

# New Muricidae (Mollusca, Gastropoda) from the Miocene of Java (Indonesia)

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Dekkers et al. (2020: 2), even though the exact locality is unknown, the deposit is dated accurately to the Langhian. The description of these new species complements the inventory of the Indonesian Neogene muricid assemblage given in the older literature and more recently updated by Dharma (2005), Landau et al. (2020b) and Merle & Landau (2020).

## ABSTRACT

A well-preserved muricid gastropod fauna is described from Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia. In the Muricinae subfamily, six species of *Chicoreus* are recorded, of which three species and one subspecies are new: *C. (Triplex) javanus* spec. nov., *C. (T.) solidus* spec. nov., *C. (T.) martini* spec. nov., *C. (T.) altenai dekkersi* subsp. nov., *C. (T.) juttingae* (Beets, 1841) and *C. (Rhizophorimurex) cf. capucinus* (Lamarck, 1822). A new species of *Chicomurex* is described: *C. parvus* spec. nov. *Vokesimurex wanneri* (Martin, 1916) is also recorded and a lectotype is designated herein for this species previously recorded from the early Miocene of Central Java. In the subfamily Aspellinae, *Dermomurex (s.s.) wanneri* nom. nov. is proposed for *Murex acuticostatus* Wanner & Hahn, 1935 (not *Murex acuticostatus* Gümbel, 1861), originally described from the early-middle Miocene of Central Java (Indonesia) and also found in Wonosari.

Key words: systematics, Muricidae, Miocene, Indonesia, new species.

## INTRODUCTION

In this paper we continue the work of Dekkers et al. (2020) and Landau et al. (2020a, b) on the gastropod assemblage occurring at a locality close to the village of Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia in describing new fossil muricids, especially members of the subfamilies Muricinae and Aspellinae. As discussed by

## GEOLOGICAL SETTING

The material originates from the area around the village of Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, 40 km SE of Yogyakarta, Java, Indonesia. The exact locality is unknown, but the deposits outcrop on the banks of a river or stream. Based on calcareous nannofossils the age is attributed to NN5 zone (Martini, 1971), which comprises the upper Langhian and lowermost Serravallian. However based on the similarity of our samples to the nannofossils association described by Marshall et al. (2015), our assemblages can be attributed to the Langhian part of NN5, lower middle Miocene. The frequent occurrences of small reticulofenestrids (*Reticulofenestra minuta* Roth, 1970) and ascidian spicules together with discoasters point to shallow, well stratified, warm marine waters. For further discussion, see Dekkers et al. (2020).

## MATERIAL AND METHODS

The material described here is deposited in the Natural History Museum Vienna (NHMW). We have used the terminology introduced by Merle (1999, 2001, 2005) for the description of the Muricidae.

## Repository

NHMW: Natural History Museum Vienna (Vienna, Austria)  
NMB: Naturhistorisches Museum Basel (Basel, Switzerland)

MNHN: Muséum national d'Histoire naturelle, Paris (Paris, France)

RGM: Rijksmuseum voor Geologie en Mineralogie, now part of Naturalis Biodiversity Center (Leiden, The Netherlands)

### Terminology

P: primary cord

s: secondary cord

t: tertiary cord

Ad: adapical (or abapertural)

Ab: abapical (or adapertural)

SP: subsutural cord

IP: infrasutural primary cord (primary cord on shoulder)

adis: adapical infrasutural secondary cord (shoulder)

abis: abapical infrasutural secondary cord (shoulder)

P1: shoulder cord

P2–P6: primary cords of the convex part of the teleoconch whorl

s1–s6: secondary cords of the convex part of the teleoconch whorl (example: s1 = secondary cord between P1 and P2; s2 = secondary cord between P2 and P3, etc.)

ADP: adapertural primary cord on the siphonal canal

MP: median primary cord on the siphonal canal

ABP: abapertural primary cord on the siphonal canal

EAB1: extreme abapertural primary cord 1 on the siphonal canal

EAB2: extreme abapertural primary cord 2 on the siphonal canal

ads: adapertural secondary cord on the siphonal canal

ms: median secondary cord on the siphonal canal

abs: abapertural secondary cord on the siphonal canal

ID: infrasutural denticle (internal denticles of the outer lip)

D1–D6: abapical denticles of the outer lip

id: infrasutural denticle (denticles at the edge of the outer lip)

d1 and d2: abapical denticles at the edge of the outer lip

## SYSTEMATIC PALEONTOLOGY

**Class Gastropoda Cuvier, 1795**

**Subclass Caenogastropoda Cox, 1960**

**Order Neogastropoda Wenz, 1938**

**Superfamily Muricoidea Rafinesque, 1815**

**Family Muricidae Rafinesque, 1815**

**Subfamily Muricinae Rafinesque, 1815**

### Genus *Chicoreus* Montfort, 1810

Type species: *Murex ramosus* Linnaeus, 1758 by original designation. Pliocene (Java) to present-day: Indo-Pacific.

### Subgenus *Triplex* Perry, 1810

Type species: *Murex foliatus* Perry, 1810 (= *Murex palmarosae* Lamarck, 1822) by monotypy. Present-day: Indo-Pacific.

### *Chicoreus (Triplex) javanus* spec. nov.

Figs 1, 10

Type material and dimensions. — Holotype NHMW 1901/0034/0096, height 34.0 mm, width 19.9 mm.

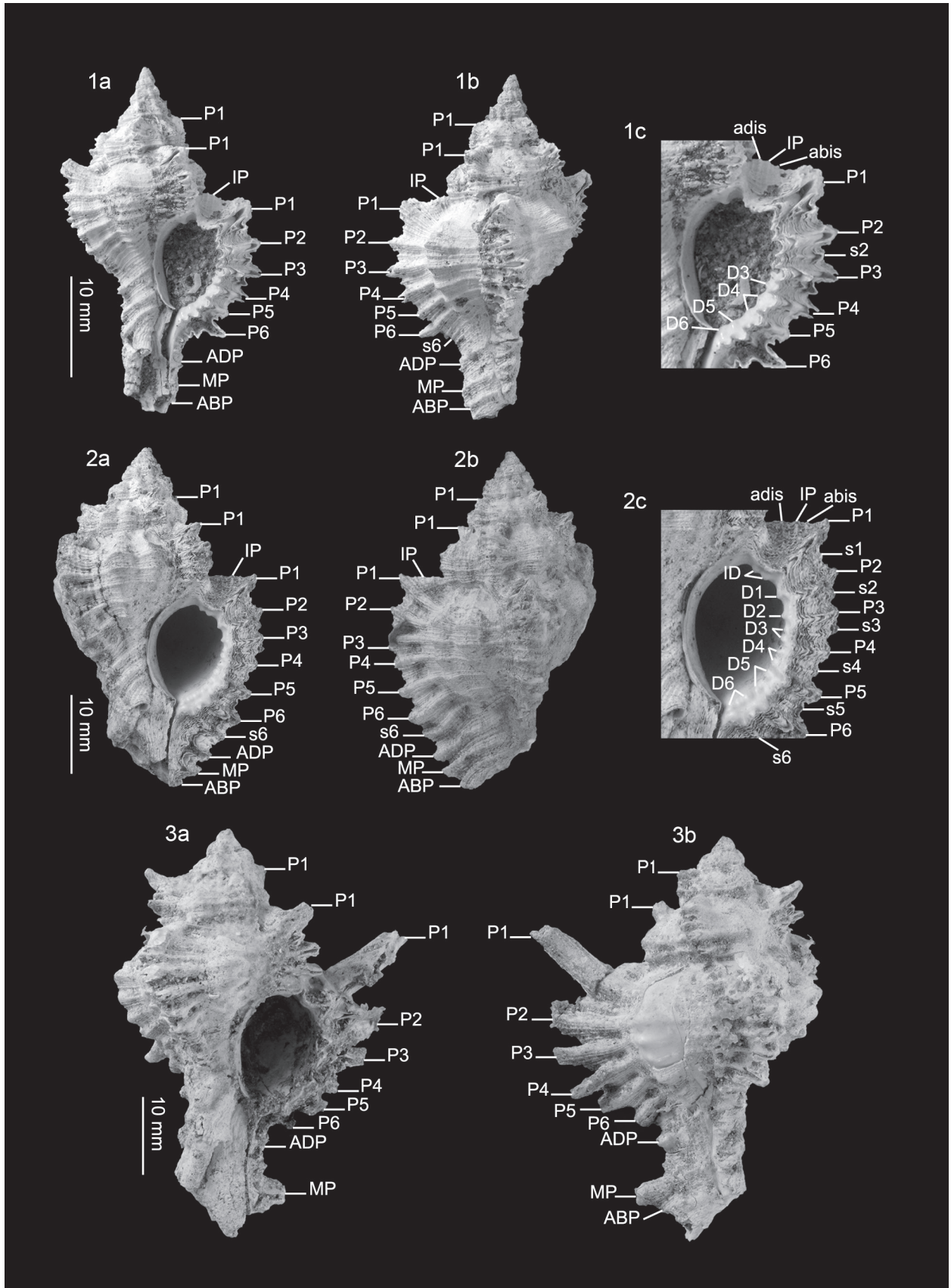
Type locality. — Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia.

Type stratum. — Langhian portion of NN5, middle Miocene.

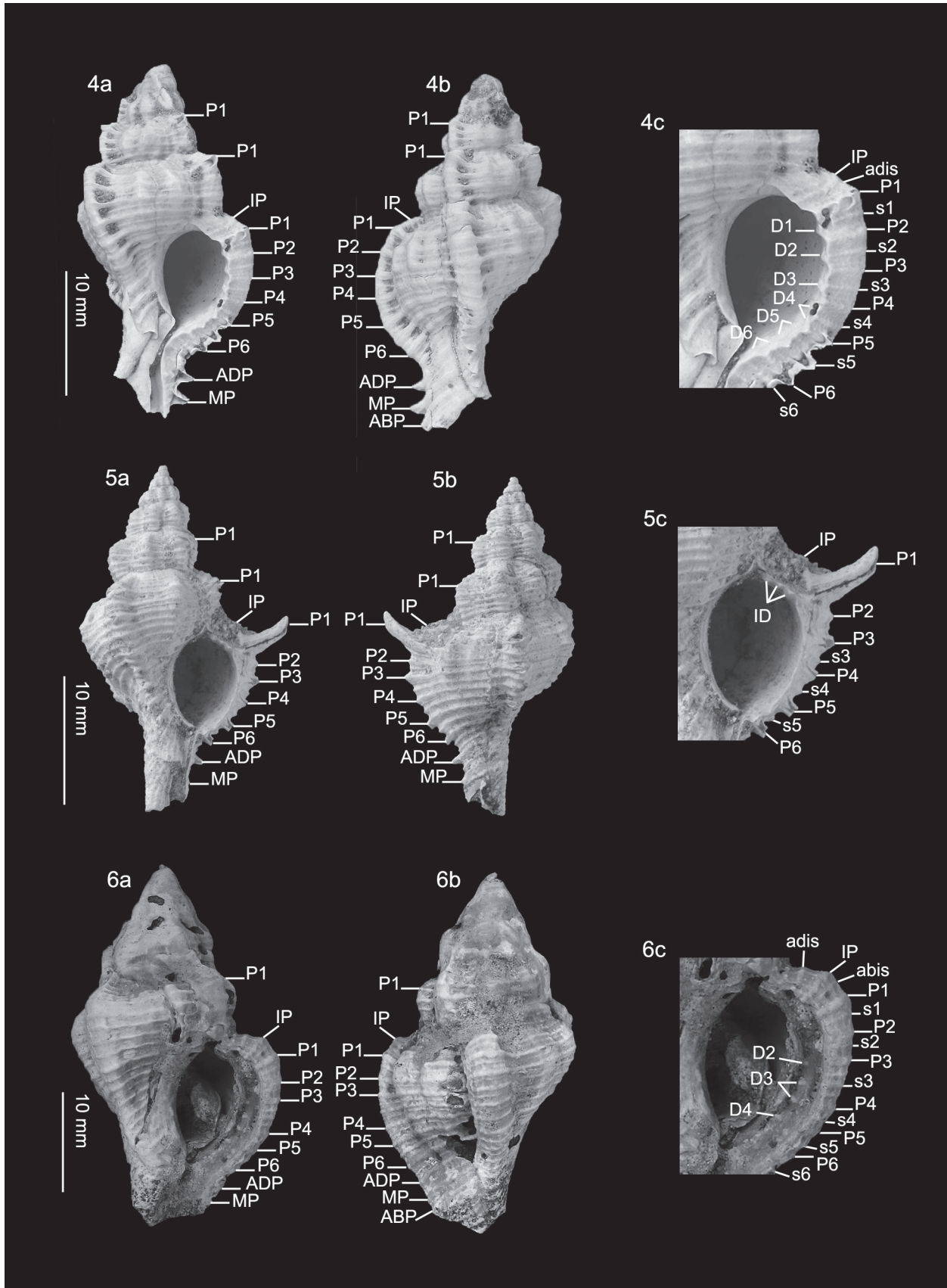
Etymology. — Named after the Island of Java where it occurred. *Chicoreus* gender masculine.

Description of the holotype. — Protoconch eroded. Teleoconch of medium size, elongate biconic in profile, composed of six whorls. Spire with five high, convex whorls, penultimate and last whorls wider, subcarinate. Last whorl up to 75% of total height. Apical angle up to 65° excluding spines, up to 76° including spines. Spiral sculpture of prominent primary cords. First whorl eroded. Second whorl: presence P1, P2 and P3. Third whorl: appearance of IP. Fourth whorl: appearance of abis and adis, s1–s3. Fifth whorl: appearance of tertiary cords and threads on sutural ramp. Sixth whorl: IP, P1–P6, adis, abis, s1–s5; secondary cords; s2 and s3 more strongly developed than other secondary cords over convex part of whorl. P6 placed on base; ADP, MP and ABP, s6, ads and ms (siphonal canal); ADP and MP more strongly developed than ADP; large space between P6 and ADP. Surface of shell with numerous threads over cords and interspaces. Varices and intervariceal nodes strengthening abapically. On second whorl, eleven protovarices. On third whorl, appearance of varices; three intervarices and two intervarices between. On fourth whorl, no change. From fifth to sixth whorl, three varices and one intervarix. Intervarices moderately developed from second to third whorl, strengthening abapically. On third whorl, appearance of P1 spine. On fourth whorl, appearance of P2 spine. On last whorl, IP not spiny; P1 spine larger than P2 and P3 spines. ABP spine shorter than ADP and MP spines. Cord spines short, not atrophied. Intervarical nodules more strongly developed on P2 and P3. Aperture ovate, up 30% of diameter including spines, up to 78% of height of last whorl (including the siphonal canal). Columellar lip slightly erect, smooth within. Parietal lip adherent. Anal notch broad, deep. Parietal callus developed. Outer lip with small internal denticles, D3 and D4 split, D5 and D6 simple, lip edge finely crenulated from the anal notch area to P3. Pseudoumbilicus narrow. Siphonal canal up to 60% of the aperture height, slightly dorsally recurved.

Comparisons. — The holotype resembles two specimens from the Late Pliocene of Central Java illustrated by



**Figs 1–3.** Analysis of the spiral sculpture of *Chicoreus (Triplex)* from Wonosari. **1.** *C. (Triplex) javanus* spec. nov., holotype NHMW 1901/0034/0096. **2.** *C. (T.) solidus* spec. nov., holotype NHMW 1901/0034/084. **3.** *C. (T.) martini* spec. nov., holotype NHMW 1901/0034/0085. Photos P. Loubry (MNHN). a) ventral view, b) dorsal view, c) detail of the aperture.



**Figs 4–6.** Analysis of the spiral sculpture of *Chicoreus (Triplex)* and *C. (Rhizophorimurex)* from Wonosari. **4.** *C. (Triplex) altenai dekkersi* n. ssp., holotype NHMW 1901/0034/0089. **5.** *C. (Triplex) juttingae* (Beets, 1941), NHMW 1901/0034/0097, photos P. Loubrý (MNHN). **6.** *C. (Rhizophorimurex)* cf. *capucinus* (Lamarck, 1822), NHMW 1901/0034/0098. a) ventral view, b) dorsal view, c) detail of the aperture.

Dharma (2005) and attributed to the present-day species *C. (T.) banksii* (G.B. Sowerby II, 1841). They share a similar spire (with higher early whorls than the two last whorls), short spines from P1 to P6 on the convex part of whorl, no atrophied spines, a larger space between P6 and ADP, and a deep anal sulcus. We cannot exclude that the holotype and these Pliocene specimens belong to a same species, but direct comparison would be required to determine if they are conspecific. The present-day *C. (T.) banksii* superficially resembles *C. (T.) javanus* in its elongate spire, but differs in the atrophied P2, shorter space between P6 and ADP, and by the development of an s6 spine (see Merle et al., 2011: pl. 62, figs 1–13). Therefore, these fossil records attributed to *C. (T.) banksii* are not that species, and need to be reassessed. Among the other *Chicoreus (Triplex)* species described here, *C. (T.) javanus* could be compared to *C. (T.) martini* spec. nov., because of the presence of spiny processes. However, *C. (T.) martini* is easily distinguishable by its shorter spire, its longer spines, particularly the P1 spine, its stronger intervarices, and the narrower space between P6 and ADP.

Distribution. — Middle Miocene: Yogyakarta, Central Java (this paper).

***Chicoreus (Triplex) solidus* spec. nov.**

Figs 2, 11

Type material and dimensions. — Holotype NHMW 1901/0034/084, height 40.2 mm, width 36.7 mm.

Type locality. — Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia.

Type stratum. — Langhian portion of NN5, middle Miocene.

Etymology. — From the Latin adjective *solidus* (= strong, solid) for the massive shell. *Chicoreus* gender masculine.

Description of the holotype. — Protoconch eroded. Teleoconch of medium size, solid, biconic in profile, composed of six whorls. Spire moderately high, with subcarinate whorls. Last whorl up to 76% of total height of teleoconch. Apical angle up to 62° excluding spines, up to 85° including spines. Spiral sculpture with well-developed primary cords. First whorl eroded. Second whorl: presence of P1–P3 and probably IP. Third whorl: IP, P, P2, P3, s1 and s2. Fourth whorl: appearance of tertiary spiral threads. Fifth whorl: appearance of abis, adis and threads covering entire whorl. Sixth whorl: IP, P1–P6, adis, abis, s1–s5; P6 placed on base on convex part of whorl; s1 to s4 more strongly developed than s5; s6 strongly developed; ADP, MP and ABP, s6 and ads (siphonal canal); ADP and MP stronger than ABP; narrow space between P6 and ADP. Entire surface covered by numerous fine threads covering primaries and interspaces. On second and third whorl, 11 or 12 protovarices. On fourth whorl, appearance of varices; three intervarices and two intervarices between. On fifth whorl, three intervarices and

two/three intervarices. On sixth whorl, three varices and two intervarices. Intervarices well developed from second to last whorl. On fourth whorl, appearance of P1 spine. On fifth whorl, appearance of P2 spine. On last whorl, IP not spiny; P1 larger than other spines (P2–P6); s6 strongly developed. ABP shorter than ADP and MP. Cord spines short, not atrophied. Intervarical nodules more strongly developed on P2 and P3. Aperture ovate, up 32% diameter including spines, and up to 70% height of last whorl (including siphonal canal). Columellar lip slightly erect, smooth within. Parietal lip adherent. Anal notch broad, well defined. Parietal callus poorly developed. Outer lip with small internal denticles: IP (bifid), D1 and D2 (simple), D3–D5 (bifid), D6 (trifid). Very small crenulations at outer lip edge from P5 to s6. Pseudoumbilicus rather wide. Siphonal canal up to 50% of apertural height, slightly dorsally recurved.

Comparisons. — This solid and massive shell can be compared to *Chicoreus (Triplex) brunneus* (Link, 1807). Dharma (2005, fig. 3a–b) attributed to that species two specimens collected from the middle Miocene of the Nyalidung Formation. Among them, the best preserved specimen (fig. 3a) strongly resembles present-day specimens of *C. (T.) brunneus*, bearing short and frondose cord spines and displays one intervarix, as in *C. (T.) brunneus*. However, the holotype of *C. (T.) solidus* spec. nov. differs from this specimen and the present-day *C. (T.) brunneus* in having two intervarices instead of one, by the strong development of s6, placed on the convex part of the whorl, and by simple and non-frondose cord spines. The other specimen attributed to *C. (T.) brunneus* by Dharma (2005, fig. 3b) displays a narrower shape than *C. (T.) solidus* and a poorly developed s6.

Distribution. — Middle Miocene: Yogyakarta, Central Java (this paper).

***Chicoreus (Triplex) martini* spec. nov.**

Figs 3, 12

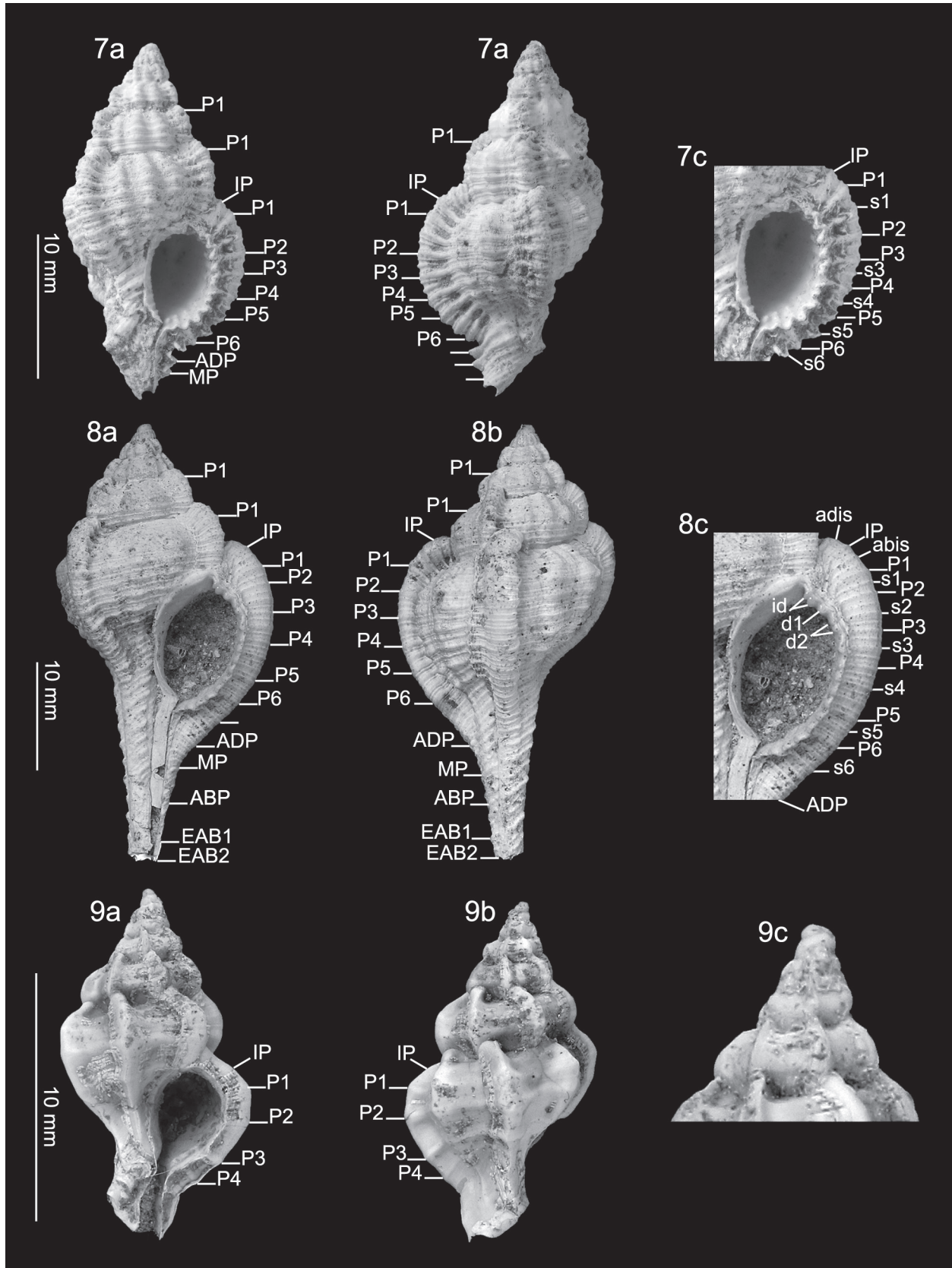
Type material and dimensions. — Holotype NHMW 1901/0034/0085, height 53.0 mm, width 37.6 mm.

Type locality. — Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia.

Type stratum. — Langhian portion of NN5, middle Miocene.

Etymology. — Dedicated to Johann Karl Ludwig Martin (1851–1942).

Description of the holotype. — Protoconch missing. Teleoconch of medium size, solid, subfusiform, composed of six whorls. Spire with moderately high, subcarinate whorls. Last whorl up to 77% of total height of teleoconch. Apical angle up to 68° excluding spines, up to 120° including spines. Spiral sculpture with well-developed primary cords. First and second whorl eroded. Third whorl: presence of P1–P3. Fourth whorl: appearance of s1. Fifth whorl: appearance of



**Figs 7–9.** Analysis of the spiral sculpture of *Chicomurex*, *Vokesimurex* and *Dermomurex* from Wonosari. 7. *Chicomurex parvus* spec. nov., holotype NHMW 1901/0034/0099, photos P. Loubry (MNHN). 8. *Vokesimurex wanneri* (Martin, 1916), NHMW 1901/0034/0101. 9. *Dermomurex* (s.s.) *wanneri* nom. nov., NHMW 1901/0034/0088. a) ventral view, b) dorsal view, 7c and 8c) detail of the aperture, 9c) detail of the spire showing the protoconch.

s<sub>2</sub> and threads covering whorls. Sixth whorl: IP, P<sub>1</sub>–P<sub>6</sub>; P<sub>6</sub> placed on base on convex part of whorl; s<sub>1</sub> more strongly developed than other secondary cords; ADP, MP and ABP (siphonal canal); ADP less strongly developed than MP and ABP; narrow space between P<sub>6</sub> and ADP. Numerous threads covering entire surface of shell. First, second and third whorl: protovarices or varices eroded. From third to sixth whorl: three varices with one intervarix between. On third whorl, appearance of the P<sub>1</sub> spine. On fourth whorl, appearance of P<sub>2</sub>. On last whorl, IP not spiny; P<sub>1</sub> larger than other spines (P<sub>2</sub>–P<sub>6</sub>). ADP shorter than MP and ABP. Cord spines short, not atrophied. Intervarical nodules more developed on P<sub>2</sub> and P<sub>3</sub>. Aperture ovate, up 27% of diameter including spines, up to 33% excluding spines, up to 76% of height of last whorl (including siphonal canal). Columellar lip poorly erect, smooth within. Parietal lip adherent. Anal notch short, narrow. No parietal callus developed. Outer lip without visible internal denticles. Small crenulations at outer lip edge from P<sub>1</sub> to P<sub>6</sub>. Pseudoumbilicus moderately large. Siphonal canal straight, up to 60% of apertural height.

Comparisons. — This species does not resemble any Indonesian fossil *Chicoreus* (*Triplex*) so far known, those illustrated by Dharma (2005). The low spire and solid shell make *C. (T.) martini* spec. nov. superficially comparable to the Pliocene western Atlantic *C. (T.) venezuelanus* (Hodson, 1931) (see Merle et al. 2011: pl. 51, fig. 3). Its long cord spines P<sub>1</sub>–P<sub>6</sub> without any atrophy is not a common feature in present-day Indo-Pacific members of the subgenus *C. (Triplex)*. *Chicoreus (T.) brunneus*, *C. (T.) elisae* Bozzetti, 1991 and *C. (T.) groshi* Vokes, 1978 from the Indian Ocean display less atrophied spines than in other Indo-Pacific *C. (Triplex)*, but these species differ together from *C. (T.) martini* spec. nov. by their narrower shape. Moreover, their spines are slightly frondose, whereas those of *C. (T.) martini* are not.

Distribution. — Middle Miocene: Yogyakarta, Central Java (this paper).

***Chicoreus (Triplex) altenai dekkersi* subsp. nov.**

Figs 4, 13

Type material and dimensions. — Holotype NHMW 1901/0034/0089, height 28.2 mm, width 13.0 mm.

Type locality. — Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia.

Type stratum. — Langhian portion of NN5, middle Miocene.

Etymology. — Dedicated to Aart Marinus Dekkers, enthusiastic molluscan researcher and friend of one of the authors (B.L.). The gender of *Chicoreus* is masculine.

Description of the holotype. — Protoconch missing. Teleoconch of medium size, biconic, composed of five whorls. Top of the spire eroded. Spire with moderately high, subcarinate whorls. Last whorl up to 72% of total height of teleoconch. Apical angle up to 50° excluding spines, up to

58° including spines. Spiral sculpture with well-developed primary cords. Second and third preserved whorls: presence of P<sub>1</sub>–P<sub>3</sub>. Fourth whorl: presence of IP, P<sub>1</sub>–P<sub>3</sub>, s<sub>1</sub>–s<sub>3</sub>. Fifth whorl: IP, P<sub>1</sub>–P<sub>6</sub>; s<sub>5</sub> more strongly developed than s<sub>1</sub>–s<sub>6</sub>. P<sub>6</sub> placed on base on convex part of whorl; ADP, MP, ABP and adis (siphonal canal); ADP less strongly developed than MP and ABP; narrow space between s<sub>6</sub> and ADP. Some tertiary threads over primary cords. Third visible whorl: three varices and two thick intervarices between. Fourth whorl: transition from two intervarices to three intervarices. Fifth whorl (last whorl): three low intervarices. From third to fourth whorl, presence of the P<sub>1</sub> spine. On fifth whorl, short spinelets on P<sub>1</sub>, P<sub>5</sub>, P<sub>6</sub>, s<sub>6</sub>, ADP and MP. Intervarical nodules low, slightly stronger on P<sub>2</sub> and P<sub>3</sub> and present on P<sub>3</sub>–P<sub>6</sub>. Aperture ovate, up 35% of diameter including spines, up to 76% of height last whorl (including siphonal canal). Columellar lip poorly erect, smooth within. Parietal lip adherent. Anal notch narrow. Parietal callus not developed. Outer lip with small internal denticles; D<sub>1</sub>–D<sub>4</sub> (simple), D<sub>5</sub> (bifid), D<sub>6</sub> (simple). Very small crenulations at outer lip edge. Pseudoumbilicus rather narrow. Siphonal canal up to 45% of apertural height, bent and slightly dorsally recurved.

Comparisons. — This *C. (Triplex)* subspecies differs strongly from the preceding congeners described herein, by having short spinelets mainly on P<sub>1</sub>, three low intervarices, low intervarical nodules from P<sub>1</sub> to P<sub>6</sub>, and by its bent and recurved siphonal canal. These distinguishing features are, however, shared with *C. (T.) altenai* (Cox, 1848) from the Plio-Pleistocene of Sabah, Malaysia (Fig. 14), from which the Javanese Miocene fossil form strongly resembles. However, the Miocene shell displays two differences. Firstly, the P<sub>1</sub> spine appears earlier in the ontogeny (on the third whorl instead on the fifth whorl in the holotype of *C. (T.) altenai* and secondly, the last whorl bears three intervarices instead four in *C. (T.) altenai*. Because of these differences, we consider the Miocene form a geographic and stratigraphic subspecies of *C. (T.) altenai*, that we name *C. (T.) altenai dekkersi*. The variation of the appearance of the cord spines was documented in Paleogene *Paziella* Jousseume, 1880 and *Poirieria* Jousseume, 1880 and corresponds to a pre-displacement when these cord spines appear earlier in the ontogeny than a form of reference (Merle & Pacaud, 2002a, b). In *C. (Triplex)* a variation of the appearance of P<sub>1</sub> occurs in the present-day West African *C. (T.) varius* (Sowerby, 1834) and could be a geographic variation (see Merle et al., 2011: pl. 75, figs 11–13).

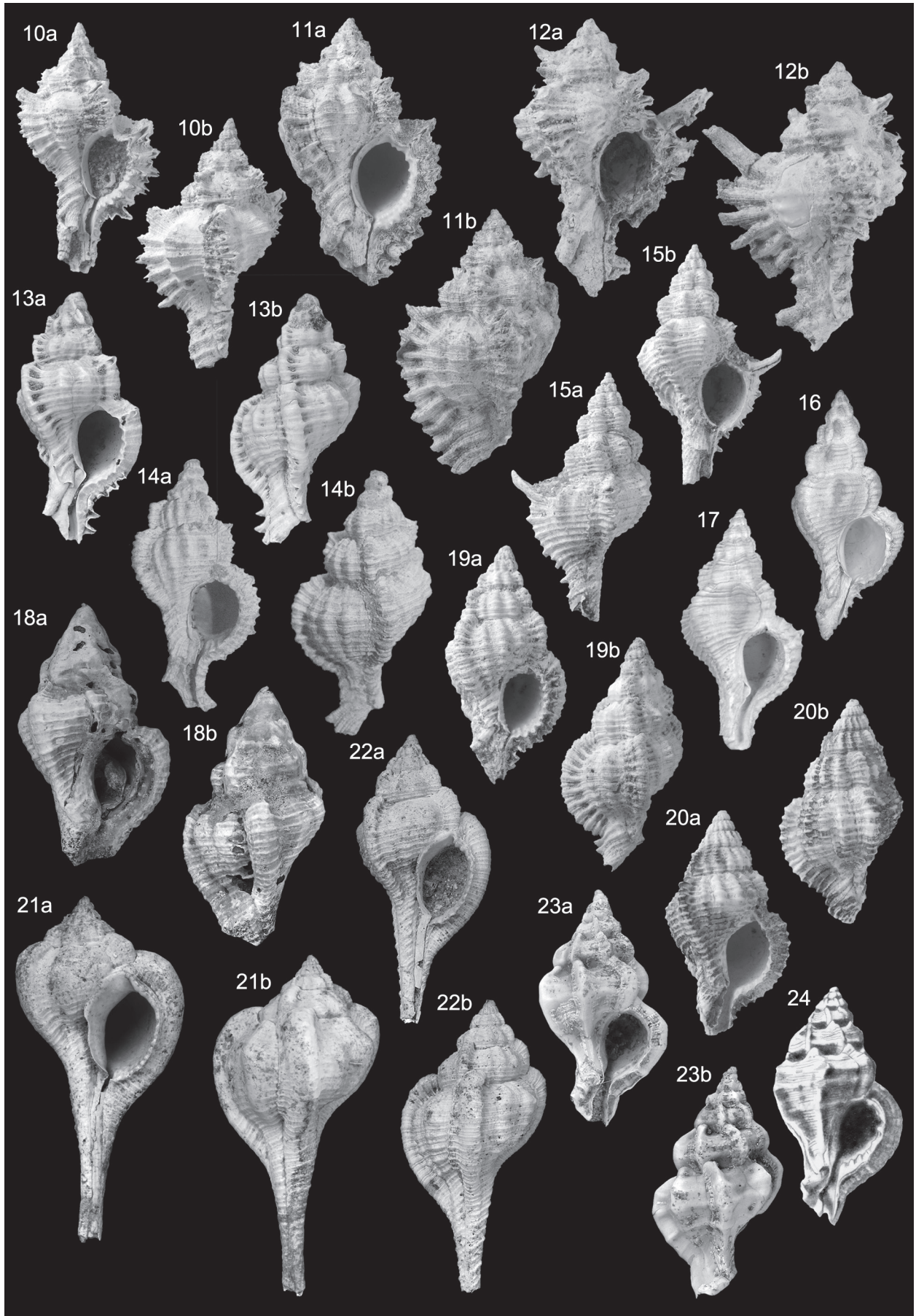
Distribution. — Middle Miocene: Yogyakarta, Central Java (this paper).

***Chicoreus (Triplex) juttingae* (Beets, 1941)**

Figs 5, 15–17

*Murex (Chicoreus) juttingae* Beets, 1941: 95, pl. 5, figs 207–211.

*Chicoreus (Triplex) juttingae* — Houart 1992 : 137, figs 83, 469–471; Merle et al. 2011: 34, pl. 49, fig. 1.





Type material and dimensions. — Holotype (RGM.312451), height 21.5 mm, width 9.3 mm; five paratypes (RGM.312453); ?late Miocene, Kalimantan, Indonesian part of Borneo.

Other material. — One specimen, NHMW 1901/0034/0097, height 25.5 mm, width 12.5 mm (excluding P1 spine); Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia; Langhian portion of NN5, middle Miocene.

Description of the studied material. — Protoconch incomplete, but probably bulbous. Teleoconch of small size, elongate, composed of six whorls. Spire with high, convex whorls. Last whorl up to 69% of total height of teleoconch. Apical angle up to 52° excluding P1 spine. Spiral sculpture with well-developed primary cords. First whorl: appearance of IP, P1–P3. Second whorl: P1–P3. Third whorl: appearance of abis and s3. Fourth whorl: appearance of s2. Fifth whorl: no change. Sixth whorl: IP, P1–P6, adis, s1–s5; P2 slightly atrophied; P6 placed on base on convex part of whorl; s1 very small; s3–s5 more strongly developed than other secondary cords; ADP, MP, ABP, s6, ads and ms (siphonal canal); narrow space between P6 and ADP. On first whorl, 13 protovarices. On second whorl, nine protovarices. On third whorl, eight protovarices. On fourth whorl, seven protovarices. From fifth to sixth whorl, appearance of three intervarices and one intervarix between. Intervarices approximately equal in strength to varices, hardly distinguishable from them when P1 varical spine not developed. P1 spine appearing on fifth whorl. On last whorl, short spinelets on P1, P3–P6, ADP and MP. No true intervarical nodules. Aperture ovate, up 31% of diameter including spines, up to 68% of height of last whorl (including siphonal canal). Columellar lip slightly erect, smooth within. Parietal lip adherent. Anal notch narrow. Parietal callus poorly developed. Outer lip lacking internal denticles, except ID (trifid). No crenulations at outer lip edge. Pseudoumbilicus narrow. Siphonal canal up to 46% of apertural height.

Comparisons. — By its narrow shape, its small size and its sculpture, this Javanese specimen is very similar to the type series of *C. (T.) juttingae* (Beets, 1941) from the late Neogene of Borneo (Figs 15–17). The strongest difference with the specimens from Borneo, is a more developed P1 spine. As the Javanese specimen is larger, it is possible that

its developed P1 spine corresponds to a gerontic character appearing late in the ontogeny. Based only on this difference, we are not able to separate the Javanese and Bornean specimens and we consider them conspecific.

Distribution. — Middle Miocene: Yogyakarta, Central Java (this paper), late? Miocene, Borneo, Malaysia (Beets, 1941).

#### Subgenus *Rhizophorimurex* Oyama, 1950

Type species: *Murex capucinus* Lamarck, 1822 by original designation. Present day: Indo-Pacific.

#### *Chicoreus (Rhizophorimurex) cf. capucinus* (Lamarck, 1822)

Figs 6, 18

Material and dimensions. — NHMW 1901/0034/0098, height 36.1 mm, width 20.2 mm.

Locality. — Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia; Langhian portion of NN5, middle Miocene.

Description. — Worn shell displaying five teleoconch whorls, first two whorls more eroded than the others. Teleoconch of medium size, biconic in profile, composed of five whorls. Spire with moderately high, subcarinate spire whorls. Last whorl up to 70% of total height of teleoconch. Apical angle up to 57° excluding spines. Spiral sculpture with well-developed primary cords. Fourth whorl (penultimate whorl): presence of IP, P1–P3. Fifth whorl: IP, P1–P6; s3 and s5 more strongly developed, s1, s2, s4 and s6; P6 placed on base on convex part of whorl; ADP, MP and ABP (siphonal canal); narrow space between s6 and ADP. Axial sculpture with three varices and two thick intervarices between. Higher relief on the intervarices on P1 and P2; no intervarical nodules. No visible cord spine. Aperture ovate, up 42% of diameter and up to 53% of height of last whorl (including siphonal canal). Columellar lip poorly erect, smooth within. Parietal lip adherent. Anal notch deep. Small parietal callus. Outer lip with small internal denticles; D2 (simple), D3 (bifid), D4 (simple), D5 and D6 (not distinct). No

◀ **Figs 10–24.** Muricidae from Wonosari with regional material for comparison. **10.** *C. (Triplex) javanus* spec. nov., holotype NHMW 1901/0034/0096, height 34.0 mm. **11.** *C. (T.) solidus* spec. nov., holotype NHMW 1901/0034/0084, height 40.2 mm. **12.** *C. (T.) martini* spec. nov., holotype NHMW 1901/0034/0085, height 53.0 mm. **13.** *C. (T.) altenai dekkersi* n. ssp., holotype NHMW 1901/0034/0089, height 28.2 mm. **14.** *C. (T.) altenai altenai* (Cox, 1848), holotype NMB 14433, height: 32.5 mm, Plio-Pleistocene, Sg. Togopi, Dent Peninsula, Sabah, photo O. Schmidt (NMB). **Figs 15–17.** *C. (Triplex) juttingae* (Beets, 1941). **15.** NHMW 1901/0034/0097, height 25.5 mm. **16.** Holotype RGM 312451, height 21.5 mm, late? Miocene, Borneo, photo F. Wesselingh (RGM). **17.** Paratype RGM 312453, same locality. **18.** *C. (Rhizophorimurex) cf. capucinus* (Lamarck, 1822), NHMW 1901/0034/0098, height 36.1 mm. **Figs 19–20.** *Chicomurex parvus* spec. nov. **19.** Holotype NHMW 1901/0034/0099, height, 23.9 mm. **20.** Paratype NHMW1901/0034/0086, height 17.1 mm. **Figs 21–22.** *Vokesimurex wanneri* (Martin, 1916). **21.** NHMW 1901/0034/0100, height 49.3 mm. **22.** NHMW 1901/0034/0101, height 40.3 mm. **Figs 23–24.** *Dermomurex (s.s.) wanneri* nom. nov. **23.** NHMW 1901/0034/0088, height 14.0 mm. **24.** Holotype drawing from Wanner & Hahn (1935, figs 8–9), height 17.0 mm, early–middle Miocene: Bringin, Central Java. a) ventral view, b) dorsal view.

crenulations at outer lip edge. Pseudoumbilicus rather narrow. Siphonal canal up to 50% of aperture height.

Comparisons. — Although the specimen at hand is rather eroded, its shape and sculpture are strongly similar to the extant *C. (Rhizophorimurex) capucinus* (Lamarck, 1822), the type species of this monotypic genus. Dharma (2005: pl. 133, fig. 9a–c) documented the geological history of this species. He recorded and illustrated it from the Nyalidung Formation (middle–late Miocene, West Java) and from the Pliocene (Pasir Ipi, West Java, middle Pliocene and Sangiran, Central Java, late Pliocene). The specimen from the Nyalidung Formation is presented only in dorsal view, but it is very similar to that from Wonosari and shares two intervarices. In addition, the two Miocene specimens do not differ from the Indonesian Pliocene specimens and from many present-day specimens. Therefore, this occurrence of *C. (Rhizophorimurex)* is a further record for the middle Miocene. We consider these records probably represent a single species that is present from the middle Miocene to present day, with the proviso that the fossil specimens do not have their protoconch preserved and can therefore not be compared to the present day specimens that have a two rounded whorls (Houart, 1992).

It is to be noted that this species currently is only known from mangroves in brackish-water estuaries (e.g. Lozouet & Plaziat, 2008). Therefore the occurrence of a single worn shell in an otherwise fully marine setting indicates the shell was displaced, either by currents or other means (e.g., a hermit crab). In NW Borneo, hermit crabs displace marine shells to estuaries and brackish-water shells to fully marine environments (Han Raven, pers. comm.). It does, therefore, indicate a relative closeness to the shore, as does the occurrence of *Taurasia striata* (de Blainville, 1832) in the Wonosari fauna (Landau et al., 2020b)—a species only known from intertidal and very shallow subtidal environments.

Distribution. — Middle Miocene: Yogyakarta, Central Java (this paper).

#### Genus *Chicomurex* Arakawa, 1964

Type species: *Murex superbus* Sowerby, 1889 by original designation. Present-day: Indo-Pacific.

#### *Chicomurex parvus* spec. nov.

Figs 7, 19–20

Type material and dimensions: Holotype NHMW 1901/0034/0099, height 23.9 mm, width 12.0 mm; one paratype NHMW 1901/0034/0086, height 17.1 mm, width 9.5 mm.

Type locality. — Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia.

Type stratum. — Langhian portion of NN5, middle Miocene.

Etymology. — From the Latin adjective *parvus* (= small) because of the small size of this species for the genus. *Chicomurex* gender masculine.

Description. — Protoconch missing. Teleoconch of small size, biconic, composed of five whorls. Spire with moderately high, weakly convex whorls. Last whorl up to 71% of total height of teleoconch. Apical angle up to 66°. Spiral sculpture with well-developed primary cords. First whorl: appearance of IP, P1–P3. Second whorl: appearance of s1 and s3. Third whorl: no change. Fourth whorl: appearance of abis. Sixth whorl: IP, P1–P6, adis, s1–s5; P6 and s6 placed on base on convex part of whorl; s1–s5 almost equally developed than other primary cords; ADP, MP, ABP (siphonal canal); narrow space between P6 and ADP. On first whorl, 11–14 protovarices. On second whorl, 10–13 protovarices. On third whorl, 10 or 11 protovarices. On fourth whorl, 10–13 protovarices. On fifth whorl, appearance of three intervarices and three to four intervarices between. Intervarices approximately equal in strength to varices, hardly distinguishable from them when IP or P1 varical spines not developed. P1 spine appearing irregularly on fifth whorl. On last whorl, short spinelets on P1, P5, P6, ADP and MP. No true intervarical nodules. Aperture ovate, up 33% of diameter, up to 71% of height of last whorl (including siphonal canal). Columellar lip slightly erect, with eight small tubercles. Parietal lip adherent with two or three tubercles. Anal notch narrow. Parietal callus poorly developed. Outer lip with small internal denticles. Series of internal denticles including D1–D4 (simple) and D5–D6 (bifid). No crenulations at outer lip edge. Pseudoumbilicus moderately large. Siphonal canal up to 42% of apertural height.

Comparisons. — This small species differs from all *C. (Triplex)* species by having columellar and parietal denticles. These characters are only shared with *Chicomurex* and *Phyllonotus* Swainson, 1833, but the range of *Phyllonotus* is restricted to eastern Pacific, western-Atlantic and Europe. *C. lophoessus* (Tate, 1888), from the middle Miocene of South Australia, is easily distinguished by having more gradate whorls, less broad varices and intervarices, a more rounded aperture and by lacking columellar ornamentation. *Chicomurex kendengensis* (van Regteren Altena, 1950) from the Pleistocene of Java is larger (46 mm in the holotype), displays a wider spire, a more rounded aperture and bears well developed spines (see Houart, 1992: figs 248–249). The present-day species *C. venustulus* (Rehder & Wilson, 1975) from the Marquesas Islands is usually spinier, but some specimens lacking spines display a superficial similarity with *C. parvus* (see Houart et al. 2015: fig. O). Specimens of *C. venustulus* lacking spines differ by having a wider shape, a lower spire and a rounded aperture.

Distribution. — Middle Miocene: Yogyakarta, central Java (this paper).

**Genus *Vokesimurex* Petuch, 1994**

Type species: *Haustellum (Vokesimurex) messorius* G.B. Sowerby II, 1841a by original designation. Miocene to present: tropical western Atlantic.

***Vokesimurex wanneri* (Martin, 1916)**

Figs 8, 21–22

*Murex (Haustellum) wanneri* Martin, 1916: 240, pl. 2, figs 37–38; Swarko & Sufiati 1994: 021.

*Murex wanneri* — Van der Vlerk 1931: 237.

*Haustellum wanneri* — Ponder & Vokes 1988: 123, fig. 166a–b; Leloux & Wesselingh 2009: 132, pl. 180, figs 2–4.

*Vokesimurex wanneri* — Merle et al. 2011: 69, 230.

Type material.— *Murex (Haustellum) wanneri* Martin, 1916 corresponding to the specimen RGM.9967 figured by Martin (1916: pl. 2, fig. 37a–b) is herein designated as the lectotype. The other specimens of the type-series are paralectotypes: RGM.9667, figured specimen pl. 2, fig. 38), RGM.9668 (two specimens) and RGM.6992 (one specimen); all from West Progo Beds, early Miocene, Central Java, Indonesia.

Other material: NHMW 1901/0034/0100 (Fig. 21), height 49.3 mm; width 21.4 mm; NHMW 1901/0034/0101 (Figs 8, 22), height 40.3 mm; width 19.2 mm.

Description of the studied material. — Teleoconch of middle size, fusiform, composed of six whorls. Spire with moderately high, weakly convex whorls. Last whorl up to 79–87% of total height of teleoconch. Apical angle up to 82–93°. Spiral sculpture with narrow primary cords. First whorl: eroded. From second to fourth whorl: IP, P<sub>1</sub>–P<sub>3</sub>. Fifth whorl: appearance of abis, adis. Sixth whorl: IP, P<sub>1</sub>–P<sub>6</sub>, adis, s<sub>1</sub>–s<sub>6</sub>; P<sub>6</sub> and s<sub>6</sub> placed on base on convex part of whorl; secondary cords almost equally developed than the primary cords; ADP, MP, ABP, EAB<sub>1</sub>, EAB<sub>2</sub>, ads, ms, abs (siphonal canal); large space between P<sub>6</sub> and ADP. On second whorl, 12 protovarices. On third whorl, seven protovarices and appearance of the varices. On fourth whorl, three varices and two to three intervarices between. On fifth whorl, no change; On sixth whorl, three massive varices and two heavy intervarices. Intervarices approximately equal in strength to varices on last whorl, but well distinguishable from them. No cord spine No true intervarical nodules. Aperture ovate, up 30–36% of diameter, up to 79–89% of height of last whorl (including siphonal canal). Columellar lip smooth. Rim partially erect. Parietal lip adherent with three or four low tubercles. Parietal callus poorly developed. Anal notch narrow. Outer lip with weak and poorly distinct internal denticles. Crenulations more developed on the convex part of the whorl than the shoulder. Inner side of the crenulation bearing denticles at the edge of the outer lip. Denticles at the edge of the outer lip more developed on the shoulder than the convex part of whorl. Most developed denticles at the edge

of the outer lip: id, d<sub>1</sub>, d<sub>2</sub> (Fig. 8c). Pseudoumbilicus narrow. Siphonal canal, long, up to 57–62% of apertural height.

Comparisons.— The studied material includes an adult (NHMW 1901/0034/0100) and a juvenile specimen (NHMW 1901/0034/0101). The spiral sculpture of the juvenile is slightly coarser than that of the adult which bears three massive varices and two heavy intervarices. The adult syntype of *V. wanneri* figured by Ponder & Vokes (1988, fig. 62A; RGM.9967) is highly similar to the adult specimen from Wonosari and both seems belong to a same species. As no lectotype was designated for this species (Ponder & Vokes, 1988; Leloux & Wesselingh, 2009), we designate herein the syntype figured by Martin (1916: pl. 2, fig. 37a–b) as the lectotype. According to Ponder & Vokes (1988: 123), massive varices and heavy intervarices characterise the sculpture of *V. wanneri* and differ from all other species attributed to *Vokesimurex*, which were previously attributed to *Haustellum* in the classification of Ponder & Vokes (1988).

Distribution. — Early Miocene, Central Java to middle Miocene: Yogyakarta, Central Java (this paper).

**Subfamily Aspellinae, 1971****Genus *Dermomurex* Monterosato, 1890**

Type species: *Murex scalarinus* Bivona-Bernardi, 1832 (junior synonym of *Murex scalaroides* Blainville, 1829) by original designation. Early Pliocene of Mediterranean Sea to present-day Mediterranean Sea and Senegal.

**Subgenus *Dermomurex* (s.s.)*****Dermomurex* (s.s.) *wanneri* nomen nov.**

Figs 9, 23–24

*Murex (Aspella) acuticostatus* Wanner & Hahn, 1935: 254, pl. 19, figs 8–10, not *Murex acuticostatus* Gümbel, 1861.

*Dermomurex* (s.s.) *acuticostatus* — Merle et al. 2011: 572, pl. 164, fig. 7a–b, not *Murex acuticostatus* Gümbel, 1861.

Etymology. — Dedicated to Johannes Wanner (1878–1959). He was a German geologist who contributed to the geology and palaeontology of the Malay Archipelago and especially Timor.

Type material: holotype from Bringin and one paratype from Sumberan-Bahasa, all not located; Bringin and Sumberan, Central Java, Indonesia, Rembang Formation, early–middle Miocene (Aswan & Osawa 2006).

Other material. — NHMW 1901/0034/0088, height 14.0 mm, width 7.5 mm; Wonosari, Gunung Kidul Regency, Special Region of Yogyakarta, Java, Indonesia; Langhian portion of NN<sub>5</sub>, middle Miocene.

Description of the studied material. — Bulbous protoconch of two whorls. Teleoconch of middle size, biconic, composed of five whorls. Spire with moderately high, weakly convex whorls. Last whorl up to 67% of total height of teleoconch. Apical angle up to 60°. Spiral sculpture with weakly marked primary cords. First to second whorl: not cord. Third whorl: appearance of P1 and P2. Fourth whorl: no change. Fifth whorl: IP weak, P1–P4 on convex part of whorl, P5 weak; siphonal canal smooth. On first whorl, nine varices. From second to fourth whorl, eight varices. On fifth whorl, seven varices. No cord spine. Aperture ovate, up 33% of diameter, up to 70% of height of last whorl (including siphonal canal). Columellar lip smooth slightly erect anteriorly. Outer lip with very weak internal denticles. Pseudoumbilicus narrow. Siphonal canal up to 39% of apertural height. Remains of intritacalx present on the spire.

Comparisons. — The shape and the axial and the spiral sculptures of this specimen are very similar to those of the holotype of *Murex acuticostatus* Wanner & Hahn, 1935 (Fig. 24). For this reason, we attribute it to this species. The binomen *Murex acuticostatus* is preoccupied by a species from the Rupelian of Europe *Murex acuticostatus* Gümbel, 1861. Therefore, we give this Indonesian species described by Wanner & Hahn (1935) a new name *Dermomurex* (*s.s.*) *wanneri*. *Dermomurex* (*s.s.*) *quilonicus* (Dey, 1961) from the early Miocene from Quilon (Kerala, India) displays a higher spire and a narrower shape.

Distribution. — Early–Middle Miocene: Central Java to middle Miocene: Yogyakarta, Central Java (this paper).

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## REFERENCES

- ASWAN A. & OZAWA, T., 2006. Milankovitch 41.000-year cycles in lithofacies and molluscan content in the tropical Middle Miocene Nyalindung Formation, Jawa, Indonesia. — *Palaeogeography, Palaeoclimatology, Palaeoecology* 235: 382–405.
- BEETS, C., 1941. Eine jungmiocäne Mollusken-Fauna von der Halbinsel Mangkalihat, Ost-Borneo (nebst Bemerkungen über andere Faunen von Ost-Borneo; die Leit-

fossilien-Frage). — *Verhandelingen van het Geologisch Mijnbouwkundig Genootschap voor Nederland Koloniëne, Geologische Series* 13 (1): 1–219.

- DEKKERS, A.M., LIVERANI, V., ĆORIĆ, S., MAXWELL, S.J. & LANDAU, B.M., 2020. A new genus for Indo-Pacific fossil strombids, and two new species from the Miocene of Java and Borneo (Caenogastropoda, Strombidae). — *Basteria* 84: 1–9.
- DEY, A.K., 1961. The Miocene Mollusca from Quilon, Kerala (India). *Memoirs of the Geological Society of India*. — *Palaeontologia Indica, New Series* 36: 1–129.
- DHARMA, B., 2005. Recent and fossil Indonesian shells: 1–424. *ConchBooks*, Hackenheim.
- GÜMBEL, C.W., 1861. *Geognostische Beschreibung des bayrischen Alpengebirges und seines Vorlandes*. 1–950. Justus Perthes, Gotha.
- HOUART, R., 1992. The genus *Chicoreus* and related genera (Gastropoda: Muricidae) in the Indo-West Pacific. — *Mémoires du Muséum national d'Histoire naturelle (Série A, Zoologie)* 154: 1–188.
- LANDAU, B.M., BEU, A.G., BREITENBERGER, A. & DEKKERS, A.M., 2020a. Middle Miocene Tonnoidean gastropods from near Wonosari, Yogyakarta, Java, Indonesia. — *Basteria* 84: 10–25.
- LANDAU, B.M., RAVEN J.G.M., BREITENBERGER, A. & DEKKERS, A.M., 2020b. *Semiricinula preturbinooides* spec. nov., a new species from the Miocene of Java (Gastropoda: Muricidae). — *Basteria* 84: 131–134.
- LELOUX, J. & WESSELINGH, F.P., 2009. Types of Cenozoic Mollusca from Java in the Martin Collection of Naturalis. — *NNM Technical Bulletin* 11: 1–765.
- LOZOUET, P. & PLAZIAT, J.-C., 2008. Mangrove environments and molluscs. Abatan river, Bohol and Panglao Islands, Central Philippines: 1–160. *ConchBooks*, Hackenheim.
- MARSHALL, N., NOVAK, V., CIBAJ, I., KRIJGSMAN, W., RENEMA, W., YOUNG, J., FRASER, N., LIMBONG, A. & MORLEY, R., 2015. Dating Borneo's deltaic deluge: Middle Miocene progradation of the Mahakam delta. — *Palaios* 30: 7–25.
- Martin, K., 1916. *Die Altmiocäne Fauna des West-Progo-gebirges auf Java. Gasteropoda*. — *Sammlungen des geologischen Reichsmuseums in Leiden, Neue Folge* 2 (6): 223–262.
- Martini, E., 1971. Standard Tertiary and Quaternary calcareous nannoplankton zonation. — *Proceedings of the 11 Planktonic Conference*. Ed. Tecnoscienza, Roma, 739–785.
- MERLE, D., 1999. La radiation des Muricidae (Gastropoda: Neogastropoda) au Paléogène: approche phylogénétique et évolutive: vi + 499. Ph.D. thesis, Muséum national d'Histoire naturelle, France.
- MERLE, D., 2001. The spiral cords and the internal denticles of the outer lip in the Muricidae: terminology and methodological comments. — *Novapex* 2 (3): 69–71.
- MERLE, D., 2005. The spiral cords of the Muricidae (Mollusca:

- Gastropoda): importance of ontogenetic and topological correspondences for delineating structural homologies. — *Lethaia* 38: 367–379.
- MERLE D. & PACAUD, J.-M., 2002a. The first record of *Poirieria subcristata* (d'Orbigny, 1850) (Muricidae: Muricinae) in the early Cuisian of the Paris Basin (Celles-sur-Aisne, Aizy Formation), with comments on the sculptural evolution of some Palaeocene and Eocene *Poirieria* and *Paziella*. — *Tertiary Research*: 21 (1–4): 19–27.
- MERLE D. & PACAUD J.-M., 2002b. The early Palaeogene muricids (Mollusca: Neogastropoda) from Oichings beds (Haunberg area, Salzburg, Austria): revision and addition to the knowledge of the evolution of the Palaeocene and Lower Eocene *Poirieria*. — *Mitteilungen Bayerische Staatssammlungen für Paläontologie und historische Geologie* 42: 3–14.
- MERLE D. & LANDAU B.M., 2020. Review of the paleobiogeography of *Eofavartia* Merle, 2002 (Gastropoda: Muricidae) with description of a new species from the Miocene of Java (Indonesia). — *Annales de Paléontologie* 106: 1–7.
- MERLE, D., GARRIGUES, B. & POINTIER J.-P., 2005. Recent and fossil Muricidae of the world. Part 1: Muricidae: 1–649. ConchBooks, Hackenheim.
- PONDER, W.F. & VOKES, E.H., 1988. A revision of the Indo-West Pacific fossil and Recent species of *Murex* s.s. and *Haustellum* (Mollusca: Gastropoda: Muricidae). — *Records of the Australian Museum Supplement* 8: 1–160.
- SKWARKO, S.K. & SUFIATI, E., 1994. Mollusca in Indonesian Cenozoic biostratigraphy (a computerised compilation), v. 3. Gastropoda: 1–796. Geological Research and Development Centre, Bandung.
- VLERK, I.M., VAN DER, 1931. Caenozoic Amphineura, Gastropoda, Lamellibranchiata and Scaphopoda. — *Leidse geologische Mededelingen* 5: 206–296.
- Wanner, J & Hahn, E., (1935) Miocene Mollusken aus der Landschaft Rembang (Java). — *Zeitschrift der deutschen Geologischen Gesellschaft* 87: 222–273.