PALYNOLOGICAL STUDY OF THE INTRAMONTANE PEAT BOG AT DOI INTHANON, CHIANG MAI PROVINCE

Mr. Ratthapong Poungtaptim

A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Botany
Department of Botany
Graduate School
Chulalongkorn University
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P43

การศึกษาเรณูของพรรณพฤกษชาติในแอ่งพรุภูเขาที่ยอดดอยอินทนนท์ จังหวัดเชียงใหม่

นายรัฐพงษ์ พวงทับทิม

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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By	Mr. Ratthapong Poungtaptim
Department	Botany
Thesis advisor	Associate Professor Kosum Pyramarn
Thesis co-advisor	Assistant Professor Dr. Thanawat Jarupongsakul

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Accepted by the Graduate School, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

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(Professor Supawat Chutivongse, M.D.)

THESIS COMMITTEE

....Chairman
(Associate Professor Sumitra Kongchuensin)

....Thesis Advisor
(Associate Professor Kosum Pyramarn)

....Thesis co-Advisor
(Assistant Professor Dr. Thanawat Jarupongsakul)

....Member
(Dr. Chumpol Khunwasi)

BRT 541047

พิมพ์ต้นฉบับบทคัดย่อวิทยานิพนธ์ภายในกรอบสีเขียวนี้

รัฐพงษ์ พวงทับทิม : การศึกษาเรณูของพรรณพฤกษชาติในแอ่งพรุภูเขาที่ยอดดอยอินทนนท์ จังหวัดเชียงใหม่ (PALYNOLOGICAL STUDY OF THE INTRAMONTANE PEAT BOG AT DOI INTHANON, CHIANG MAI PROVINCE) อ. ที่ปรึกษา : รศ. โกสุม พีระมาน, อ. ที่ปรึกษาร่วม : ผศ. ดร. ธนวัฒน์ จารุพงษ์สกุล ; 127 หน้า. ISBN 974-332-483-6

การศึกษาละอองเรณูและสปอร์ของพืชในอดีตกาลบริเวณแอ่งพรุภูเขาที่ยอดดอยอินทนนท์ จังหวัดเชียงใหม่ เพื่อสร้างแผนผังแสดงปริมาณการสะสมตัวของละอองเรณูและสปอร์ตั้งแต่อดีตในบริเวณพื้นที่ดังกล่าว sphagnum peat core ลึก 2 เมตร ที่หุ้มด้วยพลาสติก พร้อมกับแช่เย็นเพื่อป้องกันการปนเปื้อนและปฏิกิริยาออกซิเดชั่นได้มาจาก รศ. โกสุม พีระมานและ ผศ. ดร. ธนวัฒน์ จารุพงษ์สกุล ถูกนำมาใช้ในการวิจัยนี้ โดยสุ่มตัวอย่างดินที่นำมาจากหลุมเจาะ 1 ลูกบาศก์เซนติเมตร ที่ทุกความลึก 2 เซนติเมตร แล้วนำมาแยกละอองเรณูและ สปอร์ออกจากตะกอนดินด้วยวิธีของ Jarupongsakul (1987) หลังจากนั้นนำมาทำสไลด์ถาวรโดยใช้ซิลิโคนออยล์ AK 2000 เป็น mounting media ตรวจสอบชนิดและปริมาณละอองเรณูและสปอร์จากดิน โดยกล้องจุลทรรศน์แบบใช้แสงและกล้องจุลทรรศน์อิเล็คตรอนแบบส่องกราด

ผลการตีความจากไดอะแกรม ของละอองเรณูและสปอร์ของ peat bog (1A) ซึ่งอยู่สูงประมาณ 2,565 เมตร จากระดับน้ำทะเล บ่งชี้ว่าเมื่อประมาณ 4,300 ปีที่ผ่านมาบริเวณนี้เป็นป่าดิบเขา และยังสามารถแบ่งภูมิอากาศบริเวณนี้ได้เป็น 6 ช่วง ตามการเปลี่ยนแปลงของภูมิอากาศซึ่งอุ่นและเย็นขึ้น โดยใช้พรรณไม้เขตอบอุ่นเป็นดรรชนีบ่งชี้ และหลักฐานนี้ยังสนับสนุนว่า ภูมิอากาศยุค Holocene ไม่คงที่ นอกจากนี้จากการพบละอองเรณูของ polygonum และ grass บ่งชี้ว่าบริเวณนี้อาจจะถูกบุกรุกโดยกิจกรรมของมนุษย์

ภาควิชา .... พฤกษศาสตร์ .... ลายมือชื่อนิสิต ....

สาขาวิชา .... พฤกษศาสตร์ .... ลายมือชื่ออาจารย์ที่ปรึกษา ....

ปีการศึกษา 2541

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KEY WORD: SPORES AND POLLEN GRAINS / INTRAMONTANE PEAT BOG / DEPOSITION / DOI INTHANON / CHIANG MAI PROVINCE

RATTHAPONG POUNGTAPTIM : PALYNOLOGICAL STUDY OF THE INTRAMONTANE PEAT BOG AT DOI INTHANON, CHIANG MAI PROVINCE. THESIS ADVISOR : ASSO. PROF. KOSUM PYRAMARN. THESIS COADVISOR : ASSIST. PROF. THANAWAT JARUPONGSAKUL, Ph.D. 127 pp. ISBN 974-332-483-6

An attempt to study the ancient spores and pollen grains of the intramontane peat bog at Doi Inthanon, Chiang Mai Province, was carried out in order to reconstruct the pollen and spore diagram of past deposition in the above mentioned area. The sphagnum peat core (1A) of 2-metre depth, obtained from Associate Professor Kosum Pyramarn and Assistant Professor Dr. Thanawat Jarupongsakul , wrapped in plastic sheeth and stored in the refrigerator, was treated. In each 2-centrimetre peat core, a one-centrimetre cube was used for grain sampling. These subsamplings were treated by Jarupongsakul's method (1987) to extract the spores and pollen grains. Then, the grains obtained were mounted on the microscopic slides by using silicone oil, AK 2000, as mounting media. In order to reconstruction the plant community, the identification and analytical investigation of the deposited grains were done through a light microscope and a scanning electron microscope.

Interpretation of pollen and spore diagrams from peat bog (1A) at an estimated 2,565 metres above sea level indicated that from about 4,300 years ago up to present, the upper montane rain forest was dominant in this area. The reconstruction also helps confirm that the recently collected pollen grains and spores from the plants in the sampling site are of the same vegetation type. Moreover, this evidence also indicated that the climate in this vicinity could be divided into six zones according to the change of cool and warm weather by using the fluctuation of temperate plants as an indicator. This evidence further supported the theory that the Holocene climate was unstable. The occurrence of Polygonum and grass pollen grains in all zones might also indicate that this area was deforested by human activities.

ภาควิชา Botany .... ลายมือชื่อนิสิต

สาขาวิชา Botany .... ลายมือชื่ออาจารย์ที่ปรึกษา

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CHAPTER I
Introduction

Pollen analysis is the interpretation of the natural phenomena (Moore and Webb, 1978). It can give us useful information about condition of the target area in the present and the past by using the microfossil, pollen grains and spores (West, 1971). Since the outer side of pollen grain wall is made of highly resistant material, the pollen grains and spores from 400 million years ago can be found today (Moore, Webb and Collinson, 1991). Each pollen grain and spore is different in structure and shape, thus, the morphology is key to understanding the kinds of vegetation that existed and their evolutionary development (Faegri, Iverson and Waterbolk, 1964).

The sediment samples can be analyzed for pollen grains and spores. The slide preparation of which are made and identified through high-power microscope. Then a pollen diagram, the graphical presentation of pollen analysis, can be constructed in consideration with sampling scrutiny. Analysis of this kind were first produced by the Swedish geologist Von Post in about 1916 (West, 1971). From the pollen diagram, information can be obtained about vegetational, floristic and climatic changing which took place in the past. The difference in the amount of pollen in 1 cm cubic sample tells us about the condition of the forest. For example, if the amount of pollen grains is small, it could be the tundra (moss), and the larger amounts indicate the deciduous forests (vegetation which depends on pollen or spore reproduction)(West, 1971). As the studying of the pollen analysis, researchers have to deal with many aspects such as wind direction, vegetation identification of surrounding area, pollen traveling distance, sediment deposition, turn-over rate of the sampling-site ecosystem, etc. (Moore and Webb, 1978).

Plant pollen grains and spores are often used to help making the predictions. Their outer shell of pollen grains or spores is indestructible and can survive in certain sediments for tens and thousands of years (Vance and Mathewes, 1993). In pollen analysis the exines or shells of pollen grains are taken from soil and studied underneath the microscope. At this time the identification is done according to the distinctive shape and surface of exine (Moore and Webb, 1978). Once all the information is qualified the identifications are plotted as curves on a pollen diagram. Fluctuations in the curve for each plant category may indicate signs of climatic changes or forest clearance and crop planting by humans (Rhodes and Dawis, 1995; Aronson *et al*, 1993). Stratigraphy of pollen and spores provides evidence of chronology for vegetational changes in the drainage bog related to change in temperature, rainfall, soil development, and the disturbances cause by the activities of human (Ledru *et al*, 1996). Pollen stratigraphy is used in all comprehensive studies to combine other paleoecological analysis to the changes in the plant communities surrounding the area where is studied (Mancini, 1994; Rego and Rodriguez, 1993).

Moreover, the fruits, seeds, megaspores, and tissue fragments of a plant called plant macrofossils, are often found in sediments but are less abundant than microfossils. Plant macrofossils help to reconstruct the past, changes in plant succession, water levels, climate, etc.(Moore Webb and Collinson, 1983) They can be used to support the microfossil evidences.

Moore and Webb (1978) had mentioned about the value of microfossils as follow:

" Microfossils, especially pollen grains and spores, have proved so valuable as indicators of condition in the past. In the first place they are preserved much more easily than many other parts of plants due to their structural chemistry. The wall of pollen grains and spores are constructed of a complex material called sporopollenin. This material is a polymer of carotenoids and carotenoid esters and under conditions of low microbial activity, especially waterlogged, acid situations, it is decomposed very slowly. Pollen and spores are therefore preserved in considerable abundance in peat deposits, lake sediments, etc.

The second important feature possessed by these microfossils is their small size and therefore their tendency to be carried some distance from their source, suspended in turbulent air masses. In some respects this is valuable, in others it can prove a problem. The property of transportation means that the pollen grains falling upon a site suitable for their preservation did not all originate in the immediate vicinity. So the differential and long-distance transportation is therefore the factor which must be taken into account when interpreting pollen assemblages in a sediment. Macroscopic fossils in a deposit, e.g. fruits, seeds, cones, twigs, etc., because of their large size and poor dispersal, are mainly derived from the local flora. This is a result in an over-representation of wet land species in the macroscopic fossil flora. Pollen grains represent a flora from a wider area surrounding land.

The third valuable feature of pollen and spore is that their structure and sculpturing may make it a highly recognizable object. This mean that identification can often be taken to the special level, though sometimes it is only possible to deduce the genus or the family which it comes. In this respect some types of macrofossils (e.g. seeds and fruits) may be identified with a higher degree of precision and are therefore more valuable as fossil material.

The fourth useful feature is abundance with which they occur in many sediments. This abundance allows a quantitative recording of the various types to be made, though there are considerable statistical difficulties involved in the treatment of this data and in its final interpretation."

In this study, a palynological study of deposits of the intramontane peat bog at Doi Inthanon, a national park in Chiang Mai Province, which hosts a vast biodiversity, was investigated. The attempt to study the ancient pollen grains and spores, which are in Holocene period about 4,300 B.P.

(Hasting and Leinsakul, 1984), was carried out to reconstruct the pollen diagram of the past depositions which had occurred on the mentioned area. The result might provide the beneficial information on the vegetational history, the microclimate of the past to the future, the archeological research and the geological investigations. It could be the linking data to fulfil the missing evidence of the previous researches upon that site.

The aims of thesis :

1) To study the spore and pollen morphology of present and ancient plants at intramontane peat bog of Doi Inthanon Cniang Mai Province.
2) To collect the pollen and spore types from peat deposits in the pollen type collection at Professor Kasin Suvatabandu Herbarium (BCU).
3) To reconstruct the pollen and spore diagrams and summerize the plant vegetation in the past up to present.
4) To interpret the palaeo-climate and palaeo-environment of sampling site.

CHAPTER II
Literature review

Habitats of Doi Inthanon National Park

Graham (1991) reported about habitats of Doi Inthanon National Park that

"Doi Inthanon is located in the northern province of Chiang Mai, the park incorporates Thailand's highest mountain of Thailand.It is a granitic massif rising to 2,565 metres. This national park is part of the Thanon Thongchai Range, a southern extension of the Shan Hills of Burma. Sandy loams are the predominant soils on the mountain.

The area of Doi Inthanon is regarded as a vital watershed. Cascading down the forested slopes are four major tributaries of the Ping River, a lifeline of northern Thailand. The Ping, tapped for irrigation, hydroelectric power, transport and tourism, in turnforms one of the four major tributaries of the Chao Phraya River.

The park provides a wonderful spectrum of vegetation. As one ascends, the deciduous forests on lower slopes shade into seasonal broadleaved evergreen, submontane evergreen and montane evergreen forests. Native pines are found at moderate elevations; wild flowers abound including a large number of orchid species.

Above 1,800 metres, in the montane evergreen forests, the atmosphere becomes more temperate, with mists sweeping through low trees laden with orchids and moss. The forest around the peak is the only one in Thailand which resembles a true upper montane formation, Doi Inthanon rising about 300 metres above any other mountain in the country.A small sphagnum bog at the summit is dense of living-organism, especially plants.

Doi Inthanon experiences a strongly monsoonal climate. Although precise readings have not been recorded, about 2,000 milimetres of rain a year falls on the upper slopes, most of it between May through October.

The mean annual average temperature in the Chiang Mai lowlands is 25.8°C, but that on the mountain is substantially lower. The coldest months are December and January when ground frost may cover the exposed ridges near the summit where a low of -8°C has been recorded. Nights are cool even in the hottest months."

General features of upper montane rain forest in Thailand

Suntisuk (1988) stated about upper montain rain forests in Thailand as follows :

"Only a few peaks of mountains in Thailand, that are higher than 1,800 m.a.s.l., carry upper montane rain forest. These forests in the Northern Highlands, once luxuriant in the moist soils rich in organic matter and humus at elevations from 1,800-2,595 m, are at present reduced to patches covering the peaks and moist gullies of mountains as a result of the drastic destructions by various mountain tribes. Fortunately, a few patches of the primary upper montane rain forest have been left uncleared intentionally by the hill tribes cultural beliefs. On Doi Inthanon of Chiang Mai Province, the upper montane rain forest changes imperceptibly into lower montane rain forest below the cloud belt, and it is very difficult to say exactly where one forest ends and the other begins.

Upper montane rain forest is tall and dense, but the general canopy, in comparison with that of lower montane rain forest, is reduced to less than 23 m (usually 16-22 m high). The forest is typically characterized by closed, more or less evenly continuous, flat crown canopy. The forest almost approaches single storey, the lower tree storey is poorly developed on the summit areas of Doi Inthanon. Quite a few trees attain considerable sizes with straight boles. The foliage crowns are typically dome-shaped supported by the crooked branches on which epiphytic flower plants, ferns, mosses and lichens are luxuriantly developed. Under the dense canopy, undergrowth is sparse or inconspicuous, whilst a thin moss layer is frequently developed on the forest floor, on stems and branches of trees. Along the forest margin a tall shrub, *Strobilanthes involucrata,* forms a very dense undergrowth which gradually thin towards the inner forest. A small area of sphagnum bog is developed in the perpetually wet depression ground. The luxuriant epiphytes heavily loaded on branches of tree and the bog mosses on the ground are symptoms of the cool climate and high humidity.

Upper montane rain forest can be differentiated floristically from lower montane rain forest. Almost all magnolias (e.g. *Magnolia henryi*, *Michelia floribunda*, *Paramichelia baillonii* and *Talauma hodgsonii*), the common associated members in lower montane rain forest, gradually fade out with increasing altitudes together with typical lowland genera such as *Antiaris*, *Ficus* (Moraceae), *Canarium* (Burseraceae), *Sapium* (Euphorbiaceae), *Terminalia* (Combretaceae), *Aglaia*, *Toona* (Meliaceae), *Pterospermum* (Sterculiaceae), etc. Only a few magnolias are occasionally found on moderate to steep slopes with drier soils: *Manglietia garrettii* and *Michelia rajaniana*. Gymnosperms associated with lower montane rain forests, *Caphalotaxus griffithii* (Podocarpaceae), are evidently absent from upper montane rain forest. The majority of oaks, commonly encountered in lower montain rain forest (and lower montane oak forest), are not found in upper montane rain forest (e.g. *Catanopsis acuminatissima*, *C. tribuloides*, *Lithocarpus elegans*, *Quercus helferiana* and *Q. kingiana*) "

Santisuk (1988) had surveyed on the florestics of Doi Inthanon as follows :

The principle trees are *Quercus glabricupula*, *Lithocarpus aggregatus*, *L. recurvatus*, *Castanopsis purpurea* (Fagaceae), *Schima wallichii*, *Eurya nitida*, *Gordonia dalglieshiana* (Theaceae), *Lindera thomsonii*, *Neolitsea folitsea*, *Litsea garrettii*, *Beilschmiedia globularia*, *Cinnamomum tamala*, *Actinodaphne* sp. (Lauraceae), *Myrica esculenta* (Myricaceae), *Heliciopsis terminalis* (Proteaceae), *Acer laurinum*, *A. calcaratum* (Aceraceae), *Prunus cerasoides* (Rosaceae) and *Symingtonia populnea* (Hamamelidaceae).

Common small trees are *Helicia formosana* (Proteaceae), *Myrsine semiserrata* (Myrsinaceae), *Osmanthus fragrans* (Oleaceae), *Symplocos dryophila* (Symplocaceae), *Macropanax oreophilus* (Araliaceae), *Neocinnamomum caudatum* (Lauraceae), *Turpinia cochinchinensis* (*T. nepalensis*), *T. montana* (Staphyleaceae), and *Cleyera japonica* (Theaceae). The following trees are found fringing the forestmargins: *Lyonia ovalifolia*, *Vaccinium sprengelii* (Ericaceae), *Wikstroemia indica* (Thymelaeaceae), *Maesa indica*, *M. ramemtacea* (Myrsinaceae) and *Photinia integrifolia* (Rosaceae). The gnarled *Rhododendron arboreum* ssp. *delavayi* (Ericaceae), a typical species of the upper montane forest zone, attains a height of 6-9 metre along the periphery of sphagnum bogs. The trees are also found sporadically on the disturbed slopes of the upper montane rain forest.

The shrubs are mainly found fringing the forest margins and include *Strobilanthes involucrata* (Acanthaceae), *Cornus oblonga* var. *siamica* (Cornaceae), *Dichroa febrifuga* (Hydrangeaceae), *Zanthoxylum acanthopodium* (Rutaceae), *Embelia subcoriacea* (Myrsinaceae), *Astibe* *rivularis* (Saxifragaceae), *Verbunum kerrii* (Caprifoliaceae), *Gaultheria notabilis* and *Rhododedron microphyton* (Ericaceae).

The most common epiphytic shrubs, *Aeschynanthus hildebrandii* (Gesnerriaceae), *Agapetes hosseana* and *Rhododendron veitchianum* (Ericaceae), grow on mossy branches along with a parasitic shrub, *Hymenopogon parasiticus* (Rubiaceae).

Herbs are also commonly found along the forest margins and include *Arisaema consanguineum* (Araceae), *Carex baccans*, *C. indica* (Cyperaceae), *Impatiens longiloba*, *I. Racemosa* (Balsaminaceae), *Polygonun chinense*, *P. molle* (Polygonaceae), *Viola betonicifolia*, *V. pilosa* (Violaceae), *Gentiana crassa* (Gentianaceae), *Paris polyphylla* (Trilliaceae), *Disporum calcaratum*, *Ophiopogon intermedium* (Liliaceae), *Elatostema monandrum* (Urticaceae), *Polygala karensium*, *P. kerrii*, *P. lacei* (Polygalaceae), *Ainsliaea latifolia*, Anaphalis margaritacea (Compositae), Stellaria saxatilis (Caryophyllaceae), Lobelia pyramidalis (Campanulaceae), *Hypericum hancokii* and *H. wightianum* (Hypericaceae).

Large woody lianas are absent from upper montane rain forest, but the common herbaceous vines are *Amphicarpaea siamensis (Leguminosae)*, *Jasminum dispermum* (Oleaceae), *Hedera himalaica* (Araliaceae), *Tetrastigma serrulatum* (Vitidaceae), *Streptolirion volubile* (Commelinaceae), *Smilax china* (Smilacaceae), and species of *Clematis* (Ranunculaceae)

The epiphytic orchids are plentifully represented by species of *Dendrobium*, *Bulbophyllum*, *Coelogyne*, *Eria*, *Luisia*, *Mlaxis*, *Otochilus* and *Pholidota*."

Hasting and Lieangsakul(1984) presented the profile of forest zones from sea-level to the peak of Doi Inthanon (altitude about 2500metres above sea level) (Fig. 1). They divided the vegetation of the mountains into three forest zones in addition to division of climatic interpretation. The area from sea level up to 1,000 metres was defined as tropical savanah with dry dipterocarp forest type. The climate at above 1,000 metres up to the highest peak was indicated as humid subtropical climate. The florestics consisted of pine forest covered the area of altitude 800 metres to 1,300 metres above sea level. The topmost forest zone was defined as hill evergreen forest.

Smitinand (1977) mentioned that hill evergreen forest is confined to the upper elevation area from 1,000 metres upwards and is scattered all over the country with layer percentage in the northwestern highland. This type of forest is known under names as temperate evergreen forest or montane forest of some author.

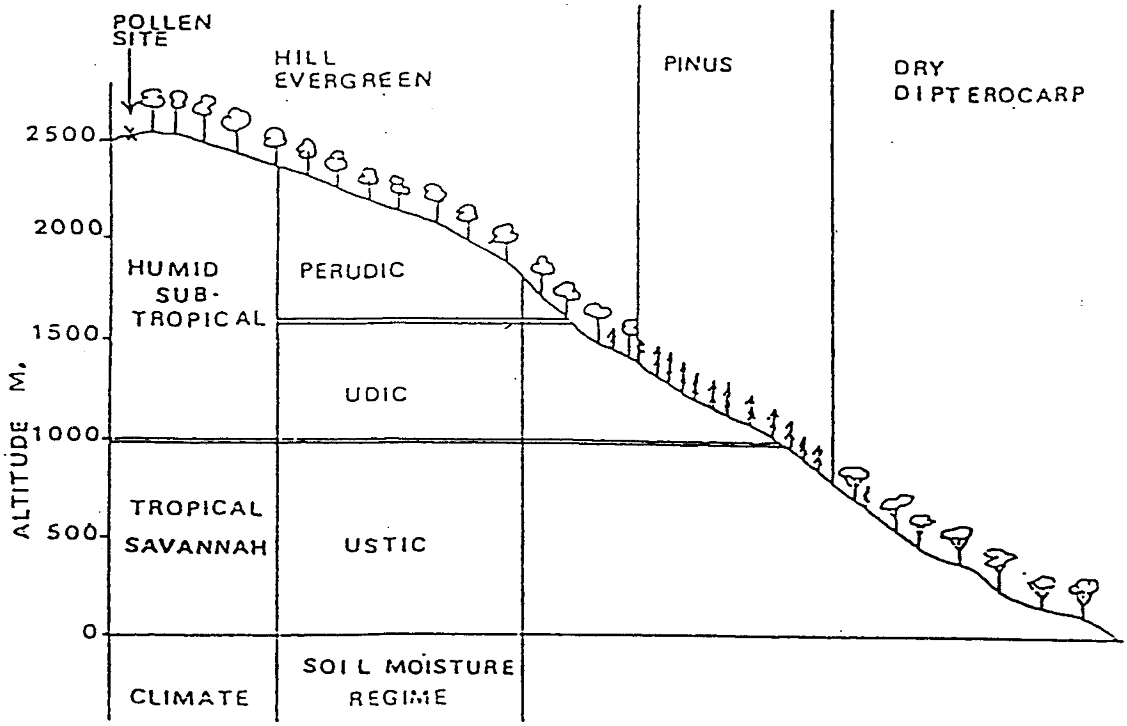


Fig. 1 The forest zones of Doi Inthanon National Park.

(Hasting and Liengsakul, 1984)

The palaeo-vegetation of Asia

Southern and Eastern Asia 18,000 years ago (in radiocabon chronology). The Last Glacial Maximum or LGM.

Low lake levels over northern China generally support the view that conditions were more arid at the LGM than at present. Yet although the level of Delai Lake (112 °E, 40 °N) was much lower at the LGM than during most of the Holocene, it was apparently higher than it is today (An *et al*, 1993). Pollen recovered from surfaces correlated as being approximately contemporaneous with the LGM, in the same area in North-western China, close to Mongolia (112 °N, 40 °S), shows that xerophytic plants (especially Artemisia and Chenopodiaceae) were virtually the only ones present (An *et al*, 1993), in a region that presently has a much denser grassy steppe cover.

For arid steppe in the north China plain and NE China (Manchuria), a cold and very sparse steppe-tundra dominated by Artemisia with grasses and chenopods was the predominant vegetation (Liu, 1986 and Wang and Sun, 1994). Trees appear to have been absent during the period of the LGM itself. The aridity itself seems likely to have prevented pollen deposition in many sites at the LGM, but radiocarbon-dated pollen diagrams from Beizuanaguan (109 °N, 34 °S) and also near Beijing indicate this sparse Artemisia vegetation.

From a pollen sequence dated to just before the LGM (finishing at 20,000 yr. BP) at Xishuang-banna in the present subtropical rainforest zone in the uplands of Yunnan Province of the extreme SW of China, Liu (1991) suggests that the LGM climate was nearly warm as at the present, but with much higher precipitation in winter (as indicated by the presence of the subalpine tree *Dacrydium*) and the driest period at this particular site, in which pine-oak scrub land with abundant herbs replaced the forest apperently due to a reduction in winter rainfall, is suggested as occurring after 18,000 years ago rather than within the interval 20-18,000 years ago.

In Japan, the abundant plant fossil from both onland and offshore cores shows a general southwards shift of the vegetation zones under LGM conditions (Reynolds and Kanser, 1990). Radiocarbon and ash-dated pollen-bearing sites near Lake Biwa in east-central Japan and at several other localities across the centre of Japan (Ooi and Sei-ichiro, 1989) indicated that the lowland vegetation at the LGM was Cyperaceae-rich grassland with sparse scattered stands of Alnus, Fraxinus and Salix. Forests of a rather open character with Quercus and Pinus seem to have been widespread in the mid-altitude uplands. Open boreal-type woodland (consisting mainly of Pinus, with Abies and Betula) covered much of Japan's uplands (Heusser,1990), from about the middle of the main island to the south of the linked chain of islands. Artemisia was often present, indicating dryness (Ooi *et al*, 1990). Warmer temperate elements of the flora (e.g. Cryptomeria) persisted only locally as minor components in lowlands towards the south, which seem to have had a dry cool-temperate climate with open vegetation and scattered woodland on the uplands (Ooi *et al*, 1990).

Drier condition in Thailand, Morley and Flenley (1983) refered to undated pollen evidence for pine forest occuring in the present rainforest areas of Thailand and Malaysia, which they suggest as possibly being of LGM age. In the lower Mun river basin, north eastern Thailand, there is loosely dated geomorphological evidence of widespread desiccation associated with aeolian activity and an increase in ground water salinity after 20,000 years ago (Loeffler *et al*, 1984). The aeolian activity does not seem to have been sufficient to form true dune systems, but riverine sands and silts were blown as sand sheets and loess layers onto the slopes and uplands surrounding the Mun River. Loeffler et al.(1984) noted that savannah species occur in pollen-bearing cores further south, but they do not state how much further south or what sources they are referring to. In addition, Thomas and Thorp (1992) emphasised that one might expect that if there was a large area of shelf exposed in SE Asia, this central area would tend to recieve less rainfall from the sea, and an initial loss of forest would provide a feedback due to a loss of water recycling.

Southern and Eastern Asia 8,000 years ago (in radiocarbon chronology), early Holocene.

For warmer and moister China, vegetation maps published by An *et al.* (1990) and Winkler and Wang (1993) are based on fossil and sedimentological evidence that at 8,000 years ago conditions were significantly warmer and moister than present. A northwards shift of the forest belts is shown; this was the result of a sudden rise in high forest tree species at the expense of *Betula* just before 8,000 years ago (Winkler and Wang 1995). In the Loess -Plateau area of north-central China, the vegetation seems to have been existing under moister conditions than a present. The proportion of drought-tolerant C4 plants in the vegetation seem to have reached its lowest point during the early-to-mid Holocene, before increasing slightly towards the present (Frakes and Jianzhong, 1994). At the Linxia site in the western part of the Loess Plateau, magnetic susceptibility suggests a rainfall of around 460 mm compared to the present 350 mm, between about 8,000 and 3,000 years ago, with temperatures about 2 °C warmer than at present (Li *et al*, 1995).

Between 8,000 and 5,000 years ago, many species of forest trees extended that their ranges further north and west than present. Thus, indicated precipitation about 100 mm higher than today in many area of China. The temperatures were perhaps 2-4 °C warmer (An *et al*, 1990 ; Winkler and Wang, 1993). For example, conditions according to palynological evidence seem to have been around 3-4 °C higher than now in Beijing and 2-4 °C higher in the lower Yangtze river area (Sun and Chen, 1991), refected in terms of the northward movement of tree taxa. The deciduous forest of north-eastern China seems to have been expanded a couple of hundred kilometres northward into the Russian far east (Velichko, 1991). In this north-eastern area, Betula and Pinus pollen were at lower percentages than at present, their place being taken by other, warmer-climate broad-leaved species (Tong and Shao, 1991).

In central Asian desert belt, Jaekel (1995) reviewed evidence from various sites in inner Mongolia (at around 100 °E and 41-43 °N) which suggested that conditions were moist and he suggested on this basis that steppe vegetation covered the region, instead of the present-day desert and semi-desert vegetation.

In SW China (around 30 °N), Javis (1993) also found pollen evidence for a considerably stronger summer monsoon than at present between 9,100 and 7,800 years ago, with deciduous oaks (Quercus) being more abundant than sclerophyllous everygreen ones in the mid-altitude forests close to the edge of the Tibetan plateau.

There was early Holocene humidity in Thailand. In the Chi River basin, northeast Thailand, Tamura (1992) regards sedimentation rates and sediment grades as indicating that a more humid than present climate from early to mid Holocene time, up until around 3,500 years ago. Likewise, the evidence from palaeoriver channels in the northern part of the central plain of Thailand (Yom River) is that water dischanges were greater than at present during the early to mid Holocene (Bishop and Godley, 1994). The present-natural vegetation of these regions is rainforest, and given a still moister climate at 8,000 years ago, the vegetation must presumably have been rainforest at that time. Jarupongsakul (1987) suggested that Chao Phaya basin, Central Thailand, used to be the mangrove forest in Holocene period because there are the pollen grains of the mangrove forest in this site.

Southern and Eastern Asia by 5,000 years ago.

Morley (1982) suggested that by 5,000 years ago the vegetation across the tropical rainforest region would have been generally very similar to the present nature. Wanthanachiseang (1997) noted that the upper montane rain forest in Holocene period (about 4,300 years ago) at the peak of Doi Inthanon, Northern Thailand, was similar to the present. Two possible non-climate explanations for type of the vegetation change about 4,300 years ago were the uplift of the site above the *Pinus* habitat and man's activities which these evidence further supported the theory that the Holocene climate was unstable (Hasting and Lieangsakul, 1984). In southern Borneo (Kalimantan), various studies on the coastal peat swamps have shown peat deposition starting around 5,000-6,000 years ago (Morley, 1981). At the upper montane rainforest boundary in central Sumatra, Morley (1982) also suggested that the first evidence of forest clearance occurs at about 4,000 years ago. Conditions across much of China at 5,000 years ago seem to have been slightly warmer than present, but cooler than in the early Holocene (Winkler and Wang, 1993).

Warmer and moister conditions in China, Sun and Chen (1991) noted that the palynological records indicated temperatures 2-4 °C warmer than at present, cooling after about 3,000-4,000 years ago. In the northeast of China (Manchuria), peat deposition seems to have begun mainly around the mid-to-late Holocene, coincident with a cooling of climate just after around 5,000 years ago and lake levels indicate conditions moister than present over most of China up until 3,500 years ago (Fang, 1991 and Li *et al.*, 1995). Agriculture in north-western regions of China currently too arid for crop-growing is furture testimony of the moister climate which prevailed at around 5,000 years ago (Petit-Maire *et al.*, 1994). Agriculture was already present and expanding throughout the south-east Asia region, but deforestation in Southern China and in the monsoon zones of Indo-China does not appear to have been significant until after around 4,000 years ago (Tallis, 1990).

CHAPTER III

Materials and methods

Materials and equipments

Meterials :

- Sampling peat core (obtained from Associate Professor Kosum Pyramarn and Assistant Professor Dr. Thanawat Jarupongsakul)
- Distilled water
- HCl 10 %
- KOH 10%
- 70% , 95% , and ethanol-absoluted alcohol
- HF 40 %
- Glacial acetic acids
- Acetic anhydride(CH_3 CHOH)
- Conc. H_2SO_4
- Silicone oil (No. AK 2000)
- Benzol (Benzene)
- Solid paraffin

Equipments :

- Centrifuge and centrifuge tubes
- Test tubes and test tube-rack
- Water bath
- Small sieves (200 microns)
- Warm plate
- Glass stirring rods
- Beaker glass 25, 50, 100, 250 and 500 cm^3
- Fume cupboard

- Residue tubes with corks
- Stove
- Microscopic slides and cover glasses
- Dissected needles
- Microscopes
    - Light microscope (LM)
    - Electron microscope (SEM)
- Vials 5 ml
- Double-sided adhesive tape
- Stubs

Methods of investigations

1) Peat core sampling

The peat core sampling was conducted by Associate Professor Kosum Pyramarn and Assistant Professor Dr. Thanawat Jarupongsakul during 29 April to 3 May, 1996 at Ang-Ka intramontane peat bog of the peak of Doi Inthanon National Park.

The five sample cores (Fig. 2) had been taken by hand-auger. All sample cores were sealed by plastic sheet. Sampling cores were stored in the refrigerator to prevent the possible contamination and oxidation.

The stratigraphic core of Ang-Ka 1A was selected by author for studying (Fig. 2 and Fig. 3)

2) Laboratory investigations

For laboratory method, each two-centrimetre of peat core was subsampled in one-centrimetre cube for analysis. These 76 peat cubes were treated by the method of Jarupongsakul (1987) to extract the spores and pollen grains. Then, the obtained grains were preserved in silicone oil-AK2000 (Andersen, 1960) and mounted on the microscopic slides. The identification and the analytical investigation were done through light microscope (LM) and scanning electron microscope (SEM). In order to confirm that the recently collected pollen grains and spores and those collected from living-plants in the area of the sampling site are of the same vegetation type. The counting of spores and pollen grains was done following the system of Moore, Webb and Collinson (1991).

2.1) Laboratory investigation for preparing permanent slide and taking photograph.

Table 1 Flow chart for processing the spore and pollen samples

Pretreatment	1) Sample 1 centimetre-cube
↓	2) Washing with H_2O (in centrifuge tube, 10 ml)
To remove eventual $CaCO_3$ and for dispersal	3) 10 % HCl at room tenperature
	4) Washing with H_2O (1-2 times)
↓	
Separation of coarse grain sediments and large wood debris	5) Sieving over 6-8 mm
↓	
To dissolve trace of clay or sand	6) 30-40 % HF 10 ml (12 hr at room temperature)
↓	7) Washing with H_2O (1-2 times)
To remove humic acids	8) 1% KOH (10 min at 50-60 °C)
↓	9) Washing with H_2O (1-2 times)
To remove cellulose and protein	10) (conc.) CH_3COOH 4 ml + 33 % $NaClO_3$ 3-4 drops + (conc.) HCl 1-2 ml
↓	11) Washing with H_2O (1-2 times)
	12) Washing with (conc.) CH_3COOH
To remove organic constituents without destruction	13) Mix acids at 80 °C, 10 min. (conc.) $(CH_3CO)_2$: (conc.) H_2SO_4 in ratio 9:1

of spores and pollen grains ↓	14) Washing with H_2O (1-2 times)
For dehydration ↓	15) Dehydrate by 70 %, 95 % and absoluted alcohol.
	16) Remove from test tube to vial by using benzol.
For microscopic-slide preparation ↓	17) Add 2-3 drops of silicone oil (AK2000) as mounting media
For identification, grain counting and taking photographs	18) Microscopic-slide was made and sealed withparaffin whenever the benzol had completely evaporated.

Grain counting were performed according to system of Moore, Webb and Collinson (1983)

2.2) Laboratory investigation for scanning electron microscope and taking photograph.

2.2.1) The acetolyzed and non-acetolyzed samples, spores and pollen grains, were fixed on stubs with double-sided adhesive tape.

2.2.2) The samples on stubs were coated with gold in a Bazer-sputter coater for a total of 5 minutes depositing about 30 nm of metal.

2.2.3) Scanning electron microscope was performed and photographed by using JOEL, model JSM-5410LV.

2.2.4) The samples were examined with 1,000 to 2,000 magnification scanning electron microscope, at 15 kV.

2.3) Laboratory investigation for macroremains through LM. Each 10-cm core was dissolved with distilled water and put on slide microscope to examine. The course debris of each subsamples were determined by the remains of plant tissue and other micro-organisms.

3) The survey of present plants

Two surveying trips on the living plants in the vicinity of sampling bog were done in November 1997 and Febuary 1998. The plants specimens as well as pollen materials were collected during the trips. Plant identification and palynological study of the dominant plants around the sampling area was consequently done.

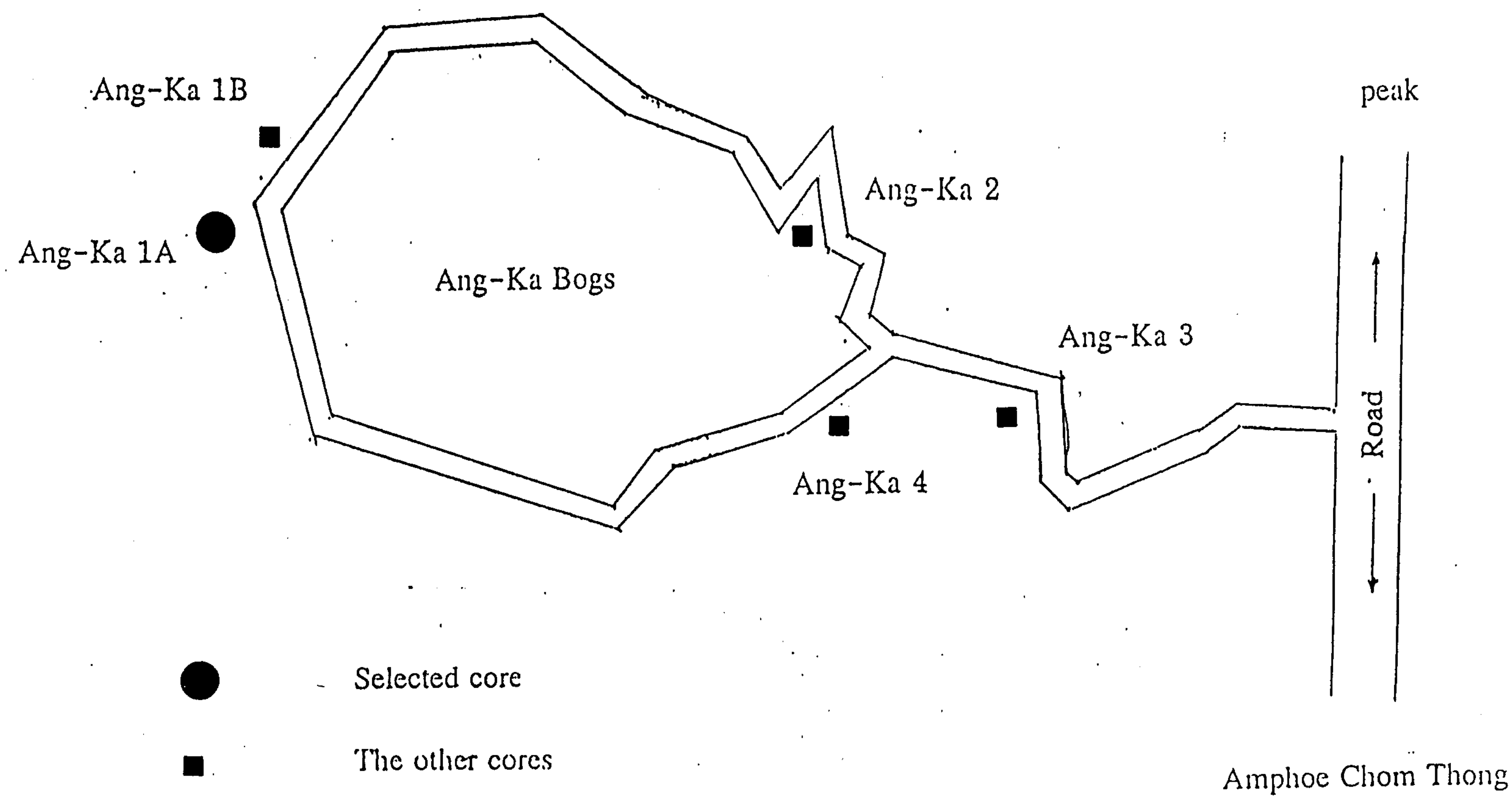


Fig. 2 Route map of Ang-Kha peat bog area around Doi Inthanon' s highest peak and location of drilling core.
(No fixed scale)

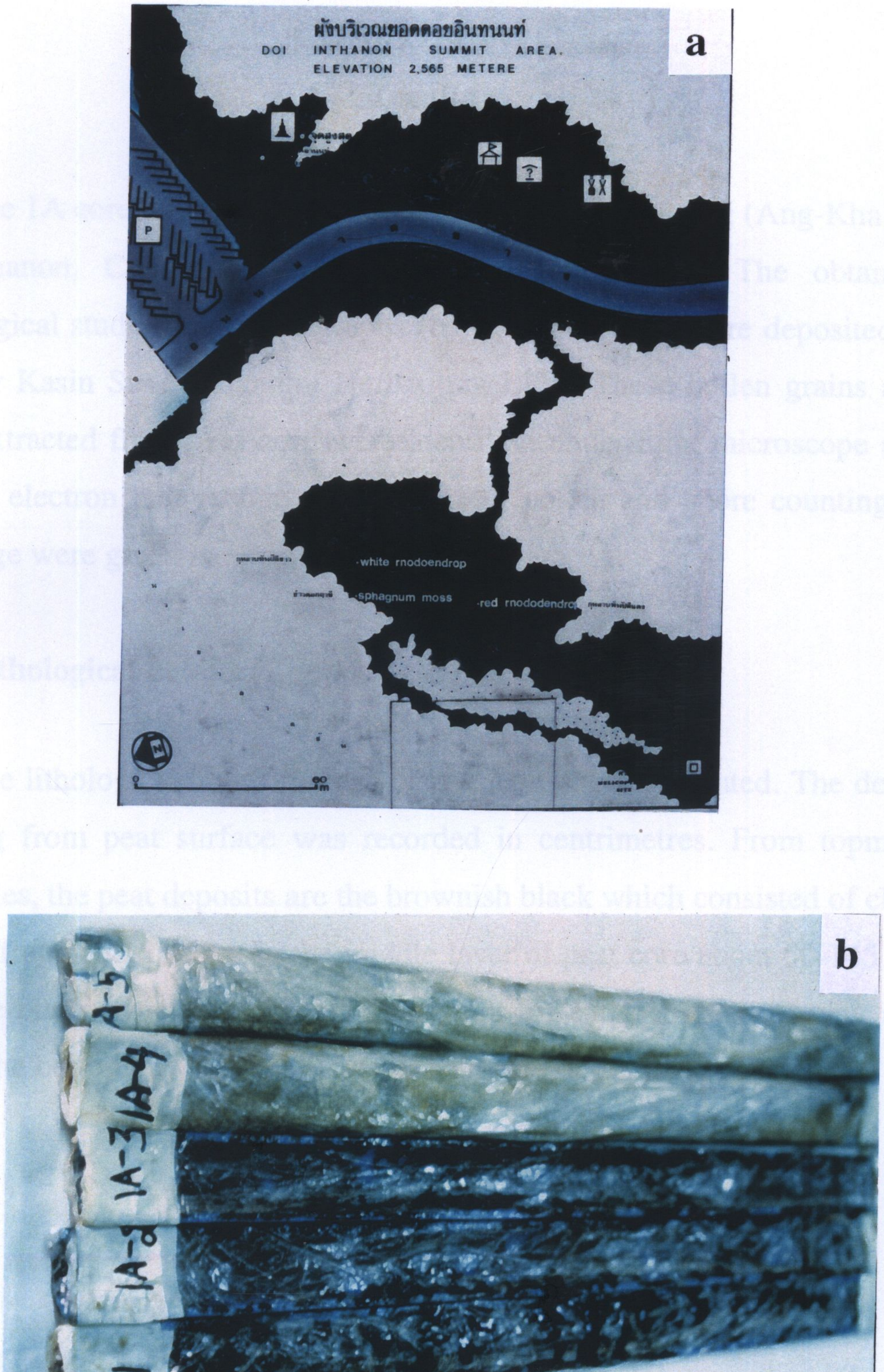


Fig. 3 a, Sampling area.

b, Sampling core, 1A.

CHAPTER IV

Results

The 1A core section (Fig. 3) from intramontane peat bog (Ang-Kha) of Doi Inthanon, Chiang Mai Province, was investigated. The obtained palynological studies and photographs (by LM and SEM) were deposited at Professor Kasin Suvatabhandhu Herbarium, BCU. These pollen grains and spores extracted from peat core were identified under light microscope and scanning electron microscope. The results of pollen and spore counting in percentage were given in appendix.

1) The lithological details of deposit column (Fig. 4)

The lithological investigations of peat core were presented. The depth of coring from peat surface was recorded in centrimetres. From topmost subsamples, the peat deposits are the brownish black which consisted of clay, peat and fragmented roots. In the middle layer of peat core about 50-145 cm depth are black which was highly water content and consisted of clay and peat. In the bottom layer of this core are saprorite or granite wash.

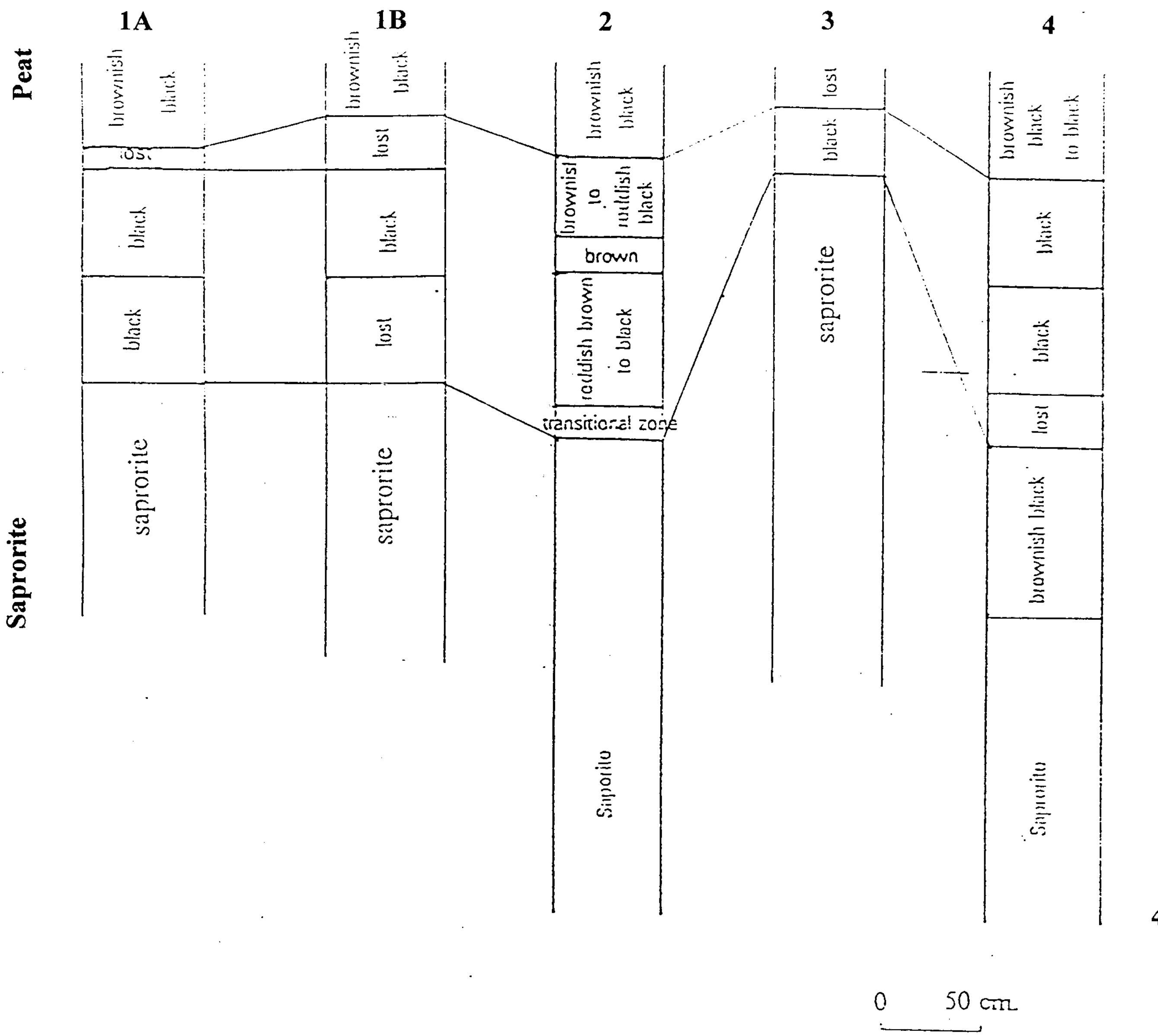


Fig. 4 Stratigraphic column of core samples : (**1A**) Ang-Kha 1A, (**1B**) Ang-Kha 1B, (**2**) Ang-Kha 2, (**3**) Ang-Kha 3, (**4**) Ang-Kha 4.

2) Pollen and spore descriptions

Spore and pollen morphology was given in short precise descriptions based on distinguished characters. The descriptions were followed the terminology of Erdtman (1969); Moore and Webb (1978); Moore, Webb and Collinson (1991); Faegri, Iversen and Waterbolk (1964) and Tryon and Lugardon (1991).

Spore and pollen descriptions of present plants around the Ang-Kha peat bog (The sexine descriptions were based on SEM data)

Spore descriptions of pteridophytes:

Lycopodium clavatum L.

Grains 20-25 μ ; nearly spheroidal; trilete arm; reticulate proximal face, distal face ridge. (pl.1, a ; pl.2, e-f)

Selaginella minutifolia Spring

Megaspore: 200-250 μ ; tetrahedral-globose; trilete arm; broken reticulate.(pl.1, b ; pl.2, a-b)

Microspores: 30-40 μ ; slightly flattened; trilete arm; verrucate. (pl.1, c ; pl.2, c-d)

Hymenophyllum polyanthos (Sw.) Sw.

Grains 60-80 μ ; spheroidal; trilete arm; papillate distal face.(pl.1, d)

Hymenophyllum exsertum Wall.

Grains 50-60 μ ; spheroidal; trilete arm; densely papillate surface.(pl. 1, e)

Dennstaedtia scabra (Wall. ex Hook.) Moore

Grains 25-40 μ ; triangular; trilete arm with coarsely ridge.(pl.1, f ; pl.4, d-f)

Pteris aspericaulis Wall. ex Ag.

Grains 40-50 μ ; tetrahedral; trilete arm; low rugate proximal face, coarsely rugate on distal face.(pl.1, g ; pl.4, i-j)

Ptris wallichina Ag.

Grains 40-50 μ ; tetrahadral; trilete arm; proximal face with low flange, partly fused tubercles, prominently rugate distal face.(pl.1, h-i ; pl.4, g-h)

Ophioglossum petiolatum Hook.

Grains 30-40 μ ; globose; trilete arm; low tuberculate.(pl.1, j)

Microlepia trapeziformis (Roxb.) Kuhn

Grains 30-35 μ ; tetrahedral-globose; trilete arm; finely reticulate with rodlets.(pl.3, a-b ; pl.6, c-d)

Microlepia firma Mett. ex Kuhn

Grains 40-45 μ ; tetrahedral-globose; trilete arm; prominently lobed, surface detail of fused rodlets.(pl.3, c-d : pl.6, a-b)

Oleandra wallichii (Hook.) Presl

Grains 35-40 μ ; ellipsoidal; trilete arm; low papillate folds.(pl.3, e)

Plagiogyria communis Ching

Grains 40-45 μ ; tetrahedral, depressed between prolonged angles; plain surface.(pl.3, f ; pl.4, a-c)

Pteris vittata Linn.

Grains 50-60 μ ; tetrahedral; trilete arm; partly fused tubercles, prominently rugate distal face.(pl.3, g)

Polystichum tenggerense Rosenst.

Grains 45-55 μ ; ellipsoidal; monolete arm; fenestrate cristae surface. (pl.3, h-i ; pl.8, d-e)

Vittaria forrestina Ching

Grains 50-60 μ ; ellipsoidal; monolete arm; plain surface.(pl.3, j ; pl.9, d)

Araiostegia faberiana (C. Chr.) Ching

Grains 55-65 μ ; ellipsoidal; monolete arm; verrucate surface.(pl.5, a,b ; pl.8, m-o)

Drynaria bonii Christ

Grains 40-45 μ ; ellipsoidal; shortly monolete arm; plain surface with echinate procession.(pl.5, c-d)

Dryopteris neoassamensis Ching

Grains 25-35 μ ; ellipsoidal; monolete arm; coarsely fold surface.(pl.5, e ; pl.6, e-g)

Polystichum semifertile (Clarke) Ching

Grains 50-60 μ ; ellipsoidal; monolete arm; fenestrately cristae fold surface.(pl.5, f-g ; pl.8, l)

Vittaria flexuosa Fe′e

Grains 60-70 μ ; ellipsoidal; longly monolete arm; plain surface.(pl.5, h ; pl.9, c)

Nephrolepis cordifolia (L.) Presl

Grains 18-25 μ ; ellipsoidal; monolete arm; fused tuberculate on distal face.(pl.5, i ; pl.8, i-j)

Acrophorus stipellatus Moore

Grains 35-45 μ ; ellipsoidal; monolete arm; long fold surface.(pl.5, j ; pl.8, p-q)

Asplenium normale Don

Grains 30-35 μ ; ellipsoidal; monolete arm; echinate cristae surface. (pl.2, g-j ; pl.7, a)

Asplenium ensiforme Hook.&Grev.

Grains 40-45 μ ; ellipsoidal; monolete arm; prominent perforate wings (perine).(pl.7, b ; pl.9, a-b)

Diplazium muricatum (Mett.) v.A.v.Ros.

Grains 40-45 ; ellipsoidal; monolete arm; fold surface.(pl.7, c ; pl.8, a)

Asplenium unilaterale Lamk.

Grains 35-40 μ ; ellipsoidal; monolete arm; cristate wings.(pl.7, d)

Oleandra wallichii (Hook.) Presl

Grains 40-50 μ ; ellipsoidal; monolete arm; low papillate fold surface. (pl.7, e; pl.8, b)

Crypsinus oxylobus (Wall. ex Kunze) Sledge

Grains 50-55 µ ; ellipsoidal; monolete arm; plain surface.(pl.7, f ; pl.8, f-h)

Polypodium amoenum Mett.

Grains 37-48 µ ; ellipsoidal; monolete arm; verrucate perine.(pl.7, g)

Pollen descriptions of seed plants:

Hymenopogon parasiticus Wall.

Grains tricolporate; oblate-spheroidal to prolate, 30-35 µ; exine reticulate.(pl.12, a,b)

Photinia nussia Kalkm.

Grains tricolporate; prolate to suboblate, 20-25 µ; amb: semi-angular; exine striate.(pl.12, c-d)

Fabaceae

Grains tricolporate; subspheroidal, 25-30 µ; amb: semi-circular; exine reticulate. (pl.11, a-e ; pl.12, e)

Myrsine semiserruta Wall.

Grains hexa-zonocolporate, 20-30 µ; exine psilate (LM).(pl.12, f,g)

Polygala karensium Kurz

Grains subspheroidal, 40-50 µ ; hetero-polar; colpi 20-24 furrows; exine granulate(pl.12, h,i)

Urticaceae

Grains 2-7 pantoporate; subspheroidal, 15-20 μ ; exine granulate. (pl.12, j)

Pinus kesiya Royle ex Godon

Grains vesiculate, 45-55 μ..(pl.10, a ; pl.13, a-c)

Pinus merkusii Jungh. & de Vriese

Grains vesiculate, 40-45 μ.(pl.10, b ; pl.13, d-f)

Vaccinium sp.

Grains tetrahedral tetrads, overall diametre 30-35 μ; individual grain with tricolporate and psilate exine (LM).(pl.10, c-d ; pl.13, l-m)

Agapetes sp.

Grains tetrahedral tetrad, overall diametre 25-30 μ; individual grain with tricolporate; psilate exine with margo; polar fields acute.(pl.10, e : pl.13, i-j)

Rhododendron sp.

Grains tetrahedral tetrad rarely decussate tetrahedral, overall diametre 40-50 μ; individual grain with tricolporate with margo;fossulate exine.(pl.10, f-g ; pl.13, g-h)

Polygonum chinense L.

Grains tricolpate spheroidal 35-45 μ; amb: sub-circular; exine with baculate processes,lumina 6μ approx.(pl.10,h ; pl.15, g-h)

Polygonum plebejum R.Br.

Grains colpate, 25-25 μ ; amb: semi-circlular; exine, reticulate. (pl.10, i-j ; pl.15, j-m)

Plantago sp.

Grains pantoporate, 15-21 μ; amb: circular; exine, verrucate. (pl.14, a ; pl.15, q-r)

Rubus sp.

Grains tricolporate: prolate to subprolate, 34-55 μ; amb: circular; exine psilate.(pl.11, n ; pl.14, b)

Castanopsis sp.

Grains tricolporate, 20-25 μ; amb: circular; exine psilate (LM).(pl.14, c,d ; pl.15, e-f)

Cynoglossum sp.

Grains tricolporate, 5-9 μ; amb: circular in equatorial view, depressed oblong, exine psilate (LM). (pl.11, i-j ; pl. 14, e)

Quercus brandisiana Kurz

Grains tricolporate; spheroidal to subspheroidal, 25-30 μ; amb: circular; exine psilate (LM). (pl.11, k-m ; pl.14, f-g)

Quercus kerrii Craib.

Grains tricolporate; spheroidal to subspheroidal, 20-25 μ; amb: circular; exine psilate (LM). (pl.11, f-g ; pl.14, h-i)

Schima wallichii Korth.

Grains tricolporate with margo; oblate to oblate-spheroidal, 34-40 μ; amb: circular; exine reticulate.(pl.15, a-d)

Descriptions of spores and pollen grains from peat deposits (1A)

(The sculpturing descriptions were based on SEM data)

Selaginella Type

Microspores: 30-40 μ ; slightly flattened; trilete arm; verrucate.(pl.16, a ; pl.17, f)

Plagiogyria communis Type

Grains 40-45 μ ; tetrahedral shape, depressed between prolonged angles; plain surface.(pl.16, b ; pl.17, b-c)

Polypodium Type

Grains 37-48 μ ; ellipsoidal; monolete arm; verrucate perine.(pl.16, c)

Crupsinus Type

Grains 50-55 μ ; ellipsoidal; monolete arm; plain surface.(pl.16, d-e)

Asplenium Type

Grains 35-50 μ ; ellipsoidal; monolete arm; cristate perine.(pl.17, a)

Pinus Type

Grains vesiculate, 45-55 μ..(pl.16, f,g ; pl.17, g-h)

Cyperaceae Type

Grains 3 aperturate (lacunae) ; oboval to rectangular, 20-25x25-35 μ; exine psilate (LM).(pl.16. h ; pl.18. d-f)

Graminae Type

Grains monoporate pore with annulus; spheroidal, 20-80 μ; exine psilate (LM).(pl.16, i-j ; pl.18, a-b)

Myrtaceae Type

Grains tricolporate; oblate to oblate-spheroidal, 30-40 μ; amb: triangular; exine granulate.(pl.19, a-b ; pl.20, f-j)

Engelhardtia Type

Grains triporate; oblate to oblate-spheroidal, 15-20 μ; amb: triangular; exine granulate.(pl.19, c-d ; pl.20, d-e)

Betula Type

Grains triporate, slit shaped pore; oblate-spheroidal to oblate, 20-25 μ; amb: triangular to subcircular with convex sides; exine psilate (LM).(pl.19, e ; pl.20, a-c)

Vaccinium Type

Grains tetrahedral tetrads, overall diametre 30-35 μ; individual grain with tricolporate and psilate exine (LM).(pl.19, f-g ; pl.20, p)

Agapetes Type

Grains tetrahedral tetrad, overall diametre 25-30 μ; individual grain with tricolporate; psilate exine with margo; polar fields accute.(pl.19, h ; pl.20, o)

Rhododendron Type

Grains tetrahedral tetrad or rarely decussate tetrad, overall diametre 40-50 μ; individual grain with tricolporate; psilate exine with margo, polar fields rather flattened. (pl.19, j ; pl.20, n)

Magnolia Type

Grains monocolpate; boat-shaped by equartorial view, 30x60 μ; exine verrucate. (pl.21, a; pl.23, a-b)

Polygonum chinense Type

Grains tricolpate, spheroidal 35-45 μ; amb: semi-circular; exine with baculate processes, lumina 6 μ approx.(pl.21,b ; pl.23, m-p)

Polygonum plebejum Type

Grains tricolpate, 25-25 μ ; amb: semi-circlular; exine with granulate processions.(pl.21, c ; pl.23, c)

Legume Type

Grains tricolporate; with or without margo colpi elongate with acute ends, oblate to oblate-spheroidal, 30-80 μ ; exine reticulate. (pl.20, l-m ; pl.21, d)

Rubus Type

Grains tricolporate; prolate to subprolate, 34-55 μ; amb: circular; exine micro-reticulate.(pl.18, c and g ; pl.21, e)

Rosaceae Type

Grains tricolporate; oblate to oblate-spheroidal, 20-35 μ; amb: semi-circular; exine striate.(pl.20, k ; pl.21, f)

Quercus Type

Grains tricolporate; spheroidal to subspheroidal, 15-25 μ; amb: circular; exine finely verrucate.(pl.21, g-j ; pl.23, j-l)

Rubiaceae Type

Grains 5-6-colporate; spheroidal to subspheroidal, 15-25 μ; amb: circular; exine psilate (LM). (pl.20, r-s ; pl.22, a-b)

Schima wallichii Type

Grains tricolporate, comparatively broad copi with margo and operculum ; oblate to oblate-spheroidal, 34-40 μ; amb: circular; exine reticulate, lumina approx. > 1 μ in diameter.(pl.22,c-d ; pl.23,d-g)

Araceae Type

Grains non-apertulate; subspheroidal to spheroidal, 15-20 μ; amb: circular; exine, psilate with scattered echinate procession.(pl.22, e ; pl.23, h-i)

Key to the deposited grains in peat core 1A

1a Grains united (tetrad)..2
1b Grains single (monad)...4

2a Without margo...*Vaccinium* Type
2b With margo...3

3a Polar fields acute ....*Agapetes* Type
3b Polar fields not acute but rather flattened..........*Rhododendron* Type

4a Grains without aperture..5
4b Grains with aperture or laesura..6

5a With bladders (vesiculate) from the body of grains..........*Pinus* Type
5b Without bladders, exine with scattered echinate processions...Araceae Type

6a With perine as shield of grains..7
6b Without perine as shield of grains.......................................11

7a With one three-branched, slit-like aperture in shape of a Y (trilete)...8
7b With one slit aperture (monolete arm)....................................9

8a Grains : slightly flattened...............................*Selaginella* Type
8b Grains : tetrahedral shape, depressed between prolonged angles...........................*Plagiogyria communis* Type

9a Grains : monolete with plains surface....................*Crypsinus* Type
9b Grains : monolete with sculpturing surface...........................10

10a Grains : monolete with cristate perine...................*Asplenium* Type
10b Grains : mopnolete with verrucate perine..............*Polypodium* Type

11a Aperture pori only...12
11b Aperture either colpi only, or a mixture of pori and copi............14

12a With one porus and annulus...............................Graminae Type
12b With more than one porus...13

13a Triporate with round shaped pores....................*Engelhardtia* Type
13b Triporate with slit shaped pores..............................*Betula* Type

14a With colpi only...15
14b With a porus and a colpus combined in each aperture................19

15a With colpus, grains boat-shaped in
equatorial view...*Magnolia* Type
15b With more than one colpus...16

16a With 5-6 colpate or 5-6 colporate........................Rubiaceae Type
16b With 3 colpate or 3 lacunae...17

17a Grains oboval to rectangular shape....................Cyperaceae Type
17b Grains spheroidal shape..18

18a With baculate processes........................ *Polygonum chinense* Type

18b With granulate .... *Polygonum plebejum* Type

19a Tricolporate with triangular amb..........................Myrtaceae Type

19b Tricolporate without triangular amb....................................20

20a With striate sexine..Rosaceae Type

20b With other patterns besides striate sexine 21

21a With verrucate sexine...*Quercus* Type

21b With reticulate sexine..22

22a Grains with micro-reticulate sexine, lumina approx.< 1 μ in diameter..*Rubus* Type

22b Grains with reticulate sexine, lumina approx.< 1 μ in diameter..23

23a With narrow colpi and with or without margo.............Legume Type

23b With comparatively broad colpi, margo and operculum present...*Schima wallichii* Type

SEM and LM photographs of pteridophyte spores of the present plants around the sampling site (plate 1-9).

Plate 1

SEM photographs:

a, *Lycopodiun clavatum* L.

b-c, *Selaginella minutifolia* Spring ; b, megaspore; c, microspore

d, *Hyminophyllum polyanthus* (Sw.) Sw.

e, *Hyminophyllum exertum* Wall.

f, *Dennsteadtia scabra* (Wall. ex Hook.) Moore

g, *Pteris aspericaulis* Wall. ex Ag.

h-i, *Pteris wallichina* Ag.

j, *Ophioglossum petiolatum* Hook.

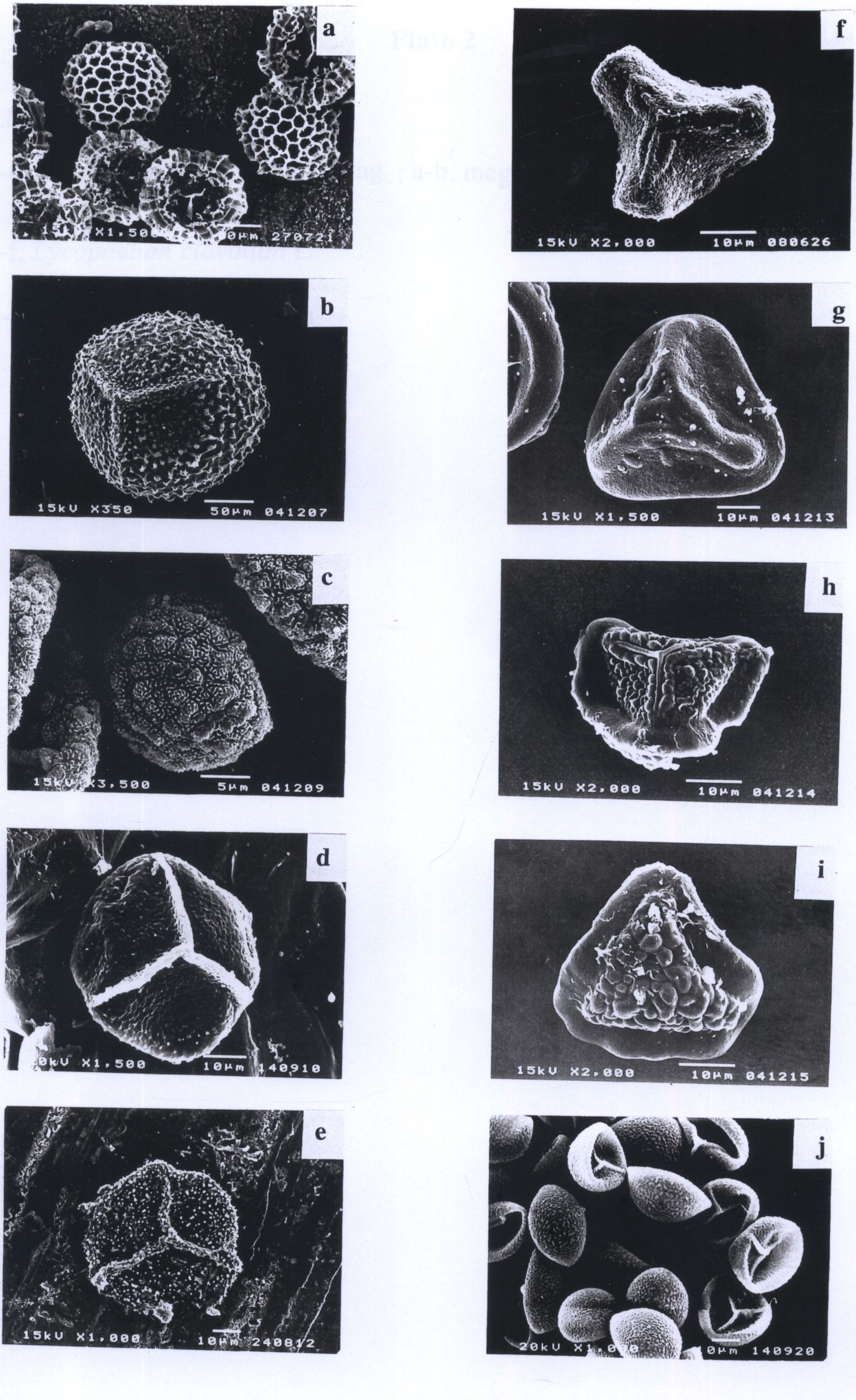

a
b
15kV X350 50µm 041207
c
5µm 041209
d
X1,500 10µm 140910
e
15kV X1,000 10µm 240812
f
15kV X2,000 10µm 080626
g
15kV X1,500 10µm 041213
h
15kV X2,000 10µm 041214
i
15kV X2,000 10µm 041215
j
20kV
140920

Plate 2

LM photographs:

a-d, *Seleginella minutifolia* Spring ; a-b, megaspore , c-d, microsspore

e-f, *Lycopodium clavatum* L.

g-j, *Asplenium normale* Don

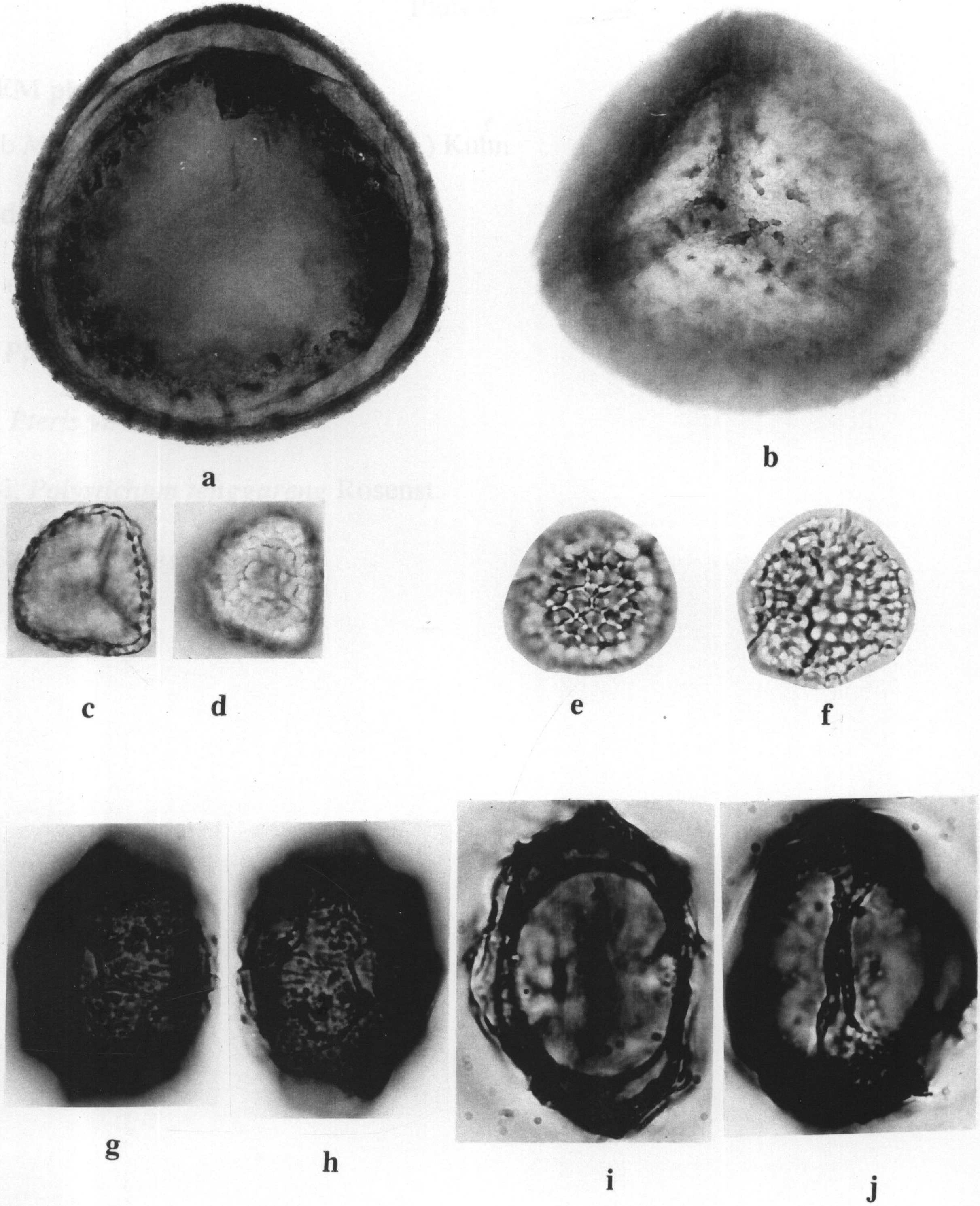

a
b
c
d
e
f
g
h
i
j

Plate 3

SEM photographs:

a-b *Microlepia trapeziformis* (Roxb.) Kuhn

c-d, *Microlepia firma* Mett. ex Kuhn

e, *Oleandra wallichii* (Hook.) Presl

f, *Plagiogyria communis* Ching

g, *Pteris vittata* L.

h-i, *Polystichum tenggareng* Rosenst.

j, *Vittaria forrestiana* Ching

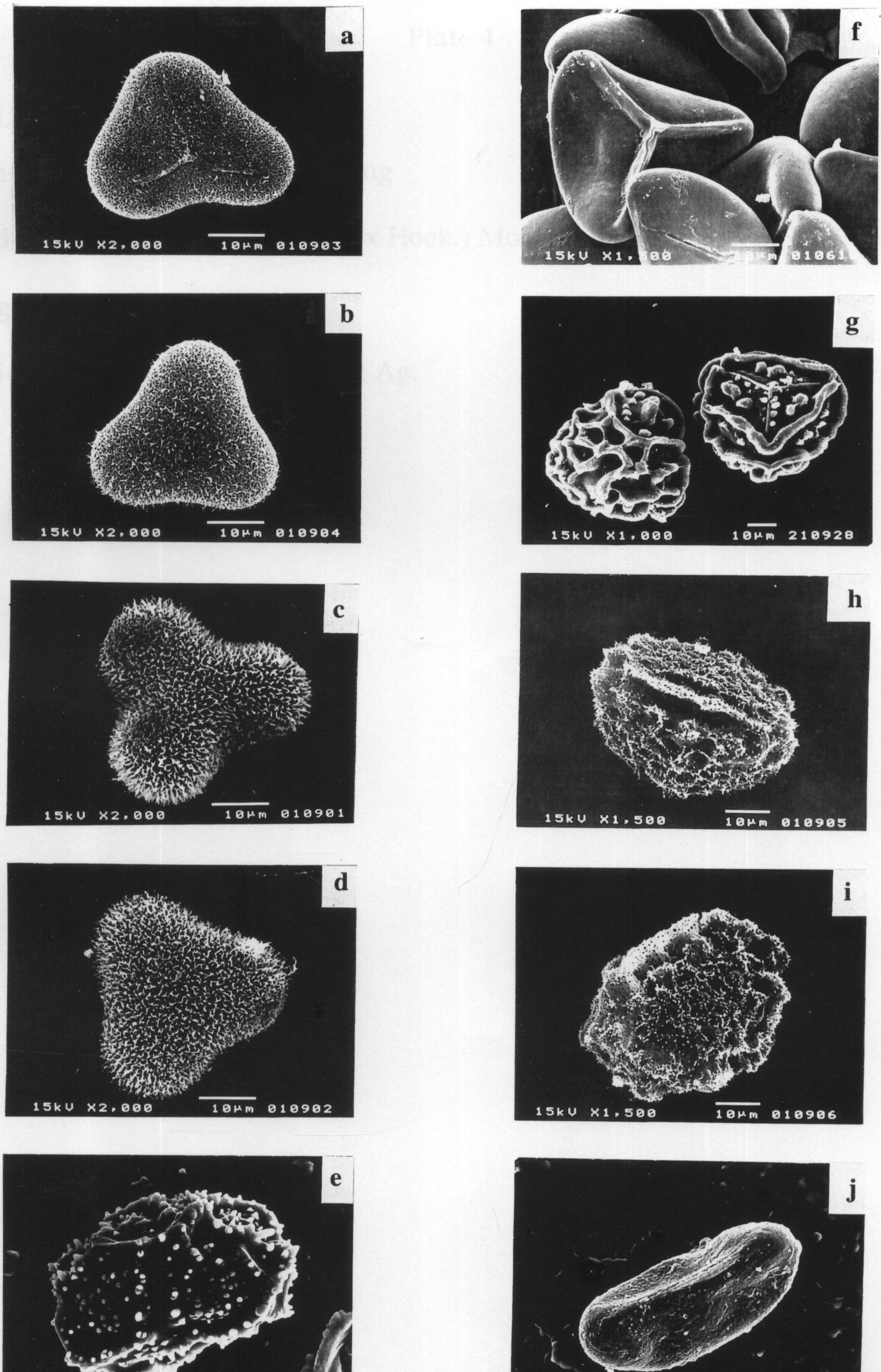

a
15kV X2,000 10µm 010903
b
15kV X2,000 10µm 010904
c
15kV X2,000 10µm 010901
d
15kV X2,000 10µm 010902
e
15kV X2,000 10µm 170819
f
15kV
g
15kV X1,000 10µm 210928
h
15kV X1,500 10µm 010905
i
15kV X1,500 10µm 010906
j
15kV X1,500 10µm 170818

Plate 4

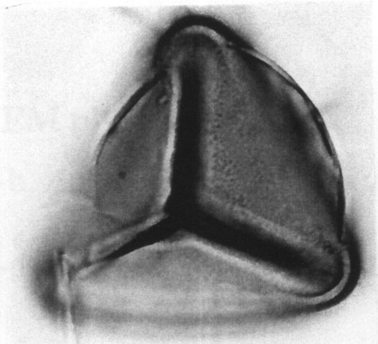
LM photographs:

a-c, *Plagiogyria communis* Ching

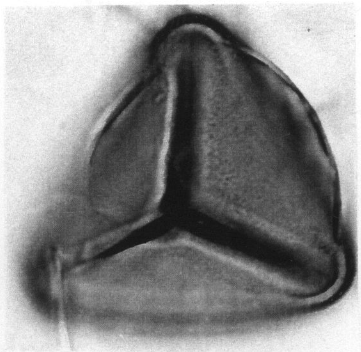
d-f, *Denntaetia scabra* (Wall. ex Hook.) Moore

g-h, *Pteris wallichiana* Ag.

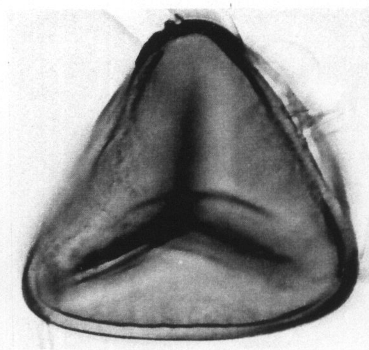
i-j, *Pteris aspericaulis* Wall. ex Ag.



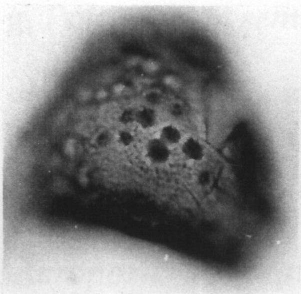
a



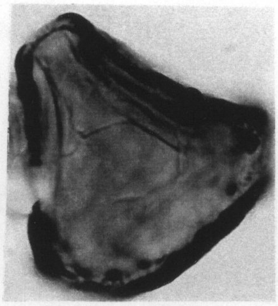
b



c



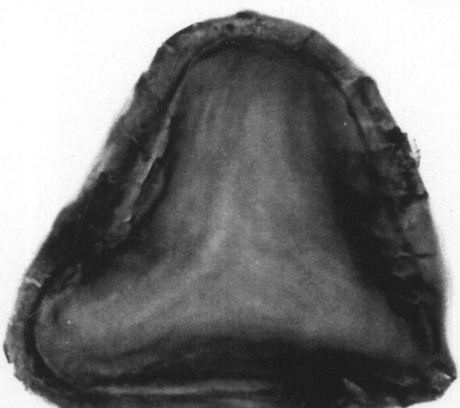
d



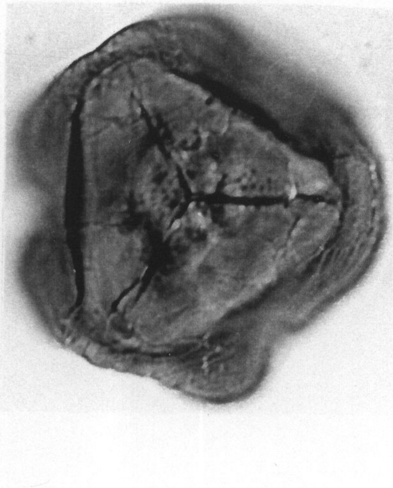
e

f

g



i



h

j

Plate 5

SEM photographs:

a-b, *Araiostegia faberiana* (C. Chr.) Ching

c-d, *Drynaria bonii* Christ

e, *Dryopteris neosamensis* Ching

f-g, *Polystichum semifertile* (Clarke) Ching

h, *Vittaria flexuosa* Fee

i, *Nepholepis cluadiforia* (L.) Presl

j, *Acroporus stipellatus* Moore

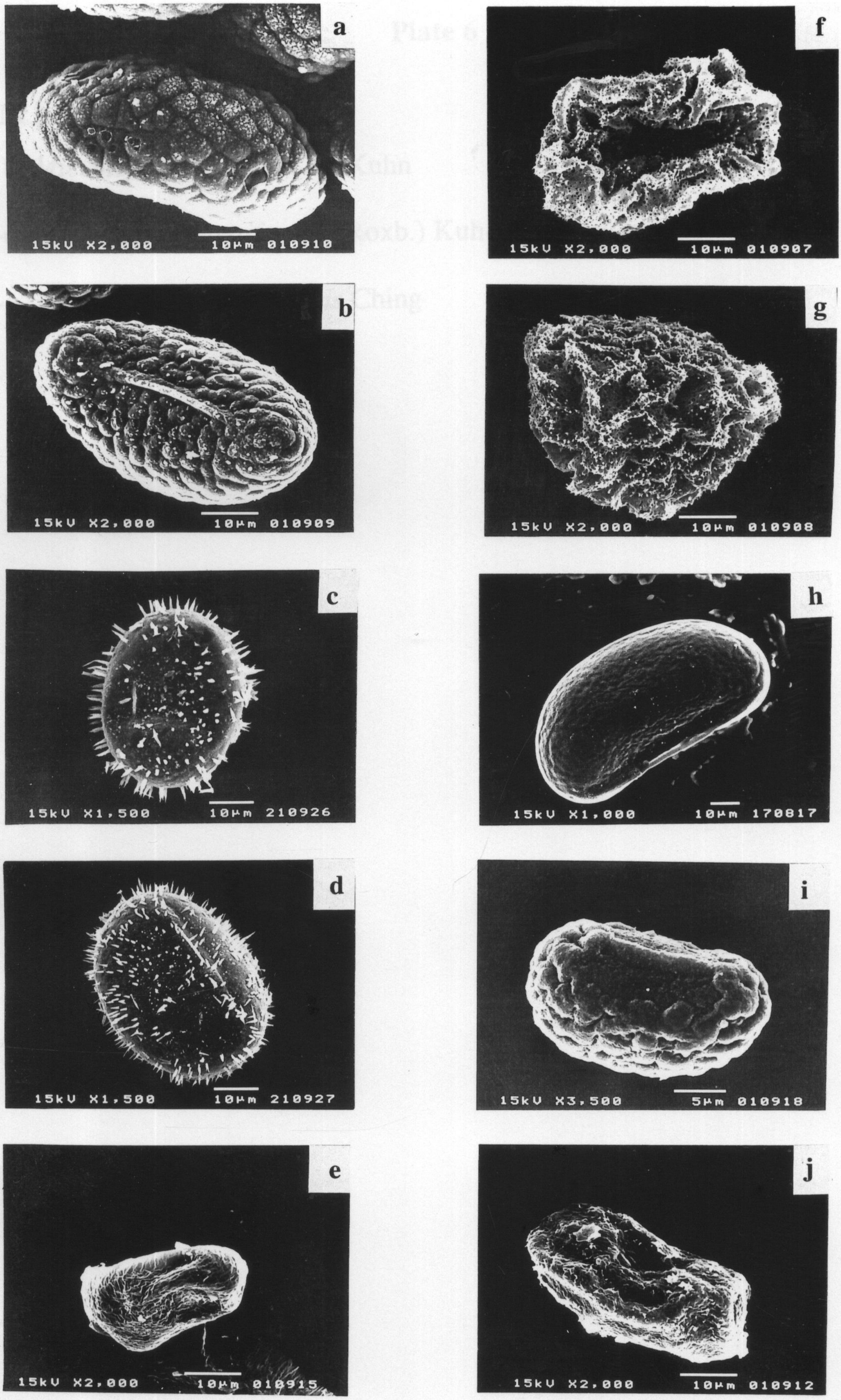

a
15kV X2,000 10μm 010910
b
15kV X2,000 10μm 010909
c
15kV X1,500 10μm 210926
d
15kV X1,500 10μm 210927
e
15kV X2,000 10μm 010915
f
15kV X2,000 10μm 010907
g
15kV X2,000 10μm 010908
h
15kV X1,000 10μm 170817
i
15kV X3,500 5μm 010918
j
15kV X2,000 10μm 010912

Plate 6

LM photographs:

a-b, *Microlepia firma* Mett. ex Kuhn

c-d, *Microlepia trapeziformis* (Roxb.) Kuhn

e-g, *Dryopteris neoassamensis* Ching

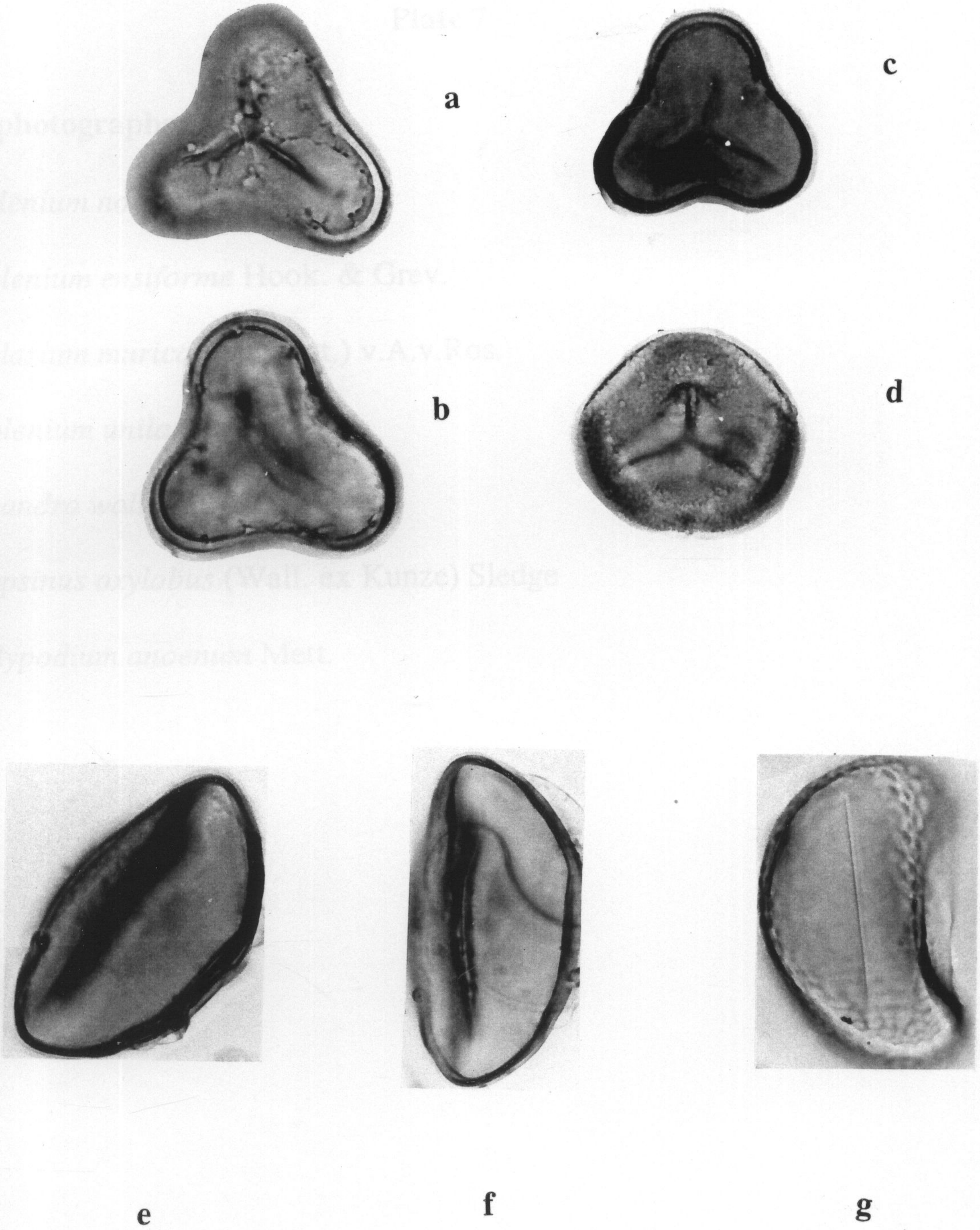

a
c
b
d
e
f
g

Plate 7

SEM photographs:

a, *Asplenium normale* Don

b, *Asplenium ensiforme* Hook. & Grev.

c, *Diplazium muricatum* (Mett.) v.A.v.Ros.

d, *Asplenium unilateraea* Lamk.

e, *Oleandra wallichii* (Hook.) Presl

f, *Crypsinus oxylobus* (Wall. ex Kunze) Sledge

g, *Polypodium anoenum* Mett.

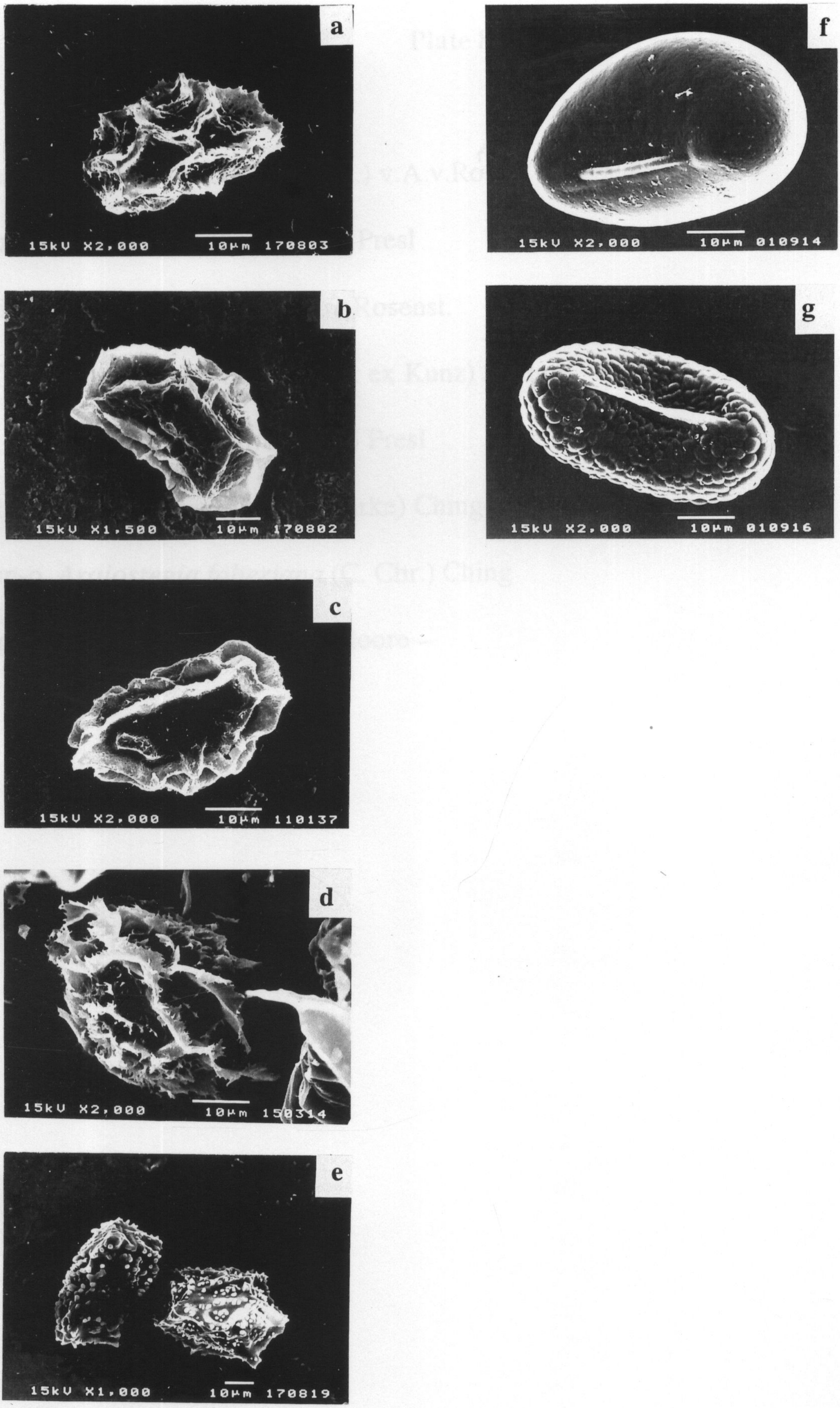

a
15kV X2,000 10µm 170803
b
15kV X1,500 10µm 170802
c
15kV X2,000 10µm 110137
d
15kV X2,000 10µm 150314
e
15kV X1,000 10µm 170819
f
15kV X2,000 10µm 010914
g
15kV X2,000 10µm 010916

Plate 8

LM photographs:

a, *Diplazium muricatum* (Mett.) v.A.v.Ros.

b, *Oleandra wallichii* (Hook.) Presl

d-e, *Polystichum tenggerense* Rosenst.

f-h, *Crypsinus oxylobus* (Wall. ex Kunz) Sledge

i-j, *Nephrolepis cordifolia* (L.) Presl

l, *Polystichum semifertile* (Clarke) Ching

m-o, *Araiostegia faberiana* (C. Chr.) Ching

p-q, *Acrophorus stipellatus* Moore

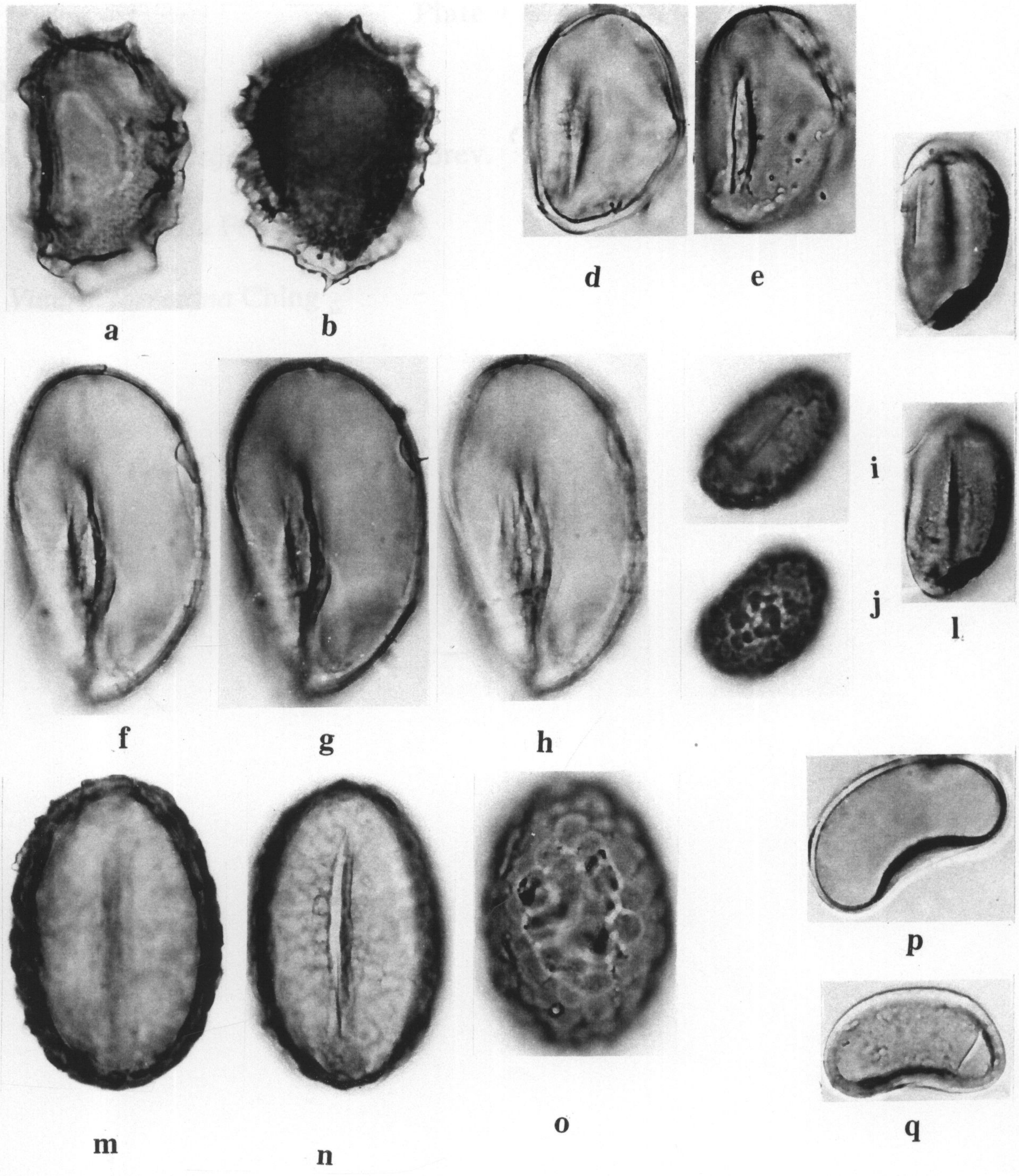

a
b
d
e
f
g
h
i
j
l
m
n
o
p
q

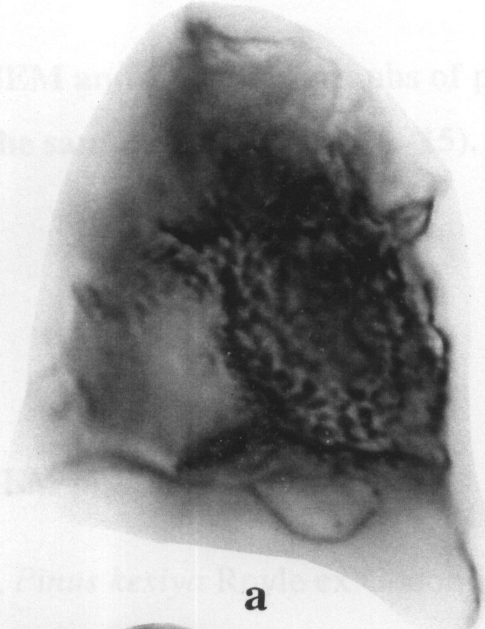
Plate 9

LM photographs:

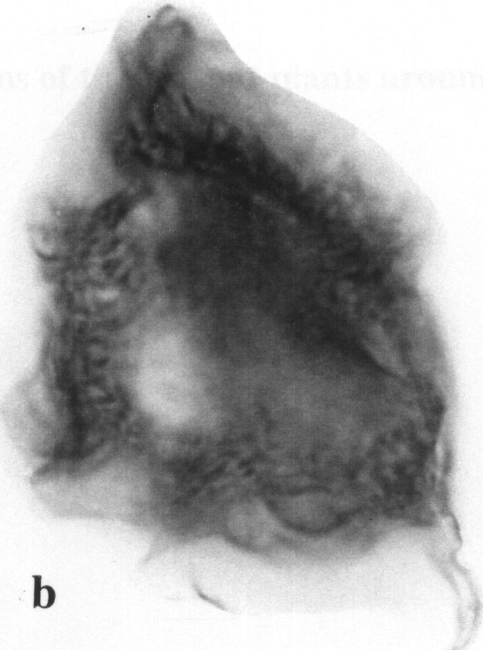
a-b, *Asplenium ensiforme* Hook. & Grev.

c, *Vittaria flexuosa* Fee

d, *Vittaria forrestina* Ching



a



b

c

d

SEM and LM photographs of pollen grains of the present plants around the sampling site (plate 10-15).

Plate 10

SEM photographs:

a, *Pinus kesiya* Royle ex Godon

b, *Pinus merkusii* Jungh. & de Vriese

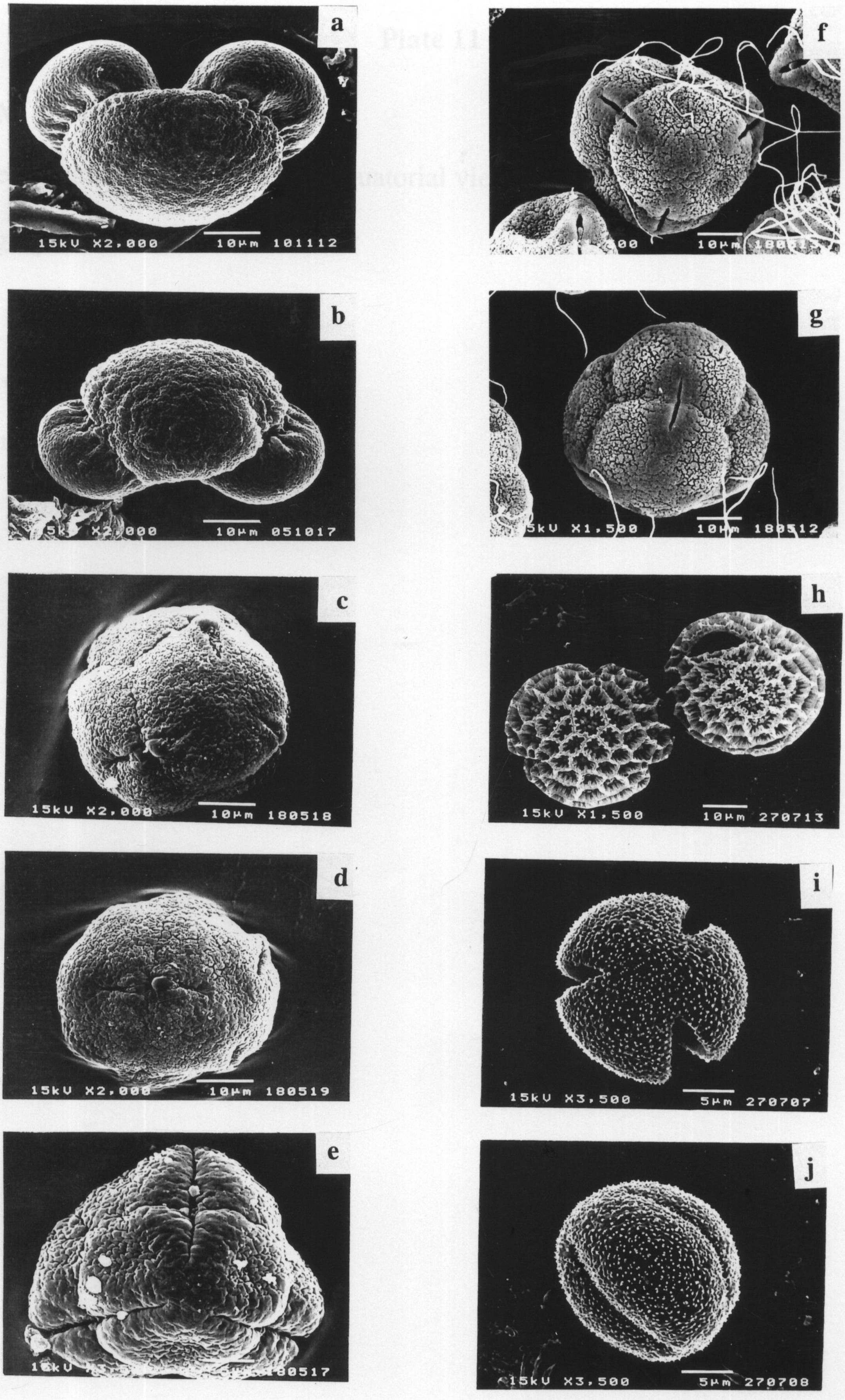
c-d, *Vaccinium* sp.

e, *Agapetes* sp.

f-g, *Rhododendron* sp.

h, *Polygonum chinense* L.

i-j, *Polygonum plebejum* R.Br.



a
15kV X2,000
10µm 101112
b
X2,000
10µm 051017
c
15kV X2,000
10µm 180518
d
15kV X2,000
10µm 180519
e
180517
f
10µm
g
X1,500
10µm 180512
h
15kV X1,500
10µm 270713
i
15kV X3,500
5µm 270707
j
15kV X3,500
5µm 270708

Plate 11

LM photographs:

a-e, Legume : polar view and equatorial view

f-g, *Quercus kerrii* Craib.

h, *Hyperculinar* sp.

i-j, *Cynoglossum* sp.

k-m, *Quercus brandisiana* Kurz

n, *Rubus* sp.

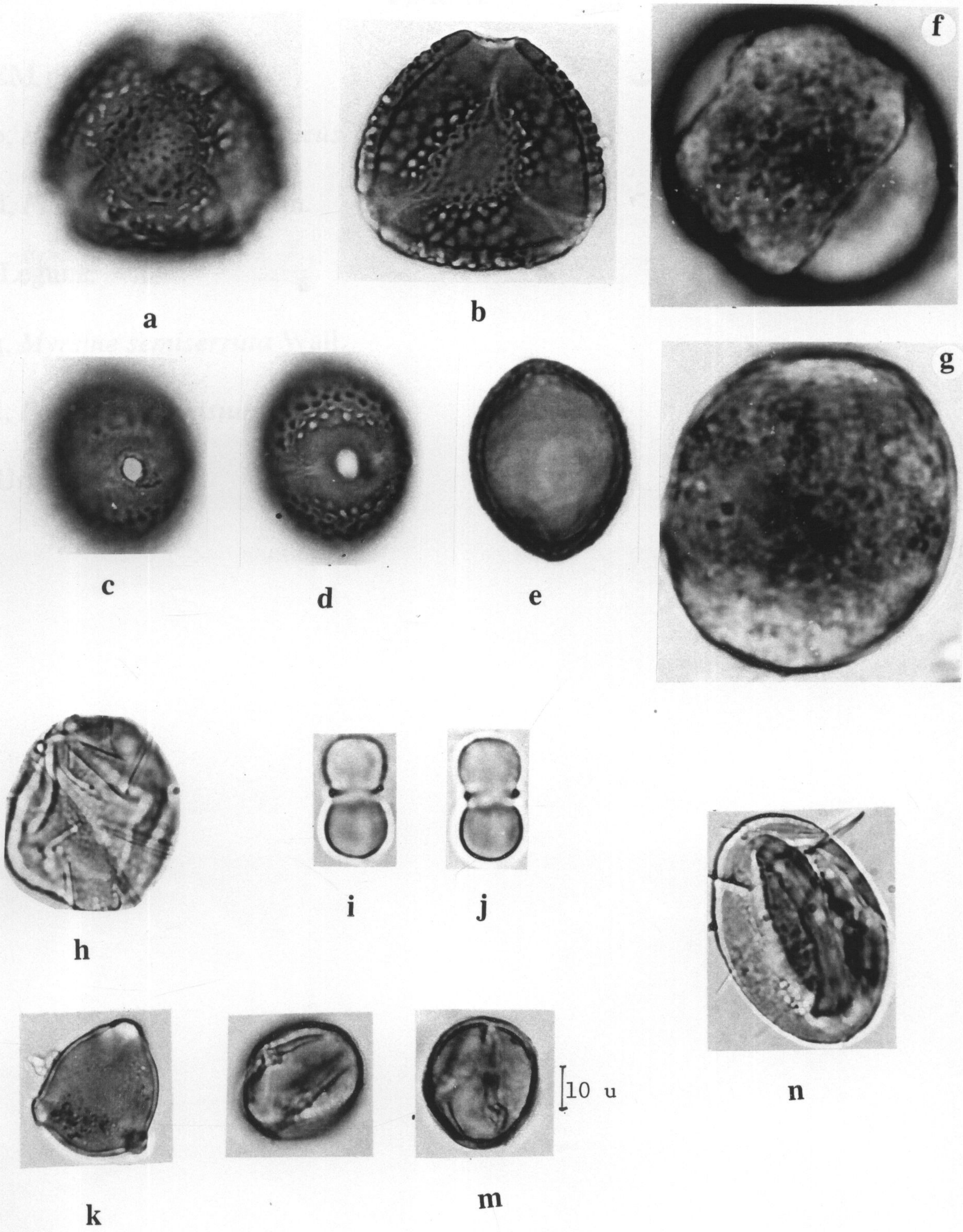

a
b
c
d
e
f
g
h
i
j
k
m
n
10 u
10 u

Plate 12

SEM photographs:

a-b, *Hymenopogon parasiticus* Wall.

c-d, *Photinia nussia* Kalkm.

e, Legume

f-g, *Myrsine semiserruta* Wall.

h-i, *Polygala karensium* Kurz

j, Urticaceae

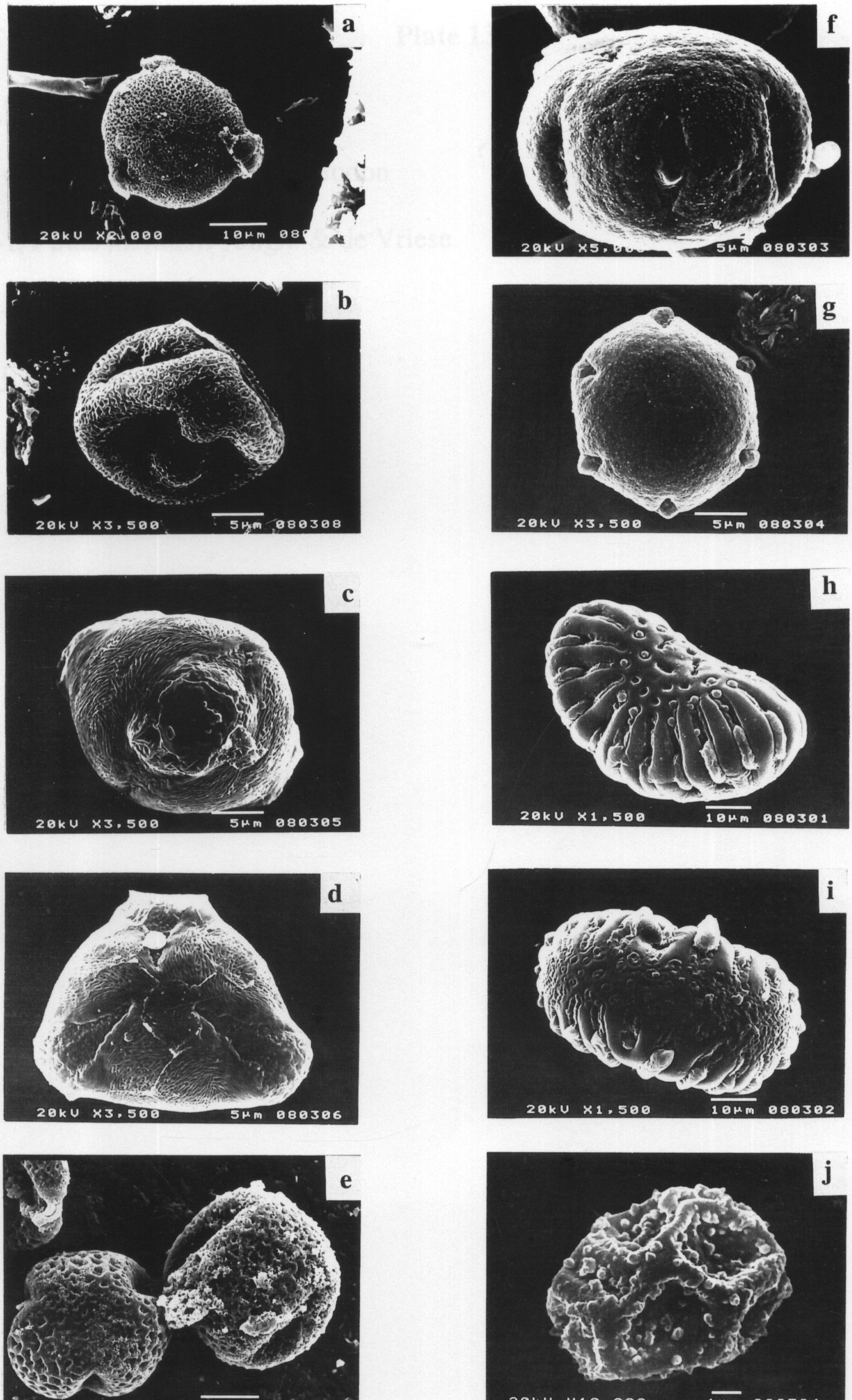

a
b
20kV X3,500 5μm 080308
c
20kV X3,500 5μm 080305
d
20kV X3,500 5μm 080306
e
20kV X2,000 10μm 020307
f
5μm 080303
g
20kV X3,500 5μm 080304
h
20kV X1,500 10μm 080301
i
20kV X1,500 10μm 080302
j
20kV X10,000 1μm 020304

Plate 13

LM photographs:

a-c, *Pinus kesiya* Royle ex Godon

d-f, *Pinus merkusii* Jungh. & de Vriese

g-h, *Rhododendron* sp.

i-j, *Agapetes* sp.

l-m,*Vaccinium* sp.

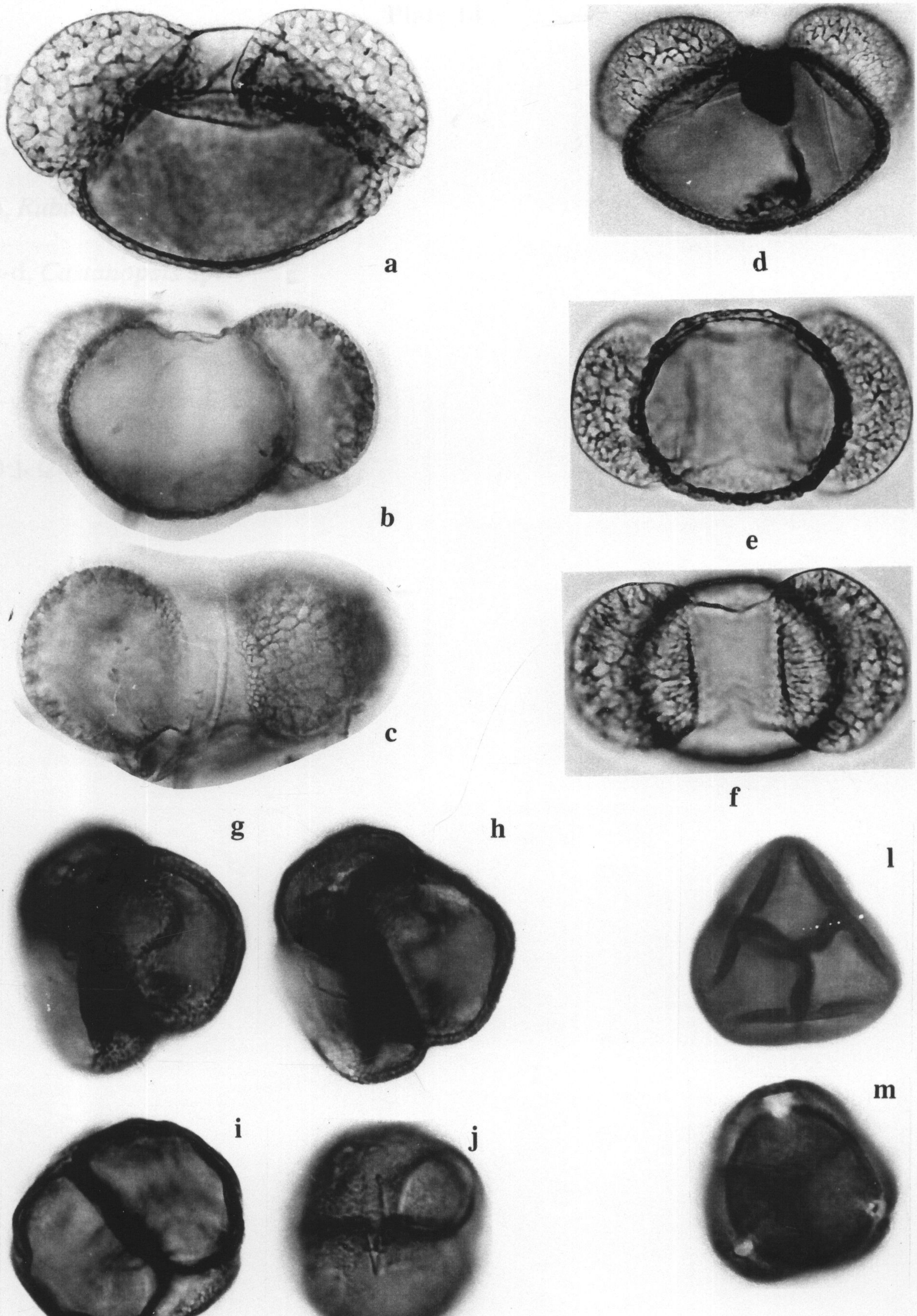

a
d
b
e
c
f
g
h
l
m
i
j

Plate 14

SEM photographs:

a, *Plantago* sp.

b, *Rubus* sp.

c-d, *Castanopsis* sp.

e, *Cynoglossum* sp.

f-g, *Quercus brandisiana* Kurz

h-j, *Quercus kerrii* Craib.

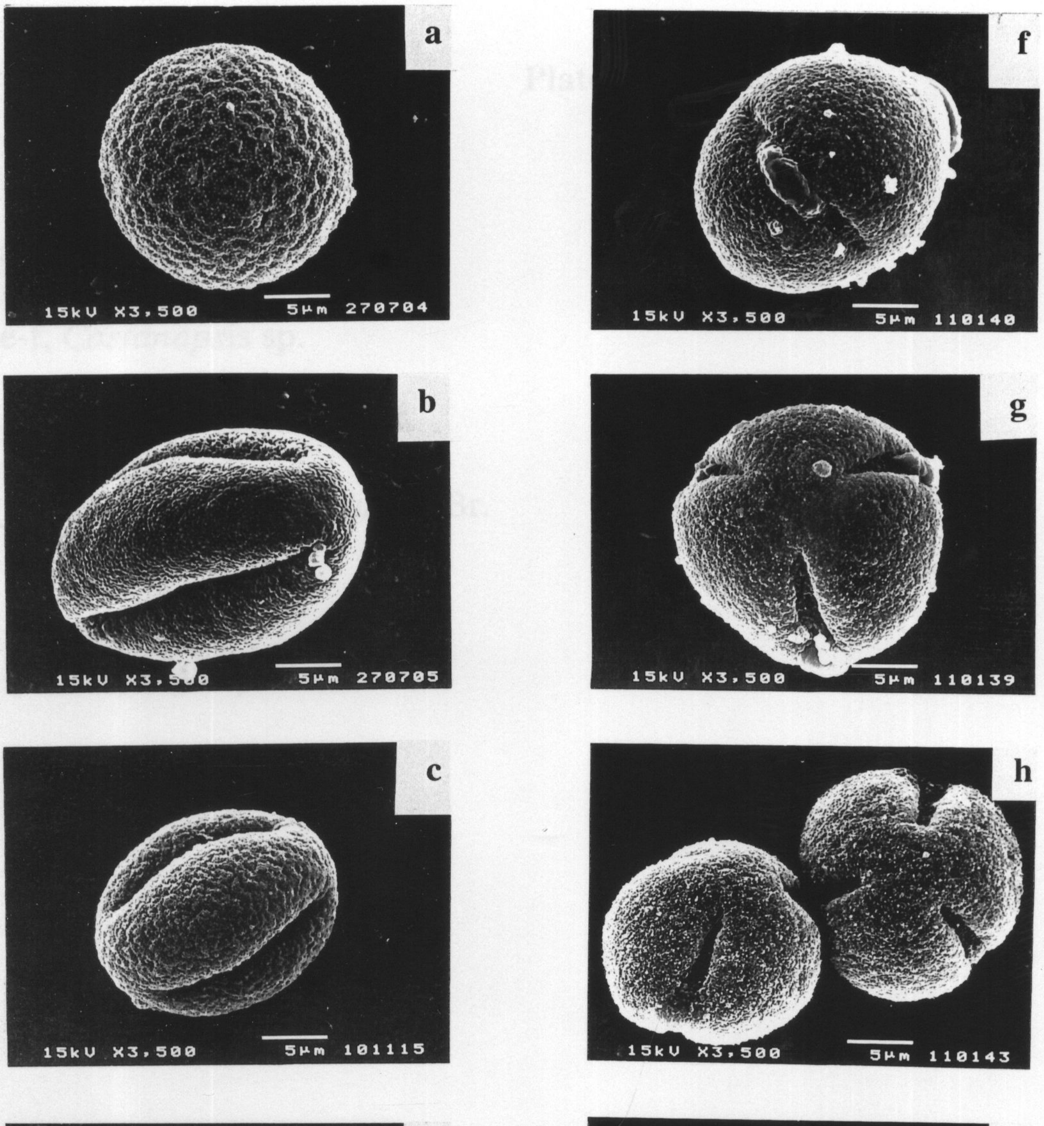

a
15kV X3,500 5µm 270704
b
15kV X3,500 5µm 270705
c
15kV X3,500 5µm 101115
d
15kV X3,500 5µm 101105
e
15kV X10,000 1µm 150313
f
15kV X3,500 5µm 110140
g
15kV X3,500 5µm 110139
h
15kV X3,500 5µm 110143
i
15kV X3,500 5µm 110142
j
15kV X3,500 5µm 110141

Plate 15

LM photographs:

a-d, *Schima wallichii* Korth.

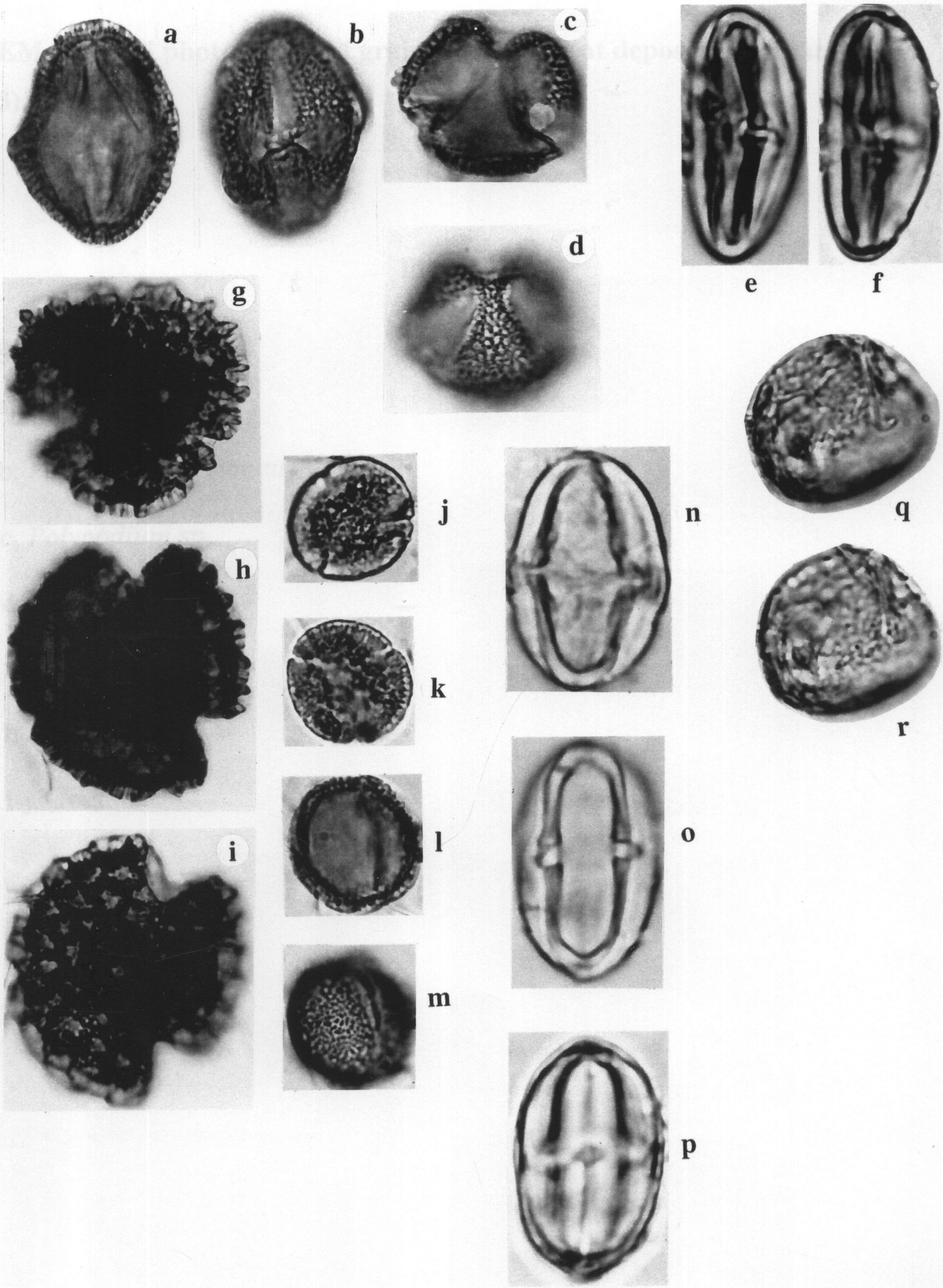
e-f, *Castanopsis* sp.

g-i, *Polygonum chinense* L.

j-m, *Polygonum plebejum* R.Br.

n-p, *Lithocarpus* sp.

q-r, *Plantago* sp.


a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p
q
r

SEM and LM photographs of grains found in peat deposit, 1A (plate 16-23).

Plate 16

SEM photographs:

a, *Selaginella* sp.

b, *Plagiogyria communis* Ching

c, *Polypodium* sp.

d-e, *Crypsinus* sp.

f-g, *Pinus* sp.

h, Cyperaceae

i-j, Graminae

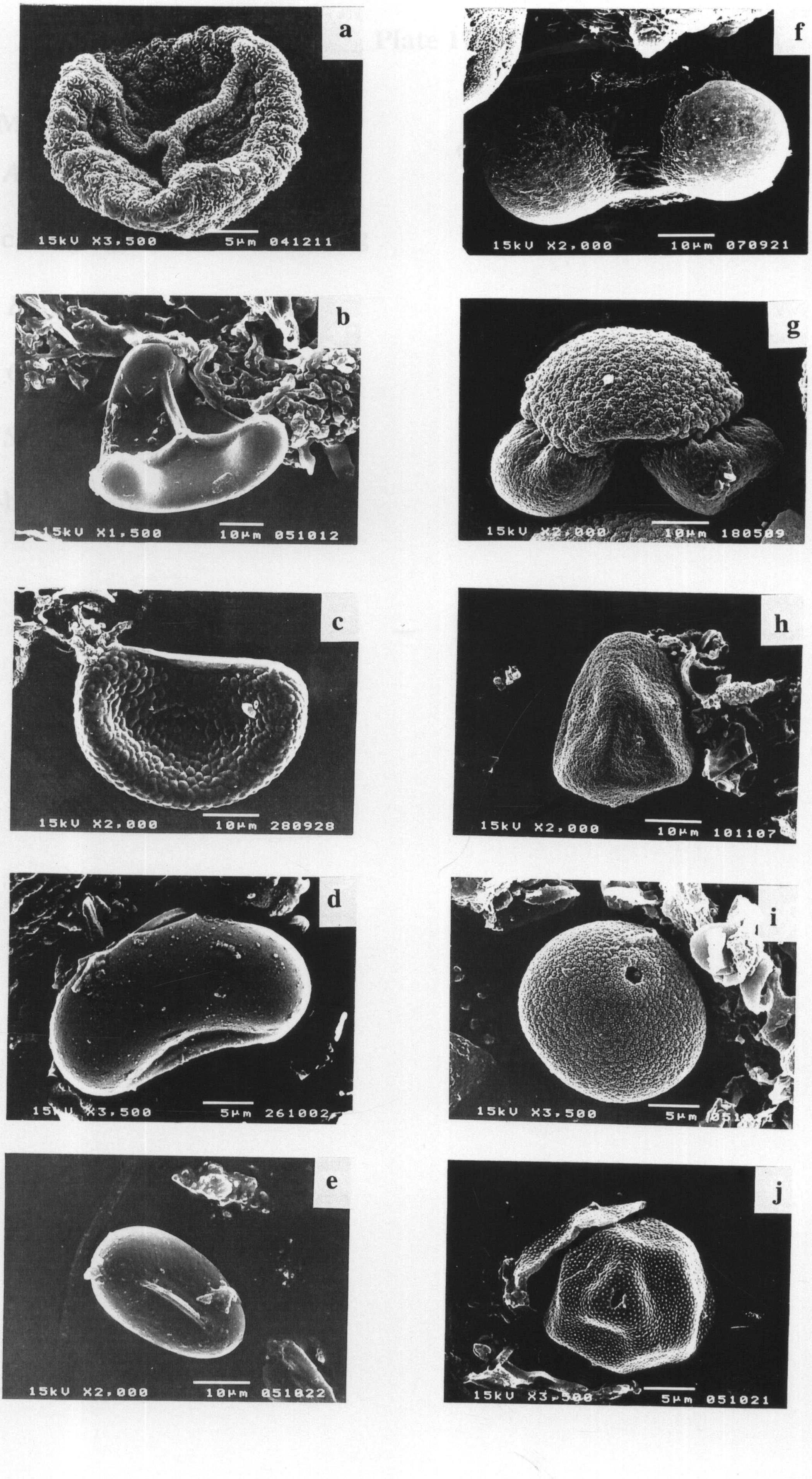

a
15kV X3,500 5µm 041211
f
15kV X2,000 10µm 070921
b
15kV X1,500 10µm 051012
g
15kV X2,000 10µm 180509
c
15kV X2,000 10µm 280928
h
15kV X2,000 10µm 101107
d
15kV X3,500 5µm 261002
i
15kV X3,500 5µm
e
15kV X2,000 10µm 051022
j
15kV X3,500 5µm 051021

Plate 17

LM photographs:

a, *Asplenium* sp.

b-c, *Plagiogyria communis* Ching

d, *Polypodium* sp.

e, *Crypsinus* sp.

f, *Selaginella* sp.

g-h, *Pinus* sp.

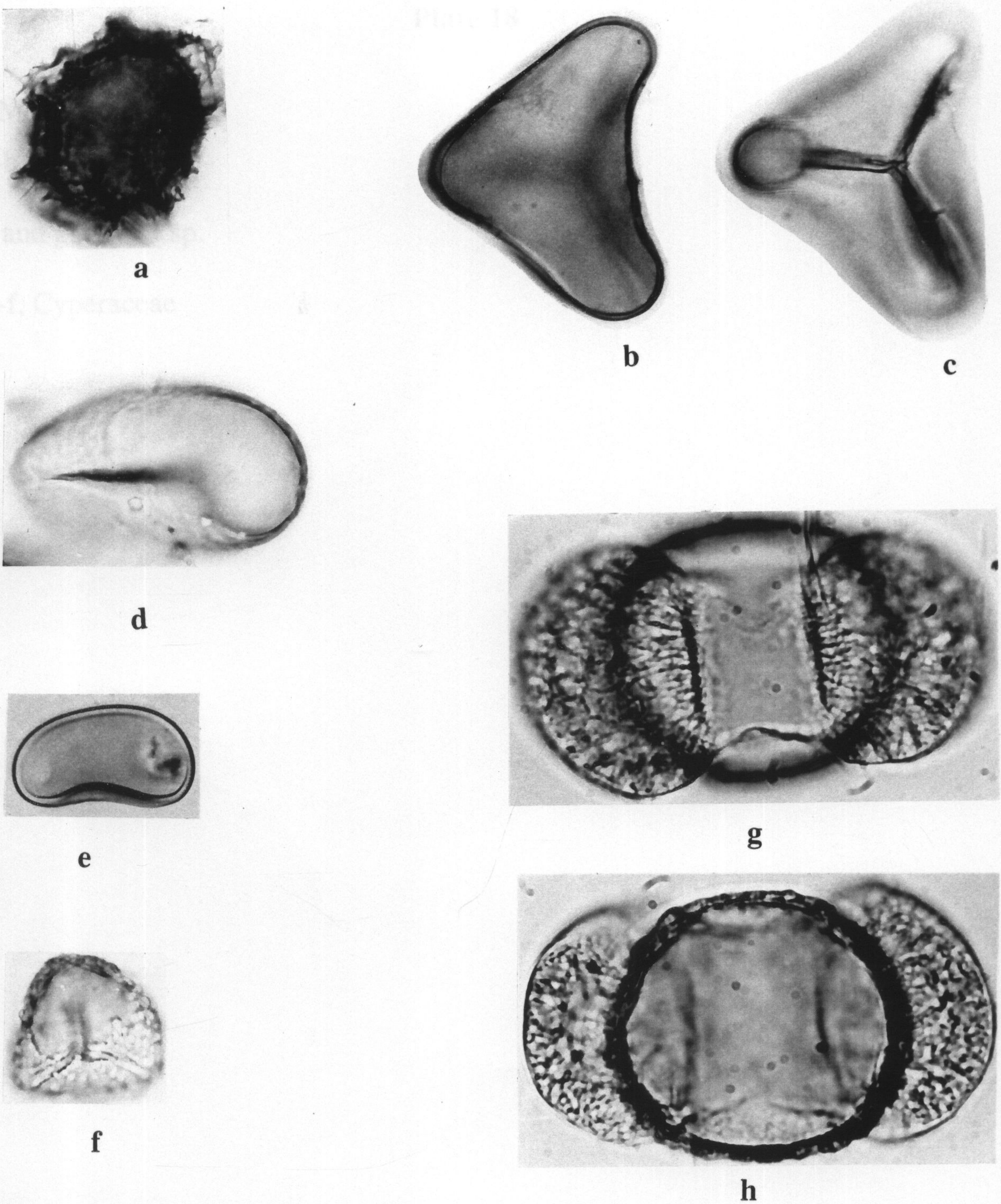

a
b
c
d
e
f
g
h

Plate 18

LM photographs:

a-b, Graminae

c and g, *Rubus* sp.

d-f, Cyperaceae

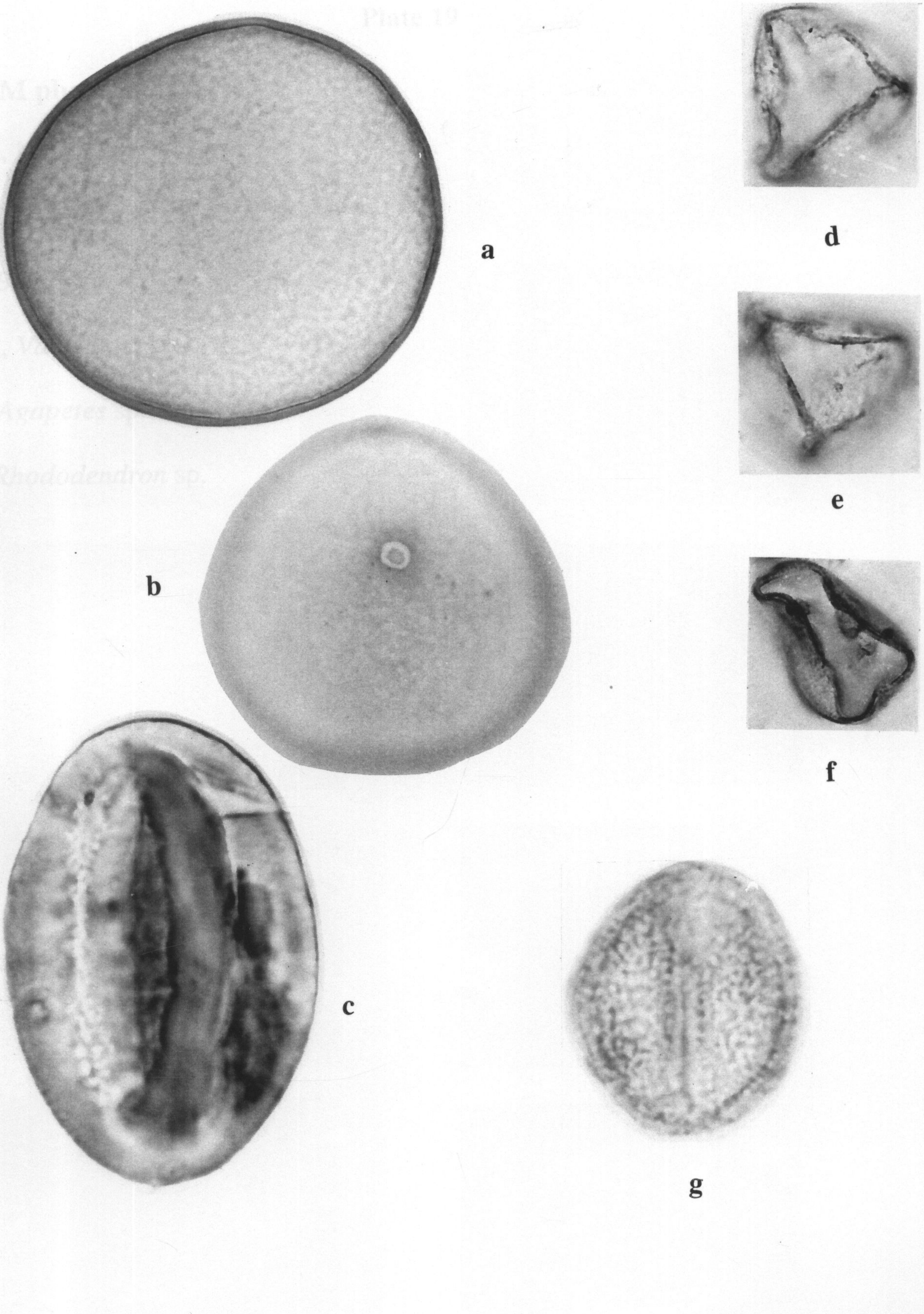

a
d
e
b
f
c
g

Plate 19

SEM photographs:

a-b, Myrtaceae

c-d, *Engelhardtia* sp.

e, *Betula* sp.

f-g, *Vaccinium* sp.

h, *Agapetes* sp.

j, *Rhododendron* sp.

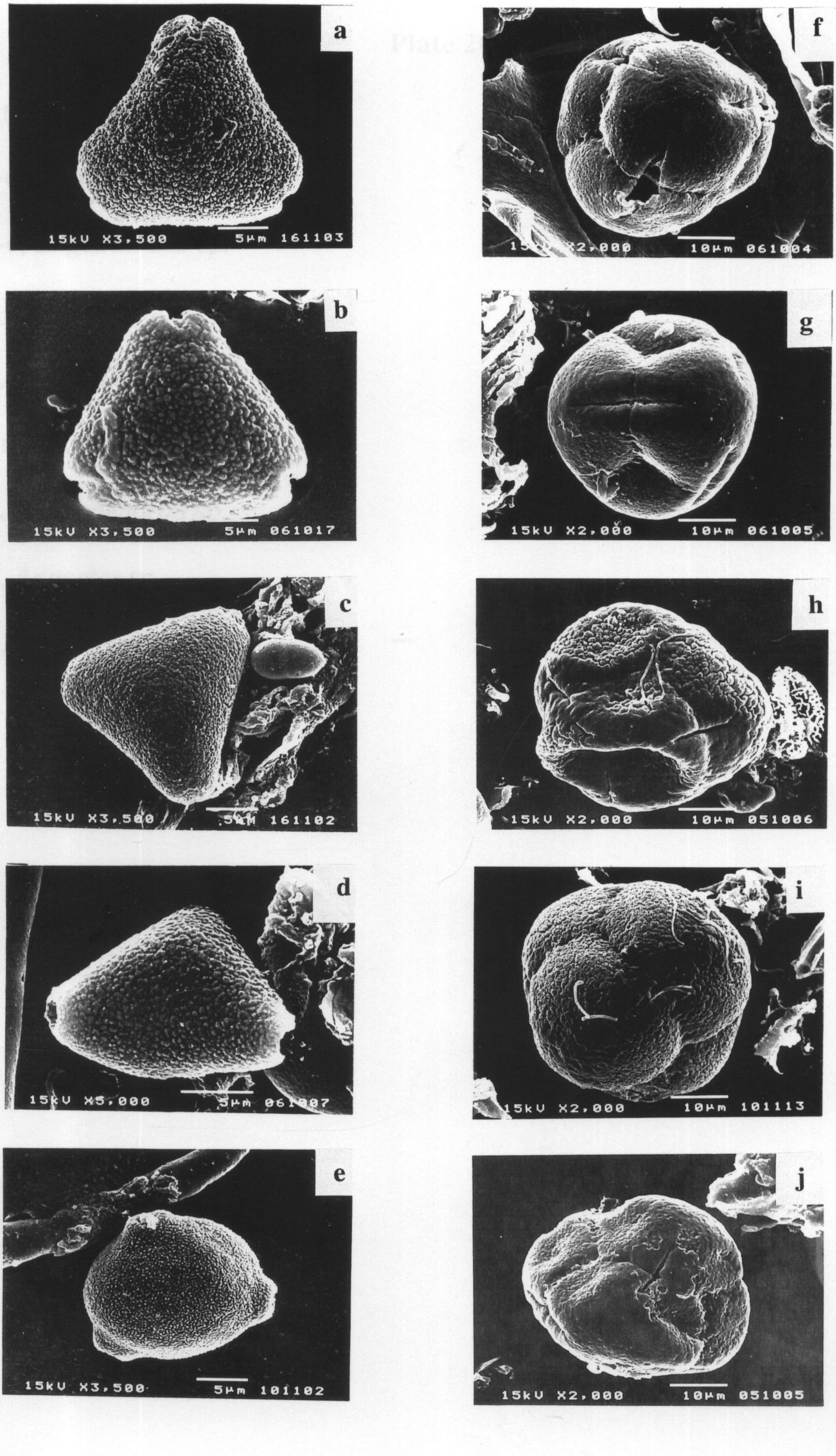

a
15kV X3,500 5µm 161103
b
15kV X3,500 5µm 061017
c
15kV X3,500 5µm 161102
d
15kV X5,000 5µm 061007
e
15kV X3,500 5µm 101102
f
X2,000 10µm 061004
g
15kV X2,000 10µm 061005
h
15kV X2,000 10µm 051006
i
15kV X2,000 10µm 101113
j
15kV X2,000 10µm 051005

Plate 20

LM photographs:

a-c, *Betula* sp.

d-e, *Engelhardtia* sp.

f-j, Myrtaceae

k, Rosaceae

l-m, Legume

n, *Rhododendron* sp.

o, *Agapetes* sp.

p, *Vaccinium* sp.

r-s, Rubiaceae

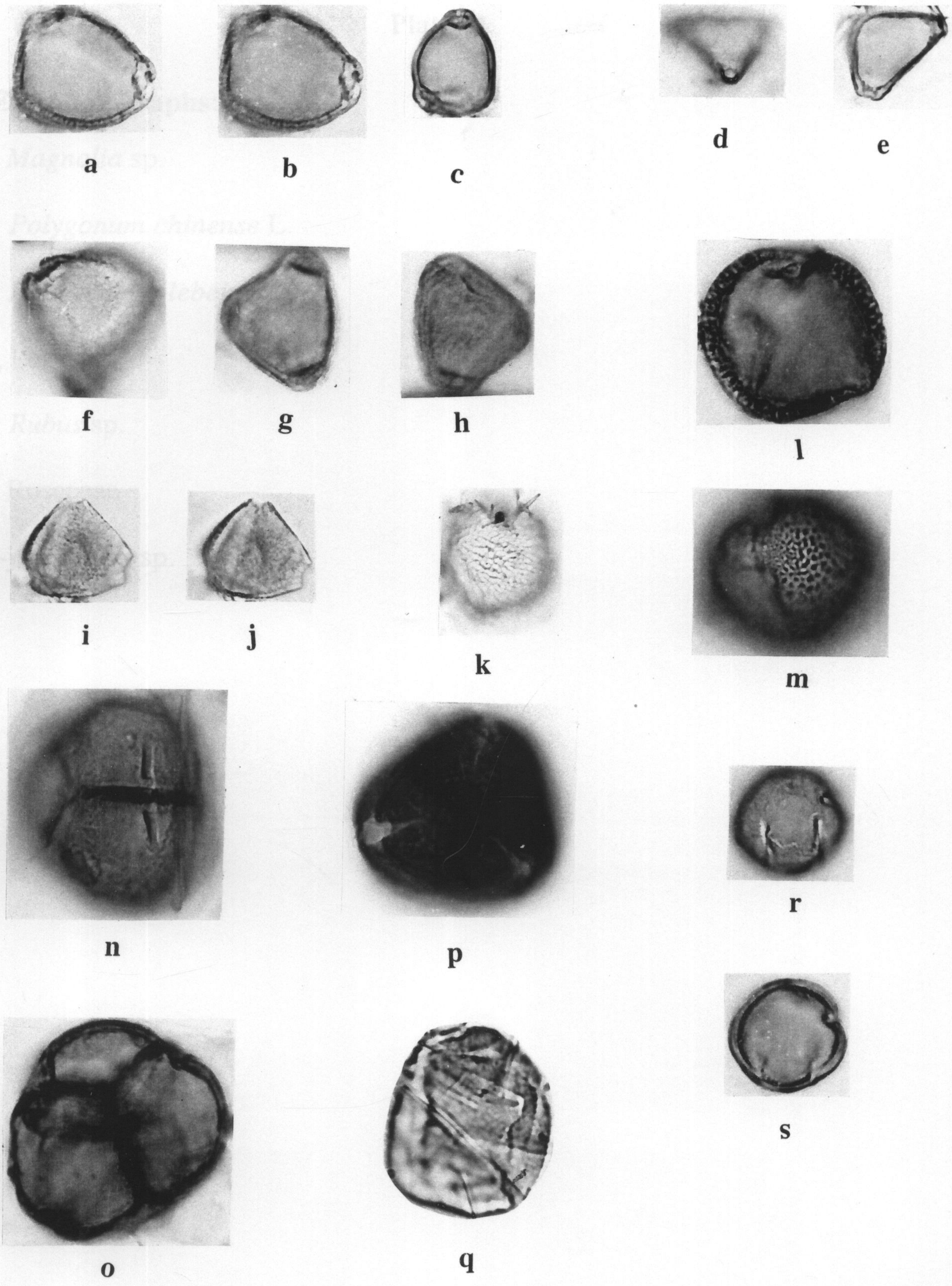

a
b
c
d
e
f
g
h
l
i
j
k
m
n
p
r
s
o
q

Plate 21

SEM photographs:

a, *Magnolia* sp.

b, *Polygonum chinense* L.

c, *Polygonum plebejum* R.Br.

d, Legume;

e, *Rubus* sp.

f, Rosaceae

g-j, *Quercus* sp.

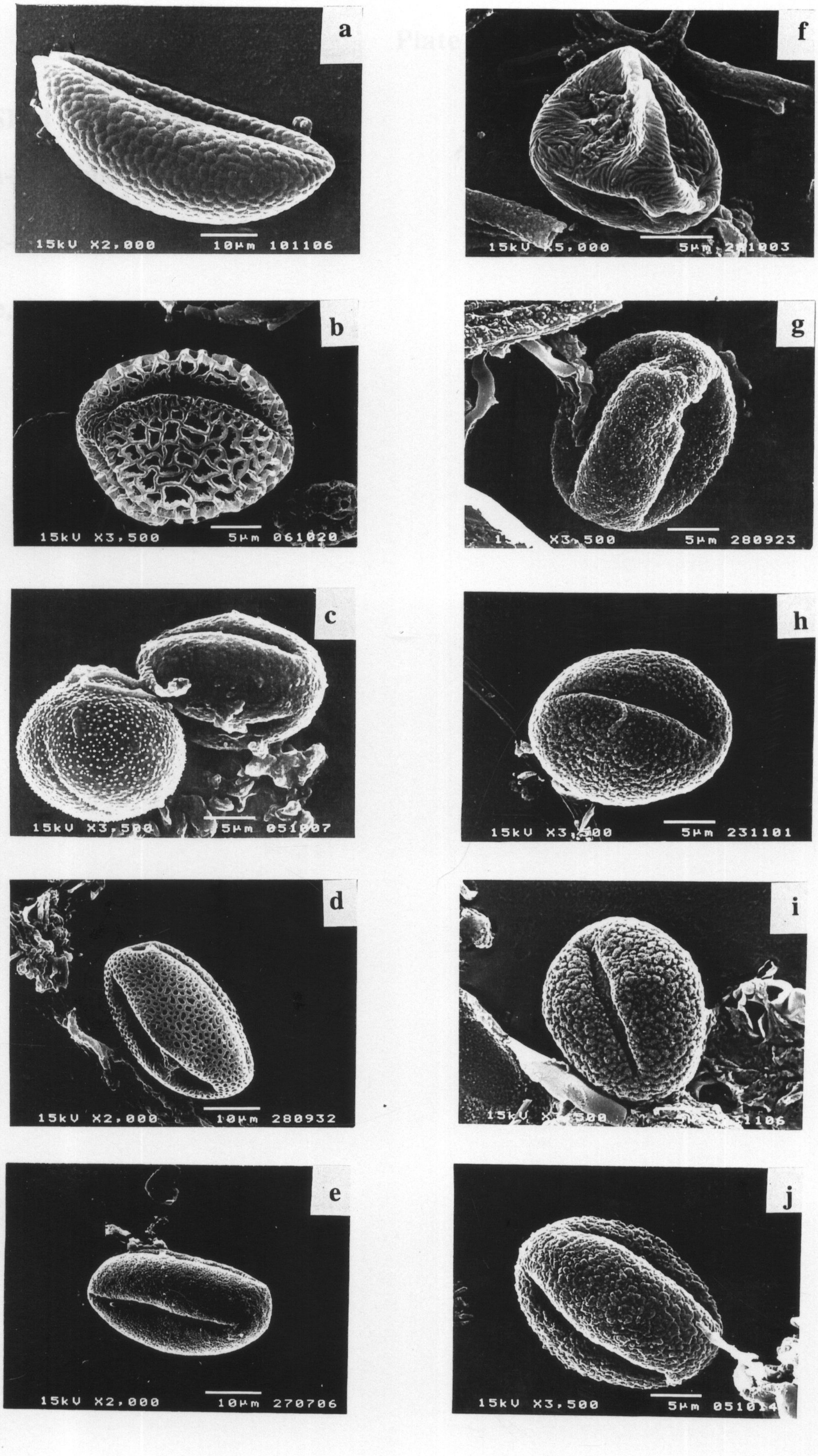

a
15kV X2,000 10µm 101106
f
15kV X5,000 5µm
b
15kV X3,500 5µm 061020
g
X3,500 5µm 280923
c
15kV X3,500 5µm 051007
h
15kV X3,500 5µm 231101
d
15kV X2,000 10µm 280932
i
e
15kV X2,000 10µm 270706
j
15kV X3,500 5µm

Plate 22

SEM photographs:

a-b, Rubiaceae

c-d, *Schima wallichii* Korth

e, Araceae

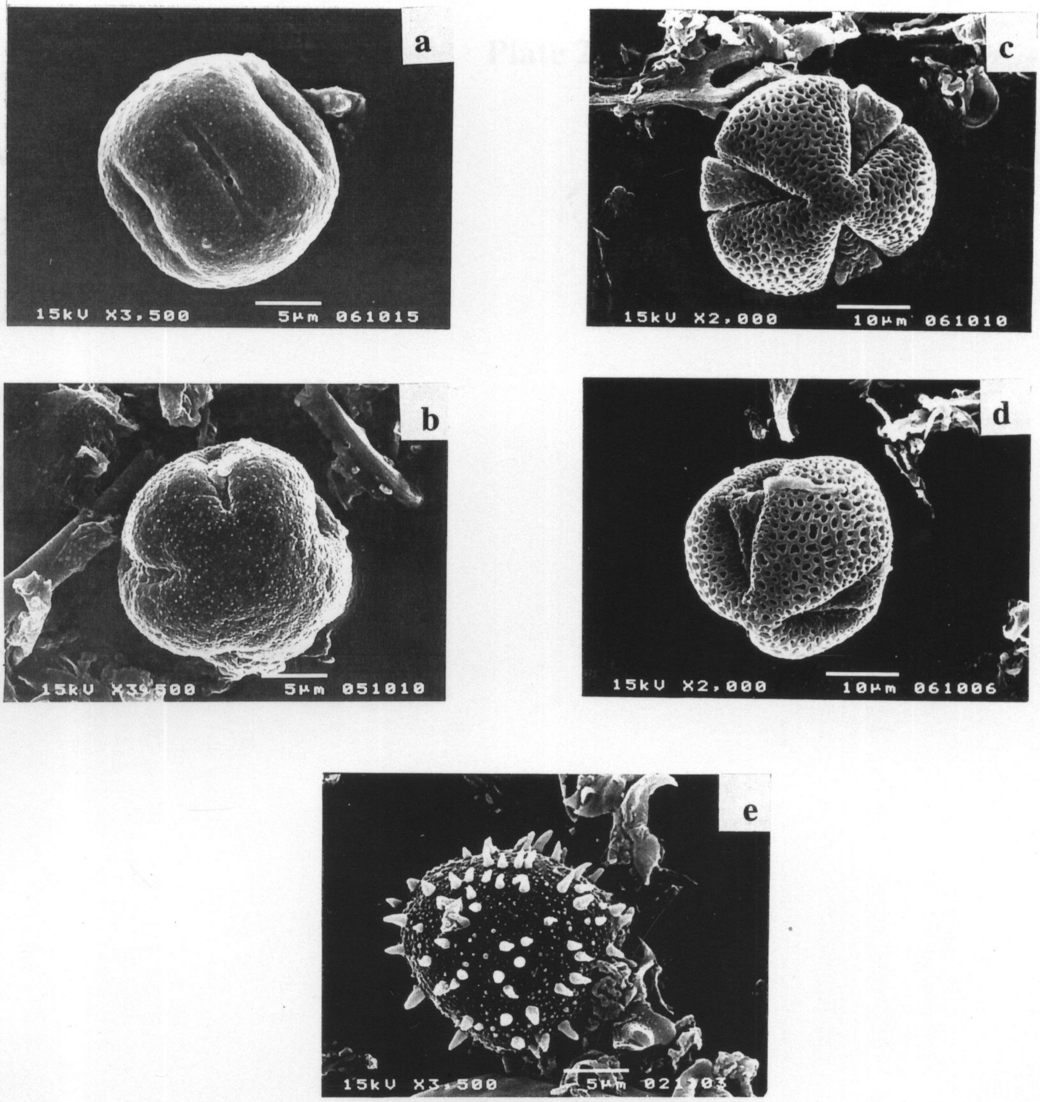

a
15kV X3,500 5µm 061015
b
15kV X3,500 5µm 051010
c
15kV X2,000 10µm 061010
d
15kV X2,000 10µm 061006
e
15kV X3,500 5µm

Plate 23

LM photographs:

a-b, *Magnolia* sp.

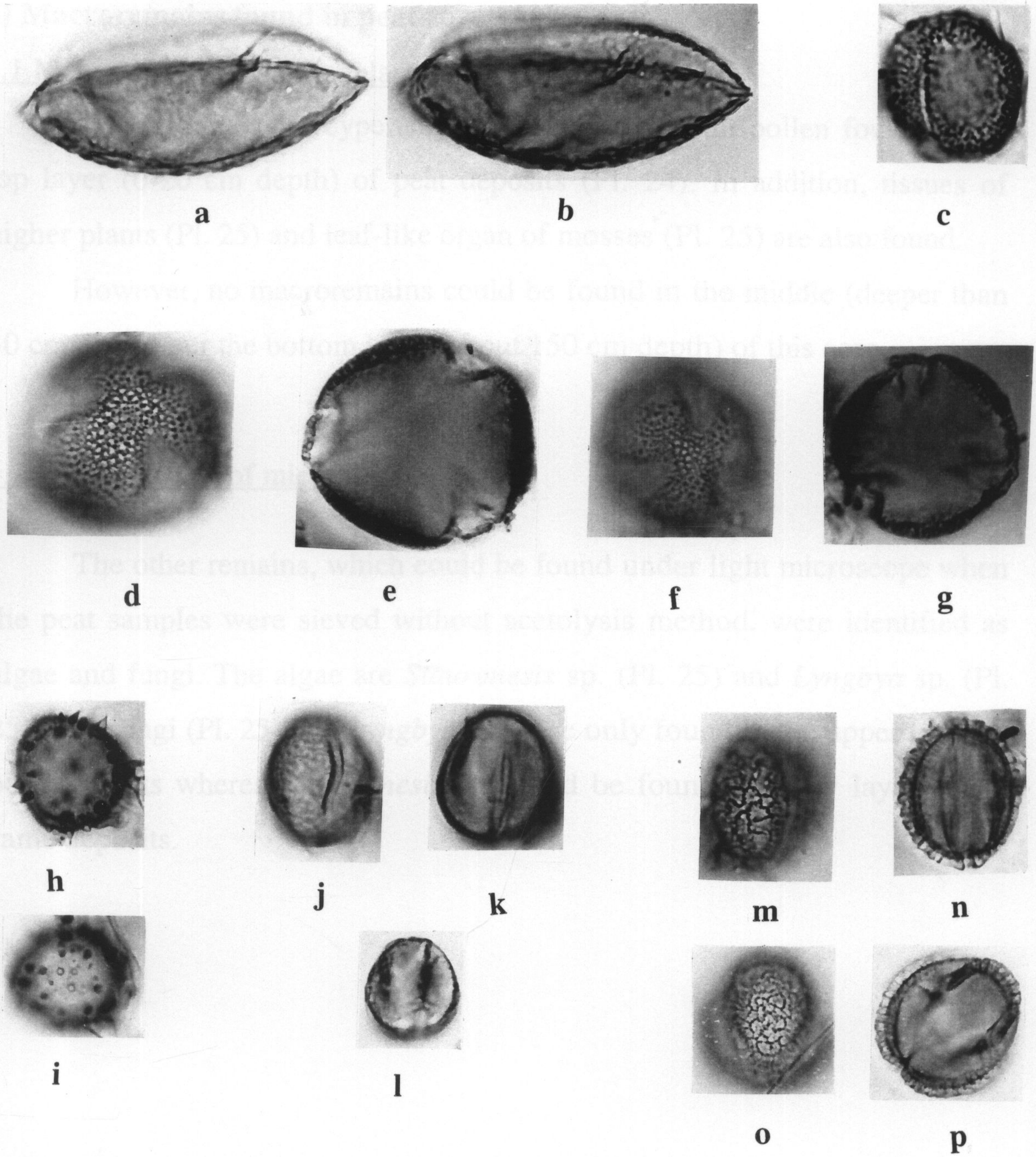
c, *Polygonum plebejum* R. Br.

d-g, *Schima wallichii* Korth.

h-i, Araceae

j-l, *Quercus* sp.

m-p, *Polygonum chinense* L.


a
b
c
d
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f
g
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i
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m
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p

3) Macroremains found in peat core 1A

3.1 Macroremains of higher plants.

The graminae and cyperaceae remains other than pollen found in the top layer (0-20 cm depth) of peat deposits (Pl. 24). In addition, tissues of higher plants (Pl. 25) and leaf-like organ of mosses (Pl. 25) are also found.

However, no macroremains could be found in the middle (deeper than 30 cm depth) nor the bottom layer (about 150 cm depth) of this core.

3.2 Other remains of micro-organisms.

The other remains, which could be found under light microscope when the peat samples were sieved without acetolysis method, were identified as algae and fungi. The algae are *Stauronesis* sp. (Pl. 25) and *Lyngbya* sp. (Pl. 25). The fungi (Pl. 25) and *Lyngbya* sp. were only found in the upper layer of peat deposits whereas *Stauronesis* sp. could be found in every layer of the same deposits.

Plate 24

a, Macroremains of higher plants on surface of peat deposit.

b, Macroremains of higher plants in 10 centrimetres depth.

c, Macroremains of higher plants in 20 centrimetres depth.

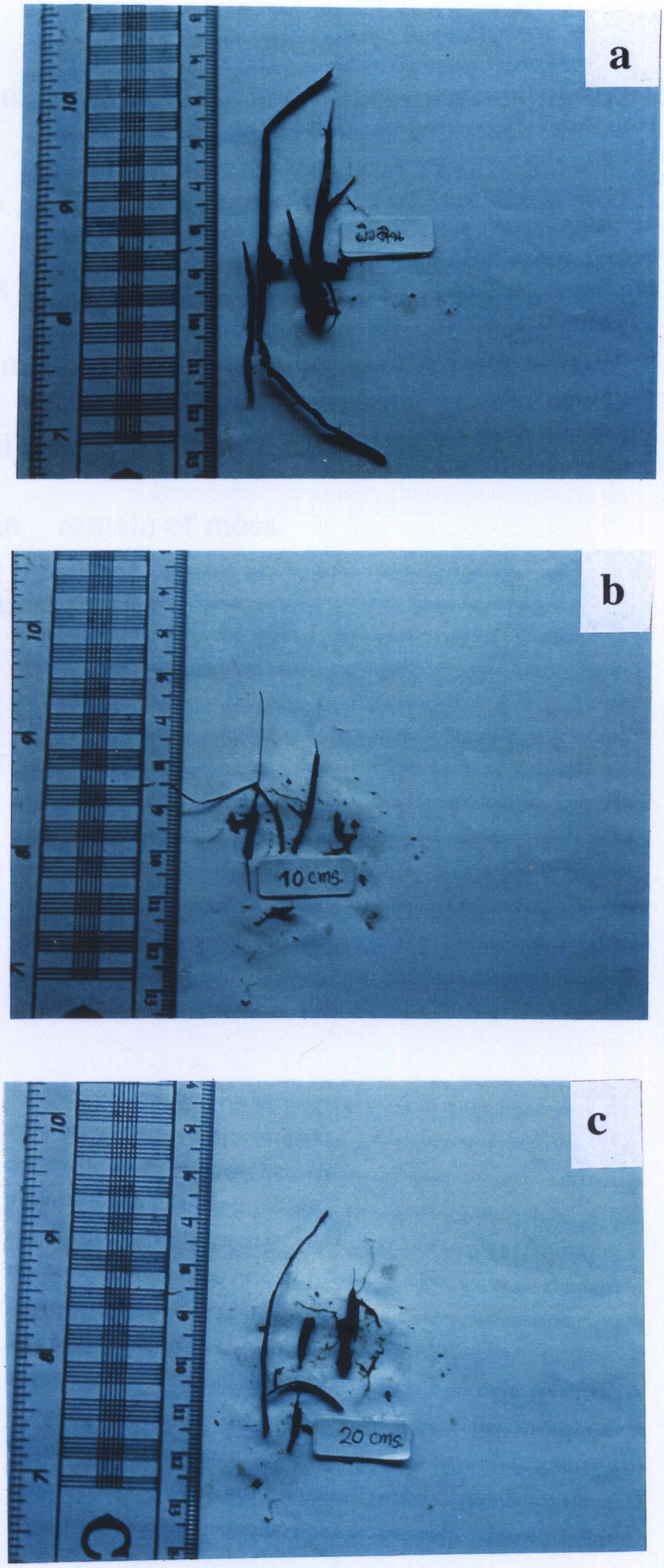

a
ผิวดิน
b
10 cms.
c
20 cms.

Plate 25

Macroremains of higher plants and micro-organisms found in peat deposit, 1A.

a, *Stenronesis* sp., a fresh water algae.

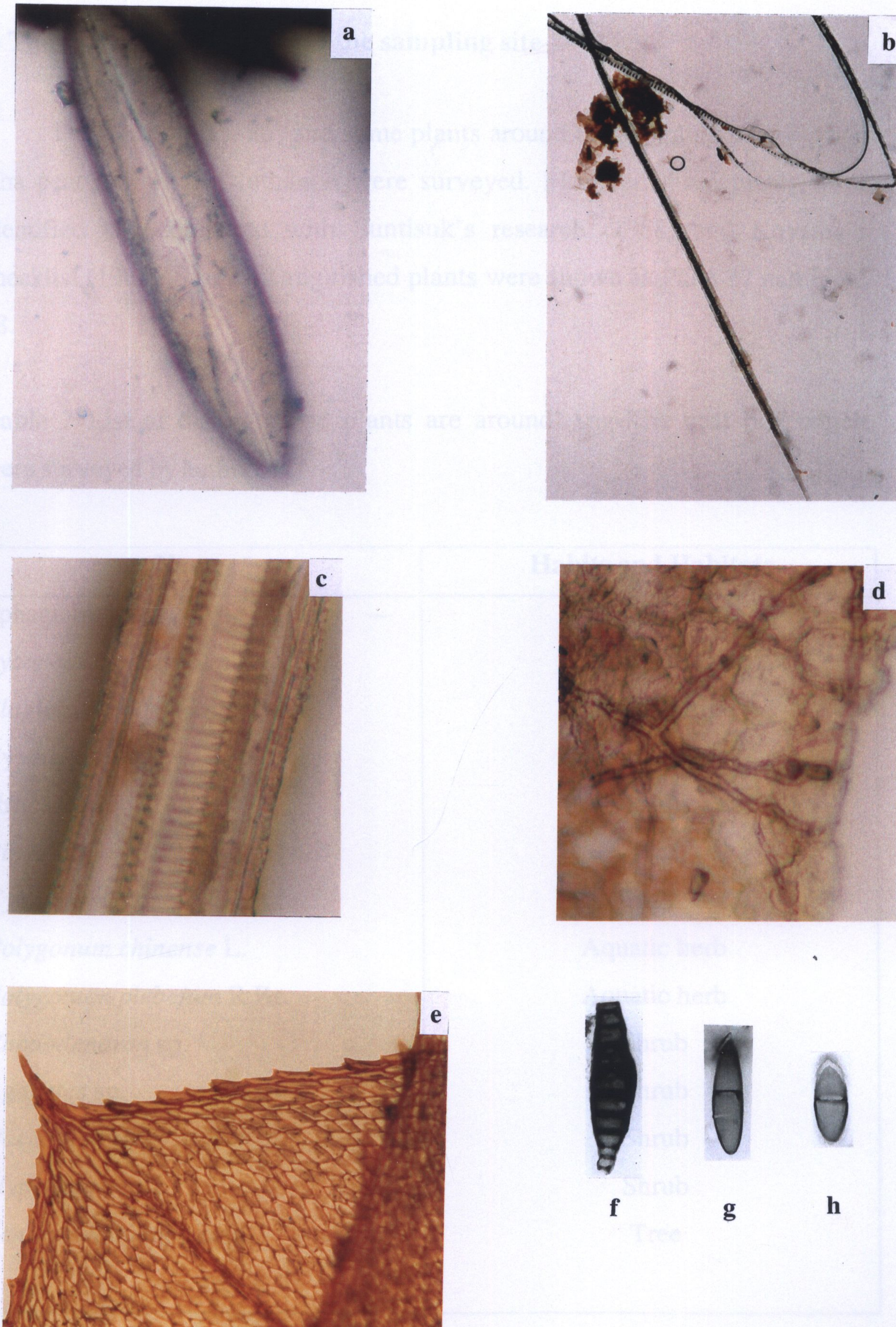
b, *Lyngbya* sp., a fresh water algae.

c, Plant tissue remain of flowering plant.

d, Leaf remain of flowering plant.

e, Leaf-like organ remain of moss.

f-h, Fungal remains, spores.


a
b
c
d
e
f
g
h

4) The present plants around the sampling site.

The location (Pl. 26) and some plants around the sampling site of Ang-Kha peat bog of Doi Inthanon were surveyed. Morover, these plants were identified and compared with Suntisuk's research (1988) and Koyama's checklist (1986). Some distinguished plants were shown as Plate 27 and Plate 28.

Table 2 List of distinguished plants are around Ang-Kha peat bog which were surveyed by author.

Names	Habits and Habitats
Sphagnum moss	Terrestial
Lycopodium clavatum L.	Herb, terrestial
Plagiogyria communis Ching	Herb, terrestial
Cyperaceae	Aquatic herb
Urticaceae	Herb
Pinus sp.	Tree
Cynoglossum sp.	Herb
Polygonum chinense L.	Aquatic herb
Polygonum plebejum R.Br.	Aquatic herb
Rhododendron sp.	Shrub
Agapetes sp.	Shrub
Vaccinium sp.	Shrub
Hypericum sp.	Shrub
Schima wallichii Korth.	Tree

Plate 26

Location around the sampling site.

a, The central part of sampling peat bog.

b, Sphagnum mosses under the shade of *Rhododendron* sp.

c, Sphagnum mosses and Cyperaceae.

d, Epiphytes on the tree trunk.

e, Trees around the sampling site.


a
b
c
d
e

Plate 27

Plants around the sampling site.

a, Sphagnum mosses.

b, *Pinus* sp.

c, Cyperaceae.

d, *Cynoglossum* sp.

e, Urticaceae.

f, *Lycopodium clavatum* L.


a
b
c
d
e
f

Plate 28

Plants around the sampling site (continued).

a, *Polygonum chinense* L.

b, *Polygonum plebejum* R.Br.

c, *Rhododendron* sp.

d, *Hypericum* sp.

e, *Agapetes* sp.

f, *Vaccinium* sp.

g, *Schima wallichii* Korth.


a
b
c
d
e
f
g

5) Pollen diagrams and interpretations

The results of palynological investigations of the intramontane peat bog core were presented in the form of pollen diagrams. Figure 5 shows the percentage of grains of lowland, temperate, upper montane rain forest, pteridophytes and unidentified plants found. The pollen zones could be determined in six zones, based mainly on the increasing and/or declining of grains in the deposits. These pollen zones made it posible to reconstruct the past environment and plant community of the sampling area.

Figure 6 shows the pollen grains and spores in summation. The summation of deposited grains shows that pollen grains were found sparsely in the deepest layers but densely on the top layers. In contrast, spores were found abundantly in the deepest layers but scantily on the top layers.

Figure 7 shows three major groups of pollen grains and spores of pteridophytes, gymnosperms and angiosperms. There are high fluctuations of gymnosperm diagram.

Figure 8 and Figure 9 present the division of pollen summary into six zones as Figure 1. Figure 8 shows the pollen summation of three groups of trees, small trees and shrubs, and herbs. Trees are defined as woody plants of more than 7 metres in height. The small trees and shrubs are definned as woody plants of 7 metres or shorter height. Herbs are characterised as non-woody plants of annual or biennial existence. Figure 9 shows the summary of pollen grains of plants in lowland, temperate and upper montane rain forest areas. *Polygonum chinense* L., *Polygonum plebejum* R.Br., Graminae, *Rubus*, Cyperaceae and Araceae indicate the characteristics of the composite vegetations of lowland. While *Betula, Engerthadia, Rhododendron,* *Vaccinium, Agapetes, Pinus, Magnolia* and Rosaceae are typical temperate plants. By definition, Myrtaceae, Rubiaceae, *Quercus, Schima wallichii* Korth. and Leguminosae are distinguished as upper montane rain forest plants.

Figure 10 shows all spores of pteridophytes in percentage which included *Plagiogyria communis* Ching, *Selaginella, Polypodium, Asplenium* and *Crypsinus,* were reported as being dominant in deposits of Ang-Kha peat bog at peak of Doi Inthanon, Chiang Mai Province, by Poungtaptim and Pyramarn (1998). All spores of these pteridophytes are dominant in the bottom layer of this core.

Figure 11 shows percentages of all pollen grains and pteridophyte spores found in peat deposits of 1A core, which can be divided into six climatic zones. Zone I (1-16 cm depth) contains the dominant pollen grains of *Polygonum chinense* Linn., *Polygonum plebejum* R. Br., *Schima wallichii* Korth., Myrtaceae, *Rhododendron, Vaccinium, Agapetes, Quercus,* Rubiaceae as well as Araceae. Zone II (16-25 cm depth) shows the increasing of grains of *Betula, Rhododendron, Agapetes, Quercus*, grass and unidentified grains. Zone III (25-100 cm depth) is rich in pollen grains of *P. chinense* Linn., *P. plebejum* R. Br. , *Betula*, Myrtaceae, *Rhododendron, Vaccinium, Agapetes, Schima wallichii* Korth., *Quercus* as well as Rubiaceae. Zone IV (100-111.5 cm depth) shows the dominant grains of *P. chinense* Linn., *P. plebejum* R. Br. , Myrtaceae, *Schima wallichii* Korth., Rubiaceae, Leguminosae, Graminae, Cyperaceae and unidentified pollen grains. Zone V (111.5-113.5 cm depth) shows that *P. chinense* Linn., *P. plebejum* R. Br. , *Schima wallichii* Korth., Myrtaceae, *Rhododendron, Vaccinium, Quercus*, Graminae, Rubiaceae, Leguminosae and Cyperaceae pollen grains are dominant as well as pteridophyte spores are still dominant. Zone VI (131.5-152 cm depth) shows that it contained low concentration of spores and pollen grains which is less than the other zones, but pollen grains of *Schima wallichii* Korth. and *Quercus* are highly quantitative grains of all plants found in this zone.

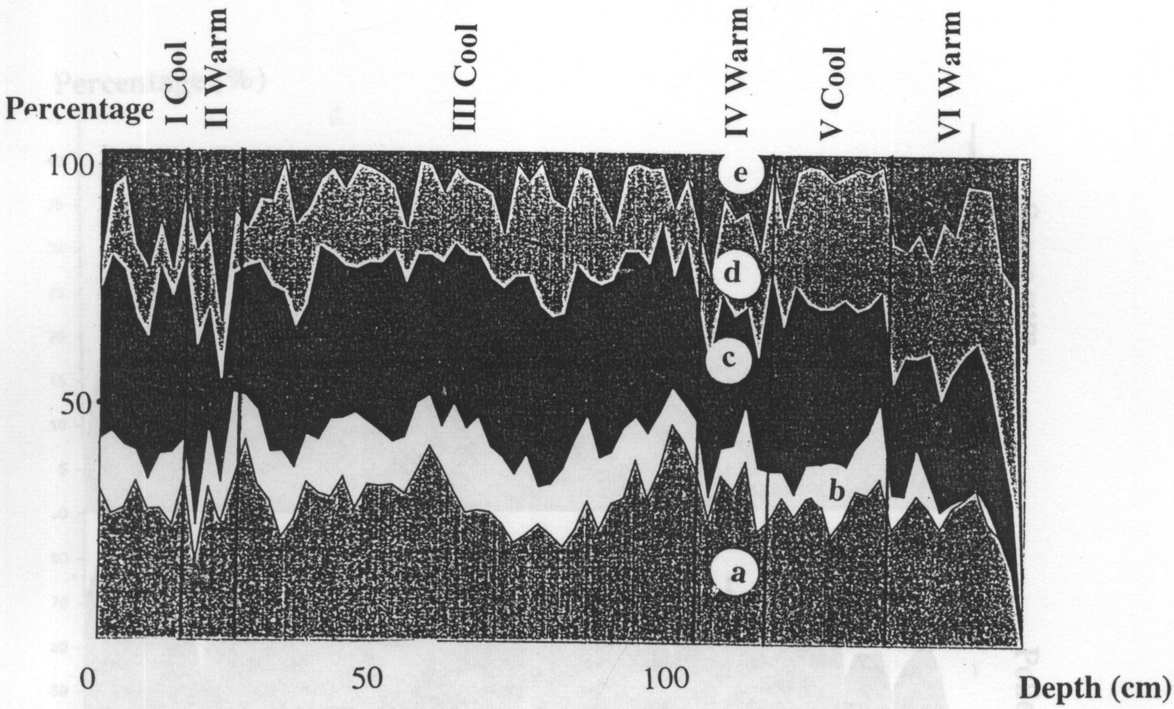


Fig. 5 Diagram of spore and pollen sum. Total summary of grain counting of peat core 1A shown in a percentage diagram. The total diagram is in 100 percent sum. The grains of lowland plants (a), temperate plants (b), upper montane rain forest plants (c), pteridophytes (d) and unidentified plants (e). The pollen diagram is divided into six climatic zones (I-VI) according to the fluctuation of the deposited grains of temperate plants.

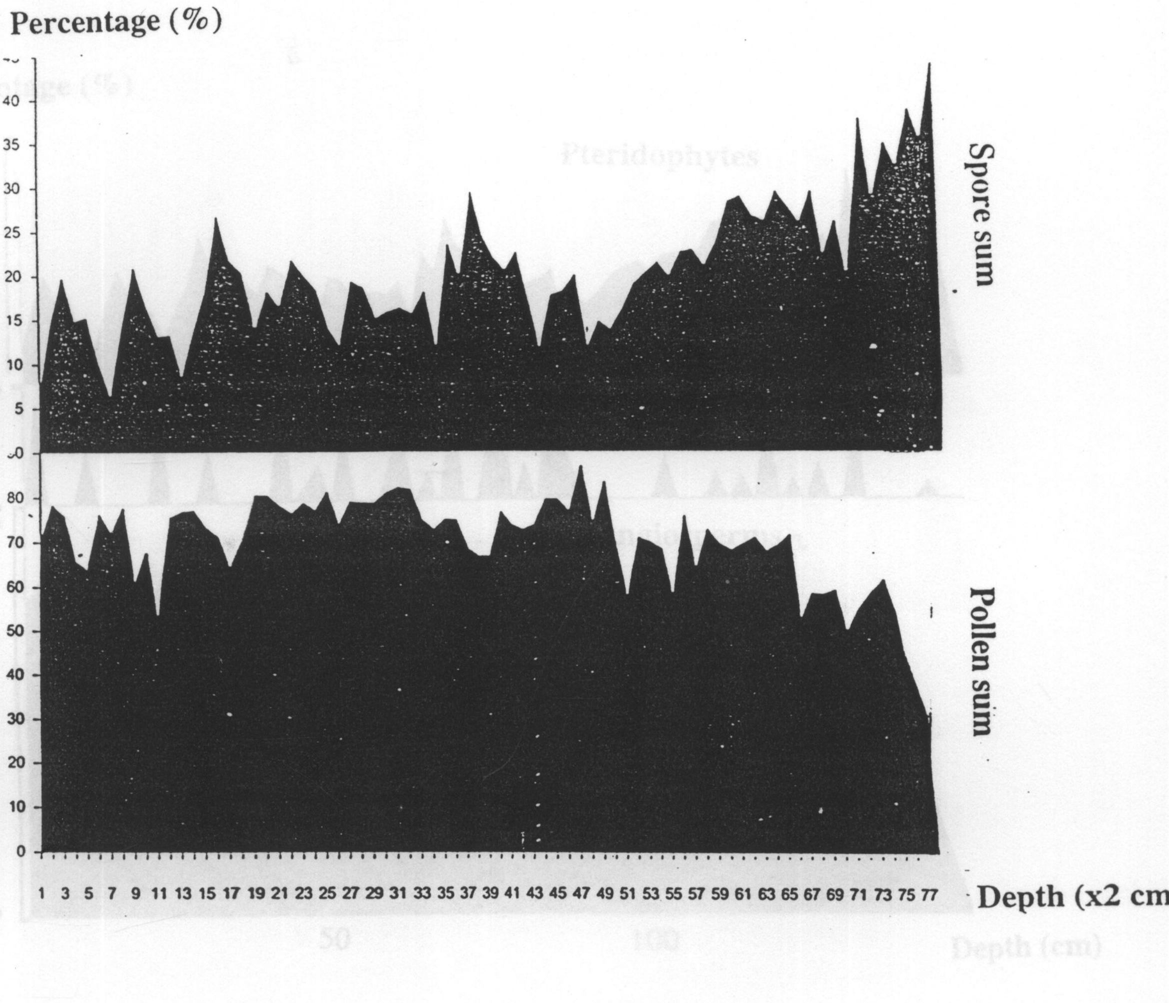


Fig. 6 A total summary of grain counting of peat core-1A shown in a percentage diagram. The upper chart refers to total spore counting. The lower chart refers to total pollen counting.

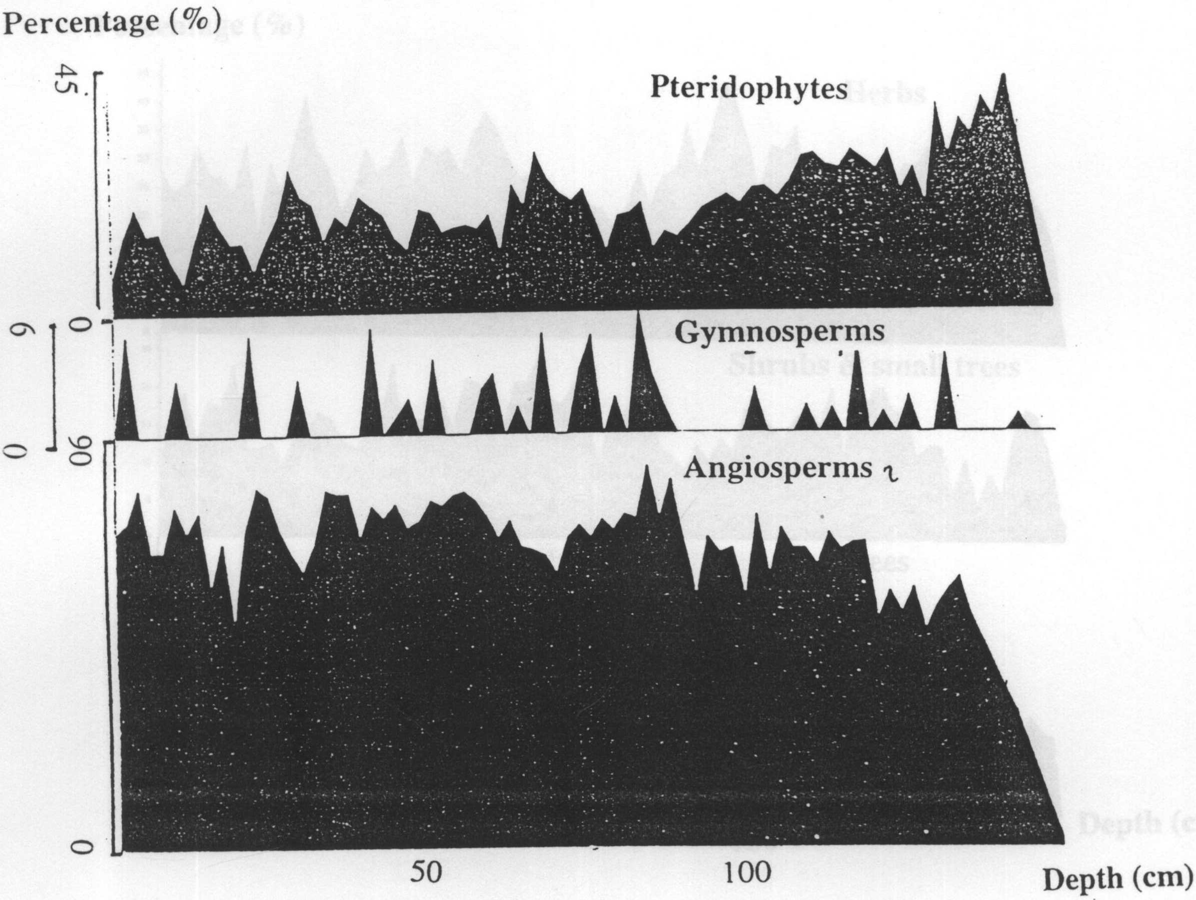


Fig. 7 Total summary of grain counting presented in 3 groups of plants, angiosperms, gymnosperms and pteridophytes, shown in a percentage diagram.

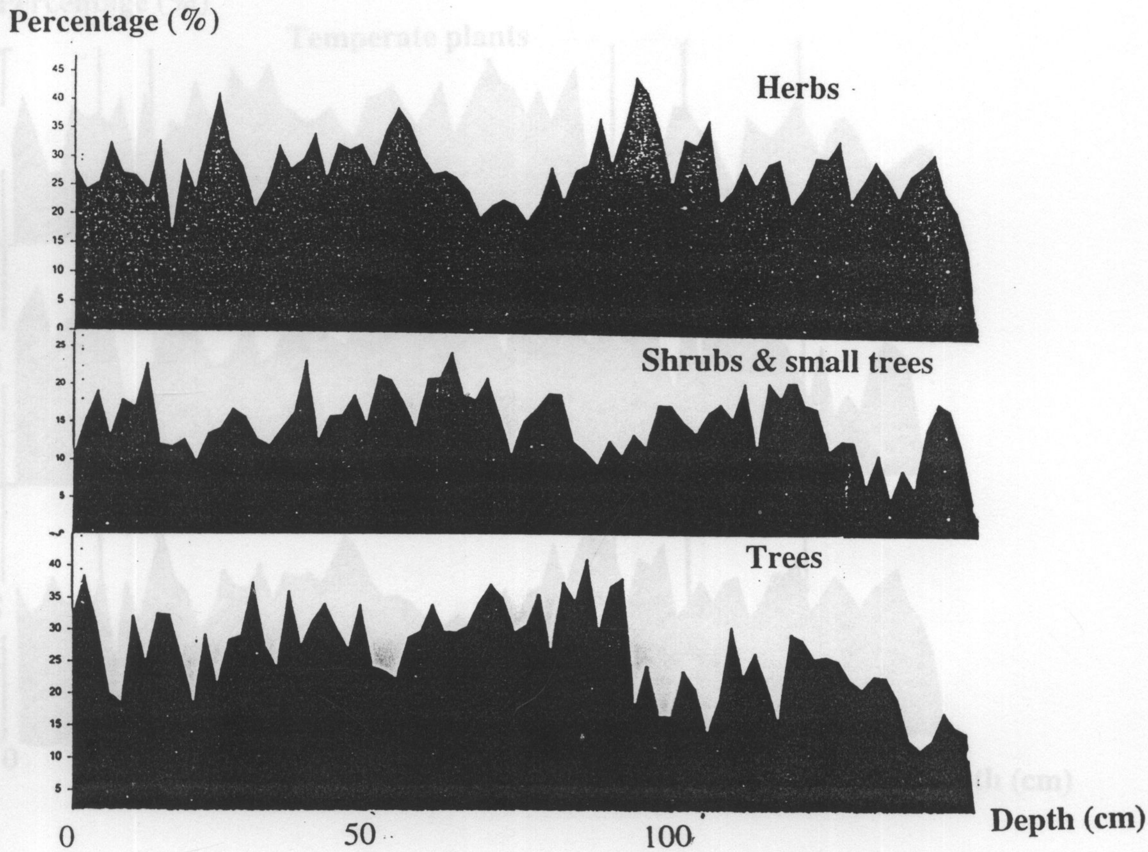


Fig. 8 Total summary of pollen counting classified according to different habits shown in percentage diagram.

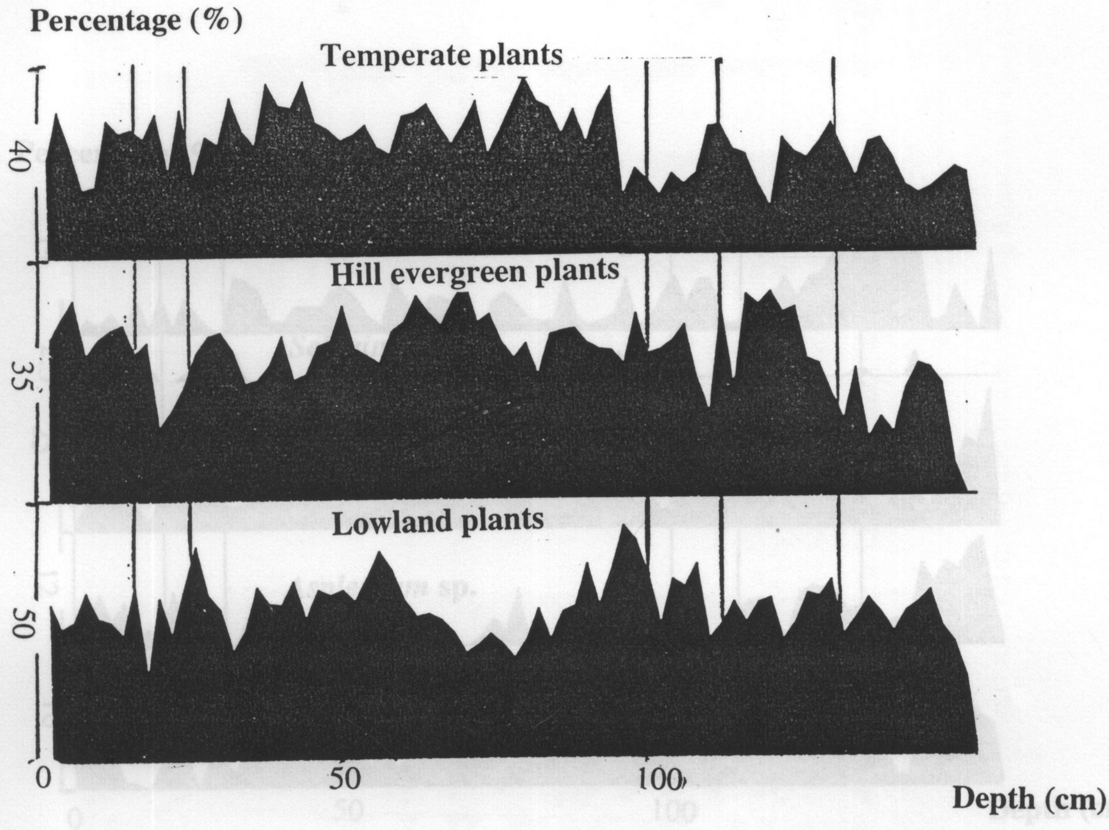


Fig. 9 A percentage diagram of total summary of pollen counting classified by vegetational type into lowland plants, hill evergreen plants and temperate plants.

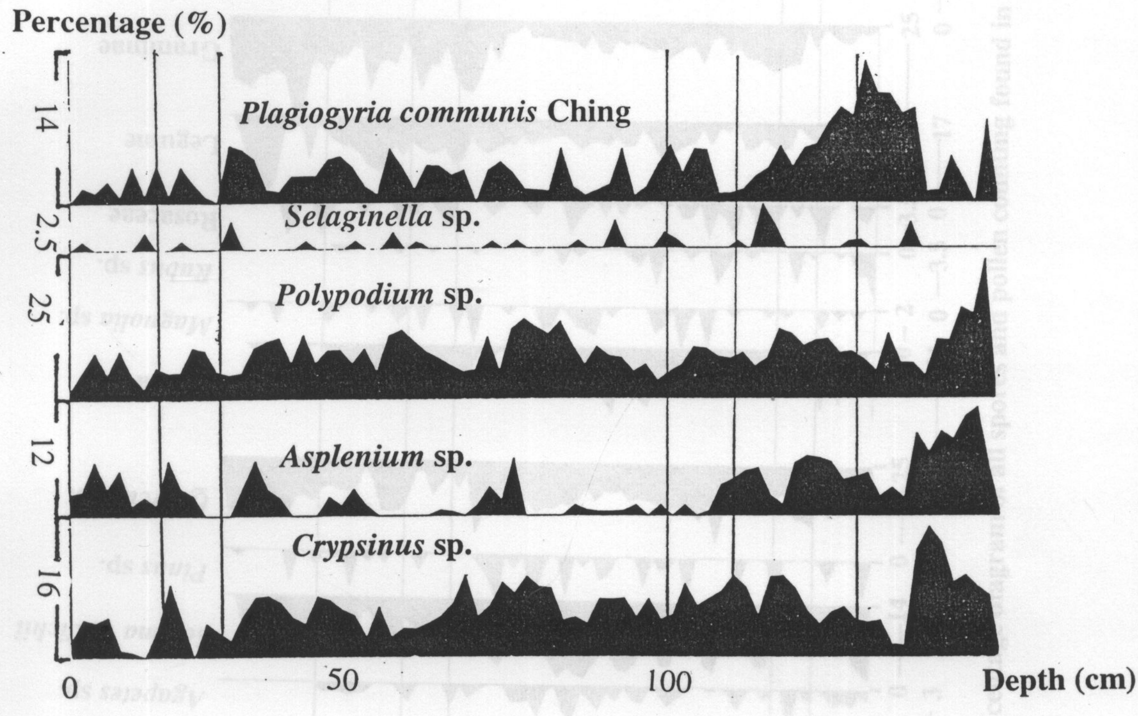


Fig. 10 A percentage diagram of total summary of spore counting classified by distinguishing in between the species of pteridophytes.

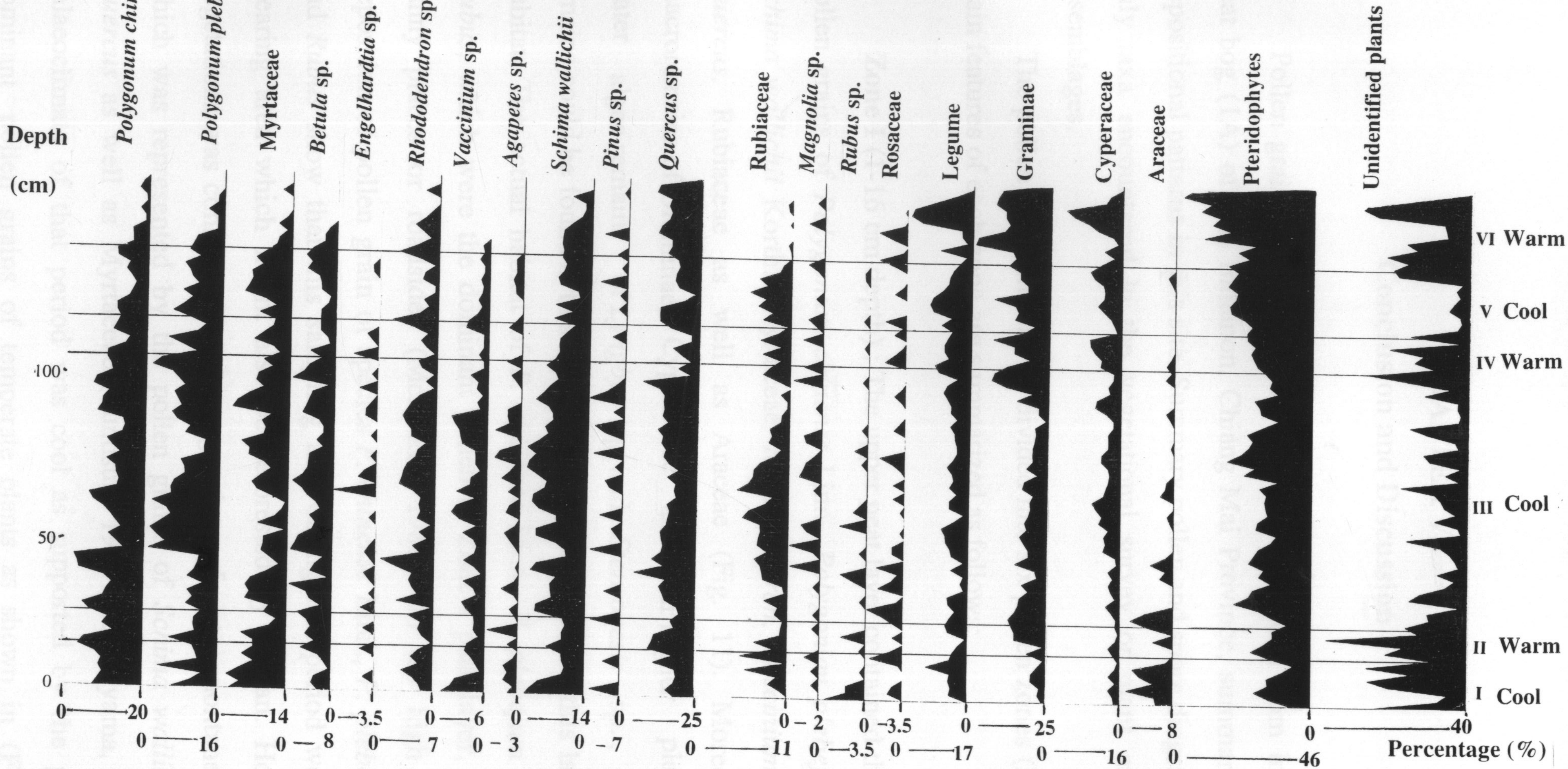


Fig. 11 A percentage diagram of all spores and pollen counting found in the peat core 1A

CHAPTER V

Conclusion and Discussion

Pollen grains, spores and other remains recorded from intramontane peat bog (1A) of Doi Inthanon, Chiang Mai Province, summarize modern depositional patterns in this site. Summary pollen and spore diagrams include only taxa encountered in the vegetational survey or plant macroremain assemblages.

The pollen diagrams can be divided into six pollen zones (Fig. 5). The main features of each zone are summarized as follows:

Zone I (1-16 cm depth) : The upper peat layer contained the dominant pollen grains of *Polygonum chinense* Linn., *Polygonum plebejum* R. Br., *Schima wallichii* Korth., Myrtaceae, *Rhododendron, Vaccinium, Agapetes, Quercus,* Rubiaceae as well as Araceae (Fig. 11). Moreover, plant macroremains of Graminae, Cyperaceae and other higher plants, fresh water algae remains of *Lyngbya* sp. and *Stenronesis* sp., and fungal remains could be found in this layer. This evidence proved this layer a damp habitat. The actual habitat of *P. chinense* Linn., *P. plebejum* R. Br. and *Rubus*, which were the dominant pollen of Zone I peat layer, are opened sunny places or roadsides (McMakin, 1988). So the high percentage deposition of pollen grain of species *P. chinense* Linn., *P. plebejum* R. Br. and *Rubus* show that this sampling area during that period would be the clearing area which might also be deforested by human. However, the vegetations was conformed to the vegetations of upper montane rain forest which was represented by the pollen grains of *Schima wallichii* Korth., *Quercus* as well as Myrtaceae (Suntisuk, 1988 and Koyama, 1986). The palaeoclimate of that period was cool as supported by the presence of dominant pollen grains of temperate plants as shown in (Fig. 5). The humidity of the area might have been high according to the existance of Araceae and Polygonum grains. The occurence of algae and fungal remains as well as Araceae pollen grains indicated the wetland. However, as the small amount of grass land pollen in the deposition was seen, it could be assumed that the upper most sediment was the discontinuous opened grass land which might be due to human activities. And the density of unidentified pollen grains and upper montane rain forest as in Figure 5 represented high potential of plant species diversity in that period.

Zone II (16-25 cm depth) : This zone shows the increase of *Betula, Rhododendron, Agapetes, Quercus*, grass and unidentified grains as in Figure 11. It is assumed that the palaeoclimate of the Zone II would be warmer than that of Zone I because the sediments consisted of Graminae, *P. chinense* Linn., *P. plebejum* R. Br. and legume, the dominant lowland plants. The vegetation of this period was still the upper montane rain forest as indicated by dominant pollen grains of *Schima wallichii* Korth. and *Quercus*. However, the deforestation could have expanded as shown by the dominant grains of Graminae, Legumenosae, *P. chinense* Linn.. *P. plebejum* R. Br. The decline of temperate plant pollen grains and increase of unidentified pollen grains (Fig. 5) was the evidence that the weather could also be warm. Nevertheless, the area was still damp according to the alga and fungal remains as well as macroremains of grass and Cyperaceae found in the deposits.

Zone III (25-100 cm depth) : This zone is rich in pollen grains of *P. chinense* Linn., *P. plebejum* R. Br. , *Betula*, Myrtaceae, *Rhododendron, Vaccinium, Agapetes, Schima wallichii* Korth., *Quercus* as well as Rubiaceae (Fig. 11) as a moderate percentage of *Stauronesis* sp., and Graminae and Cyperaceae remains were found in this layer.

Compared to all pollen zones, the highly significant amount of pollen grains of both temperate and upper montane rain forest plants of Zone III were significantly increasing. This can be interpreted that this zone would have been the upper montane rain forest which was cooler than Zone II (Fig. 5). The alga remains shows that this area was still wetland habitat.

Zone IV (100-111.5 cm depth) : *P. chinense* Linn., *P. plebejum* R. Br. , Myrtaceae, *Schima wallichii* Korth., Rubiaceae, Legumenosae, Graminae, Cyperaceae and unidentified pollen grains were high. The other macroremains were disappeared but the only alga remain, *Stauronesis* sp., was still found in this zone. The existence of abundant pollen grains of upper montane rain forest plants such as Myrtaceae, Rubiaceae and *Schima wallichii* Korth. (Fig. 11) reveal the vegetation of upper montane rain forest. Moreover, an increase in pollen grains of lowland and unidentified plants (Fig. 5) show that this area was warm, but it was stll moist wetland as supported by an increase in *P. chinense* Linn., *P. plebejum* R. Br., Graminae as well as Cyperaceae.

Zone V (111.5-113.5 cm depth) : The characteristic of pollen diagram of this zone is conformed to that found in Zone III. *P. chinense* Linn., *P. plebejum* R. Br. , *Schima wallichii* Korth., Myrtaceae, *Rhododendrn, Vaccinium, Quercus*, Graminae, Rubiaceae, Leguminosae and Cyperaceae pollen grains are dominant as well as pteridophyte spores (Fig. 11). The dominant presentation of upper montane rain forest pollen grains of Myrtaceae, Rubiaceae, *Quercus* and *Schima wallichii* Korth., in addition to pollen grains of temperate plants such as *Rhododendron, Vaccinium* and *Betula* show that the weather could also be cool. This assumption is supported by a decline in unidentified grains as well. Naturally, the plant diversity in temperate zone is limited by low temperature while the warn weather is not a limited factor of plant diversity in tropics.

Zone VI (131.5-152 cm depth) : This zone is of low concentration of pollen grains and spores. The spores were higher than pollen grains (Fig. 6). The feature of grain sedimentation was still upper montane rain forest because of the dominant pollen grains of *Schima wallichii* Korth. as well as *Quercus* (Fig. 11). Generally, the palaeoclimate of this period was warm and humid which was confirmed by rich pollen grains of lowland and unidentified plants. It was, however, a moist wetland as seen from the existence of alga (*Stauronesis* sp.) and pollen grains of Graminae and Cyperaceae. In the deposit layer than Zone VI beyond 152 cm depth, no pollen grains nor spores were found.

Based on spores and pollen grains in the counting diagram (Fig. 11), the existing pine pollen grains show high fluctuation. The discontinuous appearance of pine pollen grains in the core samples could be confined to airborne pollen from the neighberhood forests of the lower altitude. Actually, the pine pollen grains, the succate grains with aerolate wings, could have been carried to a very long distance away from their mother plants (Faegri, Iversen and Waterbolk, 1964)). Furthermore, the pine forests in the northern part of Thailand are confined to high land of altitude, about 700-1500 metres above sea level (Hasting and Leangsakul, 1984). In contrast, the pollen grains of *Betula*, *Quercus* and *Schima wallichii* Korth. which are recently dominant in upper montane rain forest (Yu, McAndrews and Siddigi, 1996) were dominant in every layer of this deposits. These conspicuously indicate that this area has been a typical upper montane rain forest since the past (about 4,300 B.P.) and confirm Wanthanachisaeng's research (1997) as well. But, this study can not confirm to the Hasting and Liengsakul's conclusion

(1984). They reported that this area in the past was a pine forest but is changed to upper montane rain forest in the present time.

Notwithstanding, *P. chinense* Linn., *P. plebejum* R. Br. which distribute around the bog are dominant pollen grains and are of the highest percentage of all found at the top layer of sediments. So it can also be assumed that this damp area was deforested by human. Fluctuations of Rosaceae, *Engerthadia, Agapetes, Vaccinium* and *Rhododendron* show that Holocene period in northern part of Thailand was an unstable climate. The unstable climate (Hasting and Leingsakul, 1984) could be seen from the disappearance and/or little pollen grains of temperate plants in certain subsampling core. This evidence support the mid-Holocene hypothesis as proposed by Liu (1990) and Webb (1993) as well as the early Holocene and early mid-Holocene hypothesis as proposed by Baker et al. (1992) and Yu (1995). Moreover, Doi Inthanon, the highest peak in Thailand, is a part of the Taunaosri mountain range which is uplifted as a part of Himalayan range (Sharma, 1977). Therefore, the *Plagiogyria communis* Ching which is common in the forest of Himalayas is a species of fern found only in this area of Thailand (Poungtaptim and Pyramarn, 1998). Thus, the discovery of this *P. communis* Ching to be exclusive only to the Ang-Kha peaks in Thailand has confirmed the theory that Doi Inthanon and the rest of Taunaosri mountain range are the part of the Himalayan range.

In the past, this area should also have been a wetland and be covered by trees of upper montane rain forest. The upper montane rain forest has never been wipped out nor replaced. Occurence of polygonum and grass pollen grains in all zones indicate the influence of human deforestation and farming.

However, the diversity of plants should also be reduced by human activities (Hasting and Leingsakul, 1984) for lodging and farming.

Recommendation

Certainly, there are many factors of the limitation in palynological study of peat bog of Doi Inthanon, Chiang Mai Province. These limited factors which are mainly difficult in determination are also accepted as follows :

1 The dispersal mechanism of pollen influences its deposition in the sampling area. Dry pollen grains and the wind-pollinated pollen grains are always better dispersed because of small size of the particle, and the greater number of pollinating units (Faegri, Iversen and Waterbolk, 1964). Moreover, the great majority of tropical species are not wind pollination but the insect-pollination, so that pollen production might be rather low (Faegri, 1966).

2 Geographical locations, aspects and local topography in relation to prevailing wind (Moore, Webb and Collinson, 1991) were also accepted.

3 Vegetational diversity of upper montane rain forest and the comformity of tropical pollen grains might lead to misdetermination of pollen and spore types (Jarupongsakul, 1987). We should be aware of this. The pollen grains and spores of plants around the bog as well as those of lower profile zone would also be studied in the details for supporting data.

4 Peat deposition and redeposition are the great factors which would be used to interpret the results (Moore, Webb and Collinson, 1991).

5 Water flow is a main factor of peat-forming ecosystem (Moore and Webb, 1978), so this factor would also be studied in details. The research on underwater flowing system should be conducted.

The criticised factors are the limited factors in palynological study in Thailand. So the author has confidently realized that all factors are very important part of determination. Unfortunately, the three years of scholar period were so short to solve all problems.

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Appendix

The table shows spores and pollen grains of plants from peat sediments in percentage ;

a : *Polygonum chinense* L.

b : *Polygonum plebejum* R.Br.

c : *Betula* sp.

d : *Engelhardtia* sp.

e : Myrtaceae

f : *Rhododendron* sp.

g : *Vaccinium* sp.

h : *Agapetes* sp.

i : *Schima wallichii* Korth.

j : *Pinus* sp.

k : Graminae

l : *Quercus* sp.

m : Rubiaceae

n : *Magnolia* sp.

o : *Rubus* sp.

p : Rosaceae

q : Legume

r : Cyperaceae

s : Araceae

t : *Plagiogyria communis* Ching

u : *Selaginella* sp.

v : *Polypodium* sp.

w : *Crypsinus* sp.

x : *Asplenium* sp.

y : Unidentified grains

Depth (cm)	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
1	12.5	10	2.5	0	11	1.5	5	1	12	0	1.5	6.5	0	0	3	0	0	1.5	2.5	0	0	2	2	2.5	
3	11.26	5.63	3.75	0	8.92	1.87	3.75	0.46	10.79	5.55	2.8	9.38	1.87	0	1.4	1.4	4.69	1.87	2.81	1.4	0.46	5.16	4.69	2.81	7
5	10.1	3.22	3.22	0.92	11.47	2.76	3.22	1.38	9.18	0	2.3	6.88	3.67	0.46	1.38	1	4.26	3.12	6.88	0.96	0	8.25	4.35	6.12	
7	11	12.3	0.45	0	9.02	4.21	0.5	1	4.56	0	4.98	6	2.56	0	0	0	4.9	1.2	3.01	2	0	4.78	5	3.1	19
9	10.3	4.1	1.38	0	6.21	2	1	1.38	4	0	4.87	6.53	5.13	3.48	0.38	0	4.56	3.01	5	0.56	0	8.53	1	5.12	21
11	12	4.56	2.5	0	8.45	3.01	1.5	0.46	4.56	3.12	3	13.44	0.87	0	0	0.5	10.75	1.3	5.98	3.36	0	4.65	0.65	1.25	14
13	16.2	5.3	5.78	1.15	6.32	2	2.21	0	4.71	0	1.2	7.3	6.78	2.89	0	3	4.65	0.57	1.1	0.64	0.87	2.46	0	2.12	22.
15	14.76	10.1	3.26	0	6.36	0.25	1.96	1	7.65	0	6.15	15.23	3.33	0	0.46	1.2	3.89	1.87	0	3.45	0	5.87	3.56	1.25	8
17	7.6	4.78	5	0	8.63	1.5	0.78	0	4.63	0	1.2	14.03	5.21	1.75	0	0	2.5	3.12	0	0.64	0	4.98	8.98	6.23	18.
19	10.2	5.12	4	0.92	3.31	2.1	1.3	3	4.68	0	10.02	13.33	2	0	1.78	1	0.5	1.2	3	3.36	0.46	5.13	4.5	3.12	15.
21	8.9	4.97	4.78	0	1.96	1.76	1.2	0	4	0	10	7	1.34	0.46	0	0	5.12	0.46	0	1.87	0	9.03	0	2.31	34.
23	13.5	3.45	6.58	0	4.31	3.45	1.3	0.36	4.56	5.55	11	8.12	0.56	0.87	0	1.01	5.87	1.28	3.76	0.56	0	8.56	4.13	0	11.
25	15.3	6.7	2.21	1.15	3.36	0.25	2.1	0.87	10	0	11.89	5.36	2.61	0.42	0	2	4.78	1.06	6.31	0	0	5.23	3.12	0	15.
27	10.2	5.32	4.3	0	8.01	5.01	2.6	0	9.87	0	9.98	6.23	2.43	0	0	3.33	3.33	2.34	4.13	5.37	1.4	4.62	2.13	0	9
29	9.4	6.45	5	0.5	7.21	2.3	1	0.46	6.78	0	8.96	10.12	3.34	1.75	0.46	0.75	5.12	3.84	0	5	0	5	5.21	3.2	8.
31	8.1	3.21	8.21	0	8	3.01	1.38	1.68	7	3.12	8.58	11.01	1.2	0	0	0	5.4	1.35	0	4.13	0	9	7.4	6.21	2.
33	10.1	6.45	0.78	0.5	7	3.45	2.45	0.46	7.12	0	6	12.03	1.13	0.43	0	2.34	1.1	2.46	0	1.23	0	10	7.56	3	14.
35	16.3	5	4.21	0.92	3.86	3.01	0.5	0	5.96	0	7.89	10	3.33	2.07	0.98	1.2	2	3.12	0	1.02	0	10.56	6.73	2	9.
37	16.7	4.32	3.36	0	1.56	5.25	1.25	0.36	11	0	3.33	20	5.64	0	1.87	0.64	1.2	2	2	2.46	0	6.54	4.87	0	5.
39	17.5	4.01	1.78	0.45	3.21	7.2	2.45	0	9.87	0	4	10.78	4.13	1.84	0	2.5	4.45	3.21	1.2	2.5	0.46	11.02	4.12	0	3.
41	5.4	14.5	8	0.87	5	2	1.3	0	4	0	10.02	14.38	5	2.05	0	0	1.23	1	3.41	2.5	0	6.56	7.42	0	5.
43	7.12	11.14	7.21	0.5	4.63	2.98	1.03	0.46	4.26	5.89	5.95	11.52	4.23	0.46	0.53	1.12	4.38	1.31	1.2	4.05	0	8.54	7	2.1	2.
45	9	12.86	6.58	0	4.56	1.02	1.4	0.97	6.1	0	6.13	10.98	4.67	1.87	0	1.12	4.87	4.65	0	4.36	0	8.6	5.84	1.2	3.
47	6	14.25	4	0	0.45	2.1	2.56	1.45	9.98	1	7.45	11.56	6.36	0	0	0	6	4	0	3.31	0.46	6.45	5.12	3	4
49	7.4	12.03	3.38	0	5.68	0.56	1.12	0.45	10	2	8.69	11.85	4.13	1.84	0	0.46	6.21	4.46	0	1.5	0	8.75	2.5	1.2	5.
51	8.75	10	4.45	0.56	2.5	2.4	3	0	5.98	0	6.53	10.02	4.89	1.2	1.98	0	7.12	3.26	0	0.73	0	5.12	6.12	0	15.
53	10.4	11	2.5	0	1.15	1.98	3.87	1.32	6.1	4.16	7.23	9.53	9.46	0	0	0	3.89	5.78	0.56	5	0.84	10.89	2.5	0	1.
55	12.98	13.84	3.33	0	0.45	2.21	3.33	1	9.54	0	6.13	9	8.23	0	1	0.46	1.32	5	1	3.33	0	11.75	3.52	0	2.
57	14	10	5	0	3	1.96	1.3	0	10.87	0	5.56	9.86	3	2.08	0.5	0	5.13	6.5	0	1.23	0.46	9.96	3.45	0	6.
59	7.2	10.12	6.03	3.33	6	3	3.33	1.12	10.68	0	5.78	7	3.68	0	0	1.1	5.12	7.59	0	3.46	0	8.23	4.13	0	3
61	6.7	9.39	7.8	0	6.98	4.87	1.9	0.38	8.46	2.5	4.78	7.65	6.12	4.45	0	0	3.21	4.65	2	3.41	0	7.21	5	0.64	1
63	7.41	7.21	5.86	1.45	5.3	4.56	1.8	1.78	8.03	3.33	8.02	7.21	4.12	4.23	0	1.1	5.12	4.02	1.3	2.56	0	6	6.6	0.46	2.
65	7.6	7.36	5	0.96	3.36	4.32	0.78	1	10	0	7.45	9.86	6.12	1.35	0	0	4.1	3.33	1.1	3	0	5	10	0	8.
67	9.8	8.1	4.86	0	4.68	3.87	1.3	0.46	12	1.5	3.56	6.32	6.23	1.12	0	0.45	4.56	2.98	0	0	0	5.32	5	1.2	16.
69	6.54	3.32	4.68	0.5	7.65	2.78	1.3	2.5	11.56	0	6.84	9.45	5.21	0.95	0.46	1.2	5.89	3.35	0	3	0.43	10.53	6.28	3.2	2.
71	8.4	3.34	2.1	0	7.52	2.5	1.37	2	10.23	5.55	5	11.24	2.91	0.43	0	2.34	4.32	5.25	0	3.78	0	5.12	9.12	1.8	5.
73	9.8	3.01	3.34	0	9.1	1.4	2.78	0	12	0	5.12	10.53	2.13	0	0.98	0	3.26	5.13	0	2.75	0.46	11.89	7.86	6.4	2.
75	6.1	7.25	2.1	0.5	4.89	3.36	3	0.38	9.68	0	5	12	3.56	0.96	0	0	3.32	3.35	0.46	1.2	0	13.44	9.87	0	9.

Depth (cm)	a	b	c	D	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y
77	5.47	6.23	2.09	0	4.46	3.39	3.15	2.45	7.94	3.61	4.46	11.54	3.33	0.58	0	0	3.87	3.33	0	1.12	0	12.12	8.67	0	12.19
79	5.98	8.97	3.02	0	5.21	4.13	3.64	1.12	8.59	5.43	4.12	13.24	3.93	0.46	0.46	1.12	4	3.4	0	1.03	0	11.06	8.46	0	2.63
81	12.3	10.08	6.1	0.96	3.38	4.56	4	1.3	7	0	4.4	10	2.24	0	0	0.56	5.12	2	0	5	0	12.98	4.56	0	3.46
83	11.2	8.12	5.45	0.92	11.02	3.98	0.87	1.29	7.12	2	1.2	11.79	2.06	0	0	0	3.33	2	0.54	1.4	0.46	9.21	4.87	1.2	9.97
85	11	8.89	4.89	0.45	10.04	3.38	1.21	0	8	0	3.33	11.26	0.57	0.46	0	0	5.01	3.84	1.23	0.61	0	6.13	4.12	0.64	14.94
87	9.5	9.65	4.33	0	7.89	2.31	0.6	0	10.46	6.66	3.33	11.58	1.02	0	0	0.46	4.98	6.89	0	1.09	0	8.98	7.12	0.46	2.69
89	13.4	7.45	1.15	1.45	5	0.35	1.3	0	9	3.36	9.98	11.36	2.31	0	0	1.12	5.98	6.45	0	1.65	1.42	7.56	7.12	0.46	2.13
91	12.6	8.78	8.12	0	6.47	1.5	1.12	0.46	7.78	1.5	5.23	13.02	0	0	0	0.46	7.1	2.95	0	4.96	0	7.23	7.21	0.56	2.95
93	8.7	10.12	5.98	0.5	6.01	0.4	1.98	1	6.13	0	13.46	18.21	1.13	1.75	0.46	0	6.13	3.42	0	0.58	0	5.03	4.95	1.2	2.86
95	9.1	14.2	4.96	0	3.33	2.1	0.54	0	6.75	0	17.83	2.96	5.84	0	0	0	3.33	2.12	1.36	1.4	0	6.12	7.12	0	10.94
97	10.13	12.3	2.56	0	5.03	2.56	0.58	1.42	8.56	0	17	7.02	2.25	2.13	0	0	8.45	1.98	0.46	3.56	0.87	3.56	4.65	1.2	3.73
99	9.98	5.1	4.86	1.96	2	0.36	1.12	0	6.82	0	13.24	3.02	2.43	0	0	2	9.46	5.64	1.24	5.31	0.53	5	5.23	0	14.7
101	5.8	7.98	1.15	0	3.36	1.5	0.61	0	6	0	6.21	6.13	4.78	1.21	0	1.18	5.86	5.31	0.53	2.75	0	6.1	8.96	1.2	23.38
103	4.69	11.03	1.56	0.5	7	2.3	0.62	0	6.13	0	11.02	8.91	2.36	0	0.38	0.46	7.01	7.12	0	4.98	0	8.98	6.32	0	8.63
105	8.78	4.98	2.96	0.92	5.21	1.35	0.6	0	5.96	2.5	11	3.02	1.23	5.22	0	0	7.11	8.21	0	4.86	0	8.76	7.21	0.56	9.56
107	7.89	3.34	3.02	0	3.36	3.33	2.58	1.32	4.56	0	17.48	3	2.98	0	0	1.2	6.13	8.45	0	0.8	0	7.46	8.12	3.5	11.48
109	7.01	6.5	3.02	0	3	6.1	2.35	0.61	3	0	8.25	9.79	0.69	0.46	0	0.46	5.03	1.28	0	0.83	0.46	7.12	10	4.2	19.84
111	7.96	10.21	2.96	0	6.02	2.56	1.36	0	7.25	0	5	13.33	5.12	0.94	0.46	2	7.86	2	0	1.2	0	8.03	8.56	5.1	2.08
113	8	7.98	1.56	0	2.87	1.3	0.87	0	3.54	1.5	11	13.45	4.12	0	0	0	5.23	2.9	0	2.45	2.21	5.86	5.12	5.4	14.64
115	5.1	6.23	1.15	0	5	2	1.3	0	7	0	10	13.33	6.98	0	0	0	10.13	4.73	0	3.21	1.23	7.15	9.87	2.3	3.29
117	4.16	8.18	2.96	0	9	0.5	0.87	0.71	2.21	1.33	11.02	5.55	5	0.48	0	0	11.02	6.47	0	5.23	0	11.8	10	1.3	2.21
119	3.35	4.96	3.03	0	8.12	0.45	0.76	0.75	2.61	0	17.45	2.15	8.56	0	0	1.21	10.21	4.86	0	3.34	0	11.09	8.46	6.01	2.63
121	4.52	6.32	3.45	0	7.46	2.24	1.05	0.98	6.13	5.03	7.21	7.48	3.25	1.98	0	0.43	7.74	4.67	0	5.09	0	9.21	5.68	6.78	3.3
123	5.89	6.87	5.69	0.5	7.68	1.89	0.66	0.66	6.59	0	7.24	8.72	5.23	1.54	0.38	0	6.21	5.03	0.53	5.45	0	10.02	4.12	6.58	2.52
125	5.01	7.93	4.85	0.56	5.58	0.5	0.63	0.68	5.48	1.12	9.58	8.36	2.47	0.38	0.41	0	5.87	7.41	1.12	7.45	0	10.26	5.59	6.12	2.64
127	8.01	4.73	5.98	0	6.89	2.5	1.2	0.71	4.98	0	9.67	7.23	1.2	0.98	0	1.18	4.96	8.51	0	8.87	0.46	8.06	6.21	4.13	3.54
129	8.21	7	4.78	0	4.87	5.34	0.7	0	5.87	2	13.12	7.86	0.63	0	0	2.6	3.33	5.62	0	8.12	0.53	8.23	4.65	4.46	2.08
131	4.34	6.2	2.5	0	3	3	0.87	0	5.64	0	11	11.23	0.78	0	0	0.58	1.56	2.15	0	13.26	0	6.95	4.32	4.86	17.76
133	4.41	5.45	2.5	0	2.56	1.13	0	0	5.96	0	12	10	1.32	0	0	0	8.46	4.87	0	10.25	0	5.12	4.56	2.3	19.11
135	4.53	1.41	1.56	0	1.03	2.21	0	0	5.87	4.5	23.36	10.06	0	0	0	1.44	1.4	1.2	0	10.14	0	11.03	1.66	3.2	15.4
137	1.34	1.38	0	0	2.68	3.33	0	0	5.64	0	22.54	14.49	0	0	0	2.68	2.86	2.5	0	8.33	1.38	6.45	1.53	2.12	20.75
139	1.38	1.38	0	0	1.02	2	0	0	4	0	14.66	13.53	0	0.98	0	0.46	3.01	6.66	0	8.79	0	6.31	13.33	9.32	13.17
141	2.72	3.31	0	0	0	1	0	0	2.1	0	13	11.03	0	0	0	0	13.33	9	0	1.03	0	4.36	16.03	7.23	15.86
143	1.03	1.38	0	0	0	0	0	0	1.39	0	14.28	10.23	1.23	0	0	0.38	16.3	13	0	1.12	0	10.12	14.12	9.56	5.86
145	1.21	1.26	0	0	0	0	0	0	1.41	0	14.3	11.21	1.01	0.46	0	0	15.47	15.12	0	4.28	0	10.03	9.31	8.75	6.18
147	3.01	0	0	0	2	2	0	0	4	1	17.39	10.45	0	0	0	0	10	4.65	0	2.17	0	15.21	10.12	11.32	6.68
149	1.96	0	0	0	0	0	0	0	0	0	16.66	15.21	0	0	0	0	4.45	3.33	0	0	0	14.36	8.78	12.34	22.91
151	0	0	0	0	0	0	0	0	0	0	15.33	14.23	0	0	0	0	0	0	0	7.69	0	23.02	7.69	5.63	26.41
153	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Biography

Mr. Ratthapong Poungtaptim was born on August 5, 1973 in Chachoengsao Province. He was graduated from Burapha University with Bachelor Degree of Science (Biology Science) in 1996. Then, he continued his study for Master Degree of Science in Department of Botany, Faculty of Science, Chulalongkorn University form 1996-1999.