhler et al., 2008; Köhler & Dames, 2009). The stomach is similar to that of *S. testudinaria* (Köhler & Dames, 2009: 694, 696; Marwoto, unpublished data) by exhibiting an undulated inner crescent fold.

Ecology. — *Sulcospira testudinaria* and *S. kawaluensis* new species usually occur in fast-flowing water such as rivers or rocky streams. Both *S. testudinaria* and *S. kawaluensis* new species from River Cibangbay in Tasikmalaya, West Java, were found attached to stones in a river with sand and gravel as substratum but they differ in the shape of their central teeth.

Table 3. Morphological characteristics of *Sulcospira* from Java (shell, operculum, embryonic shell).

Character	*S. sulcospira*	*S. pisum*	*S. testudinaria*	*S. kawaluensis*
Shape	ovoid-conical	globular	turreted	conical
Shell height (mm)	19.23 ± 2.5	11.24 ± 1.57	27.01 ± 4.60	19.17 ± 3.5
Whorls remaining	up to 6	<3	7–9	4–6
Sculpture	with spiral lirae	only with growth lines	2–3 spiral lirae near the suture	smooth
Whorls of operculum	3–4	4–5	3–4	3
Protoconch height (mm)	1.2	1.2	1.0	1.45
Number of embryonic shells	about 140	—	100–156	77–108

S. kawaluensis new species has large round major denticles, a radula form also described by von Rintelen et al. (2004) for lacustrine species of the pachychilid *Tylomeania* from Sulawesi. Von Rintelen et al. (2004) found that the soft substrate species in the Sulawesi lakes have identical or very similar radulae to those found in riverine taxa on that island, whereas hard substrate taxa often have strongly enlarged teeth. Our data shows that the shape of the central tooth, the length of the radula, and the number of rows differ between the syntopically occurring *S. testudinaria* and *S. kawaluensis* new species. The radula of *S. testudinaria* is shorter and has fewer rows compared to that of *S. kawaluensis* new species, suggesting that both species may occupy different microhabitats. A correlation between substrate type and radula shape or size has been discussed by Glaubrecht & Köhler (2004), Glaubrecht & von Rintelen (2008) and von Rintelen

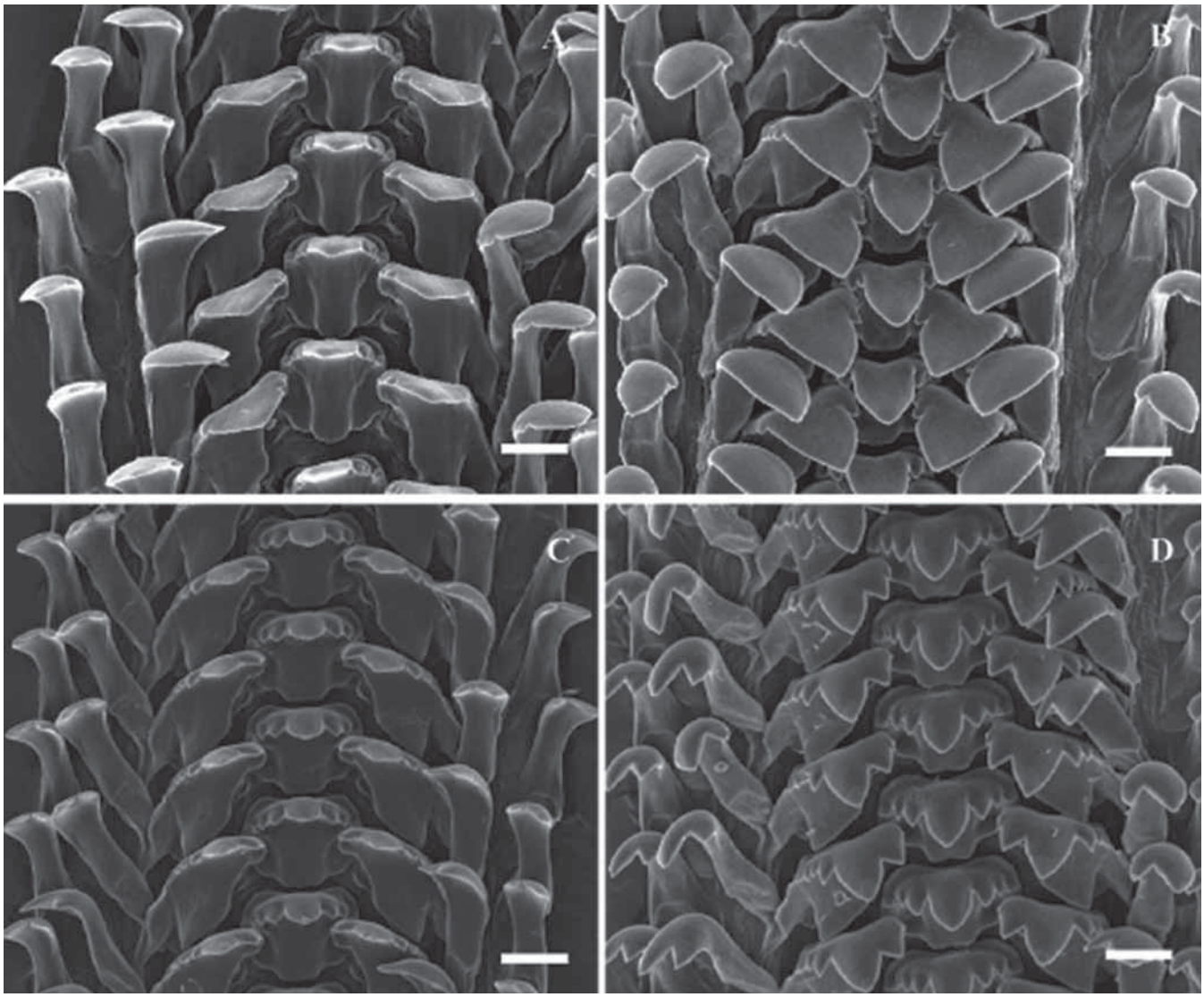

Fig. 4. Radular morphology: A–B, SEM images of a radular fragment of *S. kawaluensis* new species, showing central, lateral, marginal teeth: A, view from above; B, anterior viewed at 45° showing the shape of radular denticles. C–D, SEM images of radular fragment of *S. testudinaria* showing central, lateral, marginal teeth: C, view from above; D, anterior viewed at 45° showing the shape of radular denticles. Scale bar = 100 µm.

et al. (2004, 2007, 2010), who suggested that the radula type indicates habitat preferences (hard- versus soft-substrate). However, more detailed data on habitat preferences and the radula patterns of both species of *Sulcospira* are needed to explore this hypothesis for these taxa.

Based on their own observations, Köhler & Glaubrecht (2005) concluded that freshwater biotopes on Java are facing dramatic devastation and they believed that *S. sulcospira* may have become extinct on Java, possibly also *S. pisum*, for which only type material was available for study (Köhler et al., 2008). We also failed to find *S. sulcospira* and *S. pisum* during our survey in Java. Most of the rivers and streams in Java are indeed polluted. Wowor (unpublished data) recently studied the diversity loss in two big rivers in West Java, Cisadane River and Ciliwung River, and concluded that decreases of aquatic diversity (including gastropods) were caused by heavy pollution particularly from industrial sources. Based on our data, *S. testudinaria* has a much wider distribution (see Material examined; Marwoto & Isnaningsih, unpublished data) than *S. kawaluensis* new species, which was only found in Tasikmalaya. Although we lack quantitative data on water quality, we assume that *S. kawaluensis* new species is more sensitive to polluted water than the common *S. testudinaria*, which might explain its much more restricted distribution in comparison with that species.

The type locality (river Cibangbay) as well as other rivers in the Kawalu subdistrict appears relatively clean and clear compared to the conditions observed in Cisadane and Ciliwung rivers, since there are no industries but only rice fields and fruit plantations along the rivers. The discovery of *S.*

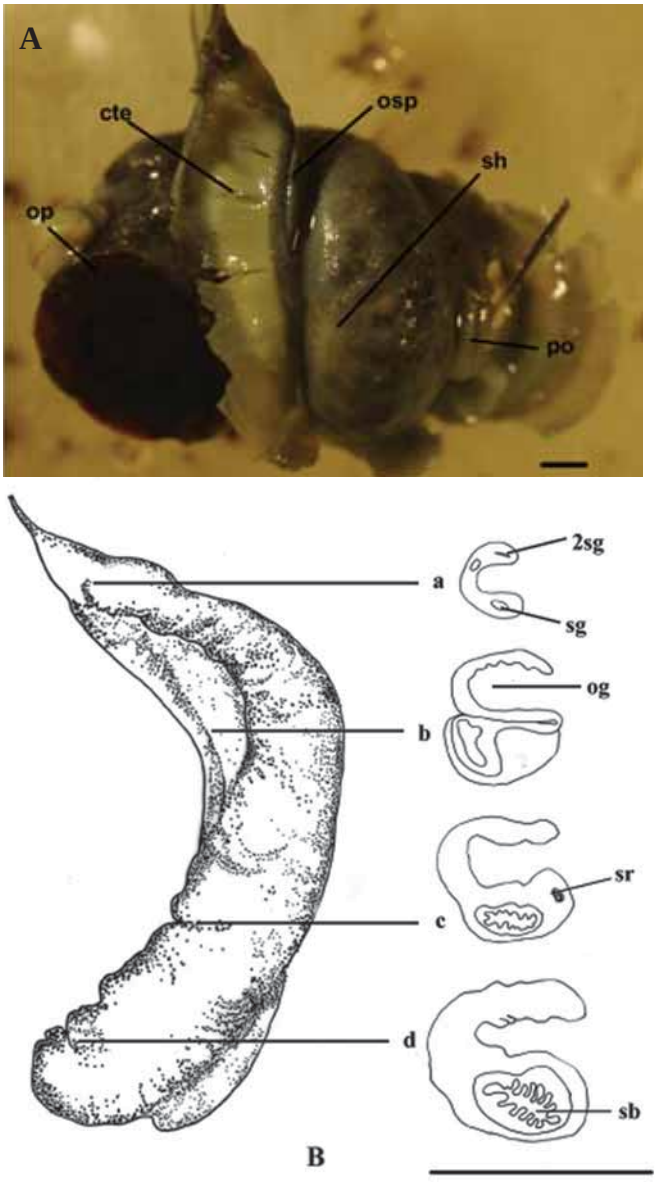

Fig. 5. External anatomy of a female *S. kawaluensis* new species: A, anatomy of a female exposed subhaemocoelic brood pouch filled with embryonic shells; B, schematic representation of the pallial oviduct morphology . Small letters (a–d) indicate approximate location of anterior part of cross section. Abbreviations: cte, ctenidium; og, oviductal groove; op, operculum; osp, osphradium; po, pallial oviduct; sb, spermatophore bursa; sg, sperm gutter; 2sg, second sperm gutter; sh, subhaemocoelic brood pouch; sr, seminal receptacle. Scale bar =1 mm.

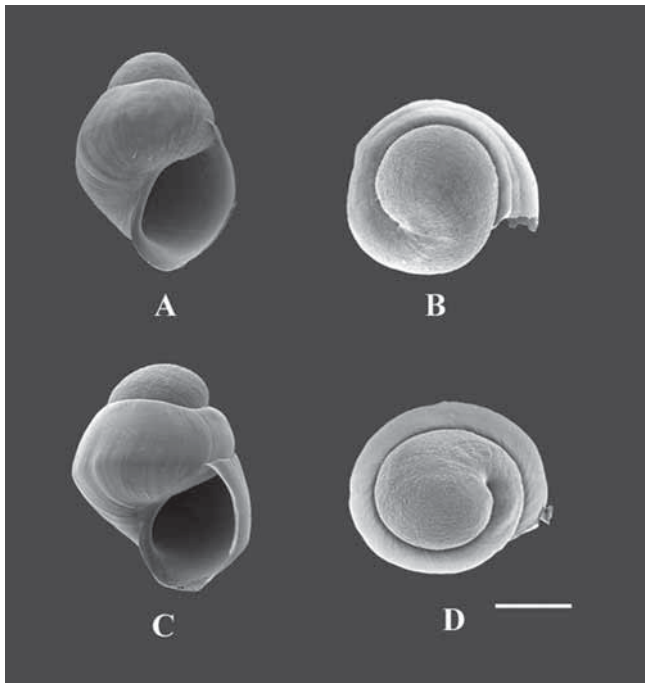

Fig. 6. Embryonic shells from brood pouches: A, B, *S. kawaluensis* new species; C, D, *S. testudinaria.* Scale bar = 0.5 mm.

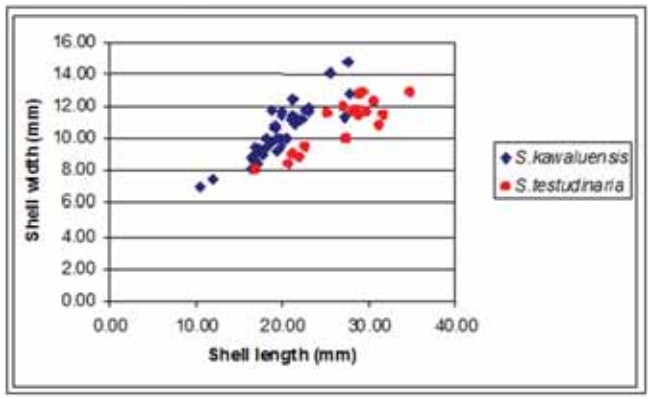

Fig. 7. Comparison of shells by parameters of length and shell width of *S. kawaluensis* new species (n = 36) and *S.testudinaria* (n = 18), both species from Cibangbay river.

kawaluensis new species increases the number of *Sulcospira* species recorded from Java to four, and we presume that only *S. testudinaria* and *S. kawaluensis* new species are still extant in Java.

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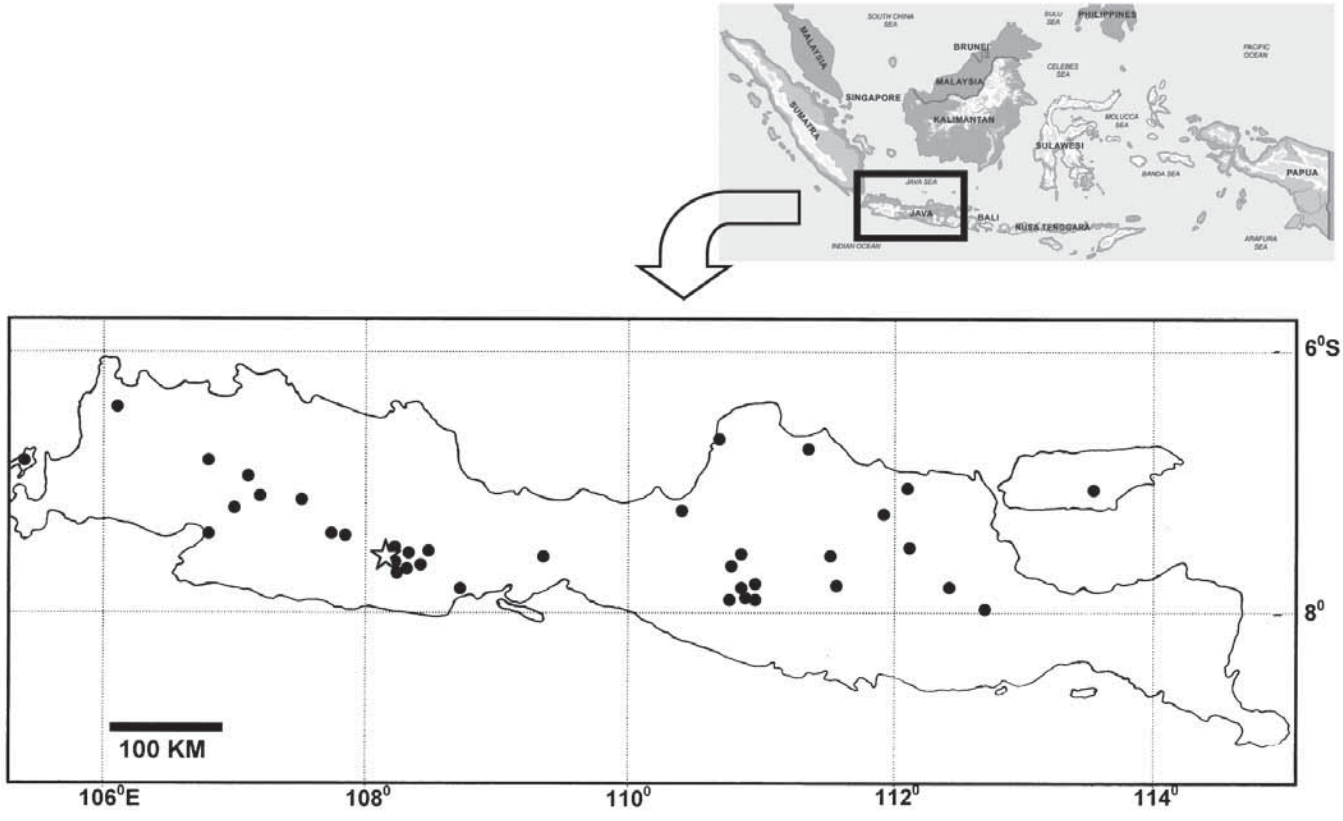

Fig. 8. Distributions map of *S. testudinaria* and *S. kawaluensis* new species in Java: *S. testudinaria* is indicated by black spot, *S. kawaluensis* new species is indicated by star.

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