EARLY MESOZOIC MARINE FOSSILS FROM CENTRAL ALEXANDER ISLAND

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ABSTRACT. An early Mesozoic, probably Triassic, fossil assemblage is described from marine sediments of the Lully Foothills in central Alexander Island. Previously, these sediments, which had been correlated with the "Trinity Peninsula Series" of Graham Land, were assigned a Carboniferous age partly on the basis of palynological data. The fossils described here are generally poorly preserved but a gastropod, *Scurriopsis* (?) *aranetexta*, is sufficiently complete to be formally described as a new species. The regional significance of the fauna is discussed.

FLORAL remains and a mixed neritic marine fauna constitute the first fossil assemblage from central Alexander Island. The fossils occur within an approximately 2 m. thick sequence of steeply dipping indurated tuffs which crops out at the north-western extremity of the Lully Foothills at lat. 70°38′ S., long. 69°44′ W. (Fig. 1). The fossiliferous sediments are restricted to a 25 m. along-strike section and they occur within a basic lava and tuffaceous sequence, which also contains interbedded metamorphosed sediments, lithologically and structurally similar to those found in the LeMay Range and eastern Lully Foothills. The fossil-bearing sequence is restricted to the western Lully Foothills and is separated from the low-grade regionally metamorphosed sediments of the eastern Lully Foothills and the LeMay Range by an approximately north–south-trending fault (Fig. 1). However, the similarities between the sedimentary lithologies in the tectonically divided area suggests that the volcanic sequence may only be a localized facies of a widespread metasedimentary sequence found over a greater part of Alexander Island, i.e. in the LeMay Range, Walton Mountains and including the deformed sequences in northern and southern Alexander Island as described by Bell (1973, 1974), Grikurov and others (1967) and Grikurov (1971). East of the LeMay Range the metasedimentary sequence is bounded by a major north–south-trending fault which separates it from the relatively undisturbed Upper Jurassic–Lower Cretaceous Fossil Bluff Formation (Grikurov, 1971; Edwards, 1979; Taylor and others, 1979).

Hitherto, the estimated age of the deformed sequence of Alexander Island was based on tentative lithological and structural correlations (Grikurov and others, 1967) between these sediments and the "Trinity Peninsula Series" of north-eastern Graham Land, which was assigned a (?) Carboniferous age on meagre palaeobotanical evidence (Croft, unpublished report quoted by Adie (1957)). Spores separated from sediments of the LeMay Range were considered by Grikurov and others (1967) to be Carboniferous in age, thus conflicting with their Jurassic–Cretaceous (105–110-165 m. yr.*) radiometric date which, however, was believed to indicate a metamorphic event. They did not rule out the possibility of a Jurassic age for the diagenesis of at least the upper horizons of the sequence. In a subsequent account of the palynological material from the "Trinity Series" [*sic*] of the Antarctic Peninsula, including the samples from the LeMay Range of Alexander Island, Grikurov and Dibner (1968) concluded that the spores were comparable to species from the Lower and Middle Carboniferous of the Donetz and Moscow Basins, Kazakhstan and elsewhere.

The spores from the sediments of central Alexander Island were reported to have Lower Carboniferous affinities. Grikurov (1971) again re-considered the information and proposed a definite pre-Mesozoic age (Upper Carboniferous–Permian) for the central Alexander Island metasediments.

The presence of a marine fossil assemblage within the largely unfossiliferous sediments of

* These dates were determined using the constants adopted in the U.S.S.R.: $\lambda_\beta = 4{\cdot}72 \times 10^{-10}$ yr. $^{-1}$ and $\lambda_\epsilon = 5{\cdot}57 \times 10^{-11}$ yr.$^{-1}$. Halpern (1971) recalculated the figures using $\lambda_\beta = 4{\cdot}72 \times 10^{-10}$ yr. $^{-1}$ and $\lambda_\epsilon = 5{\cdot}85 \times 10^{-11}$ yr.$^{-1}$, thus altering the ages for the Alexander Island sequence to 100–105-157 m. yr.

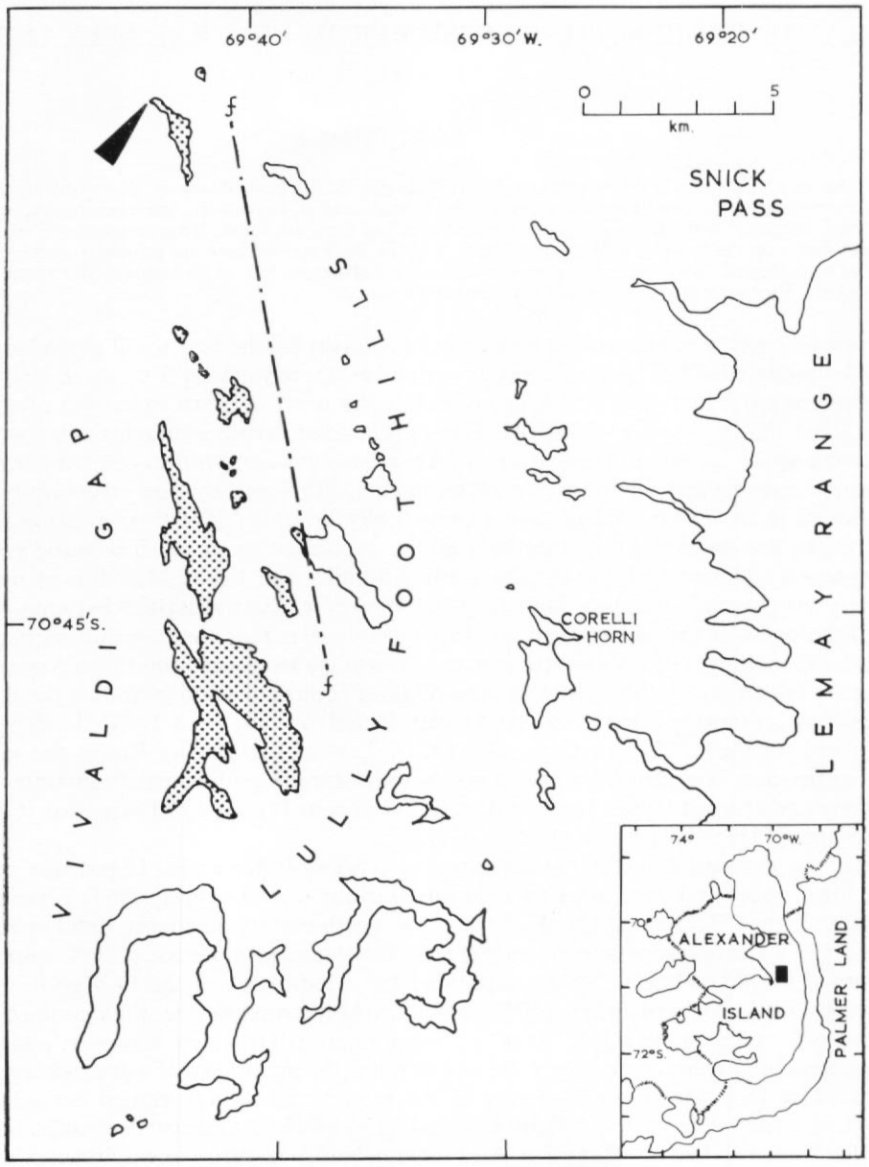

Fig. 1. Sketch map of central Alexander Island showing the postulated fault separating the dominantly volcanogenic rocks of western Lully Foothills (stippled) from the metasedimentary rocks of the LeMay Range. The fossil locality is indicated by an arrow. (Based on plane-table surveys by A. E. Gannon and C. E. Knott.)

central Alexander Island provides the first opportunity to date this apparently widespread sequence of interbedded metasediments and volcanic rocks by macro-palaeontological means. These fossils constitute a generally poorly preserved assemblage, consisting of external moulds of a scleractinian coral, ten gastropod species, five bivalve genera and fragmentary echinoid and crinoid remains. A number of small unidentifiable leaves were collected from a horizon immediately above the beds containing the marine assemblage and these may indicate a

general proximity to a shoreline. The rapid change upwards from a wholly marine fauna, consisting of disarticulated bivalve shells and fragments of robust corals, to a relatively quiet-water sediment type, containing delicate floral remains, must surely indicate a generally shallow-water environment, where rapid changes in sediment particle size and enclosed palaeontological remains may be more readily visualized.

Lithology

All the invertebrate fossils are contained within a grey vitric tuff, which is part of an extensive basalt-tuff sequence. (The classification of the sediment follows that of Fisher (1961, table 3).)

Glass shards and small fragments of vesicular pumice (both up to 1·5 mm. long) form 53 per cent of this well-sorted sediment. The shards show a characteristic vitroclastic texture but they are largely devitrified, although patches of unaltered brown glass are present. Compositional variation within some of the shards is reflected in a banding coloration. Most of the shards are angular and have concave surfaces, although some are slightly rounded. Rounded fragments (up to 1·5 mm. in diameter) of a fine-grained basalt are present in minor amounts (7 per cent) throughout the rock. Some alteration and sericitization of the plagioclase laths within the basalt has occurred but the pyroxene (augite) is relatively fresh. Calcite, both in original shell fragments and as the recrystallized mineral in the matrix, amounts to 10·5 per cent of the total rock. Most of the shell material is identifiable as fragmented or disarticulated bivalve tests. The matrix of the tuff (14·9 per cent) has undergone a considerable amount of recrystallization with quartz and feldspar as the main constituents. The quartz (8·5 per cent) exhibits a sutured texture of small interlocking plates which are frequently intergrown with the feldspar. The feldspar (6·1 per cent) is plagioclase with a composition in the oligoclase-andesine range. Alteration of the feldspar and inclusions within the mineral are commonly observed. The inclusions may be bubbles or even minute quartz crystals. The vesicles in the pumice fragments are infilled with sutured quartz, chlorite usually associated with epidote, or secondary calcite. Subangular detrital augite and authigenic pyrite are present as accessories.

The rounded nature of the lithic fragments and the slight amount of rounding of the glass shards is consistent with the presence of isolated and disarticulated bivalve shells and the rapid lithological changes, suggesting some re-working of the material in a shallow marine environment.

Palaeontology

Phylum Coelenterata

Class Anthozoa Ehrenberg 1834

Family Thamnasteriidae Vaughan and Wells 1943

Genus *Thamnasteria* Lesauvage 1823

Thamnasteria (*?*) sp.

Fig. 4e

Material

Two fragments of external moulds of a scleractinian coral (K.G.1944.1 and 2).

Description and remarks

The small fragments (2 cm. by 1 cm., and 2 cm. in diameter) are probably pieces broken from large ramifying thamnastraeoid colonies and transported. Both specimens appear to be of similar type (Fig. 4e).

The corallites are closely united by short septo-costae and there are no epithecal walls. No regular fenestration is evident but an ill-defined porous structure may exist on the septa. The columella is apparently formed by the proximal fusion of the primary septa or pali but the absence of any internal structures and the general poorly preserved nature of the specimens reduces further meaningful description to hypothetical interpretation.

These specimens appear to be similar to *Thamnastraea* → *Astraeomorpha* sp. ind. described by Koerner (1937, p. 154–55, pl. 10, fig. 2a–d) from northern Peru. His specimen is insufficient to determine other than broad similarities between the Peruvian and Alexander Island forms. The detail preserved on specimens KG.1944.1 and 2 is reminiscent of the Thamnasteriidae, to which the specimens are tentatively assigned. The confluent septa, lack of corallite walls and possibly fenestrate septa of this ramose thamnastraeoid coral distinguish it from the Astrocoeniidae.

The range of the Thamnasteriidae is considered to be Middle Triassic to Recent (Vaughan and Wells, 1943).

Phylum Mollusca

Class Gastropoda Cuvier 1797

Eight genera of gastropods are recognized among the specimens. Unfortunately most are small and incompletely preserved as external moulds; all lack the apertural detail essential to precise identification. In some specimens, parts of the test are still adhering to the moulds and recrystallized calcite has infilled the whorls in a few instances. All the specimens have been prepared as silicone rubber casts to aid identification and description.

Family Procerithiidae Cossmann 1905

Genus *Protofusus* Bonarelli 1921

Protofusus sp.

Fig. 2a

Material

Only a single external mould (KG.1944. 3a) of this small cerithiid gastropod is present in the collection.

Description

The shell (Fig. 2a) is dextrally coiled, conispiral and siphonostomatous with a 30° spire angle. The apical whorls are missing but four whorls are present, comprising a spire 4·5 mm. long and a body whorl 2·5 mm. high. The whorl profile has its maximum width in the abapical third of each whorl. There is a moderately elongate anterior siphonal canal, which extends for about 30 per cent of the total height of the shell, and this curves abruptly to the right at its extreme anterior end.

The collabral ornament is composed of eight transverse costae per whorl, aligned regularly on successive whorls. The costae merge with the convexity of the shell at their abapical end, whereas at the adapical margin of the whorls the costae slightly extend into the preceding whorl thus presenting an undulating appearance at the suture. The varices are slightly convex forward on the body whorl but on earlier whorls they are perpendicular, i.e. axial and straight. Owing to its formation on the sides of the strong transverse costae, the spiral thread ornament has a slightly undulose appearance, most noticeable on the earlier whorls. A faint growth

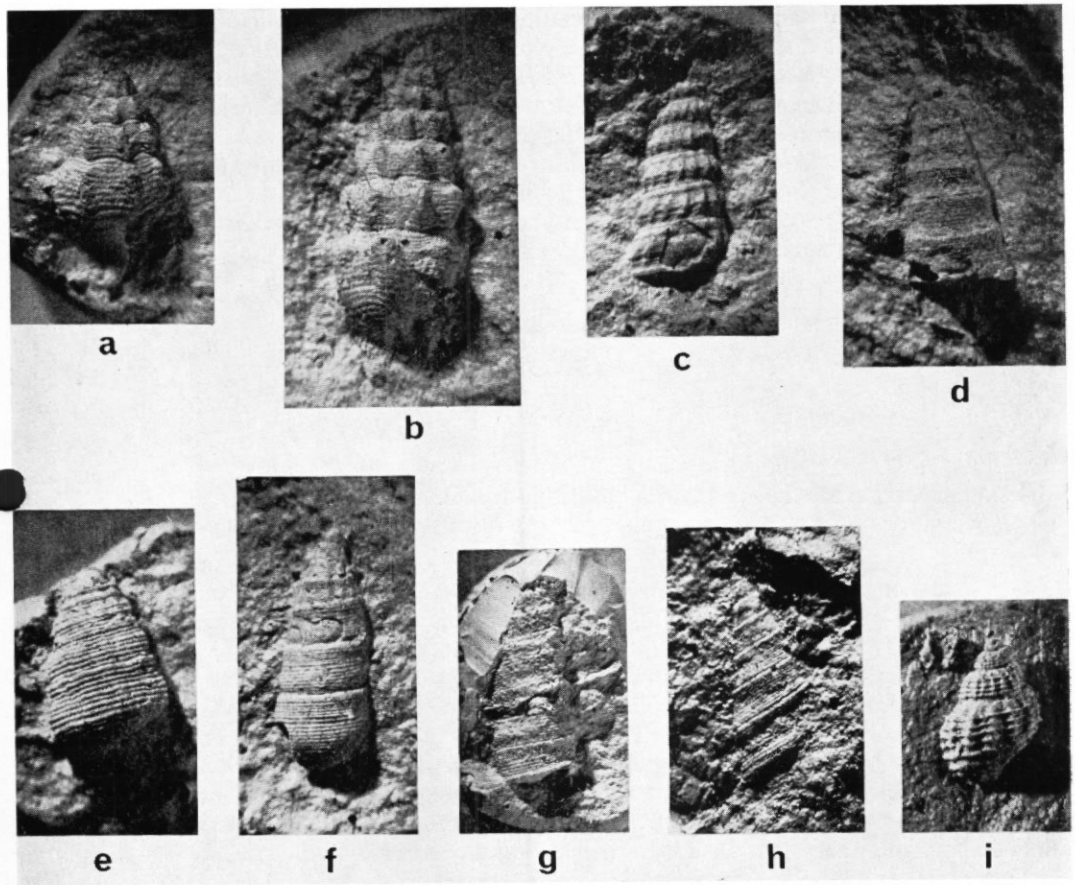

Fig. 2. a. *Protofusus* sp.; silicone rubber cast from an external mould showing the elongate siphonal canal; ×4 (KG.1944.3a).
b. *Rhabdocolpus* sp.; silicone rubber cast from an external mould; ×4 (KG.1944.3b).
c. *Zygopleura* (*Katosira*) sp.; silicone rubber cast from an external mould; ×4 (KG.1944.4).
d. Silicone rubber cast from an external mould of a procerithiid gastropod showing a conoidal outline; ×4 (KG.1944.7).
e. Silicone rubber cast from an external mould of an incomplete procerithiid gastropod showing body whorl and two latest whorls; ×4 (KG.1944.8).
f. Silicone rubber cast from an external mould of a procerithiid gastropod showing pupaeform shape and absence of axial ornament on later whorls; ×4 (KG.1944.6).
g. Incomplete turritellid gastropod showing seven spirally ornamented whorls; ×4 (KG.1944.9).
h. Turritellid gastropod showing faintly concave whorl profile; ×4 (KG.1944.10).
i. *Procerithium* (*Apicaria*) sp.; silicone rubber cast from an external mould; ×4 (KG.1944.5).

striation is present on the periphery of part of the body whorl and a fine spiral thread ornament persists on the slightly concave base.

Remarks

The outline of the conch of specimen KG.1944. 3a most closely approaches that of *Protofusus pyramidalis* Haas from northern Peru (Haas, 1953). This species has a large apical angle similar to that of specimen KG.1944. 3a but on the Alexander Island specimen the base is more concave and consequently the siphonal canal is more prominent. The boundary between the body whorl and the base on specimen KG.1944. 3a is defined by twin keels across which

the costae gradually vanish. It was this feature on *Protofusus pyramidalis* that Haas (1953) considered the most distinctive characteristic of typical members of the genus *Protofusus* as compared to *Paracerithium*, which specimen KG.1944. 3a otherwise superficially resembles. Bonarelli (1921) documented the main features used to distinguish *Paracerithium* from *Protofusus* and he emphasized the presence in the latter genus of the siphonal canal which projects beyond the outline of the aperture. *Protofusus andinus* Bonarelli, figured by Bonarelli (1927, pl. 3, fig. 12) from northern Argentina, has a smaller apical angle and 11 transverse costae per whorl but it also has a similar shape and outline to specimen KG.1944. 3a. In both species the percentage of the total height taken up by the anterior canal is similar.

Genus *Rhabdocolpus* Cossmann 1906

Rhabdocolpus sp.

Fig. 2b

Material

A single external mould of a cerithiid gastropod (KG.1944. 3b).

Description

The specimen is a small, dextral conispiral shell of seven whorls with an incompletely preserved anterior siphonal canal (Fig. 2b). The spire angle is 28°, the spire length is 6 mm. and the body whorl is 4 mm. high; the siphonal canal extends a minimum of 1·5 mm. abapically. The whorl profile is masked by strong perpendicular varices which adapically form sub-tuberculate nodes and tend to produce a shelf or "coronet" (Haas, 1953, p. 234) at the adapical margin of each whorl. The varices are strong adjacent to the nodes and adapical sutures but, about half-way between the sutures, they dissipate gradually and are virtually absent at the abapical suture; on the body whorl the varices merge abapically with the siphonal canal. The varices are offset backwards from those on preceding whorls, producing a sinstrally directed pattern on the dextrally coiled shell. A spiral ornament of about 12 weakly undulating flattened threads crosses the varices and this is maintained without interruption on the base. The base is poorly defined on specimen KG.1944. 3b but it appears to be conically pointed towards the siphonal canal, which is possibly recurved at its extremity. The whorl profile suggests that the aperture, which is not preserved, might be sub-elliptical.

Remarks

Haas (1953) maintained that *Rhabdocolpus* deserves generic rather than subgeneric status. Previously, Cossmann (1906), Bonarelli (1927) and Wenz (1938–44) interpreted the form as a subgenus of *Procerithium*.

The characteristic "coronet" (the narrow ramp adapical of the sub-tuberculate nodes) (Haas, 1953, p. 234) and the inferred presence of the curved anterior canal (Fig. 2b) both suggest that specimen KG.1944. 3b should be included in the genus *Rhabdocolpus* Cossmann.

The transverse ribs on specimen KG.1944. 3b do not end abruptly at the suture line on the body whorl but continue abapically, gradually merging with the anterior canal. This feature is reminiscent of both *Protofusus* and *Paracerithium*, and can be compared directly with *Rhabdocolpus subulatus* Haas from the Triassic of Peru (Haas, 1953). Haas considered that the merging of the ribs with the convexity of the body whorl represents "ancestral reminiscence", thus implying iterative evolution from a common (unspecified) procerithiid ancestral stock. In *Rhabdocolpus subulatus*, the beak housing the canal is slightly recurved similar to specimen KG.1944. 3b but the apical angle is greater than in specimen KG.1944. 3b, producing a more rounded whorl profile.

Genus *Procerithium* Cossmann 1902

Subgenus *Apicaria* (Kutassy 1937)

Procerithium (*Apicaria*) sp.

Fig. 2j

Material

A single external mould of a small turbinate gastropod (KG.1944.5).

Description

This small, complexly ornamented turbinate shell has four complete, rapidly expanding whorls in a shell of total height 5 mm. with a spire angle of approximately 35° (Fig. 2j). The rounded whorls have a maximum inflation approximately midway between the sutures.

The ornament is composed of both spiral and transverse elements but the two early apical whorls appear to be smooth. Four coarse, sharply defined spiral threads are present towards the periphery of the whorls, which are separated from each other by deep furrows about twice the width of the threads. The transverse ornament is composed of 16 poorly defined costae. These are almost perpendicular to the spiral threads on the earlier whorls but on the body whorl they lean backwards at a slightly oblique angle to the perpendicular. The costae extend just beyond the margins of the spirally ornamented periphery, but dissipate both abapically and adapically before reaching the sutures. On the earlier whorls the transverse and spiral ornaments are of similar intensity and produce a well-defined cancellate ornament. However, on the body whorl the transverse costae become broader and consequently less well defined. Towards both the abapical and adapical sutures, the whorl surface is smooth with neither transverse nor spiral ornament. The base is feebly concave and is delineated by two prominent keels with a less well-defined thread abapical to them. The aperture is thought to be holostomatous but it is not preserved in its entirety.

Remarks

The rounded, almost bucciniform shell and the ornament are distinctive. Kutassy (1937) described two species of his new genus, *Apicaria*, from the Upper Carnian of Hungary which have a similar rounded shell profile and ornament to those of specimen KG.1944. 5. The Alexander Island specimen (Fig. 2j) most closely resembles *Procerithium* (*Apicaria*) *trinodosa* (Kutassy, 1937, pl. 2, figs. 82 and 83) in size, shell shape and axial ornament. However, the Alexander Island specimen differs in having one extra spiral thread compared to the Hungarian species. As the name might suggest, *P.* (*Apicaria*) *trinodosa* has a tripartite spiral ornament which forms nodes where the axial and spiral ornaments intersect. The Alexander Island specimen has four such spiral threads and merely forms an accentuated cancellate ornament rather than nodes. The axial ornament on *P.* (*Apicaria*) *trinodosa* (Kutassy, 1937, fig. 82) appears to cross the spiral ornament almost perpendicularly on the earlier whorls, whereas on the body whorl the ornament is markedly opisthocline. Spiral threads persist on the weakly concave base. Thus the characteristics of the ornament on the Hungarian specimens are almost identical to those on the Alexander Island specimen.

Procerithium (*Apicaria*) *trinodosa* (Kutassy) is found in beds of Triassic (Upper Carnian) age but it persists into the Rhaetic.

Family Procerithiidae (?)

Gen. et sp. indet.

Fig. 2d–f

Material

Three external moulds of a conispiral, dextrally coiled turreted gastropod (KG.1944. 6–8).

Description and remarks

These gastropods have generally small shells (up to 8 mm. high) with a spire angle of about 7°. Normally, the shell has a gently convex profile in the earlier whorls but, as the rate of expansion of the whorls decreases relative to the height of each individual whorl, the profile becomes turriculate. This conoidal shape is only well expressed in one specimen (KG.1944. 6; Fig. 2f). The ornament in the initial three whorls is composed of both spiral threads and axial costae but on the later whorls the axial ornament gradually reduces in prominence until it disappears altogether. The axial costae are perpendicular to the sutures. Numerically, they increase abapically to about 14 per whorl before gradually losing prominence and merge with the shell convexity. The costae are regularly arranged and are aligned from one whorl to the next, although they decrease in prominence towards each suture. The spiral ornament is composed of 14 regularly spaced threads on the sides of the whorls but at the adapical margin the whorl curves to produce a narrow sloping shelf at the suture and this is devoid of ornament. The suture is narrowly grooved. The body whorl curves convexly into the base which retains the spiral ornament. The aperture is not preserved but the whorl profile suggests that it may be broadly oval.

The decrease in axial ornament on the later whorls of the shell is a common feature of the Cerithiidae. The presence of the ramp at the adapical margin is a feature found on typical members of the genus *Paracerithium* which also has an oval aperture. However, due to the lack of comparable material, the lack of aperture and the nature of the preservation, it has proved impossible to identify these specimens further than being probable members of the Family Procerithiidae.

Family Zygopleuridae Wenz 1938

Genus *Zygopleura* Koken 1892

Subgenus *Zygopleura* (*Katosira*) Koken 1892

Zygopleura (*Katosira*) sp.

Fig. 2c

Material

A single external mould (KG.1944. 4) of a small, incompletely preserved, transversely ornamented, turreted gastropod.

Description

Specimen KG.1944. 4 is a small, conispiral turreted gastropod with a spire angle of about 13°. The specimen consists of six whorls and has a spire height of 7 mm. with the whorl profile dominated by the angular periphery slightly adapical of the mid-line of the whorl (Fig. 2c). This angularity in whorl profile is accentuated by the axial costae, each of which is inflated to a node at the periphery but merges with the convexity of the whorl towards the adapical and abapical sutures. The ornament is composed of both transverse and spirally arranged elements. The spiral ornament consists of irregular poorly defined threads, which are more obvious or better preserved on the adapical whorl surfaces. The grooved suture is enhanced by a broad spiral thread on the abapical edge of each whorl. A faint spiral ornament persists on the broadly convex base. An estimated 15 axial costae per whorl truncate the spiral ornament. They show a faint median angulation and are opisthocline and concave forwards. The aperture is not preserved on specimen KG.1944. 4.

Remarks

Zygopleura (*Katosira*) was considered by Bonarelli (1927) to be the commonest and the best represented gastropod in the fauna from Carbajal, northern Argentina. Two of the species from his collection closely resemble the Alexander Island specimen: *Z.* (*Katosira*) *communis* and *Z.* (*Katosira*) *carbajalensis*. The costae on *Zygopleura* (*Katosira*) *communis*, described by Bonarelli (1927, pl. 1, fig. 16), are more or less straight on the earlier whorls but they become slightly crescentic on the body whorl. The species of *Zygopleura* (*Katosira*) figured by Bonarelli (1927) generally appear to have more pronounced curved costae than those figured by Haas (1953).

In his discussion of the population of *Zygopleura* (*Katosira*) *carbajalensis*, Bonarelli emphasized the variability in the number and relief of the costae and the broad limits of the variation in the apical angle. In the diagnosis of *Z.* (*Katosira*) *carbajalensis*, Bonarelli selected an approximate 10° apical angle and 18–20 costae per whorl, whereas in *Z.* (*Katosira*) *communis* an approximate 15° apical angle and 10–12 costae per whorl were indicated. The Alexander Island specimen (KG.1944. 4; Fig. 2c) with its approximate 13° spire angle and 15 axial costae per whorl thus lies somewhere between the two variation fields of *Z.* (*Katosira*) *carbajalensis* and *Z.* (*Katosira*) *communis*.

Family Coelostylinidae Kittl 1894

Genus *Omphaloptycha* Ammon 1892

Omphaloptycha (?) sp.

Fig. 3d

Material

Three incomplete external moulds of a holostomatous turbinate shell (KG.1944.14–16).

Description

In the most complete specimen (KG.1944.14), six complete whorls are visible (Fig. 3d). The shell height reaches 12 mm. with a spire angle of about 35°. Specimen KG.1944.14 has a conoidal shape and the whorl profile is generally feebly inflated with an incised suture line. The ratio of whorl diameter to whorl width averaged over the whole shell is 1 : 2·55, indicating that the shell has narrow whorls relative to the whorl diameter. The whorl section is subelliptical and the nepionic whorl(s) may be heterostrophically coiled. There is a distinct columella but the morphology of the base is not observable. Whereas the major part of the shell is devoid of ornament, two small areas, the apical whorl and a section of the base of the body whorl, have a faint spiral thread-like ornament.

Remarks

The outline of the shell is similar to that of *Omphaloptycha jaworskii* Haas from Cerro de Pasco, Peru, first described by Jaworski (1923) and re-examined and re-named by Haas (1953). That specimen has a total height of 17 mm. and a maximum breadth of 9 mm. which, although much larger than specimen KG.1944.14, in proportion compares favourably with it. Specimen KG.1944.14 is also similar to *Coelostylina* sp. described by Kittl (1894, p. 159, figs. 15–19). That specimen has a slightly pupaeform shape and, other than growth lines and perhaps a hint of spiral thread ornament on the body whorl, the shell is smooth, thus comparing well with the Alexander Island specimens.

FAMILY AMBERLEYIDAE WENZ 1938

Genus *Amberleya* Morris and Lycett 1850

Subgenus *Eucyclus* Eudes-Deslongchamps 1850

Amberleya (*Eucyclus*) (*?*) sp.

Fig. 3a

Material

Two external moulds of a turbiniform gastropod (KG.1944.17 and 18).

Description

Specimen KG.1944.17 is the largest gastropod of the collection from the Lully Foothills with four partially complete whorls forming a spire 6 mm. high and a body chamber about 9·5 mm. high (Fig. 3a). Specimen KG.1944.18 is smaller with a total height of 10 mm. and it is generally less well preserved. The nepionic whorls are not present on either of these specimens. The spire angle is approximately 25°. The whorls are moderately convex with the maximum width occurring mid-way between the sutures.

There is a prominent spiral ornament with a less well-developed transverse element. Three strong, coarse spiral ribs with deep furrows about twice the width of the ribs are present on each whorl. The central rib occurs on the periphery, mid-way between the sutures, with the lateral ribs almost bisecting the remaining whorl area but with the abapical rib slightly nearer the suture than its adapical counterpart. The ribs do not appear to increase in width in proportion to the whorl dimensions. On the body whorl (where the peripheral diameter of the whorl is 9 mm.), between the central and adapical ribs there is a faint development of a median intercalatory rib which increases in prominence towards the aperture. On the abapical margin of the whorls, immediately adjacent to the suture, there is a narrow spiral thread which enhances the fine grooved line marking the suture. The abapical rib of the tripartite ornament on the body whorl is divided by a fine stria along the mid-line of the rib. The base is defined by a coarse rib in the relative position of the suture in previous whorls and which also marks the adapical limit of the transverse ornament. Five closely arranged spiral threads are present on the convex base.

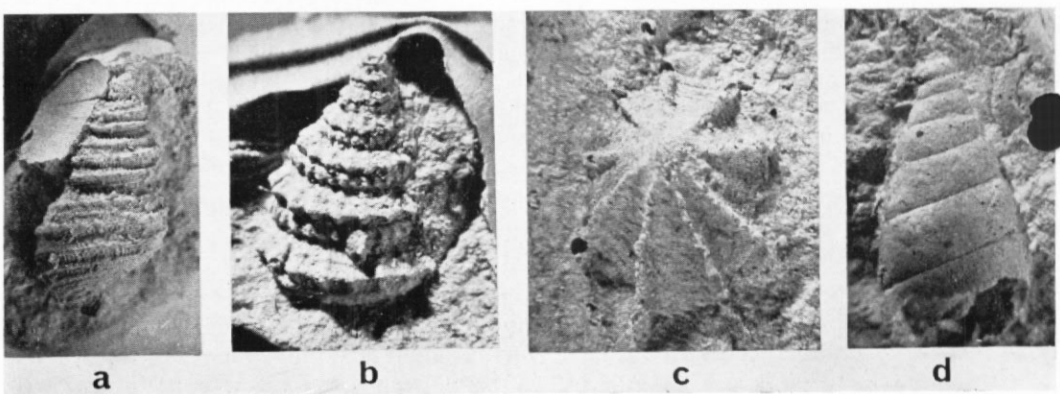

Fig. 3. a. *Amberleya* (*Eucyclus*) (*?*) sp.; silicone rubber cast from an external mould; ×2 (KG.1944.17).
b. *Amphitrochus* sp.; silicone rubber cast from an external mould; ×4 (KG.1944.19).
c. *Scurriopsis* (*?*) *aranetexta* sp. nov.; silicone rubber cast from an external mould showing the web-like arrangement of the ornament; ×4 (KG.1944.20).
d. *Omphaloptycha* (*?*) sp.; silicone rubber cast from an external mould; ×3 (KG.1944.14).

Fine transverse growth lamellae are present but only in the furrows between the ribs and adjacent to the whorl margins. The lamellae appear to be cut and completely obliterated across the spiral elements but this may be due either to abrasion or to non-formation. Between the abapical whorl margins and adjacent coarse rib, and similarly at the adapical margin, the transverse threads are convex backwards, whereas in the furrows adjacent to the central rib the ornament is straight but is prosocline. The transverse threads are best observed on the flanks of the three spiral cords but at the centre of the furrows between the ribs the ornament is usually poorly represented. No apertural details are obtainable from either specimen.

Remarks

Although the turbiniform outline of specimen KG.1944.17 resembles that of *Apachella translirata* Winters from the Permian of Arizona (*in* Moore, 1960, p. *I*207, fig. 120.3), that specimen possesses a distinct selenizone and only two central ribs. The sculpture of specimen KG.1944.17 is similar to that often found in species of *Amberleya* (*Eucyclus*) Eudes-Deslongchamps. It shows some resemblance to *Eucyclus denticulatus* described by Haas (1953, p. 84–87, pl. 5, figs. 49–53 and 56–61) in having a similar transverse ornament on parts of the shell. However, that species has a prominent transverse ribbing abapical of the periphery of each whorl. The shell is angular to almost pagodiform and possesses only two major spiral elements instead of three as is present on the Alexander Island specimens.

Amberleya torosa Marwick from the Lower Jurassic (Hettangian) of New Zealand (Marwick, 1953) has a similar ornament to the Alexander Island specimens, although the outline of the shell in the New Zealand form is more angular.

The general characteristics of the ornament and the outline of the shell suggest that the Alexander Island specimens should be included in the Amberleyidae. The spirally carinate ornament is considered to match closely that of species of *Amberleya* (*Eucyclus*), which commonly has a small protrusion on the apertural margin where the basal and columellar lip margins meet. Although not preserved on specimen KG.1944.17, there is a development of such a structure on specimen KG.1944.18. Without further information on the shape of the aperture and the nature of the columella, the true affinity of specimens KG.1944.17 and 18 cannot be determined.

Family Nododelphinulidae Cox 1960

Genus *Amphitrochus* Cossmann 1907

Amphitrochus sp.

Fig. 3b

Material

A single external mould of a small trochiform shell (KG.1944.19).

Description and remarks

The specimen consists of six incomplete whorls with an observable spire height of 6 mm. and a spire angle of about 40° (Fig. 3b). The whorl profile is angular and is formed by a ramp leading from the adapical suture to the periphery of the whorls which is marked by a double row of nodes. The abapical keel has an estimated 28 prominent nodes, whereas on the adapical one the nodes, estimated to be 40 per whorl revolution, are smaller and less pronounced. Transverse costae extend from the nodes abapically over the ramp but dissipate towards the sutured margin of the whorl. There is a faint trace of spiral threads on the ramp, defined largely by minor nodes where it cuts the transverse costae from the peripheral keel.

Preservation is inadequate to identify the body whorl or any growth lines. However, the ornament and general shell shape are similar to those found on species of *Amphitrochus*.

Family Turritellidae Woodward 1851

Gen. et sp. indet.

Turritellid gastropods

Fig. 2g and h

Material

Three small turreted gastropods, all external moulds and all incompletely preserved (KG. 1944.10–12 and many unnumbered fragments).

Description

The specimens are small, conispiral, orthostrophic, dextrally coiled shells. Measurements of spire angles fall into two groups (approximately 10° and approximately 21°) and this suggests that two distinct taxonomic groups may be present. However, there are no differences in the ornament and observable morphological features of the two possible sets, and it is proposed to describe the specimens together.

On the best-preserved specimen (Fig. 2g) the spire is more than 12 mm. in height and the body chamber at least 2 mm. deep. The ornament is formed of 11 or 12 flattened spiral threads, which over most of the whorl are of uniform thickness but have a slight thickening at the adapical edge of each whorl. This thickening is partially overlapped by each succeeding whorl, producing an expression of the feature at the suture. The suture line is indistinct and is often marked only by a broader thread. The profile of the shell is a smooth turret but each whorl profile may be slightly concave, perhaps a function of the marginal overlap of the whorls. The base is flat and maintains the spiral ornament. The aperture is not preserved in any of the specimens but the whorl shape suggests that it is sub-elliptical.

Remarks

The shell shape and ornament strongly resemble species of *Turritella* and are not unlike that of *Turritella* (*Tourquesia*) *hassani* Abbass from the Cretaceous (Cenomanian) of south-west England. However, that species possesses only 8 or 9 spiral threads on the whorl and is incompletely known (Abbass, 1962). No other species was discovered which resembles the Alexander Island specimens but this may have been due to the generally fragmentary nature of this collection, which as such is insufficiently preserved for a confident identification to be made.

Family Acmaeidae Carpenter 1857

Genus *Scurriopsis* Gemmellaro 1879

Scurriopsis (*?*) *arahetexta* sp. nov.

Fig. 3c

Material

A single specimen (KG.1944.20) of a strongly radially ornamented patelliform gastropod is preserved as an external mould.

Diagnosis

Bilaterally symmetrical patelliform shell with a non-perforate apex and entire margin. Nine strong, straight radiating ribs intersect a prominent concentric growth ornament, forming a web-like pattern.

The specific name *aranetexta* alludes to the web-like arrangement of the radial and concentric ornament and is taken from the Latin *aranea* (= spider) and *textum* (= web).

Description

This small, broadly elliptical, low conical shell has the apex offset from the central position. The apical area is imperforate and smooth but radial and collabral ornament rapidly become apparent towards the aperture (Fig. 3c).

Nine strong, narrow radial ribs are arranged symmetrically, or nearly so, about the antero-posterior axis with the apex about one-third from the margin of the shell. In the absence of internal musculatural detail, the orientation of the shell is not known. With the apex offset along the major axis of the ellipse, the radial ribs are necessarily of unequal length; three ribs are set on the shorter steeper side of the cone, two are laterally opposing along the minor axis of the ellipse and the four remaining ribs are symmetrically arranged on the longer and consequently less steep part of the cone. There is no other radial ornament. Lines of growth are prominent over and between the radial ribs.

In longitudinal profile, the shell has a flattened oblique triangular aspect with a rounded apex. The longer slope is slightly convex, whereas the shorter slope is flat to faintly concave.

Dimensions

Length: 8·5 mm.; width: 6·7 mm.; height: 2·2 mm.

Remarks

Patelliform gastropods generally, and Triassic forms in particular, are poorly represented in the palaeontological literature which makes any comparison of specimen KG.1944.20 with described species very difficult. The ribbing on specimen KG.1944.20 is similar to that on a Recent gastropod *Siphonaria subatra* Pilsbry (i.e. thin and well defined). Although the shape of that species is broadly comparable with the Alexander Island specimen, the diagnosis of *Siphonaria* indicated a siphon duct or groove (Hubendick, 1946), which is not present on specimen KG.1944.20.

Haas (1953) described a new species of *Acmaea* from Peru which he compared with several European Triassic species (e.g. Broili, 1907). However, none of them has such a well-defined ornament as is present on the Antarctic specimen.

Class Bivalvia Linné 1758

Family Cardiniidae Zittel 1881

Genus *Balantioselena* Speden 1962

Balantioselena aff. *gairi* Speden 1962

Fig. 4a

Material

A single external mould of a right valve of a prosogyrous bivalve (KG.1944.21).

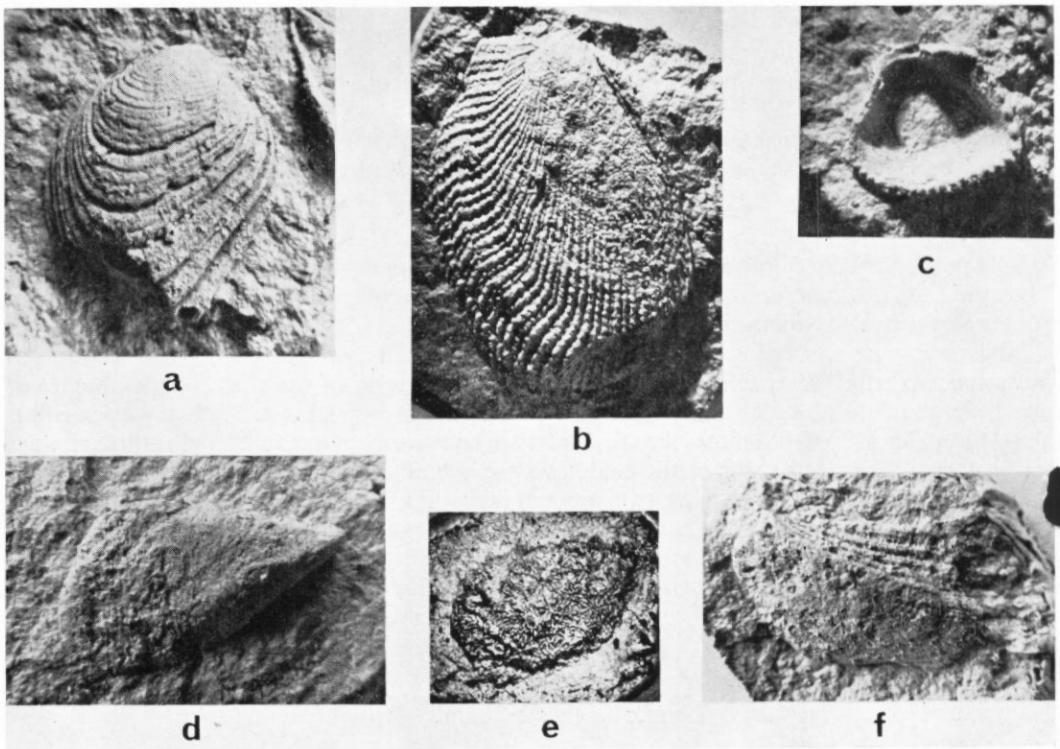

Fig. 4. a. *Balantioselena* aff. *gairi* Speden; silicone rubber cast from an external mould of a right valve showing the deep growth-pause depressions; ×3 (KG.1944.21).
b. *Antiquilima* (*?*) sp.; silicone rubber cast from an external mould of a right valve showing folded anterior wing and inflexion of ribbing; ×2 (KG.1944.23).
c. Bivalve α; silicone rubber cast from an external mould of a right valve of an inflated bivalve; ×4 (KG.1944.24).
d. *Waagenoperna* aff. *ozawai* (Kobayashi); silicone rubber cast from an external mould of a right valve; ×3 (KG.1944.22).
e. *Thamnasteria* (*?*) sp.; latex cast from an external mould; ×2 (KG.1944.1).
f. Bivalve β; silicone rubber cast from an external mould of a left valve; ×2 (KG.1944.25).

Description

The specimen is a rounded to sub-quadrate inequilateral valve. It is small and considerably inflated with the maximum inflation along a dorsally curved angulation extending from the umbo to the postero-ventral corner. Conventionally, the umbo is placed uppermost for the purposes of description for, without the dentition preserved, the precise orientation of the valve is uncertain (Fig. 4a).

The postero-dorsal margin, from the beak to the posterior extremity of the shell, is gently convex and curves smoothly into the postero-ventral margin, which is incomplete in the present specimen. However, by extrapolating the growth-pause depressions to the ventral margin of the shell, it is interpreted that the postero-ventral and the antero-ventral margins meet at an acute angle, at which the curved angulation from the umbo also terminates. The slightly concave antero-dorsal margin merges with the virtually straight antero-ventral margin in a tight convex curve. The umbo is prosogyrous and incurved, and an incompletely preserved depression along the postero-dorsal margin may indicate the presence of an escutcheon. The surface ornament is composed of regular, concentric, coarse growth lines with semi-regular, deep growth-pause depressions prominent on the later growth stages of the shell.

Dimensions

Specimen	*Height* (*h*) (mm.)	*Length* (*l*) (mm.)	*h*/*l*	*Inflation* (*i*) (mm.)	*i*/*l*
KG.1944.21	10	approx. 11·5	0·87	approx. 4·0	0·35
B. gairi (holotype)	5·8	6·6	0·88	1·8	0·55

Remarks

Speden (*in* Gair and others, 1962) described a new bivalve genus from the Middle Triassic (Ladinian) of New Zealand which, allowing for natural variation, is both dimensionally and morphologically comparable with specimen KG.1944.21. Although a comparison of the dimensions of the Antarctic specimen with those of the New Zealand form shows that the former is larger and relatively less inflated than the New Zealand holotype of *Balantioselena gairi*, the range of the ratios of *i*/*l* in the type material (Speden, *in* Gair and others, 1962) is broad enough to encompass that parameter on the present specimen.

The growth-pause depressions are particularly well developed on specimen KG.1944.21, whereas on the New Zealand material there appears to be considerable variation in this feature. The absence of dentition on specimen KG.1944.21 makes further correlation between the two forms rather speculative.

It is interesting to note that, in the original description of the genus, Speden (*in* Gair and others, 1962) placed *Balantioselena* in the Astartidae and compared its dentition with that of *Tutcheria* which it superficially resembles in notation. However, Cox and Chavan (*in* Moore, 1969, p. *N*579) assigned the genus *Balantioselena* to the Cardiniidae, presumably on a re-definition of the dentition.

Family Isognomonidae Woodring 1925

Genus *Waagenoperna* Tokuyama 1959

Waagenoperna aff. *ozawai* (Kobayashi 1935)

Fig. 4d

Material

One poorly preserved external mould of a right valve (KG.1944.22) of a bivalve with a multi-vincular ligament.

Description

Specimen KG.1944.22 is a small, compressed trigonal/mytiliform shell (Fig. 4d). It is markedly prosocline with the angle between the hinge and direction of maximum growth about 23°. Maximum inflation of the valve also occurs approximately along a poorly defined angulation on this line. The hinge line is straight and extends almost the full length of the shell. The straight antero-ventral margin curves sharply on the ventral surface, merging with the posterior margin which meets the hinge line obtusely at about 110°. No teeth are preserved.

The ligament area, which may be incompletely preserved, is narrow, smooth and of constant width (2 mm.) except at its posterior extremity, where it narrows rapidly to meet the posterior margin. There are eight straight-sided ligament pits, depressed below their intervals, which extend the full width of the area perpendicular to the hinge line; they are irregular both in spacing and size but are generally wider than deep.

The sub-terminal umbo is weakly inflated. There is no anterior auricle and no distinct separation between the body of the shell and the posterior wing. A carina anterior of the most inflated part of the shell is well defined near the umbo but it disperses postero-ventrally. Anterior of the carina, the shell meets the commisure almost perpendicularly. The surface of the shell is marked with an indistinct concentric ornament.

Dimensions

Length: 13 mm.; height: 8 mm.; inflation (of right valve only): 2·3 mm.

Remarks

The Alexander Island specimen (KG.1944.22) is almost identical to *Waagenoperna ozawai* (Kobayashi) from the Triassic (Ladinian–Carnian) of Japan. Originally described (Kobayashi, 1935) as *Edentula ozawai*, it was included by Tokuyama (1959) in his new genus *Waagenoperna* with *Edentula lateplanata* Waagen as type species. Cox (1954) had placed this latter species in a new bakevellid genus *Cuneigervillia*, which he (Cox, 1954, p. 48) had erected to receive "several Mesozoic species which resemble *Isognomon* in the terminal or subterminal positio of the beaks, in their compressed umbonal region, and in the edentulous condition of th full-grown shell, but which have the obliquely elongated shape of *Gervillia* and related genera." Tokuyama (1959) considered that *Cuneigervillia lateplanata* (Waagen) and *C. planata* (Broili), both Upper Triassic forms, were more closely related to *Isognomon* rather than *Bakevellia* and proposed the genus *Waagenoperna* to include these and other Triassic forms of *Edentula*, which he considered to be distinct from Jurassic species of *Cuneigervillia* in terms of both the phylogenetic and ontogenetic development of the dentition and in the ligament structure.

Waagenoperna planata (Broili) is similar to specimen KG.1944.22 but it has a smaller angle of growth relative to the hinge line, producing a more elongate shell shape, and there also appears to be a small anterior wing (Broili, 1904, fig. 24). His description (Broili, 1904) suggests that there are at least six deep ligament pits of differing widths on the broad ligament area, which may be faintly longitudinally striated. However, no such striations are preserved on specimen KG.1944.22 but it is uncertain whether Waagen's reconstruction of a produced umbonal region is correct (Cox, 1954, p. 49; Cox, *in* Moore, 1969, fig. C52.1a).

Several species of *Isognomon* (*Mytiloperna*) show some resemblance to the Alexander Island specimen in having a mytiliform shell profile. *Isognomon* (*Mytiloperna*) *patchamensis* Cox from the Middle Jurassic (Bathonian) of the Cutch (Cox, 1940) also possesses a well-developed area anterior of the carina as in the Alexander Island specimen but the obliquity and the ligament arrangement of the Jurassic form is not comparable with specimen KG.1944.22. The general outline of specimen KG.1944.22 is similar to that of *Isognomon* (*Mytiloperna*) *ageroensis* [*sic*] (Hayami, 1957) from the Lower Jurassic (Hettangian) of Japan but th specimen is obviously much higher, less obliquely orientated and has more ligament pi than specimen KG.1944.22.

Tokuyama (1959) considered that in the ontogeny of *Waagenoperna triangularis* (Kobayashi and Ichikawa) there is an increase in the number of ligament pits from the immature to the mature stages. Comparison of the measurements of *Waagenoperna triangularis* with those of *Waagenoperna ozawai* and specimen KG.1944.22 reveals a moderate variation in the *l*/*h* ratios, and from these results it may be deduced that specimen KG.1944.22 could represent an immature form of either *W. triangularis* or *W. ozawai*. However, as *W. triangularis* has only five ligament pits in the mature form (Tokuyama, 1959, p. 153), it must be concluded that specimen KG.1944.22 more closely corresponds to *W. ozawai*. Specimen KG.1944.22 has eight ligament pits and yet it is less than one-third the size of *W. ozaeai* which has not less than nine ligament pits at maturity (Kobayashi, 1935, pl. 7, figs. 3–6).

It is considered that the ontogenetic development of the insertion of ligament pits and the

development of any dentition must be studied with the phylogeny of the Isognomonidae and Bakevellidae before multi-vincular bivalves of this type can be confidently classified and subdivided into manageable and recognizable genera. It is not the intention to do so here.

Thomson (1975) identified *Bakevellia* (*Bakevelloides*) aff. *hekiensis* (Kobayashi and Ichikawa) in the (?) Triassic Legoupil Formation of north-western Graham Land but this bakevellid has only two deep ligament pits and apparently possesses an oblique pteriform shape. It bears little relation in terms of inflation, alation and gross morphology to specimen KG.1944.22.

Waagenoperna ozawai (Kobayashi) is common in the upper Atsu Series (Ladinian–Carnian or Lower Carnian) of south-eastern Honshu, Japan.

Family Limidae Rafinesque 1815

Genus *Antiquilima* Cox 1943

Antiquilima (*?*) sp.

Fig. 4b

Material

An external mould and part of an internal mould of a right valve of a biauriculate bivalve (KG.1944.23).

Description

The valve is of medium size, weakly inflated and inequilateral with both radial and concentric ornament. It is elongated antero-ventrally, with an angle of 85° between the short hinge line and the direction of maximum growth (Fig. 4b).

The faintly convex hinge line meets the anterior margin of the valve in a rounded obtuse angle on the anterior wing. The anterior margin is straight, merging with the convex antero-ventral margin. The weakly convex postero-ventral margin meets the hinge line in a sharp obtuse angle on the posterior alation. The opisthogyrous umbo is situated mid-way along the hinge.

The auricular sulcus differentiating the posterior wing from the body of the shell is poorly delineated, whereas the anterior wing is reduced and folded against a well-defined auricular sulcus. There is a weakly developed byssal gape slightly ventral of the anterior wing.

The concentric ornament is composed of weakly developed threads with broad concentric rugae towards the ventral margin of the valve. The radial ornament is composed of two or three orders of fine costae which increase by intercalation. The intersection of radial and concentric ornament produces a reticulate pattern. The radial costae are largely directed obliquely to the direction of growth as defined by the growth lines. However, towards the margin the ribbing is inflected to cross the growth rugae at approximately right-angles and then reverts to the original oblique attitude before terminating on the margin. The umbonal region, which is well separated from the hinge, is devoid of ornament. The internal mould shows a deep, acute triangular notch under the inferred hinge area, probably representing the umbonal cavity, a dorsal extension of the visceral cavity.

Dimensions

Length: 18 mm.; height: 24·5 mm.; inflation (right valve only): 2·2 mm.

Remarks

This bivalve is distinctive in having an unusual pattern of radial ornament with a strong deflection of the ribbing at certain stages in the growth. Arkell (1929–37, p. 120, pl. 9, figs. 1

and 2) described a pectenid from the Corallian which showed this form of disrupted growth but the shell orientation and relative dimensions of that species (*Eopecten anglica*) are unlike those of specimen KG.1944.23.

Lima marlburiensis Woods from the Cretaceous of New Zealand has a pronounced change in the direction of the ribs especially when crossing a strong growth line (Woods, 1917, p. 8, pl. 3, fig. 3). The outline of specimen KG.1944.23 is similar to that of *Lima georgiiboehmi* Wilckens from the Oretian–Otamitan (Ladinian–Carnian) stages of the New Zealand Triassic, and Wilckens (1927, p. 5) stated that the ribbing of *L. georgiiboehmi* was sometimes a little wavy. Examination of material including casts of the lectotype and paralectotype of this species revealed that, although there are similarities in the outlines of specimen KG.1944.23 and *L. georgiiboehmi*, the latter is more inflated and has a less well-developed rib pattern. Comparative measurements made on the specimens reveal that *L. georgiiboehmi* is more inflated and rounded than specimen KG.1944.23 and that it could not be classified with this species.

The absence of ornament on the umbonal area and its variability over the shell (Fig. 4b) are well known in limids (Cox, 1943, p. 156). Similarly, the relatively large folded anterior wing is a feature found on a number of species of *Lima*. *Lima swenanderi* Boehm (Boehm, 190[illegible] has several similar features to those of specimen KG.1944.23, although the long, curvi[illegible] postero-ventral margin on *L. swenanderi* produces a rounded shell rather than a more elongate form as on specimen KG.1944.23. A small anterior wing, which may be folded against the body of the shell, and a posterior wing, which is undifferentiated from the main body of the shell, are the main morphological similarities. Two orders of intercalatory rib development are almost identical to that of specimen KG.1944.23 but on *Lima swenanderi* there is no evidence of the sharp inflections of the ribbing so prominent on specimen KG.1944.23. Such inflections are reminiscent of some species of the Triassic bivalves *Halobia* and *Daonella*.

Although no described limid has an ornament of a similar character to that of specimen KG.1944.23, the bivalve most closely resembles *Antiquilima* (Cox, 1943) in having a well-differentiated anterior auricle and a posterior wing, which merges with the shell across a posterior umbonal ridge only present near the umbo. The two main orders of the radial ornament are another feature found on *Antiquilima*. Specimen KG.1944.23 may represent a new species but, until better-preserved material is available to determine any possible specific variations, formal naming has been avoided.

Bivalve α

Gen. et sp. indet.

Fig. 4c

Material

One internal mould of a right valve of a posteriorly alate bivalve (KG.1944.24).

Description and remarks

The valve is small (length 5·7 mm.; height 5·0 mm.), considerably inflated and trapeziform in outline with a prosogyral beak (Fig. 4c). The body of the shell is separated from a small posterior wing by a distinct auricular sulcus and a well-defined lunule is obvious but there is no escutcheon. The relatively thick test has crenulate ventral and posterior internal margins.

The anterior margin is straight or slightly concave around the lunule. It swings sharply on to the gently convex ventral margin. Similarly, at the postero-ventral corner, where the auricular sulcus merges with the convexity of the shell, there is an acute angle to the virtually straight

posterior margin. The corner of the auricle is obtuse-angled and the dorsal margin of the shell is straight. The umbo is sub-terminal. Concentric growth lines are visible on a small part of the external mould preserved around the umbo but it is not known whether there was ornament over the main body of the shell.

The shell is similar in characteristics to several genera of the Carditidae and Cardiidae in having a crenulated internal margin and trapezoidal shape, but the absence of hinge and dentition detail makes precise identification impossible.

Bivalve β

Gen. et sp. indet.

Fig. 4f

Material

An incomplete external mould of a left valve of a carinate bivalve (KG.1944.25).

Description and remarks

Only the posterior part of the bivalve is present (Fig. 4f). The shell is fairly small and ovoid with an approximate height of 10 mm., an estimated length of about 18 mm. (measurable length 15 mm.) and an inflation reaching a maximum of 4 mm. about mid-way along the posterior carina. The hinge line meets the gently convex posterior margin in an obtusely rounded angle. At the posterior extremity of the valve, where a sharply defined angulation from the beak broadens out to meet the posterior margin, there is a sharp convex curve between the posterior margin and the feebly convex ventral margin. The remainder of the shell margin is missing.

The shell ornament, consisting of both radial and concentric elements, is divided into two distinct areas by the posteriorly directed carina. Between the hinge line and this carina is a flattened even concave postero-dorsal area, whereas the remainder of the shell is gently convex. Both areas have a distinctive ornament. On the postero-dorsal area are three strong radial ribs separated by deep furrows slightly narrower than the ribs. Posteriorly, as the ribs broaden slightly, there is a faint development of a thin thread-like depression along the mid-line of the ribs, with faint radial riblets sometimes present in the furrows between the major ribs. On the convex remainder of the shell, the ornament is best displayed towards the postero-ventral margin of the valve where a cancellate pattern is obvious. The growth lines and radial ornament lose prominence rapidly towards the umbo, where the shell is virtually devoid of ornament.

The incomplete nature of the valve precludes exact generic location of the specimen. By extrapolation, the shell is probably parallelodontid. In his observations on the palaeontology of the Triassic of South America, Jaworski (1923) illustrated a parallelodont bivalve, which bears a strong resemblance to specimen KG.1944.25 and to which he applied the name "*Macrodon*" *juttensis* Pichler. This species has a similar shape to that of specimen KG.1944.25; both the illustration and description (Jaworski, 1923, p. 120, pl. 5, fig. 4a) indicated two ribs on the postero-dorsal area, the remainder of the valve being covered with a faint cancellate ornament. Although the Alexander Island specimen is about twice the size of the Latin American form, the ratio of length to breadth is almost identical in the geographically separated bivalves.

The absence of dentition, which is so critical in the difficult and confused classification of the Arcacea, necessitates allocation to any one genus to be made solely on external form. Specimen KG.1944.25 most closely resembles the subgenus *Grammatodon* (*Grammatodon*) in both ornament and shape.

PHYLUM ECHINODERMATA

CLASS CRINOIDEA MILLER 1821

Genus *Isocrinus* von Meyer 1837

Isocrinus cf. *californicus* Clark 1915

Fig. 5d

A fragment of an external mould of a sub-stellate to quinquelobate pentacrinoid columnal (KG.1944.26; Fig. 5d) is considered to belong to the genus *Isocrinus*. The shape of the petaloids, the thickness of the columnal (approximately 0·75 mm.) and the arrangement of the crenellae (approximately 16 per lobe) on the articular surface are similar to that of *Isocrinus californicus* Clark from the Upper Triassic of California (Clark and Twitchell, 1915, p. 21, pl. 1, fig. 2a–c).

CLASS ECHINOIDEA LESKE 1778

Genus *Triadocidaris* Döderlein 1887

Triadocidaris (*?*) sp.

Figs. 5a-c and e

Material

An external mould of a fragmentary inter-ambulacral plate (KG.1944.27) and several fragmentary primary radioles also preserved as external moulds (KG.1944.28–30).

Description and remarks

The test fragment is a 2 mm. by 2·5 mm. rectangle, containing a primary tubercle with elements of the scrobicular ring (Fig. 5e).

The mamelon is circular, perforate, non-crenulate and is not undercut. The areole is relatively narrow and has a basal terrace to the boss. An incompletely preserved ring of about nine distinct scrobicular tubercles surround the smooth flush areole. The mamelonate scrobicular tubercles are about 0·5 mm. in diameter and are interdigitated with miliary spine bases about half the size of the scrobicular tubercles. The ratio of the dimensions and the detail observed on the plate compare favourably with those given by Bather (1909) for *Triadocidaris persimilis* Bather.

	T. persimilis		*KG.1944.27*
Diameter (mm.) of:			
Mamelon	1·0	0·82	0·7
Boss	2·0	—	1·3
Scrobicule	3·0	2·3	1·9

Although the specimen from Alexander Island is smaller than those described from the Bakony district of Hungary (Bather, 1909), the arrangement of the scrobicular tubercles and miliary spine bases on the specimen is similar to that illustrated by Bather (1909, pl. 6, fig. 131). However, that specimen (*T. persimilis*) has 14 or 15 scrobicular tubercles and possesses only a faint basal terrace to the boss, whereas specimen KG.1944.27 has about nine scrobicular tubercles and a well-defined basal terrace. Koerner (1937) described a number of species of

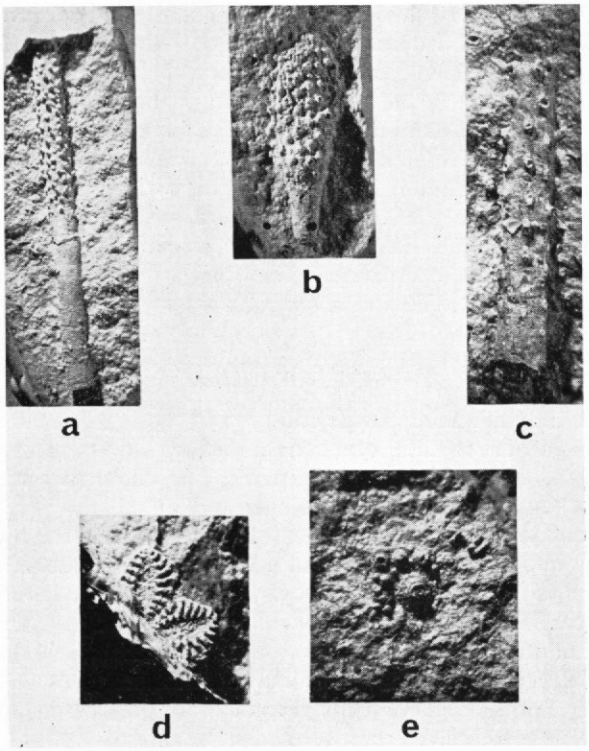

Fig. 5. a. Echinoid spine, type 1; silicone rubber cast from an external mould; ×2 (KG.1944.28).
b. Echinoid spine, type 2; silicone rubber cast from an external mould; ×2 (KG.1944.29).
c. Echinoid spine, type 3; silicone rubber cast from an external mould of a cidaroid spine; ×2 (KG. 1944.30).
d. *Isocrinus* cf. *californicus* Clark; silicone rubber cast from an external mould of a columnal fragment; ×4 (KG.1944.26).
e. *Triadocidaris* (*?*) sp.; silicone rubber cast from an external mould of an inter-ambulacral plate; ×4 (KG.1944.27).

Triadocidaris from northern Peru but the material is not readily comparable with the Alexander Island material, although he recorded an ambulacral plate (Koerner, 1937, pl. 10, fig. 9a and b) which was compared with *Triadocidaris persimilis* Bather and *Triadocidaris subsimilis* Münster. Mortensen (1928, p. 63) stated that the spines from *Triadocidaris* spp. were not known and no mention of them was made in the *Treatise on invertebrate paleontology* (Moore, 1966). However, several fragmentary radioles of three distinct types are present in the collection and, although none was observed intimately associated with the test fragment, it is possible that both the plate and one or more spine types originated from the same species of echinoid.

One of the fragments (KG.1944.28) shows the medial part of a radiole. The neck is longitudinally striated with approximately 24 lines per mm. (Fig. 5a). The striations continue uninterrupted into the shaft region where they are broken into pustules. The pustules are small, becoming slightly larger and anteriorly directed distally. The proximal diameter of the radiole is 1·5 mm. but this increases gradually to about 3 mm. on the pustulate shaft. Specimen KG. 1944.29 has a similar ornament of a striated neck and a pustulate shaft but the radiole is club-shaped with the diameter increasing rapidly from 1·5 mm. on the neck to approximately 4 mm. on the shaft (Fig. 5b). The specimen is 13 mm. long and abruptly terminated distally. The third type of radiole in the collection is more robust than specimens KG.1944.28 and 29. The

fragment forming specimen KG.1944.30 is 18 mm. long and has a constant diameter of 3 mm. throughout its length (Fig. 5c). Internally, the radiole exhibits the characteristic irregular cidaroid core within a radiating septate region (Fischer, *in* Moore and others, 1952, p. 710). The longitudinally striated shaft bears regularly arranged lines of small barbs. It is possible that these spines represent a fully developed radiole of an echinoid, which also bears lesser spines of the type shown by specimen KG.1944.28 and 29. Taylor (1966, p. 13) described rhabdocidarid spines from the Aptian sediments of south-eastern Alexander Island, but the barbs on the spines are well separated and distinct, and they are quite unlike those on specimen KG.1944.30 from central Alexander Island. Without associated ambulacral detail, the generic affinity of the spines cannot be ascertained. The internal structure indicates that at least specimen KG.1944.30 may be classified with the cidaroids.

Age of the Fauna

The Alexander Island fauna has no fossils common to the (?) Triassic Legoupil Formation fauna (Thomson, 1975) nor to any other described fossil assemblage from Antarctica. However, correlation can be obtained by comparing the Alexander Island specimens with those of circum-Pacific faunas of early Mesozoic age.

Perhaps the most confident correlation that can be made is with the bivalve *Waagenoperna* aff. *ozawai*, which has been described from the Middle–Upper Triassic (Ladinian–Carnian) of Japan (Kobayashi, 1935). Gross morphological details of that species compare well with the Alexander Island specimen (KG.1944.22). *Balantioselena gairi* Speden, first described from the Middle Triassic (Ladinian) of New Zealand (Gair and others, 1962), compares well with the Alexander Island specimen (KG.1944.21) but unfortunately, as with almost all of the material from the Lully Foothills, there is insufficient detail preserved (in particular the dentition of the bivalve) to be absolutely certain of the identification.

The coelenterates are poorly preserved and age determinations at both family and genus level are insufficient in themselves to narrow the fauna to any specific age other than post-Palaeozoic. The identifications of the echinoderms *Triadocidaris* and *Isocrinus* are based on fragmentary material but they broadly indicate a Triassic age. It is interesting to note that this faunal association of thamnastraeoid coelenterates, *Triadocidaris* and *Isocrinus* is also found in northern Peru in beds of Cassianer–Raibler (Ladinian–Carnian) age (Koerner, 1937).

Many of the gastropods, especially the Procerithiidae, can be compared directly with described forms from the Upper Triassic of Peru and northern Argentina (Bonarelli, 1927; Haas, 1953). *Protofusus pyramidalis*, which is regarded as similar to specimen KG.1944.3a, was described by Haas (1953) from the Upper Triassic of the Cerro de Pasco area of Peru. *Zygopleura* (*Katosira*) (KG.1944.4) is compared with two morphologically similar forms from the Upper Triassic (Norian) Petrolífera Formation of Salta Province, northern Argentina. Although some of the Procerithiidae are felt to be inadequately preserved to warrant their use as *precise* stratigraphical time indicators, a broad indication of an Upper Triassic age can be obtained from most of them. Of the other gastropods, only *Omphaloptycha* (*?*) and perhaps the turritellid gastropods have possible stratigraphical ranges which extend into the Palaeozoic. Of the more confident determinations, both the Procerithiidae and the Nododelphinulidae are wholly Mesozoic families, whereas the Amberleyidae range from Middle Triassic to Oligocene.

The general characteristics of the fauna are consistent with an early Mesozoic age, probably Middle–Upper Triassic, with many of the Alexander Island forms having similarities with fossils of Ladinian–Carnian age from circum-Pacific localities. The radiometric date of 165 m. yr. determined by Grikurov and others (1967) for specimens from central Alexander Island must now be considered to represent perhaps the latest date for the deformation of these sediments and not the time of sedimentation and/or diagenesis.

Regional Relationships

Only lithological and structural similarities led Grikurov and others (1967) to equate the folded metasediments of central Alexander Island with the "Trinity Peninsula Series" (Adie, 1957; Grikurov, 1971) (or "Trinity Series" (Grikurov and others, 1967)) of the northern Antarctic Peninsula.

The volcanic rocks and fossiliferous sediments of the Lully Foothills have also been affected by the polyphase deformation of the metasedimentary sequence of central Alexander Island. Bell (1974) suggested two, or perhaps three, phases of deformation for similar sediments in northern Alexander Island, but structural examination of the Lully Foothills and the adjacent Lemay Range indicates that four or perhaps five deformational phases are present. Throughout central Alexander Island the dominant structural trend is approximately north–south and parallels the local trend of the Antarctic Peninsula. This is an agreement with observations from northern Alexander Island (Bell, 1974, fig. 6b) and the Antarctic Peninsula and Scotia arc (Dalziel, 1971) in strata of "Trinity Peninsula Series" type.

Isolated outcrops at Hurd Peninsula, Livingston Island (Miers Bluff Formation), and at Cape Legoupil, northern Graham Land (Legoupil Formation), have revealed that fossiliferous horizons with identifiable material (Schopf, 1973; Thomson, 1975) do exist in rocks which have undergone polyphase deformation (Miller, 1966; Dalziel, 1971). Evidence from the Miers Bluff Formation of an Upper Triassic (197 m. yr.) age for the deformation and/or diagenesis (Dalziel, 1971) is consistent with the palaeontological findings on Alexander Island. Schopf (1973) remarked on the close lithological resemblance of the Miers Bluff Formation to the Legoupil Formation of northern Graham Land, both of which in turn have been compared with the "Trinity Peninsula Series" (Hobbs, 1968; Thomson, 1975). In an examination of the fossils contained in the Legoupil Formation, Thomson (1975) concluded that a Triassic age seemed likely.

It has been shown that the sediments of the "Trinity Peninsula Series" are unconformably overlain by plant-bearing sediments both at Hope Bay (Bibby, 1966) and on Alexander Island (Edwards, 1979). In the belief that these were mid-Jurassic in age at Hope Bay, Adie (1957) suggested a pre-Jurassic or Upper Triassic–Lower Jurassic age (Adie, 1964) for the folding of the "Trinity Peninsula Series" there. The Alexander Island plant material in the sediments immediately above the unconformity with the "Trinity Peninsula Series" sediment type was considered by Edwards (1979) to be undiagnostic and insufficiently preserved to be able to date even tentatively. No fossils older than (?) Oxfordian have been reported from Alexander Island.

The significance of the Alexander Island fauna and its age determination with respect to the timing of orogenic events in the Antarctic Peninsula is considerable. The deformation of the fossiliferous sediments must, of necessity, be of Upper Triassic–Lower (? Middle) Jurassic age. However, the presence of the fossils within a tuffaceous/volcanic succession could point to the early stages of orogenic activity being initiated about the time of the deposition of the sediment containing the fauna.

The general structural and lithological similarities between the metasediments of the "Trinity Peninsula Series" (Adie, 1957; Aitkenhead, 1975) and the metasedimentary sequence of central Alexander Island are striking, although further laboratory study of the latter is necessary before a confident correlation can be made.

Whether the whole of the "Trinity Peninsula Series" can be referred to the Mesozoic remains uncertain, but the presence of two isolated fossil localities (Cape Legoupil and Lully Foothills) in sediments of "Trinity Peninsula Series" type and both with a probable Triassic age, suggest that at least part of the "Trinity Peninsula Series" may be of this age. From these localities within a widely distributed sequence, a pattern of early Mesozoic sedimentation is emerging in the region of the present Antarctic Peninsula.

Conclusions

A locality in the Lully Foothills, central Alexander Island, has provided a poorly preserved fauna of coelenterates, gastropods, bivalves and echinoderms which have been identified as:

Thamnasteria (*?*) sp.
Protofusus sp.
Rhabdocolpus sp.
Procerithium (*Apicaria*) sp.
Procerithiid (?) gastropods
Zygopleura (*Katosira*) sp.
Omphaloptycha (*?*) sp.
Amberleya (*Eucyclus*) (*?*) sp.
Amphitrochus sp.
Turritellid gastropods
Scurriopsis (*?*) *aranetexta* sp. nov.
Balantioselena aff. *gairi* Speden
Waagenoperna aff. *ozawai* (Kobayashi)
Antiquilima (*?*) sp.
Indeterminate bivalve α
Indeterminate bivalve β
Isocrinus cf. *californicus* Clark
Triadocidaris (*?*) sp.

Several elements of this fauna indicate a Middle–Upper Triassic (Ladinian–Carnian) age, whereas others can only suggest a Triassic or Mesozoic age. Thus, the age of the metasedimentary sequence of central Alexander Island as determined radiometrically as 165 m. y. (Middle Jurassic) by Grikurov and others (1967) must surely indicate a metamorphic event. From two localities where rocks of the (?) Carboniferous "Trinity Peninsula Series" (Adie, 1957) crop out, fossils of a Triassic age have been collected. It appears that at least part of the "Trinity Peninsula Series" of the Antarctic Peninsula must be of this age.

Acknowledgements

The author would like to thank Drs. N. J. Morris, B. Rosen and H. Owen (British Museum (Nat. Hist.)) for assistance with the identification of this fauna, and Dr. M. R. A. Thomson, who provided guidance throughout the preparation of this manuscript. Dr. I. G. Speden (New Zealand Geological Survey) kindly supplied casts of *Lima georgiiboehmi*. The assistance in the field of C. E. Knott and A. E. Gannon is acknowledged with thanks. Part of this work was carried out in the Department of Geological Sciences, University of Birmingham, using laboratory facilities provided by Professor A. Williams.

MS. received 20 September 1976

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