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A new species of *Peribrissus* (Echinoidea, Spatangoida) from the middle Miocene of South Australia

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Abstract

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A new species of spatangoid echinoid from the middle Miocene Glenforslan Formation cropping out in the Murray River cliffs near Blanchetown, South Australia, is described and assigned to the genus *Peribrissus*. *Peribrissus janiceae* sp. nov. is only the third species of this genus to be recorded, and the first to occur outside the Mediterranean area of Europe and North Africa. Brief references are made to the similarity of certain features in *Prenaster*, *Pericosmus* and *Peribrissus*, which have caused confusion with identification in the past.

Keywords Echinoidea, Spatangoida, *Peribrissus*, new taxa, middle Miocene, South Australia

Introduction

In the Miocene stratigraphic sequences along the Murray River and elsewhere in Australia, species belonging to the Spatangoida constitute approximately 50 per cent of the recorded taxa of irregular echinoids (Holmes et al., 2005). The discovery of yet another new species of spatangoid, albeit a single specimen, should come as no surprise considering the vast extent of these generally poorly examined outcrops in South Australia. However, what is intriguing is that the new species belongs to a genus that, so far, has been recorded in the literature from only the Mediterranean area of Europe and North Africa. The specimen was found by Chris Ah Yee and Janice Krause in 2007 at Museum Victoria locality PL3203 (see fig.1), the same location as the three specimens of *Murraypneustes biannulatus* Holmes et al., 2005, discovered in 2003.

Materials and methods

The specimen number prefixed ‘P’, on which this study is based, is housed in the Invertebrate Palaeontology Collection, Museum Victoria (NMV). Wherever possible, measurements where made with a dial calliper to an accuracy of 0.1 mm. Parameters are expressed as a percentage of test length (%TL), test width (%TW) or test height (%TH).

Age and stratigraphy

The Glenforslan Formation, in which the specimen was found, is synonymous with the Lower Morgan limestone, which conformably overlies the Finniss Formation and is of early middle Miocene (Batesfordian, Langian) age. The thickness of the unit is relatively consistent at 13–15 m, although this is reduced in southern exposures due to post-middle Miocene uplift and subsequent erosion. Echinoids tend to be found at or above the floatstone–rudstone contact at the base of cycles composed of mollusc–bryozoan floatstone grading upward into *Celleporaria* rudstone tops (Lukasik and James, 1998). Sediments are pervasively mottled, obscuring all physical sedimentary textures. The middle Glenforslan Formation is interpreted as being deposited in relatively shallow waters, possibly less than 10 m, based on the presence of calcareous algae and mixotrophic foraminifers (Dr Jeff Lukasik, Petro-Canada Oil and Gas, Calgary, pers. com., 2005). This section of the formation forms part of the richest warm-water biotic record from southern Australia at a time of maximum transgression of the sea across the continental shelf (McGowran and Li, 1994, and papers cited therein).

Associated fauna

Refer to Holmes et al. (2005) for a table of echinoid species recorded from the Glenforslan Formation.

Systematic palaeontology

Order Spatangoida L. Agassiz, 1840

Suborder Paleopneustina Markov and Solov’ev, 2001

Family Prenasteridae Lambert, 1905

Remarks. The family Paleopneustidae A. Agassiz, 1904, together with the families Pericosmidae, Schizasteridae and Prenasteridae, initially established as tribes within the family

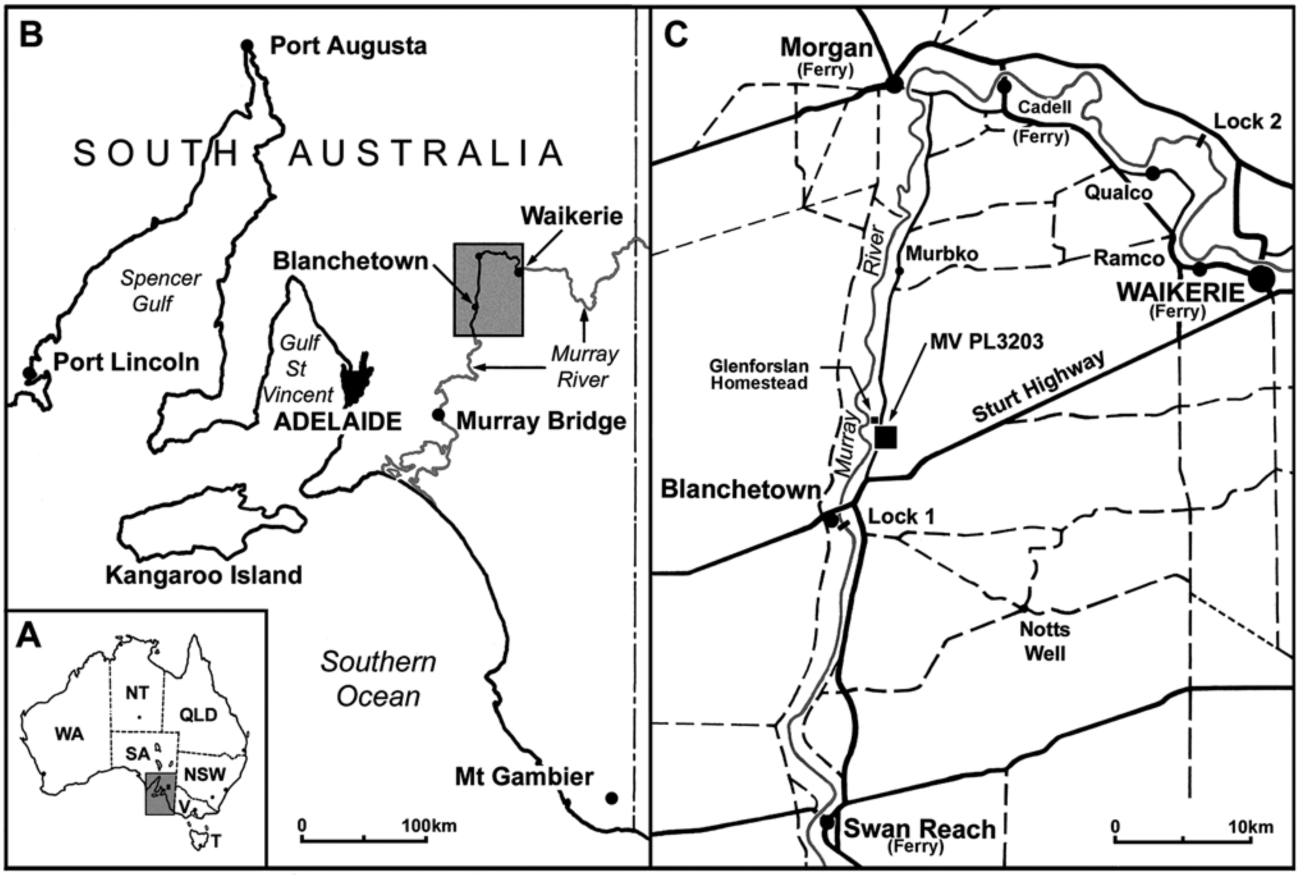

Figure 1. A and B, general location maps; C, map of Murray River between Waikerie and Swan Reach, South Australia, showing locality of NMV PL3203, north of Blanchetown.

Brissidae by Lambert (1905, p. 153), allowed numerous spatangoid genera to be divided into groups based primarily on the distinctive path followed by their fascioles. Lambert and Thiéry (1925, pp. 514–515) listed *Peribrissus* Pomel, 1883 as a subgenus of *Prenaster* Desor, 1853 within the tribe Prenasterinae. However, in subsequent classifications of the Order Spatangoida by Mortensen (1951), Termier and Termier (1953), Durham and Melville (1957), Fischer (1966) and Smith (1984), the family Prenasteridae was not recognised, and *Peribrissus* and *Prenaster* were placed within the Schizasteridae. Not until Smith et al. (2005) and Smith and Stockley (2005) did the family Prenasteridae reappear in any subdivision of the Spatangoida. Finally, Kroh and Smith (2010) presented a primary framework for the classification of post-Palaeozoic echinoids based on extant taxa into which fossil taxa have been incorporated. In this classification, Prenasteridae, Schizasteridae and Periasteridae form the Suborder Paleopneustina.

Genus ***Peribrissus*** Pomel, 1869

Type species. *Peribrissus saheliensis* Pomel, 1883, by subsequent monotypy.

Other species. *P. sotgiai* Giorgio, 1923.

Diagnosis. Modified from Smith et al. (2005). Test medium to large and cordiform with distinct anterior sulcus, posterior face oblique to vertically truncate, profile depressed to moderately domed. Apical disk well anterior of centre, ethmolytic with three gonopores. Ambulacrum III sunken aborally, the groove increasing in width and depth to ambitus, with rows of enlarged tubercules occurring just outside adradial sutures, pores small. Petals straight, narrow and depressed, cruciform, the anterior pair longer than the posterior pair. Peristome and plastron plating of type species unknown. Periproct high on posterior truncate face. Semipetalous fasciole band combines with continuous marginal fasciole immediately behind and below anterior petals.

Remarks. There has been confusion regarding the designation of the type species of *Peribrissus*. Fischer (1966, p. U576) and Smith et al. (2005) stated that *P. saheliensis* is the type species by original designation, but Pomel (1869, p. 13) did not name any species he assigned to his genus, for which he gave only a very brief diagnosis and made comparisons with *Prenaster*. Pomel later (1883, p. 36) gave a slightly more detailed diagnosis followed by the statement '*P. saheliensis* est du miocène supérieur'. As *saheliensis* was the only named species assigned to *Peribrissus*, the diagnosis given for the genus applies also to the species, thus satisfying the criteria for availability (ICZN, Article 12.2.6) and making *P. saheliensis* the type species by subsequent monotypy (ICZN, Article 68.3).

Two species of *Pericosmus* described by McNamara and Philip (1964) from the Miocene of Australia — *P. celsus* and *P. quasimodo* — were reassigned by Smith et al. (2005) to *Peribrissus*. Though *Pericosmus* and *Peribrissus* are superficially alike, the path of the peripetalous fasciole in the two Australian species is clearly different from that in the Prenasteridae and, consequently, in *Peribrissus*. Smith et al. (2005) stated that in the Prenasteridae, 'marginal and peripetalous fasciole combine anteriorly, the combined band passing several plates below the end of the anterior petals'. In contrast, the peripetalous fasciole in *Pericosmus celsus* and *P. quasimodo* — as well as in *P. torus*, also erected by McNamara and Philip in the same paper — follow a distinctly different path. These three species have the peripetalous fasciole closely bounding the distal end of the anterior petals, then transversely crossing interambulacral plates in columns 2a and 3b before taking a longitudinal path (sometimes irregular and/or intermittent) towards the marginal fasciole in interambulacral columns 2b and 3a. Due to the state of preservation of the numerous *Pericosmus* specimens inspected in Museum Victoria and private collections, it is not possible to determine whether the peripetalous fasciole always reaches the marginal fasciole on either side of the anterior sulcus. Nevertheless, in all Australian species assigned to *Pericosmus*, including *P. compressus* Duncan, 1877 and *P. maccoyi* Gregory, 1890, the peripetalous fasciole closely bounds the distal end of the anterior petals and continues transversely onto interambulacra 2 and 3, clearly negating any reassignment to Peribrissus. However, whether the five Australian fossil species listed above strictly belong in the genus *Pericosmus* is a matter of conjecture, considering the type species *Pericosmus latus* Desor in Agassiz and Desor, 1847, has separate and continuous marginal and peripetalous fascioles, the latter crossing ambulacrum III well above the anterior margin.

Stefanini (1911, p. 86) reassigned *Prenaster excentricus* (Wright, 1855) to *Peribrissus* in the belief that the two genera overlap based on the similarity of their upper test profile with highly eccentric anterior apex and four ethmolitic genital pores. Pomel's statement (1887, p. 63) — that the number of genital pores in *Peribrissus* is unknown — seems to have been ignored by Stefanini, whose reference to four genital pores may have been based on details of Wright's species. Giorgio (1923, p. 125), in describing *Peribrissus sotgiai* from Sardinia, accepted Stefanini's finding that Wright's *Prenaster* from Malta was a *Peribrissus*; noting that *P. sotgiai* has four gonopores, but that the right anterior one is poor and almost atrophied. These statements appear to have resulted in Mortensen (1951) and Fischer (1966) listing both genera as having four genital pores. However, of the eight genera now included in the family Prenasteridae by Smith et al. (2005), only *Peribrissus* and *Tripylus* Philippi, 1845 are listed as having three genital pores. Although both of these genera have a well-defined anterior sulcus, *Peribrissus* is easily distinguished from *Tripylus* by the markedly anterior location of its apical disk compared to the central position in the latter. The lack of a sulcus and the presence of four genital pores in species of *Prenaster* clearly refute Stefanini's reassignment of *Prenaster excentricus* to *Peribrissus*.

Peribrissus janiceae sp. nov.

Figures 2A–E, 3A–I, Table 1

Type material. Holotype and only known specimen, NMV P316528, from the early middle Miocene Glenforslan Formation (Batesfordian, Langian), Morgan Group, 7 km north-northeast of Murray River Lock 1, Blanchetown , South Australia [NMV locality PL3203].

Description. Test moderately large, ovate in outline with well-formed anterior sulcus; only known specimen 58.0 mm long, with maximum width of 52.0 mm (89.7%TL) occurring posterior of centre at 54.3%TL from anterior ambitus. Maximum test height 38.5 mm (66.4%TL) anterior of centre, but posterior of apical disk at 44.8%TL from anterior ambitus.

Adapical surface inflated with high, vertically convex anterior, gently curved ridge along interradial suture of interambulacrum 5 and prominent vertically truncated posterior. Laterally, sides gently curved at approximately 40° to the horizontal between dorsal ridge and well-rounded ambitus situated about one-third test height above the underside. Adoral surface posterior of peristome flat along centre line of labrum and plaston (fig. 2C–E).

Small, very closely spaced tubercles cover nearly all the test; smallest around ambitus and largest towards peristome.

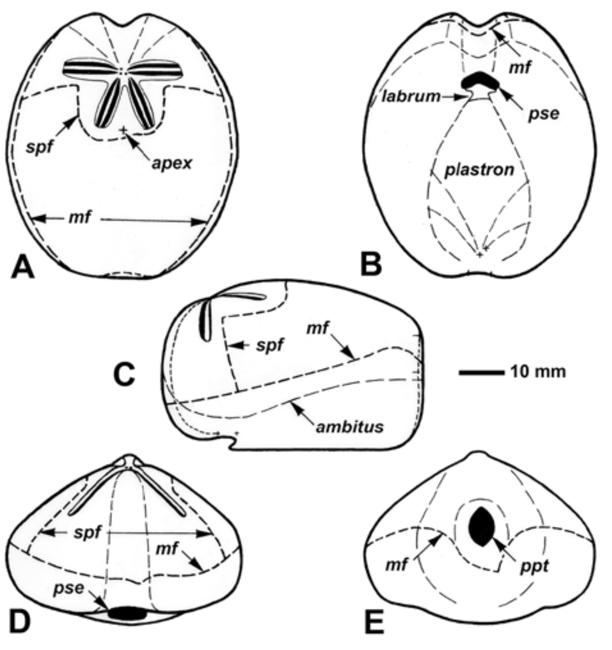

Figure 2. *Peribrissus janiceae* sp. nov. A–E, outline drawings of adapical, adoral, left lateral, anterior and posterior views of holotype NMV P316528, showing paths followed by marginal (mf) and semipetalous (spf) fascioles, and position of peristome (pse) and periproct (ppt).

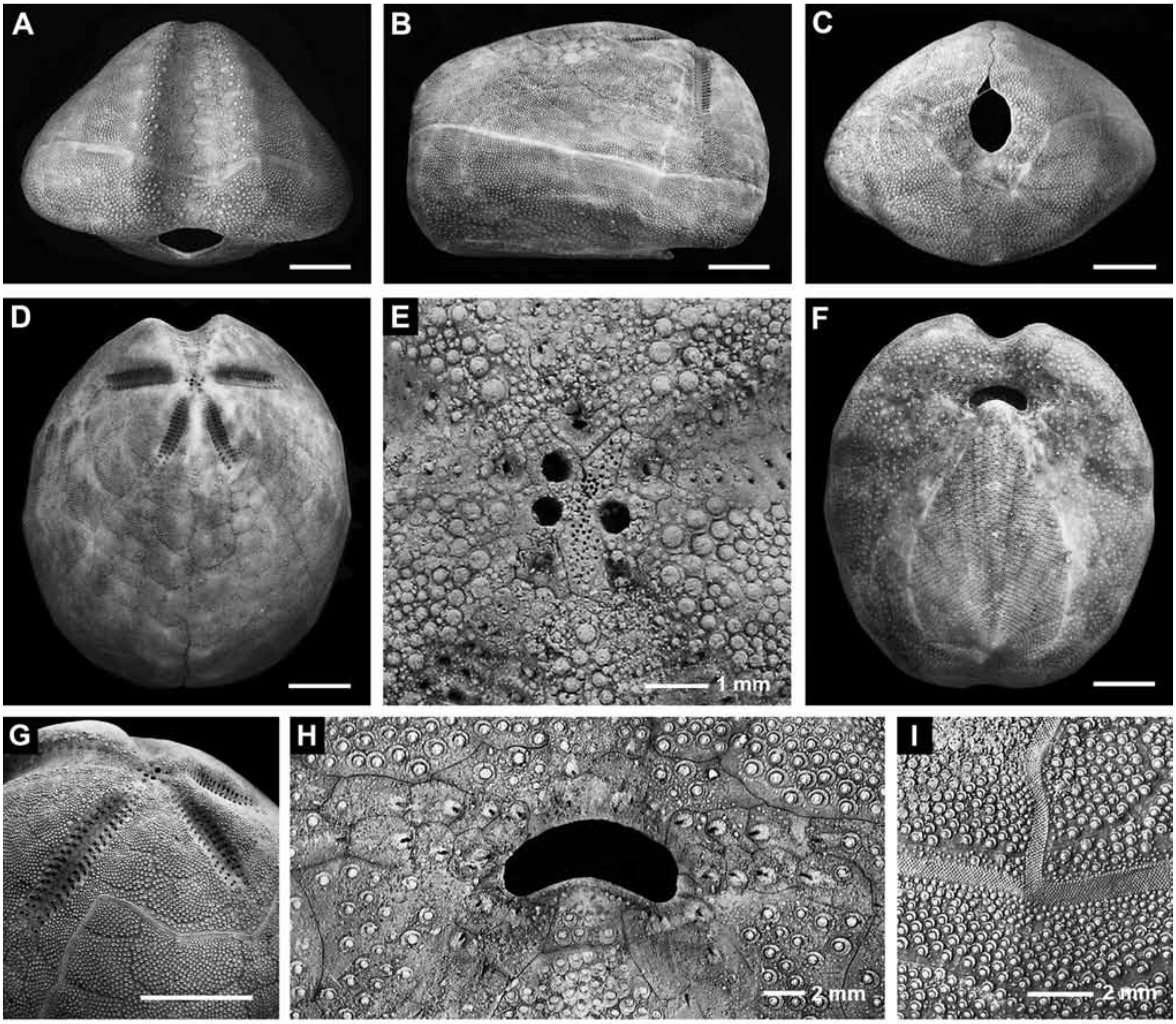

Figure 3. *Peribrissus janiceae* sp. nov. holotype NMV P316528. A–D and F, anterior, right lateral, posterior, adapical and adoral views; E, detail of apical disk; G, oblique left lateral view of semipetalious fasciole crossing interambulacrum 4, plates 7a, 8a, 9a and 9b; H, detail of peristome, labrum and phylodal plates; I, detail of junction between marginal and semipetalous fascioles on interambulacrum 1, plate 4b. Scale bars = 10 mm unless otherwise shown.

Tubercles in ambulacra II and IV first appear on plates 3a and b, and in I and V on plates 4a and b. By plates 5a and b, the size and spacing generally matches that of adjacent interambulacra. Largest tubercles with an approximate areole diameter of 1.0 mm occur on interambulacra 1 and 4 adjacent to adoral edge of plates 2a and b, aborally on plate 1, and along the adradial suture line between ambulacrum III and interambulacra 2 and 3 from the marginal fasciole to the apical disk. These tubercles have a perforate mamelon and crenulate platform but appear to lack a scrobular ring. Because of the very close spacing of these tubercles, miliary granules occur mainly towards the peristome and between the periproct and marginal fasciole in interambulacrum 5 where the spacing between the larger tubercles increases. They also occur around the apical disk.

A well-defined marginal fasciole occurs just above the sloping ambitus, dipping sharply below the periproct posteriorly but crossing ambulacrum III anteriorly slightly below the ambitus at about 25%TH (see fig. 2). The semipetalous fasciole is only marginally indented between the posterior paired petals and crosses interambulacra 1 and 4 on plates 8/9 before descending transversely to join the marginal fasciole at right angles, posterior to the angle of the anterior paired petals (see fig. 3I). Although continuous, fasciole widths vary but maintain a fine tubercule (granule) density of about 100–120 per mm^2.

Table 1. Comparison of diagnostic features of *Peribrissus janiceae* sp. nov. with those of the type species of the genus, *P. saheliensis* Pomel, 1883, and *P. sotgiai* Giorgio, 1923.

Diagnostic feature	***Peribrissus janiceae* sp. nov.**	***Peribrissus saheliensis* Pomel**	***Peribrissus sotgiai* Giorgio**
Width/length ratio of test	89.7%TL	Similar	Similar
Maximum width location	Marginally posterior at 54.3%TL	Marginally anterior, approx. 45%TL	Similar to *P. saheliensis*
Height//length ratio of test	66.4%TL	Not known	Approx. 54%TL
Maximum height location	Slightly anterior at 44.8%	Well anterior but posterior of apical disk, approx. 30%TL	Well posterior, approx. 68%TL
Anterior lateral profile	High, vertically convex	Slopes forward from apex at approx. 35°	Similar to *P. janiceae*
Posterior lateral profile	High vertical truncation	Oblique truncation	Oblique truncation
Adoral surface lateral profile	Flat, posterior of peristome	Unknown (type specimen compressed)	Slightly swollen posterior of centre
Sulcus	Max. depth/width ratio approx. 1:4.6, occurs below ambitus	Figured much deeper with a depth/width ratio of approx. 1:2.2	Figured far shallower and wider than *P. janiceae*
Apical system location and type	21%TL, ethmolitic, 3 gonopores (none in plate G2)	Approx. 33%TL, detail of apical system unknown (Pomel 1887). Stefenini (1911) incorrectly assumes 4 gonopores. This repeated by Mortensen (1950) and Fisher (1966).	Approx. average of 2 specimens 25%TL, ethmolitic. Giorgio's description refers to 4 gonopores but states the pore in G2 almost atrophied
Ambulacrum III, marginal tubercles	Not unduly prominent, situated just outside adradial sutures	Similar to *P. janiceae*	Larger, far more prominent with rows further apart
Detail of petals	Straight, parallel sided and sunken	Similar, but probably shallower	Similar
Length differentiation paired petals	Anterior petals 138% longer than posterior ones	Similar to *P. janiceae*	More equal, but posterior petals still shorter than anterior ones
Anterior paired petals divergence angle	175°	Approx.135°	Described as 140°. Giorgio's figures, however, suggest divergence wider
Posterior paired petals divergence angle	315°	Approx. 295°	Similar to *P. janiceae*
Peristome	Reniform and slightly sunken	Insufficient information for comparison	Insufficient information for comparison
Periproct	Vertically elliptical at top of posterior truncation	Semicircular, assumed high on posterior truncation	Elliptical (axis not clear), high on posterior truncation
Fascioles, marginal and semipetalous	Marginal fasciole occurs just above sloping ambitus and is joined by semipetalous fasciole at right angles behind and below anterior paired petals	Similar, but with semipetalous fasciole shown angled forward at junction with marginal fasciole, apparently due to less oblique divergence of anterior petals	Insufficient information for comparison, as stated to be only visible in some places

Apical system situated well anterior of centre at 21.0% TL from anterior ambitus to centre of disk and is level with proximal end of paired petals. Ethymolitic with three gonopores, no gonopore in plate G2, and approximately 60 hydropores fairly evenly spaced over the latter's length.

Paired petals straight, parallel sided, sunken, open distally and devoid of tubercles. Anterior paired petals 138% longer than posterior pair, extending 50% of the radius (28.0%TL) measured along the surface of the perradial suture from centre of ocular to ambitus. Anterior paired petals diverge at 175° and contain 23/24 pore pairs, posterior petals 315° and 20/21 pairs. Outer pores elliptical, inner pores slightly smaller and more tear shaped. Zone between inner and outer pores approximately equal in width to outer pores, pairs not conjugate. Interporiferous zone marginally narrower than poriferous zones.

Ambulacrurum III depressed for its full length below adjacent interambulacra, reaching a maximum depth of 3 mm (5.2%TL) below the anterior ambitus. Pore pairs are visible adapically between the ocular plate and approximately one-third of the radius to the anterior ambitus. Adapically, the pore pairs are angled inwards at approximately 45° to the perradial suture but gradually become monoserial halfway towards the anterior ambitus. The ambulacrum is covered with closely spaced small tubercles and miliary granules, the former gradually increasing in diameter adorally.

Peristome reniform and slightly sunken, longitudinal dimension 4 mm (6.9%TL), width 8.6 mm (14.8%TL), anterior edge situated 12.4 mm (21.4% TL) from ambitus. Phyllodes unipored with periporal areas protuberant. Basicoronal plates amphiplaceous.

Labrum small, wider than long, covered with small tubercles and flared anteriorly where bordered by a smooth raised rim (fig. 3H). Curved anterior edge projects over the peristome for about one-third of the latter's length. Posterior edge does not extend beyond the first adjacent ambulacraI plates. Plastron wide, long, and covered with rows of closely spaced angular tubercles without interstices. Maximum width of plastron (45%TW) occurs about three-quarters of the test length from the anterior ambitus.

Periproct elliptical shaped with slightly pointed upper and lower junction with interradial suture, height 8.0 mm (13.8%TL), width 5.0 mm (5.6%TL). Underside of vertical opening situated high above base of test (44.2%TH) on truncated posterior surface. Subanal surface slightly depressed.

Etymology. Named for Janice Krause of Hamilton, Victoria, an exceptionally dedicated fossil echinoid collector.

Remarks. Comparison of *Peribrissus janiceae* sp. nov. with the type species *P. saheliensis* from Algeria and *P. sotgiai* from Sardinia is complicated by the lack of detailed descriptions, comparative measurements and illustrations of many of the important diagnostic features of the latter two species. The difficulty is compounded by the excellent preservation of detail found on the single specimen of *P. janiceae* and the large difference in size between specimens of the three species, with *P. saheliensis* approximately twice the length and width of *P. janiceae* and four times that of *P. sotgiai*. Where possible, diagnostic features of the three species are compared in table 1, based on the descriptions of Pomel (1887), Giorgio (1923) and Stefanini (1911), together with approximate measurements taken from their illustrations of the partial and poorly preserved type specimens.

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