PHYTOCRENE MICROCARPA — A NEW SPECIES OF ICACINACEAE BASED ON CRETACEOUS FRUITS FROM KREISCHERVILLE, NEW YORK

RICHARD A. SCOTT[1] & ELSO S. BARGHOORN

U.S. Geological Survey, Denver, Colorado, and Botanical Museum & Department of Biology, Harvard University

ABSTRACT

Fossil dicotyledonous fruits from the lower Upper Cretaceous Raritan formation at Kreischerville, New York, are indentified as the endocarps of *Phytocrene* Wall. (tribe Phytocreneae, Icacinaceae). Modern species of *Phytocrene* are climbing vines from tropical Asia and Africa. The Raritan species here described as *P. microcarpa* n. sp. is the first Cretaceous record of the genus, which has also been identified from fossil leaves of Eocene age in California. The fossil endocarps of *P. microcarpa* constitute one of the common Mesozoic occurrences of reproductive structures referable to a modern genus of the angiosperms.

INTRODUCTION

AMONG the undescribed fossil plants left by the late Professor E. C. Jeffrey in the palaeobotanical collections of Harvard University are a number of lignitic dicotyledonous fruits from the Cretaceous Raritan formation at Kreischerville, Staten Island, New York. Some of these fruits are referable to *Phytocrene* Wall., a modern genus in the tribe Phytocreneae of the family Icacinaceae. The Kreischerville fossils, constituting one of the rare examples of determinable angiosperm fruits from the Mesozoic, furnish the oldest geologic record of the tribe and the earliest evidence of its existence in the New World.

The lignitic deposits in the vicinity of Kreischerville, located in the south-western part of Staten Island, were first noted in 1837 (HOLLICK & JEFFREY, 1909); however, they were not studied in detail until some 40 years later. Between the years 1881 and 1909 a series of publications, reviewed by Hollick & Jeffrey (1909), deal with various aspects of the geology and palaeobotany of the plant-bearing beds.

Both floral and lithologic similarities serve to establish the correlation of beds on the south and west parts of Staten Island, including those at Kreischerville, with strata of the Raritan formation in nearby New Jersey (HOLLICK, 1906). The Raritan formation in New Jersey contains an extensive flora, predominantly dicotyledonous, which was described by Newberry (1895) and Berry (1911). Berry considered the flora to be Cenomanian (early Late Cretaceous) in age. Spangler & Peterson (1950) consider that the Raritan formation of New Jersey is both Early and Late Cretaceous in age, correlating in part with the Potomac group of Maryland and Delaware. This interpretation has been refuted by Dorf (1952), who, after reviewing the floral and faunal evidence, reaffirms the assignment of the Raritan formation to the early Late Cretaceous.

The plants at Kreischerville occur as lenses of lignitic material interbedded with layers of crossbedded sand and clay (HOLLICK & JEFFREY, 1909). The remains, representing both gymnosperms and angiosperms, include charred and lignitic wood, twigs, bark, cones and cone scales, amber, fruits, and leaves and leaf impressions.

The collection of dicotyledonous fruits from which the *Phytocrene* endocarps were obtained was labelled by Jeffrey as being from Kreischerville, but no exact locality was recorded. The statement of Hollick & Jeffrey (1909, p. 7) that "... the finer material and nearly all the leaves and leaf impressions were obtained ... in the Androvette pit", indicates the probable origin of the material at hand. Presumably the fruits were collected by Hollick & Jeffrey along with the coniferous material described by them in their monograph of the coniferous remains (1909). The topographic map of the Staten Island quadrangle accompanying U.S. Geological Survey Folio No. 83 (MERRILL *et al.*,

1. Publication authorized by the Director, U.S. Geological Survey.

1902) shows three clay pits immediately adjacent to Kreischerville. We have not been able to determine which of them was the Androvette pit.

In addition to the one described here, there are species representing several other genera among the 200-odd specimens constituting the collection of fruits. Most of the unidentified fruits are capsules. All of the specimens are black and appear carbonized although some cellular detail is preserved (PL. 1, FIG. 1). The black appearance may be original, or, more probably, it resulted from the preparatory treatment with dilute alkali described by Hollick & Jeffrey (1909). The untreated, dried, lignitic wood from the deposit is cinnamon brown in colour.

FAMILY ICACINACEAE

Tribe Phytocreneae Engler

Genus *Phytocrene* Wall.

P. microcarpa n. sp.

Pl. 1, Figs. 1-3

Diagnosis — Endocarp small, bilaterally symmetrical, length 3·9 to 10·5 mm., maximum width 2·8 to 7·0 mm., thickness 1·5 to 2·5 mm., somewhat flattened by compression; outline in the plane of dehiscence irregularly oval to subtriangular. Endocarp wall relatively thick, bearing numerous (40-100) irregularly arranged pits on the exterior surface of each side, diameter of pits varying from 0·3 to 0·5 mm.; inner surface bearing low, rounded protuberances that are the closed inner terminations of the pits.

Seed solitary, conforming to the shape of the locule with concavities corresponding to the protuberances of the endocarp. Testa as seen in surface view composed of square to rectangular cells, the latter with their long sides parallel.

Locality — Androvette Pit, Kreischerville, New York.

Geologic Occurrence — Raritan formation, lower Upper Cretaceous.

Collectors — A. Hollick and E. C. Jeffrey, *circ.* 1904.

Material — 8 lignitized endocarps.

Holotype — Palaeobotanical Collections, Harvard University, No. 52809.

All of the specimens of *Phytocrene microcarpa* seem to have been somewhat flattened by compression following deposition. However, the compressive forces involved could not have been great, for most of the capsules and seeds occurring in the same sediments with *P. microcarpa* do not seem to have been affected. The lignitized endocarps are fragile, and broken specimens reveal the internal structure of the endocarp wall and the nature of the seed. Remains of the seed coat were recovered from one broken endocarp and mounted for microscopic study.

AFFINITIES AND DISCUSSION

The tribe Phytocreneae includes five extant genera (BAILEY & HOWARD, 1941a). The unilocular endocarps of these genera are distinctive in the possession of numerous straight canals in their walls. These canals, which are perpendicular to the surface of the endocarp, form the pits visible upon its exterior. The canals, open at their exterior ends, are closed internally by an inner layer of the endocarp wall. This inner layer may be modified at the bases of the canals into mounds or protuberances extending into the locule.

Distinctive patterns in the arrangement of the external pits and the shape and size of the internal protuberances have been found by Reid & Chandler (1933) and by us in each of the genera of the tribe. In the thick-walled endocarp of *Phytocrene* Wall. the protuberances consist only of low mounds or they may not be developed in some species. The thinner-walled endocarp of *Chlamydocarya* Baill. has prominent vertical-sided protuberances which are elongate longitudinally and are arranged in irregular longitudinal rows. The protuberances of *Miquelia* Meissn. are conical; in *Polycephalium* Engl. irregular rows of circular protuberances occur on low mounds. *Pyrenocantha* Wight shows the most variation among its species; numerous fine protuberances are most common although larger cylindrical and conical protuberances occur. If, during fossilization, endocarps of the Phytocreneae are filled with mineral matter, the resulting locule casts preserve a negative image of the protuberances (PL. 1, FIG. 5).

Two extinct genera of the Phytocreneae have been established, both from pyritized but structurally preserved fruits and locule casts found in the Lower Eocene London Clay formation of England (REID &

CHANDLER, 1933). In the genus *Palaeophytocrene* Reid & Chandler, represented in the London Clay flora by two species, the closed inner ends of the pits form parallel-sided protuberances extending into the locule (PL. 1, FIGS. 4, 5). Reid & Chandler (p. 334) consider "... that the characters of the fossils are not now combined in any one living genus, but are distributed among the three *Phytrocrene* Wall., *Miquelia* Meissn., and *Chlamydocarya* Baill.". Three species of *Palaeophytocrene*, including the London Clay species *P. foveolata* Reid & Chandler, have been described from the Eocene Clarno formation of Oregon (SCOTT, 1954).

The second genus, *Stizocarya* Reid & Chandler, also is represented in the London Clay flora by two species. The small (7·5-14·5 mm. long) ovoid endocarps of this genus contain numerous fine canals which terminate in an inner layer of the endocarp wall without producing protuberances. Reid & Chandler regard this genus as intermediate between *Pyrenocantha* and *Phytocrene*.

The structure of the Kreischerville endocarps is more like that of *Phytocrene* than any of the other genera in the tribe. In all of the modern genera except *Phytocrene*, and in the extinct *Palaeophytocrene*, the protuberances, although varying in size, shape and arrangement, form elongate extensions into the locule (PL. 1, FIG. 4). In contrast the locule lining of the extinct *Stizocarya* is smooth. Only in certain species of *Phytocrene* do the canals terminate in low mounds like those of the Kreischerville fossils (PL. 1, FIG. 3).

Observable differences between modern species of *Phytocrene* and the Kreischerville fossils are limited to the shape and size of their endocarps. The endocarps of modern species are ovoid or elongate-ovoid, not subtriangular as is the tendency among the fossil specimens (PL. 1, FIG. 1). The extant species about which we have information possess relatively large endocarps which are not smaller than about 15 to 20 mm. in length. Thus, the fruits of the smallest modern species known to us are about 2 to 3 times as large as the largest fossil endocarp. However, a considerable size range exists among the modern species of *Phytocrene* and an even greater range in relative sizes exists among the species of the extinct *Palaeophytocrene* (SCOTT, unpublished data).

Since size and shape of the endocarps are much less reliable generic criteria in the tribe Phytocreneae than is the structure of the protuberances, the evidence indicates that these fossil endocarps represent the genus *Phytocrene*. We regard the variability in number and diameter of the pits on the fossil endocarps as intraspecific rather than as a basis for segregating an additional species.

The only previous fossil record of the genus consists of leaves, *Phytocrene sordida* (Lesquereux) MacGinitie, from the Middle Eocene Chalk Bluffs flora of California described by MacGinitie (1941). The family Icacinaceae is represented in the Upper Cretaceous of Egypt by fruits referred to the form genus *Icacinicarya* Reid & Chandler by Chandler (1954).

Modern members of the tribe Phytocreneae are tropical lianas growing in Africa and south-east Asia. Living species of *Phytocrene* are native to Indo-Malaya, the Philippines, Borneo and the Celebes, although the two fossil species were found in eastern and western United States. MacGinitie (1941) considers that *P. sordida* is a member of a group of ancient Palaeotropical genera and species including such forms as *Artocarpus*, *Cercidiphyllum*, *Cinnamomum* and *Mallotus*. These genera, all present in the Chalk Bluffs flora, are thought to represent survivors of older, Late Cretaceous and Paloeocene species from the Rocky Mountain province. The Kreischerville fruits confirm that *Phytocrene*, although not known from the Rocky Mountain region, indeed was a member of a cosmopolitan Cretaceous flora in the New World. Presumably, its elimination from the flora of the New World was related to climatic deterioration during the Tertiary.

The existence of *Phytocrene* in the Cretaceous is of great interest in view of the advanced evolutionary position of the genus in the family. The investigations of Bailey & Howard (1941a, b, c, d) have shown that anatomically the tribe Phytocreneae is a highly evolved assemblage of the Icacinaceae, exhibiting structural specializations correlated with their scandent habit of growth. The Cretaceous record of *Phytocrene* is an addition to the growing body of evidence indicating that the major evolutionary advances in the structural specialization of dicotyledonous plants took place early in their geologic history.

REFERENCES

BAILEY, I. W. & HOWARD, R. A. (1941a). The comparative morphology of the Icacinaceae. I. Anatomy of the node and internode. *Jour. Arnold Arb.* **22**: 125-132.

Idem (1941b). The comparative morphology of the Icacinaceae. II. Vessels. *Jour. Arnold Arb.* **22**: 171-184.

Idem (1941c). The comparative morphology of the Icacinaceae. III. Imperforate tracheary elements and wood parenchyma. *Jour. Arnold Arb.* **22**: 432-442.

Idem (1941d). The comparative morphology of the Icacinaceae. IV. Rays of the secondary xylem. *Jour. Arnold Arb.* **22**: 556-568.

BERRY, E. W. (1911). The flora of the Raritan Formation. *New Jersey Geol. Survey Bull.* **3**: 233 pp.

CHANDLER, M. E. J. (1954). Some Upper Cretaceous and Eocene fruits from Egypt. *Bull. British Museum (Nat. Hist.).* **2**(4): 149-187.

DORF, E. (1952). Critical analysis of Cretaceous stratigraphy and paleobotany of Atlantic coastal plain. *Bull. Amer. Assoc. Petrol. Geol.* **36**: 2161-2184.

HOLLICK, A. (1906). The Cretaceous flora of southern New York and New England. *U.S. Geol. Survey. Mem.* **50**: 129.

Idem & JEFFREY, E. C. (1909). Studies of Cretaceous coniferous remains from Kreischerville, New York. *Mem. New York Bot. Gard.* **3**: 1-76.

MACGINITIE, H. D. (1941). A middle Eocene flora from the central Sierra Nevada. *Carnegie Inst. Washington Pub.* 534: 85-156.

MERRILL, F. J. H. *et al.* (1902). U.S. Geol. Survey New York City, Folio No. 83.

NEWBERRY, J. S. (1895). The flora of the Amboy Clays (edited by Hollick). *U.S. Geol. Survey Mon.* **26**: 137 pp.

REID, E. M. & CHANDLER, M. E. J. (1933). The London Clay flora. British Museum (Nat. Hist.). *London.* 561 pp.

SCOTT, R. A. (1954). Fossil fruits and seeds from the Eocene Clarno formation of Oregon. *Palaeontographica.* **96**(B): 66-97.

SPANGLER, W. B. & PETERSON, J. J. (1950). Geology of Atlantic coastal plain in New Jersey, Delaware, Maryland, and Virginia. *Bull. Amer. Assoc. Petrol. Geol.* **34**: 1-99.

EXPLANATION OF PLATE 1

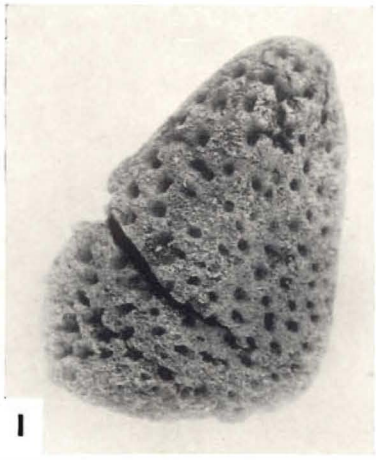
1. *Phytocrene microcarpa* Scott & Barghoorn n.sp. Lateral view of the endocarp. Note the subtriangular shape and the canal openings. Holotype × 5.

2. *P. microcarpa*. A smaller endocarp with fewer, relatively larger canals. × 10.

3. *P. microcarpa*. Portion of a broken endocarp showing the inner surface. Note the low mounds which are the closed inner ends of the canals. × 15.

4. *Palaeophytocrene hancockii* R. A. Scott. A transversely cut endocarp with its locule filled by calcite. Note the prominent, straight-sided protuberances extending into the locule. × 1.

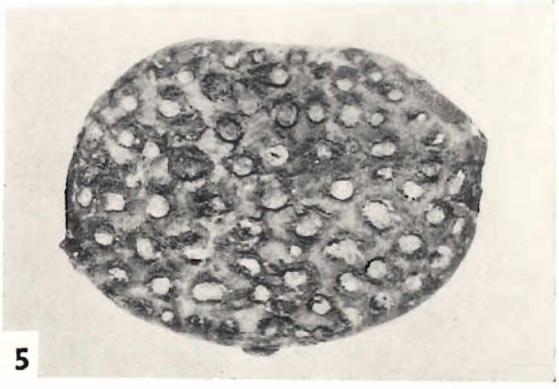
5. *P. foveolata* Reid & Chandler. Lateral view of a locule showing the cavities produced by the protuberances which extended into the locule. Most of the canals contain the volcanic ash in which the specimen was buried, producing the white fillings visible in the photograph. × 2.


1


2


3


4


5