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Aeropollen of the Pingtung Area, South Taiwan

Tseng-Chieng Huang[1, 2]

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ABSTRACT: A survey of airborne pollen grains from May 1993 to April 1995 in Pingtung Station, Taiwan is here reported: The diurnal, daily, monthly and yearly studies of airborne pollen are included; the pollen calender of this area is proposed; the long distance pollen dispersion and the relationship between weather conditions are also discussed. These results might be useful diagnostic data for local doctors to treat pollinosis patients.

Broussonetia aeropollen were captured as the largest annual amount. The largest monthly captured was found in March 1994. The diurnal collection varies in different months. It is difficult to decide when the pollen is released most abundantly per hour. The pollen calendar shows when each taxon had its different higher dispersion periods. *Mimosa pudica* dispersed in higher relative humidity and lower temperature; *Trema* in higher temperature and lower relative humidity; and *Broussonetia* without obvious realtionship to weather conditions. There are about 44 different pollen taxa found in long distance dispersion.

KEY WORDS: Airborne, Pollen, Pingtung Station, Taiwan.

INTRODUCTION

In order to elucidate the sources of inhalent pollen allergens, the investigation of airborne pollen was done by Chao *et al.* (1962), Chen (1984), Chen and Chien (1986), Chen *et al.* (1972), Chen and Huang (1980), Huang and Chung (1973), Tsou and Huang (1982), and Wang (1973). Since the trapping instruments used by these previous workers were not the same, the results were not easy to compare. Therefore a team of aeropollen surveyors consisting of six collaborators representing six different localities on Taiwan had been carried out by Su-Hwa, Chen (Taipei Station, northern Tainan), Tze-Hwa, Tsou (Taichung Station, central western Taiwan), Chang-Sen, Kuoh (Taiwan Station, southwestern Taiwan), Tseng-Chieng, Huang (Pingtung Station, southern Taiwan), Su-Hui, Chen (Hualien Station, northeastern Taiwan) and Hui-Chu, Chang (Taitung Station, southeastern Taiwan) during November 1991 and October 1995 (Map 1). The results of our team works will be appeared in the separate book entitled as " Aeropollen Flora of Taiwan" during the summer of 1998 (Huang *et al.*, 1998), but the results for Pingtung station during May 1993 and April 1995 are reported here.

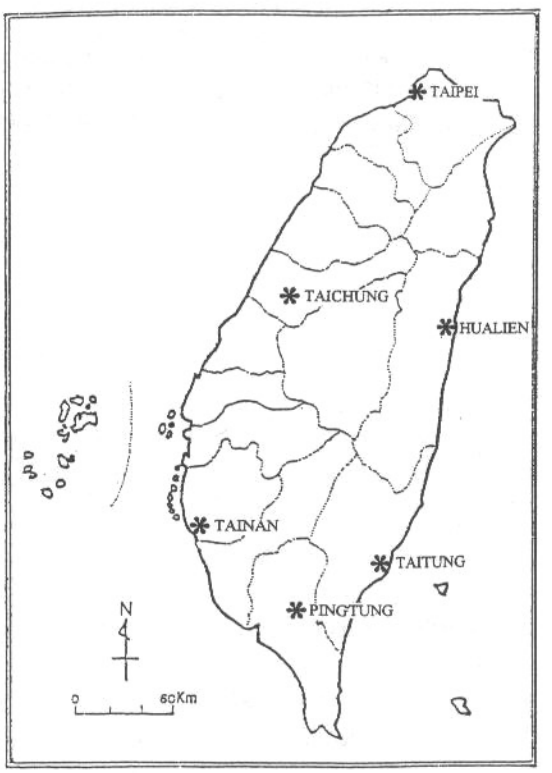
The spore trap was placed on the roof of the third floor of the Department of Forest Resources, Pingtung Technological University at Pingtung, Taiwan about 15 m above the ground. This is situated in the southern part of Taiwan, at latitude 22° 38' 57" N and longitude 120° 36' 7" E.

1. Department of Botany, National Taiwan Univerrsity, Taipei 10764, Taiwan, Republic of China.
2. Corresponding author.

MATERIALS AND METHODS

The vegetation of nearby stations was investigated, because airborne pollens are usually captured within a short distance from their pollen bearing trees or herbs (Tsou and Huang, 1982). Therefore the plants forming the vegetation within 5 km of surrounding areas were identified and listed. The surveyed area includes the eastern boundary of thee western slope, Central Mountain Range, northern boundary of Liming Village, southern boundary of Wankin Village and western boundary of the Neipu Industrial District. The highest elevation is Litingshan, at the altitude of 659 m. Local climatic data were obtained from the weather station of the Department of Horticulture, Pingtung Technological University.

The vegetation within our investigation area is reported: The commonly found trees on university compass are *Delonix regia*, *Cinnamomum camphora*, *Liquidamber formosana*, *Chorisia speciosa*, *Elaeocarpus serratus*, *Albizzia falcata*, *Jacaranda acutifolia*, *Swietenia macrophylla*; Common weeds are *Cynodon dactylon*, *Imperata cylindrica*, *Panicum maximum*, *Paspalum conjugatum*, *Panicum repens*, *Rhynchelytrum repens*, *Mikania cordata*, *Mimosa invisa*, *M. pudica*, *Pennisetum setosum* and *Microlepia speluncae* mixed with *Crotalaria pallida*, *Melastoma candidum* and *Tephrosia candida*. On plains and valleys there are *Areca catechu*, *Mangifera indica*, *Syzygium samarangense*, *Lichi chinensis*, *Ananas comosus*, *Carica papaya*, and vegetable crop. On wasteland and roadsides are *Miscanthus floridulus*, *Pennisetum purpureum*, *P. setosum*, *Chloris barbata*, *Cynodon dactylon*, *Eleusine indica*, *Panicum maximum*, *P. repens*, *Paspalum conjugatum*, *Rhynchelytrum repens*, *Leucaena leucocephala*, *Ipomaea triloba*, *Centrosema pubescens*, *Mimosa pudica*, *Ageratum houstonianum*, and *A. conijoides*. In the valleys are *Brachiaria mutica* and *Saccharum spontaneum*. On hillsides and slopes *Machilus zuihoensis* is the dominant tree species with *Acacia confusa*, *Broussonetia papyrifera*, *Macaranga tanarius*, *Mallotus japonicus*, and *Trema orientalis*. The common shrubs are *Bridelia tomentosa*, *Eurya chinensis*, *Champereia manillana*, *Ilex asprella*, *Clerodendrum cyrtophyllum*, *Litsea kurokovii* and *Clerodendrum paniculatum*, commonly mixed with *Aleurites moluccana*, *A. montana* and *Manihot esculenta*. *Mangifera indica*, *Phoenix catechu* and *Ananas comosus* are major orchard trees. The plant checklist for this area is intentionally excluded in order to save space.



Map 1. Localities of aerosamplers.

The Burkard seven days recording volumetric spore trap was used to collect the airborne

pollen three years between December 1, 1991 and November 10, 1995. The sampler was fixed on the third floor roof of the Department of Forest Resource building, Pingtung Agriculture Technological University about 15 m above the ground. A weekly sampling basis was exposed as a Cellophane tape (Melinex, Burkard) coated with vaseline adhesive on a rotating drum passing an orifice calibrated to deliver on the tape 10 L of air per minute for seven days. Exposed tapes were cut into seven 48 mm sections corresponding to each 24 hours of sampling. Sections were mounted on slides made permanent with Entellan (xylene and alkylacrytate mixture, Merck, Germany), covered, and the pollen scanned using a Leitz compound microscope at x400 or x1000. For each section 24 transverse lines 2 mm apart (corresponding to a one hour sampling period) were scanned and the pollen recorded to give pollen (number)/m^3. All pollen grains are reported per m^3 of air or as indicated by hourly (0.6 m^3), daily (14.4 m^3), monthly (432 m^3) and yearly (5184 m^3) values. All slides were recorded for pollen amounts and frequencies every hour. These data are converted to express different conditions. For identification, Huang's Pollen (1972) and Spore (1981) Floras were consulted.

Voucher slides of plant species were also prepared as many as possible in order to compare with the impacted pollen from the sampler and to help with the identification of aeropollen as much as possible. All permanent slides and voucher slides of airborne pollen are deposited in the Department of Botany, National Taiwan University.

RESULTS

Vegetation

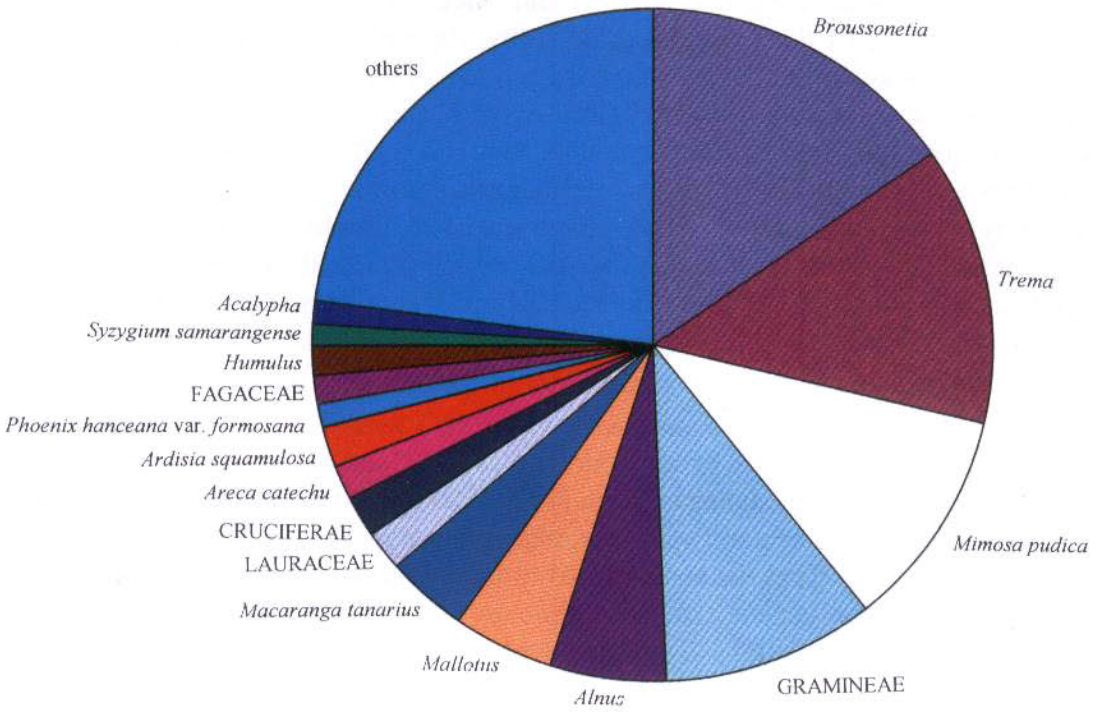
The plants within the investigated area consisting of the 78.5 km2 circular area were counted. There were 118 families, 379 genera and 539 species of vascular plants. Of these Pteridophytes contributed seven families and ten species, Gymnosperms five families and 12 species, Dicotyledons 92 families and 441 species, and Monocotyledons 14 families and 76 species.

Total aeropollen

Total pollen grains captured within two years (from 1 May 1993 to 30 April 1995) at this station are 151,892 grains. *Broussonetia* gave the largest count with 23,225 grains forming 15.30 %, *Trema* 20,018 grains, 13.18 %, *Mimosa* 10.61 %, Gramineae (Poaceae) 10.19 %, and *Alnus* 5.48%. There are 148,788 grains, 97.96 %, identifiable at least to the family level and 3,104 grains, 2.04 % are unidentifiable (Fig. 1, Table 1).

Monthly aeropollen count

The change of pollen sums varies from the lowest amount in May 1993, increasing in number from June and reaching the highest peak in September 1993, then decreasing in number but with the second peak appearing in March 1994, then decreasing in amount again. The lowest taxa identified is in February 1995 and the highest peak appeared in March 1994 (Figs. 2-3).



Taxa	Amount	Percent (%)
Broussonetia	23,235	15.30
Trema	20,018	13.18
Mimosa pudica	16,114	10.61
GRAMINEAE	15,484	10.19
Alnus	8,327	5.48
Mallotus	7,101	4.68
Macaranga tanarius	5,767	3.80
LAURACEAE	3,084	2.03
CRUCIFERAE	2,849	1.88
Areca catechu	2,749	1.81
Ardisia squamulosa	2,725	1.79
Phoenix hanceana var. *formosana*	2,025	1.33
FAGACEAE	1,948	1.28
Humulus	1,914	1.26
Syzygium samarangense	1,746	1.15
Acalypha	1,626	1.07
others	35,180	23.16

Fig. 1. Total numbers and percentages of the major aeropollen biyearly at Pingtung Station during May 1993 and April 1995.

Table 1. Monthly total numbers of aeropollen at Pingtung Station during May 1993 and April 1995.

Taxa \ Month	May -93	Jun -93	Jul -93	Aug -93	Sep -93	Oct -93	Nov -93	Dec -93	Jan -94	Feb -94	Mar -94	Apr -94	May -94	Jun -94	Jul -94	Aug -94	Sep -94	Oct -94	Nov -94	Dec -94	Jan -95	Feb -95	Mar -95	Apr -95	Total
ACANTHACEAE											8														8
ACERACEAE											64									4	4				72
ACTINIDIACEAE				8																		4			12
ADIANTACEAE								4	4																8
AIZOACEAE	4											4		4	4									4	20
AMARANTHACEAE														20	96	56	92	60	228	204	124	88	148	200	1316
Achyranthes	15		12	24	4		24	36	100	100	56	84	28	12	16			24							535
Alternanthera										4															4
Amaranthus	130	132	152	128	104	16	8	16	36	36	40	60	84	44	40			16							1042
Amaranthus patulus						4																			4
Amaranthus spinosus	5	12	12	8	4		4	16	12	80	88	40	32	12	12			48							385
Amaranthus viridis	27	8	28	76	64	88	136	140	156	48	132	164	132	36				16							1251
Deeringia	1			12	4	12	8				24	8	32	4	4										109
Gomphrena L.					20													8	12	12					52
Telanthera amoena				4				4															4		12
ANACARDIACEAE		4	4		4		4											4						4	24
Mangifera indica							8											8	4						20
Rhus						4				4			4					16							28
ANONACEAE													4	4									12	4	24
Artabotrys																8		12							20
Artabotrys hexapetalus								4		4			4		8	4	12		4						40
Cananga odorate						4																			4
APOCYNACEAE				8				4				4			4								4		24
Ecdysanthera rosea	4																								4
Formosia											16														16
Trachelospermum										4	8	4													16
Ilex							8				4														12
ARALIACEAE				4	16	8	4	8	24	8		12					4							4	92
Schefflera						12																			12
Araucaria cunninghamii					4	64	16	4								4		4			4				100
ASPIDIACEAE				4			4																		8
ASPLENIACEAE			12		4			4					4	4											28
ATHYRIACEAE			4	4	12	8		4				8													40
Basella alba								4																	4
BEGONIACEAE								4				20													24
Begonia			12											4											16
BERBERIDACEAE			4																						4
Alnus	4			212	2871	1708	220	48	24		12			8		44	1376	1600	148	40	4	4	4		8327
Carpinus					8					8	600	24										4			644
BLECHNACEAE				12	20	4	4	20	4	4		4													72
Ananas comosus	1	56		8	12						8	8	4											56	153
BUXACEAE														4											4
CAPRIFOLIACEAE									4																4
Viburnum												8													8
Carica papaya						4					4	4	4												16
CARYOPHYLLACEAE									4												4		16	8	32
Casuarina	51	24	4	28		8	4		4	16	496	404	20	4	4		4	4		28	4	12	72	88	1279
CHENOPODIACEAE				4						4					4				12	4		8	20	8	64
Murdannia formosana			4													4							4		12
COMPOSITAE	4											4			36	8	68	4	264	148	4	4	16	16	576
Ageratum		4					8				4							8							24
Ambrosia elatior					28		20																		48
Artemisia				12	164	164	88	16	4						4	32	72	100	20						676
Bidens																		16							16

Table 1. Monthly total numbers of aeropollen at Pingtung Station during May 1993 and April 1995, continued.

Taxa \ Month	May -93	Jun -93	Jul -93	Aug -93	Sep -93	Oct -93	Nov -93	Dec -93	Jan -94	Feb -94	Mar -94	Apr -94	May -94	Jun -94	Jul -94	Aug -94	Sep -94	Oct -94	Nov -94	Dec -94	Jan -95	Feb -95	Mar -95	Apr -95	Total
Bidens chinensis	8	4	4			4	8	8	4	4		12	4												60
Crassocephalum rabens			4	4	64	60			4	4															140
Crepidiastrum taiwanianum									4																4
Erigeron		16	12	4	12	8	68	108	20	16	28	8													300
Eupatorium	1			4		4	244	100	20	4	8	16		8	12		4								425
Evolvulus alsinoides	4																								4
CRASSULACEAE								8			4														12
CRUCIFERAE	229	1972	152	36	4	4	16	52	24	12	28	16	4	120	104		8	8		16			28	16	2849
Capsella																					12				12
CUCURBITACEAE				20														16					4	4	44
Actinostemma lobatum						4																			4
Gynostemma											4														4
CUPRESSACEAE								4																4	8
Calocedrus formosana				8		4			44	436	200	8		8	8	8	16	16	24	4			56		840
Juniperus chinensis v. *kaizuka*													4										12		16
Thuja Orientalis	4	4													4	32	16	8	32	20	4		4		128
CYATHEACEAE			36	60	24	20	12	4	4			4	4	48	12										228
Alsophila loheri															20	24	8	4	8	4			4		72
CYCADACEAE								4						8	16										28
Cycas	2														8	4		8	4				28	12	66
CYPERACEAE	4	8	8	28	180	16		32				4	52	68	108	64	8	56	36	60	4	1	24	28	789
DAPHNIPHYLLACEAE								12			16	4	8				4								44
DAVALLIACEAE			12	44	20	16	32	20			16	4		56											220
Davallia																	4						8		12
DENNSTAEDTIACEAE			4		24	8	12		4		20	12		28											112
Microlepia speluncae			316	104	172	28	52	16	24	12	24	20	12	32	8	4	4	4	8	8	4	4	4	12	872
DRYOPTERIDACEAE			8	28	8	8		28																	80
DRYPODIACEAE							12																		12
Elaeocarpus			128	192	32	20				52	24	20	32	32	40	4	12	20					8	20	636
ERICACEAE																		4							4
EUPHORBIACEAE							4			4	16	4		8	12	36	24	56	8	28	8	4	12	60	284
Acalypha	14	136	164	264	116	52	80	12	8	28	24	160	236	168	20	24	12	24	4	4		4	44	28	1626
Antidesma	63	180								8		48	24	16	72	12	4	20			8	4	24	20	503
Bischofia javanica	4		12	4	92	64	8			84	860	40	4	4	8		8	36	24		8	24	100	84	1468
Breynia							4																		4
Bridelia	64	20		24	112	32						4		4	36	4			4						304
Claoxylon												4	8												12
Euphorbia				4	12	4		8	24	20	12	4	24	24							4				140
Euphorbia hirta			12	12																					24
Euphorbia thymifolia															4										4
Gelonium	7																								7
Glochidion														4											4
Macaranga tanarius	27	28	44	36	80	108	80	192	180	484	2704	492	164	28	76	36	108	152	44	168	84	56	284	112	5767
Mallotus	53	44	20	144	1412	2040	724	104	12	16	92	168	204	36	40	200	448	708	88	96	124	16	80	232	7101
Phyllanthus										4	4	4		8									28	96	144
Phyllanthus emblica			4				16		4	16	8		4		8			4							64
Phyllanthus urinaria											4														4
Ricinus communis	4		4		16	4	4	8	12	12	56	40	20		4		20	40	20	16		24	48	40	392
FAGACEAE			16	20	28	4	20	28	12	44	156	288	220	380	316		8	24	8	24	60	32	84	176	1948
Cyclobalanopsis												100													100
FERN														12	124	176	52	84	96	60	12	28	8	56	708
GENTIANACEAE																	4								4
GESNERIACEAE							4	80	4		16		4				4			12	4			4	132
Chirita minuteserrulata											4														4
GLEICHENIACEAE			48	44	20				4		4	24													144
Dicranopteris					8	4							12	64	24	20	32	56	8				16	12	256

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GRAMINEAE	376	608	824	1080	1328	912	1252	548	268	168	660	728	584	848	568	484	808	952	884	412	132	32	428	600	15484
GUTTIFERAE											4														4
GYMNOSPERM																					8			4	12
Liquidambar formosana Hance										36	332	24											52		444
HYMENOPHYLLACEAE			4			8																			12
Engelhardtia roxburghiana			16																						16
LABIATAE												4													4
LAURACEAE			60	296	584	492	44	24	8	20	24	20	20	36	8		112	1236	4	20	12	24	16	24	3084
Cinnamomum	1																								1
LEGUMINOSAE	1			12	4		12		4	16											4				53
Acacia	18	84	4		12	12	20				20	4	32	68	12	16	8	4	12					4	330
Aeschynomene												4													4
Cassia														4			4						4		12
Crotalaria										4	4	4													12
Crotalaria anagyroides	1																								1
Crotalaria pallida					4			4	4		8	4		4								16		16	60
Mimosa invisa							4																		4
Mimosa pudica	122	92	920	1740	1868	2368	3080	1264	296	384	388	164	232	348	672	28	400	1172	196	240	8	8	68	56	16114
Ormocarpum cochinchinense											4														4
Phaseolus atropurpureus	4											4													8
Sesbania											4														4
Tephrosia											4														4
LENTIBULARIACEAE							4		4				4	4											16
Utricularia vulgaris																		4							4
LILIACEAE				8				4															4	12	28
Asparagus	1																								1
LINDSAEACEAE													4												4
LYCOPODIACEAE					12	8		4				12	12	8											56
Heimia myrtifolia											16	8												36	60
Lagerstroemia			4																						4
Lagerstroemia subcostata		4	28	56	20																				108
MAGNOLIACEAE														4	4										8
Magnolia		20	40	20	48	32		4					4	4	12	12	4	16	4	4	4		8		236
Michelia	1		4	12	4		4	12	24	4	12						8		4		4				93
Hiptage benghalensis												4													4
MELASTOMATACEAE												4													4
MENISPERMACEAE											4	4	44												52
Cocculus									4			8													12
Pericampylus										4	4		8												16
Mollugo		4								16	12	4		8										4	48
MONOCOT														4	8	16	4	12	52	12	12		20	32	172
MORACEAE			4	8	12					4	12	32	4	76	160	48	60	16	16	20	4	32	304	192	1004
Artocarpus lanceolate									4			84	332	40	4	8				8		4	132	16	632
Broussonetia	91	52	156	340	2664	156	204	80	20	172	1296	8436	364	24	44	180	156	132	4			72	772	248	23235
Humulus	150	68	4	156	148	136	68	64	52	16	236	192	40	20	116	68	52	104	16	40	20	36	44	68	1914
Morus																		8							8
Morus australis	7									12	144	56	8					4							231
Myrica								4			4														8
MYRSINACEAE										4															4
Ardisia			4				8	12		24	32	4													84

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Taxa \ Month	May -93	Jun -93	Jul -93	Aug -93	Sep -93	Oct -93	Nov -93	Dec -93	Jan -94	Feb -94	Mar -94	Apr -94	May -94	Jun -94	Jul -94	Aug -94	Sep -94	Oct -94	Nov -94	Dec -94	Jan -95	Feb -95	Mar -95	Apr -95	Total
Ardisia crenata												4													4
Ardisia sieboldii	31	12	44	20	4	60	200	188	28	4			16	20	72			28	8	16		8	20	184	963
Ardisia squamulosa	661	388	100	12	8	16	16	24	16	52	20	112	252	296	496	4	16	12	8	20			52	144	2725
Maesa		4	4																		8				16
MYRTACEAE			4	4							4		4	4							4				24
Psidium guajava		4									16	12	12					16		12					72
Syzygium formosanum	16	64	24	4		4				4	8	8		16			8	8		4	8		8	72	256
Syzygium samarangens	110	8	4	8	8	48	76	56	152	52	276	208	248	16			4	96	88	164	44	12	12	56	1746
OENOTHERACEAE				4							4														8
OLEACEAE				8	4								4												16
Fraxinus formosana	4		4			4	48			8	64	84	24	356	684	4	12		4		4				1304
Osmanthus					8	24	4																		36
Champereia											8	4	4												16
Areca catechu	164	324	420	364	153	36	8		16	4	12	44	212	500	232	104	72	16			4		12	52	2749
Cocos nucifera					32			4																	36
Elaeis																		4	4						8
Elaeis guineensis			4	4		4				4															16
Livistona											4														4
Phoenix hanceana v. *formosana*	245	124	52	4			12		16	96	380	384	244	28	8		4	4	4	20	8		308	84	2025
PARKERIACEAE			4																						4
Pinus	23	8					4			20	80	48	60	8	4						8	4	52	80	399
Pinus luchuensis	4											4													8
Tsuga												20													20
PIPERACEAE			68	308	24	20							8		4										432
Piper	20	4	112	40	16	20	4	12	8		12	8	60		16										332
Piper betle					212		132																		344
PLANTAGINACEAE				4																					4
POLYGONACEAE			4						4												8				16
POLYPODIACEAE			20	20	36	4	12	8		4		8	4												116
Colysis														4											4
Polypodium														4											4
PORTULACACEAE								4																	4
Talinum												4													4
PSILOTACEAE											4														4
PTERIDACEAE				8		8					4		4	8	4						4				40
Punica										4															4
RANUNCULACEAE			4											12	4		4	12	4	4					44
Clematis											12		4	4											20
ROSACEAE			4		8	4			8				4					8							36
Rubus						4	8			8	4			4				4							32
Spiraea																		4							4
RUBIACEAE						8	4	4			4		4	8			4								32
Coffea arabica L.									4	4															8
Hedyotis hedyotidea											4													32	36
Ixora L.				36	4	4	4	4			4	4	4	12				8		8	4	4	4	8	116
Mussaenda											4														4
Psychotria rubra						8																			8
RUTACEAE								4				4		4		12		12		4					40
Citrus		4					4																8		16
Clausena										12															12

Table 1. Monthly total numbers of aeropollen at Pingtung Station during May 1993 and April 1995, continued.

Taxa \ Month	May -93	Jun -93	Jul -93	Aug -93	Sep -93	Oct -93	Nov -93	Dec -93	Jan -94	Feb -94	Mar -94	Apr -94	May -94	Jun -94	Jul -94	Aug -94	Sep -94	Oct -94	Nov -94	Dec -94	Jan -95	Feb -95	Mar -95	Apr -95	Total
Evodia merrillii					8					4					4										16
Evodia					44	4					456	176	16												696
Fagara											8														8
Murraya paniculata										4											4				8
Serissa japonica															4			4							8
Zanthoxylum			4	4	8																				16
SALICACEAE						4																			4
Salix																					4				4
Champereia											4														4
SAPINDACEAE	10	4										4													18
Cardiospermum halicacabum				4																					4
Euphoria longana											264	72											16	552	904
SAXIFRAGACEAE		8																							8
Hydrangea aspera											4														4
SELAGINELLACEAE				4		4													4	4					16
Selaginella doederleinii														4											4
SOLANACEAE			24	16	24		20	8	4	16	32	4	4				4							8	164
Lycopersicomm esculeutum		8																							8
Solanum	4										4	20		12						4			4	4	52
Solanum indicum								4																	4
Solanum nigrum												8													8
Trichodesma khasianum												24													24
Waltheria americana												8													8
THEACEAE														8											8
THELYPTERIDACEAE			4	4	4	16				4			4		4										40
Christella														8							4				12
TILIACEAE				4					4																8
Muntingia calabura				24										4										4	32
Triumfetta															4										4
TYPHACEAE							4																		4
Typha	6	4																						4	14
ULMACEAE			8	4	8			16	12	4	8	4													48
Celtis	8				4							4													16
Trema	641	1296	580	1756	468	68	40		36	112	3268	6120	1920	365	160	48	28	60	8	4	8	40	448	2528	20018
Ulmus										4	248	4		4				16					4		280
Zelkova													4												4
Zelkova formosana											100														100
UMBELLIFERAE			8				8							8				12			12			12	60
Cryptotaenia canadensis											4														4
URTICACEAE	24	132	4	144	4	4	24	8		88	48	64		8	28	8		28					52	36	704
Boehmeria	8	40	72	60	116	24	8	32	4	56	124	44	36	12	32			24				32	100	12	836
Boehmeria tratescens				8	12													4							24
Gonostegia hirta	52										8		4										4		68
Laportea pterostigma					4					4	32		12												52
Lantana camara				4																					4
Vitex		24	16																						40
VITACEAE				12																					12
unknown	56	40	120	64	76	32	120	84	152	80	500	280	168	144	212	20	156	96	56	28	36	16	220	348	3104
Total	3594	6084	5044	8328	13784	9180	7428	3648	1940	3116	26832	15876	6428	4705	4896	1868	4364	7432	2488	2008	864	661	4384	6940	151892

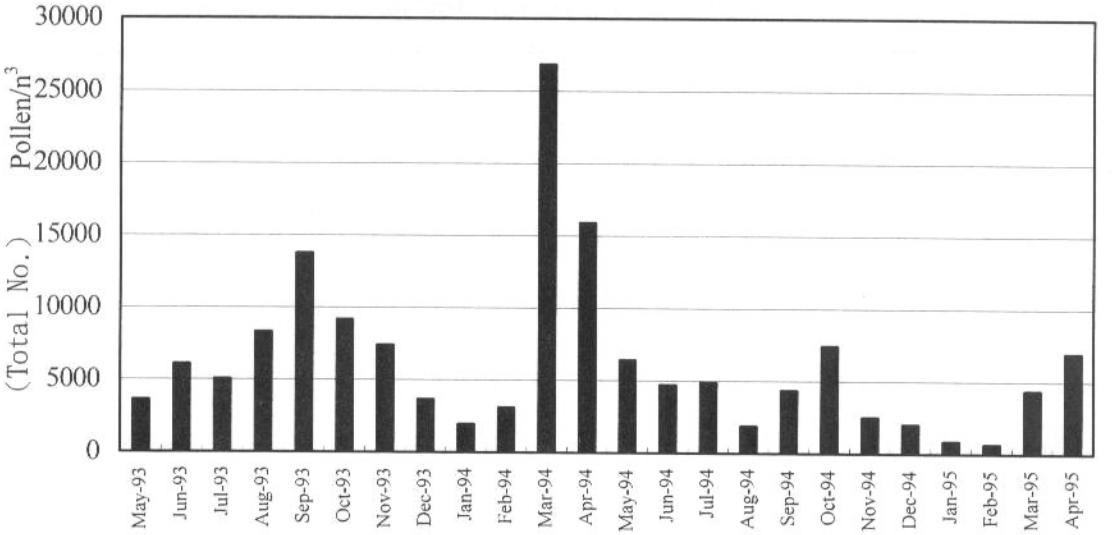

Fig. 2. Monthly 432 m3 totals of aeropollen at Pingtung Station during May 1993 and April 1995.

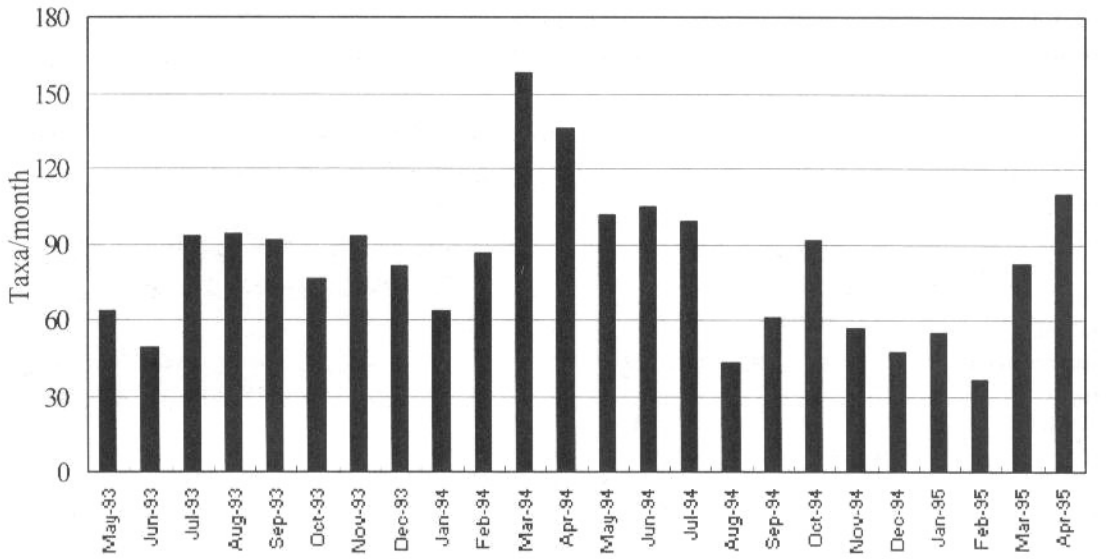

Fig.3. Monthly total aeropollen taxa at Pingtung Station during May 1993 and April 1995.

The dominant taxa vary in monthly total aeropollen. The top three taxa per month are described as follows (Table 2):

1. May 1993: Total captured aeropollen taxa are 63 with 3,594 grains. The largest count is for *Ardisia squamulosa* forming 18.39 %, followed by *Trema spp.* and Gramineae.
2. June 1993: Total captured aeropollen taxa are 49 with 6,084 grains. The largest count is for Cruciferae (Brassicaceae)which form 32.41 %, followed by *Trema spp.* and Gramineae.
3. July 1993: Total captured aeropollen taxa are 93 with 5,044 grains. The largest count consists of *Mimosa spp.*, forming 18.24 %, followed by Gramineae and *Areca catechu.*
4. August 1993: Total captured aeropollen taxa are 94 with 8,328 grains. The largest count consists of *Mimosa spp.* forming 25.80 %, followed by *Macaranga tanarius* and the Gramineae.

Table 2. Seasonal most abundant captured aeropollen during May 1993 to April 1995.

season(↓)	year(→) Taxa(↘) month (↓)	1993	1994	1995
Spring	2		*Mallotus paniculatus*	Amaranthaceae
	3		*Broussonetia*	*Broussonetia*
	4		*Trema*	*Trema*
Summer	5	*Ardisia squamulosa*	*Trema*	
	6	Cruciferae	Gramineae	
	7	*Mimosa*	*Fraxinus formosanus*	
Autumn	8	*Mimosa*	Gramineae	
	9	*Alnus*	*Alnus*	
	10	*Mimosa*	*Alnus*	
Winter	11	*Mimosa*	Gramineae	
	12	*Mimosa*	Gramineae	
	1		*Mimosa*	Gramineae

5. September 1993: Total captured aeropollen taxa are 91 with 13,784 grains. The largest count consists of *Alnus spp.* forming 32.41 %, followed by *Broussonetia spp.* and *Mimosa* spp.
6. October 1993: Total captured aeropollen taxa are 76 with 9,180 grains. The largest count consists of *Mimosa spp.*, forming 25.80 %, followed by *Macarenga tanarius* and *Alnus formosanus.*
7. November 1993: Total captured aeropollen taxa are 93 with 7,428 grains. The largest count consists of *Mimosa spp.,* forming of 41.46 %, followed by Gramineae and *Macarenga tanarius.*
8. December 1993: Total captured aeropollen taxa are 81 with 3,648 grains. The largest count consists of *Mimosa spp.,* making up 41.46 %, followed by Gramineae and *Mallotus paniculatus* .
9. January 1994: Total captured aeropollen taxa are 63 with 1,940 grains. The largest count consists of *Mimosa spp.,* making up 15.26 %, followed by Gramineae and *Mallotus paniculatus.*
10. February 1994: Total captured aeropollen taxa are 86 with 3,116 grains. The largest count consists of *Mallotus paniculatus* making up 15.53 %, followed by *Calocedrus formosanus* and *Mimosa spp.*
11. March 1994: Total captured aeropollen taxa are 158 with 26,832 grains. The largest count consists of *Broussonetia spp.,* making up 48.33 %, followed by *Trema spp.* and *Mallotus paniculatus.*
12. April 1994: Total captured aeropollen taxa are 136 with 15,876 grains The largest count consists of *Trema spp.,* forming 38.55 %, followed by *Broussonetia spp.* and *Mallotus paniculatus.*
13. May 1994: Total captured aeropollen taxa are 101 with 6,428 grains. The largest count consists of *Trema spp.,* making up 29.87 %, followed by Gramineae and *Broussonetia spp.*
14. June 1994: Total captured aeropollen taxa are 105 with 4,705 grains. The largest count consists of Gramineae making up 18.02 %, followed by *Mimosa spp.* and *Fraxinus formosanus.*

15. July 1994: Total captured aeropollen taxa are 99 with 4,896 grains. The largest count consists of *Fraxinus formosanus* making up 13.97 %, followed by *Mimosa spp.* and *Ardisia squamulosa*.
16. August 1994: Total captured aeropollen taxa are 43 with 1,868 grains. The largest count consists of Gramineae making up 25.91 %, followed by *Macarenga tanarius* and *Broussonetia spp.*
17. September 1994: Total captured aeropollen taxa are 61 with 4,364 grains. The largest count consists of *Alnus spp.*, making up 31.53 %, followed by Gramineae and *Mallotus paniculatus.*
18. October 1994: Total captured aeropollen taxa are 91 with 7,432 grains. The largest count consists of *Alnus formosanus* making up 21.53 %, followed by *Mimosa spp.*
19. November 1994: Total captured aeropollen taxa are 57 with 2,488 grains. The largest count consists of Gramineae, making up 41.46 %, followed by *Mallotus paniculatus* and *Mimosa spp.*
20. December 1994: Total captured aeropollen taxa are 47 with 2,088 grains. The largest count consists of Gramineae making up 20.52 %, followed by *Mimosa spp.* and Amaranthaceae.
21. January 1995: Total captured aeropollen taxa are 55 with 864 grains. The largest count consists of Gramineae making up 15.28 %, followed by Amaranthaceae and *Mallotus paniculatus.*
22. February 1995: Total captured aeropollen taxa are 36 with 661 grains. The largest count consists of Amaranthaceae making up 13.31 %, followed by *Broussonetia spp.* and *Mallotus paniculatus.*
23. March 1995: Total captured aeropollen taxa are 82 with 4,384 grains. The largest count consists of *Broussonetia spp.*, making up 17.61 %, followed by *Trema spp.* and Gramineae.
24. April 1995: Total captured aeropollen taxa are 110 with 6,940 grains. The largest count consists of *Trema spp.*, making up 36.43 %, followed by Gramineae and *Euphoria longana.*

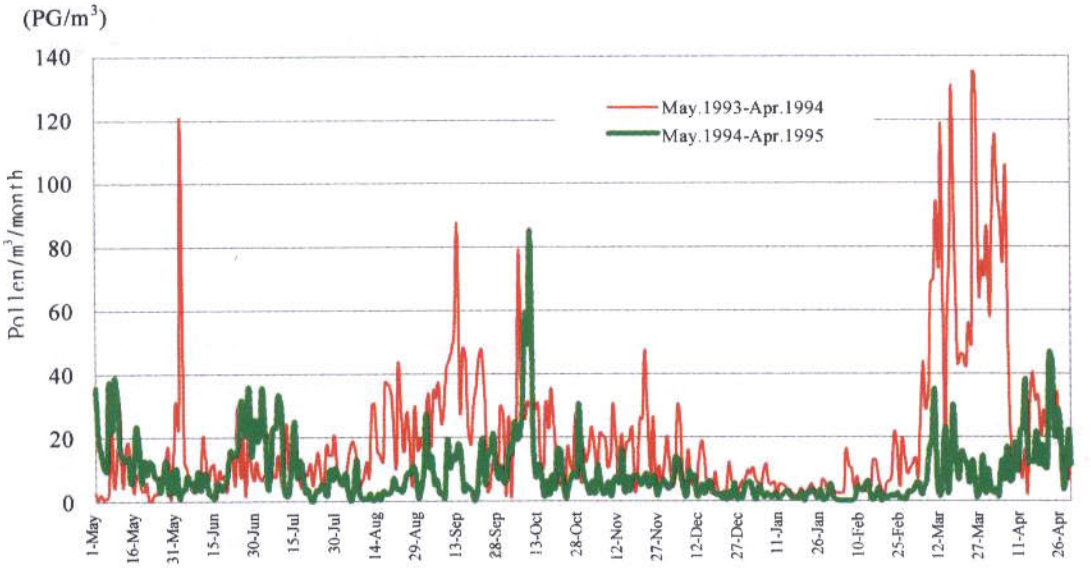

Fig. 4. Daily variation of aeropollen at Pingtung Station between May 1993 and April 1995.

Daily aeropollen variation

Daily captured aeropollen between 1993 and 1995 were counted (Fig. 4). There are two highest peaks in the spring and autumn seasons in both years. The highest amount was obtained on 25 March 1994 with 1,940 grains captured per day; and on 10 October, 1994 with 1,240 grains captured per day.

Diurnal captured aeropollen

The diurnal variation of aeropollen per month during these two years are compared. During 1993 and 1994, the highest peaks appeared in early morning and at noon time in January 1994; the highest peaks at noon time appeared in February 1994 and May 1993; evenly appearance in March 1994, the highest peak in the morning appeared in April 1994, the highest peak at morning and night for other months. During 1994 and 1995, January, February and April the highest peak appeared at noon time; March showed no difference, and the highest peak appeared in the morning in other months (Figs. 5-16).

Pollen calendar

The pollen calendar (Figs. 17-18) from May 1993 to April 1995 was analyzed. Only the major 15 taxa are reported here. These taxa had a similar pollen calendar in two years. They are: *Macaranga tanarius*, *Casuarina sp.*, *Trema orientalis*, *Phoenix hanceana* var. *formosana*, *Broussonetia papyrifea*, Gramineae, *Ardisia squamulosa*, *Areca catechu*, *Mimosa pudica*, *Alnus*, *Syzygium sarmarangense* and *Eupatorium*.

In winter, plants deliver less pollen grains until the later part of January. Pollen of *Macaranga tanarius* was captured as the major component of angiospermous aeropollen at this time.

The pollen of *Macaranga tanarius* reached its highest peak in March. *Casuarina sp.*, *Trema orientalis* and *Phoenix hanceana* var. *formosana* also reached their highest peaks in March. Aeropolllen of *Broussonetia papyrifea* were captured to some extent from February to April but the largest amount was captured in March 1994 with 12,968 grains, forming 48.51 %, of that month.

In April, *Brousonnetia papyrifera* was the major component, followed by Gramineae and *Casuarina spp.*

In May, pollen of *Ardisia squamulosa* was captured the most abundantly but lasted only a short period. *Areca catechu* began to appear in this month and maintained a certain amount until September.

In June, Cruciferae pollen were captured as the largest amount for that month forming 32.35 %.

In July *Mimosa pudica* pollen was captured and continued to the highest peak in November, followed by Gramineae pollen.

In August, the most abundant aeropollen captured was of *Mimosa pudica*, followed by *Trema orientalis* and Gramineae. This is the second peak for *Trema orientalis* captured in the year.

In September, *Alnus* pollen was captured the largest amount and appeared intensively from September to Octobeer. *Mallotus* pollen were also captured intensively from September to November.

During October and December, the major aeropollen were also *Mimosa pudica*, followed by Gramineae pollen. Grass pollen reached their peaks in August and November separately.

During November and December, the major aeropollen were from *Syzygium sarmarangense* and *Eupatorium* species.

Aeropollen and climatic factors

It is generally accepted that temperature, precipitation and moisture content of air influence airborne pollen greatly. The largest three aeropollen taxa captured were selected to compare with climatic conditions, these being *Mimosa, Broussonetia* and *Trema.* A one week period of pre- and post- peak of each taxon was selected for comparison (Figs. 19-21).

The largest captured *Mimosa* pollen was in November 19 to 25, 1993 between 10 pm to 3-4 am the next morning. During these times temperature was lowest and moisture content is highest. This indicates aeropollen shedding in opposite proportion to increasing temperature and in proportion to the higher moisture content. In the morning of November 24 and 25, the pollen captured decreased due to rainfall.

The largest captured *Broussonetia* pollen was between March 14 and 20, 1994 evenly through the day. It indicates no climatic preference. Possibly their amentiferous inflorescences prolong the large pollen delivery. March 19, 1994 there was rain between 3 to 7 pm which decreased amount of pollen captured.

The largest captured *Trema* pollen was between April 1 and 7, 1994 mainly at 9 pm to 11-13 am. During these times the tempeature was higher and the moisture content was lower, which might indicate that the delivery of pollen grains of *Trema* was in proportion to that increased temperature and decreased moisture content. The aeropollen was captured in normal condition because there was no rain at this period.

Aeropollen dispersed at long distance

There are about 44 taxa which do not grow within the 5 km^2 circular investigated areas. The major taxa are *Bischoffia javanica, Casuarina, Artemisia*, and *Carpinus.* Their captured aeropollen was 6,184, or 4.07 % of the total count (Table 3).

DISCUSSION

Some aeropollen dispersed at long distance could be found in small amounts. Such pollen were derived from lowland species such as *Bischoffia javanica, Casuarina,* and *Artemisia*, and from higher elevation such as *Carpinus*.

The three most abundantly captured aeropollen per month were from *Broussonetia, Trema, Mimosa*, Gramineae and *Alnus* in that order, which were captured in different months and years.

Arsdisia squamulosa produced the most abundant aeropollen captured in May 1993, but *Trema* did so in 1994. The Cruciferae produced the most abundant captured aeropollen in June 1993, but Gramineae did so in 1994. *Mimosa* produced the most abundant captured aeropollen in July 1993, but *Fraxinus formosanus* did so in 1994. *Mimosa* produced the most abundant captured aeropollen in August 1993, but Gramineae did so in 1994. *Alnus* produced the most

Table 3. Long disperion aeropollen taxa and their numbers and frequences at Pingtung Station during May 1993 and April 1995.

Taxa	Amount	Percent
Actinostemma lobatum	4	0.00
Ardisia crenata	4	0.00
BUXACEAE	4	0.00
Crepidiastrum taiwanianum	4	0.00
Cryptotaenia canadensis	4	0.00
Gynostemma	4	0.00
Ormocarpum cochinchinense	4	0.00
Punica	4	0.00
Spiraea	4	0.00
Talinum	4	0.00
Utricularia vulgaris	4	0.00
Gelonium	7	0.00
Fagara	8	0.01
OENOTHERACEAE	8	0.01
Pinus luchuensis	8	0.01
Serissa japonica	8	0.01
ACTINIDIACEAE	12	0.01
Capsella	12	0.01
Claoxylon	12	0.01
DRYPODIACEAE	12	0.01
Schefflera	12	0.01
Telanthera amoena	12	0.01
Celtis	16	0.01
Champereia	16	0.01
Engelhardtia roxburghina	16	0.01
Formosia	16	0.01
LENTIBULARIACEAE	16	0.01
Trachelospermum	16	0.01
AIZOACEAE	20	0.01
Tsuga	20	0.01
Trichodesma khasianum	24	0.02
DAPHNIPHYLLACEAE	44	0.03
Ambrosia elatior	48	0.03
Gomphrena L.	52	0.03
UMBELLIFERAE	60	0.04
CHENOPODIACEAE	64	0.04
ACERACEAE	72	0.05
Zelkova formosana	100	0.07
Pinus	399	0.26
Carpinus	644	0.42
Artemisia	676	0.45
Ardisia sieboldii	963	0.63
Casuarina	1279	0.84
Bischofia javanica	1468	0.97
Total: 44	6184	4.07

abundant captured aeropollen in September 1993 and also in 1994. *Mimosa* produced the most abundant captured aeropollen in October 1993, but *Alnus* did so in 1994. *Mimosa* again produced the most abundant captured aeropollen in November 1993, but Gramineae did so in 1994. *Mimosa* again produced the most abundant captured aeropollen in December 1993, but Gramineae did so in 1994. *Mimosa* again produced the most abundant captured aeropollen in January 1994 but Gramineae did so in 1995. *Mallotus paniculaltus* produced the most abundant captured aeropollen in February 1994 but Amarantaceae did so in 1995. *Broussonetia* produced the most abundant captured aeropollen in March 1994 and also in 1995. *Trema* produced the most abundant captured aeropollen in April 1994 and also in 1995.

The seasonal variation was prominent in the different representative taxa captured (Table 1): During spring the most abundant captured aeropollen were from *Mallotus paniculatus, Broussonetia* and *Trema* of tree species in 1994 and Amaranthaceae, *Broussonetia* and *Trema* of herbs and trees. During summer the most abundant captured aeropollen were *Ardisia squamulosa,* Cruciferae and *Mimosa* in 1993 and *Trema,* Gramineae and *Fraxinus formosanus* in 1994. During autumn the most abundant captured aeropollen were *Mimosa* and *Alnus* in 1993 and, Gramineae and *Alnus* in 1994. During winter the most abundant captured aeropollen were *Mimosa* in November to December of 1993 and January of 1994 and Gramineae in November to December of 1993 and January of 1994.

The daily and diurnal variations were also obvious. But the variation consists of different taxa.

The pollen calendar might be useful (Figs. 5-6) for local doctors. The major aeropollen taxa captured varied at different times. During spring season, the major aeropollen taxa were *Calocedrus formosana, Macaranga tanarius, Casuarina, Phoenix hanceana var. formosana, Trema, Broussonetia* and *Syzygium samarangense* for tree pollen species; during summer, the major aeropollen taxa captured were from the herbaceous Cruciferae and woody *Ardisia squamulosa* and *Areca catechu*; during autumn, the major aeropollen taxa captured were from herbaceous plants of *Mimosa pudica* and woody *Mallotus;* during winter, the major aeropollen captured were from *Eupatorium* species. Grass pollen appeared abundantly throughout the year.

The patterns related to the weather conditions were found the same as in a previous report (Chen and Huang, 1980). Thus the variation between temperature and relative humidity and the amount of aeropollen captured always varies with different taxa, but not the rainfall.

There are still 3,104 grains or 2.04 % captured aeropollen remain unidentified. Their occurrences were higher in January to April when the grasses and tree pollen were dominant.

ACKNOWLEDGMENT

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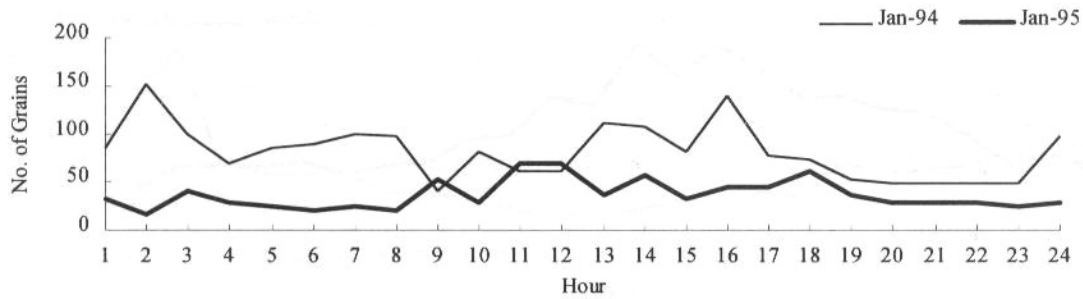

Fig. 5. Diurnal variation by total monthly aeropollen in January 1994 and 1995 at Pingtung Station.

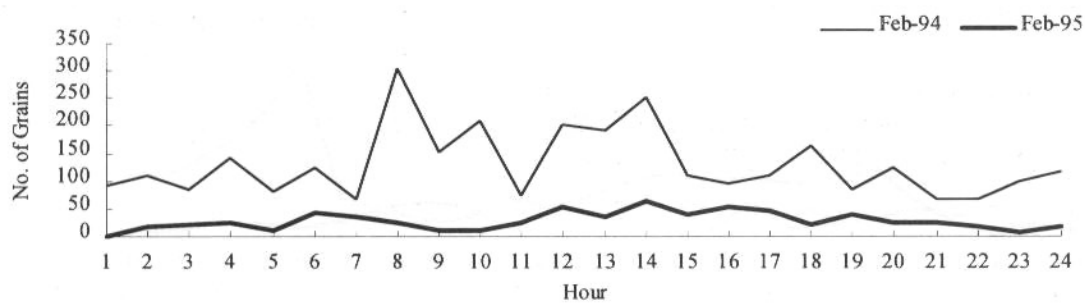

Fig. 6. Diurnal variation by total monthly aeropollen in Feburary 1994 and 1995 at Pingtung Station.

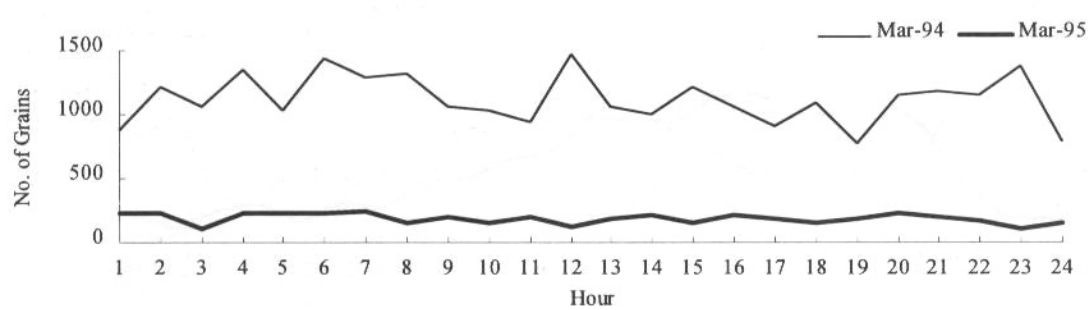

Fig. 7. Diurnal variation by total monthly aeropollen in March 1994 and 1995 at Pingtung Station

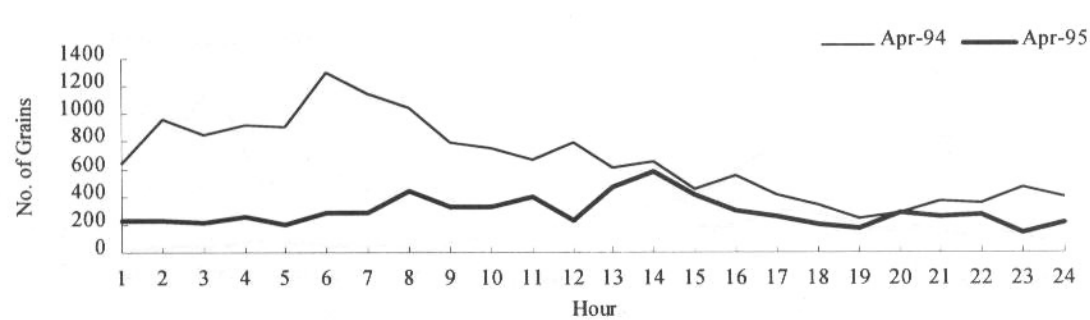

Fig. 8. Diurnal variation by total monthly aeropollen in Aprril 1994 and 1995 at Pingtung Station

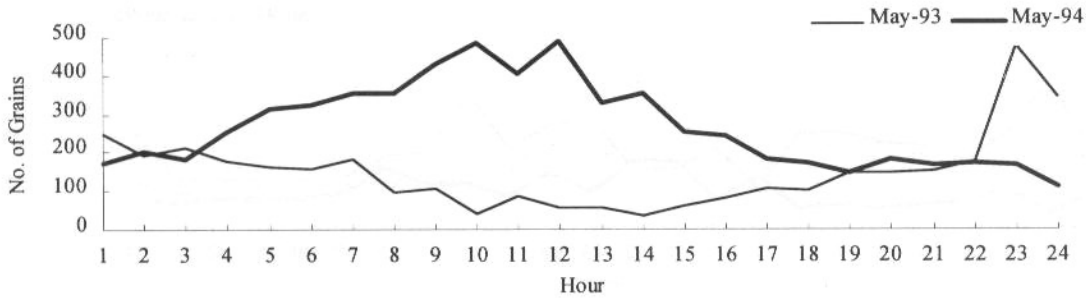

Fig. 9. Diurnal variation by total monthly aeropollen in May 1993 and 1994 at Pingtung Station

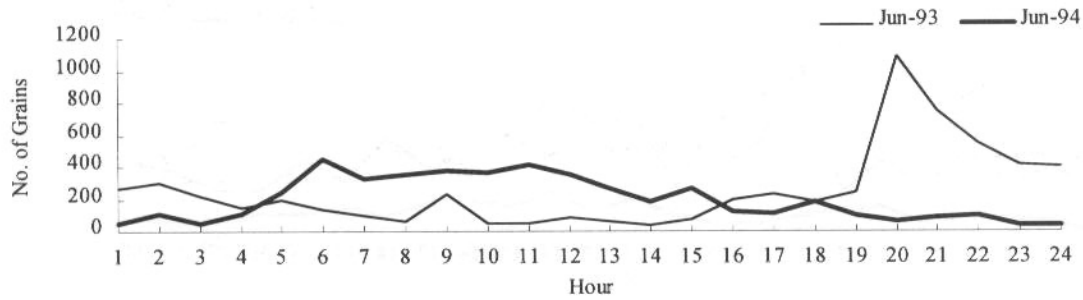

Fig. 10. Diurnal variation by total monthly aeropollen in June 1993 and 1994 at Pingtung Station

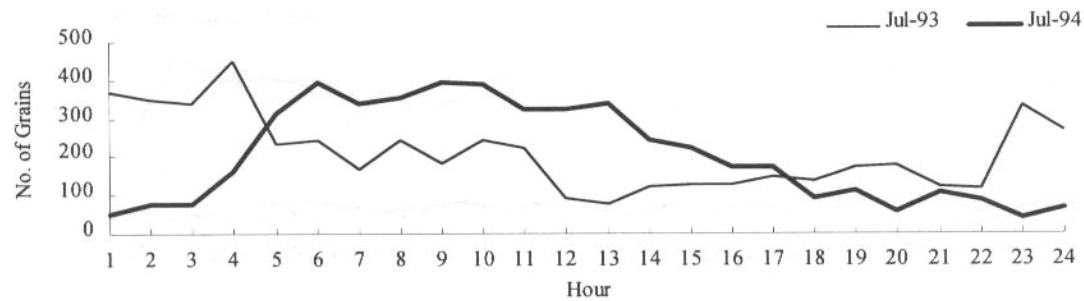

Fig. 11. Diurnal variation by total monthly aeropollen in July 1993 and 1994 at Pingtung Station

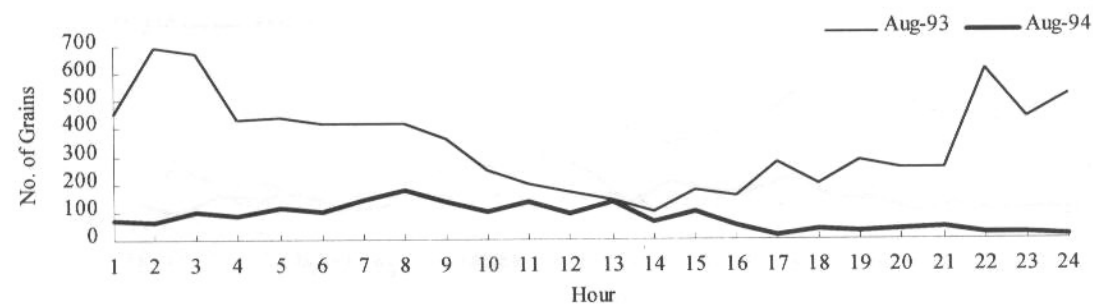

Fig. 12. Diurnal variation by total monthly aeropollen in August 1993 and 1994 at Pingtung Station

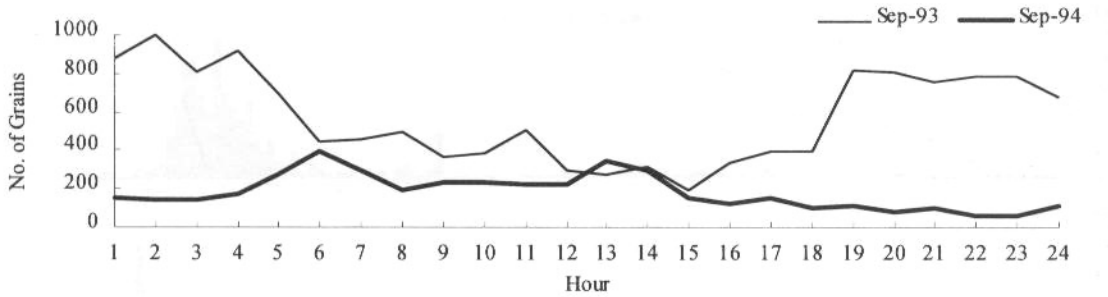

Fig. 13. Diurnal variation by total monthly aeropollen in September 1993 and 1994 at Pingtung Station

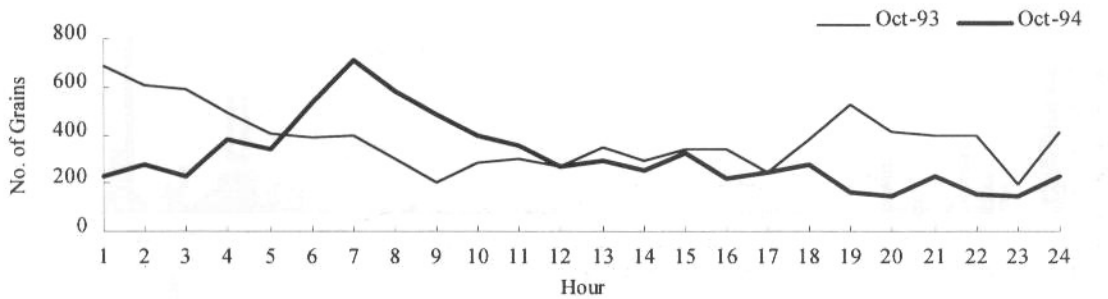

Fig. 14. Diurnal variation by total monthly aeropollen in October 1993 and 1994 at Pingtung Station

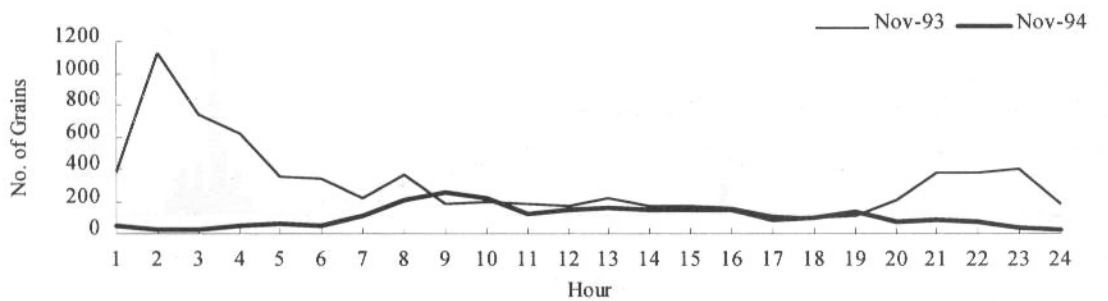

Fig. 15. Diurnal variation by total monthly aeropollen in November 1993 and 1994 at Pingtung Station

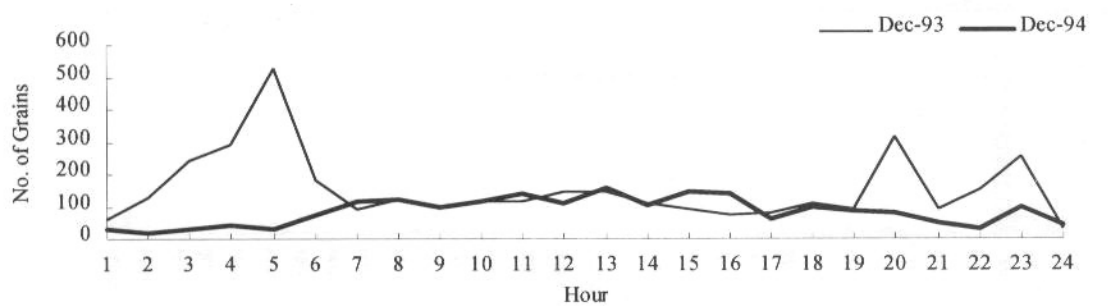

Fig. 16. Diurnal variation by total monthly aeropollen in December 1993 and 1994 at Pingtung Station

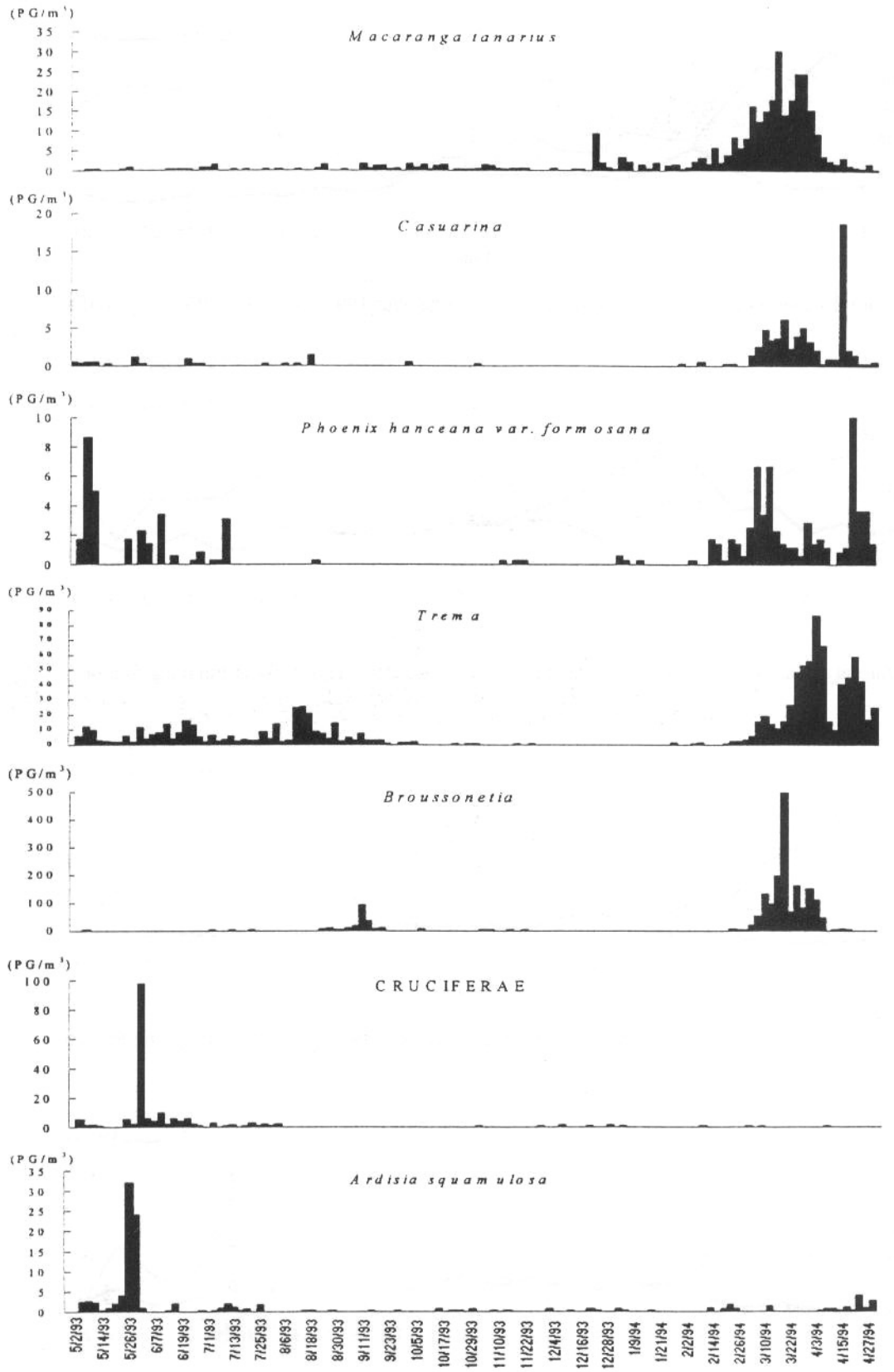

Fig. 17. Pollen calender at Pingtung Station during May 1993 and April 1994.

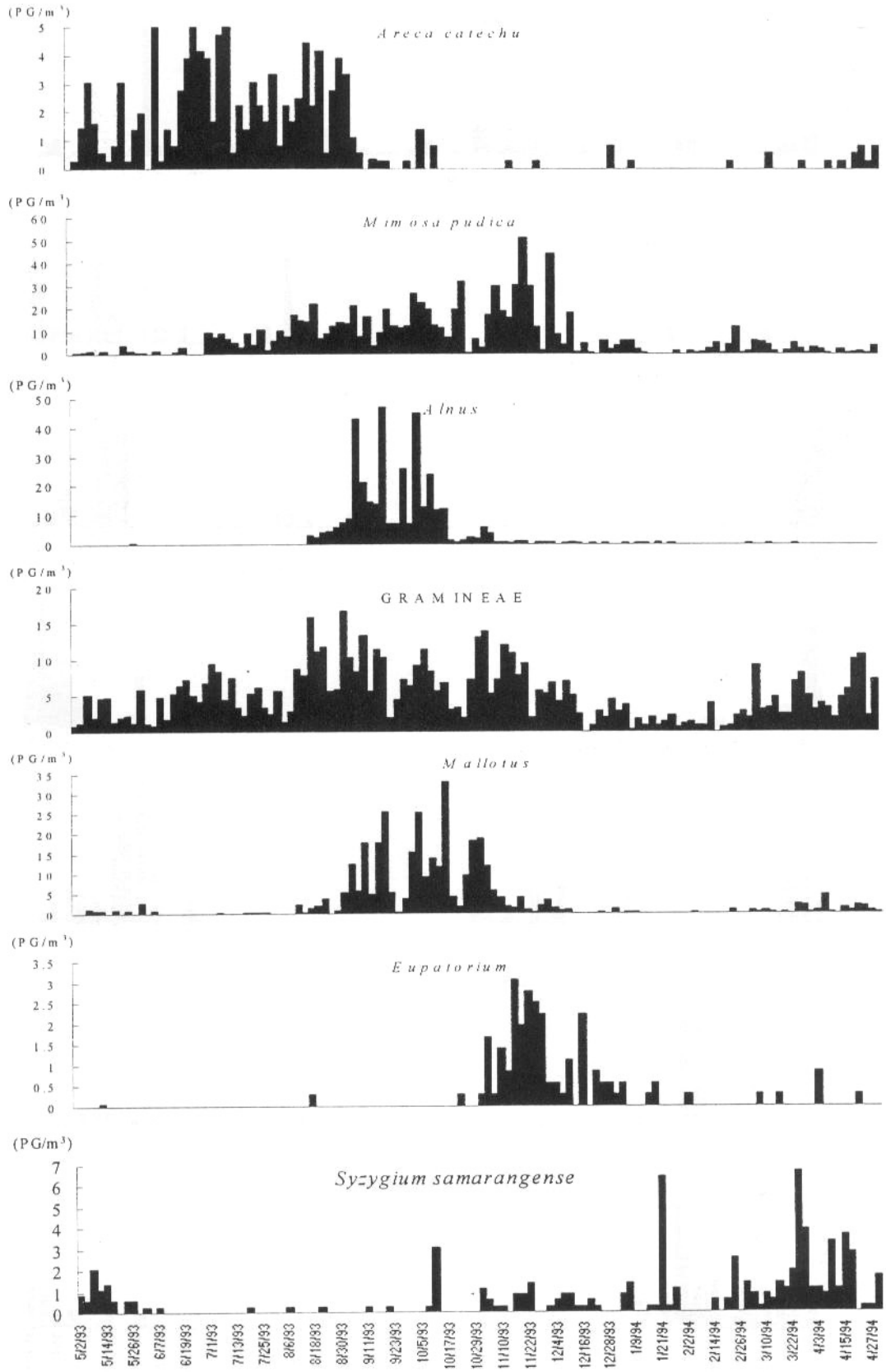

Fig. 17. Pollen calender at Pingtung Station during May 1993 and April 1994, continued.

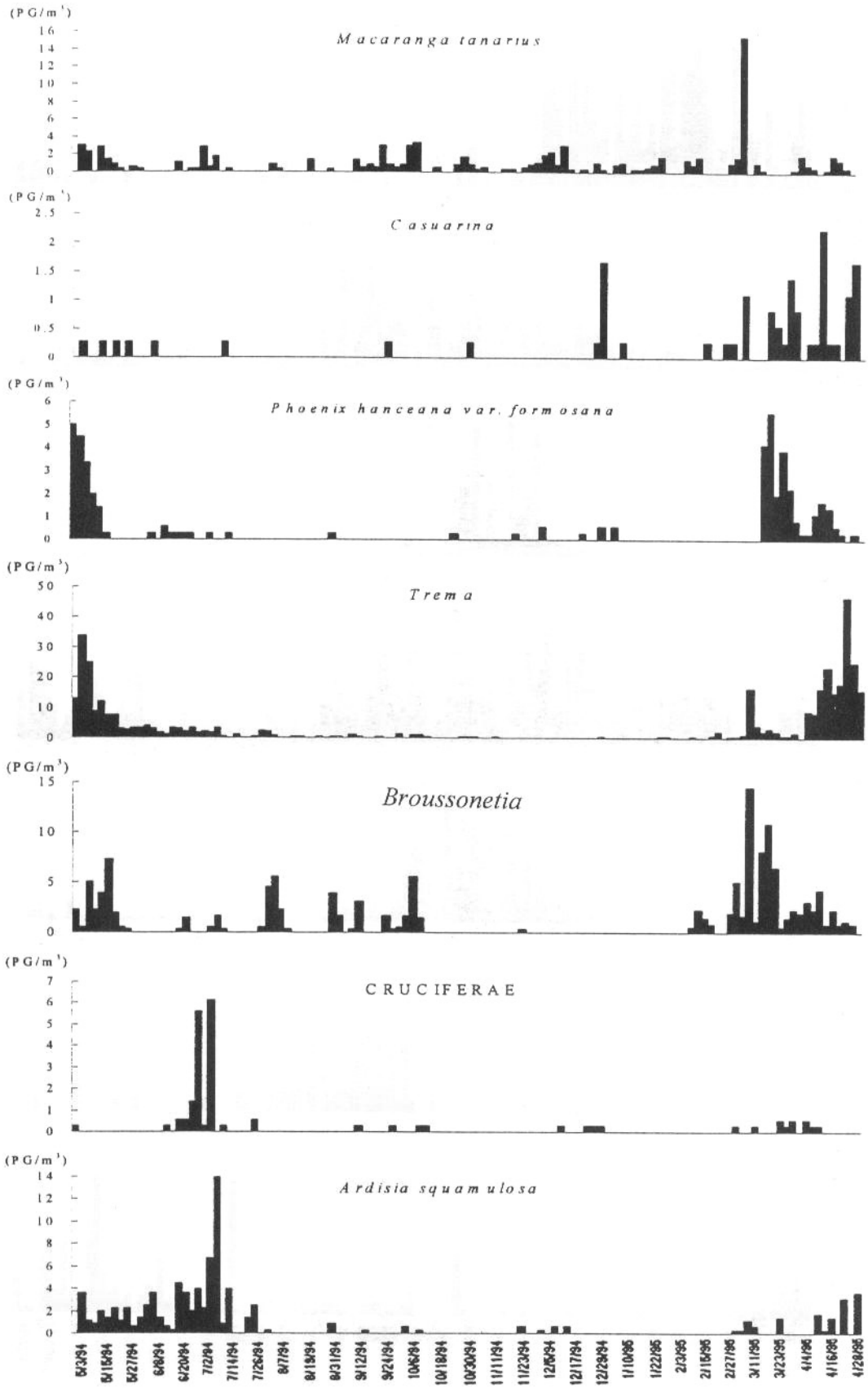

Fig. 18. Pollen calender at Pingtung Station during May 1994 and April 1995.

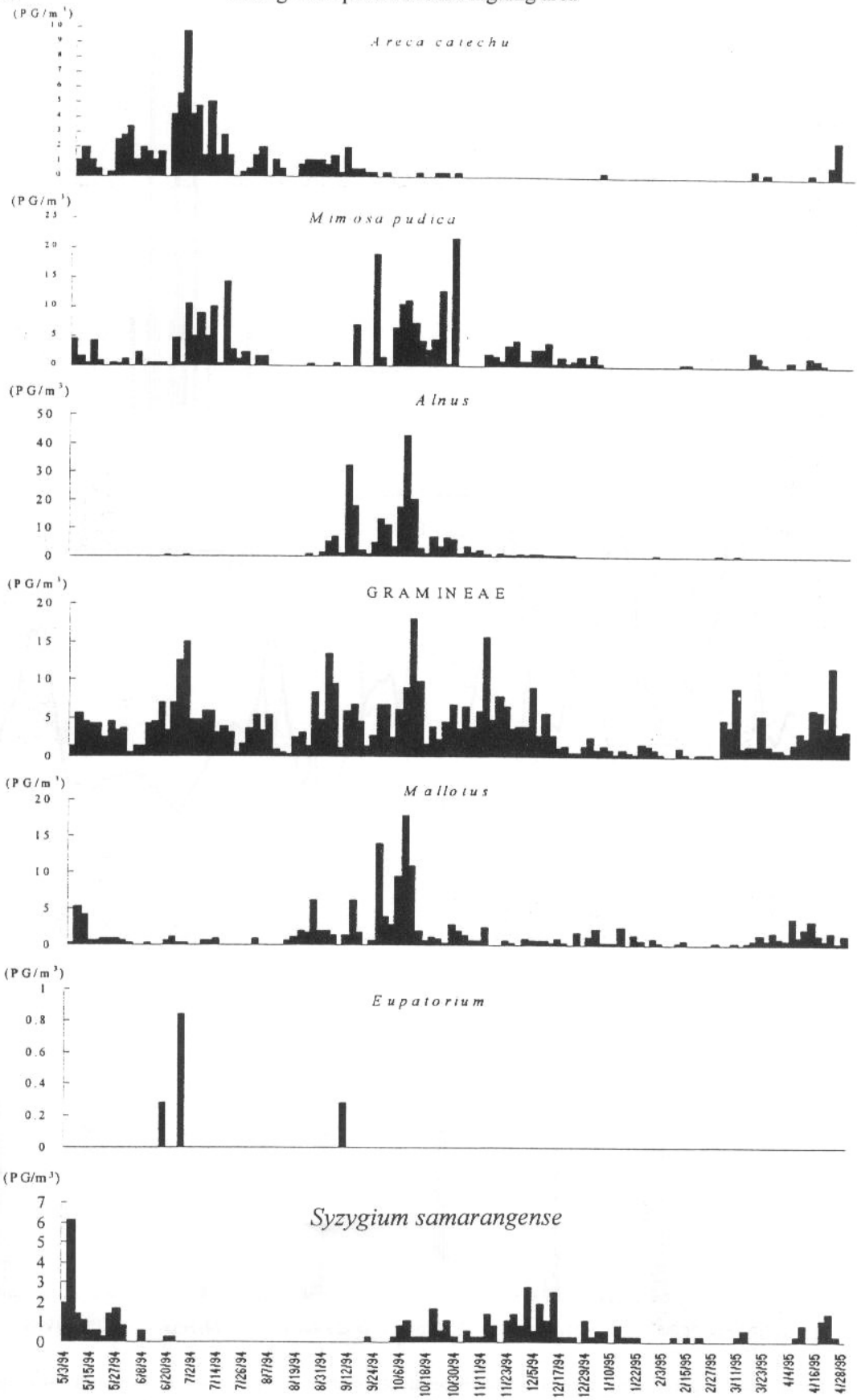

Fig. 18. Pollen calender at Pingtung Station during May 1994 and April 1995, continued.

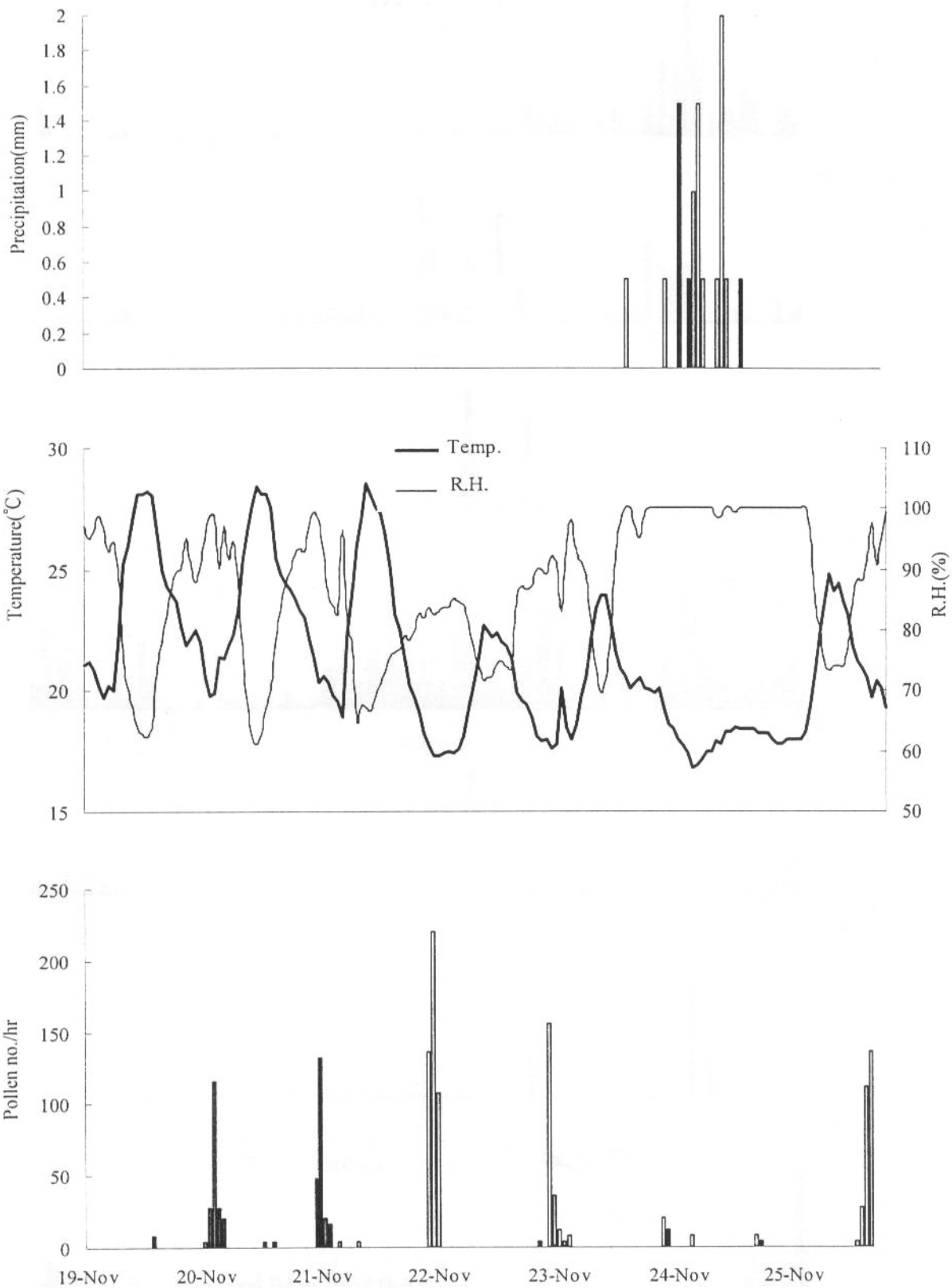

Fig. 19. *Mimosa pudica* aeropollen in relation to temperature, relative humidity and precipitation at Pingtung Station during November 19 and 25.

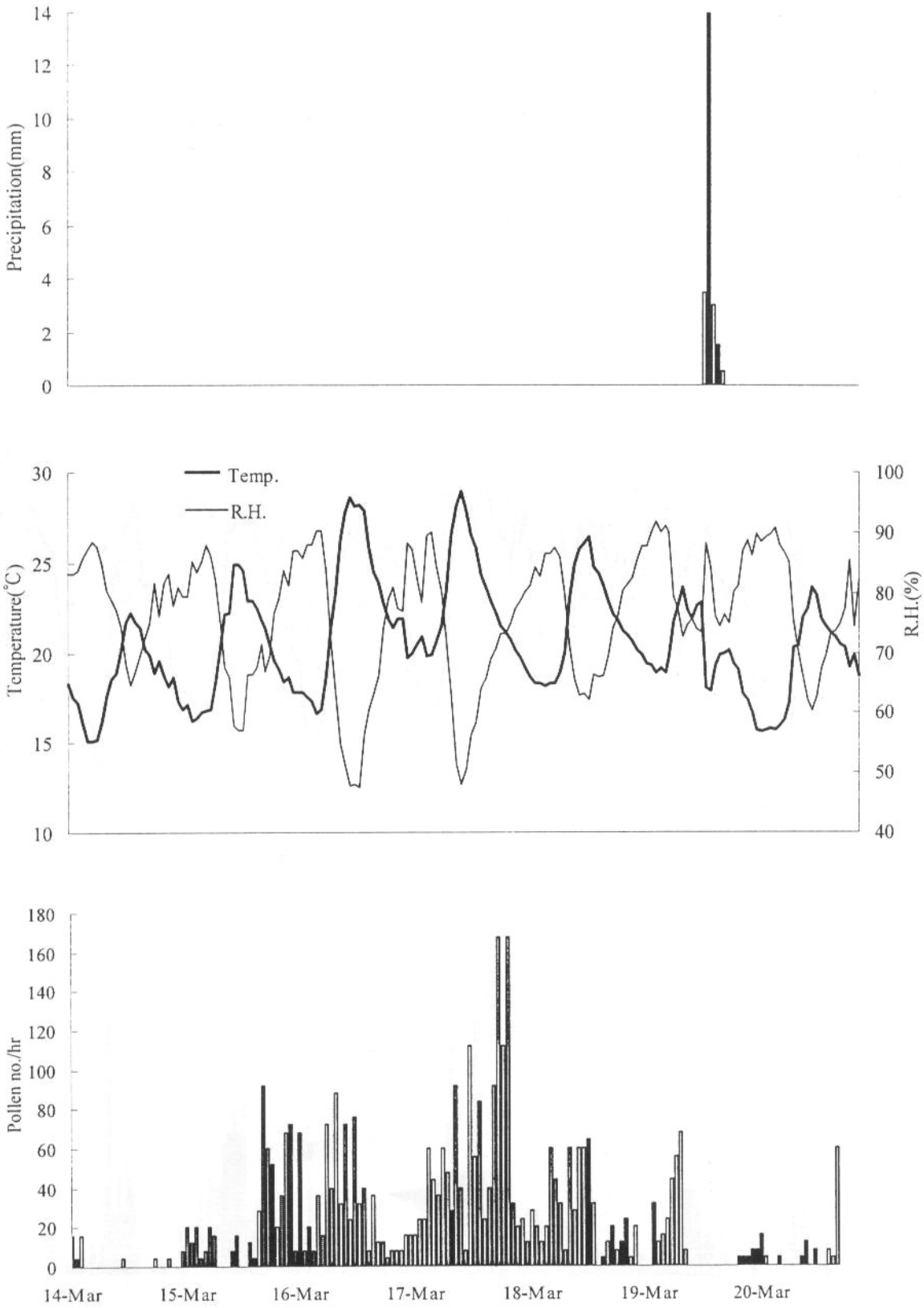

Fig. 20.*Broussonetia* aeropollen in relation to temperature, relative humidity and precipitation at Pingtung Station during March 14 and 20.

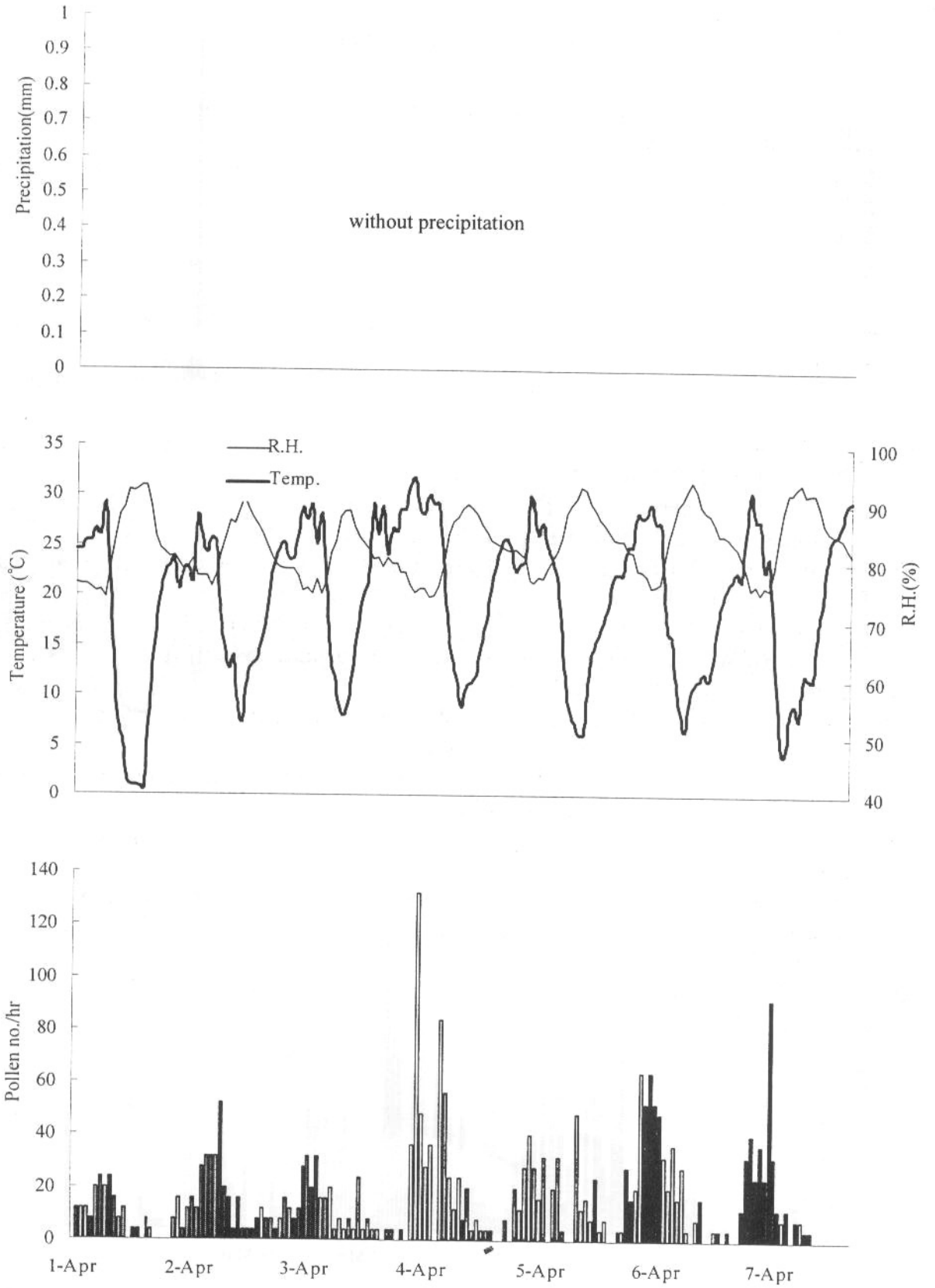

Fig. 21. *Trema* aeropollen in relation to temperature, relative humidity and without precipitation at Pingtung Station during April 1 and 7.

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屏東地區之空中孢粉研究

黃增泉[1, 2]

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摘　要

花粉(孢子)引起過敏症通稱為花粉(孢粉)病。過去台灣醫學界已展開此類基礎性之研究，例如趙懿族、陳正言、莊哲彥、韓韶華、王世睿、蔡肇基、劉雨田等教授。國科會為鼓勵設置監測站長期性研究各地空氣過敏原供醫療機構參考，自1992年11月起至1996年7月止共進行補助為期3年9月之研究調查。參與規劃研究群分散於五大學術機構及分別負責六大研究站之空中孢粉搜集，製片，鑑定及撰寫研究成果。因此將各組研究結果較為整齊之兩年，自1993年5月至1995年4月整合成書[台灣空中孢粉誌]，又經國科會贊助將於1998年7月中出版。本文內容僅報導屏東站自1993年5月至1995年4月之研究成果，其研究項目包括環境概況，孢粉總量，每月孢粉數量和種類，二年間孢粉每日之密度，孢粉曆，空中孢粉量與氣象因子，遠距離傳送的花粉，重要空中孢粉與植被，致敏花粉等。

結果顯示空中花粉年收集量，以構樹具有最大量；月最大收集量發生於1994年三月；每小時最大收集量每月不同，難以決定其每小時之最大收集量。藉由花粉曆可得知各個分類群於何時具有較大的散發量。至於花粉散發量與氣候因子間之關係，因樹種而異。例如，含羞草在高相對濕度及低溫下具最大散發量；山黃麻則是在低相對濕度及高溫的狀況下具最大散發量；而構樹的最大散發量與氣候因子間的關聯性不大。由資料所得，約有44個花粉分類群屬於長距離分佈。

關鍵詞：空中，孢粉，屏東，台灣。

1. 國立台灣大學植物學系，台北市106，台灣，中華民國。
2. 通訊聯絡員。