

# NEW FOSSIL AND RECENT GENERA AND SPECIES OF CYTHERACEAN OSTRACODA (CRUSTACEA) FROM SOUTH ISLAND, NEW ZEALAND

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## ABSTRACT

Ayress, M.A. & Swanson, K.M. (1991). New fossil and recent genera and species of cytheracean ostracoda (Crustacea) from South Island, New Zealand. *New Zealand Natural Sciences* 18: 1-18.

Two new cytheracean genera, *Bisulcocythere* and *Clinocythereis*, both ranging in age from Late Eocene (Kaiatan Stage) to Recent, are described. *Bisulcocythere* is based on five species; *B. novaezealandiae* (the type species), *B. eocenica*, *B. micropunctata*, *B. compressa* and *B. campbelli*, all are described as new. *Bisulcocythere* is endemic to New Zealand. Only *B. novaezealandiae* is extant, occurring in a mid to outer shelf marine environment. *Clinocythereis*, represented only by the type species, *C. australis*, occurs at mid shelf to slope depths off South Island, New Zealand. *C. australis* has also been recorded outside the New Zealand region in Late Pliocene to Quaternary sediments of the Lord Howe Rise and in Quaternary sediments off western Australia.

KEYWORDS: Ostracoda - New Zealand - new taxa - fossil - Eocene - Recent.

## INTRODUCTION

The most significant previous taxonomic studies of marine Ostracoda of New Zealand include those of Hornibrook (1952, 1953), Swanson (1969) and Ayress (1990), which provide important descriptions of fossil species throughout the Cenozoic, whilst those of Swanson (1979a, b, 1980) report on Recent species from the Otago shelf and Stewart Island, and the paper by Hartmann (1982) describes species from Lyttelton, Stewart Island and several South Island localities. Apart from Hartmann (1982), all previous taxonomic descriptions have relied only on carapace morphology, as we do in this contribution.

Recent intense sampling of fossil localities throughout North Otago and South Canterbury has produced abundant and diverse ostracod assemblages, including material reported here. A

similarly high recovery of ostracods, many with soft parts, was obtained from samples of Recent sediments collected during a series of New Zealand Oceanographic Institute cruises to the Westland shelf (West Coast Ecosystem Project 1979 and 1982) and the eastern shelf/canyon complex off Kaikoura (Kaikoura Benthos 1982). Some additional material, collected from Fiordland, was also available to the authors by courtesy of Dr N. de B. Hornibrook (New Zealand Geological Survey, Lower Hutt). Ostracod collections housed at the New Zealand Geological Survey, Lower Hutt have also been examined.

Data relating to ostracod distribution in most Deep Sea Drilling Project cores from the South West Pacific (Legs 20, 21, 27-30, 90) were also available to the authors.

These large sets of material not only provide new additional information on carapace morphology and soft part anatomy of species previously inadequately described, but also reveal a large number of completely new taxa.

This paper describes two new ostracod gen-

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era, represented by species that occur somewhat consistently although in low numbers in our samples. The stratigraphic and geographic distribution patterns of these species are also discussed.

### MATERIALS AND METHODS

Fig. 1 shows the localities where the genera described herein have been recorded. Details of the samples and sample localities are given below. Fossil record numbers are recorded in the New Zealand Fossil Record File, administered by the Geological Society of New Zealand. Fossil specimens were extracted from rock matrix using the methods described by Hornibrook *et al.* (1989). The drawings were made using a camera lucida microscope attachment. All photomicrographs were taken using a Cambridge Stereoscan 360 electron microscope.

Onshore fossil samples were dated by means of foraminifera, using the correlations of Hornibrook *et al.* (1989). The ages of the DSDP core samples were derived from the information given in the relevant volume of the Initial Reports of the Deep Sea Drilling Project.

#### DETAILS OF RECENT LOCALITIES AND SAMPLES

##### *Otago shelf.*

Agassiz trawl 1500 cc muddy sand samples:

- 1) Station MU 68-86, water depth 182 m, lat. 45° 53'S, long. 171°04'E.
- 2) Station MU 67-61, water depth 397 m, lat. 45° 54'S, long. 171°03'E.
- 3) Station MU 68-24, water depth 520 m, lat. 45° 50'S, long. 171°00'E.
- 4) Station MU 68-29, water depth 580 m, lat. 45° 38'S, long. 171°06'E.
- 5) Microfossil slide deposited at the Department of Geology, University of Canterbury, Christchurch, by an anonymous worker. Slide is labelled: (4), sandy silt, 87 fathoms off Oamaru.

##### *Eastern shelf off Kaikoura.*

- 6) Station U258, anchor box dredge and Agassiz trawl, sandy mud, water depth 110 m-180 m, lat. 42°41.83'S, long. 173°38.05'E.
- 7) Station U229, anchor box dredge, fine grey mud, water depth 525 m, lat. 42°28.2'S, long.

173°37.4'E.

- 8) Station U246, anchor box dredge, mud, water depth 670 m - 660 m, lat. 42°30.5'S, long. 173° 38.6'E.
- 9) Station U260, box core, mud, water depth 1130 m, lat. 42°36.4'S, long. 173°42.6'E.

##### *East Tasman Sea.*

"Wesp" Agassiz trawl, anchor box dredge and box core, approx. 3500 cc, samples:

- 10) Station P658, sandy mud, water depth 123 m, lat. 41°38.6'S, long. 171°25.6'E.
- 11) Station P656, muddy sand, water depth 138 m, lat. 42°30.0'S, long. 170°53.0'E.
- 12) Station P660, gravelly muddy sand, water depth 154 m, lat. 41°31.1'S, long. 171°13.2'E.
- 13) Station Q722, muddy sand, water depth 167 m, lat. 42°22.8'S, long. 170°51.7'E.
- 14) Station P664, muddy sandy silt, water depth 187 m, lat. 42°57.3'S, long. 170°01.7'E.
- 15) Station P662, muddy sand, water depth 196 m, lat. 41°29.7'S, long. 171°00.9'E.
- 16) Station P655, gravelly muddy sand, water depth 249 m, lat. 42°18.0'S, long. 170°38.0'E.
- 17) Station P661, sandy mud, water depth 621 m, lat. 41°12.5'S, long. 170°25.8'E.
- 18) Station Q719, sandy mud, water depth 750 m, lat. 42°04.4'S, long. 170°12.4'E.
- 19) Station P654, mud, water depth 769 m, lat. 42° 02.1'S, long. 170°12.7'E.
- 20) New Golden Hind Station 83 of Hornibrook (1952), water depth 69.5 m, Doubtful Sound, Fiordland.

#### DETAILS OF FOSSIL LOCALITIES AND SAMPLES

##### *Onshore South Island, New Zealand.*

- 21) Kaiata Mudstone. Point Elizabeth, Westland. Fossil Record File Number J31/f9688, grid reference J31/635675 (NZMS 260, 1975 overprint series), lat. 171°13.1'E, long. 42°23.0'S. Lower Whaingaroan Stage, Early Oligocene.
- 22) Glenmark Limestone. Weka Creek, below road bridge, North Canterbury. Fossil Record File Number M34/f7035, grid reference M34/86059810 (NZMS 260, 1975 overprint series), lat. 43°01.6'S, long. 172°42.5'E. Waiau Stage, Middle Miocene.
- 23) Shellbed at base of Chalk Quarry Sandstone, Burnt Hill Group (*sensu* Carlson *et al.* 1980),

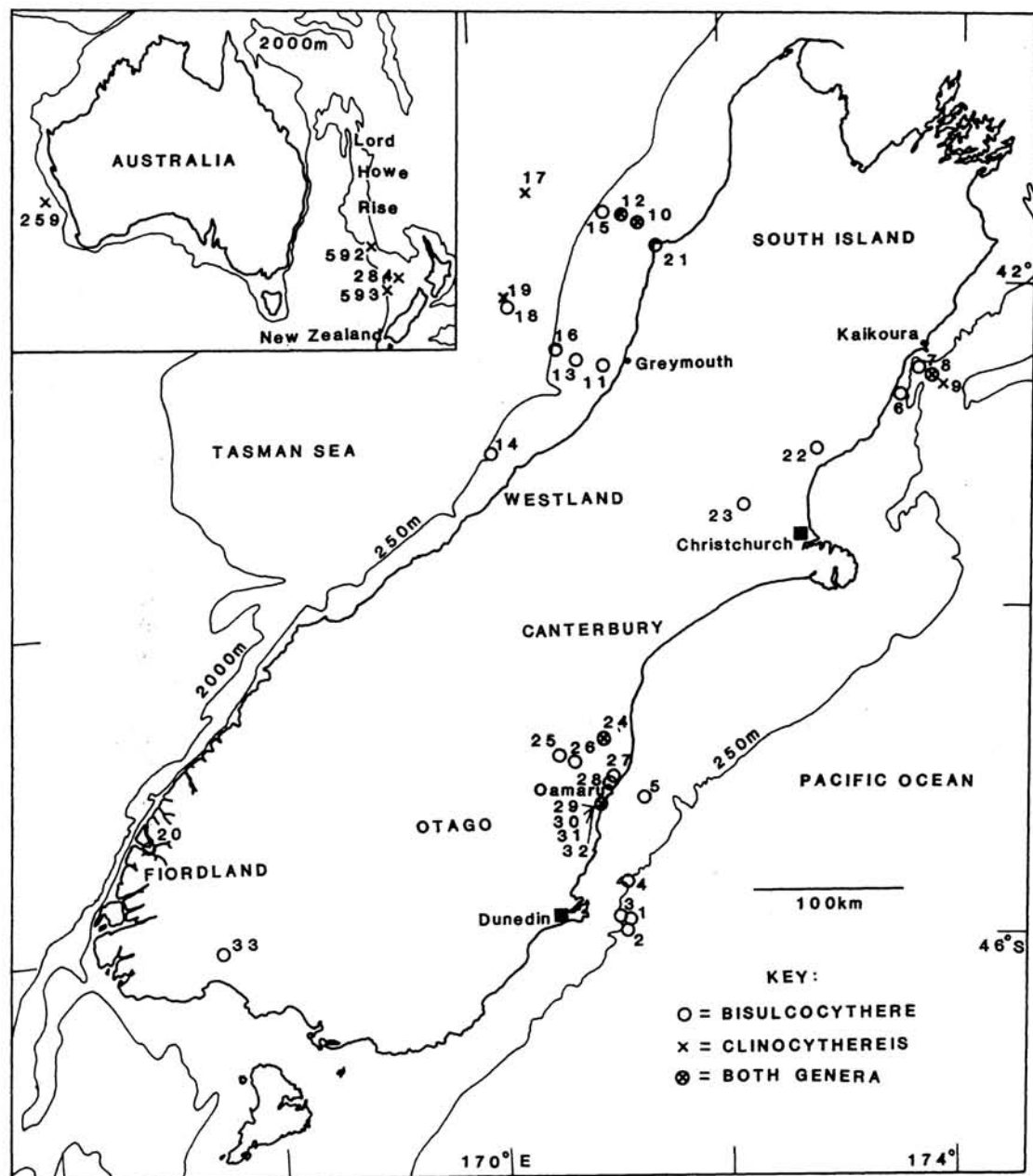


Figure 1. Map of South Island, New Zealand, showing position of sites at which *Bisulcocythere* and *Clinocythereis* have been recorded, and Australia-New Zealand (inset) showing DSDP Sites at which *Clinocythereis* has been recorded.

- Burnt Hill, near Oxford, North Canterbury. Fossil Record File Number L35/f70, grid reference L35/398586 (NZMS 260, 1975 overprint series), lat. 43°22.8'S, long. 172°08.2'E. Waiau Stage, Middle Miocene.
- 24) Bank outcrop near McCulloch's Bridge, Waihao River, South Canterbury. Ashley Mudstone Formation. Fossil Record File Number J40/f90, grid reference J40/497988 (NZMS 260, 1975 overprint series), lat. 44°48.3'S, long. 170°58.3'E. Kaiatan Stage, Late Eocene.
- 25) Miller Member, approx 1 m above top of main ("lower") shellbed, at top of Maerewhenua Member, Otekaike Limestone Formation. Escarpment, Trig Z, Otiake. Fossil Record File Number I40/f231, grid reference I40/146974 (NZMS 260, 1975 overprint series), lat. 44°48.7'S, long. 170°31.6'E. Waitakian Stage, latest Oligocene - earliest Miocene.
- 26) Earthquakes, near Duntroon. Kokoamu Greensand Formation. Fossil Record File Number I40/f90, grid reference I41/224898 (NZMS 260, 1975 overprint series), lat. 44°52.9'S, long. 170°37.5'E. Duntroonian Stage, Late Oligocene.
- 27) Pukeuri road cutting, North Otago. Rifle Butts Siltstone. Fossil Record File Number J41/f214, grid reference J41/545733 (NZMS 260, 1975 overprint series), lat. 45°02.1'S, long. 171°01.6'E. Altonian Stage, Early Miocene. University of Canterbury Microfossil Catalogue number 609.
- 28) Ardgowan shell-bed, Rifle Butts Formation, near Oamaru, North Otago. Fossil Record File Number J41/f8816, grid reference J41/482701 (NZMS 260, 1975 overprint series), lat. 45°03.7'S, long. 170°56.8'E. Altonian Stage, Early Miocene.
- 29) All Day Bay, North Otago. Rifle Butts Formation. Sample F5273 used by Hornibrook (1952). Fossil Record File Number J42/f6757, precise grid reference unknown. Altonian Stage, Early Miocene.
- 30) All Day Bay, North Otago. Gee Greensand Formation. Fossil Record File Number J42/f6544, grid reference J42/445550 (NZMS 260, 1975 overprint series), lat. 45°10.8'S, long. 170°53.7'E, Otaian Stage, Early Miocene. University of Canterbury Microfossil Catalogue number 624.
- 31) All Day Bay, North Otago. Gee Greensand Formation. Fossil Record File Number J42/f208, grid reference J42/446549 (NZMS 260, 1975 overprint series), lat. 45°11.8'S, long. 170°53.2'E. Waitakian Stage, latest Oligocene - earliest Miocene.
- 32) All Day Bay, North Otago. Rifle Butts Formation (=Tokama Siltstone of Field & Browne 1986). Fossil Record File Number J42/f169, grid reference J42/442547 (NZMS 260, 1975 overprint series), lat. 45°12.0'S, long. 170°53.0'E. Altonian Stage, Early Miocene.
- 33) Brown shelly concretionary sand at top of Park Bluff Sandstone, south bank of Clifden section, Southland. Fossil Record File Number D45/f8465, grid reference D45/002511 (NZMS 260, 1975 overprint series), lat. 46°02.0'S, long. 167°41.7'E. Waiau Stage, Middle Miocene.

#### *Tasman Sea.*

Deep Sea Drilling Project core samples:

- 34) Site 284, Core 1, Sections 2 and 5. Present day water depth 1066 m, lat. 40°30.48'S, long. 167°40.81'E. Late Pliocene to Pleistocene.
- 35) Site 592, core catcher samples of Cores 1 and 4. Present day water depth 1088 m, lat. 36°28.40'S, long. 165°26.53'E. Late Pliocene to Pleistocene.
- 36) Site 593, core catcher samples of Cores 11-23. Present day water depth 1068 m, lat. 40°30.47'S, long. 167°40.47'E. Middle Miocene to Early Pliocene.

#### *Off western Australia.*

Deep Sea Drilling Project core samples:

- 37) Site 259, Core 1, Sections 3 and 4. Present day water depth 4696 m, lat. 29°37.05'S, long. 112°41.78'E. Pleistocene.

Type and figured specimens are deposited in the collections of the Geology Museum, University of Otago (the catalogue numbers with prefix OU apply to these) and in the New Zealand Geological Survey, Lower Hutt (the catalogue numbers with prefix TO and OP apply to these).

## SYSTEMATICS

The following abbreviations are employed in the descriptions: C = carapace, V = valve, RV = right valve, LV = left valve. All measurements are in mm.

Cass: Ostracoda Latreille 1806  
Order: Podocopida Müller 1894  
Suborder: Podocopina Sars 1866  
Superfamily: Cytheracea Baird 1850

FAMILY: LEPTOCYThERIDAE HANAI 1957

Genus: *Bisulcocythere* gen. nov.

Type species: *Bisulcocythere novaezealandiae* gen. et sp. nov.

*Etymology.* Latin, from the two dorsal sulci of this genus.

*Diagnosis.* An eyeless, medium to large sized cytheracean genus characterised by subrectangular lateral outline with broad symmetrically convex anterior margin. Maximum length below mid-height. Sexually dimorphic: female valves higher than male valves. Moderately thick-shelled. Maximum inflation situated mid- to postero-ventrally forming a pseudo-alar structure. Two dorsal sulci; median sulcus subvertical and narrow dorsally, anterior sulcus narrow and curved subparallel to anterior margin. Surface ornament variably punctate to reticulate. Low longitudinal ridge extends through mid-height of valve at extremity of lateral inflation. A second low ridge extends subparallel and close to dorsal margin. Snap-knob and pit structure present at mid-length close to ventral margin. Entomodont hingement; median element slightly flexured and in LV bears approximately 16 prominent denticulations. Muscle scars consist of 4 closely adjacent adductor scars in a subvertical row, the uppermost and lowermost scars relatively large and semi-circular; a single large heart-shaped frontal scar occurs ahead of adductors. Fulcral notch large and deep, just ahead of upper two adductor scars. Duplicature wide and vestibulate. True radial pore canals narrow and straight; about 15 anteriorly, 10 posteriorly.

*Remarks.* By virtue of its internal features *Bisulcocythere* is best placed within the Leptocytheridae. Its external morphology somewhat re-

sembles certain genera of the Bythocytheridae Sars 1926, but it is clearly distinguished from all bythocytherid genera by its dorsal sulci, snap-knob and pit structure, and its ventrally positioned posterior extremity which lacks a caudal process. The adductor muscle scars consists of 4 scars not 5 as in bythocytherids. With respect to its strongly denticulate hingement *Bisulcocythere* is comparable to *Dentibythere* Schornikov 1982. *Bisulcocythere* differs from that genus, however, in all other respects. Within the Leptocytheridae the straight radial pore canals and pseudoalar structure of *Bisulcocythere* is comparable to *Cluthia* Neale 1973, known from both northern and southern hemispheres. *Bisulcocythere* can easily be distinguished from *Cluthia*, however, by virtue of its dorsal sulci, its larger size and in details of its lateral outline.

*Bisulcocythere* is apparently endemic to New Zealand and is represented by 5 species, only one of which, *Bisulcocythere novaezealandiae* sp. nov., is known to be living today. N. de B. Hornibrook (pers. comm.) has recorded this species at localities from North Cape to the southern fiords. In our material Recent specimens were collected from a depth range of 182 m - 580 m on the Otago continental slope, 110 m - 750 m on the eastern shelf, 138 m - 621 m on the Westland continental slope and 69.5 m in Doubtful Sound, Fiordland. Our fossil specimens of this genus range in age from Kaiatan Stage (Late Eocene) to Waiauan Stage (Late Miocene).

*Bisulcocythere novaezealandiae* sp. nov.

Fig. 2, 3A-J and 4A

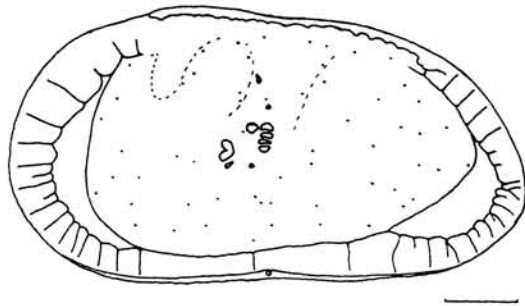


Figure 2. Camera lucida drawing of *Bisulcocythere novaezealandiae* sp. nov., holotype, OU 39612, female RV. Scale bar = 0.1 mm.



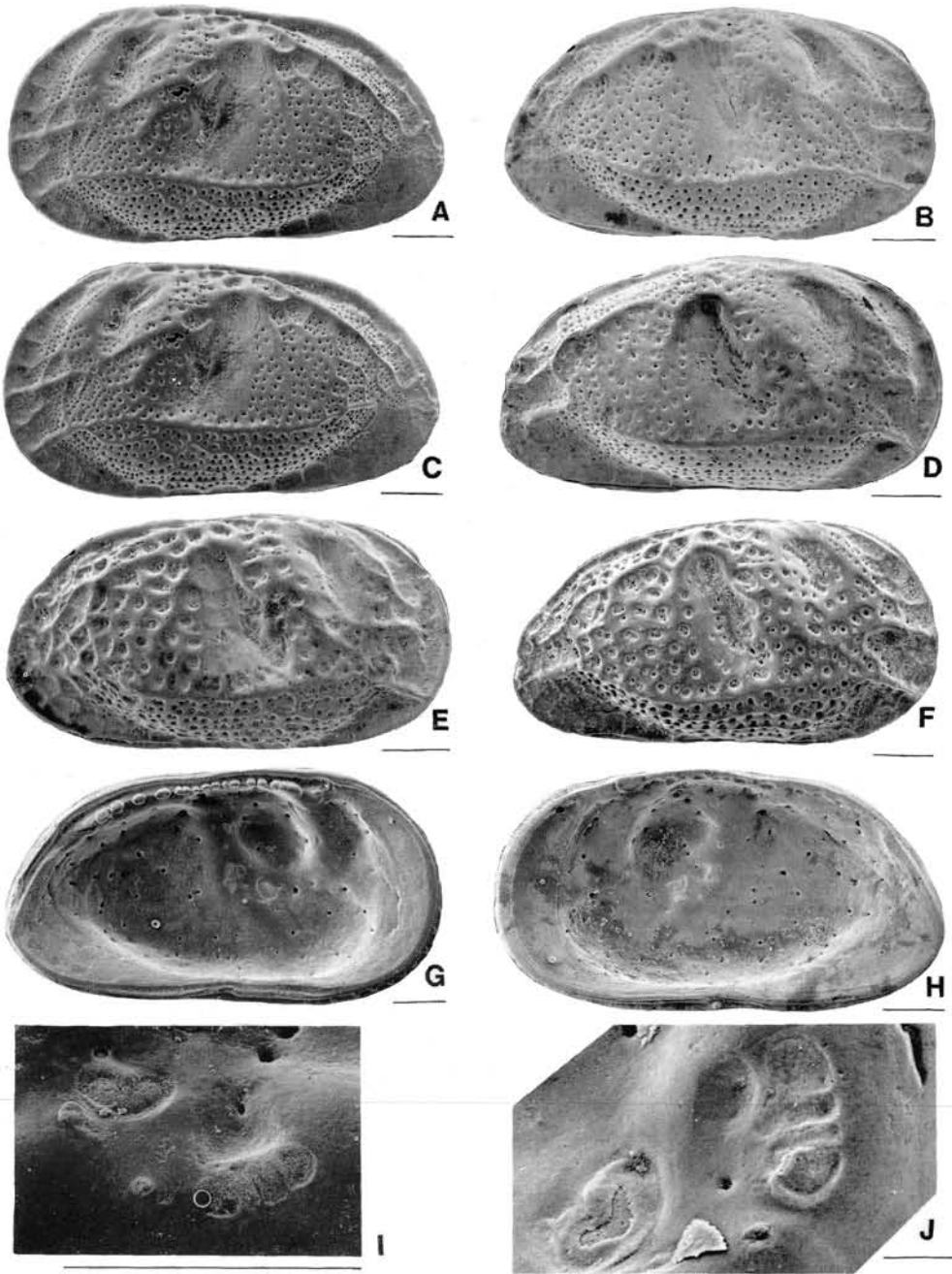


Figure 3. SEM micrographs. All scale bars = 0.1 mm unless otherwise indicated: A-J *Bisulcocythere novaezealandiae* sp. nov., (A & C) Stereo pair, paratype female LV, OU 39613, external lateral view, Recent; (B) holotype female RV, OU 39612, external lateral view, Recent; (D) male RV, OU 39617, external lateral view, L35/f70, Waiauan, Middle Miocene; (E) female RV, OU 39616, external lateral view, J41/f214, Altonian, Early Miocene; (F) male RV, OU 39615, external lateral view, sample number 5, Recent; (G) paratype female LV, OU 39613, internal lateral view, Recent; (H) holotype female RV, OU 39612, internal lateral view, Recent; (I) holotype OU 39612, details of central muscle scars; (J) male RV, OU 39617, details of central muscle scars, L35/f70, Waiauan, Middle Miocene, scale bar = 0.02 mm.

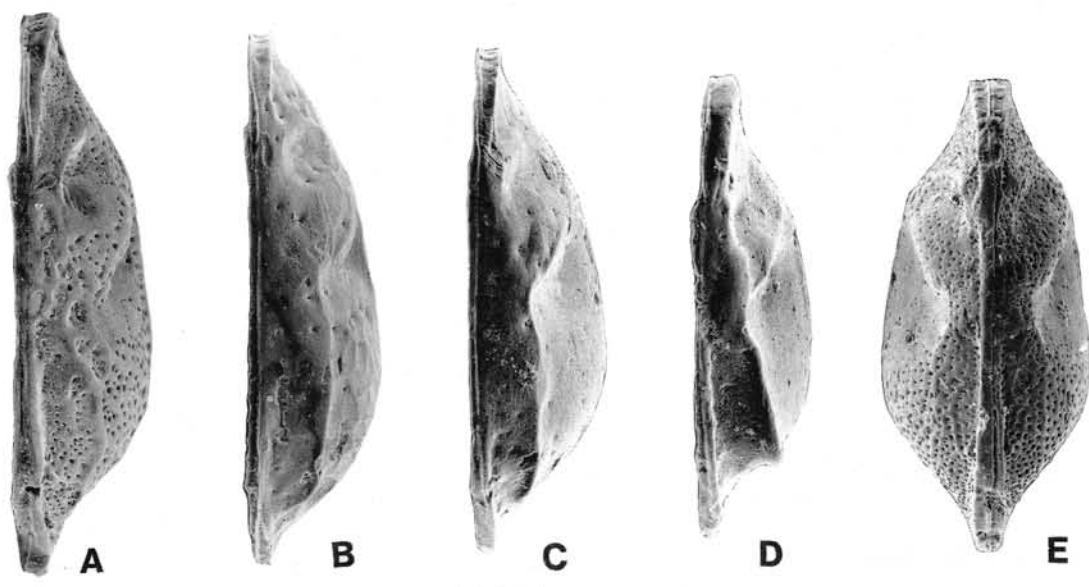


Figure 4. SEM micrographs. Dorsal view of species of *Bisulcocythere*. Scale bar = 0.1 mm: (A) *Bisulcocythere novaezealandiae* sp. nov. holotype female RV, OU 39612; (B) *Bisulcocythere campbelli* sp. nov. male RV, OU 39618, L35/170; (C) *Bisulcocythere micropunctata* sp. nov. paratype female RV, OU 39631; (D) *Bisulcocythere compressa* sp. nov. paratype female RV, OU 39629; (E) *Bisulcocythere eocenica* sp. nov. holotype female C, OU 39619.

**Etymology.** With reference to the restricted occurrence of this species to New Zealand.

**Type locality and Horizon.** Recent muddy sand of Otago shelf (Station MU 68-24), lat. 45°50'S, long. 171°00'E. Water depth 520 m.

**Material.**

**Recent specimens:**- females: 14V, males: 3V, juveniles 1V.

**Fossil specimens:**- females: 13V, males: 3C, 21V, juveniles 2V.

**Distribution.** Recent of Otago shelf (depth range 182 m - 580 m, samples 1 - 5), eastern Shelf (depth range 110 m - 750 m, samples 6 - 8), east Tasman

Sea (depth range 138 m to 621 m, samples 11 - 16 and 18), Doubtful Sound, Fiordland (water depth 69.5 m, sample 20); Waiau Stage, Middle Miocene, of Burnt Hill, North Canterbury (sample 23), and Altonian Stage, Early Miocene, near Oamaru, North Otago (samples 27 and 28).

**Diagnosis.** A moderately well inflated, strongly dimorphic species of *Bisulcocythere* with inflated surfaces covered with punctate or reticulate ornament. Dorsal ridge extends irregularly through posterior half, branching posteriorly and medially. Vento-lateral ridge extends throughout length of valve. A third sinuous ridge is present at mid-height anteriorly.

**Dimensions for *B. novaezealandiae* sp. nov. (mm):**

	Catalogue no.	Length	Height	Sample
Holotype, female RV	OU 39612	0.71	0.40	MU Stn. 68-24
Paratype, female LV	OU 39613	0.70	0.40	MU Stn. 68-24
Paratype, female RV	OU 39614	0.70	0.40	MU Stn. 68-24
Topotype, female LV	TO 1157/2	0.70	0.40	MU Stn. 68-24

*Description.* Medium sized, thick-shelled, subrectangular in lateral view. Anterior margin broadly rounded; posterior margin asymmetrically convex, apex at lower third of height. Dorsal margin straight in females, slightly convex and tapers to lower posterior in males. Ventral margin with very gentle oral incurvature. Subhastate in dorsal view, subtriangular in anterior view. Moderately well inflated, marginal areas compressed. Two dorsal sulci; median sulcus subvertical shallowing posteriorly, anterior sulcus short and crescentic subparallel with anterior margin. Inflated surface punctate or reticulate; fossae circular medianly, polygonal posteriorly, secondarily reticulate and longitudinally aligned ventrally. Dorsal ridge extends irregularly through posterior half of valve length, prominent at dorsal border of median sulcus; anterior and posterior ends of ridge branch and become obscured by strong mural elements of the reticulation. A second ridge extends throughout length of valve ventro-laterally. A third, sinuous, short, longitudinal ridge present at mid-height anteriorly. Normal pore canals numerous, simple and well spaced. Internal carapace features as for genus.

*Remarks.* This species differs from other species of *Bisulcozythere* in its relatively large size, its dorsal ridge pattern and long ventro-lateral ridge. Both punctate and reticulate forms are included in this species since neither of these features are confined to one outline (sexual dimorph), locality or stratigraphic age. It is most likely that *B. novaezealandiae* sp. nov. developed from *B. micropunctata* sp. nov. during the Altonian Stage.

*Bisulcozythere eocenica* sp. nov.

Fig. 5F-H and 4E

*Etymology.* From the Eocene occurrence of this

species.

*Type locality and Horizon.* Outcrop of Ashley Mudstone Formation (*sensu* Field & Browne 1986) in bank of Waihao River about 500 m upstream from McCulloch's Bridge, South Canterbury; grid ref. 497988 (NZMS 260, 1975 overprint series), Fossil Record File Number J40/f90; Kaiaitan Stage, Late Eocene.

*Material.* Females: 6C, 6V; males: 3C, 1V; juveniles: 1V.

*Distribution.* Known only from the type locality and horizon (sample 24).

*Diagnosis.* A species of *Bisulcozythere* with straight dorsal and postero-dorsal margins which meet to form a distinct posterior cardinal angle. Ventral margin biconvex. Maximum length at or below mid-height. Surface ornament consists of two fields of dense punctation anteriorly and posteriorly; punctae diminish in size distally. Subdued dorsal ridge extends close to dorsal margin and along anterior border of antero-dorsal sulcus.

*Description.* Small sized, thick-shelled, subrectangular in lateral view. Anterior margin broadly rounded; posterior margin truncate dorsally, convex ventrally. Dorsal margin straight with distinct posterior cardinal angle. Ventral margin biconvex. Subhastate in dorsal view, subtriangular in anterior view. Sexually dimorphic; males more elongate than females. Moderately well inflated, marginal areas compressed. Two dorsal sulci; median sulcus subvertical and shallow, anterior sulcus short and crescentic subparallel to anterior margin. Dense punctation covers lateral surface except within sulci and marginal areas which are smooth. Punctae diminish in size towards the

*Dimensions for B. eocenica* sp. nov. (mm):

	Catalogue no.	Length	Height	Sample
Holotype, female C	OU 39619	0.64	0.32	J40/f90
Paratype, female RV	OU 39620	0.62	0.33	J40/f90
Paratype, female LV	OU 39621	0.63	0.36	J40/f90
Paratype, female C	OU 39622	0.63	0.34	J40/f90
Paratype, male C	OU 39623	0.60	0.32	J40/f90
Topotype, female C	TO 1158/2	0.63	0.33	J40/f90



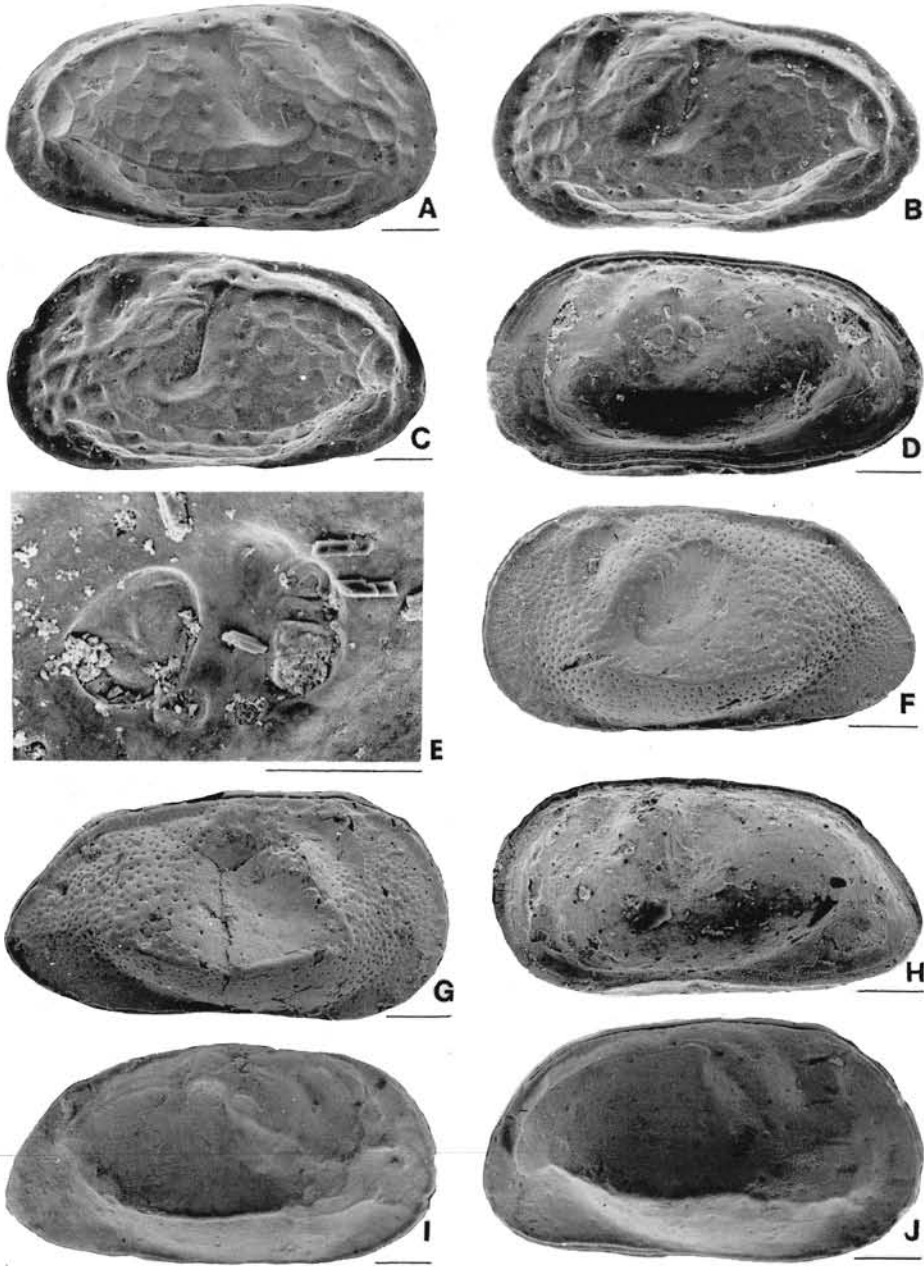


Figure 5. SEM micrographs. All scale bars = 0.1 mm unless otherwise indicated: (A-E) *Bisulcozythere campbelli* sp. nov. (all figured specimens are of Waiauian, Middle Miocene age), (A) male RV, OU 39618, external lateral view, L35/f70; (B) holotype male LV, TO 1162/1, external lateral view, (C) paratype female LV, TO 1162/2, external lateral view, (D) male RV, OU 39618, internal lateral view, L35/f70; (E) male RV, OU 39618, details of central muscle scars, L35/f70, scale bar = 0.05 mm; (F-H) *Bisulcozythere eocenica* sp. nov. (all figured specimens are of Kaiatan, Late Eocene age), (F) holotype female C, OU 39619, external lateral view of LV; (G) paratype female C, OU 39622, external lateral view of RV; (H) paratype male RV, OU 39620, internal lateral view, (I-J) *Bisulcozythere micropunctata* sp. nov. (both figured specimens are of Waitakian, latest Oligocene - earliest Miocene age), (I) holotype male RV, OU 39624, external lateral view; (J) paratype female RV, OU 39625, external lateral view.

periphery. Weakly developed ridge extends close to dorsal margin and continuing along anterior border of antero-dorsal sulcus. A second low ridge extends longitudinally at extremity of medio-ventral inflation. Internal features as for genus.

*Remarks.* This species is distinguished by its anteriorly and posteriorly distributed coarse surface punctation and its virtually indistinct dorsal ridge. It is similar to *Bisulcoythere novaezealandiae* sp. nov., but that species differs in its larger size, its strong dorsal ridge and surface reticulation. *Bisulcoythere eocenica* sp. nov. is the oldest known member of this genus.

*Bisulcoythere micropunctata* sp. nov.

Fig. 5I-J, 6A-D and 4C

*Etymology.* Alluding to the fine punctation covering the whole surface of this species.

*Type locality and Horizon.* Approximately 1 m above top of main ("lower") shellbed at base of Miller Member, Otekaike Limestone, escarpment, Trig Z, Otiake, North Otago. *Globoquadrina dehiscens* Zone, Fossil Record File Number I40/f231, Waitakian Stage, latest Oligocene - earliest Miocene.

*Material.* Females: 2C, 5V; males: 22V; juveniles: 2V.

*Distribution.* Lower Whaingaroan Stage, Early Oligocene to Altonian Stage, Early Miocene, of North Otago (samples 21, 25, 26, 29, 30 and 31).

*Diagnosis.* A species of *Bisulcoythere* with fine punctation covering entire lateral surface. Dorsal ridge extends through posterior half and obliquely across inflated area between dorsal sulci.

*Dimensions for B. micropunctata* sp. nov. (mm):

	Catalogue no.	Length	Height	Sample
Holotype, male RV	OU 39624	0.62	0.34	I40/f231
Paratype, female RV	OU 39625	0.65	0.35	I40/f231
Paratype, male LV	OU 39626	0.62	0.33	I40/f231
Paratype, female RV	OU 39627	0.66	0.37	I40/f231
Paratype, female RV	OU 39631	0.66	0.36	I40/f231
Topotype, male RV	TO 1159/2	0.62	0.33	I40/f231

*Description.* Small sized, thick-shelled, subrectangular in lateral view. Anterior margin broadly rounded; posterior margin asymmetrically convex, apex at lower third of height. Dorsal margin straight in females, slightly convex and tapers to lower posterior in males. Ventral margin with very gentle oral incurvature. Subhastate in dorsal view, subtriangular in anterior view. Moderately well inflated, marginal areas compressed. Two dorsal sulci; median sulcus subvertical shallowing posteriorly, anterior sulcus short and crescentic subparallel with anterior margin. Low dorsal ridge extends subparallel and close to dorsal margin through posterior half and obliquely across inflation between dorsal sulci. Short anterior longitudinal ridge at mid-height sometimes weakly present. Low alar ridge. Lateral surface finely punctate. Internal features as for genus.

*Remarks.* *Bisulcoythere micropunctata* sp. nov. is clearly distinguished by its very finely punctate surface which lacks reticulation. It closely resembles *Bisulcoythere compressa* sp. nov. but in that species the dorsal and ventro-lateral ridges are more robust and prominent posteriorly, the dorsal margin is straight, the carapace is much more compressed dorsally, and most of the lateral surface lacks punctation.

*Bisulcoythere compressa* sp. nov.

Fig. 6E-I and 4D

*Etymology.* With reference to the weak inflation of this species.

*Type locality and Horizon.* Gee Greensand Formation at All Day Bay, North Otago, lat. 170° 53.7'E, long. 45° 10.8'S, Fossil Record File Number J42/f6544. Otaian Stage, Lower Miocene.

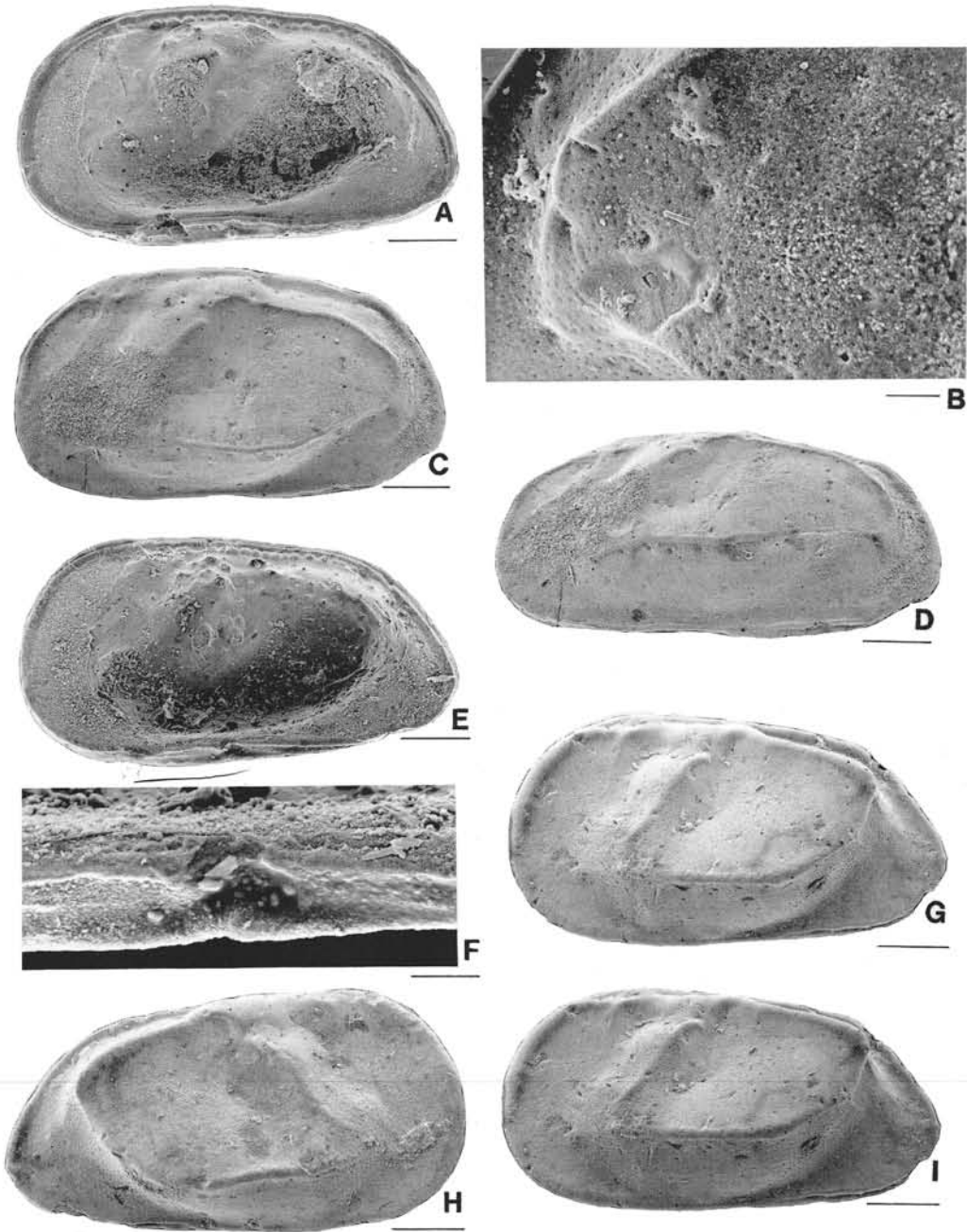


Figure 6. SEM micrographs. All scale bars = 0.1 mm unless otherwise indicated: (A-D) *Bisulcocythere micropunctata* sp. nov. (all figured specimens are of Waitakian, latest Oligocene - earliest Miocene age), (A) paratype female RV, OU 39631, internal lateral view; (B) paratype female RV, OU 39631, detail of surface punctation, scale bar = 0.02 mm; (C) paratype male LV, OU 39626, external lateral view; (D) paratype male LV, OU 39626, external postero-ventral oblique view; E-I *Bisulcocythere compressa* sp. nov. (all figured specimens are of Otaian, Early Miocene age), (E) paratype female RV, OU 39629, internal lateral view; (F) paratype female RV, OU 39629, detail of snap-knob structure, scale bar = 0.02 mm; (G & I) stereo pair, holotype female LV, OU 39628, external lateral view; (H) paratype female RV, OU 39629, external lateral view.

*Dimensions for B. compressa* sp. nov. (mm):

	Catalogue no.	Length	Height	Sample
Holotype, female LV	OU 39628	0.60	0.32	J42/f6544
Paratype, female RV	OU 39629	0.60	0.33	J42/f6544
Paratype, male RV	OU 39630	0.59	0.30	J42/f6544
Topotype, female RV	TO 1160/2	0.60	0.32	J42/f6544

*Material.* Females: 5V; males: 2V.

*Distribution.* Otaian Stage, Middle Miocene of All Day Bay, N. Otago and Waiauian Stage of Clifden, Southland (samples 30 and 33 respectively).

*Diagnosis.* A weakly inflated species of *Bisulcocythere* with straight dorsal and ventral margins. Antero-dorsal sulcus shallow. Dorsal ridge well developed and prominent posteriorly, continuous with low oblique ridge on inflated area between the dorsal sulci. Vento-lateral ridge also well developed. Anterior and posterior inflated surfaces finely punctate, remaining lateral surface smooth.

*Description.* Small sized, thick-shelled, subrectangular in lateral view, subhastate in dorsal view. Anterior margin broadly rounded; posterior margin asymmetrically convex, apex at lower third of height. Dorsal margin straight, ventral margin with very gentle oral incurvature. Males lower than females. Subhastate in dorsal view, subtriangular in anterior view. Weakly inflated, marginal areas compressed. Two dorsal sulci; median sulcus subvertical, shallowing posteriorly; anterior sulcus short and crescentic, subparallel with anterior margin. Dorsal ridge robust and prominent posteriorly, joins low subvertical median ridge at dorsal border of median sulcus. Alar ridge robust. Fine punctation covers surface of inflation anteriorly and posteriorly. Remaining surface smooth. Internal features as for genus.

*Remarks.* This species is clearly recognised by its robust dorsal and ventral ridges, its weak dorsal inflation and straight dorsal margin.

*Bisulcocythere campbelli* sp. nov.

Fig. 5A-E and 4B

*Etymology.* In honour of associate professor J. D. Campbell of the Department of Geology, University of Otago.

*Type locality and Horizon.* Glenmore Limestone. Below road bridge, Weka Creek, North Canterbury. Fossil Record File Number M34/f7035. Waiauian Stage, Middle Miocene.

*Material.* Females: 7V, males: 4V.

*Distribution.* Waiauian Stage, Middle Miocene of Weka Creek, North Canterbury and Burnt Hill, near Oxford (samples 22 and 23 respectively).

*Diagnosis.* A species of *Bisulcocythere* with surfaces of lateral inflation covered with fine punctation and low reticulation, the fossae of the latter are wide and polygonal. Dorsal ridge moderately well developed, extending to mid-height posteriorly where it joins an equally well developed ventro-lateral ridge. Ventral end of median sulcus curves towards the anterior.

*Description.* Medium sized, thick-shelled, subrectangular in lateral view. Anterior margin broadly rounded; posterior margin asymmetrically convex, apex at lower third of height. Dorsal margin straight, ventral margin with very gentle oral incurvature. Males smaller and slightly more elongate than females. Moderately well inflated, marginal areas compressed. Two dorsal sulci; median sulcus sub-vertical forward curved sub-centrally, shallowing posteriorly; anterior sulcus short, subvertical. Inflated surface finely punctate and reticulate; fossae wide, shallow and polygonal. Postero-dorsal ridge well-developed, parallel and close to margin, joins equally well-developed ventro-lateral ridge at mid-height posteriorly; course of ventro-lateral ridge anteriorly obscured by strong mural elements of the reticulation. Internal features as for genus.

*Dimensions for B. cambelli* sp. nov. (mm):

	Catalogue no.	Length	Height	Sample
Holotype, male LV	TO 1162/1	0.69	0.37	M34/f7035
Paratype, female LV	TO 1162/2	0.70	0.35	M34/f7035
Paratype, male RV	TO 1162/3	0.70	0.35	M34/f7035
Paratype, female RV	TO 1162/4	0.70	0.39	M34/f7035
Topotype, female RV	OP 1150	0.70	0.39	M34/f7035

**Remarks.** This species is clearly distinguished from the other four known members of this genus by the open meshwork of reticulate ornament and fine punctation. It is apparently restricted to the Middle Miocene, Waiau Stage.

FAMILY: TRACHYLEBERIDIDAE SYLVESTER-BRADLEY 1948

**Genus:** *Clinocythereis* gen. nov.

Type species: *Clinocythereis australis* gen. et sp. nov.

**Etymology.** Latin, referring to the inclined posterior margin of this genus.

**Diagnosis.** As for the only included species, *C. australis*, described below.

**Remarks.** At present the genus includes only the type species. In outline, shape of the vestibule and number of adductor muscle scars *Clinocythereis* resembles the genera *Parakrithe* van Den Bold 1958 and *Krithe* Brady, Crosskey & Robertson 1874, but it lacks the posterior indentation of the latter genus, the trefoil frontal scar and the adont hingement present in all krithiids. It differs from other smooth genera which are posteriorly acuminate, such as *Paracypris* Sars 1866, *Macrocypris* Brady 1868, *Argilloecia* Sars 1866, by virtue of its

straight dorsal margin, its surface depressions and its internal features. *Clinocythereis* clearly belongs to the Trachyleberididae by virtue of its strong amphidont hingement. Its smooth lateral surface is distinct within the family.

***Clinocythereis australis* sp. nov.**

Fig. 7 and 8A-J

**Etymology.** Latin, with reference to the southern distribution of this species.

**Type locality and Horizon.** All Day Bay, North Otago. Blue-grey siltstone of Rifle Butts Formation. Fossil Record File Number J42/f169. Altonian Stage, Early Miocene.

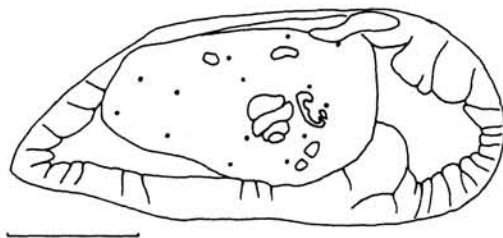


Figure 7. Camera lucida drawing of *Clinocythereis australis* sp. nov., holotype, OU 39632, male RV. Scale bar = 0.1 mm.

*Dimensions for C. australis* sp. nov. (mm):

	Catalogue no.	Length	Height	Sample
Holotype, male RV	OU 39632	0.40	0.17	J42/f169
Paratype, male LV	OU 39633	0.41	0.18	J42/f169
Paratype, female C	OU 39634	0.40	0.20	J42/f169
Paratype, female LV	OU 39635	0.40	0.20	J42/f169
Topotype, female RV	TO 1161/2	0.40	0.20	J42/f169



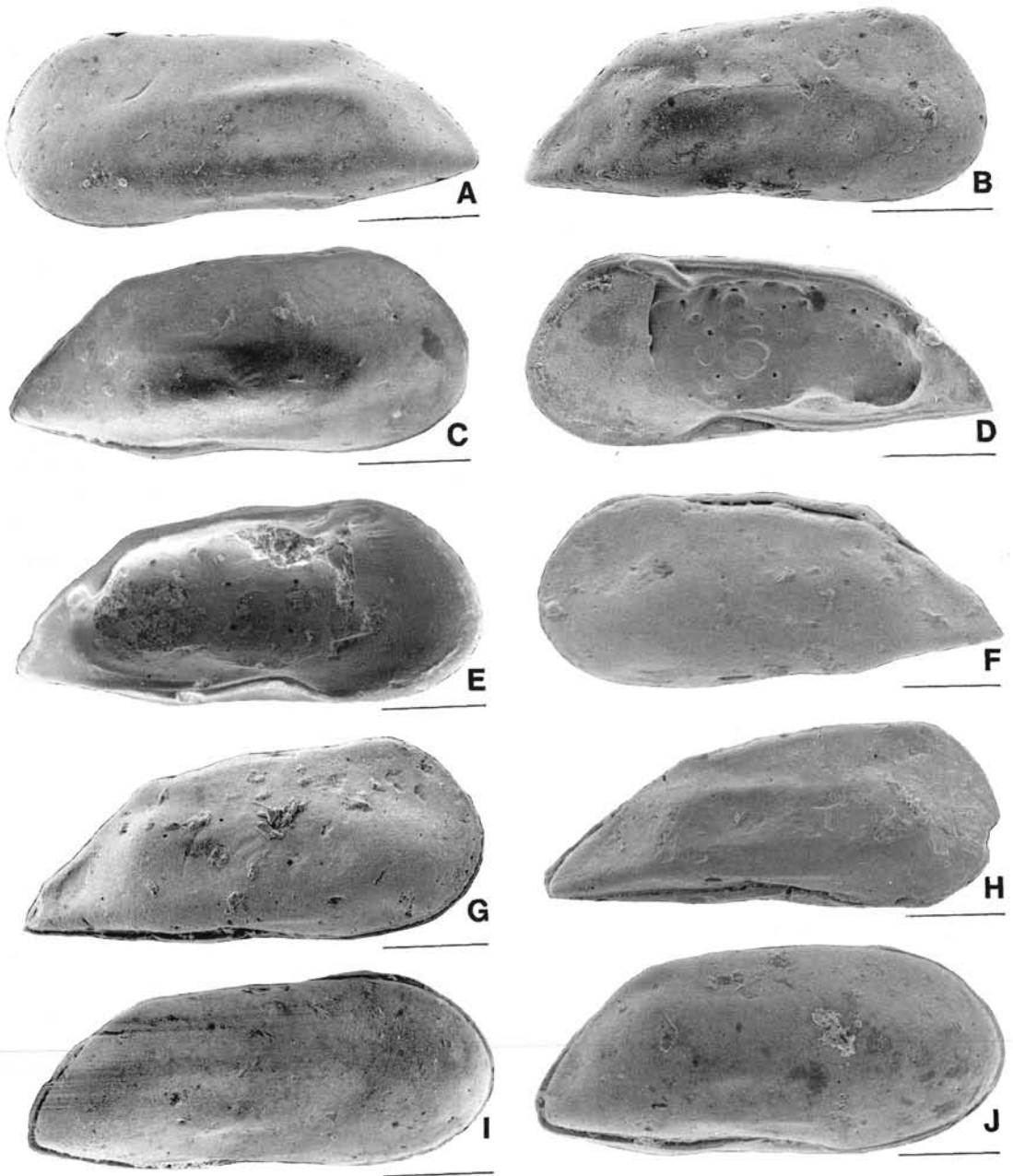


Figure 8. SEM micrographs. All scale bars = 0.1 mm: (A-J) *Clinocythereis australis* sp. nov., (A) paratype male LV, OU 39633, external lateral view, Altonian, Early Miocene; (B) holotype male RV, OU 39632, external lateral view, Altonian, Early Miocene; (C) paratype female C, OU 39634, external lateral view of RV, Altonian, Early Miocene; (D) holotype male RV, OU 39632, internal lateral view, Altonian, Early Miocene; (E) paratype female LV, OU 39635, internal lateral view, Altonian, Early Miocene; (F) female C, OU 39638, external lateral view of LV, Kaiatan, Late Eocene; (G) female C, OU 39638, external lateral view of RV, Kaiatan, Late Eocene; (H) male C, OU 39639, external lateral view of RV, Kaiatan, Late Eocene; (I) male C, OU 39636, external lateral view of RV, Altonian, Early Miocene; (J) female C, OU 39637, external lateral view of RV, Altonian, Early Miocene.

*Material.* Females: 32C, 38V; males: 15C, 10V.

*Distribution.* **Tasman Sea:** Recent off Westland (depth range 621 m - 769 m, samples 10, 12, 17 and 19) and eastern shelf (depth range 123 m - 1130 m, samples 8 and 9); Pleistocene of DSDP Site 284 (present day water depth 1066 m, sample 34); late Pliocene to Pleistocene of DSDP Site 592 (present day water depth 1088 m, sample 35); Middle Miocene to Early Pliocene of DSDP Site 593 (present day water depth 1068 m, sample 36); **East Indian Ocean:** Pleistocene of DSDP Site 259 (present day water depth 4696 m, sample 37); **New Zealand:** Otaian to Altonian Stage, Early Miocene, of All Day Bay, North Otago (samples 30 and 32); Kaiatan Stage, Late Eocene, of Waihao district, South Canterbury (sample 24).

*Diagnosis.* A small, subrectangular to wedge-shaped genus, with a convex anterior margin, straight dorsal margin and an inclined posterior margin which forms an approximately 45° angle with ventral margin. Three longitudinal, parallel depressions on lateral surface. Whole of lateral surface smooth. Sieve type normal pore canals. Inner lamella broad with a "mushroom-shaped" antero-ventral vestibulum and a long narrow posterior vestibulum which extends to posterior extremity. Hinge modified hemiamphidont with a strong tooth at posterior end of median element in the LV. Posterior terminal element of hinge situated at mid-length of posterior slope. Muscle scars large; a subvertical row of 4 adductors and a single crescentic frontal scar.

*Description.* Small sized, subrectangular to wedge-shaped in lateral view. Males more elongate than females. Anterior margin broadly convex; posterior margin straight to slightly sinuous slope forming an acute angle with ventral margin. Dorsal margin straight subparallel with straight to slightly concave ventral margin. Valve inflation moderate, compressed antero-dorsally and posteriorly, with three parallel, longitudinally flattened to slightly concave areas medianly. Surface smooth. Normal pore canals well spaced, sieve type. Inner lamella broad with large downturned "mushroom-shaped" vestibule antero-ventrally, of variable size; and subtriangular vestibule postero-ventrally. Radial pore canals simple; about

14 anteriorly, the dorsal most two are long, about 10 posteriorly. Hinge modified hemiamphidont; in the RV, the anterior terminal element is an elongate arched tooth, the median element a smooth groove expanded at each end, and the posterior terminal element is a weakly dentate tooth. Adductor muscle scars a subvertical row of 4 large elongate and closely adjacent scars; frontal scar single and crescentic.

*Remarks.* The elongation of this species and expansion of the anterior vestibule is somewhat variable. Some Lower Miocene specimens collected from the Rifle Butts Formation at All Day Bay, where this species occurs in abundance, differ in having a relatively blunt posterior acumination, weakly developed surface depressions, and a very strongly convex and symmetrical anterior margin (see Fig. 8I and 8J). These specimens may belong to a separate species. Despite the observed intraspecific variation, the carapace morphology and size of *C. australis* has remained remarkably constant throughout its long geological range.

## DISCUSSION

*Bisulcocytthere novaezealandiae* is the only living representative of its genus. It occurs only in marine waters surrounding New Zealand, with a depth range of 69.5 m to 750 m. These records, however, are based on the occurrence of valves only. Therefore, our records of this species may not accurately reflect the water depth range at which this species lives. Although rare, the species was found most consistently, and well preserved, at depths less than 600 m; specimens found at deeper stations often showed signs of abrasion and corrosion, and had probably been transported downslope.

Unlike other invertebrate groups few marine ostracod genera are reported to be restricted to the New Zealand region; most ostracod genera of New Zealand also occur in Australian waters (Hornibrook 1952, Titterton & Whatley 1988). Those few ostracod genera that are endemic *eg. Miracythere, Waiparacythereis*, appear to be relatively young taxa. Therefore, the rather long geological range of *Bisulcocytthere* (at least Late Eocene - Recent) is unusual. This unusual pattern probably reflects the poor data base that currently

exists for the New Zealand fossil ostracod fauna.

The stratigraphical distribution of the known records of the five species of *Bisulcoythere* indicate that the genus originated in the Late Eocene. It diversified during the Oligocene and Early Miocene, to produce at least four species, only one of which, *B. novaeseelandiae* subsequently survived to the present. The temporal distribution and possible phylogenetic relationships of the five species are shown in Fig. 9. The inferred phylogenetic relationships were deduced from a cladistic analysis based on five morphological characters: punctation (primitive - coarse, derived - fine), reticulation (absent/present), dorsal ridge (subdued, weak, strong or prominent), median ridge (absent/present), and a continuous ventro-lateral ridge (absent/present). The coarse punctation of *Bisulcoythere eocenica* was identified as plesiomorphic because it occurs in this early species and because similar ornament is present in the chosen out-group, *Cluthia* Neale 1973. Polarities for other characters were established by comparison with the out-group and the oldest known species *B. eocenica*. It would be desirable to use more than five characters to analyse cladistic relationships amongst five species. However, as will be apparent from descriptions of these species no more characters could reasonably be obtained. Similarly, stratigraphic position is used initially to determine character polarities because all species of *Bisulcoythere* are highly derived relative to the out-group. Further discoveries of new species and of new stratigraphic records will allow the inferred relationships to be reassessed. The evolution of the carapace ornament of *Bisulcoythere* shows an overall trend towards the enhancement of dorsal ridges (from subdued to weak to strong or prominent) and the development of reticulation.

*Clinocythereis* is represented only by one species, *C. australis*. In Recent sediments it has been recorded most consistently at slightly greater depths than *Bisulcoythere* (total depth range 123 m to 1130 m), only rarely recorded shallower than 500 m. The finding of this species in abundance in the deep water facies (outer shelf to upper slope; Fordyce *et al.* 1985, Beu & Maxwell 1990) of the Rifle Butts Formation at All Day Bay, also indicates its rather "deep water" habit in the past.

Although very rare, *C. australis* has been re-

corded in Late Miocene to Quaternary sediments of DSDP sites situated at bathyal depths of the Tasman Sea. One of these, Site 592 on the Lord Howe Rise, is the most northerly occurrence recorded for the species in the New Zealand/Tasman Sea region. In addition, the Quaternary record at DSDP Site 259, an abyssal (4696 m) site adjacent to the steep continental slope of western Australia, is the only record outside the New Zealand region. The ostracod assemblage from that site is rather mixed; allochthonous Australian shelf taxa occur together with *in situ* deep water, psychrospheric taxa (Ayress 1988). *C. australis* is clearly not in place at that site but has been displaced from shallower depths of the Australian continental slope/shelf.

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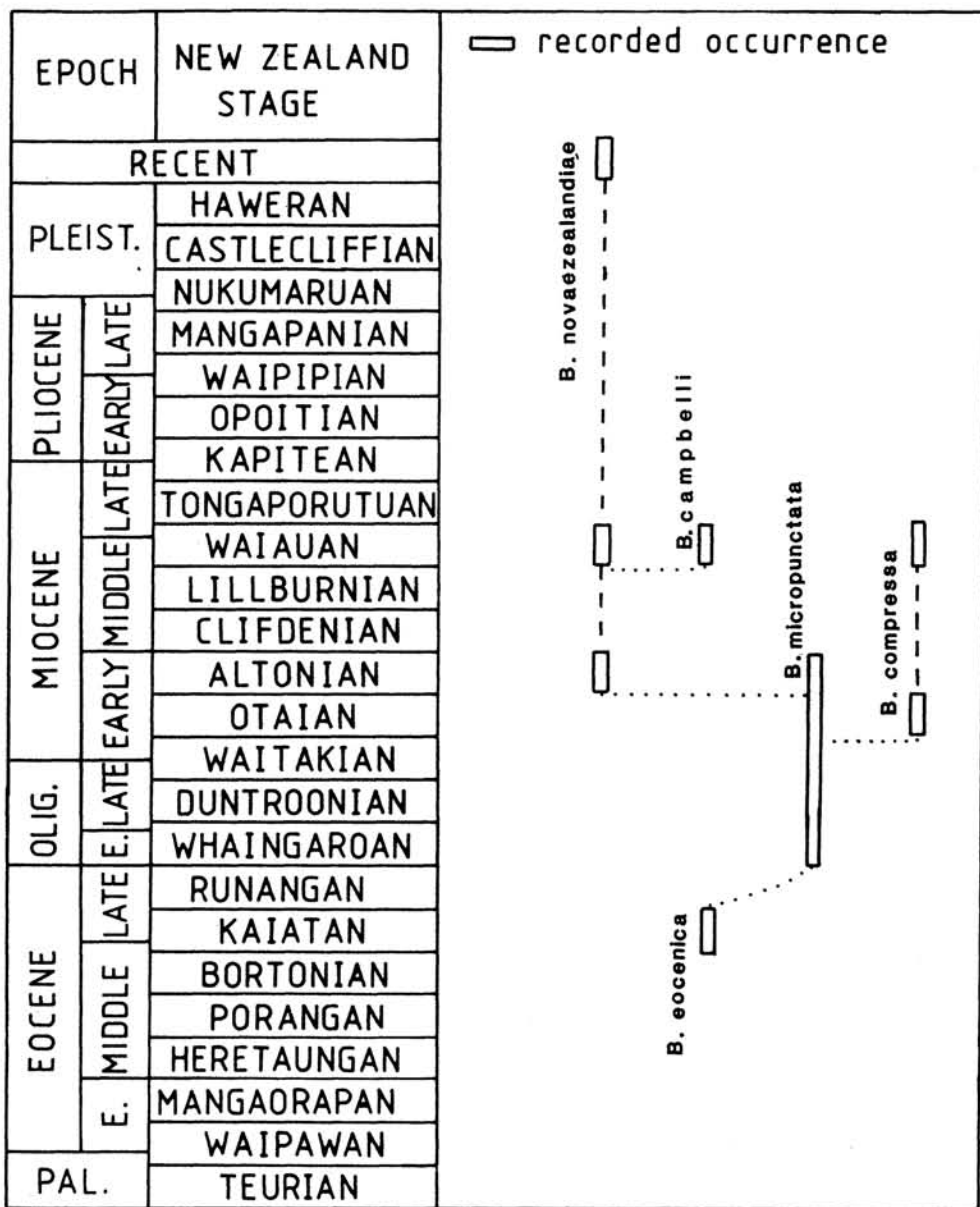


Figure 9. Stratigraphical distribution and suggested phylogenetic relationship of species of *Bisulcocythere*.

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