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A new late Cenozoic species of *Abertella* (Echinoidea: Clypeasteroida) from Patagonia

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Abstract

A new species of abertellid sand dollar, *Abertella miskellyi* **n. sp.**, is described from the Miocene Camarones Formation of Patagonia, southern Argentina. The new taxon corroborates the existence of the genus in South America, given that *Abertella* is most common in the southeastern USA and the eastern coast of Central America. It is characterized by a unique basicoronal circle, in which the interambulacral basicoronal plates are very heterogeneous in size (small in interambulacrum 5, largest in interambulacra 2 and 3). Additionally, it features disjunct oral interambulacra involving two ambulacral plates in some of the interambulacra rather than one, thus being the most disjunct of all known species of *Abertella*. A key to the species of the genus is provided.

Key words: Clypeasteroida, Abertellidae, sand dollars, new taxon, Argentina, Patagonia, Camarones Formation, Miocene, identification key

Introduction

Abertellids are a relatively small group of New World sand dollars that were most common during the early and middle Miocene. Their main area of distribution is the southeastern United States and the eastern coast of Central America, where at least four species occur. Two additional species are known from South America (Brazil and Argentina). Except for the recently described *Abertella gualichensis* Martínez, Reichler & Mooi, 2005 and *A. dengleri* Osborne & Ciampaglio, 2010, these species, plus two additional ones of uncertain abertellid affinity, all are relatively poorly known and in need of redescription. The Brazilian species *Karlaster pirabensis* Marchesini Santos, 1958, was initially considered to belong to a separate genus within the monophorasterids, but subsequently found to be identical to *Abertella complanata* Brito, 1981. *Karlaster* was designated a junior subjective synonym of *Abertella* by Martínez & Mooi (1997) and Mooi *et al*. (2000: 266).

Abertellids, albeit well typified as a group by characters reviewed by Martínez *et al*. (2005) and Osborn & Ciampaglio (2010), are of uncertain systematic position. They were largely ignored in analyses of sand dollar evolution by Seilacher (1979) and Smith (1984). While Durham (1966) derived them from European scutellids, they were resolved as immediate sister-group of a clade containing all lunulate sand dollars except the rotulids (i.e. astriclypeids, monophorasterids and mellitids) in the morphological cladistic analysis performed by Kroh & Smith (2010). Recent findings indicate that *Abertella* is an important component of Miocene sand dollar diversity, and will likely offer crucial information towards our understanding of the evolution of scutelline clypeasteroids in the Americas.

With its slightly alate shape the new species of *Abertella* described here is superficially similar to some

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representatives of the monophorasterid *Amplaster* Martínez, 1984. It is, however, clearly differentiated from the latter not only by the lack of an anal lunule, but also by the completely different plate architecture with widely disjunct oral interambulacral columns.

Geological setting. The fossils come from the thick cover of Cenozoic deposits cropping out at the Atlantic coast of South America. From these strata a number of new sand dollar species have been described over the last few decades (Martínez 1984; Parma 1985; Rossi de García & Levy 1986; Martínez & Durham 1988; Martínez & Mooi 1997, 2005; Mooi *et al*. 2000; Martínez *et al*. 2005). The specimens studied come from a locality named "P. Camarones" in the Chubut Province of southern Argentina. Although there is no exposure at Camarones itself, material from fossiliferous strata in the vicinity of Camarones have commonly been labeled with that locality name in the past. Unfortunately, these outcrops have never been described in detail or revisited during modern times. Attempts by one of us (CdR) to locate the classic "Camarones" outcrops during several field seasons have failed so far. While the presence of marine deposits could be confirmed, the fossiliferous sections which have delivered the "Camarones" mollusk and echinoid material present in the Ihering/Ameghino collection housed at the Museo Argentino de Ciencias Naturales B. Rivadavia could not be found.

The stratigraphic position of material derived from Camarones, therefore, is uncertain. The first reports of material from Camarones are those by Ameghino (1903) and von Ihering (1907). The latter referred the material to the "formation patagonienne inférieure" (von Ihering 1907: 230, 239, 240, 242). Camacho (1974) assigned the beds exposed around Camarones to the "Estratos con *Monophoraster* y *Venericor*" ("*Monophoraster* and *Venericor* beds" of del Río & Camacho 1998: 51) and later (Camacho 1979) proposed the designation "Camarones Formation" for these strata.

The *Monophoraster* and *Venericor* beds are Early Miocene in age (del Río 2004) and crop out well south of Camarones in the region of Comodoro Rivadavia (San Jorge Basin). Neither the bivalve *Venericor* nor the sand dollar *Monophoraster* were ever found at Camarones, so a correlation among these units is doubtful. Likewise, most molluscan species known from Camarones are not found anywhere else (del Río 2004: 1106), making any correlation to other, more reliably dated sections difficult. The precise stratigraphic age of the new *Abertella* species described herein is therefore not clear. Based on the fact that all well-dated occurrences of *Abertella* are of Miocene age, the most parsimonious assumption is for a Miocene age of *Abertella miskellyi* **n. sp.** This is corroborated by the fact that some of the molluscan species of Camarones are part of the *Nodipecten* sp.–*Venericor abasolensi*–*Glycymerita camaronesia*–Assemblage which in the San Jorge Basin is restricted to the early middle Miocene (del Río 2004).

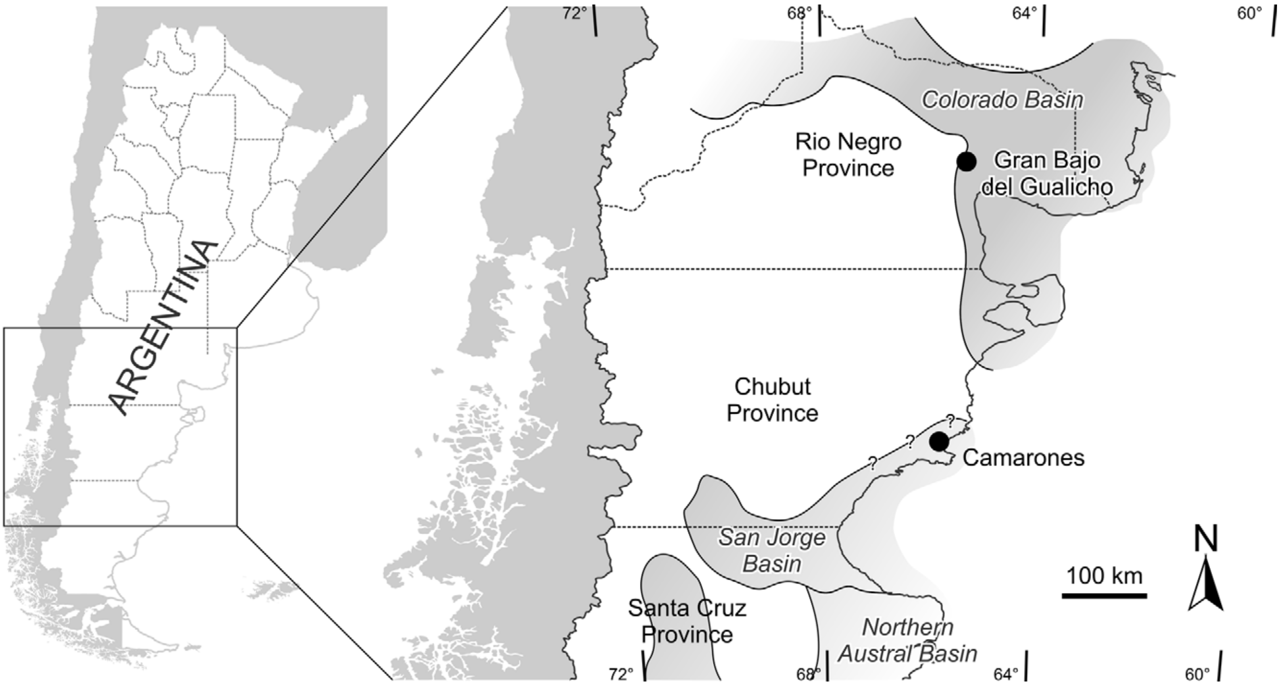

FIGURE 1. Geographical locations (black circles) of localities with *Abertella* in the Cenozoic of Patagonia. Location of the main Cenozoic basins modified from del Río (2004).

Material and methods

The specimens studied come from (and deposited in) the collections of the Museum für Naturkunde (Berlin, Germany). They were collected in 1922 by R. Vogdt from a Patagonian locality named “P. Camarones”. To the best of our knowledge they represent the only examples available of this new species.

Abbreviations

CAS	California Academy of Sciences, San Francisco, California, USA
NHMW	Naturhistorisches Museum Wien, Vienna, Austria
UCMP	University of California Museum of Paleontology, Berkeley, California, USA
TL	test length
TW	test width

Systematic part

Class Echinoidea Leske, 1778

Irregularia Latreille, 1825

Order Clypeasteroida A. Agassiz, 1872

Family Abertellidae Durham, 1955

Genus A*bertella* Durham, 1953

Type species. *Scutella aberti* Conrad, 1842, by original designation (Durham, 1953, p. 350).

Abertella miskellyi n. sp.

Figures 2A–F, 3A–B, 4, 5A–B, 6A–F

Diagnosis. *Abertella* with heterogeneous interambulacral basicoronal plates (small in interambulacrum 5, largest in interambulacra 2 and 3) and disjunct oral interambulacra involving two ambulacral plates rather than one in some of the interambulacral areas.

Etymology. Named after Ashley Miskelly, a fellow echinologist from Australia, for his continuous support and help in echinoid matters.

Types. Holotype is MB E.7463, from P. Camarones, Chubut Province, southern Argentina. Camarones Formation, Miocene. Paratype MB E.7462 has the same provenance as the holotype.

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Description. Adult test size exceeding 60 mm in length (Table 1). Aboral surface slightly domed, oral surface flat (Fig. 2C, F). Highest point of test located at apical system. Outline slightly angular when viewed from the aboral aspect. Test distinctly widened laterally (TW 115–120 per cent of TL), almost alate (*sensu* Mooi *et al*. 2000). Two very broad, but very shallow marginal indentations present in ambulacra I and V. Moderately deep anal notch at posterior interambulacral interradial suture opening at an angle of about 110–120° (Figs. 2, 3, 6D).

Apical system monobasal, slightly anterior, with numerous hydropores scattered over the madreporic plate (Fig. 6A). Four gonopores, one in each of the paired interambulacra and located at the suture between the madreporic plate and the first adapical plates of the interambulacral column.

Ambulacra petaloid adapically, extending about 50–58 per cent of the corresponding test radius. Petals almost closed distally, with three to five trailing podia (*sensu* Mooi 1989) at the distal end of each column of respiratory podia (Fig. 3A). Posterior paired petals longest, anterior paired petals intermediate in length, and anterior unpaired petal shortest. Respiratory podial pairs strongly conjugated, inner pore circular or almost circular, outer pore distinctly elongate (Fig. 6C). Only one or two occluded plates present at the tips of the petals (Fig. 4), sometimes none. Occasionally, a supernumerary interambulacral plate present where the petals end (Fig. 4). At the ambitus, ambulacra strongly widened, forming strip-like ambital plates (Fig. 3A). Ambulacrum III of both specimens (Fig. 5A-B) and ambulacrum II of specimen MB E.7462 (Fig. 5B) apparently disagreeing with Lovén's Rule (David *et al*. 1996). In specimen MB E.7462 a tiny plate seems to be present, wedged in between the basicoronal plates of ambulacrum III, re-establishing Lovén's pattern. Ambulacral basicoronal plates all similar, narrow and relatively short (Fig. 5). Interambulacral basicoronal plates unequally developed, shortest in interambulacrum 5 and longest in interambulacra 2 and 3, where they are strongly enlarged and almost twice as long as the ambulacral basicoronal plates (Fig. 5).

TABLE 1. *Abertella miskellyi* **n. sp.**: measurements (in mm).

	Holotype (MB E.7463)	Paratype (MB E.7462)
Test Length	61.2	64.8
Test Width	73.0	74.4
Test Height	8.0	7.3
Apex Position (from anterior edge of test to anterior edge of madreporic plate)	27.7	28.6
Petaloid I Length	19.4	19.2
Petaloid I Width (at widest point)	7.6	7.6
Petaloid I Interporiferous Zone Width (at widest point)	2.7	2.3
Petaloid II Length	17.2	16.5
Petaloid II Width (at widest point)	8.2	8.2
Petaloid II Interporiferous Zone Width (at widest point)	3.0	2.8
Petaloid III Length	15.2	15.1
Petaloid III Width (at widest point)	8.4	7.9
Petaloid III Interporiferous Zone Width (at widest point)	4	3.3
Peristome Diameter	2.9	3.1
Peristome Position (anterior edge of test to anterior edge of peristome)	29.2	30.0
Periproct Position (anterior edge of test to anterior edge of periproct)	52.9	55.4

Interambulacra narrow and straight, with four post-basicoronal plates in each half of interambulacral column on the oral surface. Interambulacra only about one-seventh the width of the ambulacra at the ambitus and forming narrow bands of radially elongated plates on the oral side. Interambulacrum 5 extremely narrow at the ambitus, being only about one quarter of the width of the other interambulacra. All interambulacra discontinuous, separated from the basicoronals by the first post-basicoronal pair and (in interambulacra 2, 3, 4, and 5 of specimen MB E.7463 and interambulacra 4 and 5 of specimen MB E.7462) one plate of the second ambulacral post-basicoronal plates (Figs. 3, 5). In the cases in which only one ambulacral plate is involved in the disjunction this plate has a pronounced, distally directed, curved extension that joins the proximal edges of the first interambulacral post-basicoronal plate.

Peristome (Fig. 6B) circular, almost central on the oral side, with a distinct perradial process in each ambulacrum extending into the peristome beyond the slight bulge containing the sphaeridium. Periproct small, close to the posterior margin, but placed distinctly on the oral surface, approximately four times its own diameter from the ambitus, and surrounded by second pair of interambulacral post-basicoronal plates. Area around the periproctal opening slightly raised (Fig. 6E).

Both aboral and oral tuberculation homogeneous. A clear differentiation of the oral tubercles in geniculate and locomotory spine fields cannot be observed (Fig. 6D).

Food grooves well developed (Fig. 6D–F), with primary bifurcation near the distal ends of the ambulacral basicoronal plates (Fig. 5A). After this branch point, grooves continuously diverge as they approach the ambitus, but secondary bifurcations apparently absent (Fig. 6E), or at least not discernible, even under very low-angle light conditions.

In the paired interambulacra very shallow channels are present extending from close to the peristome to the margin. They are visible under low-angle light conditions only (Fig. 6F). The margins of these depressions coincide with the strongly parallel buttresses on either side of this narrow interambulacral region known from other species of *Abertella*. It is possible that these depressions are taphonomically induced, due to sediment compaction deforming this relatively thin part of the test. Similar depressions occur in the region around the peristome in other fossil scutellines as well, and although they look very natural, are here interpreted as preservational artifact.

Occurrence. Known only from the type locality.

Discussion. *Abertella miskellyi* **n. sp.** is easily distinguished from all congeners by its heterogeneous interambulacral basicoronal plates. From its geographically nearest congener, *A. gualichensis* (lower to middle Miocene of Argentina), it additionally differs by its slightly deeper anal notch, narrower interambulacrum 5 at the ambitus, and lack of prominent, secondary branching of the food grooves.

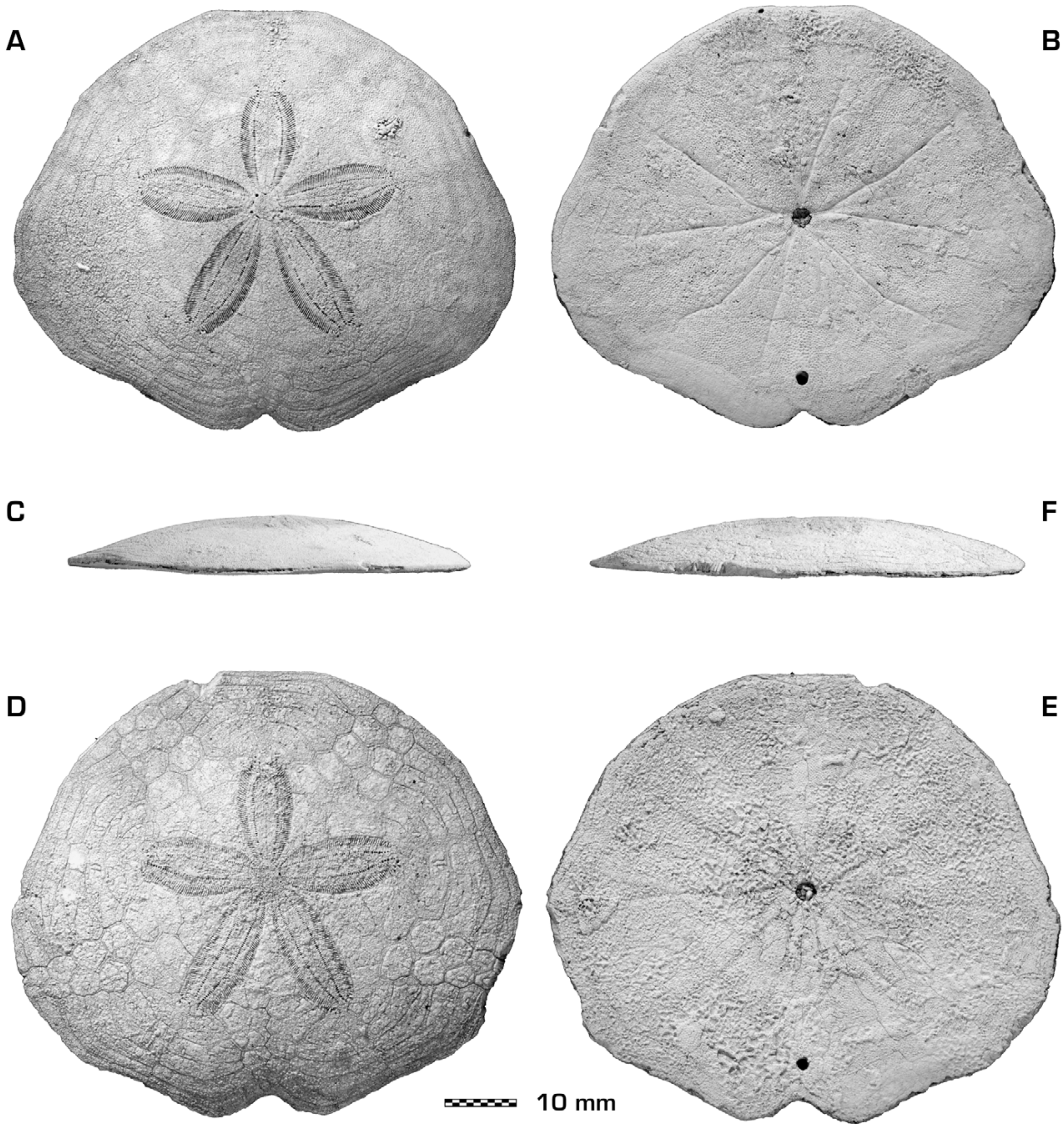

FIGURE 2. *Abertella miskellyi* **n. sp.** A–C: Holotype MB E.7463; D–F: Paratype MB E.7462. A, D: aboral views; B, E: oral views; C, F: right lateral views. Specimens whitened with ammonium chloride.

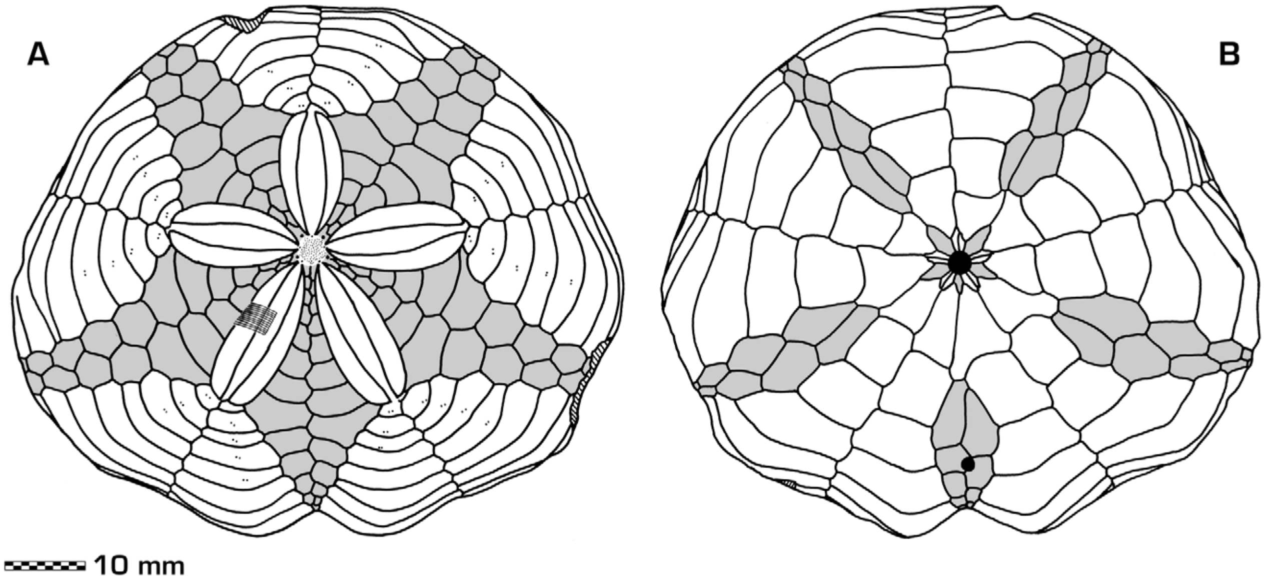

FIGURE 3. *Abertella miskellyi* **n. sp.**, Paratype MB E.7462. A: plate architecture of the aboral surface; B: plate architecture of the oral surface. Interambulacra shaded.

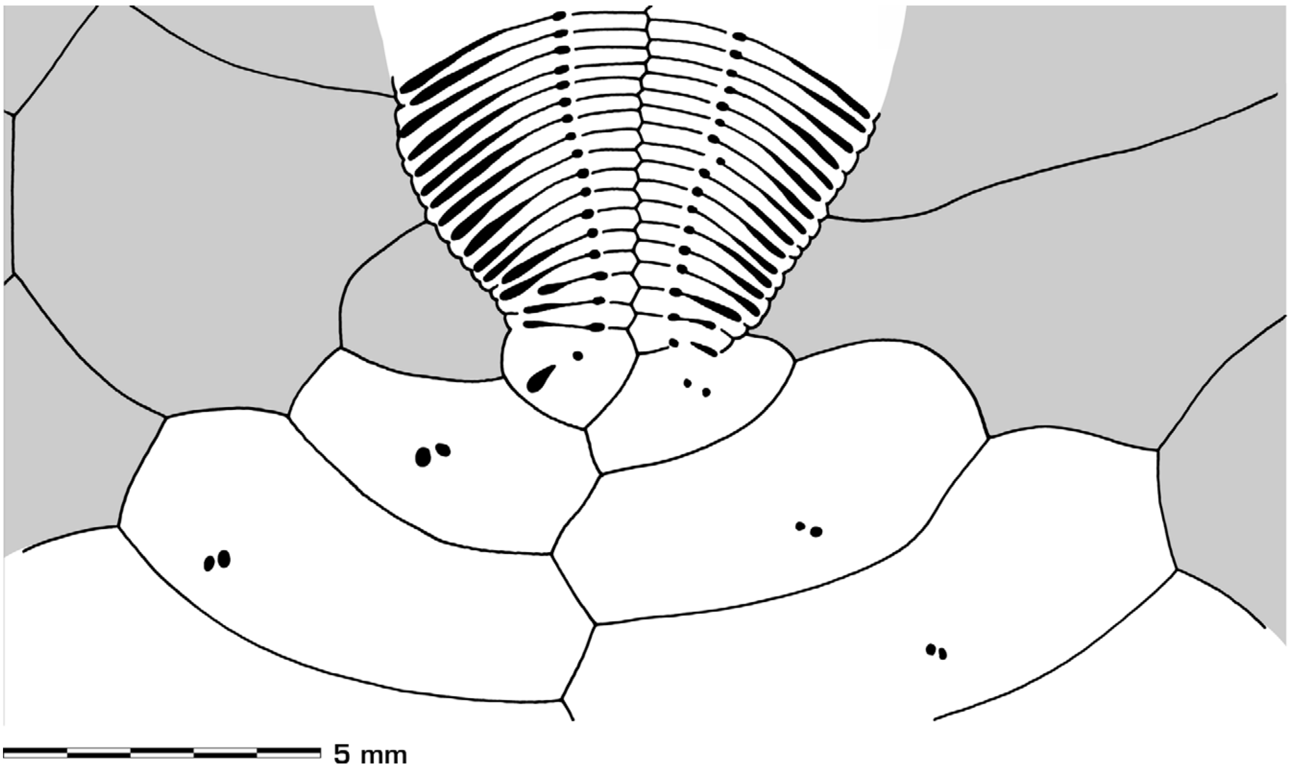

FIGURE 4. *Abertella miskellyi* **n. sp.**, Holotype MB E.7463. Detail of the plate architecture at the tip of petal IV. Interambulacra shaded.

The type species of the genus, *Abertella aberti* (Conrad, 1842) (= *Abertella floridana* (Cooke, 1942)) (middle Miocene of Maryland, USA), differs by its less widened outline, deeper marginal indentations and anal notch, larger petaloids, higher number of occluded plates at the ends of the petals, and wider oral interambulacra with hexagonal plates. The latter are strongly elongate in *A. miskellyi* **n. sp.**

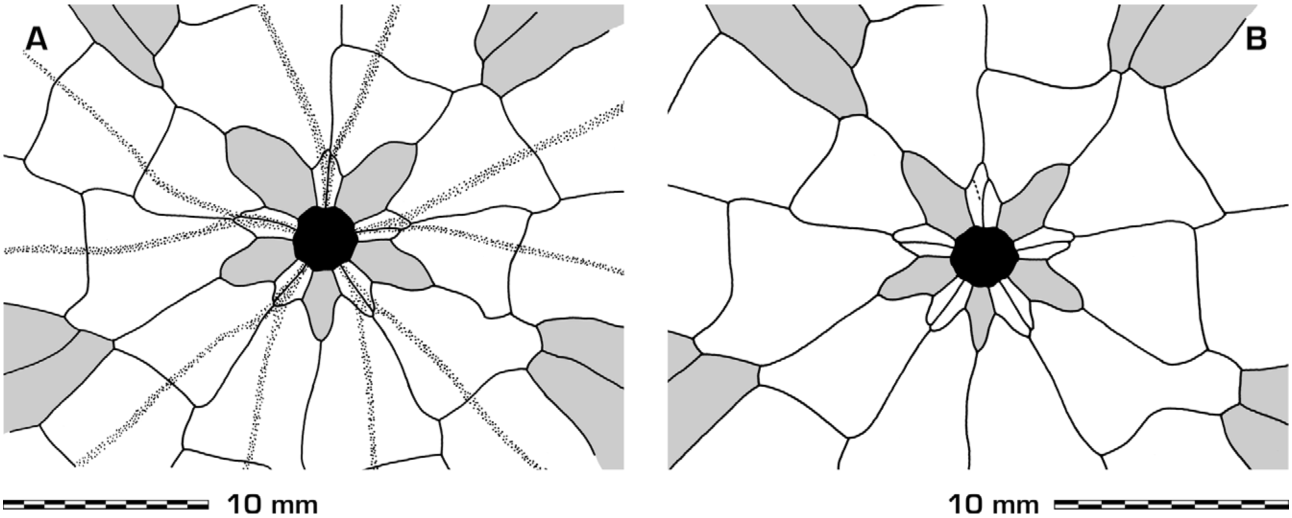

FIGURE 5. *Abertella miskellyi* **n. sp.** Plate architecture of the basicoronal circle of (A) the holotype (MB E.7463) and (B) the paratype (MB E.7462). Interambulacra shaded; food grooves (not visible in the paratype) stippled.

Abertella cazonensis Kew *in* Dickerson & Kew, 1917 (upper Oligocene or lower Miocene of Mexico) is very similar to *A. miskellyi* **n. sp.**, but differs by its more homogeneous interambulacral basicoronal plates, more circular test, much higher number of occluded plates at the ends of the petals, and interambulacral disjunctions involving only a single pair of adjacent ambulacral plates (based on re-examination of CAS material).

Abertella dengleri Osborne & Ciampaglio, 2010 (upper Miocene of Florida, USA) has a much wider test and narrower petaloids than *A. miskellyi* **n. sp.** From drawings in the original description and re-examination of CAS material, it would appear that there are at least 4 or 5 occluded plates at the ends of petals. Otherwise, the plate pattern of *A. dengleri* is largely unknown due to the strongly agatized mode of preservation of all known specimens.

Abertella? *habanensis* (Sánchez-Roig, 1949) (Oligocene to Miocene of Cuba) is very poorly known, but clearly differs from *A. miskellyi* **n. sp.** by its small, semicircular anal notch, homogeneous petaloid length, and sharply truncated posterior margin. The attribution of this species to *Abertella* is uncertain due to the fact that its plate pattern is unknown.

"Abertella" kewi Durham, 1957 (middle (?) Miocene of Mexico) is similar in shape to *A. miskellyi* **n. sp.**, but was found to possess continuous oral interambulacra (R. Mooi, unpubl. data, UCMP material) and therefore differs not only from *A. miskellyi* **n. sp.** but from any other member of the genus *Abertella*.

Abertella palmeri Durham, 1957 (lower Miocene of Guatemala) has a deep and narrow anal notch, deeper marginal indentations, trapezoidal outline, three or four occluded plates at the ends of the petals, and wider interambulacra at the ambitus.

Abertella pirabensis (Marchesini Santos, 1958) (= *A. complanata* Brito, 1981) (lower Miocene of Brazil) additionally differs from *A. miskellyi* **n. sp.** by its much deeper anal notch and different periproct position as illustrated by Marchesini Santos (1958), who showed the periproct as being framed by 5a2 and 5b2, as opposed to 5a3 and 5b3 in *A. miskellyi*).

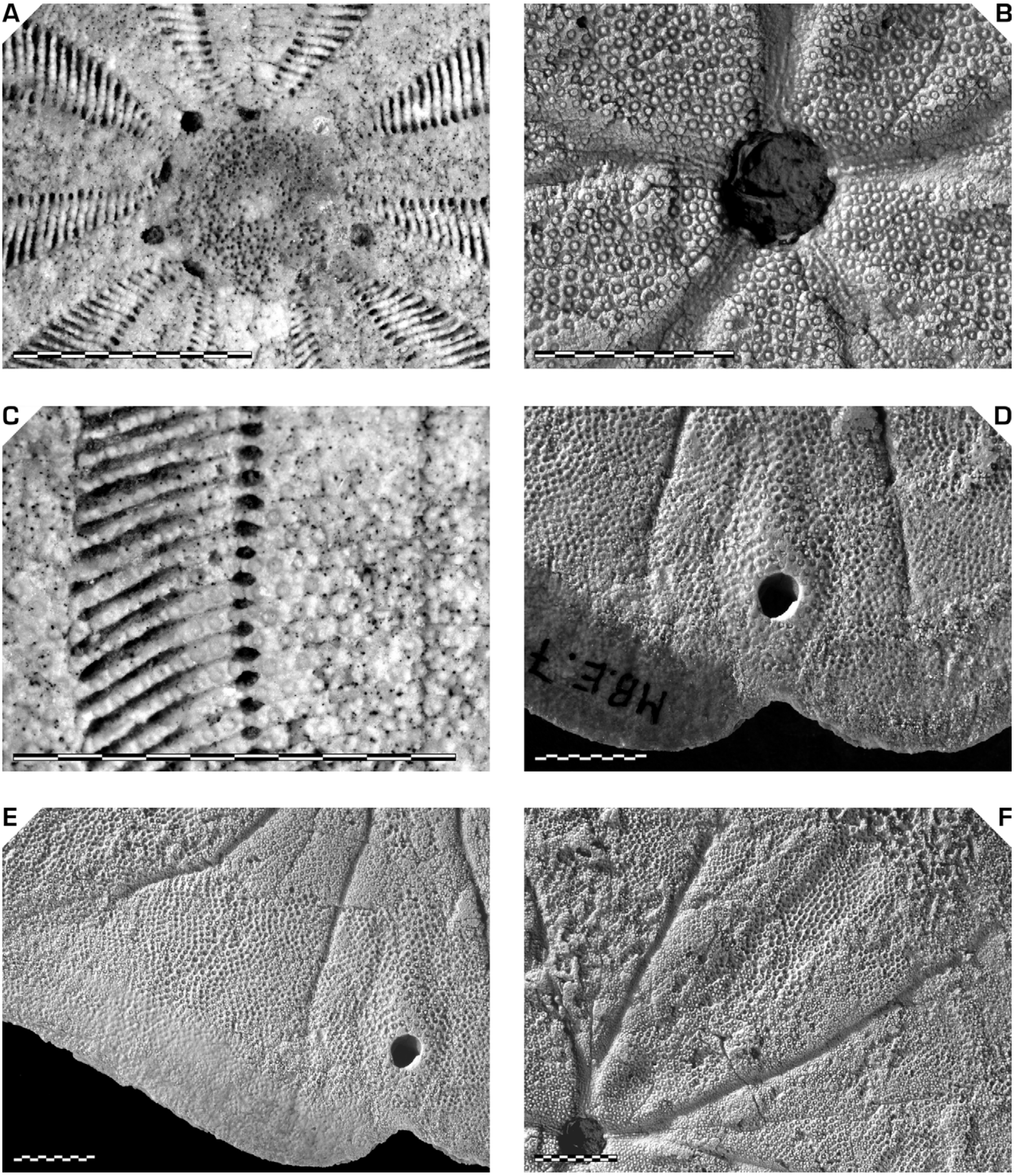

FIGURE 6. *Abertella miskellyi* **n. sp.**, Holotype MB E.7463. A: apical disc; B: peristome; C: poriferous zone of petal III; D: periproct; E: distal end of food grooves in ambulacrum I; F: tuberculation and surface structure in interambulacrum 3. Scale bars equal 10 mm. In B, D and F specimen whitened with ammonium chloride.

Key to species of *Abertella*

Note: *"Abertella" kewi* has been excluded from the key, since it does not conform to the characters of the genus and its placement is currently uncertain.

1. Anal notch shallow and wide (opening at an obtuse angle >90°) 2

1’. Anal notch deep and narrow (opening at an acute angle <90°) 7

2. Interambulacrum 5 strongly constricted at ambitus 3

2’. Interambulacrum 5 not constricted at ambitus 4

3. Interambulacral basicoronal plates all similar in size, more than 4 or 5 occluded plates at ends of petals . . . . . *A. cazonensis*

3’. Posterior interambulacral basicoronal plate only about half the size of the anterior paired interambulacral basicoronal plates, only one or two, if any occluded plates at ends of petals . . . . . *A. miskellyi* **n. sp.**

4. Posterior margin truncated on either side of posterior notch . . . . . *A.? habanensis*

4’. Posterior margin with projections on either side of posterior notch 5

5. Test much wider than long . . . . . *A. dengleri*

5’. Test length and width roughly equal *6*

6. Anal notch shallow, maximum depth half its width; distal oral interambulacral plates elongate . . . . . *A. gualichensis*

6’. Anal notch rather prominent, usually as deep as wide; distal oral interambulacral plates hexagonal, not elongate . . *A. aberti**

7. Periproct bounded by first pair of postbasicoronal plates (5a2/5b2) . . . . . *A. pirabensis*

7’. Periproct bounded by second pair of postbasicoronal plates (5a3/5b3) 8

8. Interambulacrum 5 strongly constricted at ambitus; distal oral interambulacral plates elongate . . . . . *A. palmeri*

8’. Interambulacrum 5 not strongly constricted at ambitus; distal oral interambulacral plates hexagonal, not elongate . . *A. aberti**

* *Abertella aberti* is included twice in the key, as some specimens of this species show a rather deep anal notch, whereas in the majority of the specimens it is only of moderate depth.

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