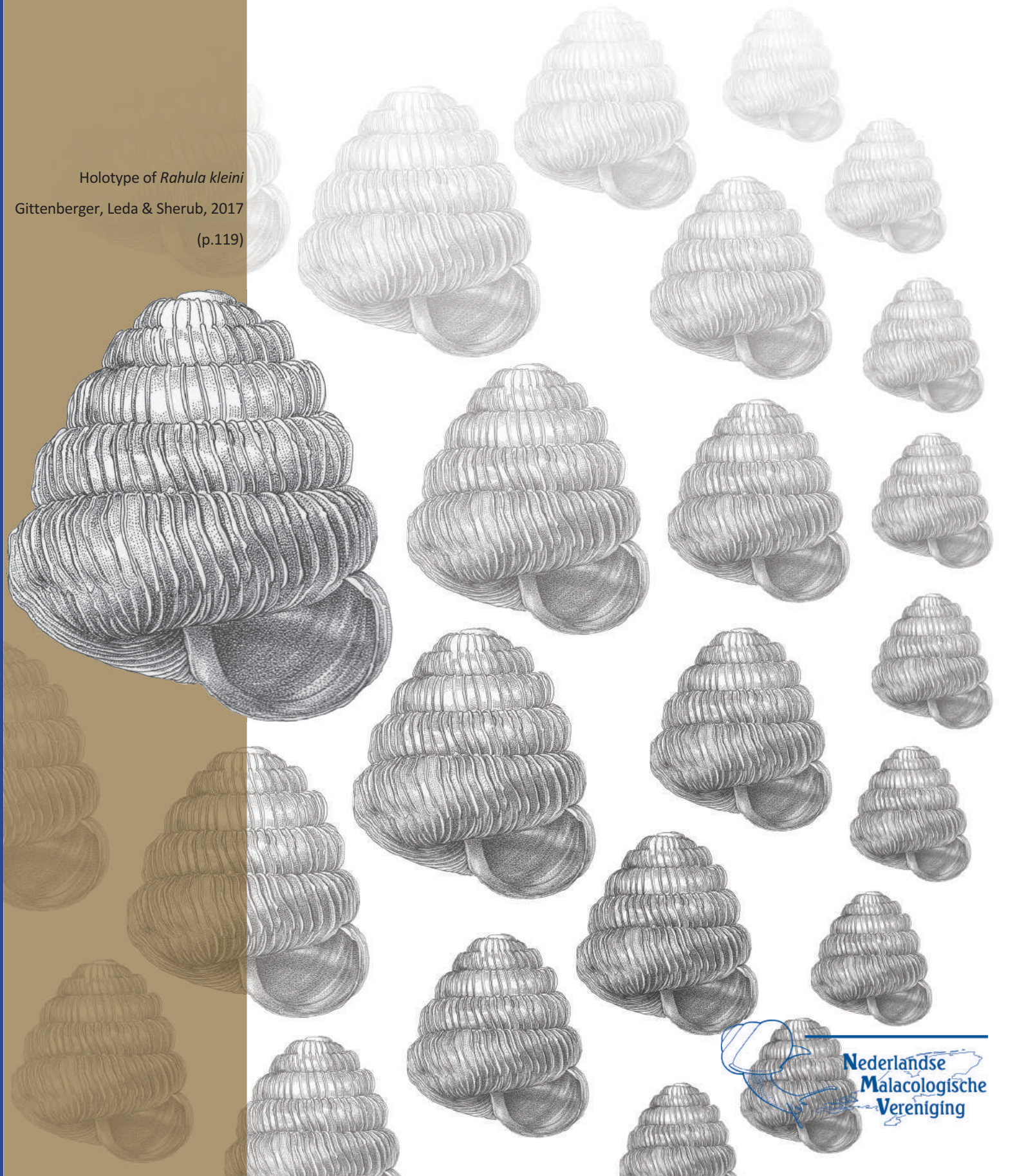
Basteria

TIJDSCHRIFT VAN DE NEDERLANDSE MALACOLOGISCHE VERENIGING
VOLUME 81 (4-6) | 18 DECEMBER 2017

Holotype of *Rahula kleini*
Gittenberger, Leda & Sherub, 2017
(p.119)



Nederlandse Malacologische Vereniging

Inhoudsopgave

BASTERA VOLUME 81 (4-6) | 18 DECEMBER 2017

Fulvia kaarei spec. nov., a new *Fulvia* from Vietnam (Bivalvia, Cardiidae)

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Fulvia kaarei spec. nov. (Cardiidae) is described from various localities in Vietnam. It is compared with the related *Fulvia nienkeae* ter Poorten, 2012, and with *Fulvia australis* (G.B. Sowerby II, 1834). *Laevifulvia* Vidal, 1994, is synonymised with *Fulvia* J.E. Gray, 1853.

Key words: Bivalvia, Cardiidae, *Fulvia*, new species, Indo-Pacific, Vietnam.

Introduction

The genus *Fulvia* J.E. Gray, 1853, originated in the Oligocene (Schneider, 1995) and has an Indo-Pacific, Japonic, south Australian, African and Mediterranean distribution (ter Poorten, 2009). It has a littoral-sublittoral bathymetric range, predominantly living in shallow waters with few species recorded up to a depth range of 160-210 m. At present 18 extant species are recognized (ter Poorten et al., 2014) of which the size ranges from circa 10 to just over 100 mm. As outlined by ter Poorten (2012), the paucity of differentiating gross morphological characters renders identification problematical at species level. The works of Vidal (1994), Vidal & Kirkendale (2007), Hylleberg (2011) and ter Poorten (2009, 2012) facilitated a better understanding of the genus. Subtle differences in the lunular area, local presence or absence of minute granulations, rib number and degree of rib development on various parts of the shell and nature of the colour patterning have proven to be the most informative characters in species segregation. Given the roughly similar shell morphology, it is expected that several so far unrecognized species are present in collections and that several others in fact represent cryptic species (ter Poorten, in prep.). One of these unrecognized species is described hereafter and appears rather range restricted, until now only recorded from shallow waters off Vietnam.

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Figs 1-6. *Fulvia* species. **1-5,** *F. australis* (G.B. Sowerby II, 1834). **1**, one of the four syntypes of *Cardium pulchrum* Reeve, 1845. 'China' (description); 'China and Mauritius' (labels), NHMUK 1978136, H 25.7 mm (a: LV exterior, b: RV interior, c: RV exterior, d: LV interior with '42/C' written in shell). **2-5**, possible syntypes of *Cardium australe* G.B. Sowerby II, 1834. 'Australia and China Sea' (description and labels), NHMUK 1996512. **2**, H 29.1 mm (a: LV exterior, b: RV interior). **3**, H 28.3 mm, LV exterior. **4**, H 31.8 mm (a: LV exterior, b: RV interior with '42/C' written in shell, c: dorsal view). **5**, H 26.8 mm, RV exterior. **6.** *Fulvia nienkeae* ter Poorten, 2012. New Caledonia, Grand Passage, 31-36 m, alive, 27.04.2008. Leg. P. Bouchet & P. Lozouet, CONCALIS, stn. CC231, holotype, MNHN-IM-2000-25275, H 33.2 mm (a: LV exterior, b: LV interior, c: RV interior, d: dorsal view).


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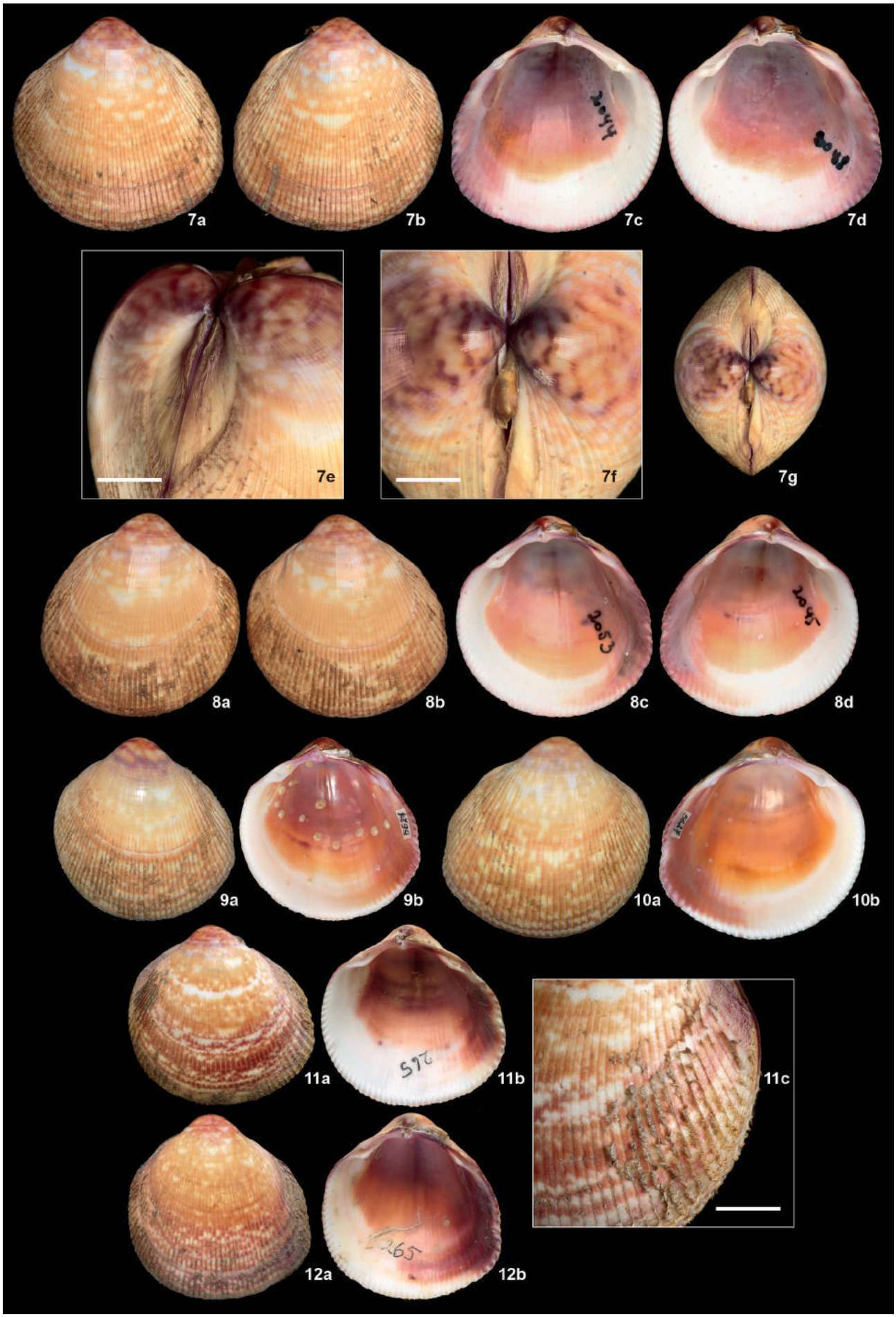
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Material and methods

Unless stated otherwise, the used morphological terminology follows Vidal (1994). The height is measured along an axis perpendicular to the hinge, and the length is the greatest distance between the anterior and posterior ends, parallel to the hinge line. In the captions only the largest size is given, either length or height. The weight was defined with a high precision balance (capacity 500 gr, readability 0.01 gr).

Acronyms of institutions and repositories: ANSP, Academy of Natural Sciences, Philadelphia, United States; JH, colln J. Hylleberg, Aarhus, Denmark; JJTP, colln J.J. ter Poorten, Hilversum, The Netherlands; MNHN, Muséum national d'Histoire naturelle, Paris, France; NHMUK, The Natural History Museum, London, U.K.; PMBC, Phuket Marine Biology Center, Phuket, Thailand; RMNH, Naturalis Biodiversity Center, Leiden, The Netherlands; USNM, Smithsonian Institution, National Museum of Natural History, Washington D.C., U.S.A. (former United States National Museum); WAM, Western Australian Museum, Welshpool, Australia; ZISP, Zoological Institute, Russian Academy of Sciences, St.-Petersburg (former Leningrad), Russia; ZMFU, Zoological Museum, Far Eastern Federal University, Vladivostok, Russia; ZMUC, Statens naturhistoriske Museum, University of Copenhagen, Denmark.

Abbreviations: H, height; L, length; LV, left valve(s); PV, paired valves; RV, right valve(s); V valve(s); W, width.

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Figs 7-12. *Fulvia kaarei* spec. nov. **7-8**, Vietnam, Nha Trang, fishermen's cleaning area in front of Research Institute of Aquaculture No. 3 (RIA 3), 05.11.1999. Leg. JH. **7**, holotype, MNHN-IM-2014-6050, L 38.0 mm (a: LV exterior, b: RV exterior, c: LV interior, d: RV interior, e: antero-dorsal view with lunule, f: detail of dorsal area, g: dorsal view). Same specimen as figured by Hylleberg & Kilburn (2003: 179, fig.). **8**, paratype, RMNH.5006727, H 35.2 mm (a: RV exterior, b: LV exterior, c: RV interior, d: LV interior). **9-10**, Vietnam, Nha Trang, near RIA 3, beach, 11.2001. Leg. L.A. Prozorova and K.A. Lutaenko, paratypes, ZMFU 37942 / Bv-5627, (photos: Irina E. Volvenko). **9**, L 31.2 mm (a: LV exterior, b: RV interior). **10,** L 34.6 mm (a: RV exterior, b: LV interior). **11-12**, Vietnam, Nha Trang Bay, Tre Island, Dambai Inlet, 6-7 m, on sand bottom, 06.05.2015. Leg. B. Sirenko, paratypes, ZISP 1/115. **11**, L 32.6 mm (a: LV exterior, b: RV interior). **12**, H 33.9 mm (a: LV exterior, b: RV interior, c: anterior slope showing radially arranged periostracum and microscopic granulations). Scale bars: 5 mm.

Systematic part

Class Bivalvia Linnaeus, 1758
Family Cardiidae Lamarck, 1809
Subfamily Cardiinae Lamarck, 1809

Fulvia J.E. Gray, 1853

Fulvia J.E. Gray, 1853: 40. Type species by monotypy: *Cardium apertum* Bruguière, 1789; Recent, 'l'océan Asiatique' & 'Jamaïque' (Indo-West Pacific; Jamaica in the original publication was in error).

Laevifulvia Vidal, 1994: 97 (as a subgenus of *Fulvia*). Type species by original designation: *Cardium hungerfordi undatopictum* Pilsbry, 1904; Recent, 'Hirado, Hizen' [Kyūshū, Nagasaki Pref.], Japan **[syn. nov.]**.

Diagnosis. – Shell small (10 mm) to very large (100 mm), generally rather thin-shelled, occasionally slightly translucent, rounded to obliquely ovate, equilateral to inequilateral with posterior part more or less expanded. Radial ribs generally rather low to hardly defined on median part. Ribs unsculptured, only bearing periostracal insertions and occasionally few calcified tubercles in juveniles near postero-dorsal margin. Posterior radial groove often present. Shell surface often partly covered with minute granulations, sometimes commarginally aligned. Animal with guard tentacles on incurrent and excurrent aperture, carrying ocular organs on their tips.

Distribution. – Oligocene to Recent (Schneider, 1995: table III), west African, south African, Mediterranean, Indo-Pacific, Japonic, south Australian; littoral-sublittoral on mud and sand bottoms, often in association with seagrass or coral rubble.

Remarks. – Vidal (1994) introduced subgenus *Laevifulvia* in order to differentiate a number of relatively small (H up to 20 mm) Indo-Pacific taxa that are lacking periostracal insertions. Recent molecular research (Herrera et al., 2015) has shown *Laevifulvia* to be paraphyletic, as *F. undatopicta* (type species of *Laevifulvia*) is well rooted in a clade with other *Fulvia* s.s. species, whereas *F. hungerfordi*, also placed in subgenus *Laevifulvia* by Vidal (1994), forms a separate clade. The absence of periostracal insertions acting as diagnostic marker at generic or subgeneric level is doubtful because on well-preserved juveniles of *Fulvia* (*Laevifulvia*) *lineonotata* Vidal, 1994, these insertions are occasionally present (MNHN, SANTOS 2006, st LD29 sample). This leaves the relatively small size as only remaining character, which is hardly justified as several taxa placed in *Fulvia* s.s. by Vidal (1994) and Vidal & Kirkendale (2007) do not exceed 20 mm in height, i.e. *Fulvia dulcis* (Deshayes, 1863), *Fulvia scalata* Vidal, 1994, and *Fulvia colorata* Vidal & Kirkendale, 2007.

Lacking a well supported distinction, *Laevifulvia* is herein considered synonymous with *Fulvia*.

Following Herrera et al. (2015), *Fulvia* is placed in Cardiinae. It is not closely related to any member of Laevicardiinae, the subfamily in which it was traditionally placed by most earlier workers (Schneider, 1995).

***Fulvia kaarei* spec. nov.** (Figs 7-16, Tables 1-2)

Fulvia australis (Sowerby II, 1834) – Hylleberg, 2000: 532; Hylleberg & Kilburn, 2003: 178, pl. 2 fig. 4; Thach, 2005: 274, pl. 84 fig. 21; Thach, 2012: pl. 138 fig. 1612, top.

Fulvia stigmacum (Pilsbry, 1904) [sic! *stigmaticum*] – Thach, 2007: 197, fig. 1037.

Fulvia cf. *australis* – Hylleberg, 2009: 210 (Vietnamese record JH #2812).

Fulvia (*Fulvia*) *australis* (G.B. Sowerby II, 1834) – Huber, 2010: 304, pars (2nd row only).

Fulvia sp. – Lutaenko, 2016: pl. 12 figs K-L (ZMFU 18943).

Type locality. – Vietnam, Nha Trang, fishermen's cleaning area in front of Research Institute of Aquaculture No. 3 (RIA 3) of the Ministry of Fisheries.

Description. – Shell up to circa 40 mm high, rounded-quadrangular (L/H 0.93-1.04, mean 0.97, *n* = 35, Fig. 14), inflated (W/(L+H/2) 0.64-0.75, mean 0.70, *n* = 35), rather solid (Fig. 13), glossy and almost equilateral. Margins rounded, with a slight truncation of antero-dorsal corner and a partly straight posterior margin. Umbo prosogyr. Circa 55 (range 50-58, mean 54.6, *n* = 25, Fig. 15) low rounded radial ribs, persistent on all parts of the shell but anterior and posteriorly stronger developed. Interstices small, becoming wider anteriorly, of irregular size posteriorly. Lunular heart large and sharply bordered, elevated and roughly the same size in both valves. Lunular area large, broad and smooth, with a slightly concave, well delimited ventral border and a slightly sinuous dorsal margin. Hinge arched, characteristic of the genus, teeth rather fragile, cardinals unequal in size in both valves, not connected, laterals thin, tip of posterior further away from main cardinal than anterior. Margins crenulated. Granula-

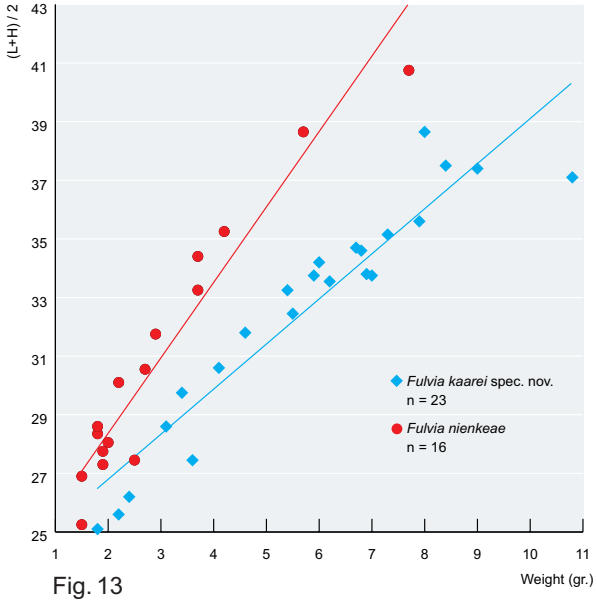

Fig. 13

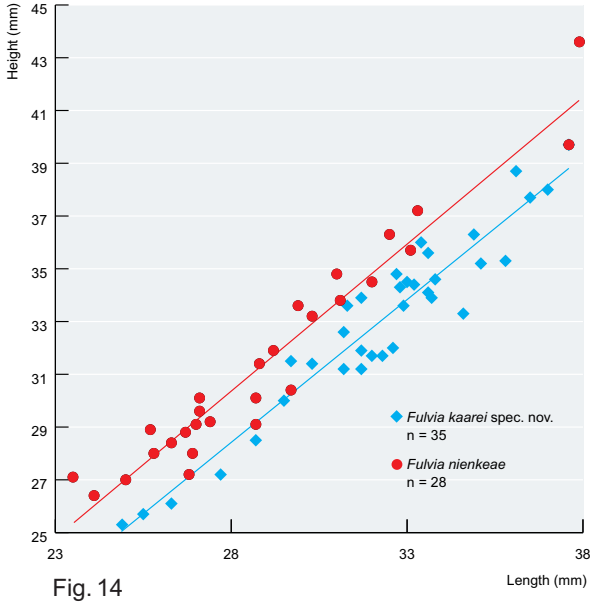

Fig. 14

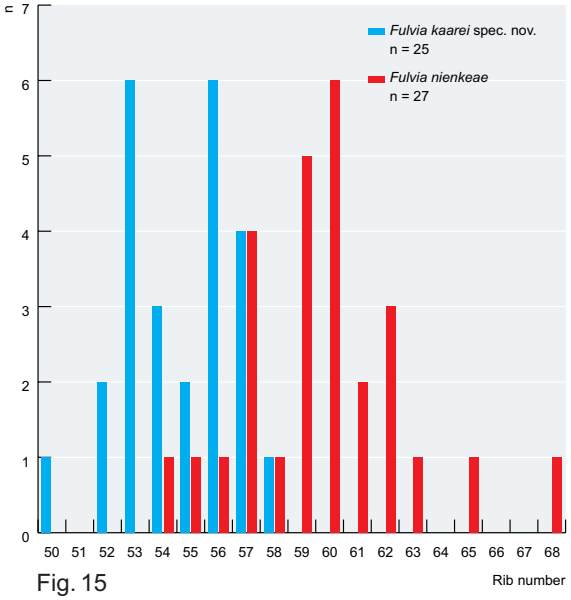

Fig. 15

Figs 13-15. Graphic representation of the morphospace of *Fulvia nienkeae* ter Poorten 2012 (red) and *F. kaarei* spec. nov. (blue). **13**, relationship between length and height and weight of the shell. **14**, relationship between height and length of the shell. Only (sub)adult shells are plotted, defined as all those individuals with a size of at least 25 mm. **15**, number of radial ribs, whenever possible based on LV. *Fulvia nienkeae* samples originating from the following collections: ANSP, JJTP, MNHN, RMNH (ex ZMA) and WAM.

Collection, registration number	*length (mm)*	*height (mm)*	*width (mm)*	*weight (gr)*	*ribs (LV, if available)*	*L/H*	*(L+H)/2*
MNHN-IM-2014-6050, holotype*	37	38	26.4	8.4	56	0.97	37.5
JH2832L+2832R, paratype	37.6	39.7	26.7	8	54	0.95	38.65
JH2046L+2051R, paratype	32.9	33.6	22.3	5.4	56	0.98	33.25
RMNH.5006727, paratype*	35.1	35.2	25	7.3	56	1	35.15
PMBC 29902, paratype	33.6	35.6	24.4	6.8	54	0.94	34.6
JH2336R	28.7	28.5	-19.8	-3.1	53	1.01	28.6
JH2049R	33	34.5	-23	-7	55	0.96	33.75
JH2054R	33.2	34.4	-24.6	-6.9	54	0.97	33.8
JH2057R	32.7	34.8	-24.6	-5.9	55	0.94	33.75
JH2058R	29.5	30	-20.6	-3.4	56	0.98	29.75
JH2056R	33.8	34.6	-23	-6	56	0.98	34.2
JH4024R	26.3	26.1	-17.4	-2.4	57	1.01	26.2
USNM 762768/1, paratype	31.7	31.9	-22.4	-4.6	53	0.99	31.8
USNM 762768/2, paratype	29.7	31.5	-22.4	-4.1	53	0.94	30.6
USNM 762768/3, paratype	31.3	33.6	-22.8	-5.5	52	0.93	32.45
USNM 762768/4, paratype	27.7	27.2	-18.4	-3.6	53	1.02	27.45
USNM 762768/5, paratype	25.5	25.7	-17.8	-2.2	53	0.99	25.6
USNM 762768/6, paratype	24.9	25.3	-17.1	-1.8	57	0.98	25.1
ZISP Russia 1/115/1, paratype*	31.7	33.9	23.5		58	0.94	32.8
ZISP Russia 1/115/2, paratype*	32.6	32	21.7		57	1.02	32.3
ZMFU Russia 18943/1	32	31.7	22.1			1.01	31.85
ZMFU Russia 18943/2	33.7	33.9	-23			0.99	33.8
ZMFU Russia 18943/3	35.8	35.3	-22.8			1.01	35.55
ZMFU Russia 18943/4	31.7	31.2	-20.6			1.02	31.45
ZMFU Russia 37942/1, paratype*	34.6	33.3	24.6			1.04	33.95
ZMFU Russia 37942/2, paratype*	31.2	31.2	22.7			1	31.2
ZMFU Russia 37942/3, paratype	30.3	31.4	21.1			0.96	30.85
ZMFU Russia 37942/4, paratype	33.6	34.1	-22.8			0.99	33.85
ZMFU Russia 37942/5, paratype	32.3	31.7	-21.8			1.02	32
ZMFU Russia 37942/6, paratype	31.2	32.6	-22.4			0.96	31.9
JJTP 1907	36.1	38.7	27.6	9	53	0.93	37.4
JJTP 4386/1, paratype	36.5	37.7	27.3	10.8	52	0.97	37.1
JJTP 4386/2, paratype	34.9	36.3	24.5	7.9	56	0.96	35.6
JJTP 4386/3, paratype	33.4	36	26.1	6.7	50	0.93	34.7
JJTP 4386/4, paratype	32.8	34.3	23	6.2	57	0.96	33.55
Mean values					**54.64**	**0.97**	

Table 1. Shell measurements of *Fulvia kaarei* spec. nov. Sizes in brackets refer to extrapolated values. Only (sub)adult shells are included, defined as all those individuals with a size of at least 25 mm. Material with an asterisk (*) is figured herein.

tions occasionally present on anterior slope near margin. Periostracum radially well developed along posterior rib flanks (anterior and median part of shell) and rib crests (posterior shell slope), leaving minute undulating periostracal insertions when worn off. Exterior cream or yellowish mottled with small triangular striped patterns, purple-brown in juvenile stage and ocher brown in adult stage, combined with whitish more or less triangular shapes. Umbonal tip deep purple, lunular heart pink to purple, lunular area white with purple margins. Interior generally white with a pink-orange umbonal cavity and a pink to brown pos-

Character	*Fulvia kaarei* spec. nov.	*Fulvia nienkeae* ter Poorten, 2012	*Fulvia australis* (G.B. Sowerby II, 1834)
Shell shape	rounded quadrangular, almost equilateral	elongate-quadrangular, often only weakly inequilateral	variable, but commonly slightly obliqueovate, habitually clearly inequilateral
Solidity	shell solid	shell thin	shell rather solid
Size	H up to 39.7 mm [JH2832]; 44 mm (literature)	H up to 43.6 mm [JJTP 4216]	H generally up to 30 mm (rarely 35 mm), often smaller
Microscopic granulations	occasionally present on anterior slope	absent	nearly always to some extent visible on anterior slope
Lunular heart	broad, well developed and demarcated, size roughly identical in both valves	broad, well developed and demarcated, larger in RV	small, raised and elongate, habitually equally sized in both valves
Lunular area	large sized, well delimited and slightly concave margin	large sized, well delimited and slightly concave margin	medium sized, generally vaguely delimited, only by difference in colour
Radial ribs	50-58	54-68	34-55
Median ribs	small and low but still rather well developed	small and low but still clearly developed	very superficial or indistinct

Table 2. Comparative summary of shell characters (based on adult material).

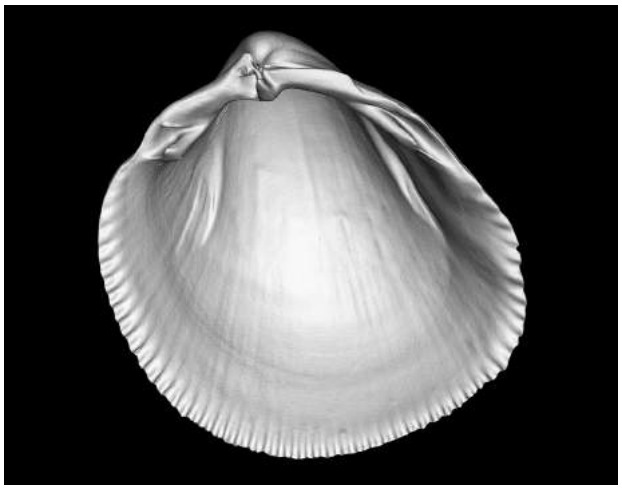

Fig. 16. *Fulvia kaarei* spec. nov. (JJTP 4386/1, paratype, 3dPDF). Image by K.S. Collins, courtesy of the Jablonski Lab, University of Chicago. For animation see http://www.spirula.nl/extra-informatie-supplementary-information/

terior slope. Animal not observed.

Distribution and ecology. – *Fulvia kaarei* spec. nov. appears to be a range restricted species, at present only known from shallow waters in Central and Southern Vietnam and possibly endemic to this area. Much of the material originates from the fishermen's cleaning areas in front of the Research Institute of Aquaculture No. 3. These cleaning areas were a source of many species entangled in crab nets that were suspended in shallow water in the vicinity of the institute (Hylleberg, 2000). Locality data of the other examined material point at a similar preference for shallow water with a sandy bottom. The depth indication of JJTP 1907 ('40 m') is considered unreliable as it is obtained from a shell dealer.

Etymology. – Named after Kaare Hylleberg, in appreciation of many field samples of Indo-Pacific cardiids, including the present species.

Remarks. – Although in literature *Fulvia kaarei* spec. nov. is invariably misidentified as *F. australis* (G.B. Sowerby II, 1834), its closest congener is *F. nienkeae* ter Poorten, 2012 (Figs 6, 13-15, Table 2). The latter differs by having a thinner shell (Fig. 13), by a more elongate shape (Fig. 14), by a higher rib number (Fig. 15) and by the colouration that generally displays more orange-yellowish elements at margins and in the umbonal cavity (Table 2). *F. australis* (Figs 1-5) is a highly variable species but remains smaller than *F. kaarei* spec. nov., is less solid, has a lower rib number and commonly has some microscopic granulations on the anterior slope. See Table 2 for further comparisons.

Material cited as *Fulvia australis* by Hylleberg & Kilburn (2003) from Central and Southern Vietnam (Nha Trang, Ho Chi Minh City, Poulo-Condore) in all probability relates to *Fulvia kaarei* spec. nov. No samples of *F. australis* originating from Vietnamese waters have been encountered.

The largest recorded specimens of the new species (identified as *F. australis*) well exceed 40 mm (Huber, 2010: 304, 2nd row: largest extension 42.9 mm; Thach, 2005: pl. 84 fig. 21, H 43.8 mm).

Cardium pulchrum Reeve, 1845, was described from 'China', although 'China and Mauritius' is mentioned on the accompanying labels. All four syntypes (NHMUK 1978136, two PV and two V) are figured by Hylleberg (2011: 929) and were studied. The smallest specimen, figured by Reeve (1845: pl. 19 fig. 98), is figured herein (Fig. 1) and has circa 47 ribs. The obliquely ovate outline, rib number and colour pattern perfectly match that of *F.* (*F.*) *australis.*

Type series (indicated in bold-italic type) and other material examined.

Central Vietnam, Quang Nam Province, Chu Lai Bay, Uso Beach. Acc.: 312337; leg. R. Rasely (***paratypes*** USNM 762768, 9

SV; USNM 762759, 7 SV). Khanh Hoa Province, Nha Trang, fishermen's cleaning area in front of Research Institute of Aquaculture No. 3 (RIA 3), 05.11.1999; leg. JH (***holotype*** MNHN-IM-2014-6050, ex JH 2044L-2048R, 1 PV; ***paratype*** RMNH.5006727, ex JH 2053R-2045L, 1 PV; ***paratype*** PMBC 29902, ex JH 2041L-2055R, 1 PV; ***paratype*** JH 2046L-2051R, 1 PV; JH 2047L, 1 SV; JH 2049R, 1 SV; JH 2050R, 1 SV; JH 2052R, 1 SV; JH 2054R, 1 SV; JH 2056R, 1 SV; JH 2057R, 1 SV; JH 2058R, 1 SV). Nha Trang, 09.2001 (JH 2770, 1 PV). Nha Trang, fishermen's cleaning area in front of RIA 3, 10.1996; leg. JH (JH 2336R, 1 SV). Nha Trang, offshore, in mud, depth 40 m (JJTP 1907, 1 PV). Nha Trang, fishermen's cleaning area in front of RIA 3, 09.2005; leg. JH (JH 4024R, 1 SV). Off Nha Trang, trawling at 40-50 m depth, muddy bottom, 23.02.2001; leg. JH (JH 1882-1889, 8 SV). Nha Trang, depth 15 m (***paratypes*** JJTP 4386, 4 PV). Nha Trang, near RIA 3, beach, 11.2001; leg. L.A. Prozorova and K.A. Lutaenko (***paratypes*** ZMFU 37942 / Bv-5627, 3 PV, 3 SV). Nha Trang, 10.1996 (***paratype***, JH 2832, 1 PV). Nha Trang, 08.2001; leg. K.A. Lutaenko (ZMFU 18943 / Bv-2584, 1 PV, 3 SV). Nha Trang Bay, Tre Island, Dambai Inlet, Coll. no. 256, depth 6-7 m, on sand bottom, 06.05.2015; leg. B. Sirenko (***paratypes*** ZISP 1/115, 2 PV). Nha Trang, 10.1996 (JH 2832, 1 PV). Nha Trang Bay, W. of Honlon, sand, shells, 12 m, 08.10.1959. Leg. J. Knudsen (ZMUC, JH 2821, 2 SV). Nha Trang, islands in front of the city, 04.2002; leg. W. & L. van Gemert (colln. L. van Gemert, 1 SV).

South Vietnam, Binh Thuan Province, Mui Né, beached, 5-6.01.2008; leg. S. van Leeuwen (colln. S. van Leeuwen, 1 SV).

Acknowledgements

Philippe Bouchet (MNHN), Andreia Salvador and Kathie Way (NHMUK), Boris Sirenko (ZISP), and Ellen Strong (USNM) are acknowledged for allowing the first author to study the collections under their care and/or for sending material on loan. Leo van Gemert and Sylvia van Leeuwen (The Netherlands) kindly gave access to their private collection. Konstantin Lutaenko (ZMFU) kindly provided photographs of Vietnamese material and is acknowledged for reviewing the manuscript. Cardiid research and travel costs of the first author were partly supported by the U.S. National Science Foundation under awards DEB-0919124 / 0918982 / 0919451; travel costs to ZISP were supported by the MNHN. Figure 16 provided by the biv3D project, supported in part by NSF grant 16-33535 (to D. Jablonski).

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