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# REVISION OF THE TALBRAGAR FISH BED FLORA (JURASSIC) OF NEW SOUTH WALES

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## SUMMARY

The three well known form-species of the Talbragar Fish Bed Flora—*Podozamites lanceolatus*, *Elatocladus planus* and *Taeniopteris spatulata*—are redescribed as *Agathis jurassica* sp. nov., *Rissikia talbragarensis* sp. nov. and *Pentoxylon australica* sp. nov. respectively. The minor components of the assemblage are described and illustrated, and in some cases, reclassified. Additions are made to the list of plants recorded from the horizon.

## INTRODUCTION

The Talbragar Fish Beds are characterised by their beautifully preserved fish and plant remains which occur in great profusion throughout the shale lens which comprises the Beds. The ochre-coloured shale is ferruginous, with impressions of plants and fish, white in colour, standing out dramatically. The weathering of the outer layers of blocks of the shale has resulted in contrasting bands of iron-rich stain framing many of the specimens and enhancing their appearance. Specimens are much prized by collectors.

The fossil locality is the valley of the Talbragar River, about twenty miles due North of Home Rule Mine in the Cassilis District, "on the southern boundary of Boyce's selection" (Anderson 1889). Foldvary (1979) describes the locality as the northern slopes of Farris Hill, North East of Gulgong.

The Talbragar Fish Beds are considered to be Early to Middle Jurassic in age (Hind and Helby, 1969 in Geology of New South Wales). Dr P. R. Evans of the University of New South Wales kindly undertook a palynological examination of samples submitted by the author, but was unfortunately not able to obtain any diagnostic spores.

The Fish Beds were discovered by Mr A. Lowe of Wilbertree in 1889. The Geological Surveyor of the New South Wales Mines Department, Mr William Anderson, described his visit to the site in that year (Anderson 1889) and remarked on the very large numbers of specimens which were awaiting transportation. These specimens, obtained from the splitting up of the oblong or square blocks of shale "which lay scattered over the surface of the hill", and not from excavating the underlying beds of the hill, are the Cullen Collection. The many thousand specimens of this first collection are held by the Mining Museum, Sydney, and until recently were stored in their original crates at the Mines Department Depot at Londonderry. The contents of the crates had been superficially examined once (one crate by Mining Museum staff and three by The Australian Museum), since the specimens were packed away in 1890. At the time of their crating, they had been briefly examined by Mr W. S. Dun, Assistant Palaeontologist (a cadet at the time) and by Mr R. Etheridge Jr., the Government Palaeontologist. A selection of specimens, representing all the fish species present, was sent to Mr A. Smith Woodward at the British Museum, and resulted in his monograph on the fish (Woodward, 1895). A small number

of specimens containing all the plant species were also selected, and a plant list was published by Etheridge in 1889. Walkom, 1921, wrote his account of the Talbragar flora from a study of these specimens.

As a result of the first brief inspection of the specimens at Londonberry in 1978 by Dr A. Ritchie, Dr R. Molnar and the author at the start of this revision, a request was made for further study of the collection. Dr J. Pickett, Principal Research Officer of the Mining Museum, kindly arranged for the specimens to be brought back to Sydney and supplied facilities for their examination. The collection is now housed at the Mining Museum and two hundred of the best plant specimens have been registered.

When the (approximately) five thousand specimens of the Cullen Collection were closely examined, a count was made to show the relative proportions of the components of the flora. (The specimens reported on by Walkom were added into the tally.) As "*Podozamites lanceolatus*" occurs as foliage spurs of several leaves and a twiglet, an occurrence of the species was recorded for each twiglet or recognisable fragment of such. Single leaves were not recorded. For "*Taeniopteris spatulata*" the unit was single leaves or reasonable sized fragments of leaves. All recognisable fragments of other components of the flora were recorded.

On this somewhat arbitrary basis, there were 1300 occurrences of "*Podozamites*" and 1060 of "*Taeniopteris*". The relative rarity of "*Elatocladus*" with only 75 occurrences was surprising. (The Museum collections of The Australian Museum and the Mining Museum had been made by selecting specimens to show the different components of the flora from collections other than the Cullen. The impression thus gained was that "*Elatocladus*" was second in dominance to "*Podozamites*", instead of a relatively rare member of the flora.) Pteridosperm leaves of the *Pachypteris crassa* and "*Thinnfeldia pinnata*" type together numbered 300 occurrences. Fifteen conifer fragments of *Allocladus milneanus* type and only 9 of the *Allocladus cribbii* (*Brachyphyllum*) type, show the rarity of the lesser conifers in the assemblage. There were 27 occurrences of *Coniopteris hymenophylloides* (mostly small fragments) and only ten of *Cladophlebis australis*. Only one frond of *Nilssonia compta* was found, and one specimen with branchlets of a *Selaginella*.

The reproductive structures found were six large *Agathis* ("*Podozamites*") cone scales, five young *Agathis* cones and two pollen cones — a total of thirteen structures relating to the 1300 occurrences of "*Podozamites*". There were six *Pentoxylon* female cones (*Carnoconites*) and two groups of microsporangia presumably of *Pentoxylon*, making eight structures relating to the 1060 occurrences of "*Taeniopteris*". There was one cone fragment (and counterpart) of the *Rissikia* type relating to the 75 occurrences of "*Elatocladus*", and one group of detached seeds of the sort borne by *Rissikia talbragarensis*.

In all the specimens examined, there was no fragment which could be indentified as of insect origin, and the only insect found to date in the Talbragar Fish Beds is "*Cicada lowei* Etheridge" which was found in a specimen from the Cullen Collection in 1890 (Etheridge and Olliff, 1890).

From this analysis of the relative proportions of the species comprising the vegetation at Talbragar in Jurassic times, a clear picture emerges, of a lake containing many fish in an area of "Kauri Pine" forest. Numerous smaller trees of *Pentoxylon* grew interspersed in the forest (in much the same way as *Banksia* trees today form a lower tree zone below eucalypts) with occasional scattered trees of "*Elatocladus*" and podocarpaceous conifers, and with a heath zone surrounding the lake composed of

*Pachypteris* type Pteridosperms. A few ferns and rare cycads grew in suitable places in the forest and the lake surrounds. "*Cicada lowei*" presumably stridulated loudly in the trees at certain seasons.

#### GENERAL DISCUSSION OF THE TALBRAGAR FISH BED FLORA

##### 1. "*Podozamites lanceolatus* L. & H."

The dominant plant is "*Podozamites lanceolatus*", the name used by Dun and retained by Etheridge in 1889. Walkom (1921) continued the use of this name when he wrote the first detailed account of the Talbragar Flora. It is most unfortunate that this name was ever used, as it was not acceptable. The specimens described and illustrated by Lindley and Hutton (1836) from the Jurassic of Great Britain as *Podozamites lanceolatus* are superficially similar to the Talbragar material, but Lindley and Hutton's species was a cycad as the name implied, and it is quite clear from their descriptions and illustrations that the pinnae were arranged in two ranks in cycad fashion, attached to the sides or possibly the top of the rachis. The Talbragar specimens clearly show a spiral phyllotaxy of leaves, not pinnae, and the characteristic branchlets with numerous leaves of different sizes are obviously foliage spurs which abscised readily from the plant. They are clearly not pinnate cycad fronds. Dun and Etheridge should have referred the specimens to the conifer genus *Albertia* which had been described by Schimper in 1874 in a treatise available to them at the time, or to another conifer genus.

When Walkom reviewed the plants in 1921, he would have had Seward's (1900) revision of *Podozamites lanceolatus* available to him, and should have been aware that the attachment of the pinnae and their arrangement was stressed, indicating cycad affinity. Walkom did recognise that the Talbragar Specimens were most probably conifer foliage, and he should have corrected the mistake and renamed them accordingly. Florin (1940) in his review of Southern conifers, suggested that "*Podozamites lanceolatus*" in the Australian Jurassic was probably podocarpaceous. Townrow's (1967 a, b) revision of conifers, including some Talbragar species, does not touch on *Podozamites*.

Present day limited usage of *Podozamites* Braun 1843 as a form genus for detached conifer foliage, in which the leaves look like individual pinnae of *Zamites*, continues. In Laurasia, cones are known in association with leaves of this sort, which are invariably detached; never in foliage spur arrangement. The cones are *Cycadocarpidium* and *Swedenborgia* type. In South Africa, Anderson (1978) has just described a new cone *Telemachus* associated with leaves of "*Phoenicopsis elongatus* (Morris) Seward 1903", which is now referred to *Podozamites elongatus*. Thus it is no more appropriate to classify the Talbragar specimens in *Podozamites* as it is now defined, than it was to place them in *Podozamites lanceolatus* originally.

A review of living conifers and some study of specimens in the National Herbarium and of trees growing in the Royal Botanic Gardens, Sydney, was undertaken as a preliminary to revising the Talbragar gymnosperms. Although in leaf shape there are podocarpaceous genera which resemble "*Podozamites lanceolatus*", all are characterised by a prominent midrib. It is with *Agathis* that the greatest affinity exists.

The Talbragar material not only shows a full range of leaf size and form all consistent with *Agathis*, but the deciduous foliage spurs are also diagnostic of the genus, and the only reproductive structures which can be related to the foliage are young female cones of Araucarian type (*Agathis* is Araucarian) and cone scales undeniably of *Agathis*. Prior to this investigation, Walkom (1921) had described a "young Araucarian cone" (his Fig. 6, Plate 6), and several more have now been discovered. *Agathis* trees growing in the

Botanic Gardens in Sydney have numerous aborted female cones in the litter of foliage spurs beneath them, and only a few mature cone scales are interspersed. (See Figure 20 A, B.) Only relatively few female cones reach maturity and these explode into component scales on impact with the ground when knocked down as they are borne at considerable heights, or they shed the scales gradually while still attached to the tree.

The first mature cone scale found in the Talbragar Fish Beds was described by Walkom (1921) as *Araucarites grandis*. Although obviously Araucarian, it differs from the other relatively common type found in this investigation and recognised as belonging with the *Agathis* foliage. At this stage of knowledge, it is considered to be a varietal form. (As the "*Elatocladus planus*" foliage and the lesser conifers of the assemblage are regarded as podocarpaceous, its affinities are also almost certainly with the *Agathis* foliage.)

"*Podozamites lanceolatus* L. & H." is redescribed as *Agathis jurassica* sp. nov. It is not possible to call it *Agathis lanceolatus* as there is a living species with that name.

## 2. "*Elatocladus planus* (Feist.)"

Conifer foliage with long, linear leaves with prominent midribs, attached spirally, was referred to the form species *Elatocladus planus*. Walkom (1921) states "these plants form a large proportion of the Talbragar collections" as he was not aware of how much selection had been done in the assembling of the small collection of representative plants. In his review, Townrow (1967b) retained the Talbragar specimens in the form species because he had no additional evidence of cuticle structure or related fructifications, other than the fragmentary "? Cone fragments" which he mentions (p.121). He stated, however, that there was some overlap with his genus *Rissikia* and that several true species might be represented by the "*Elatocladus planus*" he re-defined.

The discovery of a magnificent cone (Figure 26) in a specimen recently bought by the Museum from a private collection has enabled the determination of *Elatocladus planus* foliage as a podocarpaceous conifer. There are foliage leaves attached to the base of the cone, so the relationship of cone and leaves is positively identified. It was the acquisition of this cone which prompted the examination of all available specimens from Talbragar to look for fragmental evidence related to it, as it is a perfect, virtually complete specimen, and there had never been any suggestion of such a fructification by seeds, scales or fragments. Only one cone fragment and one specimen with loose seeds were discovered in this investigation.

The cone is an elongated, cylindrical structure made up of units each composed of a bract with a scale in its axil, and a reflexed ovule borne on the scale. Thus in essence it is of the same general structure as *Rissikia* (Townrow 1967b). The bracts are prominent and leafy, unlike the reduced, trifid structures in *Rissikia*. Bearing in mind the amount of variation in structures of cones which is tolerated within a genus of living conifers like *Podocarpus* (see Bucholtz and Gray 1948 and Gray, 1953), it is considered preferable at this stage to describe the Talbragar cone as a new species of *Rissikia* and not to create another new genus. No firm conclusions can be reached on whether all the foliage types are one species.

The name *Rissikia talbragarensis* sp. nov. is given to the cone and the attached leaves, and to some part (still undefined) of the "*Elatocladus planus*" form species foliage associated with it in the Talbragar Fish Beds fossil horizon.

### 3. "*Taeniopteris spatulata* McClelland"

The second commonest foliage in the Fish Beds is long, narrow, taeniopteroid leaves which are referable to the form species *Taeniopteris spatulata*.

Walkom (1921, Figs. 4, 4a, 7; Plate 6) illustrated as "?cones", two of the very rare examples of casts of cone-like bodies. The specimen in his Figs. 4, 4a unfortunately cannot be found at the Mining Museum. The one which is illustrated in Walkom's Figure 7 was cleaned and a latex mould was made from it. The result was a perfect fructification, which is illustrated in Figure 37 of this paper. A slender axis bears a number of sessile, ridged seeds in four alternating whorls of five. This is a *Carnoconites* type fructification (Srivastava 1946), and its discovery is very exciting as it enables the determination of the leaves of *Taeniopteris spatulata* and the fruit as *Pentoxylon*. Two further examples of fructifications of this sort were found during this investigation, and a new species *Pentoxylon australica* is made.

The Pentoxylaceae were described from the Jurassic Rajmahal Series in India. (Sahni, 1948; Vishnu-Mittre 1958; Pant, 1957). *Pentoxylon* silicified wood, *Taeniopteris spatulata* type leaves and *Carnoconites* cones were shown to belong together. In 1962, Harris described a new species of *Carnoconites* from New Zealand, also with *Taeniopteris spatulata* type leaves, so the discovery of *Pentoxylon* in Australia has been expected.

Wood of *Pentoxylon* type occurs in Australia. A silicified stem was recently acquired by The Australian Museum and it appeared to be of this type. It was sent to Dr. R. Gould at Armidale University for further study and he (pers. comm.) confirms that it is of the same sort as that described from India.

Thus, the three best known form species of the Talbragar Fish Bed Flora, "*Podozamites lanceolatus*", "*Elatocladus planus*", and "*Taeniopteris spatulata*" are all assigned to their appropriate botanical classifications on factual information, and are removed from the form genera to which they had originally been referred.

Detailed examination of so much material in connection with the revision of the three species has resulted in elucidation of new facts about lesser components of the flora. Walkom's "*Brachyphyllum*" conifer, which was redescribed by Townrow as *Allocladus cribbii*, is shown to be podocarpaceous. His "*Pagiophyllum peregrinum*" was identified by Townrow as *Allocladus milneanus*. No attempt has been made in this revision to deal with the Pteridosperms as they were revised by Townrow (1965). Some additions are made to the list of species identified by Walkom, and a complete new list of the flora and fauna of the Fish Beds is given below:

#### SPECIES COMPRISING THE FLORA OF THE TALBRAGAR FISH BEDS

1. *Agathis jurassica* sp. nov. Foliage "*Podozamites lanceolatus* L. & H." Young female cones, mature cone scales, male pollen cones. Araucariaceae.
2. *Rissikia talbragarensis* sp. nov. Foliage, female cone. Podocarpaceae. Foliage of "*Elatocladus planus*" form species type.
3. *Pentoxylon australica* sp. nov. Foliage, female fructifications, groups of male microsporangia. Leaves of "*Taeniopteris spatulata*" form species type. Pentoxylaceae.
4. *Allocladus cribbii* Townrow. Foliage and cones. Podocarpaceae.

5. *Allocladus milneanus* (Ten. Woods). Townrow. Foliage. Podocarpaceae.
6. *Elatocladus australis* (Freng.) Foliage. Podocarpaceae.
7. *Nilssonia compta* (Phill.) Harris. Nilssoniaceae. (Cycadales).
8. *Selaginella* sp. Selaginellaceae (Lycopodiales).
9. *Onychiopsis* sp. Fern fragment.
10. *Cladophlebis australis* (Morr.) Fern fragments.
11. *Coniopteris hymenophylloides* Bgt. Fern fronds. Dicksoniaceae.
12. *Pachypteris crassa* Townrow. Pteridosperm fronds.
13. "*Thinnfeldia pinnata* Walkom (pars.)" Pteridosperm or fern fronds.

#### FAUNA OF THE TALBRAGAR FISH BEDS

Insecta: *Cicada lowei* Etheridge & Olliff 1890.

Fish: (Sherbon Hills, 1958)

*Coccolepis australis* Smith Woodward

*Uarbryichthys latus* Wade

*Aetheolepis mirabilis* Smith Woodward

*Aphnelepis australis* Smith Woodward

*Archaeomene tenuis* Smith Woodward

*Madariscus robustus* Smith Woodward

*Leptolepis talbragarensis* Smith Woodward

#### PALAEOBOTANY

##### 1. *Agathis jurassica* sp. nov.

Figures 1-15

Classification: (Arnold 1948)

Gymnospermophyta

Class. Coniferophyta

Order. Coniferales

Family. Araucariaceae

Genus. *Agathis*. Salisbury 1807

*Agathis jurassica* sp. nov.

Foliage:

"*Podozamites lanceolatus* L. & H."

Specimens AMF 59990, MMF 23682, AMF 59983

Female Cones:

*Agathis* cone scales. Specimens MMF 24075, 24123, 24076, 24074, 24077.

Scale in Fig. 13 lent by Mr R. Moffitt, private collection.

Immature female cones. AMF 59984, MMF 23943, 24080, 24135, 24079.

Male Cones:

Small, fragile pollen cones. MMF 24082, 24081.

Mature Female Cone Scale:

"*Araucarites grandis*" Walkom 1921. MMF 3170 = *Agathis jurassica* var *grandis* (Walkom) nov. comb.

a. Foliage

Leaves lanceolate, when mature between 4 and 7 cm long, maximum width between 0.5 and 0.75 cm, arranged in lax spiral on foliage spur branchlets with 20-40 leaves. Each leaf has 5-8 parallel veins.

The range of leaf form seen in the species is illustrated in Figures 1-4. The common forms are Figures 1, 2, 4 with wider leaves, but narrower types are part of a series and do not seem to represent a separate species. In counting occurrences of the foliage in the Cullen Collection, a note was kept of the narrowest leaves which are of "*Podozamites gracilis*" type (Fig. 3) and might represent a separate species. Only 14 of this sort were recorded. There may well be two varieties of the species, the one with consistently wider foliage which ranges to fairly narrow, and the other with "*gracilis*" foliage ranging into medium-wide. In view of the variation in cone scale type found, one considerably longer than wide (var. *grandis* (Walkom)), and the other ovate, there is some added suggestion that this may be so.

The very pronounced foliage spur nature of the branchlets makes their original inclusion in a species with cycad affinity the more surprising. Figures 2 and 4 show the swollen stem bases with scale leaves. Whether the spurs were shed annually as in the extant *Metasequoia*, or at longer intervals as in *Podocarpus imbricata*, another living conifer with deciduous spurs, is not known. The leaf spur arrangement with swollen stem bases is a feature of *Rissikia* (Townrow 1967b) and is also seen in "*Elatocladus planus*" from Talbragar, though as a less obvious character. The living species of *Agathis* growing in the Royal Botanic Gardens, Sydney, has a ground cover of shed spurs below them representing some of that year's new growth. They do not have swollen stem bases, and the bud scales from the overwintering bud remain loosely round the stem bases as the new shoot grows out through them in the spring.

#### b. Female Cones

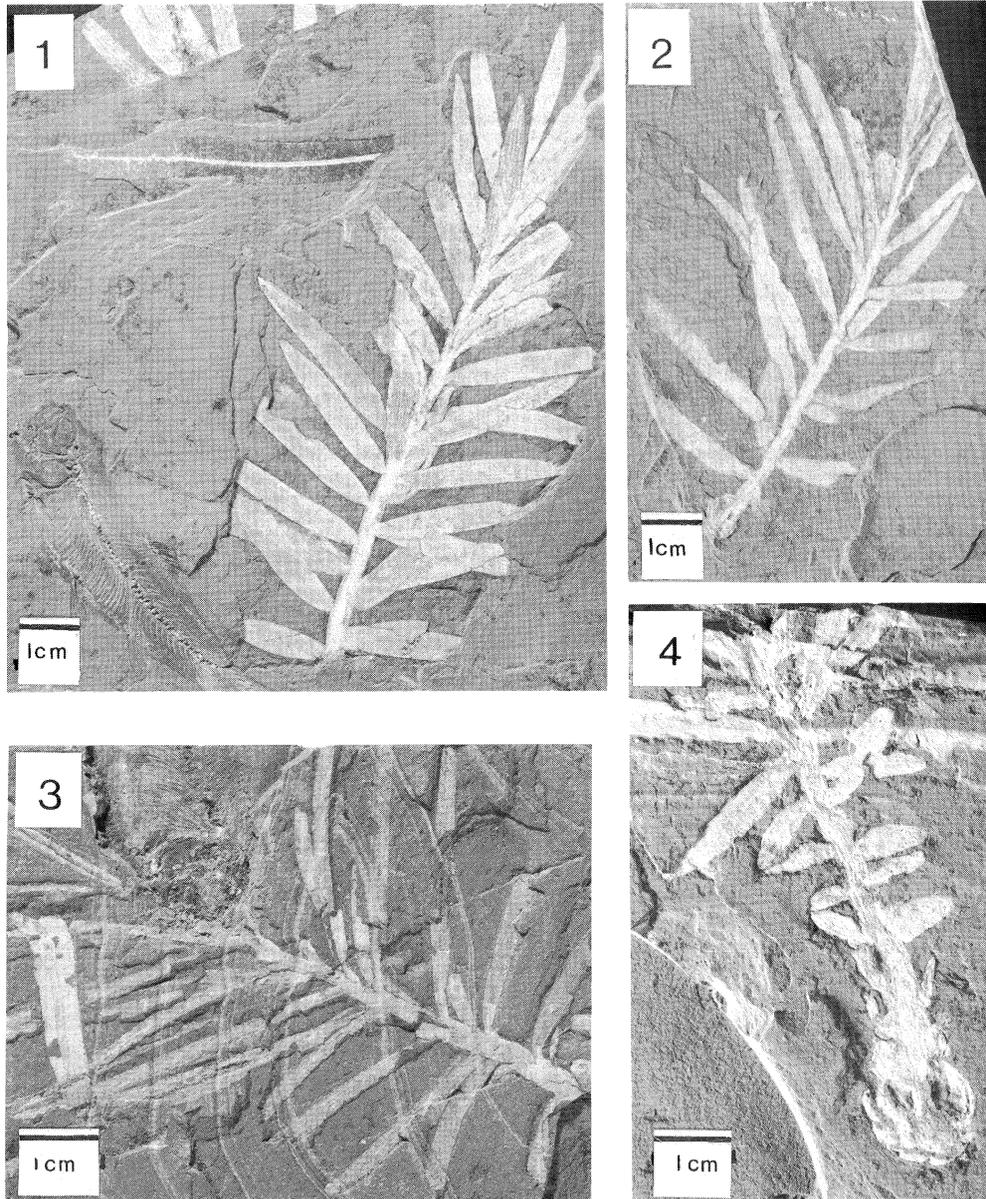
Walkom (1921, Fig. 8, Pl. 6) illustrated a young Araucarian cone. The specimen has been lost, but a similar one was found in The Australian Museum collection (AMF 59984, Fig. 7), and others were found in the Cullen Collection. (Specimens MMF 23943, 24080, 24079, 24135.) The cones are cylindrical, at least twice as long as they are wide. (Compare these cones with aborted cones of *Agathis robusta*, Figure 20 A,B.)

Walkom's mature cone scale "*Araucarites grandis*" has been cleaned, and is re-illustrated in Figure 5 (MMF 3170). It differs from the others found in this investigation in its proportions, being relatively long and narrow with a wide, wrinkled area between the seed indentation and the apical point of the scale. The other scales are much broader in proportion to their length, the apical point is less marked and, because they are relatively common, they are assumed to be the typical scales of *Agathis jurassica* and are so named (Fig. 6,10,11,13). Walkom's "*grandis*" type is retained as a variety — *Agathis jurassica* var. *grandis* (Walkom) nov. comb., applied only to the scales at this stage of knowledge.

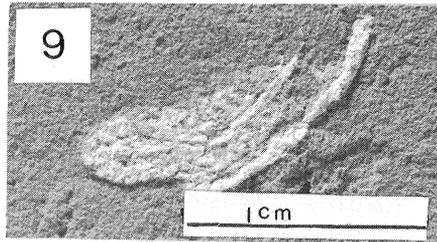
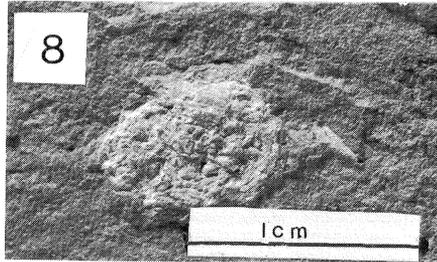
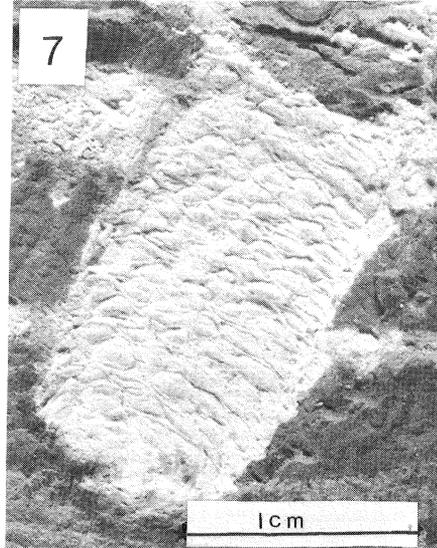
#### c. Male Cones

Two very delicate organs, believed to be male cones, are present on specimens MMF 24081 and 24082. Figure 9 illustrates one of them. They are poorly preserved but are obviously cones, and their delicate, papery texture is what would have been expected. There are also two examples of very small spherical cones found in the Cullen Collection. One is illustrated in Figure 8. They may be very young female cones, or could be male, and their affinities are not known.

A living *Agathis* (*A. robusta*) is illustrated in Figure 20 to show the foliage, the appearance of leafy branchlets, young and mature female cones, and cone scale and pollen cone.



Figures 1-4. *Agathis jurassica* sp. nov. Figs. 1 & 2. Foliage spurs. AMF 59990.  $\frac{1}{2}$  natural size. Fig. 3. "gracilis type" foliage. MMF 23682. Natural size. Fig. 4. Foliage spur. Enlarged stem base with scale leaves. AMF 59983. Natural size.



Figures 5-9. *Agathis jurassica* sp. nov. Fig. 5. "*Araucarites grandis* Walkom" MMF 3170. X3 = *Agathis jurassica* var. *grandis* (Walkom). Fig. 6. Cone scale. MMF 24075. X3. Fig. 7. Young cone. AMF 59984. X3. Fig. 8. Small cone. MMF 24073. X3. Fig. 9. Pollen cone. MMF 24082. X3.

The distribution of *Agathis* in the modern world is significant as it is a genus of Southern Hemisphere origin, extending marginally into the Northern Hemisphere in relatively recent times (Bucholtz 1948). "Kauri Pines" today occur in two areas in Queensland and otherwise are confined to the eastern Pacific, extending from the Philippines to New Zealand and from Malaysia to Fiji. In the Tertiary, a conifer referred to *Dammara* by Ettinghausen (1888) and now recognised as *Agathis* (Florin 1940) occurred throughout eastern Australia from north Queensland to Tasmania. Cone scales associated with *Dammara* leaves are clearly referable to *Agathis*. Figures 16-19 illustrate leaves and a cone scale of *Dammara intermedia* from the Vegetable Creek mine at Elsmore, N.S.W. These specimens were illustrated by Ettinghausen (1888, pl. 8, Figs. 34,35,36,38).

2. ***Rissikia talbragarensis* sp. nov.**

Figures 21 - 31

Classification: (Arnold 1948)

Gymnospermophyta.

Class. Coniferophyta

Order. Coniferales

Family. Podocarpaceae

Genus. *Rissikia* Townrow 1967

*Rissikia talbragarensis* sp. nov.

Foliage:

"*Elatocladus planus* (Feist) Townrow". Specimens MMF 23689, MMF 17857, AMF 38839, AMF 58289, AMF 59992.

Female Cone:

*Rissikia talbragarensis* sp. nov. AMF 59822, MMF 23946.

Seeds:

MMF 3151.

a. Foliage

The range of leaf form seen in the Talbragar material is shown in Figures 21 - 25. Complete foliage spurs are seen in Figures 21 and 25. Townrow retained the full range in *Elatocladus planus* but there may be more than one species involved.

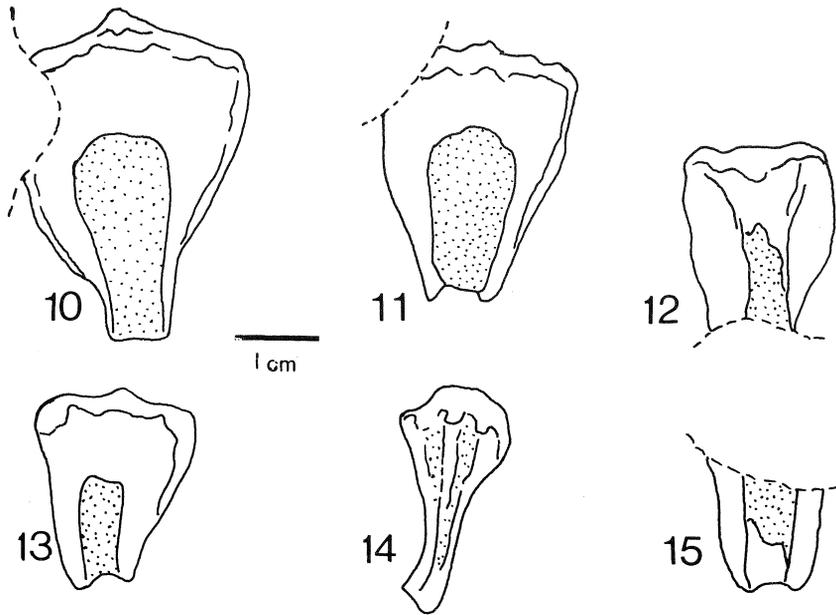
b. Seed Cone

The cone in Figures 26,27,28 has foliage leaves attached to it (L in Fig. 27), so that there is no doubt that the linear leaves with prominent midribs, which are indistinguishable from individual leaves of *Elatocladus planus*, belong to the cone.

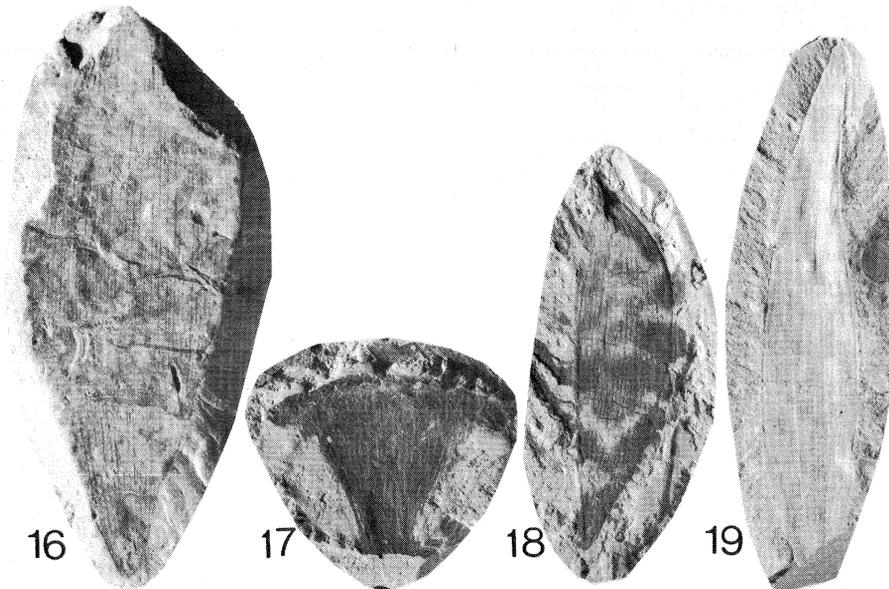
The cone is 12 cm long from its lowest seeds to its bluntly rounded apex. It has a stem 5.5 cm long and 0.4 cm wide from which two linear leaves arise at approximately 2 cm intervals. The maximum width of the cone is 2 cm. It tapers to 1 cm at its base, and approximately 1.5 cm at its apex. There are about thirty whorls of seeds, each measuring 3 mm by 2 mm, oval and reflexed with their micropyles towards the cone axis. The bracts are leafy with bluntly rounded apices. Preservation is not perfect and they may be lobed with the central part prominent and two lesser lobes flanking it.

A fragment of a cone found on specimen MMF 23946 (counterpart MMF 24134) is illustrated in Figure 29. It shows that the seed is borne on a scale. The scale is in turn borne in the axil of the leafy bract (Fig. 30).

Figure 31 shows specimen MMF 3151 in which loose seeds are present, of the type seen in the *Rissikia talbragarensis* cone.



Figures 10-15. Tracings of *Agathis jurassica* cone scales. Fig. 10. MMF 24075. Fig. 11. 24123. Fig. 12. MMF 24076. Fig. 13. R. Moffitt specimen. Fig. 14. MMF 24074. Fig. 15. MMF 24077.



Figures 16-19. *Dammara intermedia* Ettinghausen. Fig. 16. AMF 51216. Natural size. Fig. 17. AMF 51150. Natural size. Fig. 18. AMF 51139. Natural size. Fig. 19. AMF 51171. Natural size.

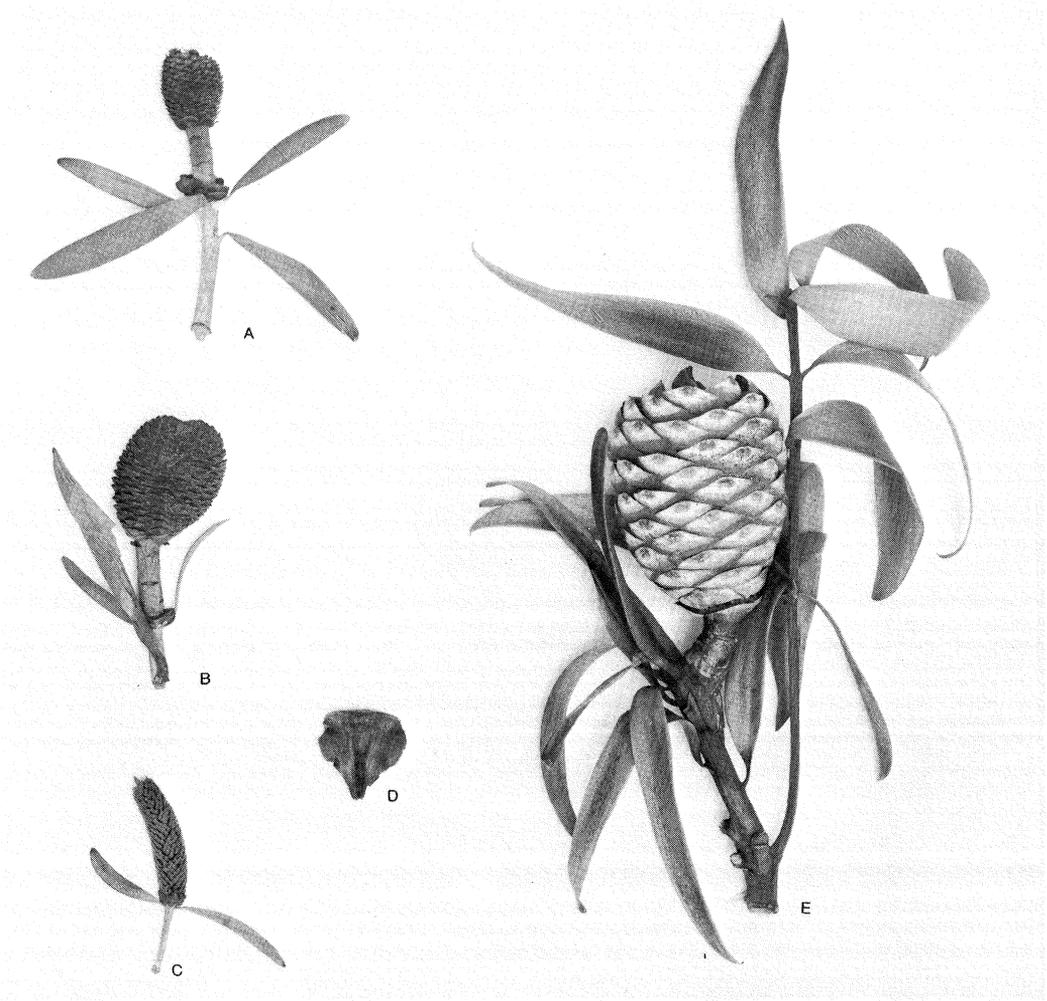


Figure. 20. A modern *Agathis* (*A.robusta*) to show foliage and cones. *A, B*, young female cones. *C*, pollen cone, *D*, female cone scale *E*, foliage and mature female cone.

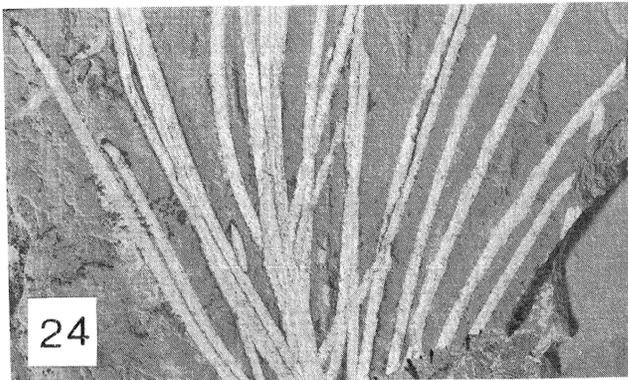
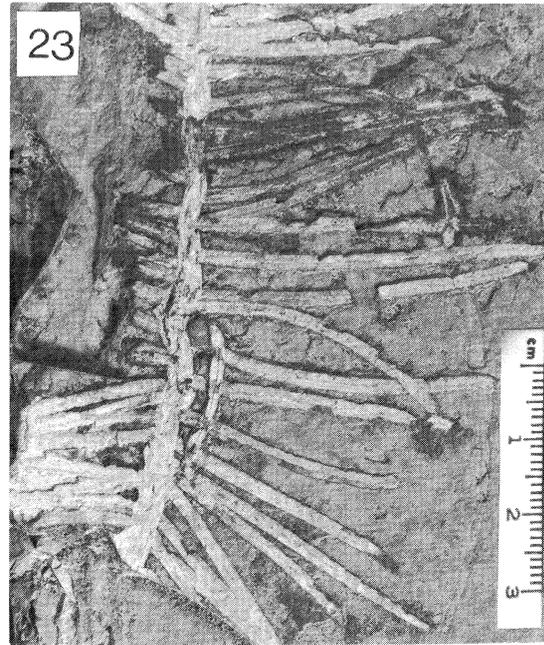
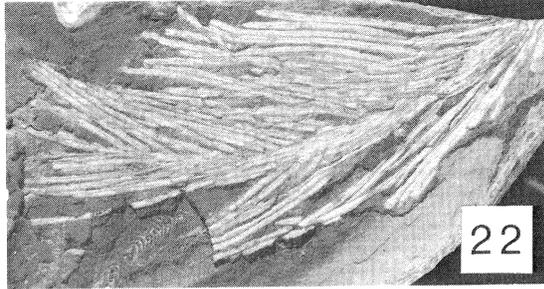
3. ***Pentoxylon australica*** sp. nov.  
 Figures 32 - 43

Classification: (Pant 1957)  
 Division. Cycadophyta  
 Class. Pentoxylopsida  
 Order. Pentoxylales

*Pentoxylon australica* sp. nov.

Leaves:

*Taeniopteris spatulata* McClelland. Known from impressions only. Specimens AMF 38831, 58454, 59994, 16443.



Figures 21-25. *Rissikia talbragarensis* sp. nov. foliage. Fig. 21. MMF 23689. Natural size. Fig. 22. AMF 38839. Natural size. Fig. 23. AMF 58289. Natural size. Fig. 24. MMF 17857. Natural size. Fig. 25. AMF 59992. Natural size.

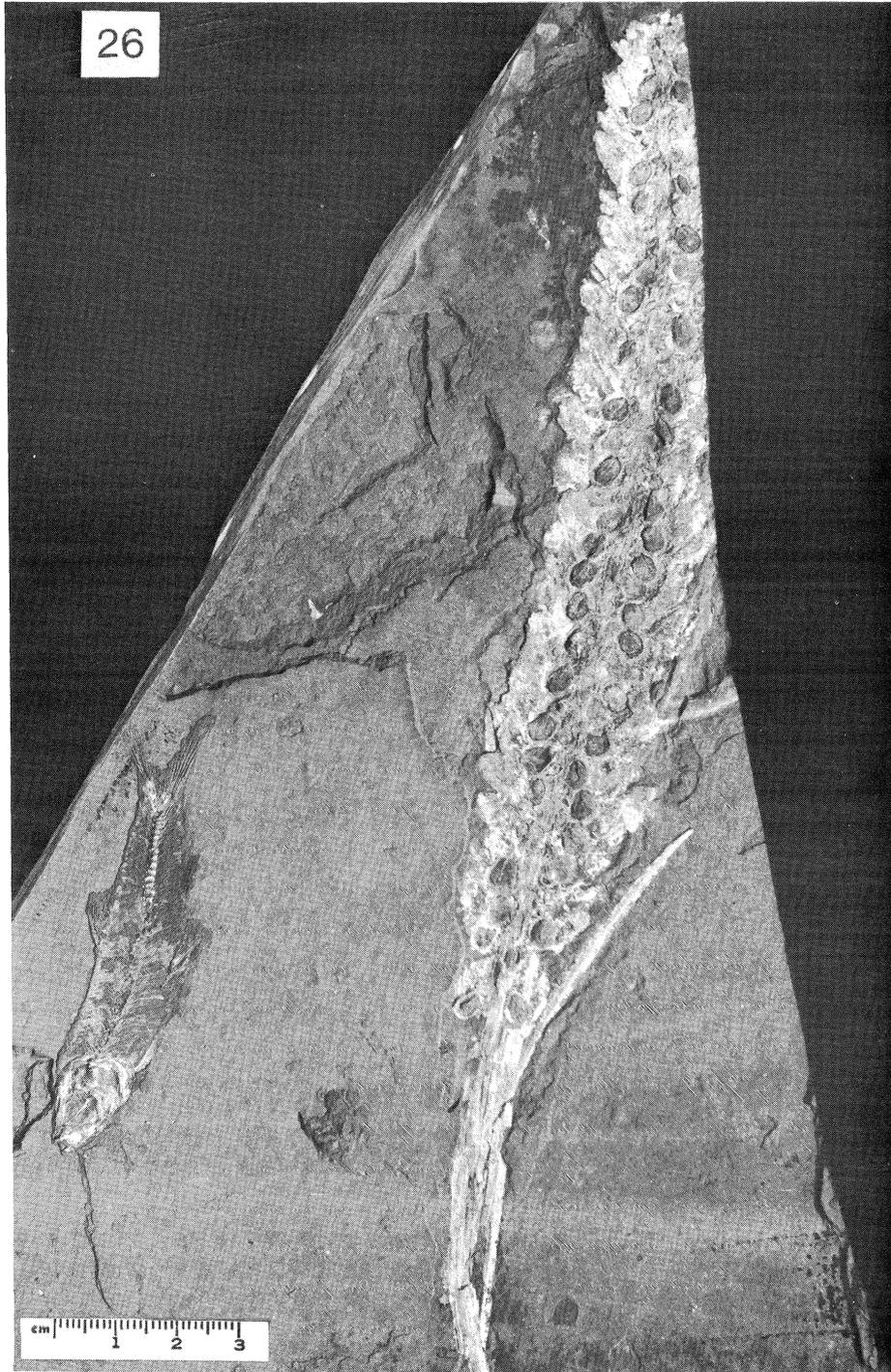
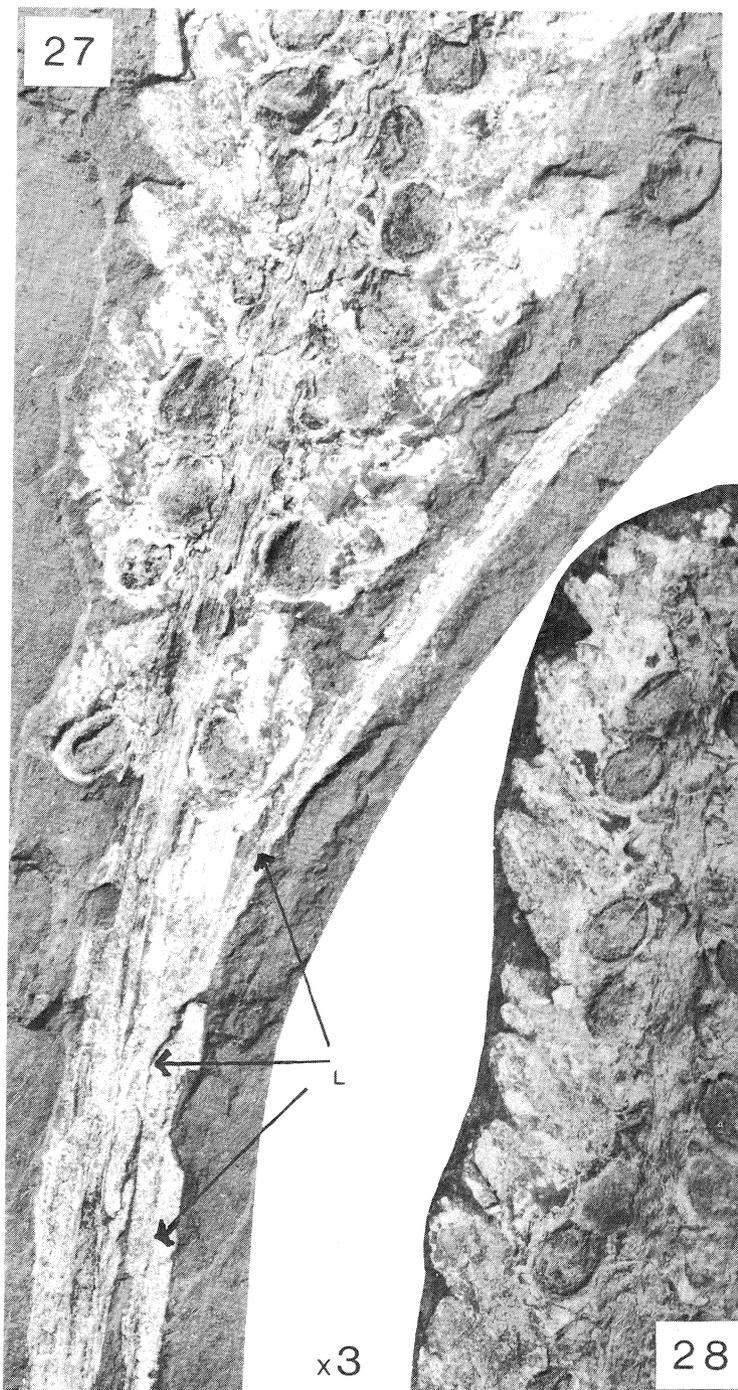


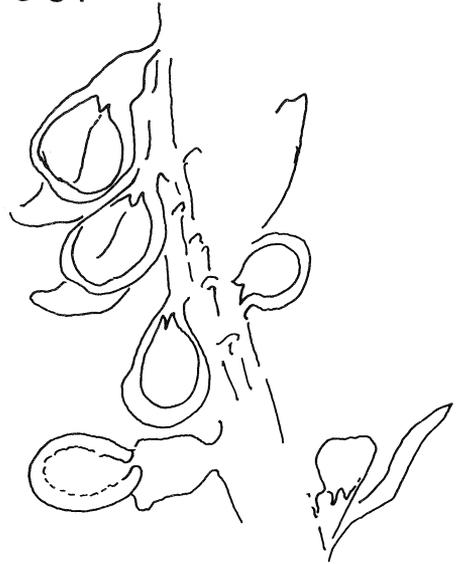
Figure 26. *Rissika talbragarensis* sp. nov. Seed Cone. AMF 59822. Natural size.



Figures 27 & 28. *Rissikia talbragarensis* sp. nov. Fig. 27. Base of cone, AMF 59822. Magn. X3. Foliage leaves at L. Fig. 28. Apex of cone, AMF 59822, Magn. X3.



30.



Figures 29-31. *Rissikia talbragarensis* sp. nov. Fig. 29. Base of cone. MMF 23946 Magn. X3.  
Fig. 30. Tracing of Fig. 39, Fig. 31. Seeds. MMF 3151. Magn. X3.

## Female Cones:

"*Carnoconites australica* sp. nov." Specimens MMF 3163, 24078, 23680, 23681, 24013.  
Genus *Carnoconites* Srivastava 1964. Latex casts of female cones.

## Male Microsporangial groups:

Specimens MMF 24150, 24148. AMF 60862, presented by Keith Holmes from his private collection.

The discovery of four cones of *Carnoconites* type in the Talbragar Fish Beds makes it possible to refer the leaves known as *Taeniopteris spatulata* to *Pentoxylon*. In India, the association of *Pentoxylon* silicified wood, *Taeniopteris* leaves and *Carnoconites* cones, is proved beyond any doubt. (Sahni 1948 summarises the evidence.) In the case of the Rajmahal fossils, petrifications of stems, leaves and cones have given a full understanding of all the phases of the plant. The recognition of *Pentoxylon* necessitated a revision of cycadophyte classification, as the Pentoxylales are a distinct order as are the Bennetitales.

The Indian Pentoxyleae are two plants, one of "*Carnoconites compactum*" cones on "*Pentoxylon sahnii*" with leaves of "*Nipaniophyllum raoi*"; and the other of "*Carnoconites laxum*" cones on "*Nipanioxylon guptai*" stems, with leaves "broader than *Nipaniophyllum raoi*". (*Nipaniophyllum* is the generic name used for *Taeniopteris* leaves when known in petrified state.) Sahni (1948) states that "the old genus *Taeniopteris* founded by Brongniart is an artificial assemblage. As our knowledge of individual species grows, they can be transferred to their proper systematic positions."

Harris (1962) reported the occurrence of a new species of *Carnoconites* – *C. cranwelli* – in New Zealand in Lower Cretaceous strata. The New Zealand cones were associated with leaves referable to the form species *Taeniopteris spatulata* McClelland. *C. cranwelli* is very different from *C. australica* as it has much smaller cones on very long pedicels arranged in a whorl of at least twelve at the stem apex.

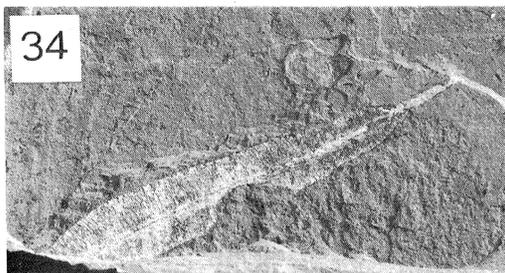
## a. Leaves

The leaves of "*Taeniopteris spatulata*" in the Talbragar material vary considerably in size, from long, narrow examples more than 15 cm in length and about 0.25 cm wide, to the more commonly occurring forms which average about 1 cm in width and are proportionately less elongated. The leaf margins are parallel to most of the length of the lamina, tapering at the base into a well defined petiole in some cases, and to an acuminate or bluntly-rounded apex. A few show undulating margins. The midrib of each leaf is prominent, and lateral veins are at right angles to it and very numerous, about 25-30 per cm. Laterals fork near the midrib or further into the laminal tissue.

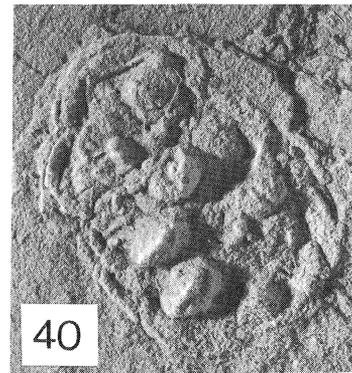
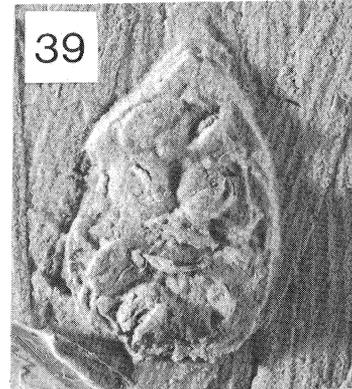
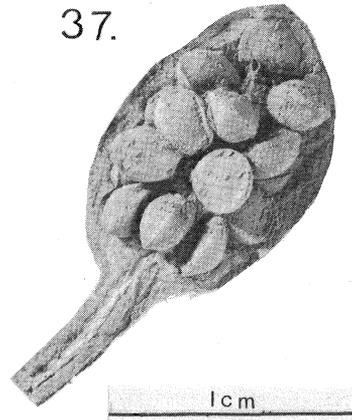
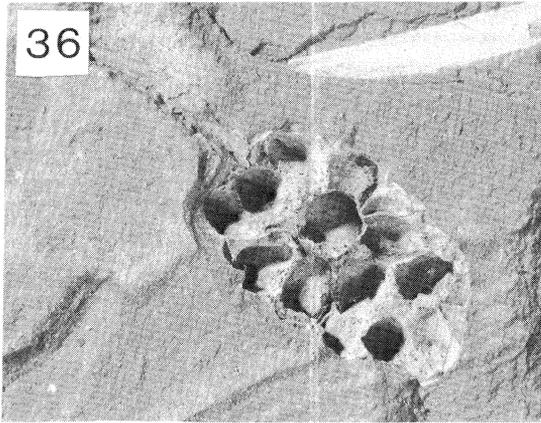
Figures 32 - 35 illustrate the range of form in leaves. In Figure 43, a leaf is seen magnified X 3 to show venation. These leaves are now assigned to *Pentoxylon australica* sp. nov.

## b. Female Cones

Walkom's type specimen for the "? cone", MMF 3163, figured on Pl. 6, Fig. 7 (Walkom 1921) is re-illustrated in Figure 36. The other example he figured (Figs. 4, 4a) is also referred to as MMF 3163, but it cannot be located at the Mining Museum. A latex mould made from MMF 3163 is seen in Figure 37. Moulds from two newly found examples are illustrated in Figures 39 and 40. In Figure 38 a cone and two leaves are seen attached to a stem apex.



Figures 32-35. *Pentoxylon australica* sp. nov. Fig. 32. AMF 38831. Long narrow leaf. Natural size. Fig. 33. Two normal leaves. AMF 58349. Natural size. Fig. 34. AMF 58454. Leaf with petiole. Natural size. Fig. 35. AMF 59994. Leaf with curled top. Natural size.



Figures 36-40. *Pentoxylon australica* sp. nov. Fig. 36. MMF 3163. X3. Fig. 37. Latex mould from MMF 3163. X3. Fig. 38. MMF 24078. Cone and leaves attached to stem apex. X3. Fig. 39. Latex mould from MMF 23680. X3. Fig. 40. Latex mould from MMF 23681. X3.

The fructifications can be seen to be composed of sessile seeds attached to a central axis apparently in four alternating whorls of five seeds each. In Figure 37, the fleshy part of the fruit is only vaguely outlined. The stony seeds each have a median ridge. Figures 39 and 40 give a clearer impression of the "mulberry" nature of the fruit as described by Indian authors. Each seed has a fleshy sarcotesta. Cones of this sort are referred to the genus *Carnoconites* but no useful purpose can be served by doing so when they can be referred to a species which encompasses the whole plant. The name "*Carnoconites*" may be used in a descriptive role.

The Talbragar fructifications are similar in size and in the number of seeds comprising them to *C. compactum* (*Pentoxylon sahnii*). The male flower of *Pentoxylon sahnii* is *Sahnia nipaniensis*, and its microsporophylls are only a fifth of the size of the mature microsporophyll found at Talbragar (Figure 41), a fact supporting the erection of a new species for the Talbragar material.

Figure 38 of MMF 24078 is of particular interest and importance as it shows two leaves of "*Taeniopteris spatulata*" and a *Carnoconites australica* cone attached to a stem apex. A second specimen, MMF 24013, also shows two narrow leaves and a cone attached to a stem apex, removing any doubt about the association. The pedicel attaching the cone to the stem apex is short.

#### c. Microsporangia

In the examination of the Cullen Collection, two examples were found of aggregations of microsporangia. One of these is illustrated in Figure 42. It probably represents an immature example of the male phase of *Pentoxylon australica*. The Australian Museum is most grateful to Mr. Keith Homes of Wellington for presenting a specimen AMF 60862 to complete the information on *Pentoxylon australica*. It had been in his collection for some time, but as *Pentoxylon* had not been recognised in Australia, its significance has not been appreciated. This specimen, Figure 42, contains a filiform microsporophyll with 14 pear-shaped, unilocular sporangia borne on short pedicels. Apart from the size of the specimen, which is five times larger than the microsporophylls recorded for *Sahnia nipaniensis*, it is similar in form to the individual microsporophylls of the male flowers of *Pentoxylon* in India (Vishnu-Mittre 1953).

#### 4. Conifer foliage — "*Brachyphyllum* sp. Walkom 1921" Figures 43-46

*Allocladus cribbii* Townrow 1967a.

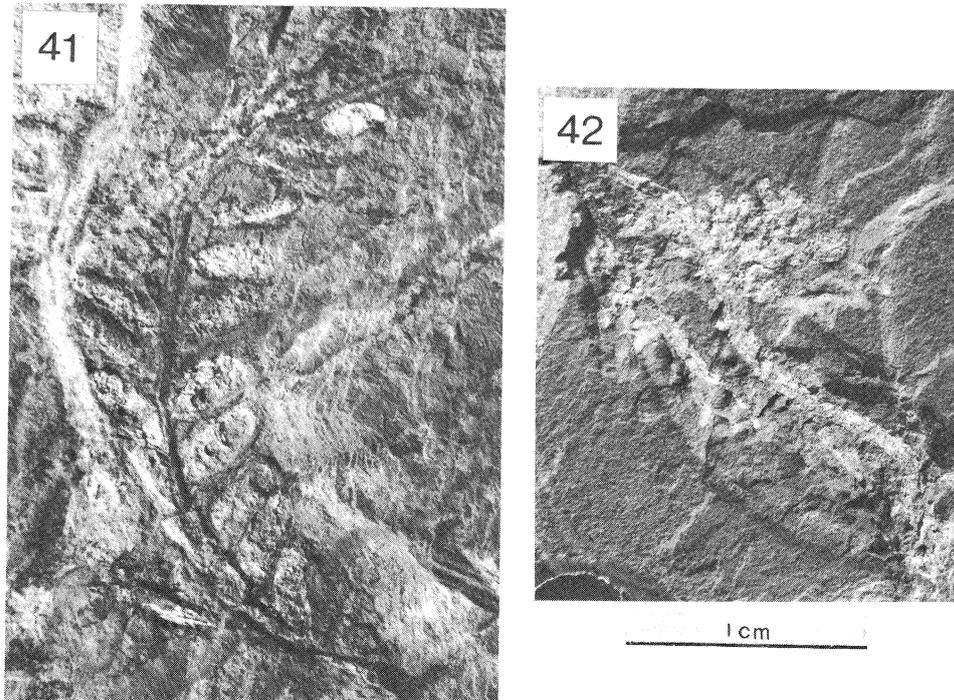
Classification: Townrow 1967a.

Coniferales incertae sedis.

New classification: Coniferales. Podocarpaceae.

Branching conifer twigs with closely adpressed, triangular leaves. Specimen AMF 16443, illustrated in Figure 43, shows a typical slender, forking branchlet. Townrow described the vegetative organs and had no evidence on cones to allow allocation to a family.

Specimen AMF 59988 (counterpart 59989), Figures 44 and 45, show a small twig of the conifer which bears three cones at its apex. Preservation is poor and little detail of the cones can be seen. A specimen was found (AMF 59991) in which three small cones are preserved in a symmetrical tripartite arrangement (Fig. 46). The cones are detached, but they are believed to be referable to *Allocladus cribbii*. They are the same size and shape, and correspond in all discernible details.



Figures 41 & 42. Microsporophylls of *Pentoxylon australica* sp. nov. Fig. 41. AMF 60862. Magn. X3. Mature microsporophyll. Fig. 42. MMF 24150. Magn. X3. Young microsporophylls.

Details of cones are not clear, but knowledge of their arrangement is sufficient to identify the affinities of the conifer. Trimerous symmetry is characteristic of Podocarpaceae. An examination of living podocarps emphasises this — the New Caledonian *Dacrydium balanse* is a similar conifer, with closely adpressed foliage and bearing three cones at the end of slender branchlets. *Dacrydium araucarioides*, *Acmopyle pancheri* and *Decussocarpus comptonii* of the Podocarpaceae show similar cone arrangements. (See de Laubenfels 1972 for illustrations of all these species.) *Dacrydium novogunense* of New Guinea has similar foliage.

Podocarpaceae is the most important family of conifers in the Southern Hemisphere. Although there are some representatives north of the Equator they are assumed to have arrived relatively recently, and the family is believed to have originated in the South.

5. Conifer foliage — “**?Pagiophyllum peregrinum** (L. & H.) Walkom 1921”  
Figures 48, 49, 51

*Allocladus milneanus* (Ten. Woods) Townrow 1967a

Figures 48, 49, 51 show conifer foliage which is referred to this species. Foliage is variable, leaves from narrow (Fig. 48) to foliose (Fig. 49), and until cones are found attached and the foliage can be placed in a family, it should be regarded as a form-species

and not necessarily related to *Allocladus cribbii* which is now known to be Podocarpaceous.

6. Conifer foliage — **Elatocladus australis** (Frenguelli)  
Figure 47

Figure 47 of AMF 58303 shows a rare type of foliage which does not belong to any of the conifer species so far described. It is closest in appearance to *Elatocladus australis*, a species which Townrow considered valid and to which he referred some conifer foliage from New South Wales (Townrow 1967b).

7. Cycad frond — **Nilssonia compta** (Phill.) Bgt.  
Figure 52

Figure 52, AMF 59980, shows a small cycad frond in The Australian Museum collection from Talbragar. A similar frond was found in the Cullen Collection.

8. **Selaginella** sp.  
Figure 53

Figure 53 shows a portion of specimen AMF 25679 in which a delicate branching plant occurs. The stems are clothed in small leaves, and small side branches with larger leaves, appear to bear round ? fruits. This specimen is doubtfully assigned to *Selaginella*.

9. **Onychiopsis** sp.  
Figure 50

A very small, repeatedly dichotomising, fragment of a fern is seen in Figure 50, specimen MMF 24147. It is referred to the genus *Onychiopsis* Yokoyoma 1890, and it resembles the ultimate segments of *Onychiopsis tenuiloba* Lorch (1967). The fragment is only 1 cm long, with smallest segments 2 mm in length, so no close identification can be made. No fern of this sort has been described from the Jurassic in Australia before.

#### ACKNOWLEDGEMENTS

Mr John Fields of the Photography Department of The Australian Museum photographed the specimens. I acknowledge with gratitude his most valuable contribution to this paper.

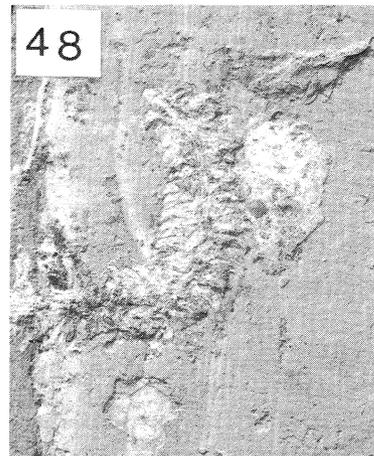
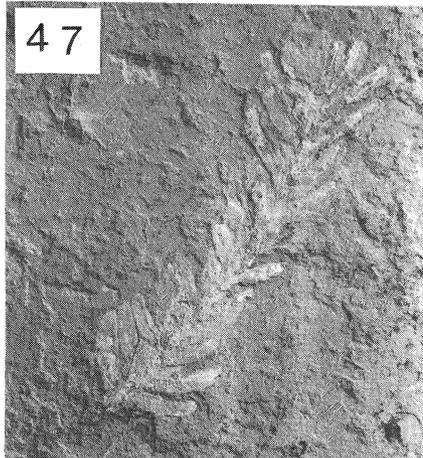
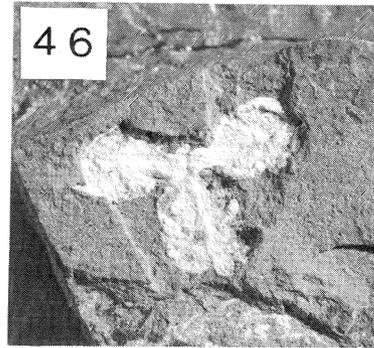
I am grateful to Dr John Pickett, Principal Research Officer of the Mining Museum, for making arrangements enabling me to examine the Cullen Collection, and for the loan of specimens from it and from the other collections of the Mining Museum.

Mr D. Macgillivray and staff of the National Herbarium were most helpful in my study of living plants relating to the Talbragar fossils and kindly lent literature.

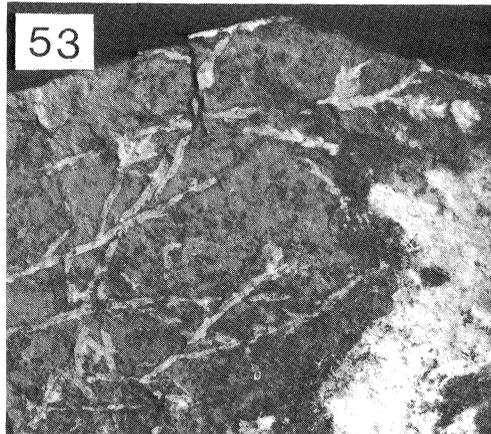
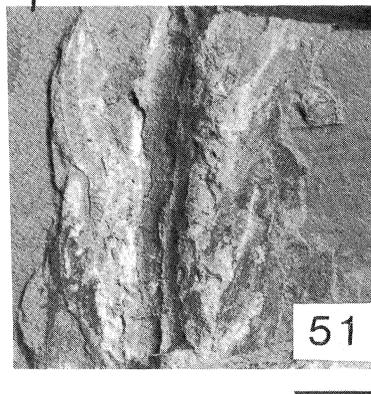
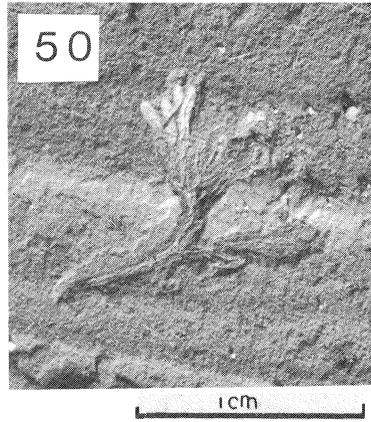
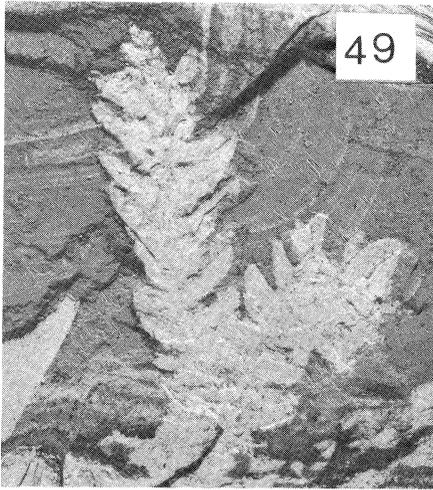
I wish to thank Dr Alex Ritchie, Curator of Fossils, of The Australian Museum for his advice and assistance.



Figure 43. Conifer twig — *Allocladus cribbii* Townrow, and leaf of *Pentoxylon australica* sp. nov. showing venation. AMF 16443. Magnification X3.



Figures 44 - 46. *Allocladus cribbii* Townrow. Magn. X3. Fig. 44. AMF 59988. Twig terminating in three cones. Fig. 45. AMF 59989. Counterpart. Fig. 46. AMF 59991. Three cones. Figure 47. *Elatocladus australis* Frenguelli. AMF 58303. Natural size. Figure 48. *Allocladus milneanus* (Ten.Woods) Townrow. Natural size. MMF 23941.



Figures 49 & 51. AMF 59981, 59993. *Allocladus milneanus* (Ten.Woods) Townrow. X1. Figure 50. *Onychiopsis* sp. MMF 24147. X3. Figure 52. *Nilssonia compta* (Phill.) Bgt. AMF 59980. Natural size. Figure 53. *Selaginella* sp. AMF 25679. Natural size.

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