Biodiversity Journal, 2014, 5 (2): 269–290 **MONOGRAPH**

Analysis on a sample *of Echinodiscus* cf. *auritus* Leske, 1778 (Echinoidea Clypeasteroida)

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ABSTRACT In order to ascertain the extent of the natural intraspecific variability of living and fossil echinoids belonging to the family Astriclypeidae Stefanini, 1912, morphometric and structural aspects were examined in a number of specimens of extant *Echinodiscus* cf. *auritus* Leske, 1778, from Madagascar and Philippines. The data obtained will be compared, in a following work, with those of other echinoids belonging to the same family. The analysis of the results indicates, for the sample studied, a great variability in the length of the posterior ambulacral notches, in the petaloid length and in the position of the periproct respect to the posterior margin, while the study of the complete scheme of the plates has clarified the stability and constancy of some parts of this scheme and the variability of other. On the basis of these observations, it has been claimed that the variability of these measures is not so extensive as to affect or determine specific distinctions, if used without careful analysis of the plating pattern in particular in the interambulacrum 5 and in the ambulacra I and II. The results of these analyses, finally, suggests that these echinoids belong to a different genus, than *Echinodiscus* Leske, 1778.

KEY WORDS Astriclypeidae; *Echinodiscus* cf. *auritus*; morphometric variability; Recent.

Received 25.06.2013; accepted 30.05.2014; printed 30.06.2014
Paolo Stara (ed.). Studies on some astriclypeids (Echinoidea Clypeasteroida), pp. 225–358

INTRODUCTION

The variability in shape of some parts of the test in echinoids belonging to family Astriclypeidae Stefanini, 1912, has been a problem discussed for a long time (Stara & Fois D., 2014). Considering the wide variability in the extinct genus *Amphiope* L. Agassiz, 1840, Philippe (1998), in the absence of comparative studies on the intraspecific variability in living echinoids belonging to the same family, poses in synonymy many *Amphiope* species present in the Miocene levels of the Rhône Basin (Southern France). In fact, given the large variability in size and shape of the lunules of these echinoids, he concluded that most nominal species previously established should be in synonymy with the type species: *Amphiope bioculata* des Moulins, 1837. The same difficulties are also experienced by Stara & Borghi (2014) during the study of Sardinian's *Amphiope* species, some put in synonymy by Philippe (1998) and, later, also by other authors. In this case, however, the study of the species from Sardinia was addressed by analyzing both the variability of lunules, both the internal structure and the scheme of the plates that compose the test, as already done by other authors for this family of echinoids (Durham, 1955; Kroh, 2005; Pereira, 2010).

Therefore, the goal of this work is to verify the extent of the morphometric variability in some echinoids belonging to the genus *Echinodiscus*, in order to compare it with that observed by Stara & Borghi (this volume) on a sample of at least a hundred of specimens of different species of *Amphiope* collected in a number of Oligo-Miocene Sardinian outcrops.

MATERIAL AND METHODS

The samples examined are housed in the collections of the Museo di Storia Naturale Aquilegia of Cagliari (acronym MAC). Being irregular echinoids in bilateral symmetry, with the symmetry plane passing along the line stoma - procto, we realize that it was the distance measured along the test length (TL) could provide the major reference point, according by Kier (1972) and Stara & Borghi (2014). Therefore, specimens were ordered on the basis of the TL, as done previously by Lohavanijaya & Swan (1965), Alexander & Ghiold (1980) and Stelmle (1990).

We detected the structure of the test, showing the relative platings of the plates, as was done by Durham (1955), but including both faces of specimens. The internal structure was studied by sectioning the test, and by X-ray; 3 specimens from Mangili, 2 from Philippines were used for this purpose.

Because of the similarities between the two genera object of the parallel study, to reach homogeneity we use on *Echinodiscus* the same set of measurements used to collect data on *Amphiope* by Stara & Borghi (this volume) with the addition of some further measures, such as the attached drawings.

Morphological abbreviations (Fig. 1) ß angle between major axis of the two lunules; TL = Test Length; TW = Test Width; TH = Test Height; WA= ambulacral and interambulacral width at ambitus; L1-L2 = lunule length and width, respectively; L3 = distance between petal tip and corresponding lunule,

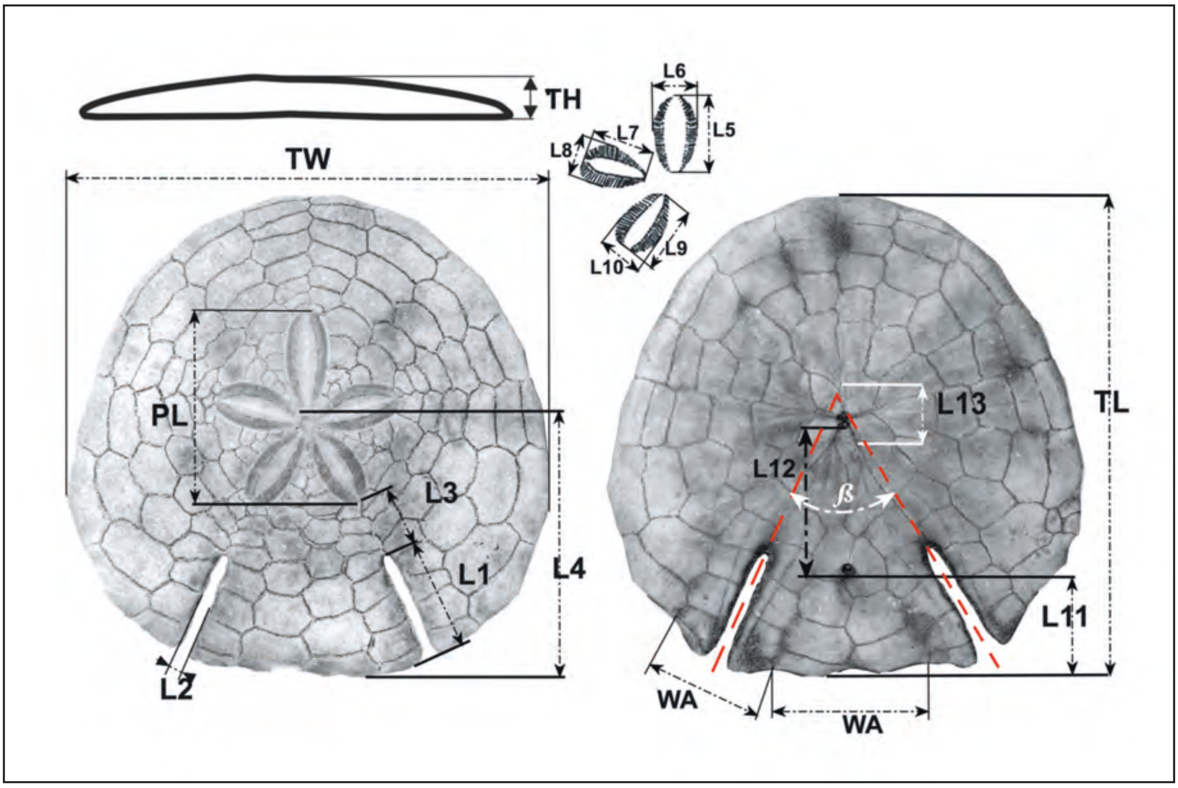

Figure 1. Biometric parameters measured in the studied samples.

L4 = distance apical system-posterior margin, L5–L6 = length and width of the frontal petal, respectively; L7-L8 = length and width of the anterior paired petal, respectively; L9-L10 = length and width of the posterior petal, respectively; L11 = distance between periproct and the posterior border of the test; L12 = distance between periproct and peristome, L13 = front-rear diameter of the basicoronal circlet. PL = Petalodium Length; ø pc = periproct diameter; ø ps = peristome diameter; Σ = summation. To reduce the lunules shape and dimension into a numeric value, we introduced a Shape Index (SI) corresponding to the ratio L2/L1 and a Width (wideness) Index (WI) corresponding to the formula (L1 + L2) / 2. In the chapters of the analysis/descriptions of samples/specimens, the interambulacrum 5 was abbreviated as inter 5.

Measurements were taken with caliper and/or metallic decimeter (with division to the millimeter) measures of TL and thickness of the anterior and posterior margins were taken in millimeter; all other linear measurements were reported as percentage TL; while the angular divergence between the axis of the notches, were detected in degrees, using a computer graphics program. The use of the percentages was adopted to decrease the influence of the variations due to the growth and to the difference in size. Finally, the width of the different ambulacral and interambulacral areas at margin (WA), was performed measuring the distance between the interradial sutures of each area.

Plates were numbered according to Lovén (1872) system and interambulacral areas were shaded in grey. The systematic classification used, follows Kroh & Smith (2010).

Note

Since it is very rare that minute spines, pedicellaria, parts of the lantern or even the soft parts of the intestines conserve, the information which we consider useful for the classification of fossils will be searched in the structure of the test and, where possible, in the internal support. Moreover, even many tests of living clypeasteroids, because of the fast taphonomic processes they are subject, they come to us devoid of spines. In order to observe and compare the internal structures of some specimens examined, we also used specimens dissections and numerous x-rays in supero-inferior position.

Critical value of the Spearman rank correlation ro (α, n), with α = 0.05 and n = number of samples, are extract from the table of critical values obtained through the software SuppDist (Wheeler, 2005) implemented in R and based on the method of Kendall & Smith (1939).

OBSERVATIONS ON SAMPLES

SAMPLE 1

Echinodiscus cf. ***auritus*** Leske, 1778
Recent, Philippines (Plate 1 Figs. 1–8; Plate 2 Figs. 1–9; Figs. 2 a–d; Tables 1, 2).

EXAMINED MATERIAL. 5 specimens from Talibon in the north of the Bohol island, dredged at 50 m depth, code MAC.IVM 206 - 210, TL. 131 ÷ 154 mm; 5 specimens from Oslob, Cebu Island, MAC.IVM 211–215, TL 125 ÷ 173 mm; 2 specimens of generic provenance "Philippines" MAC.IVM81, 133; TL 150 and 152 mm.

GENERAL. In detail, the line of the ambitus is almost always polygonal, with almost rectilinear sections in correspondence of the different ambulacral and interambulacral areas. The line of the rear edge, with the two ambulacral notches, forms a "dovetail", which is always very irregular and sometimes is asymmetrical (Plate 1 Figs. 1, 2). In some cases, the "tail" protrudes from the ideal line of the ambitus, in other cases it does not arrive there because of its shortness; sometimes it is not straight and draws an arch that seems to continue the roundness of the rest of the ambitus. For this reason, it often happens that the two sides of each notch show a different length. The irregularities that occur along the margins, or even inside the notches, sometimes seem to be caused by attacks of predators, or by deformities present at birth, or by growth malformations. The test is very depressed (mean = 8% TL); the highest part of the test is located just before the apical disc which is eccentric forward, in a range that should be 54–58% TL. From a side-view, the profile is not uniformly tapered but, starting from the posterior margin, it goes up with a slight slope along the length of the notches, then it increases rapidly until just beyond the peak, from where it descends rapidly towards the anterior margin. The ambital margin is thin and sharp rear (0.8 to 1.5 mm), and it becomes thicker more and more, as it gets closer to the front where the thickness varies from 2.5 to 3.5 mm. The adoral surface is flat or slightly plano-concave, with the inner point near the peristome; the last one is opened in a central position.

Test structure. In summary, the structure can be divided into two main parts: the central cavity, which houses most of the viscera, and the peripheral system that mechanically "supports" the whole test (Plate 2 Fig. 1). It is noted that the distribution of the interior supports (pillars, buttresses, "trabeculae") is not linked to the plates distribution, so they do not constitute the inner extension of their structure.

Visceral hollow. This central cavity contains both the gut and the main vital parts (inner part of the respiratory organs, reproductive organs, etc.). In plan view, the shape is roughly rounded-polygonal, with the base line lying between the two rear ambulacra and located at right angled of the inter. 5. From the rear wall to the front, the length of the hollow corresponds to an average of ≈ 43% TL. From this cavity opens some pocket containing several vital organs, and two elongated cavities: one of these opens along the ambulacrum II and contains the caecum, while the other one, longer, contains the terminal intestines along the inter. 5 and leads into the periproct. L. Agassiz (1838–41) described in detail the path of the intestine compared to visceral hollow. From the aboral view the visceral cavity of these echinoids coincide with the width of the petalodium, whose PL ≈ 43% TL (Table 2). From the adoral side, instead, the visceral hollow is roughly contained into the limits of the first distal ambulacral post-basicoronal plates that are particularly extended, as you can see from the relative plating. The visceral hollow ceiling is supported by a system of 5 trabeculae that, from the lateral supports of the cavity (pillars and cellular tissue) run along the interambulacra, between the petals, until they join the reinforcement ring that supports the apical disc and the components connected to it (Plate 2 Fig. 2). The poriferous areas are flat, or in some cases slightly sunken. The Aristotle's lantern rests around the peristome, which opens at the center of the floor and has a sub-pentagonal outline. The auricles which support the lantern, flanked distally from navicular pits, stand on the basicoronal interambulacral plates (Plate 2 Figs. 6d, 7a). The plank is formed mainly by post-basicoronal ambulacral plates; these ones are thin, measuring less than 1 mm thick, but they are reinforced by a "network" mesh structure more and more thick and dense as it gets closer to the side walls of the visceral hollow. Looking down the hollows, it is noted that the lantern covers most of the floor because it's relatively large in this population of echinoids. The lantern is "balanced" on the auricles, and it is moved by a system of ligaments attached to the perradial ambulacral sutures.

Apical disc. The apical disc is star-shaped with the points turned towards the interambulacra and is formed by a small madreporite (mean width = 5% TL), in which the 4 genital pores open. The genital and the ocular pores can be observed only on naked specimens (Plate 2 Fig. 3).

Peripheral ballast system. This system is formed by a sandwich composed by the oral and aboral parts of the test, each with its own combination of plates, and from an internal "cushion" formed by pillars or by buttresses of tissue with a cellular structure, crossed by more or less wide cavities. This "cushion" (with a probable coelomic origin) is formed by emi-structures that extend from the plates and are joined together in a plane more or less median (Plate 2 Figs. 4a, 6a). You note that the structure formed by radial ribs and micro-canal that constitutes each plate, and which is evident after erosion, is the evidence of the direction of the growth of the same, which follows the distribution of the microchannels of the aquifer system and that isn't related to the direction of growth of the underlying internal structures. This complicated "sandwich" system constituted from plates, buttresses and trabeculae, reaches the ambitus where, in general, the last plate is "refolded" on itself in a peculiar way, forming precisely the margin. Counting the plates, in fact, you will sometimes consider that the last plate of a face is also the first one of the other face; only in some cases the two plates that delimit the upper and lower face appear to join up to the margin.

To illustrate this peripheral system of reinforcement, we also used simple radiological techniques, which show well the pillars, buttresses support and internal cavities distribution, and that is becoming a potential diagnostic tool (Plate 2 Fig.1).

AMBULACRAL AREAS. Along these areas opens the petals and the upper part of rear notches. The petals are closed, long twice their width and are sub-equal to each other (mean L5 = 23% TL, L7 = 19% and L9 = 20.5%). In 7 out of 12 specimens of this group, only one pair of post-basicoronal ambulacral plates occlude those of inter. 5; in the remaining specimens (MAC.IVM206; 207, 208, 209, 211, 212; 81) the inter. 5 is occluded by two pairs of post-basicoronal plates (Figs. 2b, c). The doubling of the post-basicoronal ambulacral plates in the ambulacra I and V, sometimes leads to a shifting of the position of the periproct towards the rear margin. In the ambulacra I and V, the width at the ambitus WA, is on average the 23% TL and the plates per column are 14-15; in the ambulacra II, III, IV, the WA are on average 37% TL but the plates are 12–13 in the ambulacra II and IV, while they are 13–14 on the ambulacrum III.

NOTCHES. The notches extend along the perradial sutures of the rear ambulacrum and they are opened in the posterior margin. Differences in shape and asymmetries observed in these notches, are common and therefore we have considered them as normal. The length of the notches (L1) in this sample varies from 18 to 27% TL (mean 23%). Because of the constant presence of deformations and/or malformations along the notches, the detection of L2 is not significant from a statistical standpoint. The notches are surrounded by 4 and 4 plates per column on the oral face and by 4–5 plates per column on the aboral one, approaching, therefore, to a 1/1 ratio (Fig. 2a–c). Between the petal tip and the corresponding notch there are 3–4 couples of plates, while, on the oral face the notches opens between the plates 4a/5b or 5a/4a. The ß angle is small and on average is almost 57° (Table 2).

INTERAMBULACRAL AREAS. The WA in interambulacra 1 and 4, is 40% TL and the plates per column are 14-15; in the interambulacra 2, 3, 5, however, the WA is on average 33% TL, while the plates per column are 15-16. The WA remains relatively constant, with the areas of the interambulacra 1 and 4 always larger than the other. The number of post basicoronal plates in inter. 5 is always 3 in column "a" and 3–4 in column "b".

PERIPROCT. The periproct is round (range 1.5–2, average 1.8% TL) and far from the rear margin (L11 = 14.5 ÷ 24.5% TL, average = 20%). Except a clearly abnormal specimen, the periproct always opens along the suture between the post-basicoronal plates 2b and 2a, that are partially paired (Figs. 2b, c).

FOOD GROOVES. The adoral face is crossed by very branched food grooves. Every single column in the ambulacral plates is traversed in the center by a main groove, which are joined to other numerous secondary thinner and less deep grooves (Fig. 2d). Other large grooves are joined to the main one at various levels: on the ambulacra I, II, IV and V these converge to the greater one in the middle of the corresponding ambulacral column; on the III, however, in several cases the secondary grooves converge closer to the stoma, within the post basicoronal area. Finally, the two main grooves of each column are joined exactly at the height of the tip of the basicoronal ambulacral plates, that then lead to the stoma. In the rear ambulacra they run along both sides of the notches. The ambulacral plates crossed by food grooves have a greater deflection near of the stoma.

PERISTOME AND ARISTOTLE'S LANTERN. The peristome varies from rounded to sub-pentagonal shape and is relatively small (mean = 3% TL). The basicoronal circlet is small (mean L13 = 11% TL). The basicoronal interambulacral plates are quite regular and always are disjointed from the corresponding post-basicoronal ones. The Aristotle's lantern is very flat and especially developed in width, and it is formed by five jaws delta-wing shaped, whose bisector is a groove within where the teeth run horizontally. The teeth are knife shaped, with the sharp end facing toward the stoma (Plate 2, Figs. 5, 8); Always along the bisector near the stoma, a small fork and the corresponding navicular dimples that fit in the underlying auricle are located in each jaw. The jaws are held together by ligaments attached to perradial ambulacral sutures. We verified if there was a direct relationship between the size of the lantern and the size of its basicoronal circlet. In the specimen of Bohol, MAC.IVM209 (TL = 152 mm) the size of the basicoronal circlet (L13) is 11.5% TL; the height of the pentagon formed by the Aristotle's lantern, as in the plating, measures ≈ 40 mm, equal to 26.3% TL; the distance between the support of the inter. 5 and the edge of the stoma is of ≈ 6.5 mm and the diameter of the stoma exceeds 3.5 mm.

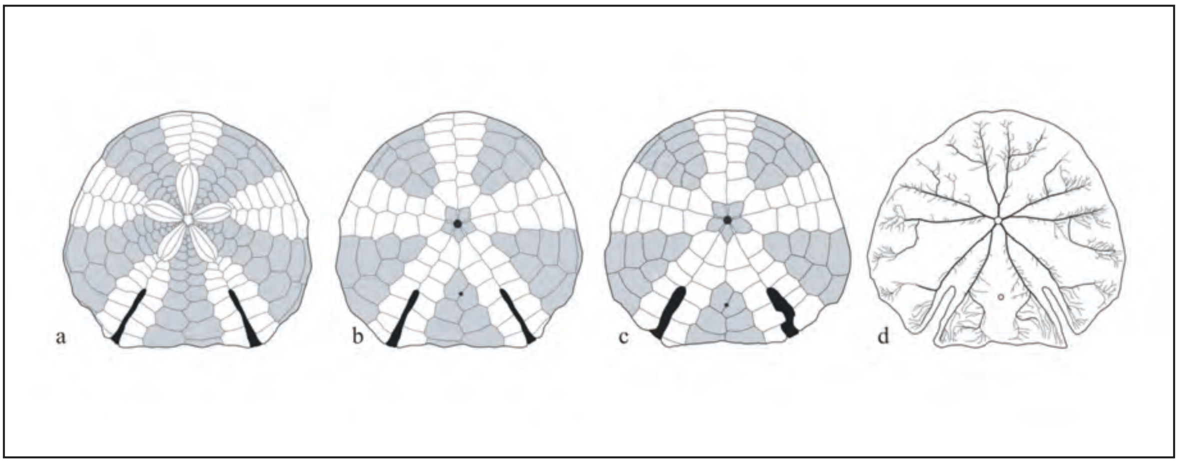

Fig. 2: "*Echinodiscus*" cf. *auritus*, Recent, Philippines: a, b) respectively, aboral and oral plate structure of MAC.IVM 210; c) oral plate structure of MAC.IVM 211: d: food grooves.

Specimen	TL	TW	TH	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	øPc	øSto
IVM215	173	103	7.5	21.5	2	13.5	57	22	11.5	18	10	20	9.5	21.5	31	11	1.8	3
IVM208	131	104	7.4	26	2	17	55	20	10	16.5	9.5	17	8	20	33	10	1.5	2.8
IVM210	141	104	7.4	27	1.5	14	54	22	10	17.5	9	19	8.5	22.5	28.5	10.5	1.8	2.5
IVM206	148	103.5	7.4	25	2	11.5	55	21	9	18	9	18.5	8	24.5	28	9.5	1.5	2.5
IVM209	152	106.5	9.2	22.5	2.5	15.5	56	24.5	12	18.5	11	20	10	20	31	11.5	2	2.8
IVM081	152	102	7.5	20	2	12.5	54	27	10	22.5	10	23	9	14.5	35	11.5	1.6	3
IVM213	152	106	8.5	23	3	12.5	56.5	24.5	12.5	19	11.5	21.5	10.5	22	30.5	12.5	2	3.5
IVM207	154	101	8	18	2.5	15	56	22.5	11	20.5	10.5	22	10	17.5	32	11.5	1.8	2.5
IVM214	156	108	9	25	3	12	58	23	13.5	21	13	22	12.5	21	31.5	11.5	2	3.2
IVM212	157	103	9	22.5	3.5	10	56	26	13.5	20	12.5	20.5	11	20	31.5	12	2	3.5
IVM211	159	105	8	24	4.5	14	57	23	11.5	20	10	22	9.5	16.5	35	11.5	1.6	3.5
Range		101 - 108	7.4 - 9.2	18 - 27	1.5 - 4.5	10.0 - 17.0	54 - 58	20 - 27	9.0 - 13.5	16.5 - 22.5	9.0 - 12.5	17.0 - 23.0	8.0 - 12.5	16.5 - 24.5	28.0 - 35.0	9.5 - 12.5	1.5 - 2	2.5 - 3.5
Mean		104	8	23	2.5	13	56	23	11	19	10.5	20.5	10	20	31.5	11	1.8	3
Variance		7		9	3	7	4	7	4.5	6	3.5	6	4.5	8	7	3	0.5	1
Range-V		4.7		39	120	54	7	30	41	31.5	33	29	45	40	22	27	28	33

Table 1. Morphometric data of "*Echinodiscus*" cf. *auritus* (Philippines, Recent). TL in mm, other data in % TL.

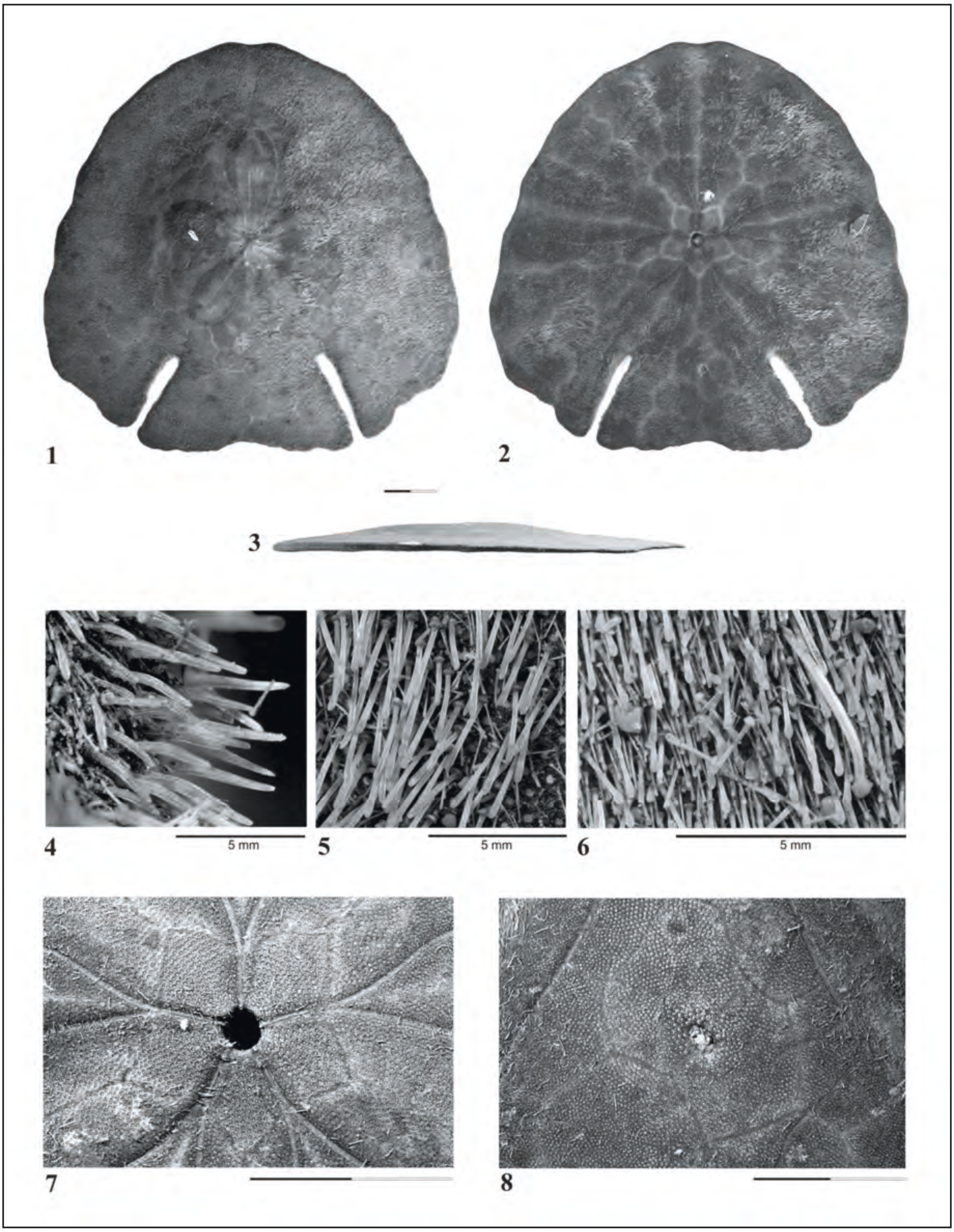

Plate 1: *Echinodiscus* cf. *auritus* from Philippines (Recent): external features. Figures 1, 2, 3. Aboral, adoral and lateral views of MAC.IVM 212. Figure 4. Close up view of the pointed spines on the inner slits surface. Figure 5. Primary and secondary aboral spines. Figure 6. Claviform primary and secondary aboral spines. Figure 7. Tuberculation and food grooves of the peristomial area. Figure 8. Periproct, tuberculation and food grooves on posterior areas.

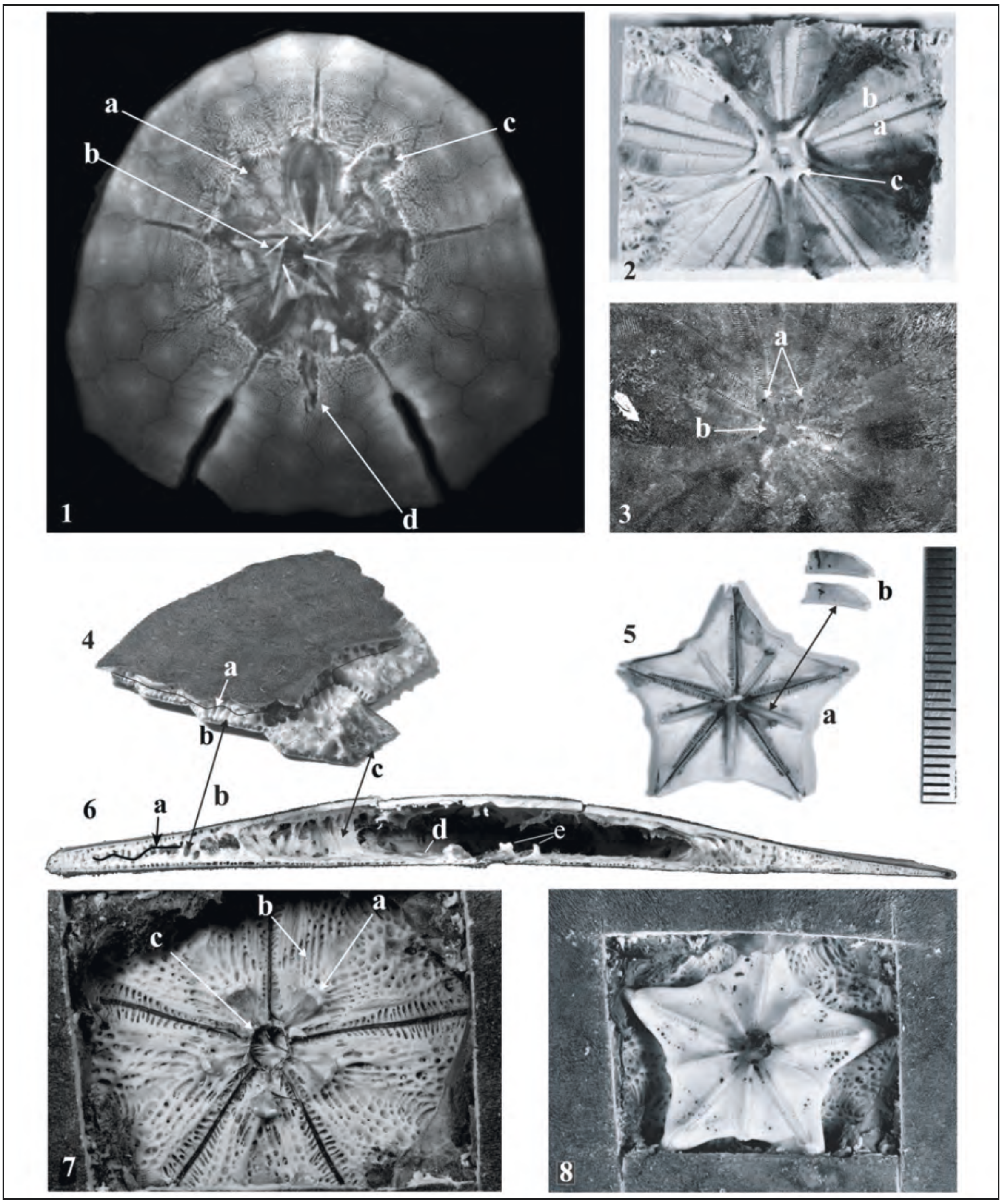

Plate 2. *Echinodiscus* cf. *auritus* from Philippines (Recent): internal features. Figure 1. Radiograph of specimen MAC.IVM 215 (Dap = 173 mm): a) central hollow; b) teeth on wing of disarticulated lantern; c) caecum cavity; d) terminal intestine cavity. Figure 2. Internal view of ceiling of central hollow: a) interporiferous areas; b) poriferous areas; c) apical disk reinforcement. Figure 3. Corresponding external view of apical disc: a) genital pores; b) madreporite. Figure 4. Fragment of the test with: a) separation surface of internal structures; b) peripheral pillar and buttresses; c) walls delimiting the central hollow. Figure 5. Aristotle's lantern of MAC.IVM 209, upper view: a) jaw; b) teeth. Figure 6. MAC.IVM 209: antero-posterior section (from the left to the right); a) separation surface of internal structures; b) peripheral pillar and buttresses; c) walls delimiting the central hollow; d) floor of the central hollow; e) lantern supports. Figure 7. a) lantern support; b) rib in a network of floor reinforcement; c) peristoma. Figure 8. MAC.IVM 209: Aristotle's lantern in position.

In the specimens MAC.IVM81, with the same length as the previous one, L13 is ≈ 12% TL; the height of the pentagon of Aristotle's lantern measures 38 mm, equal to 25 % TL; the distance between the support of the interambulacrum 5 and the stoma is 7 mm, equal to 4.6% TL, while the diameter of the stoma is 3 mm. In the specimen MAC.IVM206 (TL = 148 mm), the lantern measures 30 mm, which corresponds to ≈ 20% of the TL. So the size of Aristotle's lantern varies, in the specimens tested, around 20-26% TL and does not seem related to the width of the basicoronal circlet (L13). The basicoronal interambulacral plates are flat and studded with large tubercles crenulated and perforated. The spines that surround the stoma, post-mortem, are inclined to cover it completely.

TUBERCULATION AND SPINES. In the oral face the tuberculation is dense, consisting of primary tubercles medium sized, poorly differentiated and extended over the face, and secondary tubercles that form a granulation background, scarcely distinguishable. The tubercles are larger around the periproct and the smaller sized ones are found particularly along the main food groves (Plate 1 Figs. 7, 8). In the aboral face the tubercolation is undifferentiated, thick and petite, evenly distributed over the entire surface.

The spines are well differentiated according to the areas in which they are located, the larger are surrounded by numerous small ones, that are also much thinner. Both types are more or less cylindrical, slightly thinner distally, and traversed by numerous thin longitudinal ribs, and both end with a rounded tip (Plate 1 Figs. 4–6). Spines of medium and large size are found around the stoma; other ones with a medium-length cover ambulacral center areas, including the entire length of the notches, even on the inner surfaces; other spines, much shorter and thinner and with a hinted club-shaped, however, cover the areas around the food grooves. Along the ambitus and along the notches there are often curved and sharp spines. Also, together spines of medium length, cylindrical and with pointed termination, there are stubby, short and clearly club-shaped spines. Even all the aboral face is covered from thickly spines, generally smaller than those already described. Apart the surfaces of the petals, where the spines are cylindrical and pointed, and near of the notches, there are transitions forms of spines between those of the adoral face and those of the aboral one, while all the other spines have club-shaped with the ends decidedly thickest of the rest of the stem (Plate 1 Fig. 6).

Specimen	TL	Apical disc	PL	WA	ß
IVM206	148	4.5	41	33	61
IVM207	154	4.5	43	30	58
IVM208	131	5	40	37	57
IVM209	152	5.5	45	37	54
IVM210	141	5	41	33	55
IVM211	159	4	45	30	56
IVM212	157	4	48	32	56
IVM213	152	4	45	34	57
IVM214	156	5	43	34	59
IVM215	173	4.5	43	34	55
Mean		4.6	43.4	33.4	57
Range		4-5.5	41-48	30-38	54-61

Table 2. Morphometric data of apical disc, PL, WA and ß, in "*Echinodiscus*" cf. *auritus* (Philippines, Recent). TL in mm, ß in degree, other data in % TL.

SAMPLE 2

Echinodiscus cf. ***auritus*** Leske, 1778

Recent, Madagascar (Plate 3 Figs. 1–7; Plate 4 Figs. 1–7; Figs. 3a–c; Tables 3–7)

EXAMINED MATERIAL. 32 specimens from Mangili, Province of Tulear, caught in back-barrier lagoon, ≈ 5 to 8 m deep, MAC.IVM82 - 113, TL = 74 ÷ 140 mm.

GENERAL. The ambital line is almost polygonal; the posterior margin line, sited between the two notches (the tail), is always irregular and often very asymmetric. Although in smaller individuals seem to prevail lines with a rounded shape, the larger individuals present clearly truncate lines.

As in the specimens coming from Philippines, in some cases the "tail" comes out from the ideal rounded line in the ambitus (Plate 3 Figs. 1, 2). The test is medium - large (max TL = 140 mm), with a consistent variability of the relationship TL/TW, and very depressed (mean TH = 8% TL). The highest part of the test is located at the apical disc that is forward eccentric (mean L4 = 55% TL). The side profile is slightly and almost uniformly sub-conical. Starting from the posterior margin, it rises almost uniformly and then decreases as the inclination, finding the maximum in an area that has the apical disc in the center. This trend is repeated to the anterior margin, just a little steeper (Plate 3 Fig. 3). Only on some larger specimens the line of the rear profile rises more gently towards the top and remained low over the "tail" of the echinoid. On the specimen MAC.IVM111 (TL = 140 mm), the ambitus is thin and sharp posteriorly (0.8 mm), but it thickens more and more as it gets closer to the front, where the margin is often ≈ 2.5 mm and rounded. The adoral surface is flat or slightly plano-concave, with the inner point near the peristome; the last one opens in a central position (L11+L12 mean = 50% TL). The periproct is far from the posterior margin (L11 = 17 to 23.5 % TL). Especially in larger specimens there are showy deformations, due to both growth malformations, or to damage from predations. Many of these damages from predation are self-repaired in life, since they are covered with new tubercles.

TEST STRUCTURE. The structure of the test of these echinoids is not very different from that of the specimens coming from the Philippines; this structure can then be divided into two main parts: the central one, which contains visceral cavity, and the peripheral one, which contains the pillars and buttresses made of cellular structure (Plate 4 Figs. 1, 4).

VISCERAL HOLLOW. On the specimen MAC.IVM111, this cavity has a rounded to sub-pentagonal plan, with the base placed between the rear ambulacra and right-angled to the interambulacrum 5; the distance between the extreme rear and the front of the hollow is approximately 38% TL. In general, from an upper view the echinoid present the visceral hollow circumscribed into the petalodium (mean PL = 40), while the floor ends before the distal limit of the first post-basicoronal ambulacral plates. The ceiling structure of the visceral hollow is comparable to that of the specimens coming from Philippines; the surface of the interporiferous areas are raised, while that the poriferous ones are flat or very slightly concave. Unlike the specimens coming from the Philippines, the relationship between basicoronal and post-basicoronal plates is very changeable even in the same specimen itself. This population shows a high variability in the development of the basicoronal interambulacral and the post-basicoronal ambulacral, while the development of the other plates is normal (Plate 5 Figs. 3–5).

APICAL DISC. the small apical disc (about 5.5% TL) is formed by the star shaped madreporite, and presents 4 genital and 5 ocular pores (Plate 3 Fig. 4). All the specimens are adult and present all the 4 genital pores open.

PERIPHERAL BALLAST SYSTEM. Also for the structure of the visceral hollow, there are no fundamental differences compared to those of the specimens coming from Philippines. The ribs, the pillars and the reinforcing buttresses seem more delicate than the ones of the Philippine specimens (Plate 4 Figs. 4–5).

AMBULACRAL AREAS. The petals are sub-equal, long about twice of their width and always closed, but the overall shape varies also conspicuously (mean L5 = 21%; L7 = 19%; L9 = 18.5% TL). There are interporiferous areas wide 1.2 to 2 times than the poriferous ones.

Given the numerical strength and the size range of this group of echinoids, we detected changes in petals size in relation to the size of the test (see Table 4). In all the specimens of this group, only a pair of post-basicoronal ambulacral plates occlude those of the interambulacrum 5 in the oral face. Unlike the Philippine sample, in this one the relationship between the basicoronal and post-basicoronal interambulacral plates is highly variable, with also several joint plates in the same specimen (table 5). In the ambulacra I and V, the WA is on average the 23% of TL and the plates per column are 14-15; in the ambulacra II, III and IV, WA is on average the 37% TL, while the plates per column are 12-13 in the II and IV, and 13-14 in the ambulacrum III.

Rear notches. There is a high frequency of malformations and deviations in the population, due either of delayed or unfinished processes of disjunction, occurred perhaps in the course of the individual development. In specimens MAC.IVM108, 111 and 112, the two long edges of the notches have not completed the disjunction, in other cases the notches are very malformed. Often they are also very asymmetric, so the two notches are quite different in the same individual. In this group of echinoids the disjunction of lunules interests 4–5 couples of plates on the oral face and 4–5 on the aboral ones, with a 1/1 ratio. Between the petal tips and the beginning of the notches there are 4 or 5 plates per column, in the oral face the notches opens between post-basicoronal plates 3a/3b. ß range from 49° to 62° for an average of 55° (Table 6).

Interambulacral areas. The WA of the interambulacra 2, 3, 5 measures on average the 32% TL; on the interambulacra 1, 4, however, measures on average the 40% TL. The number of plates in the ambulacra 1 and 4 are 14-16, such as in the interambulacra 2 and 3, while on the inter. 5 they are 13-14. In the oral face the inter. 5 is always occluded and it has always 4 and 3 post- basicoronal plates per column.

Periproct. The periproct is small, because in young specimens it is the 2.6% while is about the 2% TL in the larger ones. L11 is less variable than in the sample coming from the Philippines, but the average of L11 is always ≈ 21% TL. In almost all the specimens (31 of 33) the periproct opens between the plates 2/2b in the inter. 5; only in two specimens it is at the end of said suture, in position 2a/2b/3a (Table 5).

Food grooves. The food grooves in this sample do not differ much from those coming from the Philippines, only in some specimens, the two grooves of each ambulacral column join together a little before the tip of the basicoronal plates (Fig. 3c).

Peristoma, Aristotle’s lantern and basicoronal circlet. In this group of echinoids the peristoma is circular, with a diameter ranging from 4 mm on smaller samples, up to 3 mm of the larger ones (overall average 3.5%TL). The basicoronal circlet is small (mean L13 = 11.5% TL). The basicoronal interambulacral plates are completely irregular, with considerable variations in length and shape, which can diversify from triangular to lanceolate and very elongated. Often, even in the same individual, there are some post-basicoronal plates in contact and other disjointed; also, the second interambulacral plates, disjointed or not, can be found both in meridoplacous or amphiplacous condition (see Table 5). The Aristotle's lantern supports stand, on the floor of the visceral hollow of the basicoronal interambulacral plates (Plate 4 Figs. 4, 6) ; given that the length of the plates varies greatly, we observed that the relative position of the supports is independent. In the specimen MAC. IVM112 (TL = 140 mm) the pentagon formed by the lantern measures 15.3% TL, absolutely far from the 20.2% of the TL detected in the sample MAC.IVM206 (TL = 148 mm) coming from the Philippines. In another sample of TL = 116 mm, the lantern measures about 15% TL.

From what has been observed, it is clear that the abnormal length of the basicoronal interambulacral plates does not seem to lead to consequent structural changes.

Tuberculation and spines. On the oral face the tuberculation is dense, consisting of medium sized tubercles, poorly differentiated and extended over the entire surface. The tubercles are larger around the periproct (Plate 3, Figs. 5–7) and the smaller ones are found particularly along the main food grooves. On the aboral face the tubercolation is undifferentiated, thick and petite, evenly distributed over the entire surface.

The echinoids of this sample are devoid of spines, except in some restricted areas, such as the edges of the stoma and the inner surfaces of the notches. The spines that we have observed are not dissimilar to those observed in the Philippine sample.

DISCUSSION

One of the problems that has arisen in the parallel work done by Stara & Borghi (2014), was the evidence of a marked decrease in the number of plates and a reduction in the internal structure, during the geological time.

It is shown, therefore, the need to count all the plates of echinoids we examined (Table 7) subjecting the obtained data to a statistical examination.

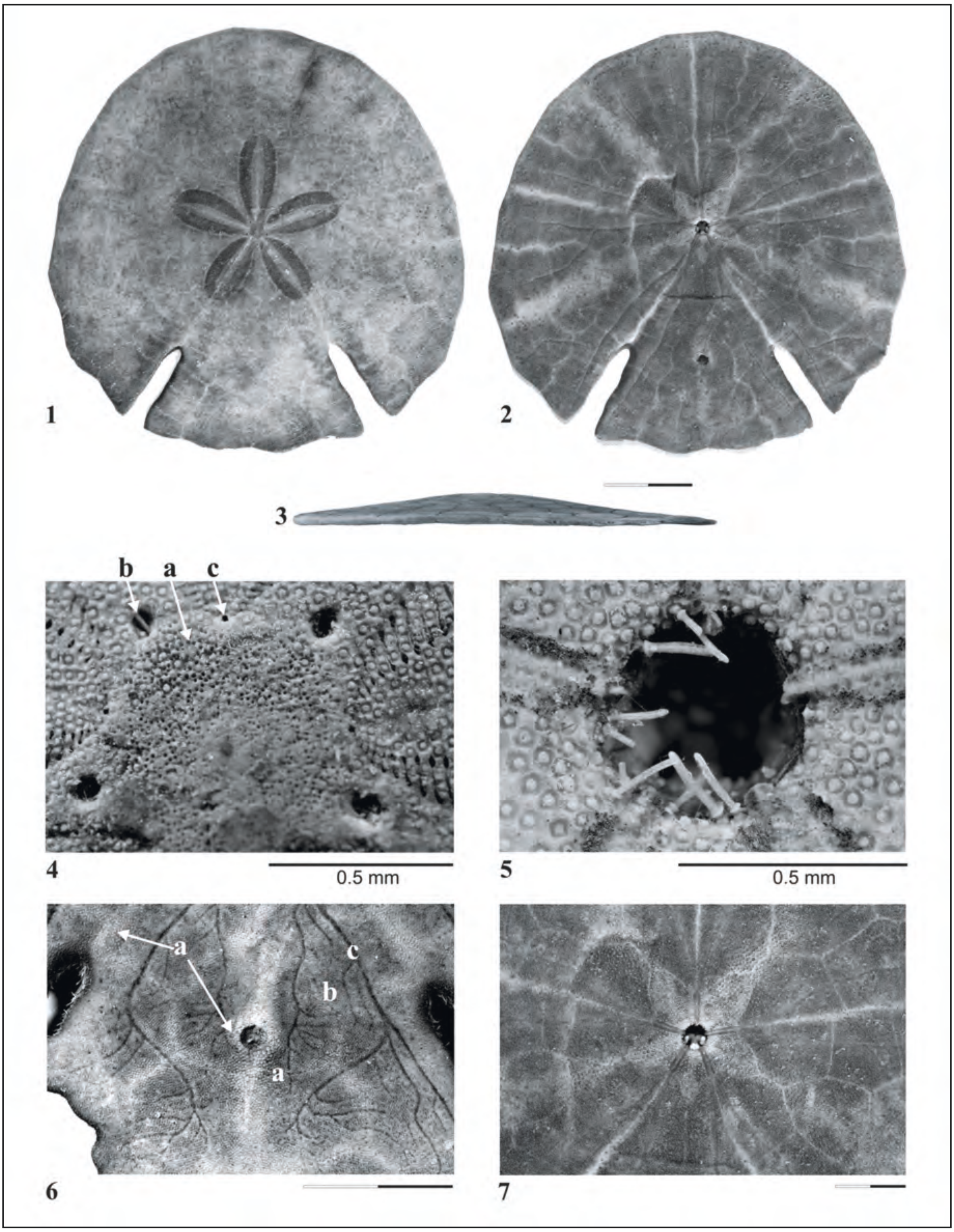

Plate 3. *Echinodiscus* cf. *auritus* from Mangili, Madagascar (recent): external features. Figures 1, 2, 3. Aboral, oral and lateral views of MAC.IVM 81. Figure 4. View of the apical disc with madreporite (a), genital (b) and ocular (c) pores. Figure 5. Stoma surrounded by medium sized tubercles and small spines. Figure 6. Large (a) and small (b) primary tubercles; (c) strongly articulated food grooves in MAC.IVM 110. Figure 7. Close up of the peristoma, disjoint basicoronals and scarcely differentiated tuberculation in MAC.IVM81.

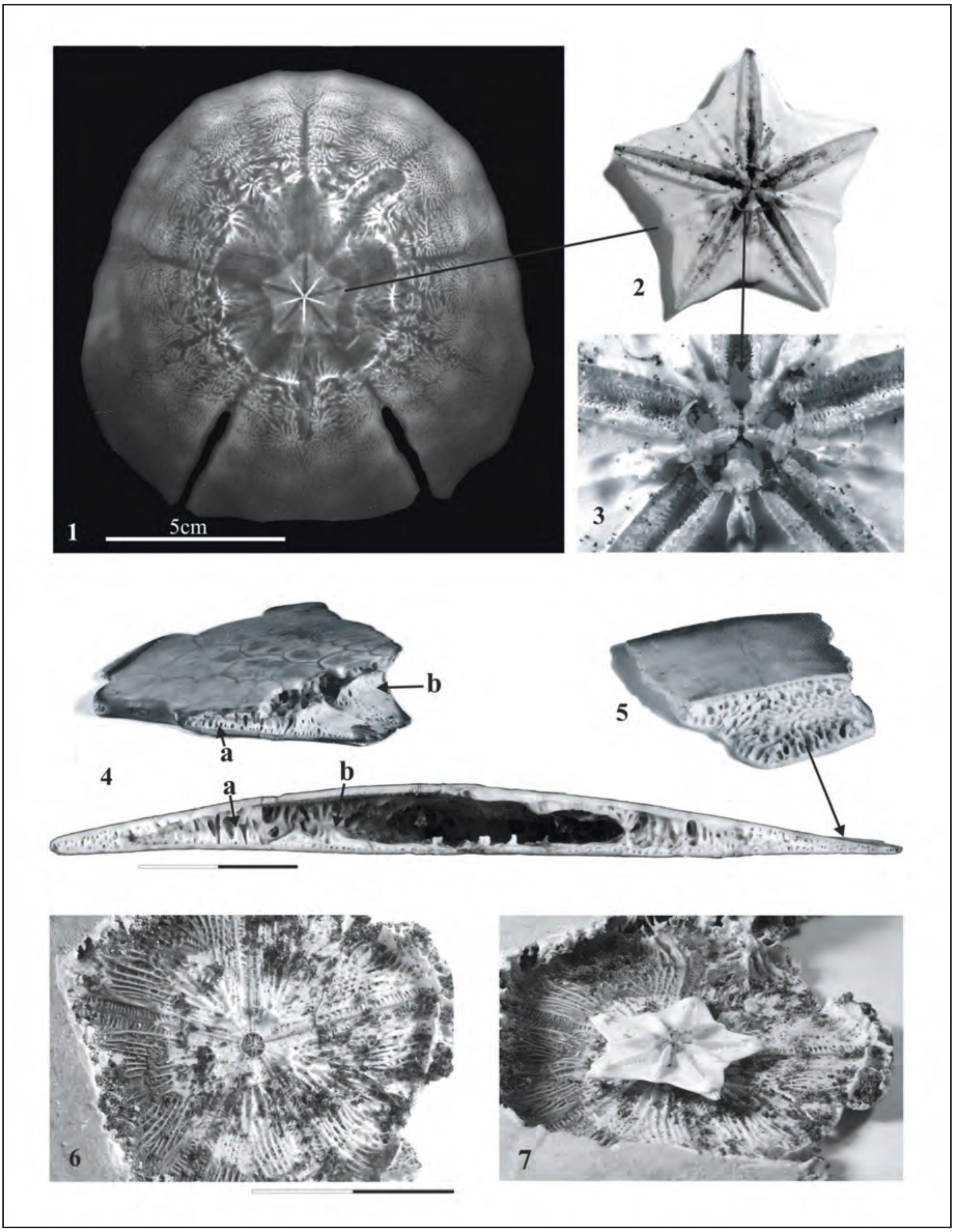

Plate 4. *Echinodiscus* cf. *auritus* from Mangili, Madagascar (Recent), internal features. Figure 1. Radiograph of MAC.IVM 109 (Dap = 125 mm). Figure 2. Aristotle's lantern, oral view. Figure 3. Close up of the support system and teeth. Figure 4. Fragment and antero-posterior test section of MAC.IVM 103 with: a) peripheral pillar and buttresses; b) walls delimiting the central hollow. Figure 5. Close-up of supports into the last aboral and adoral plates. Figure 6. Floor of the central hollow with ribs in a network of reinforcement. Figure 7. Small Aristotle’s lantern in position.

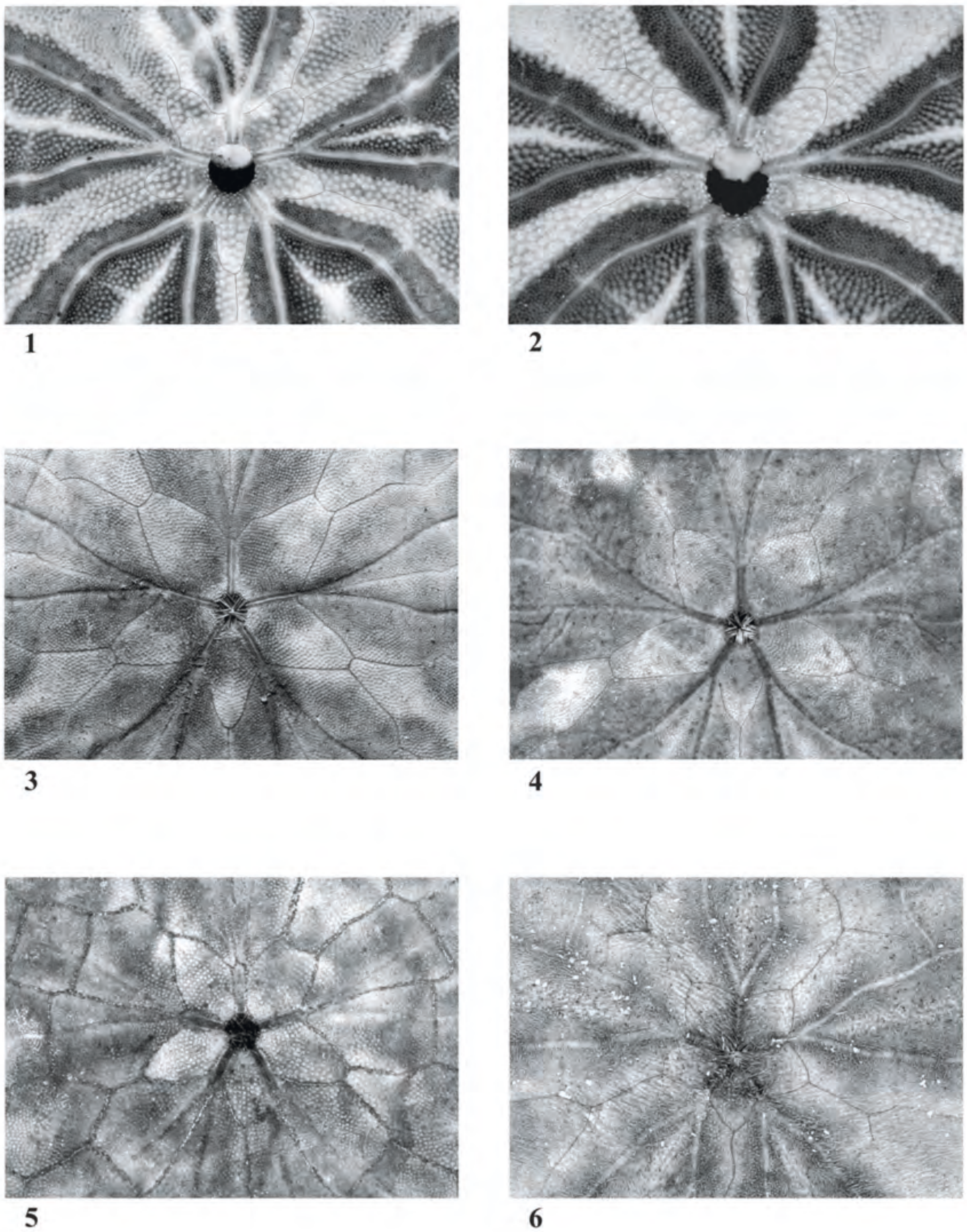

Plate 5. *Echinodiscus* cf. *auritus*. Instability of the disjunction in basicoronal interambulacral plates in“*Echinodiscus*” specimens. Figures 1, 2. *E. bisperforatus* (South Africa, Recent): 1) interambulacra 2, 3 continuous; 1, 4 and 5 disjunct; 2) all plates disjunct. Figures 3, 4, 5. *E.* cf. *auritus* (Mangili, Madagascar, Recent), MAC.IVM110: interambulacra 1, 2, 3, 4 continuous; 5 disjunct; MAC.IVM115 interambulacra 1, 2, 3, 5 disjunct, 4 continuous; MAC.IVM84 interambulacra 1, 2 continuous; 3, 4, 5 disjunct. Figure 6. *E.* cf. *auritus* (Philippines, Recent), MAC.IVM206: interambulacra 1, 2, 3, 4 disjunct.

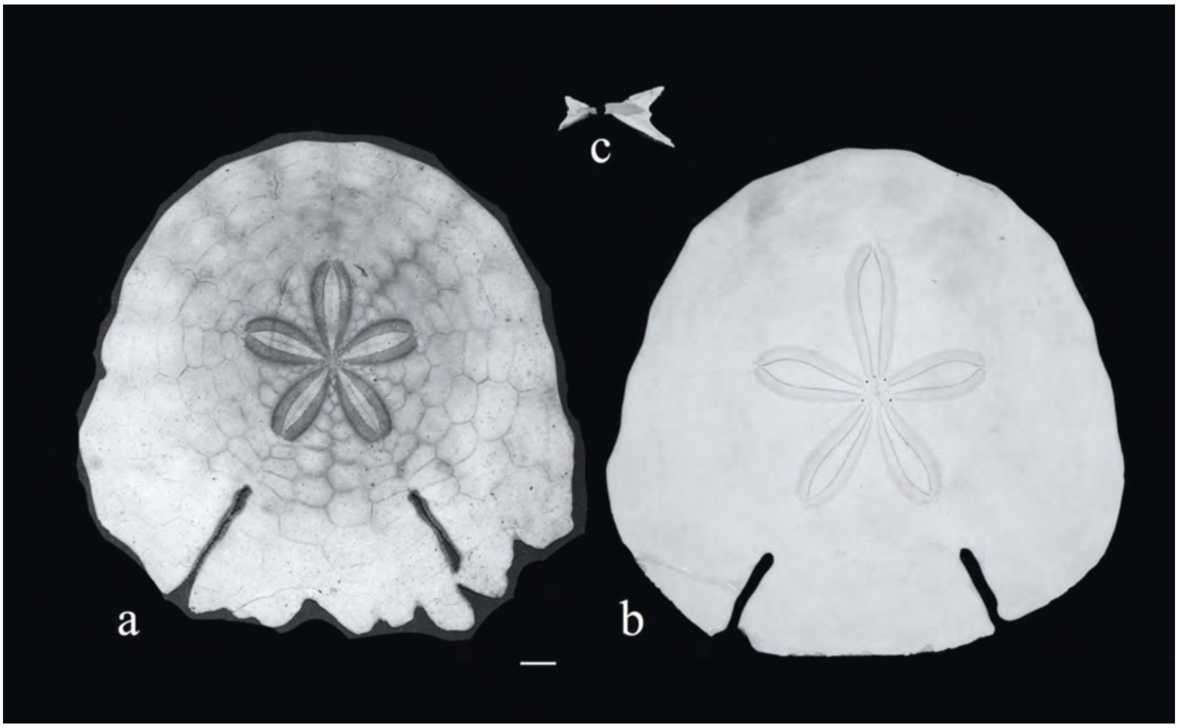

Plate 6. Comparison of Aristotle's lantern of "*Echinodiscus*" cf. *auritus* in specimens from a) Mangili; b) Philippines; c) jaws.

This has documented, as expected, given the preliminary data (Table 3) that in our sample of adult individuals, while doubling the size, the number of plates per column in some interambulacra and ambulacra does not vary significantly (see Figure 4 and conclusions).

This confirms the fact that the reduction of plate numbers observed in geologically younger specimens is credible. Moreover, even Durham (1955) cites a case like this, with a decrease of plates observed in *Echinocardium* from subsequent geological periods.

With regard to the statistical analysis, however, the samples analyzed show a distribution of length (TL) that goes from a minimum of 54 mm to a maximum of 151.5 mm (mean 104.5); standard deviation 20.7; range 77.5; median 103.3 (see Fig. 4, Length Frequency Distribution).

For each sample were also collected the counts related to the number of plates present in the various ambulacral and interambulacral column. Analyzed here are those related to oral and aboral face of the interambulacrum 5 (defined respectively 5 - oral and 5 - aboral) and those of the single-sided aboral (3-aboral) of the III ambulacrum. To assess the independence of these measures in relation to TL, we test by "Spearman ρs" the null hypothesis H0: ρs = 0 ("no correlation") for each of the following pairs of variables, considered separately: TL – 5 - oral; TL – 5 - aboral, TL – III aboral. The level of significance chosen is $\alpha < 0.05$.

Scatter plots obtained for each pair of variables do not seem to show any linear relation between the variables represented. This seems also suggested by the test of Spearman (ρs), which does not allow us to reject the null hypothesis ("no correlation") with a 95% confidence level, as reported in Table 8.

We have not considered necessary, because evident, to verify statistically the variation in the size of the back notches in this sample, which is relatively low. In fact, in a lot of sizes ranging from 21 to 28% TL (mean 24%), we observed a variation of 29% on average value).

Another goal of this work was to try to understand the real extent of variability in L1, PL, L11, WA and ß.

The variability of L1 is significant and similar in both samples (20–28%, mean 23% TL, against L1 21–28%, mean 24% TL), but does not seem to affect the possibility of specific distinction.

Specimen	TL	TW	TH	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	øPc	øSto
IVM82	74	101	5.5	22.5	3.5	13	54.5	20.5	8.5	19	9	18.5	8.5	24	27	13	2.5	4
IVM83	76	100	6	24	2.5	13	54.5	19.5	8	17.5	8.5	17.5	7.5	21	27.5	11.5	2.5	4
IVM84	79	102	7.5	24.5	3.5	12.5	53.5	19.5	8.5	18	9	18	8.5	19	30	11.5	3	4
IVM85	79	98	6	22	3	14	55	21.5	8	17.5	8.5	17.5	8	17	33	10.5	3.5	4
IVM86	82	102	8	23	3	12.5	53.5	21.5	9	18.5	9	18	8.5	21.5	27.5	11.5	3	4
IVM87	82	102	7	23	3.5	15	55	21	8.5	17.5	9	18	8	23	26.5	11.5	2.5	3.6
IVM88	82	103	6.5	23	2	12	55	19.5	7.5	17	8	16.5	7.5	22.5	27.5	11.5	2	4
IVM89	88	98	7	23	3	14	55	20	8.5	18.5	9	18	8.5	22	28.5	11.5	2.5	4
IVM90	88	103	7.5	25	3	13	55	20.5	8.5	18.5	8.5	18	8.5	19	30.5	12.5	2.5	3.5
IVM91	88	99	8	21.5	3	14.5	55	21.5	9.5	18.5	9	18.5	8	18.5	32	12.5	3	4
IVM92	93	97.5	8.5	23.5	2.5	12.5	56	22.5	9	21	10.5	19.5	7.5	22.5	28	11	2.2	4
IVM93	94	99	8	23.5	2.5	13.5	55	22.5	8.5	19	9	19	8	21	28.5	10.5	2.5	4
IVM94	96	101	7	24.5	2.5	13	54	21.5	8	18.5	8	17.5	7.5	22	27.5	10	2.5	3.5
IVM95	97	99	7	21.5	4	15	55	21	7.5	18	9	17.5	8	21.5	30	11	2.5	3.5
IVM96	98	100	7.5	27.5	2	12	55	21.5	9	17	9	18	9	25	26.5	11.5	2.2	3.5
IVM97	103	97	8.5	24	2.5	13	55	22.5	10	18.5	10	20	10	24	27	11	2	4
IVM98	104	102	8	25	5	14	54	21.5	10	18.5	10	17.5	9.5	18	33	11.5	2.2	3.5
IVM99	108	98	9	25	3.5	15	56	20.5	9	17.5	11	17	9.5	22	28	11.5	2	3.5
IVM100	108	102	9.5	27	2	12.5	55	20.5	8	19	8	19	8	22.5	27.5	11.5	2.5	3.3
IVM101	111	95.5	9	21	1.5	13	56	20.5	10	19	9.5	20	9	20.5	29	12	2.2	3.2
IVM102	112	100	7	23	2.5	12.5	55	21.5	9.5	18.5	8.5	19	8.5	19	30.5	12.5	2.5	3.5
IVM103	114	99	9	25	2.5	12.5	56	22	10.5	21	11	19.5	11	21	31	11.5	2.2	3.5
IVM104	118	100	9	26	2	15.5	55	22	9	20.5	9.5	18.5	8.5	19.5	29.5	11.5	1.8	3.5
IVM105	119	102	9	21	2	13.5	55.5	22	10	18.5	10	19	9.5	19	30.5	12	1.8	3.5
IVM106	120	98	9	23	1	16.5	56.5	20	8.5	16.5	8.5	17.5	8	20	29	11.5	2.2	3.5
IVM107	121	100	9	24.5	1	14	55	20	8.5	19	8	18.5	10	23.5	28.2	11.5	2.2	3
IVM108	121	102	9	23	1.5	14	56	21	8	18	8.5	18.5	8	24	28.3	11.5	2.2	3.2
IVM109	125	99	9.5	24	2	12.5	55	21	8	18.5	8.5	19	8.5	20	30	11.5	2	3
IVM110	135	106	12	25.5	2	11.5	55	23	8.5	21	10	21.5	9.5	18.5	31.5	10.5	2	3
IVM111	132	100	10	27.5	0.5	12.5	57	20	8.5	18	9	17.5	8	22.2	30.2	11.8	2	2.5
IVM112	140	105	12.5	26	1.5	12	56	23.5	10	21	10	22	9.5	18.5	32	11.5	2.2	2.5
IVM113	126	101	10	28	1.8	11.5	54	22.5	9.5	19.5	9.5	19	9	19.5	30	12	2	4
Range		95.5-106	5.5-12.5	21-28	1-5	11.5-16.5	53.5-56.5	19.5-23.5	7.5-10.5	16.5-21	8-10.5	17-22	7.5-10	18-24	26.5-33	10-13	1.8-3.5	2.5-4
Mean		100.3	8.3	24	2.1	13.2	55	21.18	8.8	18.6	9.1	19.5	8	20.9	29.2	11.5	2.3	3.5
Variance		10.5	7	7	4	5	3	4	3	4.5	1.5	5	2.5	6	6.5	3	1.7	1.5
Range - V		10.4	84.3	29.1	190.4	37.8	5.4	18.8		24.1		25.6		28.7	22.2	26	73.9	42.8

Table 3. Morphometric data in "*Echinodiscus*" cf. *auritus*, Recent, from Mangili, Tulear, Madagascar.

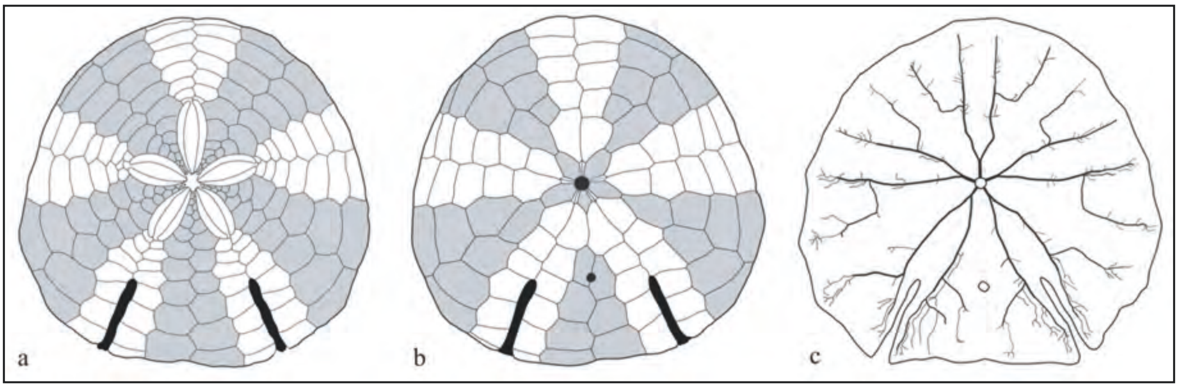

Figure 3. *Echinodiscus*” cf. *auritus* from Mangili, Tulear, Madagascar (Recent): a, b) respectively, aboral and oral plate structure of MAC.IVM 87; c) food grooves.

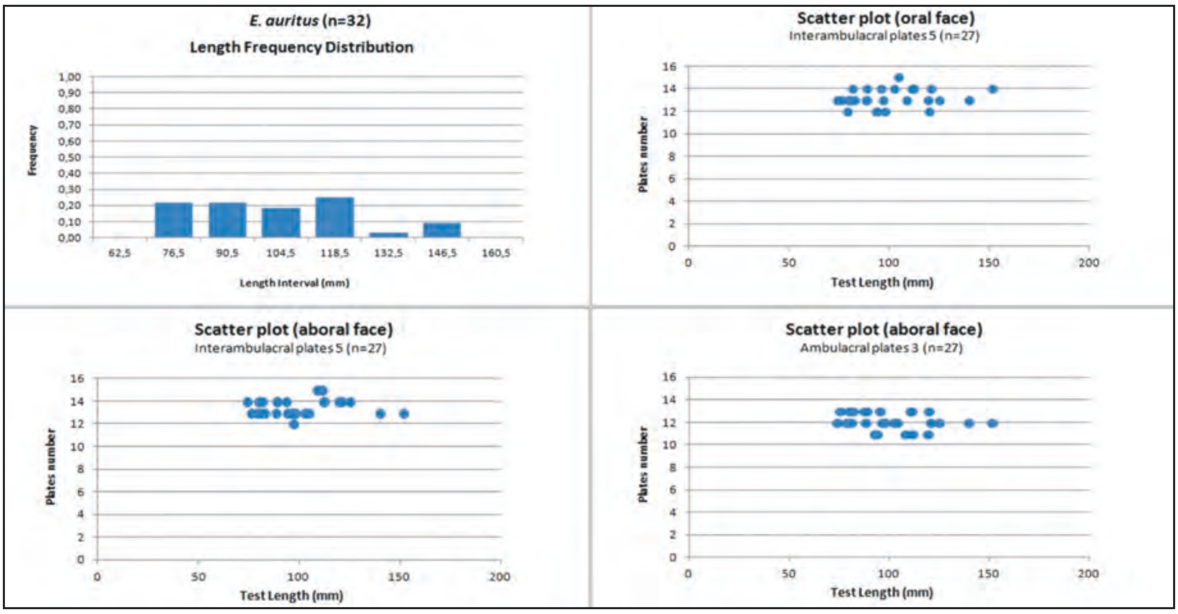

Figure 4. Ratio between number of plates and echinoids size, in a sample from Mangili, Tulear, Madagascar.

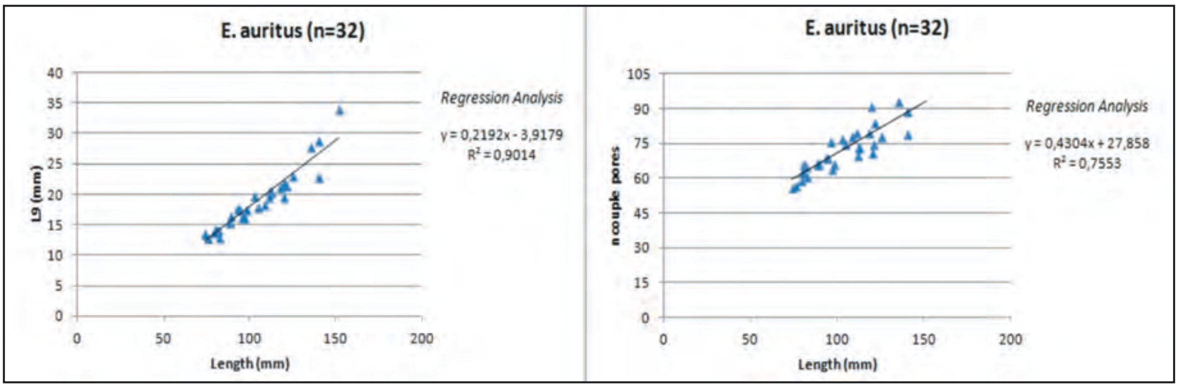

Figure 5. Ratio, by increasing dimension, between odd petals and corresponding number of pores.

Specimen	Dap	L5	L7	L9	couple of pores
IVM82	74	5.3	13.06	13.55	56
IVM83	75.6	14.3	12.65	12.8	57
IVM84	78.7	15.7	14.45	13.85	59
IVM85	79.3	17.1	14.3	14.3	63
IVM86	80.2	17.8	15.2	14.3	66
IVM87	81.3	18	14.5	14.3	65
IVM88	82.2	16	13.5	13	61
IVM89	88	18.2	15.6	15.4	66
IVM90	88.3	18.4	15.5	15.4	67
IVM91	88.6	18.8	16.8	16.5	66
IVM92	92.9	20.3	18.2	17.8	69
IVM93	93.7	20.8	17.8	17.45	69
IVM94	95.6	20.6	17.3	16.2	76
IVM95	96.5	19.7	17.85	16.35	64
IVM96	97.9	19.5	16.65	17.45	66
IVM97	102.5	21.8	18.5	19.7	77
IVM98	104.2	22.4	17.95	17.95	75
IVM99	108.2	21.8	18.65	18.25	78
IVM100	110.8	23.4	20.3	19.55	80
IVM101	111.4	23.4	21	20.55	70
IVM102	111.8	23.8	19.6	20.5	74
IVM103	112	24.8	20.6	20.3	73
IVM104	117.8	25.4	21.7	21.25	80
IVM105	119.2	26.4	23.3	21.75	91
IVM106	119.7	23.1	19	19.65	71
IVM107	120.7	24	21.05	21.35	75
IVM108	120.8	25.2	20.9	21.6	84
IVM109	124.9	25	23.35	23	78
IVM110	134.9	32.1	28.8	27.8	93

Table 4 (upper). Data of petals dimension and corresponding number of pores in ambulacral areas of "*Echinodiscus*"cf. *auritus*, Recent, from Mangili.

Table 5 (right). Data of interambulacra disjunction variability in "*Echinodiscus*" cf. *auritus*, from Mangili: C = Continuos; D = disjoint; A = Amphiplacous; M = Meridoplacous.

Specimen	Ia1	Ia2	Ia3	Ia4	Ia5	plates	pos. Pc
IVM82	D-M	D-A	D-A	D-M	D-A	4a-5b	2a-2b
IVM83	C-M	C-A	C-A	C-A	D-A	4a-4b	2a-2b
IVM84	D-M	D-A	C-A	C-M	D-A	4a-4b	2a-2b
IVM85	D-M	C-A	C-A	D-M	D-A	4a-5b	2a-2b-3b
IVM86	C-M	C-M	C-A	C-A	D-A	4a-5b	2a-2b
IVM87	C-A	C-A	C-A	C-M	D-A	4a-5b	2a-2b
IVM88	D-M	C-A	C-A	D-M	D-A	4a-4b	2a-2b
IVM89	D-A	D-A	D-A	D-M	D-A	4a-5b	2a-2b
IVM90	D-M	D-A	C-A	D-M	D-A	4a-4b	2a-2b
IVM91	D-M	C-A	C-A	D-A	D-M	4a-4b	2a-2b-3b
IVM92	D-M	D-A	D-M	D-M	D-A	4a-5b	2a-2b
IVM93	D-M	C-A	D-A	D-M	D-A	4a-4b	2a-2b
IVM94	D-M	D-A	D-A	D-M	D-A	4a-4b	2a-2b
IVM95	C-A	C-A	C-A	D-M	D-A	4a-4b	2a-2b
IVM96	D-M	D-M	C-A	D-M	D-A	4a-5b	2a-2b
IVM97	D-A	D-A	C-M	D-A	D-A	5a-5b	2a-2b
IVM98	C-M	C-A	C-A	C-M	D-A	4b-5a	2a-2b
IVM99	D-M	D-A	D-A	C-M	D-A	4a-5b	2a-2b
IVM100	C-M	D-A	C-A	C-A	D-A	5a-5b	2a-2b
IVM101	D-M	D-A	C-A	D-M	D-A	4a-5b	2a-2b
IVM102	C-A	C-A	C-A	C-M	D-A	4a-4b	2a-2b
IVM103	C-A	C-A	C-A	C-M	D-A	4a-5b	2a-2b
IVM104	-	-	-	-	-	4a-4b	2a-2b
IVM105	C-M	D-A	D-M	D-M	D-A	4a-5b	2a-2b
IVM106	C-M	C-A	D-A	C-A	D-A	4a-5b	2a-2b
IVM107	C-M	D-A	C-A	D-A	D-A	4a-5b	2a-2b
IVM108	C-M	C-A	C-A	C-M	D-A	4a-5b	2a-2b
IVM109	C-A	D-A	D-A	D-A	D-A	4a-4b	2a-2b
IVM110	D-A	D-A	D-A	D-A	D-A	4a-4b	2a-2b
IVM111	C-A	C-A	D-A	D-A	D-A	4a-5b	2a-2b
IVM112	D-M	D-A	D-A	D-M	D-A	4a-4b	2a-2b
IVM113	D-M	D-A	D-A	D-M	D-A	4a-4b	2a-2b
IVM081	D-A	D-M	D-A	D-M	D-A	4A-4b	2a-2b
IVM206	D-M	D-A	D-A	D-M	D-M	5A-5B	2a-2b
IVM207	D-M	D-A	D-A	D-M	D-A	4A-4B	2a-2b
IVM208	D-M	D-A	D-A	D-M	D-M	4A-5B	-
IVM210	D-M	D-A	D-A	D-M	D-M	4a-5b	2a-2b
IVM209	D-M	D-A	D-A	D-M	D-M	4a-4b	2a-2b
IVM211	D-M	D-A	D-A	D-M	D-M	4a-4b	2a-2b
IVM212	D-M	D-A	D-A	D-M	D-M	4a-5b	2a-2b
IVM213	D-M	D-A	D-A	D-M	D-M	4a-4b	2a-2b
IVM214	D-M	D-A	D-A	D-M	D-M	4a-4b	2a-2b
IVM215	D-M	D-A	D-A	D-M	D-M	4a-4b	2a-2b

Specimen	Apical disc	PL	WA	ß
IVM82	4.5	39	34	55
IVM83	5	38	31	53
IVM84	4.5	38	32	57
IVM85	4.5	40	29	49
IVM86	4.5	40	33	58
IVM87	4.5	38	30	56
IVM88	4.5	36	32	56
IVM89	4.5	39	32	50
IVM90	4.5	38	32	54
IVM91	6	40	34	59
IVM92	5.5	41	32	54
IVM93	5.5	41	32	56
IVM94	5.5	38	31	57
IVM95	5	39	33	62
IVM96	5	39	33	54
IVM97	5.5	43	33	57
IVM98	5.5	41	32	53
IVM99	5.5	38	29	58
IVM100	4	39	35	56
IVM101	5	41	31	53
IVM102	5.5	41	32	53
IVM103	5	43	31	56
IVM104	5	41	33	55
IVM105	6	42	33	57
IVM106	5.5	38	31	59
IVM107	5	37	31	48
IVM108	4.5	40	37	
IVM109	5	40	31	54
IVM110	4.5	43	32	53
IVM111	4.5	38	34	65
IVM112	6	47	37	55
mean	5.6	39.8	32.3	55.4
Range	4 - 6	36 - 47	29 - 37	48 - 62

Table 6. Data of apical disc, PL, WA at ambitus on interamb. 5, and angle ß, in "*Echinodiscus*" cf. *auritus*, from Mangili.

The same can be said about the variation of PL, which is higher (37–48% TL) in the sample of Mangili compared to that of the Philippines (40–48% TL) but with an average much lower (41 versus 43% TL). Also the variation of L11 is high enough, but similar in the two samples (21% TL). Even the measurement of WA to the interambulacrum 5 and of the ß angle, shows normal variability, but, already at a first comparison with data from other species of "*Echinodiscus*", it seems to provide significant results.

In fact, the low average of WA and the low grade of ß, together with the still stretched shape, makes these echinoids very characteristic and separates them significantly from other groups of the same family.

This will be useful to make direct comparisons between samples of "*Echinodiscus*" and *Amphiope*, as done by Stara & Sanciu (2014).

CONCLUSIONS

Tests and observations obtained allow us to several considerations. The variability of the notches, and in particular of the L1 is quite high, while that of L2 is not verifiable because of frequent malformations, however, these variability does not seem to change the appearance of these echinoids. The same consideration should be made for the variability of the periproct position in respect to the posterior margin. This is always very high when compared with that detected in other specimens of *Echinodiscus* seen in the literature (see Stara & Sanciu, this volume). Other measurements taken do not appear to show significant levels of variability. In reference to the plating (pattern plate), there is a great variability in the disjunction of the post basicoronals in interambulacra 1, 2, 3 and 4. An analysis of this unexpected appearance is shown in Stara & Sanciu (2014). Very important results relate to other fundamental aspects for all those who will compete in this family's systematic. Specifically, it was possible to detect a marked stability in the development of the scheme of interambulacrum 5 and in that of the adjacent ambulacra I and V.

In fact, the periproct position and the plate shape in interambulacrum 5, are very stable in both studied samples. Also the plates number per column

	5a or	5a ab	Σ	5 or	5b ab	Σ	Ia or	Ia ab	Σ	Ib or	Ib ab	Σ	1a or	1a ab	Σ	1b or	1b ab	Σ	IIa or	IIa ab	Σ	IIb or	IIb ab	Σ	IIIa or	IIIa ab	Σ	IIb or	IIIb ab	Σ
IVM82	4	9	13	4	10	14	6	8	14	6	8	14	3	9	12	4	9	13	4	7	13	5	7	12	5	6	11	5	7	12
!VM83	4	9	13	3	10	13	6	6	12	6	7	13	4	9	13	3	9	12	6	6	12	5	6	11	6	7	13	7	6	13
!VM84	3	9	12	3	10	13	6	7	13	6	7	13	3	9	12	4	9	13	5	5	10	6	6	12	6	6	12	5	7	12
IVM85	3	10	13	4	10	14	6	7	13	5	7	12	3	10	13	4	10	14	6	6	12	6	7	13	6	7	13	6	6	12
!VM86	4	9	13	4	9	13	7	6	13	6	5	11	4	10	14	3	10	13	7	6	13	6	7	13	7	6	13	6	7	13
!VM87	4	10	14	4	10	14	7	8		6	7	13	4	10	14	4	10	14	6	6	12	6	7	13	6	7	13	6	6	12
!VM88	3	10	13	4	9	13	5	8	13	6	7	13	4	9	13	3	10	13	6	7	13	6	7	13	5	7	12	5	8	13
!VM89	4	9	13	4	9	13	6	7	13	7	7	14	3	9	12	4	10	14	6	7	13	6	7	13	6	6	12	6	7	13
!VM90	3	10	13	4	10	14	6	7	13	7	8	15	3	10	13	4	9	13	5	6	11	6	7	13	6	6	12	5	7	12
!VM91	4	10	14	4	10	14	6	8	14	6	8	14	3	9	13	4	10	14	6	6	12	6	7	13	6	7	13	6	7	13
!VM92	3	9	12	4	10	14	6	7	13	6	7	13	3	9	12	4	10	14	5	6	11	5	6	11	5	6	11	5	6	11
IVM93	3	9	12	4	9	13	6	7	13	6	7	13	3	10	13	4	10	14	5	6	11	5	6	11	5	6	11	5	6	11
!VM94	4	10	14	3	10	13	6	6	12	6	7	13	3	10	13	4	10	14	7	7	14	5	6	11	6	7	13	6	7	13
!VM95	3	10	13	3	9	12	5	7	12	6	7	13	3	10	13	4	10	14	5	7	12	5	7	12	5	7	12	5	7	12
!VM96	4	8	12	4	9	13	6	7	13	6	8	14	3	10	13	4	10	14	5	7	12	6	7	13	5	6	11	6	6	12
IVM97	4	10	14	4	10	13	6	7	13	6	8	14	3	11	14	4	10	14	5	7	12	6	7	13	6	6	12	5	7	12
IVM98	4	11	15	3	10	13	6	7	13	7	8	15	3	10	13	4	10	14	6	7	13	5	6	11	6	7	13	5	7	12
!VM99	3	10	13	4	11	15	6	7	13	7	7	14	4	10	14	4	10	14	5	6	11	6	6	12	5	6	11	4	7	11
!VM100	4	10	14	4	11	15	6	8	14	7	8	15	3	10	13	4	10	14	6	6	12	6	7	13	5	7	12	5	8	13
!VM101	4	10	14	4	10	14	6	7	13	7	7	14	4	9	13	5	9	14	6	7	13	6	6	12	7	6	13	6	7	13
!VM102	3	11	14	4	10	14	6	7	13	7	8	15	3	10	13	4	10	14	6	7	13	5	7	12	5	7	12	5	6	11
!VM103	3	8+		4	8+		6	8	14	7	8	15	3	11	14	4	10	14	5	7	13	6	7	13	5	6	11	5	7	12
!VM104																														
!VM105	3	10	13	4	10	14	6	8	14	6	8	14	3	10	13	4	10	14	5	7	12	5	8	13	5	7	12	4	7	11
!VM106	3	9	12	4	10	14	6	8	14	6	8	14	3	11	14	4	10	14	6	8	14	5	7	12	6	6	12	6	7	13
!VM107																														
!VM108	4	10	14	4	10	14	6	7	13	8	7	15	3	10	13	4	10	14	5	6	11	6	6	12	6	7	13	5	7	12
!VM109	3	10	13	4	10	14	5	7	12	7	8	15	4	10	14	4	11	15	5	7	12	5	8	14	5	7	12	5	7	12
!VM110	3	10	13	3	—		6	7	13	6	7	13	3	10	13	4	10	14	6	7	13	5	6	13	5	7	112	5	7	12
IVM111																														
!VM112	3	10	13	3	10	13	6	9	15	6	9	15	3	11	14	4	11	15	5	7	12	5	7	12	5	7	12	5	7	12
!VM113	3	11	14	4	10	13	6	8	14	6	7	13	3	10	13	4	11	15	5	7	12	5	8	14	5	7	12	5	7	12

Table 7. Numbers of plates (post basicoronal only) in some ambulacra and interambulacra in the sample of "*Echinodiscus*" cf. *auritus* from Mangili. or = oral side; ab = aboral side; ∑ = summa of oral + aboral number of plates.

	TL - 5 oral	TL - 5 aboral	TL - 3 aboral
(a) r_s	0.267	0.173	-0.218
(b) r_s (0.05; 27)*	0.382	0.382	0.382
If a < b then H_0: $\rho_s = 0$	*TRUE*	*TRUE*	*TRUE*

Table 8. * Critical value of the Spearman rank correlation rs (α, n), with α = 0.05 and n = number of samples. This value is extract from the table of critical values obtained through the software SuppDist (Wheeler, 2005) implemented in R and based on the method of Kendall & Smith (1939).

relative to interambulacrum 5 and to the two adjacent ambulacra seem to be very stable for all size classes considered (see diagram in Fig. 4). On the contrary, it was observed a good linear relationship between the petals length and sample size. It is considered, for each sample, the petaloid III with the relative increase of the number of pairs of pores (Fig. 5).

Is interesting to note that, despite the significant variability of L11, the position of the periproct, compared to the scheme of the plates of these echinoids does not vary.

Also the size of PL, WA and ß seems to characterize these echinoids, particularly since, already at a first glance, it distinguishes them very well, from other groups of the same family, as you can see better in Stara & Sanciu (2014). Even the observation of the structure of the floor of the central hollow, which seems to differ from that of other genera like, for example, *Amphiope*, it may be helpful for future comparisons between species of genera apparently neighbours, through the work of those correlations.

Is very important, finally, the difference in Aristotle's lantern size for the same TL between Madagascar and Philippines specimens (Plate 6).

This suggests that there may be two distinct species, but this will be subject of another work.

ACKNOWLEDGEMENTS

We warmly thanks Enrico Borghi of the Società di Scienze Naturali of Reggio Emilia, for critical reading of the manuscript; and Mario Lai (3S, Laboratories images, Capoterra) for scoring the radiographs to the examined specimens.

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