About the surprising presence of *Donax longissimus* Thiele & Jaeckel, 1931 (Mollusca: Bivalvia: Donacidae) in Western Sahara (Morocco): a comparison with similar E Atlantic and South African species

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Abstract: Specimens of an unknown *Donax* have recently been collected off La Sarga, Dakhla, Western Sahara, Morocco, a poorly explored area. Similar specimens were already known from South Africa. Thorough investigation has revealed that these shells belong to *Donax longissimus* Thiele & Jaeckel, 1931, a species often confused with *Donax burnupi* G.B. Sowerby III, 1894 also present in South Africa and Mozambique. In this paper *Donax longissimus* is compared with other similar species from the E Atlantic waters and *D. prolongatus* (Turton, 1932) is regarded as a junior synonym.

Abbreviations:

AFC: Association Française de Conchyliologie
CAF: Private collection of Alain Ferrant (Knokke, Belgium)
CFN: Private collection of Frank Nolf (Oostende, Belgium)
CFS: Private collection of Frank Swinnen (Lommel, Belgium)
CJV: Private collection of Johan Verstraeten (Oostende, Belgium)
CP: Private collection of G. & Ph. Poppe (Conchology, Inc)
CPV: Private collection of Paul Verstraete (Koksijde, Belgium)
CSH: Private collection of Steve Hubrecht (Heverlee, Belgium)
MfN: Museum für Naturkunde der Humboldt-Universität zu Berlin (Germany), formerly: ZMB, Zoologisches Museum Berlin, Germany
NMC: Natal Museum Collection (Pietermaritzburg, South Africa)

juv: juvenile
lv: left valve
rv: right valve
sp: specimens
sv: single valves
AP: total distance between anterior and posterior margin
BP: distance between the beaks and the posterior margin

Introduction: A group of French and Belgian shell collectors (AFC) was able to obtain several specimens of an unknown *Donax* from the local fishery using ground nets 2-5 km offshore at La Sarga, Dakhla, Western Sahara (23°45' N/15°50' W) together with specimens of *Glycymeris*, *Marginella* and *Cymbium* in October 2012 (Pl. V, Figs 32-39; Pl. VI, Figs 40-49; Pl. VII, Figs 50-55; Pl. XIV, Pl. XV and Pl. XVI). At first sight these shells seemed to belong to a so far undescribed species, living in a muddy-sand bottom at a depth of 20-25 m. Markus Huber (2015) first suggested these specimens might possibly indeed belong to an undescribed species, but later on he changed his mind and identified them as representatives of *Donax prolongatus* (Turton, 1932), a species hitherto only known from South Africa (Pl. III, Figs 21-23) and so far regarded as a synonym of *Donax burnupi* G.B. Sowerby III, 1894.

This option seemed premature without checking the exact identity of similar species and justification of their names. It seemed essential to first know the differences between several South African and E Atlantic *Donax* species, before the real identity of the Dakhla specimens could be ascertained. As a consequence, the following species were subjected to a thorough study: *D. burnupi* G. B. Sowerby III, 1894, *D. longissimus* Thiele & Jaeckel, 1931, *D. prolongatus* (Turton,1932), *D. variegatus* (Gmelin, 1791) and *D. owenii* "Gray" Hanley, 1843.

The unusual fact of a *Donax* occurring in NW Africa and the possibly disjunct presence of the same species in South African waters, have already been reported by R. von Cosel (1991). He remarked the presence of subfossil specimens of *Donax burnupi* G.B. Sowerby III, 1894 together with Recent specimens of *Donax domaini* von Cosel, 1991 in sediment with shell concentrates off the coast of Guinea. Von Cosel

states 'D. burnupi *is a species originally described from South Africa, which in the northern part of its range is now strictly confined to the zone with predominant upwelling and colder water (Mauritania, North of Senegal).*'
The shell collectors of the AFC were probably influenced by von Cosel's remarks and must have thought that the unknown *Donax* sp. collected in Dakhla were representatives of *D. burnupi* and in turn von Cosel may have been influenced by the misidentifications by other authors, as will be demonstrated in this paper. However, an investigation was soon started to check the identity of the *Donax* sp. from Dakhla and *D. burnupi* from South Africa. It was clear that both belonged to different subgenera: *D. burnupi* is a *Tentidonax* with parallel posterior oblique ridges in a usually small shell, without carina, while *Donax* sp. is a *Capsella* characterised by the glossy, smooth surface only adorned with growth lines, but lacking the typical oblique ridges on the posterior side seen in *Tentidonax*. Until the publication of the monumental work by Huber (2010) *Capsella* had been regarded monospecific: *Capsella variegata* (Gmelin, 1791) from the NE Atlantic and the Mediterranean Sea with a broader shell, smooth margins and a constant radiating cream-coloured band at about the middle of the valves (Pl. XII, Figs 94-101; Pl. XIII, Figs 102-107). Huber (2010) mentioned two synonyms of *Donax burnupi* G.B. Sowerby III, 1894 (False Bay, Port Alfred, Natal, Zululand, Mozambique) in his '5. Listing of 6250 species (version 1).xls': *Donax* (*Capsella*) *longissimus* Thiele & Jaeckel, 1931 (Algoa Bay) and *Psammotellina prolongata* Turton,1932 (juv., Port Alfred).
Another problem which had to be solved was how it is possible that a presumed endemic South African *Donax* could be present in waters surrounding the Western Sahara and not occur in the Gulf of Guinea, as hitherto no specimens belonging to this species have been recorded from NW Africa or from adjacent countries.
In the following text the specimens from Dakhla will be treated as representatives of *D. longissimus* Thiele & Jaeckel, 1931 to distinguish them from *D. burnupi* G.B. Sowerby III, 1894.

Subgenus *Capsella* Gray, 1851

Elongate-cuneate and posteriorly extended. Polished, completely smooth, only adorned with growth lines, smooth ventral margin. True laterals lacking. Similar in shape to *Tentidonax* and often confused with it. However, the characteristic oblique ridges on the posterior part, which are typical of *Tentidonax*, are absent in *Capsella*. Two species known. East Atlantic and Mediterranean.

Donax (*Capsella*) *longissimus* Thiele & Jaeckel, 1931

(Pl. I, Figs 1-9; Pl. II, Figs 10-18; Pl. III, Figs 19; Pl. IV, Fig. 28; Pl. V, Figs 32-39; Pl. VI, Figs 40-49; Pl. VII, Figs 50-55; Pl. VIII, Figs 56-67)

Original description: '*Einige Schalenklappen von Station 101 (Algoabucht) gehören in die Gruppe* Capsella *Gray, von der* D. oweni *(Gray) Hanley bei Westafrika und nach Sowerby auch bei Port Elizabeth vorkommt. Von dieser ist die vorliegende Art durch den beträchtlich längeren, glatten Hinterteil deutlich verschieden; die Oberfläche is glänzend, mit wenig auffallenden Anwachsstreifen, schwach bräunlich, mit 2 etwas dunkleren braunen Strahlen zum Unterrande, der kleine Wirbel liegt weinig hinter der Mitte, der vordere Teil verschmälert sich etwas und ist ziemlich breit abgerundet, der Unterrand flach bogig, der Hinterteil etwas eckig, der Oberrand deutlich gebogen. Die Hauptzähne sind klein, der hintere Seintenzahn ziemlich lang. Länge der gröben Schale 30 mm, Höhe 13 mm.*
Zu dieser Art gehören auch ein paar zerbrochene Schalen von Station 106 (Agulhasbank).'
Diagnosis: This is an elongate, oval, glossy shell, with the beaks at about 45/100 from the posterior end. There is no sculpture except for very thin shallow growth-lines. Buff or cream, umbones brownish, with two or three darker rays, inside fawn.
The *Donax*-shells from Dakhla and South Africa have a smooth margin with nearly invisible microscopic serrations at the inner margin of the valves and are without doubt members of the genus *Capsella*. Specimens of *Donax* s.s. have a coarsely crenulate margin. The shells of the Western Sahara *Donax sp.* are solid, wedge-shaped and equivalve, inequilateral with beaks almost in the middle of the valves slightly directed inwards. The colour is light grey or cream with three yellowish brown or olive rays radiating from the umbones, while only one posterior yellow ray - surrounded by dark brown staining - is present in *D. variegatus*. The ligament is a small dark brown arched band. The distinct cruciform muscle scars are linked by a deep pallial sinus reaching far beyond the position of the beaks the middle of the valves, nearly confluent with the pallial line.
Length: 25-36 mm; larger than *D. burnupi*.
Range: Western Sahara, Mauritania, False Bay, Port Elizabeth, Winkelspruit (KwaZulu-Natal)
Material examined: Gorée Island, Senegal, several valves from shell grit dredged at 10-20 m (CFS); Kololi Beach, Gambia, some valves from shell grit dredged at -7 m, October 2008 (CFS); La Sarga, Dakhla, Western Sahara, NW Africa, 4 sp (CFN), 7 sp (CPV) and 5 juv sp (CJV) (Pl. V,

Figs 32-39; Pl. VI, Figs 40-49; Pl. VII, Figs 50-55); Jeffreys Bay, Port Elizabeth, Cape, South Africa, 2 sv (CAF) (Pl. VIII, Figs 56-59); False Bay, Cape, South Africa, 2 sp (CP, ex coll. M. Meyer) (Pl. VIII, Figs 60-61); Winkelspruit, KwaZulu-Natal, South Africa. 6 sv (CAF) (Pl. VIII, Figs 62-67).

Discussion: This species differs from *D.* (*Tentidonax*) *burnupi* G.B. Sowerby III, 1894 by the following characteristics: a more elongated posterior side, the glossy surface, two dark brown stripes radiating from the umbones to the margins, the more central location of the umbones and the lack of sulci at the posterior end.

Specimens of *D. longissimus* from Western Sahara are larger (about 40 mm) and more solid with an obtuse anterior end, a dull surface and a deeper-coloured purplish brown interior and a yellow or orange flush under the umbones. The shape of the Dakhla specimens is less inequilateral, more rounded and the anterior dorsal border is nearly straight, not slightly concavely curved and narrowing like in *Donax burnupi.* In addition, in *D. burnupi* the pallial sinus slightly surpasses the hinge area.

Specimens of *D. longissimus* from Cape Province, South Africa are slightly smaller (30-35 mm) and have more elongated valves not broadening towards the posterior end like in the Western Sahara specimens. The interior has a lighter colour and the pallial sinus completely extends towards the middle of the valves. The shell surface is glossier and the shells are thinner. All remaining characteristics observed in shells from both areas seem to be similar.

Two single valves from Port Elizabeth (South Africa) (Pl. VIII, Figs 56-59) and several small worn valves from Winkelspruit (KwaZulu-Natal, South Africa) (Pl. VIII, Figs 62-67) belonging to the collection of Alain Ferrant (Knokke, Belgium) were also studied. Photographs of two other specimens (False Bay, CP) - labelled as *D. burnupi* – almost completely matched the Western Sahara shells (Pl. VIII, Figs 60-61).

It has to be deplored that the hand-drawn figure of *D. longissimus* by Thiele & Jaeckel (1931: plate IV, fig. 116) has caused so much confusion among other researchers of the South African DONACIDAE by creating the illusion of the presence of hypothetical oblique postero-dorsal sulci. The original description and figure by Thiele & Jaeckel are so misleading that M. Huber (2015) wrongly decided that the name *D. longissimus* was not to be applied to the unknown *Donax*. However, the photographs of the type material obtained from the MfN (Pl. I, Figs 1-9; Pl. II, Figs 10-18) clearly illustrate a ***Capsella* <u>without</u> traces of deep sulci in the posterior area, visualised as accentuated growth lines**. None of these shells show traces of postero-dorsal sulci. Moreover, the description refers to a large shell (30 mm), with an elongated smooth posterior area, typical characteristics of *Capsella*. Jaeckel & Thiele (1931) believed that *D. longissimus* and *D. owenii* both belonged to the subgenus *Capsella*. Moreover, it is possible they confused *D. owenii* (as far as known a typical West African species occurring as far south as Angola) (Pl. XI, Figs 88-93) with *Donax* (*Tentidonax*) *burnupi* from Port Elizabeth (South Africa). This supposition was already made by Barnard (1964) concerning Sowerby (1892) who earlier on probably misidentified the Port Elizabeth specimens as *owenii*. *D. owenii* has postero-dorsal sulci and a distinct posterior ridge. *D. longissimus* was often regarded as a smooth form of *D. burnupi* in the past. Barnard (1964) resurrected the name *D. longissimus* from oblivion: *'It is a little remarkable that this shell should have remained so long undescribed, if indeed it is not merely a perfectly smooth form of* burnupi*.*', and further on he demonstrates his qualities as a good observer: '*The growth-lines on the posterior part are frequently slightly enlarged, as seems to be indicated in Jaeckel's figure. But the sulci as found in* burnupi *occur across the growth-lines, and when present are immediately noticeable.*' Further on we learn from the text that both species can be found together at the same localities.

***Donax* (*Capsella*) *variegatus* (Gmelin, 1791)**
(Pl. XII, Figs 94-101; Pl. XIII, Figs 102-107)

Diagnosis: The shell is solid, wedge-shaped and equivalve. Inequilateral, with the beaks in the posterior half directed inwards and backwards. Somewhat triangular in outline with the margins to the beaks straight. The sculpture consists of fine, inconspicuous concentric lines. The growth stages are sometimes very obvious. The right valve has two cardinal teeth of which the posterior one is stout and bifid and the anterior one is short and ridge-like, two posterior and one anterior lateral. The left valve possesses two cardinal teeth of which the anterior one is indistinctly bifid and one weak anterior and one posterior lateral tooth. The margins are smooth to the touch with microscopic serrations on the inside of the valves, only visible when using a magnifying lens or a high-powered binocular.

The colour is light yellow or olive, sometimes flecked with cream and one prominent yellow ray accentuated by reddish brown borders radiating from the umbones, which are occasionally stained in reddish orange or bluish purple. The interior of the shell is completely (seldomly partially) stained with dark brownish violet and there is often a deep orange blush on a white

background behind the umbones. A special characteristic is the small violet blotch in the posterior part of the hinge, just at the ligament position. The periostracum is glossy olive or light brown and the ligament is restricted to a small dark brown arched band.

Length: rarely larger than 3.5-4 cm.

Range: south and southwest of the British Isles, the Channel Islands, from Normandy and Brittany (France) through the Bay of Biscay, along the Iberian Peninsula into the Mediterranean Sea and south along the Atlantic coast of Morocco.

Material examined: The English Channel. Trawled by Belgian fishermen. 1 sp (CFN); Granville, Normandy, France. In sand at rising tide. April 2003, August 2005, August 2007. 139 sp (CFN) (Pl. XII, Figs 94-101; Pl. XIII, Figs 102-103); Plage Goas Treiz, Trébeurden, Brittany, France. In sand at extreme low tide. July 1974. 1 sp (CFN) (Pl. XIII, Figs 104-105); Palamos, Spain. Trawled by fishermen. July 1995. 1 sp (CFN) (Pl. XIII, Figs 106-107); Estartit, Gerona, Spain. Trawled by fishermen. 1973. 1 sp (CFN); Vourvourou, Sithonia, Greece. In sand among *Posidonia*. Dived at a depth of 8 m. August 1994. 6 sp (CFN).

Discussion: The position of the beaks compared to the anterior and posterior ends corresponds to that of *D. longissimus*, but on the other hand the pallial sinus is nearly twice as deep as in *D. longissimus* where the much shorter pallial sinus does not surpass the hinge area. Fresh specimens of *D. variegatus* possess a glossy yellow periostracum, whereas the periostracum in the Dakhla species is dull and much paler. Measurements are comparable, about 3.5-4 cm in adult specimens.

Subgenus *Tentidonax* Iredale, 1930

Small and fragile shell. Close to *Machaerodonax* in posterior oblique ridges, but without carina, ovate rounded shape. Weak laterals. Approximately 8 species in West Africa, the Indian Ocean and adjacent areas: *T. aperittus* (Melvill, 1897) (Indian Ocean), *T. bertini* (Pilsbry, 1901) (South and E Africa), *T. burnupi* (Sowerby, 1894) (South Africa and Mozambique), *T. domaini* (von Cosel, 1995) (W Africa), *T. francisensis* Cotton & Hedley, 1838 (S Australia), *T. kiusiuensis* (Pilsbry, 1901) (Japan), *T. owenii* ("Gray" Hanley, 1843) (W Africa), *T. veruinus* (Hedley, 1913) (NE Australia).

Donax (*Tentidonax*) *burnupi* G.B. Sowerby III, 1894

(Pl. III, Fig. 20 & 24-26; Pl. IV, Figs 27 & 30; Pl. IX, Figs 68-75; Pl. X, Figs 76-85; Pl. XI, Fig 86-87)

Original description: '*Testa elongate, angusta, leviter flexuosa, pallide fulva, obscure fusco radiata, polita; area postica sulcata, sulcis numerosis profundis oblique sub-verticalis. Margo dorsalis anticus longus, rectiusculus, leviter declivis, posticus brevis, rotundatus. Cardo normalis. Pagina interna albida, utrinque violaceo tincta.*

Antero-post. 26, umbono-marg. 12 millim.

Hab. Natal (Burnup).

At first sight this shell resembles the European D. politus *but it is distinguished by the remarkable posterior sulci*.'

Diagnosis: It concerns a smooth, oval, elongate shell, with deep oblique postero-dorsal sulci crossing the growth-lines, 8-10 on shells of 15-20 mm, 12 on a shell of 27 mm long. The umbo is at about 2/5 from the rounded posterior end. Externally buff, fawn or pale yellow coloured with brown rays; internally creamish white or fawn tinged with violet or with an orange flush in the middle. Both ends may be violaceous.

Length: 20-27 mm; smaller than *D. longissimus*.

Range: Western Sahara, Mauritania, False Bay and Still Bay, Port Alfred, Port Elizabeth, KwaZulu-Natal.

Material examined: False Bay, Western Cape, South Africa. Dived at 20 m. In sand. March 1986. 2 sp (CP, ex coll. M. Meyer) (Pl. X, Figs 80-81); Glencairn swimming pool, False Bay, Western Cape, South Cape, South Africa. January 1974. Leg. C. Connolly. 1 sp (CFN), ex coll. Natal Museum, MOLLUSCA, N° A1748 (Pl. IX, Figs 74-75); Durban, KwaZulu-Natal, South Africa. Collected from reclamation dump sand dredged off The Bluff at a depth of 18-20 m. Leg. R. Kilburn & D. Herbert (25-26 August 1984). 3 sp (CFN, ex coll. Natal Museum, MOLLUSCA, N° B8971) ((Pl. IX, Figs 68-73; Pl. X, Figs 84-85); Jeffreys Bay, Port Elizabeth, Cape, South Africa. Dredged at a depth of 70 m. 12 March 1999. 3 sp (CSH) (Pl. X, Figs 82-83); Buffels Bay, False Bay, Western Cape, South Africa. Dredged in sand and rubble bottom at a depth of 15-20 m. November 1988. 1 sp (CSH, ex coll. De Bruin) (Pl. X, Figs 76-79); Sunny Cove, False Bay, Western Cape, South Africa. Dived in sand at a depth of 20 m. March 1986. 1 sp (CSH, ex coll. M. Meyer); off Durban Bluff, KwaZulu-Natal, South Africa. In sand dredgings off Bayhead Dump. March 1982. 1 sp CSH (ex coll. M. Meyer); Addington Beach, Durban, KwaZulu-Natal, South Africa. In sand dredgings. 20 September 1993. 1 sp (CSH).

Discussion: The description and figures of *Donax burnupi* by Kilburn & Rippey (1982) (pl. 43, fig. 6; Pl. III, Fig. 26 in this paper) cause a lot of confusion with anybody who wants to identify South African *Donax* shells. It is not evident when terms such as '*posterior end produced,*

tapering and rounded', '*with or without a series of weak, oblique grooves*' refer to any of the treated species because the authors regard them as two forms of the same species, only differentiated by the presence or absence of postero-dorsal grooves. One argument seems to be the '*occurrence in the same population*'. Although it is difficult to judge from the quality of drawings, it appears their figs 6a, b & c on plate 43 (Pl. III, Figs 26a, b & c) refer to *D. burnupi* and fig. 6d (Pl. III, Fig. 26) to *D. longissimus*.

Confusion was caused again by Steyn & Lussi (1998) (Pl. IV, Fig. 27) The description refers to two different species (*D. burnupi* and *D. longissimus*), especially because they mention '*sometimes with oblique grooves on posterior margin*'. On the other hand the figure is an excellent example of *D. longissimus* (BP/AP=0.436). This observation was confirmed by Huber (2015) '*oblique grooves on posterior and deep sinus match* burnupi, *but their illustrated rounded-elongate, subequilateral species with a smooth posterior slope is very similar to the Dakhla specimens*'. The same mistake was made by Steyn & Steyn (1999) (Pl. IV, Fig. 29) who illustrate *D. burnupi* by means of a specimen of *D. longissimus* (BP/AP=0.464). The figure of *D. longissimus* by Richards (1981) is adequate.

Huber (2010) first regarded 'typical' *D. burnupi* and 'typical' *D. longissimus* as two separate species in his discussion based upon '*more and weaker oblique striae*' in the posterior part of the latter. I do not agree with his conclusion that older specimens nearly completely miss these grooves and show them as growth lines, only. Neither juvenile nor adult specimens of *D. longissimus* possess postero-dorsal sulci, a distinct characteristic in all specimens of *D. burnupi*, either juvenile or adult. It is surprising that Huber followed Steyn & Lussi (1998), who only mentioned *D. burnupi* and figured it with a suitable picture of a typical *D. longissimus*, a specimen considered as '*quite in between these two extremes*' by Huber. Huber (2010) synonymised *D. longissimus* with the older *D. burnupi*. In 2015 he changed his opinion and he introduced the name *D. prolongatus* (Turton, 1932) as the correct name for the Western Sahara specimens (Huber, 2015), degrading the name *D. longissimus* Thiele & Jaeckel, 1931 to a junior synonym of *D. burnupi*.

Psammotellina (*Tentidonax*) *prolongata* Turton,1932

(Pl. III, Fig. 21-23)

This species is most similar to the *Donax* from Dakhla and the specimens from South Africa known as *D. longissimus*. Here follows the short original description: '*The* shape *of the shells is very narrowly oval, with a straight dorsal margin behind the umbone, which is about one-third of the distance from the anterior end. The posterior end is long and slightly pointed; the* surface *is smooth; the* colour *white; and the size 3.5 x 8 mm.* Characteristics*. This is very thin and narrow, so it is easily recognized. I only found 2 opposite valves, and am taking the larger as the type*.'

Locus typicus: Port Alfred, South Africa.

Discussion: Huber (2015) decided that the name *Donax* (*Capsella*) *prolongatus* (W.H. Turton, 1932) had to be applied to representatives of the unknown *Donax* sp. from both Dakhla and South Africa. This name was first erroneously synonymised with *D. burnupi* (Huber, 2010). It already looked rather risky to apply the name of a worn, very juvenile specimen (8 mm!) to large, live-caught, adult specimens from NW Africa. The figure of one of the valves of *Psammotellina prolongata* (in: Turton, fig. 1779; in this paper: Pl. III, Fig. 21) shows traces of postero-dorsal sulci and the BP/AP ratio of resp. 0.391 and 0.382 (Table I) unequivocally refers to *D. burnupi.* Finally, *Donax prolongatus* (W.H. Turton, 1932) has to be treated as a junior synonym of *Donax burnupi* G.B. Sowerby III, 1894.

Donax (*Tentidonax*) *owenii* "Gray" Hanley, 1843

(Pl. XI, Figs 88-93)

Diagnosis: Fragile shell with very elongated valves, tapering but slightly rounded in the anterior part. The posterior part has fine oblique grooves and a typical distinct ridge. Umbones more posterior than in the other treated West African *Donax* species. Shell surface smooth and shiny. Colour from light cream to yellow with three wide light brown rays from the umbones to the lower margins. Interior of valves tinged with an orange blush.

Length: 18-25 mm.

Range: Mauritania, Senegal, Guinea-Bissau, Benin, Gabon, Angola

Material examined: Cacuaco Bay, Luanda, Angola. In fine muddy bottom. Dredged at a depth of 13 m. February 1990. 1 sp (CFN) (Pl. XI, Figs 88-89); Ile Banié, Gabon. 00°49' N/ 09°25' E. In sand on intertidal sandbar. 23 sp (CFN); Pointe Sarène, Senegal. Trawled by local fishermen at a depth of 4 m. November 1976. 2 sp (CFN) (Pl. XI, Figs 90-93); Punta da Jandia, Fuerteventura, Canary Islands. Dredged among shell grit at a depth of 200 m. 1971. 2 sp (CFN).

Discussion: This species differs from other West African *Donax* species by its very narrow, elongated outline, the postero-dorsal sulci, the distinct posterior ridge and the position of the

beaks very near the posterior end, resulting in an average BP/AP ratio of 0.377.

Conclusion: The *Donax*-shells from Dakhla (Western Sahara) possess the same shell characteristics as *Donax* (*Capsella*) *longissimus* Thiele & Jaeckel, 1932, a species hitherto thought to be endemic to the South African molluscan fauna. In literature, there is much confusion about that species: it is often confused with *Donax* (*Tentidonax*) *burnupi* G.B. Sowerby III, 1894, a South African species occurring from False Bay, Port Alfred, KwaZulu-Natal to Mozambique. *D. longissimus* mainly differs by its more tapering posterior area with the umbones at 3/5 from the posterior end, smooth surface with brown radiating rays, glossy interior, suffused with violet, yellow or brown. *Donax burnupi* is smaller with a less tapering posterior side (umbones at 2/5 from the posterior end) and provided with parallel postero-dorsal sulci.

A handy diagnostic tool is the use of the BP/AP ratio, this means the ratio between the distance beaks-posterior end and the distance between anterior and posterior end. This reveals to be a rather constant value to evaluate the difference between the two species involved, not only in the same population - even in a sample of juvenile specimens - but even in very remote localities. A comparison of the ratio of 0.453 in our specimens with the ratio in the type material of *D. longissimus* (0.444) together with the ratio in specimens of *D. burnupi* (0.384) once more proves the conclusions reached in this paper.

Another characteristic is the nature of the pallial sinus: in *D. longissimus* it generally hardly reach the position of the umbones, in contrast with *D. burnupi* where the pallial sinus extends beyond this position and with *Donax variegatus* where it always completely reaches the anterior part of the valves.

The name *Donax prolongatus* (Turton, 1932) (= *Psammotellina prolongata*) used by Huber (2015) refers to a very short description only based on two worn opposite valves of very juvenile specimens. The postero-dorsal sulci visible in one of the original figures by Turton and the BP/AP ratio (average: 0.382) unequivocally refers to *D. burnupi*. So, the name *Donax prolongatus* (Turton, 1932) must be regarded as a junior synonym of *Donax burnupi* G.B. Sowerby III, 1894. Two different forms of *Donax burnupi* are often mentioned in literature when actually two really different species are involved. I estimate this discussion can be closed from now on. Another question is: do specimens of *Donax longissimus* from Dakhla and South Africa really belong to the same species or do they constitute separate subspecies? Although the two populations slightly differ in a few characteristics, shells from both areas generally show a nearly complete similarity. Not enough differences can be observed to establish separate taxa. More evidence could possibly arise when live caught specimens of *D. longissimus* are collected in adjacent West African waters. Unfortunately, this could be wishful thinking as a result of the following records. Research into the molluscan fauna of soft sediments from the tropical, upwelling-influenced shelf in the Golfe d'Arguin, Mauritania and off Western Sahara (Le Loeuff & von Cosel, 1998; Michel, 2010; Michel et al., 2011) revealed the occurrence of thousands of valves of a so-called '*Donax burnupi*'. In fact the samples contain two different *Donax* species. This becomes clear after a careful look at the figures of sediment samples and a study of the position of the pallial sinus, the presence or absence of postero-dorsal sulci and a comparison of the BP/AP ratio: *D. longissimus* (0.440; 0.446; 0.430; 0.454; 0.432) and *D. burnupi* (0.379; 0.386; 0.404; 0.404) (Michel, 2010). *D. longissimus* even seems to be the most abundant of the two *Donax* species in rubble containing more than 75% empty shells or shell debris.

Donax shells are preserved as clean, variably fragmented and abraded shells with numerous cm-sized, entire valves. Accumulations of *Donax* shells indicate swell-exposed, subtidal water depths. *Donax* rubble is found where winnowing and sediment remobilisation occur in the northern-half of the Golfe d'Arguin; related to tropical-subtropical, high-energy and high-nutrient waters. *Donax* specimens are phytoplankton feeding organisms and are well adapted to high-nutrient environments such as upwelling areas, living from low tide to -40 m in fine sand to gravel, The molluscan fauna is overwhelmingly dominated by the two *Donax* species (10-96% of the total abundance). Living specimens are not found, but extensive deposits of fresh uneroded material have accumulated on the northern part of Golfe d'Arguin, where the broad shelf faces the swell coming from a northwestern direction. Species of *Donax* are known to be the dominant bivalves in high-energy, sandy beaches and shallow subtidal sandflats under highly productive, tropical to subtropical conditions. When high trophic resources (i.e. phytoplankton) related to upwelling, and a tropical to subtropical climate become absent carbonate production occurs. Shoreward of the sample location, on the outer part of the Banc d'Arguin, no accommodation space is available, The eroded *Donax* shells are thought to be transported by the interaction of an upwelling system by wind-induced surface currents, maritime and continental trade winds, the Canary Current from the north and the Guinean Current in the south. Further south the

abundance of *Donax* shells and fragments decreases. They show more intense erosion than the fresh-looking shells in the swell-exposed area. These shells are thought to be transported across the entire gulf and are deposited seaward of the Banc d'Arguin down to some 50 m. So, it can be expected the end of the geographic distributional range is in the north of the Golfe d'Arguin (20° N, 17° W). The *Donax* samples are probably transported in southwestern direction by the subtropical North Atlantic gyre when the Canary Current detaches from the African coast in Western Sahara, where the living population is concentrated. A same way of thinking can be used to explain why no live specimens of *D. burnupi* and *D. longissimus* have been recorded from Angolan and Namibian waters, where the Benguela upwelling from Gabon to southern Angola meets the cold current from South Africa. So, both *D. longissimus* and *D. burnupi* seem to have a disjunct distribution.

Ackowledgements: I want to thank several persons who were so kind as to offer their cooperation in preparing this paper: Alain Ferrant (Knokke, Belgium) for providing valves of *Donax longissimus* from South Africa and useful information on the tropical shelf of NW Africa, Matthias Glaubrecht and especially Christine Zorn (MfN, Germany) for providing photographs of the type material of *Donax longissimus*, Rika Goethaels & Fernand De Donder (Peutie, Belgium) for offering specimens of *D. longissimus* and a series of excellent photographs from Western Sahara, Jan Haspeslagh (Oostende, Belgium) for giving access to the impressive library of the VLIZ (Vlaams Instituut voor de Zee, Oostende, Belgium), Dai Herbert (NMC) for supplying specimens from the Cape and KwaZulu-Natal, Markus Huber (Winterthur, Switzerland) for his interesting comments, Steve Hubrecht (Heverlee, Belgium) for the loan of specimens of *Donax burnupi*, Philippe Poppe (Conchology, Inc) for sending pictures of *D. burnupi* from the M. Meyer collection, Johan Verstraeten (Oostende, Belgium) for his critical remarks and last but not least David Monsecour (Aarschot, Belgium) as a faithful corrector of the English text.

References

Barnard, K.H., 1964. Contribution to the knowledge of South African marine mollusca, Part V: Lamellibranchiata. *Annals of the South African Museum*, **47**(3): 361-593.

Cosel, R. von, 1995. Fifty-one new species of marine bivalves from tropical West Africa. *Iberus*, **13**(1): 1-115.

Huber, M., 2010. *Compendium of Bivalves*. ConchBooks, Hackenheim. 901 pp + 5. Listing of 6250 species (version 1).xls

Huber, M., 2015. *Compendium of Bivalves 2*. ConchBooks, Harxheim. 907 pp. + CD: A Systematic Listing of 8,500 Bivalve Species and 10,500 Synonyms.

Kilburn, R. & Rippey, E., 1982. *Sea Shells of Southern Africa*. Macmillan Publishers, Johannesburg, South Africa. 249 pp.

Le Loeuff, P. & Cosel, R. von, 1998. Biodiversity patterns of the marine benthic fauna on the Atlantic coast of tropical Africa in relation to hydroclimatic conditions and paleogeographic events. *Acta Oecologica*, **19**: 309-321.

Michel, J., 2010. *Heterozoan carbonate sedimentation on a eutrophic, tropical shelf of Northwest Africa (Golfe d'Arguin, Mauritania)*. Thesis. 142 pp.

Michel, J., Westphal, H. & Cosel, R. von, 2011. The mollusk fauna of soft sediments from the tropical, upwelling-influenced shelf of Mauritania (Northwestern Africa). *Palaios*, **26**: 447-460.

Richards, D., 1981. *South African Shells. A collector's guide*. Struik Publishers, Cape Town. 98 pp. 60 pls.

Sowerby, G.B. III, 1892. *Marine shells of South Africa. A catalogue of all the known species with references to figures in various works, descriptions of new species, and figures of such as are new, little known, or hitherto unfigured*. Sowerby, London. 89 pp.

Sowerby, G.B. III, 1894. Marine shells of South Africa. *Journal of Conchology*, **71**: 368-378.

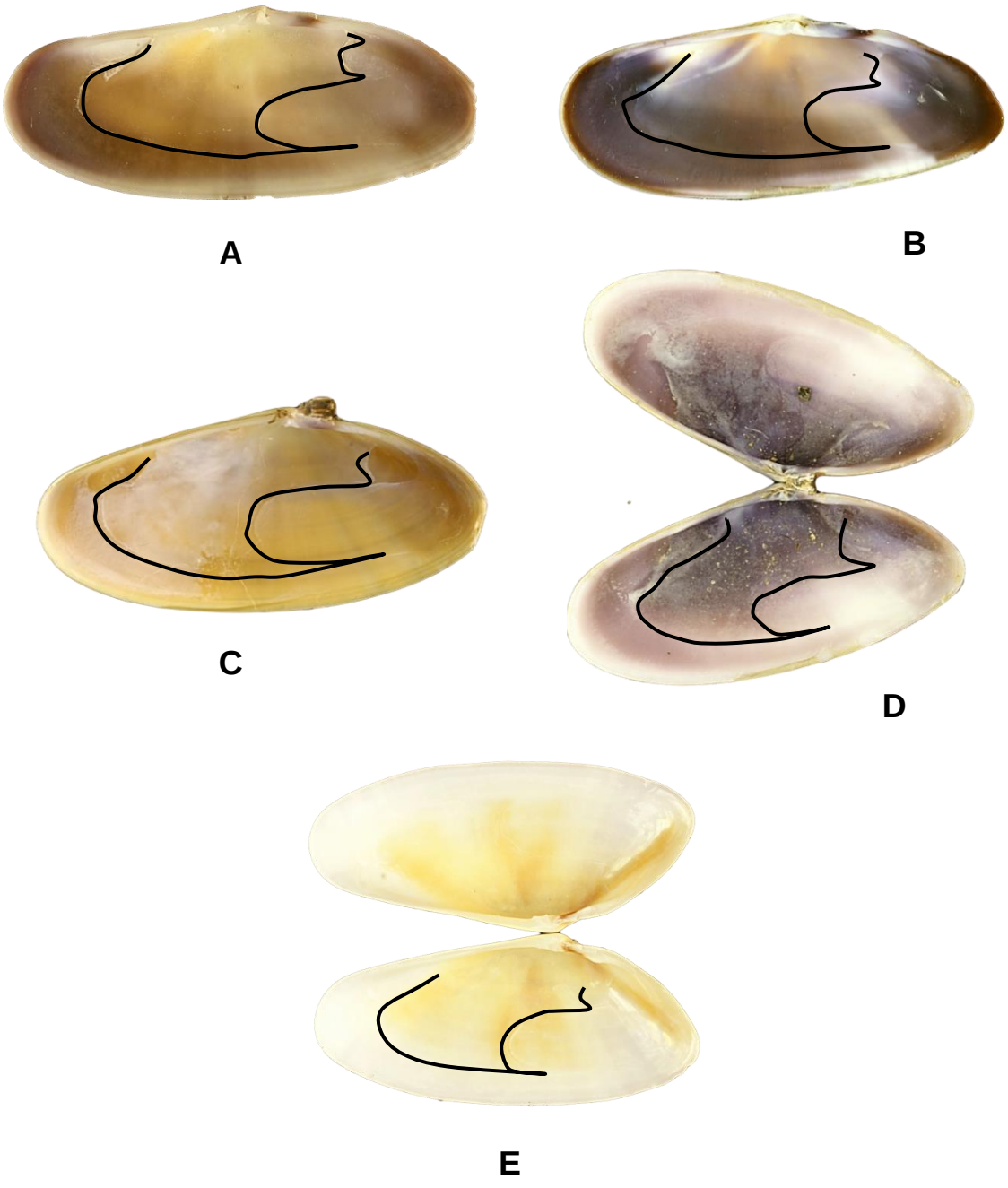
Steyn, D.G. & Lussi, M., 1998. *Marine Shells of South Africa. An illustrated collector's guide to beached shells.* Ekogilde Publishers, Hartbeespoort, South Africa. 264 pp.

Steyn, D.G. & Steyn, E.J., 1999. *The Sea Shells of Jeffreys Bay*. Eldolise Publishers, Pietermaritzburg. 89 pp.

Tebble, N., 1976. *British Bivalve Seashells*. Edinburgh. 2nd ed. 212 pp.

Thiele, J. & Jaeckel, S.G.A., 1931. Muscheln der Deutschen Tiefsee-Expedition. In: C. Chun, ed. *Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898-1899*, XX(1). Gustav Fischer, Jena. pp 161-268, plates VI-X

Turton, W.H., 1932. *The Marine Shells of Port Alfred*, *S. Africa*. Oxford University Press, London. 331 pp, 70 pls.



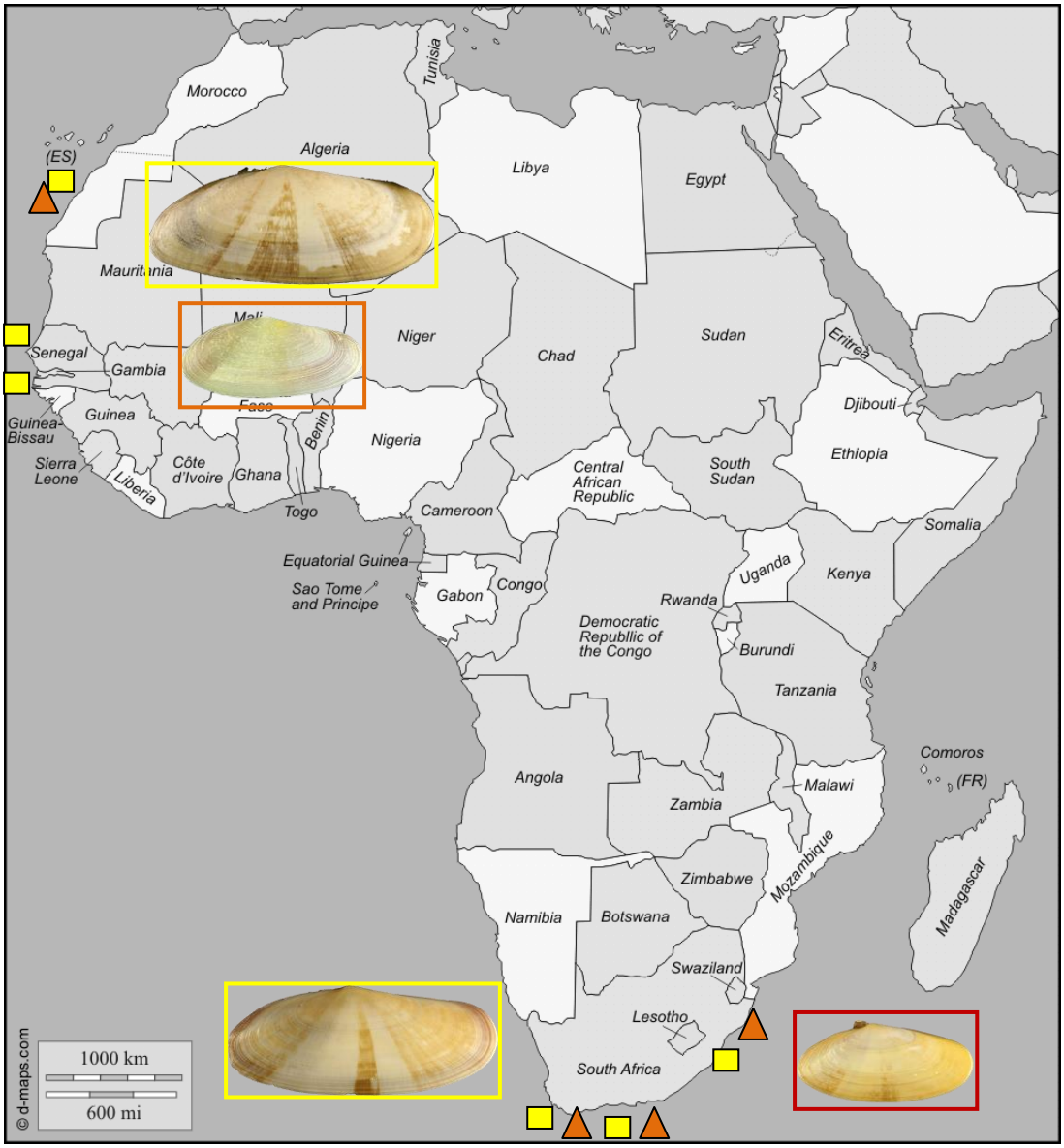
Comparison of the position of the pallial sinus in relation to the beaks: A: *Donax longissimus* South Africa; B: *D. longissimus* Western Sahara; C: *D. burnupi* South Africa; D: *D. variegatus* France; E: *D. owenii* Senegal

***Donax longissimus*: BP/AP ratio**							
							average
Dakhla	0.465	0.473	0.470	0.464	0.454	0.470	0.466
Dakhla: juv sp	0.446	0.468	0.443	0.450	0457		0.453
Port Elizabeth	0.450	0.450					0.450
False Bay	0.430	0.449					0.439
Total average							**0.453**
***Donax burnupi*: BP/AP ratio**							
							average
Huber	0.370						0.370
Durban	0.426	0.424	0.407	0.393			0.413
Port Elizabeth	0.358	0.360					0.359
Buffels Bay	0.370						0.370
False Bay	0.405	0.415					0.410
Total average							**0.384**

***Donax longissimus*: type material Algoa Bay, "Valdivia" Expedition, St. 101 - BP/AP ratio**							
111636_sh1-A							0.438
111636_sh1-B							0.425
111636_sh1-C							0.466
111636_sh1-D							0.446
Total average							**0.444**

***Donax prolongatus*: figures of type material Port Alfred, South Africa**							
Fig. 1779							0.391
Fig. 1789							0.382
Total average							**0.387**

Table I: comparison of the BP/AP ratio of the different studied specimens (ratio of the distance between beaks and posterior end and the distance between anterior and posterior end)



Geographic distribution of *Donax longissimus* Thiele & Jaeckel, 1931 ( ) and *Donax burnupi* G.B. Sowerby, III, 1894 ( )

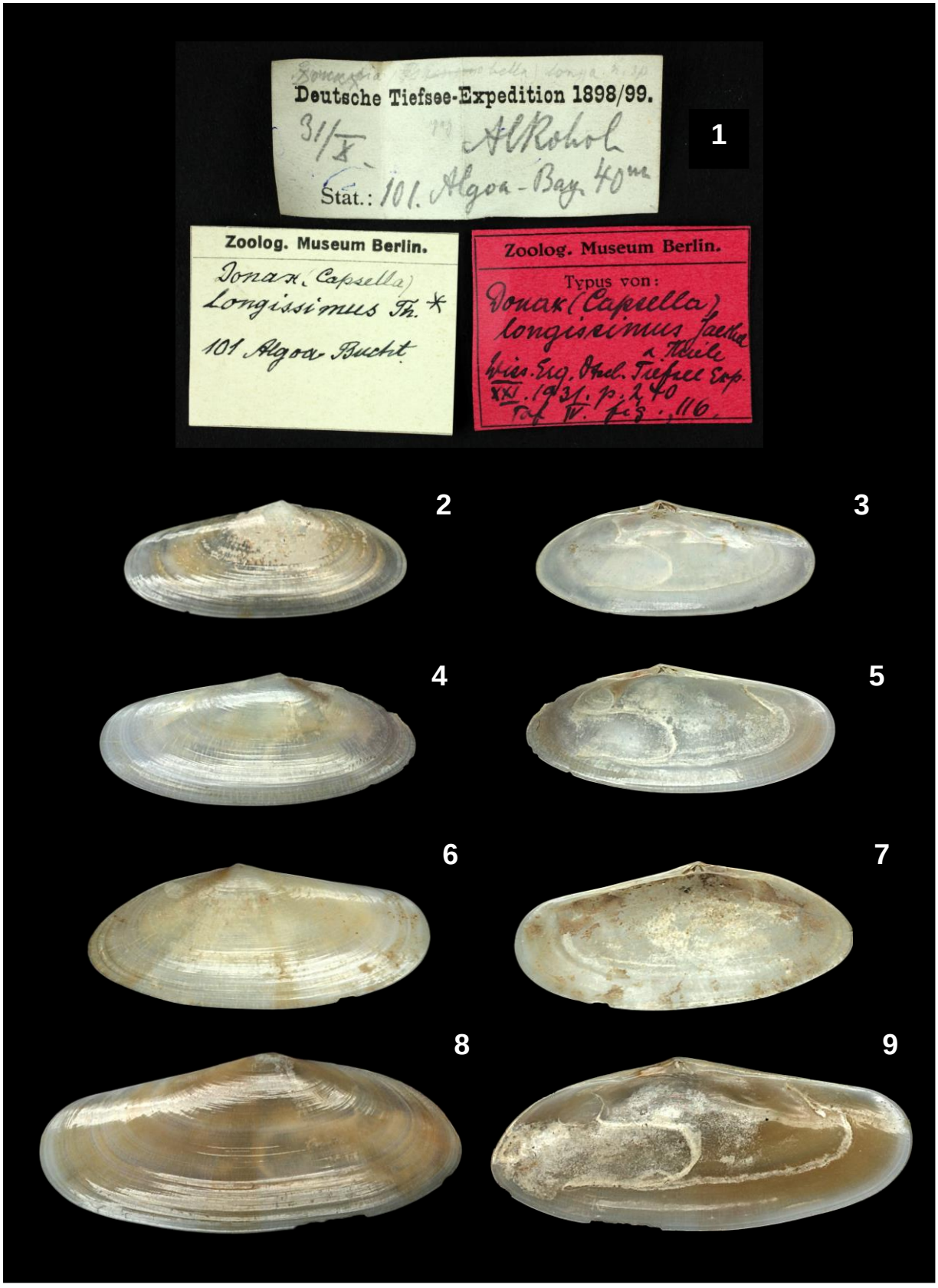


Plate I. Figs 1-9: *Donax longissimus* Thiele & Jaeckel, 1931. Algoa Bay. "*Valdivia*" Expedition 1898-1899, St. 101. Dredged at a depth of 40 m. Type specimens, MfN, 111636; 2-3: H. 8.21 mm L. 19.41 mm; 2: lv; 3: interior lv; 4-5: H. 9.32 mm L. 21.88 mm; 6-7: H. 10.28 mm L. 22.50 mm; 8-9: H. 12.04 mm L. 29.07 mm.

Plate II. Figs 10-18**.** *Donax longissimus* Thiele & Jaeckel, 1931. Agulhas Bank, South Africa. "*Valdivia*" Expedition 1898-1899, St. 106. Dredged. MfN, 111637; 11-12: H. 4.16 mm L. 8.03 mm; 13-14: H. 6.79 mm L. 14.98 mm.

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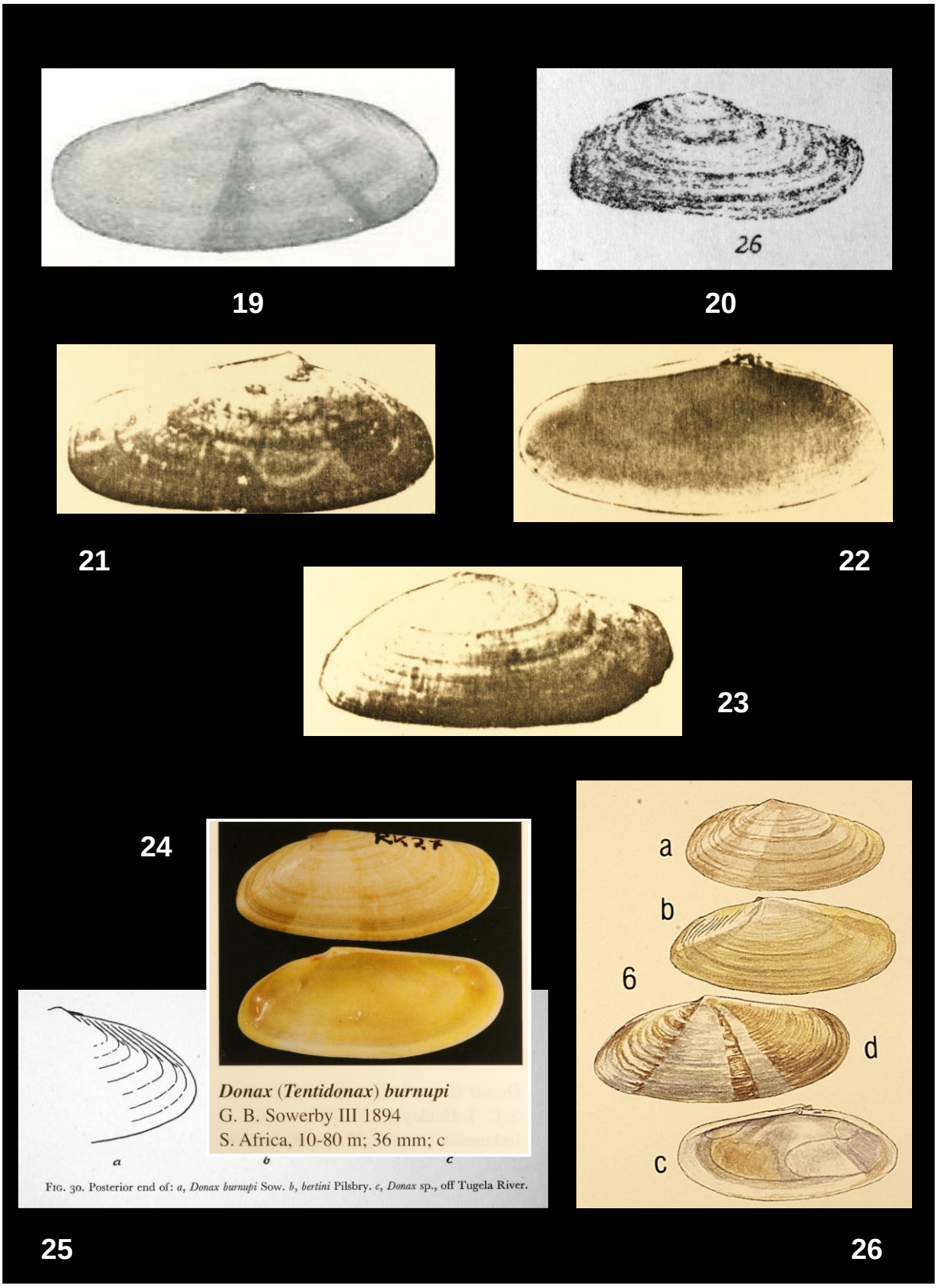

Plate III. Fig. 19: *Donax longissimus* Thiele, J. & Jaeckel, S., 1931. *Muscheln der Deutschen Tiefsee Expedition. Wiss. Ergebn. 'Valdivia',* Pl. IX, fig. 116; Fig. 20: *Donax burnupi* G.B. Sowerby III, 1894. Marine shells of South Africa. *Journal of Conchology*, **71**, Pl. 6, fig. 26; Fig. 21-23: *Psammotellina prolongata* Turton, W.H., 1932. *The Marine Shells of Port Alfred*, *S. Africa*. Pl. LXVIII; 21-22: fig. 1779; 23: 1789; Fig. 24: *Donax burnupi* Sowerby, 1894, from: Huber, M., Compendium of Bivalves, 2010; Fig. 25: *Donax burnupi* Sow., 1894, from: Barnard, K.H., 1964. *Annals of the South African Museum*, vol. XLVII, part III, p.530, fig. 30; Fig. 26: *Donax burnupi* Sowerby, 1894, from: Kilburn, R. & Rippey, E., Sea Shells of Southern Africa, 1982, plate 43, fig. 6a: *Donax burnupi* KwaZulu-Natal; fig. 6b-c: *Donax burnupi* Cape, RSA; fig. 6d *Donax longissimus*.

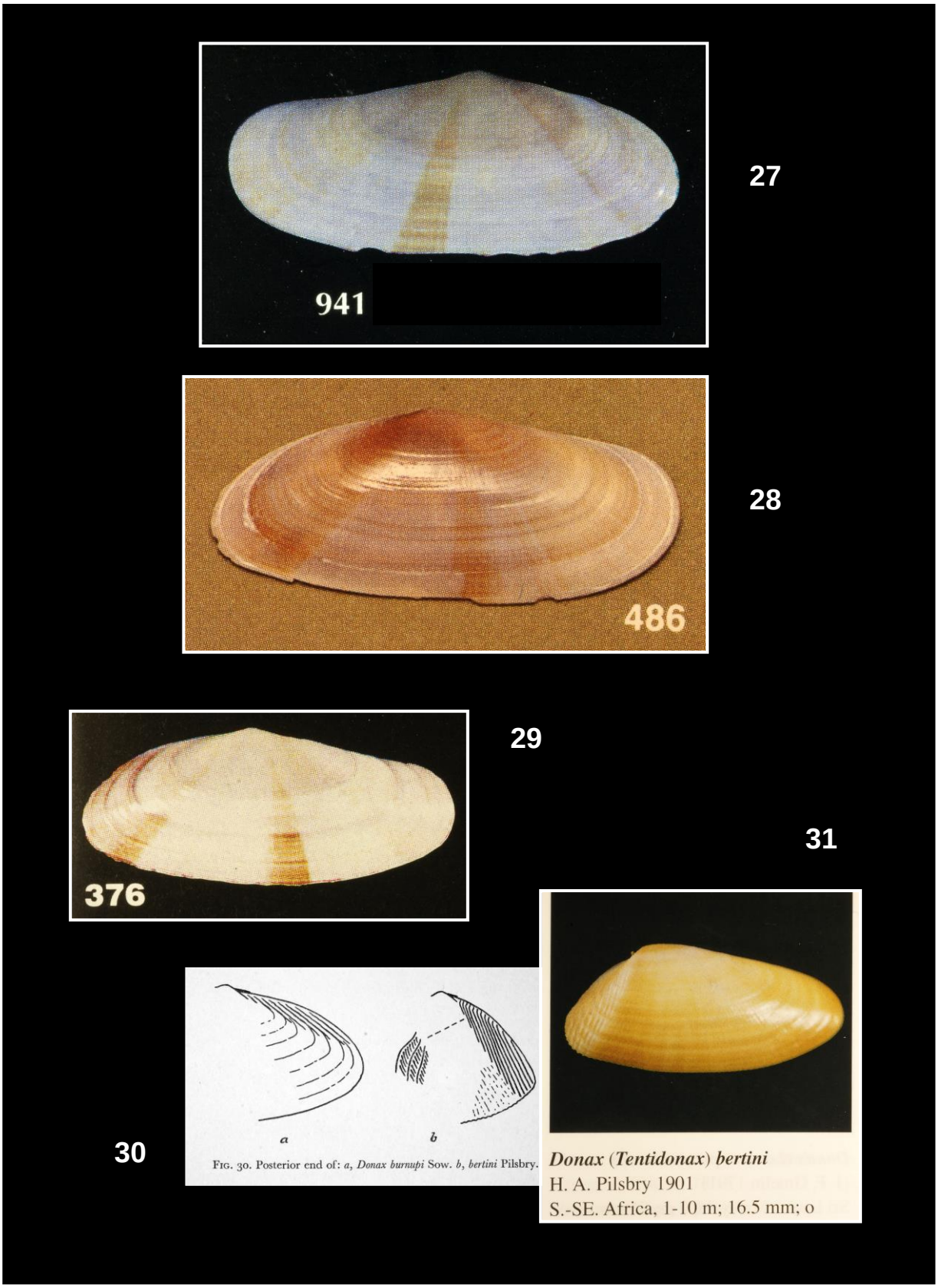

Plate IV. Fig. 27: "*Donax burnupi*" (in casu: *Donax longissimus*), from: Steyn, D.G. & Lussi, M., 1998. *Marine Shells of South Africa. An illustrated collector's guide to beached shells*, fig. 941; Fig. 28: *Donax longissimus*, from: Richards, D., 1981. *South African Shells. A collector's guide*, plate 54, fig. 486; Fig. 29: "*Donax burnupi*" (in casu: *D. longissimus*), from: Steyn, D.G. & Steyn, E.J., 1999. *The Sea Shells of Jeffreys* Bay, fig. 376; Fig. 30: *Donax burnupi* & *D. bertini*, from: Barnard, K.H., 1964. *Annals of the South African Museum*, vol. XLVII, part III, p.530, fig. 30; Fig. 31: *Donax bertini* Pilsbry, 1901, from: Huber, M., Compendium of Bivalves, 2010

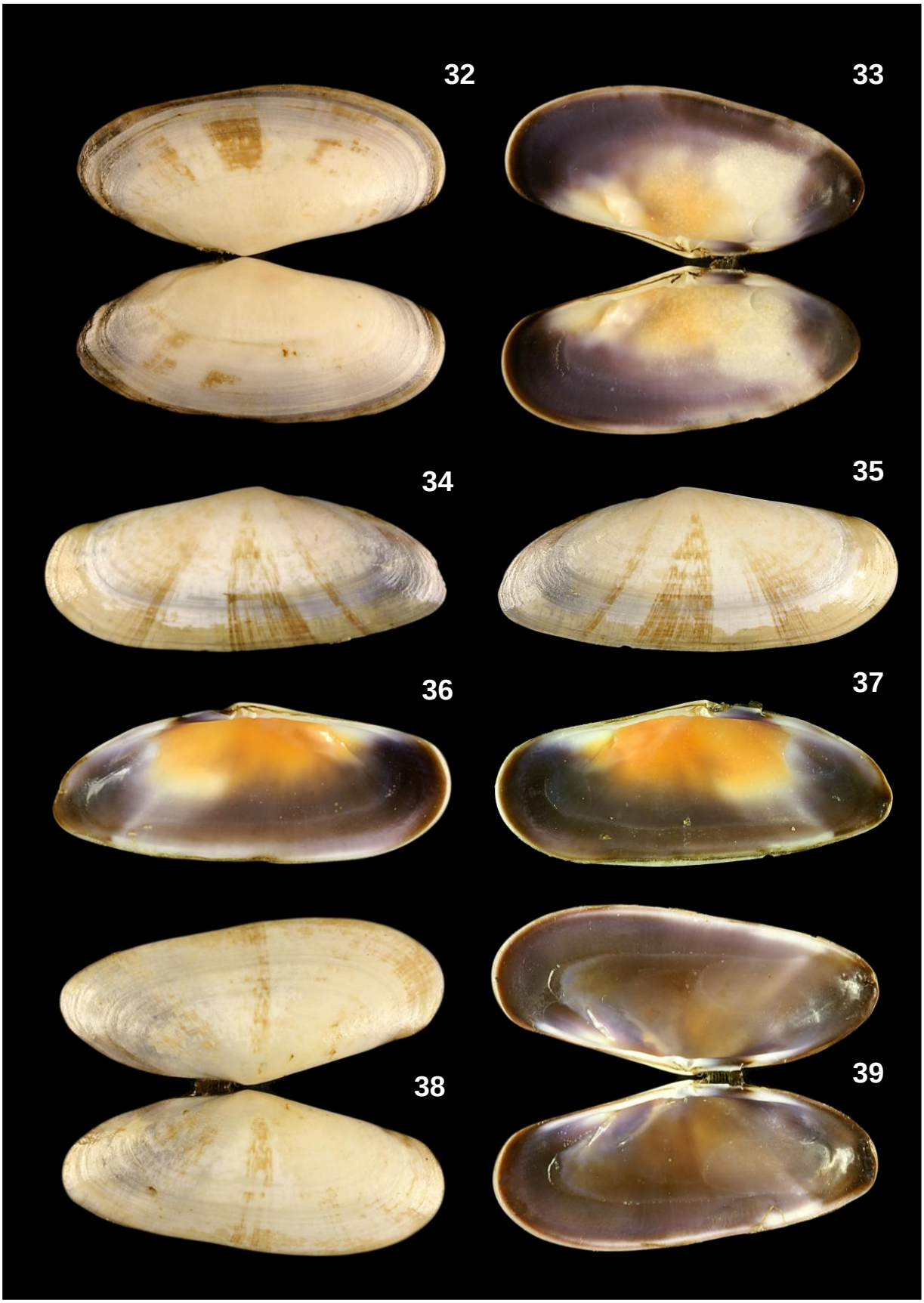

Plate V. Figs 32-39: *Donax longissimus* Thiele & Jaeckel, 1931. La Sarga, Dakhla, Western Sahara, Morocco. From local fishermen's nets. October 2012. CFN; 32-33: H. 14.19 mm L. 30.27 mm; 34-37: H. 14.31 mm L. 34.65 mm; 34: lv; 35: rv; 36: inside lv; 37: inside rv; 38-39: H. 14.96 mm L. 34.22 mm.

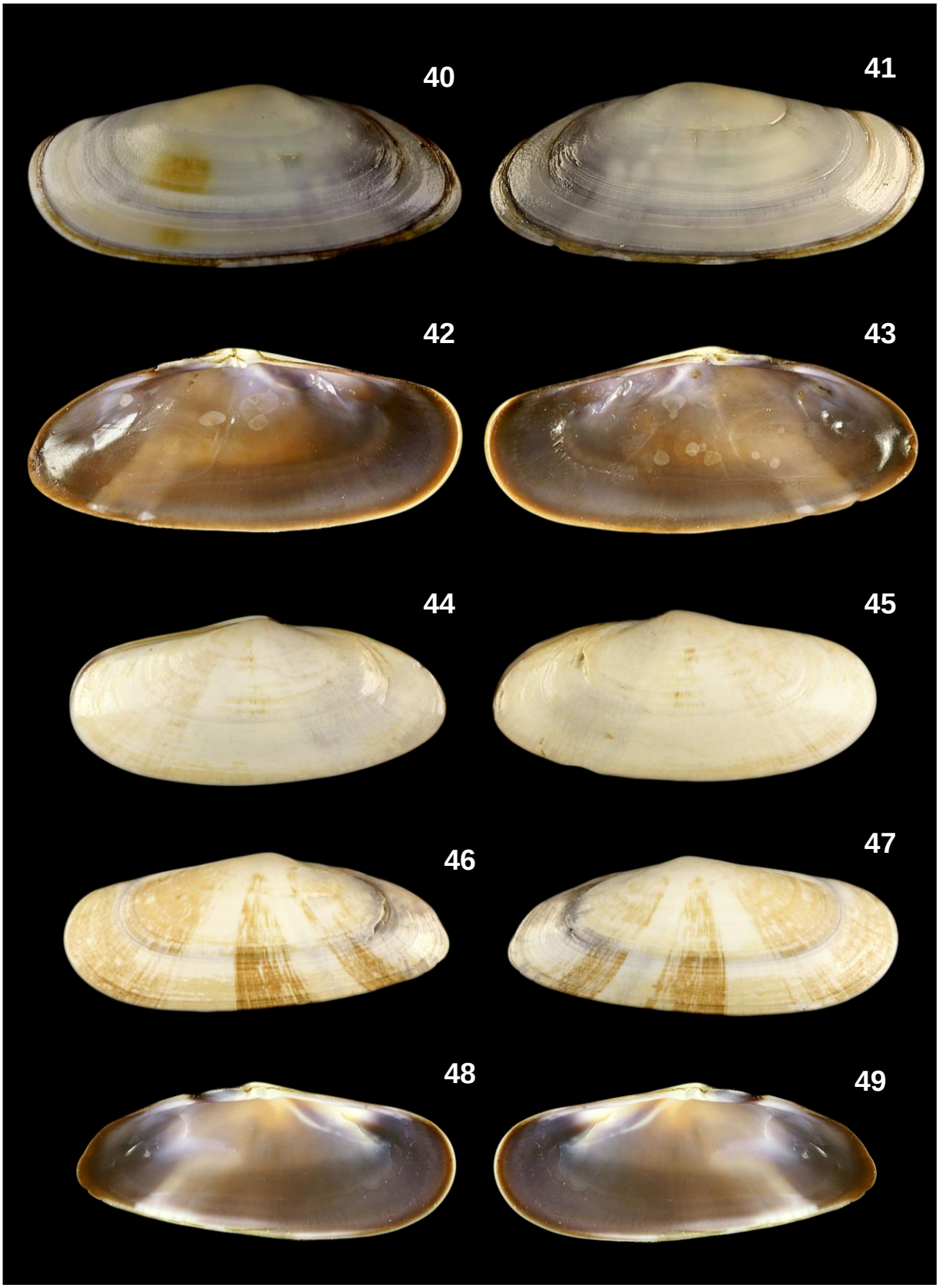

Plate VI. Figs 40-49: *Donax longissimus* Thiele & Jaeckel, 1931. La Sarga, Dakhla, Western Sahara, Morocco. From local fishermen's nets. October 2012. CFN; 40-43: H. 16.19 mm L. 37.30 mm; 40: lv; 41: rv; 42; inside lv; 43: inside rv; 44-45: H. 16.01 mm L. 36.14 mm; 44: lv; 45: rv; 46-49: H. 15.53 mm L. 37.60 mm; 46: lv; 47: rv; 48: inside lv; 49: inside rv.

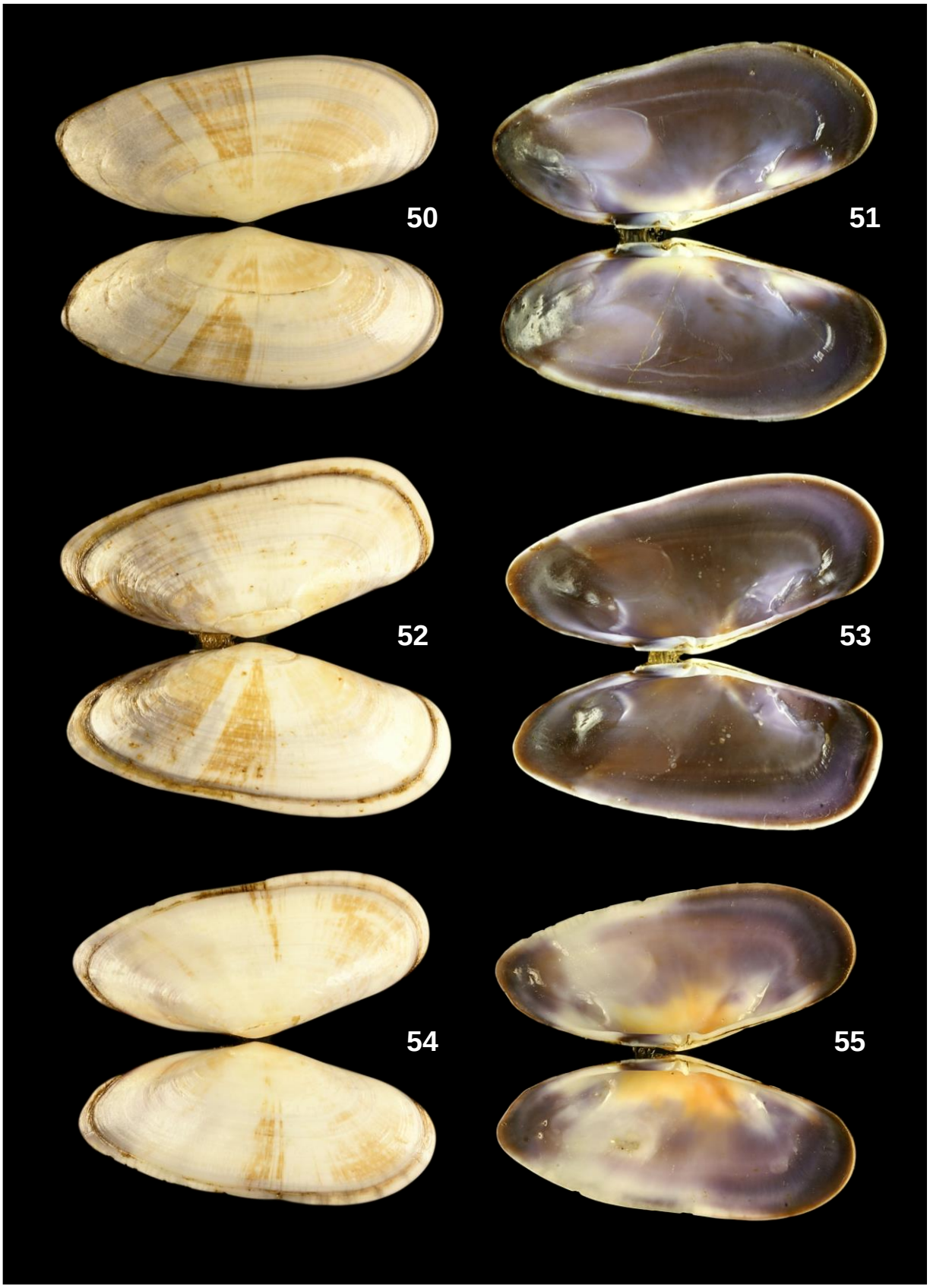

Plate VII. Figs 50-55: *Donax longissimus* Thiele & Jaeckel, 1931. La Sarga, Dakhla, Western Sahara, Morocco. From local fishermen's nets. October 2012. CFN; 50-51: H. 16.01 mm L. 36.14 mm; 52-53: H. 17.64 mm L. 39.16 mm; 54-55: H. 17.62 mm L. 38.71 mm.

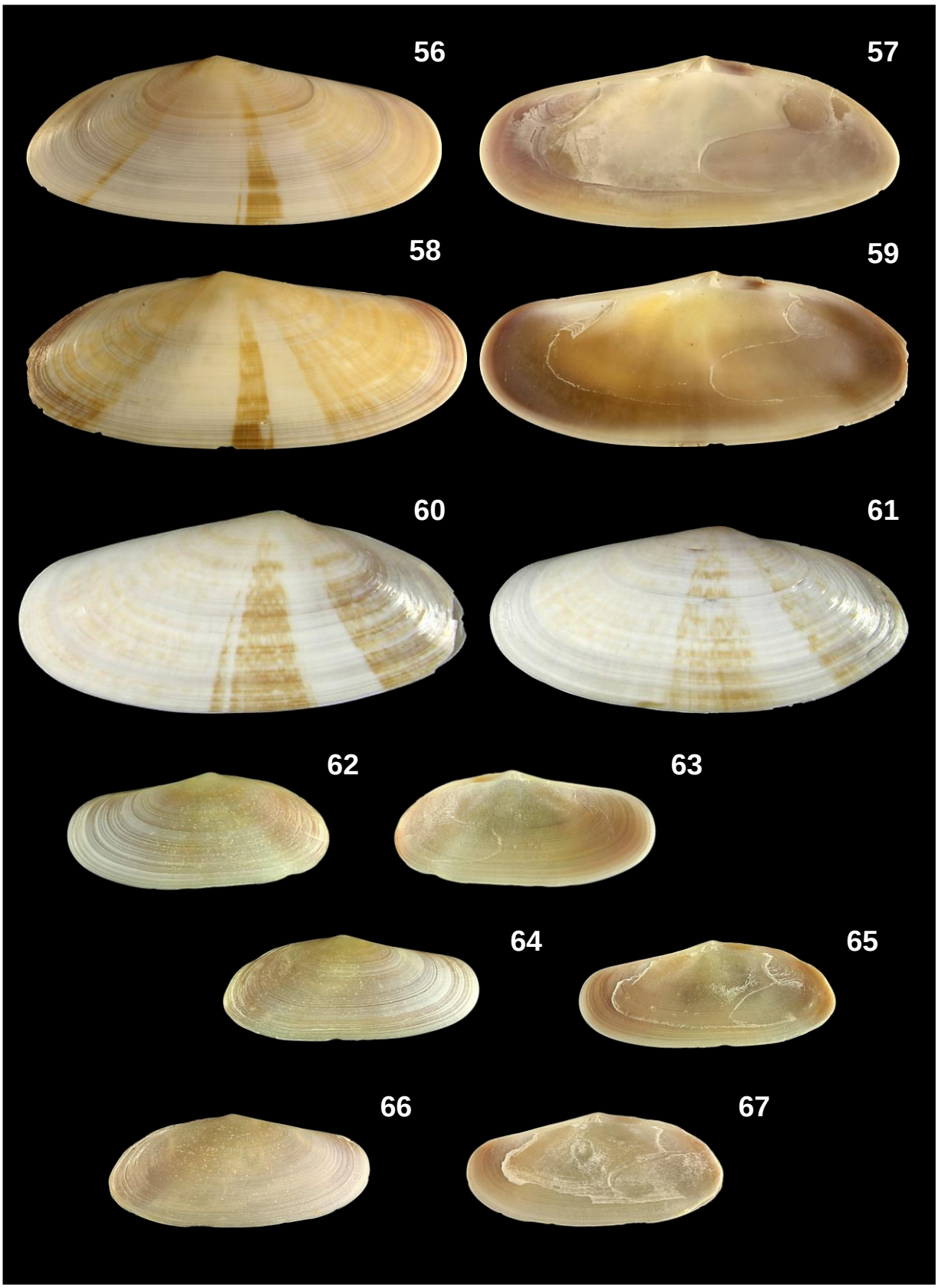

Plate VIII. Figs 56-67: *Donax longissimus* Thiele & Jaeckel, 1931; 56-59: Port Elizabeth, Jeffreys Bay, Cape Province, South Africa. Washed ashore. 2008. CAF; 56-57: H. 12.67 mm L. 31.26 mm; 56: rv; 57: inside rv; 58-59: H. 14.15 mm L. 35.61 mm; 58: rv; 59: inside rv; 60-61: False Bay, Cape, South Africa. Dived in sand at a depth of 20 m. March 1986. CP; 60: lv, L. 32.5 mm; 61: rv, L. 27.9 mm; 62-67: Winkelspruit, KwaZulu-Natal, South Africa. Washed ashore. 1990; 62-63: H. 12.42 mm L. 28.01 mm; 62: lv; 63: inside lv; 64-65: H. 12.30 mm L. 29.10 mm; 64: rv; 65: inside rv; 66-67: H. 12.42 mm L. 28.33 mm ; 66: rv ; 67: inside rv.

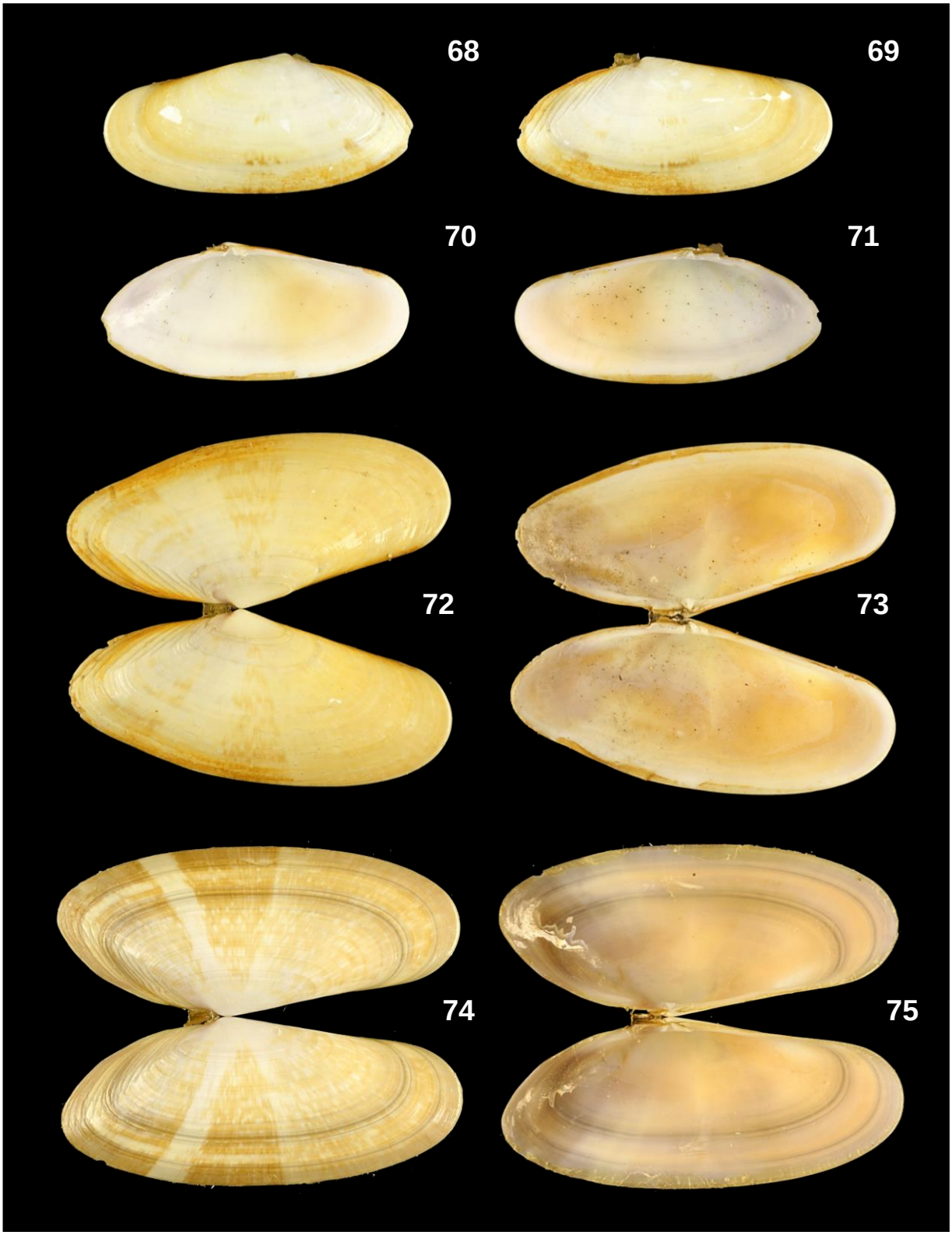

Plate IX. Figs 68-75: *Donax burnupi* G.B. Sowerby III, 1894; 68-73: Off The Bluff, Durban, KwaZulu-Natal, South Africa. Collected from reclamation dump sand dredged at a depth of 18-20 m. Leg. R. Kilburn & D. Herbert. Det. D.H., NMC. Ex Natal Museum, MOLLUSCA, N° B8971; 68-71: H. 9.91 mm L. 22.53 mm; 68: lv; 69: inside lv; 70: rv; 71: inside rv; 72-73: H. 10.88 mm L. 24.20 mm; 74-75: False Bay, Western Cape, South Africa. Glencairn swimming pool. January 1974. Leg. C. Connolly. Ex Natal Museum, MOLLUSCA, N° A1748. H. 10.48 mm L. 24.62 mm.

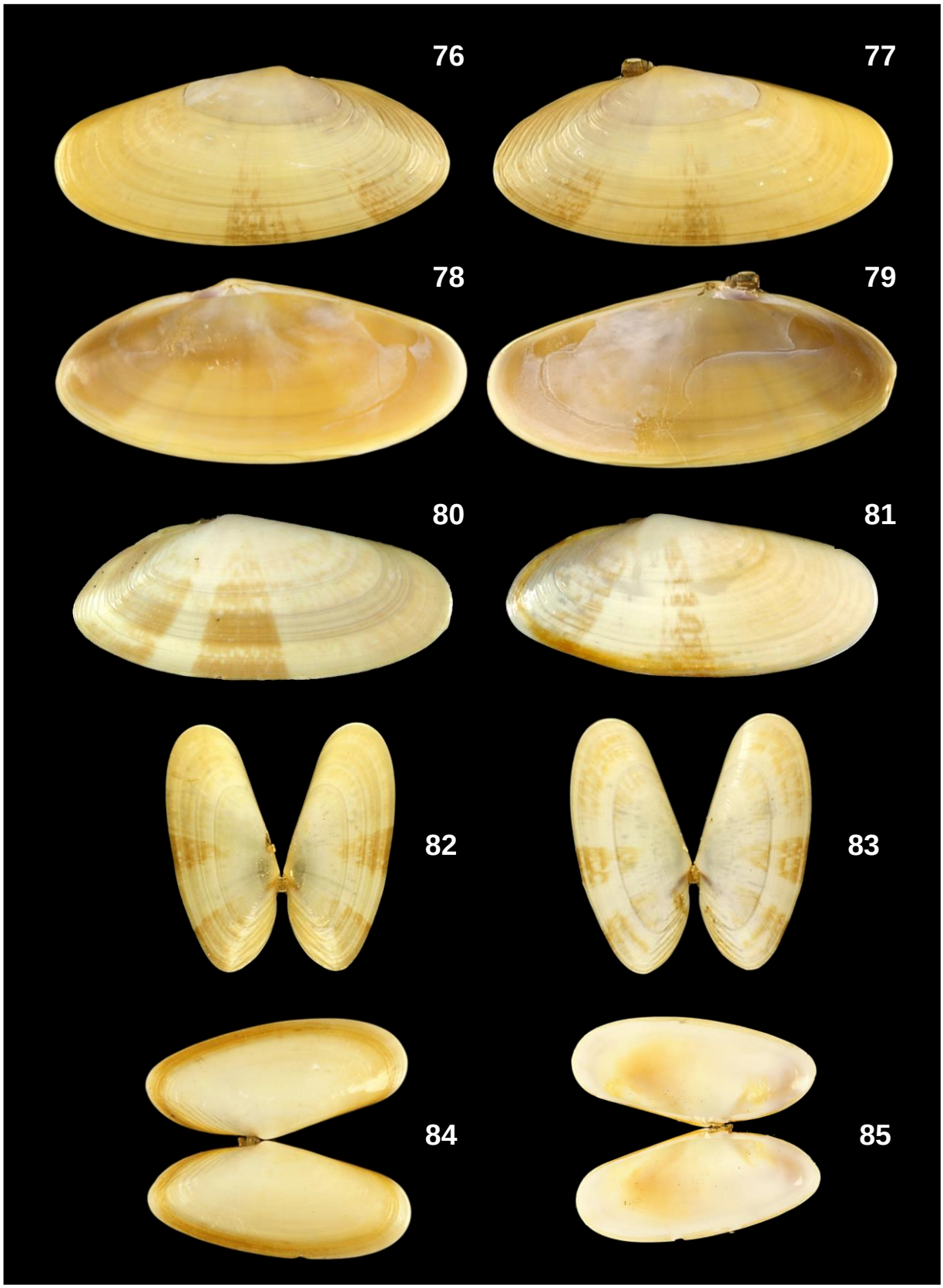

Plate X. Figs 76-85: *Donax burnupi* G.B. Sowerby, III, 1894; 76-79: Buffels Bay, Cape, South Africa. Dredged in sand and rubble at a depth of 15-20 m. November 1988. CSH. H. 11.15 mm. L. 24.64 mm; 76: lv; 77: rv; 78: inside lv; 79: inside rv; 80-81: False Bay, Cape, South Africa. Dived in sand at -20 m. March 1986. CP; 80: rv, L. 23.5 mm; 81: rv, L. 22.1 mm; 82-83: Jeffreys Bay, Cape, South Africa. Dredged at a depth of 70 m. 12 May 1999. CSH; 82: H. 6.11 mm L. 14.22 mm; 83: H. 6.64 mm L. 15.25 mm; 84-85: Off The Bluff, Durban, KwaZulu-Natal, South Africa. Collected from reclamation dump sand dredged at a depth of 18-20 m. Leg. R. Kilburn & D. Herbert. Det. D.H., NMC. Ex Natal Museum, MOLLUSCA, N° B8971. H. 10.45 mm L. 23.85 mm.

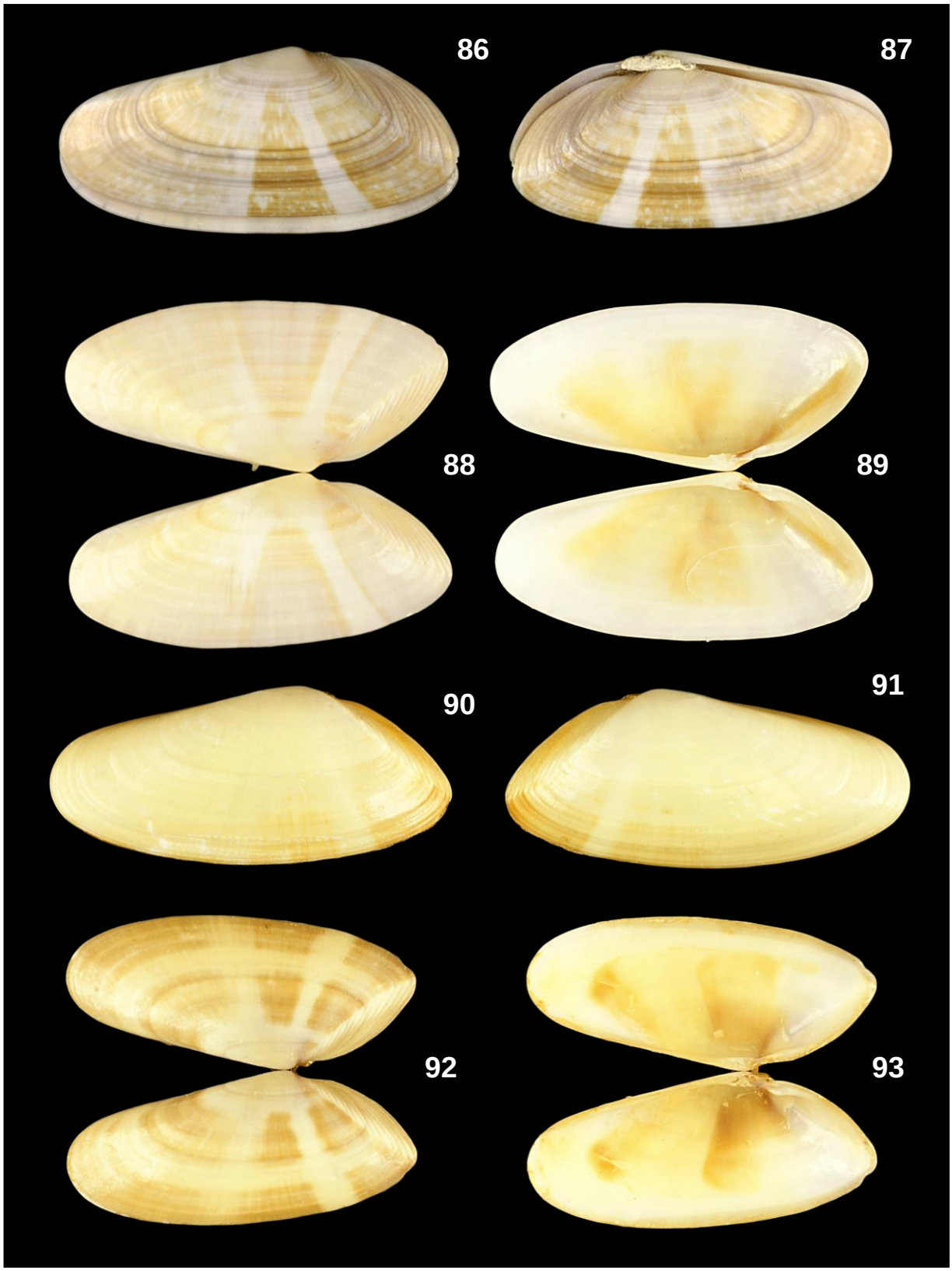

Plate XI. Figs 86-87: ***Donax burnupi* G.B. Sowerby III, 1894**. Addington Beach, Durban, KwaZulu-Natal. South Africa. In sand dredgings. 20 September 1993. CSH. H. 9.18 mm L. 21.01 mm; 86: lv; 87: rv;
Figs 88-93: ***Donax owenii* "Gray" Hanley, 1843.** CFN; 88-89: Cacuaco Bay, Luanda, Angola. Dredged at a depth of 13 m. February 1990. H. 10.81 mm L. 23.80 mm; 90-93: Pointe Sarène, Senegal. Trawled at a depth of 4 m. November 1976; 90-91: H. 11.25 mm L. 24.50 mm; 92-93: H. 9.61 mm L. 21.11 mm.

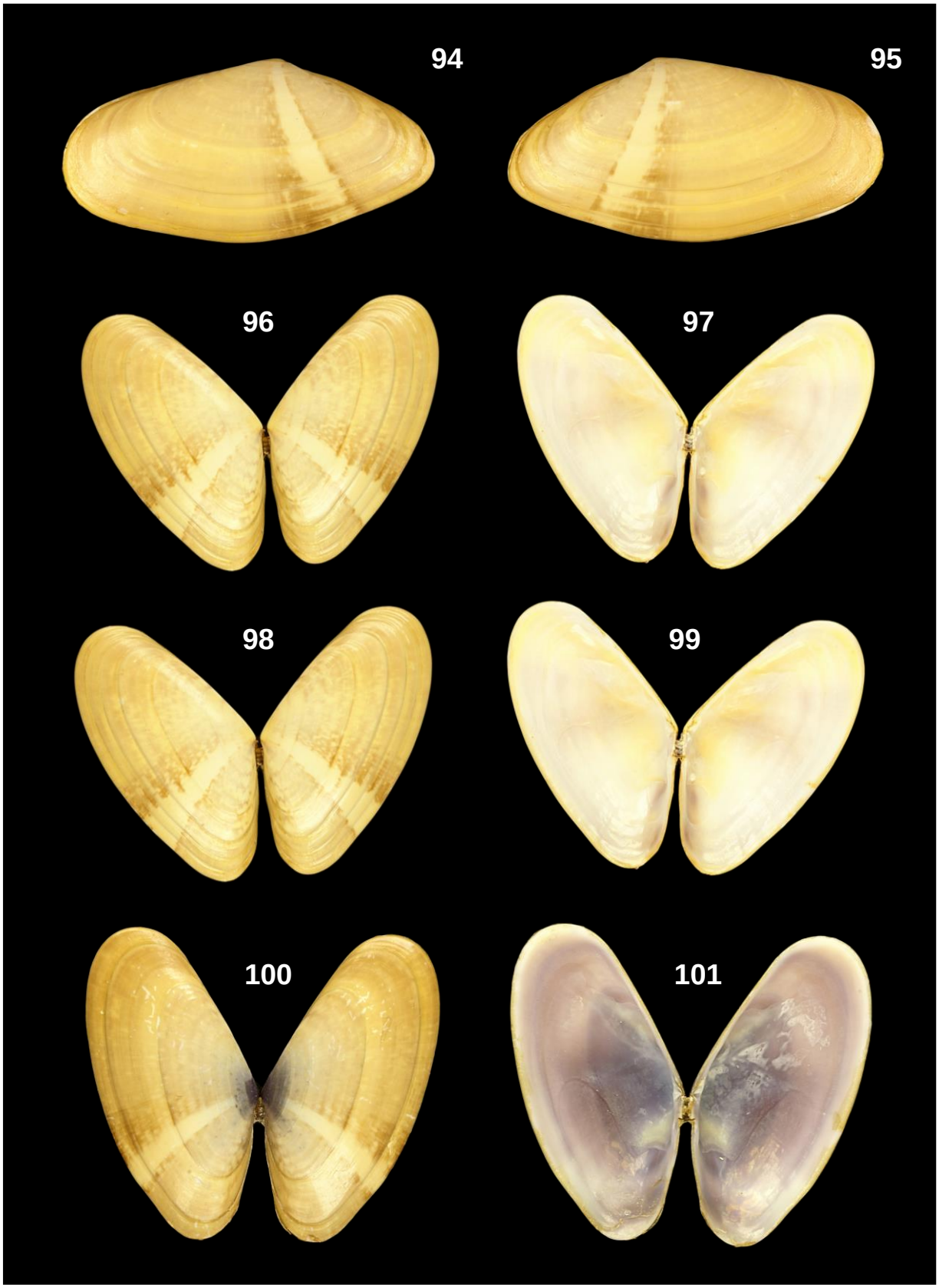

Plate XII. Figs 94-101: *Donax variegatus* (Gmelin, 1791). Granville, Normandy, France. In sand at rising extreme low tide. 16 April 2003. CFN; 94-95: H. 19.49 mm L. 39.08 mm; 94: lv; 95: rv; 96-97: H. 18.76 mm L. 33.81 mm; 98-99: *D. variegatus* var. *tristis* B.D.D., 1893. H. 16.75 mm L. 33.81 mm; 100-101: *D. variegatus* var. *laeta* B.D.D., 1893. H. 13.74 mm L. 27.46 mm.

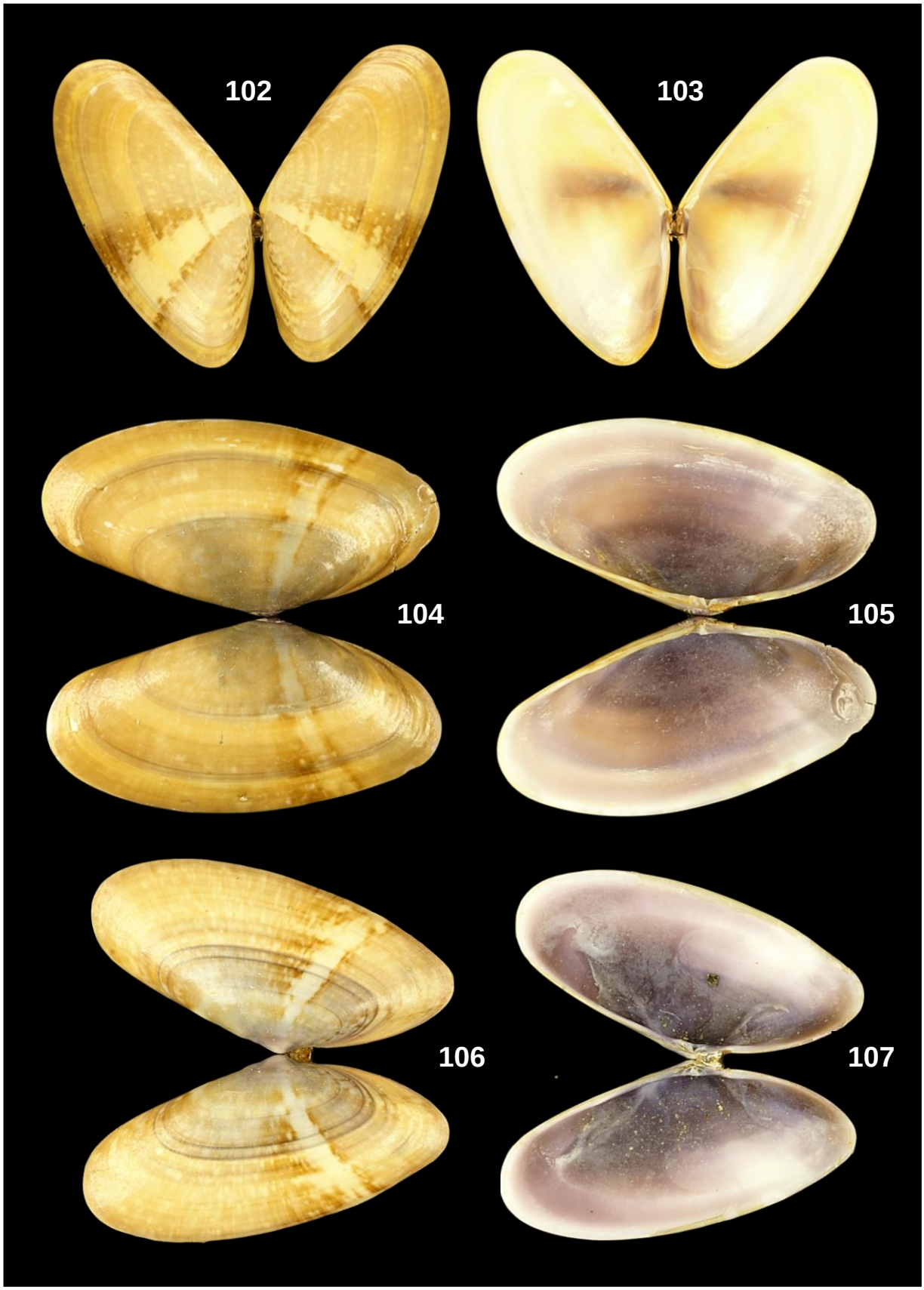

Plate XIII. Figs 102-107: *Donax variegatus* var. *saturata* B.D.D., 1893. CFN; 102-103: Granville, Normandy, France. In sand at rising extreme low tide. 22 August 2005. H. 17.12 mm L. 34.20 mm; 104-105: Plage Goas Treiz, Trébeurden, Brittany, France. In sand at rising extreme low tide. July 1974. H. 15.38 mm L. 30.98 mm; 106-107: Palamos, Spain. Trawled by local fishermen. In sand. July 1995. H. 13.74 mm L. 29.11 mm

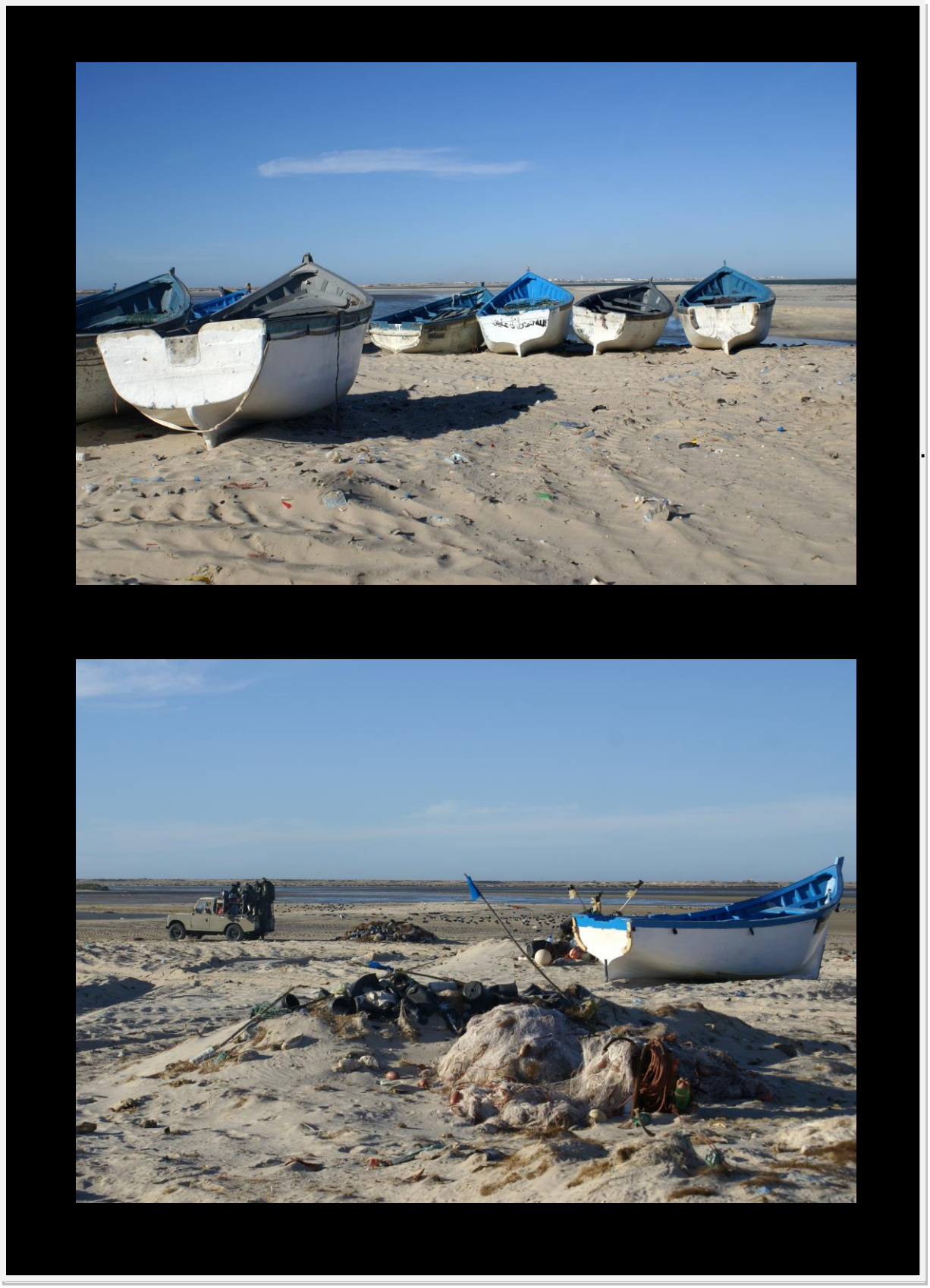

Plate XIV. The harbour of La Sagra, Dakhla, Western Sahara, Morocco.
(by courtesy of Fernand De Donder & Rika Goethaels)

Plate XV. Belgian and French members of the Association Française de Conchyliologie looking for shells in the harbour of La Sagra, Dakhla, Western Sahara, Morocco. (by courtesy of Fernand De Donder & Rika Goethaels)

Plate XVI. Debris, spider crabs and shells, e.g. *Cymbium* sp. from fishermen's nets containing samples of *Donax longissimus* Thiele & Jaeckel, 1931 (by courtesy of Fernand De Donder & Rika Goethaels)

Contributions to the knowledge of the Eratoidae. X. New species in the genus *Proterato* F.A. Schilder, 1925

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Keywords: Mollusca, Gastropoda, ERATOIDAE, Recent, new species, Philippines.

Abstract: Recently discovered species from the Philippines and belonging to the genus *Proterato* F.A. Schilder, 1925 are described. The new species are briefly discussed and compared with similar species.

Abbreviations:
DFB: collection Dirk Fehse, Berlin, Germany
ZSM: Zoological State Collection, Munich, Germany

L: length of shell
W: width of shell
H: height of shell
LT: number of labral teeth
CT: number of collumellar teeth

Introduction: *Proterato* seems to be an old genus. The first member is most probably known from the early Eocene (Fehse, 2004) as *Proterato australis* (Tate, 1878). There are at least 10 fossil species from the Eocene to Pliocene mainly from New Zealand (Schilder,1933). Ladd (1977: 17, pl. 1, figs 6-9) described '*Erato*' *hindlei* from the Plio-Pleistocene of Vanua Levu, Fiji Archipelago. It was assumed that *Proterato* had become extinct. Yet, in 2002 the author discovered *P. hindlei* in the Philippines, where it is now fairly commonly found at depths from 50 to 200 m. It was overlooked for almost 40 years – even Cate (1977) did not mention this species – and it was not expected that further taxa could be discovered. However, several species quite distinct from *P. hindlei* have recently become available to the author. One is small sized and the other unusually coloured. The minute species is hereby named *Proterato renkerorum* n. sp. and the coloured one is described as *Proterato pulcherrima* n. sp.

All the species mentioned below could be studied by means of type specimens and by hundreds of specimens from various localities in the author's collection. All type specimens of the new species were dead collected.

SUPERFAMILY: TRIVIOIDEA Troschel, 1863
FAMILY: ERATOIDAE Gill, 1871
SUBFAMILY: ERATOINAE Gill, 1871
GENUS: *Proterato* F.A. Schilder, 1925
Type species: *Erato zealanica* Suter, 1917, by monotypy

***Proterato renkerorum* n. sp.**
(Pl. I, Figs 1,2)

Locus typicus: Off Mactan Island, Cebu, Philippines; trawled at 100 to 200 m.

Type material:
Holotype: ZSM, coll. N° 20150208
Paratype 1: collection of DFB, N° 11408-1
Paratype 2: collection of DFB, N° 11408-2. Subadult.
3 further paratypes in coll. DFB, N° 7168, 11374, 11375

Etymology: Named in honour of Dr. Carsten and Anke Renker (ConchBooks) who kindly supported my studies.

Description: Shell minute, pear-shaped, smooth, with a blunt, knob-like spire. Protoconch and subsequent whorls covered with a very thin callus. Suture and junction indistinct. Body whorl almost 85% of total height, shouldered adapically, with the maximum diameter at one fifth from the adapical suture, roundly tapered below and constricted at the ventral margin. Dorsum roundly shouldered. Dorsal sulcus absent. Whole shell surface covered with a thin, semiglossy callus. Aperture comprises about 80% of total height, straight and wide. Labrum inflected, smooth, posteriorly slightly projecting, flattened, rounded and somewhat callused at outer margin, edged at inner margin, with 13 coarse, irregular denticles. Denticles extended as short, coarse folds onto the flattened part of

the labrum. Siphonal canal short, rounded and indented. Anal canal simple, slightly indented. Columella slightly convex and narrow. Parietal lip absent. Columellar denticles quite irregular, only partly developed, coarse, somewhat indistinct, anteriormost denticle extended as a wavy fold ('terminal ridge') onto ventrum. No further ventral folds. Fossula slightly concave, obsolete, not delimited from the columella. Inner fossular margin roundly callused, slightly protruded.
Entire shell of a translucent white colour.

Living animal and radula: No information on external morphology and radula is available.

Variations: The inflation of the shell, the posterior labral projecting, the height of the spire and the width of the aperture varies. Occasionally, there are denticles on the inner fossular margin. The brown colouration within the spire of the holotype is caused by remaining parts of the animal.

Geographic range: The species is only known from the Philippines, off Aliguay Island, near Dipolog, Mindanao (DFB, N° 7168) and the type locality (DFB, N° 11374, 11375, 11408).

Measurements:
Holotype: L = 4.6 mm, W = 3.4 mm, H = 2.7 mm, LT 13, CT – (ZSM, N° 20150208)
Paratype 1: L = 4.2 mm, W = 2.9 mm, H = 2.3 mm, LT 13, CT – (DFB, N° 11408-1)
Paratype 2: L = 5.5 mm, W = 3.8 mm, H = 3.1 mm, LT –, CT – (DFB, N° 11408-2)

Discussion: *Proterato hindlei* (Pl. I, Figs 3a-c) has a rostrated appearance and looks somewhat malformed. Its length varies from 6 to 11 mm. The new species is smaller (length varies from 4 to 7 mm), the spire is knoblike and blunt, the shell is more inflated and regularly or elegantly shaped in contrast to *P. hindlei*, the inner labral edge is straight whereas it is protruded in *P. hindlei*, the anterior labral and almost all columellar denticles are obscured, the siphonal canal is shorter, the aperture is slightly wider (caused by the straight inner labral edge), the labrum is narrower, the labral profile is almost straight and the anterior terminal collar is shorter and straight.

***Proterato pulcherrima* n. sp.**
(Pl. II, Figs 1 to 3)

Locus typicus: Off Mactan Island, Cebu, Philippines; trawled at 100 to 200 m.

Type material:
Holotype: ZSM, coll. N° 20150209
Paratype 1: Coll. of DFB, N° 11409
Paratype 2: Coll. of DFB, N° 11220
Etymology: From the Latin adjective, *pulcherrimus*, meaning very beautiful.

Description: Shell minute, pear-shaped, smooth, with a blunt, conical stair-shaped spire. Protoconch and subsequent whorls completely covered with a thin callus. Suture distinct. Junction with teleoconch smooth. Body whorl almost 99% of total height, shouldered adapically, with the maximum diameter at one tenth from the adapical suture, evenly tapered below and only slightly constricted at the ventral margin. Dorsum shouldered at posterior third. Dorsal sulcus absent. Whole shell surface covered with a quite thin, semiglossy callus. Aperture comprises about 80% of total height, straight and narrow. Labrum inflected, smooth, rounded, anteriorly declivous, posteriorly sharply edged, outer margin rounded, edged with 15 somewhat coarse, irregular, anteriorly almost obscured denticles on the inner margin. Denticles extended as short, coarse folds onto labrum. Siphonal canal short, rounded and indented. Anal canal funnel-like widened, indented. Columella almost straight, narrow with a weakly developed inner carinal ridge and a roundly thickened, slightly projected, irregularly shaped parietal lip. Columellar denticles coarse, slightly irregular and somewhat indistinct. Ventral folds absent. Inner fossular margin slightly protruded. Terminal ridge broad. Shell colour translucent white with a light reddish brown cloud at mid-dorsum and on the anterior terminal collar. The reddish brown cloud at mid-dorsum and anterior terminal collar forms an indistinct, irregular transverse band that is ventrally only barely visible.

Living animal and radula: No information on external morphology and radula is available.

Variations: The spire is more or less elevated and stair-shaped. Sometimes the spire is brown.

Geographic range: The species is only known from the Philippines, off Balicasag Island, Bohol, (DFB, N° 11220) and the type locality (DFB, N° 11409).

Measurements:
Holotype: L = 5.3 mm, W = 3.2 mm, H = 2.7 mm, LT 15, CT – (ZSM, N° 20150209)
Paratype 1: L = 5.7 mm, W = 3.6 mm, H = 2.8 mm, LT 14, CT – (DFB, N° 11409)
Paratype 2: L = 4.6 mm, W = 2.9 mm, H = 2.4 mm, LT 16, CT – (DFB, N° 11220)

Discussion: *Proterato pulcherrima* n. sp. is immediately distinguishable from *P. hindlei* and *P. renkerorum* n. sp. by its coloured shell. The dorsal and ventral colouration is also visible in the dead collected specimens. It also differs from *P. hindlei* by the smaller (length varies from 4 to 6 mm vs. 6 to 11 in *P. hindlei*) and narrower, more elegant shell, the narrower aperture, the knob-like, blunt spire, the straight inner labral edge, the more callused outer labral margin, the obscured columellar denticles, the shorter siphonal canal, the funnel-shaped anal canal with the projected posterior labral angle and the less convex labral profile.

Besides the colouration, *P. pulcherrima* differs from *P. renkerorum* by the narrower, more elongated shell and aperture, the funnel-shaped anal canal, the angular and projected posterior labral portion, the convex label profile, the more callused outer labral margin, the stair-shaped spire and the slightly more elongated anterior terminal collar.

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References:

Cate, C.N., 1977. A Review of the Eratoidae (Mollusca: Gastropoda). *The Veliger*, **19**(3): 341-366, 366a + 366b.

Fehse, D., 2004. A new fossil species in the gastropod family Eocypraeidae (Mollusca: Gastropoda: Cypraeoidea) from the Mediterranean Pliocene. *La Conchiglia*, **36**(311): 37-40, 1 pl., 1 text fig.

Fehse, D. & Grego, J., 2012. Contributions to Eratoid systematics (Mollusca, Gastropoda, Trivioidea), 5. Middle Miocene, Badenian Eratoidae from Borsodbóta (Hungry). *Cenozoic Research*, **9**(1): 15-63, pls 1-15, text figs A-D.

Ladd, H.S., 1977. Cenozoic Fossil Mollusks from Western Pacific Islands; Gastropods (Eratoidae through Harpidae). *Geological Survey Professional Paper*, **533**: i-iv + 1-84, pls 1-23, text figs 1-6, tabs 1-4.

Schilder, F.A., 1925. Revision der Cypraeacea (Moll., Gastr.). *Archiv für Naturgeschichte*, **91**. Jahrgang, Abteilung A, 10. Heft: 1-171.

Schilder, F.A., 1933. Monograph of the subfamily Eratoinae*. Proceedings of the Malacological Society of London*, **20**(5): 244-283, text figs 1-85.

Suter, H., 1917. Description of new Tertiary Mollusca occurring in New Zealand, accompanied by a few notes on necessary changes in nomenclature. Part I. *New Zealand Geological Survey*, *Paleontological Bulletin*, **5**: 1-93.

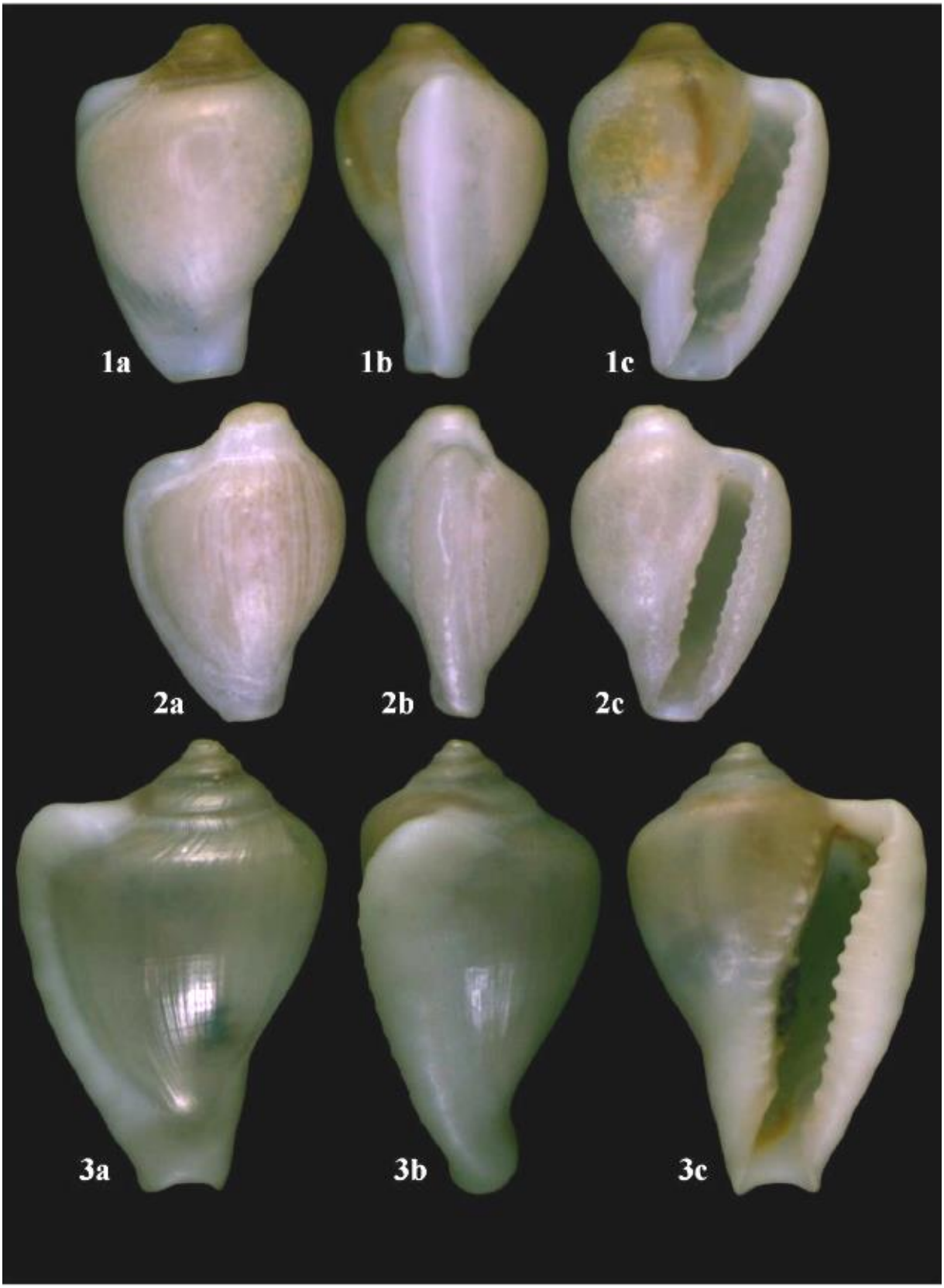

Plate I. Figs 1-2: *Proterato renkerorum* n. sp. Off Mactan Island, Cebu, Philippines. Trawled at 100 to 200 m; 1a-c: 4.6 mm, holotype (ZSM, N° 20150208); 2a-c: 4.2 mm, paratype 1 (DFB, N° 11408-1);

Figs 3a-c: *Proterato hindlei* (Ladd, 1977). Off Mactan Island, Cebu, Philippines. Trawled at 100 to 200 m; 10.1 mm (DFB, N° 11374-1).

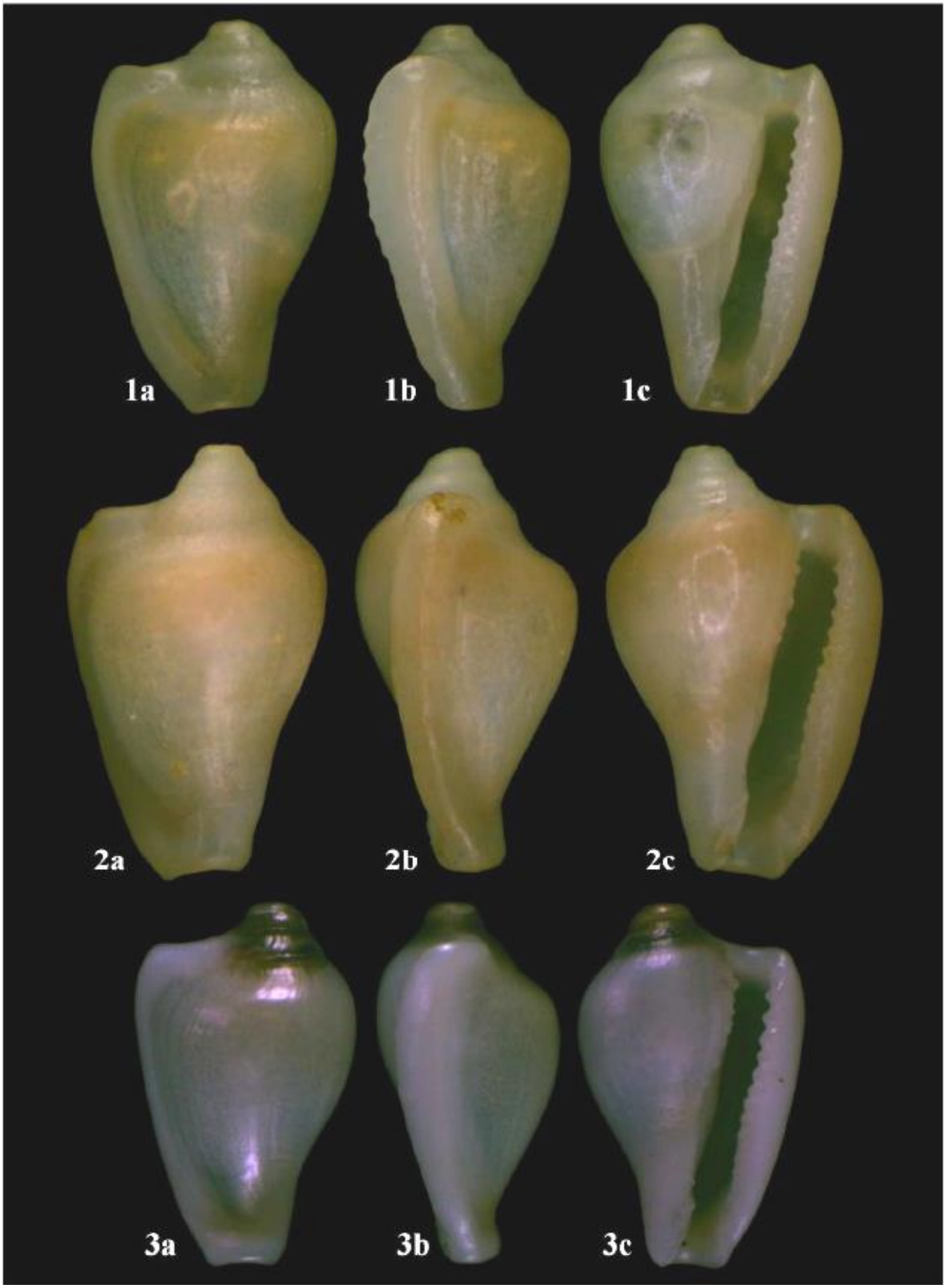

Plate II. Figs 1-3: *Proterato pulcherrima* n. sp. Off Mactan Island, Cebu, Philippines. Trawled at 100 to 200 m; 1a-c: 5.3 mm, holotype (ZSM, N° 20150209); 2a-c: 5.7 mm, paratype 1 (DFB, N° 11409); 3a-c: 4.6 mm, paratype 2 (DFB, N° 11220).

A dark-marginated form of *Zonaria pyrum* (Gmelin, 1791) (Mollusca: Gastropoda: Cypraeidae) from Lebanon: further evidence of a wrongly assumed subspecies

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Keywords: *Zonaria pyrum*, CYPRAEIDAE, subspecies.

Abstract: A specimen of a dark marginated *Zonaria pyrum* has been collected from the coast of Lebanon. Until now it has always been supposed that such a form was restricted to the south of the Iberian Peninsula. It was therefore regarded as a subspecies (Deprez & Govaert, 2009). The presence of a similar pattern from the eastern Mediterranean Sea excludes this supposition and downranks the subspecies *Z. pyrum nigromarginata* Deprez & Govaert, 2009 to the status of a mere form.

Abbreviations:
CFN: Private collection of Frank Nolf (Oostende, Belgium)

Discussion: Deprez & Govaert (2009) described *Zonaria pyrum nigromarginata* as a subspecies from the Gulf of Cadiz (Spain) (Pl. I, Figs 1-4) and southern Portugal (Pl. I, Figs 5-6) after studying several specimens dived in shallow water. The samples differ from specimens collected elsewhere by the dark brown colour of the margins and the indistinct marginal spotting on both columellar and labral sides. The authors argue that these characteristics allow for distinguishing the samples collected from the southern Iberian Peninsula from classic *Zonaria pyrum* (Gmelin, 1791). However, a study of the shells of *Z. pyrum* reveals the immense variability within this species. Specimens dived off Bodrum (Turkey) (Pl. II, Figs 11-12) have similarly dark-coloured margins but the dorsum is dark orange instead of pale and banded like in *Z. pyrum nigromarginata*. Spotting occurs in all populations throughout the Mediterreanean Sea and adjacent West African waters. It is not a constant feature. Even specimens from Tunis (Tunisia), for instance show some of the characteristics of this 'subspecies', namely the brownish orange colour of the base and the margins provided with spots. Moreover, the margins of the new subspecies are never as black as could be supposed by the name '*nigromarginata*'.

I have recently been able to obtain a specimen from Lebanon (Pl. I, Figs 7-8) showing the same faint dots and dark margins as in specimens from the type locality of *Z. pyrum nigromarginata*. Once more it has to be concluded there is no proper justification to establish a new subspecies for a species that lives in a continuing range from the Eastern Mediterranean Sea to Angola.
Dark margins are not unusual in CYPRAEIDAE. Pl. III, Figs 13-14 show a specimen of *Erosaria turdus* f. *winckworthi* Schilder & Schilder, 1938 with a dark brown ring above the marginal callus. Specimens of *Erosaria spurca* (Linnaeus, 1758) can also have black stains or a dark brown ring in this area (Pl. III, Figs 15-20).
Members of one subspecies have to differ from members of another subspecies of the species, either morphologically or by different coding sequences of the DNA. It is evident that specimens which belong to a subspecies live in an isolated area (for instance in the waters of an archipelago) or are separated by geographic barriers from other specimens of the same species. We can assume that two groups of different subspecies can freely interbreed if some external barrier is removed. Finally, the distinction between two subspecies of the same species only depends on the likelihood that in the absence of external barriers the two populations would merge back into a single, genetically unified population. It has nothing to do with 'how different' the two groups appear to be to the human observer. The differences described by Deprez and Govaert (2009) are not constantly observed in all the specimens (Goutal, 2008; Muñoz Sanchez, pers. com.) from the same habitat and no correlation with feeding and environmental conditions has been made. More information was obtained from divers in Cadiz (SW Spain). They state that 'real *nigromarginata* specimens' inhabit the same habitat as paler shells. All the described differences between known subspecies and forms can be observed in a single population in the south of the Iberian Peninsula. Shells with different colours (orange, creamy white and even almost whitish) live together in this area, though the dark-marginated shells are only predominant in Cadiz and

southern Portugal. The darker margins are in fact so striking because they strongly contrast with the paler creamish dorsum transversed by 3-4 bluish-brown bands. The mantle of the animal is also very variable in colour, from creamy yellow to mauve, including a nice brownish orange. *Z. pyrum* is as variable in the south of the Iberian Peninsula as elsewhere in the Mediterranean Sea. Moreover, as the differences described by Deprez and Govaert (2009) are also present in specimens from other localities (Tunisia, Morocco, Sicily, Turkey, Lebanon, …) it is evident that *Z. pyrum nigromarginata* does not belong to an isolated group.

Zonaria pyrum is an inhabitant of most shores of the Mediterranean and the East Atlantic coasts of W Africa, where it lives as a polytypic species with several local forms or subspecies such as *Z. pyrum angelicae* (Clover,1974), *Z. pyrum angolensis* (Odhner, 1923) and *Z. pyrum petitiana* (Crosse & Fischer, 1872), which are more related to a specific habitat than *Z. pyrum nigromarginata* Deprez & Govaert, 2009.

According to F. Goutal (2008), the habitat of *Z. pyrum* in the south of the Iberian Peninsula is very variable: it lives on detritus bottoms, under large rocks or hiding under seaweed. Specimens are often found in turbid waters. Suspended particles may be absorbed by the mantle of the animal and cause the dark colour of the margins of some shells (the '*nigromarginata*' form). In spite of all these arguments, several authors still continue to mention *Zonaria pyrum nigromarginata* as a valid subspecies.

Fortunately, Bergonzoni (2013) synonimised this name with *Z. pyrum insularum* Schilder, 1928 in his revision of the *Zonaria* complex. *Z. pyrum insularum* groups specimens from Portugal, Morocco, Madeira and the Canary Islands. It can be questioned why Bergonzoni (2013) saved the chaotic splitting of CYPRAEIDAE in a number of subspecies and form names in his publication, instead of moving both names to the rank of junior synonyms of *Z. pyrum* itself. It is to be appreciated he finally downranked a few subspecies to the rank of form, but as his paper was a revision of the *Zonaria* complex, it can be regarded a missed opportunity. Moreover, Bergonzoni introduced two new forms *Z. pyrum* f. *turgida* and *Z. pyrum petitiana* f. *pseudopyrum*, thereby violating the ICZN-rules. In the previous decades too many so-called species and subspecies names have been introduced in CYPRAEIDAE, without proper justification.

Conclusion: There are four main reasons to reject the subspecies *Z. pyrum nigromarginata*. First of all, many specimens from other areas in NW Africa and the Mediterranean Sea (Turkey, Lebanon, …) nearly show the same features. Secondly, not all specimens in the same habitat in Cadiz (Spain) and Algarve (Portugal) show the characteristics described by Deprez & Govaert (2009). Thirdly, the dark coloured margins covering faint dots are in no way distinct characteristics to separate individuals or small populations from the remaining members of *Z. pyrum.* Fourthly, as the southern coasts of the Iberian Peninusla form a passage between the Mediterranean and E Atlantic waters they offer enough possibilities to members of this group to interbreed. The populations are not enough isolated from those living in the nearby waters. So, I prefer to regard the subspecies '*nigromarginata*' only as a dark local form of *Zonaria pyrum*. This can also be supposed of the taxons *senegalensis* Schilder, 1928 and *petitiana* (Crosse, 1872) and a number of forms (*undata*, *maculosa*, *turgida*, *pseudopyrum*, …) which only differ in minor characteristics.

Acknowledgements: Many thanks go for David Monsecour (Aarschot, Belgium) for correcting the English text.

References:

Bergonzoni, M., 2013. The *Zonaria pyrum* complex. *Beautiful Magazine*, n°3, 35-56.

Deprez, J. & Govaert, P., 2009. *Zonaria pyrum nigromarginata*: A new subspecies of *Zonaria pyrum* (Gastropoda: Cypraeidae) from the Atlantic coast of the Iberian Peninsula. *Gloria Maris*, **48**(4-5): 91-98.

Goutal, F., 2008. *Zonaria pyrum* des côtes Atlantiques de l'Europe. *Xenophora*, **121**: 12-13.

Lorenz, F., 2002. *New Worldwide Cowries*. Conchbooks, Hackenheim. 292 pp.

Lorenz, F. & Hubert, A., 2000. *A Guide to Worldwide Cowries*. Second edition. Conchbooks, Hackenheim. 584 pp.

Nolf, F., 2010. Some critical notes about the introduction of the subspecies *Zonaria pyrum nigromarginata* Deprez & Govaert, 2009 (Mollusca: Gastropoda: Cypraeidae). *Neptunea*, **9**(2): 14-27.

Schilder, F.A. & Schilder, M., 1952. Ph. Dautzenberg's collection of CYPRAEIDAE. *Mémoires Institut Royal des Sciences Naturelles de Belgique* (2ième série), fasc. 45. 243 pp, 4 pls.

Plate I. Figs 1-6: *Zonaria pyrum* (Gmelin, 1791). CFN; 1-2: Off Cadiz, southern Spain. Under rock with sponges in moderately turbid water. By SCUBA diving at a depth of 5 m. 31 May 2010; 1-2: 30.65 mm; 3-4: 36.56 mm; 5-6: Olhão, Portugal. Dived under large rocks at a depth of 15 m. 43.02 mm.

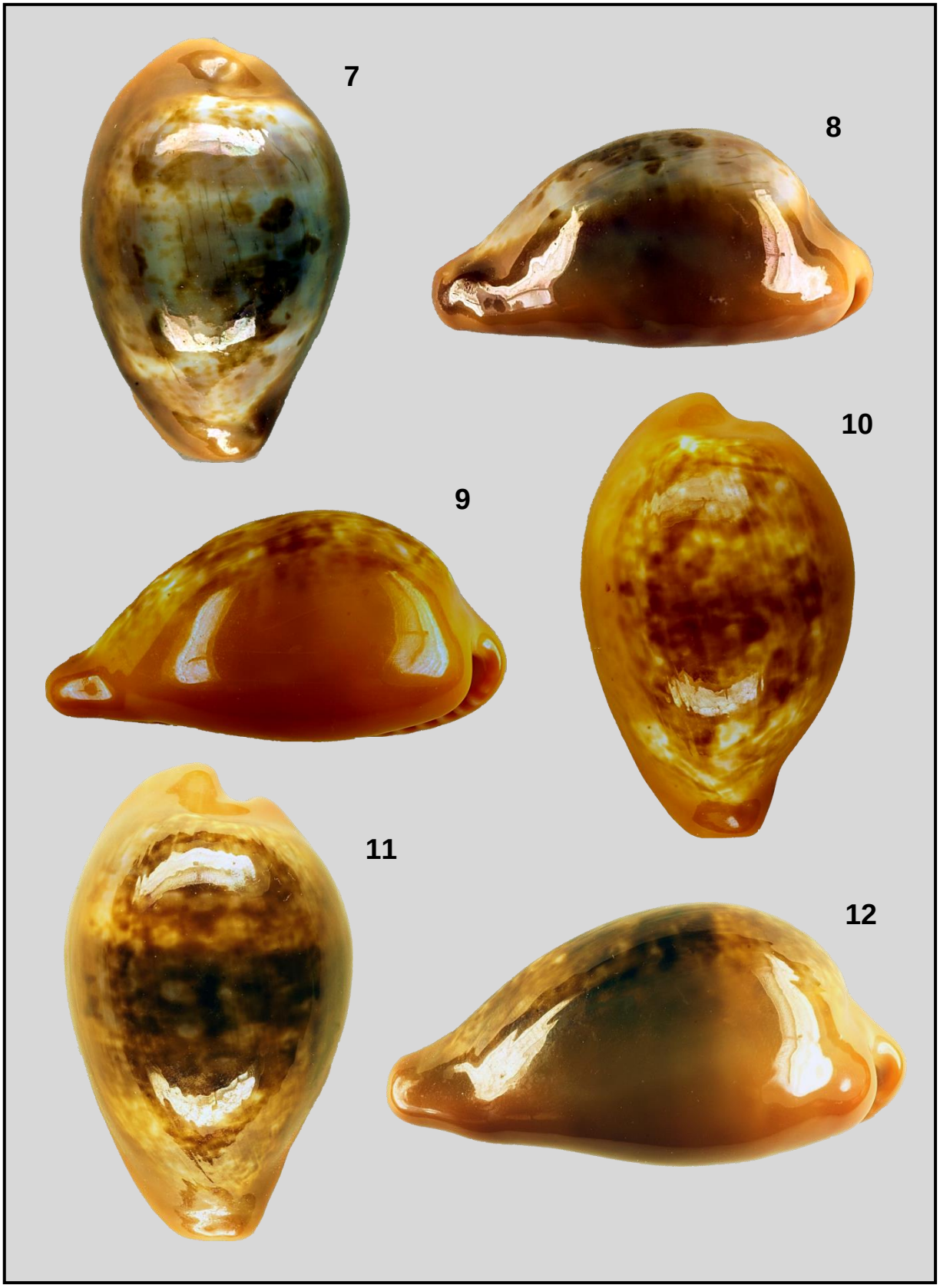

Plate II. Figs 7-12: *Zonaria pyrum* (Gmelin, 1791). CFN; 7-8: Beirut, Lebanon. From diver. Under rock at a depth of 7-10 m. August 1969. 31.27 mm; 9-10: Haifa, Israel. From diver. 33.92 mm; 11-12: Bodrum, Turkey. Dived at a depth of 12 m. 44.08 mm.

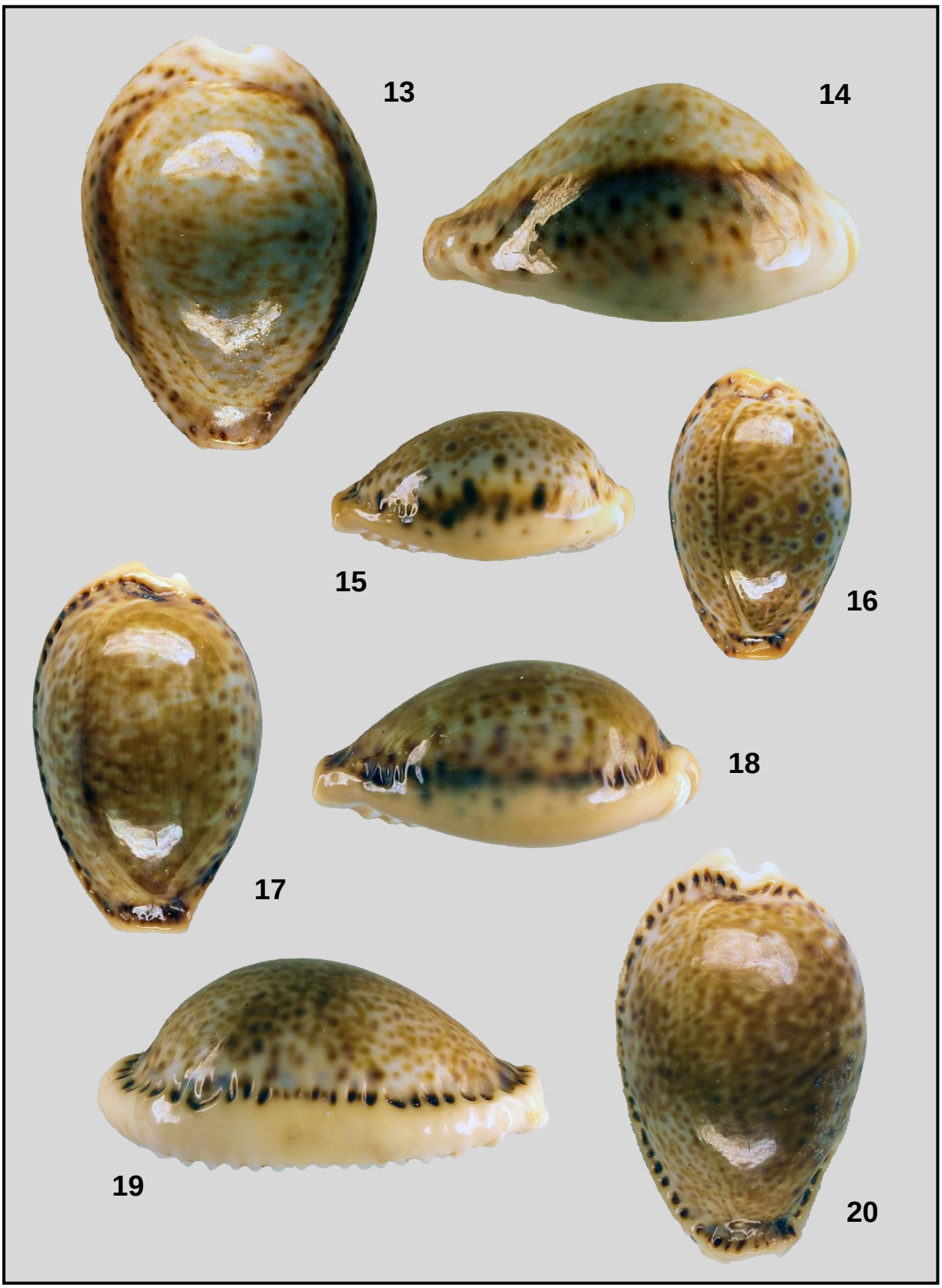

Plate III. Figs 13-14: ***Erosaria turdus* f. *winckworthi* Schilder & Schilder, 1938.** Muscat, Gulf of Oman. On rock at low tide. 30.24 mm. CFN;

Figs 15-20: ***Erosaria spurca* (Linnaeus,1758).** Messina, Sicily, Italy. Dived at a depth of 5 m. On rock. April 2003. CFN; 15-16: 19.63 mm; 17-18: 27.56 mm; 19-20: 30.14 mm.