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PRELIMINARY REPORT ON FOSSIL FRUITS AND SEEDS FROM THE MAMMAL QUARRY OF THE CLARNO FORMATION, OREGON

By Thomas M. McKee*

> **The Department encourages students of geology and paleontology to submit original articles of scientific merit for publication in The ORE BIN. This paper by Thomas M. McKee on the fossil fruits and seeds from the Mammal Quarry site in the Clarno Formation is a noteworthy example of what a young person with aptitude, motivation, and guidance can achieve.**
>
> **Tom McKee, a recent graduate of Jefferson High School in Portland, has been keenly interested in paleobotany since elementary school days. He is a member of the Oregon Museum of Science and Industry Student Research Center and is on the paleontology research team at Camp Hancock. His work on fossil fruits and seeds from the Mammal Quarry won him a number of state and national awards, including one in the Westinghouse National Science Talent Search. This report, originally printed in mimeograph form by the OMSI Student Research Center, is published here with only slight alterations. --- Ed.**

Introduction

During the summer of 1969 the author was a member of the Vertebrate Paleontology Research Team of the Oregon Museum of Science and Industry. This team consisted of eight high school students and a field director. The team's objective was to recover vertebrate fossils from the Clarno Formation Mammal Quarry near Clarno, Oregon. It was evident from previous excavations that abundant fossil plant material was located in the middle and lower units of the quarry. Therefore it was decided to collect and study the fossil fruits and seeds associated with the

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vertebrate fossils, allowing a more complete reconstruction of the paleoecology of the Clarno Mammal Quarry site and a detailed analysis of the depositional environment.

This paper is a preliminary report on the fossil seeds and nuts so far collected and studied by the author. He expects to continue his research on plant material at the Clarno Mammal Quarry site and extend his studies to adjacent areas.

Geologic Occurrence

The Clarno Mammal Quarry (OMSI Loc. No. ONT-1) is located about 2 miles east of Clarno, Oregon, in the NE$\frac{1}{4}$ sec. 27, T. 7 S., R. 9 E., in the Clarno quadrangle, Wheeler County. The quarry is in the Clarno Formation, which is widely exposed throughout central Oregon. R. L. Hay (1963, p. 201) states that "The Clarno Formation consists largely of lava flows and volcanic breccias, but volcanic conglomerates and sandstone, claystones and vitric tuffs are common in some places. The various lithologic units interfinger laterally and no units have been found which are sufficiently widespread to subdivide the formation over a distance of more than ten miles. The full thickness of the formation is about 5000 feet...."

In the area of the Clarno Mammal Quarry, the Clarno Formation consists of interbedded mudflows and tuffs and andesitic lavas that have been altered both hydrothermally and by weathering. The upper limit of the Clarno Formation is a subject of debate, but it is usually accepted that the lower member of the overlying John Day Formation (upper Oligocene) was deposited on the surface of the eroded Clarno Formation. Well-core data from the vicinity of the Clarno Mammal Quarry show that the Clarno Formation rests unconformably on Cretaceous marine sediments (figure 1).

Previous Work

The Clarno Formation was considered to be upper Eocene by Merriam (1901) in his original description of the formation. This age determination was based on the analysis of fossil leaf remains from the Clarno Formation by Knowlton, who published his findings in 1902. Chaney (1952) considered the Clarno Formation as middle and upper Eocene, also based on fossil leaf remains. Scott (1954) described the fossil flora of the Nut Beds of the Clarno Formation and stated that "The affinities of the fruits and seeds substantiate the Eocene age of the Clarno Formation and suggest, but do not confirm, that it is older than upper Eocene." Mellett (1969) describes a partial skull of _Hemipsalodon grandis_, a large Pterodon-like hyaenodontid from the Clarno Mammal Quarry. Mellett states that _Hemipsalodon_ is stratigraphically limited to the early Oligocene. Bruce Hansen of the University of California, Berkeley, who is working on the Clarno vertebrate fauna, states (oral communication, 1969) that the two prepared brontothere

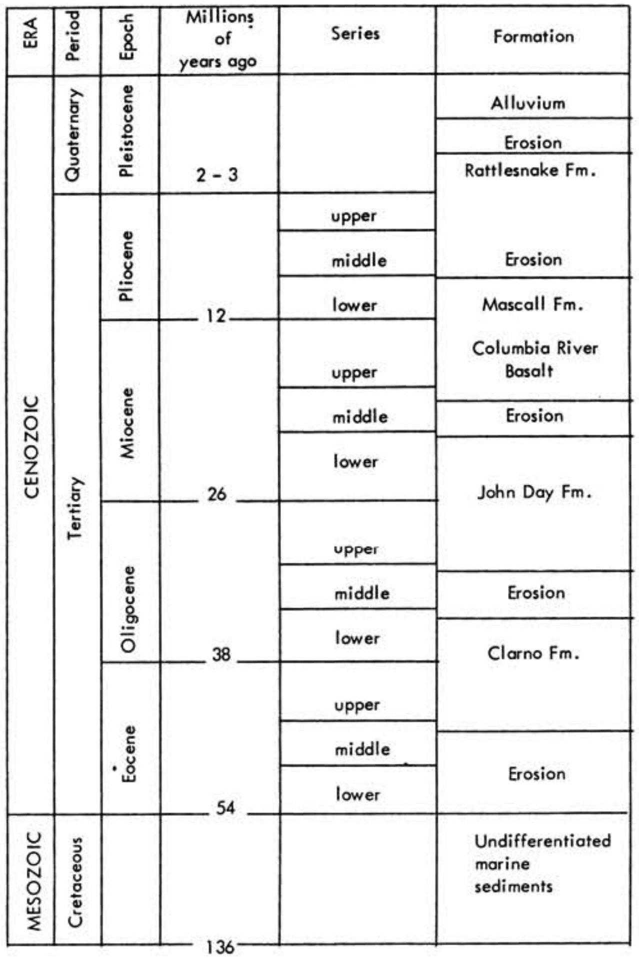


Figure I. Generalized geologic time chart showing age relationship of the Clarno Formation.

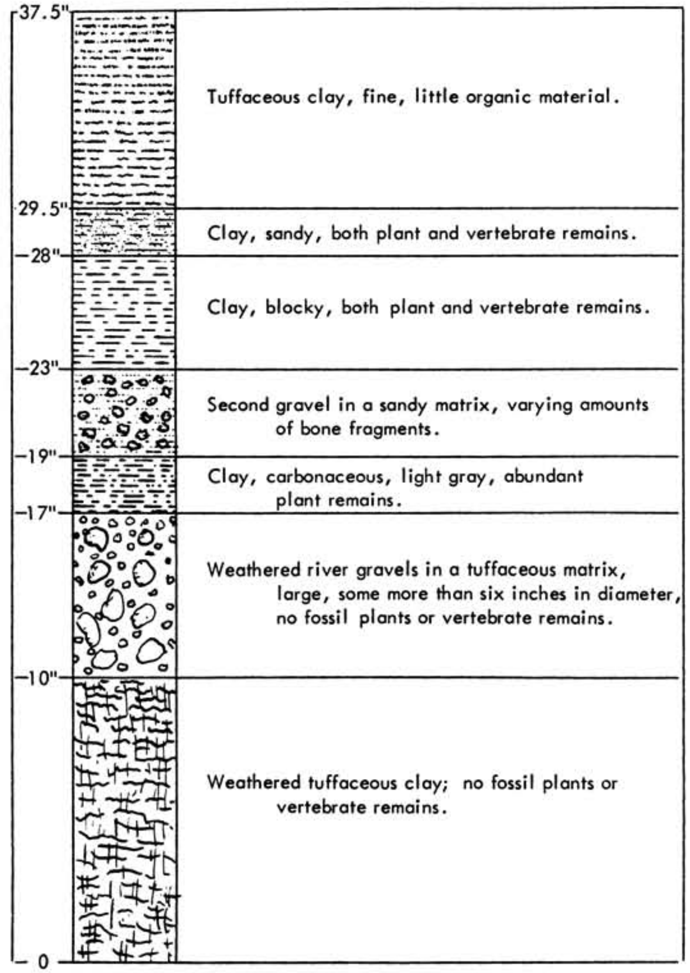


Figure 2. Measured section of the Clarno Mammal Quarry.

mandibles collected from the Clarno Mammal Quarry during 1969 seem to be of species limited to the Oligocene (figure 1).

Stratigraphic Relationships

An occurrence of fossil plant remains known as the Clarno Nut Beds (Scott, 1954) is found approximately half a mile southwest of the Clarno Mammal Quarry. Stratigraphically above the Nut Beds is a deposit known locally as Red Hill. This deposit consists of a clay soil weathered from tuffaceous sand and volcanic dust (Taylor, 1960).

Taylor ran a series of tests on the red tuffs at Red Hill and on the tuff that occurs at the Clarno Mammal Quarry. He found that the two tuffs are texturally similar. The Clarno ignimbrite caps both the Red Hill and the Clarno Mammal Quarry tuffs. This seems to place the Clarno Mammal Quarry in the same clay stratum as the red tuff which occurs at Red Hill. Based on the textural similarity and the fact that the Clarno ignimbrite caps both deposits, the author assumes that the Clarno Mammal Quarry was deposited at the same time as the tuffs of Red Hill. Therefore, the Clarno Nut Beds, which occur stratigraphically below Red Hill, are older in age than the Clarno Mammal Quarry, although the difference may be very slight.

Age

A potassium-argon date of 34.5 million years was determined for the Clarno Nut Beds by Evernden, Curtis, and James (1964). The assumption then can be made that the Clarno Mammal Quarry is younger than 34.5 million years. Placement of the quarry in the early Oligocene agrees with the suggested assignments to early Oligocene age based on vertebrate remains from the Clarno Mammal Quarry by both Mellett (1969) and Hansen (oral communication, 1969).

Stratigraphy at the Clarno Mammal Quarry

The Clarno Mammal Quarry occurs in a large slump block of tuffaceous clays that appears to have moved down slope about 40 feet from its original position. Capping the clays is the Clarno ignimbrite which is used as the marker bed for the displaced sediments. To the east of the main quarry and about 40 feet above the fossil-bearing level of the main quarry is a smaller mammal deposit. The beds at this second deposit probably represent part of the main quarry beds not displaced by slumping.

On the basis of limited excavation, the general stratigraphy of the deposit shows distinctly stratified sediments dipping 12° northwest and striking N. 30° E. (figure 2). The sediments at the bottom of the excavation appear to be a highly weathered tuffaceous clay. Resting on this clay is a deposit consisting of highly weathered river gravels composed of chert and tuffaceous cobbles in a tuffaceous matrix. The larger cobbles in this unit are more than 6 inches in diameter. Lying on the river gravels is a carbonaceous unit of very fine, light-gray clay containing abundant plant remains. Directly above this carbonaceous unit is a second gravel in a sandy matrix which contains varying amounts of bone fragments. Resting on the second gravel is a deposit of blocky clay containing both vertebrate and plant remains. The blocky clay underlies a thin unit of sandy clay containing both plant and vertebrate remains. The top unit in the excavation consists of a fine tuffaceous clay containing little organic material.

Floral Composition

Of the 204 specimens of fossil fruits and seeds recovered from the Clarno Mammal Quarry, 39 have been identified. The unidentified material is so poorly preserved that identification is either unreliable or impossible. All identified specimens belong to the Phylum SPERMATOPHYTA, Class ANGIOSPERMAE, Subclass DICOTYLEDONAE. Four families and six genera are represented in the identified flora, with three identified to the species level.

Systematic List

Phylum: SPERMATOPHYTA
- Class: ANGIOSPERMAE
  - Subclass: DICOTYLEDONAE
    - Family: JUGLANDACEAE
      - Genus: JUGLANS Linnaeus
        - *Juglans clarnensis* Scott
    - Family: MENISPERMACEAE
      - Section: TINOSPOREAE Diels
        - Genus: ODONTOCARYOIDEA Scott
          - *Odontocaryoidea nodulosa* Scott
      - Subsection: COCULINAE
        - Genus: DIPLOCLISIA
          - *Diploclisia* sp.
    - Family: ICACINACEAE
      - Section: PHYTOCRENEAE Engler
        - Genus: PALAEOPHYTOCRENE
          - *Palaeophytocrene* cf. *P. foveolata* (Reid & Chandler)
    - Family: VITACEAE
      - Genus: VITIS (THURNBERG) Linnaeus
        - *Vitis* sp.
      - Genus: TETRASTIGMA Planchon
        - *Tetrastigma* sp.

The genus DIPLOCLISIA is the most abundant plant represented in the Clarno Mammal Quarry flora with 31 specimens having been recovered. Second in abundance is the species *Odontocaryoidea nodulosa* with three specimens (figure 3).

Species	No. of specimens
Juglans clarnensis	1
Odontocaryoidea nodulosa	3
Diploclisia sp.	31
Palaeophytocrene cf. *P. foveolata*	2
Vitis sp.	1
Tetrastigma sp.	1
Total	39

Figure 3. Numerical data.

Systematic Relationships

Phylum: SPERMATOPHYTA

Class: ANGIOSPERMAE

Subclass: DICOTYLEDONAE

Family: JUGLANDACEAE

Genus: JUGLANS Linnaeus

Juglans clarnensis Scott

(Plate 1, figures 1-2)

Specimen: OMSI No. PB-1.

Discussion: One specimen of this species was found, consisting of a lateral half of the cotyledon. The specimen is a cast that is slightly compressed, distorting the two lateral halves of the primary embryo lobes. The surface of the lobes is smooth. Length: 11 mm.; width in the plane of dehiscence is distorted; thickness (at right angles to plane of dehiscence) 11 mm.

Family: MENISPERMACEAE

Section: TINOSPOREAE Diels

Genus: ODONTOCARYOIDEA Scott

Odontocaryoidea nodulosa Scott

(Plate 1, figures 5-6)

Specimen: OMSI No. PB-31.

Discussion: Three specimens of this species were recovered. All are locule casts with a carbonaceous cover which appears to have been the exocarp. The specimens have been slightly compressed. The locule cast is elongate, length: 22-28 mm.; width: 5 mm.; thickness: undeterminable owing to compression; and deeply boat shaped. The apical end is pointed, the shoulder region slopes, and the basal end is blunt with a small median projection. The dorsal side is smooth, with a slight median ridge marking the suture. The ventral side is concave.

Family: MENISPERMACEAE

Section: TINOSPOREAE Diels

Subsection: COCULINAE

Genus: DIPLOCLISIA Miers

Diploclisia sp.

(Plate 1, figures 3-4)

Specimen: OMSI No. PB-6.

Discussion: This genus has the largest representation in the Clarno Mammal Quarry flora, with 31 specimens consisting of both locule casts and impressions. Most of the specimens show the flattened interface of one valve of the endocarp in the plane of dehiscence. This view shows the horseshoe-shaped ring of about 22 large tubercles with corresponding hollows between them, surrounding a slightly elevated flat surface. The walls of the specimen appear to consist of radially directed coarse fibers and are thick with a pronounced ridge extending completely around the horseshoe-shaped ring. Length: 9-11 mm.; width in plane of dehiscence: 5-7 mm.; thickness: undeterminable owing to compression.

Family: ICACINACEAE

Section: PHYTOCRENEAE Engler

Genus: PALAEOPHYTOCRENE Reid & Chandler

Palaeophytocrene cf. P. foveolata Reid & Chandler

(Plate 2, figures 3, 4, 4a)

Specimen: OMSI No. PB-37.

Discussion: Two incomplete locule casts of this species were recovered from the Clarno Mammal Quarry. Their estimated length is 14-16 mm.; width 7-9 mm.; and the thickness indeterminable. There are approximately 7-8 surface pits lengthwise and 5-6 pits across the width. These incomplete specimens compare favorably with the species Palaeophytocrene foveolata.

Family: VITACEAE

Genus: VITIS (Thurnberg) Linnaeus

Vitus sp.

(Plate 2, figures 5-6)

Specimen: OMSI No. PB-39.

Discussion: One complete seed of this genus was recovered from the Clarno Mammal Quarry. The seed is split into two parts along the raphe ridge and is distorted by compression. It is obovoid with smooth contours sharply pointed at the apex and rounded at the base. Length of seed: 3 mm.; width 2.3 mm.; thickness: undeterminable. The specimen has been compared at the Oregon Museum of Science and Industry to No. 984 of the

Hancock collection from the Clarno Nut Beds.

The Clarno Mammal Quarry specimen does not appear to represent the London Clay species Vitis pygmaea. The London Clay species, Vitis pygmaea, differs from this specimen in the appearance of the apex, which is highly stipitate in Vitis pygmaea but smooth in the Clarno specimen. Moreover, the raphe ridge of the Clarno specimen extends onto the apex, but not in the London Clay species; and the ventral infolds are much narrower in the London Clay species.

Family: VITACEAE

Genus: TETRASTIGMA Planchon

Tetrastigma sp.

(Plate 2, figures 7, 8, 8a)

Specimen: OMSI No. PB-40.

Discussion: One complete seed of this genus was recovered. The seed is ovate and is ornamented with prominent radial lobes separated by deep furrows. The raphe ridge extends the length of the ventral face. Length: 5 mm.; width: 3.5 mm.; thickness: undeterminable.

ANGIOSPERM

INCERTAE SEDIS

(Plate 2, figures 1-2)

Specimen: OMSI No. PB-34.

The specimens consist of three much compressed fruiting heads which are only partially intact, preventing identification. Diameter of globular fruiting heads is 18-22 mm.

Relation of Living and Fossil Floras

Present-day distributions of the modern equivalent genera of the fossil plant remains so far identified in the Clarno Mammal Quarry flora have habitats ranging from cool-temperate to exclusively tropical (see figure 4). However, the majority of the identified fossil genera (4 of 6) have modern equivalents living in subtropical to tropical habitats.

Fossil Genus	Nearest modern equivalent	Habitat
Juglans	Juglans	Tropical to cool temperate
Odontocaryoidea	Odontocarya	Lowland tropical
Diploclisia	Diploclisia	Tropical to sub-tropical
Palaeophytocrene	Phytocrene	Lowland tropical
Vitis	Vitis	Tropical to cool temperate
Tetrastigma	Tetrastigma	Subtropical and lowland tropical

Figure 4. Present-day distribution of the nearest modern equivalent genera.

The nearest modern equivalents to identified fossil genera of the Clarno Mammal Quarry have a wide geographical distribution ranging from Canada to many tropical areas in the Old World. A majority of the modern equivalents (5 of 6) are found in India and Ceylon (figure 5).

The Clarno Mammal Quarry fruit and seed genera are found in several other Tertiary floras in the New and Old Worlds. The Clarno Nut Beds correlate best with the Clarno Mammal Quarry by having all six genera present. The lower Eocene London Clay Flora of England comes next, with four out of six genera represented (figure 6).

Summary

This report is preliminary to further collecting and study at both the Clarno Mammal Quarry and the Clarno Nut Beds.

Based on the information previously discussed, the author concludes that the Clarno Mammal Quarry is younger than the Clarno Nut Beds, and probably early Oligocene in age. This assignment agrees with age determinations of vertebrate remains from the Clarno Mammal Quarry.

The 39 identified specimens indicate the presence of a tropical to subtropical climate at the site of the Clarno Mammal Quarry during early Oligocene time. Based on the limited flora identified, the composition of the Clarno Mammal Quarry flora appears to be essentially the same as the flora found in the Clarno Nut Beds.

EXPLANATION OF PLATE I

Juglans clarnensis Scott - Page 122

Fig. 1. OMSI No. PB-1. The lateral half of the cotyledon. The specimen has been compressed, distorting the two lateral halves of the primary embryo lobes. 3 X

Fig. 2. Drawing showing the lateral half of the cotyledon and the correct position of the two lateral halves of the primary embryo lobes. 3 X

Diploclisia sp. - Page 123

Fig. 3. Drawing showing the horseshoe-shaped furrow enclosing the plug. 3 X

Fig. 4. OMSI No. PB-6. The flattened interface of one valve of the endocarp showing the horseshoe-shaped ring of tubercles and corresponding hollows. 7.5 X

Odontocaryoidea nodulosa Scott - Page 123

Fig. 5. OMSI No. PB-31. Dorsal side showing a slight median ridge marking the suture. 3 X

Fig. 6. Same, ventral side concave, showing the pointed apical end, blunt basal end with a small median projection, and the sloping shoulder region. 3 X

EXPLANATION OF PLATE II

Incertae sedis - Page 125

Fig. 1. OMSI No. PB-36. Fruiting head partially intact, showing awns. 3 X

Fig. 2. OMSI No. PB-34, the same. 3 X

Palaeophytocrene cf. *P. foveolata* - Page 124

Fig. 3. OMSI No. PB-37. Incomplete locule cast, showing surface pits. 3 X

Fig. 4. OMSI No. PB-38, the same. 6 X

Fig. 4a. Drawing showing external shape of complete locule cast in relationship to fig. 4. 3 X

Vitis sp. - Page 124

Fig. 5. OMSI No. PB-39. One-half of the obovoid seed, split down the raphe ridge. 3 X

Fig. 6. The same. Other half of the seed in matrix. 9 X

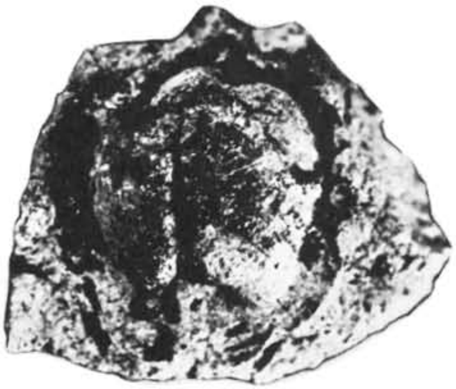
Tetrastigma sp. - Page 125

Fig. 7. OMSI No. PB-40. Impression of seed in matrix. 6 X

Fig. 8. The same. Obovate seed showing its ornamentation with prominent radial lobes separated by deep furrows and the raphe ridge which extends the length of the ventral face. 6 X

Fig. 8a. Drawing of fig. 8, emphasizing the radial lobes and deep furrows and the prominent raphe ridge. 3 X

PLATE I



1

2

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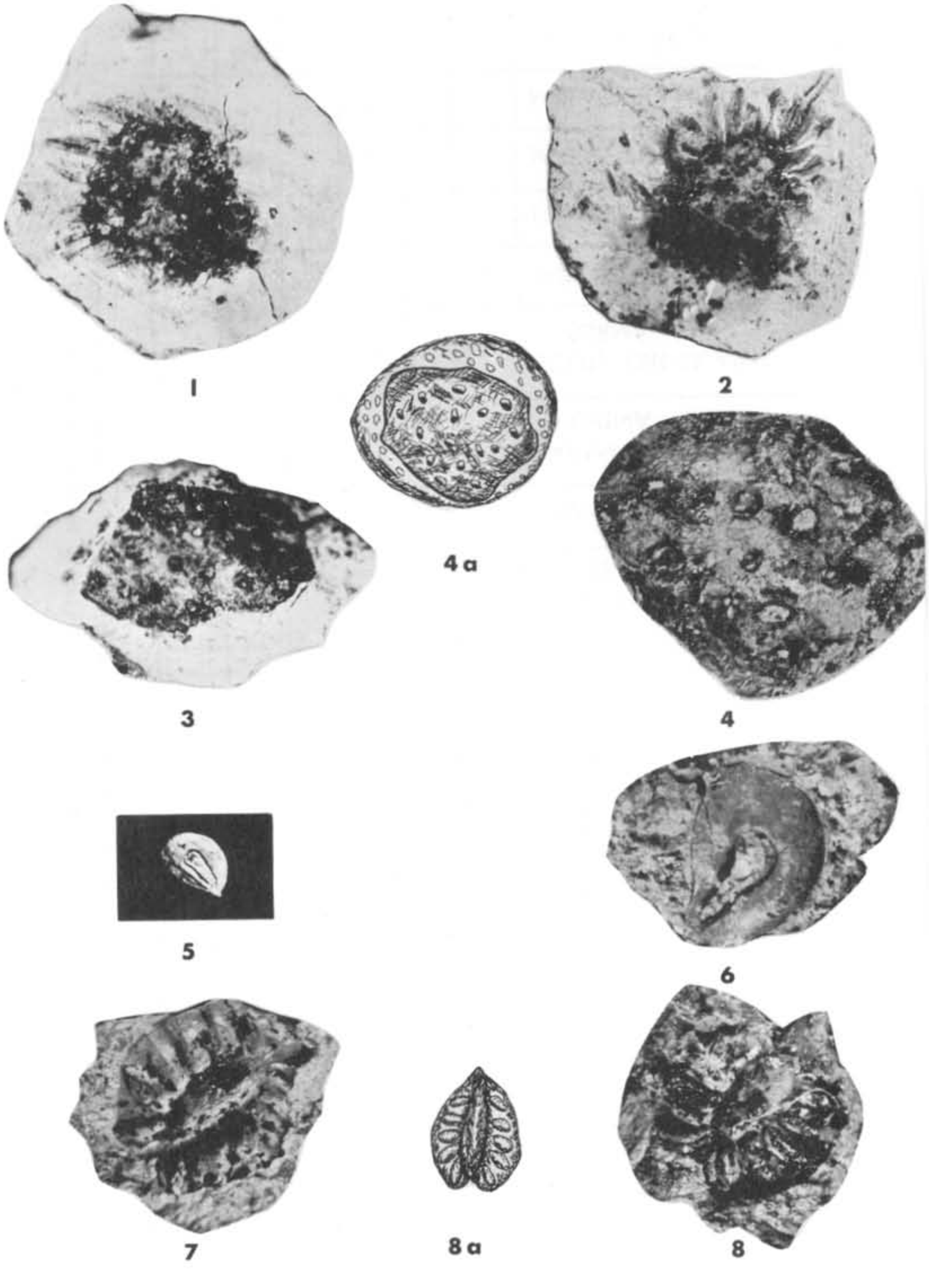
PLATE II



Fossil genus	Nearest modern equivalent	CANADA	UNITED STATES	MEXICO AND CENTRAL AMERICA	HIMALAYAS	JAPAN AND NORTH CHINA	SOUTH CHINA AND BURMA	INDIA AND CEYLON	FURTHER INDIA	MALAY PENINSULA	MALAY ISLANDS	TROPICAL AFRICA	PHILIPPINES
Juglans	Juglans	X	X	X	X	X		X					
Odontocaryoidea	Odontocarya			X									
Diploclisia	Diploclisia						X	X		X	X		
Palaeophytocrene	Phytocrene							X	X	X			X
Vitis	Vitis		X	X	X	X	X	X	X	X	X	X	X
Tetrastigma	Tetrastigma				X		X	X	X	X	X		X

Figure 5. Geographical distribution of the nearest modern equivalents of the Clarno Mammal Quarry fruit and seed genera.

Genera	Clarno Nut Beds	Chalk bluffs	London Clay	Lower Bagshot	Bournemouth
Juglans	X				
Odontocaryoidea	X		X		
Diploclisia	X				
Palaeophytocrene	X	X	X		
Vitis	X		X	X	X
Tetrastigma	X		X		

Figure 6. Occurrence of Clarno Mammal Quarry fruit and seed genera in other Tertiary floras.

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OREGON TERTIARY PHYTOPLANKTON

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ABSTRACT

Silicoflagellates have only recently been studied in the Pacific Northwest. Specimens of this bizarre group of planktonic plant microfossils, examined from late Tertiary sediments in the Bandon, Oregon area, demonstrate their usefulness as a biostratigraphic tool.

Introduction

A study of fossiliferous strata in western Oregon (Orr and Ehlen, 1970) has revealed microfossil groups previously unreported from the Pacific Northwest. Subsequent studies (Orr and Zaitzeff, 1970) have indicated that one of these groups of microfossils known as silicoflagellates may be of substantial biostratigraphic value where it occurs in the Tertiary sediments of Oregon and Washington as well as in submarine rock exposures off this coast.

Within Oregon, silicoflagellates have been successfully recovered from localities south of Bandon as well as from submarine exposures off the Oregon coast (see figure 1).

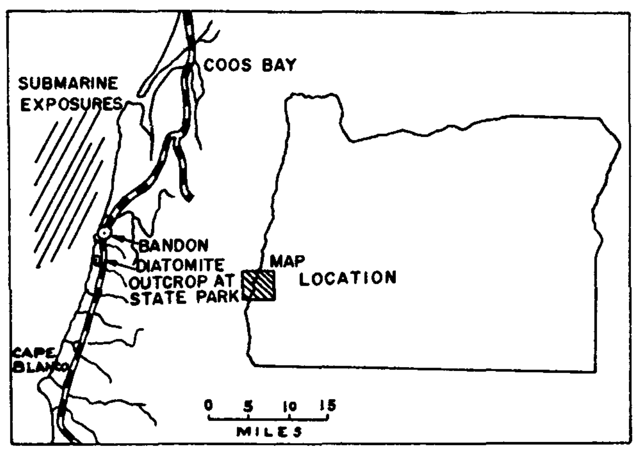


Figure 1. Map of the Bandon area of western Oregon showing location of silicoflagellate-bearing sediments studied. Submarine exposures are generalized (cross-shaded).

Silicoflagellates have been described from numerous localities in California (Hanna, 1928; Mandra, 1968, and others), but much of the important and original literature on this fossil group appears in German and French journals. Previously, silicoflagellates have been variously classified with the diatoms because they are autotrophic, or with the radiolaria because of their skeletal morphology. However, present evidence indicates that these small fossils are the skeletal remains of a group of solitary marine planktonic algae of the Order Chrysomonadina, Class Flagellata. They are a common component of modern marine plankton, and, although they are technically pelagic or drifting with the marine currents, locomotion is effected by a single whiplike flagellum on each organism (see figure 2). The average size of the silicoflagellate skeleton is around 30 μ * and, like many planktonic organisms, they most frequently display a radial symmetry.

Of particular significance here is the siliceous composition of the skeletal framework of the silicoflagellates. The tubular opaline silica skeleton is able to withstand the action of the various acids (nitric, hydrochloric, acetic) used to concentrate and extract the fossils from the rock matrix retaining them. This resistance to strong acids makes the silicoflagellates an attractive fossil group in a geologic terrain such as the Pacific

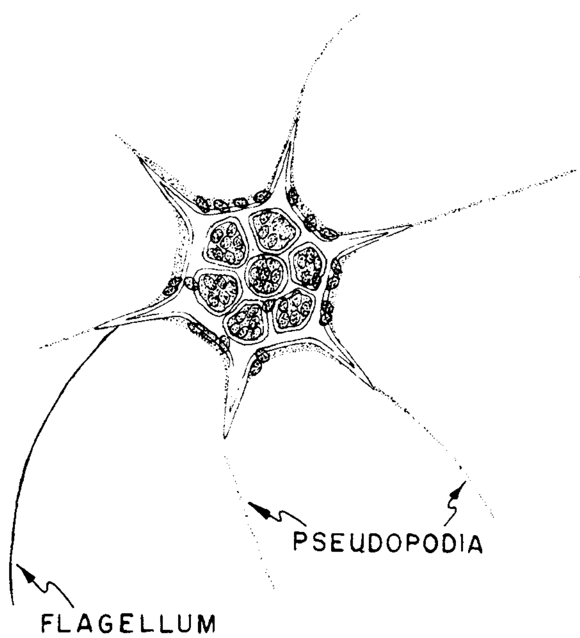
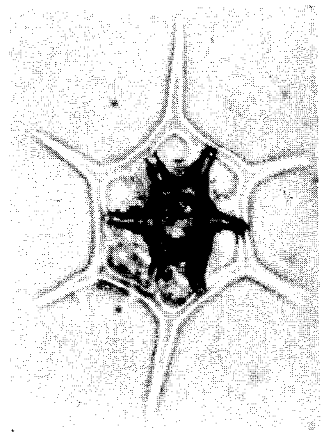


Figure 2. Distephanus speculum, living specimen illustrating protoplasm, chromatophores, pseudopodia and the flagellum. Redrawn after Loeblich (Marshall, 1934).

* 1 μ = ~ 4/10,000 inch.



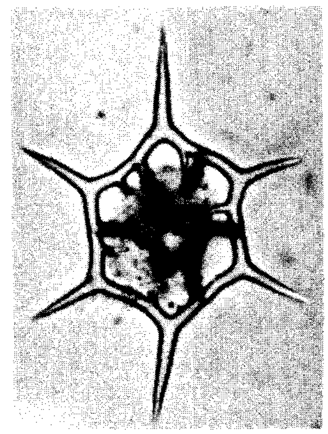


Figure 3. Microphotographs of the same specimen of Distephanus speculum focused on the basal ring and apical ring, respectively. Basal accessory spines are visible in the basal ring focus, and the tubular nature of the skeleton may be seen in the apical ring focus.

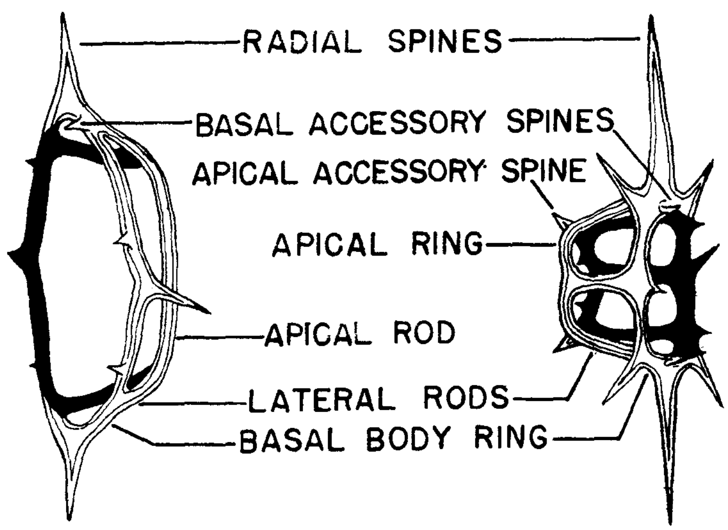


Figure 4. Nomenclature of the silicoflagellate skeleton (modified after Tynan and Deflandre).

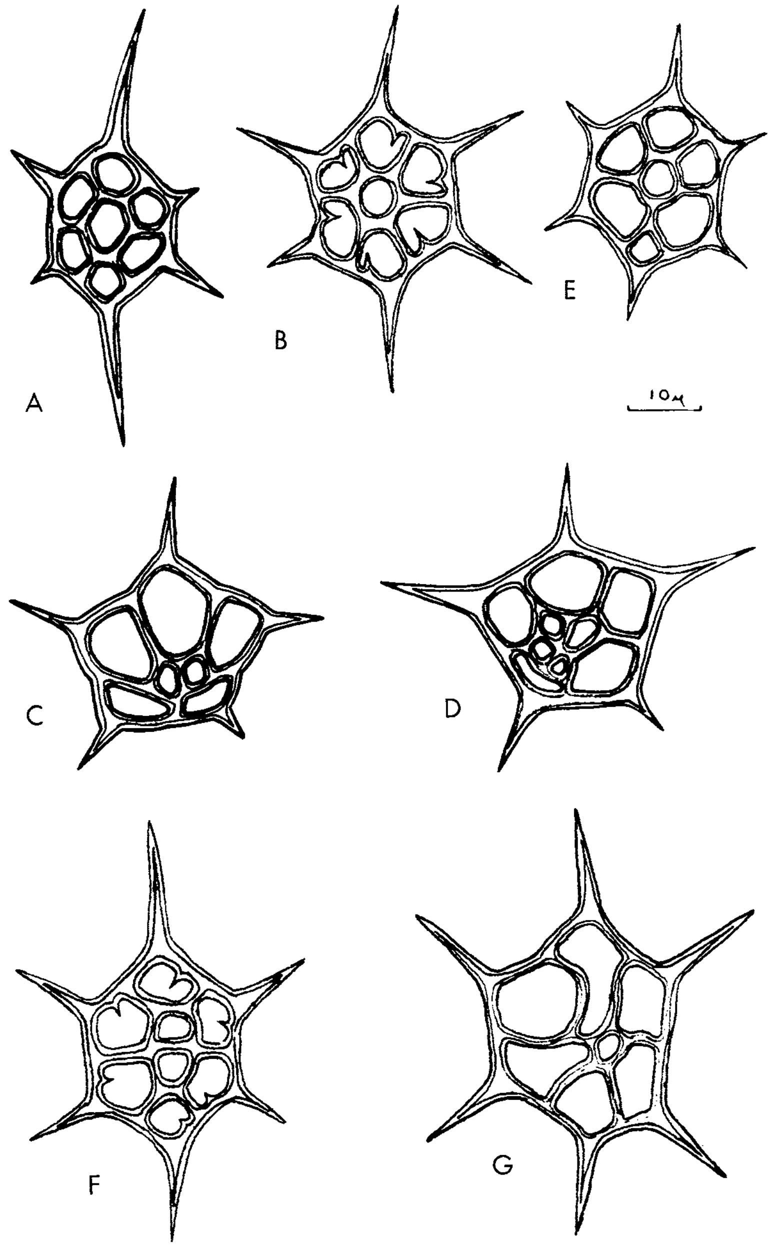


Figure 5. Representative Oregon silicoflagellates:

a. *Distephanus speculum* (Ehrenberg)

b. *Distephanus speculum* var. *regularis* Lemmermann

c, d. *Distephanus speculum* var. *pentagonus* Lemmermann

e, f, g. *Distephanus speculum* var.

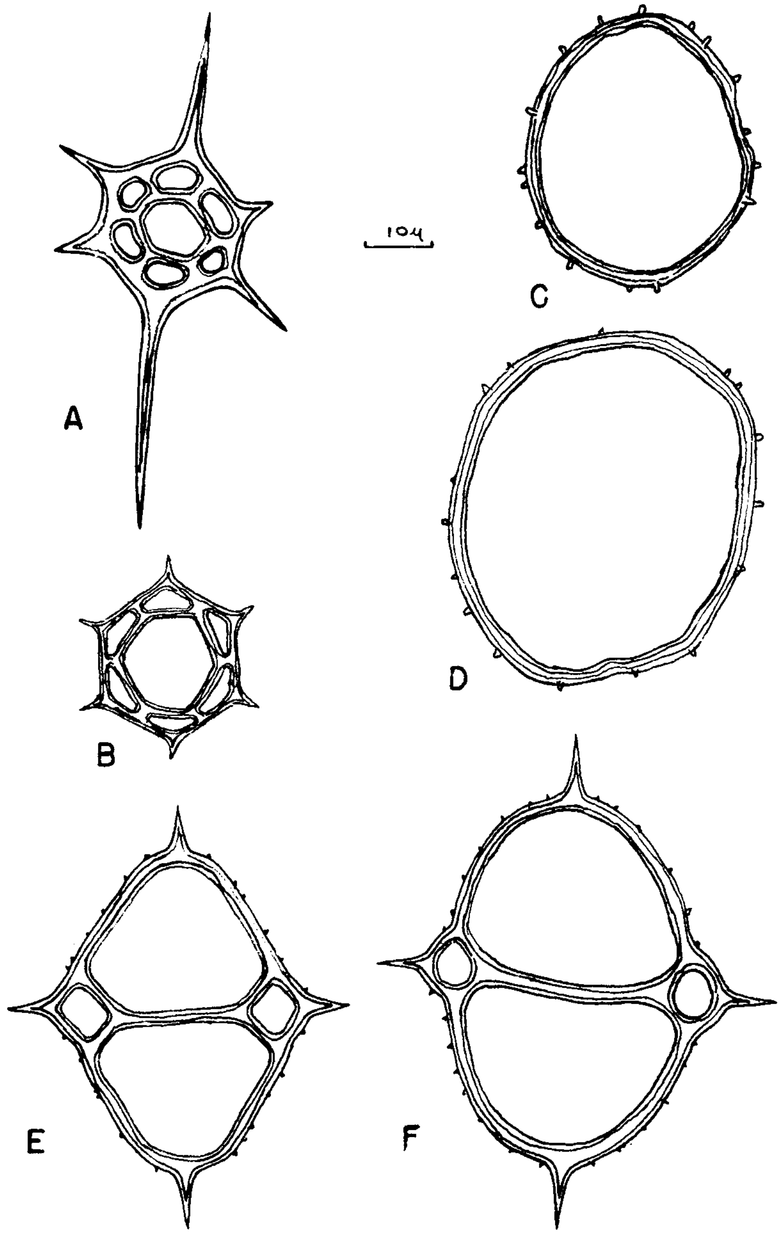


Figure 6. Representative Oregon silicoflagellates:
a. *Distephanus ornamentus* (Ehrenberg)
b. *Distephanus speculum* var. *brevispinatus* Lemmermann
c,d. *Paradictyocha polyactis* (Ehrenberg)
e,f. *Dictyocha mutabilis* Deflandre

Northwest where many of the Tertiary sedimentary rocks have undergone substantial induration, and standard techniques of removing fossils fail to produce satisfactory results. An additional feature enhancing the silicoflagellates as a biostratigraphic tool in this area is their apparent abundance in certain of the later Tertiary rocks of the Pacific Northwest. Silicoflagellates are known from contemporary oceans as well as from rocks as old as Lower Cretaceous. The greatest frequencies of their skeletal remains are found in Tertiary-age rocks which have substantial amounts of biologically precipitated silica such as marine diatomites and radiolarian oozes.

Morphology

Typically the silicoflagellate skeleton consists of a single or double ring of opaline silica (figures 3 and 4). Spines projecting from these rings are frequently of two succinct types: the larger radial spines, and the much smaller accessory spines projecting from either the basal body ring or the smaller apical ring or apical rod. The skeleton itself is tubular in structure (indicated here by double lines). The apical ring, if present, is oriented in the same plane as the basal ring and is supported by lateral rods.

Utility in Oregon

All of the silicoflagellate-bearing sediments collected from the Bandon localities (figure 1) are very rich in diatom frustules with lesser amounts of radiolaria and other nonsiliceous microfossils including plant spores and pollen, foraminifera, discoasters, and coccoliths. Examination of the siliceous phytoplanktonic microfossils from these localities (diatoms, silicoflagellates) indicates that the sediments bearing these microfossils range in age from the late Miocene to the early Pliocene (Delmontian Stage to Repettian Stage) and may be correlative with the lower part of the Empire Formation. Further studies of samples from offshore submarine exposures (see Kulm and Fowler, 1970) as well as from a number of late Tertiary formations in western Oregon are presently underway. It is expected that these current studies will permit the eventual establishment of a standard chronology for the fossil phytoplankton of the late Tertiary in the Pacific Northwest. Because of their mobility and relative freedom from limitation to particular rock facies, pelagic organisms have for some time been recognized as being ideal as index microfossils. The subsequent cosmopolitan distribution of silicoflagellates combined with their abundance, small size, and resistant opaline skeleton greatly enhances their value as correlative means for later Tertiary sediments of the Pacific Northwest.

Representative late Tertiary silicoflagellates of Oregon are illustrated in figures 5 and 6. These genera and species are from various localities near Bandon and offshore submarine exposures of diatom-rich sediments.

Acknowledgments

The authors gratefully acknowledge Drs. L. D. Kulm and G. A. Fowler of the Oregon State University Oceanography Department for supplying the samples from submarine rock exposures on the continental shelf off Oregon. This research was supported in part through funds supplied by the University of Oregon Graduate School.

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MAPS OF JOHN DAY UPLIFT ON OPEN FILE

Predominantly marine sediments, ranging in age from Devonian to Cretaceous, unmetamorphosed and not intruded by large igneous bodies, are exposed in the John Day uplift of central Oregon. Detailed mapping of these beds and their structural features in the southwestern part of the uplift by H. J. Buddenhagen has provided important clues to the pre-Tertiary geological history of the vast lava-covered plateau region east of the Cascade Mountains.

Because of the recent interest in the geology of this complex area by the oil industry, the Department is placing on open file all the maps and cross sections prepared by Buddenhagen. These maps are drafted on dimensionally stable mylar sheets and can be easily reproduced. This material is available for inspection at the Department's Portland office.

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"ONE THIRD OF THE NATION'S LAND"
REPORT OF THE PUBLIC LAND LAW REVIEW COMMISSION

"One Third of the Nation's Land," the report of the Public Land Law Review Commission that was presented to the President and Congress on June 23, is now available for distribution. The 342-page book contains a total of 400 recommendations for revision of public land policies. Recommendations regarding mineral resources appear on pages 121-138.

The report is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402. The price is $4.50.

* * * * *

REYNOLDS TO BEGIN LOCAL BAUXITE PROGRAM

Reynolds Mining Corp., a subsidiary of Reynolds Metals Co., reports that it will soon begin a small-scale mining program in Columbia, Washington, and Marion Counties, Oregon, and in Cowlitz County, Washington, to obtain laterite (bauxite) for research purposes. For the past 10 years the company has been drilling laterite samples from the four counties and making small-scale processing tests. With this phase of the research completed, the company is now ready to run larger-scale tests. Approximately 50,000 tons of the laterite will be taken from sites totaling about 12 acres. Local contractors will be employed to mine the ore, and trucks will transport it to outloading points for rail or water shipment to a Reynolds plant in another part of the country. The company will continue to follow good conservation practices, and once the work is completed it will restore the area and seed the surface.

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