

# Yellow rain in Lucknow

H.P. Gupta, A.P. Bhattacharya & Asha Khandelwal

*Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India*

Gupta, H.P., Bhattacharya, A.P. & Khandelwal, Asha, 1992. Yellow rain in Lucknow. *Geophytology* 21 : 195-198

Present paper communicates the results obtained from pollen analysis of yellow rain spots in Lucknow. The study has unfolded two important aspects, viz., (i) the yellow rain spots contain enormous quantity of pollen which belong chiefly to angiosperms and (ii) the source of pollen in these yellow spots is honey bee.

**Key-words** -- Yellow rain, pollen, faeces, Lucknow.

## INTRODUCTION

During the first quarter of February, 1991, viscous yellow spots from leaves and other objects were collected from Maqboolganj and Vikas Nagar, Lucknow. Their size varied from 1-3 mm and shape from circular, subcircular, oval to linear. These yellow spots were pollen analysed date-wise and area-wise. The study has revealed that such spots contain enormous quantity of pollen chiefly of angiosperms. In addition, a few insect legs, algal filaments and fungal spores have also been encountered. The pollen assemblage is predominated by Oleaceae, Brassicaceae, *Salmalia*, etc. whereas, *Morus*, Myrtaceae, Fabaceae are co-dominant taxa. Comma Brilliant Blue R-250 test was also tried on these pollen which gave negative signals for proteins.

Thus, overall analysis has revealed that these yellow spots in question are the faeces which fall when the atmosphere is charged with optimal temperature conditions with relatively humid environs.

## GLOBAL RECORD OF YELLOW RAIN

Almost two decades ago the yellow spots were first observed on leaves and rocks in southeast Asia and was alleged to be an agent of chemical warfare emerged from Laos and Kampuchea. There was hue and cry all around *Ban Vinai* refugee camp in Thailand that *Kemi*, their term for presumed poison, is falling. Later the investigators were prompted by U.S. Government and medical teams were deployed in the neighbourhood to investigate the cause of

sufferings. Leaves spotted with yellow substance were passed on to Army's Chemical Research Development Centre (C.R.D.C.) who conducted investigations and interviews with refugees from Laos and found that the deposits of alleged chemical warfare agent are almost always described as yellow and subsequently they have been known as 'yellow rain'. The chemical analysis, by British Chemical Defence Establishment (B.C.D.E.) in Salisbury, England, confirmed that yellow rain contained huge quantity of pollen (Seeley & Nowicke, 1985). Zhongying (1989) has analysed several yellow rain samples from different places in northern Jiangsu Province, E. China and found yellow rain substance to be exclusively composed of angiosperm pollen.

## PEOPLE'S INTERVIEWS AND THEIR REACTION DURING YELLOW RAIN

Coincidentally, yellow spots, varying in size from 1 mm to 3 mm in different shapes such as circular, subcircular, oval and linear, were observed in Lucknow on February 3, 1991, when the Gulf war was on its full swing (Photo 1). Residents of area were panicky for quite some days for the fear that it might be the repercussion of warfare going on in the Persian Gulf. Nevertheless, yellow spots in question were first observed by a farmer on the leaves of his garden plants and adjacent vegetation and later those leaves with yellow substance were passed on to us for investigation. After chemical processing it was found that the samples of yellow rain contain huge amount of pollen, mostly forming lumps (Plate 1). Furthermore, these yellow droppings are

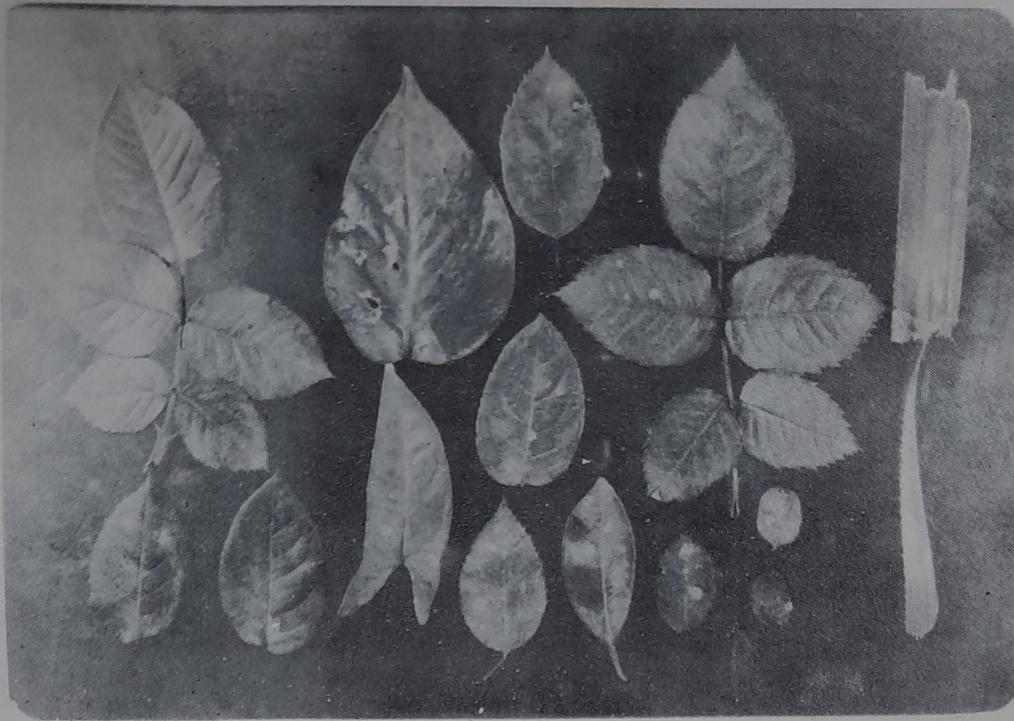


Photo 1. Yellow rain spots on the leaf surface.

not qualitatively rich in pollen *vis-a-vis* enormous quantity of pollen is present. Amongst 20 pollen types encountered, only 3-4 types of pollen are dominant, whereas rest are either sporadic or present in low frequencies. It was further confirmed that the pollen recorded from yellow rain spots are not windborne; rather they are the types that honey bees gather from flowers to feed their young ones.

Survey was regularly made and such yellow substances were collected from different parts of Lucknow on the objects like leaves, roof tops, vehicles, etc. The rain-like substance fell to form viscous yellow blotchy spots which soon dried to form crispy powder. To know more about such spots we conducted interviews with the residents of the area and neighbourhood people. Most of them endorsed the regular fallings of yellow substance during particular time between 9 am to 10 am. The descent of yellow rain lasts for 10-15 minutes only. The phenomenon of falling the yellow substance generally takes place when temperature conditions are optimal with relatively more humid environment. Windy atmosphere however, discourages the falling of such substance. The record of interviews has

"revealed" that it was due to the bombardment by air-craft in the Gulf. Some people in the vicinity also complained of itching and scabies when such substance fell directly on the exposed part of their body, although the magnitude of itching was described differently. The feelings of itching on the body parts could be either due to the mixing of some fungal toxins into the yellow substance, or certain pollen being allergenic to certain people might have resulted into such feelings.

#### CAUSE OF YELLOW RAIN

The phenomenon of lumping of pollen in the atmosphere and pouring on earth surface in the form of droplets has raised two-fold concern. Whether the clustering of pollen is a natural process in the atmosphere under certain set of climatic conditions or is it a phenomenon of voiding excrement by honey bees? To confirm this aspect, Coomassie Brilliant Blue R-250 test for protein contents was tried on yellow rain pollen and freshly collected pollen from *Calendula* (Asteraceae) flowers. The yellow rain

#### PLATE 1

1. Apiaceae, x 750
- 2-5. Oleaceae (*Jasminum* sp.), x 500.
6. A part of limb of honey bee, x 500.
7. *Ailanthus excelsa*, x 500.
- 8-13. Myrtaceae (*Eucalyptus* sp.), x 1000.
- 14-15. Brassicaceae (*Brassica* sp.), x 750.
16. Unidentified pollen I, x 500.
17. *Morus* sp., x 500.
- 18-19. *Cycas* sp., x 500.
20. Chenopodiaceae, x 500.
21. Unidentified pollen II, x 500.
- 22-23. Fabaceae, x 500.
24. Chenopodiaceae, x 500.
- 25-27. Fabaceae, x 500.
28. Poaceae, x 500.
29. Unidentified pollen III, x 500.
- 30-31. Asteraceae, x 500.
- 32-33. Brassicaceae (*Brassica* sp.), x500.
- 34-35. Fabaceae, x 500.
- 36-37. Acanthaceae, x 750.
- 38-39. *Salmalia malabarica*, x 750.
- 40-42. Unidentified pollen IV, x 500.



PLATE 1

Table 1. Showing details of yellow rain

Venue	Maqboolganj								Vikas Nagar
	Leaf surface	Leaf surface	Leaf surface	Leaf/Rock surface	Leaf surface	Leaf surface	Leaf surface	Leaf surface	Leaf surface
Date of collection	3.2.91	7.2.91	13.2.91	16.2.91 (a)	16.2.91 (b)	17.2.91	18.2.91 (a)	18.2.91 (b)	10.2.91
1. <i>Ailanthus excelsa</i>	-	-	12(1.9)	31(5.6)	34(4.5)	-	12(7.5)	10(2.5)	-
2. Apiaceae	-	-	2(0.3)	5(0.9)	7(0.9)	9(1.0)	4(2.5)	1(0.2)	30(9.7)
3. Asteraceae	1(0.5)	30(8.9)	26(4.1)	34(6.2)	47(6.2)	40(4.7)	18(11.3)	40(10.2)	-
4. Brassicaceae	20(10.7)	52(15.4)	46(7.4)	26(4.7)	47(6.2)	92(10.9)	8(5.0)	26(6.7)	95(30.9)
5. Caryophyllaceae	-	-	-	2(0.3)	1(0.1)	-	-	-	-
6. Chenopodiaceae	-	-	-	-	-	1(0.1)	-	-	-
7. Fabaceae	-	9(2.6)	27(4.3)	52(9.4)	21(2.7)	57(6.7)	-	-	17(5.5)
8. <i>Justicia</i> sp.	-	-	-	-	5(0.6)	-	-	-	-
9. <i>Holoptelea integrifolia</i>	-	-	3(0.4)	4(0.7)	3(0.3)	4(0.5)	4(2.5)	4(1.0)	-
10. Liliaceae	-	-	-	-	-	1(0.1)	-	-	-
11. <i>Morus</i> sp.	-	-	12(1.9)	69(12.5)	59(7.8)	101(11.9)	35(22.1)	5(1.2)	60(19.5)
12. Myrtaceae	-	2(0.5)	45(7.2)	95(17.3)	139(18.5)	82(9.7)	24(15.1)	17(4.3)	105(34.2)
13. Oleaceae	136(73.1)	161(47.9)	410(66.0)	193(35.2)	301(40.0)	344(40.8)	30(18.9)	133(34.2)	-
14. Poaceae	1(0.5)	-	-	-	-	-	-	-	-
15. Rosaceae	-	-	3(0.4)	7(1.2)	3(0.4)	30(3.5)	-	-	-
16. <i>Salmalia malabarica</i>	1(0.5)	69(20.5)	15(2.4)	30(5.4)	46(6.1)	82(9.7)	16(10.9)	116(29.8)	-
17. Unidentified pollen-I	-	-	14(2.2)	-	11(1.4)	-	2(1.2)	15(3.8)	-
18. Unidentified pollen-II	27(14.5)	9(2.6)	6(0.9)	-	27(3.5)	-	2(1.2)	11(2.8)	-
19. Unidentified pollen-III	-	-	-	-	-	-	3(1.8)	11(2.8)	-
20. Unidentified pollen-IV	-	4(1.1)	-	-	-	-	-	-	-
Total	186	336	621	548	751	843	158	389	307

Remarks- A few fungi, diatoms and insect legs are also recorded.

Note : Figures in brackets are percentages calculated for absolute number of pollen against each taxon.

pollen showed negative results, whereas fresh pollen showed positive signals (deep blue stain) for protein. This study has confirmed that the yellow substance collected from leaves, etc. is nothing but the faecal droppings. The pollen collected by honey bees to feed their young ones passes through the intestine. In this process of digestion, pollen contents including proteins are digested with the aid of certain enzymes and only pollen exine is released as faeces. This faecal material is stored in the outer chambers of the honey comb and honey bees periodically defecate their behives which falls in the form of droplets during humid environs. This is what actually had happened whenever and wherever such yellow rain spots were observed.

#### YELLOW RAIN EVENT IN LUCKNOW, FEBRUARY 1991

Yellow spot substance collected from different objects in different parts of Lucknow were chemically processed employing acetolysis. The pollen analytical investigation of

all the samples has revealed the following three-fold aspects.

1. The pollen encountered in all the samples belong to angiosperms. There is almost total absence of gymnospermous pollen, pteridophytic and bryophytic spores. However, a few types of fungal spores and insect legs have been recorded.
2. The pollen present in the samples are generally coarsely ornamented conforming their origin from insect pollinated flowers.
3. Oleaceae almost always predominates the pollen assemblage. Co-dominant taxa recorded are Brassicaceae, Myrtaceae, *Salmalia malabarica*, *Morus* sp., etc.

Pollen record, area-wise and date-wise, is presented in Table 1.

#### REFERENCES

- Seeley, T.D. & Nowicke, J.W. 1985 Yellow rain. *Scientific American* 253 (2) : 122-131.  
Zhongying, Z. 1989. Yellow rain in China. *Sci. Prof. Oxf.* 73: 301-316.