論　説

千葉県における空中浮遊花粉の季節的変動（2）

付記；マツ属花粉の走査電顕（SEM）による観察

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Seasonal fluctuations of the airborne pollen grains & spores in Chiba Prefecture (2).

Additional notes on *Pinus* pollen by the SEM.

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In our previous reports[5),6)] we have been investigated to clarify on the relationship between the dispersal counts of pollen grains and humid influence at the onset of pine pollination. In the present paper we try reagain further investigations about this noticeable problem in early May, 1977. The results gave us more important effect about the relationship of the effect of humidity and the dispersal pollen grains (Table 1 & 2).

While we have new airborne collecting method in the tree season. This method was carried out in an instrument shelter (Fig. 1). The results are as shown in the table 3 and 4.

Furthermore we set the pollen-slide shelter[1)] besides Narashino City, i. e. Kisarazu, Mobara and Sakura (Fig. 2). Both in the tree and ragweed season in 1977, the airborne pollen grains of *Cryptomeria japonica*, *Pinus* spp. and *Ambrosia elatior* were investigated at above the four urbanized areas. The comparative pollen counts at the different localities gave us some interesting results (Table 5, 6 & 7).

Another investigations for *Pinus* pollen grains by the scanning electron microscope was done both from the detail of the surface and the section of the pollen wall. We found some noticeable observations on the *Pinus* pollen wall or its saccus, and the fine relief on the proximal face of the body (Pl. I & II).

Materials and Methods

The standard pollen-slide shelters were set at Narashino (1 m and 15 m above the ground), Kisarazu (1 m and 20 m above the ground), Mobara (2 m above the ground) and Sakura (2 m above the ground). The slide was replaced daily or every two days. While a slide was laid in the instrument shelter and the results

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were compared with those of the pollen-slide shelter.

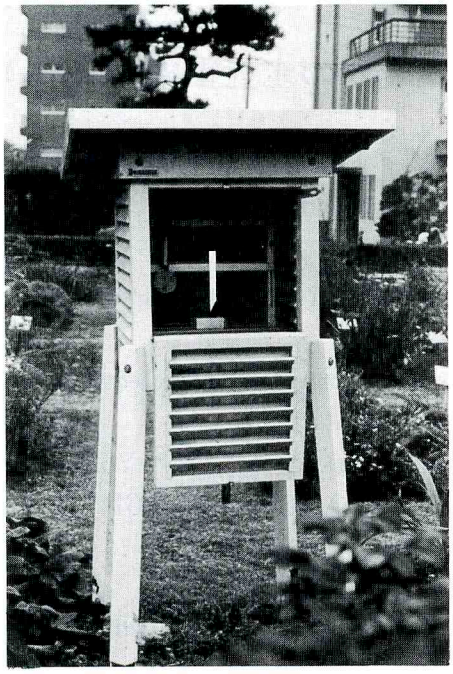

Fig. 1. A slide is setting in the instrument shelter, arrow points to the slide holder.

In the meantime, on May the second in 1977, we have observed the fluctuations of the dispersal pollen counts of *Pinus thunbergii* at every hour during 24 hours, at Narashino City both 1 m and 15 m above the ground.

The method of preparation and identification of species was taken almost as our previous paper[5].

The SEM materials were collected at Narashino and Kisarazu City during in full pine pollination in 1976 and 1977. Both the pollen grains and their sections were coated with thin gold metal after critical point*. Sections were made with a freezing microtome at a thickness of 4 μm.

Results and Discussion

In the previous report[6] we observed an unexpected dispersal pollen counts at the onset of pine pollination. In spite of the higher humidity, there was a large number of the pollen counts collected in an hour before the rain starts (Table 4). Usually the maximum dispersal pollen counts of the *Pinus* pollen grains has been obtained almost at the lowest humidity during the day. In this time we got only small peaks at noon in spite of the low humidity, then there was a highest peak during an hour at the midnight both 1 m and 15 m above the ground (Table 1 & 2). This unexpected phenomenon must be derived from a sudden drop in humidity as shown in the table 1 and 2. Effectually of this observation, the maximum *Pinus* pollen

*Critical point dry method : Materials were dehydrated in normal method by alcohol series, and substituted for n-amyl acetate, and then resubstituted for liquid-CO_2 at its critical point.

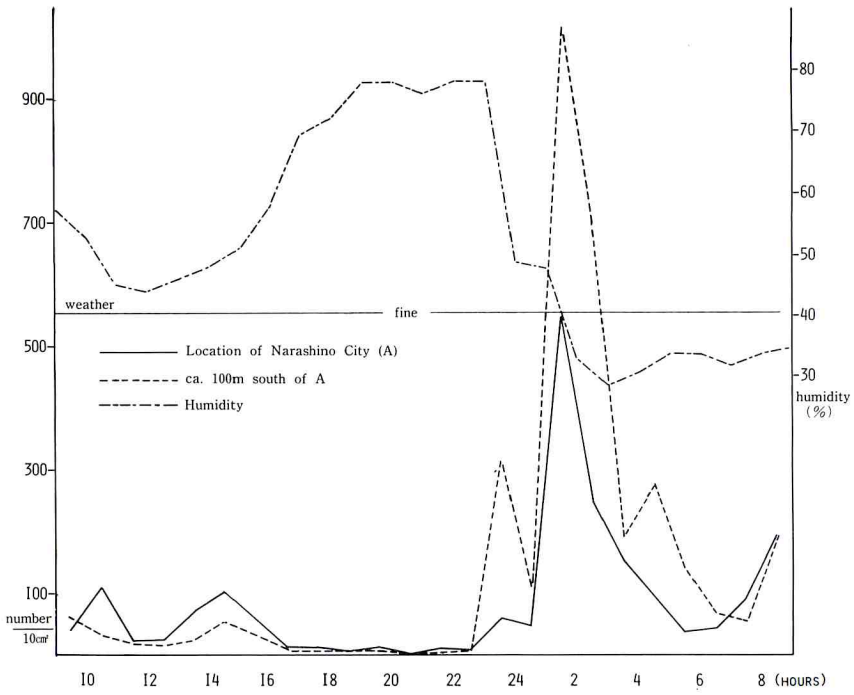

Table 1. Effect of humidity on dispersal pollen grains at the height of 1 m (*Pinus thunbergii*)

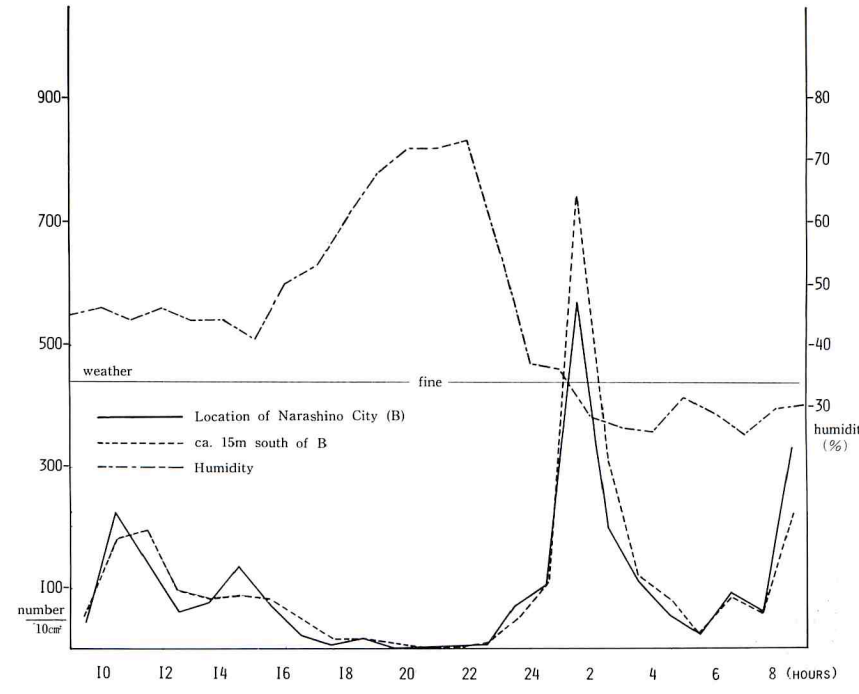

Table 2. Effect of humidity on dispersal pollen grains at the height of 15 m (*Pinus thunbergii*)

counts must be observed at a sudden drop in humidity without distinction of day and night. Also we consider that some another wind-pollinated flowers can be obtained same results as in the present study.

Table 3 shows the comparative dispersal pollen counts of *Cryptomeria japonica* collected at the height of 1 m and 15 m above the ground in Narashino City. The pollen-slide shelter was set at the location of A and B. While at location C, we set an instrument shelter and a slide was laid in it (Fig. 1). In the present results we could not get sharp peak than the previous paper[6]. The highest peak shows 601 grains at 1 m above the ground, and 15 m above the ground, we got only 224 grains that was about one-tenth in the previous season (2260 grains were counted in 1976). While in the instrument shelter, we observed more two sharply peaks than the pollen-slide ones. On the contrary, the effect of the dispersal pollen grains of *Pinus* spp. were obtained two sharp peaks as shown in the table 4. The sudden drop in number on the 25th of April was caused by the rainfall. The maximum daily counts of *Pinus thunbergii* was nearly equal to that of the previous survey (1737 grains were collected in 1976). In the meantime, the effect of the

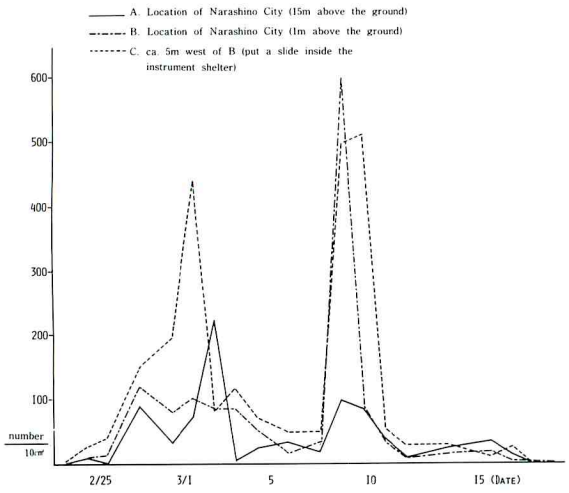

Table 3. Comparative pollen counts at three places in Narashino City (*Cryptomeria japonica*, 24h/10cm²)

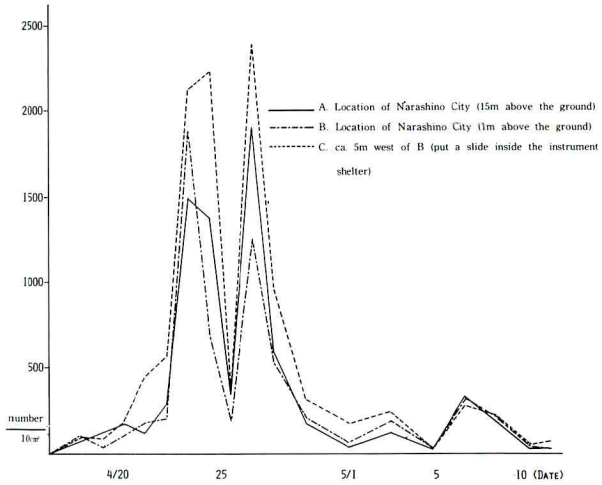

Table 4. Comparative pollen counts at three places in Narashino City (*Pinus* spp., 24h/10cm²)

collected grains in the instrument shelter brought satisfactly results at least from a view-point of the pollen counts. The method of the pollen counts using the instrument shelter seems fairly good for the *Pinus* pollen grains (Table 4). We also suspect that it may be good for wind-pollinated flowers. But we must have more investigations about this new method, especially the relationship among pollination, rainfall and wind velocity.

Further investigations in this study, the pollen counts of *Cryptomeria japonica, Pinus* spp. and *Ambrosia elatior* were investigated at the different urbanized four areas (Fig. 2) during both tree and ragweed season in 1977. On *Cryptomeria japonica,* the slide sampls were obtained per two days (48 hours). The different four localities pollen counts are summarized in the table 5. The maximum pollen counts in each

locality is almost same period. But the pollen counts are obtained variously, i. e. the large number of pollen counts (the highest peak is 4655 grains) was given at Kisarazu City, about 35 km south of Tokyo, while at Narashino City, about 25 km east of Tokyo, only 361 grains were collected even the highest peak in this season. We can not grasp well enough the reasons of the various results even to this day. But we believe that some principal reasons of the various pollen counts at the different areas are the weather condition (especially rainfall, humidity and wind velocity), the influence of the urbanization and the vegetation of the plants.

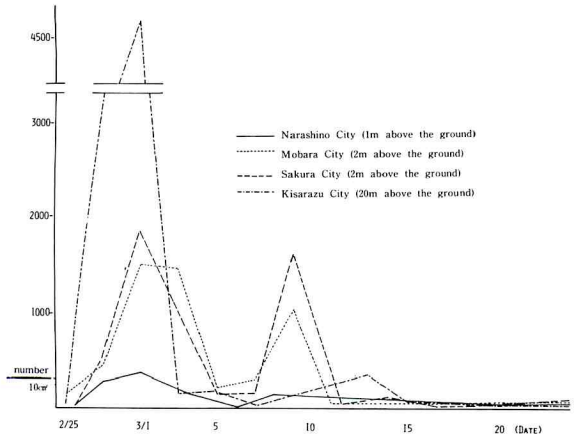

Table 5. Comparative pollen counts at four localities in Chiba Pref. (*Cryptomeria japonica*, 48h/10cm²)

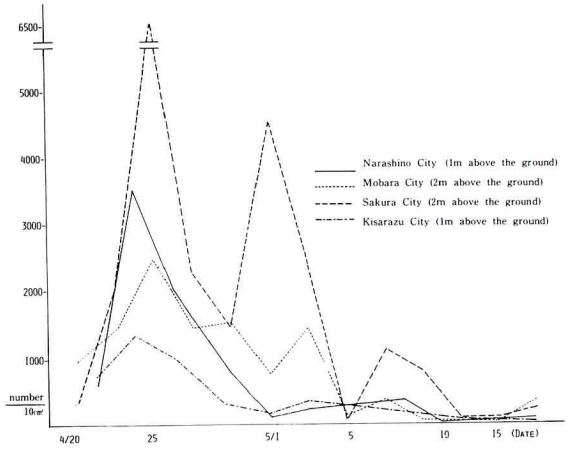

Table 6. Comparative pollen counts at four localities in Chiba Pref. (*Pinus* spp., 48h/10cm²)

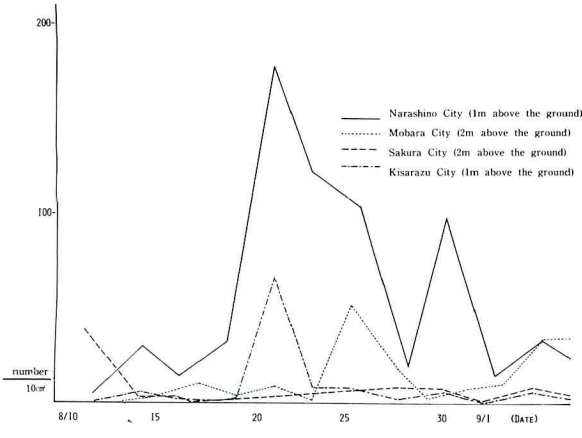

Table 7. Comparative pollen counts at four localities in Chiba Pref. (*Ambrosia elatior*, 48h/10cm²)

Fig. 2. Location of the airborne pollen sampling areas in Chiba Prefecture in 1977.

On *Pinus* spp. (almost pollen counts is *P. thunbergii* according to its pollination), the maximum pollen counts was obtained at Sakura City, about 40 km east of Tokyo (Table 6), that is 6487 grains, and the minimum counts is 1340 grains at Kisarazu City. The result of Kisarazu City is an interesting fact that *Cryptomeria* pollen counts is the largest but *Pinus* pollen is the smallest. This may be caused by the different vegetation on both plants at southern region of Chiba Prefecture.

On *Ambrosia elatior* (Table 7), we got a higher peak at Narashino City, but 178 grains were counted only on account of the maximum counts than any other localities. The main reason of the ragweed pollen poor counts in this season must be sure about the weather condition. In August of 1977, it went on raining for fifteen days or so, and just onset of the ragweed pollination. The relationship between the dispersal *Ambrosia* pollen counts and humid influense were carried out by many authors, i. e. Ogden et al. (1969) reported a further survey of *Ambrosia* pollen counts and others. In this report, *Ambrosia* pollen counts and humidity seems correlated with each other (Fig. 3). We already have investigated the correlation between *Ambrosia* pollen counts and humidity in the previous paper[5].

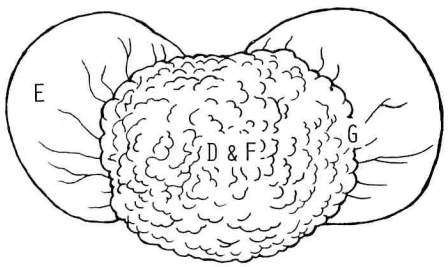

Fig. 3. Diagram of *Pinus* pollen grain, E: A saccus which surface shows in the plate I. E. D & F: Polar view, proximal face, a part of the surface is shown in the plate I. D & F. G: Marginal ridge, between the body (cap) and the saccus (bladder), a part of this area shows in the plate II. G.

One of the purpose of this survey, we wanted to find some different characters between *Pinus thunbergii* and *P. densiflora* pollen grains using the SEM observations. Pollen grains of *P. thunbergii* and *P. densiflora* are indistinguishable from each other by the light microscopic study. One of the authors, Ikuse (1956) could not find a different character between two species. In the present study, we observed both the fine structure their pollen surface and pollen wall of *P. thunbergii* (Pl. I & II). A fresh pollen grains (non critical point) of *P. thunbergii* shows usually dry and shrink condition (Pl. I. C). This causes the two sacci (bladders) to press tightly together, so that the germinal furrow can not seen even if from the distal face. But after the critical point, the pollen grains are expanded just like moist condition as in view of the light microscope (Pl. I. A & B). In this indication, a germinal furrow can be seen clearly on the distal face (Pl. I. A. arrow). Furthermore the fine structure of saccus (Pl. I. E.), proximal face (Pl. I. D). and the marginal ridge between saccus and body (Pl. II. G) are also clearly visible. We found two different micropores (Ueno, 1958, 1960, 1978), large and small ones (Pl. I. E; white and black arrows). Usually large micro-

pores are very few through the surface of a saccus. We further observed a fine structure of the proximal face of *P. densiflora* pollen grains (Pl. I. F). A lot of materials have not investigated in this study, but at least some of fresh materials in this study, we found smaller convolute sculptures on the proximal face in *P. densiflora* than *P. thunbergii* (Pl. I. D). However some materials of *P. thunbergii* have equally ornamentations as in *P. densiflora*. About this important character will be discussed later. Meanwhile the section of Pinus pollen walls were already investigated by some authors[2),9),11),12)]. But further study by the SEM of the pollen wall of *P. thunbergii* may be for the first time in the present paper. The section of near the marginal ridge (Pl. II. H) has an interesting view, especially the structure of the columellae (black arrow). This prominent columella can only be observed at inner surface of the saccus. The section wall of the germinal furrow (Pl. II. I, black arrow) and in a saccus of the exine surface (white arrow) are almost smooth. On the contrary, the section of central part of proximal side of the body (Pl. II. J) shows irregular convolute tectum, short columellae, thin foot layer (black arrow) and thick intine (white arrow). The section of saccus (Pl. II. K) and its enlarged part (Pl. II. L) are shown large reticulate structure and smaller one. Erdtman (1965) observed carefully these large or small reticulate structure by the light microscope. He observed acetlyzed pollen grains of *P. silvestris* in aqua distillata. From his photographs (Pl. 17, 18 &19), somewhat irregualr small reticulate structure is seen near the root of the saccus which is attached to the body. We also have observed this small reticulate structure at the inside wall of the root of saccus (Pl. II. K, white arrow). From the results of the SEM survey, we conclude that the membranous murus-like ridges which observe inner wall of the saccus consist of the prominent columellae are homologous with the short columellae which can be seen in the exine of the proximal surface of the body.

Aknowledgement

During this study we got many helpful thanks from some cooporators who collected the airborne pollen grains, or preparations. we are deeply indepted to these cooporators for their kindness, espesecially to Mr. H. Ishida (Sakura City), Mr. K. Ohdake (Kisarazu City), Miss. M. Kijima (Mobara City) and some members of Sakura City hall. We also many thanks to Dr. J. Ueno for his kind suggestions, and to Prof. Emer. K. Hisauchi, Toho University, for his valuable criticism and for reading the manuscript.

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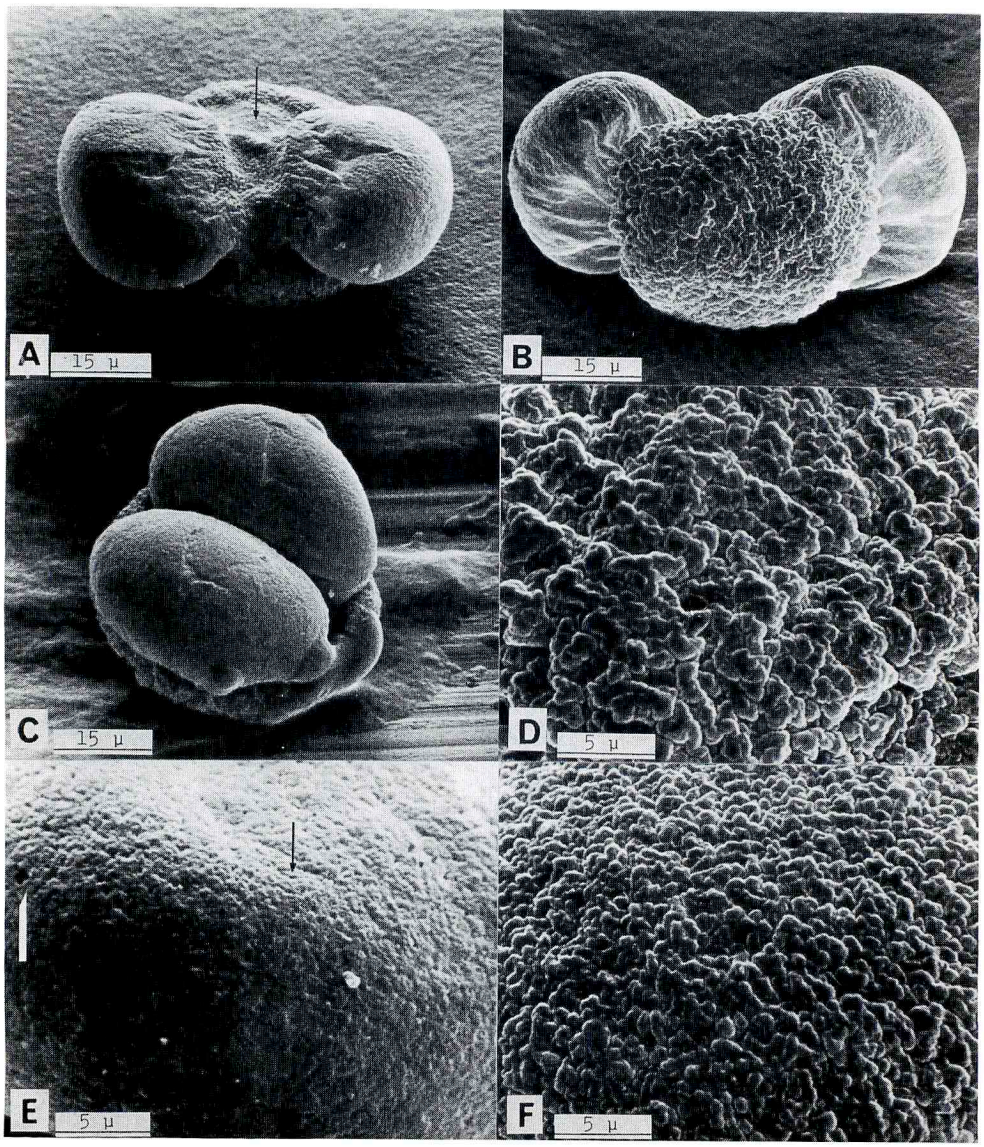
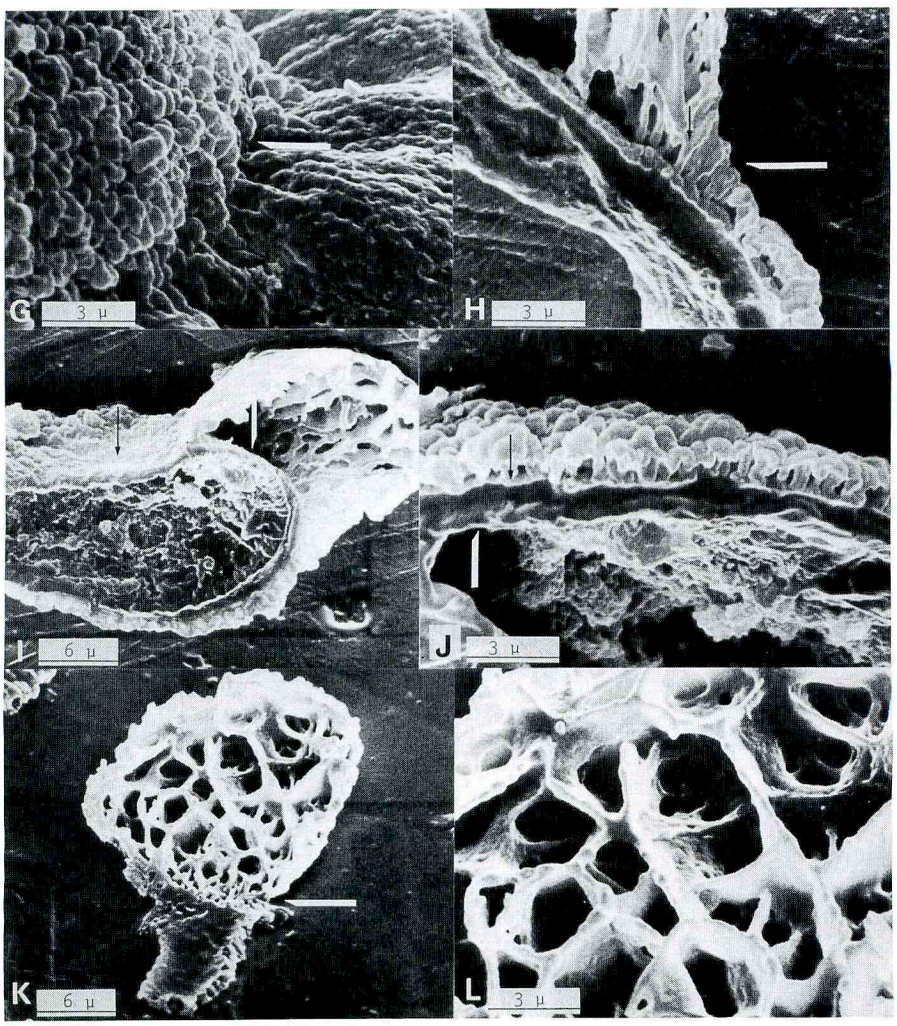


Explanation of Plate I

A - E. *Pinus thunbergii*, A: Polar view with the smooth distal face, the two finely granular sacci (bladders) are expanded, arrow points to the germinal furrow (after critical point). B: Polar view with the coarsely granular proximal face (after critical point). C: An oblique lateral view with the two sacci to press tightly together, effectually closing the germinal furrow (non critical point).

D: Detail of the exine surface of the body near the proximal area, showing irregular convolute sculptures with faintly micropores (after critical point). E: Detail of a part of saccus surface, black arrow points to the micropore, white arrow points to the more large micropore (after critical Point).

F: *Pinus densiflora*, detail of the exine surface of the body near the proximal area, showing somewhat small irregular convolute sculptures than that of *P. thunbergii* (after critical point).



Explanation of Plate II

G: *Pinus thunbergii*, a part of pollen grain, detail of the exine surface of the body (left) and a saccus (right), arrow points to the marginal ridge.

H - L. Sections of the pollen grains of *P. thunbergii*.

H. A part of near the marginal ridge (white arrow), black arrow points to the prominent columellae of the proximal root of a saccus. I : Almost cut in half of the pollen grain, black arrow points to the germinal furrow, white arrow points to the inner exine of the saccus. J: Central part of proximal side, showing irregular convolute tectum, columellae, foot layer (black arrow), white arrow points to the thick intine. K: Almost cut in half of saccus with slightly part of the body and showing inside wall of the pollen grain, arrow points to the root of the saccus.

L: Part of the inside wall of the saccus, the reticulate structure seems to form somewhat thick but interrupted membranous wall.

要　　約

1977年の２～３月のスギ、４～５月のマツ属、８～９月におけるブタクサにつき、詳細な浮遊花粉の捕集を千葉県の４地区（習志野市、木更津市、茂原市、佐倉市）で行なった (Fig. 2)。各捕集地における浮遊花粉の変動は、スギでは千葉県の南部、木更津市での捕集が最大であり48時間、10cm² あたりのピーク時捕集数4655個を得た。一方習志野市では、1975年と同様わずか361個であった (Table 5)。マツ属の浮遊花粉では千葉県の北部、佐倉市で最大であり、ピーク時、6487個を捕集したが、スギで最大の捕集数を得た木更津市では最小の1340個であり、千葉県の南部と北部で、スギとマツ属の浮遊花粉変動に大変興味ある結果を得た (Table 6)。またブタクサの浮遊花粉調査では、習志野市を除きほとんど予期した結果が得られなかった。これは調査時の低温長雨が強く影響しているものと思われるが、ブタクサ花粉の捕集数がこの数年、きわめて少ない結果を得ており（1976年、本誌報告、18号）1960年当時の捕集結果は今後おそらく得られないものと思われる。

今回新らしい浮遊花粉の捕集方法として降雨による標準捕集の流出花粉の影響を減少させる目的で規格品の百葉箱内での調査を行なった (Fig 1)。その結果、スギ、マツ属の浮遊花粉捕集時にかなりの好成績を得た (Table 3,4)。しかし百葉箱中での捕集方法が良好な方法であるかどうかは、今後の課題である。

さらに前回（1976年）同様クロマツの浮遊花粉ピーク時に１時間毎の捕集調査を行ない、24時間以内の湿度と捕集数の関係を習志野市の地上１ｍと15ｍの２地点で比較調査した。その結果　両地点で夜間（午前１～２時）に最大ピークが出現した (Table 1,2)。この時の湿度は最大ピーク時の２時間前から急激に減少しており、特に地上１ｍで捕集数と急激な湿度低下の関連が強く見られた。この結果から少なくともクロマツ花粉の場合、昼夜の区別なく急激な湿度の低下が、大きな捕集結果をもたらす原因となるようである。しかし前回（1976年）の調査のように地上20ｍで降雨直前に大きなピークを得ており、今後さらに浮遊花粉の急激な地上への落下をもたらす原因について追求していくつもりである。

今回、これまでの課題であったクロマツとアカマツの花粉の形態的な区別を走査電顕 (SEM) で試みた。その結果、花粉本体の向心極面のほぼ中央部の彫紋がクロマツでは平均して大きく (Pl.I,D)、アカマツでは小さい (Pl.I,F) ことがわかった。しかしながら個体差もあり、今後さらに詳細に観察していくつもりである。また気嚢の断面で内側の網目構造を観察し、網目を形成するコルメラ (columella) は本体の疣状構造を形成するコルメラが、伸長して形成されたものであることがほぼ判明した。

☆　日本植物学会大会形態ゼミに針葉樹花粉の系統をとりあげる。今年度の大会２日目（1978年９月27日）に前川博士（東大名誉教授）は針葉樹系統を、杉原博士（東北大名誉教授）は胚発生を、上野博士（静大名誉教授）は花粉について論ずることになった。会場は千葉大学。（上野）

新 著 紹 介

Siwert Nilsson, Joseph Praglowski, Lennart Nilsson 著 Atlas of Airborne Pollen Grains and Spores in Northern Europe (1977・Stockholm)

著者の一人、プラゴロフスキーは今はなきスエーデンの花粉学の巨匠グンナー・エルトマンの助手で上野留学の折に世話になった一人である。本のサイズは 210×240 mm のほぼ四角で 160 ページ、ほとんど花粉の写真である。それも光学顕微鏡は×1,000 を主とし、電子顕微鏡 E.M.G. は透過型（超薄切片用 T.E.M.）と走査型 (S.E.M.) の両者を併用している。S.E.M. は J.E.O.L.（日本電子 K.K.）が協力している。タイトルは Airborne とあるが全部が花粉症関係の花粉・胞子ではない。被子植物 57 属 66 種、裸子植物 3 属 3 種、シダ類 5 属 5 種を収めている。1～2 ページに 1 種づつの写真と簡単な英文説明をあげたほか、巻末に一括して記述（花粉直径・外皮厚さ・発芽装置など）と北欧における分布地図、植物名のラテン語・英語・デンマーク語・フィンランド語・ノルウェー語・スエーデン語の対比リストなどがある。花粉はＡＢＣの順の科で並べられ Acer（カエデ）から始まる。花粉は新鮮なままフクシン染色して光学顕微鏡 L.M. で写している。この点エルトマン処理（酢酸処理）したものより見にくいが、その材料を S.E.M. したり、封埋して切片として T.E.M. で写している。この三者の対比がカエデ・ Anthriscus・ヨモギ・ヤグルマギク・キク・タンポポ・ハンノキ・カバノキ・アブラナ・ニハトコ・ハコベ・Helianthemum・ハシバミ・ヰ・Hipphophaë・コケモモ・ブナノキ・カシ（落葉性）・トチノキ・スズメノヤリ・Triglochin・ヤマモモ・トネリコ・オオバコ・スズメノテッポウ・ライムギ・スイバ・Filipendula・サクラ・ポプラ・ヤナギ・シナノキ・ガマ・ニレ・イラクサ・ネズ・マツ・スギナ・オシダ・エゾデンダではみられて読者の興味をひく。とくにヤグルマギクは花粉を凍結させてタテ割とヨコ割とにし金メッキをほどこし、原形質をとり除いてある S.E.M. を示している。まことに見事に花粉膜の表裏を見せている。

しかし若干の問題点もある。それは S.E.M. の処理の際の金のコーチングが厚すぎるのではないかという点である。言いかえるとコントラストが強すぎて、微細な孔や凸起やシワなどが消される心配がある。キク科には表面に微細な孔があり、例えばヤグルマギクの T.E.M. でも見られるこれらの孔が S.E.M. では見られない（p・18—19）。ヤナギのアミ目の中に小凸起がいくつもあり、上野の S.E.M.（花粉学研究プレート 95, 1978）ではこれを示しているが、本書 pp. 98—101 では少し不鮮明である。

しかし本書により明らかに紹介された単子葉類の発芽孔（ヰ・ワタスゲ・オオフトヰ・スズメノテッポウ・カモガヤ・ドクムギ・ヨシ・アワガエリ・カラスムギ・オオムギ・ライムギ・コムギ）は比較しながら研究すると仲々興味がある。またブナの花粉膜表面構造はカシとは全然違ったものであることなど本書のもつ意義は大きい。

このような図書が今後も継出することを望みたい。出版は Natur och Kultur. Huvudkontor: Torsgatan 31. Postadress: Box 6,408, 11,382 Stockholm. Order: Lararcentrums ordencentral, Fack 171 19 Solma. Distribution: Gardsvagen 6,171 52 Solma, Sweden.（丸善外書部に問合せられたい）。