A new Late Eocene cassiduloid (Echinoidea) from Yorke Peninsula, South Australia

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Abstract

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A new species of cassiduloid, from the Muloowurtie Formation on the east coast of Yorke Peninsula, is described and tentatively assigned to the genus *Rhynchopygus. R*? *janchrisorum* sp. nov. is the first record of the genus, as redefined by Smith and Jeffery (2000), to occur outside Europe, and the first confirmed from the Cainozoic. The history of species previously assigned to *Rhynchopygus* is briefly discussed and details of further occurrences of the type species, *R. marmini*, listed.

Keywords

Echinoidea, Cassiduloida, *Rhynchopygus*, Late Eocene, South Australia, new species

Introduction

Australian Tertiary echinoids, donated to Museum Victoria by R.J. Foster in 1996, included a single specimen of a cassiduloid quite distinct from any other species of this order so far recorded from Australia. The specimen was collected in the 1970s from "Sliding Rocks" (Fig. 1), the type section of the Muloowurtie Formation (redefined by Stuart, 1970), 9.9 km SSW of Ardrossan and 1.1 km NNE of Muloowurtie Point, on the east coast of Yorke Peninsula, South Australia [MV locality PL3497].

Materials and methods. Specimen numbers prefixed P, on which this study is based, are housed in the Invertebrate Palaeontology Collection, Museum Victoria (NMV). Measurements were made with a dial calliper to an accuracy of 0.1 mm. Parameters are expressed as a percentage of test length (%TL) or test width (%TW).

Age and stratigraphy

The early to middle Late Eocene Muloowurtie Formation at "Sliding Rocks" consists of a 12 m thick sequence of biogenic calcarinites, quartz sands, calcareous and glauconitic quartz sands and sandstones with minor thin conglomerates, silts and clays, disconformably overlying the Lower Cambrian Kalpara Formation. While it is unclear from which specific horizon Foster collected his specimen (the holotype), three additional specimens were found by C. Ah Yee and J. Krause during 2002, in the uppermost bed of the formation about 800 m north of

"Sliding Rocks". This latter horizon, consisting of variegated argillaceous quartz sands interbedded with arenaceous clays, lies immediately below the disconformity separating the Muloowurtie Formation from the overlying Throoka Silts.

The fossiliferous beds of the Muloowurtie Formation are generally considered to be Aldingan (Priabonian) in age lying within planktonic foraminiferal zones P15 and P16, although the base of the formation is probably late Middle Eocene (P14). In general, the Muloowurtie Formation is contemporaneous with the Tortachilla Limestone at Maslin Bay on the south-east side of the Basin, both having been deposited during the Tortachilla and Tuketja transgressions. However, the uppermost beds of the formation are currently considered to be equivalent to the upper middle part of the Blanche Point Formation, which overlies the Tortachilla Limestone, a time of relatively high sea level preceding the onset of the Chinamans Gully regression.

Associated fauna

Stuart (1970) recorded the echinoids *Fibularia gregarta* Tate, 1885, *Salenidia tertiaria* (Tate, 1877) and *Eupatagus* sp. (?), together with crinoid plates, brachiopods, bivalves, the bryozoans *Retopora* and *Cellopora*, ostracods and foraminiferans from richly fossiliferous sands in the lower part of the Muloowurtie Formation at "Sliding Rocks". In addition to the new cassiduloid, a typical Australian Late Eocene echinoid fauna consisting of *Australanthus longianus* (Gregory, 1890),
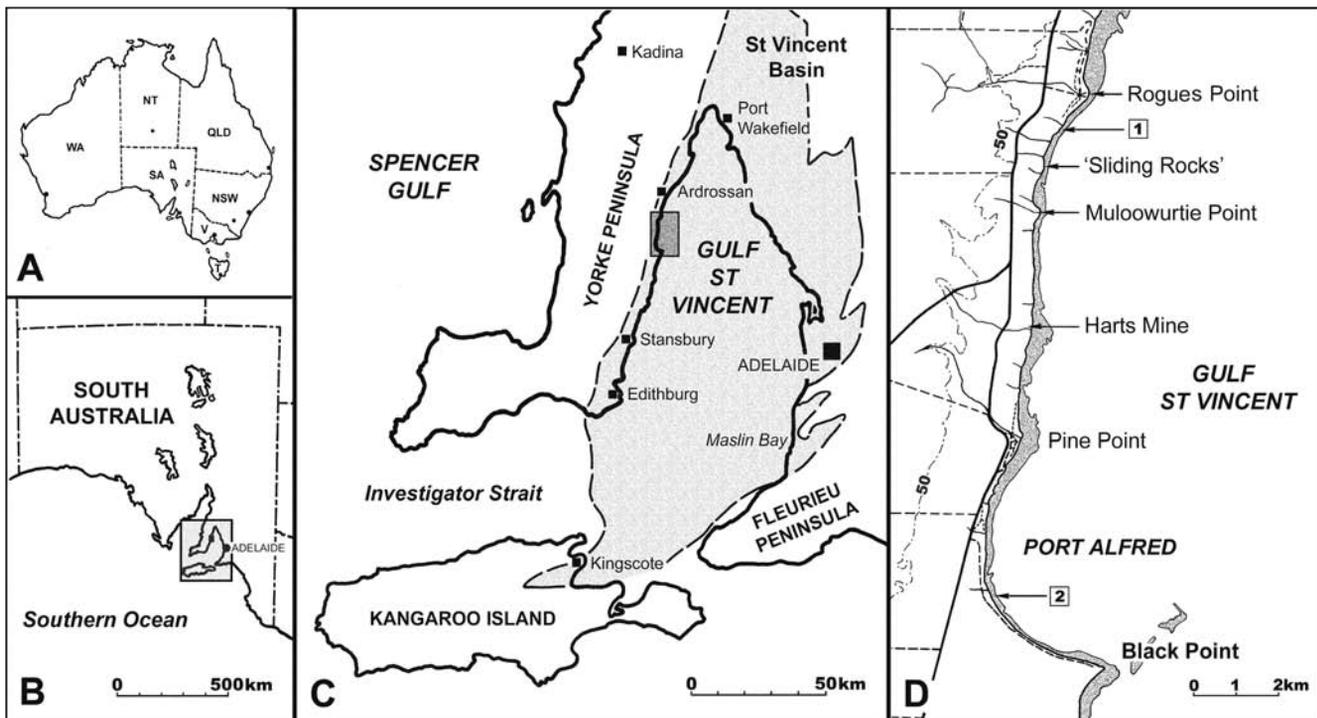
Figure 1. A and B, general location maps; C, map of St Vincent Basin in relation to Yorke Peninsula, Kangaroo Island and the Fleurieu Peninsula (Maslin Bay), South Australia; D, location of the northernmost exposure (1), and southernmost exposure (2), of the Muloowurtie Formation, west side of Gulf St Vincent.

Eurhodia australiae (Duncan, 1877), *Gillechinus cudmorei* Fell, 1963, and *Schizaster* (*Paraster*) *tatei* McNamara and Philip, 1980, have been found in the same general area. Two of these, *Gillechinus cudmorei* and *Salenidia tertiaria* occur with *Hemiaster* (*Bolbaster*) cf. *subidus* McNamara, 1987 and the new cassiduloid in the uppermost bed of the Formation. *Apatopygus vincentinus* (Tate, 1891) was recorded from "Muloowurtie", near Ardrossan, although no specific localities were given with Tate's syntypes of this species. The neolampadoid *Pisolampas concinna* Philip, 1963, is also found in the Formation in the vicinity of Harts Mine, approximately 3.8 km south of "Sliding Rocks".

A list of echinoid species recorded from the three major Late Eocene formations in the St Vincent Basin, the Tortachilla Limestone, Kingscote Limestone (lowest unit) and Muloowurtie Formation, is given in the Appendix.

The difference in the number of species recorded from each of these formations is no doubt primarily due to collecting bias; the Tortachilla Limestone in the coastal cliffs along Maslin Bay being well exposed and easily accessible from Adelaide. Although the Kingscote (Kangaroo Island) and Muloowurtie (Yorke Peninsula) deposits have been known for over 120 years (Tepper, 1879; Tate, 1883), virtually no systematic study of their echinoid fauna has been carried out. It is only in comparatively recent times that detailed stratigraphic information relating to these deposits has been published (Kingscote Limestone, Milnes et al., 1985; Muloowurtie Formation, Stuart, 1970). The variation in sedimentary lithology within the Basin, a consequence of small basin size, narrow basin width, and the

paralic nature of deposition (Cooper, 1985), rather than any minor age difference, must also be considered in relation to species distribution and difference in size, preservation, and number of specimens of individual species found in the three formations. As well as the apparent unique occurrence of the new cassiduloid in the Muloowurtie Formation, the lack of *Echinolampas posterocrassa posterocrassa* Gregory, 1890, one of the most common species in the Kingscote and Tortachilla Limestones, may, in this context, be quite significant.

Systematic Palaeontology

Order **Cassiduloida** Claus, 1880

Family **Faujasiidae** Lambert, 1905

Rhynchopygus d' Orbigny, 1856

Type species. Cassidulus marmini Agassiz, *in* Agassiz and Desor, 1847, by monotypy.

Diagnosis. See Smith and Jeffery (2000: 191)

Remarks. Because of its monobasal apical system (Fig. 3) and lack of known phyllode detail, the new Late Eocene species from South Australia can only tentatively be assigned to the genus; although Smith and Jeffery (2000: 192) suggested that the apical system of *Rhyncopygus donetzensis* Faas, 1918, may indeed be monobasal or at least have very reduced genital plates. *Rhyncopygus*, has been used in the past 150 years as a genus or subgenus to accommodate nearly 40 species, ranging

in age from early Late Cretaceous (Turonian) to Recent. Virtually all of these species have subsequently been reassigned to other genera, namely *Cassidulus* Lamark, 1801, *Eurhodia* Haime, 1853, *Procassidulus* Lambert, 1918, *Rhyncholampas* Agassiz, 1869, and even the holasteroid *Corystus* Pomel, 1883. The type species of all these genera, except *Eurhodia*, have at some time been assigned to *Rhynchopygus*. The most recent review of *Rhynchopygus* (Smith and Jeffery, 2000) noted that the differently shaped and positioned periprocts of three species included in the genus by Kier (1962), the type species *R. marmini, R. lapiscancri* (Leske, 1778) and *R. macari* (Smiser, 1935), preclude uniting them into a single genus-level taxon; referring only to *R. marmini* and *R. donetzensis* as belonging to the genus. Although *R. donetzensis* was listed by Lambert and Thiéry (1925: 588), no reference to this important species was made by Kier (1962). *R. lapiscancri* has since been assigned by van der Ham et al. (1987) to *Procassidulus* and *R. macari* by Smith and Jeffery (2000) to *Rhyncholampas*. Without comment the latter authors also assigned both *Rhynchopygus* and *Procassidulus* to the Faujasiidae, rather than the Cassidulidae.

Both Mortensen (1948: 201) and Kier (1962:161) blame the inaccurate illustrations of d'Orbigny (1856: pl. 927) for the early taxonomic problems in defining *Rhynchopygus*. While this is unquestionably true, d'Orbigny(1856) and Desor (1855–1858) did illustrate and refer to the prominent lip-like projection of the test that occurs in interambulacrum 5 adjacent to the periproct; the main feature now considered to distinguish *Rhynchopygus* from genera which have many other characteristics in common. However, Mortensen (1948) considered this projection to be of no generic value and Kier (1962) did not even mention it in his generic diagnosis, but added to the confusion by describing the periproct opening as either transverse or longitudinal, presumably to accommodate other species then assigned to the genus.

Mortensen (1948) considered *Rhynchopygus* a synonym of *Cassidulus* while Kier (1962) regarded the tetrabasal apical system as a major feature separating the two genera. In addition he deemed *Procassidulus*, a genus retained by Mortensen, to be a synonym of *Rhynchopygus*.

Rhyncopygus? *janchrisorum* sp. nov.

Figures 2A–F, 3A, B, 4A–C, 5, 6A

Type material. Holotype, NMV P145616 from Late Eocene (Aldingan, Priabonian) Muloowurtie Formation, "Sliding Rocks", Yorke Peninsula, South Australia. Paratypes. NMV P312113 to P312115 from the uppermost bed of the same formation, NNE of "Sliding Rocks" at approximately 34°34.17'S, 137°53.40'E (Fig. 1).

Description. Test moderately small, oval in outline at the ambitus, anterior and posterior evenly rounded, widest point central. Aboral surface moderately inflated, except for a depression posterior to the periproct, with the apex just anterior of the apical disk at the proximal end of slightly swollen ambulacrum III. Adoral surface slightly depressed around peristome and along the posterior paired ambulacra I and V.

Aboral tubercules very small, about 0.15mm diameter, and closely spaced with a density of about 12–15 tubercles per

mm2. Adoral tubercles, where visible near the margin, are also closely spaced but larger, about 0.6 mm diameter. Naked granular zone in ambulacrum III and interambulacrum 5.

Apical system monobasal, centre of disk 42–45%TL from anterior margin, with 4 gonopores in contact with the apical disk but extending into the first pair of interambulacral plates, anterior pair closer together than posterior pair. Ocular plates relatively small and about equal in size. Approximately 80 hydropores (Fig. 3).

Petals moderately short, broad and unequal in length. Longest in ambulacrum III (approx. 62% radius with about 30 pores per tract) and shortest in anterior pair II and IV (approx. 50% radius with about 20 pores per tract). Inner pores of pore pairs oval, outer pores slot like, with alignment noticeably oblique in ambulacra II and IV. At widest point interporiferous zone in ambulacra II, III and IV about equal in width to zones of pore pairs, parallel sided and open ended in ambulcrum III and narrowing distally in II and IV. Posterior pair of petals have narrower poriferous zones curving outwards distally with poriferous zones Ib and Va noticeably wider than Ia and Vb. Poriferous zones in individual petals equal in length. Anterior pair of petals diverge between 134° and 140°, posterior pair between 306° and 310°. The aboral swelling in ambulacrum III forms a low ridge along line of perradial suture for full length of petal.

Periproct supramarginal, transverse, situated at the anterior end of a pronounced posterior anal depression in interambulacrum 5, beneath a wide semi-circular projecting lip (about 19%TW) extending to nearly 20%TL from the posterior margin. The anal depression diminishes posteriorly and barely reaches the margin.

Peristome small, pentagonal, centre of opening situated 37-40%TL from the anterior margin, Floscelle well developed with very pronounced pointed and inflated bourrelets, anterior pair wide and wedge-shaped, posterior single and pair elongated and near parallel sided. Phyllodes deeply sunken proximally but with pronounced ridge between bourrelets at edge of peristomal opening. Detail of phyllode pores unknown.

Etymology. For Janice Krause and Christopher Ah Yee of Hamilton, Victoria.

Remarks. The description is based on four specimens, all of which have been subject to diagenetic compression resulting in radial cracks along adradial and interradial sutures. In the case of the holotype these cracks extend between half and two-thirds distance between ambitus and distal end of petals. Compared with a similarly compressed specimen of *Australanthus longianus* from the same locality, it is estimated that the holotype of *Rhyncopygus*? *janchrisorum* sp. nov. would have been about 24.0 mm long, 20.5 mm (85.5%TL) wide and a minimum of 10.5 mm (44%TL) high compared with the 26.8 mm long, 22.9 mm wide and 7.8 mm high dimensions of the compressed fossil test (Fig. 4). *Rhyncopygus*? *janchrisorum* is easily distinguished from the type species of the genus, *R. marmini*, in having a larger, less elongated and less inflated test, a monobasal apical disk, far more pronounced and broader petals, and prominent bourrelets. It differs from *R. donetzensis*, based on the illustrations in Smith and Jeffery (2000),
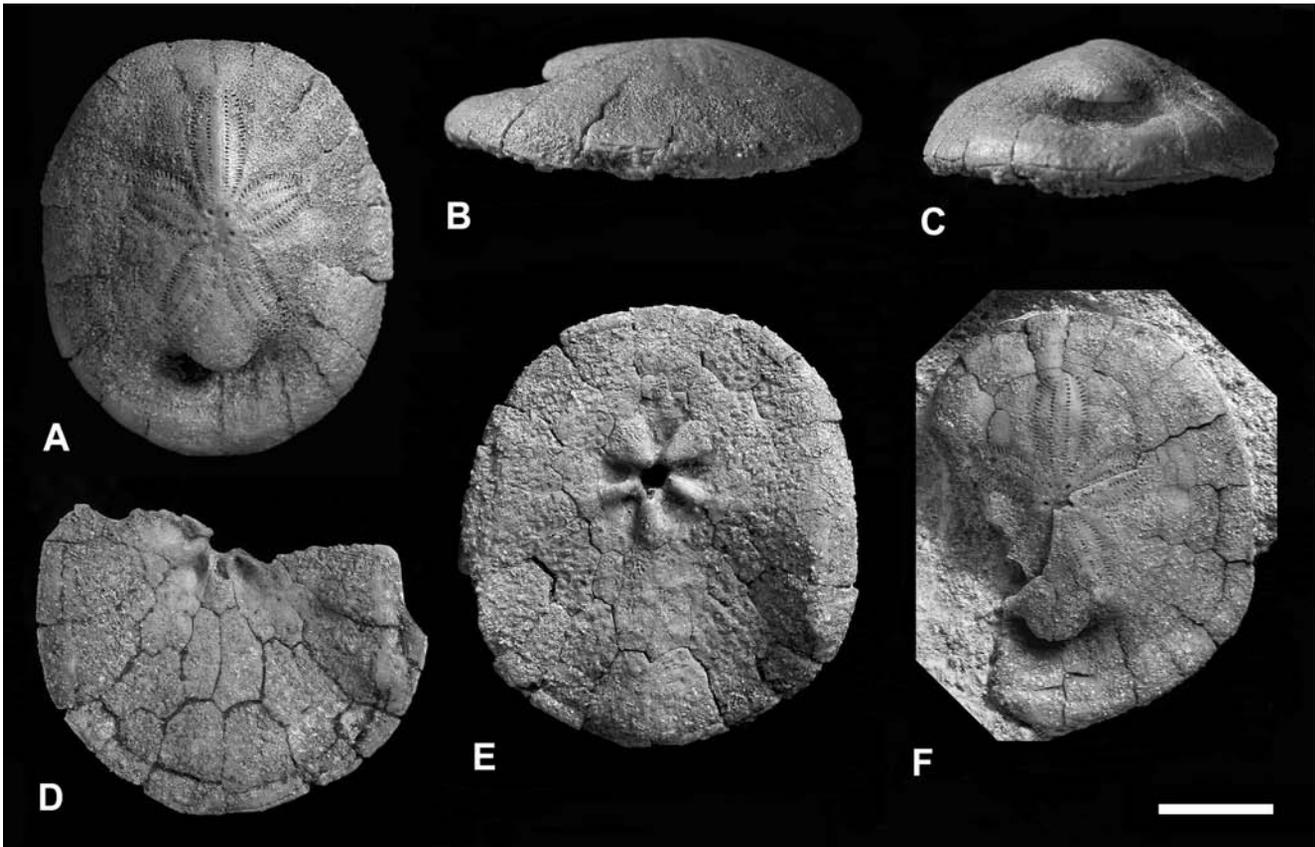
Figure 2. *Rhynchopygus*? *janchrisorum* sp. nov. A–C, adapical, right lateral and posterior views of holotype NMV P145616; D, adoral view of paratype NMV P312115; E, adoral view of paratype NMV P312114; F, adapical view of paratype NMV P312113. All specimens form the Late Eocene Muloowurtie Formation, Yorke Peninsula, South Australia. Scale bar 10 mm.
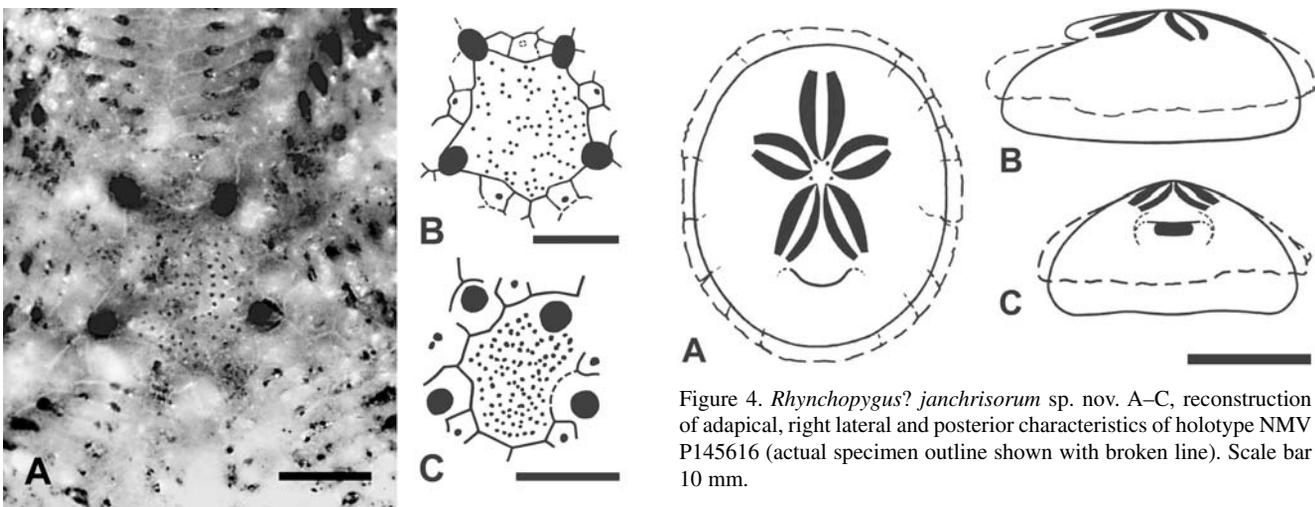
Figure 3. Apical plate structure. A and B, *Rhynchopygus*? *janchrisorum* sp. nov., Late Eocene holotype NMV P145616; C, *R. marmini*, Late Cretaceous USNM 19559 from Port Brechay, La Manche, France (drawing adapted from Kier, 1962). Scale bars 1mm.
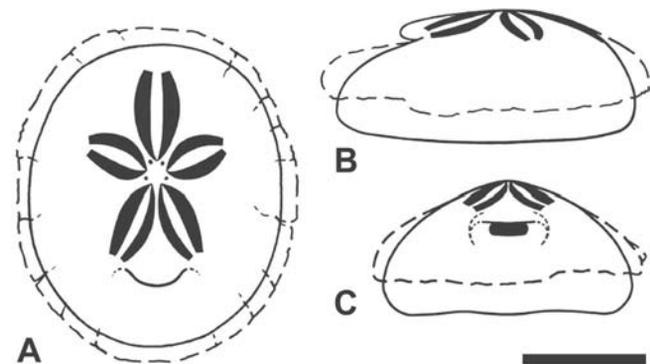
Figure 4. *Rhynchopygus*? *janchrisorum* sp. nov. A–C, reconstruction of adapical, right lateral and posterior characteristics of holotype NMV P145616 (actual specimen outline shown with broken line). Scale bar 10 mm.
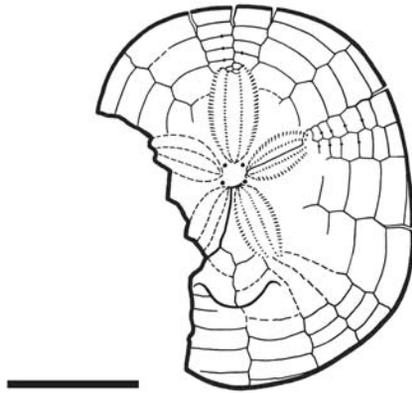
Figure 5. *Rhynchopygus*? *janchrisorum* sp. nov. Drawing of adapical surface of NMV P312113 showing plate structure distal to petals. Scale bar 10 mm.

primarily in being far less tumid and having a longer and broader petal in ambulacrum III, shorter posterior petals and considerably wider ambulacral plates at the ambitus (Fig. 5). The test of *R.*? *janchrisorum* is longer and proportionately wider than the other two species and has a more anterior periproct and projecting lip.

The occurrence of a similar but much less pronounced canopy above the periproct is also present in *Hardouinia* (*Fauraster*) *priscus* Lambert, *in* Lambert and Thiéry, 1924. Kier (1962: 143), in his description of the poorly preserved and compressed test, noted that the periproct is very wide and low; however, Smith and Jeffery (2000: 205) referred to this as an external feature that funnels into an opening only a little wider than tall and list *Hardouinia waageni* Holland and Feldman, 1967, and *Hardouinia nuratensis* Moskvin, 1984, as synonyms of this species. Apart from this feature, H. (F.) priscus differs from *R.*? *janchrisorum* in its near circular outline with slightly truncated posterior, its tetrabasal apical system and smaller and equal sized petals with narrower poriferous tracts and much wider interporiferous zone

Distribution and age of *Rhynchopygus*

The type species *R. marmini* recorded from France, Belgium, and The Netherlands, has until now been considered to occur only in the Late Maastrichtian, becoming extinct at the Cretaceous/Tertiary boundary (Smith et al., 1999: 136). Recent investigations (Philippe Mercier, pers. comm., 2004) showed that *R. marmini* occurs in the Late? Santonian Calcarénite de la Bouchardière, Craie de Villedieu, at La Richardière, Dissay (Sarthe), France; and that three specimens (NMV P311748) from cliffs on the right bank of the Gironde Estuary, between the south side of Pointe Suzac northwards to Pointe de Vallières, Royan and St Palais-sur-Mer, France, are Late Campanian. In the southeast Netherlands and northeast Belgium, *R. marmini* has so far been recorded only from the Nekum and Meerssen members of the Maastricht Formation (Jagt, 2000: 263).

A partial specimen, *R.* sp., is recorded from the Maastrichtian section, west of Cabo Major, near Santander (Cantabria), Spain (Smith et al., 1999: 105), and the Muséum national d'Histoire naturelle, Paris, holds a single specimen preserved in flint, labelled as originating from the Danian of St Cristophe (*sic*), Loire et Cher, France, which Smith and Jeffery (2000) suspected to be reworked Maastrichtian. Philippe Mercier (pers. comm.) suggested this latter locality is probably St Christophe in Eure et Loire (near Loire et Cher) but is uncertain of the local stratigraphy.

The second species, *R. donetzensis*, is recorded from the Maastrichtian (Cretacé Superieur) of the Donetz Basin, in the vicinity of Krymskoïé and Sérébrianca, Ukraine (Faas, 1918). Savchinskaya (1974) referred to the species occurring in the Maastrichtian of the Don Basin, Russia. As with *R. marmini*, Smith and Jeffery (2000: 192) did not show this species crossing the K/T boundary.

The additional information on French localities and the discovery of *R*? *janchrisorum*, extends the range of *Rhynchopygus* from the Late? Santonian to the Late Eocene, an interval of approximately 85 million years (Table 1).
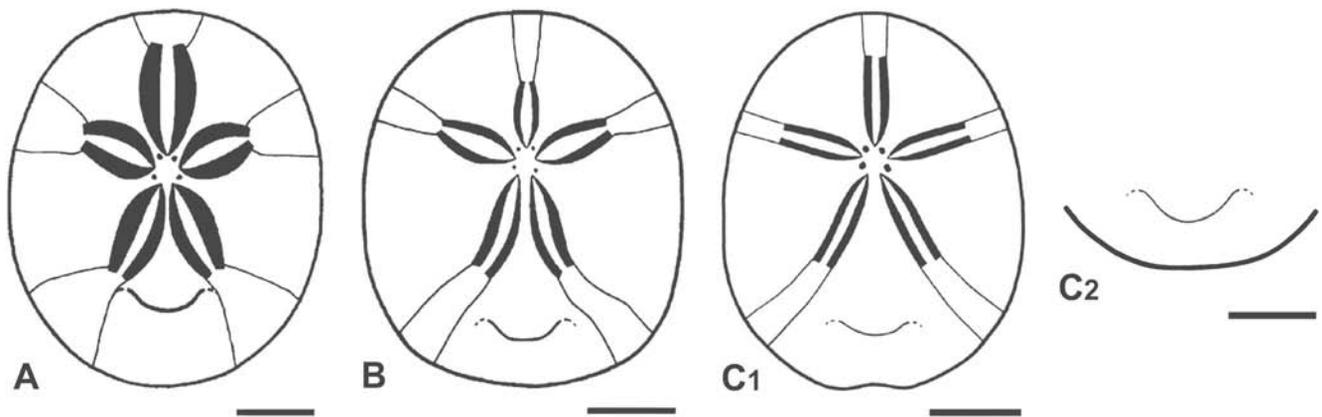
Figure 6. Comparative drawings of A, Late Eocene *Rhynchopygus*? *janchrisorum* sp. nov. from Yorke Peninsula, South Australia; B, Late Cretaceous (Late Maastrichtian) *R. donetzensis* from the Severny Donetz Basin, Ukraine (adapted from Smith and Jeffery, 2000); C1, Late Cretaceous (Late? Santonian) *R. marmini* from La Richardière, Dissay, France; C2, posterior profile of Late Cretaceous (Late Campanian) *R. marmini* from near Royan and St Palais-sur-Mer, France. Based on published illustrations, latter profile typical of Maastrichtian *R. marmini* specimens in general. Scale bars 5 mm.

Table 1. Currently known distribution and age of *Rhynchopygus marmini* (1); *R.* sp. (2); *R. donetzensis* (3); and *R*? *janchrisorum* sp. nov. (4). Triangle (▲) indicates occurrence in Late (Upper) section of Stage; inverted triangle, Early (Lower) section (▼); and square (■), non specific. Spain (Sp), France (Fr), Belgium (Bel), The Netherlands (Net), Ukraine (Ukr). Australia (Aus).

Epoch	Stage	Est. Age	Sp	Fr	Bel	Net	Ukr	Aus
		33.0ma						
	Priabonian							■4
		37.0						
	Bartonian							
Eocene		41.3						
	Lutetian							
		49.0						
	Ypresian							
		54.8						
	Thanetian							
		57.9						
Paleocene	Selandian							
		60.9						
	Danian			?1				
		65.0						
	Maastrichtian		▲ 2	▲ 1	▲ 1	▲ 1	■3	
		73.0						
	Campanian			▲ 1				
		83.0						
Late Cretaceous	Santonian			▲ 1				
		87.0						
	Coniacian							
		89.0						
	Turonian							
		91.0						
	Cenomanian							
		97.5						

Found with *R*? *janchrisorum* (see Appendix), *Australanthus* Bittner,1892, from the Middle/Late Eocene of southern Australia is the only member of the Faujasiidae previously recorded from this continent. Kier (1962: 18) considered *Australanthus* a possible descendant of *Hardounia* Haime, *in* d'Archiac and Haime, 1853.

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Appendix

South Australian Middle?–Late Eocene echinoids recorded from the Tortachilla Limestone, Maslin Bay (**TL**), lowest unit of the Kingscote Limestone, Kangaroo Island (**KL**), and the Muloowurtie Formation, Yorke Peninsula (**MF**). Named species confirmed from all three formations are marked ▶. Information based on published literature and specimens housed in Museum Victoria Invertebrate Palaeontology collection or privately owned. References to authors cited but not listed in the main text references can be found in Holmes (1993)

		TL	KL	MF
Cidaroida	Cidaridae sp.	●[1]	●[1]	
	Stereocidaris cudmorei Philip, 1964	●		
	S. fosteri Philip, 1964	●		
	S. inermis Philip, 1964	●		
	S. sp. 'C' Philip, 1964	●		
	S. sp. [unidentified]			●[4]
	S. (?) *hispida* Philip,1964	●		
	S. (?) *intricata* Philip, 1964	●		
Salenoida	▶ *Salenidia tertiaria* (Tate, 1877)	●	●	●
Temnopleuroida	*Tatechinus nudus* Philip, 1969	●		
	Temnopleuridae sp.	●[1]	●[1]	●[1]
	Ortholophus bittneri Philip, 1969	●		
Clypeasteroida	*Fibularia*. sp. 'A' [Irwin pers. com.]	●		
	F. sp. 'B' [Irwin pers. com.]	●		
	F. sp. 'C' [Irwin pers. com.]		●	
	F. sp. [unidentified, non. *F. gregata* of Stuart, 1970]			●[1]
	Monostychia sp. 'A' [small undescribed species]		●[4]	
	M. sp.'B' [medium sized undescribed (?) species]		●[4]	
Cassiduloida	▶ *Apatopygus vincentinus* (Tate, 1891)	●	●	●
	▶ *Australanthus longianus* (Gregory, 1891)	●	●	●[4]
	Echinolampas posterocrassa Gregory, 1890	●	●	●[4]
	▶ *Eurhodia australiae* (Duncan, 1877)	●	●	
	Rhyncopygus? *janchrisorum* sp. nov.			●
Neolampadoida	*Aphanopora*? *bassoris* Holmes, 1995	●[4]	●	
	▶ *Pisolampas concinna* Philip, 1963	●	●	●
Holasteroida	*Corystus dysasteroides* (Duncan, 1877)	●[2]	●[2]	
	Giraliaster bellissae Foster and Philip, 1978	●		
	G. sulcatus (Hutton, 1873)	●		
	G. tertiaria (Gregory, 1890)	●		
Spatangoida	*Eupatagus* sp.		●[3]	●[3]
	▶ *Gillechinus cudmorei* Fell, 1963	●	●	●[4]
	Hemiaster (Bolbaster) subidus McNamara, 1987	●		●[4]
	Linthia pulchra McNamara, 1985	●		
	Prenaster aldingensis Hall, 1907	●		
	Protenaster preaustralis McNamara, 1985	●		
	Psephoaster lissos McNamara, 1987	●		
	Schizaster (Paraster) tatei McNamara and Philip, 1980	●		●[4]
Total	37	27+3?	11+4?	10+3?

[1] Not specifically identified, may belong to one of the listed species

[2] Although almost certainly Late Eocene, occurrence of species in the formation requires confirmation

[3] No reference to occurrence of species in taxonomic literature: may have been incorrectly identified or come from an overlying stratigraphic unit

[4] Previously unpublished identification