論　　説

Dedicated
to
a special issue to the memory
of Dr. J. Ueno whose retirement from office

千葉県における空中飛散花粉の季節的変動

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Seasonal fluctuations of the airborne pollen grains & spores in Chiba Pref.

(especially at Narashino City)

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We studied on airborne pollen grains in details may be for the first time in Japan during 1957 and 1960[8]. After that many authors included us have reported on airborne pollen grains[9,11,18,19,21,22], and the results were almost same as in our first report.

Recently the dispersal pollen grains in the air became one of the most important problems between the relationship of the pollen allergic study [12,13,16,17,23,26]. Hence we have further investigated successively that had studied on airborne pollen grains collected at Narashino City, Chiba Prefecture, about 25 km east of Tokyo about fifteen years ago. In this paper we have compared the results of this survey with our first report, especially the fluctuation of the daily counts and the number of species of airborne pollen grains at Narashino City that have a marked tendency to urbanization during 1974 and 1976.

Furthermore we had also a preliminary survey on some airborne grains such as spores of ferns, mosses and fungi. But in this report we have studied only to identify these species. As another purpose of this survey we tried to collect airborne grains in the air from a helicopter at the tree season in 1976, and the

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ragweed season in 1975 and 1976.

The result of this new survey we got some noticeable views about atmospheric grains.

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Methods

The equipage used was the shelter (standard sampling apparatus) holding inside a slide wetted with vaseline. Two shelters were laid at the height of 20 m at Narashino City during 1974 and 1976, and a slide for pollen grains was replaced daily, while the other for spores on every third day. The method of preparation and identification of species was taken almost following our previous paper[8].

In the meantime, on the third of September in 1975, airborne grains were obtained at the height of 100 to 300 m on the area of Kisarazu City, about 70 km east of Tokyo from the helicopter. The airborne grains were collected as follows, i. e. two slides with vaseline holding outside of the helicopter were kept during about 20 minutes at various heights against the direction of flying machine. And also both on the third of March and the sixth of September, 1976, we obtained airborne grains on the helicopter at almost same place and same method as in 1975. Thus these sampling slides were treated as the same method used for shelter ones.

Results and Discussion

Table 1 shows the number of species of airborne pollen grains collected during 1974 at the height of 20 m in a space of 10 square centimeter. The identified pollen grains in the previous survey (1957-1960) were 86 species, but in 1974, only 47 ones were identified, so that the latter reduced to half than the former ones. Nevertheless we observed for the first time some noticeable airborne grains, such as *Tsuga sp., Ginkgo biloba, Ephedra sp.* and so on.

One of the remarkable fact in this paper, the maximum daily counts of some airborne grains showed a fairly decrease or increase in number than the previous report as shown in the table 2. For example, the grains of *Typha angustata* and *Ambrosia elatior* showed conspicuously decreased in number. In the former 353 grains were counted in the previous data, but merely 1 or 2 grains in this study, and in the latter 1, 813 grains found in 1959, while only 175 in 1976 in a space of 10 square centimeter. Moreover the grains of *Cryptomeria japonica, Pinus thunbergii* and *P. densiflora* are also fairly decreased in daily counts. Especially in March of 1975, the grains of *Cryptomeria japonica* were only 235. There are some reasons why such conspicuous decrease in number of grains during 15 years or so. It may not be caused only by the climatic change. The more reasons may have under the following plausible causes, i. e. recently the land improvement in Narashino City and its outskirts and the tendency of the urbanization have been made with rapid progress since 15 years or so. So that many trees and grasses which were dispersed airborne grains are decreased of their population.

On the contrary we cannot overlook that some species are increased in number of grains rather than previous data. For instance, 15 grains of *Humulus japonicus* were obtained even the highest peak in 1957,

Table 1. The number of species of airborne grains collected during 1974 at the height of 20 m (10cm²).

SPECIES	10 cm²	1	2	3	4	5	6	7	8	9	10	11	12
Cryptomeria japonica	1128												
Alnus japonica	33												
Chenopodium ambrosioides var. anthermintcum	1												
Gramineae	39												
Eligeron sp.	1												
Solidago japonica subsp. asiatica	1												
Chamaecyparis pisifera	19												
Pinus sp.	2274												
Ginkgo biloba	1												
Chamaecyparis obtusa	57												
Ribes sp.	2												
Zelkova serrata	258												
Alnus sieboldiana	2												
Carpinus japonica	2												
Nerium indicum	1												
Moraceae	3												
Quercus acutissima	15												
Ixeris sp.	3												
Juglandaceae	1												
Rumex obtusifolius	8												
Ilex crenata	2												
Celtis sinensis var. japonica	88												
Cunninghamia lanceolata	1												
Quercus dentata	1												
Pittosporum tobira	14												
Broussonetia papyrifera	6												
Juglans ailanthifolia	8												
Tilia japonica	14												
Quercus serrata	5												
Quercus acuta	1												
Sciadopitys verticillata	1												
Tsuga sieboidii	2												
Ephedra sp.	2												
Carex aphanolepis	1												
Gnaphalium affine	2												
Ribes fasciculatum	4												
Castanea crenata	66												
Weigera sp.	1												
Diospyros kaki var. domestica	16												
Typha latifolia	1												
Mallotus japonicus	2												
Rumex conglomeratus	1												
Plantago lanceolata	2												
Typha angustata	2												
Euphorbiaceae	1												
Prantago asiatica var. densiuscula	1												
Leguminosae	1												
Artemisia princeps	29												
Ambrosia elatior	163												
Rumex sp.	1												
Chenopodium album	25												
Humulus japonicus	222												
Lactuca indica	1												
Euxolus viridis	1												
Foeniculum vulgare	1												
Chenopodium ambrosioides	6												
Solidago altissima	28												
Reynoutria japonica	1												
Macleya cordata	1												

Table 2. A comparative table of the maximum daily counts of fifteen wind-pollinated flowers (10 cm^2).

Species	1957-1960	1974	1975	1976
Cryptomeria japonica	3764	1128	235	2260
Ginkgo biloba	0	1	5	4
Pinus densiflora	1210	522	449	288
Pinus thunbergii	3387	2274	3220	1737
Alnus japonica	7	33	57	35
Zelkova serrata	23	258	40	384
Typha angustata	353	2	1	2
Typha latifolia	0	1	1	1
Chenopodium album	6	25	9	5
Humulus japonicus	15	222	114	73
Plantago lanceolata	28	2	10	11
Ambrosia elatior	1813	163	109	175
Artemisia princeps	0	52	63	42
Solidago altissima	1	28	13	21

but 222 grains were counted in 1974, that is fifteen times increase in number of grains. While *Solidago altissima* which has a strong propagating power became the object of public attention as one of the public nuisance plants. This grains were counted 1 only in 1957, but in 1974 increased to 28. However we expected to obtain more grains than 28, because of its large population in Chiba Prefecture.

In our previous report[8], we showed the relationship between the dispersal counts of pollen grains and humid influence. Namely the maximum counts in a day are showing the time of the lowest humidity. In this time we tried again the relationship between humid influence and dispersal grains at the onset of pine pollination. Table 3 shows the effect of humidity on the dispersal pine pollens at the height of 1 m during 24 hours. Naturally we come to substantially the same result as in the previous data. But, at the height of 20 m, we obtained an unexpected result as shown in the table 4, i. e. just before rainfall there was a sudden great peak of dispersal grains during only an hour. This may be caused by raindrops with pollen grains. Because, it is said that heavy rain washes the pollen from the air[4,5].

Further investigations in this study, we observed many spores of ferns, mosses and fungi as shown in Pl. II. Some spores of ferns were identified, i. e. *Equisetum arvense, Osmunda japonica, Pteris multifida* and *Cyrtomium fortunei*. But, spores of mosses were very difficult to identify even their genera. On the other hand spores of fungi brought some quite interesting views, such as *Myxomycetes, Ascomycetes* and *Basidiomycetes*. However those spore morphology are quite similar in outline, so that we could not easy to clarify the real name of these species. The obtained spores of the maximum number of grains during three days in each month, we collected about 500 grains from August to October. On the contrary only 20 to 70

Table 3. Effect of humidity on dispersal pollen grains at the height of 1 m (*Pinus thunbergii*).

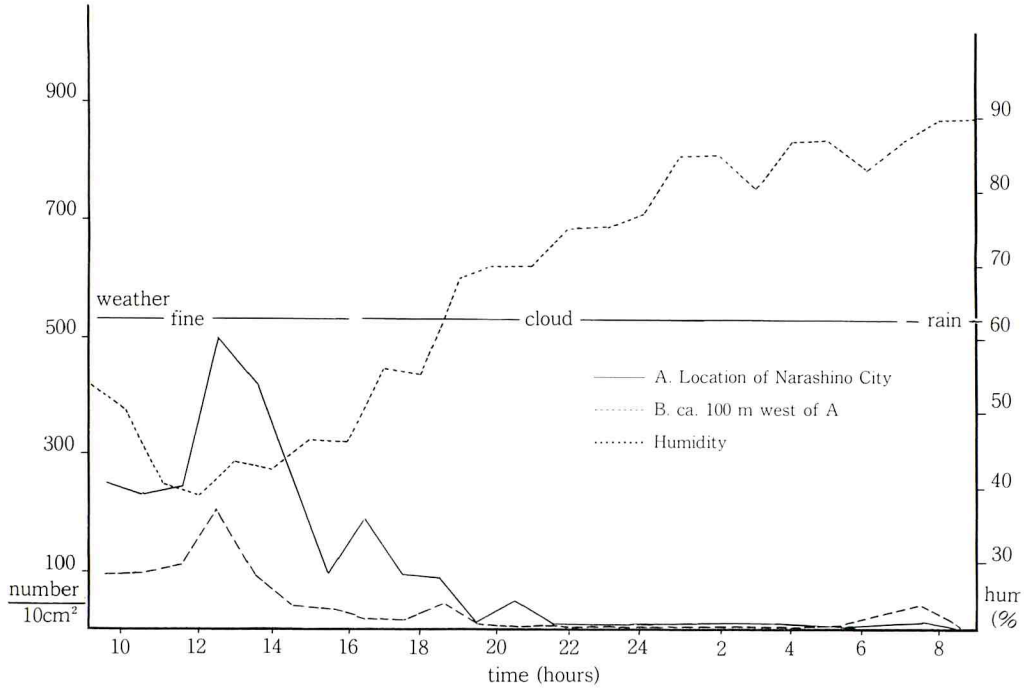

Table 4. Effect of humidity on dispersal pollen grains at the height of 20 m (*Pinus thunbergii*).

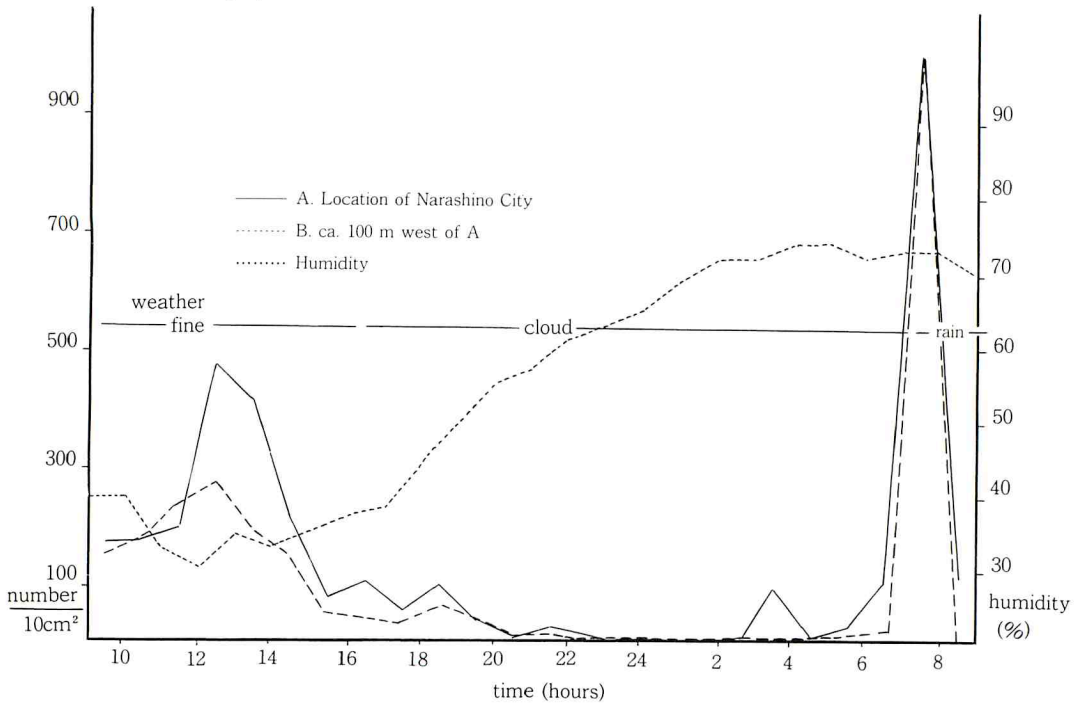

Table 5. Pollen counts at different heights during 20 minutes on a helicopter (20 cm^2).

Height (m)	Sept. 1975	Mar. 1976	Sept. 1976	Notes
20			189	Humulus japonicus,
50			285	Ambrosia elatior,
100	40		444	Artemisia spp.,
200	46			Chenopodium spp.,
300	25			grass, etc.
400		26		Cryptomeria japonica,
500		22		Alnus japonica, etc.
600		16		
1000		25		
3000			3	Humulus japonicus, etc.

grains were counted from December to February. So that in summer, we got more spore counts than pollen grains in a space of 10 square centimeter.

In the ragweed season of 1975 and 1976, and in the tree season of 1976, a new method airborne grains survey have been investigated by a helicopter. We showed the number of obtained grains at various heights per 20 minutes survey on a helicopter in the table 5. At first we could not expect to get more airborne pollen grains than usual method. Nevertheless the total number of grains at each height from 20 to 200 m were conspicuous rather than usual data only 20 minutes survey. Especially, we had the maximum number of grains at the height of 200 m in September of 1976. Furthermore at the height of 3000 m during only 20 minutes, we obtained 3 grains, i. e. *Humulus japonicus, Alnus japonica* and a kind of the grass family.

Up to this time, numerous students have been reported on airborne grains by sampling from aeroplanes. Scheppegrell [1,2] showed that pollen was found at up to 5800 m over the Mississippi. However, in general the pollen grains are obtained easily at up to 1000 m. So that our record may be one of the highest altitude tested on airborne pollen grains. Rempe[3] described that in night flights, the maximum number of grains was often reached at a height of about 200 m. This effect is equal as our survey.

In this survey we could not investigate on volumetric methood, so in near future we hope to collect airborne pollens and spores from the helicopter on the volumetric method, and want to clarify on daily or seasonal fluctuations of airborne grains at various hights.

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要　　約

我々は1957—1960年の間、我が国では初めて空中飛散花粉について詳細に報告した。その後多数の同じような報告が我々も含めてなされ、その結果は、ほぼ同様であった。最近になって花粉アレルギーが我が国でも次々報告され、年間の空中花粉の調査が重要視されてきた。今回我々は、1974—1976年の間、最初の調査地である。千葉県習志野地区で調査した空中花粉について前回（1957—1960）の報告と、飛散花粉の種類や、10 cm²あたりの個体数等比較した結果、次の様であった。

1）1974年の一年間では、判明した花粉の種類数は47種で前回の約半数であった（table 1.）。

2）前回に捕集できなかった種類、例えば、ツガ類、イチョウ、マオウ類等、個体数は少ないが捕集した。

3）前回の調査と比較して個体数が非常に減少した種類は、ヒメガマ（353個→2個）、ブタクサ（1813個→175個）等である。また、スギ、マツ類もかなり減少している（table 2.）。

4）前回より増加した種類もあり、それらはカナムグラ（15個→222個）、セイタカアキノキリンソウ（1個→28個）などである。

5）1日における湿度と花粉飛散状態をクロマツの花粉飛散時に調査した。その結果、地上1mでは前回と同様であった（table 3.）が、地上20mでは、雨の降る1時間前に驚くべき捕集数を得た

(table 4.)。

また、今回我が国ではおそらく初めてヘリコプターによる空中花粉の捕集を行ない、table 5. のような結果を得た。すなわち、地上200 mあたりが最も飛散数の多い事(これは Rempe (1937年)の胞子の調査とほぼ一致する)が言えそうである。

Explanation of Plate I

A : Cryptomeria japonica
B : Pinus thunbergii
C : Tsuga sp.
D : Ginkgo biloba
E : Chamaecyparis obtusa
F : Abies sp.
G : Ephedra sp.
H : Juglans ailanthifolia
I : Alnus japonica
J : Alnus sieboldiana
K : Zelkova serrata
L : Castanea crenata
M : Morus bombycis
N : Celtis sinensis var. japonica
O : Ilex crenata
P : Typha latifolia
Q : Oryza sativa
R : Carex sp.
S : Humulus japonicus
T : Oxalis corniculata
U : Ambrosia elatior
V : Artemisia princeps
W : Solidago altissima

Explanation of Plate II

A : Equisetum arvense
B : Osmunda japonica
C : Cyrtomium fortunei
D : Pteris multifida
E : Pteridaceae gen. sp.
F : Bryophyta (trilete, granulate type)
G : Bryophyta (alete, spinulate type)
H : Bryophyta (trilete, reticulate type)
I : Ascospore (dyad type)
J : Conidia (polyadosporites type)
K : Conidia (Alternaria sp.)
L : Conidium (Helminthosporium sp.)
M : Conidium (Tetraploa sp.)
N : Basidiospore (Merulius sp. ?)

PLATE I

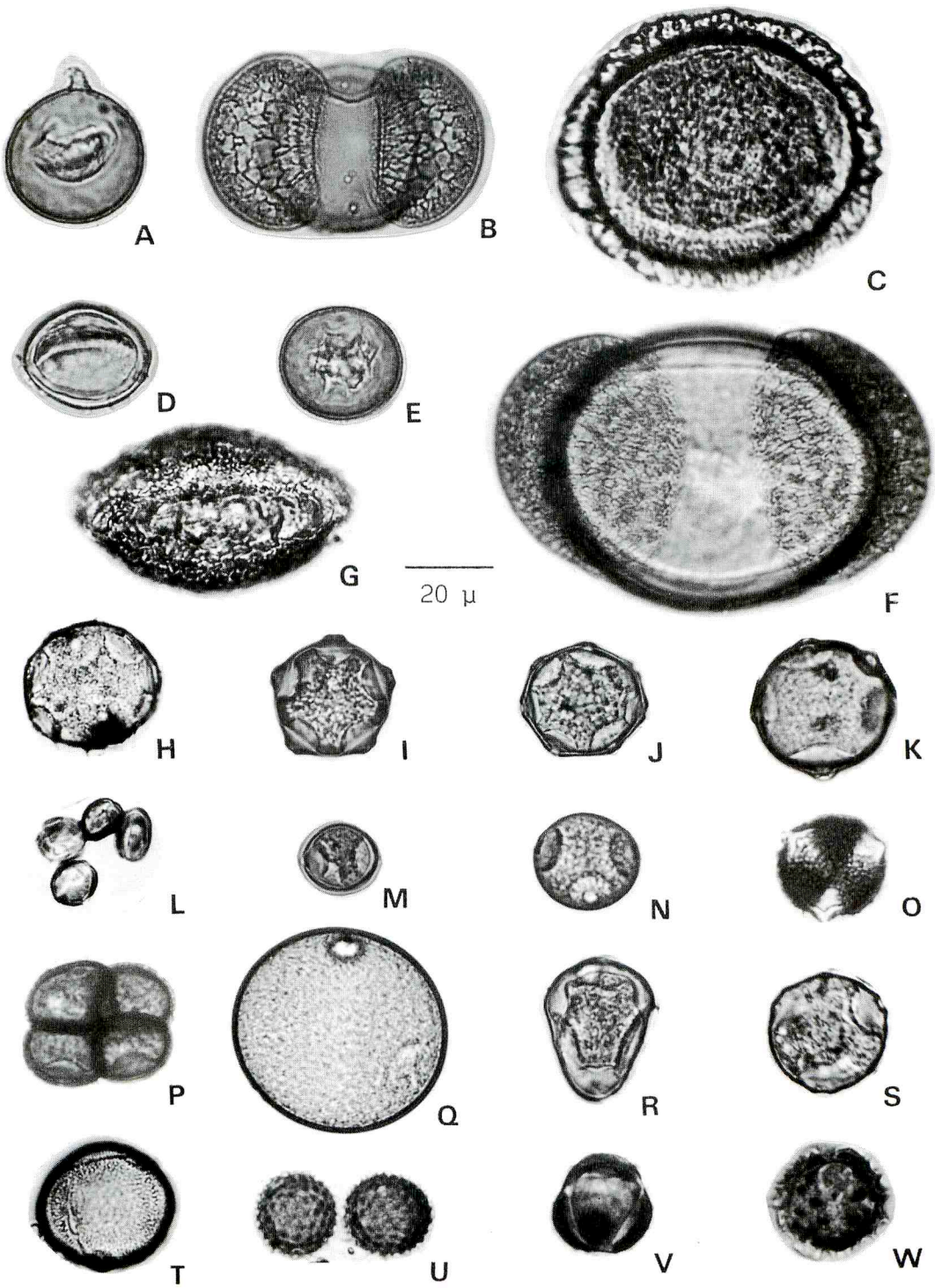

PLATE II