POLLEN ANALYSIS OF TAIWAN PLIOCENE (I)

— Chuhuangkeng Section[1]

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Abstract: This is the first report for the pollen analysis of Pliocene in Taiwan. About 6579 palynomorphs are extracted from 19 Pliocene rock samples on the west flank of the Chuhuangkeng oil field along the Houlung River, Miaoli county in northern Taiwan. They can be classified into 57.4% angiospermous pollen grains, 21% gymnospermous pollen grains and 21.6% pteridophytic spores. Four new form species and one new form record are described. Three pollen zones for the Pliocene of northern Taiwan are recognized in this study.

INTRODUCTION

Pollen analyses of Miocene and Pleistocene to Recent have been carried out by several authors (Chung & Huang, 1972a, b; Chung, Huang & Stamp, 1973; Huang 1975; Huang & Tsang, 1977; S. Y. Huang & Huang, 1977; Huang & S. Y. Huang, 1978; Huang, 1982; Liu, 1981, Shaw & Huang, 1983). The pollen analysis of Pliocene is still open to investigation in Taiwan. Therefore, the study of Pliocene palynomorphs will bring the information of both Miocene and Pleistocene together for a better understanding of the successional pattern in Taiwan Vegetation from Miocene to the Present.

MATERIALS AND METHODS

1. Materials

Nineteen outcrops of rock samples (nos. 62–80) at the west flank of the Chuhuangkeng oil field along Houlung River in Miaoli county were collected (Fig. 1) during 1974–1975. Permanent pollen slides were made in 1976.

2. Methods

Preparation of permanent pollen slides follows that of Faegri, Iversen and Waterbolk (1940) as follow:

(1) Remove the outer exposed part of weathering rock.
(2) Crack rock into samll pieces about 0.15 cm diameter.
(3) Place 10 g small pieces of rock fragments into plastic beaker.
(4) Add 47–50% HF for 3–8 days to remove silica.
(5) Centrifuge with 2,500 rpm for 5 min and decant the supernatant suspension.
(6) Add 10% HCl at 70°C to remove colloid substance, then decant supernatant suspension.

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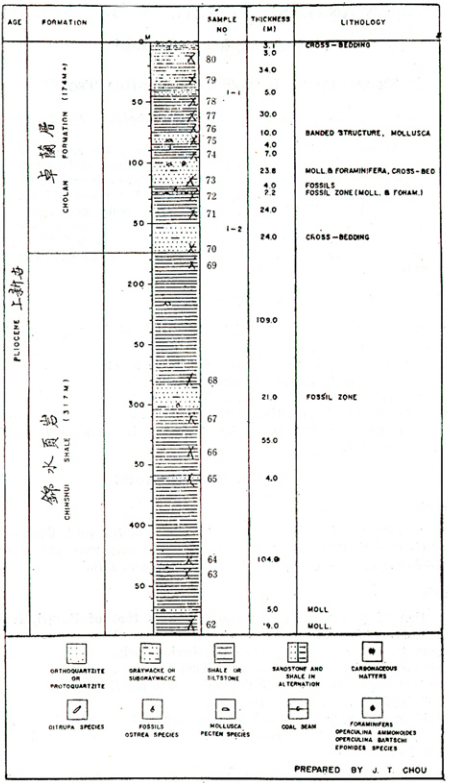

Fig. 1. Stratigraphic column and sampling plots of the west flank of the Chuhuangkeng oil field along the Houlung River, Miaoli, Taiwan. Scale 1:2000.

(7) Wash with H_2O three times.
(8) Add 10% Potassium hydroxide (KOH), heat, and agitate 30 min at 100°C, then centrifuge and decant supernatant.
(9) Wash with water three times.
(10) Add ZnCl (Zinc chloride) at density 1.90–1.98, agitate, keep it still for 15 min.
(11) Absorb supernatant into centrifuge tube, repeat it twice, discard precipitation.
(12) Add 10% H_2SO_4, centrifuge at 1,500 rpm, decant supernatant.
(13) Wash with water three times.
(14) Add 50% glycerin, centrifuge, decant supernatant.
(15) Embed with paraffin.

3. References of palynomorphs

Most palynomorphs of Pliocene are similar to those of the Miocene in Taiwan, therefore, form genera system are used for the nomenclature. Main reference sources are from Huang's publications (1972, 1978, 1979, 1980, 1981, 1982), Jansonius & Hills (1976), Liu (1981), Krutzsch (1971), Shaw & Huang (1983), and Tschudy (1969).

RESULTS

Progressive pollen deterioration (Hall, 1981) is a common phenomenon, and it is about 20–40% for each sample in the Early Pliocene or Chinshui Shale stratum and the degree of deterioration decrease from samples No. 75 up. Over 300 palynomorphs for each sample were examined except samples 62 and 65 where pollen contents are scanty.

1. Identification

About 6579 palynomorphs from 19 rock samples were identified. There were 57.4% of angiospermous pollen grains, 21% gymnospermous pollen grains and 21.6% pteridophytic spores. (Table 1).

2. New taxa

Four taxa are new species and one new record are proposed as described below:

1. ANTHOCERISPORITES Krutzsch 1963.

Trilete microspores with sculpture differently developed on both hemispheres; distally coarse verrucae together with echini that are occasionally fused at their bases; distal elements with indistinct reticulum; Y-marks delicate; amb subcircular to concavely rounded.

1. **Anthocerisporites formosensis** Huang & Tsou *sp. nov.* Pl. 1, Figs. 4–5.

Spores trilete; amb rounded triangular, 32×39μ; rays Y-mark reaching margin, the laesural arms 18–23μ long; exine about 1.5μ thick, densely covered by granulose-gemmae.

Locality: Cho-lan Formation.
Type slide: 74-2R.
Taxonomic affinity: This is closely related to the extant taxon *Anthoceros*.

Table 1. Numbers and percentages of fossil palynomorphs in Miaoli Pliocene rocks

Palynomorphs		No. & % \ Plot	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Total No. & Percentage
Spores	Monolete	No.	22	119	34	12	38	35	51	51	54	41	69	59	41	27	34	33	39	46	33	838
		%	53.7	57.5	52.3	30.0	48.7	64.8	67.1	68.0	71.1	64.1	65.7	74.7	51.3	64.3	51.5	38.8	55.7	76.7	55.0	58.9
	Trilete	No.	19	88	31	28	40	19	25	24	22	23	36	20	39	15	32	52	31	14	27	585
		%	47.3	42.5	47.7	70.0	51.3	35.2	32.9	32.0	28.9	35.9	34.3	25.3	48.7	35.7	48.5	61.2	44.3	23.3	45.0	41.1
	Subtotal	No.	41	207	65	40	78	54	76	75	76	64	105	79	80	42	66	85	70	60	60	1423
		%	25.8	39.0	21.0	16.7	9.9	17.5	25.2	22.0	17.5	21.1	34.9	24.8	24.0	13.1	21.6	26.6	21.4	19.6	17.8	21.6
Pollen grains	Gymnosperms		46	67	53	33	100	52	51	71	69	74	62	40	63	113	104	100	88	99	96	1381
	Dicotyledons		61	249	160	155	544	180	135	133	186	111	109	156	152	124	111	109	149	118	127	3069
	Monocotyledons		11	8	32	11	65	22	39	62	103	54	25	43	38	41	24	25	20	29	54	706
	Subtotal	No.	118	324	245	199	709	254	225	266	358	239	196	239	253	278	239	234	257	246	277	5156
		%	74.2	61.0	79.0	83.3	90.1	82.5	74.8	78.0	82.5	78.9	65.1	75.2	76.0	86.9	78.4	73.4	78.6	80.4	82.2	78.4
Total amount of spores and pollen grains			159	531	310	239	787	308	301	341	434	303	301	318	333	320	305	319	327	306	337	6579
S/P ratio			0.35	0.64	0.27	0.20	0.11	0.21	0.34	0.28	0.21	0.27	0.54	0.33	0.32	0.15	0.28	0.36	0.27	0.24	0.22	

2. **Anthocerisporites reticulatus** Huang & Tsou *sp. nov.* Pl. 1, Figs. 1-3.

Spores trilete; amb rounded-circular, 40-44μ wide; reticula polygonal, meshes irregular, with echinate ridges about 2μ high.
Locality: Cho-lan Formation.
Type slide: 76-2L.
Taxonomic affinity: This is closely related to the extant taxon *Anthoceros*.

2. RETICULATISPORITES Ibrahim 1953.

Trilete spores, with distinct reticulate sculpture of the surface of the exosporium; meshes ranging in size down to 1μ.

3. **Reticulatisporites taiwanensis** Huang & Tsou *sp. nov.* Pl. 1, Figs. 6-7.

Spores trilete; amb rounded-triangular, 40×70μ. Laesural arms unequal in length, 28-42μ; perine thin, with reticulate sculpture.
Locality: Cho-lan Formation.
Type slide: 77-3R.
Taxonomic affinity: Unknown.

3. LILIACIDITES Couper 1953.

Free, anisopolar, bilateral, monosulcate, occasionally trichotomosulcate; sulcus long, broad; grain usually elongate; exine clearly reticulate, lumina of reticulum variable in size; clavate, baculate in optical section.

4. **Liliacidites taiwanensis** Huang & Tsou *sp. nov.* Pl. 2, Figs. 3-6.

Grains 1-sulcate; subspheroidal, about 90μ in length; sulci as long as the axis; sexine reticulate, reticula 1.5-3μ wide; tectum psilate.
Locality: Cho-lan Formation.
Type slide: 71-1R.
Taxonomic affinity: This is closely related to certain liliaceous taxa.

4. MAGNOLIPOLLIS Krutzsch 1970.

Medium-sized to large, predominantly very thin-walled, monosulcate; pollen grains ellipsoidal to elongate oval shape and with a columellate to finely baculate, in part medio- and intrapunctate wall sculpture, with a smooth to slightly sinuous tectum. Wall sometimes nearly totally smooth.

5. **Magnolipollis graciliexinus** Krutzsch Pl. 2, Figs. 1-2.

Grains 1-colpate, subspheroidal, about 150μ long, colpus as long as the length, rounded on both ends; exine 2.5μ thick, smooth; tectum psilate.
Locality: Chin-shuei Formation.
Type slide: 69-1R.
Taxonomic affinity: This is clearly related to magnoliaceous species.

3. Classification of palynomorphs

The 6579 pollen grains and spores can be grouped into 88 taxa (Tables 1 & 2). There are 38 form genera for pteridophytic spores, but only one genus *Laevigatoparites* is very common and abundant. There are 16 form genera for gymnospermous pollen grains; *Pityosporites* is the most dominant meaningful genus. *Pityosporites*, *Cycadopites*, *Zonalapollenites* and *Taxodiacites* appeared continuously through the Pliocene. There are 32 form genera and assemblages of Fagaceae and monocotyledonous taxa for angiospermous pollen grains.

Table 2. Synopsis of Pliocene palynomorphs and their percentages in Miaoli area

Taxa	%	Taxa	%
A. Pteridophytes			
Alete			
Laevigatasporites	+	*Reticulatisporites*	+
Monolete			
Echinosporis	+	*Lunulasporites*	+
Extrapunctatosporis	+	*Microfoveolatosporites*	1.06
Gemmamonoletes	2.10	*Perinomonoletes*	+
Gemmatosporis	0.61	*Polypodiidites*	+
Intrapunctosporis	+	*Punctatosporites*	+
Laevigatosporites	5.67	*Verrucatosporites*	2.13
Latosporites	+	Subtotal	12.74
Trilete			
Anthocerisporites	+	*Plicatella*	+
Cicatricosisporites	0.70	*Polypodiaceoisporites*	1.52
Concavitriletes	+	*Pteris poris*	+
Convolutispora	0.50	*Retitriletes*	+
Crassoretitriletes	+	*Reticulatisporites*	+
Deltoidospora	+	*Toricingulatisporites*	+
Foveotriletes	+	*Toroisporis*	+
Gemmatritriletes	+	*Triplanosporites*	+
Gleicheniidites	+	*Verrucatitriletes*	+
Hymenophyllumsporites	+	*Verrucosisporites*	+
Leiotriletes	2.26	*Verrucingulatisporites*	+
Magnastriatites	1.72		
Osmundacidites	+	Subtotal	8.89
B. Gymnosperms			
Abiespollenites	+	*Pityosporites*	12.75
Cycadopites	3.38	*Podocarpites*	+
Ephedripites	+	*Psophosphaera*	+
Hesperopeucepollenites	+	*Schizosporis*	+
Inaperturopollenites	+	*Taxodiaceaepollenites*	+
Keteleeriaepollenites	+	*Taxodiacites*	+
Longicorpuspollenites	+	*Zonalapollenites*	2.17
Monosulcites	+		
Piceapollis	+	Subtotal	20.99
C. Angiosperms			
Dicotyledons			
Alnusalipollenites	+	*Periporopollenites*	3.71
Carpinites	+	*Platycaryapollenites*	+
Caryophyllidites	+	*Polygonacidites*	2.02
Chenopodipollis	0.97	*Polyvestibulopollenites*	8.65
Compositoipollenites	+	*Symplocacites*	+
Elaeagnuspollenites	+	*Tiliaepollenites*	+
Ericipites	0.50	*Triatriopollenites*	+
Eucomidites	0.64	*Tricolpopollenites*	+
Fagaceae	7.44	*Tricolporopollenites*	15.85
Ilexpollenites	0.94	*Triporopollenites*	0.97
Juglanspollenites	1.70	*Trivestibulopollenites*	0.91
Loniceraepollis	+	*Ulmipollenites*	+
Magnolipollis	0.82	*Utriculites*	+
Margocolporites	+	*Zelkovaepollenites*	+
Myricaceoipollenites	+	Subtotal	46.65
Monocotyledons			
Arecipites	+	*Liliacidites*	+
Cyperaceaepollis	0.67	Monocots	5.93
Graminidites	4.10	Subtotal	10.73

4. Dominant palynomorphs

The most abundant taxon in the 88 form genera is *Tricolporopollenites* with 23.30%, the next comes to *Pityosporites* with 12.76%. There are seven groups (Table 3) that are over 3% and are used to determine the pollen zonation of this area.

5. Pollen zones

In this paper, the zonation was based on the development of dominant taxa over 3%. There are three large zones, A, B, and C; B zone can be subdivided into B_1 and B_2 subzones (Fig. 2).

A zone: *Polyvestibulopollenites*-Fagaceae zone is equivalent to the Early Chinshui Shale Formation. This zone ranges from sample no. 62 to 66. The number of *Polyvestribulopollenites* pollen grains increase rapidly, and the amount goes up to as much as 29%. The number of *Tricolporopollenites* grains increase then decline and in *Laevigatosporites* grains increase and then decrease sharply.

B zone: *Tricolporopollenites* zone which is equivalent from the Middle Chingshui Shale Formation to the Cholan Formation. This zone ranges from sample no.

Fig. 2. Pollen zone of Miaoli Pliocene.

Tr: *Tricolporopollenites*
Fa: Fagaceae
Pi: *Pityosporites*
Po: *P. oblongus*
Pv: *Polyvestribulopollenites*
Mo: Monocots
Gr: Gramineae
La: *Laevigatosporites*
Pe: *Periporopollenites*
Cy: *Cycadopites*

Table 3. Numbers of palynomorphs for dominant taxa

Palynomorphs \ Plot No.	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	Average percentage
Tricolporopollenites (besides Fagaceae pollen)	3.1	8.1	3.5	9.6	16.9	29.5	15.3	16.4	17.3	15.2	17.6	24.2	22.9	15.0	13.4	15.7	19.6	15.7	16.9	15.85
Fagaceae pollen	7.5	12.6	15.2	10.9	4.6	10.4	8.6	8.2	10.1	6.3	3.3	5.7	8.1	5.0	8.2	6.9	4.0	3.6	3.3	7.45
Pityosporites (besides *P. oblongus*)	5.0	2.2	7.4	7.5	5.2	3.6	3.3	4.4	3.0	6.6	4.7	2.1	2.1	2.2	2.0	1.3	1.2	2.3	0.6	3.47
P. oblongus	1.3	0.6	1.6	2.5	2.9	2.6	4.0	4.7	3.5	5.3	8.3	4.5	6.3	29.7	24.6	20.7	21.1	23.5	19.9	9.29
Monocot (besides *Graminidites*)	6.3	0.6	8.7	4.6	6.0	6.5	9.3	6.7	13.9	9.9	3.3	7.2	3.6	5.6	2.3	4.7	3.1	4.2	6.8	5.93
Graminidites	0.6	0.6	1.6	0.0	2.3	0.6	3.3	8.2	8.8	6.9	4.3	5.0	6.6	6.3	4.3	3.1	3.1	3.9	8.3	4.10
Polyvestibulopollenites	3.8	4.9	10.0	28.9	25.0	7.1	11.3	5.0	4.4	3.0	3.7	5.3	3.0	4.1	3.0	1.9	10.1	6.9	5.6	8.65
Laevigatosporites	7.5	11.3	4.2	2.1	1.1	2.3	5.6	4.1	5.1	5.0	10.0	9.7	4.8	4.4	5.9	5.6	8.9	6.9	6.5	5.67
Periporopollenites	6.3	4.3	3.2	3.8	6.2	0.3	1.7	0.5	1.8	3.3	4.3	4.7	1.8	5.9	3.6	5.3	4.6	4.2	2.4	3.71
Cycadopites	1.9	3.8	3.5	0.0	1.1	3.6	2.0	5.6	3.5	5.3	3.0	3.8	5.7	2.2	3.3	6.6	2.1	3.6	5.0	3.39

67 to 74, and can be subdivided into two subzones B_1 and B_2:

B_1 subzone: This zone ranges from sample no. 67 to 68. The number of *Tricolporopollenites* grains increase rapidly. *Polyvestribulopollenites* grains decline sharply at this time; other pollen grains are less meaningful.

B_2 subzone: This zone ranges from sample no. 69 to 74. *Tricolorpollenites* are dominant, occupying 20–30%. *Polyvestribulopollenitcs* grains become less significant. Monocotyledonous grains increase, and Poaceous grains become prominently; other pollen grains are less meaningful.

C zone: *Pityosporites*, *Tricolporosporites* zone which is equivalent to Late Cholan Formation. *Pinus* (*Pityosporites* oblongus) grains increase rapidly from 6.3% with sample no. 74 to 29.7% with sample no. 75. It maintains high presence, almost 20% dominant condition through Pliocene. *Tricolporopollenites* grains are even less prominent than *Pinus* grains and plays a subdominant role at this time.

DISCUSSION

The Pliocene rock at this northern area belong to Marine sediments, therefore the past vegetational data can not closely reflect the real situation due to long distance marine transportation and reworking of deposits. Since there are over 88 form genera of palynomorphs identified, their dominant taxa might be useful to establish rough pollen zones, and make it possible to deduce the successional pattern of the past vegetation of this area.

The proportions of primitive trilete and advanced monolete spores in Pliocene is 2:3 altough they have a 1:6 ratio during the Pleistocene (Huang & Huang, 1977). This might suggest a change of spore composition from trilete to monolete spores through geological time.

There are 16 form genera of gymnospermous pollen grains which were more taxa than today. Moreover *Ephedriptites*, *Hesperopeucepollenits* and *Longicorpuspollenites* are extirpated from the present flora of Taiwan. We can raise the question as to when and why some gymnospermous taxa in Taiwan began to disappear. The pollen analysis of the Pleistocene should pay a critical study to produce a significant answer to this question. Angiospermous pollen grains give fewer form taxa (Perhaps 0.01% taxa) than actual due to their difficulties in taxonomical treatment. *Tiliaepollenites* grains can still be observed, but disappeared at Würm glaciation (Liu, 1981) of the Pleistocene. Whether or not *Ephedripites* and *Tiliaepollenites* grains are reworked pollen deposits, long distance marine sedimentation deposits and endemic taxa will be worthwhile for further studies.

The past vegetation from pollen analyses shows less fluctuation during the Pliocene. Dominant periods of *Polyvestribulopollenites* grains may suggest topographical change and *Pinus* grains open forest.

CONCLUSION

1. The result of pollen analysis reveals that angiospermous pollen grains with 57.4% are the most abundant, the next comes to gymnospermous pollen grains with 21.0% and the pteridophytic spores with 21.6%.
2. There are at least 88 form genera identified. Four new form species and one new form record are proposed. Most pollen types appear sporadically. There are only seven species over 3% with the *Tricolporopollenites* grains most abundant at 15.85% and the *Pityosporites* grains the second most abundant 12.76%.

3. Three pollen zones are recognized. A zone is characterized by dominant *Polyvestribulopollenites* and Fagaceae pollen grains; B zone is characterized by dominant *Tricolporopollenites* pollen grains. Both *Polyvestribulopollenites* and Fagaceae grains rapidly decline and monocts grains replace then and become dominant taxa in the Late Pliocene; C zone is characterized by dominant *Pinus* and *Tricolporopollenites* pollen grains, especially *P. oblongus* that maintains its superiosity until the Late Pliocene.
4. Floral components of Pliocene and Miocene are similar, the vegetational succession is changing moderately with evidence of disappearance of many taxa of gymnospermous pollen grains and pteridophytic spores. Both floras are closer to one another than the present one.

LITERATURE CITED

CHOU, J. T., 1963. A stratigraphic and sedimentary analysis of the Tsouho Formation and the Nankang Sandstone in Northern Taiwan (Part 1). Petrol. Geol. Taiwan 2: 107-120.

CHUNG, T. F. and T. C. HUANG, 1972a. Paleoecological study of Taipei Basin (1). Taipei Botanical Garden, Taiwania, 17(2): 117-141.

——— and ———, 1972b. Paleocological study of Taipei Basin (2). Neihu profile. Taiwania, 17(3): 239-247.

———, ——— and R. B. STAMPS, 1973. Paleoecological study of Taiwan (3)—The Puli Basin. Taiwania 18(2): 160-168.

FAEGRI, F., J. IVERSEN and H. T. WATERBOLK, 1964. The textbook of pollen analysis. Hafner Pub. Co., 237 pp.

HALL, S. A., 1981. Deteriorated pollen grains and the interpretation of Quaternary pollen grains. Rev. Palaeobot. Palynol. 32: 193-206.

HEDBERG, H. D., 1976. International stratigraphic guide. International subcommission on stratigraphic classification of IUGS Commission on stratigraphy. 200 pp.

HUANG, T. C., 1972. Pollen Flora of Taiwan, NTU, Taipei, Taiwan, 247 pp.

———, 1975. Paleoecological study of Taiwan (4)—Waichiataoken profile. Taiwania, 20(1): 1-22.

———, 1978. Miocene palynomorphs of Taiwan (III)—Spores. Taiwania, 23: 7-55.

———, 1979. Miocene palynomorphs of Taiwan (IV)—Gymnospermous grains. Taiwania, 24: 81-105.

———, 1980. Miocene palynomorphs of Taiwan (V)—Angiospermous grains. Taiwania, 25: 57-103.

———, 1981. Spore Flora of Taiwan, Taipei, Taiwan, 111 pp.

———, 1982. Review of palynological studies in Taiwan. Proc. Natl. Sci. Counc. R. Roc. 6(1): 59-70.

——— and S. Y. HUANG, 1978. Paleoecological study of Taiwan (7)—Pollen analysis of Yueh Tan. Bull. Exp. Forest NTU 120: 185-196.

——— and C. M. TSANG, 1977. Palaeoecological study of Taiwan (6)—The pollen analysis of four archaeological sites in Central Taiwan. Bull. Dept. Archaeology and Anthropology, p. 51-75.

HUANG, S. Y. and T. C. HUANG, 1977. Paleoecological study of Taiwan (5)—Toushou Basin. Taiwania, 22: 1-11.

JANSONIUS, J. and L. V. HILLS, 1976. Genera file of fossil spores and pollen. Dept. of Geology, Univ. of Calgary, Canada.

KRUTZSCH, W., 1971. Atlas der mittel-und jungtertiaren dispersen sporen und pollen-sowie der microplanktonformen des nordlichen Mitteleuropas. Veb. Deutscher Verlarg der Wissenschaften, Berlin.

SHAW, C. L., and T. C. HUANG, 1983. Miocene palynomorphs of Taiwan (VIII)—Pteridophytic spores and biostratigraph. Taiwania, 28: 19-41.

TSCHUDY, R. H., 1969. Applied palynology. In "Aspects of Palynology" ed. by Tschudy, R. H. & R. A. Scott, John Wiley & Sons, Inc.

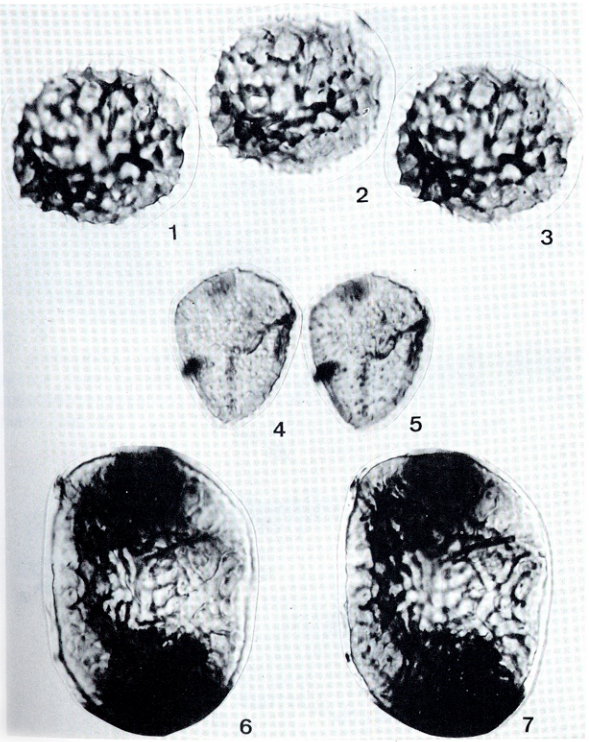

Plate 1. New fossil Pliocene spores. All figures 1000×.

1-3. *Anthocerisporites reticulatus* Huang & Tsou.
4-5. *Anthocerisporites formosensis* Huang & Tsou.
6-7. *Reticulatisporites taiwanensis* Huang & Tsou.

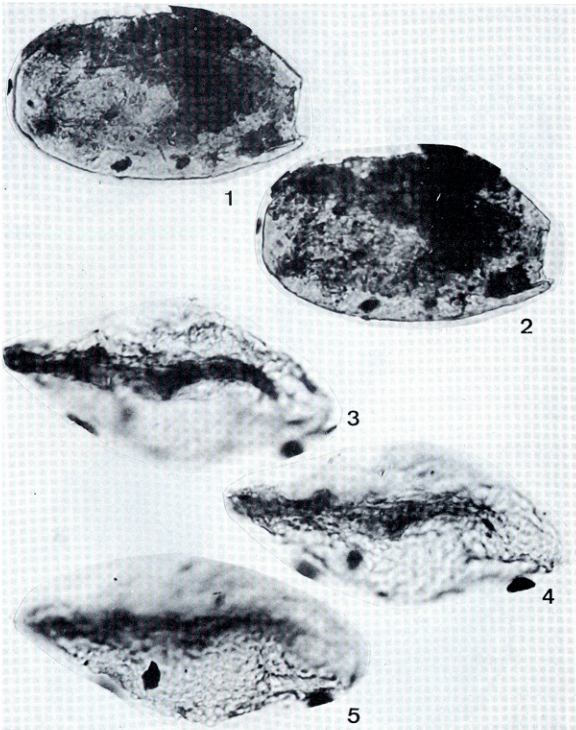

Plate 2. New fossil Pliocene pollen grains. All figures 1000×.
1-2. *Magnolipollis graciliexinus* Krutzsch.
3-5. *Liliacidites taiwanensis* Huang & Tsou.

臺灣上新世之孢粉分析(I)

—苗栗剖面

黃增泉 鄒稚華

摘 要

苗栗上新世（錦水層、卓蘭層）的孢粉分析顯示，在數量上被子植物花粉長期居於明顯優勢，占總量57.4%；裸子植物花粉占21.0%；蕨類孢子占21.6%。

組成種類至少涵括88個形態屬。新種方面有四個，新記錄一個。孢粉大多數爲零星少量地出現；其出現量占總數3%以上者視爲較優勢，共有7種，三溝孔類花粉居最首要，次以松粉占12.76%。

大體而言，上新世的孢粉組成爲中新世之沿續，在三百萬年期間種類的興起，滅絕變化不明顯。但與現生臺灣植羣比較，則顯有不同，尤以蕨類孢子和裸子植物花粉顯示了植物明顯的變遷過程。

上新世地層錦水，卓蘭兩層可劃分爲A、B、C三孢粉帶，初期爲A帶，以櫸木粉，殼斗科粉爲較重要。B帶則僅有三溝孔類花粉最優勢，但其中殼斗科粉之比例已減低，櫸木粉亦急劇沒落，後段則見單子葉花粉逐漸興盛。C帶以松屬粉及三溝孔類花粉最優勢，尤其橫長體松粉迅速蹶起並持續至上新世末期。