

**Notes on the identity of *Cardium costatum* Linnaeus, 1758,  
with the description of *Cardium maxicostatum* spec. nov.  
from tropical West Africa (Bivalvia, Cardiidae)**

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ABSTRACT

It is shown that what is generally considered a single species, the Great ribbed cockle, *Cardium costatum* Linnaeus, 1758, consists of two clearly different forms, to be separated at species level. Among the available possible type material of *C. costatum*, which is in agreement with one of these forms, a lectotype is selected. Because no alternative name is available for the remaining form, a new species is here described as *C. maxicostatum* spec. nov.

Key words: Bivalvia, Cardiidae, *Cardium*, systematics, lectotype, new species, West Africa.

INTRODUCTION

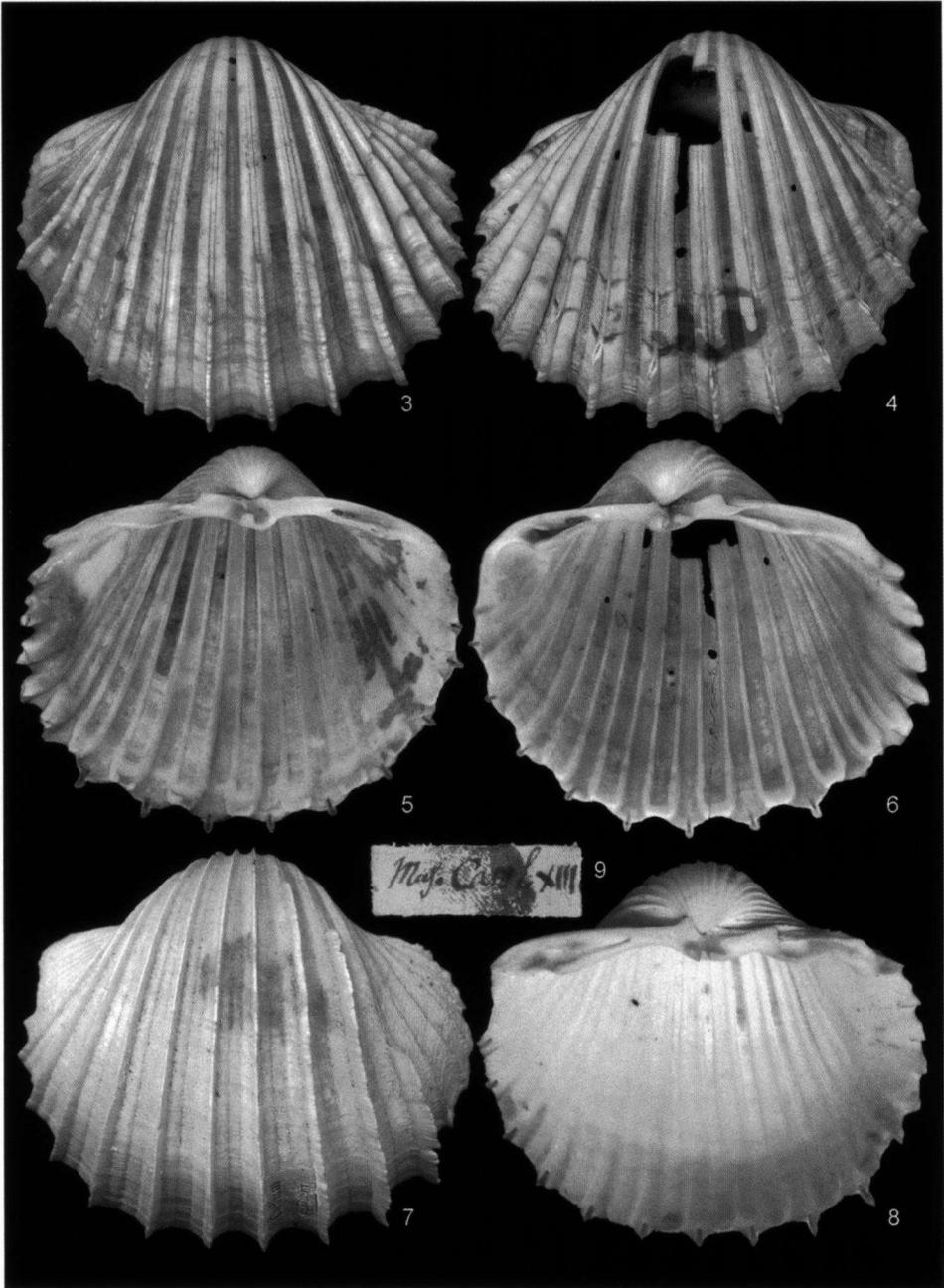
Nowadays, the majority of taxonomists assign only two extant species to the genus *Cardium* (s.s.), viz. *C. costatum* Linnaeus, 1758 (type species) and *C. indicum* Lamarck, 1819. Both species have a largely sympatric distribution along the West African coast and are morphologically easily separated from each other: shells of the latter lacking the hollow and pointed character of the ribs, exhibiting an ornamentation of spines, gaping much stronger posteriorly, with ribs not interlocking along the commissure, and having a partly purple and light brownish colour (Ghisotti, 1971).

*Cardium costatum* is a large, well-known and striking bivalve with a unique rib morphology. Because of its remarkable appearance, it is easily recognised. Below it will be demonstrated that two morphologically clearly different forms are to be distinguished, to be separated at species level. Taxonomists have apparently overlooked the existence of these differences during the past two and a half centuries, probably as a result of its seemingly obvious identification due to its characteristic specialised shell morphology. In all probability, this is also the main cause for the lack of virtually any synonyms.

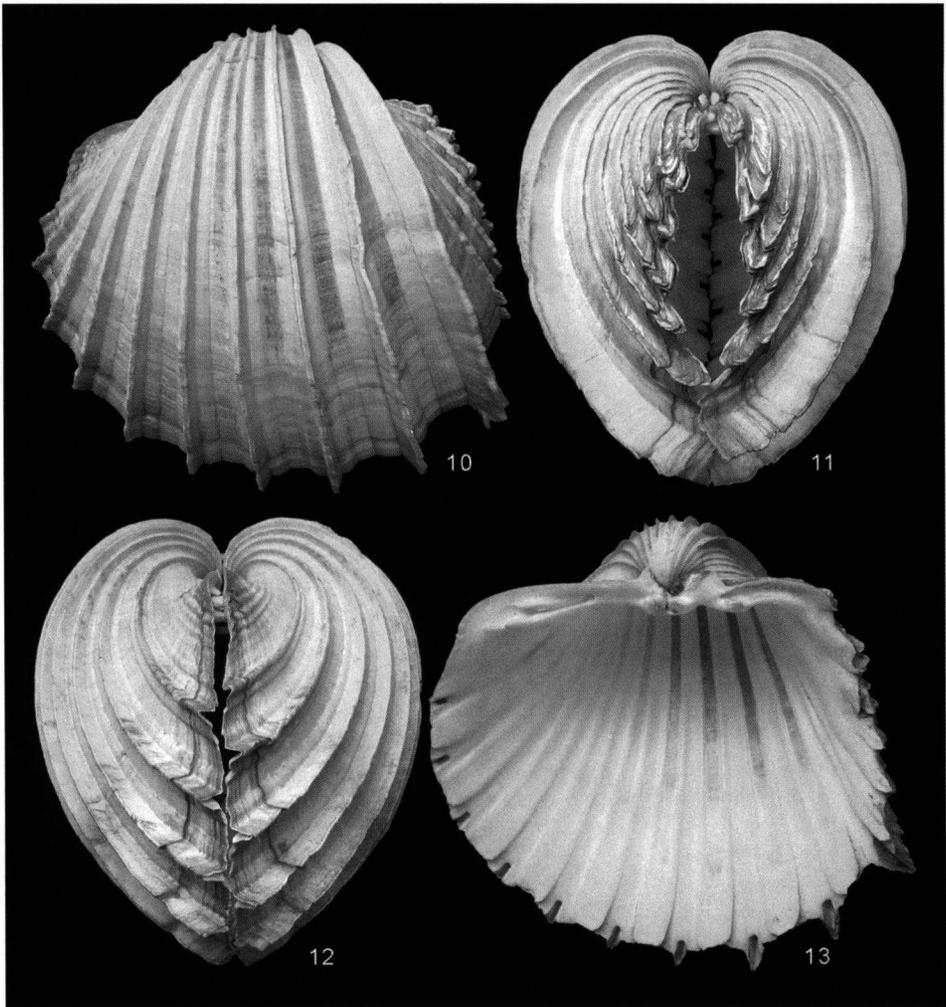
The purpose of this paper is to elucidate the differences between these forms, to treat the available possible type material and to work out the taxonomic consequences.

Abbreviations: BMNH, The Natural History Museum, London, United Kingdom; LS, Linnean Society of London, United Kingdom; RMNH, Nationaal Natuurhistorisch Museum *Naturalis*, Leiden, The Netherlands; TP, colln. J.J. ter Poorten, Hilversum, The Netherlands; UU, Museum of Evolution, Uppsala University, Uppsala, Sweden; ZMA, Zoölogisch Museum Amsterdam, The Netherlands.

Fr. = fragment(s); h. = height; l. = length; p.v. = paired valve(s); v. = valve; w = width.



Figs 3-9. *Cardium* spec. 3-6, *C. costatum*; 3, 5, lectotype, unknown provenance, colln LS, length 72 mm; 4, 6, paralectotype, unknown provenance, colln LS, length 74 mm. 7-8, *C. maxicostatum* spec. nov., unknown provenance, colln UU (Linnésammlingen, nr. 1386), length 91 mm; 9. Handwritten tag accompanying UU sample nr. 1386.



Figs 10-13. *C. maxicostatum* spec. nov., holotype, Congo Brazzaville, Pointe Indienne, from fisherman, 07.11.1972, colln ZMA Moll. 4.07.023, length 117 mm.

#### MATERIAL AND METHODS

The term *flange* is used for the substantial, continuous projections on top of the radial ribs, which have the shape of a keel. The term *median part* is used in a broad sense for the area containing the ribs that consist of a hollow section and that consist of two parts, viz. the central, broad base (the actual rib) and the pointed flange. These ribs are considered to represent the main ribs.

In some cases, the projections of the median ribs extend well beyond the shell margin. For the shell length, these extensions are included in the measurements when falling within the horizontal axis, measured parallel to the hinge line.

In total 75 samples have been studied, consisting of 196 specimens, originating from LS, RMNH, UU, ZMA, and TP.

Only those references are incorporated with figures that could unequivocally be attributed to one of both taxa. In many cases, illustrations and descriptions, especially those of earlier workers, were not accurate enough to enable a certain assignment to one of the two discussed taxa.

### THE IDENTITY OF *CARDIUM COSTATUM*

*Cardium costatum* Linnaeus, 1758, is widely known to be characterised by a relatively large, rather thin shell, which is inflated and nearly equilateral, with a limited number of large and hollow ribs and a white colour with brown areas in the intercostae. This corresponds with Linnaeus' (1758: 678) original description: '*C. testa gibba aequivalvi: costis elevatis carinatis concavis membranaceis*' [shell gibbous, equivalve: with high, keeled, concave, membranaceous ribs]. However, within this general appearance two different morphological forms, provisionally named A and B, can be detected. Nine differentiating characters are tabulated below.

Although most characters show a certain degree of variation – mainly the extent of development of the anterior riblets and the nature of the hinge plate – no intermediate forms were found. Fig. 1 shows one of its most distinctive diagnostic characters: the shell length of both taxa plotted against the height of the highest flange present on the shell. In most cases this proved to be situated on the most posterior main rib. At comparable sizes, the flange is much larger in form B (circa 1.75 times compared to form A, fig. 1); besides, the shell attains considerably larger dimensions than form A. Another clear difference is the rib number on the median part of the shell (fig. 2), which is clearly higher in form B.

Character	Form A	Form B
Length	Up to circa 100 mm	Up to circa 130 mm
Rib number on median part	7-10 ribs (mean 8.73, n=48)	9-13 ribs (mean 10.56, n=55)
Posterior part	Slightly to moderately gaping	Moderately to markedly gaping
Nature of ribs on median part	Moderately high flanges, all of approximately same height, up to 4.5 mm	Extremely high and slender flanges, becoming much higher posteriorly, up to 12.5 mm
Hinge plate	Anterior part rather small, slightly curved	Anterior part rather broad, long and straight
Posterior ribs	Well developed, strong, thick, and triangular, palisade poor	Highly flattened, strongly developed, thin palisade posteriorly
Posterior margin	Strongly digitated and projecting	Serrated or weakly digitated
Anterior riblets	Most dorsally positioned riblet generally more pronounced	Dorsal riblet generally of about the same strength as others
Shell resorption in interior	Clearly present on 6-9 interstices	Clearly present on 4-7 interstices

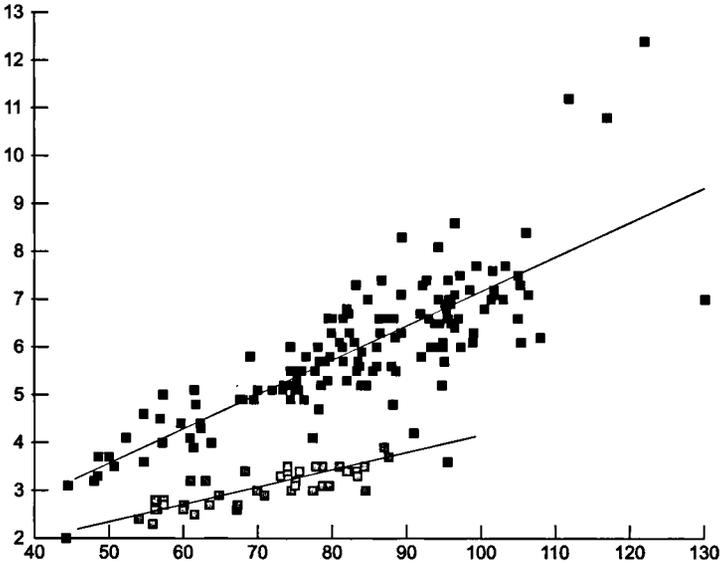


Fig. 1. Scatter diagram showing relation shell length (horizontal axis) and height of the largest flange (vertical axis) for *Cardium costatum* form A (grey squares, n = 46) and B (black squares, n = 134). Sizes in mm; based on material from RMNH, ZMA and TP.

Both forms occur sympatric practically throughout their distribution range. Given the large amount of substantial and rather constant differences in shell morphology and since intermediate forms are lacking, separation of both forms at species level is necessary.

Linnaeus' concise type description is not detailed enough to be attributed to either form A or B. Moreover, the figures Linnaeus (1758: 678) is referring to, viz. Colonna, 1616 (fig. 27), Rumphius, 1705 (pl. 48 fig. 6), d'Argenville, 1742 (pl. 26 fig. a), and Gualtieri, 1742 (pl. 72 fig. d) show a large degree of artistic freedom and are thus considered inadequate to be ascribed to one of both forms with any degree of accuracy.

According to Dodge (1952: 54) "a correctly marked specimen" is present in the Linnaeus collection. Mmes K. Way and A. MacLellan (BMNH) kindly provided me with photographs of the two valves of *C. costatum*, present at the Linnean Society of London, where Linnaeus' personal collection is housed, a left and a right one, length respectively

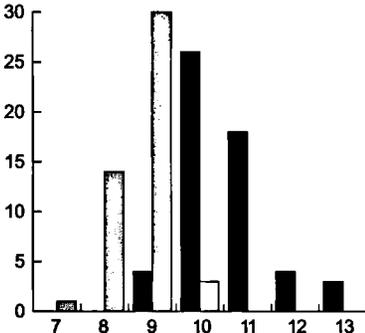
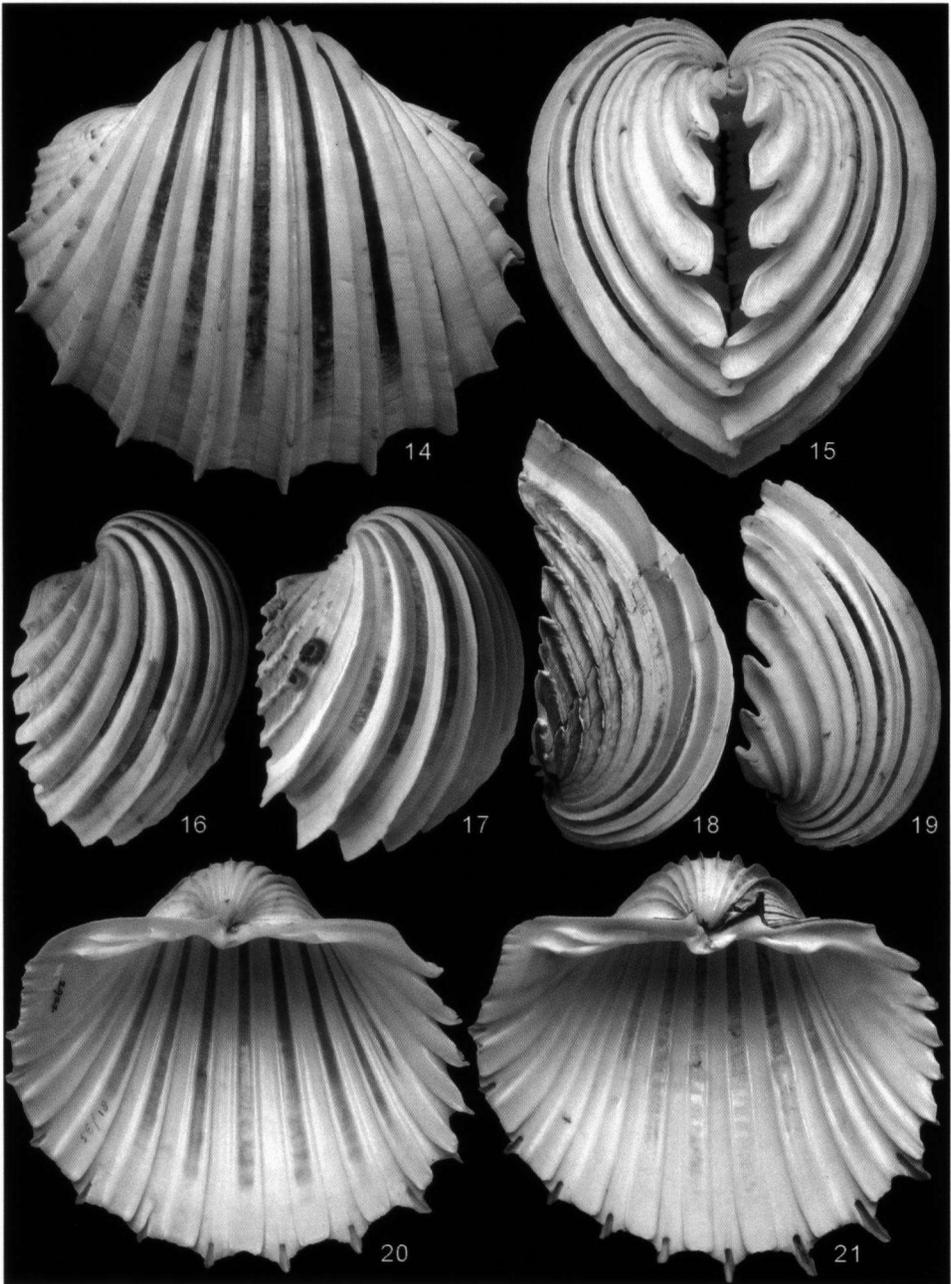


Fig. 2. Stacked bar graph showing rib number on median part of the shell (horizontal axis) of form A (grey, n = 48) and B (black, n = 55). Vertical axis showing number of shells measured; sizes in mm; based on material from BMNH, RMNH, ZMA and TP.



Figs 14-21. *Cardium* spec. 14-16, 19-20, *C. costatum*; 14-15, 19-20, Angola, Luanda, by local fishermen, 2005, colln TP 2922, length 81 mm; 16, Ghana, Greater Accra Province, Accra, floodmark, 14.xi.2003, leg. W. Regter, colln TP 1654, length 95 mm. 17-18, 21, *C. maxicostatum* spec. nov.; 17, Angola, colln TP 444, length 97 mm; 18, 21, paratype, Angola, Luanda District, Cacuaco, dredged offshore, in sand/mud bottom, depth 15 m, 1993, colln TP 898, length 94 mm.

72 and 74 mm (figs 3-6; Hylleberg, 2004: 843). The accompanying label by S.P. Dance states: "Hanley has isolated two unmatched valves. One is unmarked the other, inferior valve is marked 'C. *costatum*' in pencil". Both are clearly in agreement with form A. Linnaeus used to mark specimens in his personal collection with the name or with a number (Dodge, 1952). Only one of the valves of the LS has a marked name in pencil, in a handwriting clearly different from that of Linnaeus. No supplementary valves are present in the collection of the Linnean Society (personal communication, Mrs K. Way).

Mr. O. Israelsson (UU) kindly presented me with photographs of Linnaean material of this taxon originating from the Museum Ludovicae Ulricaе, deposited in his institution (Linnésamlingen, 1386) consisting of one complete specimen (figs 7-8), length 91 mm, in agreement with form B. It is unmarked, except for a printed "*Cardium costatum*" label, glued on the exterior of both valves. The presence of this material is in agreement with Linnaeus (1764), with *C. costatum* listed under no. 31. Of the two accompanying handwritten labels one mentions "*costatum*"; the other "Mus. Car[o]l. XIII" (fig. 9), suggesting to originate from the Swedish / Norwegian King Charles XIII (1748-1818; also named Karl XIII, Carl XIII and in Norway Carl II), the second son of king Adolf Frederick of Sweden and Louisa Ulrica of Prussia. It also could refer to the 13<sup>th</sup> edition of Linnaeus' *Systema Natura* (Gmelin, 1791) and his Christian name: "Carl" or "Carolus".

Dodge (1952) points out that from 1789 to 1803 Prof. Olaus Swartz was the curator of the collection, that the printed labels pasted on the specimens are his work and that there never has existed a single label in the collection prepared by Linnaeus. It is evidenced by Linnaeus (1764: 483) that he must have examined a Museum Ludovicae Ulricaе *C. costatum*, and the specified rib number (11-12 elevated ribs) fits with the UU specimen; therefore the above cited specimen could well be the very same Linnaeus had in front of him when studying the collection. It is possible that he partly based his 1758 description on that particular specimen as his manuscript of the Louisa Ulrica collection was completed as early as 1754 (Dance, 1986).

It can be concluded that neither the Linnean Society valves, nor the UU specimen can unambiguously be regarded as Linnaean. At the same time it cannot be excluded at all that the valves in the Linnean Society indeed did belong to Linnaeus' personal collection and to his studied material. Therefore they should be regarded syntypical. Moreover, of all shells in the collection they uniquely fit the 1758 description.

In order to stabilise this taxon, a lectotype has to be selected. For the above mentioned reasons it is advisable to choose a specimen derived from Linnaeus' personal collection at the LS. Hence the undamaged LS left valve is hereby selected as lectotype of *C. costatum* (figs 3, 5), the remaining unmatched right valve becoming paralectotype (figs 4, 6).

When searching for available names in the literature it is evident that the number of possible synonyms is very limited.

*Cardium costatum africanum* Chemnitz, 1782 (pl. 15 figs 151-152) has 8 ribs on the median part and is unmistakably in agreement with form A. Besides, Chemnitz, 1782, is not consistently binominal and rejected for nomenclatorial purposes (Direction 1, ICZN). Bruguière, 1789, when treating *C. costatum*, only lists this name under the synonymy of *C. costatum*, which does not validate Chemnitz's name (ICZN, 1999, Article 11.5.2).

*Cardium crenatocostatum* Bronn, 1831, is based on fossil material from Italian origin. This taxon is synonymised with *C. costatum* by Fischer-Piette (1977) and Hylleberg (2004). This view cannot be upheld because Bronn (1831) points out its close affinity with the fossil *Cardium hillanum* J. de C. Sowerby, 1813, a shell which is largely covered by close-set commarginal riblets, in sharp contrast with the posterior quarter that is ornamented with well developed radial ribs. It is the type species of the Mesozoic genus *Protocardia* Von Beyrich, 1845, and known from the Cretaceous. The description of Bronn (1831), not

accompanied by a figure, mentions 'sulcis 55-60', referring to the close-set commarginal riblets, which have a dense 'crenated' appearance, hence its name.

As no other names that possibly could be linked to one of the taxa are available, it will be described as new below.

## SYSTEMATIC PART

Cardiidae Lamarck, 1809

Cardiinae Lamarck, 1809

### *Cardium* Linnaeus, 1758

Type species: *Cardium costatum* Linnaeus, 1758

#### *Cardium costatum* Linnaeus, 1758 (figs 3-6, 14-16, 19-20)

*Cardium costatum* Linnaeus, 1758: 678, no. 58; 1764: 483, no. 31; 1767: 1121, no. 73. Roux, 1828: fig. 9.

Nicklès, 1950: 196, fig. 370. Knudsen & Hylleberg, 1999: 421-422, fig. 2. De Bruyne, 2003: 265. Hylleberg, 2004: 843, top row and 922 top row.

*Cardium costatum africanum* Chemnitz, 1782: 156, pl. 15 figs 151-152 [rejected work, ICZN].

*Cardium indicum* Bruguière, in Bory de St.-Vincent, 1827: pl. 293 fig. 1a-c [not *Cardium indicum* Lamarck, 1819].

Type material. — Lectotype in the Linnean Society collection (designated above), left valve, length 72 mm (figs 3, 5). Type locality not specified by Linnaeus (1758). According to Linnaeus (1767: 1121) "in M. Africano".

Description. — Shell inflated and nearly equilateral, broadly oval, large and relatively thin-shelled, especially the intercostal spaces. Length 75–95.5 mm.

Dorsal margin nearly straight, antero-dorsal margin gently rounded. Ventral margin serrated, internally exhibiting small and narrow slits of the hollow ribs. Posterior margin strongly digitated, slightly to moderately gaping, mainly caused by the digitated margin. Rib impressions pronounced and sharply delimited, superficially developed on posterior quarter. Anterior slope: 4-6 close-set riblets, well marked, dorsal one often generally much more pronounced. Median part: 7-10 radial ribs (mean 8.73,  $n = 48$ ), interlocking, consisting of a broad base and a central part with a pointed but narrow hollow flange, all of them roughly similar sized. Ratio ribs/interstices on median part of the shell of (sub)adult specimens circa 2.5–3:1. Posterior quarter: 5-6 pronounced and solid ribs, triangular in cross-section and lacking the pointed central part. Anterior side rounded and inflated, becoming flattened or even slightly concave during ontogeny; posterior side vertical, overhanging, slightly concave and carrying a weakly developed, tiny, irregular, calcareous palisade; normally only well preserved in juveniles up to a few centimetres. On fully adult specimens, this palisade becomes marginally much more pronounced and projecting. Fine growth striae present on the whole shell, especially well visible in the interstices.

Hinge plate small, hinge with one anterior lateral, two posterior lateral and two cardinal teeth in left valve; two anterior lateral, one posterior lateral and two large, projecting cardinal teeth in right valve. Ligament short.

Exterior white, except for interstices on median part, which are rusty-brown pigmented, fading towards ontogeny. Interior white with corresponding coloured rays on 6-9 intercostae where shell resorption has taken place. Periostracum olive-green; thin, but thicker near the margins.

Distribution. — West African fauna province, ranging from Senegal to Angola (exclusively based on verified samples).

Remarks. — The largest specimen observed originates from Ghana (l. 95.5 mm, leg. W. Regter, coll. TP, fig. 16). Although it is seemingly most closely related to *C. costatum*, the smaller size and the projecting digitations of the posterior margin also recall the morphology of *Bucardium ringens* (Bruguère, 1789).

Material examined. — SENEGAL, Kayar, beach, leg. G.C. Cadée, 3.xii.1976 (ZMA/2v.). GAMBIA, leg. J. van Leeuwen, 4-10.ii.2006 (TP 2967/2v.); about 8 km SW. of Bakau, Kotu Beach, leg. G. & A. Wiepking, 26.xii.1994 (TP 2878/1v.); Brufut Beach-Tanji Bird Reserve creek, sandy beach, leg. S. van Leeuwen, 6.ii.2006 (TP 2914/1v.); Tanji Creek-Solifo Point (300 m N. up to 3 km S. of Tanji), sandy beach, leg. S. van Leeuwen, 6.ii.2006 (TP 2915/1v.); Kotu Creek-Kololi, near entrance Bijilo Forest, 4 km sandy beach, leg. S. van Leeuwen, 6.ii.2006 (TP 2916/3v.); Kotu Creek-Fajara, near rock formation, leg. S. van Leeuwen, 5.ii.2006 (TP 2913/1 v.); 25 km W. of Banjul, Badala Park, sandy beach, 4.i.1998, leg. H.P.M.G. Menkhorst (RMNH 84617/1v.). IVORY COAST, E. of Grand Bassam, Kamoé river mouth, beached, leg. A.J.M. Leeuwenberg, 7.xii.1958 (ZMA/3v.); Kamoé river mouth, leg. J.J.F.E. de Wilde, ix.1956 (ZMA/1v.). GHANA, Volta Province, 4 km N. of Anjanui, on sandbank in lagoon near the ocean surf, leg. W. Regter, 31.x.2005 (TP 2797/1v.); Volta Province, Srogbar, from fisherman, leg. W. Regter, 16.xi.2004 (TP 1942/3v.); Volta Province, Big Ada, on sandbanks in rivermouth, leg. E. Makken, 8.x.1992 (ZMA/3v.); Greater Accra Province, Accra, highly exposed, steep beach with coarse sand and pebbles, floodmark, leg. W. Regter, 14.xi.2003 (TP 1654/5v.); local fishermen (TP 2921/1p.v.). NIGERIA, Lagos, leg. L. de Priester (ZMA/3fr.); Lagos, Victoria Isl., Bar beach, leg. W. Bergmans, 27.viii.1976 (ZMA/1v.); Niger delta, leg. J.P. van der Sluis (RMNH/1v.); SE. of Port Harcourt, Opobo beach (RMNH, coll. Keij/1v.). CAMEROON, Kribi beach, leg. Mr. & Mrs. W.J.J.O. de Wilde-Duyfjes (RMNH/1v.). EQUATORIAL GUINEA, Rio Mundi, leg. M. v.d. Goes van Naters, i.1969 (RMNH, coll. Timmermans/1p.v.). CONGO BRAZZAVILLE (RMNH/1v.); (ZMA/1v.); Pointe Noire, beach, 19.xii.1972 (ZMA, coll. Bergmans/1v.). ANGOLA, Luanda, leg. A.J.P. v.d. Graaf, vi.1955 (ZMA, coll. Gravestine/3v.); Luanda area, leg. A.P. v.d. Graaf (ZMA/1p.v.); Luanda area, leg. A. v.d. Graaf, 1955-1960 (ZMA, coll. Niehe/2v.; coll. Van Pel/1p.v.); Luanda, local fishermen nets, 2005 (TP 2922/1p.v.). Unknow provenance: BMNH, LS coll./2v.

*Cardium maxicostatum* spec. nov. (figs 7-8, 10-13, 17-18, 21)

*Pectunculus* 2. 'Le Kaman', Adanson, 1757: 243-244, pl. 18, G. VI, fig. 2 [not available].

*Cardium costatum* Linnaeus, 1758; Wood, 1815: 231, pl. 56 fig. 1; 1825: pl. 5 fig. 34. Reeve, 1844: pl. 2 fig. 11. Chenu, 1862: 107, figs 483-484. Thiele, 1934: 880-881, fig. 832. Popov, 1977: 42, pl. 1 figs 1-2. Keen, 1980: pl. 4 fig. 2. Abbott & Dance, 1982: 326, fig. Bernard, 1984: 114, pl. 48 fig. a. Gofas et al., 1985: 114, pl. 48 fig. a. Savazzi, 1985: 304, fig. 7a-d. Voskuil & Onverwagt, 1989: 55-56, fig. 1.1.01, pl. 1 fig. 1. Matsukuma et al., 1991: pl. 145 fig. 10. Rodríguez & Sanchez, 1997: 251. Schneider, 2002: figs 6a, 11a, 12a, 18a. Ardevini & Cossignani, 2004: 279. Savazzi & Sälgeback, 2004: figs 1a-h, 2a-g.

Description. — Shell inflated and nearly equilateral, broadly oval, large and relatively thin-shelled, especially the intercostal spaces. Length 100-130 mm. Anterior slope: 4-8 close-set riblets, weakly developed, in some cases of unequal strength, sometimes increasingly developed towards dorsal margin. Median part: 9-13 radial ribs (mean 10.56, n = 55), interlocking, each consisting of a broad base and a central part with an extremely high,

slender and pointed hollowed flange, the posterior ones becoming gradually larger, with a central part up to circa 12 mm high (fig. 1: form B). Ratio ribs/interstices on median part of the shell of (sub)adult specimens circa 1.75–2:1. Posterior quarter: 5-6 broad, highly flattened ribs, posteriorly sculptured with a strongly developed, erect and irregular calcareous palisade. Dorsal margin straight, generally with sharp and abrupt angulation on antero-dorsal corner. Ventral margin serrated, internally exhibiting large and wide slits of the hollow ribs. Posterior margin serrated or slightly digitated, clearly gaping. Rib impressions pronounced and sharply delimited, but invisible on posterior quarter. Fine growth striae present on the whole shell, especially well visible in the interstices.

Hinge plate broad, hinge with one anterior lateral, two posterior lateral and two cardinal teeth in left valve; two anterior lateral, one posterior lateral and two large, projecting cardinal teeth in right valve. Ligament short.

Exterior white, except for interstices on median part, which are rusty-brown pigmented, fading towards ontogeny. Interior white with corresponding coloured rays on 4-7 intercostae where shell resorption has taken place. Periostracum olive-green coloured; thin, however thicker near the margins.

Holotype. — Congo Brazzaville, Pointe Indienne, from fisherman, 07.11.1972. ZMA Moll. 4.07.023 (figs 10-13); l. 117.0 mm; h. 109.7 mm; w. 96.1 mm; h. largest flange 10.8 mm.

Distribution. — West African fauna province, ranging from Mauritania to Angola (exclusively based on verified samples).

Etymology. — From the Latin words *maximus* (maximum) and *costae* (ribs), referring to the large size and the pronounced flanges on top of the ribs, both aspects much more prominent than in *C. costatum*.

Remarks. — This species appears to be more common than the preceding one: the vast majority of identifiable illustrations in the literature refers to this species and it is more often encountered in collections. However, there is no indication at all that this relates to a shallower bathymetric range.

In worn valves, the angulated edge of the antero-dorsal margin is often eroded or partly broken off, similar to what is seen in *C. costatum*.

The largest specimen observed is from unspecified West African origin (length 130 mm; coll. ZMA).

Type series and other material examined. — MAURITANIA, off Banc d'Arguin, 20°00'N 17°10'W, depth 24 m, 14.vi.1988, Tyro Mauritania-II Exp. 1988, st. MAU 076 (RMNH13270/1v., paratype); ditto, 20°00'N 17°12'W, 28 m, muddy sand, 13.vi.1988, Tyro Mauritania-II Exp. 1988, st. MAU 067 (RMNH13268/3v., paratypes); ditto, 20°01'N 17°09'W, 22 m, 14.vi.1988, Tyro Mauritania-II Exp. 1988, st. MAU. 075 (RMNH.13269/1p.v., 1v., paratypes); SENEGAL (TP 72/1p.v.); Kayar, beach, leg. G.C. Cadée, 3.xii.1976 (ZMA/13v.); Rufisque, leg. G.C. Cadée, 3.xii.1976 (ZMA/2v.); Kafountine, at low tide on sandy beach, leg. H. van Oosten, iv.1995 (TP 556/2v.); Casamance, dredged on sandy bottom, 10-20 m (ZMA Moll. 4.07.025, coll. Koekkoek/1p.v., paratype); Casamance, offshore, 10-20 m, xi.1990 (TP 2877/2p.v.); ditto, 1992 (TP 147/1p.v.); N'Gor, 1987 (TP 2876/1p.v.); Rufisque (ZMA Moll. 4.vii.024, ex coll. Dautzenberg, coll. De Priester/1p.v., paratype); M'Bao, beach, 20.08.1966 (ZMA, coll. Harmon/2v.). GAMBIA, about 8 km SW. of Bakau, Kotu Beach, leg. G. & A. Wiepking, 26.xii.1994 (TP 2880/2v.); Brufut Beach-Tanji Bird Reserve creek, sandy beach, leg. S. van Leeuwen, 6.ii.2006 (TP 2918/5v.); Tanji Creek-Solifo Point (300 m N. up to 3 km S. of Tanji), sandy beach, leg. S. van Leeuwen, 6.ii.2006 (TP 2946/7v.); Sanyang-3 km N. of Sanyang, sandy beach, leg. S. van Leeuwen, 8.ii.2006 (TP 2917/25v.); Kotu Creek-Kololi, near entrance Bijilo Forest, 4 km sandy beach, leg. S. van Leeuwen, 6.ii.2006 (TP 2916/13v.); Kotu Creek-Fajara, near rock formation, leg. S. van Leeuwen, 5.ii.2006 (TP 2919/9 v.); 25 km W. of Banjul, Badala Park, sandy beach, 4.i.1998, leg. H.P.M.G. Menkhorst (RMNH 84617/5v.). IVORY COAST, E. of Grand Bassam, Kamoé river mouth, beached, leg. A.J.M. Leeuwenberg, 7.xii.1958 (ZMA/1v.); Kamoé river mouth, leg. J.J.F.E. de

Wilde, ix.1956 (ZMA/1v.). GHANA, leg. Mrs. Hoogeveen (RMNH.107843/2p.v., paratypes); Volta Province, Ketu District, beached in high tide line, leg. W. Regter, 30.x.2005 (TP 2798/2v.); Volta Province, 4 km N. of Anjanui, on sandbank in lagoon near the ocean surf, leg. W. Regter, 31.x.2005 (TP 2879/1v.); Volta Province, Big Ada, on sandbanks in rivermouth, leg. E. Makken, 8.x.1992 (ZMA/2v.); Greater Accra Province, Accra (ZMA, coll. Gravestein/2v.); ditto, leg. R. IJzerman (RMNH/10v.). CONGO BRAZZAVILLE, Pointe Indienne, from fisherman, 7.xi.1972 (ZMA Moll. 4.07.023, coll. Bergmans/1p.v., holotype). ANGOLA (TP 444/2p.v.), Luanda District, Luanda, taken in local fishermen nets, i.1995 (TP 674/1p.v.); Luanda District, Cacuaco, dredged offshore, in sand/mud bottom, 15 m, 1993 (TP 898/2p.v., paratypes); Luanda area, leg. A. v.d. Graaf, 1955-1960 (ZMA, coll. Niehe/1v.); Benguela, Lobito (ZMA, coll. Nannings/1v.); Benguela, Lobito Bay, leg. H.W.E. Croockewit, 05.07.1957 (ZMA/3fr.). UNKNOWN COUNTRY, Gulf of Guinea, leg. H. Dabbert (RMNH, coll. Mulder/1p.v.). UNKNOWN PROVENANCE, ZMA, coll. Van Pel/1p.v.; ZMA, coll. Coomans/1v.; ZMA, coll. Koloniaal Instituut/1v.; ZMA/4p.v.; ZMA, coll. De Priester/1p.v.; RMNH, old coll./1p.v.,2v.; RMNH, coll. C. Dalen/1v.; RMNH, coll. Geol. Mus. Wageningen, ex coll. Warnsinck/2v.; UU 1386, Mus. Ludovicae Ultricae coll./1p.v.

## DISCUSSION

*Cardium costatum* auct. has a larger distribution range based on literature records than provided by the data of the material examined. The Cape Verde Is. are included by Nicklès (1950), Nordsieck (1969) and Voskuil & Onverwagt (1989). It is unknown to which of the two taxa these records refer. Material from Morocco is reported by Pasteur-Humbert (1962), but description and figure clearly refer to *C. indicum*. Both records are here considered doubtful. The 300 Cape Verde Is. stations of the CANCAP VI and VII expedition did not yield a single specimen (personal communication, J. Goud). Besides, Von Cosel (1982a) and Guerreiro & Reiner (2000) do not mention it. Von Cosel (1982b) enumerates *C. costatum* from the Cape Verde Is. using a question mark, thus indicating its questionable occurrence and referring to a nineteenth century literature record. Likewise has been done by Rodríguez & Sanchez (1997) for the Canary Islands.

Remarkably little is known about the fossil history. Gofas et al. (1985) report the abundant occurrence of casts of *C. costatum* from Luanda, Angola, dating from the Pliocene; the shells themselves being rarely found.

The large numbers of beach finds of both species strongly suggest a shallower bathymetric distribution than indicated in the literature. Thousands of valves are washed ashore in Angola after winter storms (Gofas et al., 1985). The possibility of a composite of both species cannot be ruled out. Van Leeuwen (personal communication) reports hundreds of valves from Gambia, the vast majority (circa 80-90%) belonging to *C. maxicostatum* (det. and coll. TP).

## ACKNOWLEDGEMENTS

Thanks are due to Mrs C. Hödt [Universitäts- und Landesbibliothek Sachsen-Anhalt, Halle (Saale), Germany] for making available the Bronn publication, to Messrs R.G. Moolenbeek (ZMA, Amsterdam), J. Goud and L.B. Holthuis (RMNH, Leiden) for fruitful discussions and comments on the manuscript, access to the collection and library, to Mrs V. Héros (MNHN, Paris, France) for making available the Bruguière publication, to Mrs S. Hobbs (Cape May, U.S.A.) for her hospitality and access to her collection; to Mmes K. Way and A. MacLellan (BMNH, London, U.K.) and Mr O. Israelsson (UU, Uppsala, Sweden) for sending photographs of Linnaean material of *C. costatum*; to Mrs S. van Leeuwen (Bilthoven), Mr W. Regter (Hillegom) and Mr P.L. van Pel (Egmond aan Zee) for presenting and/or donating additional material and information.

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