2. S. Udenfriend, H. Weissbach, C. T. Clark, *J. Biol. Chem.* 215, 337 (1955).
3. D. W. Woolley and E. Shaw, *Brit. Med. J.* 1954, II, 122 (1954).
4. S. Udenfriend, H. Weissbach, A. Sjoerdsma, *Science* 123, 669 (1956).
5. This investigation was supported by research grant No. M-1015(c) from the National Institute of Mental Health, National Institutes of Health, U.S. Public Health Service.
6. American Instrument Co.
7. Fisher Scientific Co.
8. Instruction Manual, Aminco-Bowman spectrophotofluorometer, pp. 11, 12.
9. H. Howerton, American Instrument Co., Silver Spring, Md., personal communication.
10. P. Nolan, Farrand Optical Co., New York, N.Y., personal communication.
11. F. Wokes and E. J. Bowen, *Fluorescence of Solutions* (Longmans, New York, 1953).
12. F. Wokes, J. G. Organ, B. M. Still, F. C. Jacoby, *Analyst* 69, 1 (1944).
* Research associate supported by U.S. Public Health Service grant No. M-1015(c). Present address: New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, N.J.

26 October 1956

Minnesota Cretaceous Pine Pollen

Although plant fossils from Cretaceous sediments in Minnesota are generally poorly preserved and fragmentary, there have been occasional noteworthy finds. Chaney (*1*) has described a pine cone (*Pinus clementsii*) from Springfield, Minn., that is morphologically identical to the cones of *P. resinosa* Ait., the red pine, a species still found in the northeastern part of the state. Contemporaneous deposits from New Ulm, 25 miles east of Springfield, have yielded impressions of pine needles also similar to *P. resinosa*.

This report (*2*) is based on a preliminary analysis of sediments that occur in the vicinity of New Ulm. These deposits are assigned to the early Upper Cretaceous Dakota Series [(sensu lat.) (*3*)] and represent sediments deposited on flood plains, in stream and river channels, and in lakes or catchment basins. Extensive exposures occur sporadically along both banks of the Big Cottonwood River between Springfield and New Ulm. Coarse to fine sands, often cross-bedded and occasionally cemented, comprise the main fabric of the formation in the area, but seams of shaly clays ranging in thickness from a few millimeters to several feet are not uncommon. In some of the clay seams, intact leaf cuticles occur; because of their excellent preservation, it was thought that plant microfossils might also be present.

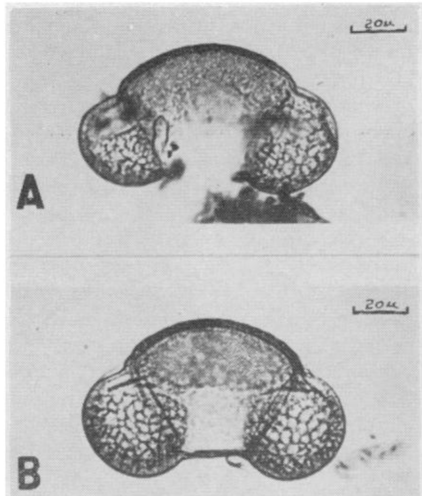

Fig. 1. (*A*) Lateral view of Cretaceous pine pollen. *Pinus resinosipites* sp. nov. (low mid-focus; slide PKP 24L-3; location, 18.9 × 119.2 (ref. 57.7 × 127.6). Vesiculated grain; bladders with coarse, internal reticulations, constricted at base (*sylvestris* type); marginal crest poorly developed; exine granular; size across widest part of body exclusive of wings, 58.4 μ; size including wings, 84.5 μ. The holotype is in the paleobotanical collection at the University of Minnesota (*7*). (*B*) Lateral view of red pine pollen.

Past analysis (*4*) of sediments of this age yielded little information, for only spores of undetermined botanical origin were recovered. My samples, when treated by Traverse's methods (*5*), provided moderately abundant spores and pollen the preservation of which is comparable to that of pollen from early postglacial peat deposits. The comparative analysis of these microfossils is still in its initial stages, but sufficient observations have been made to indicate that abietineous pollen is the most abundant (*6*).

In the accompanying figure, one such grain (Fig. 1*A*) is shown above a grain from red pine (Fig. 1*B*); both grains have been acetolyzed. There is no discernible difference between this grain and the pollen of *P. resinosa*; however, this is not unequivocal evidence that the two grains are specifically identical. Interspecific variation in the pollen of the Abietineae is slight. Descriptively, the pollen of *P. strobus, P. echinata, P. sylvestris,* and Wodehouse's pollen species *P. scopulipites* seem quite similar to the pollen of *P. resinosa*. Differences in body size and marginal crest development are not great enough for reliable use in identification of single grains, but Cain's (*8*) size-frequency data do show that this grain's body size corresponds with the average for *P. resinosa*.

With the addition of this information to the fossil record, together with the cone and foliage previously described by Chaney, it appears likely that one of the Cretaceous pines of Minnesota has a counterpart in the living red pine. It would seem unwise to conclude that red pine has existed as a specific entity since the Cretaceous, for its Tertiary record is unknown, but the morphological evidence is temptingly suggestive. If the relationship indicated by the fossil record was accompanied by an ecological similarity, there must have been heights of land sufficiently elevated to cause a vertical floral zonation, for the remainder of the fossil record of this stage indicates warm temperate conditions.

RICHARD L. PIERCE

Department of Botany,
University of Minnesota, Minneapolis

References and Notes

1. R. W. Chaney, *Ecology* 35, 145 (1954).
2. This work was supported by financial assistance from the Minnesota Geological Survey and the National Science Foundation.
3. F. W. Sardeson, *Bull. Geol. Soc. Amer.* 19, 211 (1908), named the deposits of this area the Big Cottonwood formation; however, C. R. Stauffer and G. A. Thiel, *Minn. Geol. Survey Bull.* 29, 129 (1941) described the section from which the pollen was obtained and referred it to the Dakota formation (sensu lat.). E. J. Bolin, *J. Paleontol.* 28, 512 (1954), considers the microfauna of the deposits as indicative of a Niobrara age.
4. M. P. Schemel, *Am. J. Botany* 37, 750 (1950).
5. A. Traverse, *U.S. Bur. Mines Rept.* No. 5151 (1955).
6. R. P. Wodehouse, *Bull. Torrey Botan. Club* 60, 479 (1933), made the same observation of plant microfossils in the Eocene Green River shales.
7. Descriptive terminology and measurements follow the suggestions of G. Erdtman, *Introduction to Pollen Analysis* (Chronica Botanica, Waltham, Mass., 1943).
8. S. A. Cain, *Am. J. Botany* 27, 301 (1940).

15 October 1956