

Correlation between pollen spectra and vegetation of Chhota Shigri Glacier in Himachal Pradesh, India

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Pollen analysis of modern surface samples and glacial deposits, collected from Chhota Shigri Glacier at different altitudes, ranging between 3,750 to 5,010 m, has been carried out to understand the pollen/vegetation relationship. The study reflects predominance of extra-regional arboreals over local non-arboreal taxa.

Key-words—Palynology, Vegetation, Chhota Shigri Glacier, Himachal Pradesh (India).

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सारांश

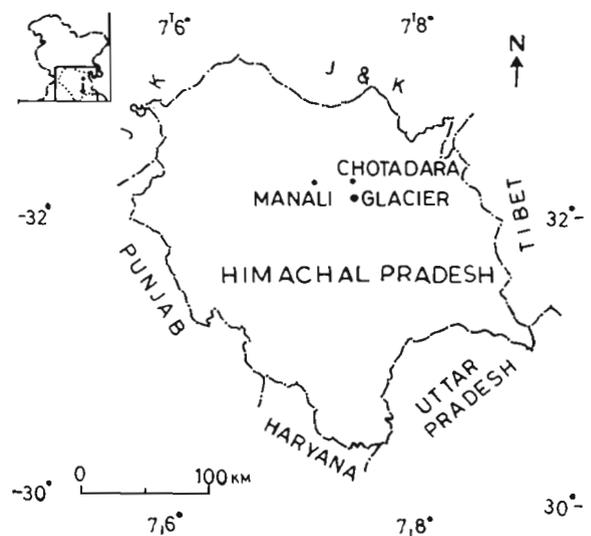
हिमाचल प्रदेश (भारत) में छोटा शिगरी हिमनद की वनस्पति एवं परागकण स्पेक्ट्रम में सहसम्बन्ध

समीर कुमार बेरा एवं हरीपाल गुप्ता

लगभग 3,750 से 5,010 मीटर की ऊंचाई के मध्य छोटा शिगरी हिमनद से एकत्र वर्तमान सतही नमूने एवं हिमानी निक्षेपों का परागकण-विश्लेषण किया गया। प्रस्तुत अध्ययन स्थानीय अवक्षीय वर्गों से बाह्य-क्षेत्रीय वृक्षीय अवयवों की अधिकता प्रदर्शित करता है।

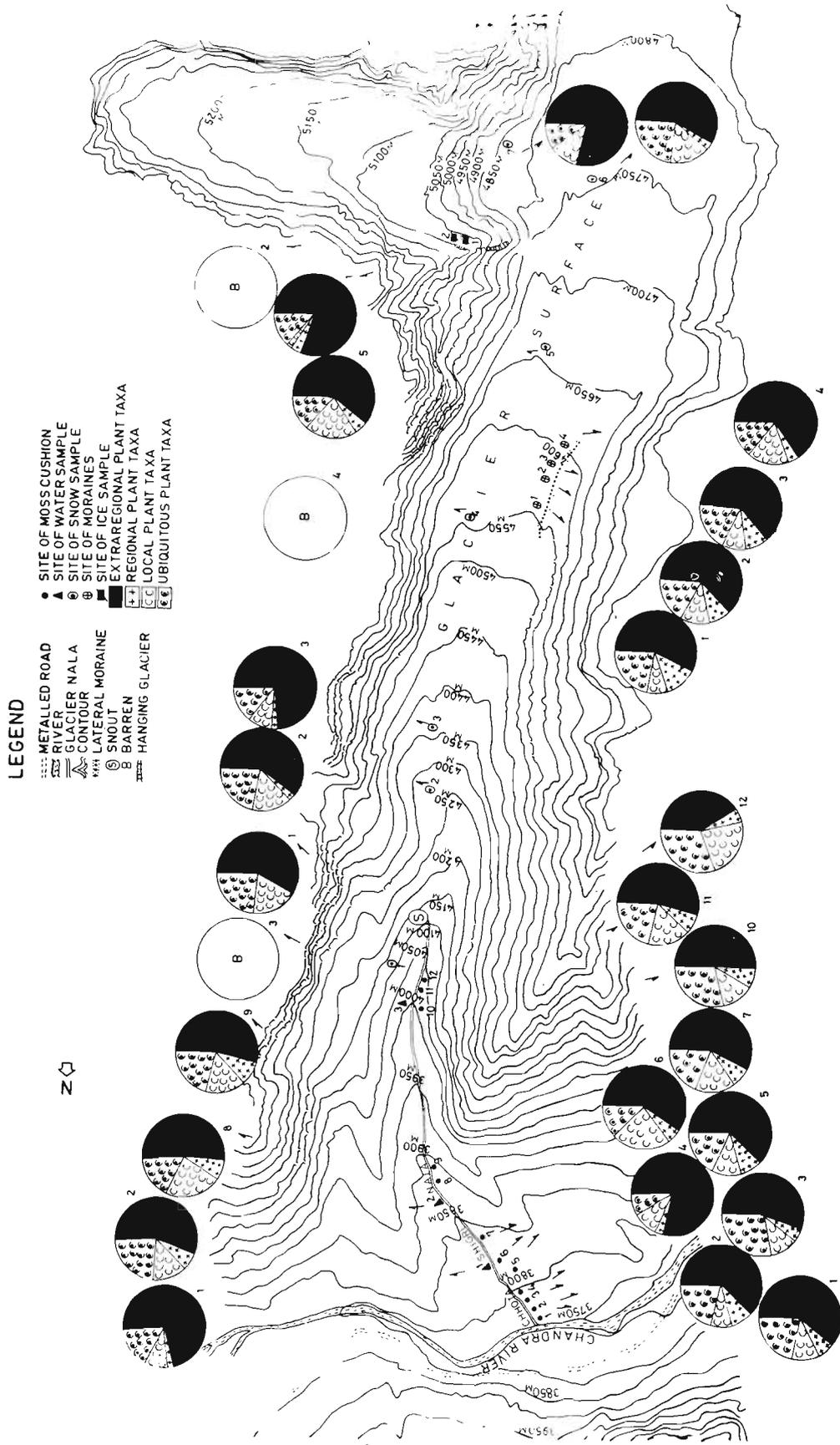
NO PALYNOLOGICAL work has been done so far on Chhota Shigri Glacier. Nevertheless, a preliminary attempt has been made to study seismotectonics and geomorphology of the area by WIHG, Dehradun during the years 1984-86 (Personal Communication). Recently a multidisciplinary research project on Chhota Shigri Glacier has been sponsored by the Department of Science and Technology, New Delhi wherein 15 various research organisations in India have participated. Consequently, an expedition to Chhota Shigri Glacier was organised from June-August, 1987, and one of us (SKB) participated in it. In the first phase, palynology of the modern surface samples has been undertaken. The study of glacier dust and Quaternary sediments are to be taken up in the subsequent phases.

The area covered in this study is situated at about 2.5 km south of Chhotadara Rest House along the old Manali-Kaza road and 98 km away from Manali (Lat. $32^{\circ}13.5'$ to $32^{\circ}16.5'$, Long. $77^{\circ}31'$ to $77^{\circ}32'$) in the Lahul and Spiti districts, Himachal Pradesh (Map 1). The area lies above the tree-line



Text-figure 1—Location map of Chhota Shigri Glacier, Himachal Pradesh.

zone comprising diversified ground vegetation only. The floristic clusters are mainly confined along



Text-figure 2—Pollen deposition model at Chhota Shigri Glacier, Himachal Pradesh.

glacier streams, river terraces, moraines and rockscrees. As a rule, glacier surfaces are generally devoid of any biota.

During the expedition it was observed that the plants are colonized either in the open flats near the river terraces or on moraines/rockscrees. A systematic collection of the following season's plants was also made:

Open flats near river terraces—The characteristic herbaceous plants of this habitat comprise *Potentilla rigida*, *P. fulgens*, *Rubus nutans* (Rosaceae); *Anemone rivularis*, *Delphinium brunonianum*, *D. denudatum* (Ranunculaceae); *Corydalis cornuta* (Papaveraceae); *Primula reidii*, *Androsace lanuginosa* (Primulaceae); *Geranium wallichiana* (Geraniaceae); *Impatiens gigantea* (Balsaminaceae); *Trifolium repens* (Fabaceae); *Saxifraga diversifolia* (Saxifragaceae); *Bupleurium himalayensis* (Apiaceae); *Saussurea gossypiphora*, *Solidago virga-aurea* (Asteraceae); *Pedicularis hoffmeisteri* (Scrophulariaceae); *Polygonum nepalense* (Polygonaceae); *Juncus himalensis* (Juncaceae); Grasses are dominated by *Agrostis munroana*, *A. nervosa*, *Deschampsia caespitosa*, *Phleum alpinum*, *Trisetum scitulum*. Sedges are represented by *Carex alpina*, *C. cruciata*, *C. setigera*, etc.

Moraines and rockscrees—The plant taxa growing in this habitat are *Anemone rivularis* (Ranunculaceae); *Draba* sp. (Brassicaceae); *Saxifraga* sp., *Suertia* sp. (Gentianaceae); *Meconopsis aculeata* (Papaveraceae); *Astragalus* sp. (Fabaceae); *Primula reidii* (Primulaceae); *Anaphalis triplinervis*; *Erigeron alpinus* (Asteraceae); *Allium* sp. (Liliaceae), etc.

MATERIAL AND METHOD

In all, 12 moss cushions were collected from the vicinity of glacier at an interval of about 100 m each in a traverse ranging between 3,750 to 4,020 m elevation approaching glacier snout. Three water samples from glacier nala, seven snow samples from glacier bed starting from 4,050 m a.s.l. (near snout) to 4,850 m a.s.l. near accumulation zone, four samples from lateral moraine deposits at 4,550, 4,570 and 4,650 m elevation, two ice samples from a well stratified hanging glacier with two distinct zones at 5,010 m near accumulation zone, been collected for pollen analysis. All the surface samples were chemically processed following the standard technique for extraction of palynofossils (Erdtman, 1943).

A sum of 150-300 arboreal and non-arboreal pollen were counted in each sample. Percentages were calculated in terms of total land plants pollen. Relative frequencies for pollen and spores were plotted separately. Because of the insufficient carbon contents in the moraine samples, the absolute dating could not be feasible

POLLEN SPECTRA

The results obtained from all the surface samples, viz., moss cushions, glacier nala water, snow and moraines, have been plotted separately in order to present a collective and comparative picture of the data (Text-fig. 3).

Moss cushion—Pollen spectra of moss cushions reveal an overall dominance of arboreal pollen except for sample no. 12 located near glacier snout

PLATE 1



(All figures, × 500)

1. *Cedrus deodara*
2. *Pinus wallichiana*
3. *Picea smithiana*
4. *Abies pindrow*
5. *Polygonum plebejum*
6. *Juglans regia*
7. *Betula utilis*
8. Polygonaceae
9. Ranunculaceae
10. *Alnus* sp.
11. Poaceae
12. Caryophyllaceae
13. Brassicaceae
14. Cyperaceae

15. Rosaceae
16. Asteraceae
17. *Ephedra* sp.
18. Trilete spore
19. Trilete spore
20. Monolete spore
21. 28. *Alternaria* sp.
22. Fungal spore, Type-1
23. Fungal spore, Type-2
24. Fungal spore, Type-3
25. *Curvularia* sp.
26. 29. *Tetraploa* sp.
27. *Helminthosporium* sp.
30. 31. *Melosira* sp.

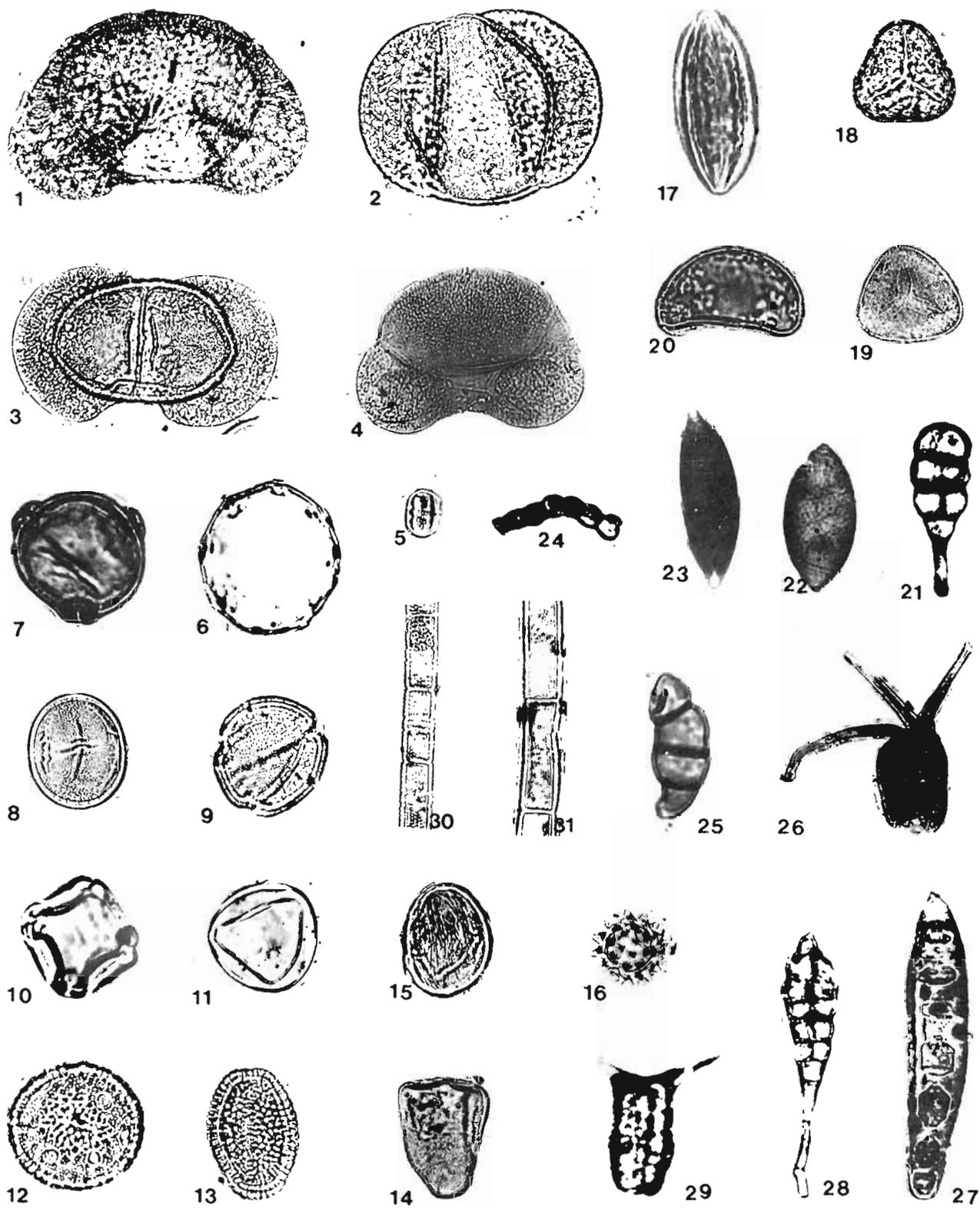
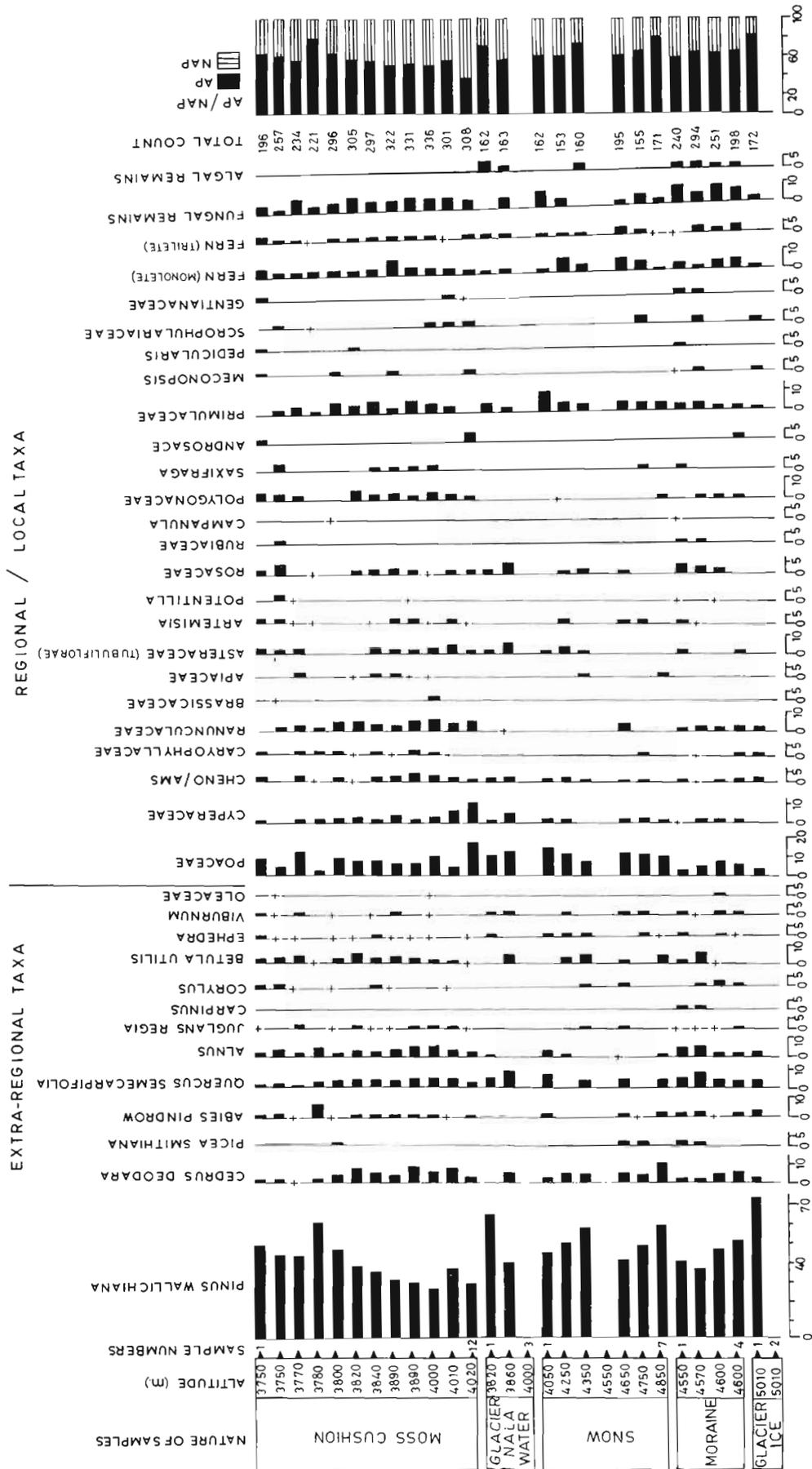


PLATE 1



Text-figure 3—Modern pollen spectra from Chhota Shigri Glacier, Himachal Pradesh.

which depicts higher values for non-arborescences. The arborescences are present to the tune of 85 per cent of the total vegetation. Amongst arborescences *Pinus wallichiana* records highest value (62%), whereas other taxa, such as *Cedrus* (7.6%), *Abies* (8.7%), *Quercus* (6%), *Betula* (5%), are present in moderately good values. The other associates, like *Carpinus*, *Corylus*, *Juglans*, *Ephedra* and *Viburnum* are either poor or sporadic.

The ground vegetation is meagre as compared to the arborescent vegetation. Poaceae has the highest value (17%) followed by Cyperaceae (10%), Rosaceae, Primulaceae (6% each) and Chen/Ams. (3%). Other taxa present sporadically are Caryophyllaceae, *Artemisia*, *Saxifraga*, *Meconopsis*, Scrophulariaceae and Gentianaceae.

Monoletic and trilete fern spores are also present in good frequencies maintaining 8 per cent and 4 per cent, respectively. Fungal spores are also recorded which maintain 8 per cent of the total value.

Glacier nala water—The pollen spectrum obtained from glacier nala water samples reflects an overall dominance of arboreal pollen. The pine pollen, amongst arborescences, attains a summit (64%) followed by *Cedrus* (5%), *Quercus* (8%), *Juglans*, *Alnus*, *Betula*, *Ephedra* which are either sporadic or absent. The ground vegetation is much lowly represented than the arborescent vegetation. The highest value is attained by Poaceae (12%), followed by Cyperaceae and Rosaceae (5% each). Other elements, such as Asteraceae, Chen/Ams., Primulaceae, are present under 4.5 per cent each; Ranunculaceae has stray occurrence. Monoletic and trilete spores are also present in low values (3% each). Fungal spores maintain 4 per cent of the total values and a few algal filaments have also been recorded.

Snow surface—The pollen spectra obtained from snow surface samples depict an overall dominance of arboreal pollen over non-arborescences. Amongst arborescences, *Pinus wallichiana* predominates attaining a summit of 57 per cent of the total values, whereas other taxa such as *Cedrus deodara* (10%), *Quercus* (7%), *Alnus* (6%), *Betula* (5%), *Abies pindrow* (2%), and *Ephedra* (2%) are present in moderately good values.

The ground vegetation is represented by low value of Poaceae (14%) followed by Asteraceae, Primulaceae, Cyperaceae, *Artemisia*, Rosaceae, Chen/Ams. and Ranunculaceae. Among fern spores, monoletic maintain 8 per cent and triletes 4 per cent. Fungal spores are recovered in higher frequency and algal remains have stray occurrence.

Moraine samples—Pollen spectra obtained from

moraine samples reveal the dominance of arborescences over non-arborescences. Amongst arborescences, *Pinus wallichiana* records highest value at 49.5 per cent, whereas other taxa such as *Cedrus* (9%), *Alnus* (6%), *Betula* (5%), *Quercus* (3%), *Picea*, *Abies* and *Ephedra* (2% each), are present in moderate values. Other associates, like *Juglans* and *Viburnum*, have stray occurrence. The ground vegetation is poor as compared to the tree taxa. Amongst non-arborescences, Poaceae attains the highest value (7%) followed by Primulaceae and Scrophulariaceae (4% each), Ranunculaceae, Rosaceae (3% each), Polygonaceae, *Saxifraga*, Chen/Ams. (under 2% each). Other associates like Caryophyllaceae, Asteraceae, *Meconopsis* and Gentianaceae have stray occurrence. Among fern spores, monoletic and triletes maintain 6 per cent and 3 per cent values, respectively. Fungal spores are present in moderately good values. Algal remains are also recovered from the samples.

Glacier ice sample—The pollen spectra obtained from glacier ice reveal the dominance of arborescences attaining 83 per cent of the total vegetation. Amongst arborescences, *Pinus wallichiana* records highest value (71%), whereas other taxa such as *Quercus* (4%), *Alnus* (3%), *Cedrus* (2%) and *Abies* (3%), are present in moderate values. The herbage is considerably reduced as compared to the arborescences. Amongst non-arborescences, Poaceae (3%), Chen/Ams. (2%), Ranunculaceae and Scrophulariaceae (under 2% each) are present in low values. The other associates like Caryophyllaceae, Primulaceae and ferns, are sporadically present. Fungal spores are higher than in other samples.

DISCUSSION AND CONCLUSION

The evaluation of all the pollen spectra individually and collectively has deduced an overall dominance of arboreal taxa. The picture thus obtained from the pollen spectra does not portray the true regional or local vegetation rather abounds with extra-regional vegetation. The conifer woods predominated by *Pinus wallichiana*, *Picea*, *Abies* and *Cedrus* in the spectra, do not grow in and around the glacier; instead they are mostly confined to the subalpine/alpine belt of climatic zone. Nevertheless, the Rohtang Range, far off from Chhota Shigri Glacier, is inhabited with coniferous forest.

Well represented *Pinus wallichiana* pollen (25-71%) in all surface samples (maximum in ice sample at 5,010 m) appear to have been derived from the temperate and subalpine regions along with *Cedrus deodara*, *Abies pindrow*, *Picea smithiana*, *Quercus*, *Corylus*, *Alnus* and *Betula* through upthemic winds. However, presence of *Quercus* pollen in low value

in all the samples needs to be reinvestigated in view of its relatively low pollen production and deficient buoyancy.

Moderately high values of Poaceae together with overall dominance of arboreals are suggestive to have derived from the local flora with vast stretches of open land. On the contrary, the conifers are derived from extra-regional zones.

Other non-arboreals, like Ranunculaceae, Primulaceae, Asteraceae, Rosaceae, Poaceae and Caryophyllaceae, are considered to be either local,

regional or ubiquitous. The fluctuations in the values of non-arboreals could be taken as reference to decipher the microclimatic changes, whereas the arboreals have been considered for macroclimatic interpretation.

REFERENCE

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