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A RECENTLY DISCOVERED CLYPEASTEROID, *ECHINODISCUS COLCHESTERENSIS* SPECIES NOVUM, FROM THE ALEXANDRIA FORMATION (LATE TERTIARY), SOUTH AFRICA

by

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ABSTRACT

A recently discovered astriclypeid, *Echinodiscus colchesterensis* sp. nov. from the Late Tertiary of South Africa is described and classified as ancestral to the living *E. bisperforatus* on the basis of certain morphological characteristics and parameters. These include a smaller interlunule angle, different ambitus shape, breadth/length ratio, and similar growth trends.

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INTRODUCTION

Sediments belonging to the Alexandria Formation lie unconformably on mudstones and sandstones of the Cretaceous Sundays River Formation at Colchester, 40 km to the northeast of Port Elizabeth (fig. 1). The near-horizontal 6 m-thick Alexandria Formation crops out in a cliff exposure, about 50 m above sea level over a distance of more than 2 km. It consists of calcarenites, calcareous sandstone, coquinites and conglomerates (fig. 4).

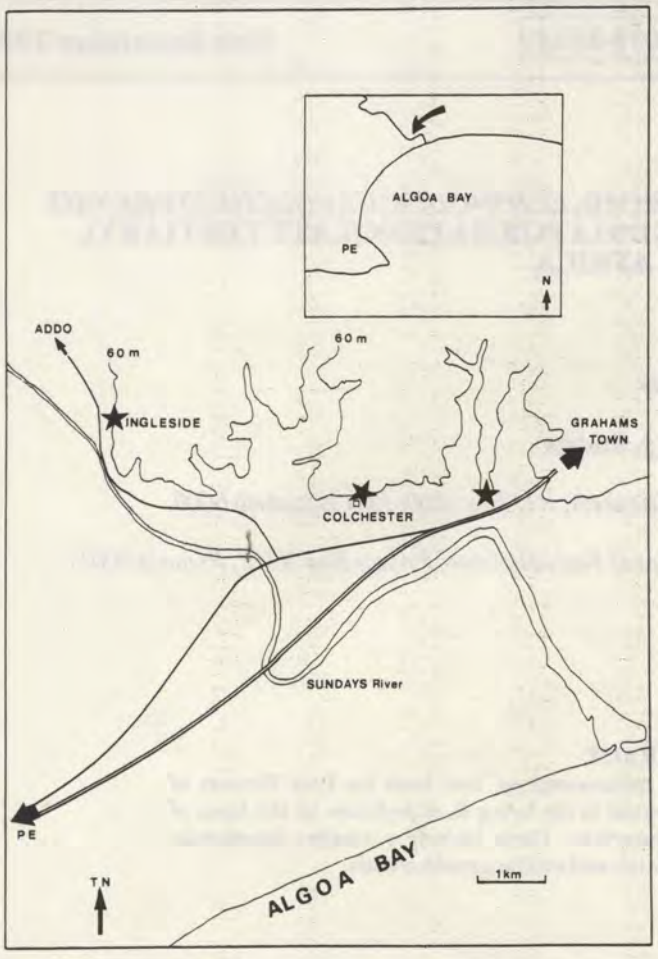


Figure 1 Locality map for *Echinodiscus colchesterensis* sp. nov. in the Alexandria Formation. The fossil localities are indicated by a star.

The first entire pansy shell (fig. 2a, b) was discovered in the flat-laminated calcarenite, exposed by differential weathering (Smuts, 1985). Numerous other tests are also visible in the cliff face but are impossible to remove because of the degree of cementation.

A number of specimens were also recovered from the overlying coquina. The excellent preservation of such specimens is probably the result of the similar mineralogy of the tests and the surrounding sediments. Water in the sediment will quickly become saturated as it simultaneously dissolves calcium carbonate from the fossil and the sediment, thus dissolving less of both (Dodd and Stanton, 1981).

Many specimens found in the calcarenite are still in the living position and unbroken. Those in the overlying coquinas are usually broken, although the fragments are extremely well preserved.

The descriptive terms employed here are those used by Durham (1966), Meglitsch (1972) and Clark and Courtman-Stock (1976). Abbreviations used in the text are as follows: BoB = breadth over broadest part of test; BoA = breadth over anterior lobe; L = length of test from posterior to anterior; ang. = angle between the two lunules (fig. 3a).

All the material described herein is housed in the palaeontological collections of the Geological Survey in Pretoria.

SYSTEMATIC PALAEONTOLOGY

Class : ECHINOIDEA Leske, 1778
Subclass: EUECHINOIDEA Bronn, 1860
Order : CLYPEASTEROIDA A. Agassiz, 1872
Suborder: SCUTELLINA Haeckel, 1896
Family : ASTRICLYPEIDAE Stefanini, 1911
Genus : *Echinodiscus* Leske, 1778
Species : *E. colchesterensis* species novum

Etymology – This species is named after Colchester cliff (overlooking Colchester station and settlement) where the holotype was found.

Type material – A8817 is selected as holotype; there are ten paratypes: A8818, A8819, A8820, A8821, A8822, A8823, A8824, A8825, A8826, A9000 and A9001.

Echinodiscus colchesterensis sp. nov. has been recovered from the Alexandria Formation at several localities in the Colchester area. It is also known in the Swartkops area to the southwest, and has since been discovered at various localities up to 120 km away.

Eleven specimens were collected from Colchester (25° 48′; 33° 41′) and environs, including the holotype. One paratype, No A8826, was collected from outcrops at the Swartkops brickfields (25° 37′; 33° 51′) 27 km southwest of Colchester.

DIAGNOSIS

A species of *Echinodiscus* characterised by distally closed (elongate) lunules, an interlunule angle of c. 94 degrees, a pronounced lobing of the ambitus, an almost straight posterior ambitus between the two lunules and a smaller width/length ratio.

DESCRIPTION

The test is very flat, broadest posteriorly (average 113% broader than long) (Table 1). Two lunules occur, one in each posterior ambulacrum (fig. 2). The lunules are situated at an average angle of 94 degrees from each other (Table 1) and they are closed distally within the test. The apical system is situated slightly towards the anterior, with four gonophore openings arranged radially around it. Of the five ambulacra (petals) present, the two posterior petals are the shortest and the anterior petal is the longest. The ambulacral plates are very narrow, hence the petaloid shape. The podial pores in each ambulacral plate (fig. 2d) are arranged in pairs to form two elongated ovals, the one within the other.

TABLE I
TEST MEASUREMENTS FOR *ECHINODISCUS COLCHESTERENSIS* AND *E. BISPERFORATUS*

Species	Specimen	L (mm)	BoB (mm)	BoA (mm)	Angle (deg)	BoB/L (%)
E. colchesterensis	A8817	71,2	82,7	61,9	99	115
	A8819	75,5	88,4	69,6	98	108
	A8820	75,0	85,6	64,5	98	116
	A8821	75,0	84,8	65,3	NP	123
	A8823	NP	NP	NP	86	NC
	A8825	79,5	87,0	NP	87	109
	A8826	NP	NP	NP	98	NC
	A	37,9	41,2	34,2	94	109
	A	36,7	39,9	33,3	95	109
E. bisperforatus	JSVR 1	66,6	76,4	60,7	111	115
	2	45,1	51,9	41,7	114	115
	3	53,8	62,3	48,7	111	116
	4	57,6	69,0	54,5	116	120
	5	60,0	72,5	57,3	127	121
	6	38,2	46,2	35,9	106	121
	7	62,3	76,0	59,0	109	122
	8	54,9	67,1	51,6	106	122
	9	39,3	47,1	35,9	109	120
	10	50,5	61,2	47,3	116	121
	11	64,5	73,9	59,6	113	115
	SF 1	31,9	37,2	28,4	119	116
	2	34,7	38,9	31,8	100	112
	3	39,3	44,9	36,4	98	114
	4	45,5	55,5	44,2	99	122
	5	52,1	62,0	45,6	102	119
	6	53,8	60,0	50,0	106	112
	7	51,4	60,3	47,4	105	117
	8	71,6	84,6	67,0	110	118
	9	28,8	33,5	25,7	103	118
	10	25,3	29,6	23,1	108	117
	11	24,6	27,5	22,3	113	112
	12	32,5	37,0	29,0	112	114
	13	30,0	33,3	26,6	101	111
	14	26,3	30,0	24,1	101	114
	15	60,0	70,6	54,6	106	118
	16	19,0	21,0	16,9	102	111
	17	34,5	38,3	29,7	98	111
	18	45,7	53,4	49,7	106	117
	19	45,2	50,0	40,3	105	111
	20	50,0	58,1	44,7	110	116
	21	45,6	49,8	40,5	105	109
	22	44,8	50,6	40,8	105	113
	23	45,6	53,4	42,0	108	117

L = length of test
BoB = breadth over broadest part of test
BoA = breadth over anterior lobe of test
Angle = inter-lunule angle
NP = not preserved
NC = not calculated

The periproct is approximately nine-tenths (of the distance between peristome and ambitus) away from the periostome towards the ambitus in the posterior interambulacral shield.

Internal test support is very well developed. The area surrounding the periostome, which in life contained the internal organs, lacks internal supports. Subsequent loading has therefore resulted in crushing of the oral areas. The internal support struts in the posterior interambulacrum are fused to form an enclosed duct between the peristomal area and the periproct.

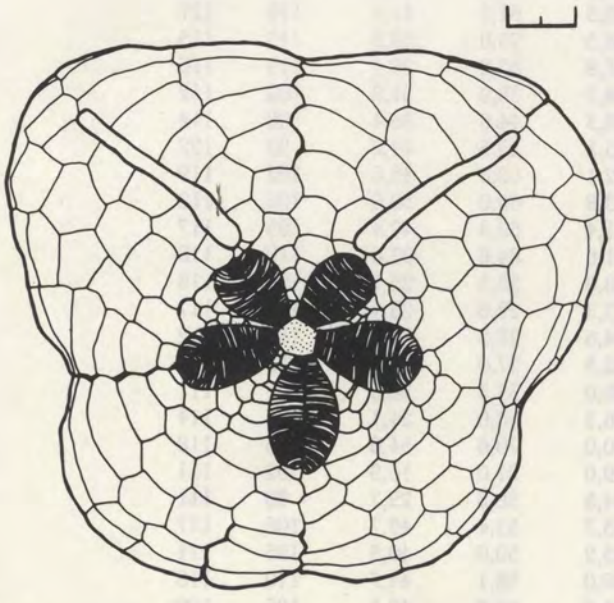
The size and shape of the skeletal plates of *Echinodiscus colchesterensis* sp. nov. are distinctly discernible in the holotype (fig. 2c, aboral view). Two paratypes (fig. 2d, 3b), clearly show the tubercles on which spines hinged. From the size and number of these tubercles it is evident that the spines were very frag-



Figure 2
(a) *Echinodiscus colchesterensis* sp. nov. Aboral view of holotype (A8817) showing the lunules and the petaloid ambulacra. The bar scale in all figures is 50 mm long.



(b) Oral view of the holotype (A8817) – note the sand grains and shell fragments cemented to the test by the reaction of leaking body fluids with the sediment after death in the living position.



(c) A camera lucida drawing of the holotype showing the size and shape of the skeletal plates. The bar is 10 mm long.



(d) View of the posterior petal (top) and an anterolateral petal showing the paired podial pores. Specimen No. A8826.

ile and that they formed an almost hair-like covering. No spines were observed in the sediment. However, petrologic studies of the calcarenite revealed the presence of spines of this nature as part of the framework. The tubercles on the aboral side are all of uniform size and spread homogeneously over the whole test surface. On the oral side tubercles indicating two sizes of spines are present. Extending from the peristome relatively large tubercles occur on the interambulacral shields between the food grooves. Small tubercles cover the immediate area of the food grooves. The side walls of the lunules appear to have been devoid of spines. A denser grouping of tubercles is found on the interambulacra than on the ambulacra.

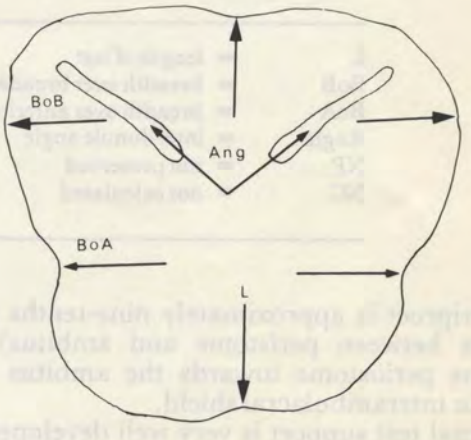
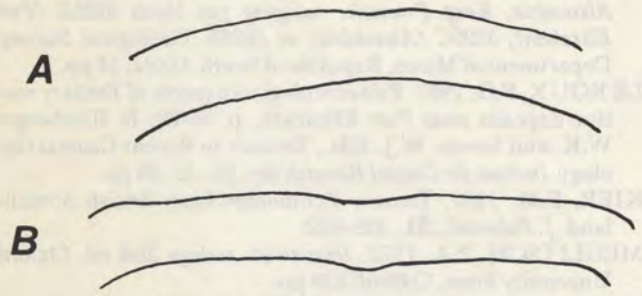


Figure 3
(a) Measurements taken from tests for analysis. See text for explanation of abbreviations. Detail in the test has been omitted for the sake of clarity.



(b) Oral view of test showing the pattern of tubercles. Note the dense grouping on the interambulacra. The larger tubercles occur between the bifurcating food grooves in five zones with the smaller tubercles situated between these zones and towards the margins. This test was cleaned by scavengers before being deposited in the coquina, hence the clean, well-preserved oral surface. Compare with Figure 2b.



(c) The profile of the posterior ambitus between the two lunules of (a) *Echinodiscus bisperforatus* and (b) *E. colchesterensis* sp. nov.

The posterior ambitus between the lunules forms a comparatively straight line with a definite indentation opposite the apical system (fig. 3c: b), compared to the ambitus of *E. bisperforatus* which forms an arcuate line (fig. 3c: a) with only a very slight indentation present, if at all.

MORPHOMETRIC ANALYSIS

All test measurements are tabulated in Table 1 with comparative data for *E. bisperforatus*. These are: 1) length of test; 2) breadth over broadest part of test; 3) breadth over anterior lobe of test; and 4) the angle between the two lunules. The breadth/length ratio is given as a percentage.

The average BoB/L (%) is 113% for *E. colchesterensis* sp. nov. and 116% for *E. bisperforatus*. *Echinodiscus colchesterensis* sp. nov. has an average inter-lunule angle of 94 degrees compared to 108 degrees for *E. bisperforatus*. Figure 5 is a comparison of the growth lines of *E. colchesterensis* sp. nov and *E. bisperforatus*.

ASSOCIATED FAUNA AND DEPOSITIONAL ENVIRONMENT

Echinodiscus colchesterensis sp. nov. is the only macrofossil that occurs in the calcarenite, except for one broken crinoid stem that was found with the echinoids in a hummocky, stratified calcarenite. Associated trace fossils are *Thallassinoides*, *Arenicolites*, *Ophiomorpha*, a variety of *Fugichnia* traces and a trace that resembles that of the echinoid *Echinocardium* (J.S.V. Reddering, pers. comm.) belonging to a mixed *Skolithos/Cruziana* assemblage (Smuts, 1987).

In the coquinite *Echinodiscus* is associated with numerous bivalves, and gastropods, some of the more common examples being *Glycymeris* spp., *Melapium*

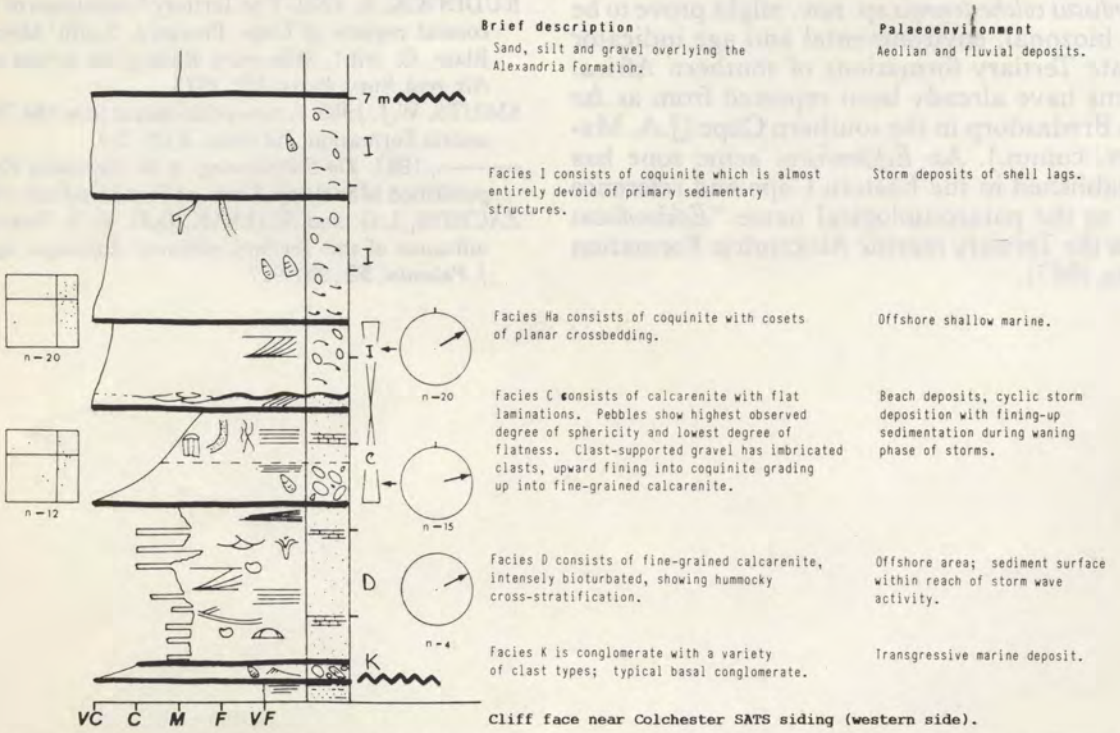


Figure 4 Stratigraphic profile of the Alexandria Formation at the discovery site of *Echinodiscus colchesterensis* sp. nov. Modified after Smuts 1987.

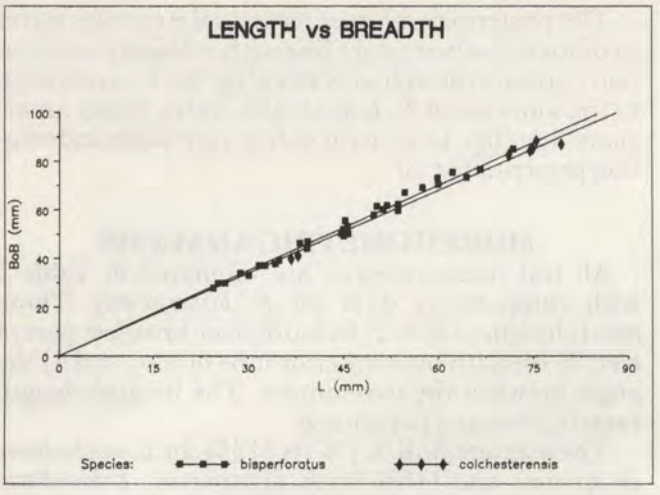


Figure 5 Length (L) versus width (BoB) plot for tests of *Echinodiscus bisperforatus* (squares) and *E. colchesterensis* (diamonds). The solid line is the least-squares fit for all *Echinodiscus* specimens.

spp., *Scissodesma spengleri* and *Bullia* spp. Escape traces and *Ophiomorpha* burrows (*Skolithos* assemblage) are the only trace fossils present.

E. colchesterensis sp. nov. lived in the tidal/subtidal zone, burrowing in a sandy substrate. Periodic storms also washed many individuals into coquina bars and berms where they were broken up during these high energy conditions (Smuts, 1987).

Using the number of tests in the sediment as an indicator, *Echinodiscus colchesterensis* sp. nov. occurred in great profusion during late Tertiary times. A density of up to 60 specimens per square meter has been noted in coquinite beds.

IMPLICATIONS

Echinodiscus colchesterensis sp. nov. might prove to be a useful biozonal, environmental and age indicator in the late Tertiary formations of southern Africa. Specimens have already been reported from as far afield as Bredasdorp in the southern Cape (J.A. Malan, pers. comm.). An *Echinodiscus* acme zone has been established in the Eastern Cape and reference is made to the palaeontological name "*Echinodiscus* beds" for the Tertiary marine Alexandria Formation (Le Roux, 1987).

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