PALEOECOLOGICAL STUDY OF TAIPEI BASIN

(2) Neihu Profile[1]

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Abstract: The samples for this palynological study were taken from a sedimentary deposit in the northeast section of the Taipei Basin, namely the Neihu District. Soil was sampled to a depth of 34.5 m, and covered all ranges of the Sungshan Deposit. Altogether sixty-four families, including 12 families of pteridophyta, 5 families of gymnosperms and 47 families of angiosperms were identified. The successive series of plant communities of the Neihu area of Taipei Basin were based on the Sungshan Deposit from about 380,000 to 4,500 years B. P. as follow:

Convolvulaceae, Cycadaceae, Typhaceae, Cyperaceae of Tropical plants (33.6 m) → Pinaceae, Taxodiaceae, Moraceae, Convolvulaceae, Magnoliaceae, Solanaceae, Fagaceae of Subtropical forests with increasing Warm temperate elements (31.5 m) → Taxodiaceae, Pinaceae, Fagaceae, Elaeocarpaceae and Magnoliaceae of Warm temperate forests (25.2 m) → Palmae, Cycadaceae, Apocynaceae, Fagaceae, Betulaceae, Pinaceae and Euphorbiaceae of Tropical to Subtropical forests (16.5 m, 6.5 m) → Taxodiaceae, Pinaceae, Juglandaceae and Trochodendraceae of Warm temperate forests (5.5 m) → Magnoliaceae, Pandanaceae, Moraceae, Betulaceae and Fagaceae of Subtropical forests (5-1 m).

INTRODUCTION

Neihu is located at the northeast section of the Taipei Basin, about 11 km from Taipei Botanical Garden (Fig. 1). As in the previous study (Chung & Huang: 117–141), the geohistory of the Neihu profile is known as the late Pleistocene and middle Holocene of the "Sungshan Deposit" by geologists (Lin, 1963), where the uppermost part of this deposit was exposed to an open site.

MATERIALS AND METHODS

The soil samples were obtained on waste land at Neihu by a rotary driller to a depth of 34.5 m. According to the different sediments due to the eustastic movement which was caused by the effect of the glacial action, 11 soil samples were chosen for this study. The methods for soil analysis and pollen grains or spores extraction were the same as those followed in the previous work.

RESULTS

1. Soil analysis: The soil samples of this profile were mostly clay or silt, only in the lowermost part was sand the major component. The color is gray to brown, but dark pieces of lignitoid wood were found in some of the sediments. The soil components and textures are listed in Table 1.

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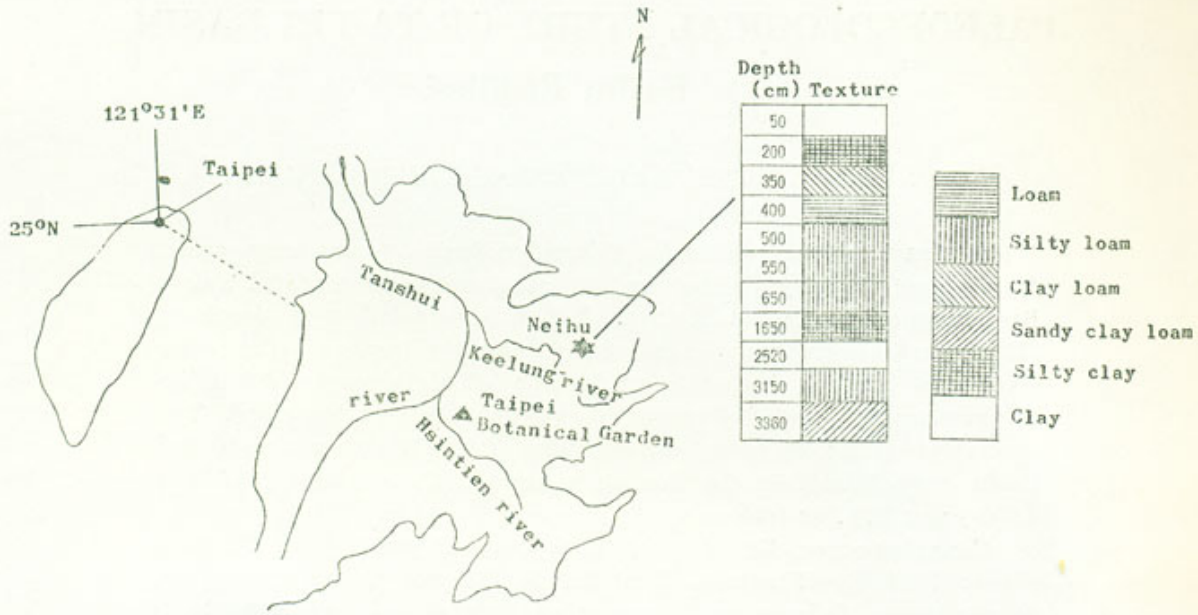
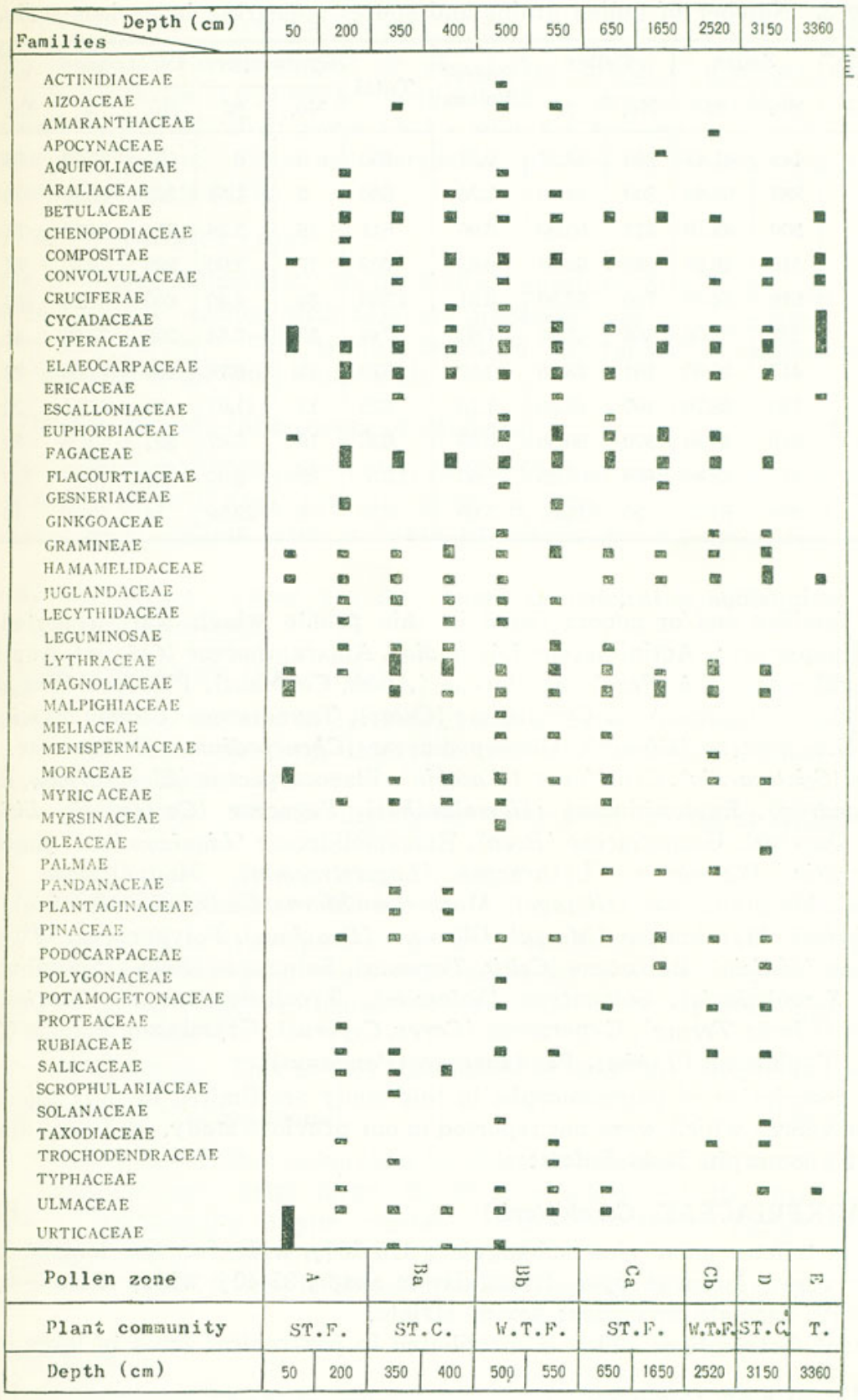


Fig. 1. Geographical map showing the sampling locality and soil textures of the sediments

Table 1. Soil components and textures of various sediments

Characters / Depth (cm)	Texture	Color	Sand (%)	Silt (%)	Clay (%)
50 (0-100)	Clay	Brown with golden spots	14	30	56
200 (101-270)	Silty clay	Gray with dark pieces of wood	6	46	48
350 (271-370)	Clay loam	Greenish-gray with yellow spots	28	38	34
400 (371-410)	Loam	Yellow	30	48	22
500 (411-510)	Silt loam	Grayish-yellow	30	62	8
550 (511-580)	Silt loam	Gray	20	74	6
650 (581-800)	Silt loam	Gray with dark pieces of wood	14	78	8
1,680 (801-1,800)	Silty clay	Greenish-gray with shell fragments	6	46	48
2,520 (1,801-3,000)	Clay	Grayish-brown	2	16	82
3,150 (3,001-3,200)	Silt loam	Brown	24	72	4
3,360 (3,201-3,450)	Sandy clay loam	Yellow-brown	58	20	22

2. Pollen analysis: More than 7,000 microfossils were analysed; about 50% of the records were fern spores and the other 50% were pollen grains. Altogether 12 families of the pteridophyta, 5 families of gymnosperms and 47 families of angiosperms were identified (Pollen diagram 1, Table 2).



T. : Tropical thickets
ST. C. : Subtropical with increase cool temperate forests
W. T. F.: Warm temperate forests
ST. F. : Subtropical forests

Table 2. Number of pollen grains and spores appearing in various sediments

Contents / Depth (cm)	Spore		Pollen		Spore/ Pollen	Total	Gymnosperm		Dicotyledon		Mono-cotyledon	
	No.	%	No.	%			No.	%	No.	%	No.	%
50	145	41.43	205	58.57	0.77	350	0	0	151	73.80	54	26.20
200	383	55.80	303	44.20	1.26	686	5	1.65	260	85.30	38	13.05
350	300	49.10	311	50.90	0.96	611	16	5.14	264	84.96	31	9.90
400	318	45.20	385	54.80	0.82	703	15	2.90	289	74.80	81	21.30
500	610	44.80	750	55.20	0.81	1,360	34	4.40	609	81.20	105	14.40
550	377	52.08	366	47.92	1.03	743	33	9.54	292	79.33	41	11.20
650	417	72.00	162	28.00	2.57	579	11	6.78	129	79.66	22	13.56
1,680	120	53.70	109	46.30	1.10	229	13	11.91	74	68.00	22	20.10
2,520	316	49.50	320	50.50	0.98	636	18	5.67	231	72.15	70	22.18
3,150	417	38.75	659	62.25	0.63	1,076	39	6.00	496	75.37	122	18.63
3,360	198	84.95	35	15.05	5.65	233	8	22.89	14	40.00	13	37.11

The families and/or genera found in this profile which were reported in our previous paper are: Actinidiaceae (*Actinidia*), Amaranthaceae (*Celosia*), Aquifoliaceae (*Ilex*), Araliaceae (*Schefflera*), Betulaceae (*Alnus, Carpinus*), Pinaceae (*Tsuga, Pinus*) Podocarpaceae (*Podocarpus*), Cycadaceae (*Cycas*), Taxodiaceae (*Cunninghamia, Cryptomeria*), Ginkgoaceae (*Ginkgo*), Chenopodiaceae (*Chenopodium*), Compositae, Convolvulaceae (*Stictocardia*), Cruciferae (*Wasabia*), Elaeocarpaceae (*Elaeocarpus*), Ericaceae (*Rhododendron*), Euphorbiaceae (*Homalanthus*), Fagaceae (*Castanopsis, Lithocarpus, Pasania, Quercus*), Gesneriaceae (*Boea*), Hamamelidaceae (*Liquidambar*), Juglandaceae (*Engelhardtia, Platycarya*), Lythraceae (*Lagerstroemia*), Magnoliaceae (*Michelia, Magnolia*), Malpighiaceae (*Hiptage*), Moraceae (*Morus, Cudramia, Malaisia*), Myricaceae (*Myrica*), Myrsinaceae (*Maesa*), Oleaceae (*Fraxinus*), Polygonaceae (*Polygonum*), Proteaceae (*Helicia*), Rubiaceae (*Celtis, Tarenna*), Salicaceae (*Salix*), Scrophulariaceae (*Mazus, Scrophularia*), Solanaceae (*Solanum*), Trochodendraceae (*Trochodendron*), Ulmaceae (*Ulmus, Trema*), Cyperaceae (*Carex, Cyperus*), Gramineae, Palmae (*Calamus, Arenga*), Typhaceae (*Typha*), Pandanaceae (*Pandanus*).

The description of palynomorphs in this study are limited to only those pollen grains or spores which were not reported in our previous study. A detail description of the palynomorphs is as follow:

(1) PARKERIACEAE (*Ceratopteris*) Pl. 1: 1–3

Grains trilete; polar view subangular; 110–120 μ wide for the longest diameter in polar view; laesurae open, triangular in shape, 35–40 μ wide; exine 3–4 μ thick; tectum with baculate processes; sexine striate.

Present distribution: This is distributed in pantropical areas in lakes or ponds.

(2) AIZOACEAE (*Mollugo*) Pl. 1: 4–5

Grains 6–pericolpate; subspheroidal; 25–30 μ wide; colpi noncrassimarginate; exine 1 μ thick; tectum with scabrate processes; sexine reticulate, with OL-pattern.

Present distribution: This is distributed in tropical to subtropical thickets, at altitudes below 500 m high.

(3) APOCYNACEAE (*Alyxia, Formosia*) Pl. 1: 6–7

Grains 2–porate; tubular-shaped or vessel-like; 45×20 μ; aperture drop type, pores 18 μ wide; exine 1.5 μ thick; tectum psilate; sexine granulate for *Alyxia*; grains subspheroidal; 22×20 μ; pores 1.5–2 μ wide for *Formosia*.

Present distribution: These are distributed in tropical to subtropical forests, at altitudes below 300 m high.

(4) ESCALLONIACEAE (*Itea*)

Grains 2–porate; ellipsoidal; 15–18×7–10 μ; aperture drop type, pores 1–1.5 μ wide; exine 1 μ thick; tectum with scabrate processes; sexine granulate.

Present distribution: This is distributed in subtropical to warm temperate forests, at altitudes from 500–1,800 m high.

(5) EUPHORBIACEAE (*Macaranga* or *Mallotus*) Pl. 1: 8–11

Grains 3–colporate; oblate-spheroidal; 18–25×23–28 μ; amb circular to subangular; colpi nearly as long as P axes; aperture common type, ora transversally parallel; exine 1–1.5 μ thick; tectum with scabrate processes; sexine reticulate, with OL-pattern.

Present distribution: These are distributed in tropical to subtropical thickets, at altitudes below 300 m high.

(6) FLACOURTIACEAE (*Flacourtia*) Pl. 1: 12–13

Grains 3–colporate; prolate; 13–18×9–12 μ; amb circular; colpi noncrassimarginate, crustate; ora circular; exine 1 μ thick; tectum with scabrate processes; sexine reticulate with OL-pattern.

Present distribution: This is distributed in tropical forests, at altitudes below 300 m high.

(7) LECYTHIDACEAE (*Barringtonia*) Pl. 1: 14–16

Grains 3–colporate or syncolporate; prolate; 43–45×42–47 μ; amb circular; colpi crassimarginate; aperture drop type, ora longitudinally elliptic; exine 2–3 μ thick; tectum psilate; sexine hetero-reticulate on the colpi marginal area, granulate on most of the other parts.

Present distribution: This is only distributed in tropical coastal regions.

(8) LEGUMINOSAE (*Caesalpinia*) Pl. 1: 17–20 & Pl. 2: 1

Grains 3–colporate; prolate-spheroidal to oblate-spheroidal; 35–45×40–45 μ; amb circular or inter-circular; colpi large, 35×20 μ, membrance with finely reticulate elements; ora longitudinally elliptic, crustate; exine 2–3 μ thick; tectum with verrucate processes; sexine reticulate, with OL-pattern.

Present distribution: This is distributed in tropical areas, generally near the seashore.

(9) LABIATAE

Grains 6–colpate; 35 μ wide in polar view; amb circular; colpi as long as P axes; exine 1.5 μ thick; tectum with scabrate processes; sexine reticulate, with OL-pattern. The morphology of this genus is similar to those of *Galium* of Rubiaceae.

Present distribution: This family is mostly distributed in tropical to subtropical open areas.

(10) MELIACEAE (*Melia*) Pl. 2: 2–3

Grains 4–colporate; prolate; 35–37×28–31 μ; amb circular; colpi as long as P axes; aperture drop type, ora transversally elliptic; exine 1.5 μ thick; tectum psilate; sexine granulate.

Present distribution: This is distributed in tropical to subtropical forests, at altitudes below 300 m high.

(11) PLANTAGINACEAE (*Plantago*) Pl. 2: 4–5

Grains 4–6–porate; spheroidal; 22–26 μ wide; pores 1.5 μ wide, crustate; exine 1 μ thick; tectum psilate; sexine granulate.

Present distribution: This is distributed in tropical to subtropical cultivated lands, at altitudes below 300 m high.

(12) POTAMOGETONACEAE (*Potamogeton*) Pl. 2: 6–7

Grains 1–colpate; prolate; 18–25×13–15 μ; exine 1 μ thick; tectum with gemmate processes or intectate; sexine reticulate, with OL–pattern.

Present distribution: This is distributed in tropical to subtropical areas, especially in ponds or lakes.

(13) RUBIACEAE (*Gardenia, Randia*) Pl. 2: 14–19

Grains tetrad; 3–porate; 22–32 μ wide; aperture drop type, pores 1.5–2 μ wide; exine 1.5 μ thick; tectum with scabrate processes; sexine reticulate, with OL–pattern (*Gardenia*).

Grains 3–porate; subspheroidal; 12–15 μ wide; aperture drop type, pores 1 μ wide; exine 1 μ thick; tectum with scabrate porcesses; sexine reticulate, with OL–pattern (*Randia*).

Present distribution: These are distributed in tropical to subtropical thickets, at altitudes below 800 m high.

DISCUSSION

According to the kinds of microfossils identified, the estimated plant communities of each sample layer of the profile from about 380,000 to 4,500 years B. P. have been classified (Pollen diagram 1).

At a depth of 33.6 m, sand is the major component, therefore, only 35 pollen grains and 198 fern spores were obtained from two extractions. Convolvulaceae, Cycadaceae, Typhaceae and Cyperaceae were found abundantly, thus, it was most likely a tropical thicket period (Pollen zone E). Pinaceae, Taxodiaceae, Moraceae, Convolvulaceae, Magnoliaceae, Typhaceae, Solanaceae, Fagaceae and Elaeocarpaceae were the representative elements at a depth of 31.5 m, those elements probably, belonged to a subtropical forest period, with increasing numbers of warm temperate elements such as Pinaceae, Taxodiaceae and Fagaceae (Pollen zone D). The representative plants appearing at a depth of 25.2 m were quite similar to that of 31.5 m, this could be a warm temperate to subtropical broad-leaved forest period (Pollen zone Cb). Magnoliaceae, Palmae, Cycadaceae, Apocynaceae and Euphorbiaceae were commonly found at a depth of 16.5 m, this was a tropical thicket. At a depth of 6.5 m, the families of the major elements were the same as those at 16.5 m but cool elements such as Pinaceae, Betulaceae, Fagaceae and Elaeocarpaceae increased, thus, this was a subtropical forest period with little cooler weather (Pollen zone Ca).

Taxodiaceae, Pinaceae, Juglandaceae, Trochodendraceae, Fagaceae and Elaeocarpaceae were found at a depth of 5.5 m, this was a warm temperate forest period, but still some of the former tropical elements remained as Leguminosae, Meliaceae and Euphorbiaceae. Quite the same components appeared at a depth of 5 m as those of 5.5 m, but the grains of Myricaceae, Rubiaceae, Myrsinaceae, Magnoliaceae, Leguminosae and Euphorbiaceae increased, this belonged to a warm temperate or subtropical forest period (Pollen zone Bb). Pinaceae, Magnoliaceae, Cycadaceae, Pandanaceae, Moraceae, Leguminosae and Betulaceae were found at the depth of 4 m, and 3.5 m, it seems these were a subtropical thicket period, but still some of the warm temperate elements were found (Pollen zone Ba). At the depth of 2 m, and 0.5 m, there was the same type of vegetation as exists in Northern Taiwan today. This was a period of subtropical forests (Pollen zone A).

CONCLUSIONS

1. More than 7,000 microfossils were analysed from the Neihu profile, 5 families of gymnosperms, 47 families of angiosperms and 12 families of pteridophyta were classified.

2. Marine plants such as *Barringtonia*, *Pandanus* and aquatic plants such as *Potamogeton*, *Ceratopteris* were commonly found in some sediments of this profile.

3. Past successive series of plant communities for this area are: Tropical thickets (33.6 m) → Subtropical forests (31.5 m) → Warm temperate forests (25.2 m) → Subtropical forests (16.5 m, 6.5 m) → Warm temperate forests (5.5 m) → Subtropical forests (5–1 m).

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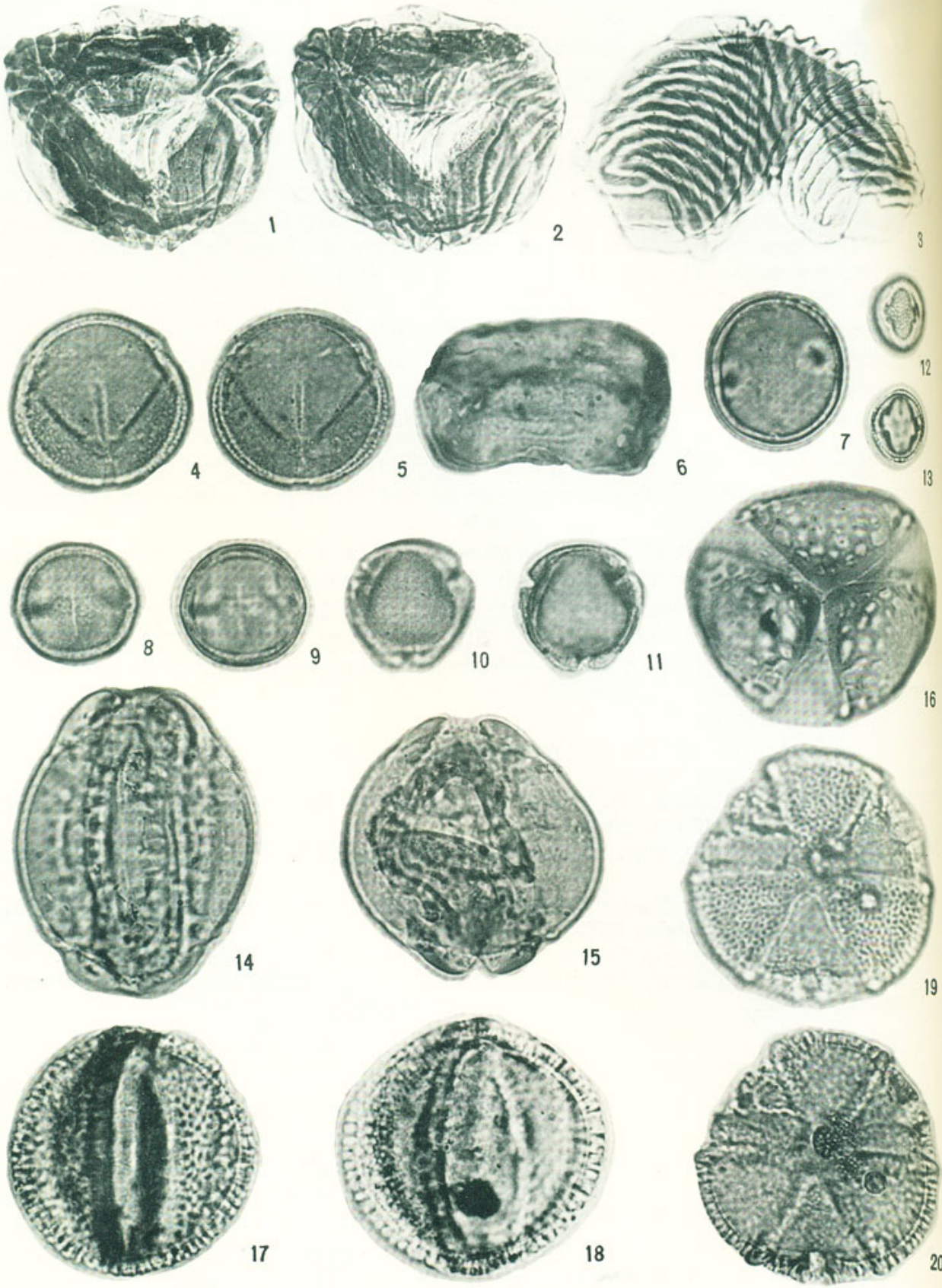

Plate 1: 1-3, Parkeriaceae (***Ceratopteris***) NH-350-610, 200-713; 4-5, Aizoaceae (*Mollugo*) NH-350-214; 6, Apocynaceae (*Alyxia*) NH-1680-66; 7, Apocynaceae (*Formosia*) NH-400-113; 8-11, Euphorbiaceae (*Mallotus*) NH-500-374, 500-321; 12-13, Flacourtiaceae (*Flacourtia*) NH-500-651; 14-16, Lecythidaceae (*Barringtonia*) NH-200-49, 400-68, 500-653; 17-18, Leguminosae (*Caesalpinia*) NH-200-322, 200-324, 400-382. 1-3, ×400; 4-20, ×1000.

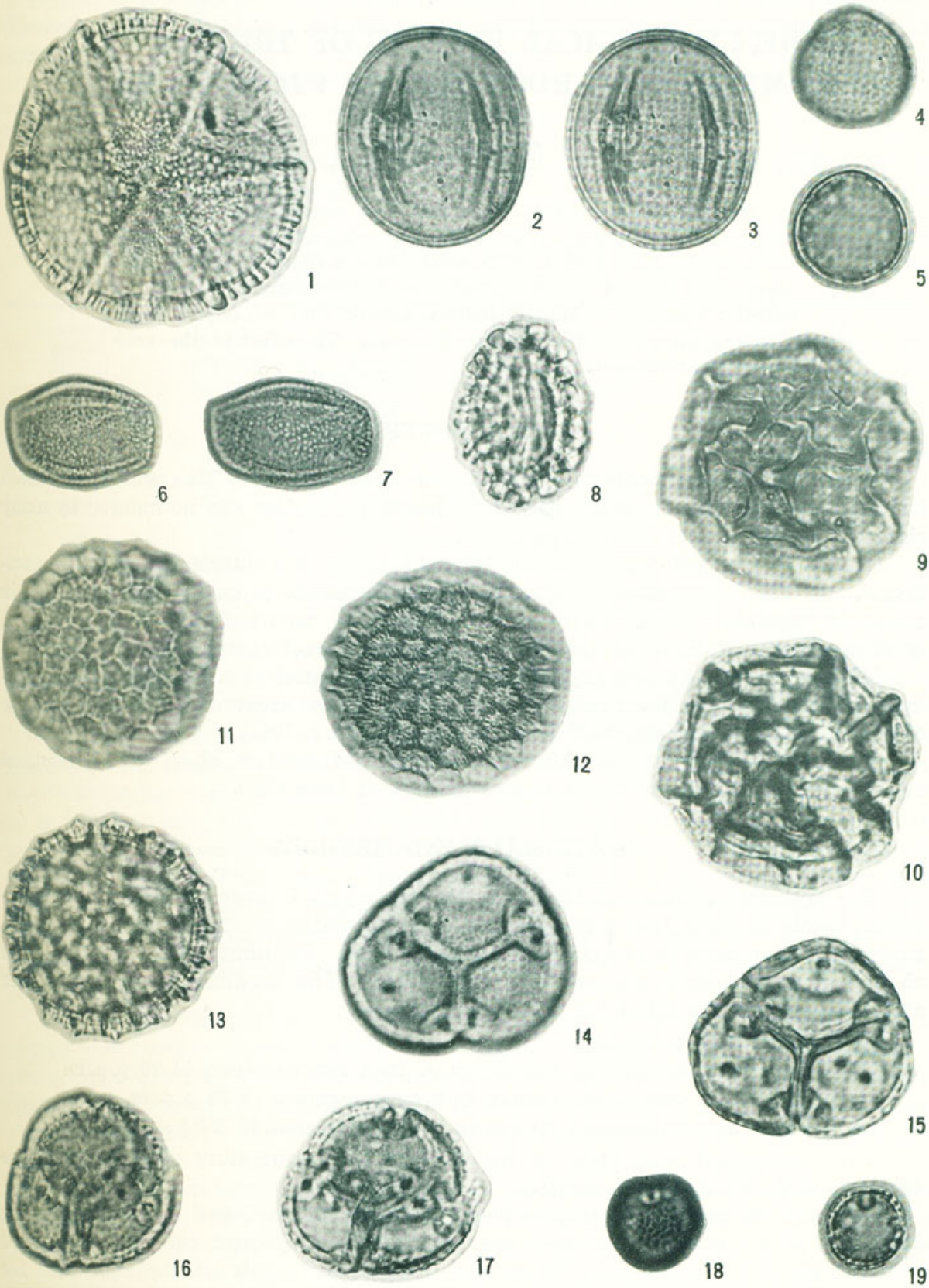

Plate 2: 1, Leguminosae (*Caesalpinia*) NH-200-325; 2-3, Meliaceae (*Melia*) NH-650-159; 4-5, Plantaginaceae (*Plantago*) NH-400-133; 6-7, Potamogetonaceae (*Potamogeton*) NH-500-69; 8, Aquifoliaceae (*Ilex*) NH-200-321; 9-10, Compositae (*Elephantopus*) NH-3150-27; 11-13, Polygonaceae (*Polygonum*) NH-500-719; 14-17, Rubiaceae (*Gardenia*) NH-3150-656, 3150-657; 18-19, Rubiaceae (*Randia*) NH-350-74. 1-19, ×1000.