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SOME NEW AND RARE POLLEN GRAINS FROM NEOGENE DEPOSITS AT OSTRZESZÓW (SOUTH-WEST POLAND)

Kilka nowych i rzadko spotykanych ziarn pyłku z neogeńskich osadów z Ostrzeszowa

ABSTRACT. This paper contains descriptions and photomicrographs of some interesting sporomorphs found in Neogene deposits at Ostrzeszów. Pollen of the *Acer palmatum* Thunb.-type, *Skimmia laureola* Hook.-type and *Clerodendrum* sp. has not hitherto been recorded from fossil deposits, whereas grains of *Cercidiphyllum* sp., *Diospyros* sp., *Nelumo* sp. and *Trapa* sp. are rarely met with in them. To be sure, these last forms have been reported from several localities, but often without any descriptions or photographic documentation.

Remarks concerning the occurrence of each taxon in fossil and modern floras have also been included.

INTRODUCTION

In course of a palynological study of Neogene deposits from Ostrzeszów some unknown forms were come across beside numerous sporomorphs already known from that period. Because some of them were well preserved and occurred in several samples, an attempt was made to determine their systematic position.

Investigation was based on the rich collection of comparative palynological preparations of the Institute of Botany, Polish Academy of Sciences, in Cracow, the following monographs of modern floras being also used: Pollen Flora of Taiwan by Huang (1972), Morphology of Pollen of Chinese Plants by Fu-Hsung & Nan-Feng (1960), Pollen Grains of Japan by Ikuse (1965), etc.

Pollen grains of *Acer palmatum* Thunb.-type, *Clerodendrum* sp. and *Skimmia laureola* Hook.-type hitherto unknown from fossil pollen floras and those of *Cercidiphyllum* sp., *Diospyros* sp., *Nelumbo* sp. and *Trapa* sp., rarely encountered in them, have been determined. In palynological literature they are mentioned sporadically, generally without descriptions and photographs, this fact being decisive of their inclusion in the present paper.

The above-mentioned taxons represent trees, shrubs, climbers and aquatic plants, which nowadays grow in tropical, subtropical and temperate climatic regions, mainly in south-eastern Asia. Except for *Nelumbo* and *Trapa* they are frequent components of various forest communities.

METHODICAL REMARKS

Material for palynological studies was prepared by heating in a 10 % KOH solution and boiling in hydrofluoric acid prior to its being steeped by the acetolysis method of Erdtman (1960). Sporomorphs were observed on permanent preparations (pollen grains mounted in glycerine gel), heated for the observation of the grains in different positions.

Erdtman's (1969, 1971) nomenclature is adopted in the description of grains; the dimensions given are always the length of the polar axis by the length of the equatorial axis (PxE) in the equatorial aspect of the grain. Measurements were taken using an eyepiece micrometer, the fundamental scale interval being 0.77 μ with a 40 × objective and 0.32 μ with an 100 × immersion objective.

DESCRIPTION OF POLLEN GRAINS

Family *Aceraceae*

Acer palmatum Thunb.-type

Pl. I, figs. 1—10

Fifteen 3-colporate sporomorphs resembling the pollen grains of the genus *Acer* sect. *Palmata* Pax in structure have been found in the material examined.

Description. Grains 3-colporate, oval-elliptic in outline in equatorial view, and 31.0—33.0 × 20.0—23.0 μ in size. Pores, situated halfway along colpi, oval, polarly elongated, measuring about 8.0 × 3.0 (3.5) μ. Exine ca. 1.5 μ thick, sexine thicker than nexine. Grain surface striated.

A comparison of the fossil material with the grains belonging to the modern species *Acer campbelli* Hook. et Thomps., *A. circinatum* Pursch., *A. japonicum* Thunb., *A. palmatum* Thunb., *A. rufinervae* Sieb. et Zucc., *A. spicatum* Lam. and those of the endemic Chinese genus *Dipteronia* (Biesboer 1975; comparative preparations) shows that it most resembles *A. palmatum* (Pl. I, figs. 11—12) and, to a smaller extent, *A. circinatum* and *A. japonicum*.

So far the 3-colporate type of pollen grains of *Acer* has been described only from the Pliocene of the G.F.R. (Menke 1976) and referred to *A. spicatum*. In comparison with the sporomorphs from Ostrzeszów these grains are decidedly smaller (P = 20.0—25.0 μ), their pores being also smaller and distinctly circular in outline.

Grains included in the genus *Acer* are found in fossil deposits starting from Oligocene ones. At present several types of these grains are distinguished, they differ in size, arrangement of colpi and pores, and in sculpture and are referred to the modern species *A. campestrae*, *A. negundo* and *A. spicatum*, *A. campbelli* and *A. saccharum* being also suggested (Muller 1981).

Macroscopic remains of maples appear in the Cretaceous and are frequently noted in fossil floras of younger age.

A. palmatum and *A. japonicum* have their natural stations in south-eastern Asia, whereas *A. circinatum* grows along the southern coast of Alaska and in the states Oregon and Washington in the USA (Firsov 1982).

Family *Cercidiphyllaceae*

Cercidiphyllum sp.

Pl. I, figs. 13—15, Pl. II, fig. 1—3

Fossil pollen grains of *Cercidiphyllum* are rather rarely met with. Eleven specimens have hitherto been found in 6 samples of the deposits from Ostrzeszów.

Description. Fine grains, 3-colpate, in equatorial view round to oval in outline, with a diameter of ca. 31.0—36.0 μ. In polar view it is distinctly trilobate with broad colpi (lacunae). Their edges are slightly jagged, probably owing to the burst of the closing membranes. Exine ca. 1.0 μ thick, grains semitectate, reticulate, with very fine meshes, polygonal to circular in outline, less than 0.5 μ in diameter.

The Ostrzeszów sporomorphs were compared with grains of *C. japonicum* Sieb. et Zucc. (Pl. II, figs. 4—7) and with the descriptions and photographs of grains of the remaining modern species of *Cercidiphyllum* and other fossil specimens (Praglowski 1974; Sadowska et al. 1973).

The oldest grains of *Cercidiphyllum* come from Cretaceous deposits, whereas as regards younger deposits they have been recorded, among other periods from the Oligocene of Austria (Hochuli 1978). In Poland they were identified for the first time in the Miocene deposits of Piaseczno (Oszast 1967) and next given from several Neogene localities in the west and south of the country (Sadowska 1977; Oszast & Stuchlik 1977).

The oldest macroremains known are the leaves of *C. ellipticum* (Newberry) Braun from the Lower Cretaceous deposits of the USA. In Europe, however, the oldest traces of this genus go back to the Eocene and it reaches the height of development in the Neogene (Hummel 1970, 1971; Jähnichen et al. 1980).

Nowadays relics of the family *Cercidiphyllaceae*, i.e. *C. japonicum* Sieb. et Zucc., *C. magnificum* (Nakai) Nakai and the Chinese variety *C. japonicum* var. *sinensae* Rehd. & Wils. (Krüssmann 1976), occur in China and Japan. They belong to the highest deciduous trees and *C. japonicum* is besides numbered among the oldest elements of the Japanese flora. This species grows in thick and wet forests on hillslopes, less than 300 m a. s. l. The Chinese variety is also encountered on the slopes of mountain ranges, but rather in open places, on good wet soils (Hummel 1971). Wang (1961) gives *C. japonicum* var. *sinensae* as one of the components of mixed forests in China beside *Acanthopanax evodiaefolius*, *Acer flabellatum*, *A. laxiflorum*, *Aesculus Wilsonii*, *Cerris racemosa*, *Davidia involurata*, *Pterocarya insignis* and *Magnolia sargentiana*.

Family *Verbenaceae*

Clerodendrum sp.

Pl. II, fig. 8, Pl. III, figs. 1—2

Only one pollen grain built characteristically of the genus *Clerodendrum* has been found in the material examined.

Description. Grain 3-colpate, oval in outline in equatorial view, measuring 68.0 × 44.0 μ. Exine ca 2.0—2.5 μ thick, sexine much thicker than nexine. The thick (ca 1.0 μ) uniform tectum is a characteristic feature of the structure of the grain wall. The surface bears sparsely but regularly distributed fine spikes, ca 1.5 μ in height. Between the spikes the sexine is finely granulated.

The comparative material consisted of pollen grains of 10 modern species of *Clerodendrum*: *C. colebrooksianum* Walp., *C. discolor* (Klotzch) Vatke, *C. eriophyllum* Gurke, *C. grandiflorum* Schan., *C. griffitianum* Clarke, *C. johnstonii* Oliver, *C. thomsonae* Balf. f. (comparative preparations) and descriptions and photomicrographs of *C. cryptophyllum* Turcz., *C. inermae* (L.) Gaertn., *C. paniculatum* L. and *C. trichotomum* Thunb. (Huang 1972). From among them the grains of *C. thomsonae* (Pl. II, fig. 9, Pl. III, figs. 3—4) most closely resemble the fossil material.

So far the genus *Clerodendrum* in the fossil state has been known only from macroscopic remains obtained from several Tertiary localities of Europe. In Poland fossil leaves of *C. silesiacum* Zast. have been described from Upper-Miocene deposits at Mirostowice Dolne and Pliocene ones at Domański Wierch (Zastawniak 1978).

Nowadays the genus *Clerodendrum* comprises more than 150 species of evergreen low trees, shrubs and creepers inhabiting subtropical and tropical regions of both hemispheres (Krüssmann 1978), but some species, e.g. *C. trichotomum*, growing in China and Japan, may extend into the temperate zone (Kurata 1968). *C. mandarinorum*, occurring in China, goes into the making of mesophytic mixed forests beside *Metasequoia glyptostroboides*, *Cunninghamia lanceolata*, *Liquidambar formosana*, *Rhus* sp., *Meliosma oldhami*, *Nyssa sinensis*, *Cercidiphyllum japonicum*, etc. (Wang 1961).

Family *Ebenaceae*

Diospyros sp.

Pl. IV, figs. 4—9, Pl. V, figs. 1—2

The pollen grains recognized as belonging to the genus *Diospyros* are not met with very often. They have been found, 15 in number, in 12 samples from the profile at Ostrzeszów.

Description. Grains 3-colporate, in equatorial view oval-elliptic in outline, 47.0 × 57.0 μ in size. Their outline is circular in polar aspect. Colpi long, reaching close to poles, slightly rounded at ends. Characteristic, rectangular endopores, ca 5.0 — 6.0 × 7.0 — 8.0 μ, situated halfway along colpi. Exine ca 1.5 μ thick. Grain surface smooth or very finely sculptured.

The above-presented structure is characteristic of the pollen grains of the family *Ebenaceae*. A comparison of these fossil sporomorphs with the modern ones of the genera *Royena*, *Euclea*, *Maba* and *Diospyros* made it possible to eliminate the first three of these genera because of their somewhat different arrangement of the colpi and small size of the grains. Out of the 12 species of *Diospyros*, *D. lotus* L. (Pl. IV, figs. 1—3) and *D. kaki* L. f. have their pollen grains nearly identical with the fossil pollen. Close similarity characterizes above all the size of grains, the mutual proportions and structure of the colpi and endospores and the surface sculpture.

Fossil grains of *Diospyros* are known from scarcely several Tertiary localities of Europe. The *Diospyros*-type pollen grains from the Eocene of France are considered to be well identified and documented, whereas two other records also from the Palaeogene of France are probable (Muller 1981). Younger deposits are represented by pollen grains of *D. ovalis* Taras., found in the Miocene of the Oka-Don Lowland in the U.S.S.R. (Tarasevich 1980). In Poland grains of this type have been reported only from the Miocene deposits of Piaseczno near Tarnobrzeg (Oszast 1967), but their comparison with the material from Ostrzeszów and modern species is impossible for lack of their descriptions and photographic documentation.

As regards macroscopic material of this genus, leaves and their impressions are prevalent in fossil floras. The oldest specimens come from Upper Cretaceous deposits in the U.S.S.R. (Shilin & Romanova 1978), U.S.A., Africa, Europe and Antarctic (Němejc 1975), but they are met with in largest numbers in the Tertiary. The impressions of calyces from Eocene sandstones in England are interesting; fruits, described as *Diospyrocarpum* sp., have also been found in the Eocene of France (Vaudois-Miéja 1980, 1982). In Poland fossil leaves have been described from several localities: *D. lotoides* Ung. from the Miocene of Krywałd (Raniecka-Bobrowska 1957), *D. brachysepala* A. Br. from the Oligocene of Osieczów (Raniecka-Bobrowska 1964), the Middle Miocene of Rozewie (Heer 1869) and the Tortonian of Swoszowice (Ilinskaja 1964). The determination of the calyx from Wieliczka as *D. salinaria* Zabłocki (Zabłocki 1928, 1930) is however regarded as dubious (Mai 1964).

At present the genus *Diospyros* comprises about 500 species of trees and shrubs, evergreen and those shedding leaves for winter, growing in the tropical and subtropical zones of both hemispheres (Krüssmann 1976).

According to Browicz (1982), *D. lotus* is an evergreen tree which today occurs in three discontinuous areas: 1. central and southern China, 2. the western Himalayas and mountainous regions of Tadzhikistan and Uzbekistan and 3. north-eastern Iran, along the Caspian Sea up to northern Anatolia. It usually grows in lower-lying parts of the mountains, sometimes forming pure stands, more often however entering into the composition of various forest communities, beside *Alnus, Carpinus, Fagus, Fraxinus, Pterocarya, Juglans, Celtis*, etc. It has no special soil requirements, but is often encountered close to rivers and streams. *D. kaki* L.f. is also an east-Asiatic species, growing in China and Japan, in mesophytous mixed forests (Wang 1961).

Family *Nelumbonaceae*

Nelumbo sp.

Pl. V, figs. 3—7

Three sporomorphs found in the Ostrzeszów deposits belong to the genus *Nelumbo.*

Description. Pollen grains 3-colpate, oval in equatorial view, circular in outline in polar view, big, ca 77.0 × 56.0 μ in size. Exine ca 3.5 μ thick, sexine thicker than nexine. Grains coated with thin smooth perforated tectum. Perforations very fine, irregular in outline. The columellae that support the tectum are distinctly broadened at the top and the tectum seems slightly undulated or depressed in intercolumellar spaces.

These fossil grains were compared with grains of modern *N. jamaicensis* D.C. and *N. lutea* (Wild.) Pers., and with descriptions and illustrations of *N. caspicum* (D.C.) Fisch. (Kuprianova & Alešina 1978) and *N. nucifera* Gaertn. (Huang 1972; Ikuse 1956).

The palynological records of *Nelumbo* are well documented and go back to the Palaeogene, but they are not numerous (Muller 1981). In Poland fossil grains of two species, *N. nucifera* and *N. jamaicensis* (= *N. lutea*), have been described from Miocene deposits in Upper Silesia (Macko 1957).

Macroremains of *Nelumbo*, chiefly leaves and their impressions, occur relatively rarely in fossil floras. The oldest specimens are those of *N. tenuinervis* Font. from the Lower Cretaceous of the U.S.A. This species is also met with in somewhat younger deposits in the European and African Cretaceous. In the Tertiary the genus *Nelumbo* occupied a large Euro-Siberian area till the Pliocene (Němejc 1975).

Nowadays the range of *Nelumbo* includes the subtropical and tropical regions of Eurasia, Malasia, north-eastern Australia, Central America (Colombia and northern Brazil) and the south-eastern part of the U.S.A. (Bratzeva 1970; Good 1964). Vasiliev (1961) draws attention to the fact that all the contemporary species occur in river valleys, mostly at river mouths, in places of a slow flow of water, in areas marked by a warm, very humid climate. He also thinks that the fossil species grew in similar conditions.

Family *Rutaceae*

Skimmia laureola Hook.-type

Pl. VI, figs. 1—8

Ten pollen grains of the genus *Skimmia* have been found in 9 samples of material so far examined.

Description. Pollen grains, 5-colporate, oval in outline in equatorial view, 31.0—40.0 × 23.0—28.0 μ in size. Circular in polar aspect. Colpi long, narrow, reaching nearly up to the poles. Pores situated halfway along colpi, also narrow, equatorially elongated. Exine ca 2.5 μ thick, sexine clearly thicker than nexine. The grain surface is distinctly reticulated, with irregular meshes. The diameter of meshes decreases towards the colpi and poles of the grain, the meshes besides show a tendency to form striae. Hence, the sculpture of the surface turns from reticulate, through striato-reticulate, into almost striate at the poles.

The fossil specimens were compared with pollen grains of *S. laureola* Hook. and with descriptions and photographs of grains of *S. japonica* Thunb. (Erdtman 1971; Ikuse 1956) and *S. reveesiana* Fortune (Huang 1972).

Fossil leaves of *Skimmia* are known only from two localities: *S. tortonica* Palam. et Usunova from the Neogene of Bulgaria (Palamarev & Usunova 1970) and *Skimmia* sp.? from the Sarmatian flora of Krynka (Krishtofovich & Bajkovskaya 1965).

Now the genus *Skimmia* numbers about 7—8 species of evergreen shrubs, growing in south-east Asia, China, Japan and the Himalayas (Krüssmann 1978). *S. laureola* Hook can be seen beside *Acer caesium* Wall., *A. campbelli* Hook et Thomps., *Betula alnoides* Buch.-Ham. ex Don., *Celtis australis* L., *Juglans regia* L., *Magnolia campbelli* Hook. f., *Symplocos phyllocalyx* Clarke and others in high forests of the Himalayas. It also goes to the making of evergreen rhododendron thickets, occurring at an altitude of ca 3100 m a.s.l. (Walther & Stuchlik 1982).

Family Trapaceae

Trapa sp.

Pl. VII, figs. 1—4

Fifteen polen grains of the aquatic plant *Trapa* were met with in one of the samples.

Description. Pollen grains, 3-colpate, oval, slightly rhomboidal in outline in equatorial view, triangular in polar view. The dimensions of grains are 66.0—77.0 × 66.0—68.0 μ. Three characteristic crests of slightly wavy sexine extend meridionally and meet at the poles. The grain surface is delicately granulated. The sexine of the crest is not homogeneous, it shows distinct opaque thickenings.

The fossil material was compared with grains of modern *Trapa natans* L. (Pl. VII, figs. 5—8) and with their descriptions and photographs (Huang 1972; Kuprianova & Alešina 1978).

Fossil grains of *Trapa* under the name of *Sporotrapoidites illingensis* were first described from the Pliocene deposits of Austria (Klaus 1954). Later, single specimens were reported from the Lower-Miocene deposits of Czechoslovakia (Konzalová 1976) and Nagy (1969) described a small form of this genus, *Sporotrapoidites hungaricus*, from the Middle Miocene of Hungary. In Poland pollen grains of *Trapa* were present in Miocene deposits at Rypin (Stuchlik 1964) and in Upper-Miocene deposits at Gerlachów (Ziembińska-Tworzydło 1974).

Macroscopic remains of *Trapa* are come across much more frequently than are the pollen grains, especially characteristic nuts, their fragments, and leaves. The most numerous localities are known from the Pliocene and Pleistocene of Europe, Asia and North America (Szafer 1954); from the Neogene deposits of Poland they have been reported from Sośnica, Turów, Konin, Żar (Hummel 1983) and other localities.

The present range of occurrence of this interesting plant, growing in stagnant or sluggish water, covers the central and southern Europe and tropical and subtropical regions of Asia and Africa (Hutchinson 1973).

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All microscopic analyses and microphotographs were carried out with the use of the Carl Zeiss Nfpk Research Microscope nr 469260 with apochromatic objectives: 40 × n.a. — 0.95 and 100 × n.a. — 1.32 and eye-piece projectives 4:1, 6.3:1.

All the microphotographs are at a magnification of 1000× unless otherwise stated.

In the descriptions of plates are given slide numbers and the co-ordinates of the microscope cross-table, indicating the position of the pollen grain on the slide.

Plate I

Acer palmatum — type

1—3, A31a, 105.6/16.5
4, 8, A2a, 110.1/7.9
5—7, A40a, 99.6/5.3
9—10, A2a, 97.2/13.8
11, 12, *Acer palmatum* Thunb. — recent

Cercidiphyllum sp.

13—15, A2a, 105.3/9.1

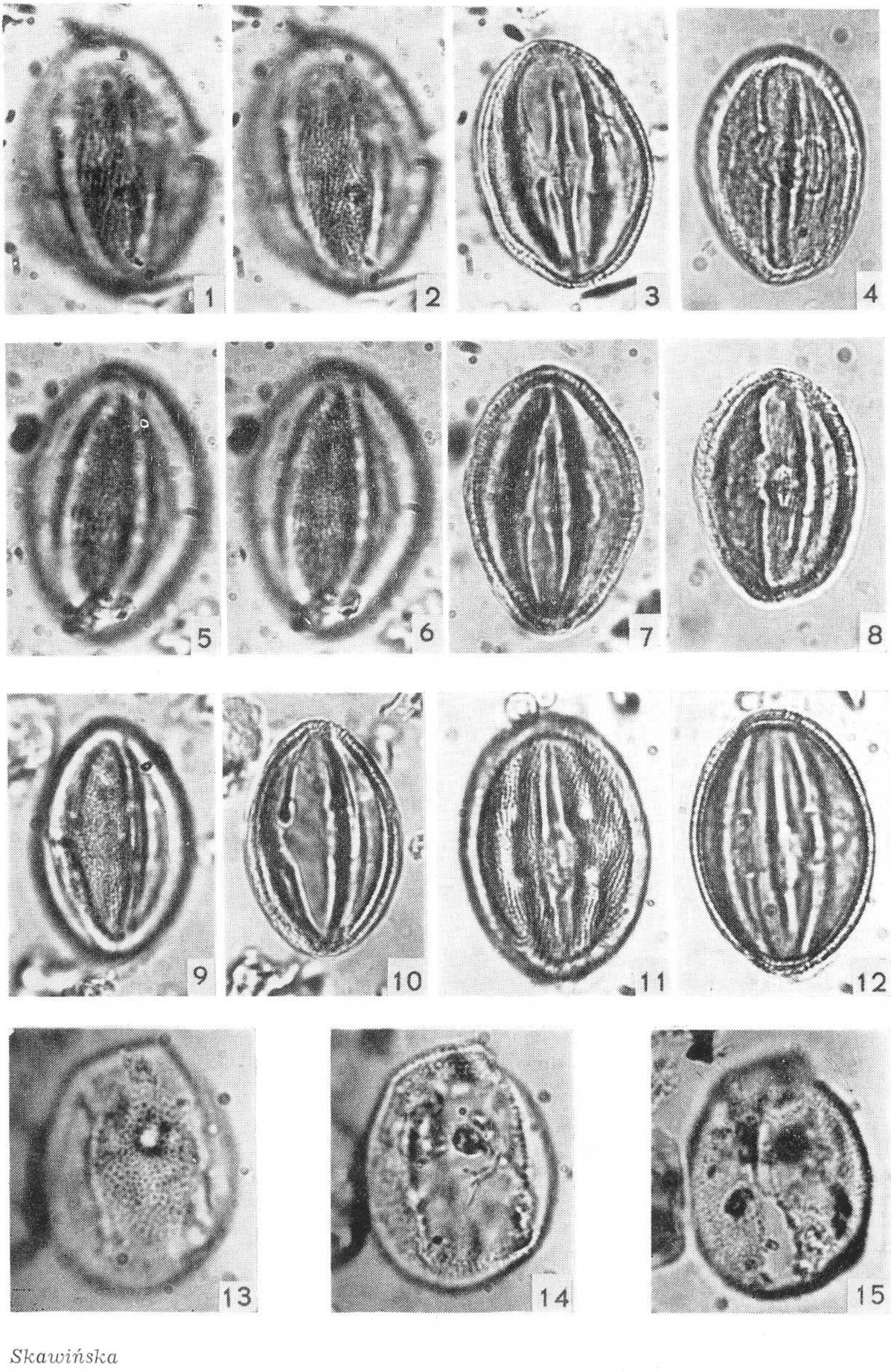
1
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Plate II

Cercidiphyllum sp.

1, B28a, 100.6/5.1
2, 3, A20b, 103.3/23.2
4—7, *Cercidiphyllum japonicum* Sieb. et Zucc. — recent

Clerodendrum sp.

8, A20b, 94.9/5.1
9, *Clerodendrum thomsonae* Balf. — recent

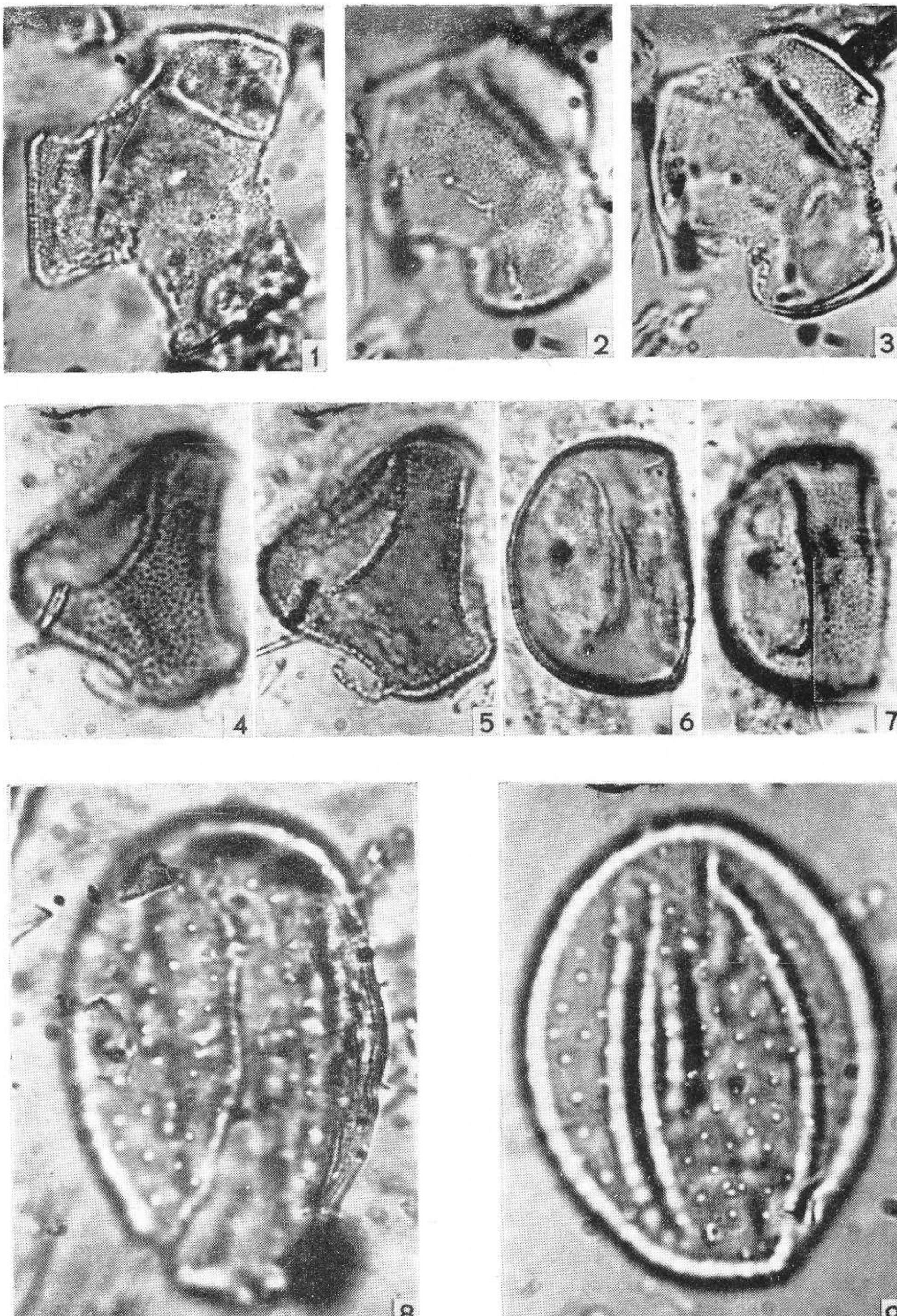
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Plate III

Clerodendrum sp.

1, 2, A20b, 94.9/5.1
3, 4, *Clerodendrum thomsonae* Balf. — recent

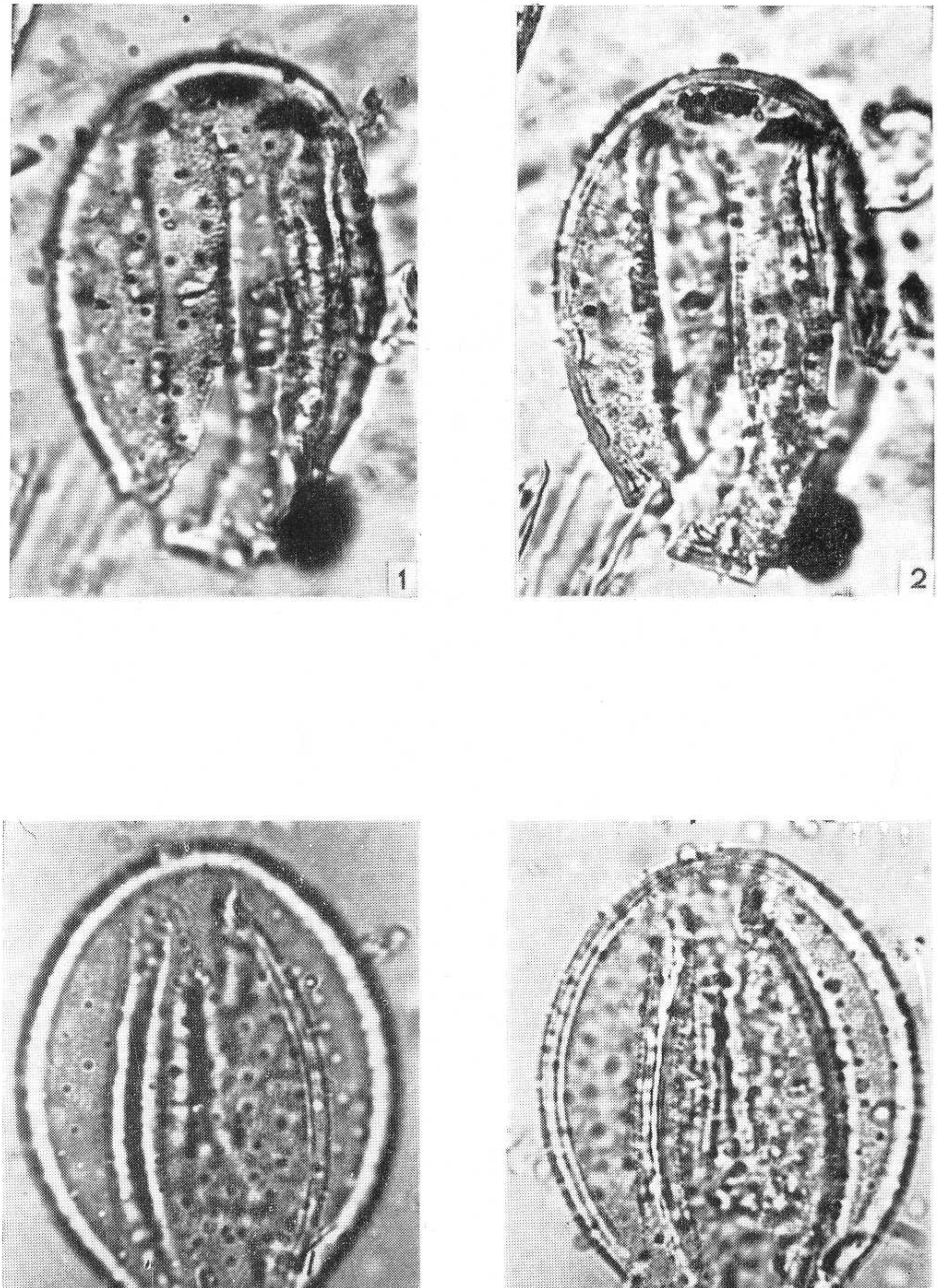
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Plate IV

Diospyros sp.

1—3, *Diospyros lotus* L. — recent
4, 5, A15a, 105.4/24.4
6, A24b, 105.2/3.4
7, 8, A33d, 102.7/8.0
9, B28a, 100.4/9.9

Plate IV

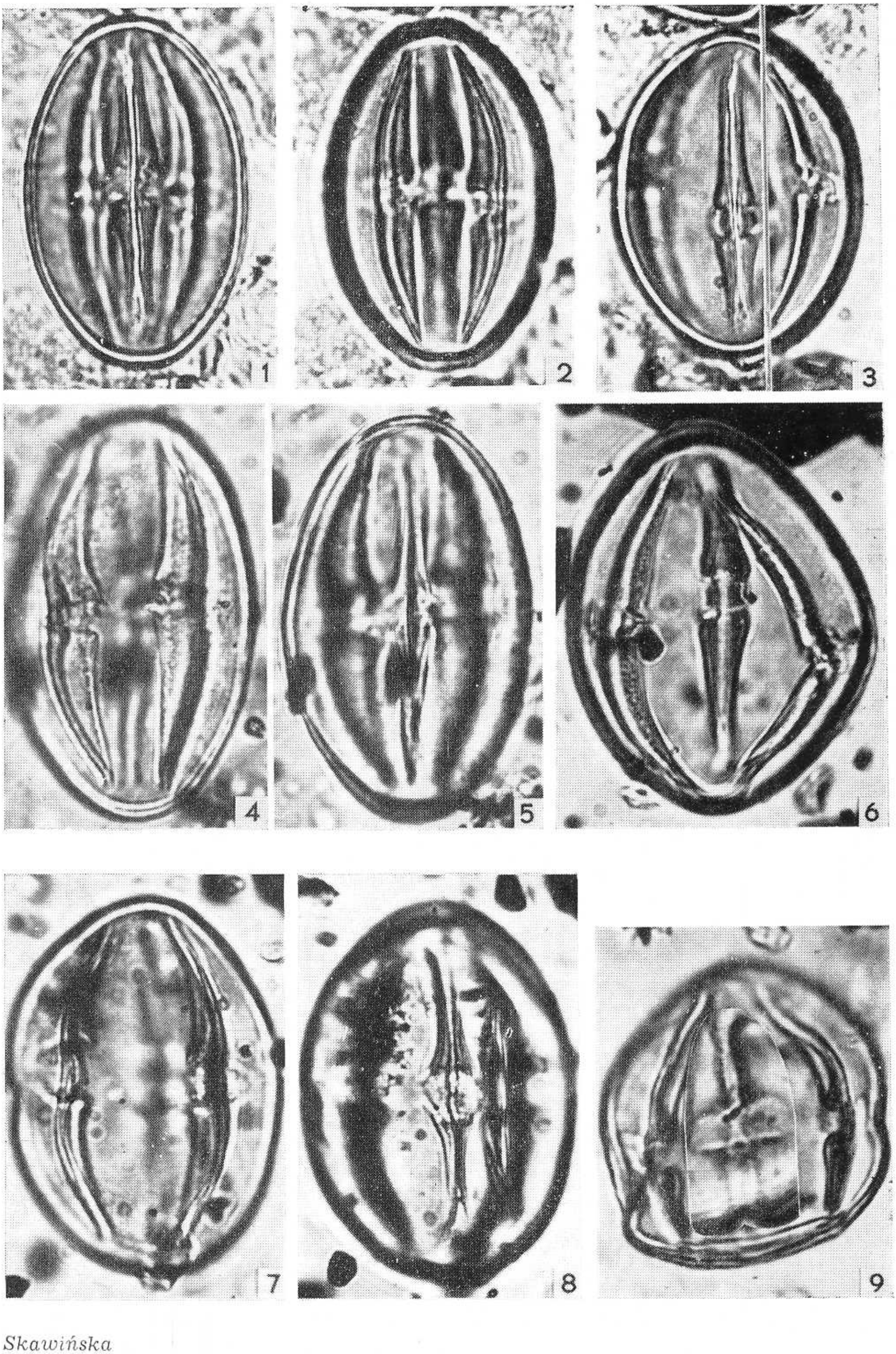

Plate V

Diospyros sp.

1, 2, B28a, 100.4/9.9

Nelumbo sp.

3—7 (3, 4 — 700 ×), B27b, 93.5/17.6
8—11 (8, 9 — 700 ×), *Nelumbo lutea* L. — recent

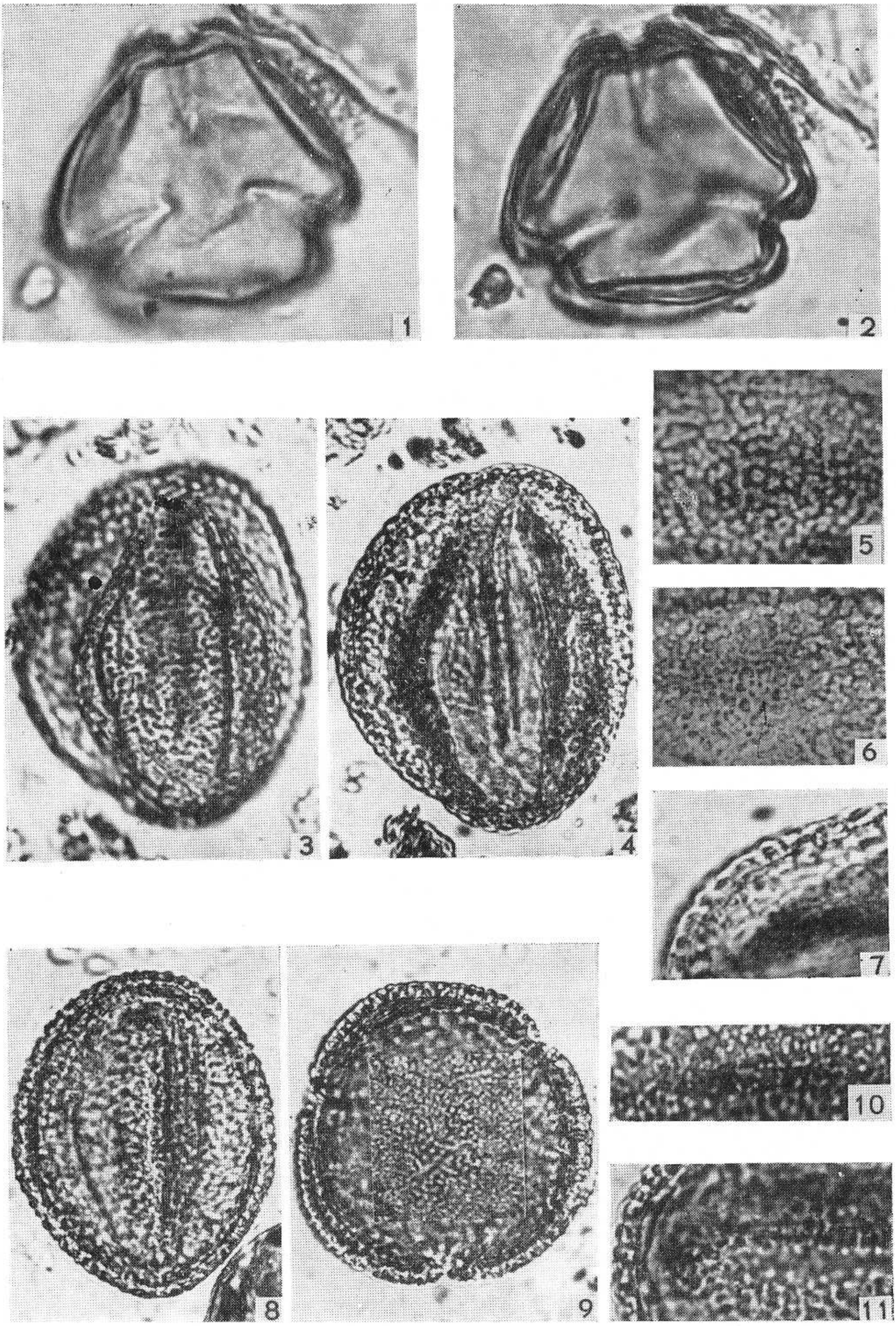
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Plate VI

Skimmia laureola — type

1—4, 8, A24a, 110.0/13.0
5—7, A38a, 107.6/1.8
9—12, *Skimmia laureola* Hook. — recent

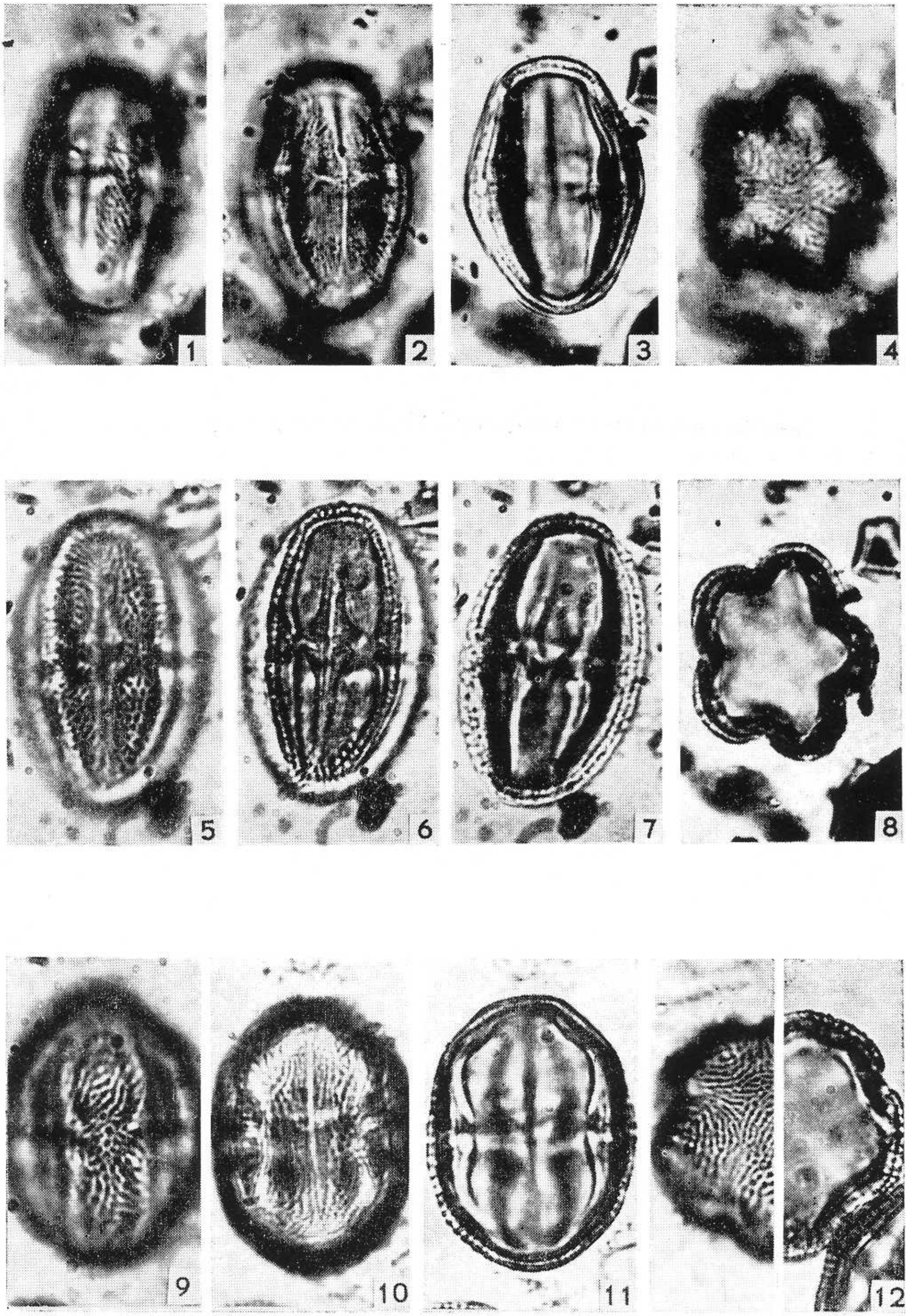
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Plate VII

Trapa sp.

1—4 (1, 2 — 700 ×), B22b, 103.6/12.5
5—8 (5—7 — 700 ×), *Trapa natans* L. — recent

Plate VII