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Middle Triassic megafossil marine algae and land plants from near Benmore Dam, southern Canterbury, New Zealand

G. J. Retallack*

The upper Black Jacks Conglomerate, near Benmore Dam, contains megafossil plants very similar to Ladinian (Kaihikuan local stage) fossil plants in Long Gully, only 5 km to the southwest, and in Tank Gully, Canterbury. A greater variety of fossil plant associations has been discovered near Benmore Dam than in these other two areas of New Zealand, and these allow improved understanding of Triassic coastal vegetation of the Gondwana supercontinent.

Abundant fossil codiacean algae, *Shonabellia verrucosa* gen. et sp. nov., at one locality, are evidence that these were near-marine and coastal floras. *Shonabellia* is intermediate in several features between well-known Ordovician fossils of *Palaeoporella* and the modern seaweed *Codium*. It provides evidence that these unsegmented and weakly-calcified codiacean algae may have evolved independently of segmented, calcareous codiaceans since the early Palaeozoic.

Seed fern leaves of *Pachydermophyllum* were found in an almost monodominant association nearest the locality for marine algae and probably formed mangal vegetation along inland reaches of estuaries. At least two species (*P. dubium* and *P. praecordillerae*) are present, along with some distinctive un-named fragments which have crenate margins and bundled, secondary veins.

Other forms identified are usual for Middle Triassic megafossil floras, and include leaf remains of *Todites* (sterile and fertile), *Cladophlebis, Dicroidium, Taeniopteris, Ginkgophytopsis* and *Linguifolium,* and fossil fructifications of *Peltaspermum, Pilophorosperma, Pteruchus* and *Carpolithus.* Leaves of the seed fern *Lepidopteris madagascariensis,* and of the problematical *Ginkgophytopsis cuneata* and *G. tasmanica,* are here recorded for the first time from New Zealand.

INTRODUCTION

Megafossil plants from Middle Triassic rocks of New Zealand have proved useful not only for linking the land-based floral biostratigraphy of the Gondwana supercontinent with the marine-based international geological time scale, but also for understanding the palaeoecology and palaeogeography of Triassic vegetation in New Zealand, as an aid to unravelling its complex tectonic history (Retallack, 1979, 1980, 1981, 1983; Retallack and Ryburn, 1982). Unlike the megafossil floras already described from Tank and Long Gullies, that near Benmore Dam is not associated with biostratigraphically-useful marine fossils. Megafossil floras from all three areas are very similar, and belong to the *Dicroidium odontopteroides* Oppel-zone (of Retallack, 1977) of Late Anisian to Ladinian (late Middle Triassic) age. The greater variety of fossil plant associations found near Benmore Dam than in these two other areas allows improved understanding of Middle Triassic coastal vegetation of New Zealand, and includes several fossil plants either new to science, or new to New Zealand.

All the fossil plants described here were found in the uppermost Black Jacks Conglomerate of the Otematata Group, at localities described in detail elsewhere (Retallack, 1983). Although some vitric tuffs in the overlying Spillway Formation are metamorphosed only to zeolite grade (Bishop, 1976), most of the Spillway Formation and Black Jacks Conglomerate has been metamorphosed to prehnite-pumpellyite grade.

* Department of Geology, University of Oregon, Eugene, Oregon 97403, U.S.A.

All the fossil plant localities are in the structurally-complex Glen Begg Shear Zone, which is a tract of sheared and deformed rock, separating less-deformed blocks of Spillway Formation and Black Jacks Conglomerate. As a result, the plant remains are preserved as impressions only, variously distorted, and lacking any preparable cuticular material. At one locality, however, marine algae have been preserved in three dimensions in a calcareous sandstone, and could be studied in petrographic thin sections.

Fossil plants were first collected from near the future site of Benmore Dam by H. J. Harrington and I. C. McKellar (Bell, *et al.*, 1956), and these were described by Shona Bell. Additional collections were made by Shu (1964), before completion of the dam, for his unpublished B.Sc. Honours thesis. These localities were listed, with tentative identifications of fossil plants from them by Campbell and Warren (1965).

The suprageneric classification used here is adapted from that of Harland *et al.* (1967), and was preferred over more modern classifications because it includes most of the well-known extinct groups. Fossil numbers prefixed by B are housed in the collections of the Geological Survey of New Zealand, Lower Hutt; those prefixed by OU in the Geology Department, University of Otago, Dunedin. Fossil localities are cited in the code of the New Zealand Fossil Record File, based on the metric, 1:50,000, topographical map series (NZMS 260).

DIVISION: CHLOROPHYTA

Class: Chlorophyceae

Order: Siphonales

Family: Codiaceae

Subfamily: Codioideae

Genus: *Shonabellia* gen. nov.

Type species: Shonabellia verrucosa sp. nov.

Diagnosis: Weakly-calcified, dichotomously-branched, unsegmented thallus; medulla containing thick, main thread and a loose mesh of narrow longitudinal filaments; narrow medullary filaments arising in bundles from bulbous swellings of the main thread; cortex consisting of closely-packed filaments, arching outward and little differentiated from the narrow medullary filaments; cortical filaments branching dichotomously once or twice, without any pronounced change in thickness or bulbous swellings, and meeting the margin at an angle of about 45°.

Derivation: This generic name is proposed in honour of Shona Bell, who first described fossil plants from near Benmore Dam.

Comparison: Few new codiacean genera have been proposed (by Elliott, 1970; Pantic, 1971; Guilbault and Mamet, 1976) since the reviews of this group of marine algae by Johnson (1961), Endo (1961), Konishi (1961) and Wray (1977). *Shonabellia* is distinct from most codiacean genera in its unsegmented, weakly-calcified thallus, and its thick central medullary thread.

Initially it was thought that both *Boueina* (Johnson, 1964) and *Anchicodium* (Johnson, 1963) may have been unsegmented. Later investigations (Elliott, 1965, 1981) have shown *Boueina* to be segmented, and closely allied to living *Halimeda.* The thallus of *Anchicodium* has proved to be bladed, like that of living *Udotea* (Konishi and Wray, 1961; Wray, 1977), and quite unlike that of *Shonabellia.*

Only the Paleozoic *Palaeoporella* and *Callisphenus* and the extant genera *Codium* and *Pseudocodium* need be compared more closely. Detailed studies of well-preserved, silicified material of *Palaeoporella* have revealed that this genus had a thick, main thread and associated thin medullary threads (Kozlowski and Kaźmierczak, 1968), like *Shonabellia.* These features were not so evident in material of *Palaeoporella* preserved in limestone (Elliott, 1961). Well-differentiated subcortical branches and cortical utricles, as in *Palaeoporella,* were not seen in *Shonabellia,* although these differences may be related to differences in preservation. In addition, the cortical filaments of *Shonabellia* appear to arch outwards as an extension of similar longitudinal, medullary filaments, rather than arising from them at an angle, as in *Palaeoporella*. The genus *Callisphenus* is known from two small, club-shaped impressions, with densely-packed filaments (visible only as striations), radiating from a thick, central axis (appearing like a midrib). Høeg (1937) believed that this was a dasycladacean alga, but the dense, undifferentiated and non-verticillate filaments are more like those of the Codiaceae and the central axis could be homologous with the thick, main thread of *Palaeoporella* and *Shonabellia*. It is not possible meaningfully to compare *Callisphenus* with these genera in the absence of detailed information about its internal structure. It does differ from both these genera in being unbranched, although the unimportance of this as a taxonomic character is amply demonstrated by living species of *Codium* (Fritsch, 1965). Both *Codium* and *Pseudocodium* (Fritsch, 1965; Dawes and Mathiesen, 1972) have a similar habit to *Shonabellia*, but both have large, cortical utricles, which are much too prominent to have been obscured in *Shonabellia* during fossilization.

Remarks: The recognition of a thick, central thread in yet another fossil codiacean alga (in addition to *Palaeoporella* and possibly *Callisphenus*), may be interpreted as an indication that this feature is of greater phylogenetic significance than previously realized. Contrary to Kozlowski and Kaźmierczak (1968), I think that this main thread is unlikely to be homologous to the several medullary threads of extant codiacean algae, such as *Codium* and *Halimeda*. There are now morphological, stratigraphical and palaeontological reasons for regarding it as homologous with the main axis of ancestral forms similar to dasycladaceans. The thick, central thread is found in the oldest codiacean, *Palaeoporella* of Cambrian to Devonian age. Codiaceans without a main medullary thread appeared and diversified during the Ordovician (Guilbault and Mamet, 1976; Wray, 1977). Dasycladaceans also originated during the Cambrian and were already diverse at that time (Endo, 1961; Wray, 1977). The poorly-preserved Silurian fossil, *Calisphenus*, has a dasycladacean habit, but its internal organization is probably codiacean, so it may be an intermediate form. The derivation of codiaceans from dasycladaceans, or a generalized intermediate form, has been postulated by numerous phycologists on other grounds (Nizamuddin, 1964; Pickett-Heaps and Marchant, 1972; Herak *et al.*, 1977; Lee, 1980, p. 356).

Shonabellia forms a Triassic link between Cambrian to Devonian (*Palaeoporella*) and extant (*Codium, Pseudocodium*), poorly-calcified, unsegmented, codiacean algae. It is thus additional evidence that these algae evolved independently of segmented calcareous codiaceans, such as *Udotea* and *Halimeda*. These two groups of codiacean algae may have been distinct from each other and from the dasycladaceans since the early Palaeozoic. This stratigraphical and palaeontological evidence supports the division of codiacean algae into separate subfamilies (Udotoideae and Codioideae of Konishi, 1961) or families (Udotaceae and Codiaceae of Bold and Wynne, 1978).

Shonabellia verrucosa sp. nov. (Figs. 1,2)

Holotype: A slabbed fragment (B1082.6) and petrographic thin sections (Figs. 1G, 2E), in the collections of the New Zealand Geological Survey, Lower Hutt, New Zealand.

Type locality: A north-south striking lense of conglomeratic, coarse-grained, calcareous sandstone (H39/f9759), downhill from a bend in a disused, unsurfaced road, near prominent wall-like outcrops of conglomerate, 1 km east of Benmore Dam; upper Black Jacks Conglomerate, Otematata Group; Middle Triassic (Late Anisian to Ladinian).

Derivation: The specific epithet is from the Latin *verrucosus,* meaning warty, and refers to irregular protuberances, of uncertain origin, on the surface of the thallus.

Diagnosis: Large, cylindrical thallus, up to 20 cm in diameter, dichotomously branching at intervals of about 4 cm; thallus surface covered in rounded protuberances of uncertain origin, about 5 mm in diameter; medulla of wide portions of thalli with more distantly spaced longitudinal filaments than in narrow portions of thalli.

Description: At the type locality, fragments of *Shonabellia* form a significant portion of the rock volume (Fig. 2H). Generally the fossil algae are weathered white in colour, have a fibrous texture, and form recesses in the hard, enclosing, grey-green sandstone. There is some calcareous cement in the sandstone, but its reaction with hydrochloric

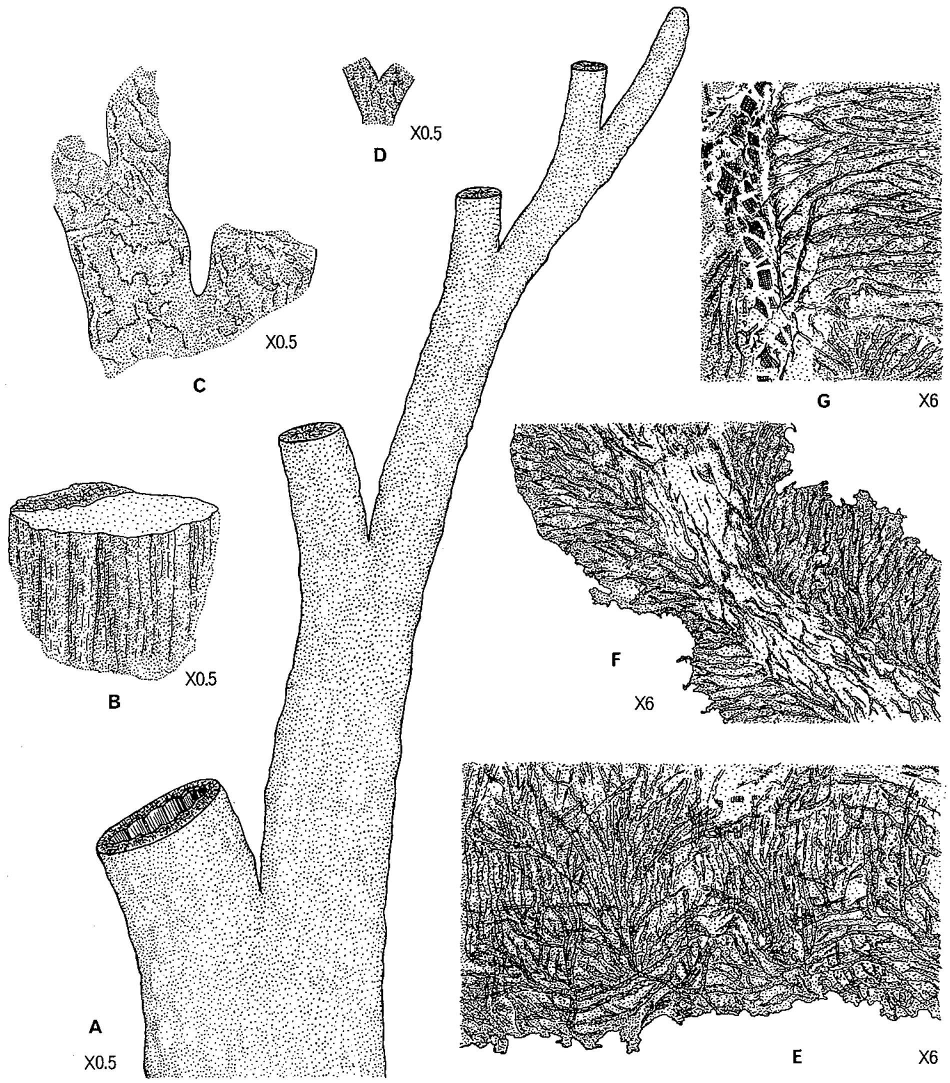

Fig. 1—Codiacean alga *Shonabellia verrucosa* from near Benmore Dam. A, cutaway reconstruction of thallus; B, medullary mould of lower portion of broken thallus, B1082.4; C, thick dichotomizing thallus, B1082.3; D, thin dichotomizing thallus, B1082.7, E, transverse section of large thallus attached to medullary mould, B1082.4; F, tangential longitudinal section of narrow thallus, to one side of the median thread, B1082.5; G, radial longitudinal section of holotype, showing median thread, B1082.6. A-D, all half natural size; E-G, all six times natural size.

acid is not nearly as marked as that of the fossil algae. The fragments of algae have a radially-symmetrical internal structure indicating that they were once tubular, but they have been flattened so that their thickness, vertical to bedding, is about one half of their width. Because they are not completely flattened, like other plant remains, the thallus must have either had some original interfilamentary carbonate or have been calcified before or very soon after burial. In the medullary region, clear, sparry calcite separates loose longitudinal filaments. Some of these filaments are broken into cubes, resembling coal cleat, and the fissures around the cubes are filled with additional calcite. Calcification of the cortex was not as extensive, because this region of the thallus is

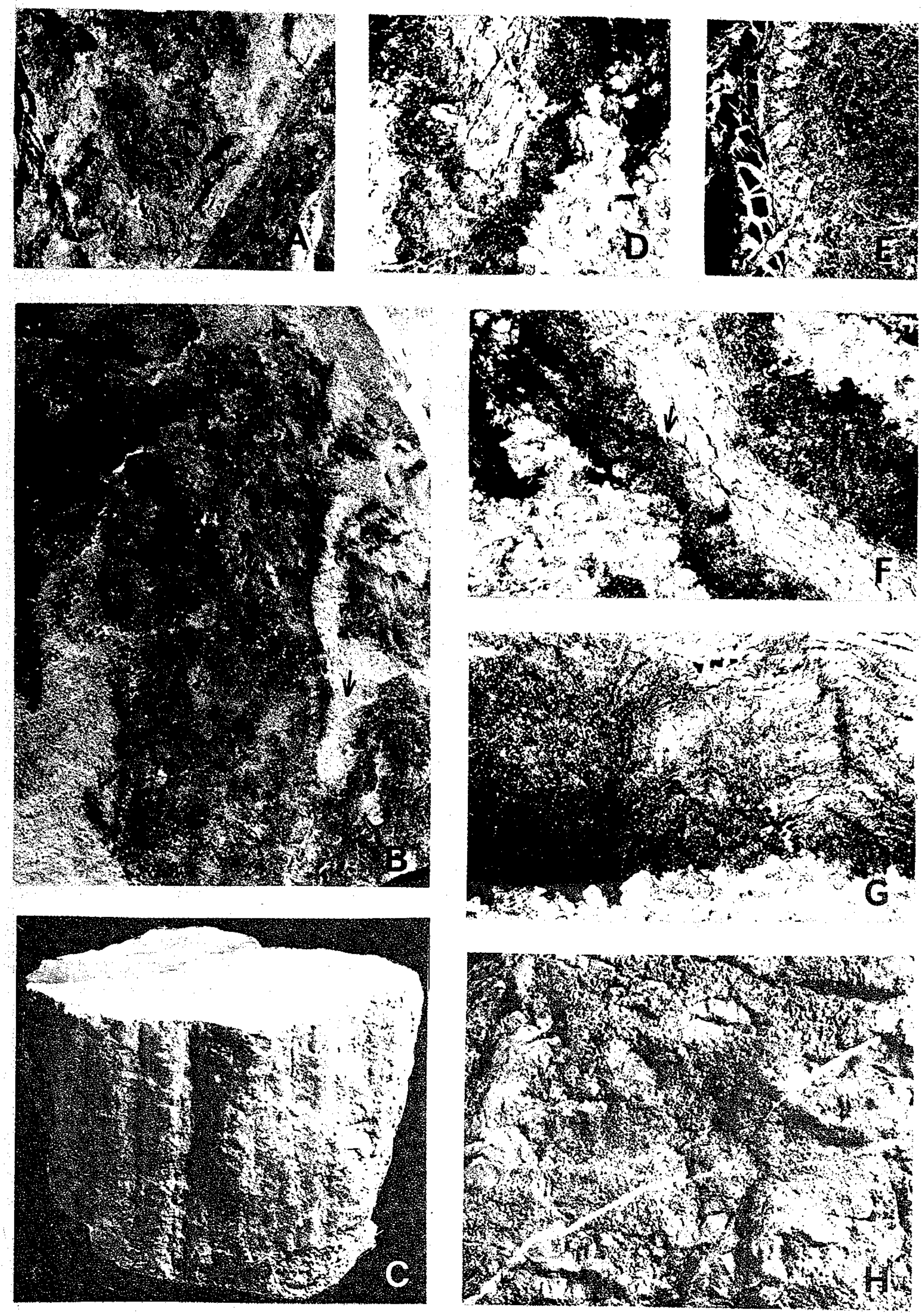

Fig. 2—Codiacean alga *Shonabellia verrucosa* from near Benmore Dam. A, thin dichotomizing thallus, B1082.7; B, thick dichotomizing thallus, B1082.3; C, medullary mould of lower portion of broken thallus, B1082.4; D, tangential longitudinal section of thallus to one side of the main thread, B1082.5; E, radial longitudinal section of holotype, showing main thread, B1082.6; F, tangential longitudinal section of thallus to one side of main thread, arrow indicates well-preserved branching filaments, B1082.5; G, transverse section of large thallus attached to medullary mould, B1082.4; H, several thalli (light-coloured and fibrous) in a naturally weathered surface of sandstone (dark and granular), B1082.9. A-C, H, natural size; D-G, six times natural size.

clouded by dense, contorted, filaments. The margins of the thallus are often deeply embayed by individual grains, an additional indication that the outer cortex was soft and weakly calcified. Some attempts were made to obtain three dimensional preparations of the thallus by dissolving the silicate grains of the sandstone in hydrofluoric acid. Unfortunately the thallus was not sufficiently organic or calcified to withstand this treatment.

In the centre of small fragments of thalli is a prominent, thick (0.3 to 0.8 mm diameter), main thread (Figs. 1G, 2E). Lateral thickenings of this central thread may locally increase its diameter to 0.9 mm. From these bulbous swellings, distributed at intervals of 6 mm or more along the central thread, arise bundles of narrow, longitudinal, medullary threads, just as in the Ordovician codiacean alga *Palaeoporella* (Kozlowski and Kaźmierczak, 1968). The medullary area contains the main thread and well-spaced, narrow, longitudinal filaments. It occupies about one third of the diameter of small branches of thallus, and a greater fraction of the diameter of progressively larger thalli.

The cortex consists of densely-spaced filaments, mostly inclined toward the apex of the thallus and reaching the margin at an angle of about 45°. In places, the narrow, longitudinal, medullary filaments can be seen to arch outward and become cortical filaments. The filaments are poorly preserved, and often appear truncated by calcite crystals, or withered. For these reasons, it is not possible to establish whether the filaments consist of only one, or several cells. The filaments branch at least twice before reaching the margin, each branch being an open dichotomy. Well-preserved filaments with parallel sides vary from 45 to 65 μm in width.

The narrowest fragment of thallus found has a width of 6 mm, which is probably close to the original diameter, according to Walton's (1936) compression hypothesis. In this specimen (B1082.2), one branch of this width is preserved for a length of 32 mm after the last dichotomy. In other fragments of thallus (Figs. 1C, 2B), the length between dichotomies of the thallus was about 4 cm. The largest fragment of thallus found (B1082.1) is 12 cm wide. This is less than half of the original diameter, because the fossil becomes thickest at the edge of the slab. These measurements were considered in preparing reconstructions of the alga (Fig. 1A; Retallack, 1983, fig. 8), although it is freely acknowledged that the distance between branches may have varied with different growth conditions and in different parts of the plant, as in comparable modern algae (Fralick and Mathiesen, 1972).

Although some specimens show constrictions of thallus (Figs. 1F, 2F) and only fragments of thallus were found, *Shonabellia* is presumed to have been unsegmented for the following reasons. The constricted thalli do not show disruption of internal structure to the extent found in segmented codiaceans (such as *Halimeda,* as illustrated by Lee, 1980, fig. 15-36c), but only a slight change of orientation as would be expected if the thallus were locally twisted (Figs. 1F, 2F). Fragments with two dichotomies have been found (Figs. 1C, 2B), without evidence that the points of branching were articulated as in segmented codiaceans. Finally, the broken ends of fragments are irregular (Figs. 1C, D, 2A, B) and appear torn, rather than rounded or constricted.

In thalli over 4 cm wide, the medullary area is commonly filled with sandstone. One of these medullary moulds (Figs. 1B, 2C) has prominent, longitudinal furrows, probably impressions of longitudinal filaments near the boundary of the medulla and cortex. Traces of the central thread and other scattered filaments can be seen embedded in the medullary mould. The cortex itself is thicker in these large fragments than in smaller ones, but the medulla is proportionally larger in larger thalli. From these observations, it appears that thalli increased in diameter by proliferation of cortical filaments without a corresponding proliferation of medullary filaments. Presumably sediment was introduced into the medulla, around these well-spaced filaments, after the thallus was torn from its holdfast.

Despite a diligent search for holdfasts, none could be recognized. They are probably large and irregularly-shaped.

Dimensions of the holotype: width of thallus 7.6 mm; width of medulla 1.2 mm; maximum width of main thread (excluding areas of dichotomy) 0.97 mm; minimum width of main thread 0.8 mm; width of best-preserved medullary filament 80 μm; width of best-preserved cortical filament 55 μm.

Reconstruction: Shonabellia appears to have had a very similar habit (Fig. 1A) to modern branching species of *Codium* (as illustrated by Lucas, 1936; Fralick and Mathiesen, 1972). Like these, it was probably attached to bedrock or loose stones (Retallack, 1983, fig. 8), from near low tide level to depths of about 5 m (Lucas, 1936; Boney, 1966). Like all other recent and fossil codiacean algae it was probably marine (Johnson, 1961, p 94).

Occurrence: Shonabellia has been found only at the type locality.

DIVISION: PTERIDOPHYTA

Class: Pteropsida

Order: Osmundales

Family: Osmundaceae

Genus: *Todites* Seward emedn. Harris 1961: 75.

Todites maoricus Retallack 1981 (Figs. 3A-C, 10A-B)

Remarks: Only a few specimens of this species were collected by Shu (1964; unnumbered specimens from H39/f9664) and by Harrington and McKellar (in Bell *et al.*, 1956, from H39/f950) from localities now under the water of Benmore Dam. A sterile leaf (Fig. 3C) has recurved pinnules with strong lateral wrinkles, obscuring their secondary venation. A small fertile fragment (Figs. 3A-B, 10A-B) is covered by sporangia only loosely aggregated into sori.

Order; incertae sedis

Genus: *Cladophlebis* Brongniart emend. Frenguelli 1947: 12.

Cladophlebis australis (Morris) Halle 1913 (Fig. 3D)

1845 *Pecopteris australis;* Morris, p. 248, pl. 7, figs. 1, 2, 2a.

1890 *Alethopteris australis;* Feistmantel, p. 93, pl. 8, figs. 15, 15a.

?1924 *Cladophlebis australis;* Walkom, p. 81, pl. 27, figs. 1E.

1928 *Cladophlebis australis;* Walkom, p. 459, pl. 26, fig. 1.

1947 *Cladophlebis australis* (in part); Frenguelli, p. 56, pl. 2, figs. 8-10 only.

1947 *Cladophlebis mendozaensis* (in part); Frenguelli, p. 60, pl. 9, fig. 4, pl. 10, figs. 1, 6, 7 only.

1947 *Cladophlebis johnstoni;* Jones and de Jersey, p. 11, fig. 3, pl. 1, figs. 3.

1965 *Cladophlebis johnstoni;* Hill, Playford and Woods, pl. T2, figs. 4-5.

1967 *Cladophlebis australis;* Jain and Delevoryas, p. 568, pl. 88, figs. 1-4, pl. 89, fig. 1.

Holotype: I have searched for the specimen figured by Morris (1845) in the British Museum (Natural History), and although others of his specimens are there (Retallack, 1981, p. 185), this one is lost, as has also been confirmed by J. M. Pettit (for Herbst, 1978, p. 9). An Early Cretaceous specimen from near Geelong, Victoria, has been designated the neotype by Herbst (1978), but this belongs to a different, un-named species, as explained below. This neotype is not accepted here because it is too far removed morphologically, stratigraphically and geographically from Morris's holotype. Triassic megafossil floras of Tasmania should be re-examined with a view to establishing a neotype from the type locality or nearby. Some of the specimens collected from the Langloh Mine, Tasmania (Townrow, 1965), and now in the Mining Museum of the Geological Survey of New South Wales (especially specimens MMF16673, MMF16669) agree in all respects with Morris's figures. Since such Tasmanian Triassic fossils do exist, Morris's figures are accepted as accurate and typical until an acceptable neotype is located and described.

Type locality: Morris (1845) reported the locality of the lost holotype as the "Jerusalem

Basin", which Townrow (1966a) has taken to mean the Triassic sandstone cropping out along the bank of the Coal River, 1 km east of Lowdina Homestead, near Campania, Tasmania. Judging from the matrix of the holotype of *Heidiphyllum elongatum* (Morris) Retallack 1980 (which I have seen and with which the lost holotype of *C. australis* was found), the type locality is more likely to be about 15 km north, in the roof shale of the coal seam behind the former Spring Hill Police Station, Tasmania, and to be of Aniso-Ladinian age (Milligan, 1851; Gould, 1869; Feistmantel, 1890; S. M. Forsyth, *pers. comm.*, 1982).

Description: The name *Cladophlebis australis* is used here strictly for sterile fern-like fronds with long, falcate pinnules, each with a slightly undulose margin and doubly-forking secondary venation throughout. An amended diagnosis of this important Triassic species is needed, but is not attempted here on the basis of the few, fragmentary specimens found near Benmore Dam.

Comparison: The numerous species of *Cladophlebis* have been reviewed by Frenguelli (1947), Herbst (1971, 1978) and Boureau and Doubinger (1975), and additional species discussed by Kawasaki (1925), Oishi and Huzioka (1938), Oishi (1940), McQueen (1956), Harris (1961), Lebedev (1965) and Kimura (1976). The following species of comparable or smaller size also have doubly-forking venation, but differ from *Cladophlebis australis* (as strictly defined here) in the following features: dentate or markedly undulose or crenate margins (*C. mendozaensis, C. serrulata, C. uralica, C. virginiensis, C. albertsii*), less falcate pinnules (*C. gondwanica, C. roessertii, C. alberta, C. yanschinii*), shorter and more triangular pinnules (*C. divaricata, C. mongolica, C. nampoensis, C. sengalensis, C. tungusorum*), more elongate pinnules (*C. integra*) and much smaller pinnules (*C. falcata*). The following species of *Cladophlebis* differ from *C. australis* mainly in being either much larger (*C. lenaensis, C. aldanensis, C. aktashensis*), larger with lobate, crenate or dentate pinnule margins (*C. haiburnensis, C. gigantea, C. raciborskii*) or larger with consistently thrice-forked secondary veins (*C. halleiana, C. fukiensis*).

Cladophlebis australis is especially similar to *C. gondwanica* Frenguelli 1947 and *C. mendozaensis* (Geinitz) Frenguelli 1947. In *Cladophlebis gondwanica,* the pinnules are less falcate and have a more obtuse apex than in *C. australis.* The pinnules of *Cladophlebis mendozaensis* are quite variable in shape, but are usually more deeply lobed than in *C. australis.* The secondary veins of *Cladophlebis mendozaensis* are more clearly marked and further apart than in *C. australis.* These three Gondwanan, Middle Triassic species may all be closely related, perhaps the remains of one species, because they all occur together at some localities, such as the Nymboida Colliery open cut in northeastern New South Wales (Retallack, 1977, microfiche frame G11). They are maintained as separate species in order to retain some of the order so admirably introduced by Frenguelli (1947) into the chaotic nomenclature of this genus.

Remarks: Cladophlebis australis has been so loosely identified in the past, that it has become erroneously regarded as the most widespread, long ranging and common fern of the Gondwanan Mesozoic. A strict interpretation of this species, based on the material figured by Morris (1845), includes only those fossils listed in the synonymy, restricted to Middle and Late Triassic rocks of eastern Australia and Argentina. This confusion over *C. australis* arose firstly by separation of Gondwanan forms from remains equally indiscriminately identified as *Cladophlebis denticulata* by Seward (1910) and others. Secondly, Frenguelli (1947) evidently regarded some Early Cretaceous specimens from Cape Paterson, Victoria, as more typical of the species than the holotype. This error was compounded by Herbst's (1978) nomination of an Early Cretaceous neotype from near Geelong, Victoria (ages of these Victorian localities are given by Douglas, 1969). Frenguelli (1947, p. 25) defined this widespread, and now un-named, Jurassic and Early Cretaceous form as a "species with oblique pinnules, subalternate (almost subopposite), linear-oblong, slightly falcate, tapering towards an obtuse apex or ending in a rounded point, with entire or slightly undulose margins, and rarely, slightly serrate at the apex; secondary veins with a second bifurcation of one of the branches from the first dichotomous bifurcation, excepting at the apex of the pinnule, where once-forked secondary veins predominate, and at the base, where both branches may fork again"

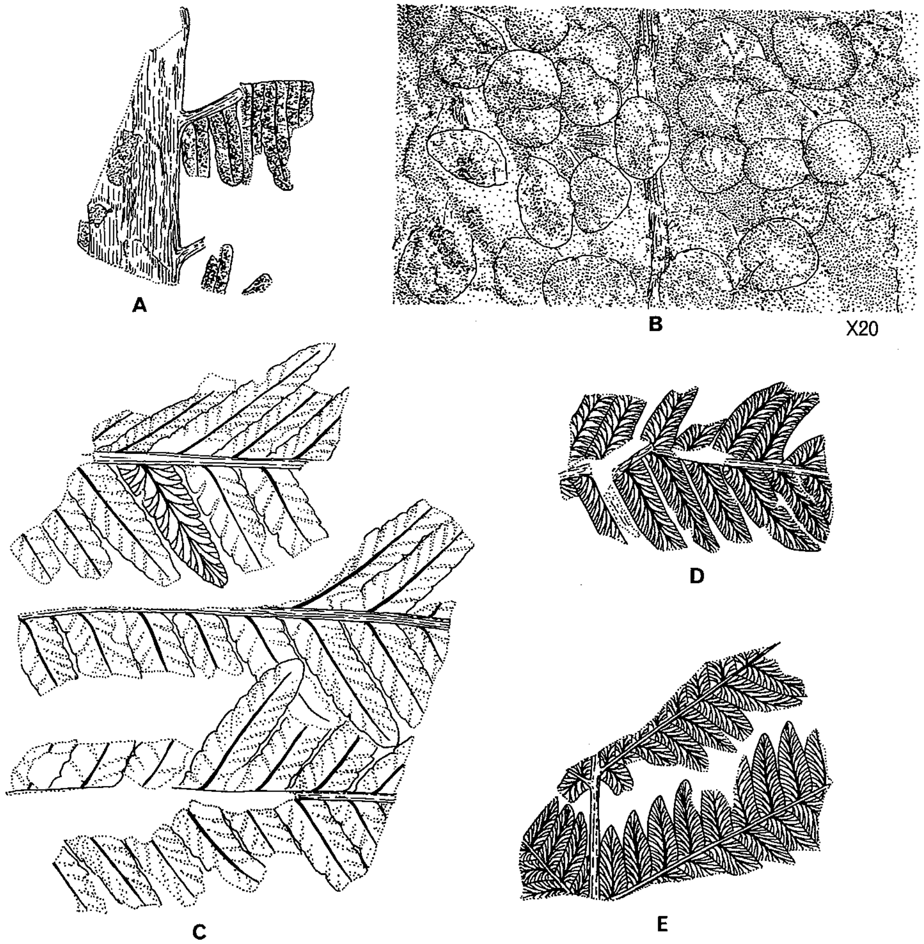

Fig. 3—Filicaleans from near Benmore Dam. A-C, *Todites maoricus*. A-B, fertile frond, B42.74; A, portion of rachis and two pinnae; B, detail of two sori on second lower pinnule of upper pinna, twenty times natural size; C, sterile frond fragment, B42.37; D, *Cladophlebis australis*, B42.46; E, *Cladophlebis indica*, B42.59. All natural size unless otherwise indicated.

(translated from the original Spanish by the author). By contrast *Cladophlebis australis* in the strict sense has more erect, falcate pinnules, entire or slightly undulose margins, and secondary veins doubly-forking throughout the pinnules.

The species *Cladophlebis australis* has commonly been attributed to Seward (1900 or 1904), but since he regarded the fossils described by Morris (1845) as part of *C. denticulata* or a variety of that species, Halle (1913) must be credited with the first valid emendation according to article 60 of the International Code of Botanical Nomenclature. Herbst (1978) has discounted Halle's emendation, on the basis that the fossils he described were subsequently identified as another species. However, this is not relevant to his priority over the emendation of Morris's name, in the pertinent section of the Code.

Occurrence: The fragments of *Cladophlebis australis* described here were collected by me from locality H39/f9757, and by Harrington and McKellar (in Bell *et al.*, 1956) from localities now under the water of Benmore Dam (H39/f950). This species has also been illustrated from Middle or Late Triassic rocks of Tasmania (Morris, 1845; Feistmantel, 1890), the Toogoolawah Group and Tingalpa Formation of southeastern Queensland (Walkom, 1924, 1928; Jones and de Jersey, 1937; Hill, Playford and Woods, 1965;

Day *et al.* 1974), and from the Potrerillos Formation of the Cacheuta Group, the los Rastros Formation of the Ischigualasto Group and near Malacara, in Argentina (Frenguelli, 1947; Jain and Delevoryas, 1967; Stipanicic, 1967). This species has also been collected from the Basin Creek Formation, near Nymboida, New South Wales (Retallack, 1977, microfiche frame G11). Following the stratigraphic correlation of these units proposed by Retallack (1977), *Cladophlebis australis,* as strictly defined here, has a range of Middle to Late Triassic (late Anisian to Norian).

Cladophlebis indica (Oldham et Morris) Sahni et Rao 1933 (Fig. 3E)

Remarks: This species has been discussed in detail by Retallack (1979). Specimens from Benmore Dam were misidentified as "*Cladophlebis australis*" by Bell (in Bell *et al.*, 1956, fig. 4.1). This species was found at most localities near Benmore Dam (H39/f2, f950, f9664, f9665, f9756, and f9760).

DIVISION: GYMNOSPERMOPHYTA

Class: Pteridospermopsida

Order: Peltaspermales

Family: Peltaspermaceae

Genus: *Lepidopteris* Schimper emend. Townrow 1956: 4.

Lepidopteris madagascariensis Carpentier 1935 (Fig. 5A)

Remarks: A single slab (B1085.9/10, part/counterpart from locality H39/f9756) has impressions of two of these leaves, side by side at a slight angle to each other. They do not show blisters on the rachis characteristic of this species, but do have rachis pinnules (Zwischerfiedern) and the pinnae appear to be attached to one side (probably the upper or adaxial) of the rachis. Comparable fragments (un-numbered and B42.62) are present in old collections from localities now under water (H39/f9664 and f950, respectively).

This species has been discussed at length by Townrow (1966) and Retallack *et al.* (1977). Although it is possible that *Lepidopteris* and *Pachydermophyllum* leaves may have been borne on one plant species (as assumed by Townrow, 1960, and by Retallack, in Retallack *et al.*, 1977), I now believe that they are better distinguished until their palaeoecology and stratigraphic occurrence can be demonstrated to be identical.

Genus: *Pachydermophyllum* Thomas et Bose 1955

Pachydermophyllum dubium (Burges) Retallack 1981 (Fig. 4A)

Remarks: This species has short pinnae, coalescing at the base (Retallack, 1981). It was found by Harrington and McKellar (in Bell *et al.*, 1956) at several localities near Benmore Dam now under water (H39/f950; Fig. 4A), and later collected by Shu (1964) from these same localities (H39/f9665; unnumbered specimens).

Pachydermophyllum praecordillerae (Frenguelli) Retallack 1981 (Figs. 4B-H, 10F)

Remarks: An appreciation of the variation within this species was gained from the extensive collections from near Benmore Dam. Some specimens (Figs. 4B-C) have thickened margins, like those of "*Cycadopteris*" and "*Lomatopteris*", genera which are now largely submerged within *Pachypteris* (Boureau and Doubinger, 1975). Others (Fig. 4D) have prominent transverse wrinkles, evidence that the leaf was fleshy in life.

The callused abscission scar at the base of one specimen (Fig. 4D) is proof that these leaves were unipinnate and unforked, as is also apparent from the decrease in pinna length toward the extremities of nearly complete specimens. The apical pinnule (Fig. 4F) is formed by coalescence of the apical pinnae.

I have found this species in modest numbers at several localities near Benmore Dam (H39/f9756, f9760), but it is almost the only species present at locality H39/f2. In old collections by Harrington and McKellar (in Bell *et al.*, 1956; H39/f950) and Shu (1964; H39/f9664, f9665) from localities now under water, it was found with a variety of other species.

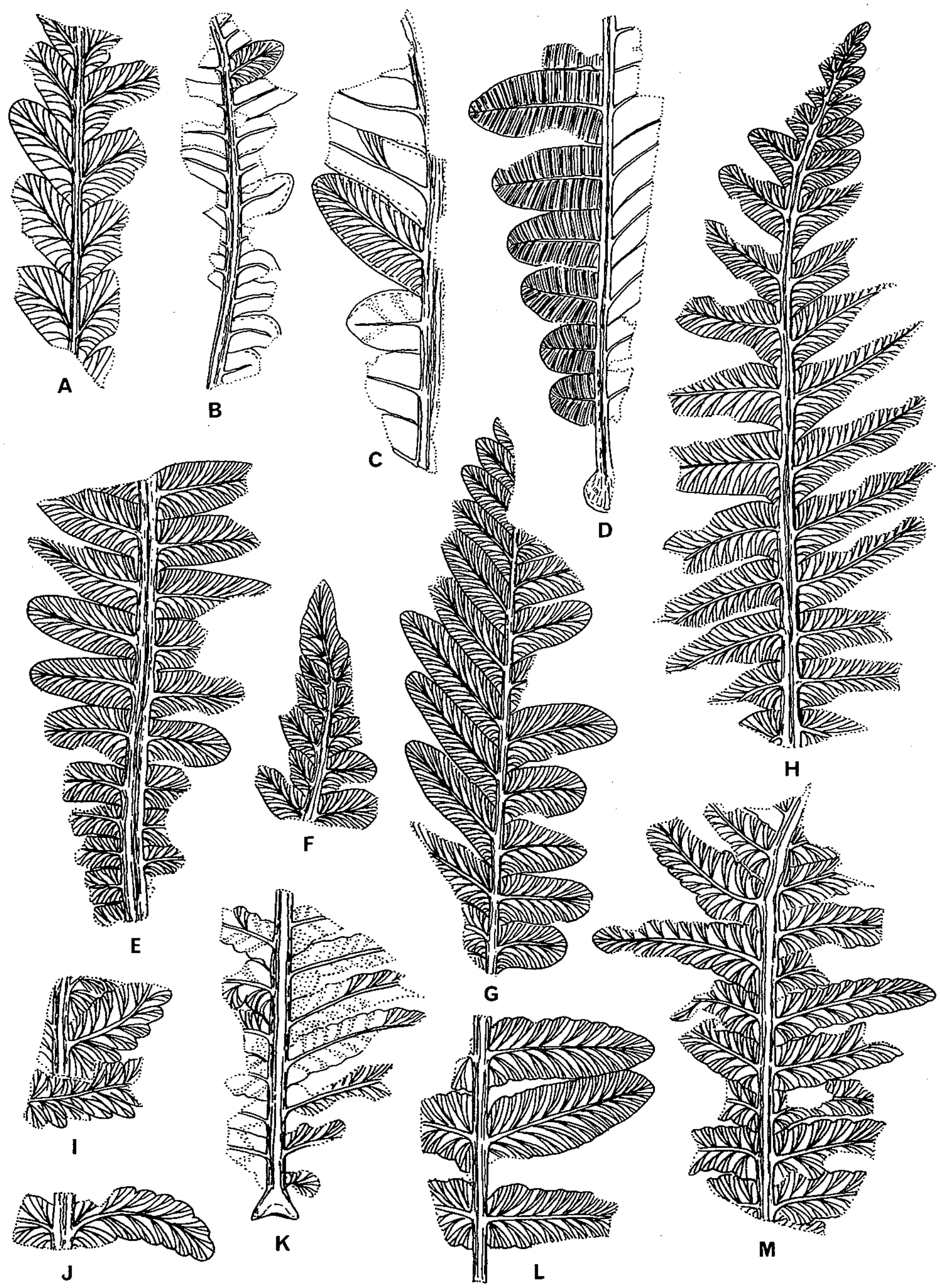

Fig. 4—*Pachydermophyllum* leaves from near Benmore Dam. A, *Pachydermophyllum dubium,* B.42.21; B-H *Pachydermophyllum praecordillerae;* B. OU14198; C, OU14200; D, OU14207; E, B1085.3; F, B1085.8; G, B42.26; H, B1085.1; I-M, *Pachydermophyllum* sp. indet.; I, B42.10; J, B42.41; K, B42.12; L, B42.20; M, B42.30. All natural size.

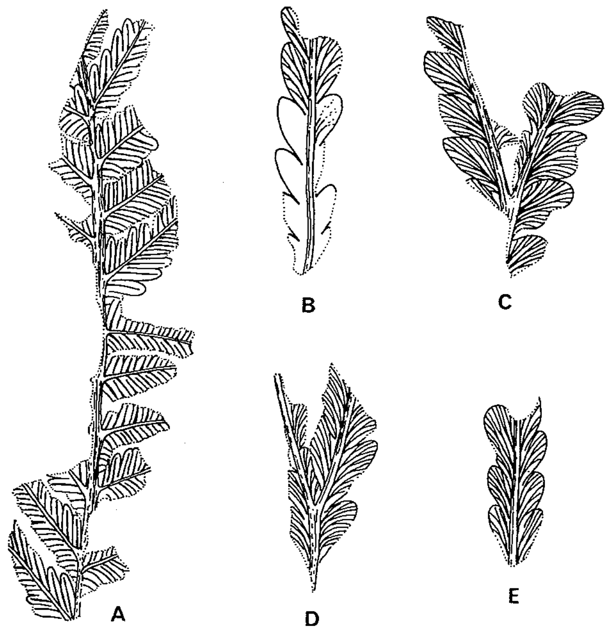

Fig. 5—*Lepidopteris* and *Dicroidium* leaves from near Benmore Dam. A, *Lepidopteris madagascariensis*, B1085.10; B-E, *Dicroidium odontopteroides* var. *moltenense;* B, B42.27; C, B42.20; D, B42.29; E, B42.67. All natural size.

Pachydermophyllum sp. indet. (Figs. 4I-M)

1956 ? *Thinnfeldia* sp.; Bell, in Bell *et al.*, p. 669, fig. 4.5.

1956 ? *Callipteridium* sp.; Bell, in Bell *et al.*, p. 670, fig. 4.2.

1978 *Cladophlebis mendozaensis;* Herbst, p. 12.

Remarks: Several fragments collected from localities (H39/f950, Fig. 4I-M; f9665, unnumbered) on the ridge now under water and from locality H39/f9756 (B1085.4,5) are referred to *Pachydermophyllum* because of their several points of similarity with *P. praecordillerae:* their similar size and general appearance, thick primary rachis, prominent basal abscission scar and transversely wrinkled pinnae. They differ from *P. praecordillerae* in their crenate pinna margins, with each lobe supplied by a discrete bundle of secondary veins. These distinctive differences may prove to distinguish a new species or genus, or merely a variety of *Pachydermophyllum* or *Lepidopteris*. This last possibility is apparent from comparison with "*Callipteridium argentinum*" of Frenguelli (1944), which Baldoni (1972) included within *Lepidopteris stormbergensis*, but which agrees better with *Lepidopteris madagascariensis,* according to all the criteria developed by Townrow (1966b). Frenguelli's specimen differs from the fragments from Benmore Dam only in having bundles of pinnately-arranged secondary veins and an alate primary rachis. Otherwise the similarity is striking. A firm decision on the exact nature of these fragments from Benmore Dam is best deferred until more and better-preserved material is available.

Several form-genera for fern-like leaves with bundled secondary venation and lobate margins are available, but none are suitable for these fragments. The genus *Validopteris* was resurrected by Boureau and Doubinger (1975) for leaves with these features, although the included species have few other features in common. Crookall (1955) and Wagner (1968) have pointed out that the type specimen of the type species of *Validopteris* is difficult to identify, but probably a fragment of *Alethopteris*. Other species which have been referred to *Validopteris,* are probably allied to *Pecopteris*. Most of these are best included in the genus *Lobatopteris* Wagner 1958, which is tripinnate and bipinnate, quite unlike the fragments from Benmore Dam. *Fascipteris* is another genus for distinctive fertile and sterile *Pecopteris*-like leaves with lobate ultimate segments (Peking Institute *et al.*, 1974; Li and Yao, 1982). Asama (1959) attempted to establish the genus *Aipteris* for unipinnate leaves with bundled venation. However, the type material of the type species of *Aipteris* described by Zalessky (1939) is a poorly preserved fragment of either *Pecopteris* or *Scytophyllum* (Boureau and Doubinger, 1975). Both Zalessky's (1939) original figure of *Aipteris speciosa* and the numerous species of *Scytophyllum* (Boureau and Doubinger, 1975; Dobruskina, 1969, 1975) have elongate and pinnate bundles of veins, quite different from those in the fragments from Benmore Dam.

Some of these fragments (Figure 4J) are similar to robust pinnules of *Cladophlebis mendozaensis* (Geinitz) Frenguelli 1947, as is evident from Herbst's (1978) citation of Bell's (in Bell *et al.*, 1956) figures of specimens from Benmore Dam, in his synonymy for that species. The bundles of veins in these fragments are less-regularly twice-forked, and have veins more curved, closer together and forking at a smaller angle, than in *C. mendozaensis*. Leaves of this species are also bipinnate, perhaps tripinnate, whereas the fragments from Benmore Dam are unipinnate.

Genus: *Peltaspermum* Harris emend. Townrow 1960: 353.

Peltaspermum sp. indet. (Figs. 6F-H, 10G-I)

Remarks: These radial aggregates of seeds are similar to a specimen found at Long Gully, 5 km southwest of Otematata (Retallack, 1981, fig. 3B). They furnish a more convincing record of the genus in New Zealand, because they are more numerous, better preserved and found wherever *Pachydermophyllum* is abundant (B1085.22, 23 from H39/f9756: OU14210-1 from H39/f2). The best preserved specimen (Figs. 6H, 10I) has been sheared, presumably during metamorphism and deformation, so that some seeds appear shortened and others elongated. This group of seeds measures 17.5 by 9.1 mm. The least deformed seed (lower right) is ovate and measures 5.8 by 4.1 mm, and has a nucule 4.6 by 4.3 mm. The seeds are attached to a central flattened structure by their broad chalazal ends. In another specimen (Figs. 6F, 10H) there are wrinkled fragments of tissue under the seeds, like the laminar heads of *Peltaspermum*. The outer surface of the outer integument appears smooth, and this integument thickens towards the micropyle. The integument contains a sclerotesta of fibrous texture, which has three longitudinal ridges. The inner nucule is clearly delineated, but details of its structure are obscured by compression of the sclerotesta.

These seeds form a more regular radial arrangement than found in *Peltaspermum thomasii* (Townrow, 1960), or in other fossils which I consider to be related, such as "*Umkomasia*" *cacheutensis* Frenguelli 1942a and "*Karibacarpon*" *problematicum* Lacey 1976. In this respect, these specimens are more like *Peltaspermum rotula* Harris 1937 and *P. buechivae* Gomankov et Meyen 1979, although there is no evidence that the fragmentary heads from Benmore Dam were also peltate, as in these species. Two other, poorly-known fossils are similar to the fragments from Benmore Dam: megasporophylls attributed to leaves of *Vittaephyllum hirsutum* (Boureau and Doubinger, 1975, fig. 327), and "megasporophyll, Type 1" of Douglas (1969, p. 242), which was found associated with abundant leaves of *Pachydermophyllum*, cycadophytes and conifers.

Order: Corystospermales

Family: Corystospermaceae

Genus: *Dicroidium* Gothan emend. Townrow 1957: 26.

Dicroidium odontopteroides var. ***moltenense*** Retallack 1977 (Figs. 5B-E)

Remarks: These fragments were found only in localities (H39/f950) now under water (by Harrington and McKellar, in Bell *et al.*, 1956). They are very similar to remains of this variety from Tank Gully, Canterbury (Retallack, 1980), and like them were probably once part of more inland communities of plants than the assemblages dominated by *Pachydermophyllum* and *Linguifolium*, which can now be collected near Benmore Dam.

Genus: *Pteruchus* Thomas emend. Townrow 1962: 289.

Pteruchus dubius Thomas 1933 (Figs. 6A, 10J)

Remarks: Only a single fragment of a sporangial head was found from the localities now under water (H39/f950), which also yielded *Dicroidium*, the presumed foliage of

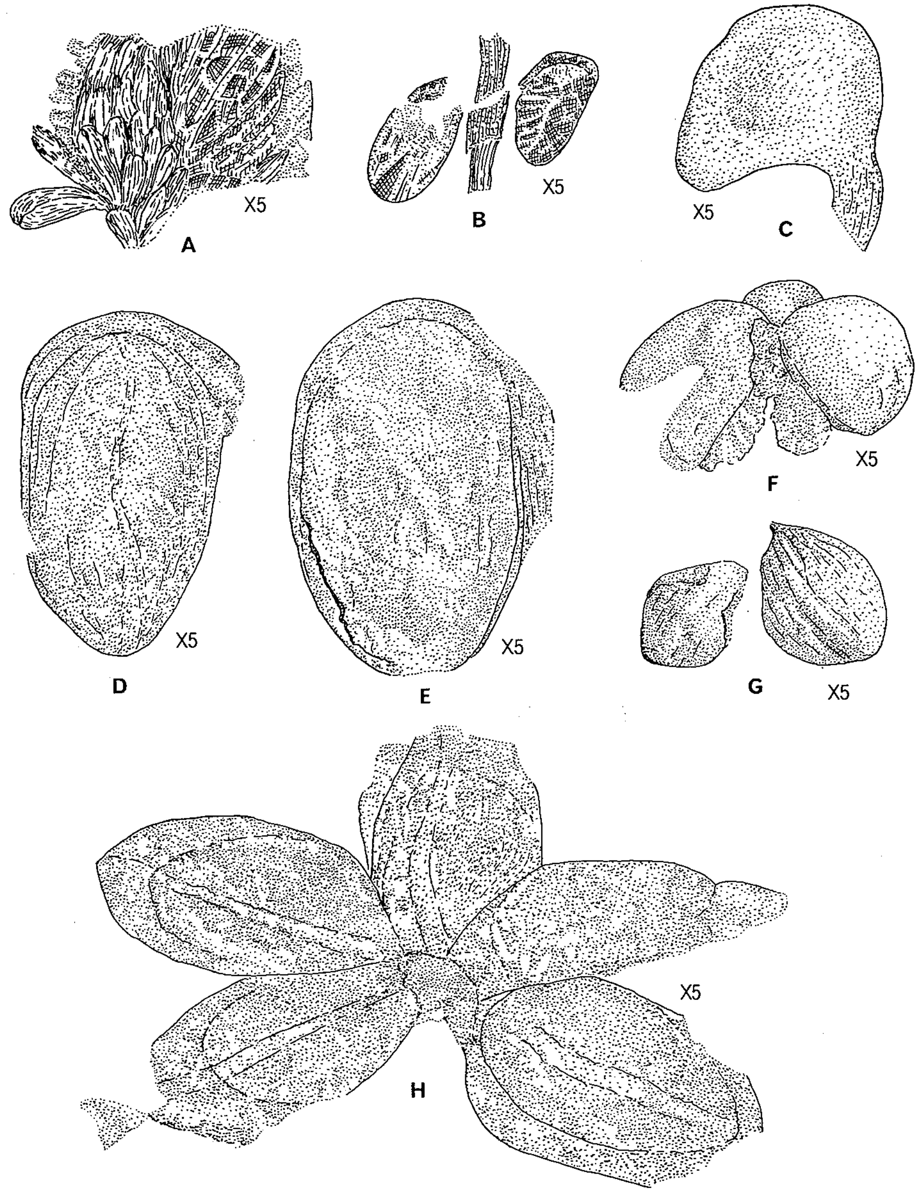

Fig. 6—Pteridosperm fructifications from near Benmore Dam. A, *Pteruchus dubius,* B42.27; B-C, *Pilophorosperma* sp. indet.; B, B42.15; C, B42.83; D-E, *Pilophorosperma* sp. A; D, B1085.28; E, B1085.25; F-H, *Peltaspermum* sp.; F, B1085.23; G, B1085.22; H, OU14210. All five times natural size.

plants bearing the microsporophyll *Pteruchus* (Townrow, 1962). The head is incomplete, but had an original width of close to 14.8 mm. The pollen sacs on the right hand side are irregularly broken and strongly coalified. Those on the left show more clearly, characteristic features of longitudinal wrinkling, cellular striation and likely dehiscence slits. This species has been discussed in more detail by Retallack (in Retallack *et al.*, 1977) and Petriella (1980).

Genus: *Pilophorosperma* Thomas 1933

***Pilophorosperma* sp. indet. (Figs. 6B-C)**

Remarks: Two small fragments of very different appearance are here referred to this genus for megasporophylls, attributed to plants with *Dicroidium* leaves (Thomas, 1933). Both fragments were collected from localities now under water (H39/f950), like most of the corystosperm material from near Benmore Dam. One fragment is a pair of small coalified seeds which Bell (in Bell *et al.*, 1956, fig. 4.15) called "seeds of Corystospermaceae", here redrawn for Fig. 6B. The pinnate arrangement and abundant coalified (perhaps formerly woody) tissue are most like those of *Pilophorosperma costulatum* Thomas 1933, although this fragment is much smaller than Thomas's original specimen. A second fragment (Fig. 6C) is an empty cupule, with portions of its stalk. It could belong to several species of *Pilophorosperma,* although its straight lower margin distinguishes it from *Pilophorosperma costulatum, P. crassum, Spermatocodon sewardii* and *Umkomasia* spp. of Thomas (1933). Careful examination of Thomas's type material has reinforced my former view (in Retallack *et al.*, 1977), that there are probably only as many species of megasporophylls as Townrow (1962) recognized in his revision of the microsporophylls in these collections from Burnera Waterfall, South Africa. A revision of *Pilophorosperma* and allied genera is much needed.

***Pilophorosperma* sp. A (Figs. 6D-E, 10K-L)**

Remarks: These large seeds, borne on thin cupules were found only at locality H39/f9756. Considering the absence of *Dicroidium* at this locality, there is some doubt about the generic determination. The designation "A" is used to affirm their identity with remains found at Tank Gully, Canterbury, New Zealand, and in the Ipswich Coal Measures, near Brisbane, Queensland (Retallack, 1980), where they are associated with *Dicroidium.* The New Zealand fossils are uniformly fragmentary and poorly-preserved, so better understanding of this form will depend on future studies of the Queensland material.

Class: Cycadopsida

Order: *incertae sedis*

Genus: *Taeniopteris* Brongniart emend. Harris 1932: 33.

***Taeniopteris* sp. indet. (Fig. 9C)**

Remarks: A single fragment from locality H39/f9758 is referred to this genus. The leaf reaches up to 32.9 mm wide. Its exposed midrib is only 0.4 mm wide, but there are folds on either side of this, as an indication that the midrib on the underside of the leaf was 4.5 mm wide. The secondary veins are unforked, parallel, dense (23 veins per cm at the margin), and meet the margin at a wide angle. This fragment is a little larger and more robust, and has less erect secondary venation, than an otherwise similar fragment found at Long Gully, 5 km southwest of Otematata. It is also similar to several described Gondwanan *Nilssonia*-like leaves, previously compared with that fragment (Retallack, 1981).

Plantae incertae sedis

Genus: *Ginkgophytopsis* Høeg emend. Retallack 1980: 43.

***Ginkgophytopsis cuneata* (Carruthers) Retallack 1980 (Fig. 7A)**

1872 *Cyclopteris cuneata;* Carruthers, p. 355, p. 27, fig. 5.

1889 *(?) Anthrophyopsis* sp.; Feistmantel, p. 67, pl. 2, fig. 4.

1895 *Anthrophyopsis* sp.; Etheridge, p. 141, pl. 4, fig. 2.

1898 *Sagenopteris cuneata;* Shirley, p. 24, pl. 23.

1899 *Chiropteris copiapensis;* Solms-Laubach, p. 602, pl. 13, figs. 1-4.

1903 *Chiropteris cuneata;* Seward, p. 62, pl. 9, fig. 4.

1917 *Chiropteris etheridgei;* Arber, p. 28.
1925c *(?) Rhipidopsis narrabeenensis;* Walkom, p. 221, pl. 30, figs. 3-4.
1926 *(?) Psygmophyllum etheridgei;* Chapman and Cookson, p. 171, pl. 23, fig. 20, pl. 24, fig. 21.
?1927 *Psygmophyllum fergusoni;* Chapman, p. 141, pl. 12, fig. 31; pl. 13, figs. 44-45.
1927 *Chiropteris copiapensis* (in part); Du Toit, p. 324, figs. 3C, E only.
1931 *Chiropteris cuneata* (in part); Rühle von Lilienstern, p. 202.
1932 *Chiropteris etheridgei* (in part); Rühle von Lilienstern, p. 230.
1935 *Rhipidopsis narrabeenensis;* Burges, p. 262, fig. 9.
1965 *Chiropteris copiapensis;* Archangelsky, p. 270.
?1967 *Chiropteris copiapensis;* Fleming, in Houston, p. 14.
?1969 *Chiropteris copiapensis;* Stipanicic and Bonetti, p. 1093.
?1969 *Chiropteris cuneata;* Stipanicic and Bonetti, p. 1093
1970 *Chiropteris copiapensis;* Azcárate and Fasola, p. 251, fig. 2.

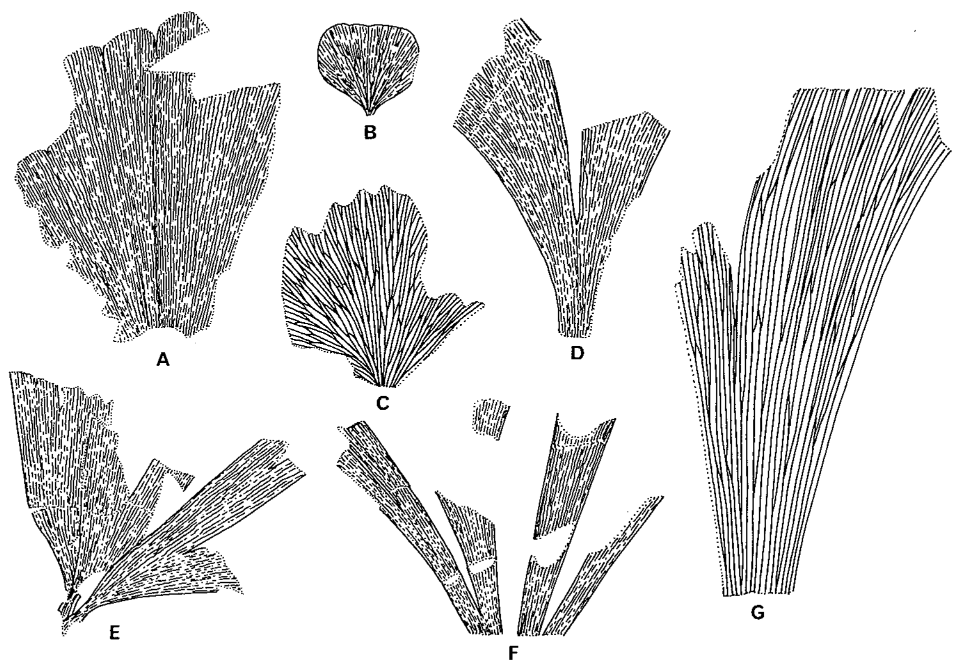

Fig. 7 — *Ginkgophytopsis* leaves from near Benmore Dam. A, *Ginkgophytopsis cuneata,* B42.5; B-C, *Ginkgophytopsis tasmanica;* B, B1085.14; C, B1085.15; D-G, *Ginkgophytopsis lacerata;* D, B42.3; E, leaf group, attached to slender axis, B42.16; F, B42.6; G, B42.4. All natural size.

Holotype: The specimen of "*Cyclopteris cuneata*" figured by Carruthers (1872, p. 27, fig. 5); number v4197, British Museum of Natural History, London.

Type locality: Tivoli Coal Mine, near Brisbane, southeastern Queensland; Ipswich Coal Measures; Late Triassic (latest Ladinian to Norian). The type impression is in a dark, grey-green shale, including also impressions of *Xylopteris elongata* (Carruthers) Frenguelli 1943 (Baldoni, 1980) and *Dicroidium odontopteroides* var. *moltenense* Retallack 1977, as would be expected at this locality and stratigraphic horizon.

Description: Only one specimen referrable to this widespread Gondwanan Triassic species was found. This specimen is not complete, but shows a greater expanse of leaf than any other associated *Ginkgophytopsis* leaves, without any indication of apical division of the lamina. Its venation is radiating, dichotomising and anastomosing, but is in most places obscured by woody, interveinal striae.

Comparison: This species has entire leaves, only slightly lobed or frayed along the apical margin; quite unlike the associated *Ginkgophytopsis lacerata.* A comprehensive review of the genus and species of *Ginkgophytopsis* may be found elsewhere (Retallack, 1980).

Some specimens of this species, illustrated by Walkom (1925c) and Burges (1935), are superficially like leaves of *Ginkgo.* On close examination, they differ in their anastomosing venation, and are actually groups of cuneate leaves arranged in a helix around slender axes.

The species "*Chiropteris etheridgei* " (of Arber, 1917; Etheridge, 1895; Chapman and Cookson, 1926; Rühle von Lilienstern, 1932) was established for a single specimen because of its distinctively constricted lamina above an apparently expanded base. Because the venation is more dense over the constricted region, this is probably a feature of shrinkage and curling of the leaf before burial, rather than a morphological feature of any importance. Its apical split also appears to be a laceration, rather than an original feature.

Occurrence: Near Benmore Dam, this species was found by Harrington and McKeller (in Bell *et al.,* 1956) from localities now under water (H39/f950). In Australia, this species has been recorded from the Leigh Creek Coal Measures of South Australia (Etheridge, 1895; Chapman and Cookson, 1926), Triassic rocks in Victoria (Chapman, 1927; see also Douglas, 1976), the Newport Formation, Narrabeen Group, Sydney Basin, New South Wales (Walkom, 1925; Burges, 1935) and the Ipswich Coal Measures, near Brisbane, Queensland (Carruthers, 1872; Shirley, 1898). It has also been found at Punta Puquen, Chile (Azcárate and Fasola, 1970), and in the Molteno Formation, Karroo Basin, South Africa (Feistmantel, 1889; Seward, 1903; Du Toit, 1927). Less certain is its occurrence in the Tingalpa Formation, near Brisbane, Queensland (listed by Fleming, in Houston, 1967) and in various Argentine localities (Archangelsky, 1965; Stipanicic and Bonetti, 1969). From the stratigraphic ranges for these formations proposed by Retallack (1977), *Ginkgophytopsis cuneata* ranges from the Early (Smithian part of Scythian) to Late Triassic (Norian).

Ginkgophytopsis lacerata (Arber) Retallack 1980 (Figs. 7D-G)

Remarks: This is the most common species of *Ginkgophytopsis* near Benmore Dam (localities H39/f950, f9756, f9757, f9760, f9664), as well as in other Middle Triassic megafossil floras of New Zealand (Retallack, 1980, 1981). The degree of apical dissection of the leaves varies considerably, so that the leaf segments may be broad and flaring (Fig. 7D) or narrow and parallel-sided Fig. 7F). I have redrawn the specimen (Fig. 7E) described by Bell (in Bell *et al.,* 1956, p. 671, Figure 4.16) as "*Ginkgo digitata*". Like the remains of *Ginkgophytopsis cuneata* already discussed, this proved not to be a simple ginkgoalean leaf, but three separate leaves arranged in a close helix on a slender axis.

Ginkgophytopsis tasmanica (Walkom) Retallack 1980 (Figs. 7B-C)

1894 *Sagenopteris salisburoides;* Etheridge, p. 34, pl. 7, fig. 2.

1925a *Chiropteris tasmanica;* Walkom, p. 72, pl. 9, fig. 2.

Holotype: Specimen of "*Chiropteris tasmanica*" illustrated by Walkom (1925a, pl. 9, figure 2); this may be an unlabelled specimen recently discovered in the collections of the Tasmanian Department of Mines by S. M. Forsyth (*pers. comm.,* 1982).

Type locality: Not known precisely; Tasmania (see Walkom, 1925a, p. 68); "Feldspathic Sandstone Series," Triassic.

Description: These are small deltoid to orbicular leaves of *Ginkgophytopsis* up to 3 cm wide. Dichotomizing and anastomosing venation radiates evenly throughout the lamina in these fragments from Benmore Dam, one of which is almost complete (Fig. 7B).

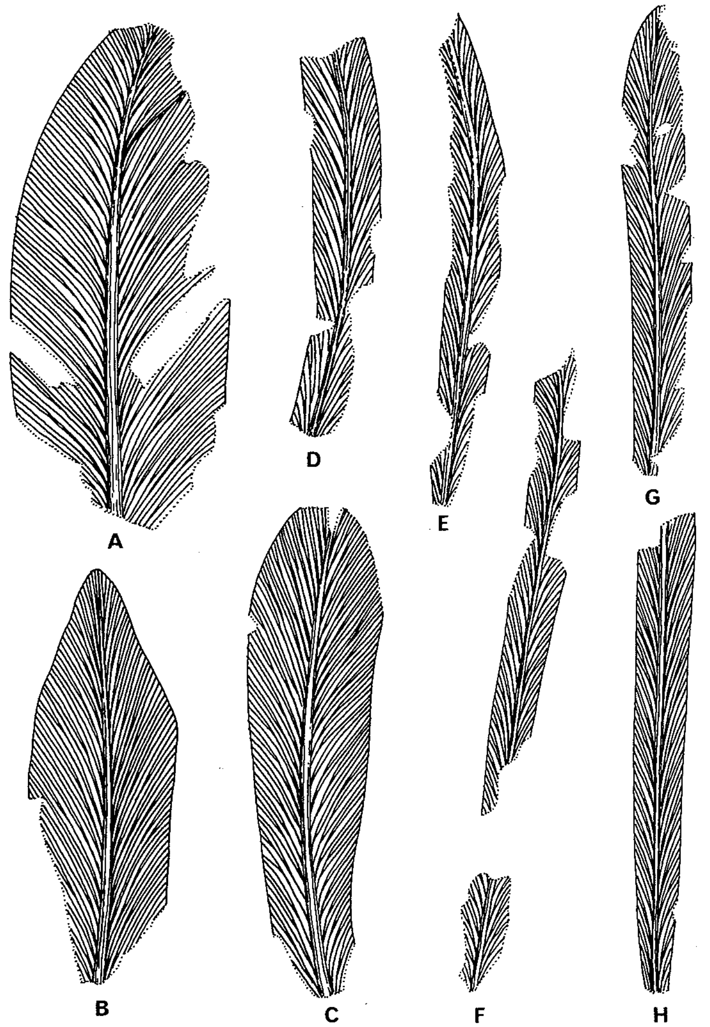

Fig. 8—*Linguifolium* leaves from near Benmore Dam. A, *Linguifolium lilleanum,* B42.11; B-C, *Linguifolium steinmannii;* B, B42.112; C, B1081.1; D, *Linguifolium arctum,* B1085.15; E-H, *Linguifolium tenison-woodsii;* E, B1085.17; F, B1085.16; G, B42.27; H, B42.24. All natural size.

Comparison: This distinctive small species may prove to be a juvenile leaf of some other species of *Ginkgophytopsis,* when larger collections of better preserved material are available. Frenguelli (1942b) decided that a very similar fossil was a juvenile leaf of *Chiropteris barrealensis,* with which it was associated. It is difficult to be certain from the published illustrations, whether this fossil has a long petiole, characteristic of *Chiropteris,* or whether it was attached, without a petiole to a slender stem, as in *Ginkgophytopsis* (Retallack, 1980). A specimen of *Ginkgophytopsis tasmanica* illustrated by Etheridge (1894) clearly shows the apetiolate, sheathing leaf bases, attached to slender axes, characteristic of *Ginkgophytopsis.* There is no hint of a petiole in the fragments from Benmore Dam, which are associated with *Ginkgophytopsis lacerata.*

The abandoned name *"Sagenopteris salisburoides"* was established by Johnston (1887, pl. 1, figs. 4, 4a) and the specimens were refigured by Johnston (1888, pl. 28, figs. 4, 4a) and Feistmantel (1980, pl. 9, figs. 1, 1a). Walkom (1925a, p. 85) examined them, and failing to detect any anastomoses, referred them to *Ginkgoites.* Unfortunately, these specimens also are lost from the Tasmanian Museum and Art Gallery (N. R. Kemp, *pers. comm.*, 1975) and the Tasmanian Department of Mines (S. M. Forsyth, *pers. comm.*, 1982).

Occurrence: In addition to these specimens from near Benmore Dam (locality H39/f9756), examples of this species have been found in the upper Bulgo Sandstone, in the second Cremorne bore, near Sydney, New South Wales (Etheridge, 1894), and the "Feldspathic Sandstone Series", Tasmania (Walkom, 1925a, b). Considering the age of these formations (Retallack, 1977), the securely established range of the species is Early to Middle Triassic (Smithian to Ladinian), although the "Feldspathic Sandstone Series" as understood in Walkom's time may also have included some Late Triassic rocks.

Genus: *Linguifolium* Arber emend. Retallack 1980: 45.

Linguifolium arctum Menendez 1951 (Fig. 8D)

Remarks: This species is rare near Benmore Dam, occurring only at localities H39/f2, f950, f9756.

Linguifolium lilleanum Arber 1913 (Fig. 8A)

Remarks: These large leaves are very common at the leaf coal locality (H39/f9760), and in old collections made by Harrington and McKellar (H39/f950) and recollected by Shu (H39/f9665).

Linguifolium steinmannii (Solms-Laubach) Frenguelli 1941 (Figs. 8B-C, 10E)

Remarks: Only a few specimens of this species were found at the leaf coal locality (H39/f9760) and in old collections (H39/f950). Some have a sub-acute apex (Fig. 8B), while others are spathulate (Figs. 8C, 10E).

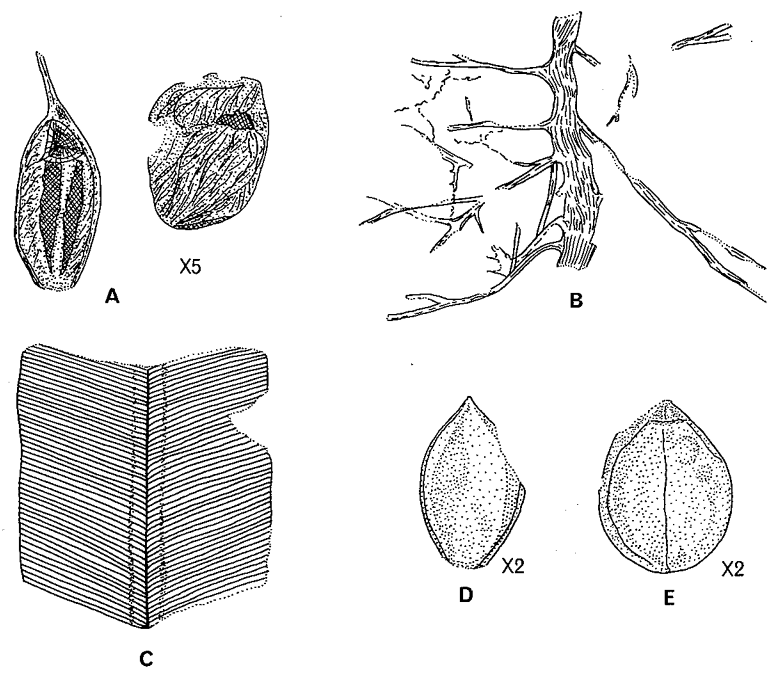

Fig. 9—Plant remains of uncertain affinities from near Benmore Dam. A, unidentified ovulate fructification, five times natural size, B42.10; B, thick root with helically-arranged rootlets, natural size, B1085.24; C, *Taeniopteris* sp., natural size, B1083.3; D-E, *Carpolithus mackayi,* twice natural size, B42.18.

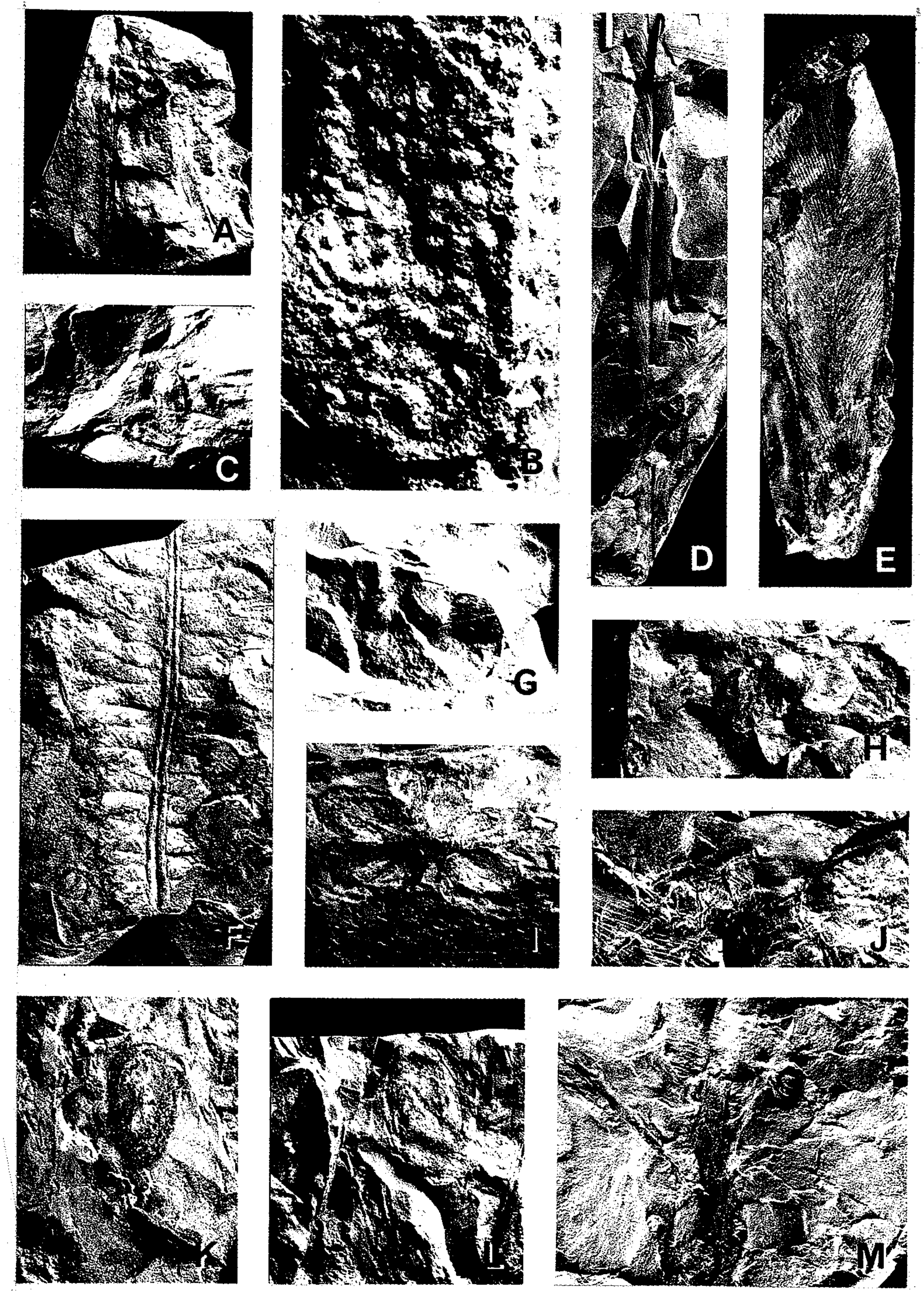

Fig. 10—Plant fossils from near Benmore Dam. A-B, *Todites maoricus,* B42.74; A, natural size; B, detail of second lower pinnule of upper pinna, ten times natural size; C, unidentified ovulate fructification, twice natural size, B42.10; D, *Linguifolium tenison-woodsii,* natural size, B1085.16; E, *Linguifolium steinmannii,* natural size, B1081.1; F, *Pachydermophyllum praecordillerae,* natural size, B1085.3; G-I, *Peltaspermum* sp., twice natural size, G, B1085.22; H, B1085.23; I, OU14210; J, *Pteruchus dubius,* twice natural size, B42.27; K-L, *Pilophorosperma* sp. A, twice natural size, K, B1085.28; L, B1085.25; M, thick root, with helically-arranged lateral rootlets; natural size, B1085.24.

Linguifolium tenison-woodsii (Etheridge) Retallack 1980 (Figs. 8E-H, 10D)

Remarks: This species was found, often abundantly, at several localities (H39/f2,f950, f9756,f9757,f9758,f9664,f9665). Some of them were longer than 8.6 cm.

Genus: *Carpolithus* Linnaeus emend. Seward 1917: 364

Carpolithus mackayi Arber 1917 (Figs. 9D-E)

Remarks: These seeds are possibly fructifications of the plant which bore *Linguifolium* leaves (Retallack, 1980). Some were found at locality H39/f9756 and the two examples illustrated (Figs. 9D-E) are those described by Bell (in Bell *et al.*, 1956, p. 671, fig. 4.13), from localities now under water (H39/f950).

Unidentified ovulate fructification (Fig. 9A)

Remarks: These two seeds are near each other on the same slab, in the orientation shown (Fig. 9A). The right hand seed is attached to an elongate structure, perhaps a peduncle. The outermost layer of the seeds appears to have been fleshy, but broken away to reveal the wrinkled inner surface of the sclerotesta. Some of this woody layer remains as coal in grooves and depressions. The coal cleat of the former sclerotesta has left a clear imprint on the visible surface of the seeds. The seeds appear to have six radial ribs and an ovate outline. The left hand seed is probably obliquely crushed, with its chalazal end visible.

There are some resemblances between these seeds and those identified as *Peltaspermum* sp. from Long Gully, 5 km southwest of Otematata (Retallack, 1981) and from near Benmore Dam (this report), but no evidence of a radial arrangement or laminar head in this specimen. It was found in old collections (H39/f950).

Carbonized roots (Figs. 9A, 10M)

Remarks: Root traces of this kind are common in immature palaeosols near Benmore Dam. The illustrated example (Figs. 9B, 10M from H39/f9756) is a thick root with several, irregularly-branching, helically-arranged, lateral rootlets.

Compressed logs

Remarks: As in Tank (Retallack, 1979, 1980) and Long Gullies (Retallack, 1981: Retallack and Ryburn, 1982), South Island of New Zealand, large logs are common in localities with abundant *Linguifolium* leaves (such as H39/f9756). Some of these are up to 10.6 cm wide. According to Walton's (1936) compression hypothesis, this would have been the original diameter of the tree trunk.

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REFERENCES

Arber, E. A. N., 1913. A preliminary note on the fossil plants of the Mt Potts Beds, New Zealand, collected by Mr D. G. Lillie, biologist to Captain Scott's Antarctic Expedition in the "Terra Nova". *Proceedings of the Royal Society, London* B86: 344-347.

——— 1917. Earlier Mesozoic floras of New Zealand. *N.Z. Geological Survey Palaeontological Bulletin* 6, pp. 72.

Archangelsky, S., 1965. Tafofloras paleozoicas y eomesozoicas de Argentina. *Boletin del Sociedad Argentino Botanico* 10: 247-291.

Asama, K , 1959. Systematic study of so-called *Gigantopteris*. *Science Report of Tohoku University, Geological Sciences* 31: 1-72.

Azcárate, V., and A. Fasola, 1970. Sobre formas nuevas para la flora triásico de Los Molles. *Boletin del Museo Nacional de Historia Natural de Chile* 29: 249-269.

Baldoni, A. M., 1972. El genero *Lepidopteris* (Pteridosperma) en el Triasico de Argentina. *Ameghiniana* 9: 1-16.

——— 1980. Revision de las especies del genero *Xylopteris* (Corystospermaceae) en el Triasico de Argentina, Australia y Sudafrica. *Ameghiniana* 17: 135-155.

Bell, S., H. J. Harrington and I. C. McKellar, 1956. Lower Mesozoic plant fossils from Black Jacks, Waitaki River, south Canterbury. *Transactions of the Royal Society of N.Z.* 83: 663-678.

Bishop, D. G., 1976. The Torlesse Terrane of the Waitaki Valley. *In* D. S. Coombs; J. D. Campbell; I. C. McKellar; C. A. Landis; D. G. Bishop (Eds.): Regional geology of the southern part of the South Island, New Zealand Geosyncline. *25th International Geological Congress, Excursion Guide* 59C: 11-13.

Bold, H. C., and M. J. Wynne, 1978. *Introduction to the Algae.* Prentice-Hall, New Jersey.

Boney, A. D., 1966. *A Biology of Marine Algae.* Hutchinson, London.

Boureau, E., and J. Doubinger, 1975. *Traité de paléobotanique IV(2). Pteridophylla (première partie).* Masson, Paris.

Burges, N. A., 1935. Additions to our knowledge of the flora of the Narrabeen Stage of the Hawkesbury Series in New South Wales. *Proceedings of the Linnaean Society of New South Wales* 60: 257-264.

Campbell, J. D., and G. Warren, 1965. Fossil localities of the Torlesse Group in the South Island. *Transactions of the Royal Society of N.Z., Geology* 3: 99-137.

Carpentier, A., 1955. Études paléobotaniques sur le groupe de la Sakoa et de la Sakamena (Madagascar). *Annales Géologiques du Service des mines de Madagascar 5:* 7-32.

Carruthers, W., 1872. Notes on fossil plants from Queensland, Australia. *Quarterly Journal of the Geological Society of London* 28: 350-359.

Chapman, F., 1927. Monograph of the Triassic flora of Bald Hill, Bacchus Marsh, Victoria. *Memoir of the National Museum Melbourne* 7: 121-155.

Chapman, F., and I. C. Cookson. 1926. A revision of the Sweet Collection of Triassic plant remains from Leigh Creek, South Australia. *Transactions of the Royal Society of South Australia* 50: 163-178.

Crookall, R., 1955. Fossil plants of the Carboniferous rocks of Great Britain (second section). *Memoir of the Geological Survey of Great Britain, Palaeontology* 4: 1-84.

Dawes, C. T., and A. C. Mathieson, 1972. A new species of *Pseudocodium* (Chlorophyta, Siphonales) from the west coast of Florida. *Phycologia* 11: 273-277.

Day, R. W., L. C. Cranfield and H. Schwarzböck, 1974. Stratigraphic and structural setting of Mesozoic basins in southeastern Queensland and northeastern New South Wales. *In* A. K. Denmead, G. W. Tweedale (Eds.): *The Tasman Geosyncline,* pp. 320-363. Queensland Division of the Geological Society of Australia, Brisbane.

Dobruskina, I. A., 1969. Rod *Scytophyllum* (morfologiya, epidermalinoe stroenie i sistematicheskoe polozhenie) [The genus *Scytophyllum* (morphology, epidermal structure and systematic position)] *Trudy Akademia Nauk S.S.S.R. Moskva* 190: 35-58.

——— 1975. The role of peltasperm pteridosperms in Late Permian and Triassic floras. *Paleontological Journal* 9: 536-549.

Douglas, J. G., 1969. The Mesozoic floras of Victoria. *Memoir of the Geological Survey of Victoria* 28, pp. 310.

——— 1976. Triassic. *In* J. G. Douglas and J. A. Ferguson (Eds.): Geology of Victoria. *Special Publications of the Geological Society of Australia* 5: 143-146.

Du Toit, A. L., 1927. The fossil flora of the upper Karroo Beds. *Annals of the South African Museum* 22: 289-420.

Elliott, G. F., 1961. A new British Devonian alga, *Palaeoporella lummatonensis,* and the brachiopod evidence of the age of the Lummaton shell-bed. *Proceedings of the Geologists Association London* 72: 251-260.

——— 1965. The interrelationships of some Cretaceous Codiaceae (calcareous algae). *Palaeontology* 8: 199-203.

Elliott, G. F., 1970. New and little-known Permian and Cretaceous Codiaceae (calcareous algae) from the Middle East. *Palaeontology* 13: 327-333.

——— 1981. The Tethyan dispersal of some chlorophyte algae subsequent to the Palaeozoic. *Palaeogeography, Palaeoclimatology, Palaeoecology* 32: 341-358.

Endo, R., 1961. Phylogenetic relationships among the calcareous algae. *Science Report of Saitama University, Series B, Endo Commemorative Volume:* 1-46.

Etheridge, R., 1894. Palaeontologia Novae Cambriae Meridionalis. Descriptions of New South Wales fossils no. 1. *Records of the Geological Survey of New South Wales* 4: 32-38.

——— 1895. Additional remains from the Leigh Creek coal field, central Australia. *Transactions of the Royal Society of South Australia* 19: 138-146.

Feistmantel, O., 1889. Die Karroo-Formation und die dieselbe unterlagernden Schichten. *Abhandlungen der Königlichen Böhmischen Gesellschaft der Wissenschaften, Mathematisch-Naturwissenschafliche Klasse* 3, pp. 89.

——— 1890. Ohlonosné ûtvary v Tasmanii. *Královské České Spolecnosti Nauk Prague* 3, pp. 162.

Fralick, R. A., and A. C. Mathieson, 1972. Winter fragmentation of *Codium fragile* (Suringar) Hariot ssp. *tomentosoides* (van Goor) Silva (Chlorophyceae, Siphonales) in New England. *Phycologia* 11: 67-70.

Frenguelli, J., 1941. *Sagenopteris* y *Linguifolium. Notas del Museo de La Plata* 6, *Paleontologia* 33: 393-403.

——— 1942a. Contribuciones al conocimiento de la flora del Gondwana Superior en la Argentina. 7. *Umkomasia cacheutensis* n. sp. *Notas del Museo de La Plata* 7, *Paleontologia* 48: 315-321.

——— 1942b. Contribuciones al conocimiento de la flora del Gondwana Superior en la Argentina. 10. *Chiropteris barrealensis* n. sp. *Notas del Museo de La Plata* 7, *Paleontologia* 51: 341-353.

——— 1943. Reseña critica de los géneros atribuidos a las "Serie de de *Thinnfeldia*". *Revista del Museo de La Plata* 2, *Paleontologia* 12: 225-336.

——— 1944. Contribuciones al conocimiento de la flora del Gondwana Superior en la Argentina. 16. *Callipteridium argentinum* n. sp. *Notas del Museo de la Plata* 9, *Paleontologia* 64: 377-383.

——— 1947. El genero *Cladophlebis* y sus representantes en la Argentina. *Anales del Museo de la Plata* B2(2), pp. 74.

Fritsch, F. E., 1965. *The Structure and Reproduction of Algae.* Cambridge Unviersity Press, Cambridge.

Gomankov, A. V., and S. V. Meyen, 1979. Members of the family Peltaspermaceae from the Permian of the Russian Platform. *Paleontological Journal* 13: 240-254.

Gould, C., 1869. Coal south of Oatlands. *Tasmanian House of Assembly and Legislative Council Paper* 18: 5 pp.

Guilbault, J. P., and B. L. Mamet, 1976. Codiacées (algues) ordoviciennes des Basses-Terres du Saint-Laurent. *Canadian Journal of Earth Science* 43: 636-660.

Halle, T. G., 1913. Some Mesozoic plant-bearing deposits in Patagonia and Tierra del Fuego, and their floras. *Kungliga Svenska Vetenskaps-Akademien Handlingar* 50: 1-58.

Harland, W. B.; C. H. Holland; M. R. House; N. F. Hughes; A. B. Reynolds; M. J. S. Rudwick; G. E. Satterthwaite; L. B. H. Tarlo; E. C. Willey, 1967. *The Fossil Record: A Symposium with Documentation.* Geological Society of London: London.

Harris, T. M., 1932. The fossil flora of Scoresby Sound, East Greenland. Part 2. Descriptions of seed plants *incertae sedis,* together with a discussion of certain cycadophyte cuticles. *Meddelelser øm Grønland* 85(3), pp. 112.

——— 1937. The fossil flora of Scoresby Sound, East Greenland. Part 5. Stratigraphical relation of the plant beds. *Meddelelser øm Grønland* 112(2), pp. 114.

——— 1961. *The Yorkshire Jurassic Flora. I. Thallophyta, Pteridophyta.* British Museum of Natural History, London.

Herak, M., V. Kochansky-Devidé, and I. Gušić, 1977. The development of dasyclad algae through the ages. *In* Flügel (Ed.): *Fossil algae: Recent Results and Developments,* pp. 143-153. Springer Verlag, Berlin.

Herbst, R., 1971. Revision de las especies argentinas del genero *Cladophlebis. Ameghiniana* 8: 265-281.

——— 1978. Revison de las especies australasicas de *Cladophlebis. Facena Corrientes* 2: 3-28.

Hill, D., G. Playford and J. T. Woods, 1965. *Triassic Fossils of Queensland.* Queensland Palaeontographical Society, Brisbane.

Høeg, O. A., 1937. *Callisphenus gracilis* n. gen. et n. sp., fossil alga from the Wenlock of the Oslo region. *Norsk Geologisk Tidsskrift* 17: 43-45.

Houston, B. R., 1967. Geology of the city of Brisbane. *Publications of the Geological Survey of Queensland* 324, pp. 86.

Jain, R. K., and T. Delevoryas, 1964. A Middle Triassic flora from the Cacheuta Formation, Minas de Petroleo, Argentina. *Palaeontology* 10: 564-589.

Johnson, J. H., 1961. *Limestone Building Algae and Algal Limestones.* Colorado School of Mines, Boulder.

——— 1963. Pennsylvanian and Permian algae. *Quarterly of the Colorado School of Mines* 58(3), pp. 211.

——— 1964. The Jurassic algae. *Quarterly of the Colorado School of Mines* 59(2): pp. 129.

Johnston, R. M., 1887. Fresh contribution to our knowledge of the plants of Mesozoic age in Tasmania. *Papers and Proceedings of the Royal Society of Tasmania* for 1886: 160-179.

——— 1888. *The Geology of Tasmania.* Government Printer, Hobart.

Jones, O. A., and N. J. de Jersey, 1947. The flora of the Ipswich Coal Measures — morphology and floral succession. *Papers of the Department of Geology, University of Queensland* 3(3), pp. 88.

Kawasaki, S., 1925. Some older Mesozoic plants in Korea. *Bulletin of the Geological Survey of Chosen* 4(1), pp. 71.

Kimura, T., 1976. Mesozoic plants from the Yatsushino Formation (Albian), Kumamoto Prefecture, Kyushu, southwest Japan. *Bulletin of the National Science Museum, Tokyo* C2: 179-208.

Konishi, K., 1961. Studies of Palaeozoic Codiaceae and allied algae. Part 1. Codiaceae (excluding systematic descriptions). *Science Report of Kanazawa University* 7: 159-261.

Konishi, K., and J. L. Wray, 1961. *Eugonophyllum,* a new Pennsylvanian and Permian algal genus. *Journal of Palaeontology* 35: 659-666.

Kozlowski, R., and J. Kaźmierczak, 1968. On two Ordovician calcareous algae. *Acta Palaeontologica Polonica* 13: 325-341.

Lacey, W. S., 1976. Further observations on the Molteno flora of Rhodesia. *Arnoldia* 7: 1-14.

Lebedev, E. L., 1965. Pozdneyurskaya flora reki zei i granitsa yury i mela (The Late Jurassic flora of the Zeia River and the Jurassic-Cretaceous boundary). *Trudy Institut Geologicheskii Akademia Nauk S.S.S.R.* 125, pp. 142.

Lee, R. E., 1980. *Phycology.* Cambridge University Press, Cambridge.

Li, X., and Z. Yao, 1982. A review of recent research on the Cathaysia flora in Asia. *American Journal of Botany* 69: 479-486.

Lucas, A. H. S., 1936. *The Seaweeds of South Australia. Part II. Introduction and the Green and Brown Seaweeds,* Government Printer, Adelaide.

McQueen, D. R., 1956. Leaves of Middle and Upper Cretaceous pteridophytes and cycads from New Zealand. *Transactions of the Royal Society of N.Z.* 83. 673-685.

Menendez, C. A., 1951. La flora mesozoica de la Formacion Llantenes. *Revista del Instituto National de Investigacion de las Ciencias Naturales Anexo al Museo Argentino de Ciencias Naturales "Bernadino Rivadavia", Ciencias Botanicas* 2: 147-261.

Milligan, J., 1851. Richmond and Jerusalem. *Papers and Proceedings of the Royal Society of Van Diemens Land* 1: 67-81.

Morris, J., 1843. Fossil flora. *In* P. E. Strzelecki, *Physical Descriptions of New South Wales and Van Diemens Land,* pp. 245-250. Brown, Green and Longmans, London.

Nizamuddin, M., 1964. Phylogenetic position of Siphonocladales. *Transactions of the American Microscopical Society* 83: 282-290.

Oishi, S., 1940. The Mesozoic floras of Japan. *Journal of the Faculty of Science, Hokkaido Imperial University, 4th Series, Geology and Mineralogy* 5: 123-180.

Oishi, S., and K. Huzioka, 1938. Fossil plants from Nariwa. A supplement. *Journal of the Faculty of Sciences, Hokkaido Imperial University, 4th Series, Geology and Mineralogy* 4: 69-101.

Pantic, S., 1971. *Baccanella floriformis* n. gen. et n. sp., from the Middle Triassic of the Dinarids. *Bulletin Scientifique du Counseil des Academies des Sciences et des Arts de la R.S.F. de Yougoslavie* A16: 269-271.

Pickett-Heaps, J. D., and J. H. Marchant, 1972. The phylogeny of green algae: a new proposal. *Cytobios* 6: 225-264.

Peking Institute of Botany and Nanking Institute of Geology and Palaeobotany, 1974. *Paleozoic Plants of China.* Science Press, Peking.

Petriella, B., 1980. Sinopsis de las Corystospermaceae (Corystospermales, Pteridospermophyta) de Argentina. II. Estructuras fertiles. *Ameghiniana* 17: 168-180.

Retallack, G. J., 1977. Reconstructing Triassic vegetation of eastern Australasia: a new approach for the biostratigraphy of Gondwanaland (with an 86 frame microfiche appendix). *Alcheringa* 1: 247-277.

——— 1979. Middle Triassic coastal outwash plain deposits in Tank Gully, New Zealand. *Journal of the Royal Society of N.Z.* 9: 397-414.

——— 1980. Middle Triassic megafossil plants and trace fossils from Tank Gully, Canterbury, New Zealand. *Journal of the Royal Society of N.Z.* 10: 31-63.

——— 1981. Middle Triassic megafossil plants from Long Gully, near Otematata, north Otago, New Zealand. *Journal of the Royal Society of N.Z.* 11: 167-200.

——— 1983. Middle Triassic estuarine deposits near Benmore Dam, southern Canterbury and northern Otago, New Zealand. *Journal of the Royal Society of N.Z.* 13: 107-127.

Retallack, G. J., R. E. Gould and B. Runnegar, 1977. Isotopic dating of a Middle Triassic megafossil flora from near Nymboida, northeastern New South Wales. *Proceedings of the Linnaean Society of New South Wales* 101: 77-113.

Retallack, G. J., and R. J. Ryburn, 1982. Middle Triassic deltaic deposits in Long Gully, near Otematata, north Otago, New Zealand. *Journal of the Royal Society of N.Z.* 12: 207-227.

Rühle von Lilienstern, H., 1931. Über *Chiropteris. Paläontologische Zeitschrift* 13: 253-277.

——— 1932. Nachtrag zu meiner Arbeit über *Chiropteris* Kurr. *Paläontologische Zeitschrift* 14: 229-232.

Sahni, B., and A. R. Rao, 1933. On some Jurassic plants from the Rajmahal Hills. *Journal of the Asiatic Society of Bengal* 27: 183-208.

Seward, A. C., 1900. *The Jurassic Flora. I. Catalogue of the Mesozoic Plants in the Department of Geology, British Museum.* British Museum of Natural History, London

——— 1903. Fossil floras of the Cape Colony. *Annals of the South African Museum* 4: 1-122.

——— 1904. On a collection of Jurassic plants from Victoria. *Records of the Geological Survey of Victoria* 1: 155-187.

——— 1910. *Fossil Plants. Volume II. Sphenophyllales (Cont.), Psilotales, Lycopodiales, Filicales, Pteridosperms (Incertae Sedis).* Cambridge University Press, Cambridge.

——— 1917. *Fossil Plants. Volume III. Pteridospermeae, Cycadofilicales, Cordaitales, Cycadophyta.* Cambridge University Press, Cambridge.

Shirley, J., 1898. Additions to the fossil flora of Queensland. *Bulletin of the Geological Survey of Queensland* 7: 9-25.

Shu, Y. K., 1964. Greywacke structure and petrography around Benmore Dam, north Otago. Unpublished B.Sc. Honours thesis, University of Otago.

Solms-Laubach, H. G., 1899. Das Auftreten und die Flora der rhätischen Kohlenschichten von La Ternera (Chile). 2. Beschreibung der Pflanzenreste von La Ternera. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie BeilageBand* 12: 593-608.

Stipanicic, P. N., 1969. Las sucesiones triásicas argentinas. *In* A. J. Amos (Ed.): *Gondwana Stratigraphy, Proceedings of the 1st I.U.G.S. Gondwana Symposium, Buenos Aires,* pp. 1121-1149. U.N.E.S.C.O., Paris.

Stipanicic, P. N., and M. I. R. Bonetti, 1969. Consideraciones sobre la cronologia de los terrenos triásicos argentinas. *In* A. J. Amos (Ed.): *Gondwana Stratigraphy, Proceedings of the 1st I.U.G.S. Gondwana Symposium, Buenos Aires,* pp. 1081-1119. U.N.E.S.C.O., Paris.

Thomas, H. H., 1933. On some pteridospermous plants from the Mesozoic rocks of South Africa. *Philosophical Transactions of the Royal Society of London* B222: 193-265.

Thomas, H. H., and M. N. Bose, 1955. *Pachydermophyllum papillosum,* gen. et sp. nov. from the Yorkshire Jurassic. *Annals and Magazine of Natural History, London* 12: 535-543.

Townrow, J. A., 1956. The genus *Lepidopteris* and its southern hemisphere species. *Avhandlinger Utgitt av Det Norske Videnskaps-Akademi i Oslo* 1: 1-28.

Townrow, J. A., 1957. On *Dicroidium,* probably a pteridospermous leaf and other leaves now removed from this genus. *Transactions of the Royal Society of South Africa* 60: 21-60.

——— 1960. The Peltaspermaceae, a pteridosperm family of Permian and Triassic age. *Palaeontology* 3: 333-361.

——— 1962. On *Pteruchus,* the microsporophyll of the Corystospermaceae. *Bulletin of the British Museum of Natural History, Geology* 6: 285-316.

——— 1965. A new member of the Corystospermaceae. *Annals of Botany* 29: 495-511.

——— 1966a. On *Dicroidium odontopteroides* and *D. obtusifolium* in Tasmania. *In* K. R. Surange (Ed.): *Symposium on Floristics and Stratigraphy of Gondwanaland,* pp. 124-136. Birbal Sahni Institute for Palaeobotany, Lucknow.

——— 1966b. On *Lepidopteris madagascariensis* Carpentier (Peltaspermaceae). *Journal and Proceedings of the Royal Society of New South Wales* 98: 203-214.

Wagner, R. H., 1958. *Lobatopteris alloiopteroides,* una nueva especie de Pecopteridea del Estefaniense a l'Espanõl. *Estudios Geológicos* 14(38): 81-106.

——— 1968. Upper Westphalian and Stephanian species of *Alethopteris* from Europe, Asia Minor and North America. *Mededelingen van de Rijks Geologische Dienst, Serie C,* III, 1(6): pp. 318.

Walkom, A. B., 1924. On fossil plants from Bellevue, near Esk. *Memoir of the Queensland Museum* 8: 77-92.

——— 1925a. Notes on some Tasmanian Mesozoic plants. Part I. *Papers and Proceedings of the Royal Society of Tasmania* for 1924: 73-89.

——— 1925b. Notes on some Tasmanian Mesozoic plants. Part II. *Papers and Proceedings of the Royal Society of Tasmania* for 1925: 63-74.

——— 1925c. Fossil plants from the Narrabeen Stage of the Hawkesbury Series. *Proceedings of the Linnaean Society of New South Wales* 50: 214-224.

——— 1928. Fossil plants from the Esk district, Queensland. *Proceedings of the Linnaean Society of New South Wales* 53: 458-468.

Walton, J., 1936. On the factors which influence the external form of fossil plants; with descriptions of the foliage of some species of the Palaeozoic equisetalean genus *Annularia* Sternberg. *Philosophical Transactions of the Royal Society of London* B226: 219-237.

Wray, J. L., 1977. *Calcareous Algae.* Elsevier, Amsterdam.

Zalessky, M. D., 1939. Végétaux permiens du Bardien de l'Oural. *Problemi paleontologii Moskva* 5: 329-374.

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