

# Studies on Pollen Allergy in Delhi

## Diurnal Periodicity of Common Allergenic Pollen

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The volumetric sampling of the air has been carried out with the Suction Impaction Sampler devised by Tilak & Kulkarni (1970). The pollen counts have been expressed as number per cubic metre volume of the air. Based on the percentage of pollen peaks, diurnal patterns of the total count of all the types, and six dominant allergens have been determined. For these allergens, daily fluctuations have also been recorded. The influence of meteorological factors such as temperature, wind, rainfall, relative humidity and sunshine hours/day on the variation patterns in the concentration of atmospheric pollen has been discussed. It has been shown that 25–30°C temperature, 5–15 km/h wind speed, 60–70% RH, bright, sunny and rain-free days are favourable for high pollen catch. These weather conditions might be conducive for the high discharge, dispersal, and deposition of air-borne pollen. Too low or too high temperature, very high wind speed, high humidity, and cloudy and rainy days hinder high pollen catch.

*Key words:* atmosphere of Delhi; diurnal patterns; meteorological factors; pollen allergens; pollen peaks.

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It is now well-established that the inhalation of air-borne pollen and fungal spores is the prime causative factor for respiratory allergic diseases in human beings. The need for intensive aerobiological studies has been emphasized by both clinicians and botanists during recent years (1, 5, 13, 26). A knowledge of the diurnal and seasonal fluctuations in the concentration of atmospheric pollen is of paramount value in the diagnosis and therapeutic treatment of patients suffering with respiratory allergic disorders caused by pollen.

Although Shivpuri and his colleagues have studied some aspects of pollen allergy in Delhi (3, 11, 17, 19), information on the diurnal periodicity of pollen is totally lacking. The present paper deals with the diurnal and daily variation patterns of atmospheric pollen, and the role of environmental factors in regulating the concentration of atmospheric pollen.

## MATERIAL AND METHODS

Among the four different ecogeographical zones selected for aerial surveys (18), Vallabhbhai Patel Chest Institute was selected for volumetric sampling of air. The sampling was carried out with the help of the Suction Impaction Sampler devised by Tilak & Kulkarni (27), from February 1974 to July 1974. The sampler was placed on the roof of Clinical Research Centre of Vallabhbhai Patel Chest Institute (at a height of about 10 m from the ground level). Transparent Sellotape (used as an adhesive) coated with safranin-stained glycerine-jelly was stuck to the rotating disc of the sampler. The length and breadth of the Sellotape used was 67.2 and 1.9 cm, respectively. A volume of 5 litres/min of air—the capacity of the sampler—was allowed to impinge on the Sellotape stuck to the rotating

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disc. The sampler was operated continuously for 4–8 days.

After exposure, the Sellotape from the rotating drum was removed carefully, and it was divided into 21-mm-long segments so as to obtain a 6-hourly catch. The segments were mounted in one or two drops of molten jelly, and then covered with cover glasses. The mounted segments were demarcated into 7-mm-long areas with the help of Reeves ink to obtain 2-hourly counts. The entire mounted area (15.9 cm<sup>2</sup>) of the segments of Sellotape was scanned by several sweeps to obtain the counts for 24 h.

The different pollen types were identified, and the identifications were confirmed with the help of reference slides prepared from the pollen of flowers collected direct from the plants.

The pollen catch was expressed as number per cubic metre volume of air. Based on the percentage of pollen peaks, the diurnal patterns for total pollen counts of all the types together, as well as for six individual pollen allergens, were determined. The number of peaks for every 2 h of the day was calculated on the basis of pollen counts of 40 rain-free days selected at random among the total 110 days sampled. From the total peaks of 24 h, the percentage of peaks for every 2 h was estimated.

The meteorological data were collected from India Meteorology Department, New Delhi. The data were recorded at Safdarjang Air Port which is located 15 km south of the sampling site.

## OBSERVATIONS

Altogether 58 different pollen types were identified from the volumetrically sampled air (Table I). The dominant pollen types were grasses, Chenopod, *Prosopis*, *Morus*, *Broussonetia*, *Putranjiva* and some others.

As is evident from Figs. 1–3, significant hourly fluctuations in the concentration of atmospheric pollen were observed. The maximum catch was usually observed between 04

and 06 hours. But the highest peak (70\*) was also noted at 22 hours on March 3, 1974, besides at 06 hours on February 18, 1974. The pollen content in the atmosphere was rather poor during afternoon hours, and touched lowest figures during the early hours of the night.

Similar variation pattern was observed in day-to-day pollen counts (Fig. 4). The maximum pollen catch (35) was recorded on March 25; there were days with only a few pollen grains in the air.

For the total pollen count of all the types together, the early morning pattern was observed with highest percentage of pollen peaks at 02 and 06 hours (Fig. 5A). Nearly half of the total peaks (48.9%) were found between 0 and 06 hours. 02 and 06 hours together accounted for 40% out of 48.9% pollen peaks. The number of pollen peaks at 18 hours was the lowest (1.2%).

The early morning pattern (04–06 hours) was shown by the grass pollen—the dominant pollen type in the airspora of Delhi (Fig. 5B). Highest percentage of pollen peaks (22.2) was observed at 06 hours, while lowest percentage (3.2) was found at 22 hours. Pollen of *Morus* and *Putranjiva* had also shown the early morning pattern (Fig. 5C, D). Maximum percentage of peaks for both *Morus* (27.6) and *Putranjiva* (19.2) were recorded at 06 hours, but in the latter a minor peak (15.2%) was also observed at 24 hours.

The noon pattern (10–14 hours) was exhibited by the *Prosopis* pollen (Fig. 6A) which showed the maximum percentage of peaks (22.2) at 12 noon.

The Chenopod pollen (Fig. 6B) had shown the afternoon pattern, with 37.5% of pollen peaks falling between 12 and 18 hours.

The high percentage of peaks (16.1) was observed at 16 hours.

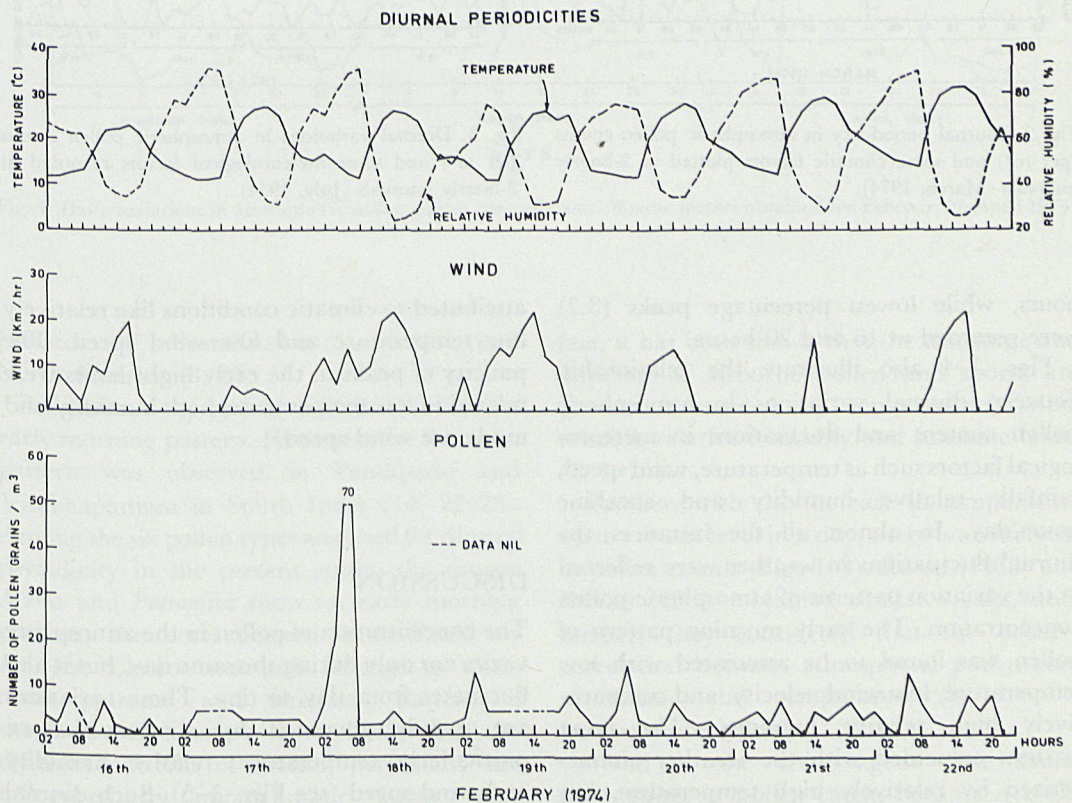
The *Broussonetia* pollen (Fig. 6C) revealed an irregular diurnal pattern, with highest percentage of peaks (48.5) observed at 02

\*Numerical values in parentheses refer to number of pollen grains per m<sup>3</sup> of air.

Table 1.

List of pollen types identified from Delhi atmosphere during volumetric sampling from February 1974 to July 1974

|                                |                                |                                 |
|--------------------------------|--------------------------------|---------------------------------|
| <i>Acacia</i>                  | CYPERACEAE                     | <i>Mimusops elengi</i>          |
| <i>Adhatoda vasica</i>         | <i>Dalbergia sissoo</i>        | <i>Morus alba</i>               |
| <i>Ailanthus excelsa</i>       | <i>Dodonaea viscosa</i>        | <i>Peristrophe bicalyculata</i> |
| <i>Albizia lebbek</i>          | <i>Ehretia laevis</i>          | <i>Pinus</i>                    |
| <i>Argemone mexicana</i>       | <i>Emblica officinalis</i>     | <i>Phoenix sylvestris</i>       |
| <i>Artemisia</i>               | <i>Ephedra</i>                 | <i>Plantago major</i>           |
| <i>Asphodelus tenuifolius</i>  | <i>Eucalyptus</i>              | <i>Polygonum plebium</i>        |
| <i>Azadirachta indica</i>      | GRAMINEAE                      | <i>Potamogeton crispus</i>      |
| <i>Bauhinia variegata</i>      | <i>Guazuma tomentosa</i>       | <i>Prosopis juliflora</i>       |
| <i>Betula</i>                  | <i>Heliotropium</i>            | <i>Putranjiva roxburghii</i>    |
| <i>Brassica campestris</i>     | <i>Holoptelea integrifolia</i> | <i>Ricinus communis</i>         |
| <i>Broussonetia papyrifera</i> | <i>Juniperus</i>               | <i>Rumex dentatus</i>           |
| CAESALPINIOIDEAE/PAPLIONOIDEAE | <i>Lagerstroemia</i>           | <i>Salix tetrasperma</i>        |
| <i>Calligonum polygonoides</i> | <i>Livistona chinensis</i>     | <i>Salvadora</i>                |
| <i>Cannabis sativa</i>         | <i>Maerua arenaria</i>         | <i>Syzygium cumini</i>          |
| <i>Capparis decidua</i>        | MALVACEAE                      | <i>Terminalia arajuna</i>       |
| <i>Casuarina equisetifolia</i> | <i>Mangifera indica</i>        | <i>Typha angustata</i>          |
| CHENO/AMARANTH                 | <i>Maytenus senegalensis</i>   | UMBELLIFERAE                    |
| COMPOSITAE                     | <i>Melia azedarach</i>         | <i>Xanthium strumarium</i>      |
| CRUCIFERAE                     |                                |                                 |

Fig. 1. Diurnal variations in the atmospheric pollen counts (per m<sup>3</sup>) in comparison with the diurnal variations of some climatic factors. The data were plotted at 2-hourly intervals (February, 1974).

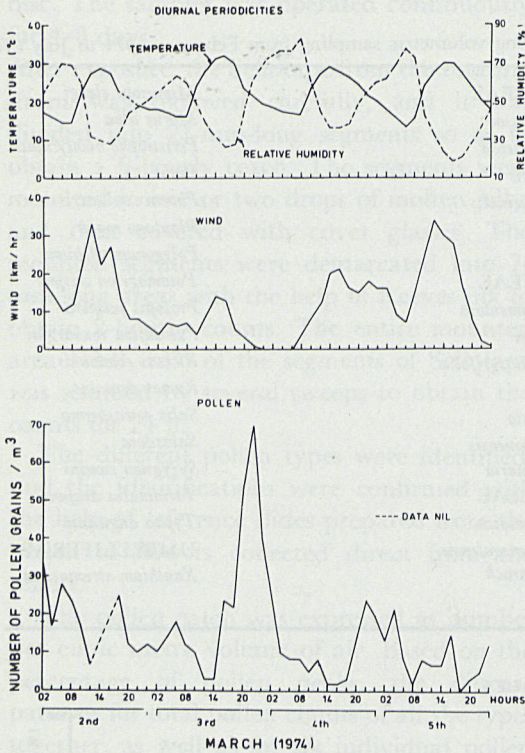


Fig. 2. Diurnal periodicity in atmospheric pollen counts (per m<sup>3</sup>) and some climatic factors plotted at 2-hourly intervals (March, 1974).

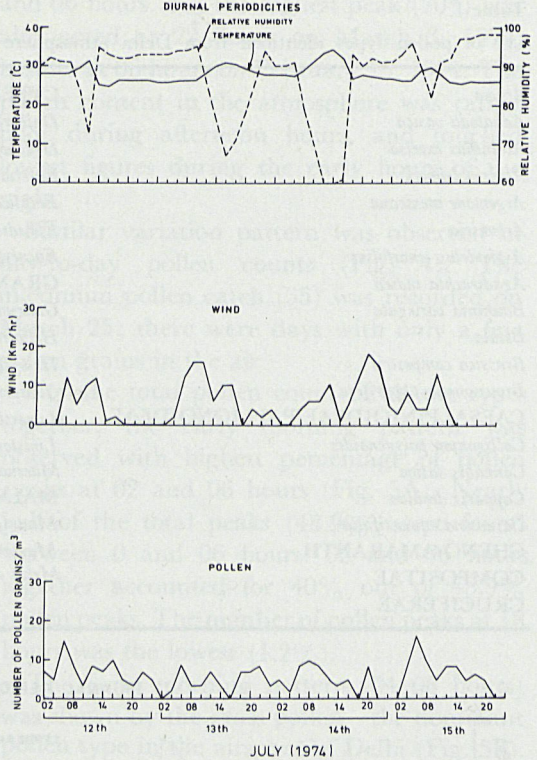


Fig. 3. Diurnal variations in atmospheric pollen counts (per m<sup>3</sup>) and some meteorological factors recorded at 2-hourly intervals (July, 1974).

hours, while lowest percentage peaks (3.7) were recorded at 16 and 20 hours.

Figs. 1–4 also illustrate the relationship between diurnal variations in atmospheric pollen content and fluctuations in meteorological factors such as temperature, wind speed, rainfall, relative humidity and sunshine hours/day. In almost all the instances the diurnal fluctuations in weather were reflected in the variation patterns of atmospheric pollen concentration. The early morning pattern of pollen was found to be associated with low temperature, low wind velocity, and comparatively high relative humidity. The noon pattern coincided with the weather characterized by relatively high temperature, low relative humidity and comparatively high wind speed. The evening pattern was

attributed to climatic conditions like relatively low temperature and low wind speed. The paucity of peaks in the early night hours were related to low temperature, high humidity and moderate wind speed.

## DISCUSSION

The concentration of pollen in the atmosphere varies not only during the same day, but it also fluctuates from day to day. These variations are mainly governed by climatic factors, particularly temperature, relative humidity and wind speed (see Figs. 1–5). Such diurnal and daily variations were also observed in the atmospheric pollen in England (4, 6, 9),

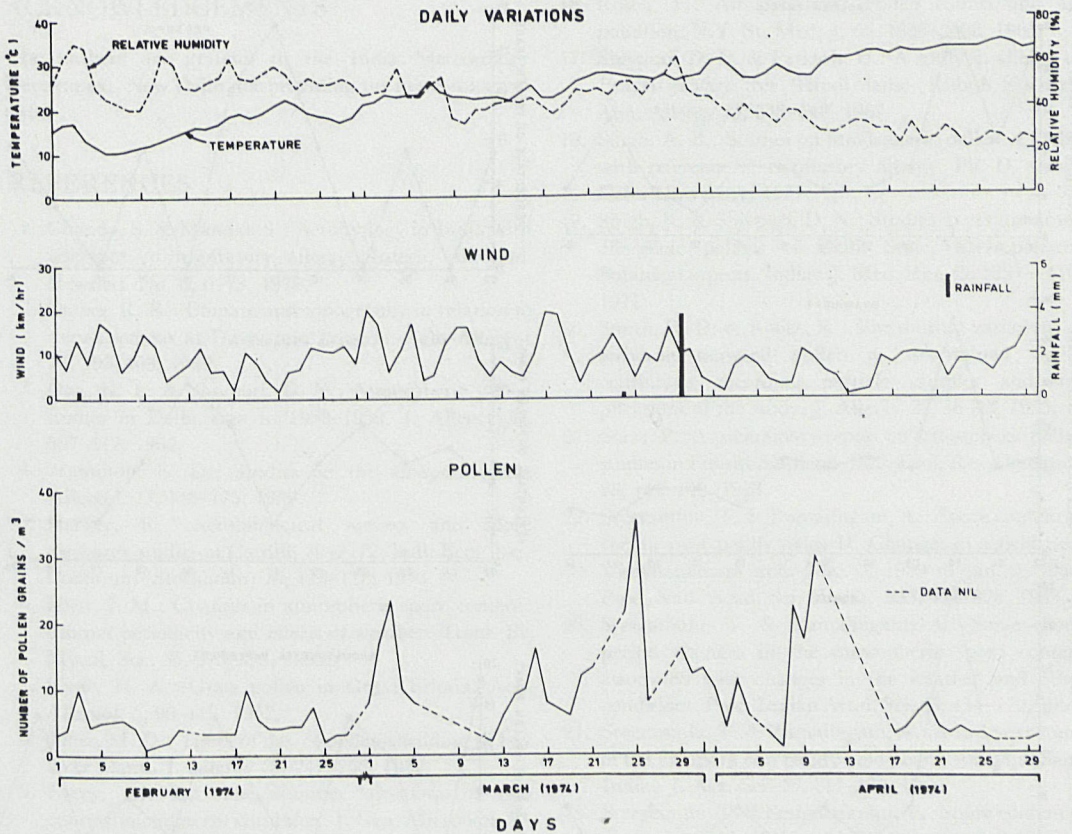


Fig. 4. Daily variations in atmospheric pollen counts (per  $m^3$ ) and climatic factors obtained for February to April 1974.

Jamaica (12), Scandinavia (5, 10, 21), and North America (8, 20).

In general, the pollen of Delhi exhibits an early morning pattern. However, the forenoon pattern was observed in Pentapadu and Visakhapatnam in South India (14, 22–25). Among the six pollen types analysed for diurnal periodicity in the present study, the grasses *Morus* and *Putranjiva* show an early morning pattern; the noon pattern is exhibited by *Prosopis*; Chenopodiamorpha belongs to afternoon pattern; and irregular pattern is shown by *Broussonetia*. It is likely that the different patterns of diurnal periodicity are influenced by microclimatic factors that control the time of anthesis, dehiscence of anthers and discharge of pollen into the air. In

fact, it has been shown that the discharge and dispersal of airborne pollen and spores are greatly influenced by temperature, wind, rainfall, relative humidity and sunshine hours (2, 4, 15).

Further, with the increase in temperature up to certain level in a day, there is an increase in pollen counts (Figs 1–3). Rosen (1965) and Davies (1969) obtained similar results, and, further, they considered that the positive correlation between atmospheric pollen concentration and temperature is due to 'temperature inversion' (2, 16).

Wind is the chief agent that causes fluctuations in pollen catch, because it is the sole dispersal agent and also regulates the rate of deposition for most of the aeroallergens. A

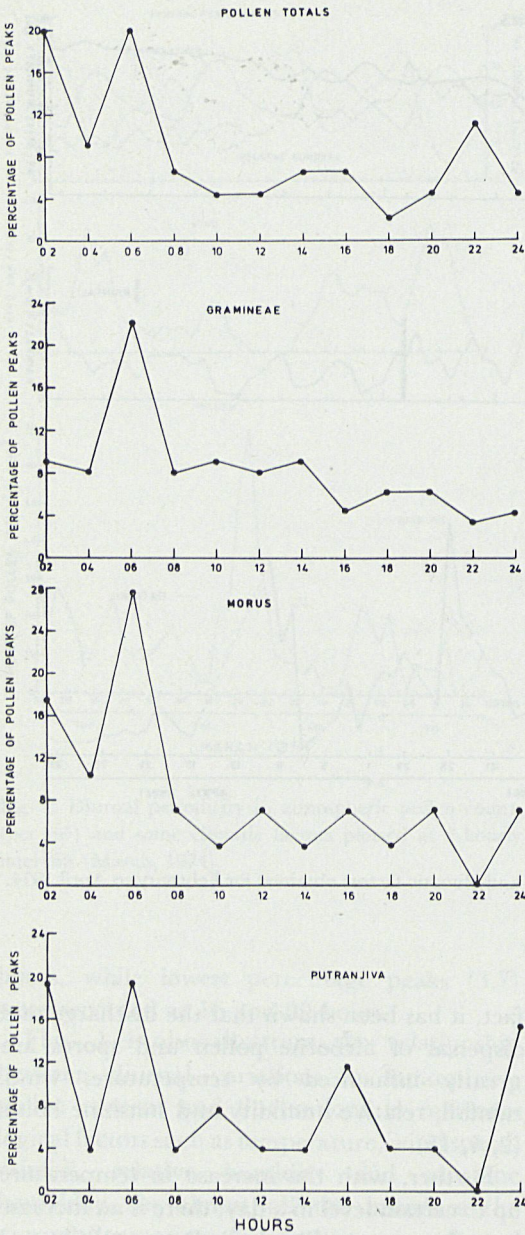


Fig. 5. Diurnal pattern of atmospheric pollen represented as the percentage of pollen peaks plotted at 2-hourly intervals showing early-morning pattern. A, Total pollen counts of all the types together. B, Grasses (Gramineae). C, *Morus*. D, *Putranjiva roxburghii*.

wind speed of 5–15 km/h brings out a high pollen catch (Figs. 1–4). Ramalingam also reported that a wind speed of 8–20 km/h fetches a relatively higher catch (14).

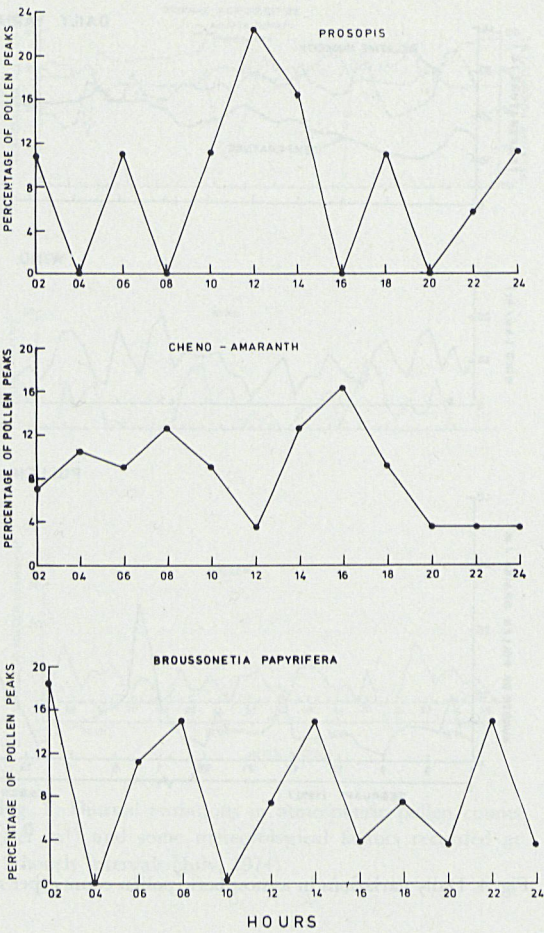


Fig. 6. Diurnal patterns of atmospheric pollen as represented by the percentage of pollen peaks plotted at 2-hourly intervals, showing different patterns. A, *Prosopis*-noon pattern. B, *Cheno-Amaranth*-afternoon pattern. C, *Broussonetia papyrifera*-irregular pattern.

Relative humidity of 50–70% is found to be conducive for high pollen catch.

Rainfall has an immediate effect on pollen concentration, as it generally washes the air-borne pollen down to the ground.

Bright sunny days are correlated with high pollen catch. The occurrence of pollen peaks in early morning hours indicates that the number of daily sunshine hours does not have much influence on the concentration of atmospheric pollen. Hyde (1952), however, reported a correlation between grass pollen and daily sunshine hours (7).

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