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PLIOCENE *NOTHOFAGUS* WOOD FROM THE TRANSANTARCTIC MOUNTAINS

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ABSTRACT

Subfossil wood fragments up to 10 cm long and 2 cm in diameter recovered from a locality thought on the basis of diatom deposits to be upper Pliocene–lower Pleistocene (Oliver Bluffs, Sirius Formation, 85°10′S., between 1800 and 1900 m in the Transantarctic Mountains) were sectioned for identification. Degradation prevented observation of some wood features, but others were well preserved. All of the fragments appear to represent one species. Features of growth rings (ring porous, vessels mostly solitary in earlywood), rays (predominantly uniseriate, both erect and procumbent cells common), vessel perforation plates (simple, at least in earlywood), lateral wall pitting of vessels (predominantly transitional in earlywood, scalariform in latewood) and tyloses (present) permit one to identify the Oliver Bluffs woods as a *Nothofagus.* Wood sections of *Nothofagus* from New Guinea, New Caledonia, Tasmania, and southern South America were prepared in order to secure a more precise identification. The Oliver Bluffs woods very closely matches *N. betuloides* from Tierra del Fuego and southern Chile as well as *N. gunnii* from Tasmania in qualitative and quantitative features. Original data on wood of these *Nothofagus* species are presented. The nature of the Oliver Bluffs woods is discussed with relation to reports of *Nothofagus* wood from the Falkland Islands and *Nothofagus* pollen from Antarctica, and the implications of this polar flora are considered.

Key words: Antarctica, *Nothofagus,* Pliocene, wood anatomy.

INTRODUCTION

Webb and Harwood (1987) reported the discovery of wood fragments, some up to 10 cm in length and 2 cm in diameter, in the Sirius Formation at Oliver Bluffs (85°10′S.) near the head of the Beardmore Glacier in the Dominion Range, Transantarctic Mountains. This locality is described in detail, with maps and photographs, by Webb, McKelvey, Harwood, Mabin and Mercer (1987), and the relevant Late Cenozoic glacial history of the Transantarctic Mountains is sketched by Webb, Harwood, McKelvey, Mabin, and Mercer (1987). The Sirius Formation is described by Mercer (1972) as a "compact glacial drift that uncomformably covers pre-Tertiary rocks." Thick deposits (ca. 60 m) of this glacial unit at Oliver Bluffs, the site from which the wood samples were recovered, represent deposition by the Beardmore Glacier, which varied in size, periodically covering the area and depositing glacial till during ice advances as well as, during warmer times, exposing the area and supplying outwash debris. This is certainly a very southerly locality for higher plants during a relatively recent period. The Sirius Formation appears to be as old as about 3.1 Ma but more likely is younger than 2.5 Ma (Harwood 1986*a, b*), based on the presence of reworked marine diatoms. This modifies earlier views, some of which placed the Sirius Formation at from 4.2 to more than 20 Ma (see Webb, McKelvey et al. [1987] for a review). A dissent has been registered by Mercer (1987), who argues that the flora studied herein must have been extinguished by late Miocene cooling. The Oliver Bluffs collection localities range between 1800 and 1900 m in elevation, although there is reason to believe that the elevation at the time the woods were deposited might have been lower, perhaps even near sealevel (Mercer 1986; Webb, Harwood et al. 1987).

The location of wood fragments stratigraphically is consistent at all sites where they have been found (Webb and Harwood 1987). Webb and Harwood conclude that the woods represent vegetation growing on top of diamictites after temporary withdrawal of an oscillating ice margin, and that the plants were buried by outwash debris and later by lodgement till as the Beardmore Glacier thickened and advanced over the area. Webb and Harwood present evidence that the plant fragments are located in situ and that redeposition has not occurred or was only local. The wood samples are subfossil and can even be ignited, although small granules of mineralization occur in some of the fragments. Wood fragments at outcrop surfaces of Oliver Bluffs exhibit some oxidation (Webb and Harwood 1987), and these authors believe that wood fragments in the outcrop surfaces may have been exposed for at least 15,000 years, subsequent to the erosion of the surface of Oliver Bluffs by ice from the last glacial advance. Nevertheless, remarkably little fungal or microbial degradation is evident to Webb and Harwood (1987) on the basis of superficial appearance. A fungal hypha within a wood fragment was located by J. A. Snider (in Webb and Harwood 1987), but no fungal hyphae were evident in my preparations—a noteworthy fact when one knows how readily fungal hyphae can invade modern wood samples when humidity and temperature are suitable for fungal growth.

The Oliver Bluffs wood samples studied here come mostly from Unit 2; a few fragments were also collected at Unit 4. These are stations on a transect of Oliver Bluffs, cited on a map given by Webb, McKelvey et al. (1987).

The purpose of the present study has been to determine the taxonomic identity of the wood fragments provided to me. Pollen grain identifications from Oliver Bluffs deposits have been made by Askin and Markgraf (1987). The significance of the wood determinations with respect to the findings of Askin and Markgraf is discussed in the terminal portion of this paper. The comparisons required for the present study necessitated development of original data on wood anatomy of species for which data are not currently present in the literature.

MATERIALS AND METHODS

The Oliver Bluffs wood samples studied were kindly provided me by Dr. Peter-N. Webb of the Department of Geology and Mineralogy, and Institute of Polar Studies, Ohio State University. The wood samples represent four collections: (1) Unit 2, Section 5; (2) Unit 2, Section 8, single stem; (3) Unit 2, Section 8, other stems; (4) Unit 4, Section 5, Sample 9. The unsectioned wood fragments illustrated (Fig. 1) represent the last of these localities, and these provided most of the sections from which photomicrographs (Fig. 3–9) were prepared because the larger sections they permitted offered a better choice of structures to illustrate.

Sections were prepared from all major fragments in each of the four collection sites. Examination of wood fragments prior to sectioning revealed the presence of minute mineral granules in some. Because these mineralizations would have interfered with sectioning, the wood samples were boiled, soaked for a week in

20% hydrofluoric acid, and then washed (successive transfers of water over the period of a week) and stored in 50% ethyl alcohol. Wood fragments were not hard in texture, so an attempt was made to infiltrate them with paraffin according to the usual techniques and to section them on a rotary microtome. Some sections were obtained, but inspection under the microscope revealed excessive fragmentation into minute pieces, much more than obtained when sectioning modern woods with this technique. This fracturing not only rendered the woods unattractive for photographic purposes, it also obscured diagnostic features.

As an alternative procedure, woods were embedded in collodion. In order to accomplish this, samples were transferred by means of intermediate-strength solutions from 50% ethyl alcohol into absolute ethyl alcohol. Samples were then placed into plastic bottles containing an ether solution of collodion. The lids of bottles were left ajar so that the collodion would concentrate, and additional amounts of collodion solution were added during the evaporation process. Over a period of several months a viscous collodion solution, more gellike than liquid in consistency, was obtained. Final evaporation was permitted when collodion concentration was so high that little shrinkage occurred as the solvent was completely evaporated.

Wood-containing portions of the dried collodion were trimmed preparatory to sectioning. An attempt was made to embed the collodion segments in paraffin, followed by sectioning on a rotary microtome. That technique did not prove successful because sections curled excessively. However, the collodion segments surrounded by paraffin sectioned well on a sliding microtome. Collodion segments embedded in paraffin could be rotated on mounting blocks so as to obtain transverse, radial, and tangential sections (see Fig. 2–9, especially Fig. 2–4). This facilitated analysis and comparison with modern species.

Sections were placed into perforated crucibles and treated with xylene to remove paraffin. After two changes of xylene and one of absolute ethyl alcohol, staining was accomplished with a safranin-fast green combination in anhydrous solutions. After they were destained in absolute ethyl alcohol, sections were transferred to xylene. As a matter of convenience, the celloidin margins on sections were removed with forceps before the sections were placed on slides and mounted in synthetic resin. The sections obtained in this way were relatively free from fractures and demonstrated optimally those features still in the wood fragments despite the degradation present in wood cells.

Wood samples of modern species were boiled in water, stored in 50% ethyl alcohol, and sectioned on a sliding microtome. Sections were stained with a safranin-fast green combination. Macerations were prepared from the stems stored in 50% ethyl alcohol by means of Jeffrey's Fluid; safranin was used as a stain for macerations.

Wood collections of modern woods studied are as follows: *Nothofagus antarctica* (Forst.) Oerst., *Mexia 7918,* UC, Estancia La Esperanza, Tierra del Fuego, Argentina; *N. betuloides* (Mirb.) Blume, *Goodall 1007,* Estancia Harberton, Tierra del Fuego, Argentina; *N. codonandra* (Baill.) Steenis, *Thorne 28685,* RSA, Montagne des Sources, New Caledonia; *N. gunnii* (Hook.) Oerst., *Thorne 26663,* RSA, Lake Dobson, 1000 m, Tasmania; *N. procera* Poepp. & Endl., *USw-8556, RSAw,* Central Chile; *N. pumilio* (P. & E.) Krasser, *Goodall 806,* RSA, Estancia Harberton, Tierra del Fuego, Argentina; *N.* sp., *Royen & Steenis 8013,* RSA, Vogelkop, New Guinea (West Irian).

The sample of *N. procera* is a stem 4 cm in diameter from a xylarium portion. Although the *N. antarctica* sample was mounted on an herbarium specimen, it is a portion of a mature stem of unknown diameter. The remainder of the samples are from herbarium specimens and are of twig diameter except for *N. gunnii,* in which the stem available was near 1 cm in diameter. The small size of stems in the herbarium specimens is not considered disadvantageous, because the Oliver Bluffs fragments are also relatively small. In younger stems of *Nothofagus,* rays are more commonly uniseriate and erect ray cells are more common; this is in accordance with dicotyledons at large, in which rays become wider and attain a higher proportion of procumbent cells with age (Barghoorn 1941). Thus, trunks of old *Nothofagus* trees should not be used for anatomical comparisons with the Oliver Bluffs fragments.

Use of wood anatomy terms corresponds to the usage of the IAWA Committee on Nomenclature (1964).

RESULTS

Wood Fragments from Oliver Bluffs

The wood fragments recovered (Fig. 1) are devoid of bark and represent relatively small stems; many are appreciably contorted and only a few are straight. Webb (personal communication) reports that bark was present on samples still in the outcrops, but that bark flaked off specimens after they were collected. The surface texture of the wood is smooth like that of a coniferous wood. That appearance is deceptive however, because vessels are superficially not visible on account of the compression of the wood fragments (viz., Fig. 2). Because of the compression of the wood, growth rings are not visible in gross aspect, although they can be seen under the microscope (Fig. 2). The uniseriate nature of rays (Fig. 3) is reminiscent of the uniseriate nature of conifer woods, although the ray cells histologically are unlike those of conifers. All of the wood samples sectioned represent a single species, so that the description below represents all samples studied. The description is based mostly on Sample 9 of Unit 4, Section 5, because of the better visibility of features in fragments of that sample.

Growth rings can be detected in transection (Fig. 2) because tangentially oriented zones containing wider vessels can be seen. Many narrower vessels in the wood are not visible because of alteration in vessel walls, chiefly due to vessel collapse. This has resulted in the homogenized appearance of the wood transection, in which imperforate tracheary elements are not clearly visible. Degradation has occurred in the cellulosic walls of the imperforate tracheary elements, and pits are not visible in them although individual cell limits are preserved as seen in longisection (Fig. 3).

Although imperforate tracheary elements are not well preserved, some vessels are, especially as seen in radial section (Fig. 4). The wide vessels to the right in Figure 4 are earlywood, the narrower vessels in the left half of the photograph represent latewood. Growth ring presence can be established from radial sections more clearly than in transections. Also evident in Figure 4 is a feature which, in modern woods, one best sees in transections: vessel (pore) grouping. Although earlywood vessels appear mostly solitary in Figure 4, the latewood vessels are clearly grouped in radial files.

Ray characteristics are shown in Figures 3 and 4. The rays are mostly uniseriate,

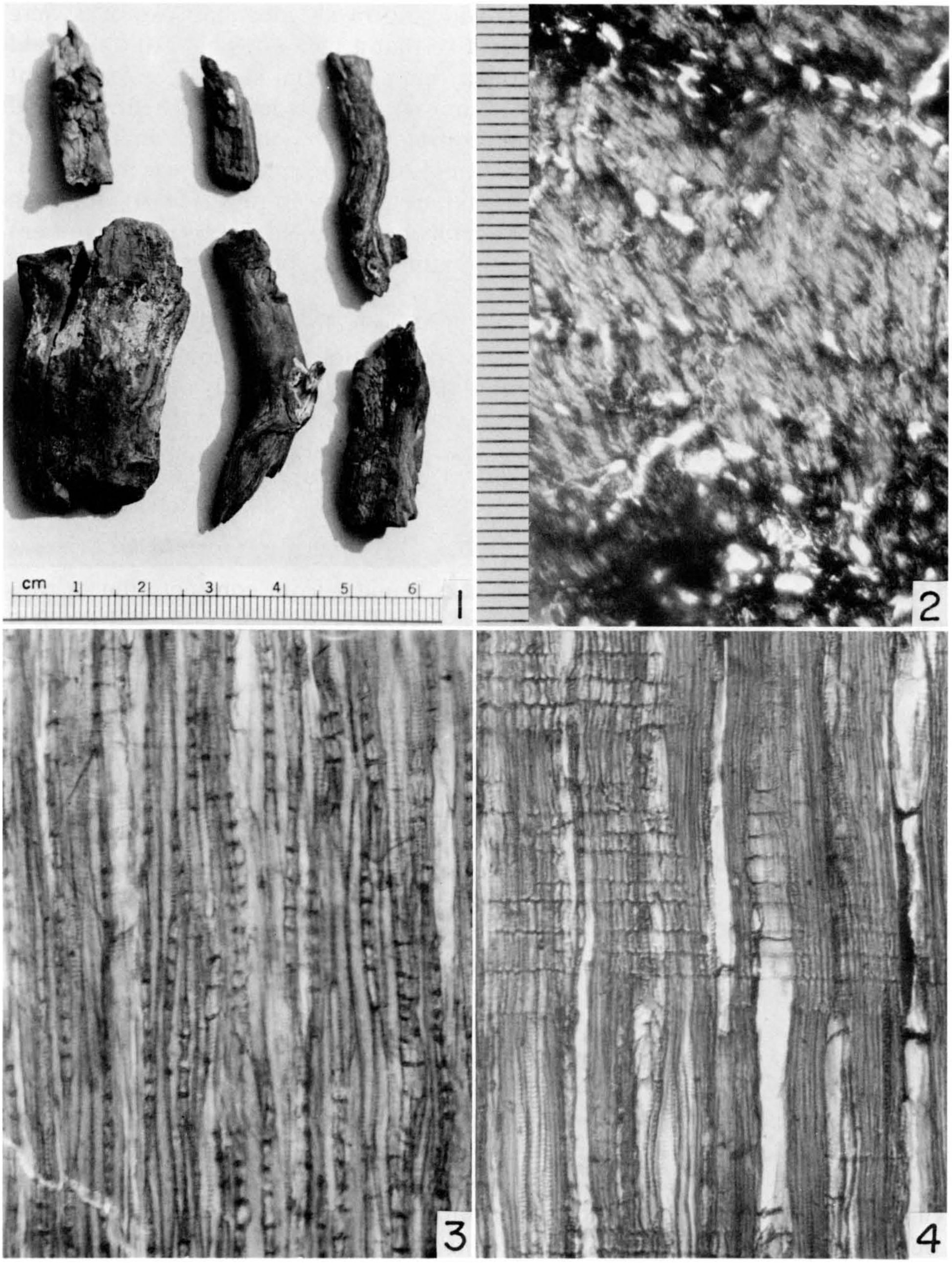

Fig. 1–4. Woods from Oliver Bluffs.—1. Wood fragments from Unit 4, Section 5, Sample 9.—2. Transection of wood (Unit 2, Section 8); growth rings evident at top and bottom; compression and degradation of libriform fibers have occurred.—3, 4. Wood sections (Unit 4, Section 5, Sample 9).—3. Tangential section; uniseriate rays are abundant.—4. Radial section; earlywood, left half of photograph; latewood has grouped narrow vessels. (Fig. 2–4, magnification scale to left of Fig. 2 [divisions = 10 μm].)

although occasional rays are two cells wide; no rays wider than two cells were observed. The rays are sufficiently intact so that a mean height, 210 μm, could be obtained (Sample 9). The shape of ray cells in radial section, an important diagnostic feature in wood anatomy, is not so reliably determined from radial sections because a certain amount of compression has occurred in the wood samples. Given that possibility, which would make erect cells appear more common, both erect and procumbent cells still are present in rays (Fig. 4), although the proportion of the two types cannot reliably be estimated. Erect cells are present at upper and lower tips of rays (Fig. 4, extreme left, center), procumbent cells occur in central portions of rays.

Vessel details are presented in Figures 5–9. Vessels contain tyloses (Fig. 5, center; Fig. 6, lower right). Although only a few perforation plates could be observed clearly, those discernible were all simple (Fig. 6). Lateral walls of wider vessels characteristically bear transitional pitting, well displayed in Figure 7. Narrower vessels bear either scalariform pitting (Fig. 8) or a mixture of scalariform and transitional pitting (Fig. 9).

Wood of Modern Species

Most modern woods could be eliminated rapidly from consideration as candidates for comparison to the Oliver Bluffs woods because of certain critical features. For example, *Laurelia* and *Eucryphia* have scalariform perforation plates almost exclusively, and both have numerous rays wider than two cells. Neither scalariform nor transitional pitting (especially the latter) is common in dicotyledons. However, the combination of transitional earlywood pitting with scalariform latewood pitting mentioned above is highly unusual, and can be found in very few species of *Nothofagus*; transitional pitting has been illustrated in vessels of *N. menziesii* (Hook. f.) Oerst. from New Zealand (Patel 1986). This and other features led me to concentrate on that genus as the probable one to which the Oliver Bluffs woods should be compared. However, data on wood anatomy of all *Nothofagus* species are not on hand, and thus new data had to be developed, although the recent review of Patel (1986) deals with the New Zealand species in excellent detail.

The New Zealand species of *Nothofagus* offer some features like those of the Oliver Bluffs woods, but some unlike (data from Meylan and Butterfield [1978] and from Patel [1986]). These species have well-marked growth rings except for *N. truncata* (Col.) Ckn., a lowland tree. Solitary vessels in earlywood, grouped vessels in latewood, tend to characterize *N. fusca* (Hook. f.) Oerst. and *N. solandri* (Hook. f.) Oerst. var. *cliffortioides* (Hook. f.) Poole, and at least some collections of *N. solandri* var. *solandri*. Simple perforation plates in earlywood occur throughout the New Zealand species of *Nothofagus*; scalariform perforation plates in latewood (very likely present in the Oliver Bluffs woods) occur in all of them. However, transitional and scalariform lateral wall pitting of vessels, considered a significant feature in the identity of the Oliver Bluffs woods, occurs in no New Zealand species: they have opposite, occasionally alternate, pitting exclusively. Predominantly uniseriate rays like those of the Oliver Bluffs woods occur in the New Zealand species only in *N. menziesii* and *N. solandri* var. *cliffortioides*. Although age can be a factor in production of wider rays (Barghoorn 1941), all of the specimens studied by Meylan and Butterfield (1978) and by Patel (1986)

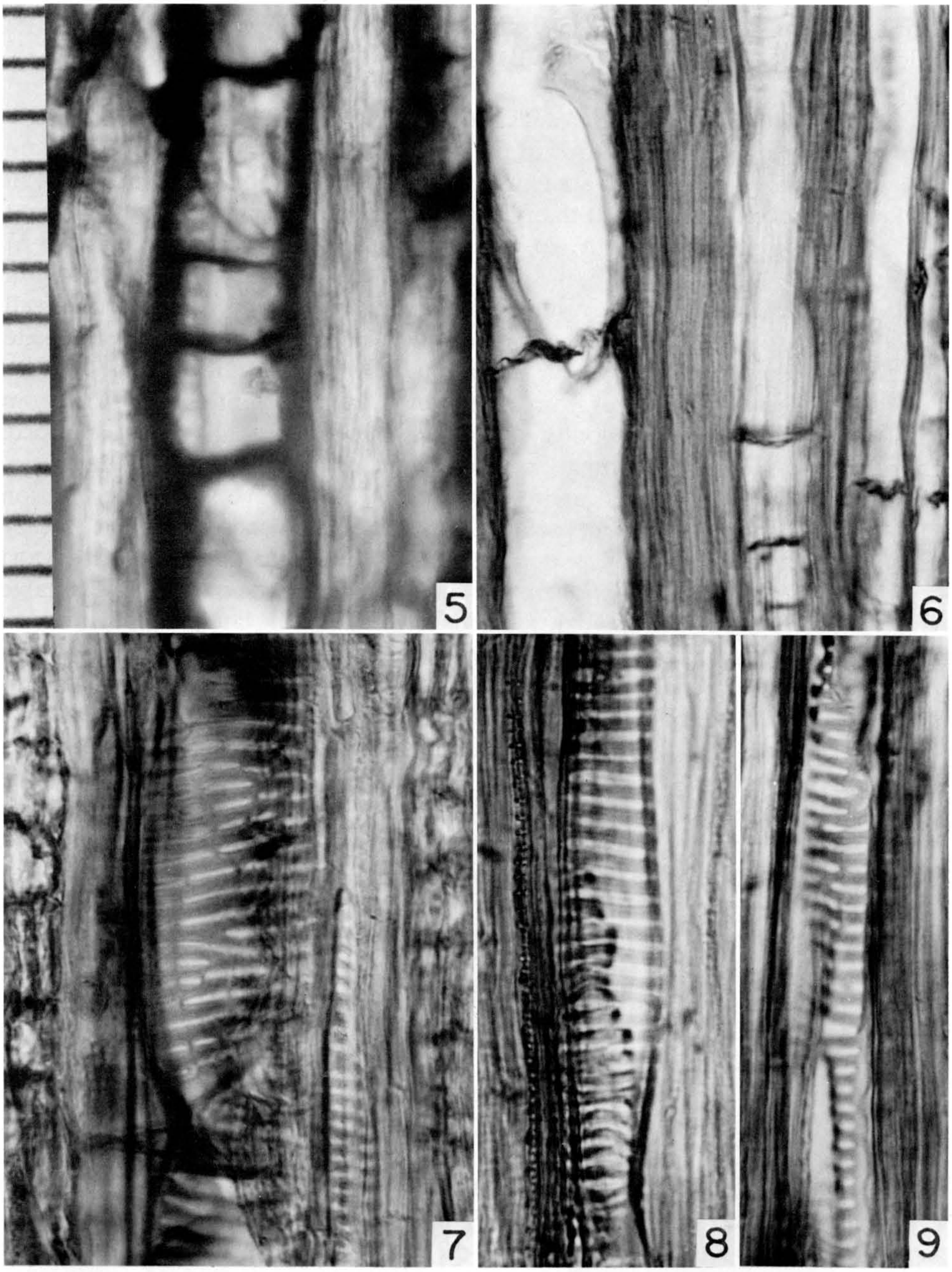

Fig. 5–9. Sections of wood fragments from Oliver Bluffs.—5. Radial section (Unit 4, Section 5); tyloses present in vessel, center.—6–9. Sections of woods from Unit 4, Section 5, Sample 9.—6. Radial section showing simple perforation plate (upper left) and tyloses (lower right).—7–9. Lateral wall pitting of vessels from radial sections.—7. Earlywood vessel with transitional pitting.—8. Latewood vessel with scalariform pitting.—9. Vessel with transitional pitting. (Fig. 5–9, magnification scale to left of Fig. 5 [divisions = 10 μm].)

appear mature, if one can judge from the nearly parallel nature of their rays. Tyloses, present in the Oliver Bluffs woods, are occasional in all of the New Zealand species of *Nothofagus.*

Two species of *Nothofagus* from subtropical to tropical latitudes show only moderate degrees of resemblance to the Oliver Bluffs woods. Growth rings are present in *N. codonandra,* but are expressed more in terms of libriform fiber wall thickness (thicker in latewood) than in vessel diameter. Growth rings are absent in the New Guinea species ("*N.* sp."). There is very little vessel grouping in *N.* sp., moderate (earlywood) to appreciable (latewood) grouping in *N. codonandra.* Perforation plates are simple, rarely scalariform, in both species. In lateral wall pitting, both species differ from the Oliver Bluffs woods: they have pitting opposite or alternate. Rays are uniseriate in *N.* sp., but often biseriate in *N. codonandra.*

Three species of *Nothofagus* from South America have features that differ from those of the Oliver Bluffs woods. *Nothofagus procera* has all vessels grouped; although growth rings are strongly marked (vascular tracheids terminate the latewood), no solitary vessels occur in earlywood. Vessels have simple perforation plates mostly (a few scalariform perforation plates in latewood vessels that precede vascular tracheids). Vessels have opposite (less commonly alternate) pitting. Most rays are biseriate. In *N. pumilio,* growth rings are sharply demarcated, with large vessels in earlywood and vascular tracheids terminating the latewood. Vessels are, however, grouped in both earlywood and latewood. Vessels have simple perforation plates (occasionally scalariform in latewood just before the vascular tracheids). Vessels have opposite or alternate (rarely transitional) pitting. Vessels of *N. pumilio* have helical sculpture, a feature otherwise reported for *Nothofagus* only in *N. moorei* (F. Muell.) Krasser (Dadswell and Eckersley 1935). Rays are uniseriate in *N. pumilio,* with erect cells nearly as common as procumbent cells. A third South American species, *N. antarctica,* has well-marked growth rings, unusual in that vessel diameter is uniformly relatively large (Fig. 10) except for the latewood, in which vessel diameter decreases somewhat. Vessel grouping is prominent (Fig. 10) in both earlywood and latewood. Perforation plates are simple. Lateral wall pitting of vessels is unusual for the genus in being transitional throughout the wood (Fig. 14). Tyloses are abundantly present (Fig. 14). Rays are mostly uniseriate, some biseriate (rays in *N. antarctica* are occasionally storied, a first report of this feature for the genus and family).

Two species of *Nothofagus* have wood that matches that of the Oliver Bluffs woods almost exactly. Of the two, *N. betuloides* has therefore been illustrated here more extensively. Photomicrographs of *N. betuloides* have been arranged so as to match the arrangements of the Oliver Bluffs woods: thus, Figures 11, 12, and 13 are arranged in the same fashion as Figures 2, 3, and 4. Vessel details of *N. betuloides* occupy another plate (Fig. 15–17) just as do vessel details of the Oliver Bluffs wood (Fig. 6–9). Growth rings in *N. betuloides* are well marked (Fig. 11); early wood vessels are often solitary, and relatively few in number compared to the numerous latewood vessels, which are grouped extensively. Growth rings terminate with a few vascular tracheids. Perforation plates are simple (Fig. 15), although a few scalariform perforation plates may be found in latewood just before the vascular tracheids. Lateral wall pitting of vessels is often transitional (Fig. 16; also, slightly out of focus, Fig. 17, left). However, latewood vessels chiefly have scalariform lateral wall pitting (Fig. 15, right; Fig. 17). This range in lateral wall

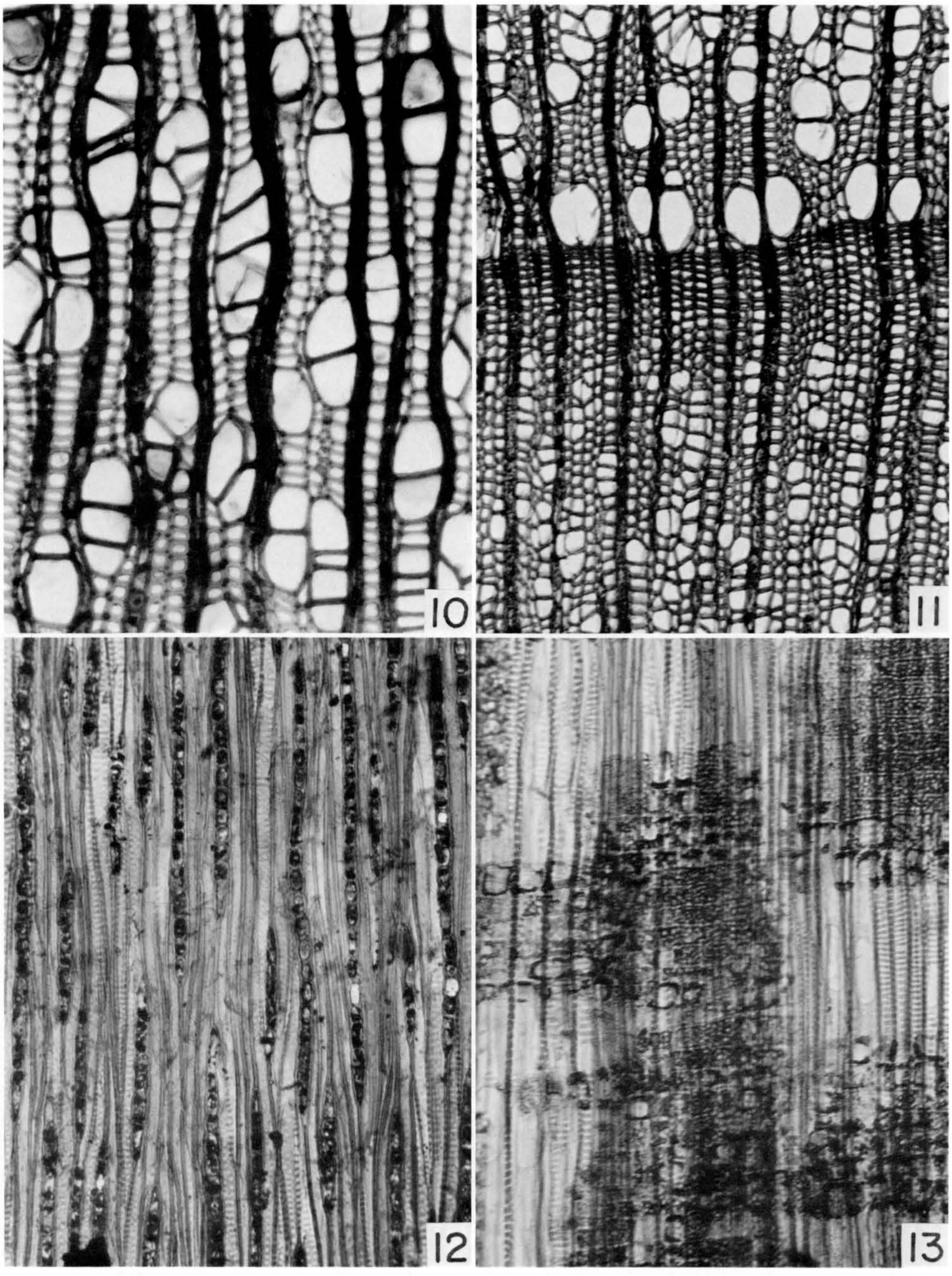

Fig. 10–13. Wood sections of *Nothofagus*.—10. *N. antarctica* (*Mexia 7918*), transection showing grouped nature of vessels and moderately large vessel diameter.—11–13, *N. betuloides* (*Goodall 1007*).—11. Transection; earlywood above with vessels solitary at outset; latewood, below, has very narrow vessels in large groups.—12. Tangential section, showing uniseriate nature of rays.—13. Radial section: earlywood at left, latewood in right half of photograph; ray cells contain dark-staining compounds. (Fig. 10–13, magnification scale to left of Fig. 2.)

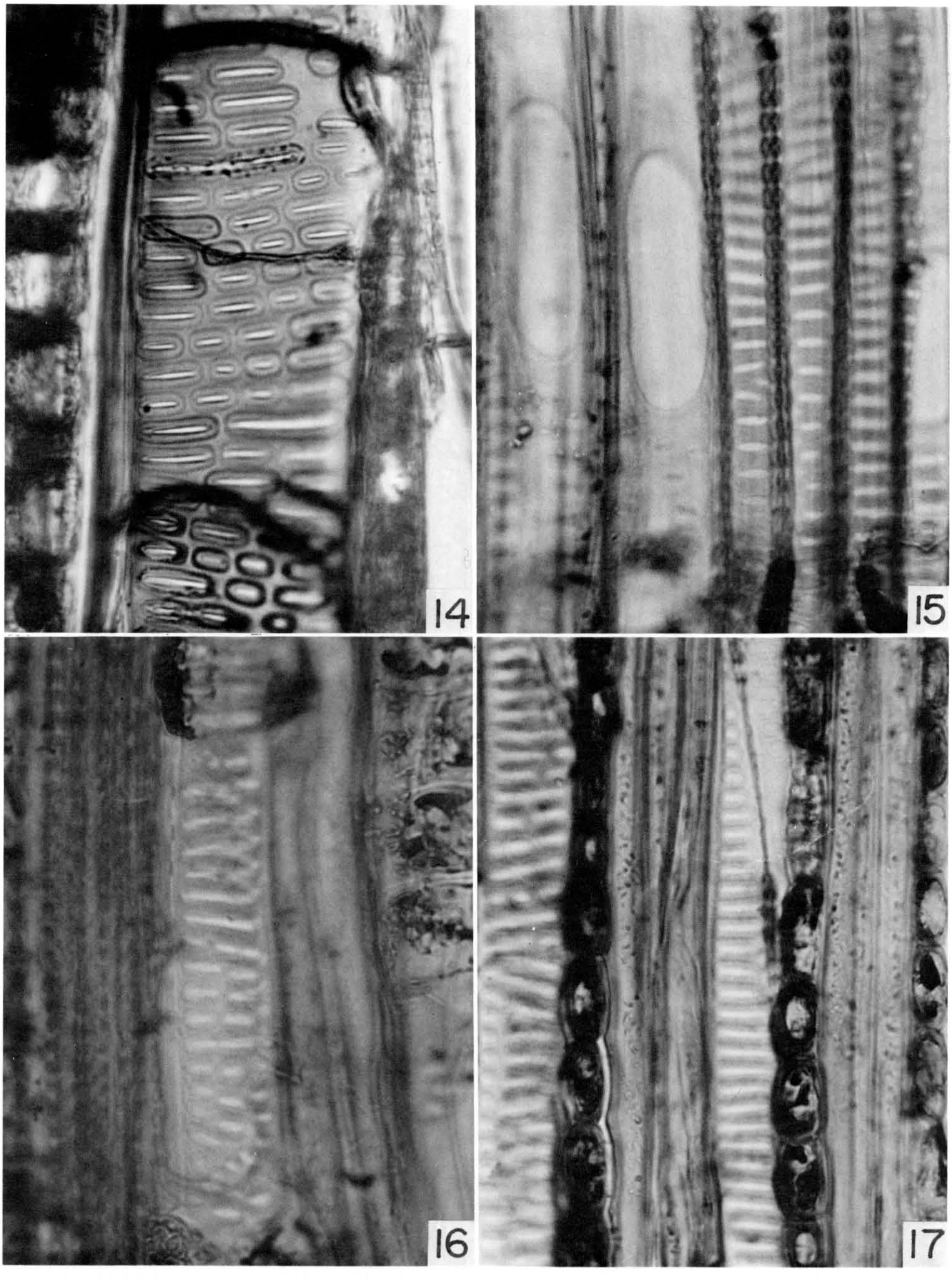

Fig. 14–17. Wood sections of *Nothofagus.*—14. *N. antarctica* (*Mexia 7918*), vessel wall from tangential section showing transitional lateral wall pitting; tylosis walls lie transversely in front of vessel wall.—15–17. *N. betuloides* (*Goodall 1007*).—15. Radial section; simple perforation plate at left; scalariform lateral wall pitting visible on the narrow elements at right, which are either narrow vessels or vascular tracheids.—16. Vessel wall from radial section, showing transitional pitting.—17. Vessels from tangential section; scalariform lateral wall pitting, center (transitional pitting, out of focus, in vessel at left). (Fig. 14–17, magnification scale to left of Fig. 5.)

pitting matches exactly what one finds in the Oliver Bluffs woods. The rays of *N. betuloides* are predominantly uniseriate, with a few biseriate rays present. The mean height of uniserate rays in *N. betuloides* is 198 μm, statistically identical to the 210 μm mean ray height found in Sample 9 of the Oliver Bluffs woods. Ray cells range from erect to procumbent in *N. betuloides,* the two types about equal in abundance or with procumbent cells somewhat more numerous (Fig. 13).

The other species that shows marked similarity to the Oliver Bluffs woods is *N. gunnii,* from alpine Tasmania—geographically remote from the Fuegian *N. betuloides.* Growth rings in *N. gunnii* are sharply demarcated, often narrow. Vessels are in small groups (rarely solitary) in earlywood, but in large groupings in latewood. Perforation plates are simple except for a few latewood vessels, in which scalariform plates may be found. Vascular tracheids are present at the ends of growth rings. Lateral wall pitting is predominantly transitional in earlywood, predominantly scalariform in latewood. Rays are almost exclusively uniseriate; only a few biseriate ray cells are present, despite the fact that the sample is more than 10 yr old (some growth rings difficult to interpret). Ray cells are both procumbent and erect; the two types are about equally frequent despite the fact one might expect procumbent cells more abundantly in a more mature wood sample such as that available for *N. gunnii* (Barghoorn 1941). Where growth rings are very short, as they are in *N. gunnii,* one might expect erect cells to be more common, however, because more radial elongation is sometimes observed in earlywood than in latewood in dicotyledons at large. This may also explain the relatively high proportion of erect ray cells observed in the Oliver Bluffs woods, in which growth rings, although difficult to discern clearly, are very likely narrower than in the arboreal species of *Nothofagus.* The libriform fibers of *N. gunnii* are notably thick walled. This feature alone would permit one to differentiate between *N. gunnii* and *N. betuloides.* The wall thickness of libriform fibers in the Oliver Bluffs woods cannot be determined accurately.

Other features characteristic of wood of *N. betuloides* and other modern species of *Nothofagus* could not be observed in the Oliver Bluffs woods. Dark-staining deposits in ray cells (Fig. 13, 17), are not present in the Oliver Bluffs woods for the most part, although a few dark-staining deposits in vessels (Fig. 5), which may not represent the same substance, were observed. Axial parenchyma strands in *Nothofagus* consist of chambered crystals, and vary from uncommon (*N. antarctica*) to very common (*N. codonandra*), but these are not evident in the Oliver Bluffs woods; the treatment with HF would have removed any crystals.

DISCUSSION AND CONCLUSIONS

The Oliver Bluffs woods studied are clearly all a species of *Nothofagus,* with so close a match to *N. betuloides* and *N. gunnii* that one cannot distinguish wood features of those two species from those of the Antarctic plant (to the extent those features are preserved). However, one should entertain the hypothesis that the Oliver Bluffs plants might not be conspecific with either of the modern species but might represent a species (presumably related to one of them) that is now extinct. The presence of transitional and scalariform patterns of lateral wall pitting in *N. betuloides* and *N. gunnii* (patterns otherwise scarce in *Nothofagus* except for *N. antarctica*) is persuasive in assigning the Oliver Bluffs woods to the vicinity of those two modern species. *Nothofagus betuloides,* along with *N. antarctica* and *N. pumilio,* extends from southern Chile and Argentina to the southern shores of Tierra del Fuego (Schick 1980), and thus represents a closer geographical approach to Antarctica than do other South American species. Likewise, *N. gunnii* also occupies similarly extreme ecology, particularly when one remembers that *N. gunnii* occurs in alpine Tasmania rather than at sealevel.

Nothofagus has been reported in Antarctica previously. The report of *Nothofagus* pollen by Cranwell (1959) applies to Seymour Island, well north of the Oliver Bluffs site. Truswell (1983) reports reworked *Nothofagus* pollen from Antarctic continental shelf sediments. *Nothofagus* pollen ("*N. fusca* group") has been reported from the Oliver Bluffs deposits by Askin and Markgraf (1987); they do not give the basis on which they assign the pollen to that group of *Nothofagus* species. Askin and Markgraf regard the *Nothofagus* grains as redeposited because the grains are "thin and somewhat corroded." In view of the degradation of cellulosic walls of libriform fibers and ray cells in the Oliver Bluffs woods, some degradation in pollen exines would be understandable, and the conclusion by Askin and Markgraf (1987) that the grains are redeposited may be questioned in view of the present report. The most pertinent find of *Nothofagus* in the Antarctic yet may be that of Peter Barrett (personal communication, via P.-N. Webb), who has recovered an intact leaf identified by Robert Hill as *N. gunnii* from an Oligocene stratum of a coring in the Transantarctic Mountains.

The presence only of *Nothofagus* among the wood samples studied may suggest floristic poverty, as does the limited number of palynomorphs recovered from the Oliver Bluffs deposits. Askin and Markgraf record, in addition to *Nothofagus,* only some presumptively redeposited conifer grains and some tricolpate grains and tetrads they refer to "Lamiaceae or Polygonaceae" (identification of tricolpate dicotyledonous pollen with reticulate exines is very difficult, perhaps impossible with some common patterns). Thus, the Oliver Bluffs woods do not mitigate the picture of floristic poverty the pollen record tends to convey.

Nothofagus wood has been found in the Falkland Islands, where the genus no longer survives, by Halle (1912); the site has recently been reexamined by Birnie and Roberts (1986). Birnie and Roberts refer the wood to the *N. fusca* group, although they do not give the basis on which that assignment is made. The dating of the Falklands *Nothofagus* wood is uncertain: the dating of the deposit as pre-Miocene because grass and composite pollens were not recovered from the same deposit as the woods is open to question.

We know little about whether *Nothofagus* or other seed plants would grow at such a high latitude as that of the Oliver Bluffs locality if temperatures were milder but the day lengths were as they are today there. The southern edge of Tierra del Fuego seems a far-southerly locality until one notes that that coast lies at about 55°S., far short of the 85°10′ latitude of Oliver Bluffs. Very likely some species could survive the day length regime of Antarctica were temperatures milder, and one can only wish that experimental attempts to ascertain this possibility would be made now that we know plants very likely managed survival under those conditions. Very interesting in this regard is the fact that the *Nothofagus* species that match most closely the wood anatomy of the Oliver Bluffs plants are those that represent the present-day furthest south extensions of the genus.

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