

Latest Cretaceous and earliest Tertiary dispersed plant cuticles from Seymour Island

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Plant cuticle—the decay-resistant outer layer of leaves and young stems—is the most abundant, systematically diagnostic component of the terrestrial plant fossil record next to pollen and spores. Plant cuticles typically preserve the shape of underlying epidermal cells, which together with features of the cuticle surface permit the paleobotanist to identify highly fragmented leaf material at taxonomic levels ranging from species to class. Plant cuticles also possess features that reflect the physiognomy of the parent plant, features that make cuticles potentially sensitive indicators of vegetational and climatic change. Because highly fragmented leaf material has greater transport and preservation potential than whole leaves, dispersed plant cuticles should provide a window to the leaf fossil record in marine stratigraphic sequences.

The research reported here constitutes a pilot study of dispersed plant cuticles in nearshore to marginal marine rocks spanning the Cretaceous/Tertiary boundary on Seymour Island, Antarctica. This study was initiated to determine the feasibility of studying dispersed plant cuticles in nearshore to marginal marine rocks and supplement extensive palynological data on floristic change at high southern paleolatitudes with data from leaf remains, which can provide evidence on ecological change independent of inferred modern affinities.

The samples examined in this study were collected by F.C. Barbis and J.R. Robinson in December 1983 from units 8, 9, and 10 of the López de Bertodano Formation, in exposures at the southern end of Seymour Island [section B-1 of Askin (1988)]. Units 8, 9, and 10 have been dated as upper Maastrichtian to lower Danian on the basis of dinoflagellate cysts, siliceous-walled microfossils, planktonic foraminifera, and macroinvertebrates (e.g., Macellari 1986; Askin 1988; Harwood 1988; Huber 1988). Precise placement of the Cretaceous/Tertiary boundary varies according to the fossil group examined; we place it in the interval where relative abundances of Maastrichtian dinoflagellate species change to typical Tertiary values (between

samples B1-108 and B1-110 of Askin 1988). This level approximates the boundary between units 9 and 10.

Dispersed cuticles were prepared from the same samples as pollen to facilitate comparisons between dispersed cuticle and palynomorph assemblages. Generally, 100 to 200 grams of sample were prepared for cuticle, with the exact amount dependent on the availability of sample. Samples were disaggregated, macerated, stained, and mounted according to the procedures outlined in Upchurch (1989).

Upper-Maastrichtian-dispersed cuticle assemblages show a roughly equal abundance of gymnosperms (e.g., conifers, cycads) and angiosperms, as is the case for pollen and spore assemblages from the same samples. Seymour Island conifers show high relative abundance and diversity, especially when compared to coeval assemblages from slightly lower paleolatitudes in the Western Interior of North America (Lance and Hell Creek Formations—Upchurch unpublished data). One distinctive group of dispersed conifer cuticles is characterized by longitudinally oriented stomata that possesses a well-defined ring of four specialized neighboring cells, a combination of features that typifies many extant Podocarpaceae and Araucariaceae. Within this group, the stomata of some species show a well-developed peristomatal rim formed by the outer walls of the neighboring cells (figure 1A, arrow), as is typical of extant Podocarpaceae, while the stomata of other species show no peristomatal rim on the neighboring cells (figure 1C), as is characteristic of many extant *Araucaria*. Another noteworthy group of dispersed cuticles is characterized by papillate epidermal cells and unoriented stomata with features characteristic of extant Cupressaceae. One species in this group has stomata with well-developed peristomatal rims (figure 1B), which characterize the genera *Chamaecyparis*, *Cupressus*, *Diselma*, *Libocedrus*, and *Thuja*; a second species has stomata with a ring of strongly pappillate neighboring cells (figure 1D, arrows), which characterize the genera *Juniperus*, *Microbiota*, *Tetraclinis*, and *Widdringtonia*. Gymnospermous cuticles of uncertain familial affinities also have been found. All gymnosperms are characterized by thick cuticle with well-defined cell outlines, which typifies evergreen conifers and cycads (e.g., Harris 1976; cf., Pant and Nautiyal 1963). Taxonomic comparisons with extant conifers are based largely on Florin (1931).

Upper Maastrichtian angiosperms comprise both monocotyledons and dicotyledons. Monocotyledons include species with the thick cuticle characteristic of evergreens and species with the thin cuticle characteristic of thin-leaved herbs. Familial affinities of monocotyledonous cuticle types are currently unknown.

Dicotyledonous cuticle types include species assignable to the primitive subclass Magnoliidae (the magnolias, laurels, and allies) and species assignable to more advanced subclasses ("higher dicots"). Magnoliid cuticle types are recognized by the occurrence of flat, lamellar cuticular thickenings on the guard cells, a character that in extant angiosperms appears to be restricted to subclass magnoliidae (Baranova 1972; Upchurch unpublished data). Magnoliid cuticle types include one species assignable to Lauraceae (figure 2A) and a species of uncertain familial affinities characterized by paracytic stomata. Both species of Magnoliidae have the thick, robust cuticle that characterizes extant relatives with evergreen leaves.

Higher dicots constitute the most abundant and diverse type of angiosperm cuticle and include species with the thick cuticle

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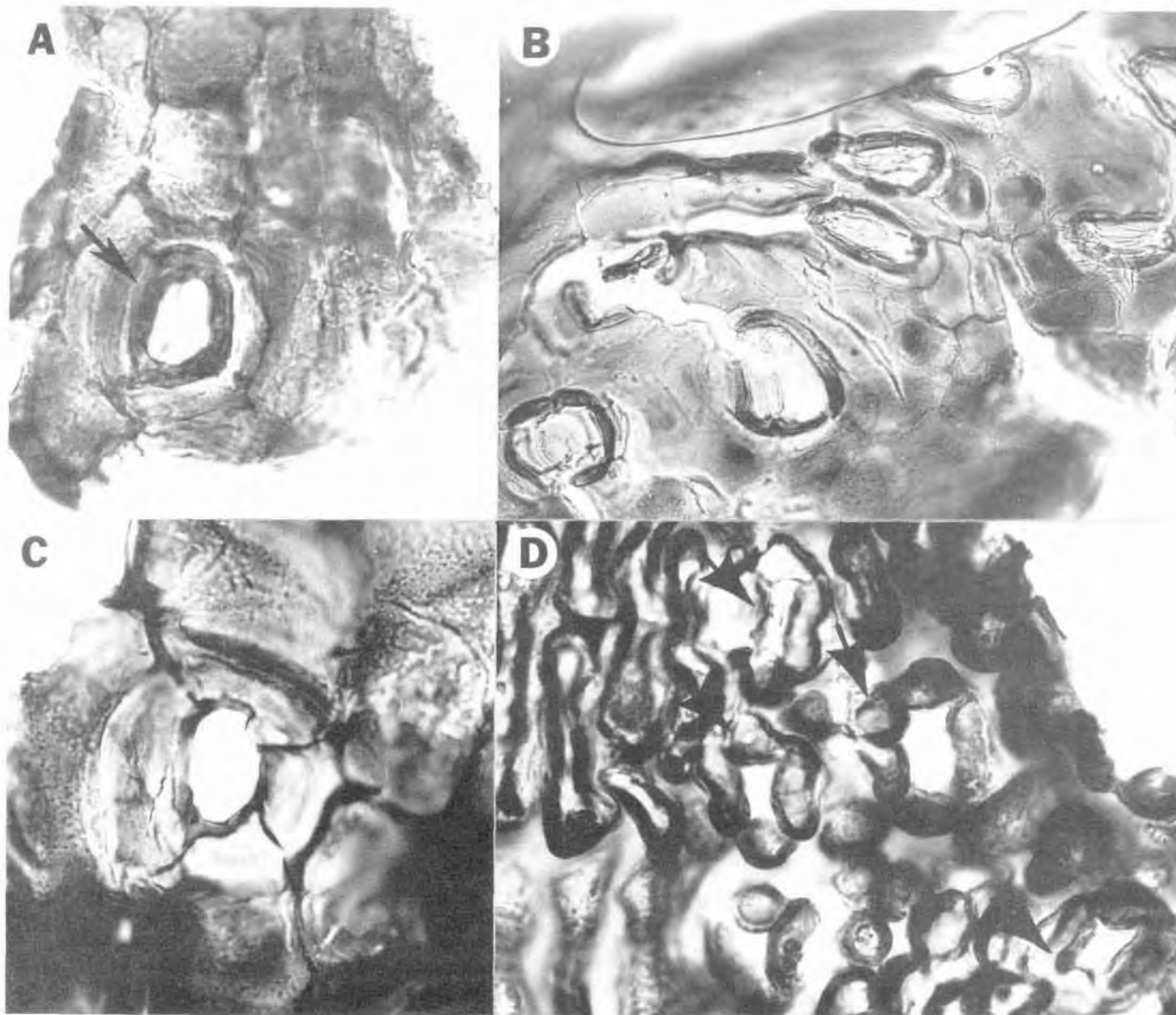


Figure 1. Coniferous dispersed cuticles. A. Species with a ring of four specialized neighboring cells and well-developed peristomatal rim (arrow) (cf. Podocarpaceae), B1-20, \times 512. B. Species of Cupressaceae with few papillate cells and well-developed peristomatal rims, B1-47, \times 400. C. Species with a ring of four specialized neighboring cells and no peristomatal rim (cf. *Araucaria*, B1-162, \times 1024. D. Species of Cupressaceae with strongly developed papillae on both the neighboring cells (arrows) and unspecialized epidermal cells, B1-87A, \times 820.

characteristic of evergreens (figures 2B, 2C) and species with the thin cuticle characteristic of deciduous woody plants and herbs (figure 2D). Higher dicot affinities are recognized on the basis of well-developed ridge-shaped cuticular thickenings adjacent to the stomatal pore (stomatal ledges), a character that is absent or only weakly developed within Magnoliidae. The most abundant type of higher dicot cuticle is characterized by a ring of specialized neighboring cells surrounding the guard cells (cyclocytic stomata) and pores that represent either glands or points of hair attachment (figure 2B). The familial affinities of this cuticle type are currently unknown. Additional types of higher dicot cuticle include one species with the generally round stomata, cyclocytic subsidiary cell arrangement, and trichome bases characteristic of extant Myrtaceae (figure 2C) and species of unknown familial affinities (e.g., figure 2D).

Epiphyllous fungi (i.e., fungi that live on the surface of leaves) are another significant component of dispersed cuticle assemblages. Notable is the occurrence of flat, branched fruiting bodies assignable to the form-genus *Trichopeltinites* (figure 2E), a taxon that commonly occurs in coeval cuticle assemblages from the Western Interior of North America.

Early Danian dispersed cuticle assemblages are known only from the upper part of unit 10; samples from immediately above the Cretaceous/Tertiary boundary preserve little cuticle and show evidence for oxidation. Although fewer species of dispersed cuticle have been observed in the early Danian than in the late Maastrichtian, dispersed cuticle assemblages show no change in dominant elements at higher taxonomic levels, and the vast majority of species is characterized by the robust cuticle typical of evergreens. This contrasts with early Danian-

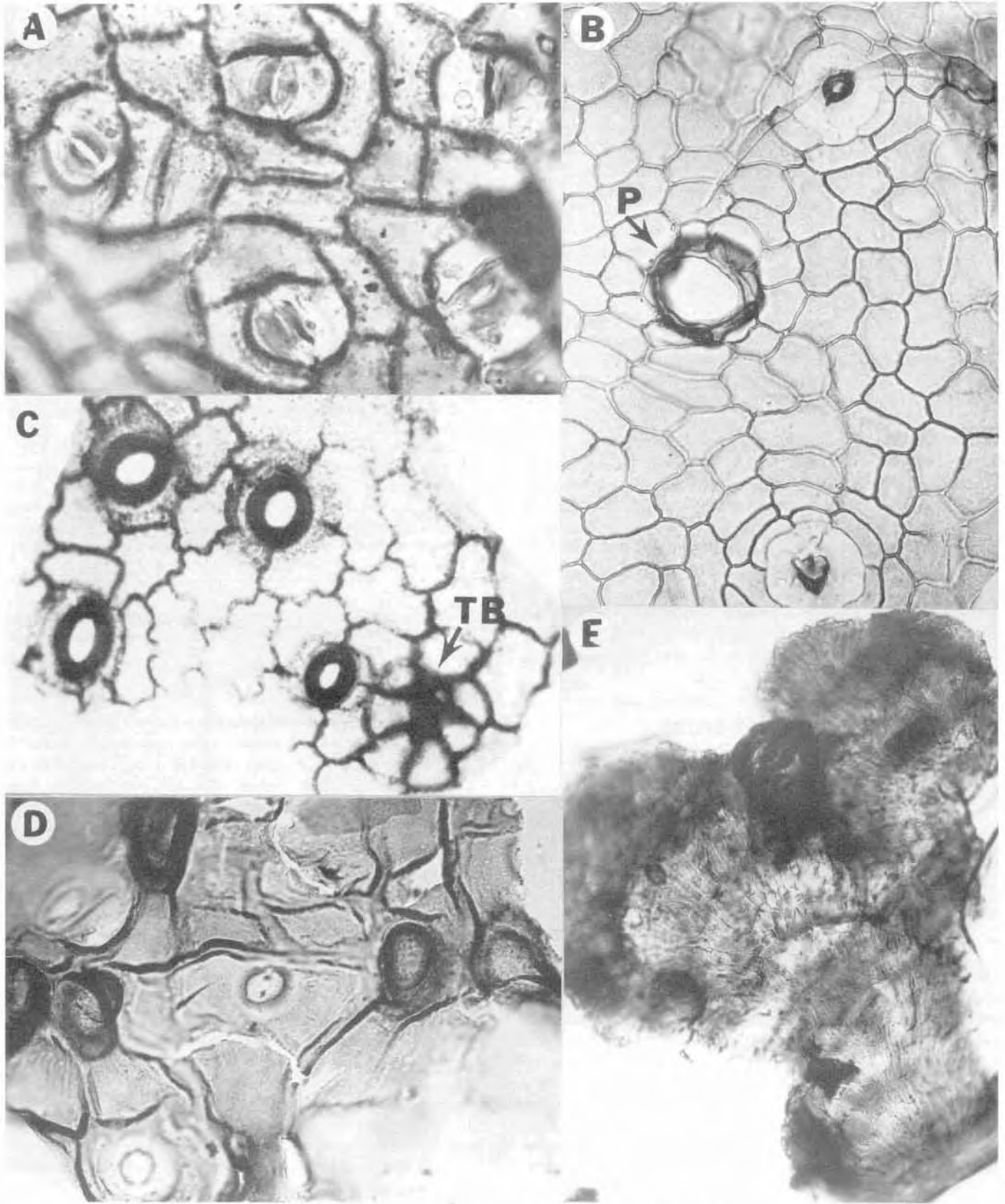


Figure 2. Angiospermous dispersed cuticles and an epiphyllous fungus. A. Lauraceae. Note the paracytic subsidiary cells and scale-like stomatal thickenings characteristic of family, B1-91, $\times 820$. B. Higher dicot with cyclocytic stomata and pore (P), B1-94, $\times 512$. C. ?Myrtaceae? with generally circular stomata, cyclocytic to laterocytic subsidiary cells, and a trichome base (TB), B1-97, $\times 512$. D. Higher dicot with thin cuticle and papillate trichomes, B1-20, $\times 640$. E. Epiphyllous fungus assignable to *Trichopeltinites*, B1-121, $\times 400$.

dispersed cuticle assemblages from the Western Interior of North America, which show a change in dominant elements (e.g., Wolfe and Upchurch 1987) and, at higher paleolatitudes, an increase in the percentage of species with thin cuticles (Fort Union Formation—Upchurch unpublished data). Also noteworthy is the occurrence of the epiphyllous fungus *Trichopeltinites* in the early Danian of Seymour Island, because *Trichopeltinites* becomes extinct at the Cretaceous/Tertiary boundary in the Western Interior of North America. These data are consistent with suggestions that the vegetation of high southern paleolatitudes was little affected by events at the Cretaceous/Tertiary boundary.

Research was supported by National Science Foundation grant DPP 87-16484 to R. A. Askin with a subcontract to G.K. Upchurch, Jr., at the University of Colorado, Boulder. Preparation of this report was supported, in part, by a postdoctoral fellowship from the National Center for Atmospheric Research to G.R. Upchurch, Jr.

References

- Askin, R.A. 1988. The palynological record across the Cretaceous/Tertiary transition on Seymour Island, Antarctica. In R.M. Feldmann and M.O. Woodburne (Eds.), *Geology and Paleontology of Seymour Island, Antarctic Peninsula*. (Geological Society of America Memoir 169), 155–162.
- Baranova, M.A. 1972. Systematic anatomy of the leaf epidermis in Magnoliaceae and related families. *Taxon*, 21, 447–469.
- Florin, R. 1931. Investigations into the phylogeny of Coniferales and Cordaitales. *Kungliga Svenska Vetenskapsakademiens Handlingar*, Series 3, 10(1). (In German.)
- Harris, T.M. 1976. Two neglected aspects of fossil conifers. *American Journal of Botany*, 63, 902–910.
- Harwood, U.M. 1988. Upper Cretaceous and lower Paleocene diatom and silicoflagellate biostratigraphy of Seymour Island, eastern Antarctic Peninsula. In R.M. Feldmann and M.O. Woodburne (Eds.), *Geology and Paleontology of Seymour Island, Antarctic Peninsula*. (Geological Society of America Memoir 169) 55–129.
- Huber, B.T. 1988. Upper Campanian-Paleocene foraminifera from the James Ross Island region, Antarctic Peninsula. In R.M. Feldmann and M.O. Woodburne (Eds.), *Geology and Paleontology of Seymour Island, Antarctic Peninsula*. (Geological Society of America Memoir 169) 163–252.
- Macellari, C.E. 1986. Late Campanian-Maastrichtian ammonite fauna from Seymour Island (Antarctic Peninsula). *Journal of Paleontology* *Memoir*, 18.
- Pant, D.D., and D.D. Nautiyal. 1963. Cuticle and epidermis of recent Cycadales. Leaves, sporangia, and seeds. *Senckenbergiana Biologica*, 44, 257–347.
- Upchurch, G.R., Jr. 1989. Dispersed angiosperm cuticles. In B.H. Tiffney (Ed.), *Phytodebris: Notes for a Workshop on the Study of Fragmentary Plant Remains*, Paleobotanical Section, Botanical Society of America.
- Wolfe, J.A., and G.R. Upchurch, Jr. 1987. Leaf assemblages across the Cretaceous-Tertiary boundary in the Raton Basin, New Mexico and Colorado. *Proceedings of the National Academy of Sciences, USA*, 84, 5, 996–5,100.