ON TWO CONIFERS FROM THE JURASSIC OF SOUTH-EASTERN AUSTRALIA

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IN 1940 I published the results of an investigation into the Eocene fossil conifers of south Chile and their phytogeographical significance (FLORIN, 1940, pp. 1-107, PL. 1-6). The assemblage was found to be of distinctly southern character, judged by the standard of recent conifer distribution, and to be quite void of northern elements. This raised the point whether other fossil conifers of the Southern Hemisphere — hitherto considered to belong to northern genera that had migrated south in Mesozoic and Tertiary times — had been wrongly determined, and actually represented floral elements belonging to, or at least most closely related to, recent southern genera. The Mesozoic and Tertiary conifers of the Southern Hemisphere and Peninsular India were, therefore, preliminarily reviewed in that paper, with special attention to the occurrence and distribution of members of the family *Podocarpaceae*. It was found that the Mesozoic and Tertiary strata of southern lands are rich in podocarpaceous remains — in contradistinction to the corresponding stages in Europe, Asia and North America.

In respect of the various genera I arrived, *inter alia*, at the following conclusions. *Podocarpus* is a southern genus, probably originating in early Mesozoic time. *Dacrydium* presumably developed in the Upper Mesozoic from some centre in the East Australian-Antarctic region. *Acmopyle* appears to have spread from an original centre of distribution in the Indo-Australian region to Antarctica and South America. *Phyllocladus* may also be looked upon as a genuine southern genus. The remaining genera, *Saxegothaea*, *Pherosphaera* and *Microcachrys*, are hardly known at all in the fossil state, but there is no reason to doubt their southern origin.

I also stated that there was little evidence of the existence in earlier periods of any considerable number of now extinct podocarpaceous genera, although *Coronelia* Florin of the south Chilean Eocene is one, and the Jurassic floras of Antarctica, New Zealand, Eastern Australia, and Peninsular India may include others.

The results obtained contradicted the widespread opinion that all conifers originated in the north temperate zone or in the Arctic regions, and spread from thence to southern lands, including the Antarctic. They pointed instead to the conclusion that the world's conifer vegetation had, from the Permian onwards, become steadily differentiated into two large separate phytogeographical dominions.

It has long been my intention to deal in greater detail with the history of the southern conifer floras, but for various reasons I will probably not be able to do so. My time for research work has in recent years been curtailed to such an extent that, at least for the time being, I must content myself to making only a few small contributions to our knowledge of certain genera. The present paper is such a contribution. It has been made possible by Dr. Isabel Cookson of the University of Melbourne, who, when visiting Stockholm in 1948, brought some specimens of Victorian conifers, of Jurassic age, from the National Museum of Victoria, Melbourne. I am much indebted to Dr. Cookson for having placed this interesting material at my disposal for study. The specimens are types of Victorian fossil plants published long ago by McCoy (1874, pp. 31-36, PL. 8). One of the species described by him, viz. "*Zamites* (*Podozamites*)" *ellipticus* McCoy, has been excluded from the present inquiry, however, since from the point of view of external morphology it appears uncertain whether the shoot belongs to any conifer at all, and its state of preservation precludes the possibility of examining the epidermal structure of the leaves.

McCoy's material, of Jurassic age, came from one of the shafts sunk in search of coal by the Geological Survey of Victoria at Bellarine (Gippsland), situated between Queenscliff and Geelong, south-west of Melbourne.

The two species re-examined here were erroneously regarded by their author as belonging to the Cycadaceae. "*Zamites* (*Podozamites*)" *Barklyi* McCoy was described by him as having pinnate leaves with distichous, very slightly alternate or opposite leaflets obliquely inserted in two rows. From McCoy's illustrations alone it is possible to say that this is a conifer with spirally disposed leaves arranged in approximately two ranks. The second species, "*Zamites*" *longifolius* McCoy, is based on a foliage shoot of similar type, but with much narrower and more spreading leaves. In my above-mentioned paper of 1940 (p. 51) I made a mistake in suggesting that the leaves of these conifers were bilateral. McCoy's illustrations gave that impression and, as a matter of fact, it is not easy to judge from the external appearance of the specimens alone whether their leaves are bilateral or bifacial. In respect of "*Zamites* (*Podozamites*)" *Barklyi*, however, the distribution of the stomata here examined for the first time indicates the bifacial nature of its leaves. The leaf cuticle is not preserved in "*Zamites*" *longifolius*, but in this case, too, I am now inclined to think that the leaves were bifacial, and not bilateral as previously suggested. There may of course be other mistakes of a similar kind in my preliminary review of the conifers of southern lands (FLORIN, 1940, loc. cit.), since, for lack of material, this was necessarily largely based on the more or less imperfect illustrations in previous papers. I venture to think, however, that it served its purpose, viz. to draw attention to the importance to our knowledge of the history of the *Coniferae* as a whole, and to Phytogeography of a thorough revision of the southern fossil conifer floras.

BELLARINEA gen. nov.

"*Zamites* (*Podozamites*)" *Barklyi* McCoy is in my opinion a podocarpaceous conifer. Its foliage shoots of ultimate order resemble those of certain living species of *Podocarpus*, and particularly those of the arboreal *P. ferrugineus* D. Don (Sect. *Stachycarpus* Endl. emend. BUCHHOLZ et GRAY, 1948, p. 58), a species widely distributed in the New Zealand forests. Owing to differences in epidermal characteristics McCoy's conifer cannot be assigned to the genus *Podocarpus* itself, however, nor to any other genus of the family represented in the living floras. Considering the so far instituted genera of fossil conifers, *Podocarpites* Andrae is based on detached linear leaves from the Liassic of Steierdorf (Banat), which certainly have nothing to do with the *Podocarpaceae* (ANDRAE, 1855, p. 45, PL. 10, FIG. 5). Later, Seward (1919, p. 405) proposed that, "in accordance with the practice usually adopted in the case of fossil species", this generic name be applied to fossil leaves as well as to sterile and fertile shoots reminiscent of those of living species of *Podocarpus*. *Podocarpites* would thus be an artificial genus comprising fossil remains, except wood, which cannot be referred with confidence to any better-defined taxonomic unit. In practice this generic name seems to have been applied exclusively to northern forms, some of which are not at all related to the *Podocarpaceae*, but represent, or at least resemble, the recent Taxaceous genus *Amentotaxus* Pilger. The same applies to *Podocarpites mentoukouensis* (STOCKMANS & MATHIEU, 1941, p. 53, PL. 7, FIGS. 5, 6) from the Jurassic of north China, which strongly resembles *Storgaardia spectabilis* Harris (HARRIS, 1935, pp. 58-60, PL. 11, FIG. 17; PL. 12, FIGS. 7, 8, and PL. 16, FIGS. 1, 2), a conifer of Liassic age from east Greenland. It is significant that the epidermal structure of the leaves of *Storgaardia* appears to be fairly close to that of *Amentotaxus* (cf. FLORIN, 1931, p. 304, PL. 33, FIGS. 6, 7).

For various reasons the generic name of *Podocarpites* seems accordingly inapplicable in the present case. This is so even if it is accepted in Seward's sense, since the genus will then be too artificial to do justice to our knowledge of McCoy's conifer.

Podocarpium Unger is a generic name used at one time to designate fossil foliage shoots of probable podocarpaceous affinities (cf. VON ETTINGSHAUSEN, 1887, pp. 37, 38, PL. 7, FIGS. 8-10, 10*a*, 11-15). It was, however, founded by Unger (1865, p. 13, PL. 5, FIGS. 1*a-c*) on a fossil coniferous wood, and is, therefore, ineligible here.

Weigelt (1928, pp. 485-553) instituted the genus *Archaeopodocarpus* for coniferous remains from the Upper Permian of central Germany, but this is obviously a synonym for *Ullmannia* Goeppert (FLORIN, 1940, pp. 71-72), and its application here consequently altogether inadmissible. Further, it should be mentioned that Soda (1936) introduced the generic name of *Palaeopodocarpites*, but I have not had access to his

paper, and his diagnosis is, accordingly, unknown to me. Von Ettingshausen (1887, pp. 38, 39, PL. 7, FIGS. 17, 18 and 18*a*) used the generic name *Dacrydinium* for *Dacrydium*-like foliage shoots of Cretaceous age from New Zealand. Seward (1919, p. 410) subsequently remarked that there is no evidence as to the nature of the reproductive organs, and that the form of the foliage shoots might with equal probability be interpreted as evidence of other conifers or of some lycopodiaceous plant. I hope to have an opportunity of discussing the question of the use of this generic name on some other occasion. Evidently, it does not suit McCoy's conifer. The differences in external morphology of the foliage shoots are too great, and the epidermal structure of the leaves of *Dacrydinium* is quite unknown.

Finally, Halle (1913, p. 82) instituted the genus *Elatocladus* to comprise sterile conifer branches or branchlets of the radial or the dorsiventral type that do not show any distinctive characters. Although all the species from the Southern Hemisphere referred by Halle himself to *Elatocladus* show a habit indicating affinity with the *Podocarpaceae*, this generic name was meant to have a much wider application and has accordingly of late been used to designate all kinds of fossil conifer remains from the Southern as well as from the Northern Hemispheres. It, too, should obviously be avoided in this particular case.

For the above reasons I have found it appropriate to institute a new generic name, viz. *Bellarinea*, derived from the name of the locality, for the conifer described by McCoy as "*Zamites* (*Podozamites*) *Barklyi*", and to designate this the type of the genus.

BELLARINEA, gen. nov. — *Woody plants. Leaves on branchlets of moderate length, bifacial, spirally disposed but expanded approximately in one plane, turning the morphological upper surface upwards, spreading to divaricate, coriaceous, entire, flat, linear-lanceolate, straight or more or less strongly falcate, subacute or obtuse at the apex, only slightly contracted at the base, decurrent on the axis, and uninerved.*

Leaves on branchlets hypostomatic, showing two narrow bands with irregularly, mostly obliquely orientated stomata on the under surface. Stomatal apparatus in the bands somewhat irregularly arranged in longitudinal rows. Leaf margins entire. Stomatal apparatus haplocheilic; perigene subsidiary cells 4 to 6 in number; guard-cells only slightly sunk. Anticlinal walls of epidermal cells straight in the stomatiferous bands, but often slightly sinuous in the non-stomatiferous areas on both surfaces.

BELLARINEA BARKLYI (McCoy) Florin comb. nov.

Pl. 1, Figs. 1, 4-6; Pl. 2, Figs. 11-15

Zamites (*Podozamites*) *Barklyi* McCoy 1874, pp. 33-34, Pl. 8, Fig. 1 (non Stirling 1900, p. 5, PL. 5, FIGS. 4-5)

Type — The specimen illustrated in this paper in Pl. 1, Fig. 1, and the microscopic slides made from it (PL. 2, FIGS. 12, 13 and 15) (Nat. Mus. Victoria, No. 12220).

Diagnosis — Woody plants. Branchlets resembling those of certain recent podocarps of the *Stachycarpus* section, straight or slightly curved, up to 10 cm. long or longer. Leaves of sterile branchlets bifacial, spirally disposed but expanded by the twisting of the leaf bases in approximately the same plane, turning the morphological upper surface upwards, spreading to divaricate (40° to 90°), linear-lanceolate, 14 to 32 mm. long, 1·8 to 3 mm. broad, subacute or obtuse at the apex, only slightly contracted at the base, distinctly decurrent on the axis, and provided with a median vein running from base to apex.

Leaves of sterile branchlets hypostomatic, with two about 0·5 mm. broad stomatiferous bands borderd by non-stomatiferous zones at the margins and separated from each other by a similar median zone. Non-stomatiferous zones of about the same breadth as the stomatiferous bands. Stomatal apparatus somewhat irregularly arranged in longitudinal rows and more or less separated in each row, mostly orientated obliquely to the long axis of the leaf. Epidermal cells of the stomatal bands outside the stomatal apparatus non-papillate, varying in shape, but frequently rectangular, cutinized to about the same extent as the cells in the adjacent non-stomatiferous areas. Epidermal cells of the latter frequently broader and longer than the cells of the stomatiferous bands, but conforming to them in general shape. Epidermal cells on the upper surface of the leaf resembling those in the non-stomatiferous zones of the under surface, but broader and more strongly cutinized. Leaf margins entire.

Stomatal apparatus of the haplocheilic type, probably incompletely amphicyclic (dicyclic). Perigene subsidiary cells 4 to 6 in number, mostly 2 polar and the remainder lateral, all slightly papillate and probably having the "Florin ring" (BUCHHOLZ & GRAY, 1948, p. 52). Neighbouring apparatus in the same row never appearing to have a common subsidiary cell. Guard-cells only slightly sunk. No hairs. Anticlinal walls of epidermal cells always smooth, straight in the stomatiferous zones, but often slightly sinuous in the non-stomatiferous areas on both surfaces. Those on the upper surface of the leaf thicker and more distinctly perforated than those on its under surface.

As already mentioned *Bellarinea Barklyi* resembles certain recent species of *Podocarpus* Sect. *Stachycarpus* (sensu stricto) in external appearance of its leafy branchlets, and to some extent in the epidermal structure of their leaves (cf. FLORIN, 1931, pp. 263-266). It is interesting to note that the recent geographical distribution of the section extends from Central and South America to New Zealand, Australia and New Caledonia. On the other hand, this fossil conifer differs not only from the recent *Stachycarpus* species, but also from all other living *Podocarpaceae*, in that it combines relatively long, linear-lanceolate leaves with mostly obliquely (instead of longitudinally) orientated stomata. In the living *Podocarpaceae* such stomata only occur occasionally, especially at the bases and apices of short, more or less scale-like leaves, and not a single species has stomatiferous bands of the same type as *Bellarinea Barklyi*. The institution of the new genus is mainly based on this fact.

Bellarinea Barklyi differs widely (in external apperance) from the two specimens described by Stirling (1900, p. 6, PL. 5, FIGS. 3, 4) from Griffith's Point and Albert river in south Gippsland under the name of *Podozamites Barklyi*. These have been erroneously identified, and are perhaps more like the shoots of *Agathis* [*A. australis* (Lamb.) Steud.] and *Araucaria* (Sect. *Colymbea*) than anything else.

ELATOCLADUS Halle

I have previously (FLORIN, 1940, p. 51; cf. above) pointed out that "*Zamites*" *longifolius* McCoy is a conifer probably of podocarpaceous affinity. In this case, too, the generic name will have to be changed. Unfortunately, the cuticular layers of the leaves are not preserved in the material to hand, and their epidermal structure is thus unknown. Until special generic names have been instituted for fossil conifer remains resembling the various groups of living *Podocarpus* and *Dacrydium* species, the name *Elatocladus* proposed by Halle (1913, p. 82) as a collective and provisional designation for sterile coniferous branches or branchlets "which do not show any characters that permit them to be included in one of the genera instituted for more peculiar forms", may be used for "*Zamites*" *longifolius*. There is, however, one disadvantage connected with its relegation to this genus. The specific epithet must be changed, since the resulting binary name would otherwise be a later homonym. The combination *Elatocladus longifolia* having already been published by Carpentier (1927, p. 75) for sterile conifer twigs of Lower Cretaceous age from Féron, France (Dep. Nord.), which differ very distinctly from those of "*Zamites*" *longifolius*, the binary name *Elatocladus McCoyi* is proposed here.

ELATOCLADUS McCOYI Florin sp. nov.

Pl. 1, Fig. 7; Pl. 2, Figs. 8*a* & 9.

Zamites longifolius McCoy, 1874, pp. 35, 36, Pl. 8, Fig. 3

Type — The specimen illustrated in this paper in Pl. 2, Figs. 8*a* and 9 (Nat. Mus. Victoria, No. 12203).

Diagnosis — Leafy branchlets resembling those of living *Podocarpaceae*, with a thin axis carrying numerous spreading (50° to 75°) leaves spirally disposed but expanded in approximately the same plane. Leaves bifacial, turning their morphological upper surface upwards, coriaceous, entire, flat, more or less strongly falcate, uninerved, almost linear, 7 to 11 mm. long, 0·7 to 1 mm. broad, often broadest below the middle, acute or almost obtuse at the apex, somewhat contracted at the base, but broadly decurrent on the axis.

In the appearance of its leafy branchlets *Elatocladus McCoyi* recalls *Podocarpus spicatus* R. Br. (Sect. *Stachycarpus* sensu stricto) of New Zealand, although the leaves are narrower and shorter, and more crowded on the axes of the branchlets than in this living conifer. Of the Mesozoic conifers

hitherto known from southern lands, none appears to show a combination of external characteristics quite similar to that of McCoy's material from the Bellarine beds.

ELATOCLADUS sp.

Pl. 2, Figs. 8*b* & 10

Besides the branchlets of the two conifers dealt with above, one of the slabs (Nat. Mus. Victoria, No. 12203) shows the impression of a single twig which probably is not referable to either of these species. The material is not sufficient, however, to be described as of a separate species. This branchlet is only about 2·5 cm. long and carries a few sparsely and spirally arranged leaves. These are thick, 2·5 to 4·5 mm. long and up to 1 mm. broad, narrowly triangular in shape, broadly decurrent at the base, and acute or acuminate at the slightly upturned apex. The epidermal structure of the leaves is not known. This branchlet strikingly recalls the semi-juvenile form of *Dacrydium intermedium* T. Kirk, a living species of the New Zealand flora, and might well belong to the same genus.

APPENDIX

As seen in the microphotographs on Pl. 2, the leaf cuticles of *Bellarinea Barklyi* are not well preserved. The leaves had decayed to a rather considerable extent before fossilization. They contain the mycelium of a probably saprophytic fungus, the dark-coloured leathery fruiting bodies (perithecia) or pycnidia (?) of which are seen breaking through the epidermis and forming dark, circular pustules 0·3 to 0·4 mm. in diameter. They open by three to five slits radiating from the centre. Nothing can be said with certainty about the systematic position of this fungus, but judging by its general appearance it may belong to some group of the *Pyrenomycetes*. This is one of the few cases in which a microscopic fungus has been found in Mesozoic strata of the Southern Hemisphere.

SUMMARY

Bellarinea, a new genus probably of podocarpaceous affinity and externally resembling recent species of the *Stachycarpus* section of *Podocarpus*, is described from the Jurassic formation at Bellarine, situated between Geelong and Queenscliff, south-west of Melbourne in Victoria. This genus is based on the type material of "*Zamites* (*Podozamites*)" *Barklyi* McCoy, which consists of sterile leafy branchlets and permits a study of the cuticular (epidermal) structure of the leaves. *Bellarinea Barklyi* (McCoy), comb. nov., is characterized by combining bifacial, relatively long, linear-lanceolate leaves with mostly obliquely orientated stomata arranged somewhat irregularly in longitudinal rows. These rows form two narrow bands on the under surface of each leaf.

"*Zamites*" *longifolius* McCoy from the same beds is transferred to the artificial genus *Elatocladus* and named *E. McCoyi*, sp. nov. In this case, too, the sterile branchlets resemble those of living *Podocarpaceae* (Sect. *Stachycarpus*). A third type of conifer twigs from Bellarine, named *Elatocladus* sp., recalls the semi-juvenile form of the recent *Dacrydium intermedium* T. Kirk of New Zealand. The cuticular structure of the leaves is unknown in both these cases.

A probably pyrenomycetous fungus occurred on the decaying leaves of *Bellarinea Barklyi*.

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* Not seen.

EXPLANATION OF PLATES

Coniferous remains of Jurassic age from Bellarine (situated between Geelong and Queenscliff, south-west of Melbourne), Victoria, Australia (National Museum of Victoria, Melbourne).

PLATE 1

1. *Bellarinea Barklyi* (McCoy) Florin (McCOY, 1874, PL. 8, FIG. 1 ; Specimen No. 12220). Two lateral shoots probably of the same branch system. Natural size.

2-3. *Bellarinea Barklyi* (McCoy) Florin (Specimen No. 12220). Fragments of leaf cuticles with remains of a probably pyrenomycetous fungus. × 40.

4-5. *Bellarinea Barklyi* (McCoy) Florin (McCOY, 1874, PL. 8, FIG. 2 ; Specimen No. 12221). Branchlet photographed respectively before and after immersion in xylol. Natural size.

6. *Bellarinea Barklyi* (McCoy) Florin (McCOY, 1874, PL. 8, FIG. 5 ; Specimen No. 12222). Apical part of a branchlet. Natural size.

7. *Elatocladus McCoyi* Florin (McCOY, 1874, PL. 8, FIG. 3 ; Specimen No. 12203). Portion of a branchlet. Natural size.

PLATE 2

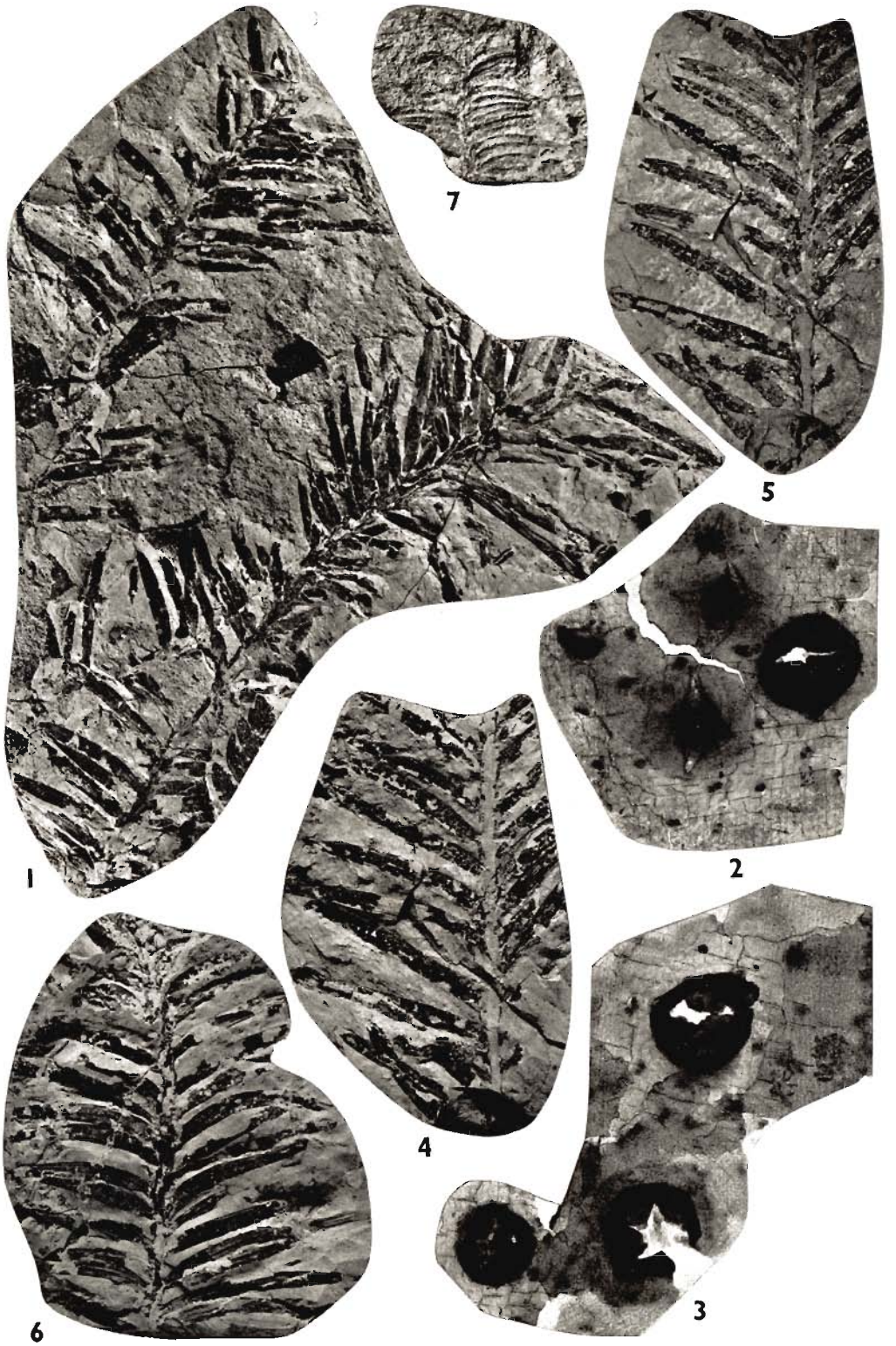
8*a*. *Elatocladus McCoyi* Florin (McCoy, 1874, PL. 8, FIG. 3 ; Specimen No. 12203). Portion of a branchlet photographed after immersion in xylol. Natural size.

8*b*. *Elatocladus* sp. (Specimen No. 12203). Branchlet photographed after immersion in xylol. Natural size.

9. *Elatocladus McCoyi* Florin (Specimen No. 12203). The same branchlet as in Fig. 7, Pl. 1, and Fig. 8*a*, Pl. 2, photographed after immersion in xylol. × 3.

10. *Elatocladus* sp. The same specimen as in Fig. 8*b* photographed in xylol. × 3.

11-15. *Bellarinea Barklyi* (McCoy) Florin. Cuticular preparations. 11. Portion of a stomatiferous band on the under side of a leaf [Specimen No. 12221 (cf. PL. 1, FIGS. 4, 5)], with obliquely orientated stomata in longitudinal rows ; to the left portion of one of the non-stomatiferous zones. × 100. 12. Portion of a stomatiferous band on the under side of a leaf [Specimen No. 12220 (cf. PL. 1, FIG. 1)], with obliquely or transversely orientated stomata somewhat irregularly arranged in longitudinal rows and, to the left, portion of one of the non-stomatiferous zones. × 100. 13. Stomatal apparatus on the under side of a leaf, focalized on the guard-cells (internal view) [Specimen No. 12220 (cf. PL. 1, FIG. 1)]. × 800. 14. Stomatal apparatus, in external view, on the under side of a leaf, showing what appears to be the " Florin ring ", viz. a furrow giving a transparent circle in the cuticular layer above subsidiary cells [Specimen No. 12221 (cf. PL. 1, FIGS. 4-5)]. × 500. 15. Portion of the epidermis of the upper (ventral) side of a leaf [Specimen No. 12220 (cf. PL. 1, FIG. 1)]. × 100.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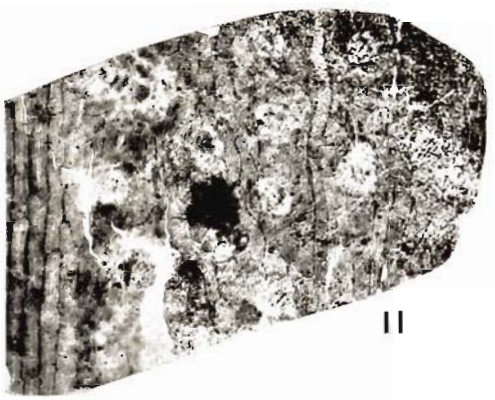

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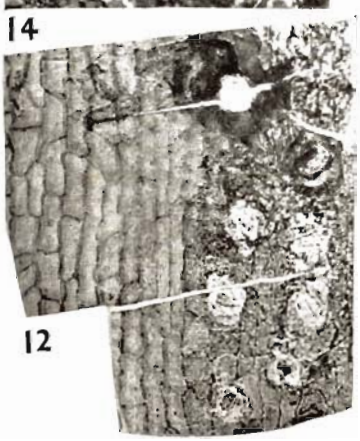

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