

INARTICULATE BRACHIOPODA FROM THE LOWER CRETACEOUS OF SOUTH-EASTERN ALEXANDER ISLAND

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ABSTRACT. Two species of *Lingula* and *Discinisca variabilis* sp. nov. are described from the Aptian sediments of south-eastern Alexander Island. The palaeoecological implications of these fossils are discussed and evidence is given which suggests that some of the specimens of *Discinisca* may have lived attached to terrestrial plant debris found in the same sediments.

THE Brachiopoda described here were collected from six localities near Fossil Bluff, Alexander Island (Fig. 1). The sedimentary rocks in this area form part of a marine sequence several

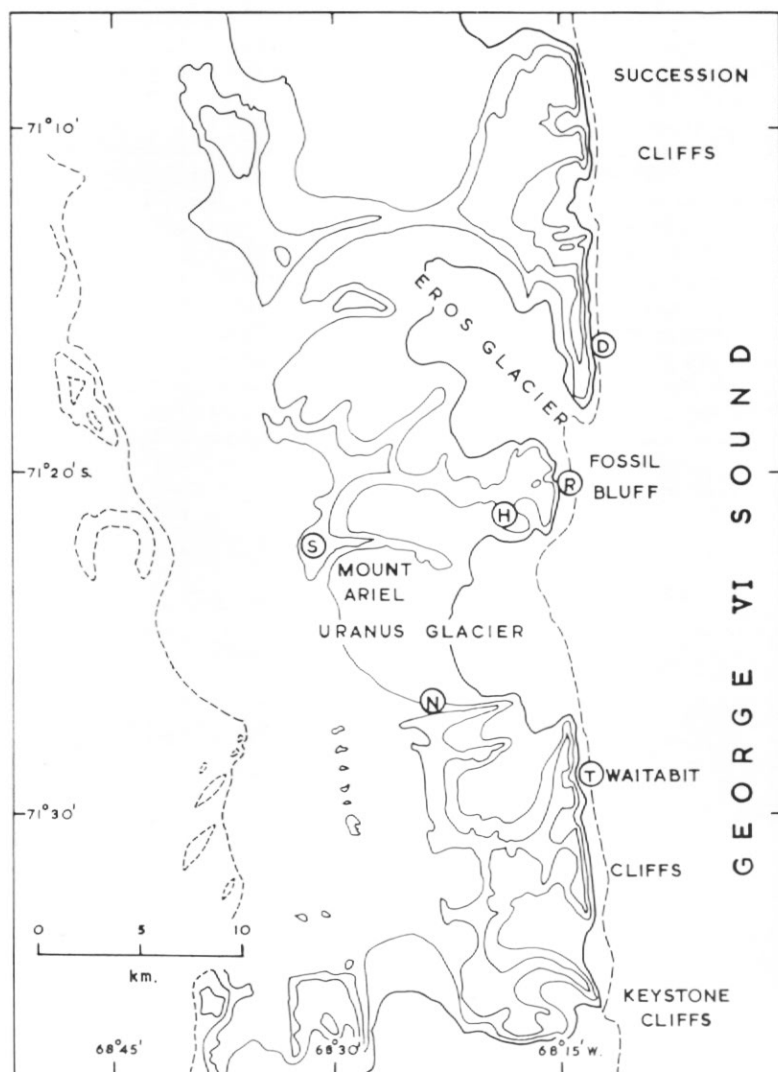


Fig. 1. Sketch map of south-eastern Alexander Island, showing the source localities of the inarticulate brachiopod specimens. The form lines are approximate.

thousand metres thick, spanning a period of geological time at least from the Upper Neocomian to the topmost Aptian. These specimens may be considered as coming from the middle part of the Aptian sequence as it is represented in this area.

The broad palaeogeography and sedimentation pattern of south-eastern Alexander Island, in Lower Cretaceous times, have already been described by Horne (1969) and it is only necessary here to state that general faunal and sedimentological considerations indicate a shallow-water near-shore environment for the species under consideration.

In the outcrops, the inarticulate brachiopods are typically confined to certain horizons, being common over short thicknesses, whereas occurrences outside such beds are uncommon. *Discinisca* and *Lingula* are frequently found together, although either may occur without the other, *Lingula* having a less limited vertical distribution than *Discinisca*. Invariable associates of *Discinisca* in the localities so far examined are aporrhaid gastropods (*Anchura* (?)), although the reverse of this statement is not true. Whether these two species were mutually compatible for some reason, or whether their association is because the conditions preferred by these particular discinids were also admirably suitable for *Anchura* (?), is not understood. It is possible the reason for their association is not preserved in the geological record. These *Discinisca*/*Anchura* (?) horizons are sufficiently well marked and laterally persistent to be of use in local stratigraphical correlations and one such horizon was used to assist in correlating the stratigraphical sections measured at localities R, H, S and N (personal communication from B. J. Taylor). The limited vertical distribution of these brachiopods, especially *Discinisca*, is presumably a reflection of the frequent recurrence of certain conditions which were adverse to these organisms, but which are not immediately evident from the enclosing sediments. *Lingula* is sometimes found in highly pyritic, poorly fossiliferous mudstones, suggesting it persisted in conditions which became too toxic for other species (a habit for which it is famous) but it is more abundant in association with a normal marine fauna. Both *Discinisca* and *Lingula* sometimes occur in distinctive black sediments, often finely laminated and containing relatively large amounts of terrestrial plant debris and fish-scales. They may be just as common in massive dark grey sandy mudstones which are more typical of the succession as a whole.

Microscopic borings, which might be attributed to some form of alga or fungus, have been observed in the test of some of the *Discinisca* specimens. They are comparable with similar and better developed examples in the cuticle of decapod crustaceans from the same area (personal communication from B. J. Taylor).

SYSTEMATIC DESCRIPTIONS

CLASS INARTICULATA HUXLEY 1869

FAMILY LINGULIDAE MENKE 1828

Genus *Lingula* Brugière 1797

Lingula cf. *beanii* Phillips 1828

Fig. 2a

Material

Seven specimens from localities N, R and T.

Description

The lateral margins of the shell in this small species (Fig. 2a) are straight or gently convex and the anterior margin is squarely rounded or truncated. The umbo is obtusely angular and there is a marked angle at the junction between the posterior and lateral margins of the shell. Ornament is restricted to fine growth lines and periodic concentric rugae.

Remarks

Only one species of *Lingula* has previously been described from the Antarctic Peninsula region, *L. antarctica* Buckman (1910); this is a Lower Miocene species which differs from the

present specimens in its narrower form and more acuminate umbo. A morphologically closer species is *L. beanii* from the Jurassic of England. Examples of this species, comparable to the Alexander Island specimens, have been illustrated by Davidson (1876, pl. IX, figs. 10–12), together with a species identified by Terquem as *L. voltzii* (Davidson, 1876, pl. IX, fig. 13) but which is believed to be a misidentification for *L. beanii*. An unidentified specimen (Davidson, 1876, pl. X, fig. 2b), which probably also belongs to *L. beanii*, is illustrated with a collection of the brachial valves of *Disciniscia reflexa* Sowerby. The simple shell form in *Lingula* does not lend itself to much morphological variation and, apart from the smaller size of the present specimens, it is difficult to separate them from the Jurassic species of England except on stratigraphical and geographical grounds. *L. plagemann* from the Jurassic of Chile (Möricke, 1894, p. 95, pl. V, fig. 9) is similar to *L. beanii* and the present specimens but it differs from the latter in its larger size and from both in the blunter form of the umbo. The Cretaceous species *L. truncata* Sowerby (Davidson, 1852–55, pl. I, fig. 27) of England differs from both *L. beanii* and *L. cf. beanii* in possessing a more sharply pointed umbo.

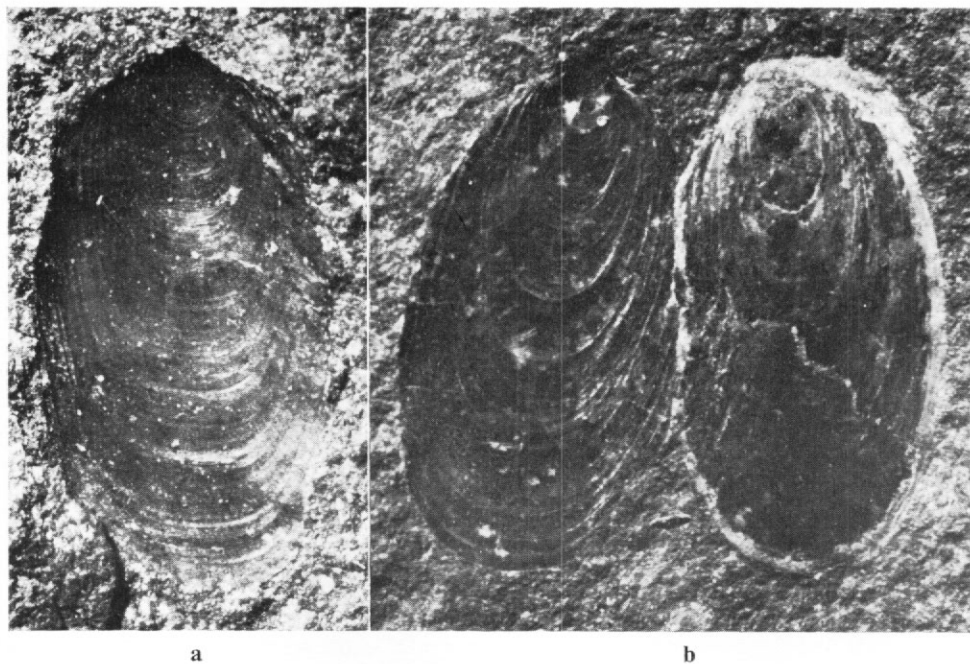


Fig. 2. a. *Lingula cf. beanii* Phillips. A large specimen from locality T; $\times 10$. (KG.103.79)
b. *Lingula cf. subovalis* Davidson. Both valves of an individual; locality N; $\times 10$. (KG.11.27)

Lingula cf. subovalis Davidson 1852

Fig. 2b

Material

About five specimens from localities H, N and S.

Description and remarks

This species (Fig. 2b) differs from the above examples of *L. cf. beanii* in its slightly narrower form and more ovate outline. Fig. 3 is a plot of length against width for all the measurable specimens of *Lingula* from south-eastern Alexander Island and it shows a slight but nevertheless constant difference in proportions between the two species. Features which distinguish even fragmentary examples of this species from *L. cf. beanii* are the more narrowly rounded anterior margin, more convex lateral margins and more acute umbo of the former. They compare well

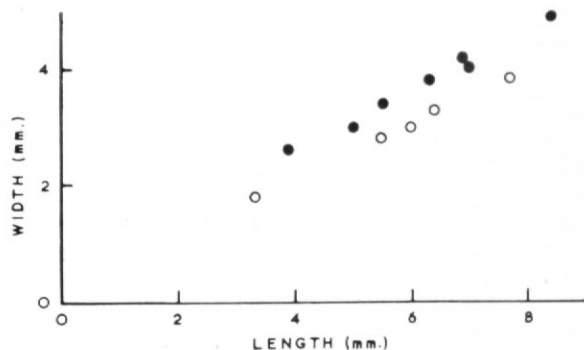


Fig. 3. A graph showing the relationship between the length and width of the shell for *L. cf. beanii* (solid circles) and *L. cf. subovalis* (open circles). *L. cf. subovalis* is slightly but consistently narrower.

with the Lower Greensand species *L. subovalis* (Davidson, 1852-55, pl. I, figs. 29-30) of England and also with a small Cretaceous species from Queensland, described by Moore (1870, pl. X, fig. 14) as *L. ovalis*. Despite the fact that this particular *Lingula* was commonly represented in his collection, the illustration is of a very poor specimen. Moore (1870, p. 236) made it clear that he regarded *L. ovalis* (Kimmeridge Clay) and *L. subovalis* (Lower Greensand) as synonyms.

FAMILY DISCINIDAE GRAY 1840

Genus *Discinisca* Dall 1871

Discinisca variabilis sp. nov.

Figs. 4a-e, 5, 6

Material

About 40 individuals, all of which are brachial valves, from localities D, N, R, S and T. The holotype is specimen KG.11.28 from locality N.

Diagnosis

Brachial valve variable in shape, generally sub-circular and truncated posteriorly, profile low and asymmetrically conical with the apex generally positioned in the posterior quarter of the shell. Apex reflected in many examples, especially those with the lower profiles. External ornament confined to fine growth lines and periodic concentric corrugations; faint radial markings are present on the internal surface of the test.

Description

The shape of the shell (Figs. 4a-d, 5) is very variable but it has the basic form of a low asymmetrical cone with the apex generally situated in the posterior quarter. The margin is sub-circular and truncated posteriorly. Usually the shell is a little longer than wide and the margin is often naturally distorted so that the commissure could not have been planar; this is presumably a reflection of the close attachment of the shell to an irregular substrate (p. 91). Fig. 5 shows a series of shell profiles which give some idea of the variation between low forms and higher forms. The anterior slope of the shell is usually convex but it may appear concave where strong concentric corrugations are present; the posterior slope, however, is usually straight or concave and drops steeply to the truncated posterior margin of the shell. In one specimen (KG.3.76) the apex is very close to the posterior margin and the posterior slope is correspondingly almost vertical.

Internal and external moulds of many of the specimens are accompanied by remains of the test which is thick and varies in colour from lustrous black to dark green or greenish white.

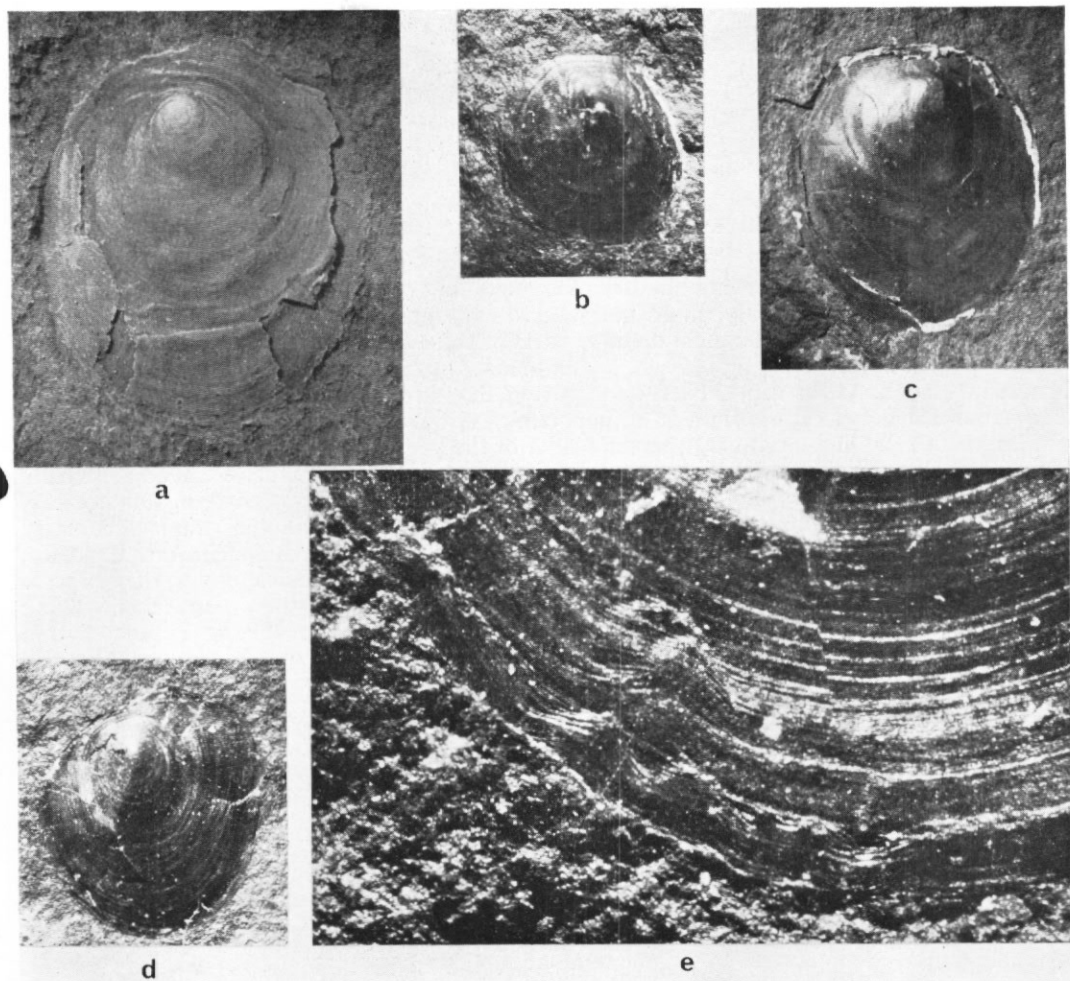


Fig. 4. a. *Discinisca variabilis* sp. nov. A latex cast from the external mould selected as holotype; locality N; $\times 5$; coated. (KG.11.28)
 b. *D. variabilis*. An internal mould of a small specimen with a high profile (see Fig. 5). Faint radial threads and traces of muscle scars are preserved on this specimen; locality T; $\times 5$. (KG.103.78)
 c. *D. variabilis*. This internal mould is the largest specimen known; it has a very low profile in relation to its length (see Fig. 5); locality R; $\times 2.5$. (KG.1.899)
 d. *D. variabilis*. A good specimen with much of the shell preserved; locality T; $\times 5$. (KG.103.60)
 e. *D. variabilis*. An enlargement of part of the shell of specimen KG.103.60 showing irregular growth lines following damage to the shell; $\times 20$.

The greenish colours may be original, whereas the black test is believed to have undergone a certain amount of chemical alteration. On damaged or thin edges, the black test appears milky blue in colour, probably due to the formation of vivianite.

External ornament is confined to fine growth lines and periodic coarse concentric corrugations. The corrugations are also present on internal moulds which are otherwise almost smooth, except in a few cases where faint radial striae are visible. Several of the specimens show evidence of having suffered damage to the margin of the shell (Fig. 4e) but this has later been naturally repaired. Shell growth following damage is marked by V-shaped notches in the holoperipheral growth lines and these successively become less marked as the broken area is filled in.

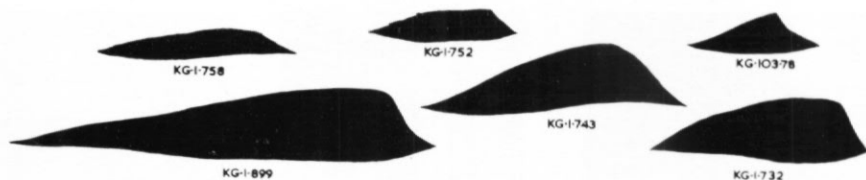


Fig. 5. *Discinisca variabilis*. A series of silhouette profiles to show the variation in form. Low profile forms are on the left and those with higher profiles are on the right. All approximately $\times 3$.

Very little is known of the musculature of the shell but on two internal moulds (KG.1.899, 103.78) there are some faintly raised markings on the posterior part which may be muscle attachment scars (Fig. 6). The most obvious parts of these scars are two elongate ridges which form a broken horseshoe (Fig. 6, X, X'). The break or gap is situated on the posterior slope beneath the apex. At the gap, the left-hand part of the "broken horseshoe" scar terminates at a low rounded boss (Y); the right-hand part curves upwards for a short distance ending at a similar boss (Y'). On the right side, in the corner of the horseshoe, is yet another flat boss (Z') but there is no equivalent marking on the opposite side of the mould. Muscle scars on specimen KG.1.899 are less well marked but they appear to conform to the same pattern. It is not easy to interpret these incomplete scar markings but a comparison with the simple scheme of muscle scars, illustrated by Davidson (1888, pl. 26, fig. 4) for the modern *D. lamellosa* Broderip, suggests that the bosses marked Y and Y' on the present specimen correspond to the retractor muscle scars, and the one marked Z' to one of the posterior adductors. Comparison with the more complex and complete muscle pattern given by Bulman (1939, p. 439, fig. 3) suggests that the scars Y and Y' correspond to the posterior oblique muscles and that Z' can probably still be regarded as one of the posterior adductors.

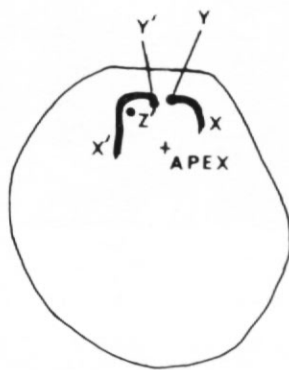


Fig. 6. *Discinisca variabilis*. A diagrammatic representation of the faint traces of muscle scars as preserved on specimen KG.103.78 (Fig. 4b). The posterior end of the shell is at the top of the illustration and all the annotations are explained in the text.

Remarks

Descriptions and records of *Discinisca* on a world-wide basis are sparse (Muir-Wood, 1929, 1939) and none at all has yet been described from the Cretaceous of Patagonia, where the most comparable species might be expected to occur. However, Feruglio (1949, p. 172, fig. 34) has illustrated a geological section from Cerro Meseta, Lago San Martín, in which, between "capas con *Belemnopsis patagoniensis*" (Tithonian) and "capas con *Crioceras* y *Leptoceras*" (Neocomian), there is a "capa con *Orbiculoidea*". If these *Orbiculoidea* are brachiopods, it is most probable that they really belong to the genus *Discinisca*, but they do not appear to have been systematically described anywhere and Feruglio made no further mention of them. In a similar manner, Piatnizky (1938, fig. 3) indicated the presence of *Orbiculoidea* in a section

measured at Cañadón de la Mina, Lago San Martín, between beds containing *Neocomites* and beds with *Leptoceras*. Boehm (1911) recorded a species, *D. kawhiana*, from the Jurassic/Cretaceous boundary in New Zealand but its brachial valve is too poorly known for comparison. *D. insularis* Muir-Wood (1939), from the London Clay of the Isle of Wight, is perhaps the most similar fossil species to the present specimens, both in its general form and in having a thick test. However, the apex of the former is set slightly closer to the centre of the shell and the posterior margin is less truncated.

PALAEOECOLOGY

It has long been believed that *Discinisca* and *Lingula* are not only indicators of shallow water but also warm water (Schuchert, 1911; Muir-Wood, 1929). However, in a recent discussion of the palaeoecology of *Discinisca*, Stenzel (1965) pointed out that the present-day distribution of *Discinisca* extends well into the temperate regions of Chile and Japan, and therefore this brachiopod is no sure indicator of tropical or sub-tropical waters in earlier geological periods. Similarly, the distribution of *Lingula* extends into the present-day temperate waters of Japan, China and Korea (Craig, 1952, p. 113). The presence of *Lingula* in this area might be affected by the presence of such warm-water currents as the Kuro Shio but *Discinisca* is able to tolerate the effects of the cool Peru Current off the Chilean coast.* Stenzel (1965) has also noted that there are exceptions to the rule that *Discinisca* is confined to shallow waters in modern seas. Although it is common in waters of less than 16.5 m., it has been recorded from depths down to 330 m. In south-eastern Alexander Island there is no reason to suspect that these fossils originally lived in other than a shallow-water environment and evidence for this has already been given by Taylor (1967, p. 2) and Horne (1969). With regard to the temperature of the water, the presence of abundant plant remains in the sediments, indicative of arboreal vegetation on the nearby shore, clearly suggests a far more amenable climate than that of the present day.

Two rock slabs, bearing specimens of *Discinisca variabilis* from locality R (Fossil Bluff), show some unusual features which are worthy of detailed discussion. On specimen KG.1.777 (Fig. 7a) a single brachial valve appears as if it might have originally been attached to a cycad-like frond via the pedicle issuing from the lower valve. The brachial valve is preserved as an external mould or a conical depression lying immediately below the bedding surface of the rock fragment on which the impression of the cycad-like frond appears. On the second example (KG.1.803; Fig. 7b) the bedding surface of the rock bears a leaf imprint and the crushed remains of a carbonized twig. In a similar manner to that of the last specimen, about 15 small (1 mm.) brachial valves of *Discinisca* appear as cones (external moulds) projecting into the rock beneath the leaf impression and with their margins in the plane of the leaf. Of the four larger specimens (7 mm.) associated with the twig fragment, one was partly buried beneath the carbonaceous remains but removal of this material failed to produce traces of the pedicle valve. The last observation would seem to rule out the possibility that these discinids might have actually lived attached to the plant material but the pedicle valve in *Discinisca* is very fragile and this might account for its uncommon occurrence in the fossil state (Muir-Wood, 1929, p. 468). Furthermore, the pedicle valve in *Discinisca* is sometimes so closely attached to the substrate that it is moulded to the latter. A comparable case is that of *D. insularis* from the Eocene of England which was found so closely attached to specimens of the bivalve *Astarte subrugata* that "the shell [brachial valve] was consequently moulded to that of the lamelli-branch" and "The lower pedicle valve was not seen, and if still preserved is in close contact with the surface of support" (Muir-Wood, 1939, p. 153).

It is suggested here that, while the association between the large specimen of *Discinisca* and the cycad-like frond (Fig. 7a) may be one of chance, in the second example (Fig. 7b) too many brachiopods are so obviously associated with the plant fragments that they may not be dismissed so easily. Furthermore, only small *Discinisca* individuals occur with the leaf, which

* On the Pacific coast of South America, *Discinisca* occurs as far south as lat. 43° (Stenzel, 1965, p. 625, fig. 2). With reference to the effect of the cold Peru Current on this coast, Ekman (1967, p. 209) remarked that "in no other part of the world's oceans does the southern limit [of the tropical-subtropical fauna] lie so far to the north". The surface sea-water temperatures for the Chilean coast at lat. 43° S. during February and August are 16° and 9.5° C, respectively.

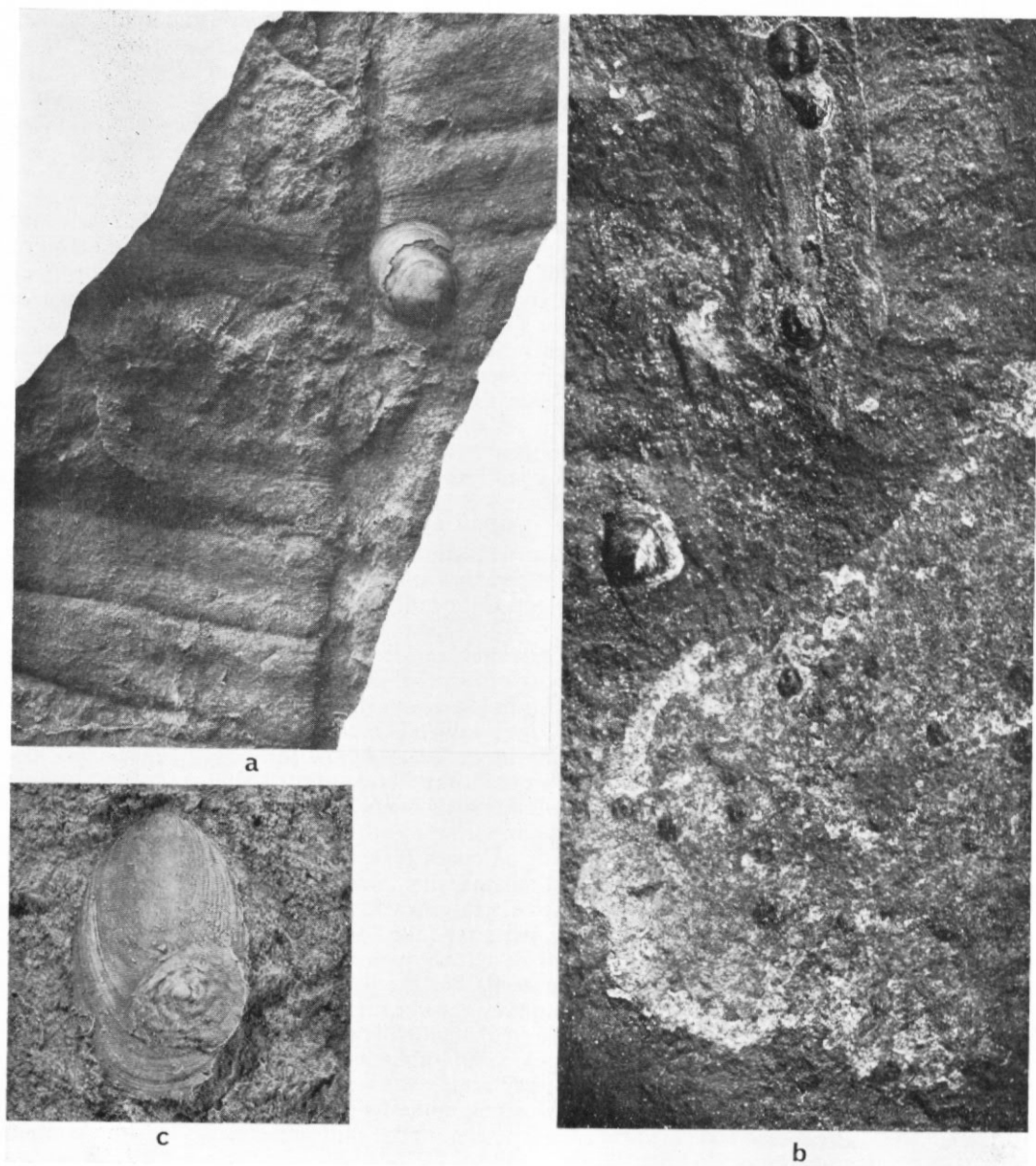


Fig. 7. Close associations between *Discinisca variabilis* and possible attachment substrates.

- a. A single, medium-sized brachial valve in a position suggesting attachment to a cycad-like frond; latex cast from a natural external mould; locality R; $\times 2$; coated. (KG.1.777)
- b. Minute specimens, apparently once attached to a leaf, and small specimens similarly associated with a carbonized twig fragment; locality R; $\times 2$. (KG.1.803)
- c. Latex cast from the external mould of a small specimen attached to *Lingula cf. beanii*; locality R; $\times 5$; coated. (KG.1.900)

would have soon been buried, while the twig, which probably floated around for longer or may have lain projecting out of the sediment on the sea floor, bears larger brachiopods. The theory that at least some individuals of this brachiopod lived attached to terrestrial plant debris in the sea must be considered as a distinct possibility.

In the present collections there is only one other specimen of *Discinisca* which appears to be attached to anything. An external mould of *Lingula* cf. *beanii* (KG.1.900) is "penetrated" by the external mould of a small *Discinisca*. A latex cast (Fig. 7c) shows that, for three-quarters of the perimeter of the shell, the brachial valve of *Discinisca* was closely pressed against the *Lingula* shell; where the valve of *Discinisca* is raised slightly away from the *Lingula* possible traces of a pedicle valve are present. Although the *Discinisca* valve is slightly crushed where it is in contact with the *Lingula*, it is intimately moulded to the surface irregularities of the latter and there can be little doubt that the *Discinisca* was actually attached to the *Lingula*.

Fossa-Mancini (1933, p. 379-80) noted the preference of discinids for rocky sea bottoms and he suggested that, in those cases where they were found on sandy sea bottoms, their shells had been washed in from elsewhere. The specimens from Alexander Island occur in even finer-grained sediments and some at least might have been washed in from areas with a rocky or consolidated substrate, but this does not invalidate the possibility that some may have been attached to terrestrial plant fragments washed into the sea. As far as the author is aware, no evidence has been offered previously to suggest that *Discinisca* might have lived attached to terrestrial plant debris, floating or otherwise. Modern species live attached not only to rocks but to pebbles or shells on the sea bed; an example from the Lower Turonian of New Mexico (Ager, 1963, p. 91, fig. 5.12) was believed to have been attached to the shell of the ammonite *Scaphites warreni* while the latter was still alive.

In the South American literature on the Mesozoic there are several references to the close association of plant fossils and *Discinisca*-like brachiopods (usually referred to as *Orbiculoidea*) but there are none which record an actual attachment. Feruglio (1949, p. 93) referred to "valvas de *Orbiculoidea* asociadas con restos vegetales" in the Lower Lias near Cerro Ferrarotti, and he also recorded a similar association in the Lower Lias of Río Genua, northern Patagonia (p. 111-13). The specimens from Río Genua, which were unusual in that they were all pedicle valves, were described by Feruglio (1934) as *Orbiculoidea annae* but Muir-Wood (1939, p. 156) recorded them as species of *Discinisca*. Fossa-Mancini (1933) described specimens of "*Orbiculoidea*" found in association with terrestrial plant debris in the Rhaetic of western Chubut (northern Patagonia). It appeared as if the sediments in which these were found (Serie Lignitifera) were deposited under conditions fluctuating between lagoonal (plant beds with *Estheria*) and true marine (plant beds with "*Orbiculoidea*"). Finally, Schuchert (Berry, 1917) described a new species of *Discinisca* (*D. singewaldi*) from a sequence of late Tertiary tuffs, conglomerates and slates at Potosi Mountain, Bolivia; some of these sediments are rich in plant remains but it is not clear whether the brachiopods actually came from a plant-bearing horizon or not. It is true that, in the above cases, the association of *Discinisca* and well-preserved plant remains may merely reflect the near-shore origin of the sediments and the habitat of the brachiopods, but renewed investigations in such areas might reveal further examples of the type of association described here (p. 91).

In conclusion, it is interesting to note that the possibility of inarticulate Brachiopoda living attached to sea-weed, if not plant debris, has been considered before. Weller (1957, p. 351), in describing a black shale from the Pennsylvanian of Illinois, suggested that such forms as *Orbiculoidea* and byssiferous pelecypods which were found in this deposit "probably were attached to sea weed above the anaerobic zone".

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