PALAEOGENE OSTRACODS FROM THE SOUTH AFRICAN CONTINENTAL SHELF.

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ABSTRACT

92 cytheracean species, representing 44 genera are recorded from the Palaeogene Agulhas Bank and west coast margin of South Africa. 11 genera and 3 species are common with the Upper Cretaceous faunas. 12 genera (18 species) are left in open nomenclature. The following genera are represented:- Bythoceratina, Incongruellina, Ruggieria, Eucythere, Krithe, Parakrithe, Eucytherura, Cytheropteron, Ambostracon, Urocythereis, Muellerina, Leguminocythereis, Loxoconcha, Schlerochilus, Poseidonamicus, Bradleya, Agrenocythere, Australileberis, Chrysocythere, Costa, Echinocythereis, Haughtonileberis, Henryhowella, Parvacythereis, Phacorhabdotus, Soudanella, Stigmatocythere, Togoina, Trachyleberis, Veenia, Atlanticythere, Xestoleberis.

Data on South African Cretaceous and Palaeogene ostracod faunas are discussed in terms of: faunal associations for the South African Palaeogene JC-1, Agulhas Bank and west coast provinces; characteristic species of Upper Eocene and Upper Eocene to Oligocene strata; generic variations across the Cretaceous/Tertiary boundary.

Palaeo-environmental trends from a Cytheracea, Cypridacea + Bairdiacea, Cytherellidae (CCBC) plot indicate a sea level change from <100m (Palaeocene - Eocene), to shallower water with restricted circulation (Upper Eocene) to moderate depth, 100 - 200m (Lower Oligocene).

South African faunas are compared with those from adjacent Palaeogene ostracod faunal provinces. Strong generic links occur with West Africa (8 genera in common) and Pakistan (9 genera in common) with only 3 genera in

common with Australia and 3 with Argentina.

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1.1 INTRODUCTION

Marine Lower Tertiary strata in South Africa are sparse on land and relatively thick, though poorly exposed offshore. The best known occurrences are those on the Agulhas Bank at the southern tip of the continent. Figure 1.1:1 shows the Tertiary outcrops in the study area, while the distribution of the twenty three Agulhas Bank and west coast offshore samples used for this work are shown in Figure 1.1:2 (See Table 1.1:1 for station data). Of these, twenty one were previously dated by Siesser (1977 plus personal communication 1986) using coccoliths, and the other two are dated in this study using ostracods.

In the area of study, the continental shelf varies in width and depth of shelfbreak from 28km and 300m in the west, near Saldanha Bay, to 86km and 200m at 24E. On the west coast, Palaeogene outcrops were sampled along the walls of the Cape Canyon where mid-Tertiary erosion has exposed older strata, and at two localities on the outer shelf (#1701 & #1706). On the Agulhas Bank, the cluster of samples on the inner shelf were collected from seaward dipping erosional outcrops, while those on the upper slope are from slump scars in Neogene structures that have exposed Palaeogene and Cretaceous strata.

The Palaeogene stratigraphy of the Agulhas Bank (the Cape St. Blaize Formation) was originally described by Dingle (1973) and then later formally described by du Toit (1976) using data from ten SOEKOR boreholes. The latter author renamed the succession the Alexandria Formation using borehole F-D/1 as stratotype, but as this name is

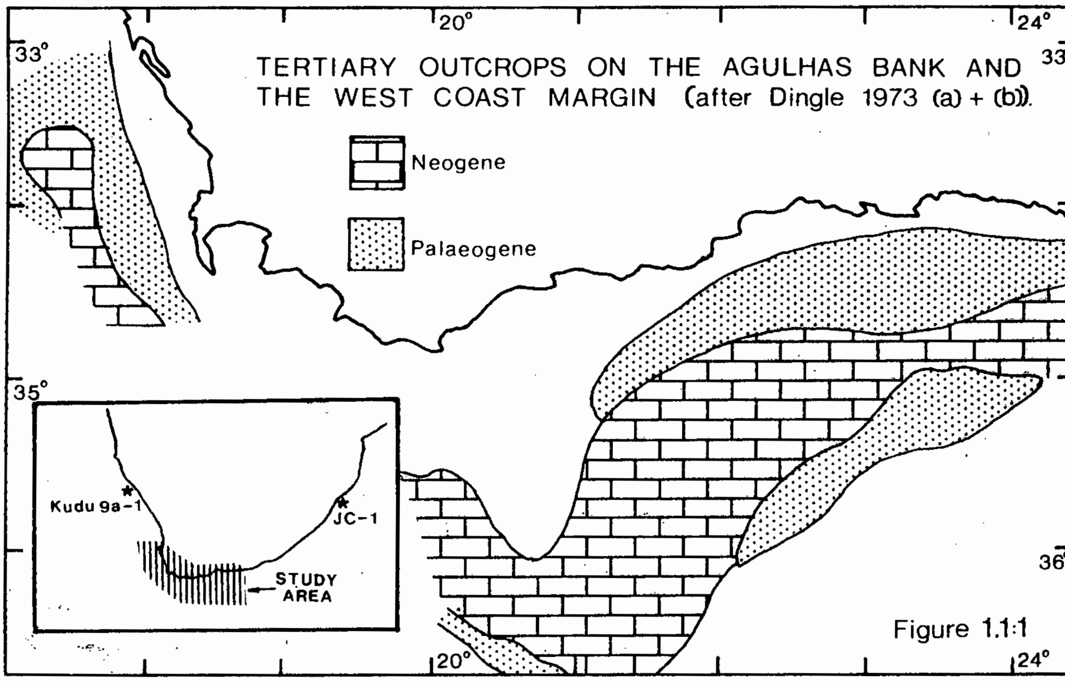


Figure 1.1:1

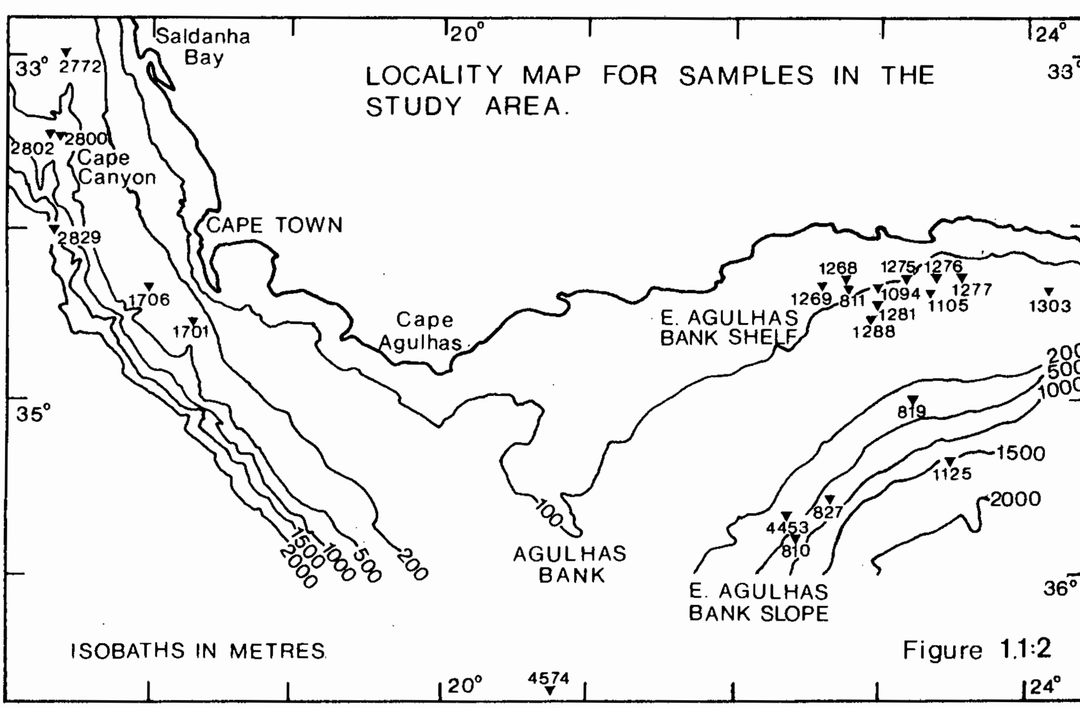


Figure 1.1:2

pre-occupied, the borehole F-D/1 is used as the stratotype for the Cape St. Blaize Formation. The Cape St. Blaize Formation consists of 4 lithologcal units which vary from the base: (1) coarse sandstone (2) grey fossiliferous, calcareous clays (3) fine, well sorted sandstone to (4) light grey, fossiliferous, calcareous, glauconitic clay. Over most parts of the Agulhas Bank, unit 4 is missing. Figure 1.1:3 outlines the stratigraphy for the study area using Dingle's (1973) interpretations of the SOEKOR Agulhas Bank data, and also shows the correlation with the important boreholes Kudu 9a-1 (28.55S, 14.58E) on the west coast and JC-1 (29.46S, 31.59E) on the east coast (Figure 1.1:1), based on their foraminiferal assemblages (Table 1.1:2). Regional thickness variations of the Palaeogene succession are also plotted on Figure 1.1:3. Sediment samples used in this thesis have been superimposed on the diagram to show their east-west distribution, ages and probable stratigraphic correlation.

1.2 PREVIOUS WORK

Previous work on South African Tertiary marine ostracods is limited to Dingle (1976) from the JC-1 borehole on the continental shelf off Natal. Relevent studies on materials of other ages have been made by : Dingle (1969a+b, 1971a+b, 1976, 1980, 1981, 1982, 1984, 1985, 1987), Jurassic and Cretaceous assemblages; Brady (1880), HMS Challenger expedition 1873-1876; Chapman (1916, 1923), Upper Cretaceous Needs Camp and Umzamba beds; Brenner and Oertli (1976), and Valicenti and Stephens (1984), Early Cretaceous Sundays River Formation; Sigal (1974), DSDP site leg 25; Ducasse and

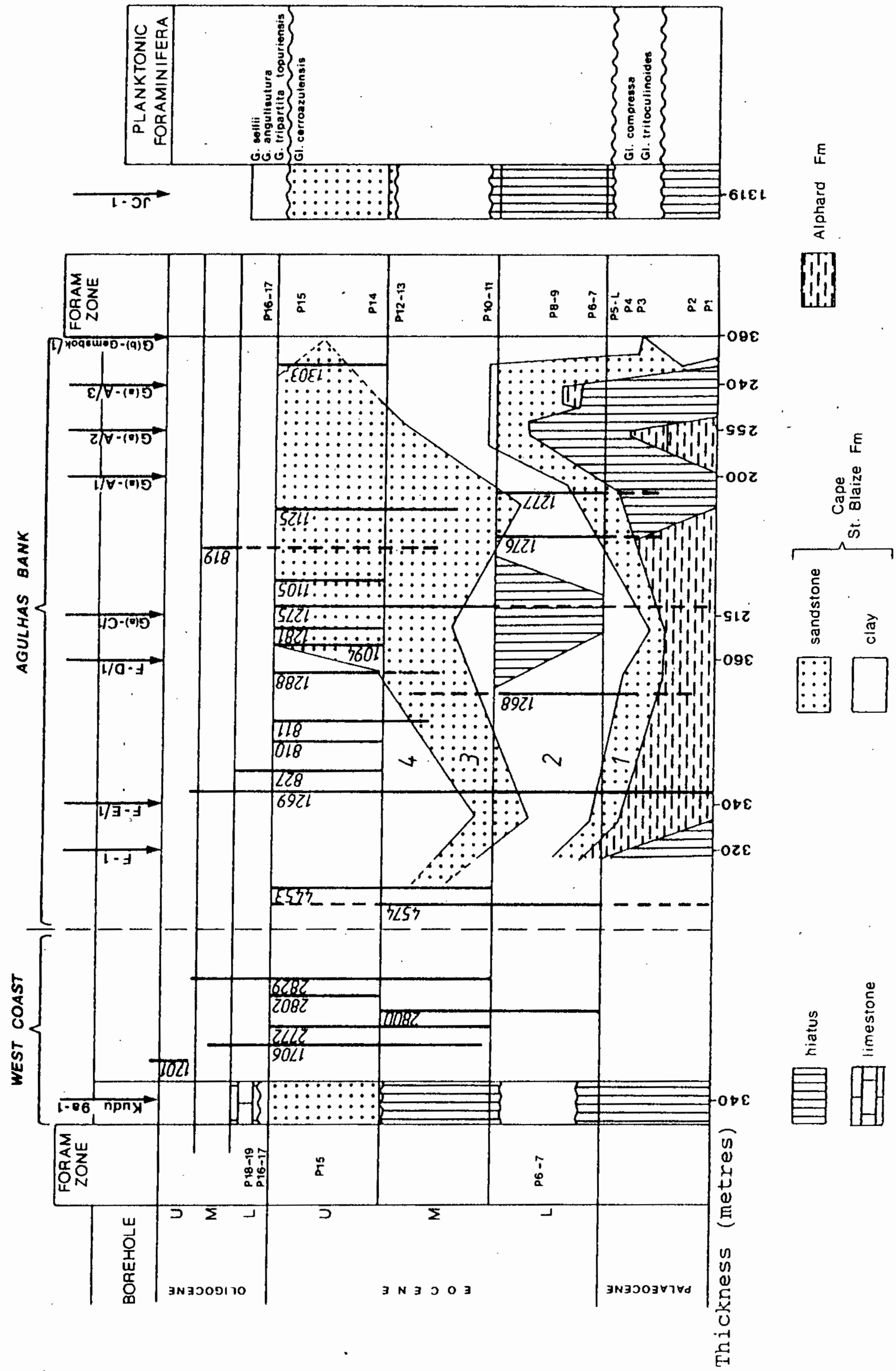


Figure 1.1:3 Bio and Litho Stratigraphic Framework of Offshore South African Palaeogene Sediments.
Arrows indicate SOEKOR boreholes, and numbered bars the ages of samples within this study (Coordinates of study area samples and SOEKOR boreholes are shown in Table 1.1:1 and 1.1:2 respectively). Kudu 9a-1 & JC-1 are also located on Figure 1.1:1. See text for explanation of stratigraphic details.
Based on Dingle et al (1983) - see this reference for full citation of biostratigraphic zonation of the boreholes.

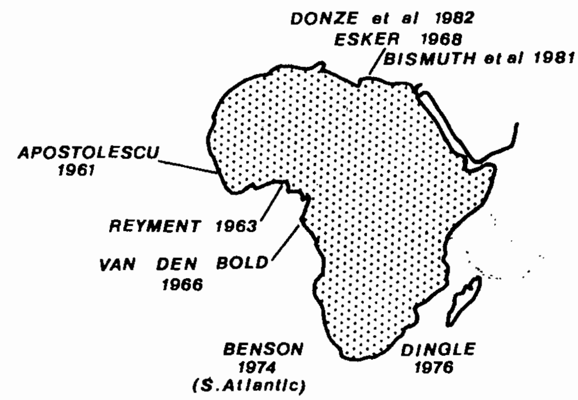


Figure 1.2:1 Tertiary localities for African Ostracod studies

Grekoff (1976), South East Indian ocean site 246; Benson (1974), DSDP South Atlantic in general; Hartmann (1974) Recent South West Africa, South Africa and Mozambique coasts; Boomer (1985 unpubl. MSc. thesis), Recent faunas of south western Africa; Benson and Maddocks (1964), Recent faunas of Knysna estuary; Klie (1940) Recent faunas of South West Africa; Keeler (1982 unpubl. MSc. thesis), Recent faunas of Agulhas Bank.

Publications from adjacent Gondwanide areas which are of significance for comparative purposes in this study are quoted below (Tertiary papers are underlined). Tertiary African localities from which ostracods have been studied are shown in Figure 1.2:1).

North and West Africa

Apostolescu 1961, 1963, Donze et al 1982, Esker 1968, Omatsola 1970, van den Bold 1966, Grosdidier 1979, Reyment 1961, 1963, Bismuth et al 1981.

East Africa

Bate and Bayliss 1969, Bate 1975.

South America

Bertels 1973, 1974, 1975, Neufville 1979, Valicenti 1977.

Australia and New Zealand

Bate 1972, 1975, Hazel and Holden 1971, Neale 1975, Swanson 1969, Whatley and Downing 1983, Hornibrook 1952.

Saudi Arabia

Ali-Furaih 1980.

India and Pakistan

Siddiqui 1971, Sohn 1970, Guha 1971, Lubimova, Guha and Mohan 1960, Neale and Pratap Singh 1985.

1.3 SAMPLE TREATMENT

All of the samples were collected as short gravity cores from the University of Cape Town's Research vessel "Thomas B Davie".

Figure 1.3:1 shows the flow chart for the preparation techniques applied to each sample. Any non-disaggregated samples were boiled in a deflocculant. Approximately 100grams of dry sample was then wet sieved to reduce specimen damage, which is more frequent in dry sieving. After separation, using a fine damp paint brush, ostracod specimens were mounted on aluminium stubs and photographed on a Scanning Electron Microscope (SEM) S180. The S180 was preferred to the S200 as it possesses the y (not x of the S200) directional tilt which is more convenient for viewing stereo-paired photographs. The mounting of the specimens on double sided sticking tape on the stubs and coating with 20-50 nm of gold palladium was found adequate for the low magnifications (<300x) used. Less than 2% of the specimens showed charging which is negligible in relation to the conveneience of this technique. Species recognition and taxonomic descriptions are based on the SEM photographs and supplemented by inspection of uncoated specimens.

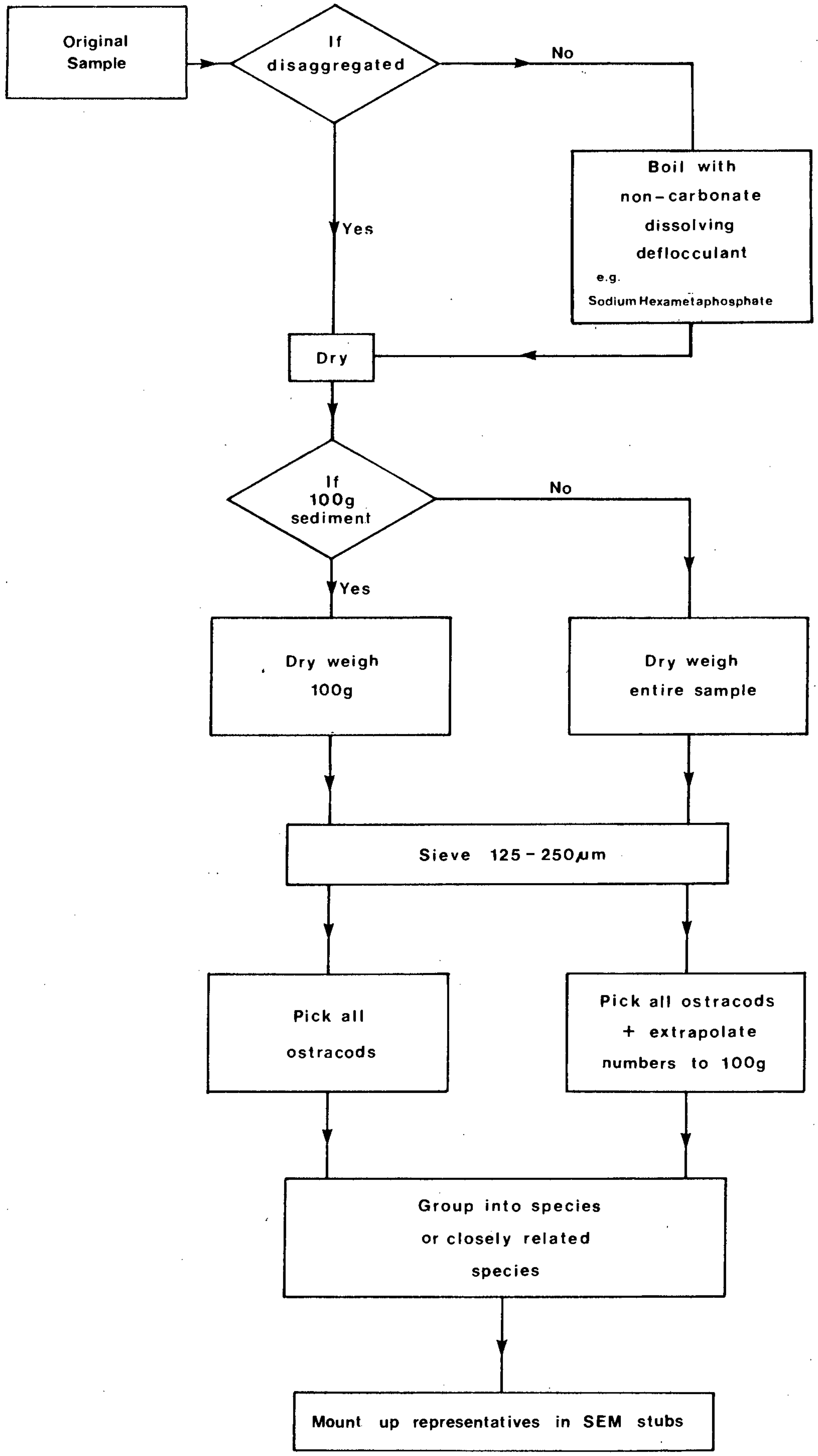


Figure 1.3:1 FLOW CHART TO SHOW PREPARATION TECHNIQUES FOR SAMPLES USED IN THIS STUDY

1.4 SCOPE OF STUDY

92 cytheracean species belonging to 44 genera of ostracod were extracted from the Palaeogene samples of the Agulhas Bank and west coast margin. A summary of the entire fauna is shown in Table 1.4:1. The cytheraceans were selected as a large and important group (76% of total fauna) for my MSc. studies.

Table 1.4:2 summarises the species and number of valves of each cytheracean taxon discussed in this thesis. Note that previously undescribed species have been allotted a sample number which is a unique SEM photo number. Various species will be formally described in suitable publications at a later date.

1.5 ABBREVIATIONS

TAXONOMY

AM = anterior margin, PM = posterior margin, DM = dorsal margin, VM = ventral margin, PVM = posterior ventral margin, ACA = anterior cardinal angle, PCA = posterior cardinal angle, SCT = sub-central tubercle, ET = eye tubercle, MA = marginal area, MS = muscle scars, AMS = anterior muscle scar, PMS = posterior muscle scar, ATE = anterior terminal element, ME = median element, PTE = posterior terminal element, TE = terminal element, AE = anterior element, AT = anterior terminal, NPC = normal pore canal, MPC = marginal pore canal, AMR = anterior marginal rim, PMR = posterior marginal rim, c = carapace, v = valve.
P,A,B or C, followed by a number = Photograph (reference numbers for SEM photo), p = page, pl. = plate, fig./Fig. = figure/Figure, unpubl. = unpublished.

TABLES

CE = Cenomanian, TU = Turonian, CO = Coniacian,
SA = Santonian, CA = Campanian, MA = Maastrichtian,
PA = Palaeocene, EO = Eocene, OL = Oligocene, MI = Miocene,
RE = Recent.

TAXONOMY

Family Bythocytheridae Sars 1926
Genus Bythoceratina Hornibrook 1952

Although previously unrecorded from Southern Africa the genus is known from adjacent areas. Ducasse and Grekoff (1976) recorded two species B. sp 3 and B. sp 4 in the DSDP Lower Eocene site 246 in the South West Indian Ocean, and van den Bold (1966) described a B. sp A from the Lower Miocene of Gabon.

The genus is considered by Van Morkhoven (1963) to indicate deeper water marine conditions. Cronin (1983) cites species from Florida and the Blake Plateau with the following depth ranges: 220-1034m, 584-1034m.

Bythoceratina sp A382

Plate 1 H, Fig. 2.1

Material: 2 fragments.

Remarks: Characterized by a blunt caudal process, serrated PVM and three elongations along the ventro-dorsal inflation: a ridged anterior dome, a blunt spine at 1/3 valve length, and a curved lance-like posterior spine. This architecture has all the elements described by Hornibrook (1952) in his type material from New Zealand (see pl.16, fig. 257-259, 269). However, Van Morkhoven (1963) suggests similarities between Monoceratina Roth (1928) and Bythoceratina, so that for a confident generic assignment, the hinge of the South African species needs to be studied.

The external features of B. sp A382 are also similar to Pariceratina trispinosa (Neale 1975) although the former is less reticulate (Figure 2.1).

Because both Palaeogene specimens show very similar

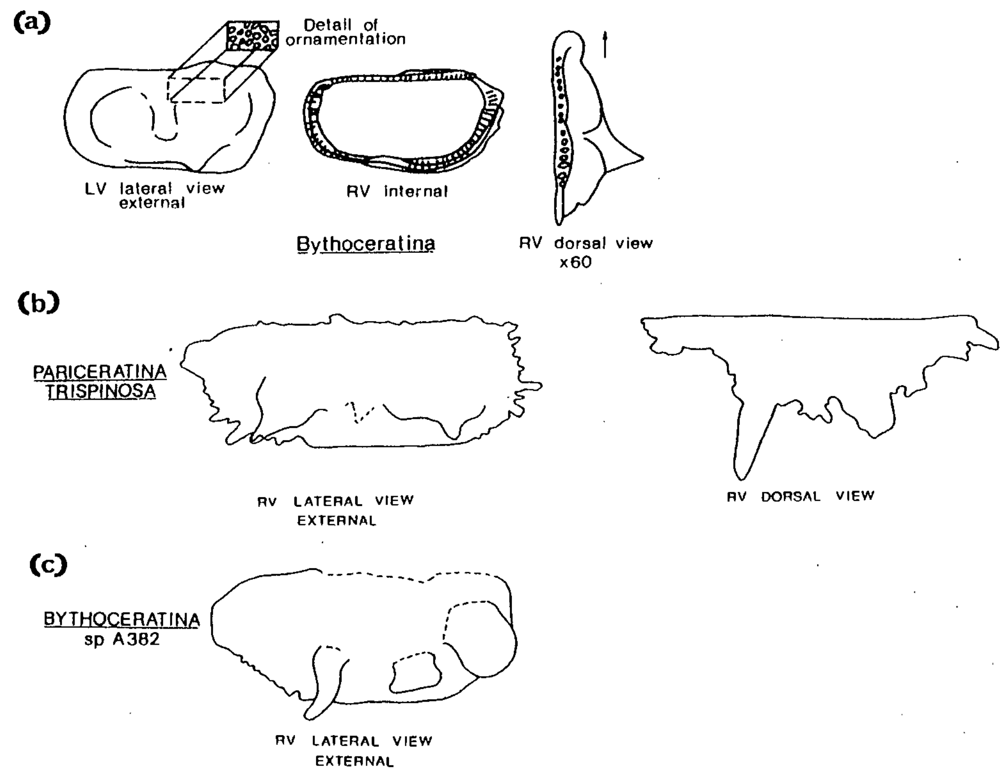


Fig. 2.1 Sketch to compare:-
(a) Bythoceratina mestayerae Hornibrook (1952)
(b) Pariceratina trispinosa (Neale 1975) and
(c) Bythoceratina sp A382.

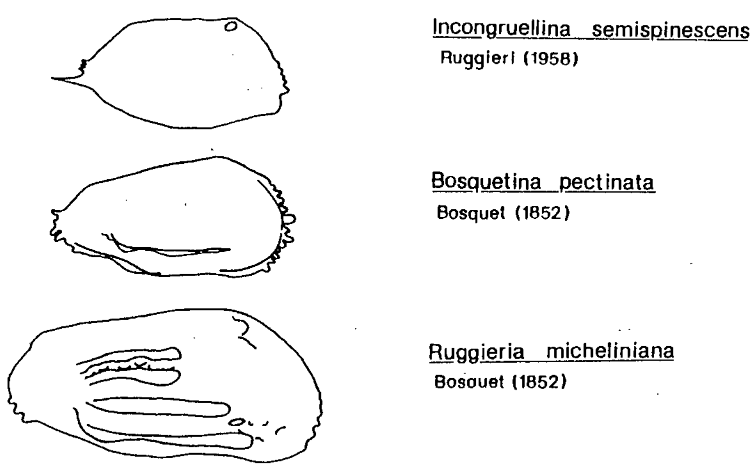


Fig. 2.2 Outlines of type species of the closely related genera Incongruellina Ruggiera (1958), Bosquetina Keij (1957) and Ruggieria Keij (1957), (Digmocythere Mandelstam (1958) not available).

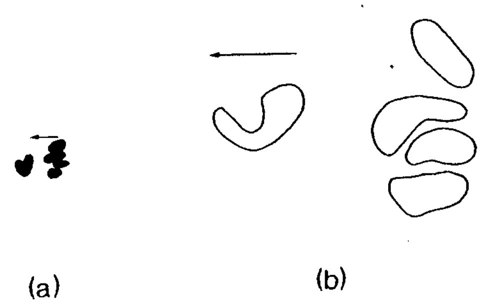


Fig. 2.3 Comparison of MS pattern for -
(a) I. semispinescens Ruggieri (1958)
(b) I. sp A500.

fragmentation styles it seems probable that these coincide with a fundamental shell weakness.

Dimensions:		length	height
	A382	0,48mm	0,21mm

Age and distribution: Only recorded from #1125 (Middle to Upper Eocene) on the East Agulhas Bank.

Genus *Incongruellina* Ruggieri 1958

This genus is closely related to a number of genera but which differ from it in the following respects:- *Digmocythere* Mandelstam (1958) - has cusped terminal hinge elements; *Bosquetina* Keij (1957) - has cusped terminal hinge elements; *Ruggieria* Keij (1957) - reticulated or ornamented with ridges on its lateral surface.

Figure 2.2 illustrates the similarities in outlines between *Incongruellina*, *Bosquetina* and *Ruggieria*.

Incongruellina has been recorded in Recent sediments from the South West African Continental shelf by Boomer (1985 unpubl.). Three species are here identified from the South African Tertiary strata.

Incongruellina sp A500

Plate 1 A-G, Fig. 2.3

Material: 3v (2 lost).

Remarks: Elongate valves with straight, subparallel DM and VM. AM broadly rounded. PM is drawn out to a subtriangular process which is more ventrally directed in LV. AM weakly spinose. Ventral ala with a longitudinal keel along its outer margin terminating in a posterior pointing spine. In RV this terminal spine is parallel to an elongate postero-marginal spine. *I.* sp A500 appears identical externally to _I. cf semispinescens_ Boomer (1985 unpubl.) from Recent sediments off South West Africa. _I. semispinescens_ Ruggieri (1958) (as cited in Catalogue of Ostracoda, supplement 22, 1976; fig. 29) has a more strongly arched DM in LV than _I._ sp A500, but otherwise the two species are very similar to _I. semispinescens_, notably the MS pattern (Figure 2.3) and the characteristic hinges. In RV these possess a broad quadrangular ATE, weakly crenulate median groove and a PTE consisting of a broad dorsal tooth, medianly connected to a more conical tooth anterior to a circular socket contiguous with the ME. Recent specimens collected from the Agulhas Bank (Dingle personal communication) appear identical to _I._ sp A500.

Dimensions:	length	height
A502	0,82mm	0,42mm
A500	0,65mm	0,38mm

Age and distribution: Recorded from #1094 (Upper Eocene) and #819 (Middle Eocene to Middle Oligocene) on the East Agulhas Bank.

Incongruellina sp A492

Plate 2 A-C

Material: 5v.

Remarks: Is more oval in lateral outline than _I._ sp A500. Its DM is slightly curved, the median-ventral inflation is less alate, is medianly displaced and has a shorter, curved keel (<1/3 valve length). There is a single spine on the posterior end of the keel (in LV, only a stump remains). AM and PM weakly spinose. The hinge is poorly preserved in all specimens but appears similar to _I._ sp A500, although the median bar is more strongly crenulate. _I. cf semispinescens_ of Boomer (1985 unpubl., pl.II, fig. 24) is similar in that it possesses a crenulate median bar and more arched DM. Unfortunately because of poor preservation MS comparisons can not be made.

<u>Dimensions:</u>

	length	height
A935	0,90mm	0,60mm
A508	0,60mm	0,36mm
A492	0,65mm	0,41mm

<u>Age and distribution:</u> Recorded on the East Agulhas Bank from the Upper Eocene (#1105 and #1094), and the Middle Eocene to Middle Oligocene (#819).

<u>Incongruellina</u> cf sp A492

Plate 2 D

<u>Material:</u> 1v.

<u>Remarks:</u> Single LV which is similar to <u>I</u>. sp A492 but differs in being more elongate, with its line of greatest length almost along the DM. The longitudinal ridge on the ventrally inflated area extends well into the posterior part of the valve.

<u>Dimensions:</u>

	length	height
P58431	0,75mm	0,39mm

<u>Age and distribution:</u> Only recorded from #1105 (Upper Eocene) on the East Agulhas Bank.

Genus <u>Ruggieria</u> Keij 1957

This genus is characterized by its elongate shape, median-ventral inflation and presence of a weakly reticulate or ridged lateral surface. The hinge is typically holamphidont. It has been recorded from the Tertiary to Recent on the West African coast (Keen 1972), the Miocene of Gabon (van den Bold 1966), the Recent of Angola (van den Bold 1966), and the Recent South West African Coast (<u>R. cytheropteroides</u> ((Brady 1880), Boomer 1985 unpubl.). This is the first occurrence in South African Tertiary strata, although the one recorded species is only tentatively placed within the genus.

?Ruggieria sp A485

Plate 2 E-F, 3 A

Material: 1v.

Remarks: Externally, the LV is typical of *Ruggieria* in outline and possession of a ridged ventral wing, plus the development of weak ridges in the antero-ventral and ventral regions. Internally *?R.* sp A485 possesses an aberrant hinge, which in the LV consists of two terminal sockets, and a median element which is split in two. The posterior half of the ME is a groove, the anterior half is a strongly crenulate bar possessing a terminal tooth which lies below the hinge line. This hinge structure is reminiscent of the RV hinge of *Pontocythere* Dubowsky (1939) but external features of *?R.* sp A485 are not compatable with this genus.

?R. sp A485 differs from *R. cytheropteroides* (Ruggieri 1962 as cited in van den Bold 1966) and *R. rotundata* (van den Bold 1966) in being more elongate, smooth surfaced and in possession of the aberrant hinge. It also differs from *R. tetraptera* Seguenza (1880) in the lack of longitudinal ribbing.

Dimensions:	length	height
P485	0,80mm	0,40mm

Age and distribution: Only found #1303 (Upper Eocene) on the East Agulhas Bank shelf.

Family Cytherideidae Sars 1925

A family which is only recorded from the East Agulhas Bank samples. It is represented by three genera and five species, of which only Krithe nibelaensis is of any numerical importance (up to 10% of the cytheracean population).

Genus Eucythere Brady 1868

The genus has previously been recorded in the southern hemisphere from the Holocene of New Zealand (Hornibrook 1952) and Palaeogene of South Africa (Dingle 1976). Van Morkhoven (1963) commented that it rarely occurs in large numbers. In the Upper Eocene of the JC-1 borehole Eucythere sp 1 and sp 2 were associated with the establishment of deep, open-water environments (Dingle 1976).

Eucythere sp A1417

Plate 3 B-E

Material: 5v.

Description: External. Subtriangular outline with straight DM and VM. Greatest height over ACA which lies just anterior of the valve midlength. AM broadly rounded, PM blunter with ventral deflection in some specimens. Valves are medianly inflated. Ornamentation consists of fine concentric ribs in marginal areas, which in some specimens consist of delicate beading. Wide NPC are semi-concentricly arranged in the marginal areas, but there is no discernible pattern in mid regions where ribbing is absent.

Internal. Wide MA anteriorly and posteriorly (0,1mm wide). About thirty coarse NPC. Ventral surface slightly undulose. Weak hinge, in LV consists of two elongate terminal sockets and a median bar above which is a dorsal groove. MS consist of an oblique row of four posterior adductors and a crescent-shaped anterior adductor. A circular fulcral point separates posterior and anterior scars.

Remarks: The external ribbing of *E.* sp A1417 is reminiscent of *E. mytila* Hornibrook (1952), from the Lower Oligocene to Recent of New Zealand, and *E. lenistriata* Rosenfeld and Raab (1984), from the Lower Cretaceous of Israel and Sinai, but differs from the latter two species by being more longitudinally aligned. The two Upper Eocene *Eucythere* species previously recorded by Dingle (1976) from JC-1 are both smooth, and appear more triangular in lateral outline.

Dimensions:

	length	height
A1417	0,52mm	0,32mm
B1547	0,38mm	0,21mm
B1555	0,38mm	0,21mm
B1556	0,45mm	0,25mm

Age and distribution: Recorded from #827 (Upper Eocene to Lower Oligocene), #810 (Upper Eocene) and #1094 (Upper Eocene) on the East Agulhas Bank.

Eucythere sp B610

Plate 3 F-G

Material: 1v.

Remarks: Smooth LV with an elongate subtriangular lateral outline. Greatest height over ACA. VM straight. Internally, specimen is poorly preserved so hinge and MS can not be characterized. Marginal areas do not appear to be well developed. *E. mytila* Hornibrook (1952), from the Lower Oligocene to Recent of New Zealand, has a similar length to height ratio of 2,0. *E.* sp B610 is distinguished from; *E.* sp A1417 in being unornamented and more elongate; and from Dingle's (1976) species in being less triangular in shape with a less rounded AM.

Dimensions:		length	height
	B610	0,50mm	0,24mm

Age and distribution: Only found in the East Agulhas shelf #1094 of Upper Eocene to Lower Oligocene age.

Genus Krithe Brady, Crosskey and Robertson 1874

Krithe have been recorded from the southern hemisphere (except the Pacific Ocean) Middle Cretaceous to Middle Tertiary by Bate (1972), Bertels (1973), Dingle (1976, 1981, 1985), Benson (1977) and this study (Table 2.1). From other Gondwanide localities, two species have been recognized from the Neogene of Gabon (van den Bold 1966), two species from the Upper Maastrichtian to Danian of Tunisia (Esker 1968, Donze et al 1982) and seventeen from the Lower to Middle Tertiary of West Pakistan (Sohn 1970).

Van Morkhoven (1963) considered this genus as an indicator of "infra-neritic and bathyal evironments". Benson (1977) considered the overall blind ostracod population of the Danian DSDP site 357 in the South Atlantic, with the occurrence of two Krithe species plus other deep water genera Poseidonamicus and Bradleya, as indicative of water depths >800 metres. Dingle (1981) suggested that K. nibelaensis occurred in water depths of 200 to 500m with K. sp A occurring between depths of 1625 and 1743m down hole in JC-1 (where its presence was used to predict variations in the depth of the Tugela cone top).

Krithe nibelaensis Dingle 1981

Plate 4 A-H, 5 A, Fig. 2.4 + 2.5

K. nibelaensis Dingle, 1981; p63-66, fig. 31.

K. spp Boomer, 1985 unpubl.; p1-98, pl.111, fig. 42.

Material: 101v.

Remarks: K. nibelaensis was defined by Dingle (1981) on its characteristic star-shaped AMS and its general slim shape. With the increase in data, I would like to extend the diagnosis to include those specimens whose AMS pattern can be derived from that of K. nibelaensis, as originally described.

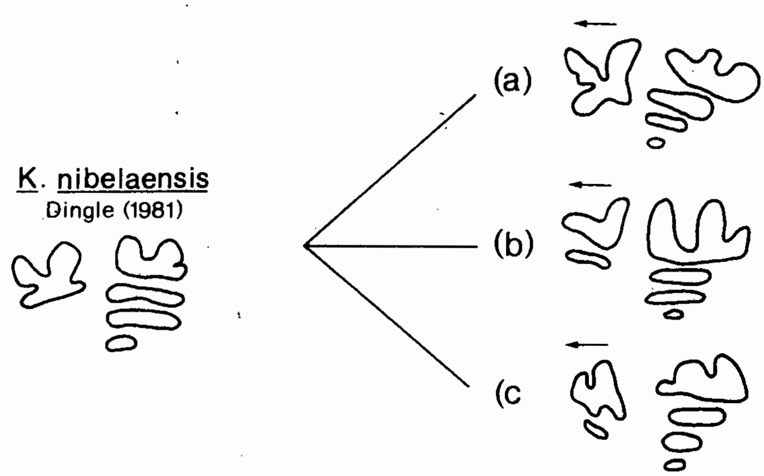


Fig. 2.4 Variation in MS pattern for Krithe nibelaensis.

On the basis of shell shape and muscle scar pattern three end members were recognized in this group (Figure 2.4). In the posterior muscle scar cluster, the two central oblong adductors and the small, more oval lower adductor were common to all. The upper posterior adductor varied from three lobed (Figure 2.4a) to a dominant bilobed either to the anterior (Figure 2.4b) or to the posterior (Figure 2.4c). The AMS varies from divided, to undivided and star shaped. As the MS patterns seem to be so closely related and potentially derivable from the basic K. nibelaensis shape, the splitting of the species into numerous subdivisions was not attempted.

In external lateral view, all examples showed similarities in their symmetrically rounded AM, acuminate PM and slightly arcuate DM. Some specimens tended to be more elongate and less dorsally arcuate i.e. more similar to the shape of K. sp A842. However the well developed posterior indentation and divided AMS are considered more diagnostic of this group.

Seven Krithe species have been recorded from South Africa (Dingle 1976, 1981, 1985 and Frewin this study). K. sp 842 is distinct in its weak development of the posterior indentation. K. sp A and K. sp 1 and K. sp A842 characteristically lack the arched DM. The MS pattern and valve outlines distinguish K. nibelaensis from K. sp 2329, K. sp 2332 and K. sp 2.

It is of interest to note that in her Argentinian studies, Bertels (1973) identified a K. sp? which shows similarities in shape and length to height ratios to K. nibelaensis as redefined here. Unfortunately, no internal features were published. Her species, however, lacked a posterior external indentation and was only tentatively placed as Krithe. Sohn's (1970) West Pakistan Krithe species also shows more similarities to K. nibelaensis than K. sp A842 but was published with no internal views. All the Tertiary South African species seem to be larger than the Cretaceous South African specimens (Figure 2.5).

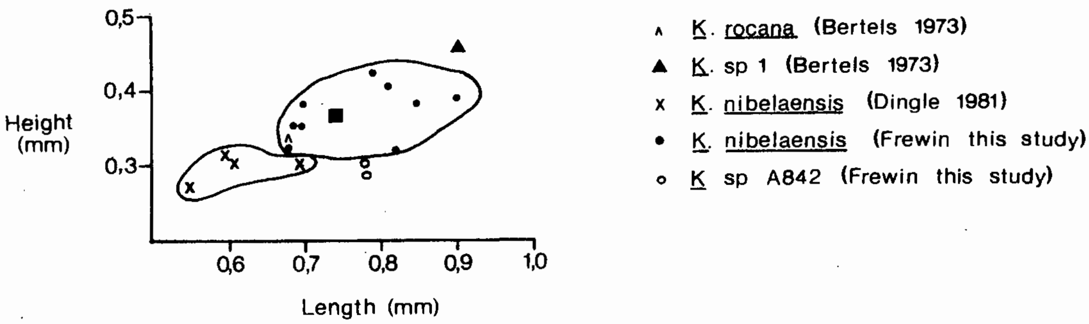


Fig. 2.5 Length versus height plot for various <u>Krithe</u> species.

<u>Dimensions:</u>		length	height
	P784	0,79mm	0,42mm
	P794	0,81mm	0,40mm
	P810	0,85mm	0,40mm
	P816	0,69mm	0,35mm
	P820	0,70mm	0,35mm
	P821	0,70mm	0,38mm
	P822	0,68mm	0,32mm
	P805	0,90mm	0,39mm
	P800	o,82mm	0,32mm

<u>Age and distribution:</u> In this study <u>K. nibelaensis</u> was recorded from the Upper Eocene (#1105, #810 and #1094), the Middle Eocene to Middle Oligocene (#819), the Middle to Upper Eocene (#1125) and the Upper Eocene to Lower Oligocene (#827) on the East Agulhas Bank. It was also recorded in the west coast margin #2829 (Middle Eocene to Middle Oligocene). Dingle (1981) recorded it from the Campanian to Maastrichtian in the Natal-Zululand onshore and Boomer (1985 unpubl.) from the South West African offshore Recent.

<u>Krithe</u> sp A842

Plate 5 B-F, Fig. 2.5

<u>Material:</u> 7v.

<u>Description:</u> <u>External.</u> In lateral view subparallel and straight VM and DM with rounded AM and acuminate PM.

Greatest height in antero-dorsal region. Length/height ratios in the region of 2,60 - 2,69. Dorsal view shows weak development of posterior indentation.

Internal. Wide anterior MA with a well developed vestibule. MPC are often branched with up to six anterior, eight ventral and eight posterior. MS consist of a bilobed undivided AMS. The upper adductor is bilobed, two central elongate and lower smaller and oval. Inner valve surface is smooth with widely spaced puncta.

Remarks: K. sp A842 is distinguished from K. nibelaensis on its non-stellate undivided AMS, and weakly developed posterior marginal indentation. K. rocana Bertels (1973) is similar in its suparallel DM and VM and in lacking a posterior indentation but is more similar to K. nibelaensis in length/height dimensions (Figure 2.5). The Tertiary Krithe identified from Tunisia (Donze et al 1982, Esker 1968) show length/height ratios closer to K. nibelaensis. Van den Bold (1966) identified K. langhiania Oertli (1961), from the Neogene of Gabon, but this species had a Y shaped AMS and is squatter than K. sp A842. Dingle's (1976) K. sp 2 is similarly restricted in occurrence to the Upper Eocene but is prominently dorsally arched and is more punctate.

Dimensions:		length	height
	P842	0,78mm	0,29mm
	P847	0,78mm	0,30mm

Age and distribution: Only recorded in the Upper Eocene #810 on the East Agulhas Bank.

Genus Parakrithe van den Bold 1958

Van Morkhoven (1963) noted van den Bold's (1958) distinction of Parakrithe from Krithe on the basis of the marginal area and lack of posterior indentation.

This genus has previously been recorded in Africa in the Miocene of Gabon (van den Bold 1966) and the Cretaceous of Tunisia (Bismuth et al 1982, Donze et al 1982).

Parakrithe sp B613

Plate 5 G-H

Material: 1v.

Remarks: RV showing rounded AM which rises dorsally to the greatest height at half valve length, DM straight. PM ventrally acuminate. Surface smooth. Internally, wide AMR (0,15mm wide) which diminishes ventrally and posteriorly (0,05mm wide). P. sp B613 is closest to P. robusta van den Bold (1966), from the Miocene of Gabon, but is smaller with a more convex DM.

Dimensions:		length	height
	B613	0,51mm	0,28mm

Age and distribution: Only found in the Upper Eocene #1094 on the East Agulhas Bank shelf.

Subfamily Cytherurinae Muller 1894
Family Cytheruridae Muller 1894
Genus Eucytherura Muller 1894

Cretaceous southern hemisphere Eucytherura have been recognised from Western Australia (Neale 1975) and South Africa (Dingle 1981, Brenner and Oertli 1976, Valicenti and Stephens 1984). Palaeogene occurrences of interest are from the Miocene of Australia (Whatley & Downing 1983), the Middle Oligocene of New Zealand (Hornibrook 1952), the

Palaeogene of West Pakistan (Sohn 1970) and the Lower Eocene of the South West Indian Ocean (Ducasse & Grekoff 1976).

The genus characteristically occurs in water depths >50m, but has been recorded from depths of over 1000m (Van Morkhoven 1963). Dingle (1981) associated E. pyramidata with oceanographically unstable environments.

Eucytherura sp A180

Plate 6 A-E, Fig. 2.6a

Material: 9v.

Description: External. Lateral view subquadrate with broadly rounded AM. PM acuminate with weakly upturned caudal process, DM and VM straight. Prominent ET mounted on reticulate tegmen.

Ornamentation consists of: a dorsal-lateral ridge (i) which commences at about midlength and is deflected ventrally beneath PCA, a ventro-lateral (ii) ridge which commences about midlength and is deflected to join the dorso-lateral ridge below the line of greatest length (in some specimens (i) and (ii) appear continuous), a median ridge (iii) which commences at AM and is crossed by a median sulcus (iv), a ventral marginal ridge (v) (Figure 2.6a). The intercostal fossae are irregularly shaped with thick muri. They bear small isolated terminally pored conjunctive spines.

Internal. DM straight, VM with slight antero-median undulation. MA narrow (0,03mm wide) generally with serrated edge possibly indicating a broken vestibule. Hinge antimerodont. LV with crenulate ME. Terminal sockets dorsally thickened and open ventrally. RV (poorly preserved) TE's do not appear crenulate. No MS were

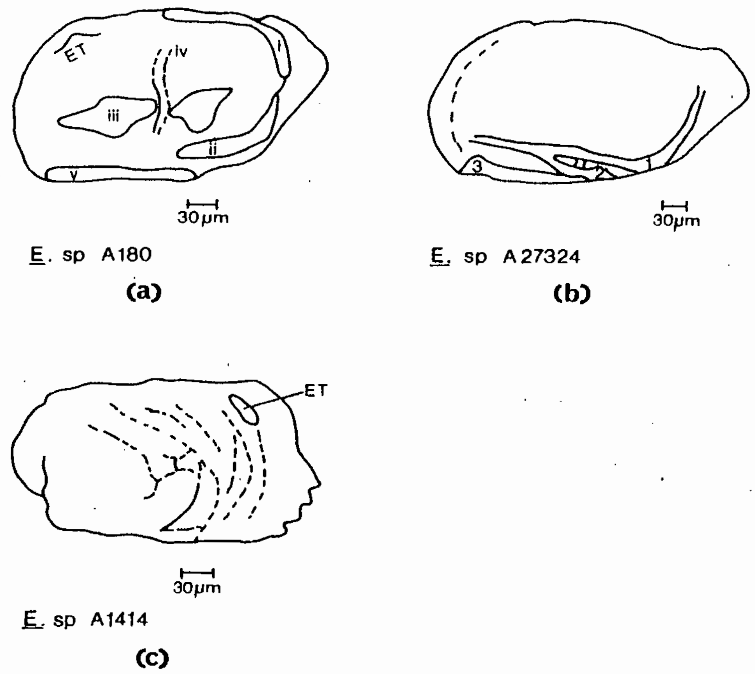


Fig. 2.6 Comparison of ornamentation of the three Palaeogene Eucytherura identified in the present study. (Refer to text for symbol interpretations).

observed.

Remarks: This species has many similarities with the Schizocytherinae :- Apateloschizocythere Bate (1972), Cnestocythere Triebel (1950) and Amphicytherura Butler and Jones (1957). However placement within these genera was rejected on the basis of (a) its prominent ET (b) its non-central caudal process (c) its non-schizodont hinge. The overall shape of the species (although some specimens showed slight arching of AM and DM), plus characteristic ventral opening of hinge TE are typical of Eucytherura. The lateral surface ridge alignments are similar to E. ?pyramidatus Dingle (1981) and Eucytherura (Eucytherura) (E(E)) antipodum Neale (1975) but are more prominent in E.

sp A180.

Dimensions:

	length	height
P177	0,33mm	0,18mm
P181	0,30mm	0,195mm
P185	0,29mm	
P	0,32mm	

Age and distribution: Only occurs in the Upper Eocene #810 on the East Agulhas Bank shelf.

Eucytherura sp A27324

Plate 6 F-G, Fig. 2.6b

Material: 1v.

Remarks: AMR relatively wide (0,03mm) and smooth. Rest of valve coarsely reticulate with isolated conjunctive pores. Valve ventrally alate and ornamented with three ridges: (1) outlines the ala (2) commences in anterior 1/3 of valve and continues ventrally to ala (3) a ventral-most ridge which outlines the VM (Figure 2.6b). The ridge pattern is accentuated by alignment of reticulum muri. *E.* sp A27324 is distinguished from other South African (Dingle 1981, this study) and Australian (Neale 1975) species by the lack of ET, and nodes and protuberances in the anterior and cardinal areas. Its hinge is badly damaged, but the internal outline is more elongate than most specimens assigned to the genus.

Dimensions:

	length	height
PA27324	0,30mm	0,16mm

Age and distribution: Occurs in the Upper Eocene East Agulhas Bank slope #810.

Eucytherura sp A1414

Plate 7 A-C, Fig. 2.6c

Material: 1v.

Remarks: Single RV characterized by antero-ventral marginal denticulation and very coarse irregularly shaped fossae which are subconcentrically arranged in anterior half of valve (Figure 2.6c). Typical Euctherura hinge in RV consisting of knob-like TE's and a long crenulate ME. The lack of ridging and presence of marginal denticulation distinguishes E. sp A1414 from E. sp A180 and E. sp A27324.

Dimensions:		length	height
	A1414	0,30mm	0,17mm

Age and distribution: Recorded from the Upper Eocene to Lower Oligocene #827 on the East Agulhas Bank slope.

Genus Cytheropteron Sars 1866

Southern hemisphere representatives of this genus have been recorded from New Zealand and Australia (Hornibrook 1952, Bate 1972, 1975, Swanson 1969, Whatley et al 1986 and Neale 1975) and southern Africa (Benson 1977, Dingle 1976, 1981, Brenner and Oertli 1976 and Boomer 1985 unpubl.). The two areas show faunal similarities, which, with the limited populations recovered (often only one specimen of a species), make species distinction and comparison difficult. Boomer (1985 unpubl.) in his Recent South West African studies encountered thirty one specimens which he grouped under Cytheropteron spp.. Dingle identified two Maastrichtian (1981), three Albian (1984) and three Middle Eocene to Middle Oligocene (1976) species. Of the eleven Palaeogene species recognised in the present study it is interesting to note that none were recorded from the west coast margin stations. Around South Africa, the genus ranges from Albian to Recent, with the greatest speciation in the Eocene and Recent (Table 2.2).

Cytheropteron is distinguished by its characteristic shape, hinge and possession of an ala. Hornibrook (1952) recognised two subgenera Cytheropteron (Cytheropteron) (C(C)) and Cytheropteron (Aversovalva) (C(A)) based on the distinction of the RV (former case) or LV (latter) possessing the two terminal teeth and a median groove in the hinge structure. The subgenus Infracytheropteron was recognised by Kaye (1964) but is not represented in this study. The fauna collected in this study shows quite a wide variation in morphology (Figure 2.7, 2.8).

Cytheropteron (Cytheropteron) sp C941

Plate 7 D-F, 8 A, Fig. 2.7, 2.8

Material: 21v.

Description: External. Suboval outline wth asymmetric, ventrally directed, rounded AM. PM subtriangular with small caudal process. DM short and straight, VM sinuous. Maximum height at anterior 2/5 of valve length. ET and SCT absent. Large blunt posteriorly directed ala which in some forms may possess a weakly developed terminal spine or a groove postero-ventrally.

Ornamentation consists of coarse puncta on the median and dorso-median surfaces above ala. It is typically superimposed on a ventrally trending reticulation which is more pronounced on the ala. The leading edge of the ala coincides with a rib that runs from the posterior spine to the AM. The ventral surface of the ala is crossed by 3-4 longitudinal ridges which give it a "petticoated " appearance.

Internal. No MS observed. MA weakly developed <0,015mm wide. Undulose VM, DM straight. PM bears a

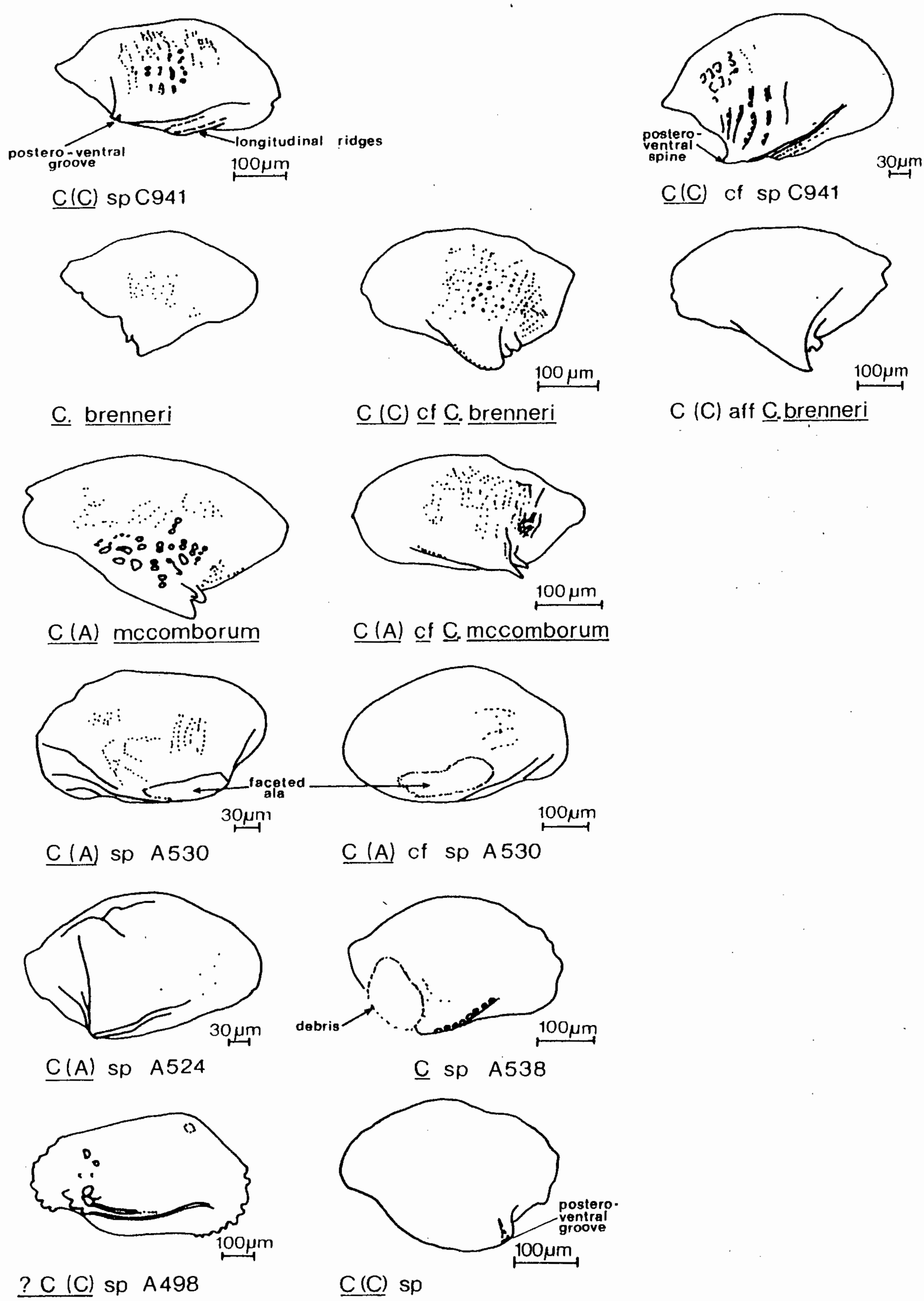


Fig. 2.7 Variation in external morphology of Palaeogene Agulhas Bank species of Cytheropteron.

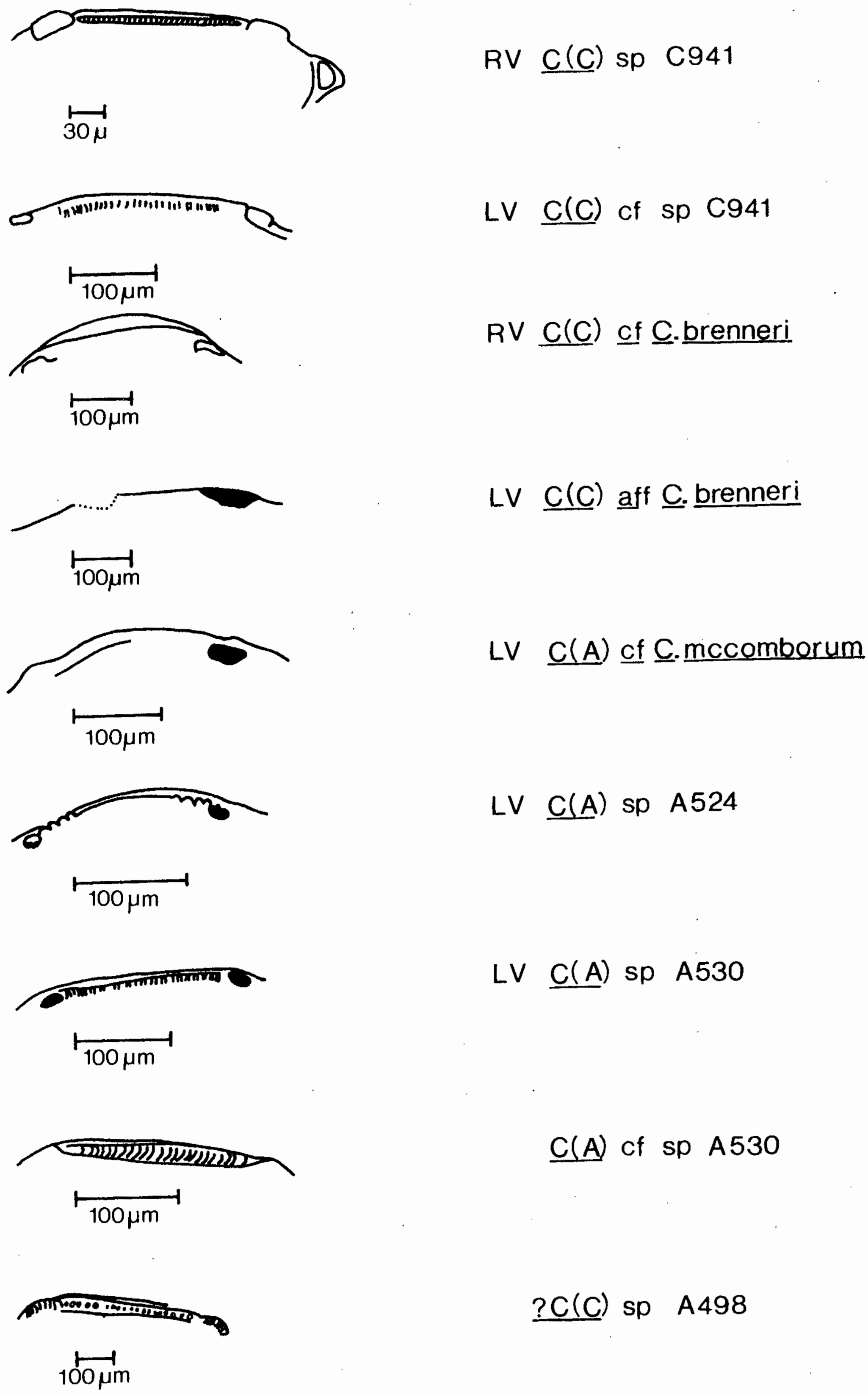


Fig. 2.8 Variation in hinge structure for various Palaeogene Agulhas Bank species of *Cytheropteron*.

triangular socket-like structure on the caudal process. Hinge in RV consists of two elongate, weakly cuspate teeth and a simple crenulate median groove.

Remarks: C(C) sp C941 shows quite a wide variation in size. It is similar to Oculocytheropteron praenuntatum Bate (1972) in possessing the four ridges on the ventral surface of the ala, but lacks the ET, has a straighter DM, and more punctate ornamentation. It is also similar in shape to Cytheroteron sp 1 Dingle (1976) from the Eocene of JC-1 but the latter possesses a blunter AM.

Dimensions:

	length	height
C941	0,42mm	0,22mm
58.450	0,30mm	0,20mm
58.444	0,38mm	0,21mm
C944	0,50mm	0,26mm

Age and distribution: Observed in #810 (Upper Eocene) and #827 (Upper Eocene to Lower Oligocene) on the East Agulhas Bank. Dingle (unpubl. data) has also recorded its presence in #1094 (East Aghulhas Bank Upper Eocene).

Cytheropteron (Cytheropteron) sp

Plate 8 B, Fig. 2.7

Material: 1v.

Remarks: Single suboval valve with rounded posterior end to ala. Ala bears a postero-ventral groove which is more pronounced than in C(C) sp C941. Surface is smooth with isolated normal pores.

Dimensions:

	length	height
P516	0,36mm	0,22mm

Age and distribution: Only found in the Upper Eocene #810 on the East Agulhas Bank slope.

Cytheropteron (Cytheropteron) cf sp C941

Plate 8 C, Fig. 2.7, 2.8

Material: 4v.

Remarks: C(C) cf sp C941 differs from C(C) sp C941 in possession of a more arched DM, more pointed caudal process and ornamentation consisting of longitudinal ridges on the posterior and median-ventral surfaces. The ridges are separated by elongate puncta.

Dimensions:		length	height
	P511	0,33mm	0,30mm

Age and distribution: Recorded from the Upper Eocene #810 and #1094 on the East Agulhas Bank slope.

Cytheropteron (Cytheropteron) cf C. brenneri Dingle 1981

Plate 8 D-G, Fig. 2.7, 2.8

C. brenneri Dingle, 1981; p44-45, pl.20A.

Material: 8v.

Description: External. Suboval, elongate RV with narrowly rounded AM. Upturned caudal process. Area adjacent to ACA dorsally thickened. VM sinuous towards anterior. Ala large and pointed with beading along its trailing edges. Posterior edge of ala bears two spines, the median of which lies on a ridge on the ventral side of ala. Ala is weakly posteriorly directed and is relatively smooth distally. The median and proximal part of ala are coarsely punctate and weakly ribbed posteriorly where puncta follow intercostal vertical trends.

Internal. Wide anterior MA (0,1mm wide). In RV there are two elongate terminal sockets. ME poorly preserved. There is a lip on ventral margin just anterior of midlength.

Remarks: C(C) cf C. brenneri strongly resembles C. brenneri

Dingle (1981) from the Upper Maastrichtian of Zululand but has a more punctate surface and posteriorly directed ala. It is similar to C(A) mccomborum Neale (1975) from the Santonian of West Australia, but the ala of the latter tends to be smoother.

Dimensions:		length	height
	P544	0,33mm	0,19mm

Age and distribution: Recorded from #810 and #1094 on the East Agulhas Bank slope. Both samples are of Upper Eocene age.

Cytheropteron (Cytheropteron) aff C. brenneri Dingle 1981

Plate 8 H, Fig. 2.7, 2.8

C. brenneri Dingle, 1981; p44-45, pl.20A.

Material: 2v.

Remarks: C (C) aff C. brenneri bears strong resemblance in external shape and internal structure to C(C) cf C. brenneri and C. brenneri Dingle (1981). However it differs in being smooth, more elongate with a more posteriorly directed ala which possesses only the postero-median spine. The latter terminates the ridge on the ventral side of ala (Figure 2.7).

Dimensions:		length	height
	A540	0,45mm	0,20mm

Age and distribution: Found in the Upper Eocene #810 and Middle Eocene to Middle Oligocene #819 on the East Agulhas Bank slope.

Cytheropteron (Aversovalva) cf C. mccomborum Neale 1975

Plate 9 A-D, Fig. 2.7, 2.8

C. mccomborum Neale, 1975; p26-27, pl.18, fig. 2.

Material: 5v.

Description: External. Elongate lateral shape with rounded

AM, and blunt caudal process. DM curved with distinct sinuosity around PCA. VM undulose. DM has narrow (<0,01mm wide) marginal rim. Strong pointed ala which bears a terminal and a postero-terminal spine.

Anterior and caudal surfaces are smooth, but ala and postero-median area are strongly pitted with a fine ramifying ridge pattern postero-ventrally. Ventral surface of ala smooth or punctate.

Internal. Narrow MA's <0,04mm wide. Hinge in LV has two terminal sockets with a crenulate median bar. No MS visible.

Remarks: C(A) cf C. mccomborum is very similar to C(A) mccomborum but its ala are not terminally trispinate, and are less coarsely punctate. It also bears resemblance to C. bispinosa Dingle (1984) from the Albian DSDP sites 330 and 327 on the Falkland Plateau, although it lacks such a broad pronounced ala and is finely punctate.

Dimensions:		length	height
	P547	0,33mm	0,19mm
	P550	0,30mm	0,16mm

Age and distribution: Recorded on the East Agulhas Bank slope at #810 (Upper Eocene) and #819 (Middle Eocene to Middle Oligocene).

Cytheropteron (Aversovalva) sp A524

Plate 9 E-G, Fig. 2.7, 2.8

Material: 2v.

Remarks: Ovate with small concavity on the postero-dorsal outline. RV smooth overall except for a few isolated puncta. Lateral surface has three fine ribs (Figure 2.7: (a) parallels the postero-dorsal margin about 0,03mm from it; (b) runs anteriorly from tip of ala to about 1/3 valve length and forms the leading edge of ala; (c) a weak lineation which joins ala tip to rib (a)). The trailing edge of ala possesses a median frill. Internally, the RV hinge consists of two terminal sockets and a ME which bears four distinct anterior and posterior terminal cusps. MA wide (0,05mm wide). No MS visible.

C(A) sp A524 bears a resemblance to C(C) cf C. brenneri where postero-lateral spines of ala have become fused to form the frill, but is smooth and possesses a broader, more triangular ala.

Dimensions:

	length	height
P524	0,37mm	0,24mm
P526	0,32mm	0,20mm

Age and distribution: Only found in the Upper Eocene #1094 on the East Agulhas Bank shelf.

Cytheropteron (Aversovalva) sp A530

Plate 10 A-C, Fig. 2.7, 2.8

Material: 1LV.

Remarks: Subovate LV with broadly rounded AM and PM. Possesses a broad ala which is terminally faceted. Ventro-lateral surface of ala is crossed by 5-6 longitudinal ribs which continue into the anterior and posterior parts of the valve. Ala surface has small, vertically arranged puncta over its median area. Puncta on antero-dorsal ala surface are randomly distributed. Dorsal region of valve and distal part of ala are smooth. Hinge in LV consists of two terminal sockets and a distinctly cuspate median bar. Accommodation groove located along dorsal part of hinge area. No MS observed.

Dimensions:

	length	height
P530	0,30mm	0,18mm

Age and distribution: Only found in the Upper Eocene #810 on the East Agulhas Bank slope.

Cytheropteron (Aversovalva) cf sp A530

Plate 10 D-F, Fig. 2.7, 2.8

Material: 1v.

Remarks: Single RV which is very similar to C(A) sp A530, notably the blunt broad ala and punctate surface. However it differs in being larger, possessing a more arched DM and less distinct ribbing on ventral surface of ala. This specimen is poorly preserved and these subtle differences may be intra-specific morphological variations (perhaps environmental adaptations) or represent RV and LV of the same species.

Dimensions:	length	height
P950	0,50mm	0,30mm

Age and distribution: Only found in the Middle to Upper Eocene #1275 on the East Agulhas Bank shelf.

?Cytheropteron (Cytheropteron) sp A498

Plate 11 A-D, Fig. 2.7, 2.8

Material: 5v.

Description: External. Subrhombohedral, elongate RV with maximum height over ACA. DM straight, VM slightly sinuous, AM well rounded, PM weakly acuminate and slightly upturned. PM and AM spinous. Ala weak and blunt bearing three flattened nodes along its trailing edge. There is a weak ocular swelling. Lateral surface is generally smooth, with isolated normal pores. Some specimens show faint polygonal reticulation in the postero-median area. A fine, single rib outlines the ala. A faint rib parallels the outline rib and runs anteriorly from the two trailing edge spines to about half valve length.

Internal. Narrow marginal areas (<0,04mm wide). Hinge in RV consists of two elongate, cuspate terminal teeth, and a median crenulate groove. No MS visible.

Remarks: Dingle (unpubl.) has recovered very similar specimens from GR 70 (209m, 35 24S, 19 14E) on the mid Agulhas Bank (Plate 11 E-F). These specimens differ in being punctate with a vertical row of four posterior adductor scars and a single anterior. ?C(C) sp A498 bears some resemblance in shape to the reticulate C(C) curvicaudum Hornibrook (1952) although the ala in the former is more blunt. Previously recorded New Zealand, Australian and South African Cytheropteron all tend to have more prominent alae.

Boomer (1985 unpubl.) recognised Ruggieria cytheroptoides (Brady 1880) which has a similar shape to ?C(C) sp A498 although the former is more elongate, punctate with a non-cytheropteron hinge. The latter could indicate that ?C(C) sp A498 are juveniles of R. cytheropteroides and so it is only tentatively placed in this genus.

Dimensions:		length	height
	A498	0,65mm	0,40mm
	A387	0,62mm	0,38mm

Age and distribution: Recorded from #1277 (Upper Palaeocene to Upper Eocene), #4574 (Middle Palaeocene to Upper Eocene), #1706 (Middle Eocene to Middle Oligocene) and #1094 (Upper Eocene) on the East Agulhas Bank. This species is relatively wide age ranging (Upper Palaeocene to Upper Oligocene) compared to other South African Cytheropteron.

Cytheropteron sp A538

Plate 11 G, Fig. 2.7

Material: 1v

Remarks: Ovate outline with arched DM, well rounded AM and blunt caudal process. Smooth surface, except for a few isolated puncta and a beaded leading to the ala. Outline is similar to *C(C)* sp A524 which lacks the ala beading.

Dimensions:		length	height
	A538	0,40mm	0,24mm

Age and distribution: Found in the Upper Eocene #827 on the East Agulhas Bank slope.

Family Hemicytheridae Puri 1953a
Subfamily Hemicytherinae Puri 1953a
Genus *Ambostracon* Hazel 1962

This genus is characterized by its subquadrate lateral outline, robust ribbed ornamentation, and holamphidont hinge, where the RV anterior tooth and socket are located on a "spatulate platform" (Hazel 1962). Valicenti (1977) considered *Patagonacythere* Hartmann (1962, in Hartmann-Schroder & Hartmann 1962) to be a subgenus of *Ambostracon*: *Ambostracon (Ambostracon)* (*A(A)*) has a weak ocular ridge, *Ambostracon (Patagonacythere)* (*A(P)*) has a distinct ocular ridge which varies in length between species. The previously recorded range of *Ambostracon*, Eocene to Recent, is increased by the present study, to Palaeocene to Recent. Both subgenera were considered to have originated in southern South America, but the earlier records in South Africa now suggest that it originated in this region.

Valicenti (1977) recognised four further morphological groups of the genus Ambostracon.

(i) cf Cythereis glaucum (Skogsberg 1928) group has a conspicuous ocular ridge.

(ii) A(P) tricostata Hartmann (1962), (in Hartmann-Schroder & Hartmann 1962) group with a prominent longitudinal ridge running from postero-dorsal to antero-ventral areas.

(iii) A(P) wyvillethomsoni (Brady 1880) group with equally developed longitudinal and vertical reticulation trends. Three well developed fossae trend from the SCT towards the PCA.

(iv) Transitional species between (ii) and (iii). The reticulation is celate rather than fossate with a secondary reticulation on the wide anterior margin.

Ambostracon (Ambostracon) sp A93

Plate 12 A-E, Fig. 2.9(A)

Material: 2v.

Remarks: Subquadrate, with broadly rounded AM, and a PM which is more triangular in RV than LV, DM is more broadly arcuate over ACA in RV. ACA and PCA are prominent in LV. Anterior and posterior marginal rims are broad (0,05mm wide) bearing pores antero-ventrally. AM and PM weakly spinous. Ornamentation consists of three ridges (a) a ventro-lateral ridge which is continuous from AM to postero-dorsal margin with a sharp indentation in the postero-ventral region; (b) a dorsal ridge which commences postero-dorsally, and runs along the DM from the PCA to about midlength of the valve, where it swings down and forms a hook-shaped deflection at about 4/10 length. It continues ventrally to meet a weak rib (c) from the ET. Internal views are poorly preserved, but the anterior tooth and socket of LV appear to lie on a

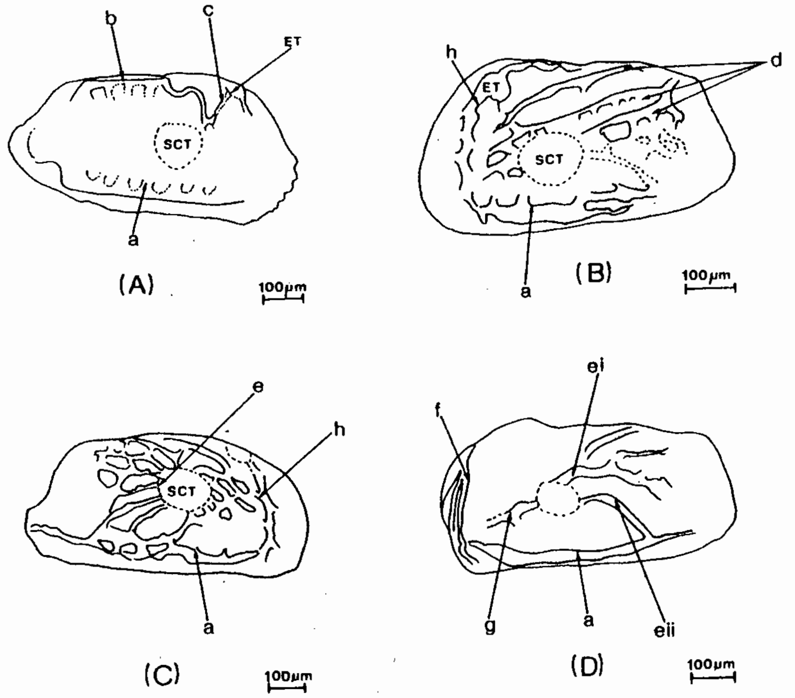


Fig. 2.9 Variation in external features of Palaeogene Ambostracon identified in the present study. (Refer to text for symbol interpretations).

spatulate platform.

Dimensions:		length	height
	P90	0,78mm	0,46mm
	P93	0,70mm	0,35mm

Age and distribution: Found only in the west coast margin #2772 (Middle to Upper Eocene).

Ambostracon (Patagonacythere) sp B1457

Plate 13 B-D, Fig. 2.9(C)

Material: 1v

Remarks: Subovoid with straight VM, postero-ventral extension, DM convex, and tapering to asymmetrically rounded AM. Ornamentation consists of a ventral ridge (Figure 2.9(C)a) that extends from an ocular ridge (h) to PM. Ribs radiate posteriorly from the SCT to the ventral rib, and the ocular rib (e). Fossae often possess central-pored nodes. A. sp B1457 is similar to both A. flabellicostata (Brady 1880), cited as A. sp 2 by Boomer (1985 unpubl. pl.IV, fig.

62) and A(P) sp A468 but is distinguished by its shape, rib pattern and conical pores. The species has a typical Ambostracon hinge, in which the AE of RV is situated on a spatulate-like platform. A. sp B1457 is tentatively placed in Valicenti's (1977) cf cythereis glaucum group (i) on the basis of its well developed ocular ridge.

Dimensions:		length	height
	B1457	0,78mm	0,40mm

Age and distribution: Only found in the Upper Eocene #1094 on the East Agulhas Bank shelf.

Ambostracon (Patagonacythere) sp A468

Plate 13 A, Fig. 2.9(B)

Material: 1v.

Remarks: Subquadrate LV with straight DM, PM with blunt postero-ventral extension. AM asymmetrically rounded. Ornamentation dominated by a ventral ridge (Figure 2.9(B)a), an ocular ridge (h) and three diagonal ribs which extend from the postero-dorsal area to the ocular ridge (d). The lowermost of the ribs passes through the SCT. A(P) sp A468 is similar to A. flabellicostata (Brady 1880), cited as A. sp 2 by Boomer (1985 unpubl., pl.IV, fig. 62), although the latter has a more convex VM and prominent PCA. A(P) sp B1457 dffers from A(P) sp A468 in possessing a more tapering PCA, convex DM and stronger ribbing.

Dimensions:		length	height
	A468	0,51mm	0,49mm

Age and distribution: Only recorded in the Lower Palaeocene to Upper Eocene #1275 on the East Agulhas Bank shelf.

Ambostracon (Ambostracon) sp A463

Plate 12 E-G, Fig. 2.9(D)

Material: 1v.

Remarks: Elongate quadrangular valve with rounded AM. Ornamentation consists of a ventral ridge (Figure 2.9(D)a), an anterior marginal ridge (f) which extends from ACA to the ventral ridge, a short rib (g) which radiates antero-ventrally from SCT (g) and two ribs (ei & eii) which radiate posteriorly to SCT. Internal features poorly preserved: hinge holamphidont with anterior tooth and socket situated below hinge line. MA's wide (0,1mm wide in antero-dorsal area).

Dimensions:

	length	height
A463	0,70mm	0,36mm

Age and distribution: Only found in the Upper Palaeocene to Lower Eocene #1277 on the East Agulhas Bank shelf.

Genus Urocythereis Ruggieri 1950

Distinguished on the basis of its subquadrangular shape, hinge, PM which is dorsally concave and vertically convex, and the coarsely foveolate reticulation. Closely related, and probably derived from, the genus Muellerina Bassiouni (1965) as commented by Hazel (1967).

Urocythereis sp A1460

Plate 13 E-G, Fig. 2.10(A)

Material: 4v.

Remarks: Elongate quadrangular valve with rounded AM and PM. Coarsely reticulate overall with large polygonal fossae that are arranged in a vertical pattern except anteriorly, where there is an alignment parallel to the AM. Weak ET.

SCT smooth and medianly situated at about 4/10 valve length. Internally, the marginal areas are narrow (<0,04mm wide) and MS are situated in a deep SCT depression. PTE in RV consists of a ventrally-open socket, ME is a smooth bar. Complex ATE consisting of a "Z"-shaped tooth and two sockets (Figure 2.10).

Boomer (1985 unpubl.) recorded a similar species from the Recent South West Africa but it differs in the hinge structure.

<u>Dimensions:</u>

	length	height
P233	0,59mm	0,29mm
P235	0,69mm	0,32mm

<u>Age and distribution:</u> Recorded in the Lower Palaeocene to Upper Eocene #1275 and the Upper Eocene #1094 on the East Agulhas Bank shelf.

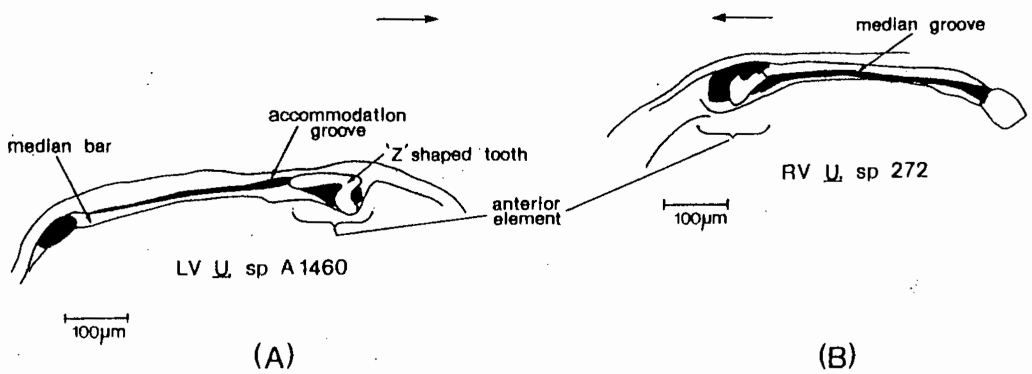


Fig. 2.10 Hinge detail in (A) *Urocythereis* sp A1460 and (B) *Urocythereis* sp 272

Urocythereis sp 272

Plate 14 A-C, Fig. 2.10(B)

<u>Material:</u> 1v.

<u>Remarks:</u> Single RV which is very similar to *U.* sp A1460 but is less elongate with a more convex DM. Hinge appears a mirror image of *U.* sp A1460. Shape variations between these two species may reflect male/female or RV/LV morphological variations.

Dimensions:		length	height
	A272	0,70mm	0,40mm

Age and distribution: Recorded in the Upper Eocene #1094 from the East Agulhas Bank shelf.

Genus Muellerina Bassiouni 1965

Distinguished from Urocythereis Ruggieri (1950) by its smaller size, less coarsely reticulate ornamentation, an alignment of pits posterior to SCT, and its weaker postero-ventral extension.

Muellerina sp A420

Plate 14 D-E

Genus Indet. 3 sp 1 Dingle, 1976; p52, fig. 9(4).

Material: 2v.

Remarks: Elongate subquadrate lateral outline. Surface coarsely reticulate with fossae aligned parallel to posterior edge of smooth SCT. Prominent ET situated on the anterior marginal rim. Maximum height above ET. Prominent depression parallel to ET. M. sp A420 is probably identical to the Genus Indet. sp 1 Dingle (1976) although he only recorded RV's. The Recent M. abyssicola (Sars 1866), from Hazel (1967; pl3, fig. 1), is similar to M. sp A420 although M. abyssicola possesses wider marginal areas and postero-dorsal and -ventral swellings.

Dimensions:		length	height
	P1420	0,40mm	0,20mm
	P227	0,70mm	0,35mm

Age and distribution: Recorded from the Upper Eocene to Lower Oligocene #827, and the Upper Eocene #810 on the East Agulhas Bank slope, and the Upper Eocene to Upper Oligocene in the Natal JC-1 borehole (Dingle 1976).

Family Leguminocytheridae Howe 1962
Genus Leguminocythereis Howe 1936 (in Howe and Law 1936)

The genus has been recorded from West African Cretaceous strata (Reyment 1961, 1966, Neufville 1973 and Krommelbein 1976), but there are no recordings from South African strata for this period. Lower Tertiary African species are summarised in Table 2.3. Dingle (1976) recorded two species from the Middle Eocene JC-1 borehole. Recent species from South West Africa and South Africa (Boomer 1985 unpubl. and Dingle personal communication) are closely related to Tertiary faunas.

Leguminocythereis sp 1507

Plate 15 A-D

Material: 17v.

Description: External. Ovate in lateral view with subparallel DM and VM, broadly rounded AM, PM narrower and blunt to subtriangular. AM and PM weakly spinous. Weak ET. Maximum height above ET. Ornamentation consists of deep subrounded fossae which are aligned to form ribs. Ribs trend longitudinally in the ventral half of valve but in the dorsal half of the valve are dorsally convex with the upper ribs impinging onto the DM. Medianly, in the subcentral area, fossae are complexly distributed.

Internal. Deep valves with broad MA (0,1mm wide), straight DM, but medianly sinuous VM. Hinge consists in RV of terminal sockets and a finely crenulate median bar which possesses an anterior bulbous tooth. DM extends 0,05mm above hinge area. No MS visible. Antero-ventral and posterior edges in LV possess a laterally directed frill of spines.

Remarks: L sp 1507 appears similar to L. lepralioides (Brady 1880) cited as L? sp by Boomer (1985 unpubl.), however no MS patterns were observed in the Tertiary specimens and Boomer considered the MS of Brady's Recent specimens to be sufficiently atypical of Leguminocythereis as to only tentatively assign them to this genus. L. sp 1507 is similar in shape to the ?L. sp 1 Dingle (1976) and L. oertli Keij (1958) (as cited in Van Morkhoven 1963; p175, fig. 270), although the development of surface ridges is less pronounced. The marked fossae development and straighter VM distinguish L. sp 1507 from ?L. cf ?L. lokassaensis Dingle (1976).

Dimensions:

	length	height
P1507	0,90mm	0,54mm
P1463	0,80mm	0,55mm
P316	0,65mm	0,41mm
P396	0,70mm	0,40mm

Age and distribution: Recorded from the following East Agulhas Bank stations - #1275 (Lower Palaeocene to Upper Eocene), #1303 (Upper Eocene), #811 (Middle to Upper Eocene) and #1094 (Upper Eocene), plus from the west coast margin #1706 (Middle Eocene to Lower Oligocene).

Leguminocythereis cf L. exigua (Apostolescu 1961)

Plate 15 E

Leguminocythereis aff exigua Donze et al, 1982; p297, pl.12, fig. 4,5.

Anticythereis exigua Apostolescu, 1961; p815, pl.10, fig. 194-196.

Material: 1v.

Remarks: Single broken RV which is very similar to the elongate L. exigua from the Palaeocene of the Ivory Coast. The ornamentation of L. cf exigua is "mesh-like" as in L.

aff exigua (Donze et al 1982) but longitudinal trends are discernible in the ventral valve half of the former.

Dimensions:		length	height
	P1411	0,80mm	0,40mm

Age and distribution: Only located in the Lower Palaeocene to Upper Eocene #1275 on the East Agulhas Bank shelf.

Family Loxoconchidae Sars 1925
Genus Loxoconcha Sars 1866

This genus has previously been recorded in southern African waters by Brady (1880), (Loxoconcha subrhombroidea), and Dingle (1976), Boomer (1985 unpubl.) and Hartmann (1974). The temporal ranges of South African tertiary Loxoconcha are summarised in Table 2.4. No Tertiary forms were recorded on the west coast marginal area in this study.

The genus is characterized by its rhomboidal shape and "aberrant" type of amphidont hinge (Van Morkhoven 1963; p388, fig. 14 + 15).

Loxoconcha sp B192

Plate 16 A-F, Fig. 2.11(A)

Material: 5v.

Description: External. Subrhomboid to oval LV wth straight DM and VM, asymmetrically rounded AM and bluntly acuminate PM. Weak ET. Maximum height at midlength. Valve strongly postero-ventrally inflated. In some specimens the valve outline is defined by a frill-like extension which is most prominent postero-ventrally. Anterior and posterior marginal areas flattened, smooth and <0,05mm wide.

Ornamentation consists of strong ribs and interib semi-circulate fossae. The ventral outline of the inflated area is marked by the two thick ribs which converge

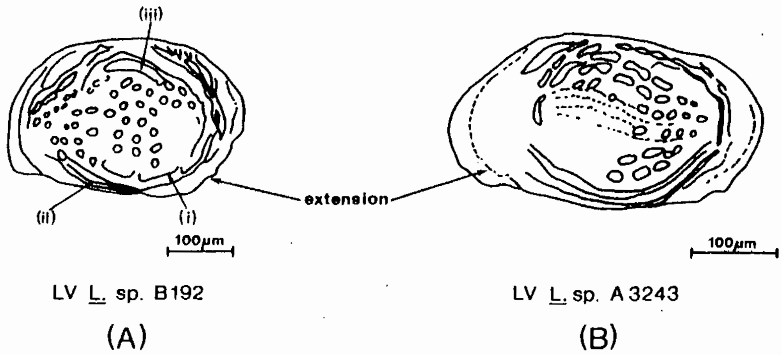


Fig. 2.11 Differences in external features between - (A) <u>Loxoconcha</u> sp B192 and (B) <u>Loxoconcha</u> sp A3243. (Refer to text for symbol interpretations).

anteriorly (Figure 2.11(A) i + ii). Ribbing is arched in the dorso-lateral area about midlength and there is a well defined looped rib in this area (Figure 2.11(A) iii).

<u>Internal.</u> The valve margin extension is well seen in internal view, particularly in the anterior and postero-ventral areas. AMA and PMA wide (0,05mm-0,07mm) and the VM sinuous. Hinge straight and consists in LV of two terminal elements and a median bar. The PTE consists of two minor, deep sockets on either side of a blunt rectangular tooth. The ATE consists of a crescentic tooth which is continuous dorsally with the median bar. The tooth lies antero-dorsally to a ventrally-open socket. In the RV, the posterior element forms a crescentic bar with terminal toothlets and a central rectangular, ventrally-open socket. MS consist of four posterior adductors where the upper two are fused to form a star-shaped MS and a single heart shaped anterior adductor.

<u>Remarks:</u> <u>L.</u> sp B192 bears a strong resemblance to <u>L. edentonensis</u> Swain (1951) as shown in Hazel (1977; fig. 9f) from the Upper Pliocene to Lower Pleistocene of Virginia and

northern North Carolina.

Dimensions:

	length	height
P192	0,40mm	0,28mm
P293	0,40mm	0,26mm
P182	0,40mm	0,30mm
P185	0,45mm	0,27mm

Age and distribution: Recorded from #1276 (Upper Palaeocene to Lower Eocene), #1094 (Upper Eocene) and #1268 (Middle Palaeocene to Middle Eocene) on the East Agulhas Bank.

Loxoconcha sp A3243

Plate 16 G-H, Fig. 2.11(B)

Material: 1v.

Remarks: Single LV which bears a strong resemblance to L. sp B192 notably in its shape, frill-like outline extensions and ventro-lateral inflation. L. sp A3243 has smooth posterior and marginal regions. Lateral surface ribbing has a well-developed longitudinal alignment but is arranged semi-concentrically in the ventro-median and dorso-median regions. Fossae are generally rounded, but contain a secondary lattice in the posterior areas of valve. Internally the preservation is poor, but the anterior most part of the ATE does not appear to curve around the anterior socket as prominently as in L. sp B192. Lateral surface rib trends in L. sp A3243 differ from L. pseudoinflata Huff and Hazel (in Hazel et al 1980) from the Lower Oligocene of Mississippi and Alhabama, in having smoother, broader and more weakly upturned posterior and anterior areas. In lateral view L. sp 188 appears less elongate than ?L. sp 1 and ?L. sp Dingle (1976).

Dimensions:

	length	height
P3243	0,44mm	0,28mm

Age and distribution: Recorded in the upper Eocene #810 on the East Agulhas Bank slope.

Loxoconcha sp 1430

Plate 17 A-C

Material: 1v.

Remarks: Single, poorly preserved RV possessing finely punctate surface with weak rammifying postero-dorsal and ventral ribbing. Hinge apparently of Loxoconcha-type with ATE consisting of isolated rounded tooth and PTE an elongate tooth. ME is a fine groove. This is distinguished from other Palaeogene South African Loxoconcha species by its shape and ornamentation.

Dimensions:

	length	height
P1430	0,27mm	0,15mm

Age and distribution: Only recorded in the Middle Eocene to Lower Oligocene #827 on the East Agulhas Bank slope.

Loxoconcha sp B188

Plate 15 F-G

Material: 3v.

Remarks: Rhombohedral valve outline DM and VM straight, parallel. Ornamentation consists of deep elongate concentrically arranged fossae. Posterior hinge element in LV is typical of the genus, consisting of an oval tooth lying between two sockets. L. sp B188 bears a resemblance to L. propunctata, from the Lower Miocene of New Zealand, Hornibrook (1952), notably in shape and ornamentation, the latter however has fewer reticulation posteriorly and dorsally. L. sp 188 appears to be more coarsely reticulate and broader than L. sp 1 Dingle (1976).

Dimensions:

	length	height
P188	0,40mm	0,24mm
P190	0,42mm	0,28mm
P3257	0,32mm	0,18mm

Age and distribution: Recorded in the Middle to Upper Eocene #811 and the Upper Eocene #1094 on the East Agulhas Bank.

Loxoconcha cf L. walvisbaiensis Hartmann-Schroder & Hartmann 1974

Plate 14 G

Material: 1v.

Remarks: Single RV appears very similar to L. walvisbaiensis Hartmann-Schroder & Hartmann (1974), a species which has also been recognized by Boomer (1985 unpubl.) from the sub-Recent on the continental shelf off South West Africa. The Tertiary form differs from Boomer's specimens in possessing a distinct, smooth dorsal area (0,015mm wide) as well as having a larger ventro-laterally situated inflation area which is outlined by a narrow rib. Further comparisons will require internal views although it can be distinguished from other Palaeogene South African species by its ornamentation and valve outline.

Dimensions:	length	height
P3002	0,28mm	0,18mm

Age and distribution: Only recorded in the Upper Eocene East Agulhas Bank slope #810.

?Loxoconcha sp

Plate 14 F

Material: 1v.

Remarks: Single LV with wide, smooth anterior and posterior marginal rims, 0,03mm wide and semi-spinose antero-ventrally, a ventro-lateral inflation, and sub-rounded fossae with thick muri.

Ornamentation in posterior and anterior areas is pseudo-concentrically arranged, but appears random in the median areas.

Dimensions:		length	height
	P3246	0,27mm	0,17mm

Age and distribution: Only observed in sample #810 from the Upper Eocene of the East Agulhas Bank slope.

Family Paradoxostomidae Brady and Norman 1889
Genus Sclerochilus Sars 1866

Recognized by its five adductor MS pattern, strongly convex DM, sinuous VM and rounded PM and AM. The genus Pellucistoma Coryell & Fields (1937) belonging to the same subfamily possesses a xestoleberis-like lucid spot but is more subovate in shape with a distinct caudal process. Ecologically both genera are found in epi-neritic environments although four Antarctic species (Mueller 1908) were associated with 385m depths (Van Morkhoven 1963).

Sclerochilus sp

Plate 17 D-E

Material: 1v.

Remarks: Single LV, semi-ovoid with strongly convex DM and well rounded AM and PM. Maximum height medianly. Well defined lateral rim along PM, AM and DM. The VM is not typically sinuous for the genus and internally there is apparently a xestoleberis-like mark in an antero-dorsal position just below the hinge. Although both features suggest a relationship with Pellucistoma, the lateral outline of the species is more like Sclerochilus in which it is tentatively placed.

Dimensions:	length	height
	0,40mm	0,29mm

Age and distribution: Only found in the Middle Eocene to Lower Oligocene #827 on the East Agulhas Bank slope.

Family Thaerocytheridae Hazel 1967

Hazel (1967) distinguished between the families Trachyleberididae Sylvester-Bradley (1948) and Hemicytheridae Puri (1953a) on the basis of their soft parts and MS pattern. The former generally have a simple frontal MS, the latter two or more. He divided the Hemicytheridae into three subfamilies - Thaerocytherinae, Hemicytherinae and Camplocytherinae. Benson (1972) elevated the Thaerocytherinae to family status. The following genera (Benson 1977) are considered to belong to this family:-

Jugocythereis Puri 1957
Quadracythere Hornibrook 1952
Puriana Coryell and Fields 1937
Hornibrookella Moos 1965
Procythereis Skogsberg 1928
Bradleya Hornibrook 1952
?Curfsina Deroo 1966
Poseidonamicus Benson 1977
Limburgina Deroo 1966
Thaerocythere Hazel 1967

Subfamily Bradleyinae Benson 1972

Benson (1972) characterized this subfamily on its amphidont hinge, four posterior adductors (uppermost divided), two anterior adductors, strong ventro-lateral and dorsal carinae, strong or traces of a reticulum (which may form a "bridge" structure over and anterior to SCT) and a blunt non-caudate posterior. He grouped the following

Cretaceous to Recent genera as members:- Bradleya Hornibrook (1952), Poseidonamicus Benson (1977), Limburgina Deroo (1966) and an undescribed genera containing B. oertlii Ducasse (1964) from the Upper Eocene of France.

Two genera from this subfamily are recorded in this study - Bradleya and Poseidonamicus. They are distinguished on their ornamentation and possession, or lack, of a defined marginal rim. The temporal ranges of South African Bradleyinae are summarised in Table 2.5.

Genus Bradleya Hornibrook 1952 emended by Benson 1972

Following Benson's (1972) revision of the genus, Bradleya can be characterized by possessing dorsal and ventral ridges. The lateral valve surface may be smooth or strongly reticulate and in the latter, which are the more common types, possess a box-like "bridge"/structure over the weak SCT. Reticulation is usually grid-like and in some species the longitudinal ridges develop from alignment of muri. In the subgenus Quasibradleya (Q) Benson (1972) the median ridge develops from the upper part of the bridge structure at the expense of the lower part. This latter condition is fundamental in the identification of the subgenus as Bradleya (Bradleya) (B(B)) adamanae possesses a median ridge which Benson (1972) considered to be muri alignment - the lower part of the bridge is still evident. B(Q) dictyonites, B(Q) productyonites, B(Q) paradictyonites and B(Q) pliococarinata lack or possess a considerably weaker lower bridge structure. The species I identified (?B. sp A649) shows a strong lower bridge structure and so is placed in the subgenus Bradleya. Benson (1972) does however comment that the subgenus Quasibradleya is by no means always easy to distinguish from Bradleya, and that ?B(B) dictyon and B(B) adamanae show Quasibradleya-type characteristics. It would appear far tidier to include these two species plus ?B(B) sp A649 in Quasibradleya and modify the subgenus diagnosis to "Bradleya possessing a median ridge". I have avoided such a revision at this stage until further specimens of ?B(B) sp A649 are available.

The genus was most important in the Neogene but ranges Palaeocene/?Lower Eocene to Recent. It shows a near global distribution including French Palaeogene (Oertli 1985), Jamaican Upper Eocene (Steineck 1981), Saudi Arabian Palaeocene (Ali-Furaih 1980), Lower Tertiary of West Pakistan (Siddiqui 1971) and West Africa (Apostolescu 1961). It is very common in deep water faunas from New Zealand (Hornibrook 1952). Steineck (1981) used the occurrence of B(B) dictyon and Agrenocythere hazelae (van den Bold 1946) as depth and water temperature indicators for the Upper Eocene to Middle Miocene of Jamaica.

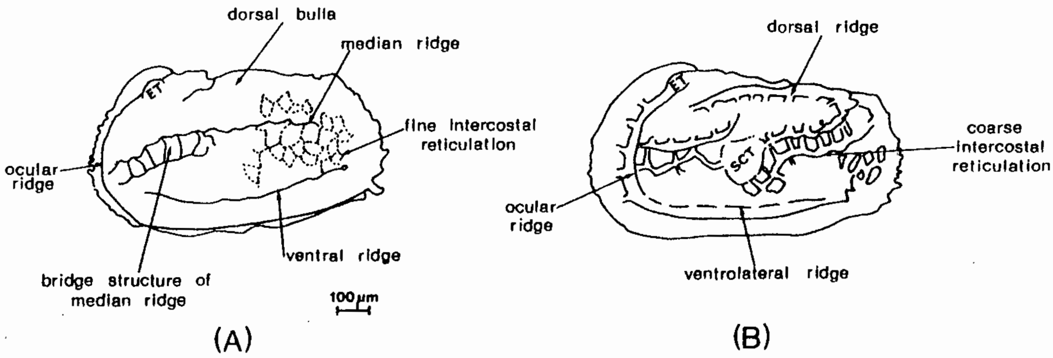


Fig. 2.12 Comparison of basic features of -
(A) ?Bradleya sp A649 from #1276 on the Agulhas Bank and
(B) Bradleya dictyon (Brady 1880) from Benson (1972); p34, fig. 15B (East Pacific specimen).

?Bradleya sp A649

Plate 18 A-C, Fig. 2.12A

Material: 1c.

Remarks: Single subquadrate carapace which is similar to B. dictyon (Brady 1880) as shown in Figure 2.12. It differs in the ocular ridge lying very close to the AM and being continuous with the VM. In B. dictyon, the ocular ridge is about 1/8 valve length from AM and is continuous with the ventro-lateral ridge. The ventral ridge of ?B. sp A649 is narrow, and like the median ridge, is developed from linear muri in an otherwise disordered reticulum. Anterior to SCT area, the median ridge splits to form a bridge structure. This ornamentation is more delicate than in B. dictyon (Benson 1972 and 1977), and perhaps is further evidence that the specimen is not mature. However, until additional specimens are available, this specimen is treated as a separate species.

Dimensions:		length	height	width
	P649	0,90mm	0,65mm	0,35mm

Age and distribution: Only found in the East Agulhas Bank shelf #1276 (Upper Palaeocene to Upper Eocene).

Genus Poseidonamicus Benson 1972

This genus is characterized by a wide suppressed DM ridge, lack of ocular ridge, well defined marginal areas, postero-median vertical arrangement of muri or fossae, central vertical mural loop and sometimes a ridge joining dorsal and ventral margins (Figure 2.13A). It is typically a deep sea form ranging Palaeocene to Recent and has been recorded in the southern deep oceans by Brady (1880) and

Benson (1972 and 1977).

Benson (1972) commented on Brady's (1880) inconsistent descriptions of Cythere dictyon and Cythera viminea which he respectively renamed as Bradleya dictyon and Poseidonamicus viminea. Benson's (1972) main consideration was to illustrate the morphologic affinities with Bradleya Hornibrook (1952), Agrenocythere Benson (1972) and Poseidonamicus Benson (1972).

One species of Poseidonamicus is recognized, in this study, which ranges Middle Eocene to Middle Oligocene. It shows some similarities to some of Hornibrook's (1952) Bradleya species but is placed in this genus on the presence of the vertical mural alignments in the posterior lateral of the valves.

?Poseidonamicus sp A126

Plate 18 D, 19 A-C, Fig. 2.13, 2.14

Material: 10v.

Description: External. Subquadrate outline with maximum height over ACA. Strongly compressed in anterior and posterior regions with a ventro-lateral swelling. LV and RV

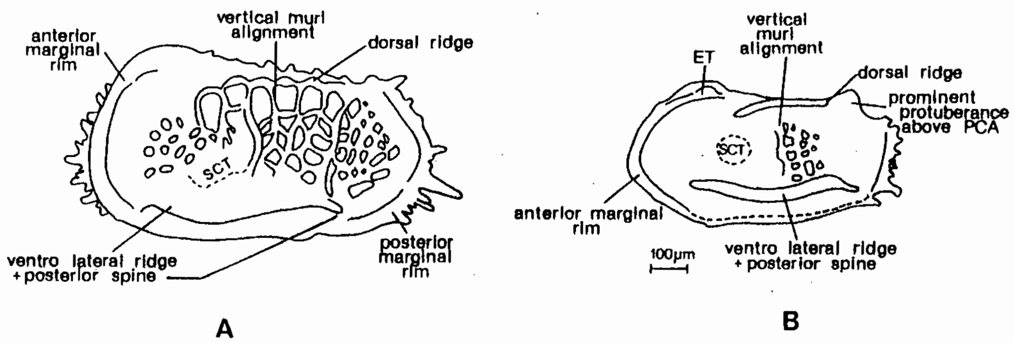


Fig. 2.13 Comparison of basic external features of Poseidonamicus -
(A) P. major Benson (1972) from the Mozambique channel
(B) ?P. sp A126 from #1094 on the East Agulhas Bank.

differ along DM: in RV, DM is straight, ACA not pronounced but PCA carries a small knob-like process; in LV, DM is straight with a large triangular protuberance over ACA. Prominent anterior (0,04mm wide) and ventral rims - the posterior margin has five spines in a fan-like arrangement. ET prominent and located on dorsal end of antero-marginal rim.

Ornamentation is strong, consisting of: a prominent longitudinal ridge on the ventro-lateral swelling which terminates in a posteriorly pointing spine, a dorsal marginal rim which descends anteriorly from PCA and terminates below and just posterior to the ET. The intercostal reticulation is coarse and rounded with occasional conjunctive pores. Posterior to SCT, the muri are weakly aligned in three vertical rows (Figure 2.13B).

<u>Internal.</u> Marginal areas 0,05-0,01mm wide. No MS were visible. Hinge amphidont, consisting in LV of two terminal sockets which are ventrally open, the ME is apparently smooth and bears a round knob at the posterior end.

<u>Remarks:</u> The ET's location on a marginal rim as opposed to an ocular ridge plus the median vertical arrangement of muri

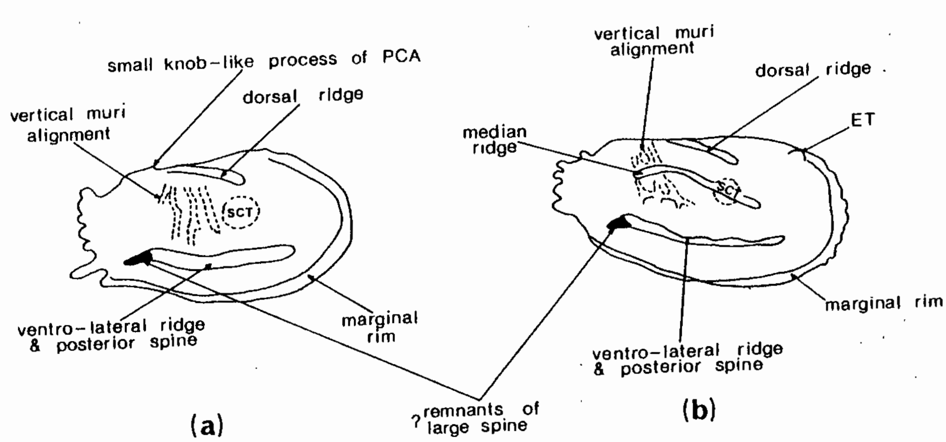


Fig. 2.14 Comparison of external features of -
(a) <u>Poseidonamicus</u> sp A126 with
(b) <u>Indet. Genus 2</u> sp B311

distinguishes this species from those placed in the genus <u>Bradleya.</u>

Figure 2.14 compares the basic features of <u>?P.</u> sp A126 with those of <u>Indet.</u> <u>Genus</u> 2 sp B311. The former is distinguished by its lack of a median ridge.

<u>Dimensions:</u>

	length	height
A126	0,55mm	0,32mm
A132	0,68mm	0,40mm
A134	0,74mm	0,41mm

<u>Age and distribution:</u> Found in #1094 (Upper Eocene), #1105 (Upper Eocene) and #1288 (Middle to Upper Eocene) on the East Agulhas Bank, and #1706 (Middle Eocene to Middle Oligocene) on the west coast margin.

Family Trachyleberididae Sylvester-Bradley 1948
Subfamily Trachyleberidinae Sylvester-Bradley 1948
Genus <u>Agrenocythere</u> Benson 1972

This is a large, blind, reticulate genus with an upturned posterior margin. Surface reticulation is characterized by the circular sub-central feature that consists of:- a CASTRUM consisting of an outer mural ring within which are 12 radial fossae; a BALLIUM made up of 12 fossae numbered clockwise 1-12; the PARAPECTUS or outer mural walls which are enlarged or raised; the ARX or inner muri of the castrum which are raised and often "H"-shaped. In addition there are prominent dorsal bullae and intramural pore conuli which vary in position (Figure 2.15 after Benson 1972; p20, fig. 8).

The reticulation and pore conuli patterns of <u>Oertliella</u> Pokorny (1964) are similar to <u>Agrenocythere</u>, but the former has a prominent ET. Benson (1972) believed <u>Agrenocythere</u> to have evolved from <u>Oertliella</u> by becoming blind plus

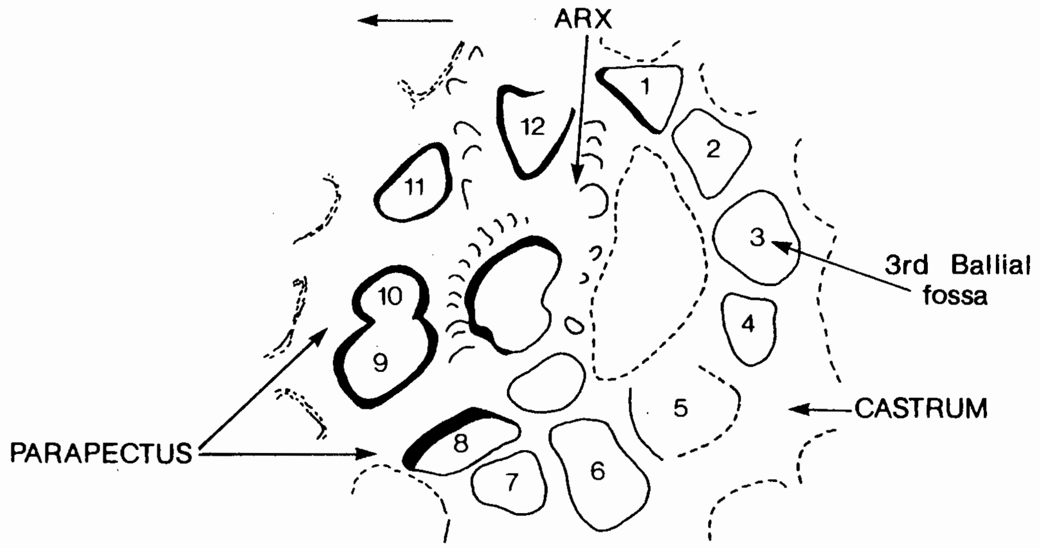


Fig. 2.15 Features of the circular sub-central area characteristic of the genus Agrenocythere (from Benson 1972).

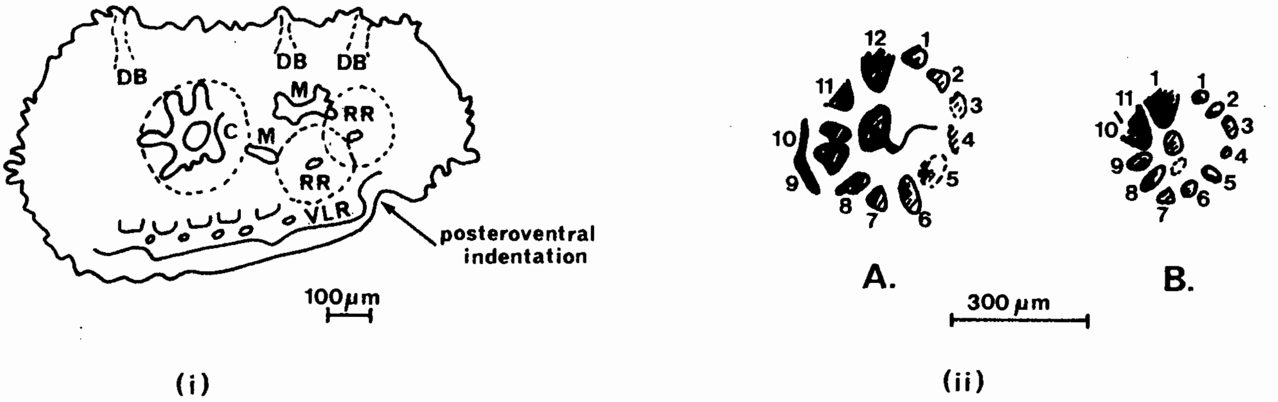


Fig. 2.16(i) Characteristic features of Agulhas Bank ?Agrenocythere hazelae. (DB = dorsal bullae, VLR = ventro-lateral ridge with conjunctive nodes, RR = radial renticulum, C = castrum, M = mural enhancement).
(ii) Comparison of Castrum regions of -
A. Caribbean type A. hazelae Benson (1972)
B. Agulhas Bank ?A. hazelae.

developing the castrum. Some later species of Oertliella have also become blind. The larger varieties of Hermanites (Puri 1954, 1955) tend to show more attenuation posteriorly, higher development of postero-dorsal and median ridges, weak castral areas and are often celate (Benson 1972). The genus is typically a deep water form, with Steineck (1981) and Whatley (1983) using the occurrence of A. hazelae (van den Bold 1946) as a depth indicator in their studies off Jamaica and in the South West Pacific respectively.

The fact that the V-shaped MS in younger species of the genus show signs of dividing indicates an evolutionary trend similar to that of the Thaerocytheridea (Benson 1972).

Table 2.6 summarises the spatial and temporal distribution of Agrenocythere species previously described from the Southern Hemisphere.

?Agrenocythere hazelae (van den Bold 1946)

Plate 19 D-E, 20 A, Fig. 2.15, 2.16

Cythereis hazelae van den Bold, 1946; p92, pl.10, fig. 4a-c.

Trachyleberis? hazelae van den Bold, 1957; p241, pl.1, fig. 11.

Hermanites(?) hazelae (van den Bold) - Ruggieri 1960; 3, pl1, fig. 8.

"Bradleya" hazelae (van den Bold) - van den Bold 1968; 66, pl3, fig. 6.

Agrenocythere hazelae Benson, 1972; p64, fig. 31-38.

Material: 5v.

Remarks: A. hazelae (van den Bold 1946) was distinguished from other Agrenocythere species by Benson (1972) on the basis of its rugose appearance, prominent ventro-lateral ridge, robust dorsal bullae and castrum, plus less ordered posterior median region. The Agulhas Bank specimens have those features typical of A. hazelae (Benson 1972) as shown in Figure 2.16, notably - the postero-ventral bullae (one at ACA, one anterior and one antero-median to PCA) and the prominent ventro-lateral ridge bearing conjunctive nodes along its crest. Benson (1972) commented on the lack of ordered fossae in the posterior median region of the type specimens. The Agulhas Bank specimens (this study) however show two semi-radiating reticulate zones which are discernable in the Caribbean type samples (van den Bold 1946) but are more evident in the South Atlantic species (Benson 1977). The Agulhas Bank samples possess two raised mural areas in the postero-median and postero-ventral areas (Figure 2.16). The castrum of the Caribbean types "forms a strong arx that extends to include the parapectus of the 9 through 12 ballial fossae" (Benson 1972). The Agulhas Bank specimens, plus those of Benson (1977), show a strong arx development where the parapectus encompasses the 9-12 ballial fossae. However the 8/9 radial muri is weaker and the 10/11 ballial fossae are fused, in contrast to the Caribbean specimens which show fusing between 9 and 10 fossae (Figure 2.16A+B). Benson (1977) in his reassessment of the A. hazelae characteristics did not feel that the castrum variations of the species would be significant in differentiating new species.

The Atlantic A. hazelae show more distinct evolutionary trends than the Pacific specimens. During the Oligocene to Early Miocene these include - increase in size, more robust reticulum muri, castrum more exaggerated or larger, dorsal bullae more pronounced and less "butte-like" (Benson 1977) and the development of marginal and conjunctive spines.

A. hazelae is the widest ranging Agrenocythere both spatially and stratigraphically. This, combined with a wide species variation suggests that it served as a central stock from which other species of the genus evolved (Benson 1972). It is typically a deep water form recorded from greater than 1650m in the Lower Miocene at sites 237 and 238 DSDP leg 24

(Benson 1974). Its occurrence in the study area is limited to one East Agulhas Bank off shore locality (#1125, present depth 1500m) and suggests that the Upper Eocene was a period of transgression with relatively deep water at #1125. This supports Siesser's and Dingle's (1981) suggestion of an Upper Eocene transgression.

Dimensions:		length	height
	A352	1,08mm	0,60mm
	A358	1,00mm	0,60mm
	A727	1,38mm	0,78mm

Age and distribution: Only recorded from the East Agulhas Bank Middle to Upper Eocene #1125.

Genus Australileberis Dingle 1976

Dingle (1976) erected this genus with the folowing characteristics - three longitudinal ridges, subdued SCT, prominent ET, amphidont hinge and smooth, pustulate or ribbed intercostal areas. Material from the present study suggests that the original diagnosis should be emended to include species with a merodont hinge and reticulate ornamentation (for example Australileberis sp B123). So far the genus has only been recorded from South East Africa, where four species are known: A. hieroglyphica Dingle (1976), A. stangerensis Dingle (1981), A. sp B123 and ?A. sp 472 (this study). Figure 2.17 summarises the different hinge types for the South African Australileberis. The genus ranges Lower Maasrichtian to Upper Oligocene (Table 2.7) and is most diverse in the Upper Eocene. The apparent absence of A. stangerensis in Palaeocene to Lower Eocene sediments is probably related to paucity of strata available for study.

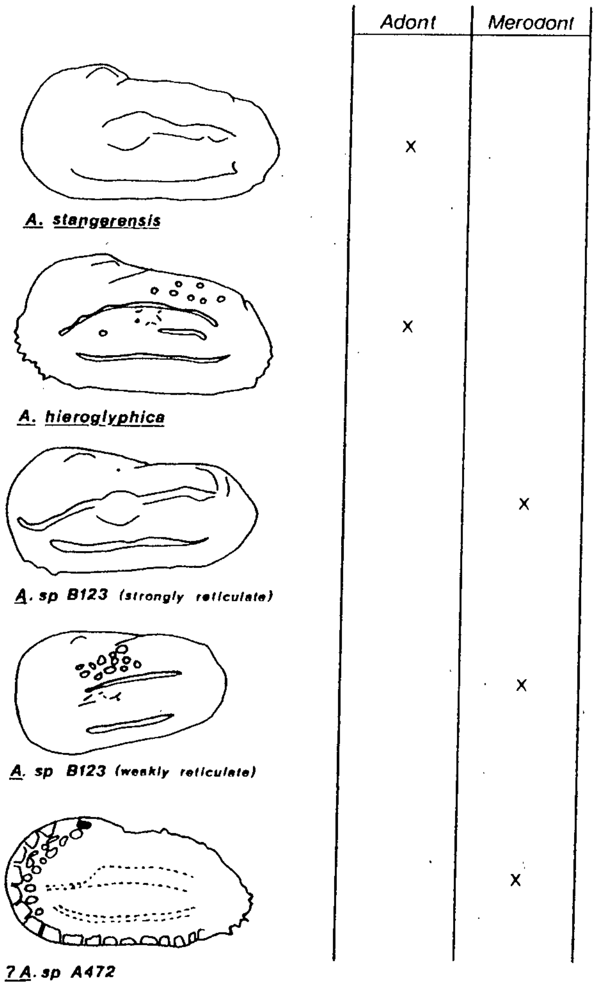


Fig. 2.17 Comparison of hinge types of the South African species of Australileberis.

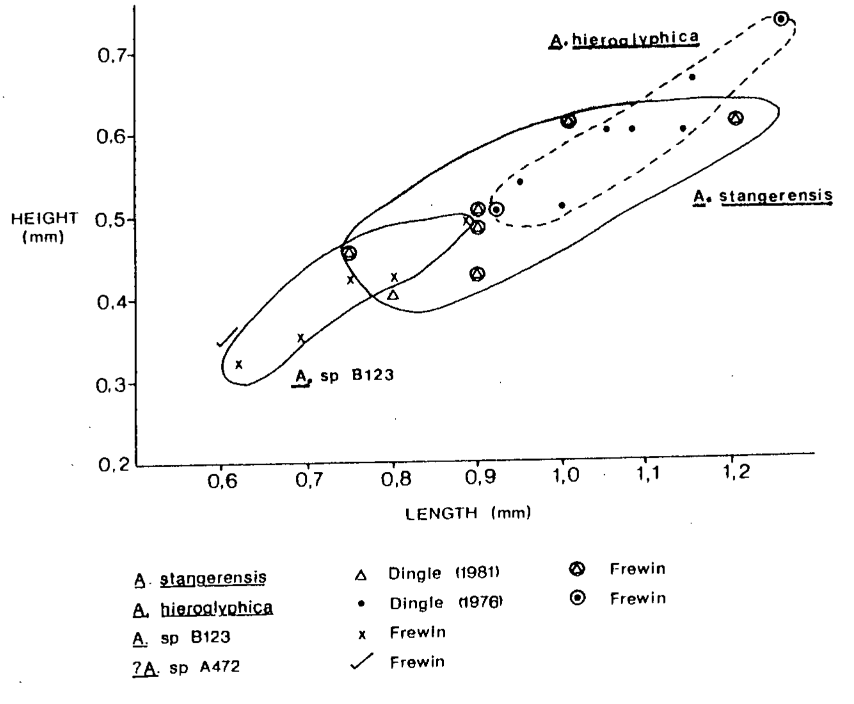


Fig. 2.18 Size variation in South African species of Australileberis.

A. hieroglyphica Dingle (1976) showed preference for open marine conditions whereas *A. stangerensis* Dingle (1981) was associated with fluvial debris-rich marine sediments deposited during Maastrichtian regressions. Dingle (1976) commented on the similarity of this genus to *Cythereis* and proposed a common Cretaceous ancestor, where *Australilebris* is the south west Indian ocean representative.

Australileberis stangerensis Dingle 1981

Plate 20 B-F, Fig. 2.17, 2.18

Australilebris stangerensis Dingle, 1981; p112-113, fig. 54.

Material: 111v.

Remarks: In the original description Dingle (1981) characterized this species by its thick AM and sharp median longitudinal ridge. With additional specimens, plus the identification of a new species to the genus, I propose the diagnosis to include the well developed SCT and prominent lateral longitudinal ridge. Some specimens show typical broadening of DM over ACA in both LV and RV. The thick, commonly smooth shells bear a few (3-4 pustules), with some specimens susceptible to abrasion possibly indicative of having undergone reworking. The TE's of the amphidont hinge still appear typically smooth, which contrast with the other species of the genus. MS appear to consist of a U-shaped AMS with the three close-lying lower posterior adductors slightly separated from a more globular upper MS.

Dimensions:	length	height
P115	0,75mm	0,45mm
P026	0,90mm	0,50mm
P002	0,90mm	0,42mm
P119	1,20mm	0,60mm
P122	1,20mm	0,60mm
P114	1,05mm	0,60mm
P035	0,90mm	0,48mm

Age and distribution: A. stangerensis has been recorded in this study on the Agulhas Bank in #1303 (Middle to Upper Eocene) and #819 (Middle Eocene to Middle Oligocene), on the west coast margin in #1706 (Middle Eocene to Middle Oligocene) and #2772 (Middle to Upper Eocene). Dingle (1981) recorded it in the Maastrichtian of the JC-1 borehole on the Natal continental shelf.

Australileberis hieroglyphica Dingle 1976

Plate 21 A-C, Fig. 2.17, 2.18

Australileberis hieroglyphica Dingle, 1976; p51-52, fig. 14,15.

Material: 13v.

Remarks: A. hieroglyphica differs from A. stangerensis in having a narrower, sharper median longitudinal ridge with a weakly developed SCT plus a varying development of pustules and short ribs in the intercostal areas, though typically between the dorsal and median ridges. A short longitudinal rib is present between the median and lateral longitudinal ridges and extends midway to postero-central area. Most specimens have the dorsal surface broadening over ACA. The denticulation on the PTE of the typically hemiamphidont hinge is not always obvious, as the specimens are abraded.

Dimensions:	length	height
P626	1,26mm	0,72mm
P014	0,92mm	0,50mm

Age and distribution: Recorded in the Middle Eocene to

Middle Oligocene #819 and the Upper Eocene #1125 and #810 on the Agulhas Bank. Dingle (1976) recorded A. hieroglyphica in the Lower Eocene to Upper Oligocene of the JC-1 borehole on the continental shelf off Natal.

Australileberis sp B123

Plate 22 A-G, Fig. 2.17, 2.18

Material: 86v.

Description: External. In lateral view, subquadrate with broadening over ACA and prominent ET. AM well rounded, PM bluntly acuminate, both with a few small spines. VM straight, DM straight to indented midway. Smooth marginal rim (0,05mm wide) extends AM, VM and PM. Three prominent longitudinal ridges: the ventral has a typical anterior upswing, the dorsal is prominent in the posterior part of the valve, but is deflected ventrally anterior of midlength, where it swings down below ET and continues as a line of 3-4 conjunctive pores. The median ridge is posteriorly connected to dorsal ridge by short rib. It extends across the prominent SCT, beyond which it swings ventrally for a short distance, thereafter it is either contiguous or weakly connected to a short, broader, longitudinal ridge. Intercostal reticulation consists typically of rounded fossae with isolated conjunctive pores.

Internal. DM straight, VM slightly sinuous. MA about 0,05mm wide, no vestibule. Hinge is typically hemimerodont where RV has prominent denticulated ATE and PTE, ME smooth. LV shows broadening over posterior and anterior sockets. MS show the typical hooked anterior adductor with the three lower vertical adductors wedge-like.

Remarks: The reticulation of this species ranges from well defined, to weakly reticulate (almost ghosted) where the ridge and SCT development is considerably subdued. The external morphology of this and other Australilebris species are shown in Figure 2.17. The strongly reticulate A. sp B123 is very similar to the smooth A. stangerensis in its prominent SCT and longitudinal ridge development whereas the weakly reticulate A. sp B123 is more similar in shape and ridge trend to A. hieroglyphica. Initially it was tempting to expand the latter's diagnosis to include the weakly reticulate forms, but the merodont hinge of A. sp B123 was considered significant enough to separate it as a new species (and broadening the generic diagonosis). Distinction can probably also be made on valve size (Figure 2.18): A. sp B123 is smaller than A. hieroglyphica with A. stangerensis overlapping both fields.

Dimensions:

	length	height
P124	0,75mm	0,45mm
P653	0,90mm	0,49mm
P656	0,75mm	0,42mm
P021	0,80mm	0,42mm
P036	0,62mm	0,32mm
P040	0,69mm	0,35mm

Age and distribution: A. sp B123 is recorded on the Agulhas Bank in the Middle to Upper Eocene #1303, the Upper Eocene #810 and #1125, the Middle Eocene to Middle Oligocene #819 and the Upper Palaeocene to Lower Eocene #1276. It is also recorded on the west coast margin in #2772 (Middle to Upper Eocene) and #1706 (Middle Eocene to Middle Oligocene).

?Australileberis sp A472

Plate 21 D-E, 23 A, Fig. 2.17, 2.18

Material: 1v.

Remarks: Single RV whose external lateral shape and tri-longitudinal ridge development is similar to other species of the genus Australileberis. A. hieroglyphica in particular possesses the distinctive broadening of well rounded AM over ET. ?A. sp A472 is strongly reticulated, bearing both conjunctive and disjunctive pores as in A. sp B123. However the muri of the latter are considerably thicker with rounder and shallower foveoli.

Internally, the hinge, though poorly preserved appears antimerodont with both crenulate end and median elements as found in A. sp B123. The anterior adductor is U-shaped and the two lower posteriors appear wedged.

Dimensions:	length	height
	0,60mm	0,35mm

Age and distribution: Only recorded in the Lower Eocene #2808 on the west coast margin. It was the only ostracod specimen in this sample.

Genus Chrysocythere Ruggieri 1962

Chrysocythere is characterised by non-compressed marginal areas, longitudinal costae which extend the full valve length, and wide vestibules. It differs from Costa Neviani (1928) which has larger marginal areas and the longitudinal costae end at 3/4 valve length. Carinocythereis Ruggieri (1956) plus the more posteriorly acuminate Cativella Coryell and Fields (1937) usually have slimmer vestibules and a slimmer anterior tooth in RV. The ventro-lateral keel of Bradleya Hornibrook (1952) is generally truncated some distance from the posterior.

The type species C. cataphracta Ruggieri (1962) has the following ornamentation - (a)" an antero-marginal ridge", (b) "a pene-anteromarginal ridge", (c) "four longitudinal ridges" (dorsal, median, latero-ventral, ventral) and (d) "a ventral marginal ridge". (b) and (d) coincide with the lateral outline of the shell and are not always evident in lateral view. The anterior MS are typicaly one large and one small which may become fused in some species.

Around South Africa, Chrysocythere has been recognised in the Recent off Mozambique (Hartmann 1974), South West Africa (Boomer 1985, unpubl., as Cativella sp which is Cythere craticula Brady (1880)) and off South Africa Cythere polytrema (Brady 1880). Van den Bold (1966) identified the type species C. cataphracta from the Upper Miocene of Gabon, and Omatsola (1970) identified a species C. asterospinosus from the Recent Niger delta (West Africa) which shows many characteristics of Chrysocythere (see Table 2.8).

Two species are here tentatively placed in this genus.

Chrysocythere sp A096

Plate 23 B, 24 A-B, Fig. 2.19A+B

Material: 1v.

Remarks: Subrectangular LV with strongly developed rib pattern. The ribs are numbered in Figure 2.19A+B and are described below. The dorsal rib (a) commences posterior of the ET and proceeds to the PCA. The median rib (b) commences at the antero-marginal rib (e), passes via the SCT to the posterior end of the valve where it intersects the oblique postero-marginal rib (c). The ventral rib (d) commences at the anterior margin and proceeds along the length of the valve almost to the VM where it terminates in three spines. It is an extension of the antero-marginal rib (e). The latter commences at the ET, runs subparallel to AM

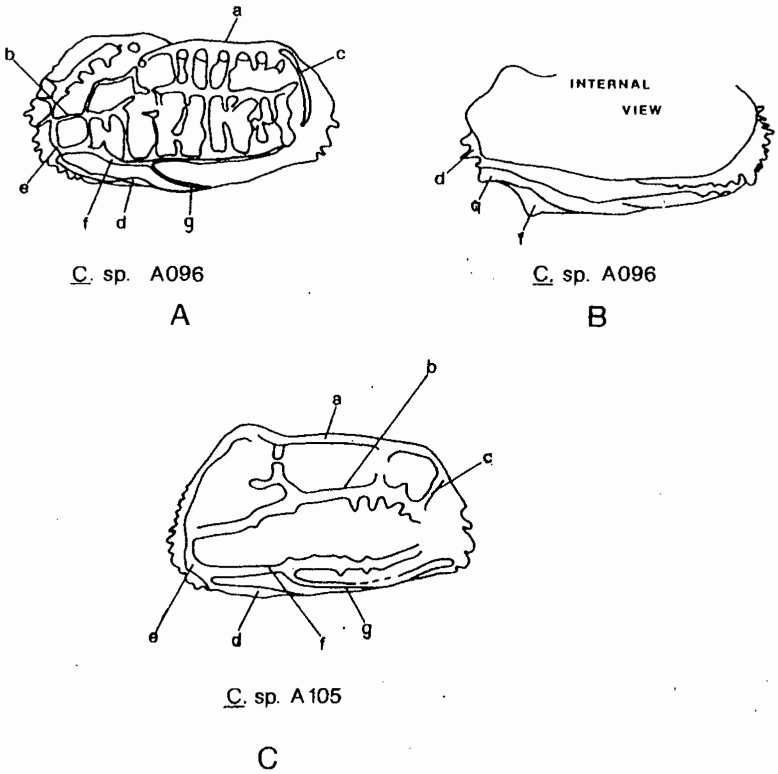


Fig. 2.19 External features of Palaeogene Chrysocythere identified in the present study.
(Refer to text for symbol interpretations).

until it joins the ventral rib. The ventro-median rib (f) commences at the antero-marginal rib and terminates in the postero-ventral area. It subdivides below the SCT where a distal subparallel branch (g) continues to the VM and terminates at a blunt spine. The dorsal (a), median (b), ventro-median (d) and antero-marginal (e) ribs are characteristically ponticulate. Their supports link across the intercostal areas as fine ribs. Greatest height over ACA.

Internally, the hinge is amphidont consisting in LV of a ventrally open posterior socket, a crenulate median bar possessing an anterior nodular tooth, the bar hooks around the AT socket. Dorsal to ATE the cardinal dorsal costa forms a "flat-based" triangular protuberance, the PTE is dorsally thickened. MS not seen. MA 0,2mm wide.

This species is very similar to C. sp A105 but is less elongate in lateral view and is less compressed posteriorly. The dorsal rib of C. sp A096 is not continuous along the DM as in C. sp A105, but swings down below the ET.

Dimensions:

	length	height
P096	0,68mm	0,33mm

Age and distribution: Recorded from the Middle to Upper Eocene #2772 on the west coast margin.

Chrysocythere sp A105

Plate 23 C, 24 C-D, Fig. 2.19C

Material: 2v.

Remarks: Subrectangular LV with straight DM and VM. Greatest height over ACA. Ornamentation consists of strongly developed rib pattern (Figure 2.19C). The dorsal rib (a) is continuous along DM terminating at the cardinal angles. The median rib (b) commences at the antero-marginal rib (e), passes through the SCT and terminates at the postero-marginal rib(c). The ventral rib (d), an extension of the antero-marginal rib, is continuous along the VM. The ventro-median rib (f) extends between the antero- and postero-marginal ribs. It subdivides below the SCT producing a subparallel rib (g) which terminates posteriorly at a blunt spine. The longitudinal ribs a, b, d, f, g are ponticulate where the supports transect the intercostal areas as finer ribbing.

Internally, no MS were observed. The MA is wide (0,01mm wide in anterior). The hinge is amphidont. In LV, the PTE is a ventrally open socket, the median bar is crenulate and possesses an anterior tooth. The bar hooks around the anterior terminal socket. The terminal elements are dorsally thickened to form "flat-based" triangular protuberances.

This species is very similar to C. sp A096 particularly in the hinge and ornamentation. However in C. sp A105 the dorsal rib is continuous along the DM and the posterior region is less blunt. C. sp A105 is similar to ?Costa cf C. dahomeyi (Apostolescu 1961) as recorded from the Upper Eocene JC-1 borehole (Dingle 1976). The latter has a blunter, non-spinose PM.

Dimensions:		length	height
	P105	0,64mm	0,44mm
	P265	0,72mm	0,40mm

Age and distribution: Recorded from #1276 (Upper Palaeocene to Lower Eocene) and #1094 (Upper Eocene) on the East Agulhas Bank.

Genus Costa Neviani 1928

Neviani (1928) (as summarised by Siddiqui 1971, p28) characterized Costa as possessing 3-4 longitudinal ridges, the median is prominent posterior to the SCT where it curves postero-ventrally. Siddiqui (1971) subdivided this genus into subgenera Costa (Costa) (C(C)) and Costa (Paracosta) (C(P)) respectively possessing three and four longitudinal ridges, respectively. In the latter the fourth ridge occurs between the ventral longitudinal ridge and the ventral margin.

Van Morkhoven (1963) distinguished this genus from Cativella Coryell and Fields (1937) which is less posteriorly elongate, Cythereis Jones (1949) on the basis of hinge type, and Hermanites Puri (1955) and Occultocythereis Howe (1951) which do not possess a distinct longitudinal median ridge.

Previously recorded African Costa are summarised in

Table 2.9. Siddiqui (1971) recognised three Upper Eocene species from West Pakistan which show similarities with Lower Tertiary Agulhas bank specimens.

Costa (Paracosta) sp A640

Plate 23 D, 24 E-F, 25 A-C

Material: 2v.

Remarks: Sighted Costa attributed to the subgenus Paracosta on the presence of four longitudinal ridges. Fossae are rounded to oval with conjunctive mural pores. A short, fifth ridge passes from the DM through the ET to the antero-dorsal region. Internally, the MS show a typical "V" anterior adductor, with the lower two posterior adductors wedge-shaped, the median has a central constriction and the upper scar is semi-elliptical and separated from the lower three by a relatively wide gap. There is an amphidont hinge, although the ME apparently is not crenulate.

C(P) sp A640 is similar to C(P) declivis Siddiqui (1971) though is less elongate, and the antero-ventral reticulation is less ordered.

Dimensions:

	length	height
A640	1,20mm	0,66mm
B153	1,00mm	0,60mm

Age and distribution: Only recorded in the Upper Palaeocene to Upper Eocene #1277 on the East Agulhas Bank.

Genus Echinocythereis Puri 1954

This common Tertiary genus is characterised by a concentric disposition of spines superimposed on a reticulation with shallow pits, and internally by a divided anterior adductor MS (Van Morkhoven 1963). It is distinguished from the similar genera Henryhowella Puri

(1957) and Trachyleberis Brady (1898) by these two both having a U-shaped AMS, in addition to which Henryhowella has longitudinal ridges in the posterior part of the valve. Siddiqui (1971) recognised six Middle to Upper Eocene species of this genus belonging to the two subgenera - Scelidocythereis (E(S)) and Echinocythereis (E(E)) respectively characterized by the presence or absence of ventral ridges. One species, E(S) rasilus, is smooth.

Echinocythereis (Echinocythereis) sp A570

Plate 25 D-F

Material: 9v.

Description: External. Subrectangular RV with well rounded AM. DM and VM straight, converging to rounded PM. No ET. Greatest height over ACA.

Ornamentation consists of a concentric arrangement of spines which are most prominent in anterior and ventral areas. The spines are conjunctively superimposed on a rounded pitted reticulation. Circular SCT crossed by a vertical row of five spines.

Internal. Wide MA (0,11mm in antero-ventral area). MS not seen. Holamphidont hinge, RV with prominent stepped ATE and large blunt PTE. Hinge elements all appear smooth.

Remarks: E(E) sp A570 is similar to E(E) sp B076 in lateral shape and ornamentation. The former however possesses five vertical spines on the SCT whereas E(E) sp B076 is characterised by its median sulcus. The AM and PM of both E(E) sp A570 and E(E) sp B076 are well rounded, both species are blind. This is in contrast to the blunter PM of the Middle to Upper Eocene species from West Pakistan (Siddiqui 1971). All the West Pakistan Echinocythereis species have prominent ET's.

Dimensions:		length	height
	P570	0,55mm	0,32mm
	P574	0,69mm	0,39mm

Age and distribution: Only recorded in the Upper Eocene #1303 on the East Agulhas Bank.

Echinocythereis (Echinocythereis) sp B076

Plate 26 A-B, 28 A

Material: 10v.

Description: External. RV subrectangular with asymmetrically rounded AM. DM and VM straight, converging to well rounded posterior. ET absent. Weak SCT. A shallow sulcus extends from the dorso-median area, proceeds posteriorly to SCT and swings down to the VM at about 1/3 valve length.

Valve surface is covered by numerous spines arranged concentrically, and superimposed on large rounded reticulation.

Internal. Hinge weakly holamphidont. In LV, terminal sockets open ventrally, ATE is dorsally thickened. In RV, ATE is elongate parallel to dorsal edge. MS not visible. Marginal area narrow (0,05mm).

Remarks: *E(E)* sp B076 differs from *E(E)* sp A570 in the possession of the weak sulcus, weak holamphidont hinge and lack of vertical spines on SCT. Both species differ from the West Pakistan *Echinocythereis* species (Siddiqui 1971) in the possession of a well rounded PM, plus lack of ET.

Dimensions:		length	height	
	P068	0,66mm	0,40mm	
	P076	0,69mm	0,40mm	
	P070	0,70mm	0,41mm	
	P072	0,70mm	0,41mm	
	P079	0,59mm	0,32mm	(juvenile)

Age and distribution: Only recorded in the Middle to Upper Eocene #2772 on the west coast margin.

Genus Haughtonileberis Dingle 1969a

Six species of this genus have been recognised from South East Africa (Dingle 1969a, 1976, 1980, 1981 plus this study), five from Gabon (Grosdidier 1979), one from Tanzania (Curfsina turonica Bate and Bayliss 1969) and one from Tunisia (Esker 1968, in Donze et al 1982), (Table 2.10).

The genus apparently originated in the Albian in the equatorial South Atlantic and only migrated into the Indian Ocean area when the Walvis/Rio barrier was no longer effective (probably Lower Cenomanian). The appearance of relatively large numbers of species in the equatorial South Atlantic during Cenomanian/Turonian times is surprising because it coincides with a low point in first appearances of ostracod species in Gondwana faunas (Dingle 1987).

The genus was numerically an important component of the South East African Santonian/Campanian cytheracean population. Dingle (1981) suggested that the subsequent decrease in numbers of specimens and species was a phylogenetic rather than an ecologic trend as both H. fissilis and H. haughtonii are considered to be environmentally tolerant. Consequently, the Tertiary species of Haughtonileberis represent the descendents of more diverse Cretaceous populations of the genus.

The conclusions from this study indicate that H. sp A075 and H. radiatus evolved from the common ancestor H. fissilis. The only other known Tertiary species is from North Africa (Donze et al 1982), (Figure 2.20).

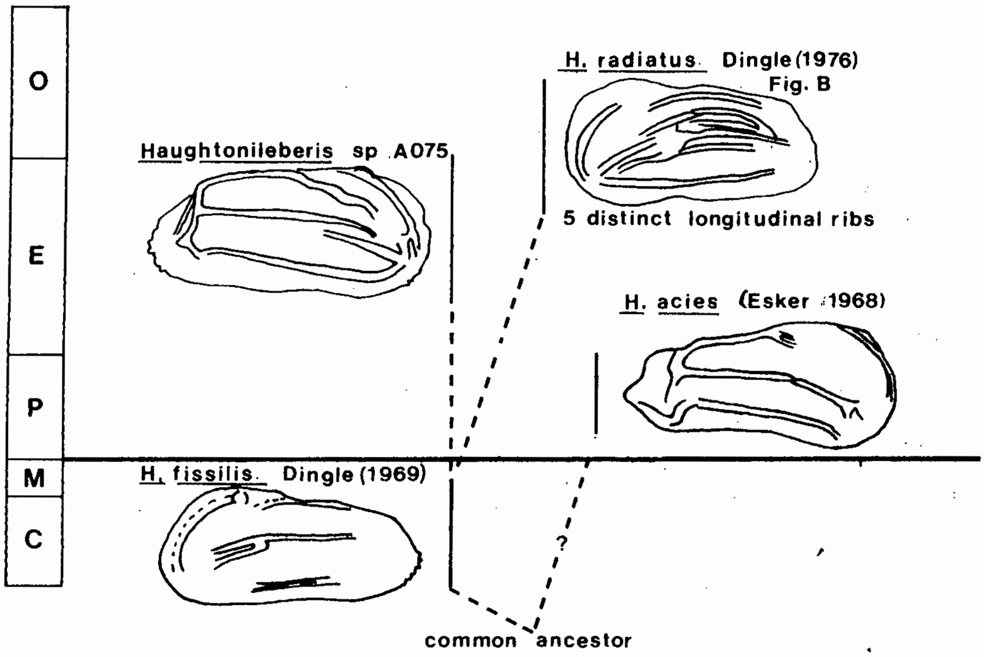


Fig. 2.20 Suggested phylogeny for various African Haughtonileberis.

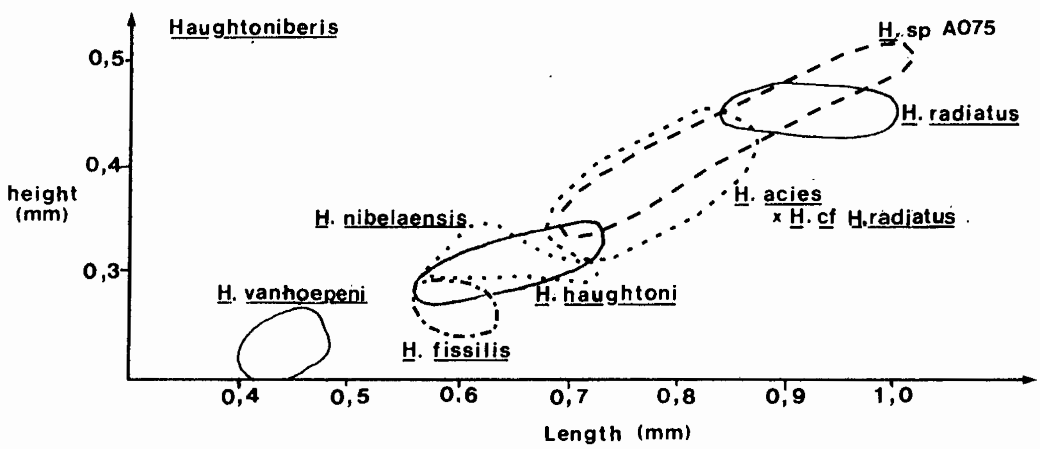


Fig. 2.21 Size comparisons for various South African Haughtonileberis.

The previously undated sample #1303 is dated Middle to Upper Eocene on the occurrence of _H._ sp A075 in it and the previously dated (Siesser 1977) Middle to Upper Eocene #2772.

Haughtoniliberis sp A075

Plate 26 C, 27 A-F, Fig. 2.20, 2.21

Material: 11v.

Description: _External._ In lateral view the outline is subrectangular with longitudinal margins almost parallel, except in LV where they are more convergent posteriorly. The ACA is broadly rounded with maximum valve height above the small indistinct eye spot. PM triangular in outline with both PM and AM weakly spinose. The three major longitudinal ribs are:- a dorsal margin rib which originates near the PCA and turns down in the anterior part of the valve; a median rib which splits anterior to the weakly developed SCT; and a ventro-median rib which runs from a posterior node to near the AM where it converges with the split median rib. There is a short oblique antero-dorsal rib which runs from the ET to about mid-valve height. Posteriorly the three longitudinal ribs are linked by a short north-south rib, which has a distinctive "tail" that runs from the PCA across the triangular posterior surface.

Ornamentation is coarsely reticulate in the intercostal areas, specimens moderately calcified. Sexual dimorphism not recognized.

Internal. A weak amphidont hinge. In RV, ATE consists of a narrow elongate tooth, PTE is rectangular, ME is a smooth groove. A shallow AM groove terminates on the dorsal side of the ATE. In LV, TE's have distinct dorsal swellings particularly over PTE. The ME is a smooth bar with very weak anterior swelling. MS not visible. MA about 0,1mm wide in both AM and PM.

Remarks: H. sp A075 differs from H. radiatus Dingle (1976) in not having five distinct longitudinal ribs and the stepped antero-dorsal outline. It is more similar to H. fissilis Dingle (1969a) and H. acies (Esker 1968) in the splitting of the median rib and weak SCT, but differs from the former in rib arrangement and finer intercostal reticulation. H. acies has a weaker central median rib which is characteristically looped in the posterior where it joins the short north-south rib. The plot of length versus height for H. sp A075, H. acies and other South East African haughtonilebrids reveals the Tertiary species as larger, with H. sp A075 having features of both H. acies and H. radiatus (Figure 2.20).

In South Africa the lineage looks fairly straightforward, with H. radiatus and H. sp A075 evolving from a common ancestor H. fissilis. H. acies from Tunisia is morphologically very similar to H. sp A075 and although on the limited data it is difficult to come to any firm conclusions, it can be considered as: a) derived from a common ancestor to it and H. fissilis, this is possibly one of the equatorial species described by Grosdidier (1979) i.e. H. GA F 18, or b) evolved from an as yet undiscovered Upper Cretaceous ancestor, and merely represents a case of homeomorphy.

Dimensions:		length	height
	A075	0,70mm	0,34mm
	A077	0,70mm	0,35mm
	A066	0,82mm	0,43mm
	A084	0,72mm	0,34mm
	A080	0,74mm	0,35mm
	A680	1,00mm	0,50mm

Age and distribution: *H.* sp A075 is recorded in the Middle to Upper Eocene #2772 on the west coast margin and the Middle to Upper Eocene #1303 on the East Agulhas Bank.

Haughtonileberis cf H. radiatus Dingle 1976

Plate 28 B-C, Fig. 2.20, 2.21

Material: 5v.

Remarks: Strongly resembles *H. radiatus* Dingle (1976) in rib arrangement. It differs in the following points: *H. cf H. radiatus* has a more sinuous ventral outline, a more acuminate PM, and there is no antero-dorsal step above the ET. On the limited data available it is difficult to justify erection of a new species, although Figure 2.21 shows a marked difference between *H. radiatus* and *H. cf H. radiatus*. The strong hinge is characterized in the RV by two large TE, the ME consists of a smooth groove with a small socket at the anterior end. MS are indistinct, but the anterior adductor is apparently U-shaped, with the dorsal two posterior adductors distinctly wedge-shaped.

Dimensions:		length	height
	P314	0,90mm	0,36mm

Age and distribution: This species is recorded on the East Agulhas Bank at #1105 (Upper Eocene) and #1303 (Middle to Upper Eocene).

Genus *Henryhowella* Puri 1957

Four Southern African species have been recorded:- *H.* sp from the Palaeogene of South Africa (Dingle 1976), *H.* sp? from the Recent and Holocene of South West Arica (Boomer 1985, unpubl.) and South Africa (Dingle personal communication), *H. melobesioides* (Brady 1880) from the Recent HMS Challenger dredges 1873-76, and *H. asperrima?* from the Lower Miocene to Pleistocene southern Atlantic - DSDP site 356 + 357 (Benson 1977) and Agulhas Bank Middle Eocene to Middle Oligocene (this study). Dingle (1985) recorded Indet. sp 2314 from the Santonian of South Africa which is very similar to *H. asperrima*.

The genus is characterized by three broad longitudinal ridges which are confined to the posterior half of the valve. The numerous spines are superimposed on reticulation and are concentrically arranged. The genus is distinguished from - *Actinocythereis* Puri (1953b) whose ridges extend across the full length of the valve and are generally broken up by spines, and *Echinocythereis* Puri (1954) by its absence of ridges.

Henryhowella asperrima? (Reuss 1850)

Plate 26 D, 28 D-G

Material: 41v.

Remarks: Benson (1977), Oertli (1985) and I have recorded specimens of *Henryhowella* which look identical. The former two were questioningly allotted to *H. asperrima* and on this basis I call my species *H. asperrima?*. This species is characterised by three prominent posterial plications - dorsal, median and ventral. The spinose ornamentation in the anterior, in the absence of the ridges, is distinctly concentric and superimposed on rounded foveolate reticulation. The SCT is exagerated by the presence of 4-5 nodes which are generally vertically arranged. The LV shows greatest height over ACA but this broadening is not prominent in RV. This species differs from Boomer's (1985), Dingle's (1976) and van den Bold's (1966) species, H. ex gr asperrima, which do not appear to have the nodular SCT. Boomer's and Dingle's also lack such distinctive plications.

This species exhibits a very wide distribution - as far North as France (Oertli 1985) plus from the South Atlantic deep sea DSDP leg 39 sites 356 and 357 (Benson 1977),from modern sediments off North West Africa (470m-1025m) by Rosenfeld and Bein (1978) with a wide age range Middle Palaeogene to Recent. Obviously all the species considered very similar to H. asperrima Reuss (1850) should be reinvestigated to clarify distribution and age trends, and for this reason I include various photos of my H. asperrima? (some specimens destroyed). A "non-spiney " specimen was found but it is grouped with this species on the assumption that the spines have been abraded (SCT shows nodular appearance). This specimen in particular shows strong similarities to Indet sp 2314 Dingle (1976, fig. 38).

Dimensions:

	length	height
P591	0,69mm	0,40mm
P578	0,70mm	0,40mm
P610	0,70mm	0,40mm
P988	0,90mm	0,60mm
P601	0,70mm	0,39mm

Age and distribution: This species was recorded in this study from; the west coast margin #2772 (Middle to Upper Eocene) and #1706 (Middle Eocene to Middle Oligocene); the East Agulhas Bank #819 (Middle Eocene to Middle Oligocene) and #1303 (Upper Eocene). Benson (1977) recorded this species from the DSDP sites 356 and 357 (Lower Miocene to Pleistocene), and Oertli (1985) from the Palaeogene of France.

Genus Parvacythereis Grundel 1973

Parvacythereis was first recorded by Grundel (1973) with a range of ?Cenomanian to Uppper Tertiary. Dingle identified two species P. monziensis (1981) and P. spinosa (originally described as Phacorhabdotus? spinosa (1971b)) from South East Africa which were characteristic, though minor elements in Maastrichtian cytheracean populations. They showed a preference for stable or quiet environments. A further two species are recognized in the present study: P. sp A3260 and P. sp A053 (Table 2.11).

Parvacythereis sp A3260

Plate 29 A-E

Material: 4v.

Description: External. In lateral view, AM rounded, PM bluntly triangular. Well developed PM and AM rims. VM rim is continuous with PM and AM rims but somewhat subdued about midlength. PM rim bears short spines and AM extends to prominent ET which is connected to sharp DM rib. DM straight, with a step at the PCA which is connected to the diagonal lateral rib by an elongate node. The diagonal, lateral rib is narrow in postero-dorsal and median areas, but broadens on either side of SCT and terminates in an antero-ventral position. The short ventro-lateral rib is situated above midlength and has a median protuberance towards the diagonal rib. A characteristic small subdued rib connects the SCT with ET. Intercostal areas are smooth, except for numerous puncta. Greatest height over ACA.

Internal. Moderately wide MA (0,05mm wide). No MPC visible. Hinge is holamphidont with anterior end of LV ME small and rounded. In LV there are high arched rims over the terminal elements. The rim over the PTE in LV has a small posteriorly directed projection. MS not well seen but the bottom two adductors are wedge-shaped.

Remarks: P. sp A3260 shows distinct similarities with P. monziensis Dingle (1981) - general shape, prominent DM rib plus posterior indentation at its termination, well developed AR and PR, broad SCT and arching over PTE and ATE, and the presence of a VM rib. P. monziensis is smaller, has a weaker ET, a less defined VM rib, an angular postero-dorsal node on dorso-lateral rib termination, and is covered in fossae. P. spinosa Dingle (1971b) has a more prominent dorso-lateral rib, has less fossae than P. monziensis although its size dimensions are more similar to the Tertiary species P. sp A3260 and P. sp A053. P. sp A3260 is very similar in lateral shape and ornamentation to Neocaudites triplistriatus Edwards (1944) as illustrated in Hazel (1977, fig. 7d), but no internal comparisons were available.

Dimensions:

	length	height
P3260	0,50mm	0,25mm
P712	0,68mm	0,35mm
P716	0,72mm	0,39mm
P3264	0,49mm	0,28mm

Age and Distribution: In this study it was only recorded in the Upper Eocene #810 but Dingle (unpubl.) observed it in the Upper Eocene #1094. Both localities are on the East Agulhas Bank.

Parvacythereis sp A053

Plate 30 A-D, 31 A-F

Material: 45v.

Description: External. In lateral view AM rounded, PM bluntly triangular. Well developed PM and AM rims. VM rim is continuous with AM and PM rims but is medianly subdued. PM and AM bear short spines. Weak ET often marked by deep reticulate depression associated with AM rim. DM and VM straight. The three longitudinal ridges are:- the weak dorsal ridge, which is more pronounced in the postero-dorsal area where it is marked by 3-4 puncta on its rim; the median ridge which is either inclined antero-ventrally in front of SCT or is slightly diagonal, commences in postero-median area broadening around and anterior to SCT; the ventral ridge commences in the postero-ventral area and extends to AM rim. In dorsal view, the valve shows marked anterior and posterior marginal depressions.

Ornamentation of deep, well rounded fossae, slightly less well-developed along costae, but well developed adjacent to marginal rims.

Internal. MA 0,05-0,1mm wide. Holamphidont hinge with small rounded anterior end to LV ME. LV has arched rims over terminal hinge elements. MS not well seen, but bottom two adductors appear elongate.

Remarks: *P.* sp A053 is distinguished from other South African parvacytheraceans in its marked reticulation although its rib trends, lateral step at PCA and marginal rim development are similar to both *P. monziensis* and *P.* sp A3260. *P.* sp A053 shows similar length/height ratios to *P. spinosa* but is larger than *P.* sp A3260.

Dimensions:		length	height
	P673	0,90mm	0,50mm
	P53	0,72mm	0,35mm
	P58	0,76mm	0,32mm
	P68	0,75mm	0,30mm
	P64	0,75mm	0,32mm
	P660	0,99mm	0,45mm
	P5667	0,98mm	0,50mm

Age and distribution: P. sp A053 was recorded from the Middle to Upper Eocene #1303 (East Agulhas Bank) and #2772 (west coast margin), the Upper Eocene #1281 and Middle Eocene to Middle Oligocene #819 on the East Agulhas Bank.

Genus Phacorhabdotus Howe and Laurencich 1958

This genus is very similar to Costa Neviani (1928), Ambocythere van den Bold (1957) and Isocythereis Triebel (1940). It dffers from the former in being less elongate with a wider duplicature, and the latter in lacking the anterior peripheral ridge. Ambocythere is considered to have developed from an Upper Cretaceous species of Phacorhabdotus, where Tertiary modifications include branching of pore canals and smoothing of hinge elements (Van Morkhoven 1963). Ambocythere is characterised by a postero-ventral projection.

Phacorhabdotus has previously been recorded in Africa (Table 2.12) by Dingle (1971b, 1981), Apostolescu (1961), Bate and Bayliss (1969), Brady (1880 as Cythere stolomonifera), Benson (1977) and Donze et al (1982). P. spinosa Dingle (1971b) was later considered by Dingle (1981) to have a ridge pattern uncharacteristic of this genus and so it was placed in Parvacythereis.

Dingle (1981) associated P. ?anomala and P? sp A with moderately deep water environments (?200m) partly based on its association with both Bythocypris and Krithe at down hole depths 1625-1652m and 1719-1780m in the JC-1 borehole.

Phacorhabdotus sp A1424

Plate 32 A-C

Phacorhabdotus? sp A Dingle, 1981; p122, fig. 59F.

Material: 6v.

Description: External. Subrectangular with well rounded AM, PM arcuate and spinose. In LV, VM straight but broadening anteriorly at 1/3 length. Narrow, upturned anterior and ventral marginal rim which broadens posteriorly (0,02mm wide). LV medianly inflated with three longitudinal ridges. The ventral is longest, extending from postero-ventral to antero-ventral positions. The median ridge runs from about 4/5 valve length to the SCT. The dorsal ridge commences near the PCA, arches above the DM and rapidly diminishes at mid-length. Intercostal areas are weakly reticulated with occasional conjunctive pustules and finer inter-reticulate pores. AMA (0,1mm) smooth and unridged. Sexual dimorphism not recognized.

Internal. Hinge poorly preserved, in LV the ME appears smooth and terminal sockets simple, open ventrally. MS not visible. Wide AMA (0,2mm) commencing from anterior terminal socket to midventral margin.

Remarks: P. sp A1424 is placed in this genus because although it shows the Tertiary modifications of Ambocythere (Van Morkhoven 1963) it lacks a postero-ventral projection. It was first recorded in the Maastrichtian of South Africa where it occured with Bythocypris and Cytherella in the JC-1 borehole off Natal and in this study is associated with either Bythocypris or Cytherella in a relatively diverse population.

P sp A1424 is similar in shape and ridge pattern to the Tunisian *P. inaequicostata* Donze et al (1982) and the smaller *P. cf P. inequicostata* Honigstein (1983) from the Lower Campanian of Israel. It is smaller than previously recorded South African *Phacorhabdotus* specimens and is easily distinguished from them by its coarse reticulation. *P. subtridentus* Benson (1977) from the South Atlantic DSDP sites 356 and 357 is larger (0,80mm long), with weaker reticulation and ridge development than *P.* sp A1424. The distinct dorsal ridge and lesser median and ventral longitudinal ridges of *P.* sp A1424 are reminiscent of *P. texanus* Howe and Laurencich (1958) from the Campanian of Texas although the latter does not have reticulate ornamentation.

Dimensions:

	length	height
P27340	0,52mm	0,33mm
P1424	0,45mm	0,28mm

Age and distribution: Recorded from the Middle to Upper Eocene #1125 and the Upper Eocene to Middle Oligocene #827 on the East Agulhas Bank, and Maastrichtian of the JC-1 borehole.

Genus *Soudanella* Apostolescu 1961

This genus has previously been recorded in the Cretaceous of Senegal (Apostolescu 1961), Upper Cretaceous of Gabon (Grosdidier 1979) and the Upper Thanetian to Lower Ypresian of Tunisia (Donze et al 1982). Bertels (1975) recognized a reticulate *Soudanella* sp from the Upper Oligocene to Lower Miocene of Argentina. It is very similar to the genera *Protobuntonia* Grekoff (1953), *Buntonia* Howe

(1935, in Howe and Chambers 1935), Quasibuntonia Ruggieri (1958) and Togoina Apostolescu (1961) but is distinguished by the shape of the carapace plus the internal characteristics. One species is recognised in this study and although MS are not visible it is tentatively placed in this genus on the basis of its shape and hinge.

Soudanella sp A151

Plate 33 A-F

Material: 33v, 4c.

Description: External. In lateral view, subtriangular with rounded AM. The straight DM and VM are connected by a subrounded PM. Dorsal view reveals flat PMA with postero-median inflation which tapers gently to the anterior. LV slightly overlaps RV. Surface generally smooth with small puncta, few isolated nodes plus posterior and anterior marginal spines. Four, short longitudinal furrows in the posterior part of the valve trend parallel to VM. The ventral-most furrow commences at the top of the posteror inflation and extends to midlength. The furrows diminish in length and strength dorsally. Sexual dimorphism apparent, males more elongate wth straighter less inflated DM.

Internal. Narrow (0,06mm wide) PMA and AMA. Hinge heterodont: ME of LV consisting of weakly crenulate bar with smooth posterior tooth. TE's are two broad sockets. MS not visible.

Remarks: S. sp A151 is similar to S. laciniosa triangulata Apostolescu (1961) but the former differs in its distinct four grooved ornamentation and so has been placed in a new species. The poorly developed furrow arrangement of S.

lacionosa triangulata Donze et al (1982) appears more closely related to S. sp A151 than S. laciniosa triangulata Apostolescu (1961).

Dimensions:

	length	height
P151	0,51mm	0,30mm
P154	0,52mm	0,30mm
P924	0,72mm	0,40mm
P922	0,71mm	0,40mm
P919	0,78mm	0,45mm

Age and distribution: Only recorded in the Upper Eocene #1105 on the East Agulhas Bank in this study.

Genus Stigmatocythere Siddiqui 1971

The genus was first recorded in the Eocene of West Pakistan (Siddiqui 1971). Five species were described; S. obliqua, S. portentum, S. calia, S. delineata and S. lumaria. Dingle (1976) identified two valves of this genus from the Middle to Upper Eocene of JC-1 borehole, offshore Natal, South Africa. These were described as Stigmatocythere cf S. obliqua Siddiqui (1971) but in the present study have been included in the new species S. sp A141.

Both Siddiqui (1971) and Dingle (1976) noted the age restriction of S. obliqua and S. cf S. obliqua (S. sp A141) to Middle to Upper Eocene and mentioned their potential use as an index fossil. Four of the five samples from which S. sp A141 has been recorded in the present study have been dated Middle to Upper Eocene (Siesser 1977). The presence of two valves in sample 1125 (undated by Siesser) suggest that this sample is also of Middle to Upper Eocene age.

Stigmatocythere sp A141

Plate 34 A-D, 35 A-F, Fig 2.22

S. cf S. obliqua Dingle, 1976; p47, fig. 11(28).

Material: 17v.

Description: External. Valve subrectangular in lateral view. AM evenly rounded with a few, small spines. PM rounded to subrectangular. In lateral view of carapace, LV extends beyond RV margin postero-dorsally and antero-dorsally over CA (Figure 2.22b). Greatest height over CA. DM straight, partly hidden in lateral view by dorsal ridge. In RV, antero-dorsal area is concave, in LV antero-dorsal area is convex (Figure 2.22b). VM is straight with small prominent concavity at about 1/3 valve length. DM and VM converge slightly posteriorly. Dorsal ridge carries three conical elevations with a smaller one sometimes developed posterior to ET. A curved ridge joins the SCT to ET. There is a prominent ventral ridge which rises posteriorly and two short longitudinal median ridges.

Internal. MS consist of four vertical elongate adductor scars with a V-shaped frontal scar (Figure 2.22c). Dentition is holamphidont. In RV, ATE is weakly stepped, PTE is large and in dorsal view slopes downward anteriorly. The ME is apparently smooth. Duplicature is wide (0,05mm wide in females). There is no vestibule.

Remarks: This species was placed in Stigmatocythere because it has the correct hinge, ornamentation, and general shape. However, S. sp A141 differs from types described by Siddiqui (1971) in having a typical trachyleberid MS with a V-shaped anterior scar (S. obliqua was noted by Siddiqui (1971) as having an oval AMS). The following tabulates the distinguishing features of S. obliqua and S. sp A141 (Figure 2.22a).

	West Pakistan S. obliqua	South Africa S. sp A141
	Lower to Upper Eocene	Middle to Upper Eocene
1.	3 well developed longitudinal ridges	-generally absent though vaguely discernible in some specimens.
2.	Median ridge commences from ET, curves to join SCT at antero-dorsal corner.	-ET and SCT joined by curved ridge.
3.	Poorly developed pattern in mid-posterior region noted in a few of specimens.	-discernible concentric pattern in mid posterior which probably masks ridge trend.
4.	SCT not very inflated.	-SCT prominent and inflated.
5.		-3 major nodes along dorsal margin with a minor node posterior to ET.

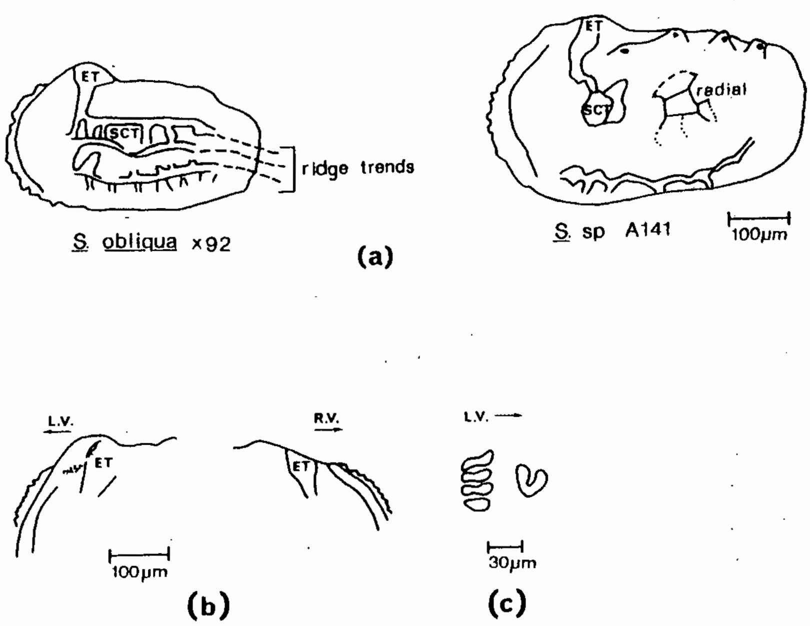


Fig. 2.22 (a) Comparison between external features of Stigmatocythere obliqua Siddiqui (1971) and Stigmatocythere sp A141.
(b) Details of lateral antero-dorsal area, and
(c) MS pattern of S. sp A141.

Dimensions:		length	height
	P141	0,48mm	0,29mm
	P137	0,51mm	0,30mm
	P874	0,60mm	carapace
	P374	0,51mm	0,32mm
	P378	0,54mm	0,32mm

Age and distribution: Recorded in the following Agulhas Bank samples: the Upper Eocene #1105 and #810, the Middle to Upper Eocene #811 and #1125 and the Middle Eocene to Middle Oligocene #827. It is also recorded from the Middle to Upper Eocene of the JC-1 borehole off Natal.

Genus *Togoina* Apostolescu 1961

Three Lower Eocene species *T. attigonensis*, *T. obesa* and *T. costellata* were originally attributed to this genus by Apostolescu (1961) in his West African studies. Two species were recognized by Bertels (1968, 1973) from the Lower Danian of Argentina. Bertels (1976) noted that although the external features of the Lower Danian Argentinian and the Lower Eocene African species are similar, the hinge bar in the former is smooth but the latter has developed crenulations.

Togoina sp A1441

Plate 32 D-E

Material: 5v, 2c.

Description: External. In lateral view - "almond" shaped/subovoid with rounded AM, DM and VM straight tapering to blunt, weakly spinose PM. In dorsal view, RV larger and overlapping LV. AM rim (0,06mm wide) is flat and punctate, concentrically parallel to AM. Antero-median area relatively free of puncta, but central valve area has four rows of puncta. No internal views available.

Remarks: T. sp A1441 is very similar in shape to T. attigonensis Apotolescu (1961) but differs in its lacking an ET, the development of an AM rim and is less punctate. T. obesa Apotolescu (1961) was characterised by its four longitudinal striae separated by puncta. T. sp A1441 shows a similar puncta trend but is more elongate and punctate.

Dimensions:		length	height
	A1441	0,40mm	0,20mm
	A1449	0,40mm	0,20mm(carapace dorsal view width)

Age and distribution: Only recorded in the Middle to Upper Eocene #811 on the East Agulhas Bank.

Togoina sp A1446

Plate 32 F

Material: 1v.

Remarks: Single valve very similar to T. sp A1441 but differs in possessing a more acuminate posterior, a punctate-free AMR (0,03mm wide) and a punctate median area. The outer puncta of the median area are concentrically arranged.

Dimensions:		length	height
	A1446	0,34mm	0,17mm

Age and distribution: Only recorded from the Middle to Upper Eocene #811 on the East Agulhas Bank.

Genus Trachyleberis Brady 1898

In the southern hemisphere, Trachyleberis has previously been recorded in Argentina (Bertels 1969, 1973, 1975), Western Australia (Bate 1972, Neale 1975) and Southern Africa (Dingle 1971b, 1980, 1981). Of these, the only Tertiary species is T. huantraicoensis (Bertels 1973). Palaeocene occurrences of interest have been made by Siddiqui (1971) from West Pakistan, Apostolescu (1961) from

Sudan and Reyment (1963) from Nigeria.

The South African species so far recorded are listed in Table 2.13. Dingle (1981) in his South East African studies commented that the environmentally tolerant T. zululandensis has a preference for deep water, T. schizospinosa for quiet, shallow water and T. minima has only been recorded from quiet mid-outer shelf environments. T. zululandensis has a relatively long age range (Campanian to Maastrichtian) and is thus of limited stratigraphic use. T. minima has a much shorter range but the fact that it may have been facies controlled also probably limits its use.

Neale (1975) discussed the problems in assigning species to this genus, particularly those relating to (a) instars and adults and (b) spination.

Trachyleberis sp A208.

Plate 36 A-D, Fig. 2.23, 2.24

Material: 15v.

Description: External. In lateral view, quadrangular with well rounded spinose AM and tapering triangular spinose PM. Wide PM and AM areas. Prominent ET flanked by 1-2 spines. DM straight, VM weakly curved. Greatest height over ACA. Weak SCT with one spine. RV more elongate and inflated than LV with shallow sulcus running from about midlength on dorsal margin to antero-ventral area. Ornamentation consists of small, rounded fossae with conjunctive spines bearing terminal pores. Spines trend in longitudinal rows: one dorsal row extends to below ET; one median row passes through the SCT; ventral margin rows.

Internal. Narrow MA (0.05mm wide). MS consisting of a hooked anterior and four posterior adductors: the first is

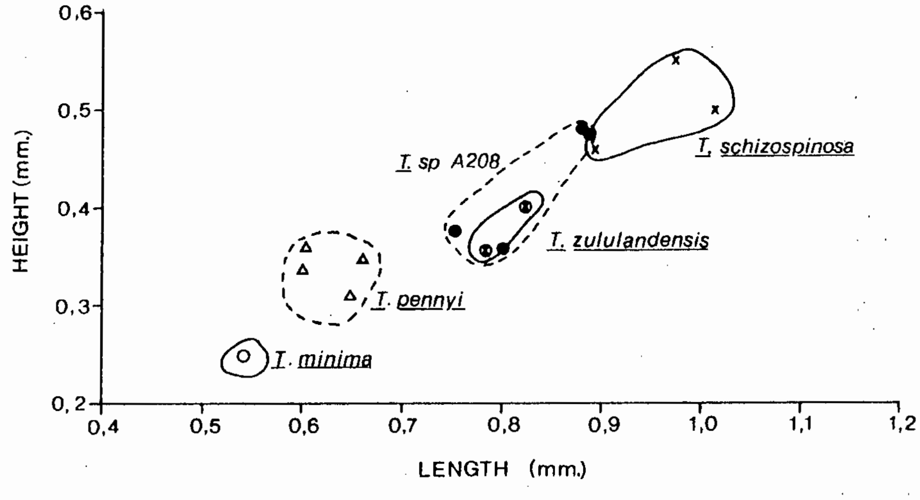
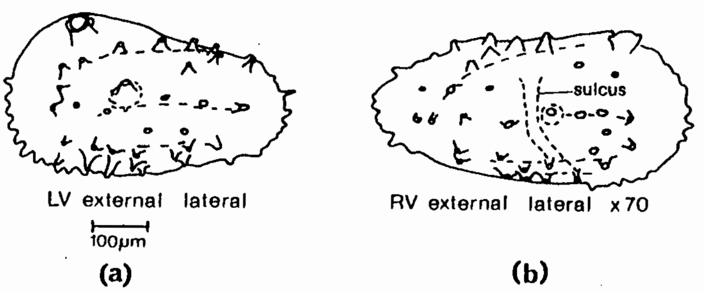


Fig. 2.23 Comparison of size of T. sp A208 with that of other externally similar Trachyleberis.



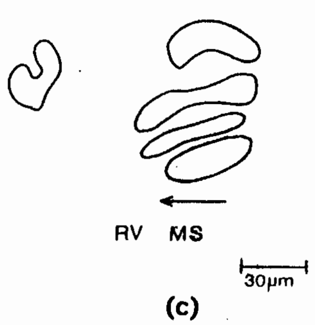


Fig. 2.24 External features of (a) LV and (b) RV, and detail of MS (c) of Trachyleberis sp A208.

crescentic; the second oval but medianly constricted. Hinge holamphidont with prominent TE's in RV, smooth ME's. RV postero-dorsal margin straighter than in LV. Ventral outline slightly sinuous.

Remarks: The spinal arrangement of *T.* sp A208 is similar to *T. schizospinosa* Dingle (1971b) but the former differs in possessing more than the three longitudinal trends of the latter. *T.* sp A208 has similar length/height relationships (Figure 2.23) and MS pattern to *T. zululandensis* Dingle (1981). The former differs by its prominent ET, distinctive RV anterior tooth, lateral surface reticulation, and inflated RV. *T. pennyi* Neale (1975) is similar to *T.* sp A208 in its lateral outline, spine trends and spined SCT. However *T.* sp A208 has a very subdued SCT and is larger. Neale (1975) noted the tendancy for early instars of *T. pennyi* to be reticulated and although a few internal views of *T.* sp.A208 looked immature, in addition to which there is a wide range in sizes, the reticulated *T.* sp A208 is considered adult.

Dimensions:		length	height
	P206	0,52mm	0,30mm
	P208	0,88mm	0,48mm
	P701	0,75mm	0,38mm
	P704	0,80mm	0,36mm

Age and distribution: Only recorded in the Upper Eocene #810 on the East Agulhas Bank.

Trachyleberis sp B250

Plate 37 A-D, 38 A-D

Material: 189v.

Description: External. Subrectangular with broadly rounded AM, DM and VM converging towards asymmetrically blunted PM. Prominent hemispherical ET.

Ventral marginal area characterized by 2-3 "saw tooth" rows of spines which cover about 2/3 valve length from antero- to postero-ventral areas. Most spines are turreted. A row of spines extends from the antero-ventral margin to a prominent postero-median node. Left valves are typically more subrectangular and often bear two large "antler-like" spines postero-ventrally.

Internal. Holamphidont hinge. In RV, strong blunt ATE and posteriorly directed PTE, ME is a smooth furrow with a shallow anterior socket. The anterior, posterior and ventral valve edges are marked by a distinct groove. Available views of MS are indistinct although a "U" shaped anterior adductor is recognized. Narrow MA (0,05mm wide) often damaged. Postero-dorsal outline straight to concave.

Remarks: This species shows a wide range in shape and spination (Plate 37 A-D, 38 A-D, various specimens were destroyed but photos are included here to show species diversity). The LV hinge of T. sp B250 is very similar to T. sp B204 in that the PTE socket is open ventrally and there is a protuberance above ATE socket which has a characteristic straight ventral edge. However, T. sp B204 differs in lacking the distinct groove/lip development where two valves of T. sp B250 interlock, in addition to which the ventral valve edge is only weakly undulated. Some valves of T. sp B250 are inflated but it is uncertain if this is sexual dimorphism. The spination could indicate an environmental adaptation against turbulence or predators.

Dimensions:

	length	height
B250	0,70mm	0,38mm
B222	0,65mm	0,40mm
B248	0,72mm	0,41mm
B217	0,66mm	0,40mm
B218	0,70mm	0,38mm
B237	0,69mm	0,36mm

Age and distribution: Recorded from the East Agulhas Bank in the Upper Eocene #1105, #1094, #1281, the Middle to Upper Eocene #811 and the Upper Palaeocene to Upper Eocene #1277.

Trachyleberis sp B204

Plate 38 E-G, 39 A-E

Material: 13v.

Description: External. Subrectangular with rounded AM and slightly upturned acuminate PM. Well developed PM rim (0,1mm wide). DM and VM straight, postero-dorsal margin straight or weakly concave. Prominent ET directed anteriorly. SCT not visible. Sexual dimorphism not recognized.

Characteristic ornamentation is: a ventral marginal frill of closely-knit spines (0,05-0,1mm long); turreted spines often trending linearly; castellate DM; prominent turreted postero-ventral node at 2/3 valve length. Reticulation often masked by spines but consists of rounded fossae with conjunctive spines.

Internal. Well developed amphidont hinge. In LV, PTE socket is ventrally open, ME is smooth, with a protuberance above ATE socket that has a fold with a truncated proximal edge. MS not clearly seen, though there is a line of four vertical posterior adductors - the upper being "n" shaped. The anterior scar is inflated and "u" shaped. MA wide (0,05-0,08mm wide). VM medianly sinuous.

Remarks: Although this species shows almost a linear spine disposition it is not allocated to Actinocythereis Puri (1953b) because there is no surface ridge development. It is similar to T. sp B250 and T. sp 047, but is distinguished by the ventral "frill" development. T. sp B204 has quite a wide size range (0,93mm-1,08mm long) and on average is larger than T. sp B250. T. sp B204 differs from T. schizospinosa in its greater size and lack of SCT development.

Dimensions:

		length	height
	B204	0,93mm	0,54mm
	B029	1,08mm	0,60mm
	B200	1.02mm	0,54mm
	B207	0,73mm	0,42mm
	B036	0,96mm	0,50mm
	B007	1,06mm	0,60mm

Age and distribution: Occurs in two stations on the East Agulhas Bank: the Upper Palaeocene to Upper Eocene #1277 and the Upper Eocene #1105 where it forms between 5-6% of the ostracod population at each station.

Trachyleberis sp 047

Plate 40 A

Material: 1v.

Remarks: T. sp 047 is characterized by a broad subrectangular LV, well developed AMR (0,05mm wide). The central area of the valve is inflated with long, stout spines along the ventral margin. The postero-ventral spine is particularly long and bilobed. The antero-median area is inflated. The whole of the central valve surface has long, widely separated spines which are bilobed, turreted and feather-like. A reticulation is discernible in AMR area (specimen is coated with sediment). The spination and lack of any distinctive ventral marginal features (ie "saw-tooth" or "frill") distinguishes this species from T. sp B250 and

T. sp B204. No internal view was seen.

T. sp 047 is most similar in size to T. sp B204 and is considerably larger than T. sp B250. T. schizospinosa Dingle (1971b) has a blunter PM and smaller SCT although the anterior view (Dingle, 1971b; p407, fig. 9k) reveals a very similar inflation.

Dimensions: length 0,84mm height 0,51mm

Age and distribution: Only found in the Upper Eocene #1094 on the East Agulhas Bank.

Trachyleberis sp A595

Plate 40 B

Material: 1v.

Remarks: Single subrectangular LV, with well rounded AM broadening over ACA. Asymmetrically rounded PM. Spines are stout and turreted. No internal views available.

T. sp A595 has similarly shaped spines to ?T. sp 606 but the former differs in being broader anteriorly. T. sp A595 is similar to Atlanticythere sp B058 (this study) but lacks the distinctive protuberances over both ACA and PCA and has a less distinct SCT.

Dimensions: length 0,62mm height 0,39mm

Age and distribution: Only recorded in the Middle to Upper Eocene #2772 on the west coast margin.

?Trachyleberis sp A606

Plate 40 C

Material: 2v.

Remarks: Subrectangular valve outline with well rounded AM. VM straight but DM is concave, rising towards ACA. Anterior to the ACA there is a sharp step in the AM. AMR is wide

(0,09mm wide) and is upturned to form a deep depression in the AM area. Thick spines generally are turreted. No internal views available.

?T. sp A606 is similar to Indet sp 7 Dingle (1981), but lacks the latters prominent anterior and posterior marginal rims and has the characteristic ACA step.

Dimensions:	length	height
	0,65mm	0,35mm

Age and distribution: Only recorded in the Middle Eocene to Middle Oligocene #1706 on the west coast margin.

Genus *Veenia* Butler and Jones 1957

Van Morkhoven (1963) describes the genus "as laterally compressed in anterior and posterior, medianly inflated, usually with three longitudinal ribs or smooth, pitted or with a hinge ear". It is distinguished from *Protocythere* Triebel (1938) by its amphidont hinge (cf merodont/entomodont of the latter).

This genus forms a significant 15% of middle Maastrichtian Argentinian fauna (Bertels 1974 and 1975) and is common in West African faunas (Reyment 1963). Two species are recorded in South Africa *V. obesa* Dingle (1969a) from the Upper Senonian Umzamba Beds, Pondoland and (1985) the Santonian Transkei, and *V.* sp 27337 from the Upper Eocene Agulhas Bank.

Subgenus *Nigeria* Reyment 1961

Reyment (1961) grouped the noncostate (ie pitted and smooth) forms into this subgenus. The type species *Veenia (Nigeria) nigeriensis* (*V(N)*) from the Campanian to Maastrichtian of West Africa possesses a characteristic amphidont hinge. In RV this consists of a triangular, smooth to notched anterior tooth, a deep socket, a crenulate median furrow and a quadrangular PTE.

Veenia (Nigeria) sp A27337

Plate 41 A-D

Material: 1v.

Remarks: Single RV anteriorly and posteriorly compressed with an inflated median area. This species is placed in the subgenus Nigeria on the grounds of its general shape and pitted appearance. It is very similar to V(N) nigeriensis Reyment (1961) particularly in the RV hinge development, but is less elongate and is concentrically pitted in AMA with a weak median ridge development. V(N) sp A27337 also shows similarities with Togoina n. sp. Bertels (1975; p344, pl.2, fig. 9) but its hinge is considered more typical of Nigeria.

Dimensions:	length	height
A27337	0,33mm	0,22mm

Age and distribution: Only recorded in the Upper Eocene #1094 on the East Agulhas Bank shelf.

Subfamily Unicapellinae Dingle 1981

The recorded age ranges of the seven genera of this subfamily are shown in Table 2.14.

Atlanticythere Benson (1977) and Paleoabyssocythere Benson (1977) are considered deep water taxa (1000m Benson 1977). Dingle (1981) however considered Dutoitella and Unicapella as having an upper continental slope or moderate to deep continental shelf environment and proposed that the subfamily originated in the Santonian of the South Atlantic/South West Indian ocean and migrated northwards during Upper Campanian to Lower Maastrichtian.

Genus Atlanticythere Benson 1977

Atlanticythere Benson (1977) is closely related to Dutoitella Dingle (1981) and Kefiella Donze et al (1982). It is characterised by its "almost equally rounded AM and PM" (Benson 1977) and the numerous distinct pore-conuli with or without an open foveolate reticulation. It differs from Dutoitella in the ventral crest not being continuous with AM, and from Kefiella in lacking a median lateral crest. It may however possess a few median-posterior nodes which are not characteristically arranged as in Dutoitella (Figure 2.25).

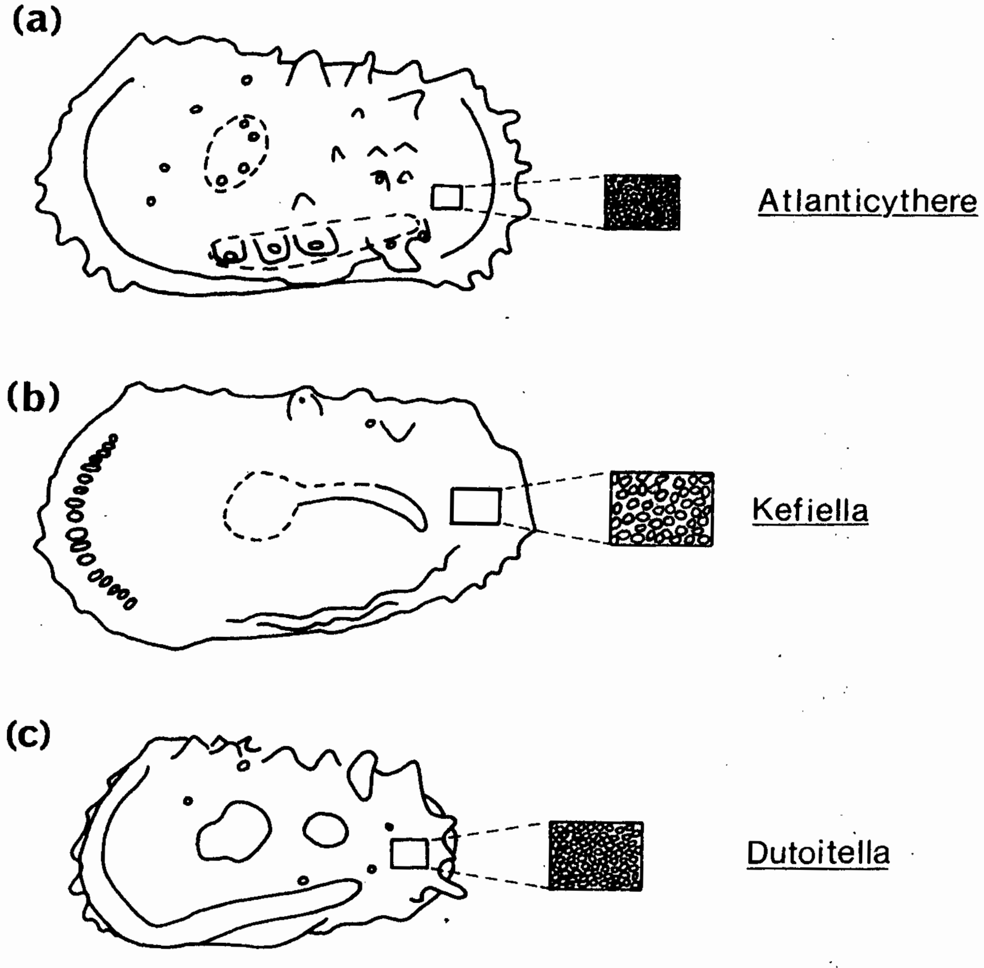


Fig. 2.25 External features of the type species of the Unicapellinae genera - Atlanticythere Benson (1977), Kefiella Donze and Said (1982, in Donze et al 1982) and Dutoitella Dingle (1981).

Atlanticythere sp B058

Plate 42 A-D, 43 A-G

Material: 14v.

Description: External. LV subrectangular in lateral view with AM and PM almost equally rounded. PM is more acuminate and the RV is apparently more inflated than the LV in the central area. DM and VM straight. Pronounced AMR and PMR (0,5 - 0,6 mm wide). There is a well-developed, oval SCT bearing 4-5 spines. Antero-ventral inflation bears 2-3 rows of spines along its ventral side. In both valves, AMA and PMA are flat and relatively free from nodes.

Ornamentation consists of broad spines and nodes randomly distributed, except where they are sublinear on the inflated ventral surface and are concentric around the antero- and postero-ventral marginal rims. There are two types of spines: simple with single terminal pores; and "flipper-like". PCA marked by a broad posteriorly directed node, ACA by a triangular protuberance which is more nodose in some specimens. Rounded foveolate reticulation is prominent in depressions adjacent to marginal rims.

Internal. Strong holamphidont hinge. In LV consisting of ventrally-open, deep terminal sockets, a smooth ME with a prominent anterior tooth. A triangular protuberance or hinge ear extends antero-dorsally to ATE. RV has a broad anterior tooth, with PTE more peaked and stepped. No MS were observed.

Remarks: Intra-specific varieties within A. sp B058 are recognised which do not show the distinctive equivalent rounding of AM and PM. Until further data is available the varieties which tend to be smaller (0,52mm-0,64mm long) are considered to be juveniles of the larger adults (0,65mm-0,90mm long) which show the equal rounding of the AM and PM. Although a few specimens were destroyed, their photos are included (Plate 42, 43) to show this species variation.

A. sp B058 is similar to A. maestrichtia Benson (1977) although it is more spinous and lacks the well developed ventro-lateral ridge. A. prethalassia Benson (1977) bears a few of the "flipper-like" nodes that typify A. sp B058.

Dimensions:

	length	height	
B058	0,79mm	0,42mm	
B062	0,63mm	0,35mm	
B985	0,90mm	0,49mm	(destroyed)
A975	0,93mm	0,48mm	

Age and distribution: Recorded from the East Agulhas Bank Middle to Upper Eocene #1125 and the Middle Eocene to Middle Oligocene #819. It also occurs in the Middle to Upper Eocene #2772 on the west coast margin.

Family Xestoleberididae Sars 1928
Genus Xestoleberis Sars 1866

The genus is characterized by the presence of the "Xestoleberis spot". It has previously been recorded in southern African waters in the Cretaceous and Tertiary by Dingle (1976, 1981) and Recent by Brady (1880) and Boomer (1985 unpubl.). The temporal ranges of South African Xestoleberis are summarised in Table 2.15. Figures 2.26 and 2.27 compare internal and external outlines of various Tertiary South African xestoleberididae.

Two species from the Brazilian Early Tertiary (Neufville 1979), four species from the Miocene of Australia (Whatley and Downing 1983), one species from the Danian of Tunisia (Esker 1968, Donze et al 1982) and one species from the Nigerian Palaeocene (Reyment 1963), are comparable with

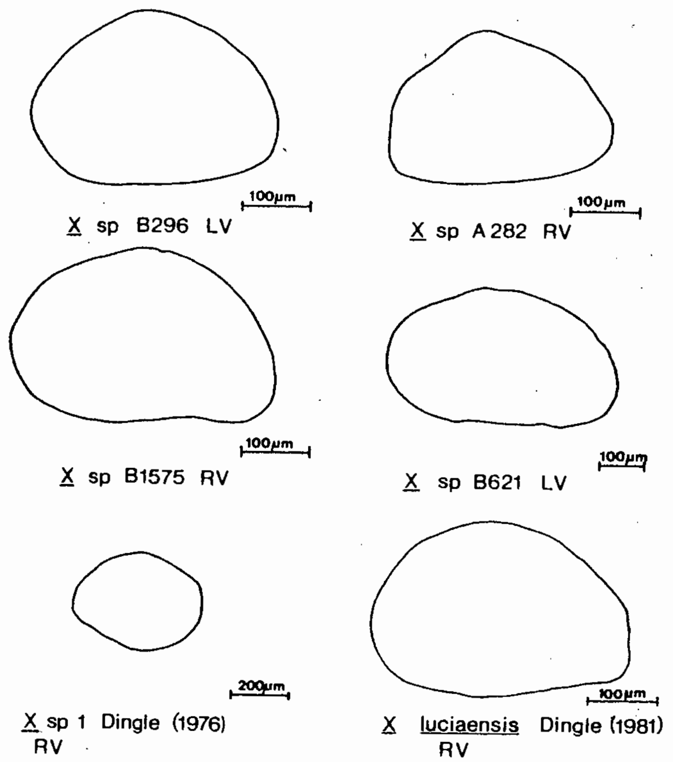


Fig. 2.26 Variation in external outlines of South African Tertiary species of Xestoleberis plus X. luciaensis Dingle (1981).

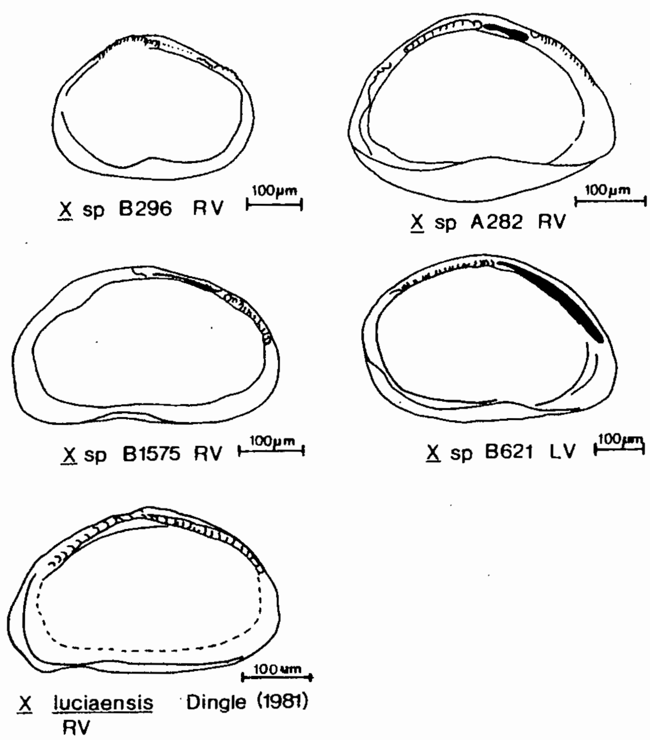
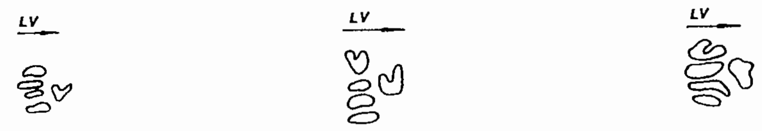


Fig. 2.27 Variation in internal features of South African Tertiary species of Xestoleberis plus X. luciaensis Dingle (1981).



X. sp 296 X. sp 282 X. luciaensis Dingle (1981)

Fig. 2.28 Comparison of MS pattern for :-
(a) Xestoleberis sp 296 (b) Xestoleberis sp 282 and
(c) Xestoleberis luciaensis Dingle (1981).

South African faunas.

Dingle (1981) noted X. luciaensis as "environmentally tolerant" with a preference for deeper water environments >300m.

Xestoleberis sp B296

Plate 44 A-D, Fig. 2.26, 2.27, 2.28

Material: 12v.

Description: External. Sub-ovoid with arched DM which slopes to broad blunt AM and asymmetrically rounded PM. VM straight. Surface smooth.

Internal. VM sinuous with antero-lateral overhang. 35-40 normal pores. Hinge strongly antimerodont where ATE is elongate and arched over the highest point of the valve. The "Xestoleberis spot" is small. MS consists of a row of four vertical posterior adductors and a single anterior which is apparently "U" shaped. MS area located median to "Xestoleberis spot".

Remarks: X. sp B 296 is similar to X. sp A282, but is blunter anteriorly and posteriorly, with a broader arched DM and less angular antero-ventral overhang. The MS of X. sp 296 is similar to X. sp 282 in the "U"-shaped anterior adductor, but differs in the upper posterior adductor of the latter also being "U"-shaped. The external lateral view of X. sp 296 is very similar to X. luciaensis Dingle (1981) (Figure 2.26). The RV internal view of the latter differs in the more prominent antero-ventral beak on AM, the characteristic DM projection above ME, with a "U"-shaped upper posterior adductor and "Y"-shaped anterior adductor (Figure 2.27, 2.28). X. sp 1 Dingle (1976) from the Lower Eocene to Lower Oligocene is more oval in shape. The broad blunt AM distinguishes this species from those recorded in Brazil by Neufville (1979) and West Australia by Whatley and Downing (1983) although the Danian X. tunisiensis (Esker 1968) is comparable.

Dimensions:

	length	height
P296	0,42mm	0,32mm
P1590	0,39mm	0,28mm
P628	0,39mm	0,25mm

Age and distribution: Recorded from the Upper Eocene #1094, the Upper Eocene #827, the Upper Palaeocene to Lower Oligocene #1276 and the Lower Palaeocene to Upper Eocene #1275 on the East Agulhas Bank.

Xestoleberis sp A282

Plate 44 E-G, Fig. 2.26, 2.27, 2.28

Material: 7v.

Description: External. Lateral view pyriform with strongly arched DM which slopes down to broad well rounded PM and asymmetrically rounded AM, VM straight. Maximum height at midlength. Antero-ventral edge overturned. Surface smooth.

Internal. RV shows sinuous VM with a beak-like outlined AM. AMA (0,05mm) wider than PMA

(0,03mm). Hinge strongly antimerodont with ME arched over maximum valve height. MS area occurs ventral to "Xestoleberis spot" and consists of a vertical row of four posterior adductors, the upper is "U" shaped, and an anterior "U" shaped adductor. About forty normal pores.

Remarks: X. sp A282 is very similar to X. luciaensis Dingle (1981) but lacks the characteristic DM projection and has a distinctly "U" shaped anterior adductor (Figure 2.26, 2.27). Dingle (1981) noted the similarity of X. luciaensis to X. chamela van den Bold (1960) recorded from the Eocene of Brazil by Neufville (1979). X. chamela possesses a sinuous VM as in X. sp A282, but also lacks the DM projection of X. lucaiensis. Neufville (1979) also identified X. aff moriahensis van den Bold (1960) which has a straighter VM than X. chamela and apart from a median ventro-lateral overhang is very similar to X. sp A282. X. sp Whatley and Downing (1983) is very similar in lateral shape to X. sp A282 but is externally more punctate.

Dimensions:

	length	height
P282	0,39mm	0,28mm
P321	0,38mm	0,22mm
P1585	0,38mm	0,26mm
P1553	0,38mm	0,22mm
P618	0,34mm	0,22mm

Age and distribution: Recorded from #1094 (Upper Eocene), #810 (Upper Eocene), #819 (Middle Eocene to Middle Oligocene) on the East Agulhas Bank.

Xestoleberis sp B1575

Plate 45 A-B, Fig. 2.26, 2.27

Material: 3v.

Remarks: RV with weakly arched DM which slopes down to broadly rounded PM and asymmetrically rounded AM which overhangs antero-ventrally. VM sligthly sinuous anterior to middle of valve. Surface smooth. Internal features poorly preserved with AMA (0,05mm) wider than PMA (0,02mm). The AM overhang is more marked in X. sp B1575 than in X. luciaensis Dingle (1981), (Figure 2.26). The overhang is also characteristic of the smaller Palaeocene X. kekere Reyment (1963) from Nigeria.

Dimensions:	length	height
P1575	0,40mm	0,25mm

Age and distribution: Found #810 (Upper Eocene) and #819 (Middle Eocene to Middle Oligocene) on the East Agulhas Bank slope.

Xestoleberis sp B621

Plate 45 C-D, Fig. 2.26, 2.27

Material: 1v.

Remarks: Single pyriform LV with maximum height at midlength. DM arched and slopes down to the broadly rounded PM and more asymmetrically rounded AM. VM weakly sinuous anterior to mid-length. Surface is smooth. Internally AMA is wide (0,05mm), PMA narrow (0,02mm wide). Hinge strongly antimerodont with very long ATE. MS not visible.

Dimensions:	length	height
P621	0,50mm	0,30mm

Age and distribution: Only found #2772 (Middle to Upper Eocene) on the west coast margin.

Indet. Genus 1

The Indeterminate 1 group is made up of three closely related species. It seems likely that I.1. sp 197 is an instar of I.1. sp 760. All possess external characteristics of the genus Ambostracon. Van Morkhoven

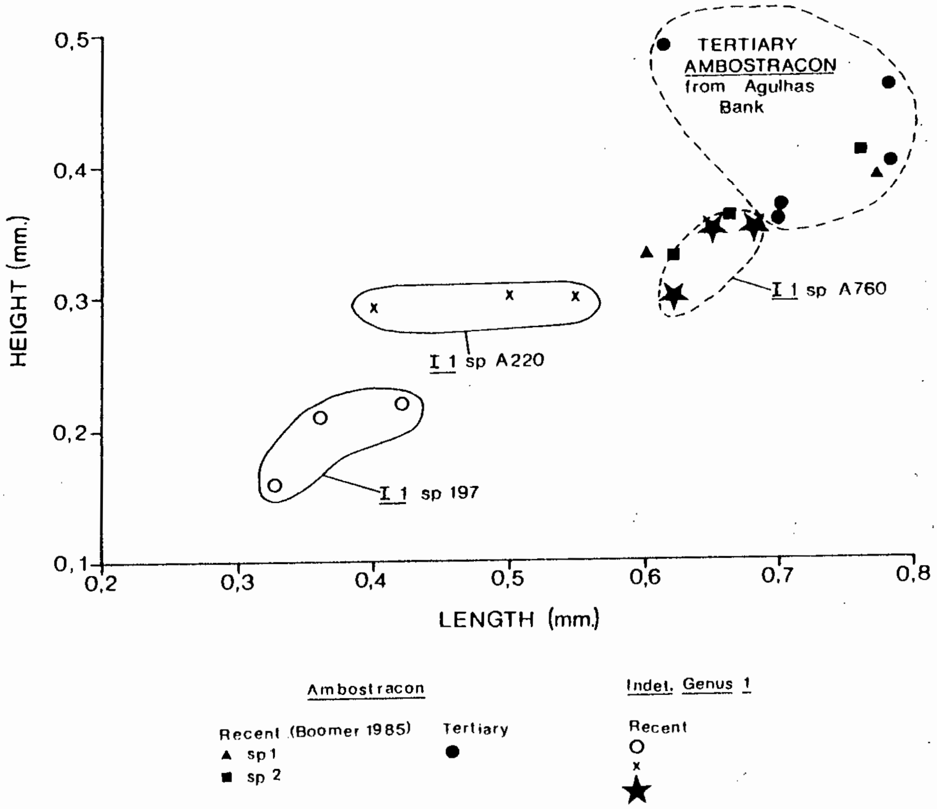


Fig. 2.29 Comparison of sizes of <u>Indet.</u> <u>Genus</u> <u>1</u> group with Tertiary <u>Ambostracon</u> from the Agulhas Bank (this study).

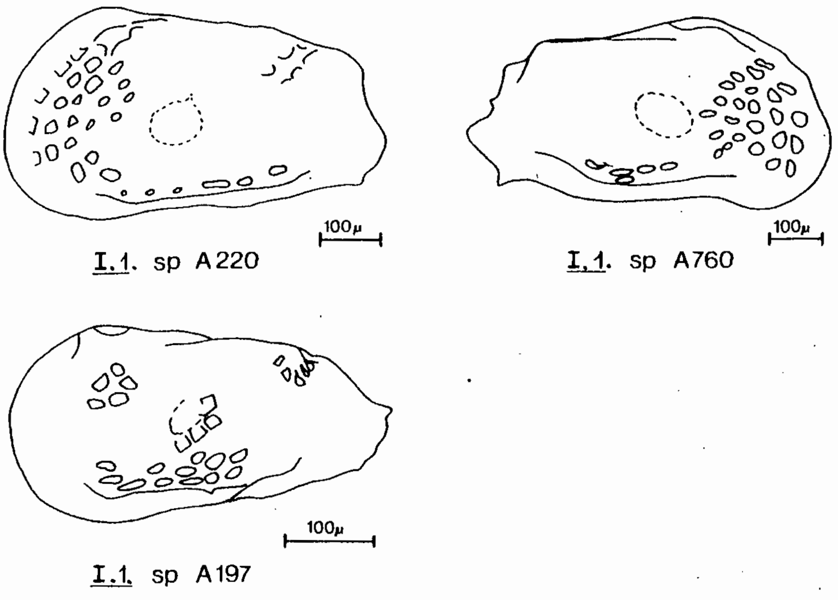


Fig. 2.30 Comparison of external features of the three <u>Indet.</u> <u>Genus</u> <u>1</u> species identified in the present study.

(1963) noted that specimens with a merodont hinge, typical of the I.1. group can be juveniles of amphidont-hinged adults. Boomer (1985 unpubl.) did relate the merodont hinged juveniles to specific Ambostracon adults but this is not so clear cut with the Tertiary forms. Figure 2.29 relates the sizes of the I.1. group species to those of the Ambostracon genus for the study area. The basic external features of the I.1. species are summarised in Figure 2.30.

I.1. sp A220

Plate 46 A-D, Fig. 2.29, 2.30

Material: 4v.

Remarks: Subquadrangular valve with straight DM and VM, well rounded AM, and PM is concave in dorsal part, convex in ventral part. Well developed ET. Valve inflated postero-dorsally and longitudinally along ventral margin. Reticulation consists of subrounded fossae which are (i) aligned along the inflations and (ii) radial anterior to the weak SCT. It is similar to I.1. sp A760 but the postero-dorsal and longitudinal valve inflations are less pronounced.

Dimensions:

	length	height
P220	0,50mm	0,03mm
P222	0,55mm	0,30mm
P308	0,44mm	0,29mm

Age and Distribution: Recorded from #1275 (Lower Palaeocene to Upper Eocene), #1276 (Upper Palaeocene to Middle Eocene) and #827 (Upper Eocene to Lower Oligocene) on the East Agulhas Bank.

__I.1__ sp A760

Plate 46 E-H, Fig. 2.29, 2.30

__Material:__ 4v.

__Remarks:__ Very similar to __I.1.__ sp A220 but overall the valve is more inflated with a more pronounced postero-dorsal area and more prominent postero-ventral nodes. In addition, the VM is more anteriorly flared. There is a weak sulcus posterior and postero-ventral to the SCT. Hinge is characteristically merodont with cusped TE's.

__Dimensions:__

	length	height
P760	0,65mm	0,35mm
P764	0,65mm	0,35mm
P261	0,62mm	0,30mm
P768	0,70mm	0,35mm

__Age and Distribution:__ Recorded from #1275 (Lower Palaeocene to Upper Eocene) on the East Agulhas Bank.

__I.1.__ sp A197

Plate 47 A-E, Fig. 2.29, 2.30

__Material:__ 9v.

__Remarks:__ Very similar to both __I.1.__ sp A760 and __I.1.__ sp A220 but differs in possessing a distinct vertical median sulcus which is deflected posterior to SCT, plus the development of mural conjugate pores. I suggest that this species could in fact be an instar of __I.1.__ sp A760. Both show typical merodont hinges.

__Dimensions:__

	length	height
P197	0,42mm	0,22mm
P200	0,41mm	0,22mm
P600	0,40mm	0,21mm
p301	0,36mm	0,21mm
P303	0,35mm	0,20mm
P597	0,40mm	0,21mm
P1433	0,33mm	0,17mm

__Age and Distribution:__ Recorded from #810 (Upper Eocene) and #827 (Upper Eocene to Lower Oligocene) on the East Agulhas

Bank slope.

Indet. Genus 2

I.2. sp B311

Plate 47 F-H, Fig. 2.14

Material: 2v.

Remarks: Two left valves with very similar features to the ?Poseidonamicus sp A126, but differs in possession of a median ridge which swings dorsally posterior to SCT (Figure 2.14). The specimens are poorly preserved and the intercostal reticulation is only just visible in posterior areas as vertically aligned muri. The hinge is weakly developed but an apparently broad crenulate anterior tooth is observed in RV. In RV dorsal view, both terminal elements appear to be crenulate teeth and thus the hinge is merodont. Externally I.2. sp B311 also shows similarities in shape and ridge alignment with the I.12. sp A477 although it is considerably smaller and is obviously reticulate in the posterior region.

Dimensions:

	length	height
P1522	0,59mm	0,30mm
P1523	0,61mm	0,32mm

Age and Distribution: Only found in #1094 (Upper Eocene) on the East Agulhas Bank.

Indet. Genus 3

I.3. sp A176

Plate 48 A

Material: 3v.

Remarks: RV reminiscent of Cornucoquimba Ohmert (1968) in shape and nodular appearance. It differs from the type C. aligera Ohmert (1968) in lacking a prominent ACA, ET, AMR and possessing a more triangular posterior outline. C. sp 1

Valicenti (1977) from the Tertiary of Patagonia appears closely related. I.3. sp A176 lacks the strongly developed postero-ventral flare characteristic of I.3. sp A313.

Dimensions:		length	height
	P176	0,50mm	0,22mm

Age and distribution: Only recorded from the Upper Eocene #1094 on the East Agulhas Bank shelf.

I.3. sp A313

Plate 48 B

Material: 1v.

Remarks: Single RV reminiscent of *Cornucoquimba* sp 1 Valicenti (1977) but is smaller and less nodose. It possesses a strongly flared postero-ventral margin.

Dimensions:		length	height
	P313	0,36mm	0,18

Age and distribution: Recorded from the Upper Eocene #810 on the East Agulhas Bank slope.

Indet. Genus 4

I.4. sp A1436

Plate 48 C

Material: 1v.

Remarks: Single subquadrate valve with well rounded AM and triangular PM. Prominent ET situated on sharp ocular ridge. Spinose AM and PM. Strong reticulation of rounded fossae, a median longitudinal ridge which is turned down anterior to SCT. Deep sulcus posterior to SCT. No internal views available.

Dimensions:		length	height
	P1436	0,80mm	0,37mm

Age and distribution: Recorded from #1276 (Upper Palaeocene to Lower Eocene) on the East Agulhas Bank shelf.

Indet. Genus 5

Distinctive genus with drawn out and downturned postero-ventral outline in both LV and RV.

I.5. sp A333

Plate 48 D

Material: 1v.

Remarks: DM and VM parallel and straight in RV, VM sinuous in LV. Well rounded AM, dorsal part of PM outline straight, with postero-ventral part acuminate, drawn out and deflected below the line of VM. Ventro-lateral area inflated medianly over about half of valve length. 2-3 weak longitudinal ribs located on the ventral surface of the inflated area. Ornamentation consists of slit-like fossae concentrically arranged around the median part of the inflated area. Otherwise valve surface is smooth. Internal views not observed.

Dimensions:		length	height
	P27333	0,80mm	0,41mm

Age and distribution: Only found #1281 (Upper Eocene) in the East Agulhas Bank shelf.

I.5. sp A850

Plate 48 E-F

Material: 2v.

Remarks: LV very similar to I.5. sp A333, but differs in possessing a prominent longitudinal ridge parallel to the axis of the medianly inflated area. 2-3 weaker ridges branch antero-ventrally from this longitudinal ridge. There is a small, dome-like elevation on the dorso-median surface, just in front of midlength.

Dimensions:		length	height
	P850	0,60mm	0,32mm

Age and distribution: Recorded from #1094 (Upper Eocene) on the East Agulhas Bank shelf.

Indet. Genus 6

I.6. sp 1583

Plate 48 G-H

Material: 1v.

Remarks: Single RV with strongly arched DM, rounded AM, sinuous VM and bluntly acuminate, ventrally directed PM.

Dimensions:		length	height
	P1583	0,36mm	0,24mm

Age and distribution: Recorded from the Upper Eocene #1094 on the East Agulhas Bank.

Indet. Genus 7

I.7. sp 1450

Plate 49 A

Material: 2v.

Remarks: Shows similarities to *Trachyleberis* sp 047 in valve outline, arrangement of spines and prominent turret-like ET. It differs in its more reticulate ornamentation, as well as the straight DM in the vicinity of PCA. The ventral margin bears 2-3 "saw-tooth" rows of spines as in *Trachyleberis* sp B250 but I have avoided placing it in this genus until internal views are available. It is also reminiscent of *Oertliella maastrichtia* Dingle (1981), from the Campanian IV to Maastrichtian II of Zululand (p 102, fig. 49), but differs in lacking the pennate spine on the dorsal ridge.

Dimensions:		length	height
	P1450	0,50mm	0,29mm

Age and distribution: Recorded from #1277 (Upper Palaeocene to Upper Eocene) and #1281 (Upper Eocene) on the East Agulhas Bank shelf.

Indet. Genus 8

I.8. sp 284

Plate 49 B

Material: 1v.

Remarks: Single valve with broadly arched DM. Surface marked by 4-5 longitudinal ridges on VM. No internal views observed.

Dimensions:		length	height
	P284	0,42mm	0,20mm

Age and distribution: Only recorded #827 (Middle Eocene to Lower Oligocene) on the East Agulhas Bank slope.

Indet. Genus 9

I.9. sp 290

Plate 49 C-E

Material: 8v.

Remarks: A number of specimens that may even belong to different species, but I have grouped them together because of their similar shapes and hinge structures. AM broadly rounded, PM pointed and spinose. Ornamentation consists of rounded foveolae with 2-3 diagonal longitudinal ridges - dorsal, median and ventral. Hinge appears holamphidont with LV possessing a prominent anterior tooth, a flat-topped posterior tooth, ME consists of a groove with a deep circular anterior socket. In interior view the broad marginal areas (0,01mm wide in anterior, 0,008mm wide and thickened in posterior) seem characteristic. This species is similar to I.10. sp B298 although it lacks the latter's prominent marginal rims, vertical rib which connects the posterior ends of the longitunal ridges, and is more coarsely ornamented.

<u>Dimensions:</u>

	length	height
P290	0,50mm	0,28mm
P294	0,41mm	0,29mm
P306	0,45mm	0,21mm
P179	0,49mm	0,28mm

<u>Age and distribution:</u> Recorded from #819 (Middle Eocene to Middle Oligocene) and #1094 (Upper Eocene) on the East Agulhas Bank slope.

<u>Indet. Genus 10</u>

<u>I.10.</u> sp B298

Plate 49 F

<u>Material:</u> 1v.

<u>Remarks:</u> A small LV with three longitudinal ridges (dorsal, median and ventral) which do not extend to AM and which are connected posteriorly by a vertical rib. Well developed PM and AM (0,03mm wide). No internal views observed. Reminiscent of <u>Sulcostocythere knysnaensis</u> Benson and Maddocks (1964, pl. 3) with respect to shell shape and ornamentation. However <u>S. knysnaensis</u> is less elongate, smoother with a more dispersed ridge pattern.

<u>Dimensions:</u>

	length	height
P298	0,40mm	0.20mm

<u>Age and distribution:</u> Only found at #819 (Middle Eocene to Middle Oligocene) on the Agulhas Bank.

<u>Indet. Genus 11</u>

<u>I.11.</u> sp B319

Plate 49 G-H

<u>Material:</u> 1v.

<u>Remarks:</u> Reticulate RV in which fossae are concentrically

arranged in anterior area. Hinge possesses a crenulate median element and terminal sockets which are open ventrally.

Dimensions:		length	height
	P319	0,68mm	0,42mm

Age and distribution: Only found #2800 (Lower to Middle Eocene) on the west coast margin.

Indet. Genus 12

Three Upper Eocene species are recognised belonging to an indeterminate genus on the basis of a vertical median sulcus running from ACA to a position postero-ventral of SCT. The features of this indeterminate genus include the bluntly acuminate posterior margin outline and the prominently ponticulate median, ventral median and marginal ridges.

I.12. sp B1465

Plate 50 A, 51 A-D

Material: 3v.

Remarks: I.12. sp B1465 is similar to I.12. sp A100 although the former has a coarser ridge development and is more acuminate posteriorly.

Dimensions:		length	height
	B1465	0,62mm	0,38mm
	B271	0,63mm	0,40mm
	B257	0,61mm	0,39mm

Age and Distribution: Only recorded in the Upper Eocene #1094 on the East Agulhas Bank shelf.

I.12. sp A100

Plate 50 B, 51 E

Material: 1v.

Remarks: Similar characteristics to I.12. sp B1465 but possesses a more bluntly acuminate posterior outline, more convex VM, weaker ridge development, weaker SCT and less prominent ET. The ridge alignments are so similar to I.12. sp B1465 that perhaps this specimen is an instar of the latter species (I.12. sp A100 is approximately 0,1mm smaller than I.12. sp B1465).

Dimensions:		length	height
	A100	0,52mm	0,31mm

Age and Distribution: Single valve recovered from East Agulhas Bank shelf Upper Eocene #810.

I.12. sp A477

Plate 50 C, 51 F-H

Material: 7v.

Remarks: Poorly preserved valves tentatively grouped in I.12. on the basis of their apparent merodont hinge and lateral ridge development. However, they differ from the other Indet. Genus 12 species in being larger and possessing a less acuminate and compressed PM, a DM ridge which splits and downturns posterior to prominent ET, plus having ridges which are not noticeably ponticulate.

Dimensions:		length	height
	A477	0,8mm	0,42mm

Age and distribution: Recovered from the Upper Eocene East Agulhas shelf #1303.

3.1 RESULTS AND CONCLUSIONS

Figure 3.1:1 shows the variation in abundance of ostracods (per 100gm sediment) over the study area. The significance of trends is uncertain because the samples are unevenly distributed, but there are two zones of >50 specimens with high points of >200 specimens per 100gm of sediment on the eastern Agulhas Bank and the west coast margin.

During the following discussions two limiting factors must be constantly borne in mind: the low abundance of ostracods in certain samples (Table 1:4); and the imprecise age determinations of several samples. There is no apparent relationship between the low abundance and the ages with long error bars.

Figure 3.1:2 plots the relative percentages of the Cytheracea, Bairdiacea, Cypridacea and Cytherellidae for each of the stations. The correlation between stations with low abundance and those with low faunal variation (ie. 100% one superfamily) is considered to be a feature of the faunal spacity and does not neccessarily represent true faunal assemblages. For the purposes of discussions in some of the following sections those stations with <80 valves per 100gm sediment are not used for data statistics and comparisons.

3.2 RELATIONSHIPS BETWEEN STATIONS OF THE STUDY AREA.

The data available lends itself to statistical correlation between stations, and Figures 3.2:1A-C represent visual aids for correlation based on the common number of cytheracean species between stations (Whatley 1983). The number in brackets adjacent to each station number refers to

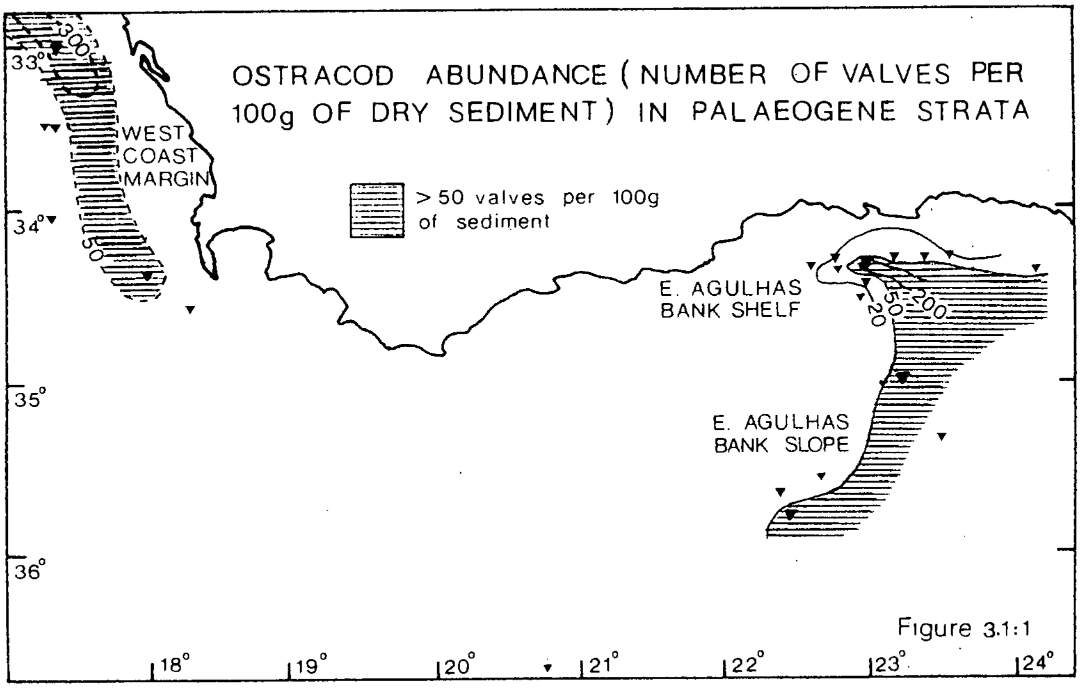


Fig. 3.1:1 Variation in abundance of ostracods (number of valves per 100gm of sediment) over the study area.

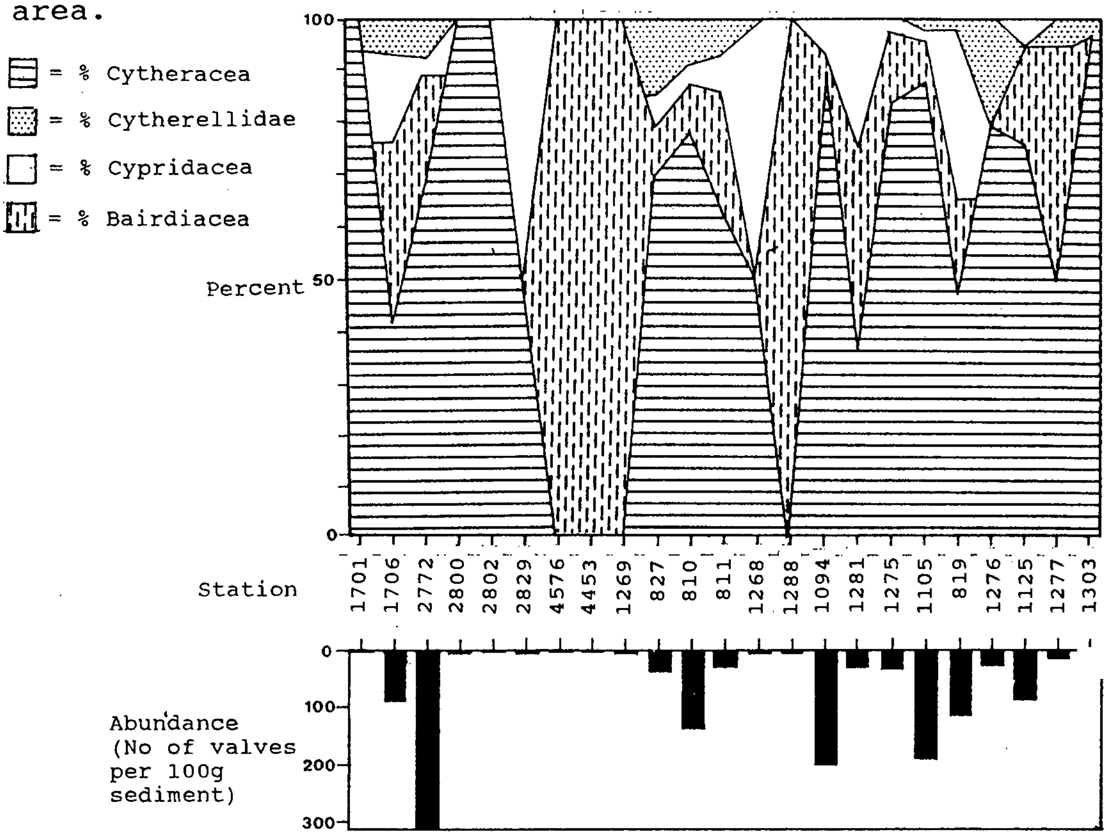


Fig. 3.1:2 West to east variation in abundance (number of valves per 100gm of sediment) and relative percentages of Cytheracea, Bairdiacea, Cypridacea and Cytherellidae for each station in the study area.

the total number of cytheracean species present at a specified locality. The sample area is divided into three zones based spatially and on water depth - west coast, East Agulhas Bank shelf (<200m depth) and East Agulhas Bank slope (>200m depth).

Data plotted was restricted to stations where >35 valves per sample were recorded. Six of these (#2772, #1125, #810, #1303, #1105, #1094) range Upper Eocene in age and two (#1706, #819) range Middle Eocene to Middle Oligocene. The diagrams represent thirty two combinations of the same data in an attempt to detect any spatial or depth related correlations between stations. The arrangement of stations in the diagrams approaches their geographical distribution, where west coast/Agulhas Bank or shelf/slope are grouped and this presentation is preferred over Whatley's (1983) actual locality plots, as the relative distance variations in this study are more diverse.

In relating three Agulhas Bank (AB) slope and three AB shelf stations (Figure 3.2:1A) the slope #810 and #819 possess the most common number of species (cns = 8). #819 correlates quite well with the deeper #1125 (cns = 5) and #1303 (cns = 5). From Figures 3.2:1B and C this relationship between #819 and #1303 is expanded by an equally high correlation between #819, #1303, #2772, and #1706. This is because the trachyleberid species Australileberis stangerensis, Australileberis sp B123 and Henryhowella asperrima? are widely geographically distributed, and extend from Upper Eocene into Oligocene. These species do not occur in #1094 and #1105, with the result that there are zero common species between these and

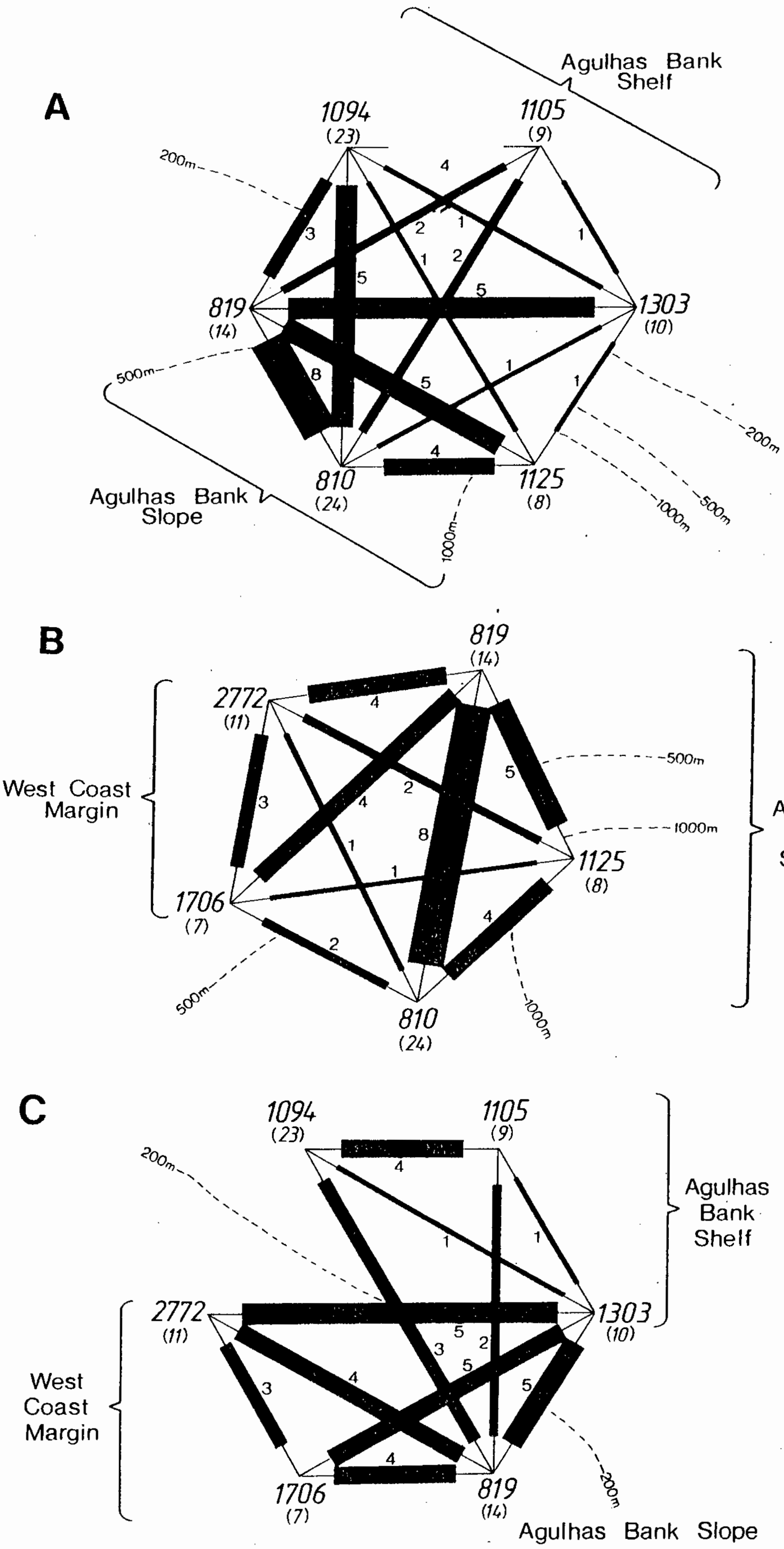


Fig.3.2:1 Polygonal log-bar diagrams to show common number of cytheracean species between:-

A - 3 Agulhas Bank shelf and 3 Agulhas Bank slope stations.
B - 3 Agulhas Bank slope and 2 west coast margin stations.
C - 3 Agulhas Bank shelf, 1 Agulhas Bank slope and 2 west coast margin stations.

the west coast margin stations. In Figure 3.2:1B, comparing species between two west coast margin stations and three Agulhas bank slope - apart from the west coast margin and #819 correlation (as above), there is a low correlation between the two groups, but a higher correlation within each group i.e. a weak geographical distinction does occur. The closely located AB shelf #1094 and #1105 possess four common species of which two _?Poseidonamicus_ sp A126 and _Krithe nibelaensis_ are typically deep water species. The distribution of _K. nibelaensis_ is further discussed later, but it is worth noting that it occurs in the Upper Eocene #810, #819, #827, #1094, #1105 and #1125, where it is the major element in the correlation between #1125-#1094, (cns = 1), #1125-#1105 and #810-#1105 (cns = 2).

The application of the polygonal log-bar diagrams is limited for the study area because environmental variables such as water temperature and salinity are unknown. They do however provide a quick assessment of faunal/station relationships which are further investigated in sections 3.3 and 3.5.

3.3 RELATIONSHIPS BETWEEN SOUTH AFRICAN PALAEOGENE OSTRACOD FAUNAS.

A total of sixty seven cytheracean genera are recorded in the Palaeogene of South Africa - twenty three from JC-1 borehole and forty four from the west coast margin and Agulhas Bank of South Africa, of which eleven are common (Table 3.3:1). Using these data we can recognize three faunal associations that characterize each locality:

(i) JC-1 - the genera _Hermanites_, _?Alcopocythere_,

?Acanthocythere, Buntonia, ?Cyamocytheridea, Brachycythere, Howecythereis, Loxonconcha, Mehesella, Hemicytherura, Paijenborchella and ?Phalcocythere.

(ii) Agulhas Bank - the families Bythocytheridae, Loxoconchidae, and genera Urocythereis, Muellerina, Bradleya, Poseidonamicus, Agrenocythere, Phacorhabdotus, Soudanella, Togoina and Veenia.

(iii) west coast - only individual species are confined to the west coast - these tend to make up 2% or considerably less of a particular station's population.

Species which form high percentages of a station population are generally widespread. Characteristic species are:- Ambostracon sp A93, Australileberis sp A472, Echinocythereis sp B076, Trachyleberis sp A575, ?Trachyleberis sp A606 and Xestoleberis sp B621.

The cytheracean families Cytherideidae and Cytheruridae occur dominantly on the Agulhas Bank and JC-1 borehole. Of the former family, nine Palaeogene species are recorded, only one (Krithe nibelaensis) is found on the west coast, where it is the only ostracod in the sample 2829. The Cytheruridae are represented by eighteen species with only ?Cytheropteron sp A498 occurring on the west coast (#2772, 0,03% of the station population).

No single species is common to all areas, although the three genera Australileberis, Haughtonileberis and

Henryhowella are. Trachyleberis is dominantly a west coast and Agulhas Bank genus, although one species has been recognized from JC-1.

Table 3.3:2 summarises the four faunal assemblages of the JC-1 borehole (Dingle 1976). Dingle noted that the Palaeocene/Eocene boundary is marked by the appearance of Xestoleberis, Henryhowella and Australileberis hieroglyphica at 3990-3950'(contrasting with Du Toit and Leith's (1974) 4000' from planktonic studies). In this study Australileberis hieroglyphica is present in only three of the Upper Eocene to Oligocene stations (#810, #1125 and #819). Haughtonileberis radiatus was proposed as an index fossil for the Upper Eocene to Oligocene (Dingle 1976). Its presence in #1105 (Upper Eocene) and #1303 is consistent with this and confirms the dating of #1303 Upper Eocene (based on the occurrence of Stigmatocythere sp A141) although Stigmatocythere is used as an index fossil for Middle to Upper Eocene of Pakistan (Siddiqui 1971).

The Upper Eocene sedimentary environments of JC-1 are characterized by Dingle (1976) as consisting of rapidly alternating episodes of restricted and open marine circulation, and are capped by a shallow water carbonate lithofacies. These data, together with comparisons with Cretaceous faunal data (Dingle 1980, 1981) enable sedimentary environmental interpretations to be made for the west coast and Agulhas Bank area during Palaeogene times (section 3.5).

3.4 RELATIONSHIPS WITH CRETACEOUS SOUTH AFRICAN FAUNAS.

It is interesting to note that the Upper Cretaceous JC-1 borehole was considerably depleted in ornamented Cytheracea (<15%). It contained two Agulhas Bank Maastrichtian species Phacorhabdotus ?anomala and Dutoitella mimica and one Eocene JC-1 genus Australileberis which were not recorded in the nearby Upper Cretaceous outcrops in Zululand.

Around South Africa the following Cretaceous faunal assemblages have been recorded:-

		%Cytheracea	%Bairdiacea +Cypridacea	%Cythere- llidae
East Coast				
Igoda Fm.	U.Camp.-L.Maas.	57	39	4
Needs Camp	" "	6	94	0
JC-1	Camp. Maast.	29	47	14
Agulhas Bank				
Alphard Fm. TBD #818	Maast III	83	7	10

This indicates that the single Upper Cretaceous Agulhas Bank #818 is faunally quite distinct from the Upper Cretaceous East Coast faunas. It is however similar to the % Cytheracea of the Agulhas Bank Palaeogene samples (76%, this study). This suggests a relatively stable depostional environment from the Upper Cretaceous to Eocene times on the Agulhas Bank.

The Upper Cretaceous Agulhas Bank TBD #818 has a cytheracean population made up of nine species of which 33% of the total valves are Trachyleberis schizospinosa and 30% Agulhasina. The average number of species per station over nineteen stations in the study area was nine, but ninety two species were recognized (15 stations have ≤11 species per station) i.e. apart from the three important species mentioned in section 3.2 (Australiberis stangerensis, Henryhowella ?asperimma and Krithe nibelaensis) individual species are not widely distributed. For this reason, comparisons between Upper Cretaceous and Tertiary strata are made at the generic level.

Dingle (1981) noted that in JC-1, the cytheraceans were numerically dominant only in the Campanian I. However, they were the most diverse group in both numbers of species and genera in the Campanian and Maastrichtian strata. The Trachyleberididae were the most diverse family during Campanian II, but showed a decline (82 to 42%) in the number of cytheracean species in the Maastrichtian II. This high level of cytheracean diversification during the Cenomanian to Maastrichtian, and its subsequent decrease in Late Cretaceous, is considered to be a global faunal trend (Whatley and Stephens 1976).

Table 3.4:1 lists the various Palaeogene species from this study with their relative age ranges. Of the ninety two species recorded only three (Krithe nibelaensis, Australileberis stangerensis and Phacorhabdotus sp A1424) occur across the Cretaceous/Tertiary boundary. The following species appear to have developed at the beginning of the Tertiary :- Ambostracon sp A468, Urocythereis sp A1460, Leguminocythereis sp 1507, Leguminocythereis cf L exigua, Trachyleberis sp B250, Trachyleberis sp B204, Xestoleberis sp 296, I.1. sp A220, I.1. sp A760 and I.4. sp A1436. There were no stations with limited Palaeocene nor Oligocene ages and so it is difficult to ascertain characteristic faunas for these time zones. However, characteristic species for:-

(i) the Middle to Upper Eocene are:- Bythoceratina sp A382, Incongruellina cf sp A492, ?Ruggieria sp A485, Chrysocythere sp A096, Echinocythereis sp A570, Echinocythereis sp B076, Haughtonileberis sp A075, Haughtonileberis cf H radiatus, Parvacythereis sp A053, Soudanella sp A151, Togoina spA1441, Togoina sp A1446, ?Agrenocythere hazelae and Veenia sp 27337. (ii) the Upper Eocene to Oligocene are:- Incongruellina sp A500, Muellerina sp A420, Parvacythereis sp A053, Stigmatocythere sp A141, ?Trachyleberis sp 606 and Atlanticythere sp 058.

Thirty three and sixty seven cytheracean genera have been recorded from the South African Upper Cretaceous and Palaeogene, respectively. Of these only thirteen occur across the Cretaceous/Tertiary boundary (Table 3.4:2). The following features at the Cretaceous/Palaeogene boundary are noted:-

(i) Figure 3.4:1 summarises the changes in (a) % Cytheracea and (b) % Trachleberididae across the boundary. The fact that 62% of the Upper Cretaceous fauna becomes extinct and 70% of the Palaeogene cytheraceans are new, implies a high turnover at the boundary and considerable Palaeogene evolutionary activity. It is interesting to note that the % Trachyleberididae within the overall Upper Cretaceous, extinct Cretaceous, inherited Cretaceous, overall Palaeogene, inherited Palaeogene and new Palaeogene faunas remains almost constant (ranging 42 -48%).

(ii) The Upper Cretaceous Schizocytheridae genera - Amphicytherura, Apateloschizocythere, Cnestocythere

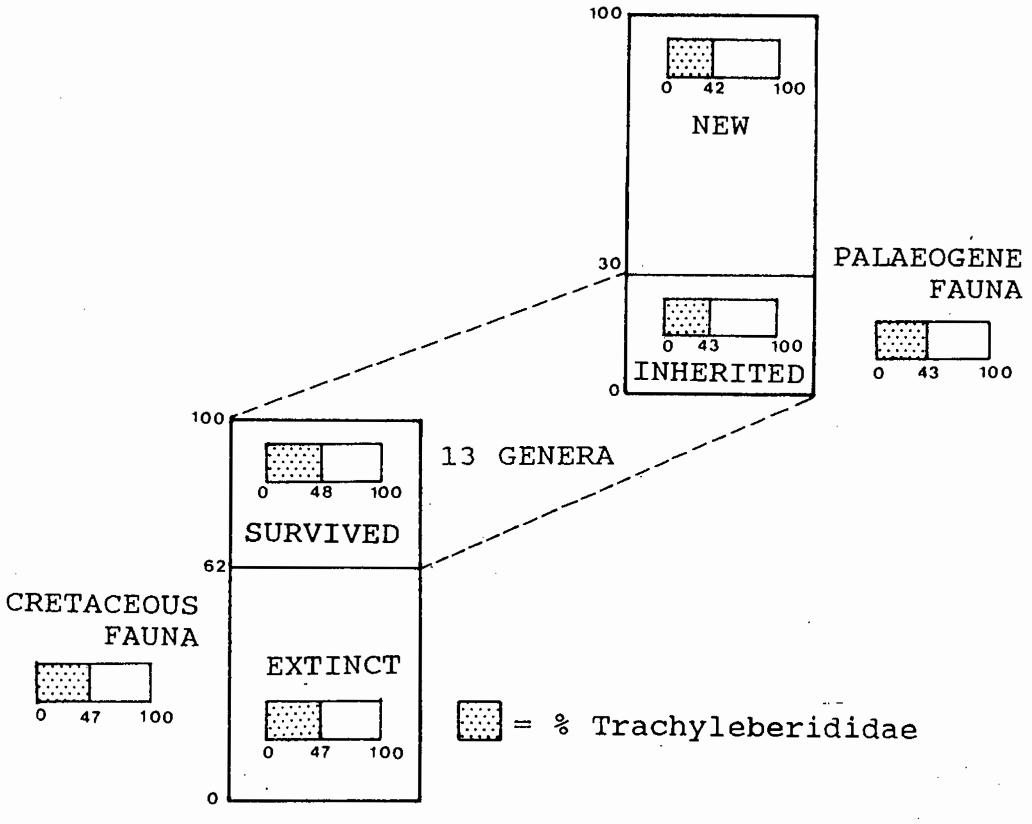


Fig. 3.4:1 Variation in percent Cytheracea and percent Trachyleberididae across the Cretaceous/Palaeogene boundary.

and Sondagella are replaced by two JC-1 species of Paijenborchella.

(iii) The Unicapellidae Dutoitella and Unicapella which formed a characteristic part of Upper Cretaceous fauna, are replaced by Atlanticythere which occurs on both the west coast margin and Agulhas Bank, but there are no representatives at JC-1.

(v) Brachycythere is common in the non-Agulhas Bank Upper Cretaceous and was recorded in the Coniacian on the Agulhas Bank (TBD #510). However it is absent in the Palaeogene faunas, although the Brachycytheridae is represented by three genera (Bythoceratina, Incongruellina and Ruggiera) always <3% at any one station.

(vi) The following inherited genera show a marked increase in the number of species across the boundary - Cytheropteron, Australileberis, Trachyleberis and Xestoleberis. Only the species Australileberis stangerensis and Krithe nibelaensis survive across the boundary i.e. although thirteen genera cross the boundary only two species are continuous.

(vii) The following inherited genera show a decrease in the number of species during the Palaeogene times in comparison to the Upper Cretaceous- Hermanites, Buntonia, Brachycythere. They are only known from the Tertiary JC-1 borehole.

3.5 ENVIRONMENTAL INTERPRETATION AND FAUNAL DISTRIBUTIONS.

Palaeo-sedimentary environmental interpretations for the Upper Cretaceous of South Africa have been aided by plotting ostracod populations onto a CCBC (Cytheracea, Cypridacea + Bairdiacea, Cytherellidae) triangular diagram (Dingle 1980, 1981, 1984, 1985). Seven assemblages have been recognized and their characteristics are summarised in Figure 3.5:1 and Table 3.5:1. The initial work was based on statistically smoothed data from a continuously cored Santanian to ?Campanian borehole (BH-9) at Richards Bay, Zululand (Dingle 1980). The diagram works well for this type of data but plots of individual points are more difficult to interpret. In the present study the data are even less easy to manipulate because of poor age resolution for several samples. Nevertheless, comparisons can be made using the CCBC plot to differentiate various depositional environments on the Palaeogene Agulhas Bank and west coast margin.

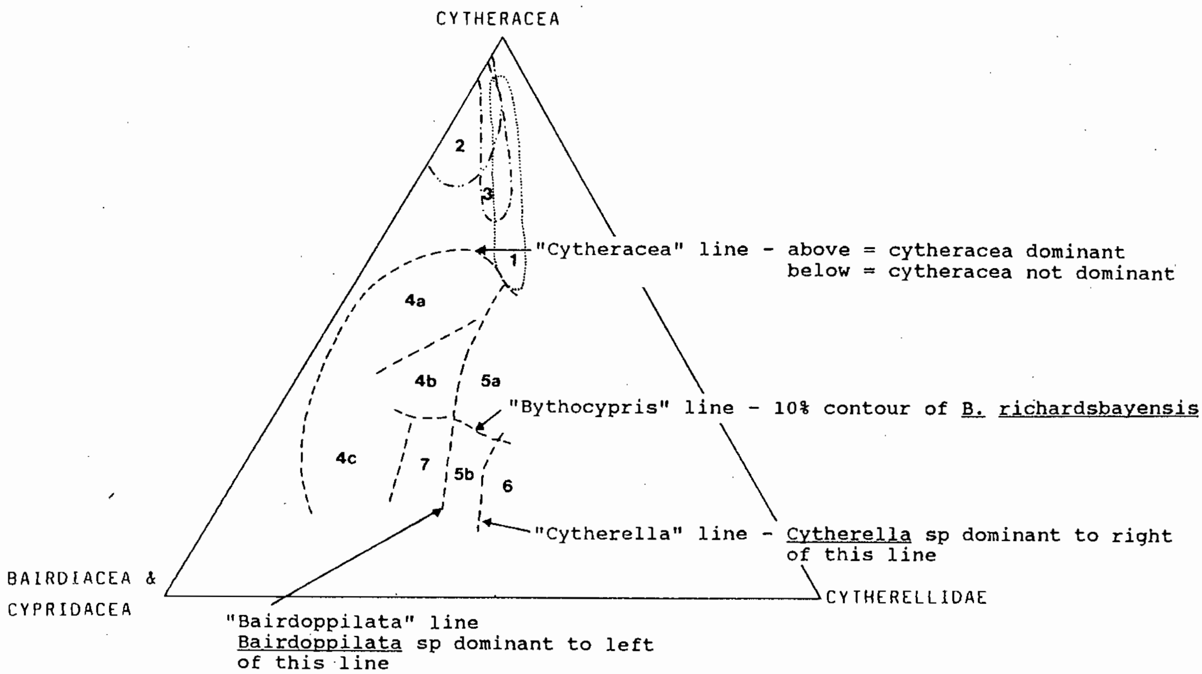


Fig. 3.5:1 CCBC (Cytheracea, Cypridacea + Bairdiacea, Cytherellidae) plot for the 7 faunal assemblages recognized by Dingle (1980, 1981, 1984, 1985).

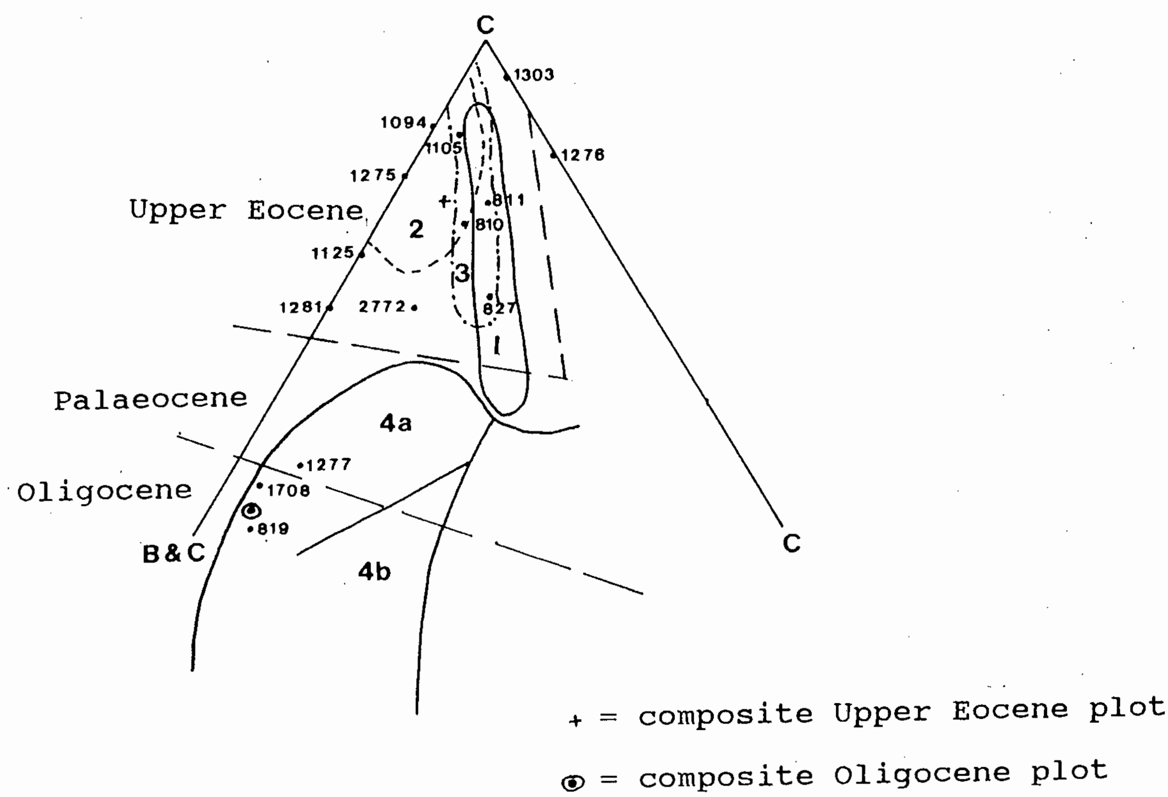


Fig. 3.5:2 CCBC plot for the study area samples.

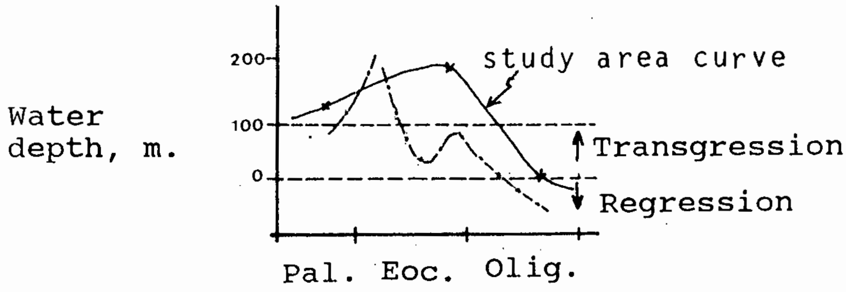


Fig. 3.5:3 Palaeogene depth variations for the west coast margin and Agulhas Bank. Comparison of results from the study areas with those observed from Siesser and Dingle (1981).

When the study area samples are plotted on a CCBC diagram there is a distinct grouping of similar aged stations, although individual stations do not always fit into one of the previously defined assemblages (Figure 3.5:2). Upper Eocene stations, if averaged, plot in field 2 which is indicative of shallow water restricted circulation. The average of the two Palaeocene to Eocene samples (#1276 and #1277) plot slightly deeper than the Upper Eocene composite location but still <100m water depth. Samples with an uncertainty range of Eocene to Oligocene plot in field 4a, which represents moderate water depth (100-200m), inner-mid shelf environments. The distinction between the samples of Upper Eocene age and those with the lower resolution of Upper Eocene to Oligocene (#819 and #1706) may indicate that the latter are more likely to be Oligocene in age than Upper Eocene. Figure 3.5:3 represents the depth trend for the Lower Tertiary as indicated by the CCBC plot. The general trend of the Eocene transgression and Oligocene regression follows that of Siesser and Dingle (1981 as emended by Dingle 1983) interpretations. The lack of more precise peaking is most likely related to the poor age resolutions of the study area samples.

The Oligocene and Palaeocene stations form two groups

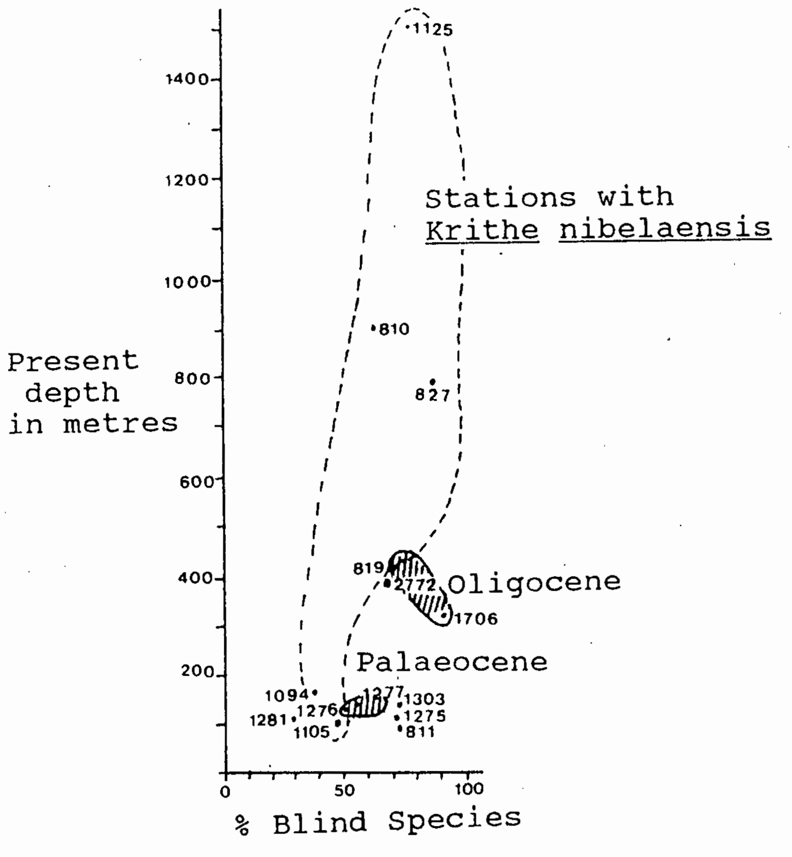


Fig. 3.5:4 Present depth versus percent blind species for specific stations in the study area.

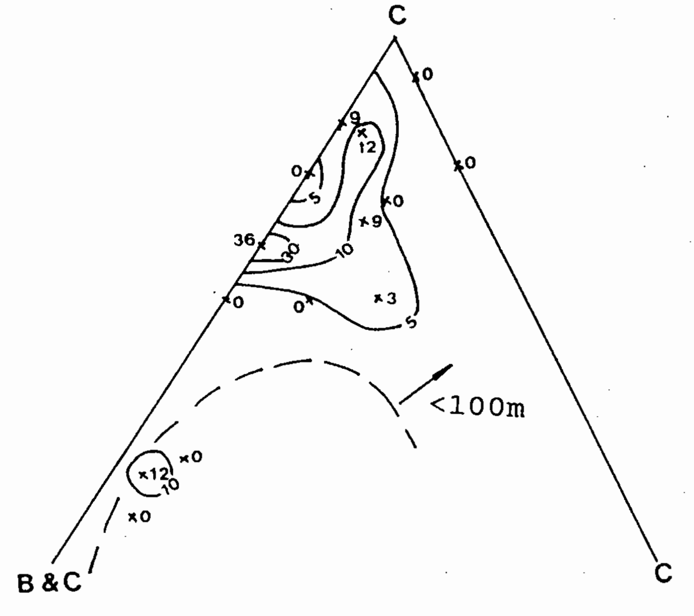


Fig. 3.5:5 CCBC plot showing distribution of percent Krithe in the study area.

on a present depth versus % blind species plot (Figure 3.5:4). The Upper Eocene stations (unshaded in Figure 3.5:4) show a wide range in depths and 29%-88% range in blind species. The diagram indicates that there is no apparent relationship between present depth and blindness. Thus, either: (i) the two are related but the sea floor has differentially subsided; or (ii) the two are unrelated. Blindness can be a response to either water depth or water turbidity - the latter possibly being significant at the shallow #1303, #1275 and #811, plus the overall shallower Upper Eocene palaeo-environments as suggested from the CCBC plot (Figure 3.5:2). The more meaningful comparison of predicted sample depth (from Figure 3.5:2) and blindness is unclear owing to the overlap of assemblage fields 1, 2 and 3 in the regions where most of the study stations occur. However an apparent inconsistency exists in the CCBC triangle when those stations where the presence of the deeper water Krithe plot in Dingle's (1980, 1981) palaeo-environments of <100m depth (Figure 3.5:5). In an attempt to clarify this, the genus Krithe is combined with Cytherellidae on a C-K, CB, C+K diagram (Figure 3.5:6). A distribution of the original assemblages appears similar on the new diagram with only one of Dingle's (1981) original samples (7-2) not fitting easily into its allotted assemblage 7. Stations 810, 819, 827, 1094, 1105 and 1125 are affected, with #1125 which lies at the greatest modern depth plotting in the deeper assemblage 5a, and #819 in 4b. However, the average Oligocene and Palaeocene values remain about the same as in Figure 3.5:2 (4a and <100m respectively). The composite Upper Eocene point falls

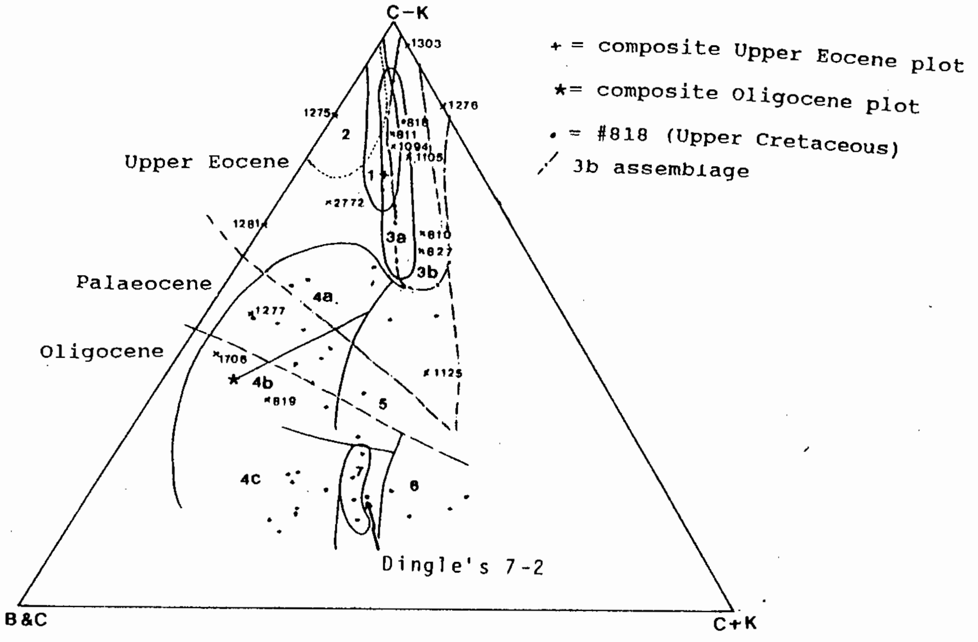


Fig. 3.5:6 A C-K, CB, C+K plot (CCBC plot modified by K = Krithe %), showing the 7 assemblages of Dingle (1981), plus the position of the 3b assemblage (this study).

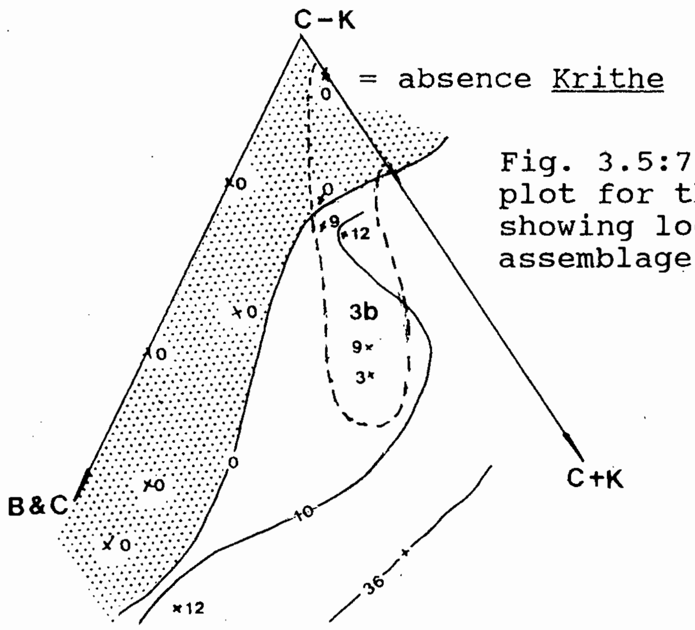


Fig. 3.5:7 A C-K, CB, C+K plot for the study area stations showing location of the 3b assemblage (this study).

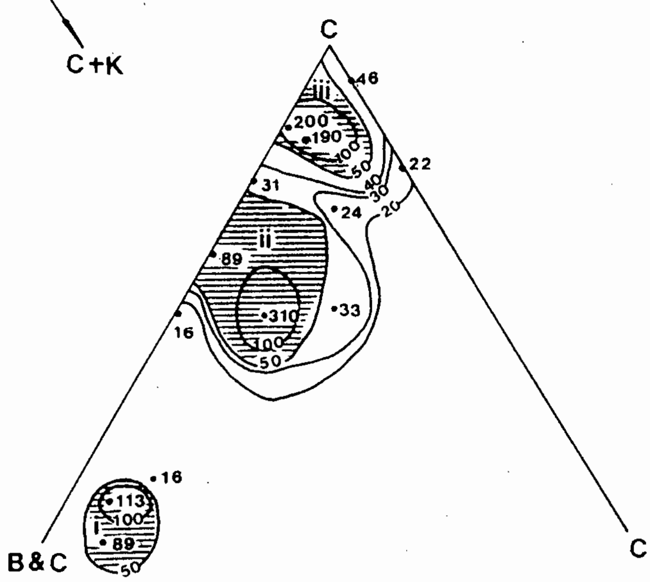
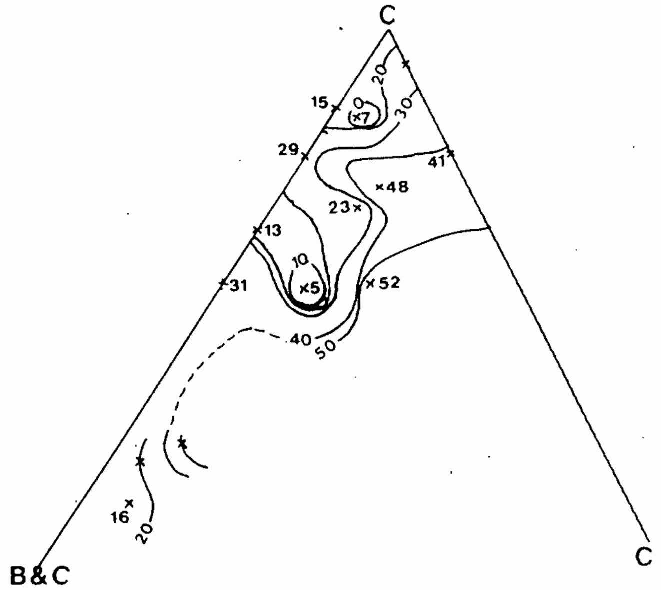


Fig. 3.5:8 CCBC plot of variation in abundance (number of valves per 100gm sediment) in the study area.

within assemblage 2 or 3, with the <u>Krithe nibelaensis</u> bearing samples clusting closer together although still mainly below the predicted 100m water depth line (Figure 3.5:7). Possible explanations of this are (i) sample contamination (ii) the migration into and adaptive tolerance of <u>K. nibelaensis</u> to shallower water conditions with time or (iii) as with Agulhas Bank Upper Cretaceous #818, which contained a high percent of blind species, a quiet shallow water palaeo-environment with dominant open-ocean influences (Dingle 1981). This is defined on the C-K, CB, C+K plot as assemblage 3b and includes #1303 and #1276 which lack <u>K. nibelaensis</u>, but have 70 - 80% blind species (Figure 3.5:6, 3.5:7).

The plot (Figure 3.5:8) of abundance (expressed as number of valves per 100gm sediment) on the CCBC triangle indicates three faunally high areas i, ii and iii. It is interesting to note that the stations associated with each faunal high are of similar present day depth, and age i.e. i - #819 (113 valves (v), 420m), #1706 (89v, 305m) - Oligocene, ii - #2772 (310v, 380m) - Upper Eocene, iii - #1105 (190v, 109m), #1094 (200v, 162m) - Upper Eocene.

Species diversity (Figure 3.5:9) shows a general increase as % Cytherellidae increases. Two low areas (<10%) occur situated on samples #1105 and #2772, which have two of the highest populated densities (190v and 310v per 100gm sediment respectively). In both cases high valve numbers are caused by the occurence of one species in large numbers (hence a low diversity) - #1105: 37% <u>Trachyleberis</u> sp B250 , and #2772: 25% <u>Australileberis stangerensis</u>. Conversely the most diverse sample (#827) has ≤12% of any single species.



3.5:9 CCBC plot of variation in percent species diversity in the study area.

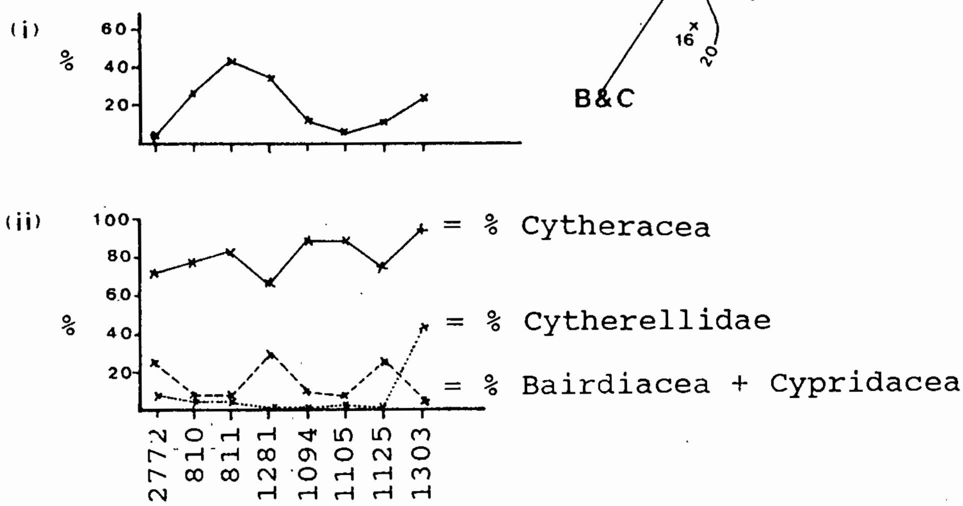


Fig. 3.5:10 West to east variation for the study area Upper Eocene stations in:- (i) species diversity; (ii) the percentages of Cytheracea, Bairdiacea + Cypridacea and Cytherellidae.

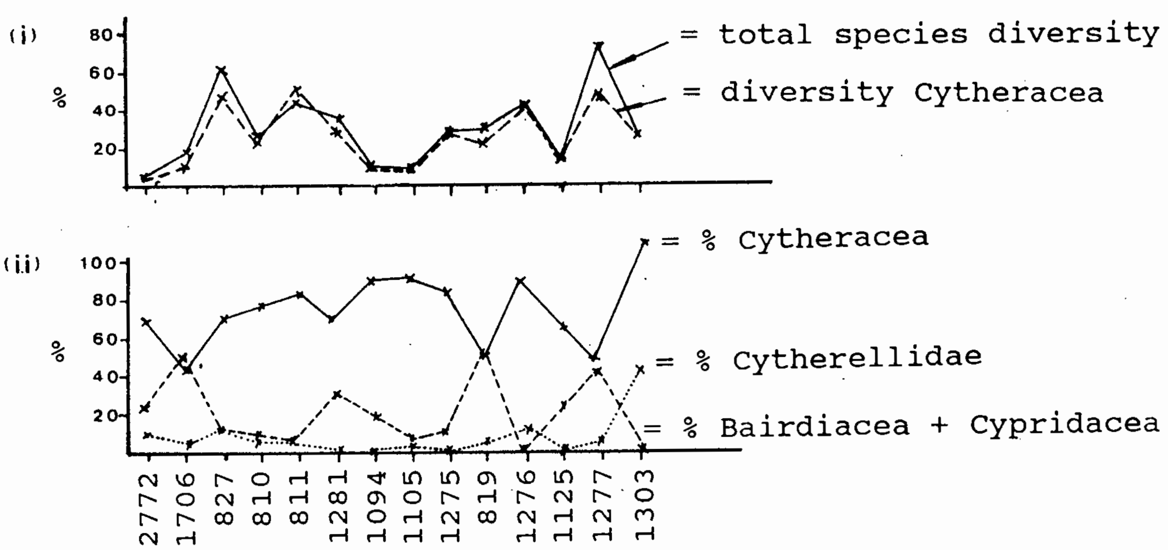


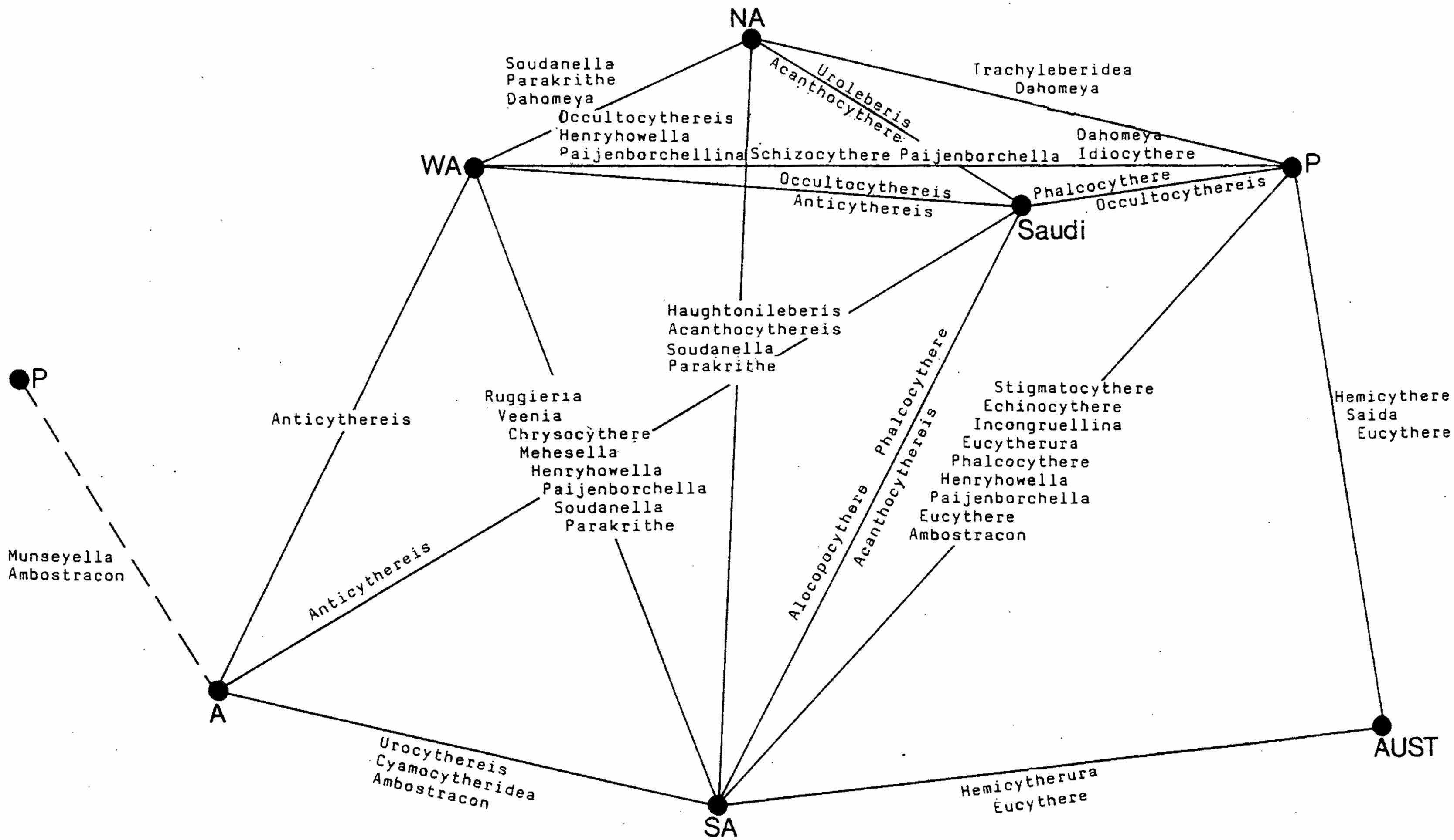
Fig. 3.5:11 West to east variation for the Palaeogene study area stations in :- (i) species and cytheracean diversity; (ii) the percentages of Cytheracea, Bairdiacea + Cypridacea, and Cytherellidae.

A plot of species diversity in a west to east direction across the study area, using only the Upper Eocene samples shows a single maximum at #811 and two minima at #2772 and #1105 (Figure 3.5:10(i)). The cytheracean % of all Upper Eocene stations is $\geq$68% (Figure 3.5:10(ii)). This high value probably plays a strong role in the link between the cytheracean diversity and total species diversities which occurs for the entire study area (Figure 3.5:11(i)). The study area generally shows Cytheracea % > Bairdiacea and Cypridacea % > Cytherellidae %, except for the Upper Eocene #1303 and the Upper Palaeocene to Lower Eocene #1276 where Bairdiacea and Cypridacea % > Cytherellidae % (Figure 3.5:11(ii)).

3.6 RELATIONSHIPS OF SOUTH AFRICAN (AGULHAS BANK, WEST COAST AND JC-1) FAUNAS TO ADJACENT PALAEOGENE OSTRACOD FAUNAL PROVINCES.

The Palaeogene South African faunas (this study and Dingle 1976) are compared with Argentina (Bertels 1973, Valicenti 1977), West Africa (Reyment 1963, van den Bold 1966), North Africa (Apostolescu 1961, Donze et al 1982), Saudi Arabia (Ali-Furaih 1980), West Pakistan (Sohn 1970, Siddiqui 1971) and Australia/New Zealand (Hornibrook 1952, Hazel and Holden 1971).

Tables 3.6:1 and 2 outline cytheracean genera which are characteristically widely distributed, i.e. are common respectively in more than five or four of the seven provinces. South African and the South East Indian Ocean area (DSDP site 246, Ducasse and Grekoff 1976) are treated as a single locality. Figure 3.6:1 summarises the less



3.6:1 Cytheracea genera common between 2 and/or 3 of the 7 recorded provinces.

widely distributed cytheracean genera common between two and/or three provinces (i.e. Urocythereis is common between the two provinces Argentina and South Africa, and Anticythereis is common between the three provinces West Africa, Saudi Arabia and Argentina).

Ali-Furaih (1980) noted that Brachycythere is a characteristic Upper Cretaceous genus with the Cretaceous/Palaeogene boundary marked by the disappearance of B. bilarata. In Pakistan there is a significant difference between the Cretaceous and Palaeogene faunas although Brachycythere still links Pakistan, Saudi Arabian and African (North, West and South) areas ie. those which moved apart on a single plate during the early Cretaceous continental separations (Figure 3.6:2 and 3.6:3).

Ali-Furaih (1980) also noted the lack in correlation between the Upper Cretaceous Australian and Saudi Arabian faunas as further evidence for the existence of Antarctica between the Afro-Arabian and Australian plates (Figure 3.6:3a). Apart from the widely distributed genera Bradleya, Loxoconcha, Actinocythereis and Hornibrookella there are no other Palaeogene ostracod faunal links between Saudi Arabia and Australia. This could be explained by the rapid northwards movement of the Saudi Arabian plate and subsequent isolation of Australia (Figure 3.6:3b). Figure 3.6:2 shows Togoina forming a link between the Argentinian and African (North, West and South West, but not JC-1) faunas. Argilloecia forms a link between North and West Africa, Pakistan and Australia, but not Saudi Arabia. The genera Soudanella and Parakrithe are limited to Palaeogene African faunas.

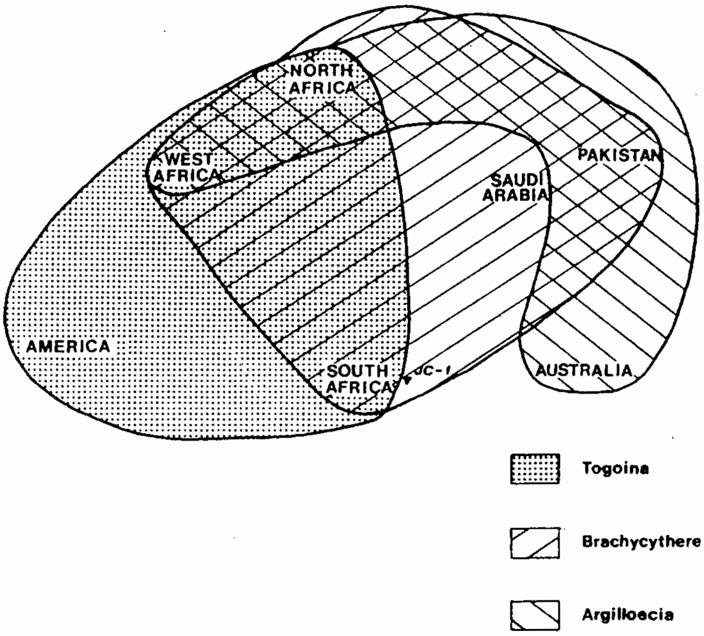


Fig. 3.6:2 Distribution of the genera Argilloecia, Brachycythere and Togoina.

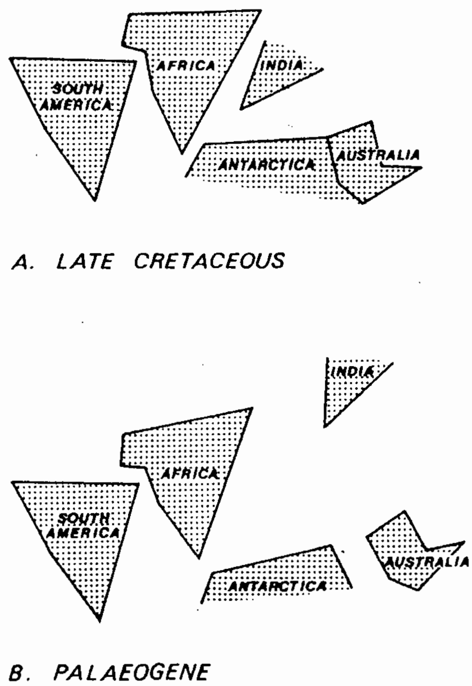


Fig. 3.6:3 Late Cretaceous and Palaeogene plate tectonic settings.

Bertels (1973) noted a stronger Palaeogene link between Argentina and West Africa than between Argentina and the Northern hemisphere. This is through the widely distributed genera Costa, Hermanites, Loxoconcha, Actinocythereis and Togoina (Tables 3.6:1 and 3.6:2). Argentina also links with South Africa through Urocythereis, Camplocytheridea and Ambostracon (Figure 3.6:1) although the highest generic links are between West and South Africa. This agrees with Bertel's suggestion (1973) that the African and Argentinian faunas evolved along parallel paths from common ancestors.

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Table 1.1:1 - Station data for Agulhas Bank and west coast samples.

A-AGULHAS BANK

STATION No	LAT.S. deg min	LONG.E deg min	PRESENT DEPTH (m)	AGE	DATED	No OF VALVES /100g dry sed
810	35 46	22 45	900	U.E.	S.1977	145
811	34 22	22 48	90	M-U.E.	"	22
819	35 07	23 13	?420	M.E-M.O.	"	111
827	35 33	22 38	790	U.E-L.O.	"	25
1094	34 31	23 00	162	U.E.	"	213
1105	34 23	23 12	109	U.E.	"	188
1125	35 21	23 29	1500	M-U.E.	Frewin	90
1268	34 20	22 48		M.P-M.E.	S.1977	3
1269	34 21	22 37	88	L.P-M.O.	"	4
1275	34 18	23 12	101	L.P-U.E.	"	30
1276	34 19	23 25	104	U.P-L.E.	"	24
1277	34 19	23 36	108	U.P-U.E.	"	20
1281	34 27	23 00	108	U.E.	"	21
1288	34 30	22 57	108	M.E-U.E.	"	3
1303	34 24	24 11	118	U.E.	Frewin	49
4453	35 38	22 22	327	M-U.E.	S.1977	1
4574	36 37	20 46	171	M.P-U.E.	"	1

B-WEST COAST

STATION NOS	LAT.S deg min	LONG.E deg min	PRESENT DEPTH (m)	AGE	DATED	NOS OF VALVES per 100 g sed
1701	34 32	18 00	310	U.O-M.M	S.1977	3
1706	34 20	17 58	305	M.E-M.O.	"	86
2772	33 09	17 24	380	M-U.E.	"	311
2800	33 27	17 23	780	L-M.E.	"	1
2802	33 27	17 19	755	U.E.	"	1
2829	34 06	17 21	1550	M.E-M.O.	"	4

BOREHOLE NUMBER	Lat.S. deg min	Long.E. deg min
F-1	35 00	22.24
F-E/1	34 93	22.36
F-D/1	34 36	22 94
G(a)-C/1	34 72	23 05
G(a)-A/1	34 55	23 72
G(a)-A/2	34 57	23 76
G(a)-A/3	34 56	23 77
G(b)-Gemsbok/1	34 48	24 24
Kudu 9-A1	28 35	14 58

Table 1.1:2 - Locality data for boreholes used in Figure 1.1:3 (after Dingle et al (1983) p159, fig. 159).

```
Subclass                            OSTRACODA
                                        :
Order                               PODOCOPIDA
                                        :
                                        :
                  -------------------------------
                  :                             :
Suborder      PLATYCOPINA                   PODOCOPINA
                  :                             :
                  :               -------------------------
                  :               :             :         :
Superfamily       :          Bairdiacea   Cypridacea   Cytheracea
                  :               :             :         :
Family      Cytherellidae     Bairdiidae   Paracyprididae :
                  :               :             :         :
Genus          Platella        Bairdia       Paracypris   :
               Cytherella      Bythocypris   Pontocyprella :
                  :               :             :         :
                  :               :             :    90 species
                  ------------------------------          :
                                  :                       :
                                  :                       :
                      24% of total fauna        76% of total fauna
                   (Not dealt with in thesis)   Subject of thesis
```

Table 1.4:1 -Classification outline of Palaeogene Agulhas Bank fauna.

Table 1.4:2 - Index of cytheracean Palaeogene Ostracods in the study area - plus actual number of valves collected.

	PAGE No	No OF VALVES
Superfamily Cytheracea Baird 1845		
F.Bythocytheridae Sars 1926		
G. Bythoceratina Hornibrook 1952		
B. sp.A382	9	2
G. Incongruellina Ruggieri 1958	11	
I. sp A500	11	3
I. sp A492	12	5
I. cf sp A492	13	1
G. Ruggieria Keij 1957	13	
?R. sp A485	14	1
F.Cytherideidae Sars 1925	15	
G. Eucythere Brady 1868	15	
E. sp A1417	15	5
E. sp B610	16	1
G.Krithe Brady,Crosskey,Robertson 1874	17	
K. nibelaensis Dingle 1981	18	101
K. sp A842	20	7
G. Parakrithe van den Bold 1958	22	
P. sp B613	22	1
F.Cytheruridae Muller 1894	22	
SF. Cytherurinae "	22	
G. Eucytherura "	22	
E. sp A180	23	9
E. sp A27324	25	1
E. sp A1414	25	1
G. Cytheropteron Sars 1866	26	
C(C) sp C941	27	21
C(C) sp	30	1
C(C) cf sp C941	31	4
C(C) cf C. brenneri	31	8
C(C) aff C. brenneri	32	2
C(A) cf C. mccomborum	32	5
C(A) sp A524	33	2
C(A) sp A530	34	1
C(A) cf sp A530	35	1
?C(C) sp A498	35	5
C sp A538	37	1
F.Hemicytheridae Puri 1953a	37	
SF Hemicytherinae Puri 1953a	37	
G. Ambostracon Hazel 1962	37	
A(A) sp A93	38	2
A(A) sp B1457	39	1
A(P) sp A468	40	1
A(P) sp A463	41	1
G. Urocythereis Ruggieri 1950	41	
U. sp A1460	41	4
U. sp 272	42	1
G. Muellerina Bassiouni 1965	43	
M. sp A420	43	2

F.Leguminocytheridae Howe 1962	44	
G. Leguminocythereis Howe 1936	44	
L. sp 1507	44	17
L. cf exigua Apostolescu 1961	45	1
F.Loxochonchidae Sars 1925	46	
G. Loxoconcha Sars 1866	46	
L. sp B192	46	5
L. sp A3243	48	1
L. sp 1430	49	1
L. sp B188	49	3
L. cf L. walvisbaiensis Hartmann 1974	50	1
?L. sp	50	1
F.Paradoxostimidae Brady & Norman 1889	51	
G. Sclerochilus Sars 1866	51	
S. sp	51	1
F.Thaerocytheridae Hazel 1967	52	
G. Bradleya Hornibrook 1952	53	
?B. sp A649	54	2
G. Poseidonamicus Benson 1972	55	
?P. sp A126	56	10
F.Trachyleberididae Sylvester-Bradley 1948	58	
SF.Trachyleberidinae "	58	
G. Agrenocythere Benson 1972	58	
?A. hazelae van den Bold 1946	60	5
G. Australileberis Dingle 1976	62	
A. stangerensis Dingle 1981	64	111
A. hieroglyphica Dingle 1976	65	13
A. sp B123	66	86
?A. sp A472	67	1
G. Chrysocythere Ruggieri 1962	68	
C. sp A096	69	1
C. sp A105	71	2
G. Costa Neviani 1928	72	
C. sp A640	73	2
G. Echinocythereis Puri 1954	73	
E. sp A570	74	9
E. sp B076	75	10
G. Haughtonileberis	76	
H. sp A075	78	11
H. cf H. radiatus Dingle 1976	80	5
G. Henryhowella Puri 1957	81	
H. asperrima? Reuss 1850	81	41
G. Parvacythereis Grundel 1973	83	
P. sp A3260	83	4
P. sp A053	85	44
G. Phacorhabdotus Howe +Laurencich 1958	86	
P. sp A1424	87	6
G. Soudanella Apostolescu 1961	88	
S. sp A151	89	41
G. Stigmatocythere Siddiqui 1971	90	
S. sp A141	91	17

G. Togoina Apostolescu 1961	93	
T. sp A1441	93	7
T. sp A1446	94	1
G. Trachyleberis Brady 1898	94	
T. sp A208	95	15
T. sp B250	97	189
T. sp B204	99	13
T. sp B047	100	1
T. sp 595	101	1
?T. sp 606	101	2
G. Veenia Butler + Jones 1957	102	
SG. Nigeria Reyment 1963	102	
V. sp A27337	103	1
SF. Unicapellinae Dingle 1981	103	
G. Atlanticythere Benson 1977	104	
A. sp 058	105	14
F.Xestoleberididae Sars 1928	106	
G. Xestoleberis Sars 1866	106	
X. sp B296	108	12
X. sp A282	109	7
X. sp B1575	110	3
X. sp B621	111	1
Indet. Genus 1	111	
I.1. sp A220	112	4
I.1. sp A760	114	4
I.1. sp A197	114	9
Indet. Genus 2	115	
I.2. sp B311	115	2
Indet. Genus 3	115	
I.3. sp B176	116	3
I.3. sp A313	116	1
Indet. Genus 4	116	
I.4. sp A1436	116	1
Indet. Genus 5	117	
I.5. sp A333	117	1
I.5. sp A850	117	2
Indet. Genus 6	118	
I.6. sp 1583	118	1
Indet. Genus 7	118	
I.7. sp 1450	118	1
Indet. Genus 8	119	
I.8. sp 1414	119	1
Indet. Genus 9	119	
I.9. sp 290	119	8
Indet. Genus 10	120	
I.10. sp B298	120	1
Indet. Genus 11	120	
I.11. sp B319	120	1
Indet. Genus 12	121	
I.12. sp B1465	121	3
I.12. sp A100	121	1
I.12. sp A477	122	7

```
------------------------------------------------
              :CE:TU:CO:SA:CA:MA:PA:EO:OL:..:RE:
------------------------------------------------
Australia                                      :
sp           ":  :  :  :  :--:  :  :  :  :  :  :
Argentina                                      :
rocana       #:  :  :  :  :  :  :--:  :  :  :  :
Tanzania                                       :
sp           *:  :  :  :  :  :--:  :  :  :  :  :
South Africa and South Atlantic                :
sp 1         @:  :  :  :  :  :  :  :  :  :-----:
sp 2         @:  :  :  :  :  :  :  :  :  : -:  :
sp           @:  :  :  :  : -------------:  :
?sp          @:  :  :  :  :  :  :- :  :  :  :
sp 2329      $: ----:  :  :  :  :  :  :  :  :  :
sp 2332      $:  :--:  :  :  :  :  :  :  :  :  :
sp 1         %:  :  :  :  :  :  : ------ :  :  :
sp 2         %:  :  :  :  :  :  :  : -:  :  :  :
nibelaensis &(:  :  :  :  : -------------:  :  :
sp A         (:  :  :  :  :-----:  :  :  :  :  :
sp A842      &:  :  :  :  :  :  :  : -:  :  :  :
assorted sp  +:  :  :  :  :  :  :  :  :  :  :--:
------------------------------------------------
```

"= Bate 1972. #= Bertels 1973.
$= Dingle 1985. %= Dingle 1976. (= Dingle 1981.
+= Dingle personal com..
@= Benson 1977. *= Bate + Bayliss 1969.
&= Frewin this study.

TABLE 2.1 to show temporal and spatial relationships of Southern Hemisphere (excluding the south Pacific) *Krithe*.

```
------------------------------------------------------------
:           :V :H :B :AP:AL:CE:TU:CO:SA:CA:MA:PA:EO:OL:.:RE:
------------------------------------------------------------
Falkland Plateau                                           :
bispinosa  @:  :  :  :  :- :  :  :  :  :  :  :  :  :  : :  :
sp 327/18  @:  :  :  :  : -:  :  :  :  :  :  :  :  :  : :  :
South/South East Africa                                    :
sp         @:  :  :  :  : -:  :  :  :  :  :  :  :  :  : :  :
persica    #: -:  :  :  :  :  :  :  :  :  :  :  :  :  : :  :
brenneri   $:  :  :  :  :  :  :  :  :  :  :- :  :  :  : :  :
cf westaustr:  :  :  :  :  :  :  :  :  :  :  :  :  :  : :  :
 aliense   $:  :  :  :  :  :  :  :  :  :  :- :  :  :  : :  :
sp 1       %:  :  :  :  :  :  :  :  :  :  :  :  :- :  : :  :
sp 2       %:  :  :  :  :  :  :  :  :  :  :  :  :  :  : :- :
sp 3       %:  :  :  :  :  :  :  :  :  :  :  :  :- :  : :  :
sp C941    &:  :  :  :  :  :  :  :  :  :  :  :  : --- : :  :
sp         &:  :  :  :  :  :  :  :  :  :  :  :  : -:  : :  :
cf sp 941  &:  :  :  :  :  :  :  :  :  :  :  :  : -:  : :  :
cf brenneri&:  :  :  :  :  :  :  :  :  :  :  :  : -:  : :  :
aff brenneri&  :  :  :  :  :  :  :  :  :  :  :  : --- : :  :
mccomborum &:  :  :  :  :  :  :  :  :  :  :  :  : ----: :  :
sp A530    &:  :  :  :  :  :  :  :  :  :  :  :  : -:  : :  :
cf sp A530 &:  :  :  :  :  :  :  :  :  :  :  :-----:  : :  :
sp A524    &:  :  :  :  :  :  :  :  :  :  :  :  : -:  : :  :
? sp A498  &:  :  :  :  :  :  :  :  :  :  :  : ------ : :  :
sp A538    &:  :  :  :  :  :  :  :  :  :  :  :  : -:  : :  :
South West Africa                                          :
Assorted sp':  :  :  :  :  :  :  :  :  :  :  :  :  :  : :--:
------------------------------------------------------------
```

%= Dingle 1976. $= Dingle 1981.@= Dingle 1984.
#= Brenner + Oertli 1976. &= Frewin this study.
'= Boomer et al 1982 unpublished.

TABLE 2.2 to show temporal and spatial relationships of Southern African *Cytheropteron*.

Taxon	Source	PA	EO	OL	..	RE
South Africa and South West Indian Ocean:						
? sp1	=		-			
cf L. lokassaensis	=		--	--		
sp 5	x		-			
sp 6	x		-			
sp 7	x		-			
sp 1507	*	--	--	--		
cf exigua	*	--	--	--		
?sp	/					--
West Africa						
bopaensis	#@	--				
frescoensis	@	--				
lagaghirobaensis	#@	--				
lokassaensis	@		-			
senegalensis	#@	--	--			
?teskoensis	@	--				
aff exigua	%@	--				

== Dingle 1976. x= Ducasse + Grekoff 1976.
@= Apostolescu 1961. #= Reyment 1963.
%= Donze et al 1982. *= Frewin this study.
/= Boomer 1985 unpubl..

TABLE 2.3 to show temporal relationships of South, South West and West African Leguminocythereis.

Taxon	Source	SA	CA	MA	PA	EO	OL	..	RE
sp 1	%						-		
?sp B192	&					-			
sp A3243	&					-			
sp 1430	&					--	-		
sp B188	&					-			
sp 3246	&					-			
cf walvisbaiensis	&					-			
walvisbaiensis	x$								--
sp 1	x								--

%= Dingle 1976. &= Frewin this study.
$= Hartmann 1974. x= Boomer 1985 unpubl..

TABLE 2.4 to show temporal relationships of South African Loxoconcha.

Taxon	Source	PA	EO	OL	MI	..	RE
Genus Bradleya							
dictyon	*!+				---	---	---
?sp A649	/	--	--				
sp?	&						--
?sp	"						--
Genus Poseidonamicus							
?sp A126	/		--	--			
sp	x						--

*= Benson 1972. != Benson 1977. += Brady 1880.
&= Benson + Maddocks 1964. "= Boomer 1985 unpubl..
/= Frewin this study. x= Dingle personal comm..

TABLE 2.5 to show temporal ranges of South African Bradleyinae.

```
-----------------------------------------------
:                     :SA:CA:MA:PA:EO:OL:..:RE:
-----------------------------------------------
Indian Ocean                                  :
spinosa              ":  :  :  :  :  :  :  :- :
radula              *':  :  :  :  :-----?-----:
S. Atlantic + Agulhas Bank                    :
hazelae            "():  :  :  :  :------?-:  :
?hazelae             &:  :  :  :  :--:  :  :  :
-----------------------------------------------
```

"= Benson 1972. *= Benson 1974. (= Benson 1977.
*= Brady 1880.)= van den Bold 1946. &= Frewin this study.

TABLE 2.6 to show temporal and spatial relationships of Southern Hemisphere Agrenocythere.

```
-----------------------------------------------
:                     :SA:CA:MA:PA:EO:OL:..:RE:
-----------------------------------------------
stangerensis         $:  :  : -----?----:  :  :
hieroglyphica        %:  :  :  :  : ----:  :  :
sp B123              &:  :  :  : ------ :  :  :
?sp A472             &:  :  :  :  :- :  :  :  :
-----------------------------------------------
```

%= Dingle 1976. $= Dingle 1981.
&= Frewin this study.

TABLE 2.7 to show temporal relationships of South African Australileberis.

```
-----------------------------------------
:                     :PA:EO:OL:MI:..:RE:
-----------------------------------------
South Africa                            :
polytrema            /:  :  :  :  :  :--:
sp A096              *:  : -:  :  :  :  :
sp A105              *: --- :  :  :  :  :
South West Africa                       :
sp                   +:  :  :  :  :  :--:
Angola                                  :
ornata               x:  :  :  :  :  :--:
Gabon                                   :
cataphracta          @:  :  :  :--:  :  :
Niger                                   :
asterospinosis       &:  :  :  :  :  :--:
-----------------------------------------
```

/= Brady 1890. @= van den Bold 1966.
&= Omatsola 1970. x= Hartmann 1974.
+= Boomer 1985 unpubl. *= Frewin this study.

TABLE 2.8 to show temporal and spatial relationships of African Chrysocythere.

```
-----------------------------------------
:                     :PA:EO:OL:MI:..:RE:
-----------------------------------------
Indian Ocean                            :
variornata           x:  :  :  :  :  :--:
stimpsoni            /:  :  :  :  :  :--:
West + South West Africa                :
dohomeyi            ?!:  : -:  :  :  :  :
upsilocostata        &:  :  :  :--:  :  :
?                    @:  :  :  :  :  :--:
South Africa                            :
sp 1                 ":  : -:  :  :  :  :
sp 2                 ":  :--:  :  :  :  :
sp A640              *: ----:  :  :  :  :
-----------------------------------------
```

x= Hartmann 1974. /= Brady 1880.
?= Reyment 1963. != Apostolescu 1961.
&= van den Bold 1966. @= Boomer 1985 unpubl..
"= Dingle 1976. *= Frewin this study.

TABLE 2.9 to show temporal and spatial relationships of various African Costa.

```
-----------------------------------------------------------
                :V :H :B :AP:AL:CE:TU:CO:SA:CA:MA:PA:EO:OL:
-----------------------------------------------------------
South Africa                                              :
haughtoni      *:  :  :  :  :  :  :  : ------ :  :  :  :  :
fissilis       *:  :  :  :  :  :  :  :  :------- :  :  :  :
vanhoepeni     /:  :  :  :  :  :  :  :  : ----:  :  :  :  :
nibelaensis    $:  :  :  :  :  :  :  :  :  :--:  :  :  :  :
radiatus       %:  :  :  :  :  :  :  :  :  :  :  :  : --- :
cf radiatus    &:  :  :  :  :  :  :  :  :  :  :  :  : -:  :
sp A075        &:  :  :  :  :  :  :  :  :  :  :  :  :--:  :
Gabon                                                     :
GAC11          #:  :  :  :  : --- :  :  :  :  :  :  :  :  :
triangulata    #:  :  :  :  :  : --- :  :  :  :  :  :  :  :
GAA30          #:  :  :  :  :  : --- :  :  :  :  :  :  :  :
GAF15          #:  :  :  :  :  : --- :  :  :  :  :  :  :  :
GAD8           #:  :  :  :  :  :  :--:  :  :  :  :  :  :  :
Tanzania                                                  :
sp             ":  :  :  :  :  :  : -:  :  :  :  :  :  :  :
Tunisia                                                   :
acies          !:  :  :  :  :  :  :  :  :  :  :  :--:  :  :
-----------------------------------------------------------
```

%= Dingle 1976. *= Dingle 1969a. /= Dingle 1980.
$= Dingle 1981. #= Grosdidier 1979.
"= Bate + Bayliss 1969.
!= Donze et al 1982. &= Frewin this study.

TABLE 2.10 to show temporal and spatial relationships of African *Haughtonileberis*.

```
---------------------------------------------
:                   :SA:CA:MA:PA:EO:OL:..:RE:
---------------------------------------------
monziensis         $:  : --- :  :  :  :  :  :
spinosa            !:  :  :--:  :  :  :  :  :
sp A3260           &:  :  :  :  : -:  :  :  :
sp A053            &:  :  :  :  : --- :  :  :
---------------------------------------------
```

!= Dingle 1971b. $= Dingle 1981.
&= Frewin this study.

TABLE 2.11 to show temporal relationships of South African *Parvacythereis*.

```
--------------------------------------------
:                  :SA:CA:MA:PA:EO:OL:..:RE:
--------------------------------------------
Senegal                                    :
sangalkamensis    *:  :  :  :- :  :  :  :  :
Tunisia                                    :
inequicostata     @:  :  : -:  :  :  :  :  :
South Africa                               :
anomala           (:  :  : -:  :  :  :  :  :
sp A1424        $+&:  :  : ---?----- :  :  :
stolomonifera     ':  :  :  :  :  :  :  :--:
South Atlantic                             :
subtridentus      %:  :  : ----:  :  :  :  :
Tanzania                                   :
sp                ":  :  :--:  :  :  :  :  :
--------------------------------------------
```

*= Apostolescu 1961. @= Donze et al 1982.
(= Benson 1971. %= Benson 1977.
&= Frewin this study. '= Brady 1880.
"= Bate and Bayliss 1969.
$= Dingle 1981.

TABLE 2.12 to show temporal and spatial relationships of Southern Hemisphere *Phacorhabdotus*.

```
----------------------------------------------
:                    :SA:CA:MA:PA:EO:OL:..:RE:
----------------------------------------------
minima             /:  :-  :   :   :   :   :   :   :
schizospinosa      @:  :   :  -:   :   :   :   :   :
zululandensis      /:  :----   :   :   :   :   :   :
sp A208            &:  :   :   :   :  -:   :   :   :
sp B250            &:  :   :   :  ----:    :   :   :
sp B047            &:  :   :   :   :  -:   :   :   :
sp B204            &:  :   :   :  ----:    :   :   :
sp A595            &:  :   :   :   :  -:   :   :   :
?sp A606           &:  :   :   :   :  ---  :   :   :
----------------------------------------------
```

/= Dingle 1980. @= Dingle 1971b.
&= Frewin this study.

TABLE 2.13 to show temporal relationships of South African <u>Trachyleberis</u>.

```
-------------------------------------------------
:                    :CO:SA:CA:MA:PA:EO:OL:..:RE:
-------------------------------------------------
Unicapella          /: ----------:   :   :   :   :   :
Dutoitella          $:  :---------:   :--:   :--:--:
Paleoabyssocythere  (:  :   :---------:   :   :   :   :
Atlanticythere      (:  :   :  -------------------:
Herrigocythere      *:  :   :  ---  :   :   :   :   :   :
Kefiella            !:  :   :   :--:   :   :   :   :   :
Aphrikanecythere    !:  :   :   :--:   :   :   :   :   :
-------------------------------------------------
```

(= Benson 1977. *= Grundel 1973.
!= Donze et al 1982.
/= Dingle 1980. $= Dingle 1981 + personal com..

TABLE 2.14 to show temporal relationships of various Unicapellinae genera.

```
----------------------------------------------
:                    :SA:CA:MA:PA:EO:OL:..:RE:
----------------------------------------------
sp 1               %:  :   :   :   :-----:   :   :
luciaensis         $:  :  ----:   :   :   :   :   :
sp B296            &:  :   :   :-----:   :   :   :
sp A282            &:  :   :   :   :  ---  :   :   :
sp B1575           &:  :   :   :   :  ---  :   :   :
sp B621            &:  :   :   :   :  -:   :   :   :
africana           /:  :   :   :   :   :   :   :--:
nov sp             !:  :   :   :   :   :   :   :--:
----------------------------------------------
```

%= Dingle 1976. $= Dingle 1981.
!= Dingle 1985 (personal com.).
/= Brady 1880. &= Frewin this study.

TABLE 2.15 to show temporal relationships of South African <u>Xestoleberis</u>.

TABLE 3.3:1 - Comparison of South African Palaeogene Ostracod species and their distribution.
(x = presence)

ASSORTED SPECIES	West Coast	Agulhas Bk	JC-1
Platella	x	x	
Cytherella	x	x	x
Bairdia	x	x	
Bairdoppilata			x
Bythocypris	x	x	
Pontocyprella	x	x	
Paracypris		x	x
SPECIES			
Bythoceratina sp A382		x	
Incongruellina sp A500		x	
I. sp A492		x	
I. cf sp A492		x	
?Ruggieri sp A485		x	
?Eucythere sp 1			x
?E. sp 2			x
Eucythere sp A1417		x	
E. sp B610		x	
Krithe sp 1			x
K. sp 2			x
K. nibelaensis	x	x	
K. sp A842		x	
Parakrithe sp B613		x	
?Cyamocytheridea sp 1			x
?C. sp 2			x
Eucytherura sp A180		x	
E. sp 27324		x	
Cytheropteron sp 1			x
C. sp 2			x
C. sp 3			x
C(C) sp C941		x	
C(C) cf sp C941		x	
C(C) cf C. brenneri		x	
C(C) aff C. brenneri		x	
C(A) cf C. mccomborum		x	
C(A) sp A524		x	
C(A) sp A530		x	
C(A) cf sp A530		x	
?C(C) sp A498	x	x	
C(C) sp		x	
C. sp A538		x	
Brachycythere			x
Ambostracon (A) sp A93	x		
A(A) sp A463		x	
A(P) sp A468		x	
A(P) sp 1457		x	
Urocythereis sp A1460		x	
U. sp 272		x	
Muellerina sp A420		x	
Leguminocythereis sp 1507	x	x	
L. cf L. exigua		x	
?L. sp 1			x
?L cf L. lokassaensis			x
Loxoconcha sp B192		x	
L. sp A3243		x	
L. sp 1430		x	
L. sp B188		x	
L. cf L. walvisbaensis		x	
?L. sp		x	
?Sclerochilus sp		x	
?Bradleya sp A649		x	
?Poseidonamicus sp A126		x	
?Hermanites			x
Acanthocythereis cf A postcornis			x
?Agrenocythere hazelae		x	
?Alocopocythere cf ? teiskotensis			x
Australileberis stangerensis	x	x	
A. hieroglyphica		x	x
A. sp B 123	x	x	
?A. sp A472	x		
Buntonia sp 1			x
Chrysocythere sp A096	x		
C. sp A105		x	
Costa sp A640		x	
?C. sp 1			x
?C. sp 2			x
?C. cf C. dohomeyi			x
Echinocythereis sp A570	x	x	
E. sp B076	x		
Haughtonileberis radiatus			x
H. cf H. radiatus		x	
H. sp A075	x	x	
Henryhowella			x
H. asperrima?	x	x	
?Howecythereis sp 1			x
Parvacythereis sp A053	x	x	
P. sp A3260		x	
Phacorhabdotus sp A1424		x	
?Phalcocythere sp 1			x
Soudanella sp A151		x	
Stigmatocythere sp A141		x	
S. cf S. obliqua			x
Togoina sp A1441		x	
T. sp A1446		x	
Trachyleberis sp A208		x	
T. sp B250		x	
T. sp B204		x	
T. sp 595	x		
?T. sp 606	x		
T. sp 047		x	
T. sp 1			x
Veenia sp 27337		x	
Atlanticythere sp 058	x	x	
Xestoleberis sp B296		x	
X. sp 282		x	
X. sp 1575		x	
X. sp B621	x		
X. sp 1			x
Loxonconcha			x
Mehesella			x
Hemicytherura			x
Paijenborchella			x

TABLE 3.3:2 - Outline of the four Palaeogene Faunal Assemblages of the JC-1 borehole (Dingle 1976).

```
                            JC-1 PALAEOGENE FAUNAS
                            ----------------------
                                     :
 ----------------------------------------------------
 :                                                  :
MAINLY CYTHERACEAN                 MAINLY NON-CYTHERACEAN
SHORT RANGING SPECIES              LONG RANGING SPECIES
    :                                               :
    :                                               :
    : 3 assemblages                                 :
    :                                               :
------------------------------------------          :
:                  :                     :          :
I                  II                    III        IV
Species appear     Species confined    Palaeocene  Palaeocene
U.Eoc.             M.- U. Eoc.         to E. Eoc.  to Olig.
:                  :                     :          :
:                  :heterogeneous        :          :
:                  :3 subgroups          :          :
:      --------------------------        :          :
:      :           :             :       :          :
:     IIA          IIB           IIC     :          :
:  U. Eoc.       M. + U. Eoc.  M. Eoc.   :          :
:  rich marine   Index fossil  small     :          :
:  assemblage    = Stigmatocythere       :          :
:     :                          :       :          :
:  --------------------   small species  :          :
:  :                 :   muddy substrate:           :
: IIA1              IIA2  inferred       :          :
: shallow normal  deeper water   :       :      Krithe sp 1
: marine, intolerance :          :       :   useful environ.
: to terrigenous.     :          :       :   indicator - open
:  :-----------------:....?.....:        :   water
:                         ?faunal break  :
:...........                             :
           :                             :
           :          ENVIRONMENTS       :
           :                             :
      marine shallow water,           restricted +
      low input terrigenous.        deteriating environ-
      + more open water with        mental conditions -
      higher terrigenous input,     faunal break at Lower
      thus faunally more            to Middle Eocene
      impoverished.                 boundary.
```

TABLE 3.4:1 - Recorded ages of the study area species.

SPECIES	:C:M:Paleo:Eocen:Oligo:..:Rec: : : :L:M:U:L:M:U:L:M:U:..: :
Bythoceratina sp A382	: : : : : : :---: : : :..:
Incongruellina sp A500	: : : : : : :-------: :..:
Incongruellina sp A492	: : : : : : :-------: :..:
Incongruellina cf sp A492	: : : : : : : :-: : : :..:
?Ruggieria sp A485	: : : : : : : :-: : : :..:
Eucythere sp A1417	: : : : : : : :---: : :..:
Eucythere sp B610	: : : : : : : :---: : :..:
Krithe nibelaensis	:---?---------------?--------:
Krithe sp A842	: : : : : : : :-: : : :..:
Parakrithe sp B613	: : : : : : : :-: : : :..:
Eucytherura sp A180	: : : : : : : :-: : : :..:
Eucytherura sp 27324	: : : : : : : :-: : : :..:
Eucytherura sp A1414	: : : : : : : :---: : :..:
Cytheropteron sp C941	: : : : : : : :---: : :..:
Cytheropteron sp	: : : : : : : :-: : : :..:
Cytheropteron cf sp C941	: : : : : : : :-: : : :..:
Cytheropteron cf C. brenneri	: : : : : : : :-: : : :..:
Cytheropteron aff C. brenneri	: : : : : : :-------: :..:
Cytheropteron cf C. mccomborum	: : : : : : :-------: :..:
Cytheropteron sp A524	: : : : : : : :-: : : :..:
Cytheropteron sp A530	: : : : : : : :-: : : :..:
Cytheropteron cf sp A530	: : : : : : :---: : : :..:
?Cytheropteron sp A498	: : : : :-----------: :..:
Cytheropteron sp A538	: : : : : : : :-: : : :..:
Ambostracon sp A93	: : : : : : :---: : : :..:
Ambostracon sp B1457	: : : : : : : :-: : : :..:
Ambostracon sp A468	: : :-----------: : : :..:
Ambostracon sp A463	: : : : :---: : : : : :..:
Urocythereis sp A1460	: : :-----------: : : :..:
Urocythereis sp 272	: : : : : : : :-: : : :..:
Muellerina sp A420	: : : : : : : :-------:..:
Leguminocythereis sp 1507	: : :-------------: : :..:
Leguminocythereis cf L. exigua	: : :-----------: : : :..:
Loxoconcha sp B192	: : : : :-------: : : :..:
Loxoconcha sp A3243	: : : : : : : :-: : : :..:
Loxoconcha sp 1430	: : : : : : :-----: : :..:
Loxoconcha sp B188	: : : : : : :---: : : :..:
Loxoconcha cf L. walvisbaiensis	: : : : : : :-----------:
?Loxoconcha sp	: : : : : : : :-: : : :..:
Schlerochilus sp	: : : : : : :-----: : :..:
?Bradleya sp A649	: : : : :-------: : : :..:
?Poseidonamicus sp A126	: : : : : : :-------: :..:
?Agrenocythere hazelae	: : : : : : :---: : : :..:
Australileberis stangerensis	: :-?---------------: :..:
Australileberis hieroglyphica	: : : : : :-----------:..:
Australileberis sp B123	: : : : :-----------: :..:
?Australileberis sp A472	: : : : : :-: : : : : :..:

SPECIES	:C:M:Paleo:Eocen:Oligo:..:Rec: : : :L:M:U:L:M:U:L:M:U:..: :
Chrysocythere sp A096	: : : : : : :---: : : :..: :
Chrysocythere sp A105	: : : : :-------: : : :..: :
Costa sp A640	: : : : :-------: : : :..: :
Echinocythereis sp A570	: : : : : : : :-: : : :..: :
Echinocythereis sp B076	: : : : : : :---: : : :..: :
Haughtonileberis sp A075	: : : : : : :---: : : :..: :
Haughtonileberis cf H. radiatus	: : : : : : :---: : : :..: :
Henryhowella asperrima?	: :-------------------------:
Parvacythereis sp A3260	: : : : : : : :-: : : :..: :
Parvacythereis sp A053	: : : : : : :-------: :..: :
Phacorhabdotus sp A1424	: :--?-------------: :..: :
Soudanella sp A151	: : : : : : : :-: : : :..: :
Stigmatocythere sp A141	: : : : : : :-------: :..: :
Togoina sp A1441	: : : : : : :---: : : :..: :
Togoina sp A1446	: : : : : : :---: : : :..: :
Trachyleberis sp A208	: : : : : : : :-: : : :..: :
Trachyleberis sp B250	: : :-----------: : : :..: :
Trachyleberis sp B047	: : : : : : : :-: : : :..: :
Trachyleberis sp B204	: : :-----------: : : :..: :
Trachyleberis sp 595	: : : : : : :---: : : :..: :
?Trachyleberis sp 606	: : : : : : :-------: :..: :
Veenia sp 27337	: : : : : : : :-: : : :..: :
Atlanticythere sp 058	: : : : : : :-------: :..: :
Xestoleberis sp B296	: : :-------------: : :..: :
Xestoleberis sp 282	: : : : : : :-------: :..: :
Xestoleberis sp B1575	: : : : : : :-------: :..: :
Xestoleberis sp B621	: : : : : : :---: : : :..: :
I.1. sp A220	: : :-------------: : :..: :
I.1. sp A760	: : :-----------: : : :..: :
I.1. sp A197	: : : : : : : :---: : :..: :
I.2. sp B311	: : : : : : : :-: : : :..: :
I.3. sp B176	: : : : : : : :-: : : :..: :
I.3. sp A313	: : : : : : : :-: : : :..: :
I.4. sp A1436	: : :-------: : : : : :..: :
I.5. sp A333	: : : : : : : :-: : : :..: :
I.5. sp A850	: : : : : : : :-: : : :..: :
I.6. sp 1583	: : : : : : : :-: : : :..: :
I.7. sp 1450	: : : : :-------: : : :..: :
I.8. sp 284	: : : : : : :-----: : :..: :
I.9. sp 290	: : : : : : :-------: :..: :
I.10. sp B298	: : : : : : :-------: :..: :
I.11. sp B319	: : : : : :---: : : : :..: :
I.12. sp B1465	: : : : : : : :-: : : :..: :
I.12. sp A100	: : : : : : : :-: : : :..: :
I.12. sp A477	: : : : : : : :-: : : :..: :

TABLE 3.4:2 - Features of cytheracean genera across the Cretaceous/Tertiary boundary. (Using data from Dingle (1976, 1980, 1981, 1985) plus this study).

GENERA THAT CROSS THE BOUNDARY:-
Krithe, Australileberis, Eucytherura, Cytheropteron, Trachyleberis, Haughtonileberis, Parvacythereis, Phacorhabdotus, Veenia, Hermanites, Buntonia and Brachycythere.

GENERA THAT BECAME EXTINCT AT THE BOUNDARY:-
Klingerella, Pariceratina, Pondoina, Parphysocythere, Pterygocythere, Ponticulocythere, Cnestacythere, Apateloschizocythere, Hutsonia, Oertliella, Pedicythere, Unicapella, Dutoitella, Gibbeleberis, Rayneria, Curfsina, Cativella, Agulhasina, Paraplatycosta, Amphicytherura, Cythereis.

GENERA THAT APPEAR ABOVE THE BOUNDARY:-
Eucythere, Ambostracon, Urocythereis, Muellerina, Leguminocythereis, Loxoconcha, Sclerochilus, Bradleya, Poseidonamicus, Agrenocythere, Chrysocythere, Costa, Echinocythereis, Henryhowella, Soudanella, Stigmatocythere, Togoina, Paijenborchella, Cyamocytheridea, Bythoceratina, Incongruella, Ruggieria, Parakrithe, Phalcocythere, Acanthocythereis, Atlanticythere, Alocopocythere, Howecythereis, Loxoconcha, Mehesella, Hemicytherura.

TABLE 3.5:1 - Upper Cretaceous Ostracod Assemblages and Palaeo-environments from Dingle 1981 & 1985.

Ostracod assembl.	Interpreted sedimentary environment	Characteristics			Camp. - Maas. diagnostic ostracoda
1	shallow water, high energy, restricted circulation	Cytheracea dominant 60-90%			*Brachycythere longicaudata*
2	shallow water, low energy restricted circulation <100m	Cytheracea dominant 80-90%			*B. longicaudata*: *Haughtonileberis haughtoni* *Pondoina sulcata*
3	shallow, low energy, open water <100m	Cytheracea dominant 70-90%			*Cythereis klingeri*
	moderate depth	% Cy	% B	% Cyth	
4a	? inner -mid shelf ?100-200m	50-60	15-40	10-20	*Bairdoppilata andersoni* *H. nibelaensis*
4b	?inner - mid shelf ?200m quieter/colder	35-45	30-40	10-25	*B. andersoni* *H. nibelaensis*
4c	intermediate depth ?300m shallower field 7	18-53			*B. longicaudata* *Paracypris zululandensis* *Bythocypris richardsbaensis*
5a	moderate depth mid-outer shelf ?200-300	30-50	<40	25-30	*B. andersoni* *Cytherella* sp
5b	deep water ?outer shelf ?300-500m	20-25	>40	25-35	*B. andersoni* *Cytherella* sp
6	deep water >500m unstable	$\pm$ 20	30-40	40-50	*Cytherella* sp
7	deep water >500m stable	20-30	40-50	20-30	*B. andersoni* *Cytherella* sp

%Cy= %Cytheracea %B= %Bairdiacea
%Cyth= %Cytherellidae

TABLE 3.6:1 Widely distributed Cytheracea - common between 5/7 provinces.

Cytheracean Genera	NO LINK RECORDED	LINK RECORDED
Trachyleberis	WA,Saudi, (JC-1)	NA,SA,P,A/Z,A
Costa	NA,A/Z	WA,SA,Saudi,P,A
Hermanites	NA,A/Z	WA,Saudi,I,P,A
Bradleya	WA	NA,SA,Saudi,I,P,A,A/Z
Cytheropteron	Saudi	NA,SA,WA,P,A,A/Z
Krithe	Saudi	NA,SA,WA.P,A,A/Z
Brachycythere	A,A/Z	SA,NA,WA,Saudi,P
Buntonia	A/Z	SA,WA,NA,Saudi,P,A
Loxoconcha	NA,Saudi	P,WA,A/Z,SA,A
Actinocythereis	SA,A/Z	NA,WA,Saudi,P,A
Hornibrookella/ Quadracythere	A,NA,SA	WA,Saudi,A/Z,P

TABLE 3.6:2 Widely distributed Cytheracea - common between 4/7 provinces.

Cytheracean Genera	LINK RECORDED
Phacorhabdotus	A,Saudi,SA,NA
Argilloecia	WA,NA,P,A/Z
Togoina	A,SA,WA,NA
Bythoceratina	SA,WA,NA,A/Z
Leguminocythereis	SA,WA,NA,P
Xestoleberis	SA,WA,NA,P

KEY
NA = North Africa
WA = West Africa
SA = South Africa
A/Z = Australia/ New Zealand
P = Pakistan
A = Argentina
S = Saudi Arabia

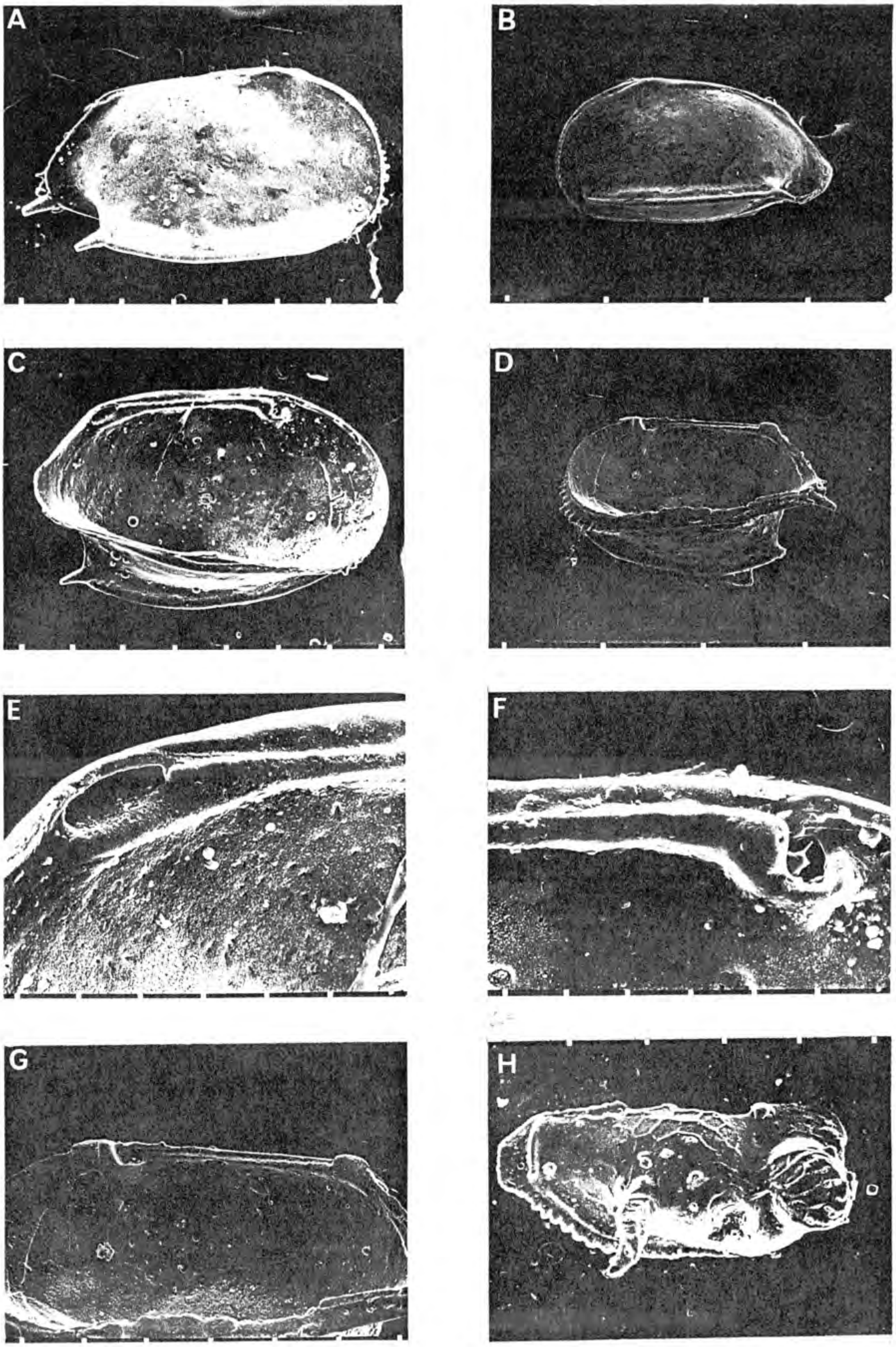

Plate 1. A-G. Incongruellina sp A500. A. RV external.
B. LV external. C. LV internal. D. RV internal.
E. LV detail PTE. F. LV detail ATE. G. LV detail hinge.
H. Bythoceratina sp A382 RV external.
Scale bars - A,B,C,G,H = 100µ , D = 300µ , E,F = 30µ .
A,D,G = P500, #1094; B,C,E,F = P502, #819; H = P382, #1125.

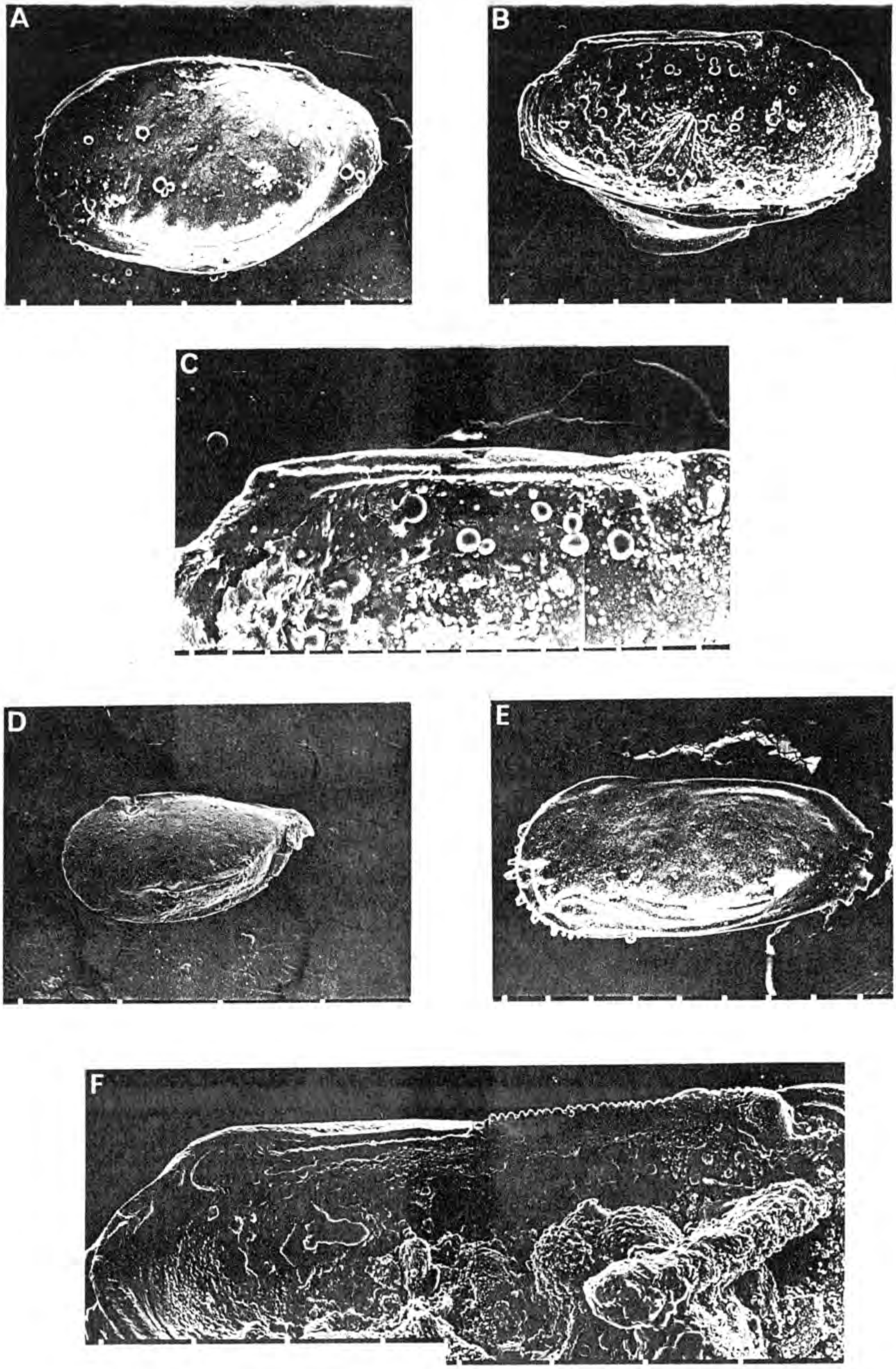

Plate 2. A-D. Incongruellina. A. I. sp A492, LV external. B. I. sp A492, LV external. C. I. sp A492, detail hinge LV. D. I. cf sp A492, LV external. E-F. ?Ruggieria sp A485, E. LV external. F. LV detail hinge.

Scale bars - A,B,E,F = 100µ , C = 30µ , D = 300µ .
A = P492, #1105; B,C = P495, #1105; D = P58.431, #1105; E,F = P485, #1303.

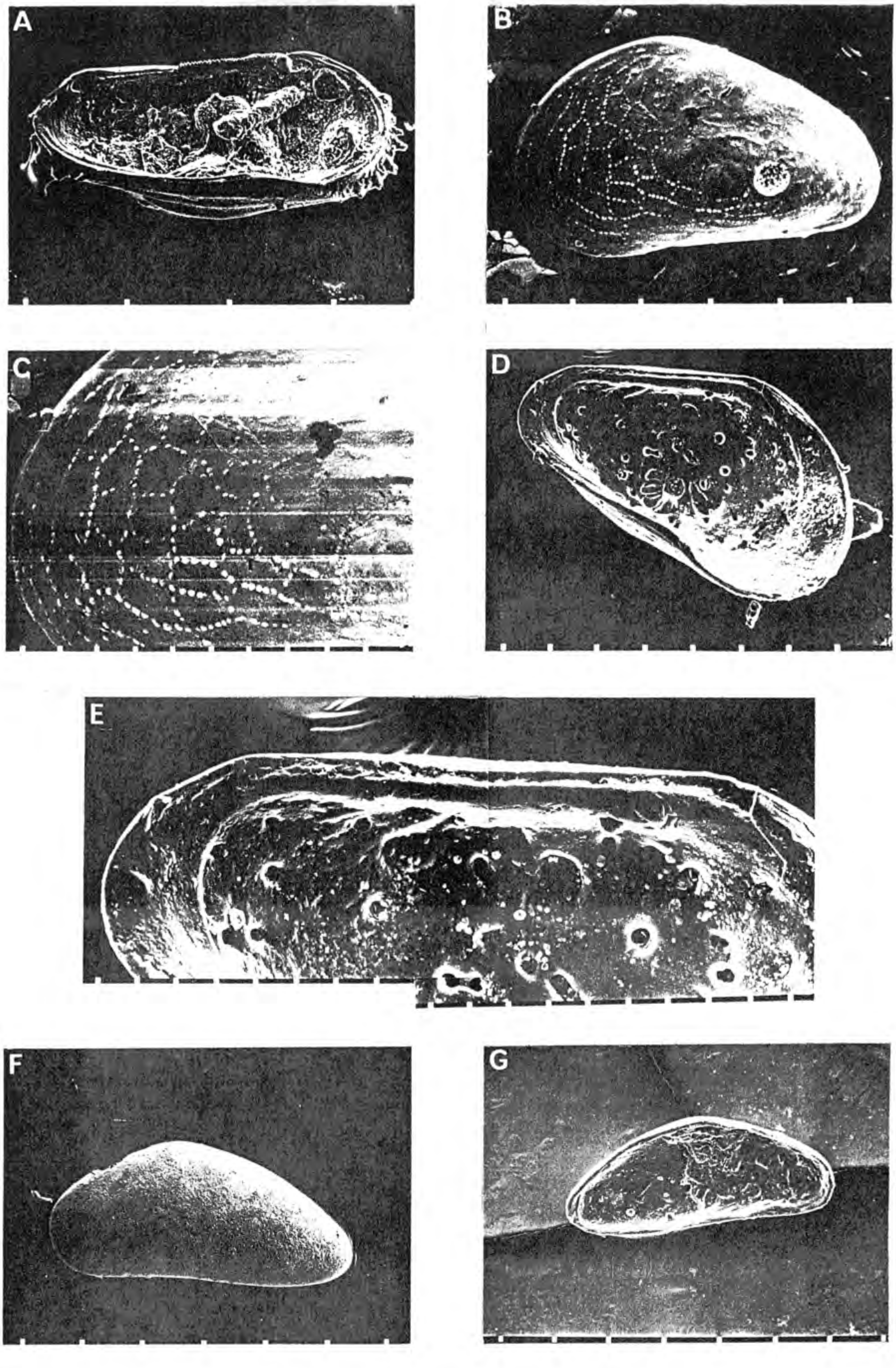

Plate 3. A. <u>?Ruggieria</u> sp A485, LV internal.
B-G. <u>Eucythere</u>. B. <u>E</u>. sp A1417, LV external.
C. <u>E</u>. sp A1417, detail external anterior.
D. <u>E</u>. sp A1417, LV internal. E. <u>E</u>. sp A1417 detail hinge LV. F. <u>E</u>. sp B610, LV external. G. <u>E</u>. sp B610, LV internal.

Scale bars - A = 300 μ, B,D,F,G, = 100 μ, C,E = 30 μ.
A = P485, #1303; B,C,D,E,F = P1419, #827; F,G = P610, #827.

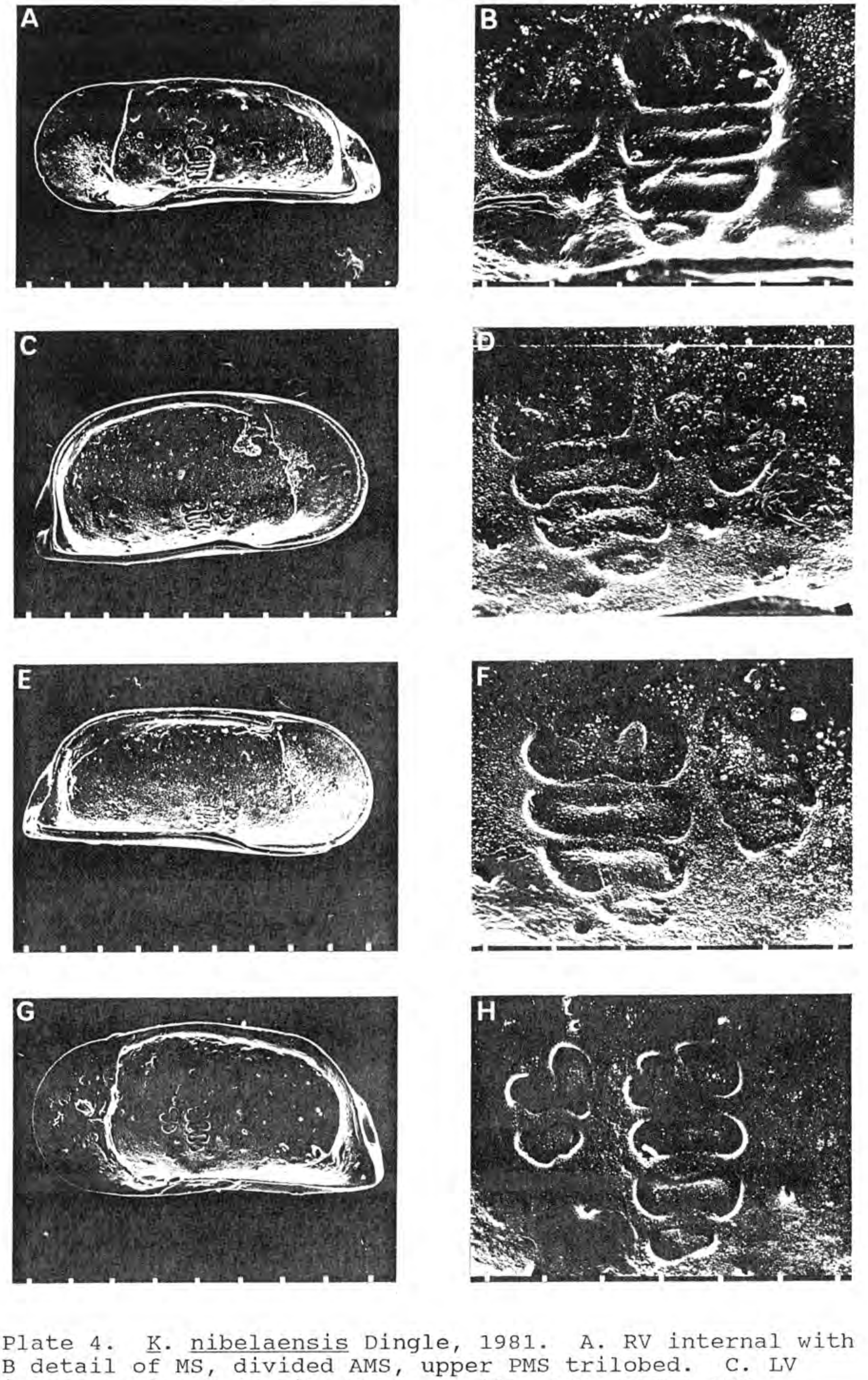

Plate 4. K. nibelaensis Dingle, 1981. A. RV internal with B detail of MS, divided AMS, upper PMS trilobed. C. LV internal with D detail of MS, stellar AMS, upper PMS trilobed. E. LV internal with F detail of MS, divided AMS, upper PMS dominant bilobed in anterior. G. RV internal with H detail of MS, divided AMS, upper PMS dominant bilobed in posterior.

Scale bars - A,C,E,G = 100μ , B,D,F,H = 30μ .
A,B = P804, #819; C,D = P793, #819; E,F = P806, #819; G,H = P785, #810.

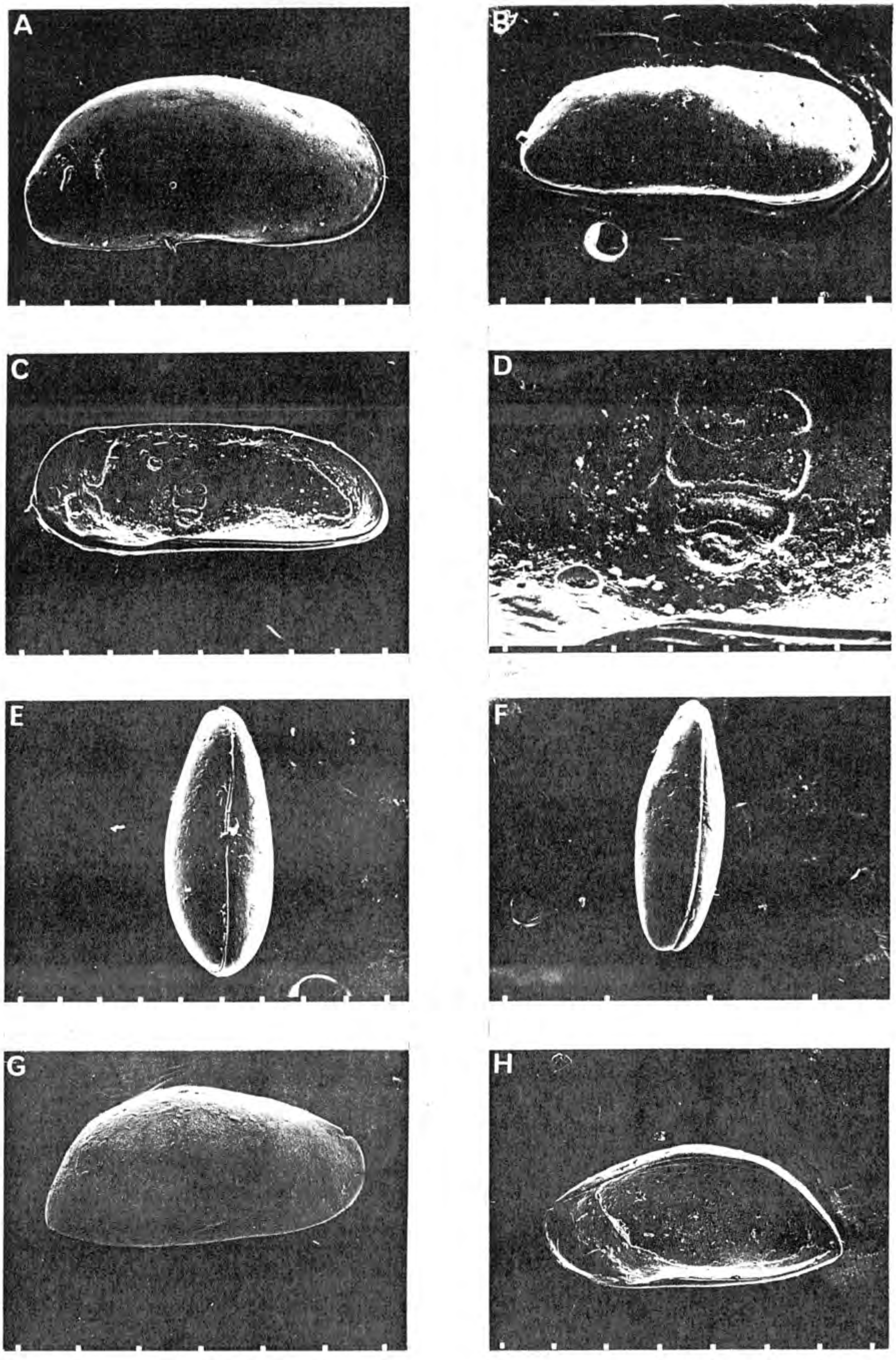

Plate 5. A. Krithe nibelaensis Dingle, 1981, RV external.
B-F. Krithe sp A842. B. RV external. C. RV internal.
D. RV detail MS. E. Dorsal view. F. Ventral view.
G-H. Parakrithe sp B613. G. RV external. H. RV internal.
Scale bars - A,B,C,E,G,H, = 100µ, D = 30µ, F = 300µ.
A = P791, #819; B = P847, #810; C,D = P843, #810;
E,F = P848, #810; G,H = P614, #1094.

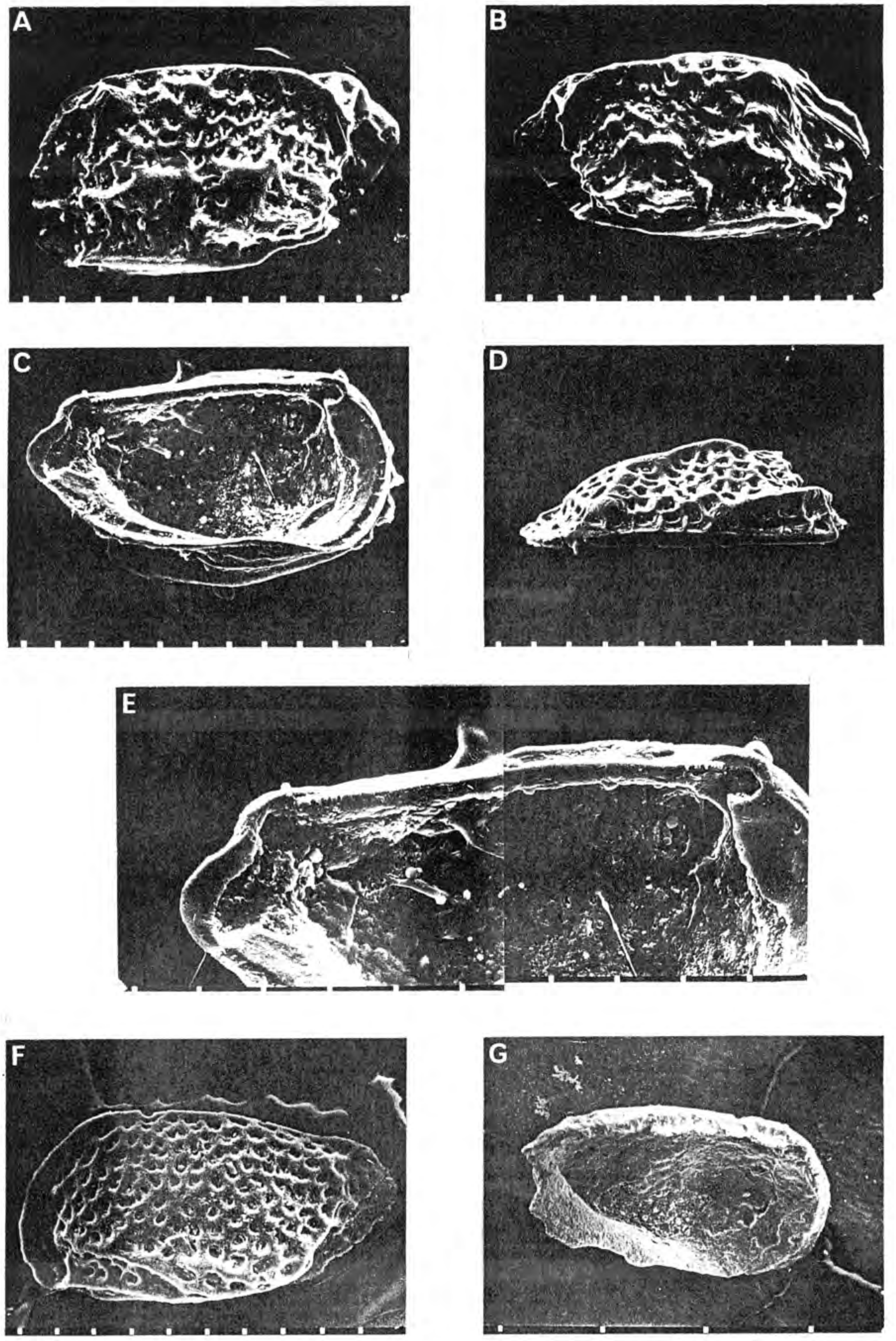

Plate 6. A-E. Eucytherura sp A180. A. LV external. B. RV external. C. LV internal. D. RV dorsal. E. LV detail hinge. F-G. Eucytherura sp A27324. F. LV external. G. LV internal.

Scale bars - A,C,E,F =30μ , B,D = 100μ .
A = P180, #819; B = P177, #810; C,E = P189, #810;
D = P192, #810; F,G = P27.325, #810.

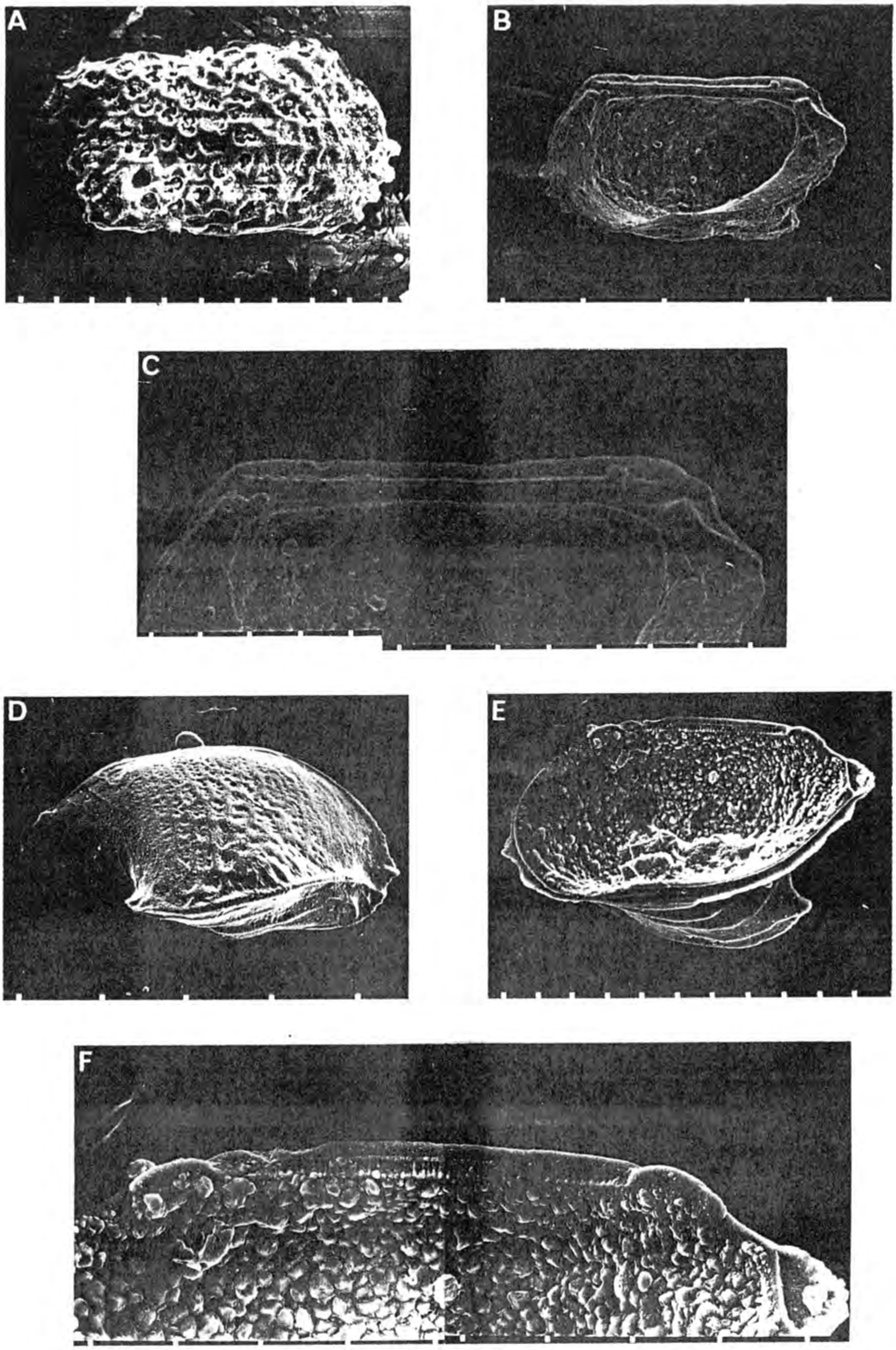

Plate 7. A-C. *Eucytherura* sp A1414. A. RV external. B. RV internal. C. RV detail hinge.
D-F. *Cytheropteron (Cytheropteron)* sp C941. D. RV external. E. RV internal. F. RV detail hinge.
Scale bars - A,C,E,F = 30µ , B,D = 100µ .
A,B,C = P1414, #827; D,E,F = P941, #810.

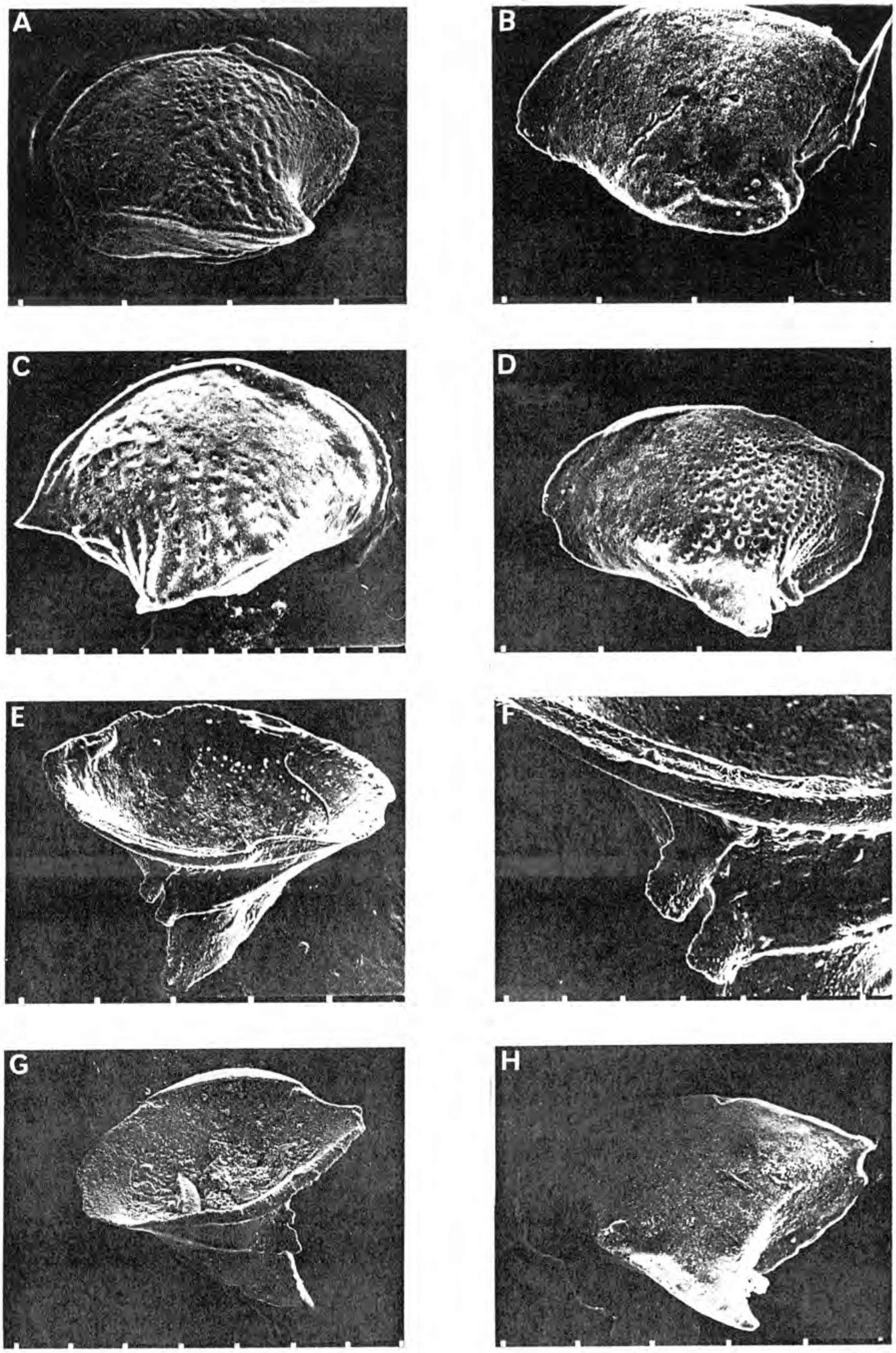

Plate 8. A-H. Cytheropteron (Cytheropteron) A. C(C) sp C941, LV external. B. C(C) sp, LV external. C. C(C) cf sp C941, RV external. D-G. C(C) cf C. brenneri Dingle, 1981. D. LV external. E. LV internal. F. LV detail of ala. G. RV internal. H. C(C) aff C. brenneri Dingle, 1981, LV external.

Scale bars - A,B,D,E,G,H = 100μ , C,F = 30μ .
A = P58.450, #810; B = P517, #810; C = P510, #810;
D,E,F = P544, #810; G = P087, #1094; H = P540, #810.

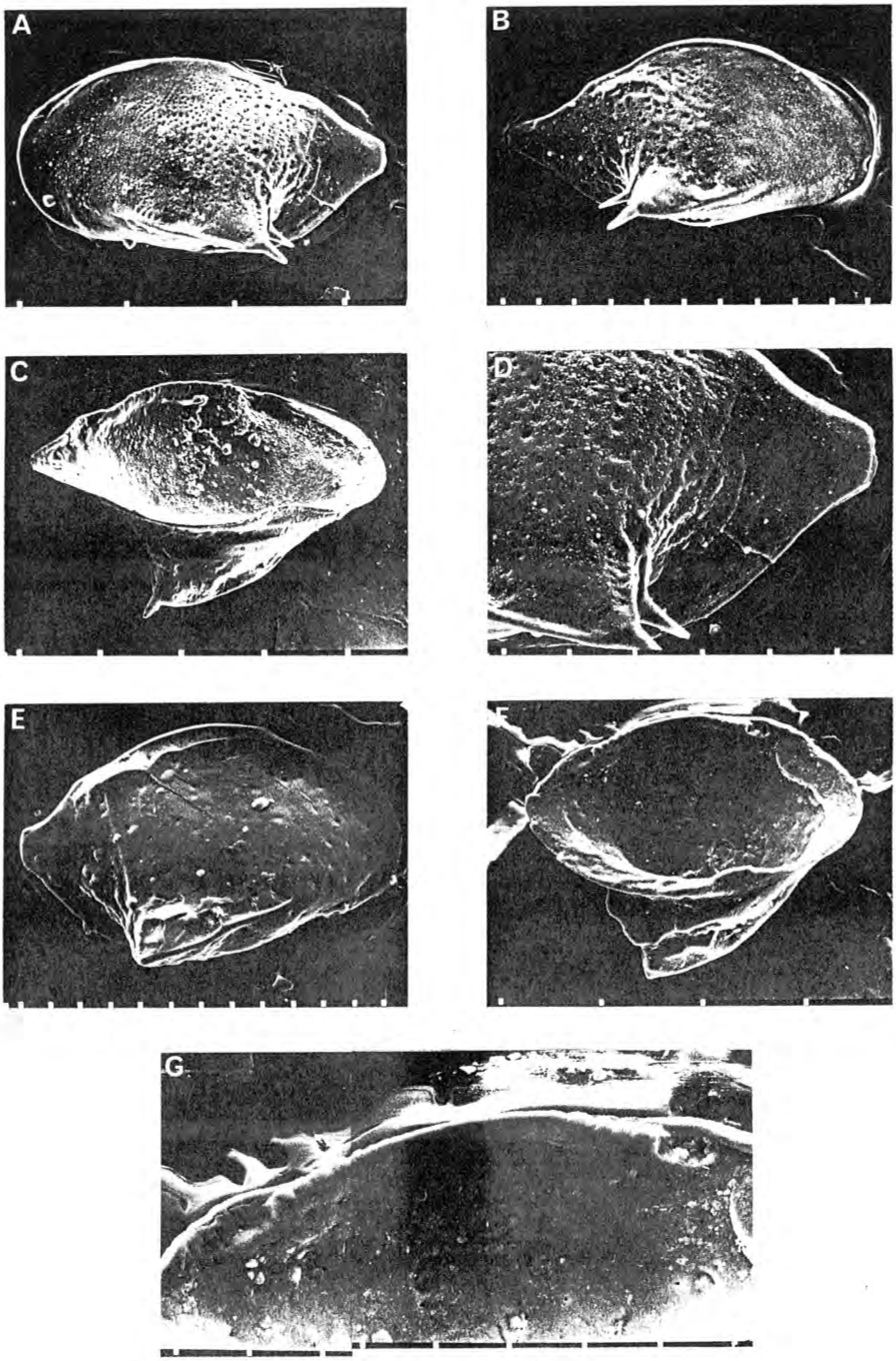

Plate 9. A-D. Cytheropteron (Aversovalva) cf C. mccomborum Neale, 1975. A. LV external. B. RV external. C. LV internal. D. LV detail external posterior.
E-G. Cytheropteron (Aversovalva) sp A524. E. RV external. F. LV internal. G. LV detail hinge.

Scale bars - A,C,F = 100μ , B,D,E,G = 30μ .
A,C,D = P548, #810; B = P550, #810; E,F,G = P525, #1275.

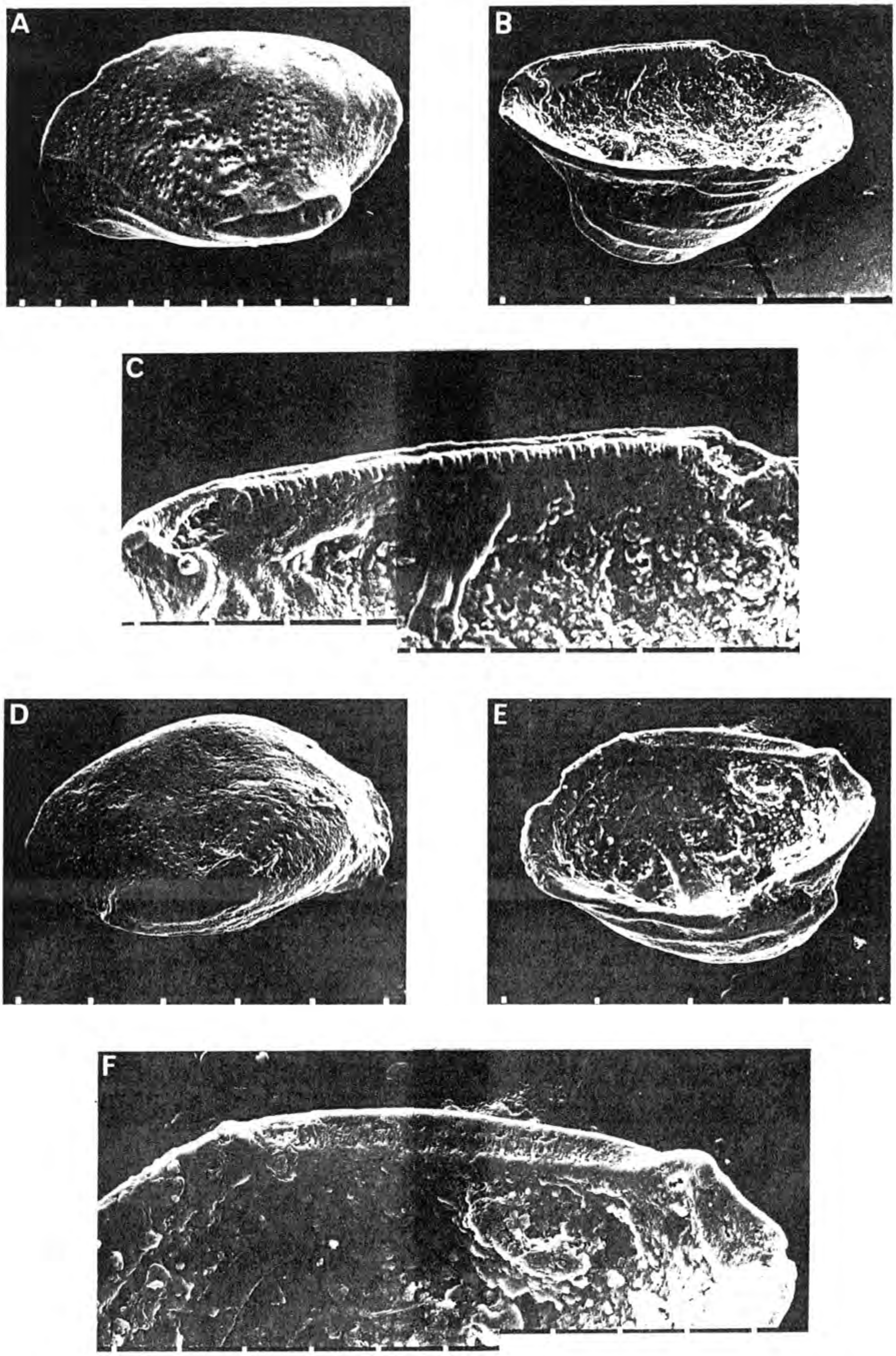

Plate 10. A-C. <u>Cytheropteron</u> <u>(Aversovalva)</u> sp A530. A. LV external. B. LV internal. C. LV detail hinge. D-F. <u>Cytheropteron</u> <u>(Aversovalva)</u> cf sp A530. D. RV external. E. RV internal. F. RV detail hinge.

Scale bars - A,C,F, = 30μ , B,D,E = 100μ .
A,B,C = P530, #810; D,E,F = P950, #1275.

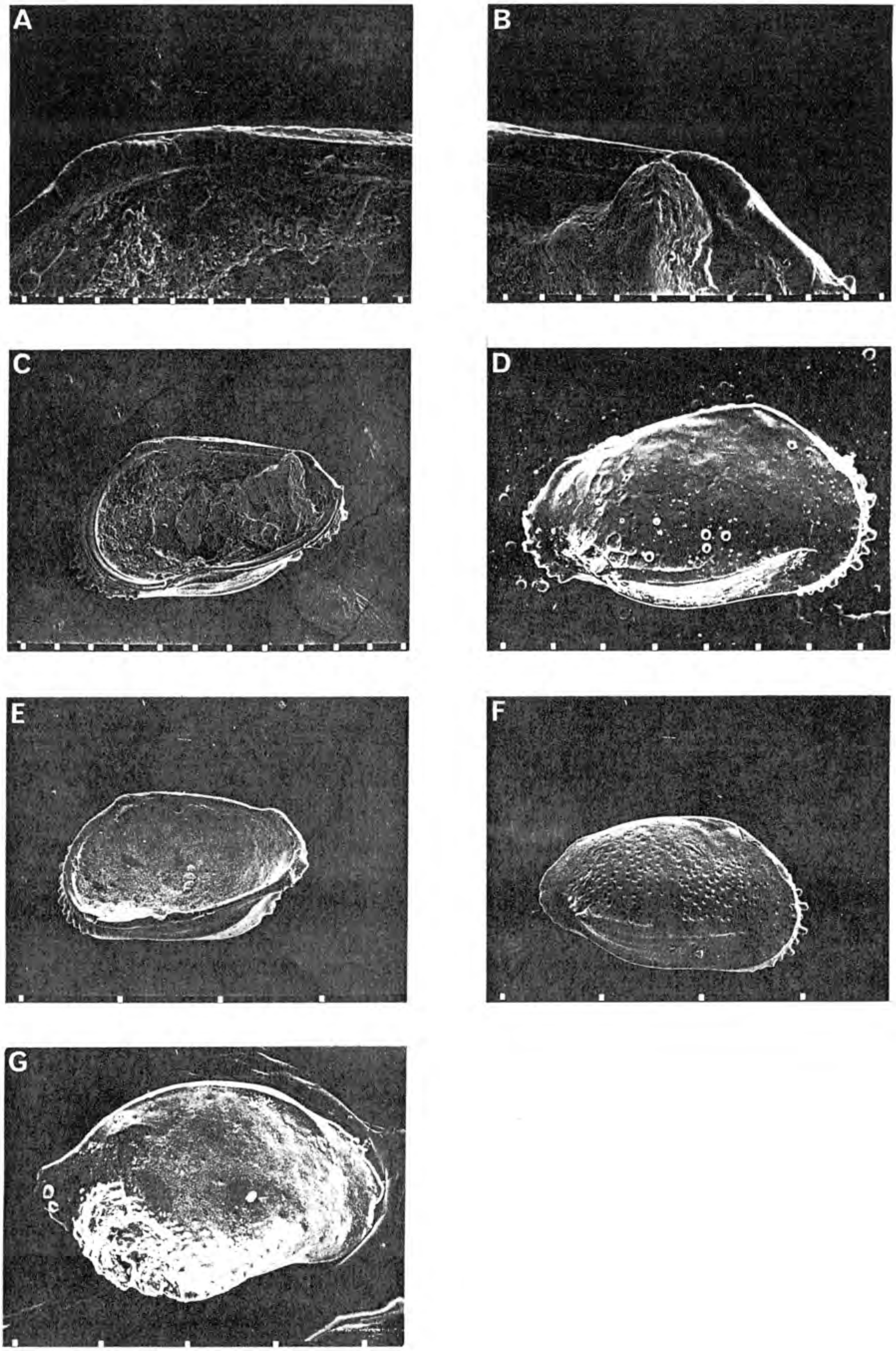

Plate 11. A-D. ?Cytheropteron (Cytheropteron) sp A498.
A. RV detail ATE. B. RV detail PTE. C. RV internal.
D. RV external. E-F. Dingle's (unpublished) GR 70 (209m) specimens. E. RV internal. F. RV external.
G. C. sp A538, LV external.

Scale bars - A,B, = 30μ , C,D,G = 100μ , E,F = 300μ .
A,B,C,D = P498, #1277; G = P538, #827.

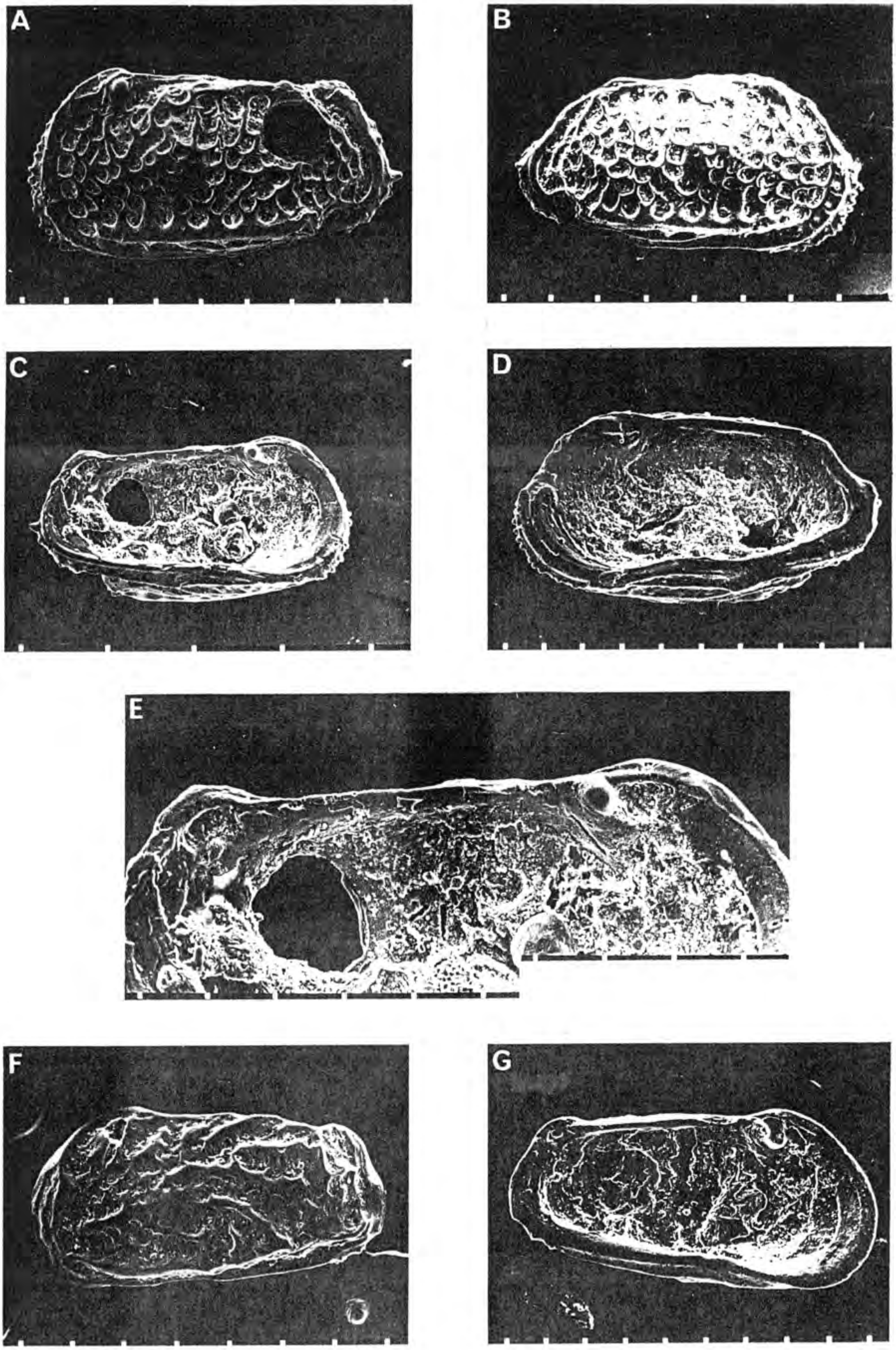

Plate 12. Ambostracon (Ambostracon) A-E. A(A) sp A93, A, LV external. B. RV external. C. LV internal. D. RV internal. E. LV detail hinge.
F-G. A(A) sp 463, F. LV external. G. A(A) sp A463, LV internal.

Scale bars - A,B,D,E,F,G = 100μ , C = 300μ .
A,C,E = P090, #2772; B,D = P093, #2772; F,G = P483, #1277.

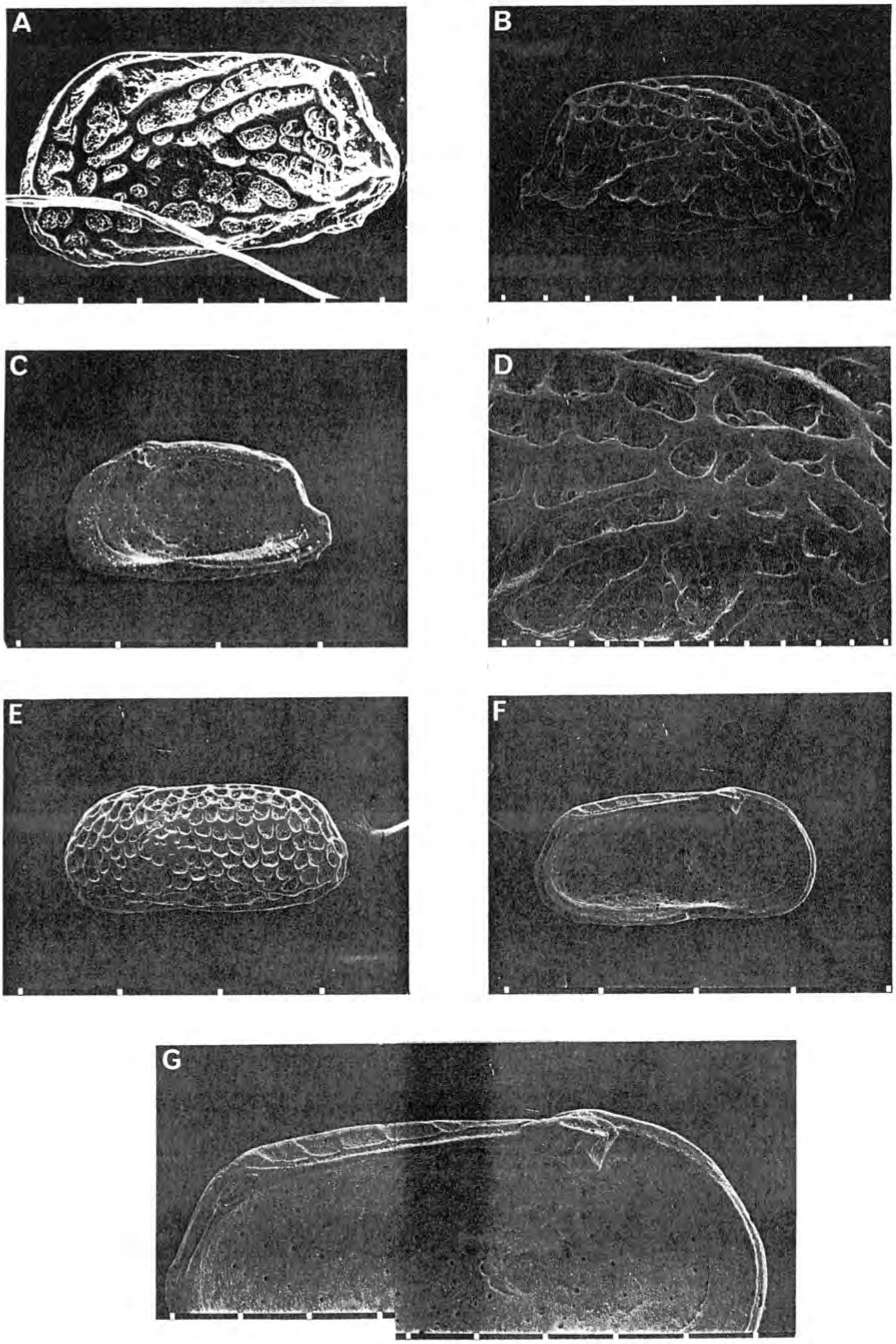

Plate 13. A-D. Ambostracon (Patagonacythere) A. A(P) sp A468, LV external. B-D. A(P) sp B1457. B. RV external. C. RV internal. D. RV detail SCT.
E-G. Urocythereis sp A1460. E. LV external. F. LV internal. G. LV detail hinge.

Scale bars - A,B,G = 100μ , C,E,F = 300μ , D = 30μ .
A = P468, #1275; B,C,D = P1457, #1094; E,F,G = P1461, #1094.

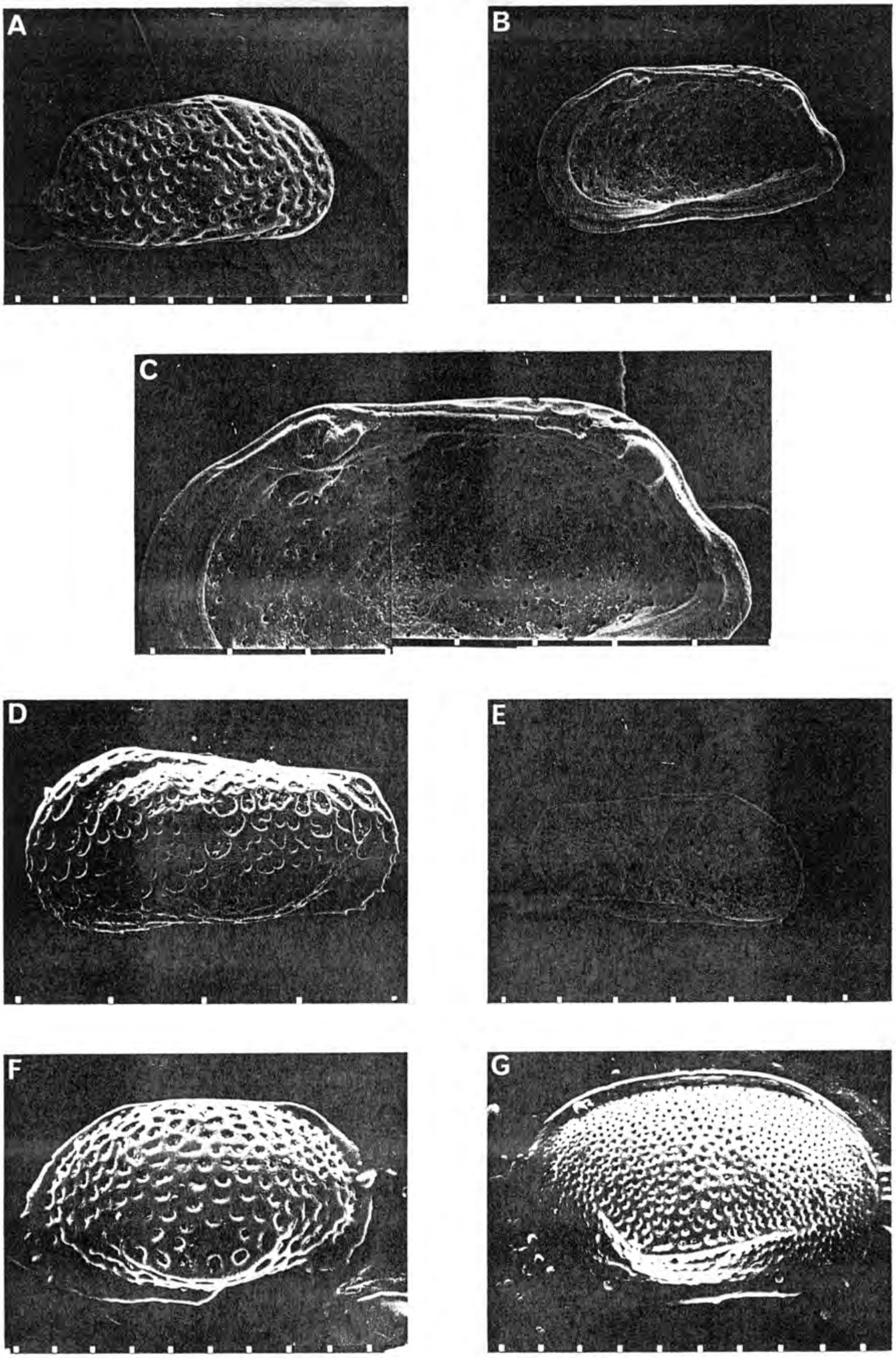

Plate 14. A-C. Urocythereis sp 272. A. RV external.
B. RV internal. C. RV detail hinge.
D-E. Muellerina sp A420. D. LV external. E. LV internal.
F. ?Loxoconcha sp, LV external. G. Loxoconcha cf L. walvisbaiensis Hartmann 1974, RV external.

Scale bars - A,B,C,D,E = 100μ , F,G = 30μ .
A,B,C = P272, #1094; D,E = P1420, #827; F = P3246, #810; G = P3002, #810.

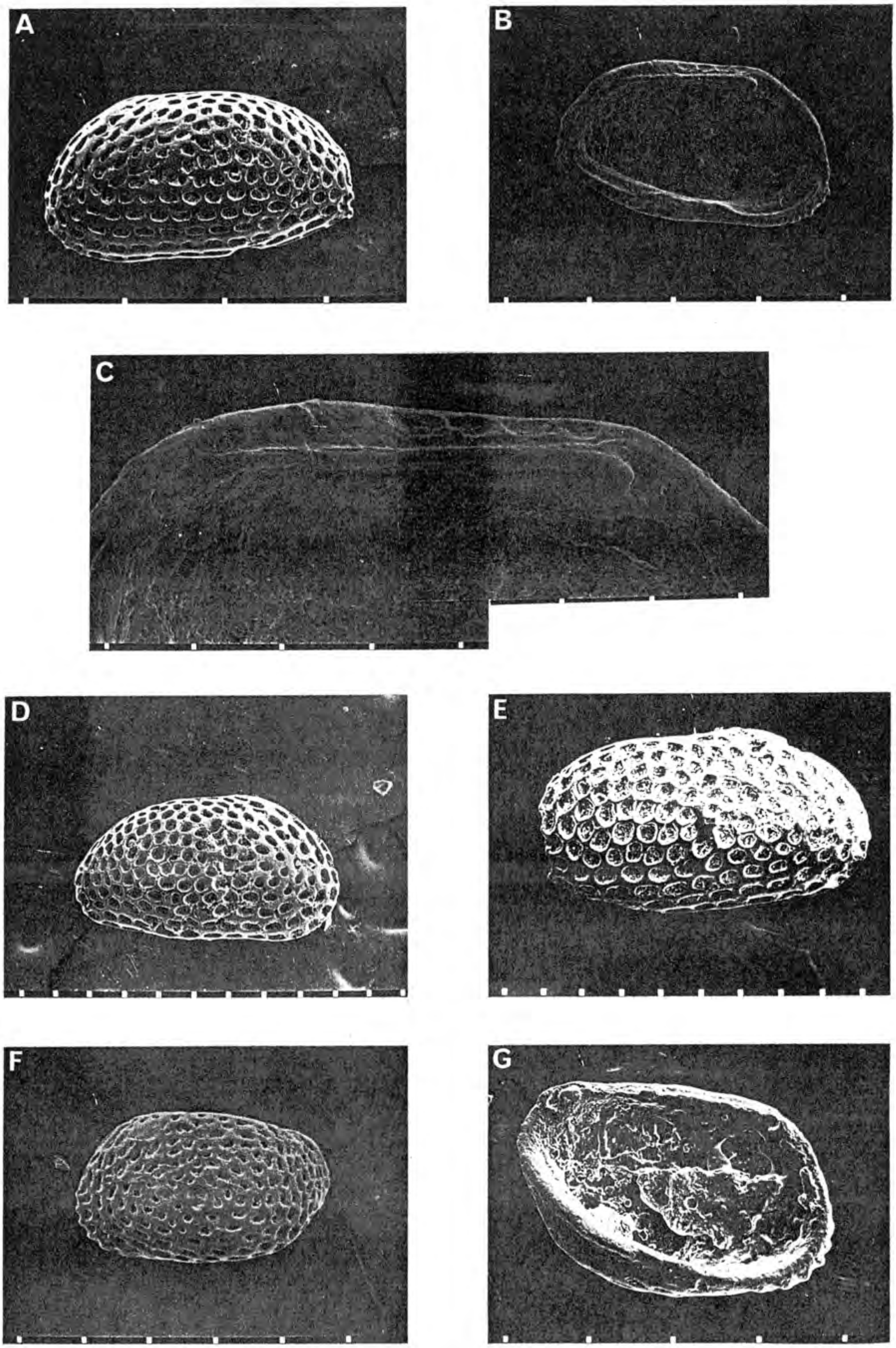

Plate 15. A-D. Leguminocythereis sp 1507. A. LV external. B. LV internal. C. LV detail hinge. D. RV external.
E. Leguminocythereis cf exigua Apostolescu 1961 , RV external.
F-G. Loxoconcha sp B188. F. LV external. G. LV internal.
Scale bars - A,C,D,E,F,G = 100µ , B = 300µ .
A,B,C = P1507, #1275; D = P1463, #1094; E = P1412, #1275; F,G = P188, #1094.

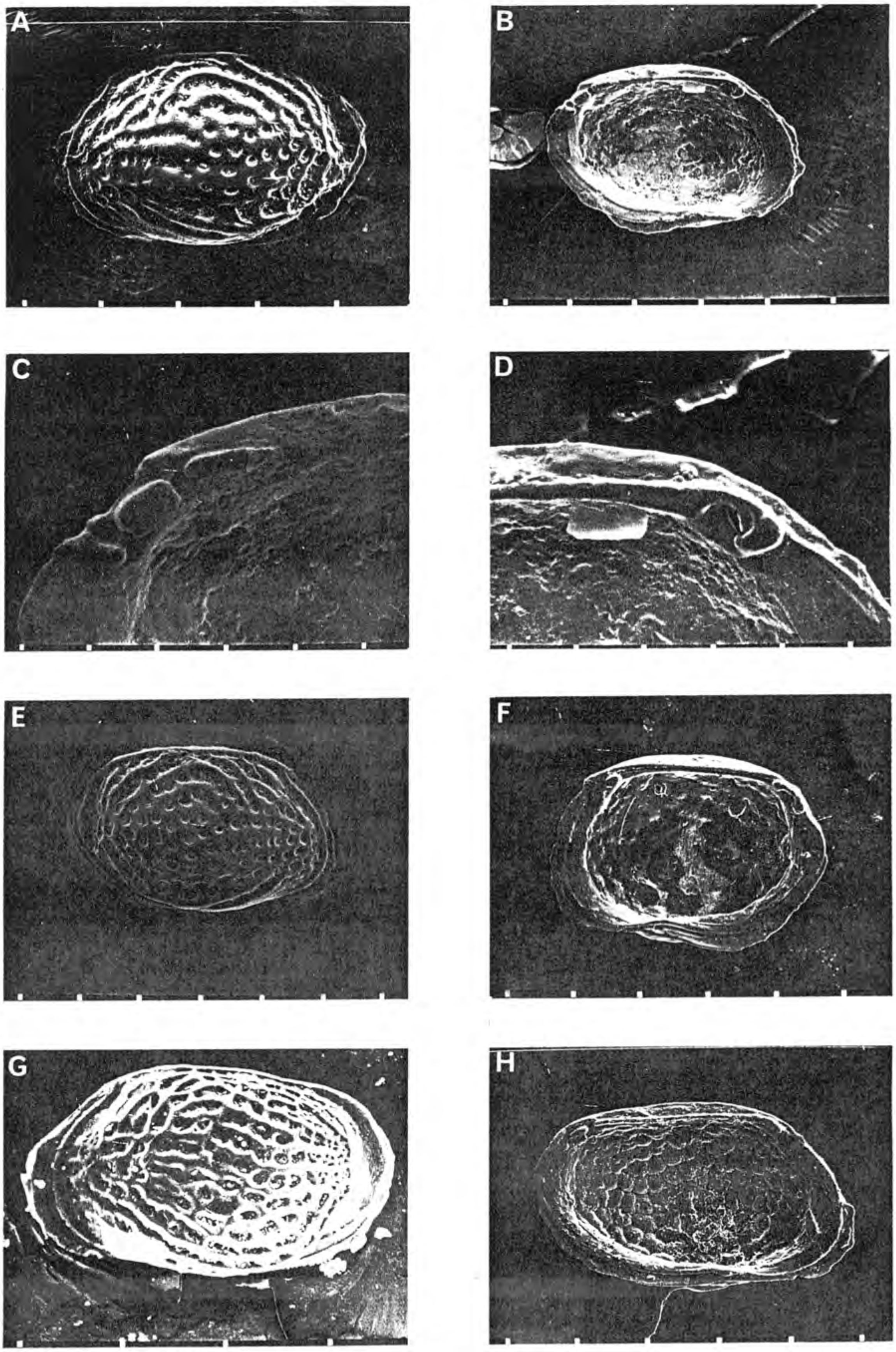

Plate 16. A-F. <u>Loxoconcha</u> sp B192. A. LV external.
B. LV internal. C. LV detail PTE. D. LV detail ATE.
E. RV external. F. RV internal. G-H. <u>Loxoconcha</u> sp A3243.
G. RV external. H. RV internal.
Scale bars - A,B,E,F,G,H = 100μ , C,D = 30μ .
A,B,C,D = P193, #1268; E,F = P185, #1268; G,H = P3243, #810.

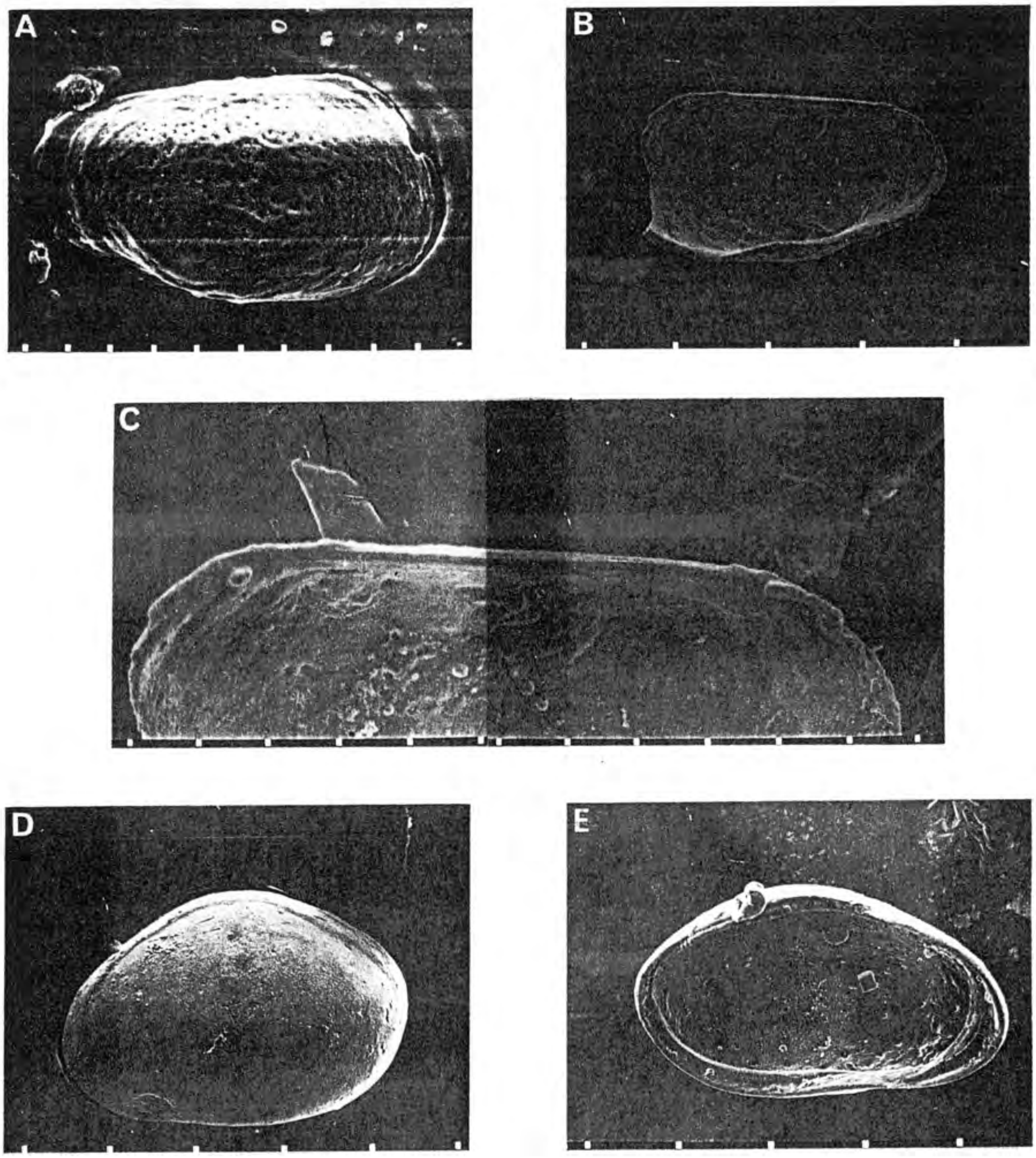

Plate 17. A-C. <u>Loxoconcha</u> sp 1430. A. RV external.
B. RV internal. C. RV detail hinge.
D-E. <u>Sclerochilus</u> sp. D. RV external. E. RV internal.
Scale bars - A,C = 30μ , B,D,E = 100μ .
A,B,C = P1430, #827; D,E = P1580, #827.

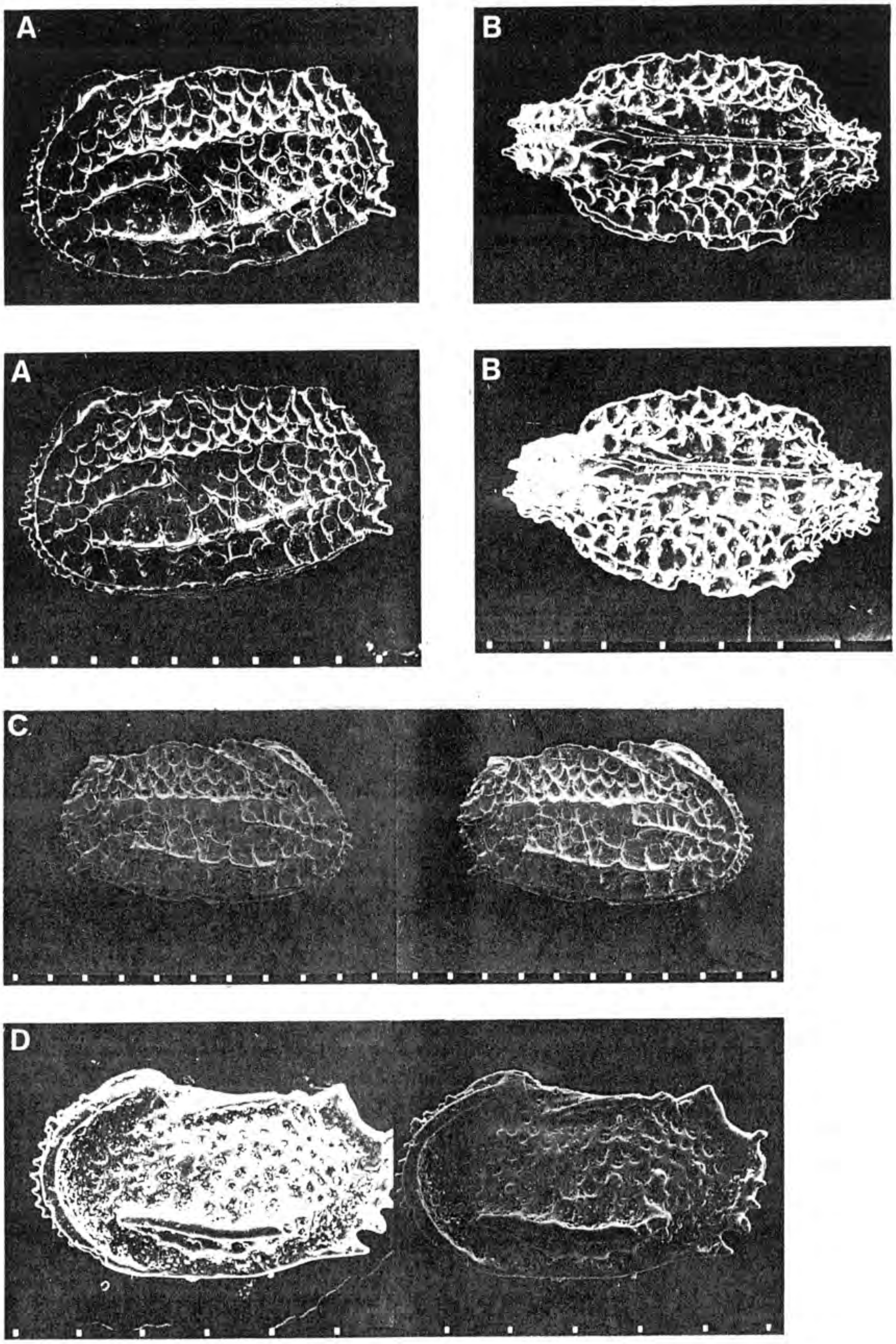

Plate 18. A-C. ?Bradleya sp A649. A. LV external, stereo. B. Dorsal view carapace, stereo. C. RV external, stereo. D. ?Poseidonamicus sp A126, LV external, stereo.
Scale bars - all 100μ .
A,B,C = P649, #1276; D = P126, #1105.

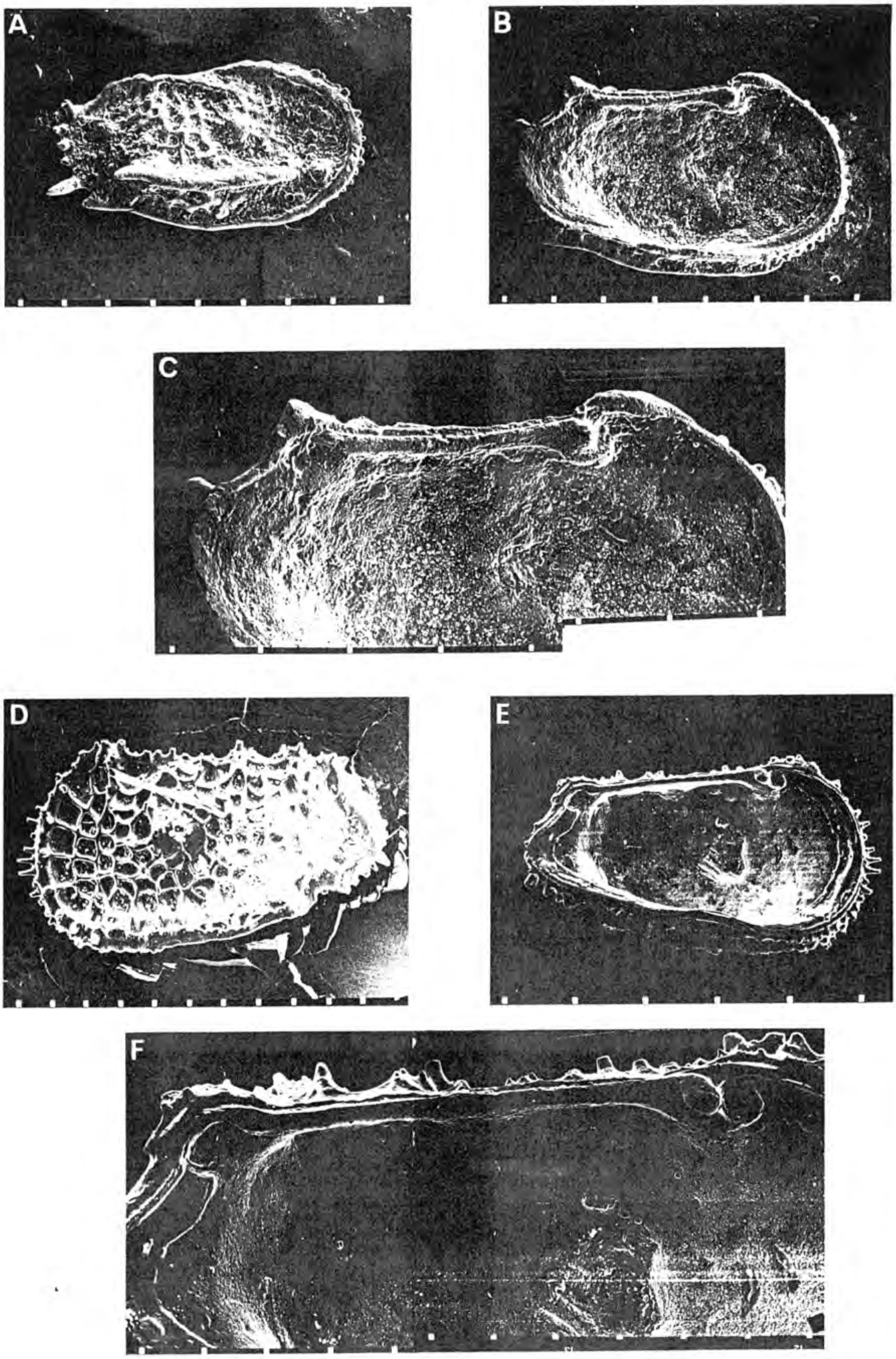

Plate 19. A-C. ?Poseidonamicus sp A126. A. RV external. B. RV internal. C. RV detail hinge. D-E. ?Agrenocythere hazelae van den Bold, 1946. D. LV external. E. LV internal. F. LV detail hinge.

Scale bars - A-E = 100μ , F = 30μ .

A = P1525, #1105; B,C = P1515, #1105; D.E,F = P357, #1125.

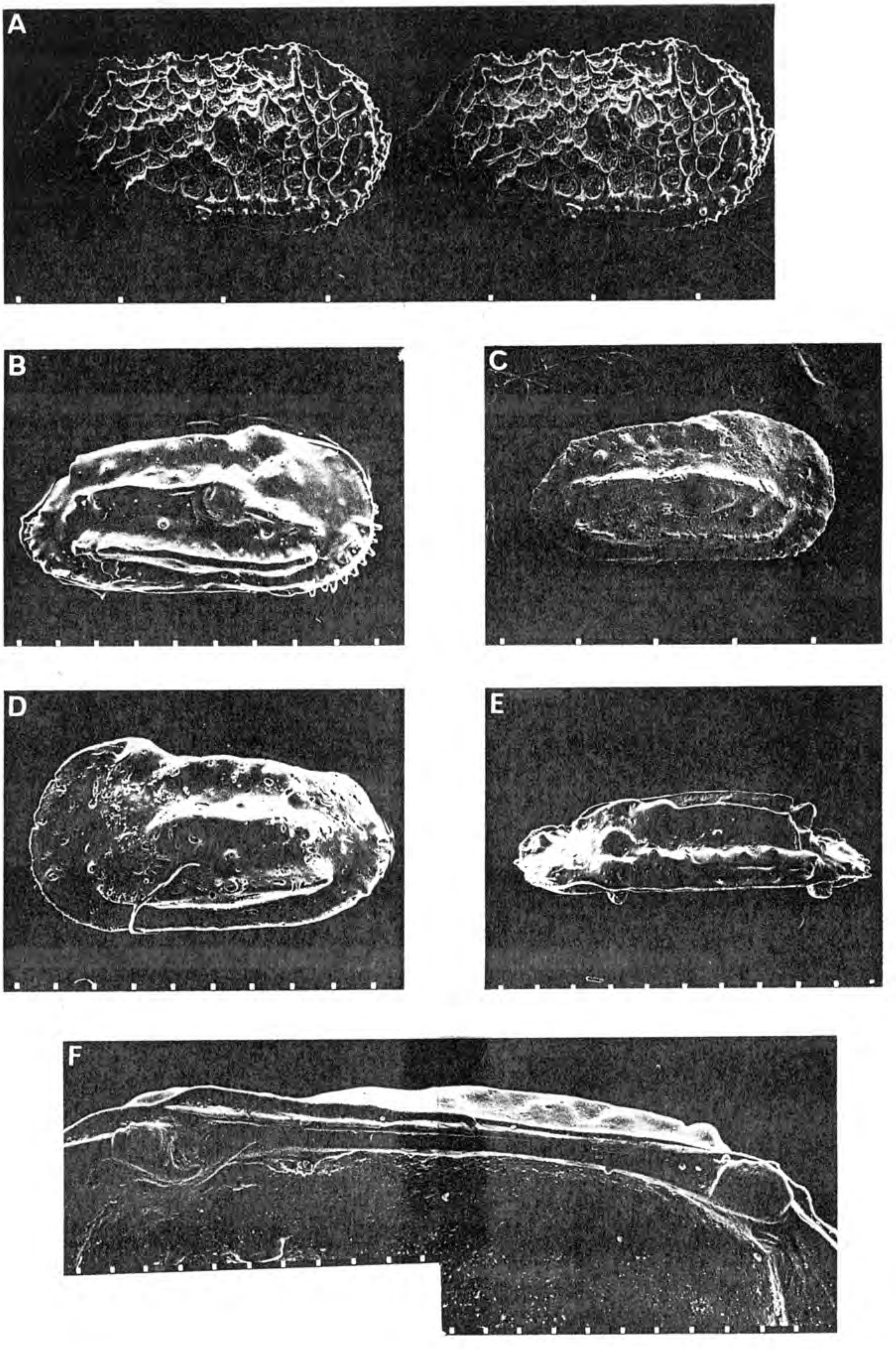

Plate 20. A. ?Agrenocythere hazelae (van den Bold 1946), RV external, stereo. B-F. Australileberis stangerensis Dingle, 1981. B. RV external. C. RV external. D. LV external. E. RV dorsal. F. RV detail hinge.

Scale bars - A,C = 300μ , B,D,E = 100μ , F = 30μ . A = P352, #1125; B = P002, #2772; C = P119, #1303; D = P026, #2772; E,F = P012, #2772.

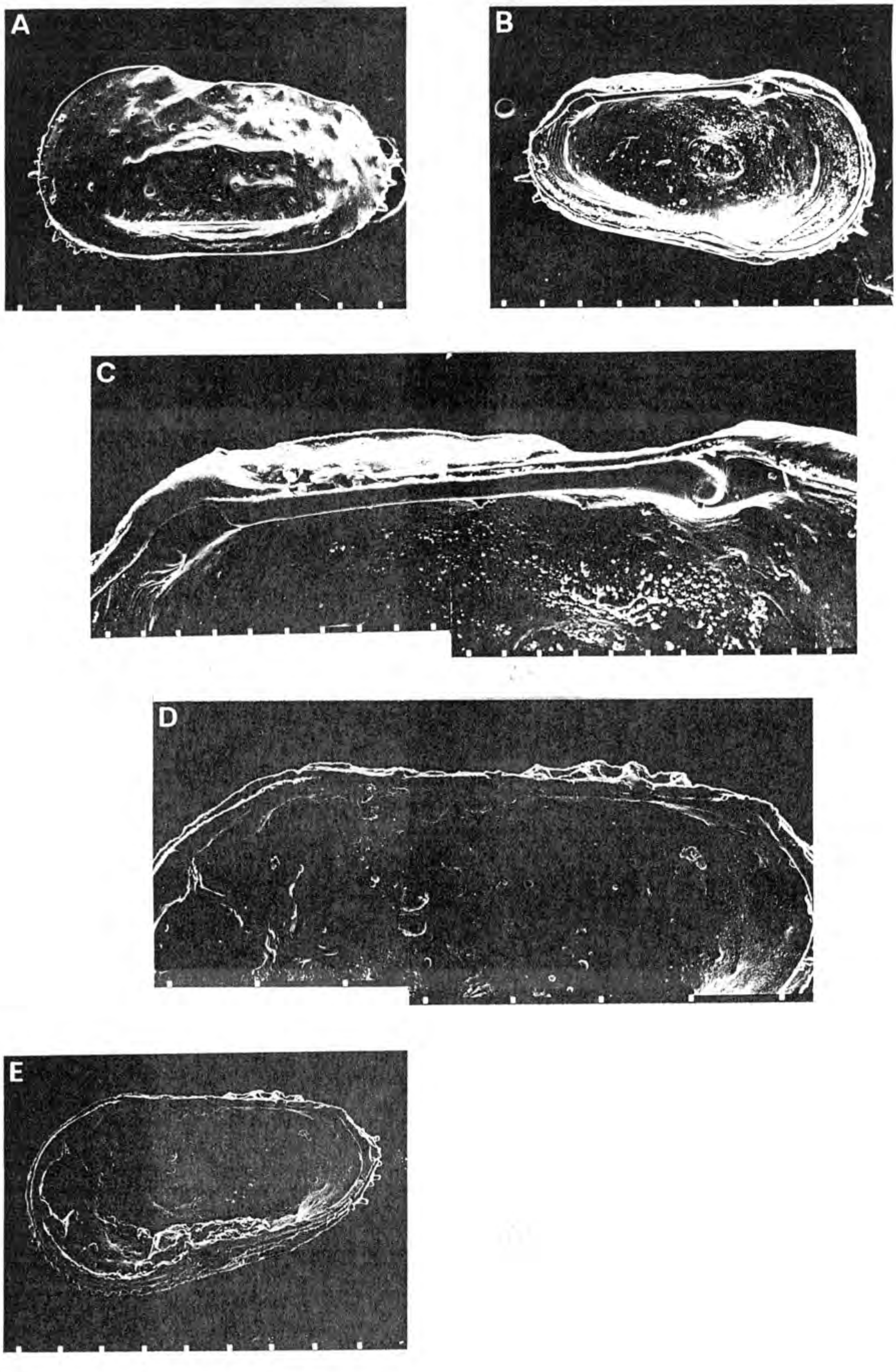

Plate 21. A-C. Australileberis hieroglyphica Dingle, 1976.
A. LV external. B. LV internal. C. LV detail hinge.
D-E. ?Australileberis sp A472. D. RV detail hinge.
E. RV internal.
Scale bars - A,B,D,E = 100μ , C = 30μ .
A = P014, #810; B,C = P017, #810; C,D = P865, #1125.

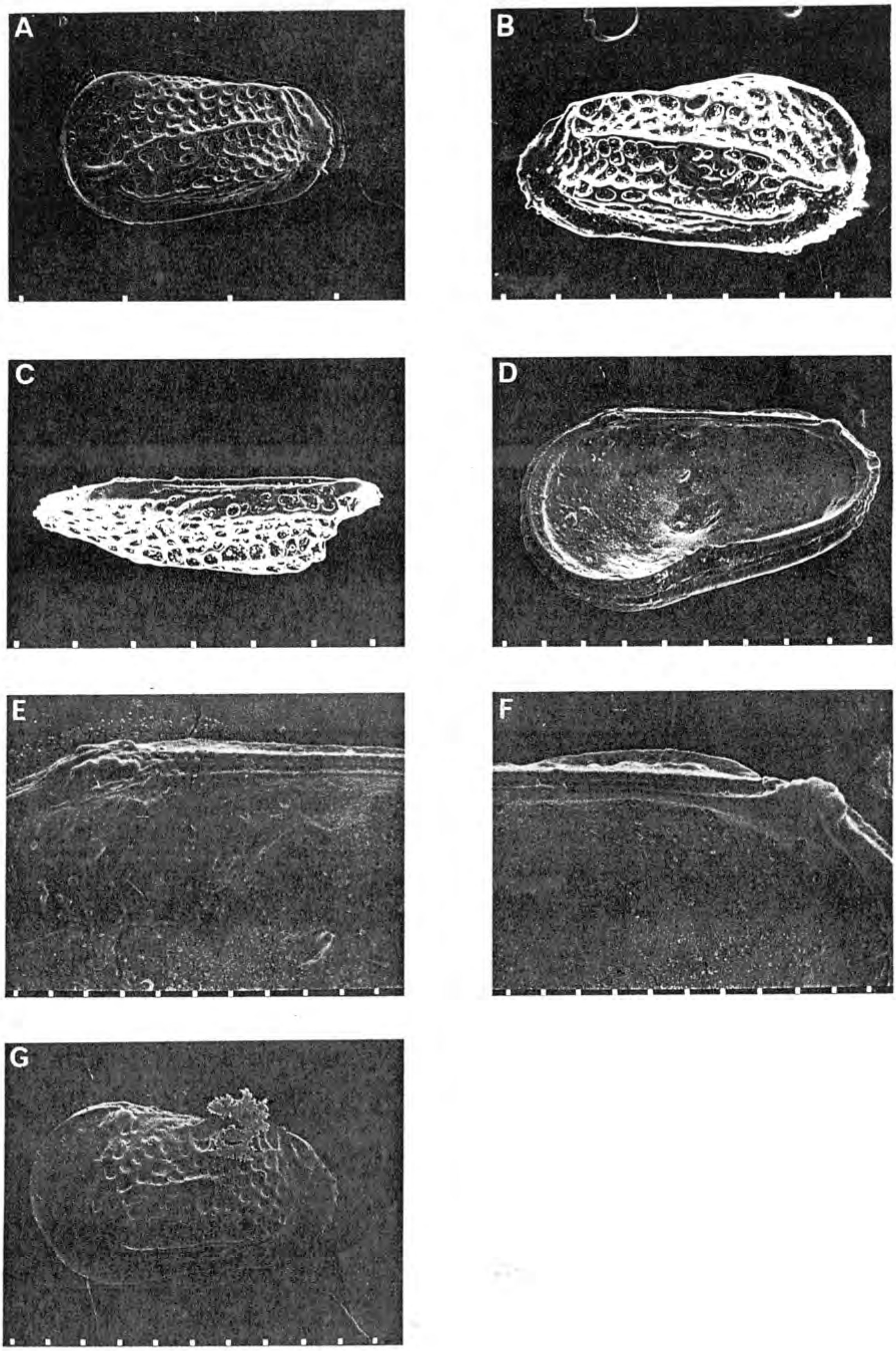

Plate 22. Australileberis sp B123. A. LV external. B. RV external. C. LV dorsal. D. RV internal. E. RV detail ATE. F. LV detail PTE. G. LV external.
Scale bars - A,C,D,G = 100μ , B,E,F = 30μ .
A = P123, #2772; B = P036, #2772; C = P048, #1706; D,E = P096, #1125; F = P99, #810; G = P130, #810.

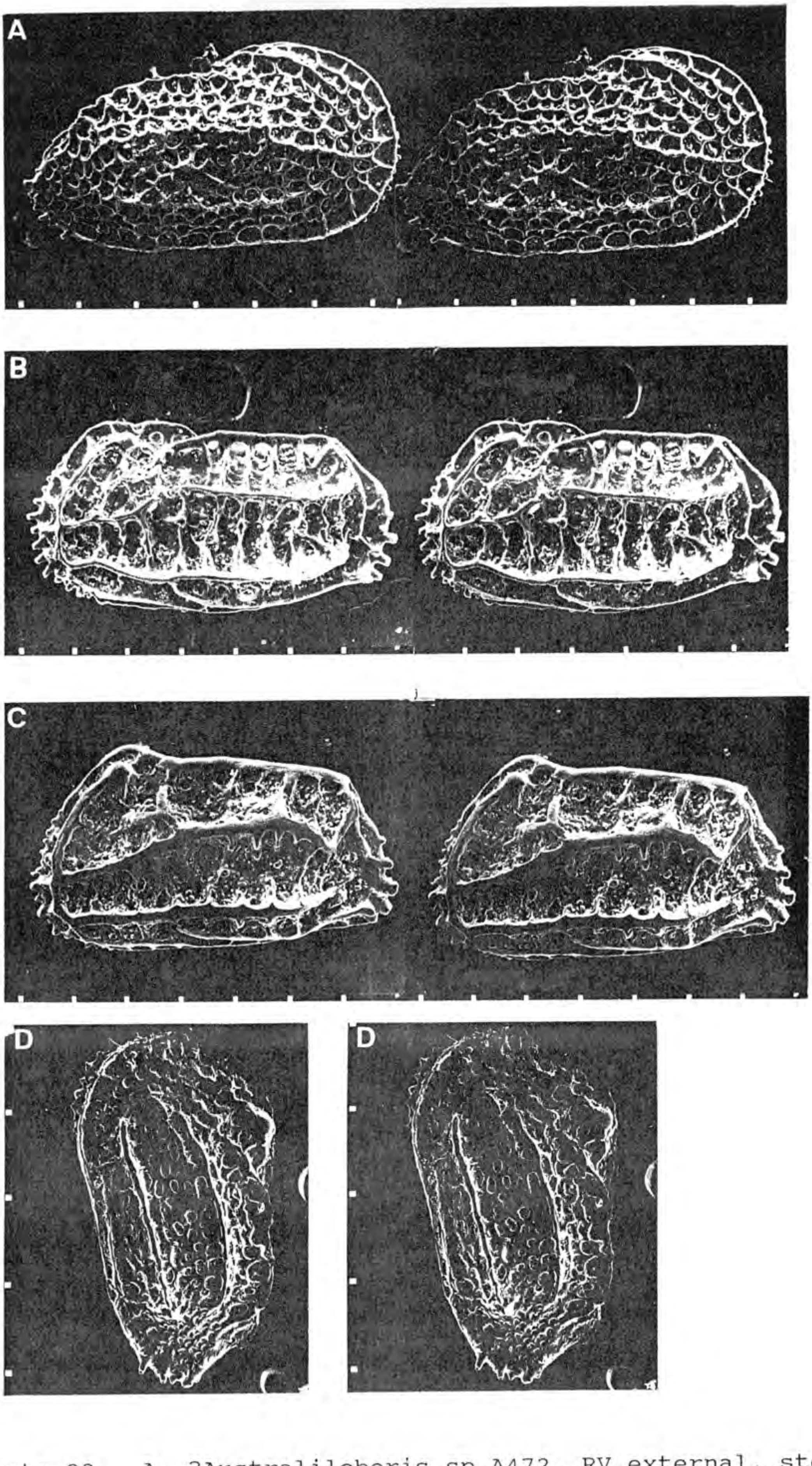

Plate 23. A. <u>?Australileberis</u> sp A472, RV external, stereo.
B. <u>Chrysocythere</u> sp A096, LV external, stereo.
C. <u>Chrysocythere</u> sp A105, LV external, stereo.
D. <u>Costa (Paracosta)</u> sp A640, LV external, stereo.
Scale bars - A,B,C = 100μ , D = 300μ .
A = P472, #2802; B = P096, #2772; C = P105, #1276;
D = P640, #1277.

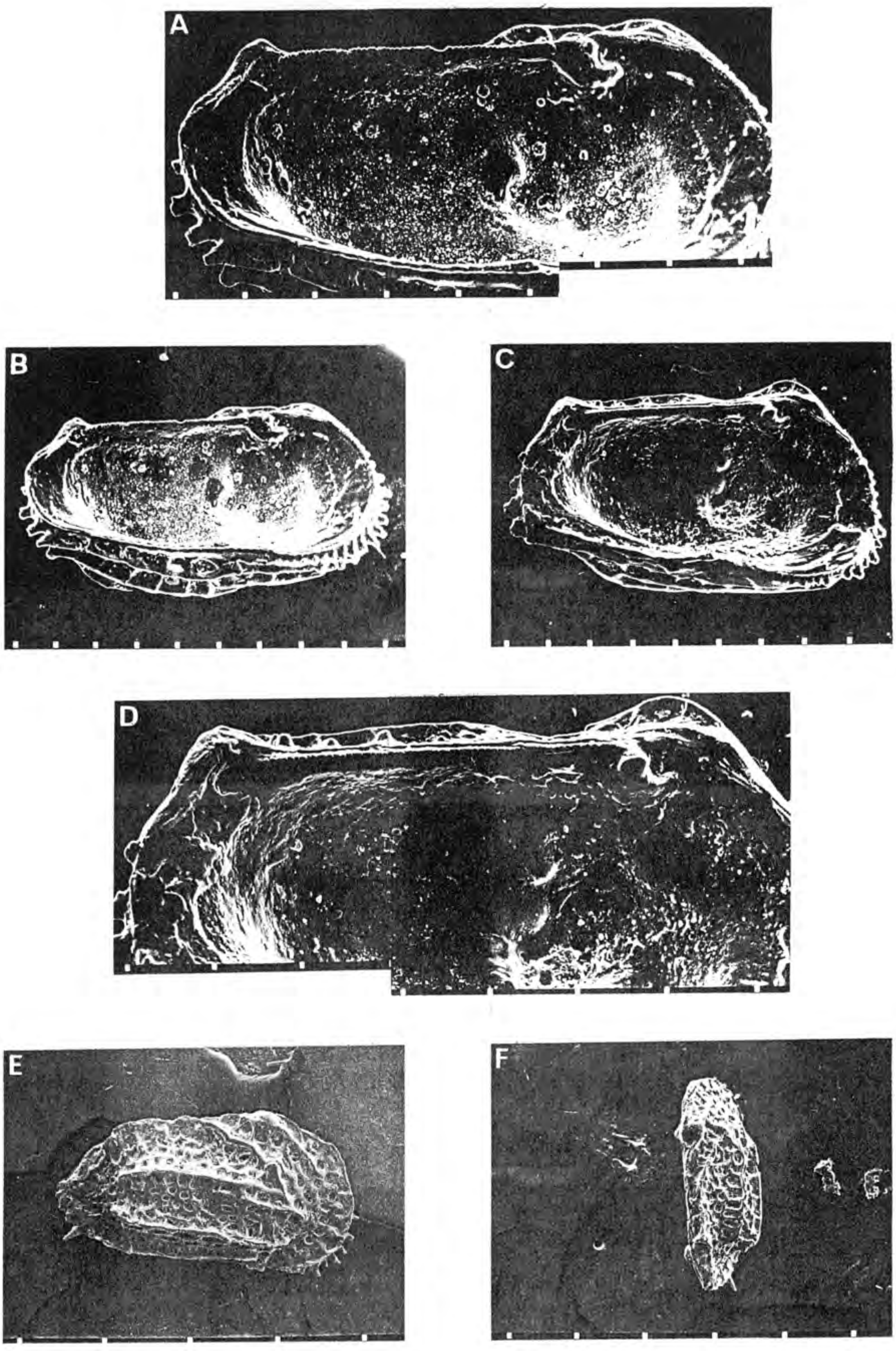

Plate 24. A-D. Chrysocythere. A. C sp A096, LV detail hinge. B. C. sp A096, LV internal. C. C. sp A105, LV internal. D. C. sp A105, LV detail hinge.
E-F. Costa (Paracosta) sp A640. E. RV external. F. RV dorsal view.

Scale bars - A,B,C,D = 100μ , E,F = 300 μ .
A,B = P076, #2772; C,D = P105, #1276; E,F = P154, #1277.

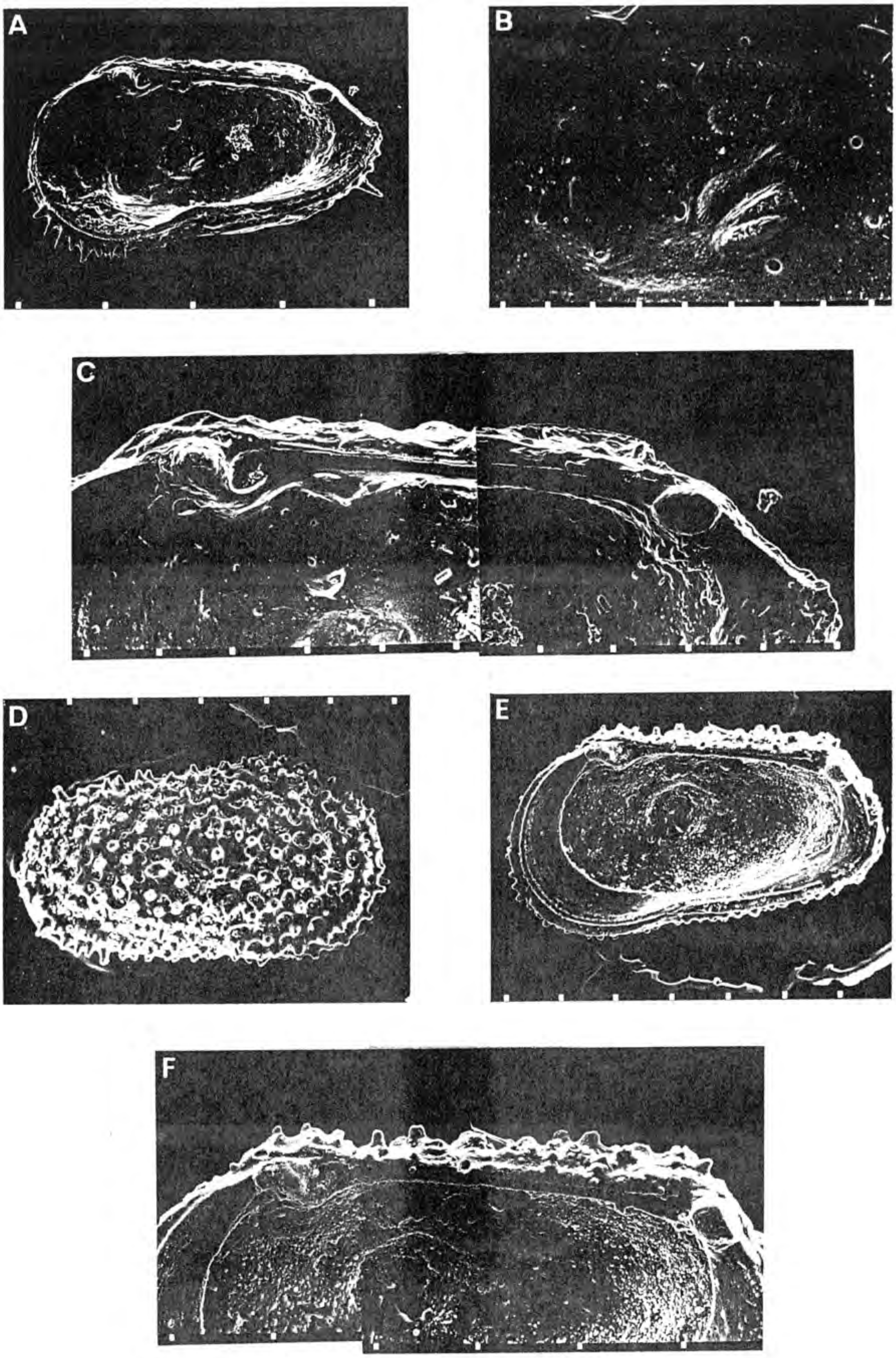

Plate 25. A-C. Costa (Paracosta) sp A640. A. RV internal.
B. RV detail MS. C. RV detail hinge.
D-F. Echinocythereis (Echinocythereis) sp A570.
D. LV external. E. RV internal. F. RV detail hinge.
Scale bars - A = 300μ , B = 30μ , C-F = 100μ .
A,B,C = P154 #1277; D = P570, #1303; E,F = P574, #1303.

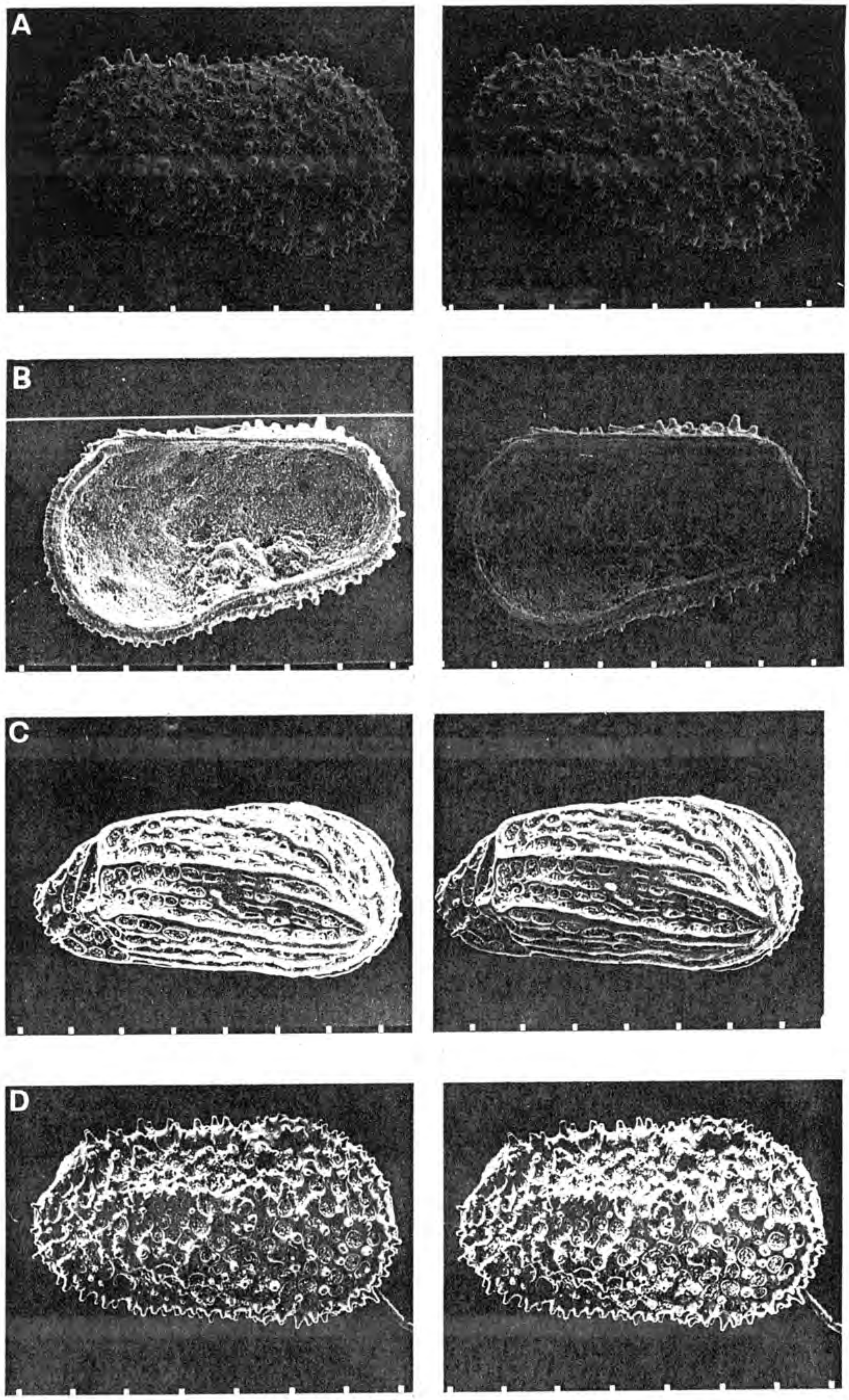

Plate 26. A-B. Echinocythereis (Echinocythereis) sp B076.
A. RV external, stereo. B. RV internal, stereo.
C. Haughtonileberis sp A075, RV internal, stereo.
D. Henryhowella asperrima? (Reuss 1850), RV external, stereo.
Scale bars - all 100μ .
A = P076, #2772; B = P065, #2772; C = P075, #2772;
D = P611, #2772.

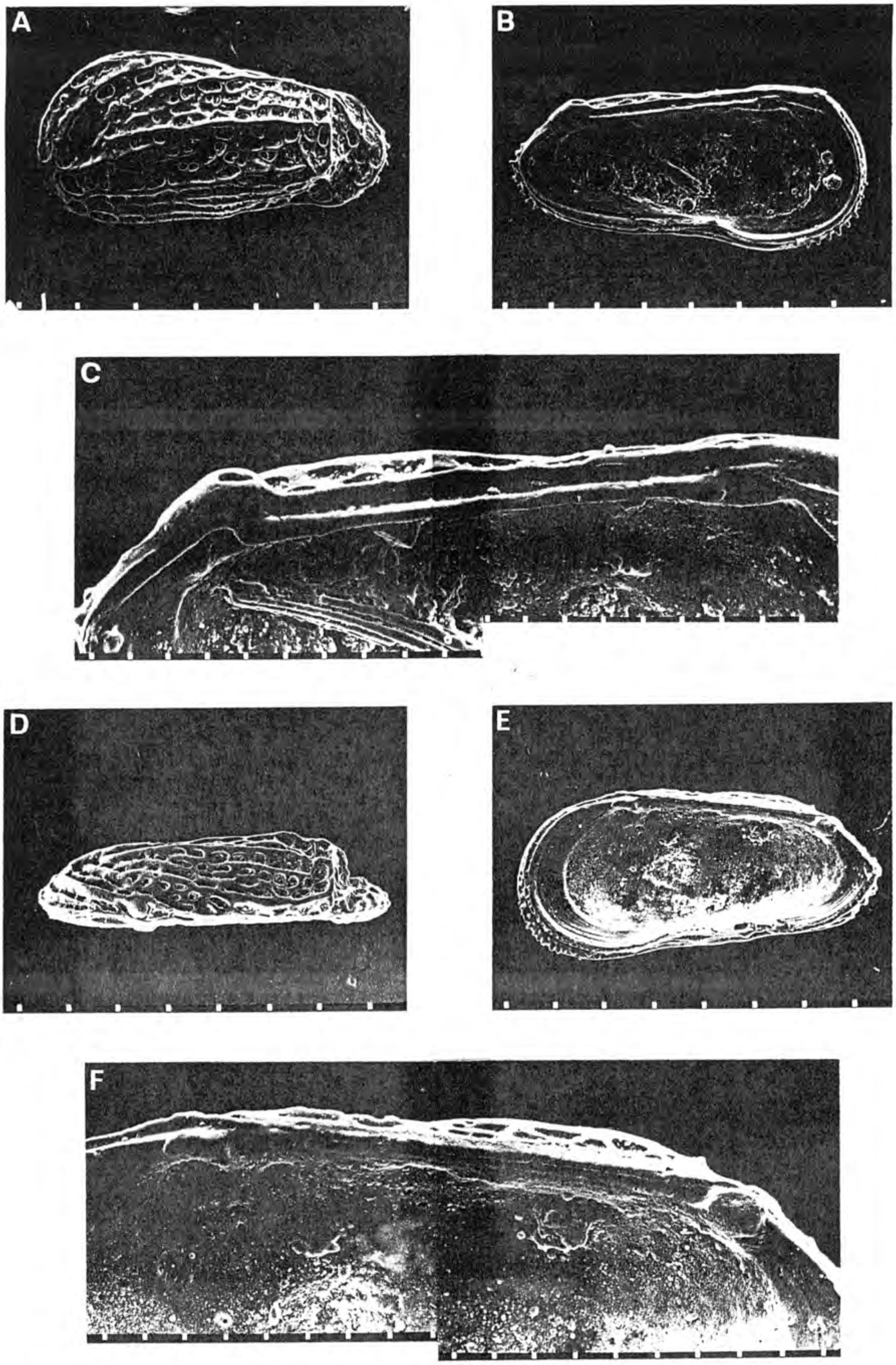

Plate 27. <u>Haughtonileberis</u> sp A075. A. LV external. B. LV internal. C. LV detail hinge. D. RV dorsal view. E. RV internal. F. RV detail hinge.
Scale bars - A,B,D,E = 100μ , C,F = 30μ .
A = P077, #2772; B,C = P080, #2772; D = P88, #2772; E,F = P85, #2772.

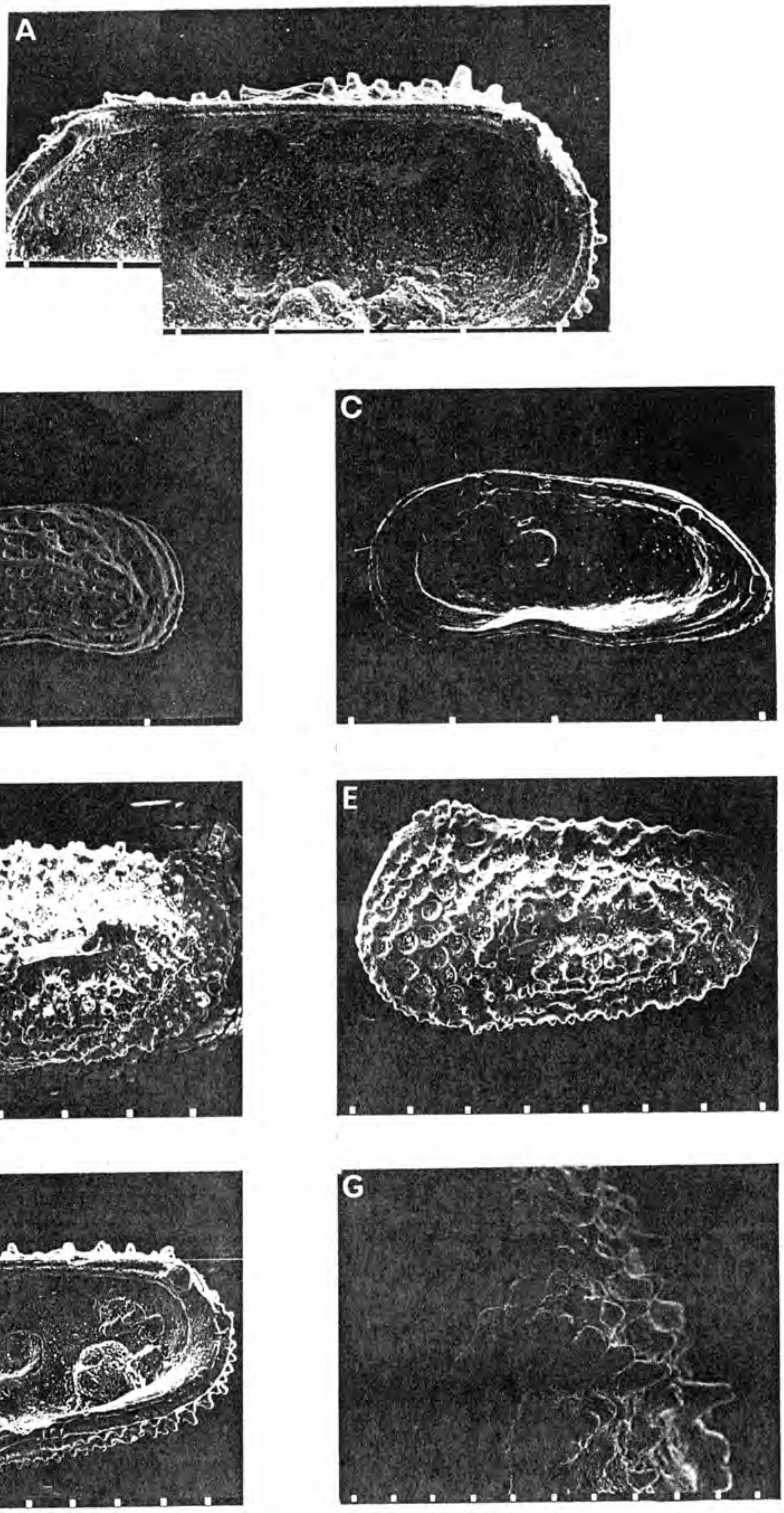

Plate 28. A. Echinocythereis (Echinocythereis) sp B076, LV detail hinge. B-C. Haughtonileberis cf Haughtonileberis radiatus Dingle, 1976. B. RV external. C. RV internal. D-G. Henryhowella asperrima? (Reuss 1850). D. LV external. E. LV, external. F. RV internal (specimen destroyed). G. RV detail ATE, Dorsal (specimen destroyed).

Scale bars - A,D,E,F = 100μ , B,C = 300μ , G = 30μ .
A = P065, #2772; B,C = P735, #1105; D,= P591, #2772; E = P601, #1706; F = P003, #2772; G = P001, #2772.

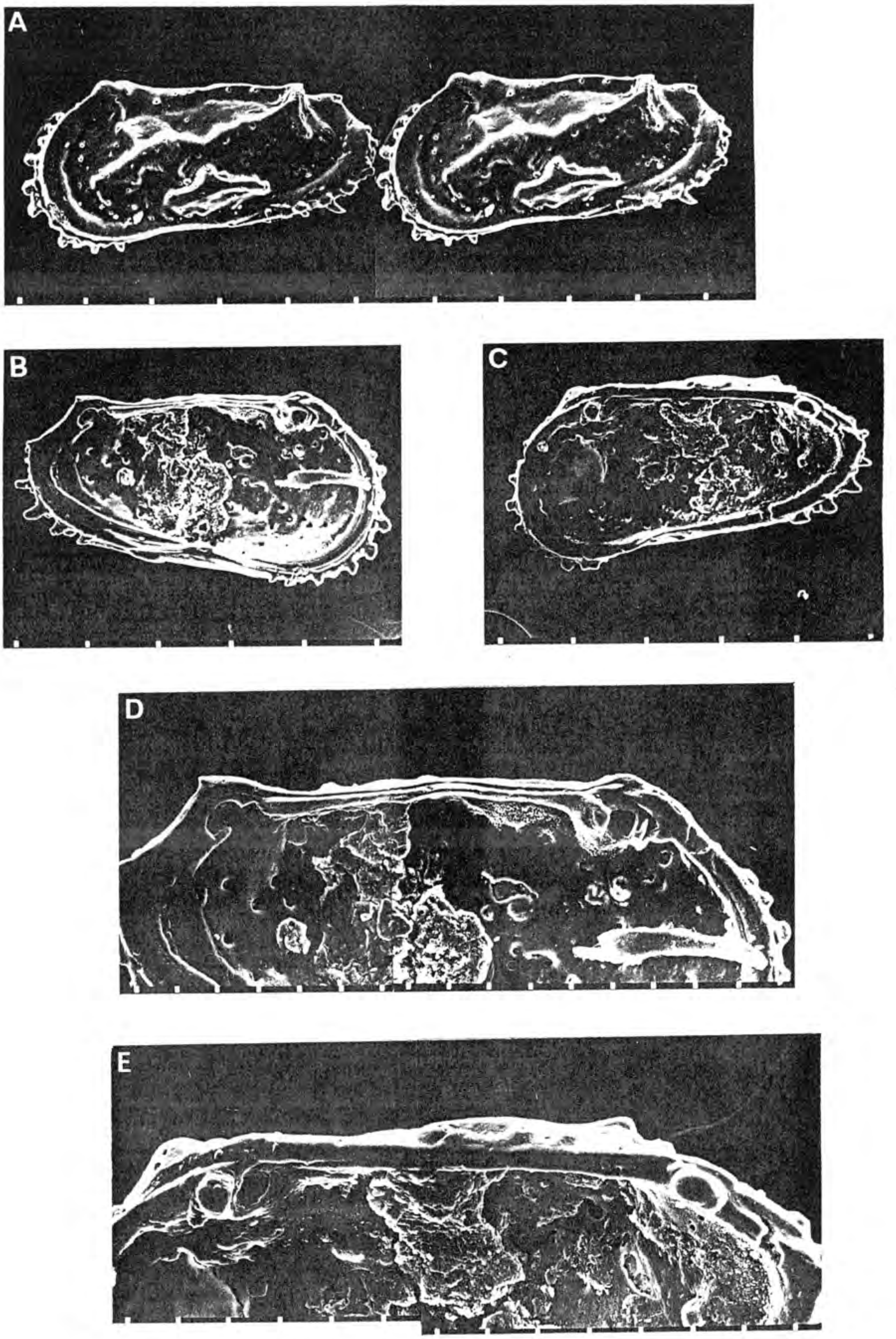

Plate 29. <u>Parvacythereis</u> sp A3260. A. LV external, stereo.
B. LV internal. C. RV internal. D. LV, detail hinge.
E. RV detail hinge.
Scale bars - A,B,C = 100µ , D,E = 30µ .
A = P3260, #810; B,D = P3268, #810; C,E = P3265, #810.

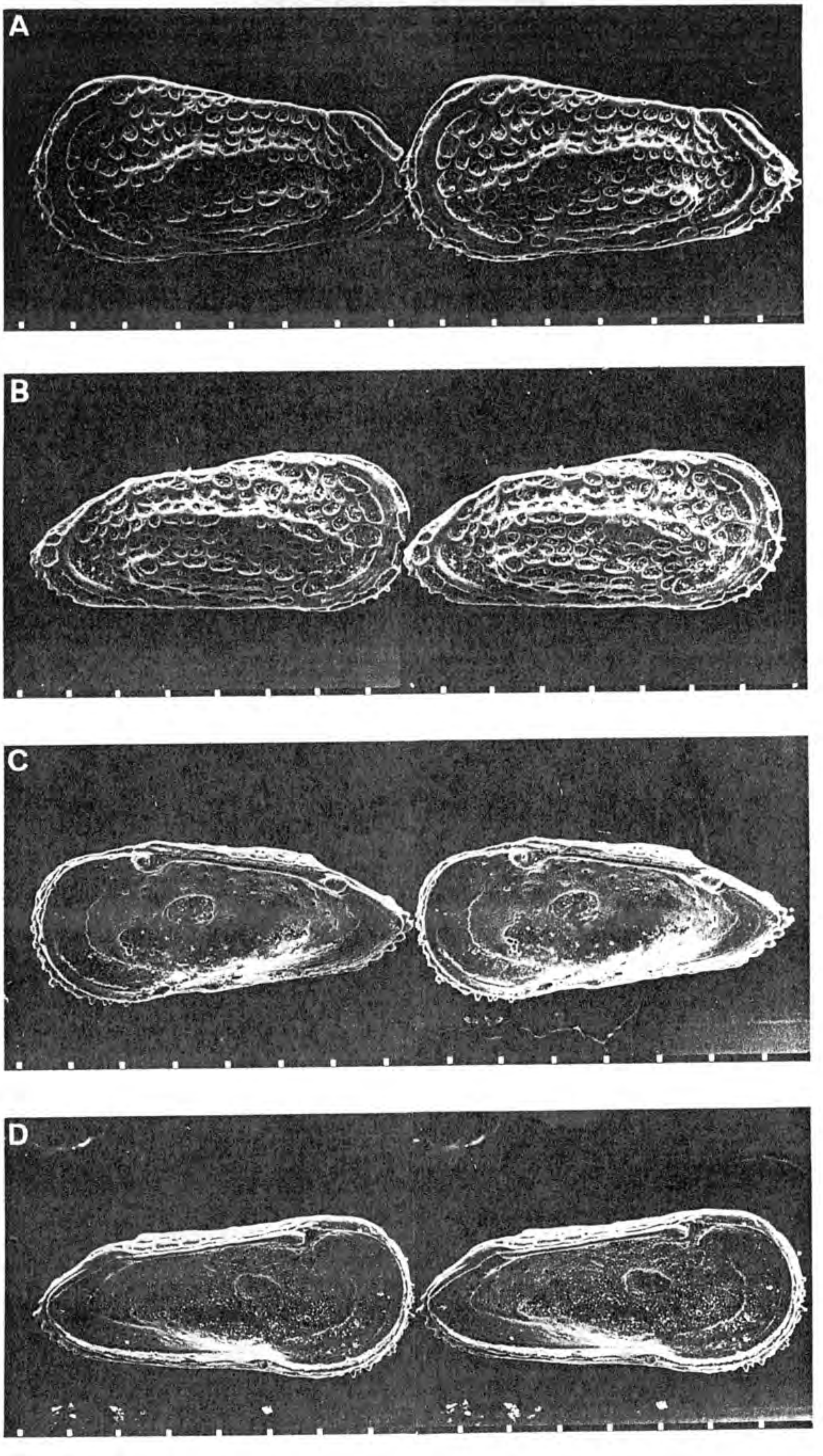

Plate 30. Parvacythereis sp A053. A. LV external, stereo.
B. RV external, stereo. C. RV internal, stereo.
D. LV internal, stereo.
Scale bars - all 100 µ .
A = P053, #2772; B = P058, #2772; C = P068, #2772;
D = P063, #2772.

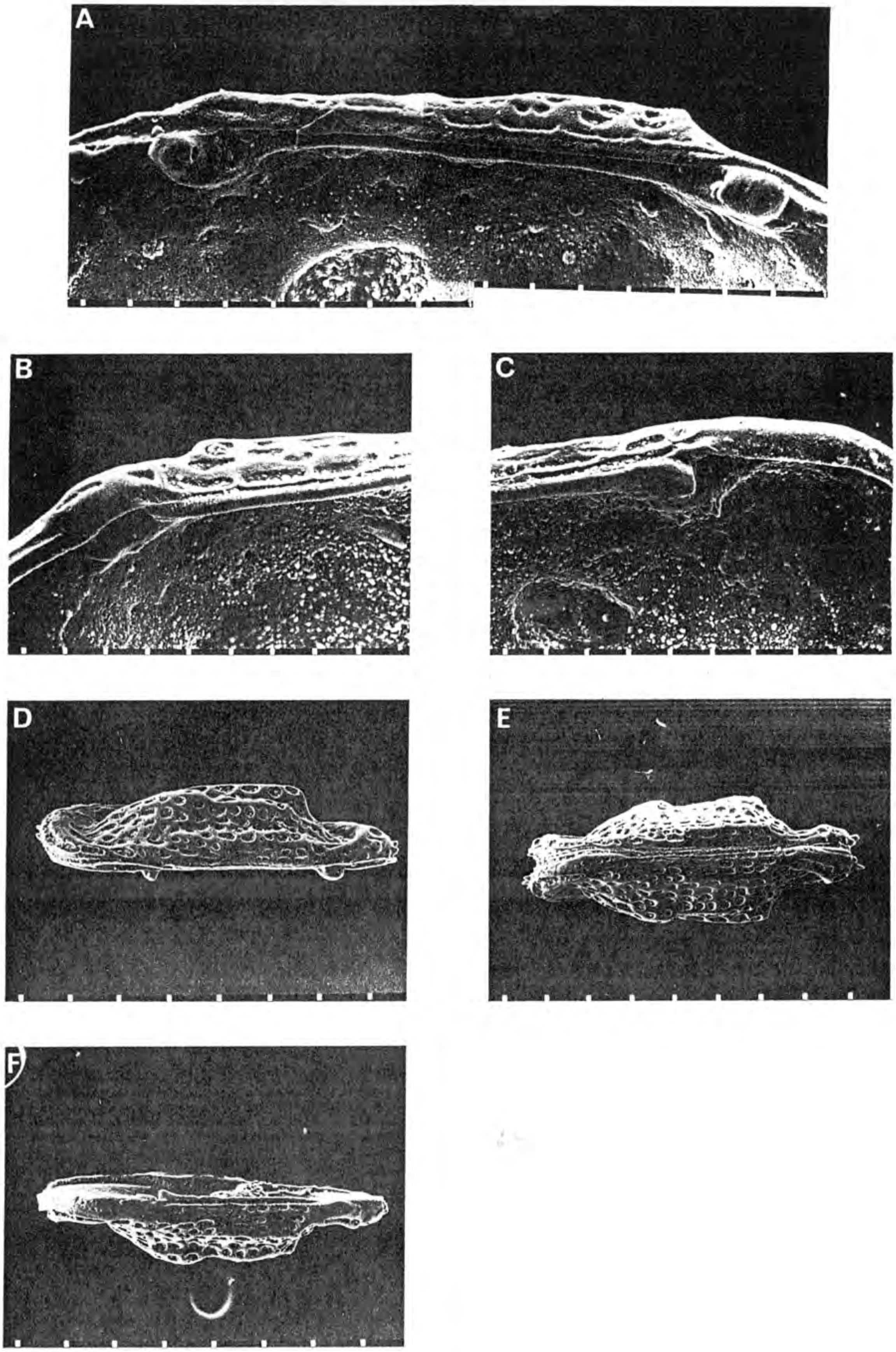

Plate 31. Parvacythereis sp A053. A. RV detail hinge. B. LV detail PTE. C. LV detail ATE. D. RV Dorsal view. E. Carapace, dorsal view. F. LV dorsal view.
Scale bars - A,B,C = 30μ , D,E,F = 100μ .
A = P068, #2772; B = P076, #2772; C = P066, #2772; D,E = P073, #2772; F = P72, #2772.

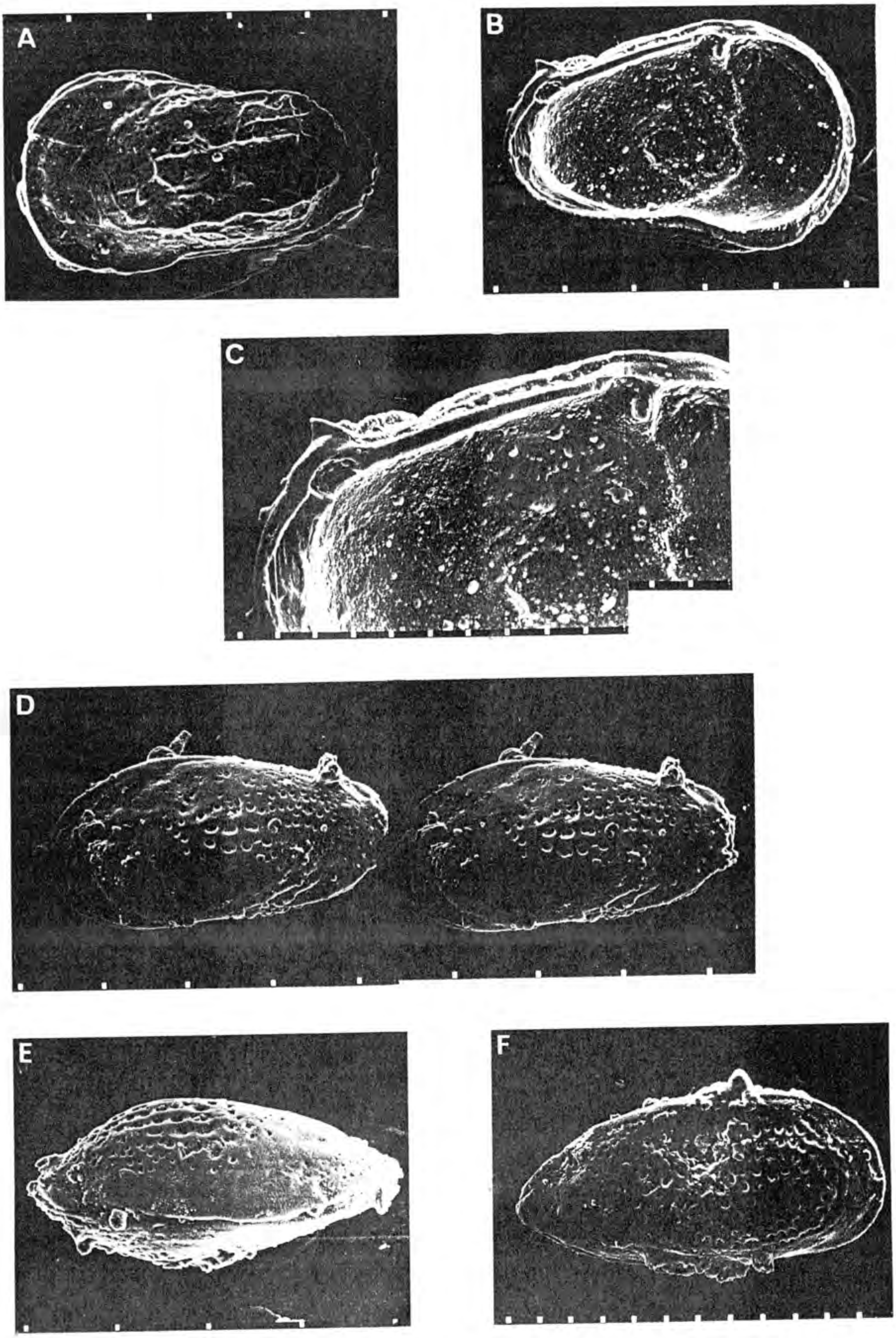

Plate 32. A-C. Phacorhabdotus sp A1424. A. RV external.
B. RV internal. C. RV detail hinge.
D-F. Togoina. D. T. sp A1441, LV external, stereo.
E. T. sp A1441, dorsal view carapace (specimen destroyed).
F. T. sp A1446, RV external.
Scale bars - A,B,D,E = 100μ , C,F = 30μ .
A,B,C = P1424, #1125; D = P1440, #810; E = P1449, #811;
F = P1446, #811.

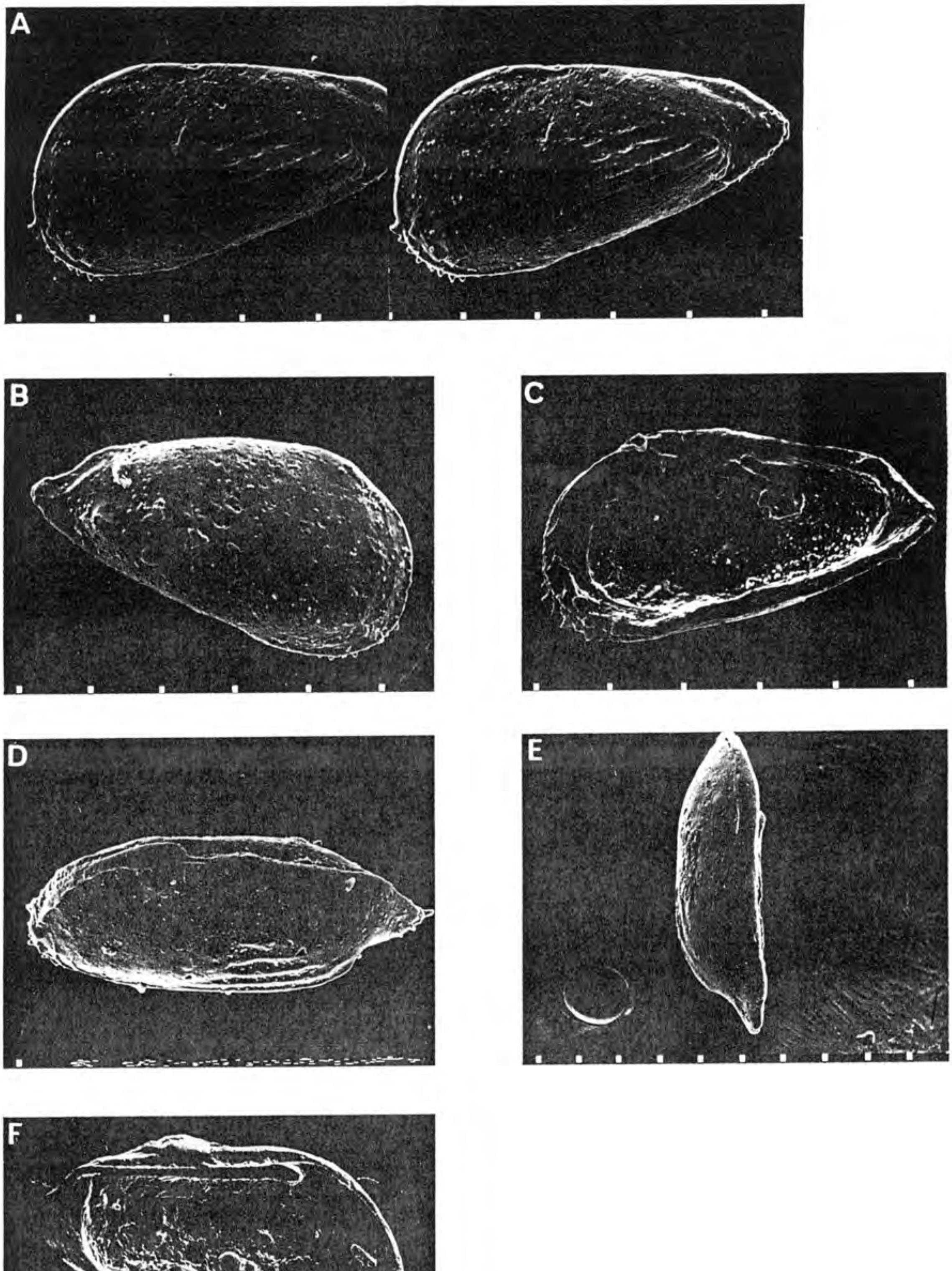

Plate 33. <u>Soudanella</u> sp A151. A. LV external stereo. B. RV external. C. RV internal. D. Carapace dorsal view. E. LV dorsal view. F. LV internal.

Scale bars - A,B,C,E,F = 100µ , D = 30µ .

A = P151, #1105; B = P154, #1105; C = P156, #1105; D = P159, #1105; E = P930, #1105; F = P925, #1105.

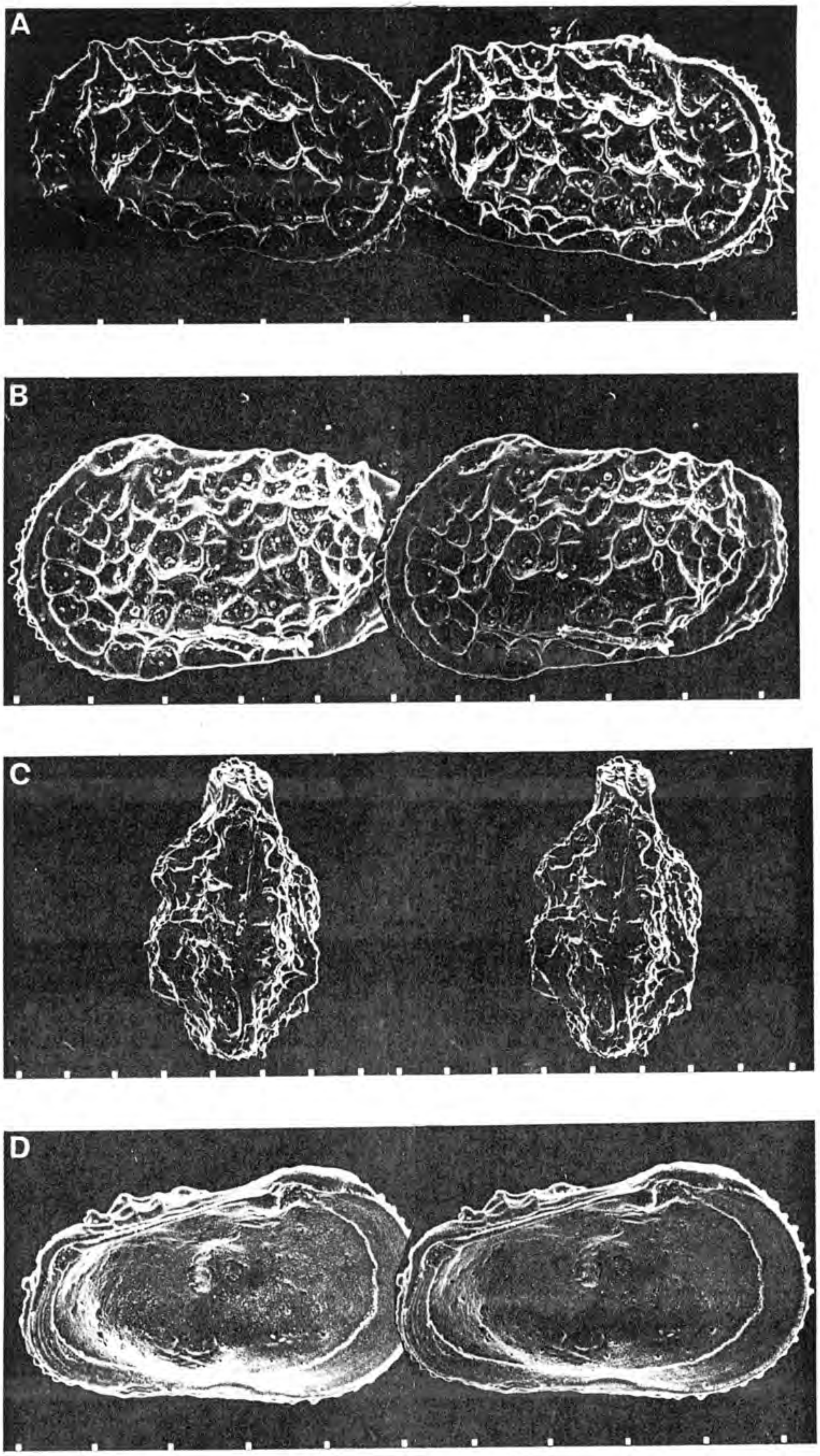

Plate 34. <u>Stigmatocythere</u> sp A141. A. RV external, stereo. B. LV external, stereo. C. Carapace, dorsal view, stereo. D. LV internal, stereo.
Scale bars - all 100μ .
A = P140, #1105; B,D = P3275, #1125; C = P873, #811.

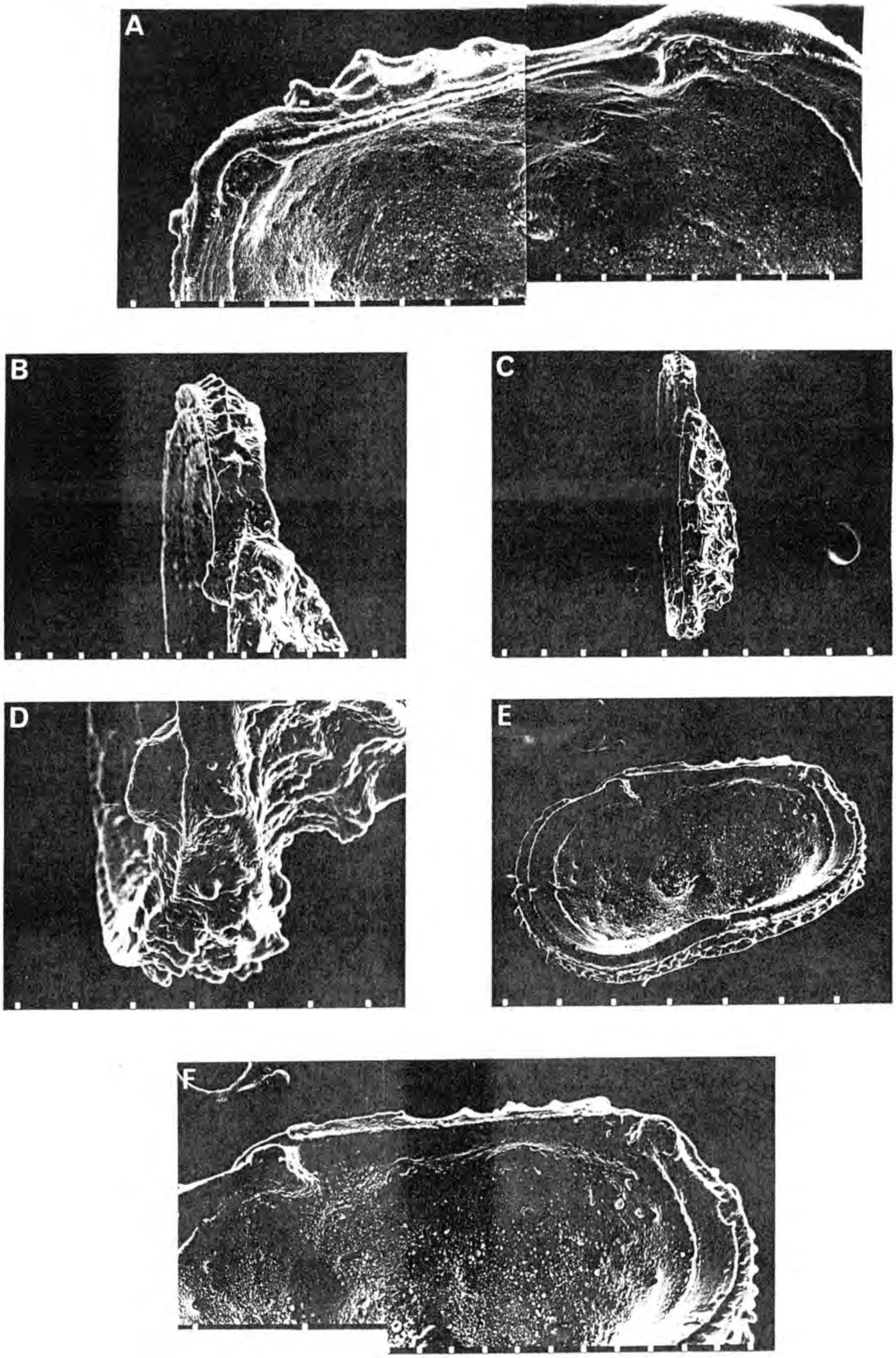

Plate 35. Stigmatocythere sp A141. A. LV detail hinge. B. RV detail ATE. C. RV dorsal view. D. RV detail PTE. E. RV internal. F. RV detail hinge.
Scale bars - A,B,D = 30μ , C,E,F = 100μ .
A = P3275, #1125; B,C,D = P878, #1105; E,F = P140, #1105.

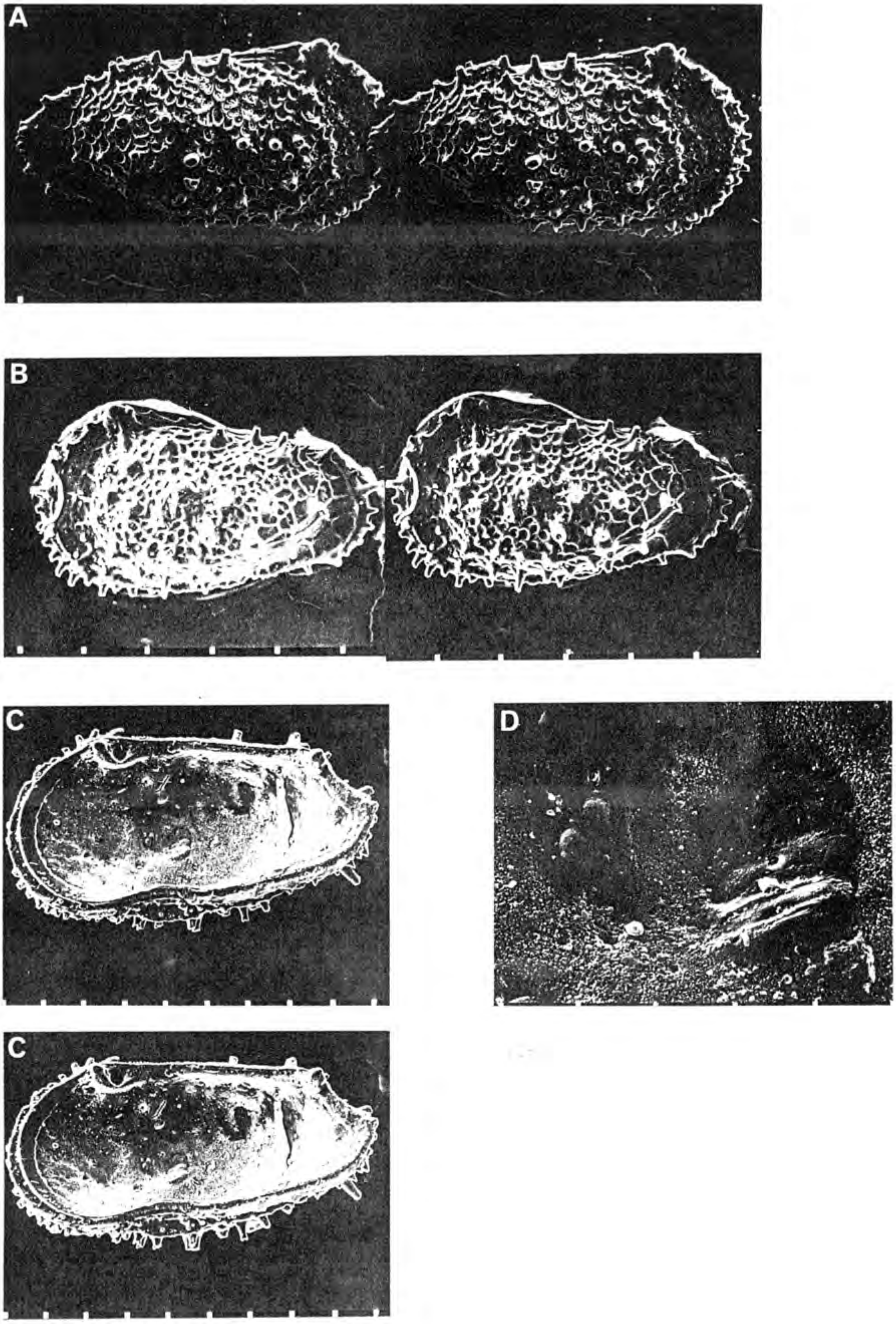

Plate 36. Trachyleberis sp A208. A. RV external, stereo.
B. LV external, stereo. C. RV internal, stereo.
D. RV detail MS.
Scale bars - A = 300µ , B,C = 100µ , D = 30µ .
A = P160, #810; B,C,D = P205, #810.

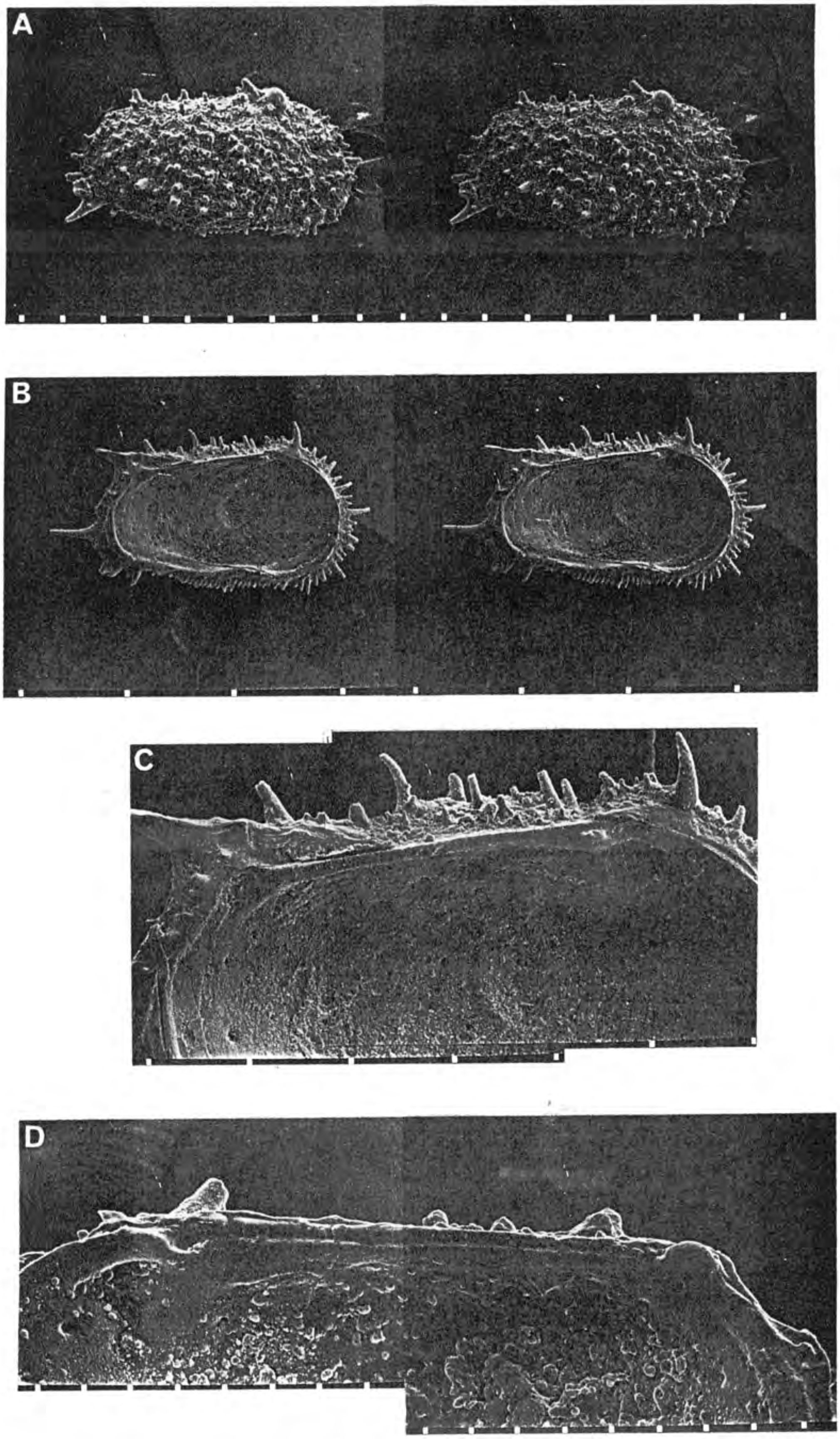

Plate 37. Trachyleberis sp B 250. A. RV external, stereo.
B. LV internal, stereo. C. LV internal, detail hinge.
D. RV internal, detail hinge.
Scale bars - A,C = 100μ , B = 300μ , D = 30μ .
A,D = P250, #1105; B,C = P230, #1094.

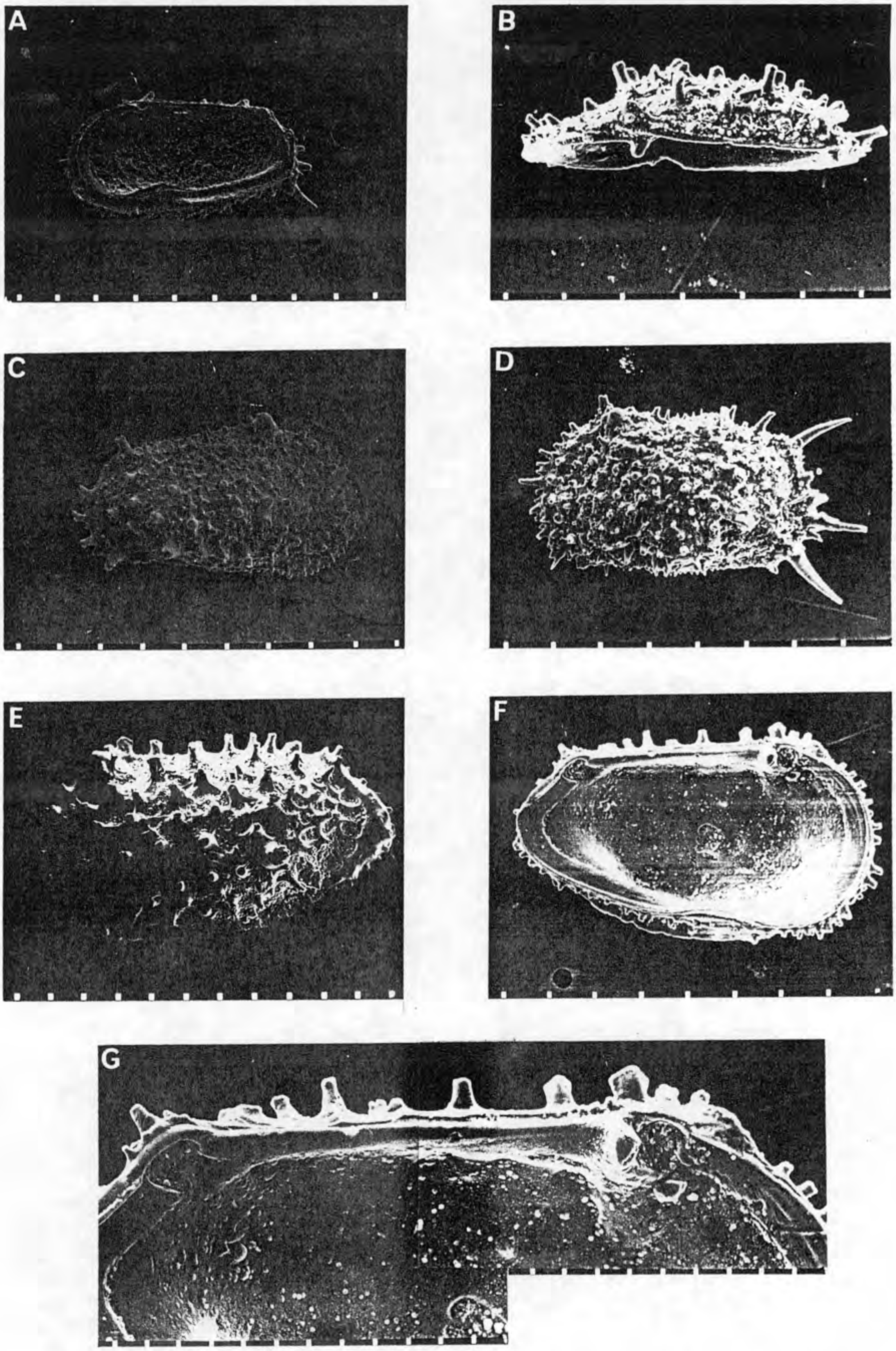

Plate 38. Trachyleberis. A. T. sp B250, RV internal. B. T. sp B250, RV dorsal. C. T. sp B250, RV external. D. T. sp B250, LV external. E-G. T. sp B204. E. LV external. F. LV internal. G. LV detail hinge.

Scale bars - A-F = 100μ , G = 30μ .

A = P250, #1105; B = P123, #1094 (specimen destroyed); C = P222, #1105; D = P107, #1094 (specimen destroyed); E,F,G = P007, #1105 (specimen destroyed).

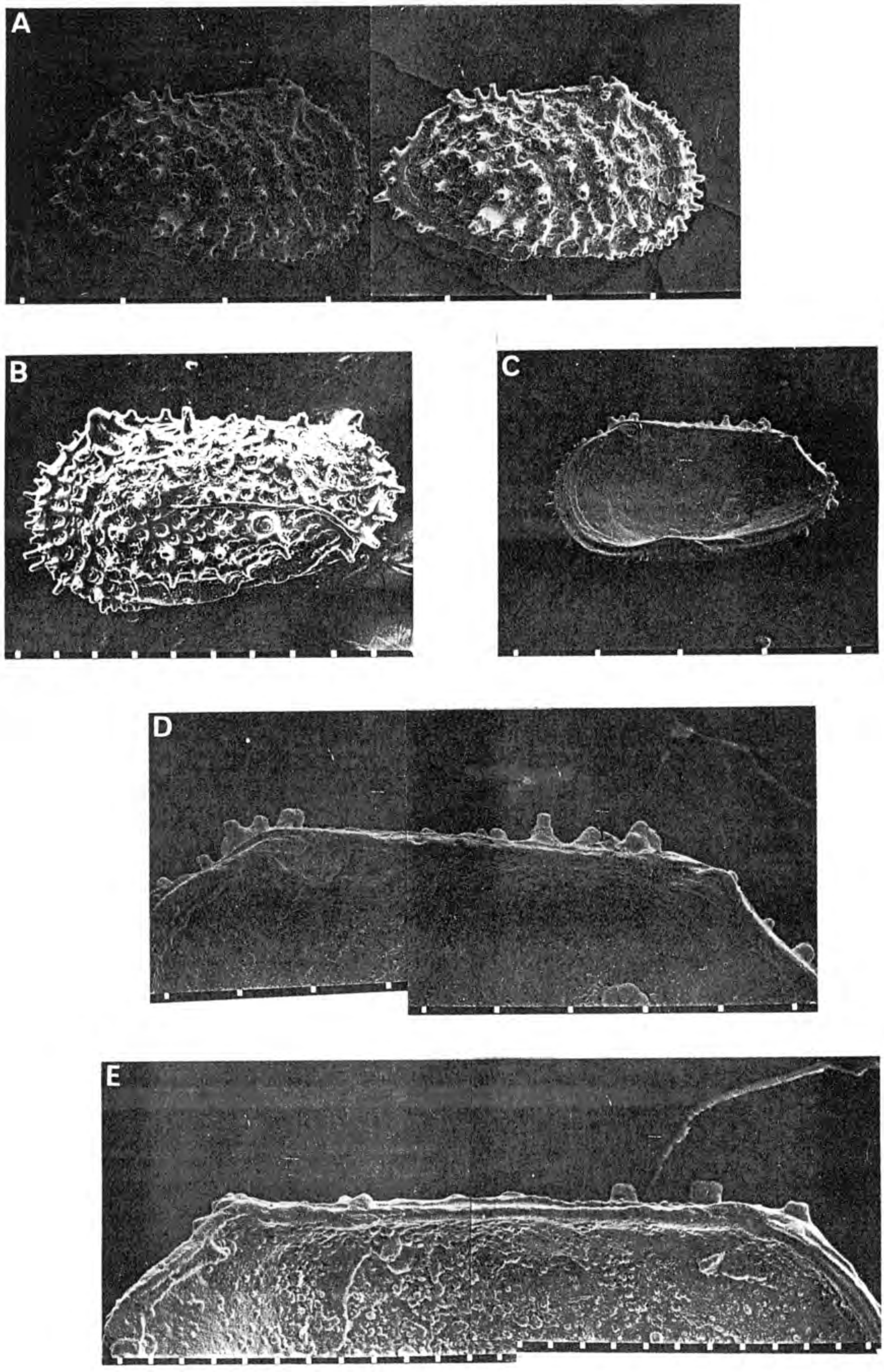

Plate 39. Trachyleberis sp B204. A. RV external, stereo. B. LV external. C. RV internal. D. RV detail hinge. E. LV detail hinge.
Scale bars - A,C = 300µ , B,C = 100µ , E = 30µ .
A,C,D = P204, #1105; B = P036, #1105; E = P210, #1105.

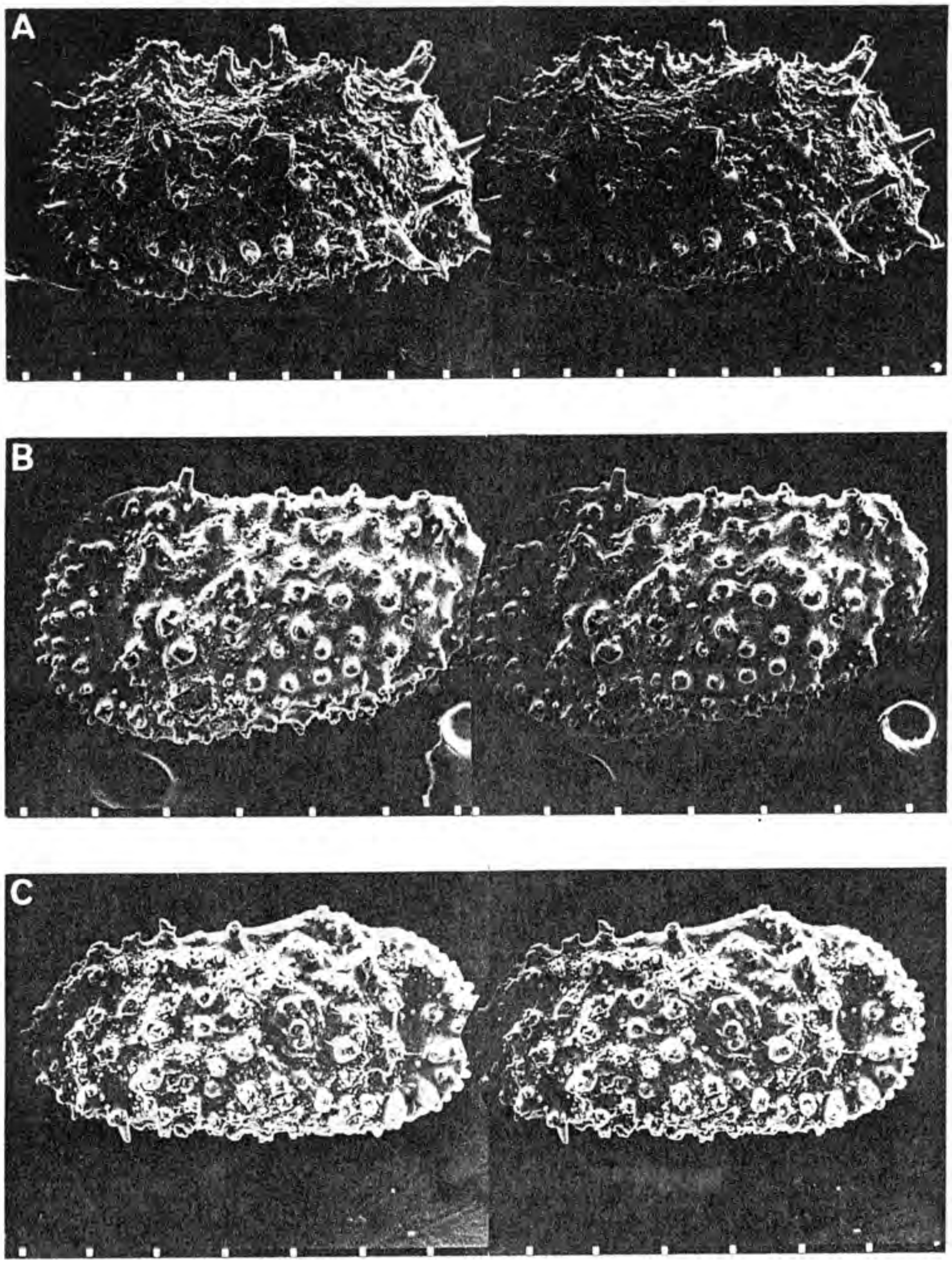

Plate 40. <u>Trachyleberis</u>. A. <u>T</u>. sp 047, LV external, stereo.
B. <u>T</u>. sp A595, LV external, stereo.
C. ?<u>T</u>. sp A606, RV external, stereo.
Scale bars - all 100 μ .
A = P047, #1094 (specimen destroyed);
B = P595, #2772 (specimen destroyed);
C = P606, #1706.

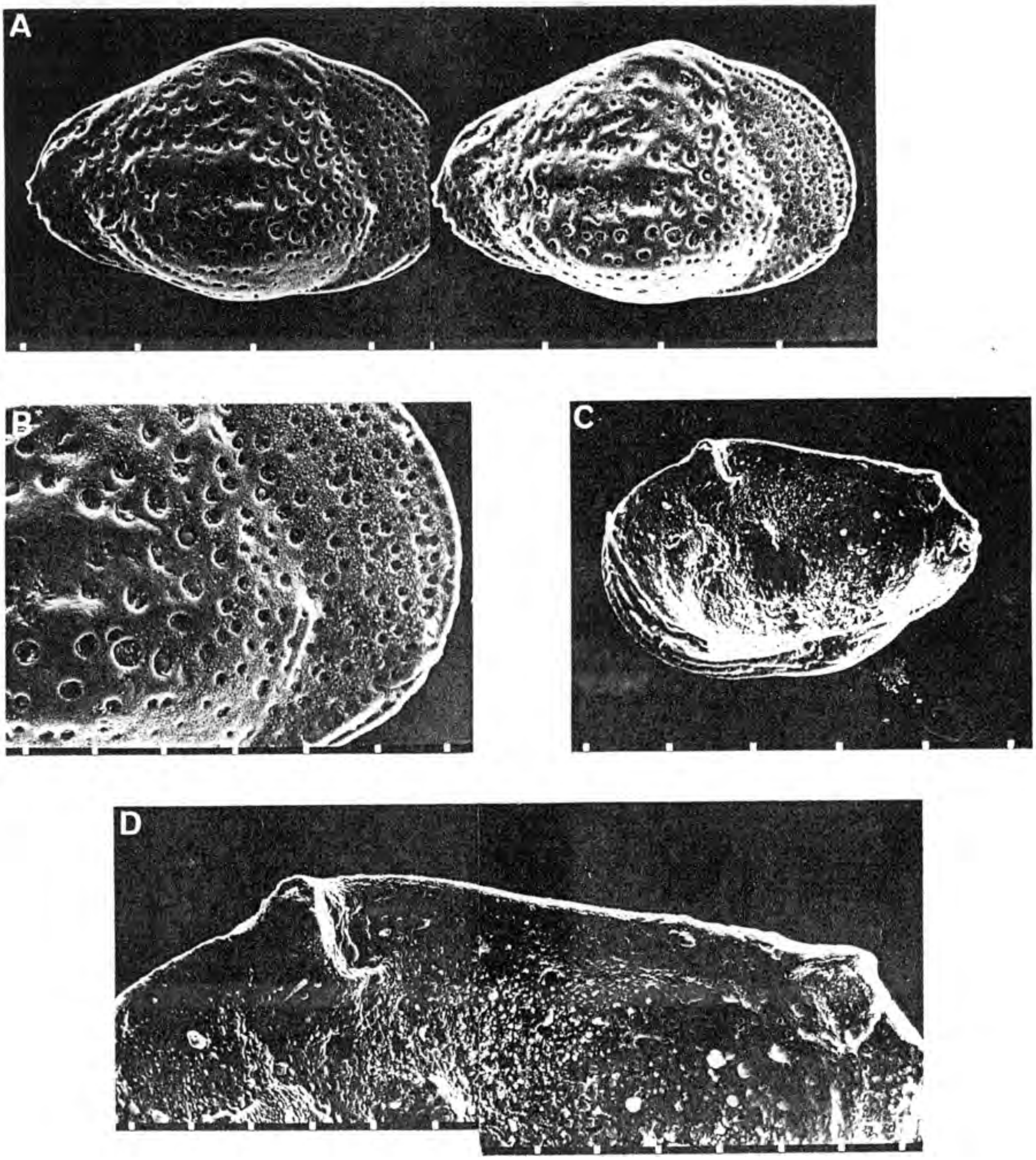

Plate 41. Veenia (Nigeria) sp A27337. A. RV external, stereo. B. RV detail ornamentation. C. RV internal. D. RV detail hinge.

Scale bars - A,C = 100μ , B,D = 30μ .

A,B,C,D = P27337, #1094.

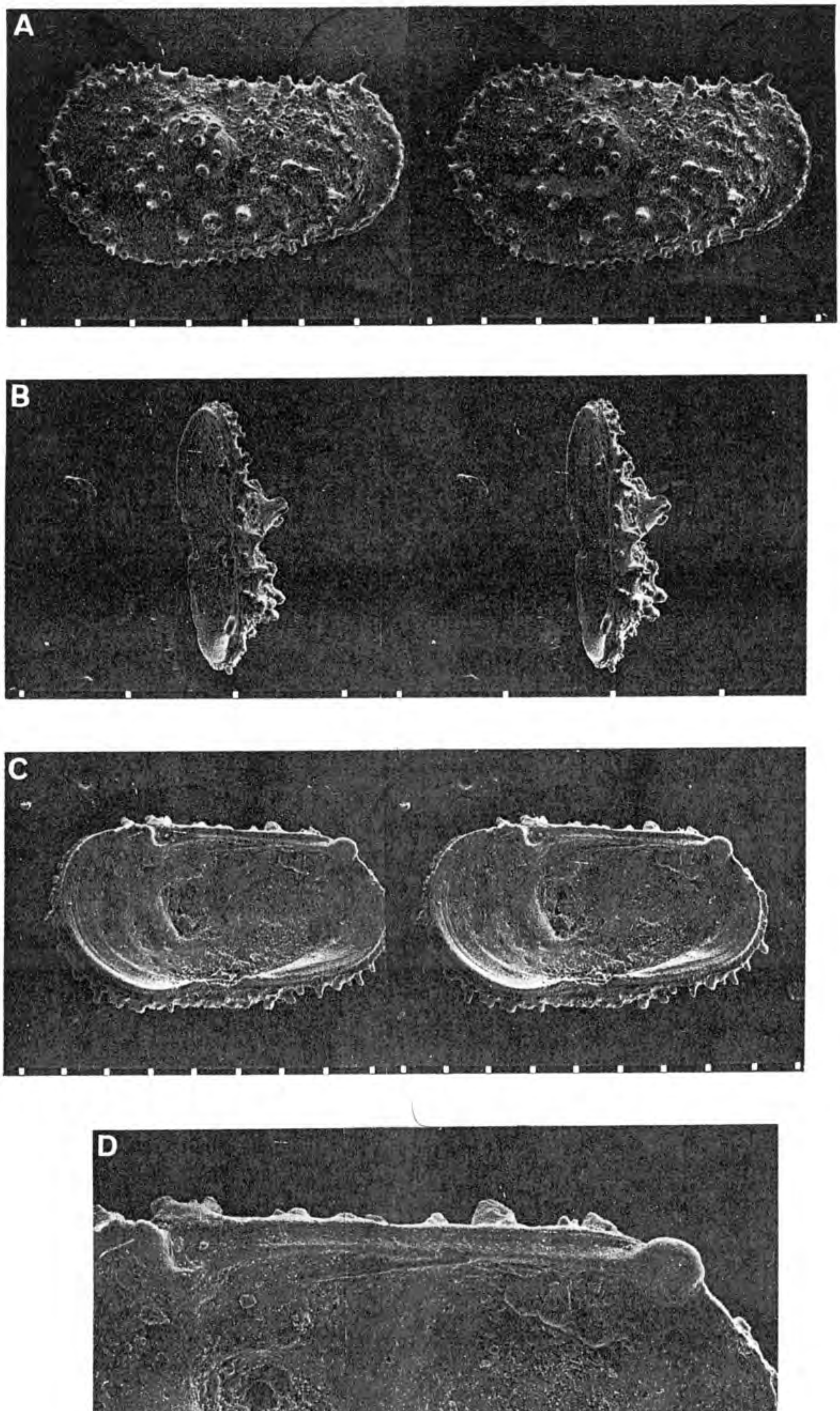

Plate 42. <u>Atlanticythere</u> sp B058. A. LV external, stereo. B. RV dorsal view, stereo. C. RV internal, stereo. D. RV detail hinge.
Scale bars - A,C,D = 100μ , B = 300μ .
A = P61, #2772; B,C,D = P57, #2772.

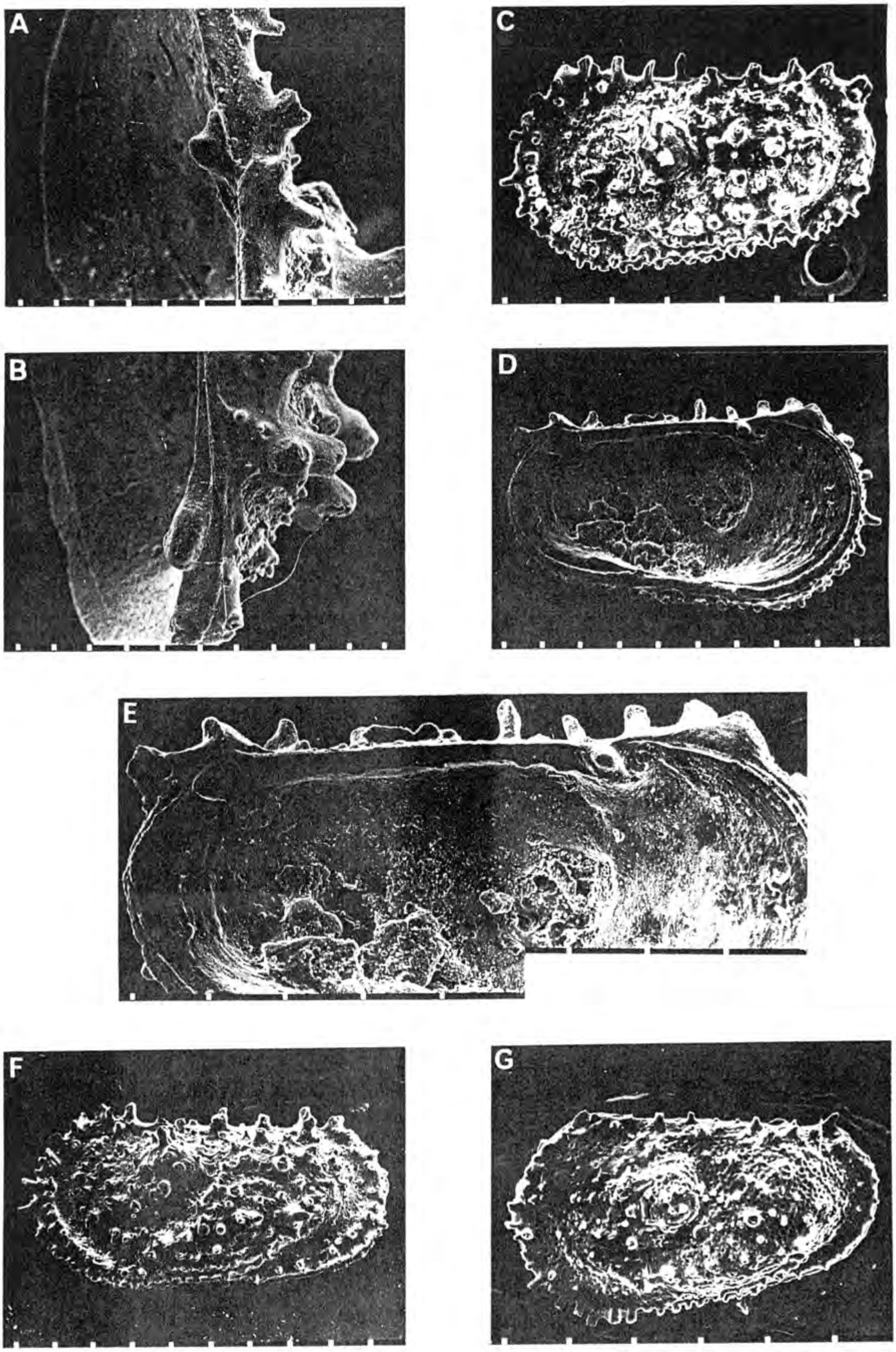

Plate 43. Atlanticythere sp B058. A. RV dorsal view, detail ATE. B. RV dorsal view, detail PTE. C. LV external. D. LV internal. E. LV detail hinge. F. LV external. G. LV external, juvenile.

Scale bars - A,B = 30μ , C-G = 100μ .

A,B = P57, #2772; C,D,E = P584, #2772; F = P985, #2772 (specimen destroyed); G = P558, #1125.

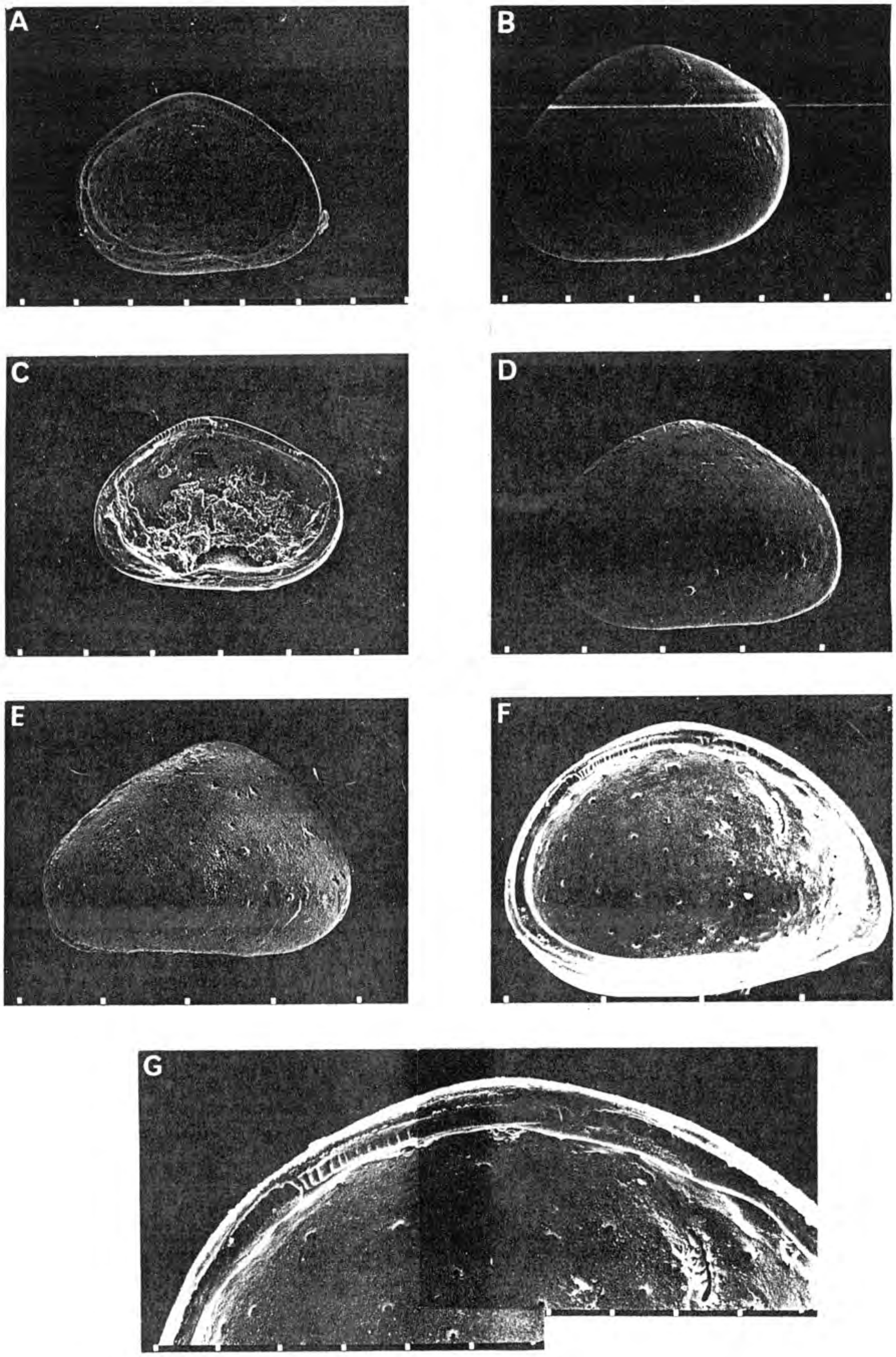

Plate 44. Xestoleberis. A-D. X. sp B296. A. RV internal. B. RV external. C. LV internal. D. LV external. E-G. X. sp A282. E. RV external. F. RV internal. G. RV detail hinge and xestoleberis spot.
Scale bars - A-F = 100μ , G = 30μ .
A,B = P296, #1094; C,D = P625, #827; E = P1585, #1094; F,G = P280, #819.

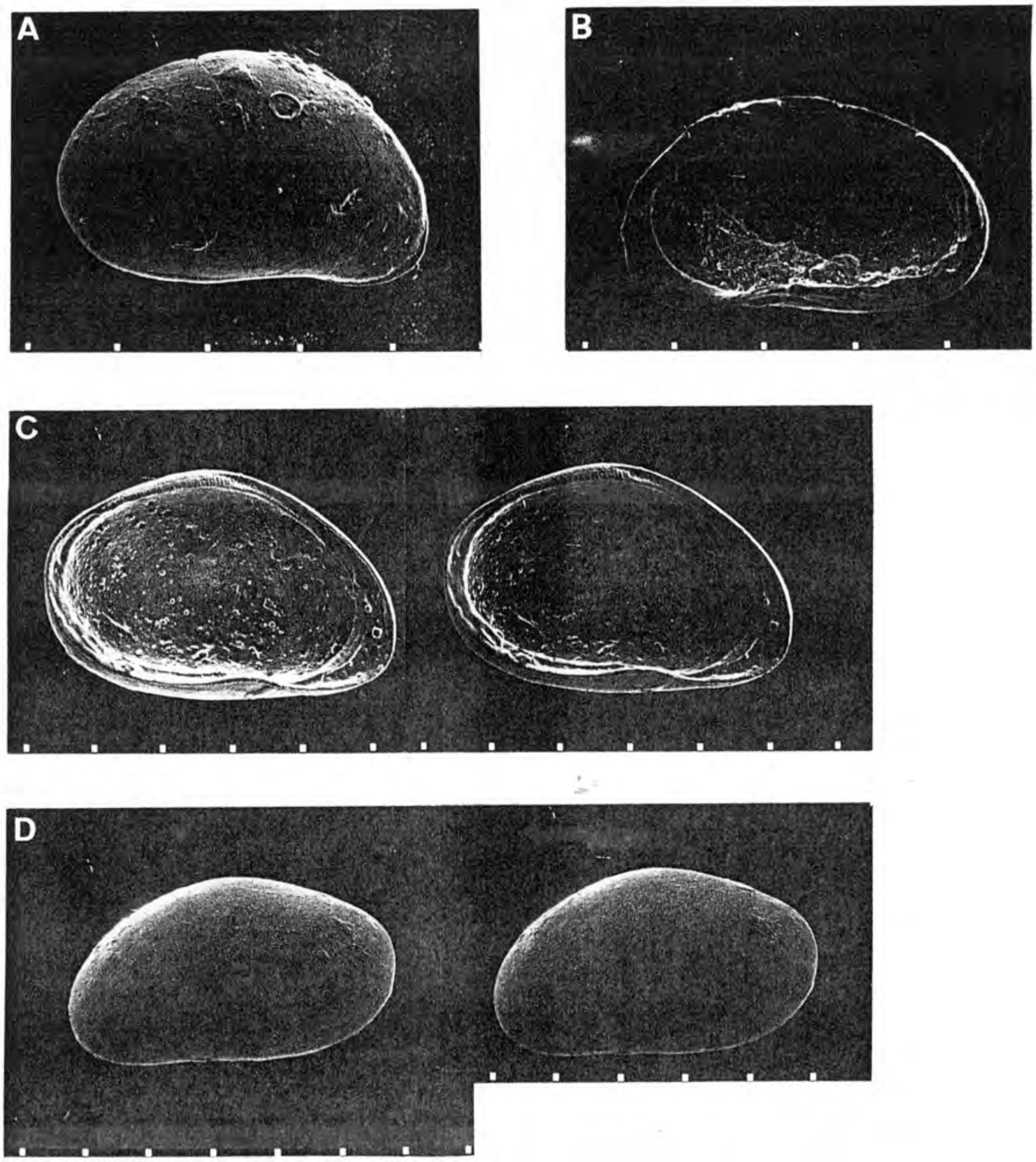

Plate 45. Xestoleberis. A-B. X. sp B1575. A. RV external. B. RV internal. C-D. X. sp B621. C. LV internal, stereo. D. LV external, stereo.
Scale bars - all 100μ .
A,B = P1575, #810; C,D = P581, #2772.

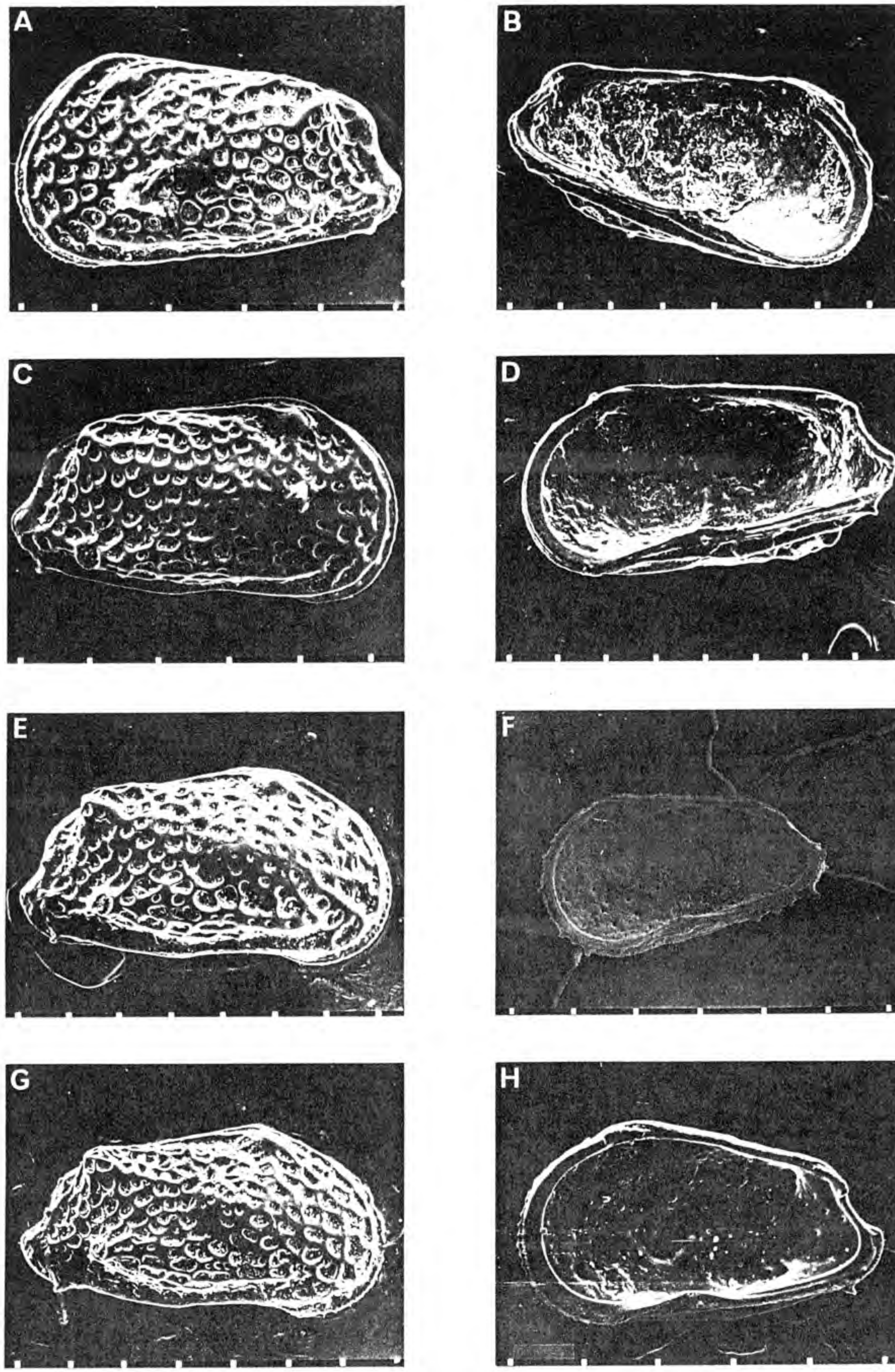

Plate 46. Indet. Genus. A-D. I.1. sp A220. A. LV external. B. LV internal. C. RV external. D. RV internal. E-H. I.1. sp A760. E. RV external. F. RV internal. G. RV external. H. RV internal.

Scale bars - all 100µ .

A,B = P219, #1276; C,D = P222, #1275; E,F = P768, #1275; G,H = P760, #1275.

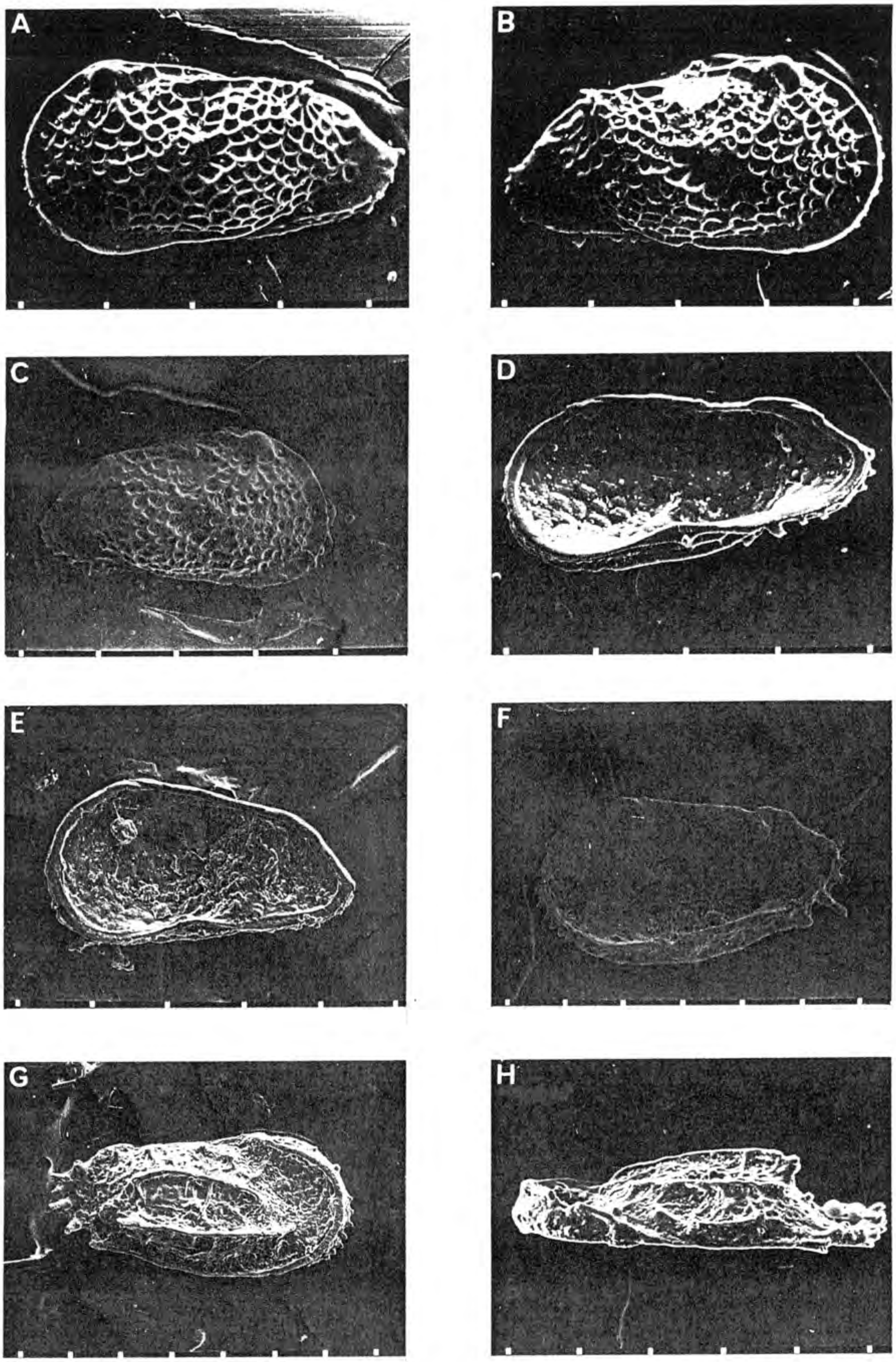

Plate 47. Indet. Genus. A-E. I.1. sp A197. A. LV external. B. RV external. C. RV external. D. RV internal. E. RV internal.
F-H. I.2. sp B311. F. RV internal. G. RV external. H. RV dorsal view.

Scale bars - all 100μ .

A = P197, #810; B = P200, #810; C = P303, #827; D = P202, #810; E = P303, #827; F,G = P310, #1105; H = P136, #1105.

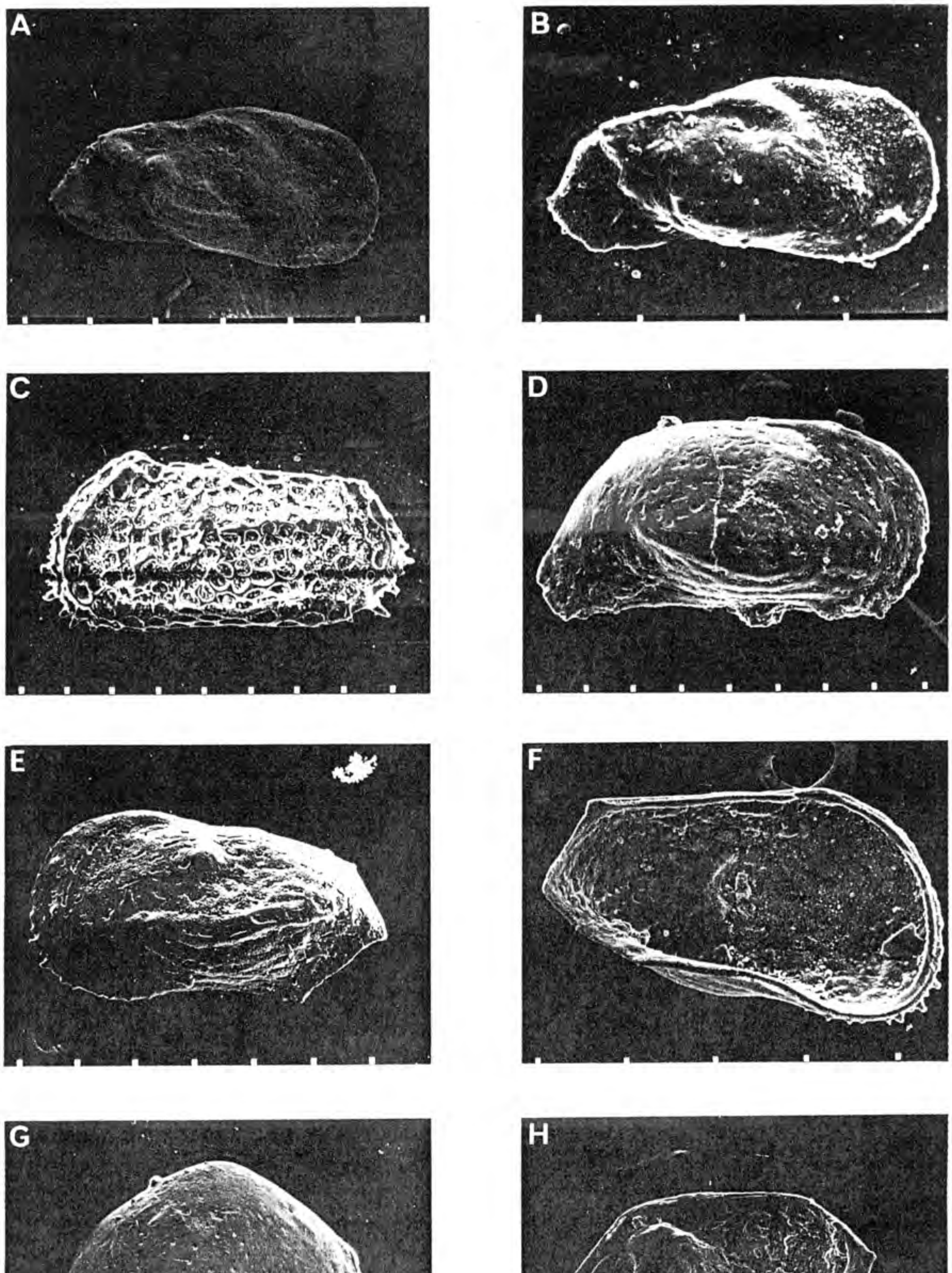

Plate 48. Indet. Genus. A. I.3. sp A176, RV external. B. I.3. sp A313, RV external. C. I.4. sp A1436, LV external. D. I.5. sp A333, RV external. E-F. I.5. sp A850. E. LV external. F. LV internal. G-H. I.6. sp 1583. G. RV external. H. RV internal.

Scale bars - all 100μ .

A = P176, #1094; B = P313, #810; C = P1436, #1276; D = P333, #1281; E,F = P850, #1094; G,H = P1583, #1094.

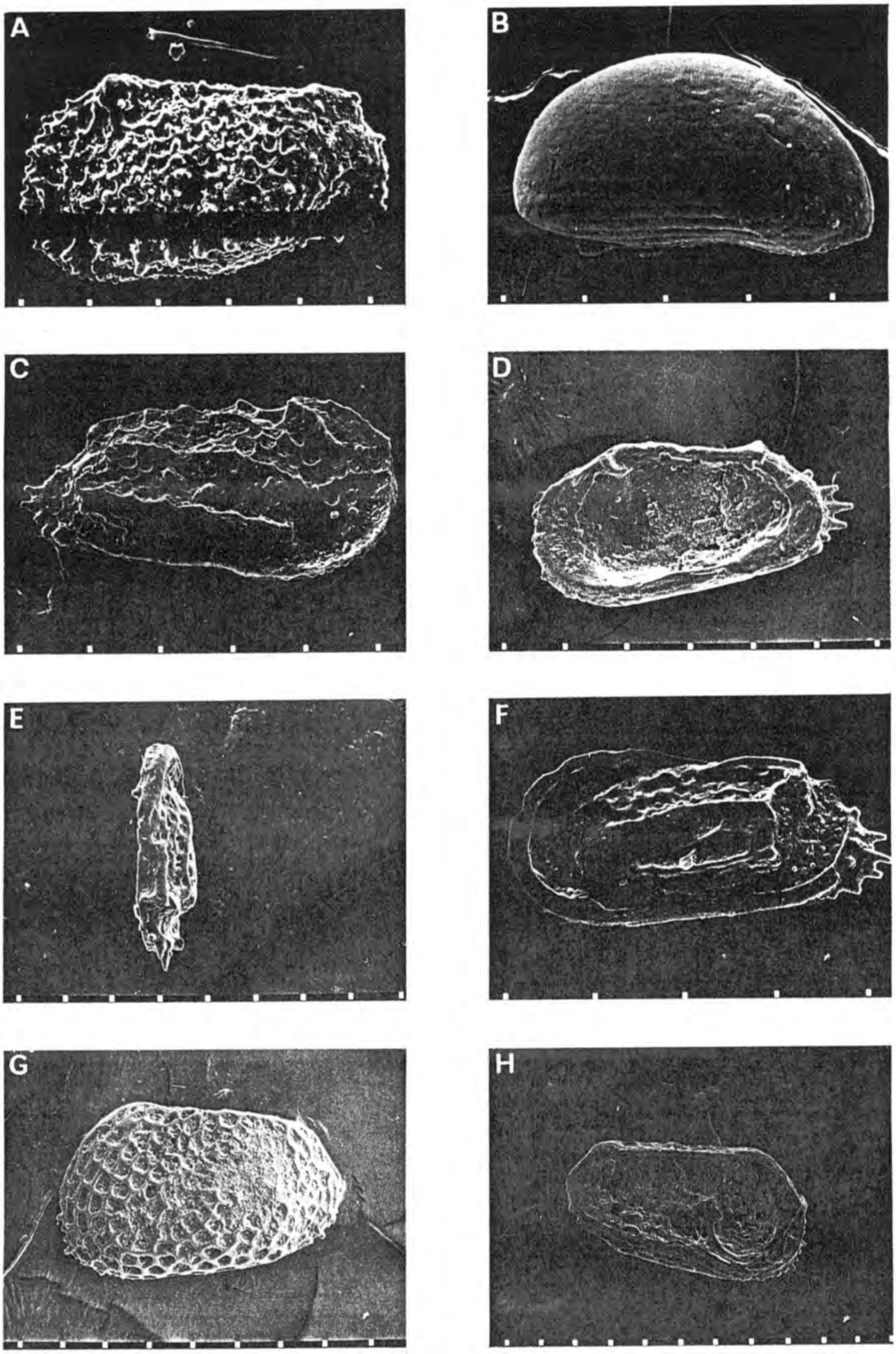

Plate 49. <u>Indet.</u> <u>Genus.</u> A. <u>I.7.</u> sp 1450, LV external. B. <u>I.8.</u> sp 284, LV external. C-E. <u>I.9.</u> sp 290. C. RV external. D. RV internal. E. RV dorsal view.
F. <u>I.10.</u> sp B298, LV external. G-H. <u>I.11.</u> sp B319.
G. LV external. H. LV internal.
Scale bars - all 100μ .
A = P1450, #1277; B = P284, #827; C = P290, #1094;
D,E = P179, #1094; F = P298, #819; G,H = P319, #2800.

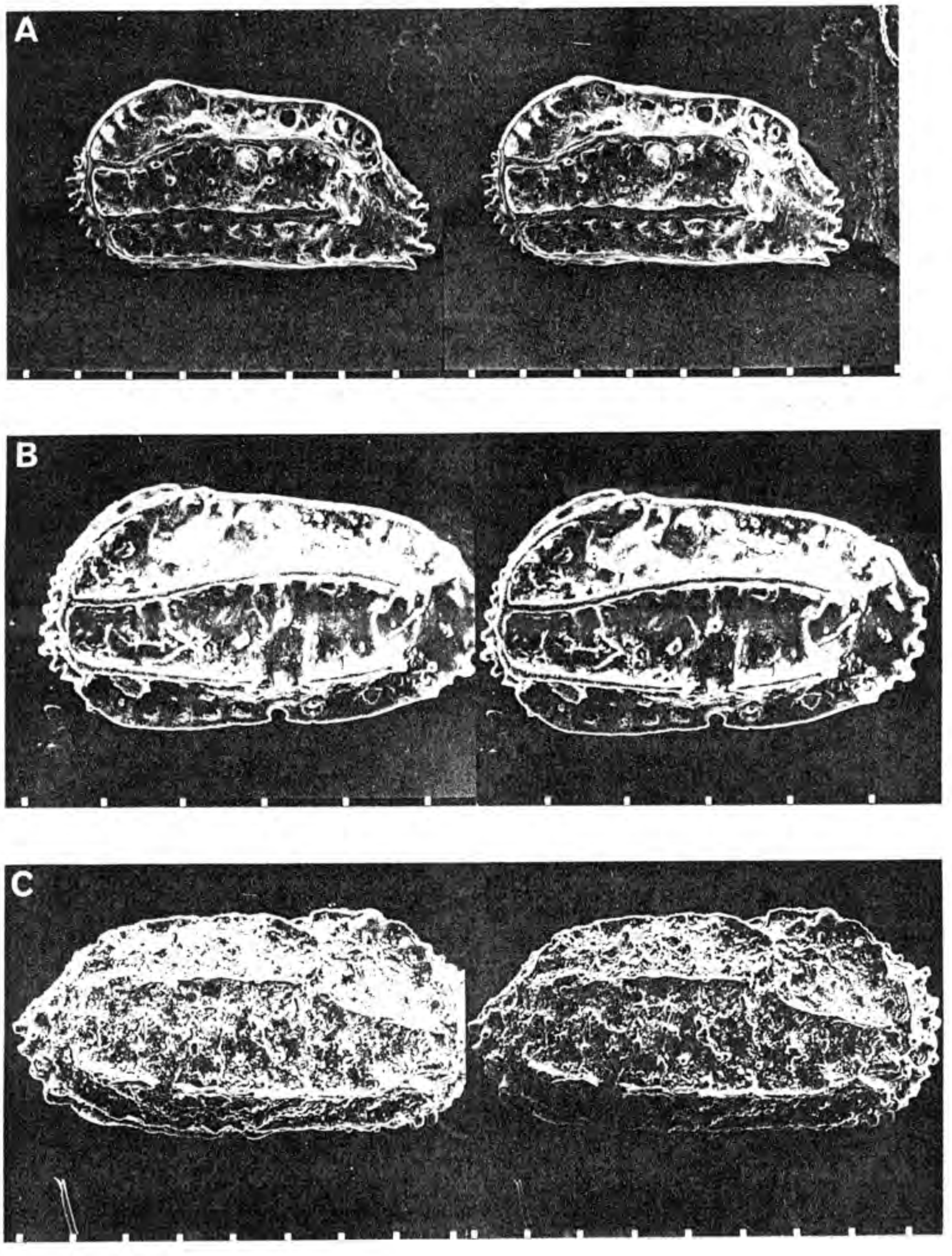

Plate 50. <u>Indet</u>. <u>Genus</u>. A. <u>I.12.</u> sp B1465, LV external, stereo. B. <u>I.12.</u> sp A100, LV external, stereo. C. <u>I.12.</u> sp A477, RV external, stereo.
Scale bars - all 100μ .
A = P1465, #1094; B = P100, #810; C = P477, #1303.

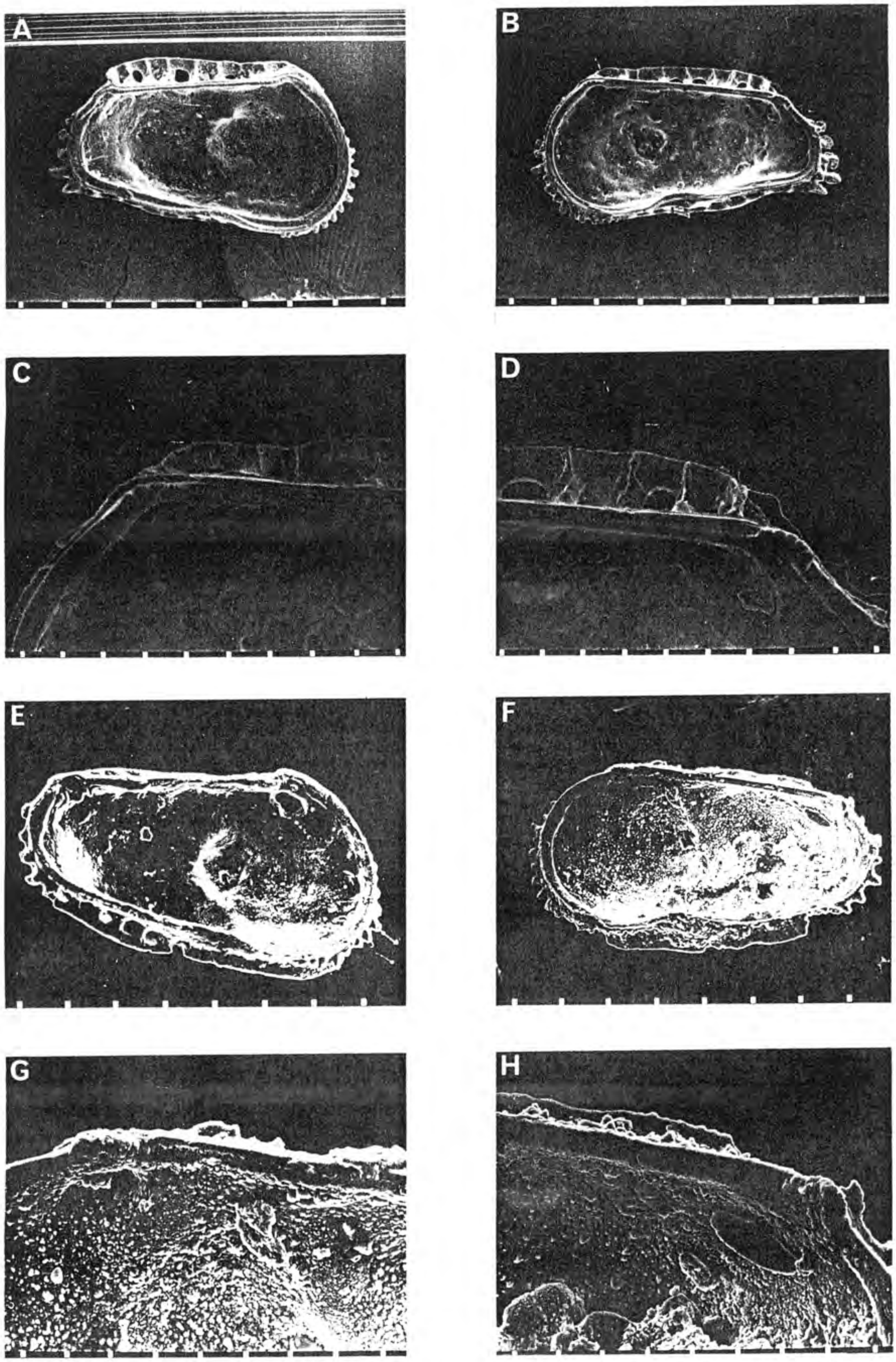

Plate 51. <u>Indet.</u> <u>Genus.</u> A-D. <u>I.12.</u> sp B1465.
A. LV internal. B. RV internal. C. RV detail ATE.
D. RV detail PTE.
E. <u>I.12.</u> sp A100, LV internal.
F-H. <u>I.12.</u> sp A477. F. RV internal. G. RV detail ATE.
H. RV detail PTE.
Scale bars - A,B,E,F = 100μ , C,D,G,H = 30μ .
A = P1465, #1094; B,C,D = P257, #1094; E = P100, #810;
F,G,H = P481, #1303.