(Short Communication)

Cold Air Dome and Role in Pollen Transport Based on Preliminary Survey of Airborne Pollen in Upper Air

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Many airborne pollen and spore surveys in the upper air using balloons and airplanes were reported by Gregory [1]. He noted that, in general, with light-to-moderate windy weather and cumulus clouds at about 2000m, pollen concentration decreased only slightly up to 1000m, and the maximum number of grains might occur as high as 200 or 500m.

Our preliminary investigations using a helicopter [2] gave similar results. Up to 1000m, a slightly greater variety and number of pollen grains were collected in lower air layers. For higher altitudes, we made one survey at altitudes up to 3000m, but there was a problem with the trapping technique. In this connection, we conducted a survey using a volumetric method in the upper air over Chiba Prefecture, Japan, on 18 May 1997. This paper reports the findings of this survey.

Key words : Cold air dome, pollen transport

Methods

Our helicopter took off from the Tokyo Yume-No-Shima heliport at about 10 : 30. We collected pollen for 20 minutes at an altitude of 1000m over Noda City, Chiba Prefecture, and also conducted collecting for 20 minutes at altitudes of 2000m and 3000m, while making a circular flight slightly to the north. The trap was a Cascade Impactor. The window of the helicopter was kept open to admit fresh air into the helicopter while collecting pollen. The circular suction slit of the Cascade Impactor was placed slightly outside the helicopter window which was closed while changing altitude.

Results

At an altitude of 1000m, a 20-minute trapping (10 : 55 - 11 : 15) yielded only five grains of Ulmaceae pollen. In contrast, a 20-minute trapping (11 : 23 - 11 : 43) at an altitude of 2000m yielded 120 pollen grains of about 10 different species including mainly *Pinus* (reflecting the season) and Japanese cedar, *Quercus*, Ulmaceae, Gramineae, and *Plantago*. A 20-minute. trapping (11 : 51 - 12 : 11) at an

Table 1. Pollen grains trapped per m^3 per 20 minutes at different altitudes using helicopter on 18 May 1997.

Altitude	1000m	2000m	3000m
Time / Trees & herbs	10 : 55 - 11 : 15	11 : 23 - 11 : 43.	11 : 51. - 12 : 11
Pinus spp.		25	60
Cryptomeria japonica		15	0
Quercus spp.		5	40
Ulmaceae	5	35	5
Juglans sp.		5	0
Gramineae		5	10
Plantago spp.		5	0
Larix sp.		5	0
Rumex spp.		0	5
unknown, 2 spp.		20	
total	5	120	120

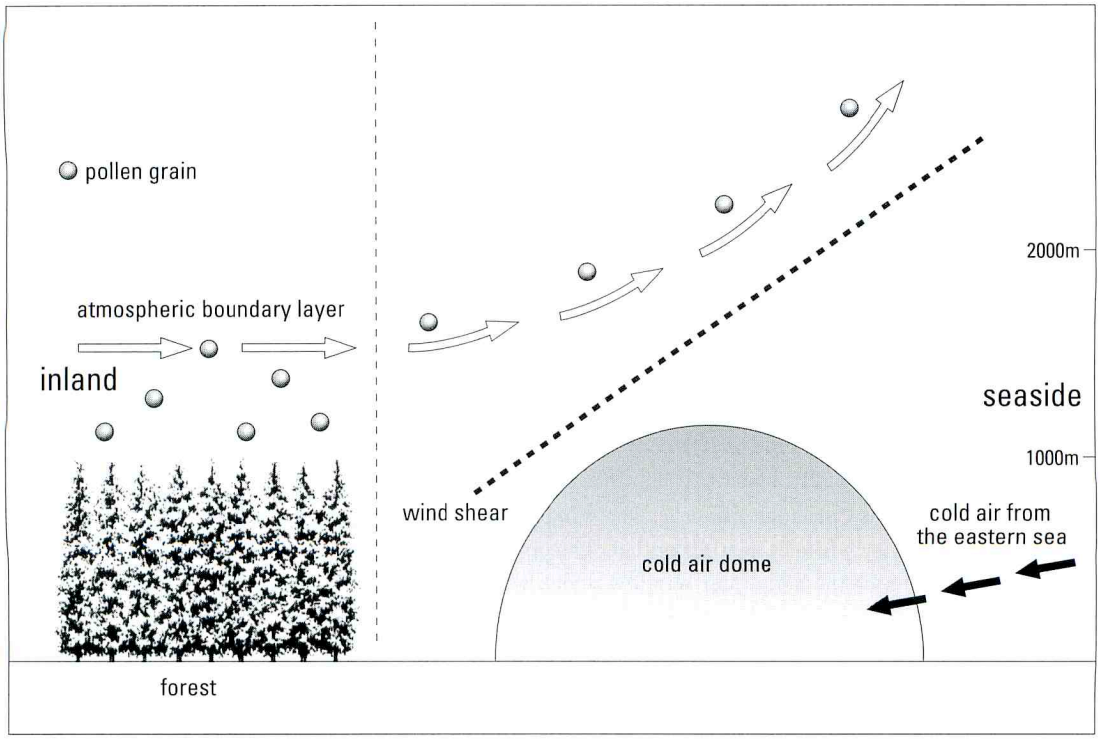

Fig. 1 Schematic image illustrating possible mechanism of cold air dome and role in pollen transport.

altitude of 3000m also yielded 120 grains of about 5 species, chiefly including *Pinus* (50%), *Quercus*, and Gramineae (Table 1).

Although it was mid-May, *Cryptomeria* pollen grains were counted at 15 grains per m^3 at 2000m, but *Cupressus* was not found at any altitude.

Usually, *Cryptomeria* pollen grains can be found both in the flowering and resting seasons, so it is not unusual to trap *Cryptomeria* pollen grains in May.

Discussion

Almost no pollen grains were collected at 1000m where we expected the greatest numbers. We explain this based on meteorological data at high altitudes obtained during the survey and on the weather chart at ground level for the day.

According to meteorological observations in the upper air, an easterly wind was blowing at lower altitudes up to 500 - 700m, and the temperature was low in the bottom layer below 200m, indicating a current of cold air flowing from the eastern sea (Figure 1). Therefore, an air mass (cold air dome) with a lower temperature than the surroundings must have formed at a low altitude. When the inland temperature rises, the atmospheric boundary layer moves toward the upper air, carrying pollen up. Pollen grains from inland are transported horizontally through this boundary layer. However, when there is a cold air dome in the lower air layer, wind shear (rapid wind change resembling local front) occurs at the upper surface of the dome and the air mass containing pollen grains moves to the upper air above the cold air dome. Consequently, there are fewer pollen grains at lower altitudes. In our case, the cold air dome was formed by inflow of air from the eastern sea, which hardly contains any pollen grains.

References

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高層大気中の空中花粉調査にもとずく寒気ドームと花粉輸送

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1997年5月18日，ヘリコプターを使用して千葉県野田市上空1000m，2000m，3000mの各高度で20分間ずつ，カスケード・インパクターにより空中花粉を捕集した．その結果，高度1000mでは測定大気1 m^3 中に僅かニレ科5個捕集したに過ぎなかったが，高度2000mでは約10種，120個，3000mでは約5種，120個も捕集された．おもな花粉は5月中旬とあってマツ属，コナラ属，ニレ科，イネ科などであった．過去の調査等から上空1000mが最も捕集されるはずが，殆ど捕集されなかった．原因は内陸から大気境界層内を水平方向に輸送されてきた花粉を含む空気塊が，東海上からの冷たい空気塊によって形成されていた寒気ドームが下層に存在すると，ドームの上の風のシアができ，花粉を含む空気塊は寒気ドームの上を上空に移動するようになる．このため下層高度では花粉数が少なくなる．特に今回のケースは東海上からの空気の流入であり，もともと花粉を含んでいないことも影響している．