MACROSCOPIC PLANT REMAINS FROM THE POST-GLACIAL DEPOSITS OF KUMAON HILLS

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ABSTRACT

The paper incorporates the studies of sub-fossil seeds, fruits and moss fragments recovered from Naukuchiya Tal and Bhim Tal in Naini Tal District (Kumaon Hills).

The study of seeds and fruits has advanced our knowledge about the developments and the fluctuations of the lake vegetation. The data concerning the palaeo-environments derived from megafossils are interpreted in relation to the microfossils of the same sites.

INTRODUCTION

Seeds fruits and pollen grains are the two main sources to our knowledge of the Pleistocene Epoch as regards to the changes in vegetation, climate and anthropogenous activities. For many years pollen-analysis has been the commonest practice for evaluating vegetational history and climatic incidences of the past. Now, however, the research based on seed and fruit characters is forthcoming as a field for current research of Quaternary Palaeobotany. Reliable and exact identification of seeds and fruits is needed in several branches of both pure and applied science.

During 1962—1967 while studying the late-Quaternary vegetational history of Kumaon Himalaya from two lakes viz., Bhim Tal and Naukuchiya Tal in Naini Tal District through pollen analysis, a fairly large number of seeds, fruits, moss fragments and some of their beautiful cut sections, cuticles, wood fragments and rootlets were encountered. Their occurrence in these deposits has decidedly supplemented the information of vegetation and climatic conditions during the post-glacial time obtained from pollen analysis (VISHNU-MITTRE, GUPTA & ROBERT, 1967).

Both the lakes Bhim Tal and Naukuchiya Tal come under Naini Tal district and lie at an elevation of 1500 m and 1333 m a.s.l. respectively. Bhim Tal is the largest lake in the district and it is 1200 m in length and 260 m in breadth. The aquatic vegetation is poorly developed and the marsh vegetation around the lake is also poor. Naukuchiya Tal lies in the basin surrounded by high mountains on three sides and the thick oak woods descend to shores of the lake. The marginal swampy area extends towards the east of the lake to about 150 m in length and 80 m in breadth. The lake is populated by the aquatic and marshy vegetation such as *Nymphaea*, *Nelumbium*, *Phragmites* and sedges. *Limnanthemum* occurs but not frequently.

Efforts have been made to identify all the macroscopic plant remains correctly to their respective families, genera and species but wherever the identification is not possible they have been put under types. For the identity of seeds and fruits, the comparison has been made with their available living counterparts and also with the photographs published by BERTSCH (1941), GODWIN (1956) and MARTIN and BARKLEY (1968). The identification of moss fragments and bryophytic sections except for *Sphagnum papillosum* Lindl. (VISHNU-

MITTRE & GUPTA, 1971), could not be ascertained because of the paucity of comparative material.

MATERIAL AND METHOD

Two profiles one each from Bhim Tal and Naukuchiya Tal were picked up with the help of Hiller's peat-auger. The samples were collected at an interval of 10 cm each. The largest profile about 5.30 m deep is at Naukuchiya Tal whereas the Bhim Tal profile is comparatively smaller about 1.80 m deep.

Twenty grams of material from each sample were macerated and the residue left after 10% KOH treatment was washed thoroughly under tap water and then examined for macroscopic plant remains. The number of seeds per sample for different taxa has been indicated by horizontal lines in Text-figs. 1 &2. The vegetational phases have been marked as indicated in the pollen diagram (GUPTA, 1966; VISHNU-MITTRE *et al.*, 1967).

ANGIOSPERMS—SEEDS AND FRUITS

RANUNCULACEAE

Ranunculus sceleratus L.

Pl. 1, Figs. 14-15

The seeds are ovate in shape and the body of the seeds is more or less granular. The seeds of *Ranuunculus* occur in uniform but low frequencies in the upper samples. The present distribution of *Ranunculus sceleratus* shows that it grows under humid and moist conditions.

NYMPHAEACEAE

Nymphaea alba L.

Pl. 1, Figs. 16-17

The seeds are semicircular and fragile. They are provided with some wart-like projections on the surface. The occurrence of the seeds in Naukuchiya Tal deposits has been noticed right from zone-b but the number increased in Zone-c.

Nymphaea alba is a free-floating water plant occurring very abundantly in Naukuchiya Tal and it is not seen growing elsewhere in whole of the district.

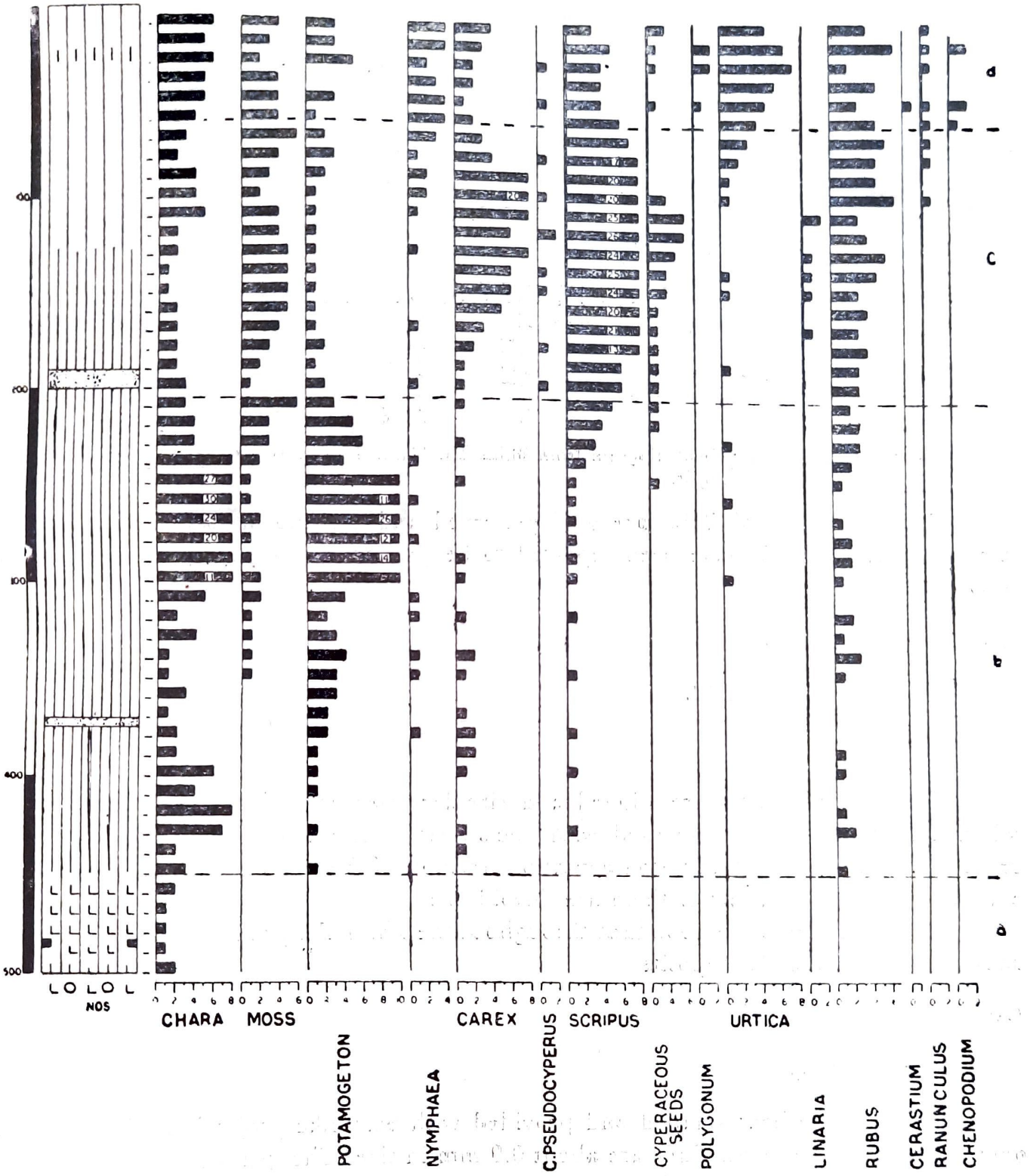
ROSACEAE

Rubus sexatilis L.

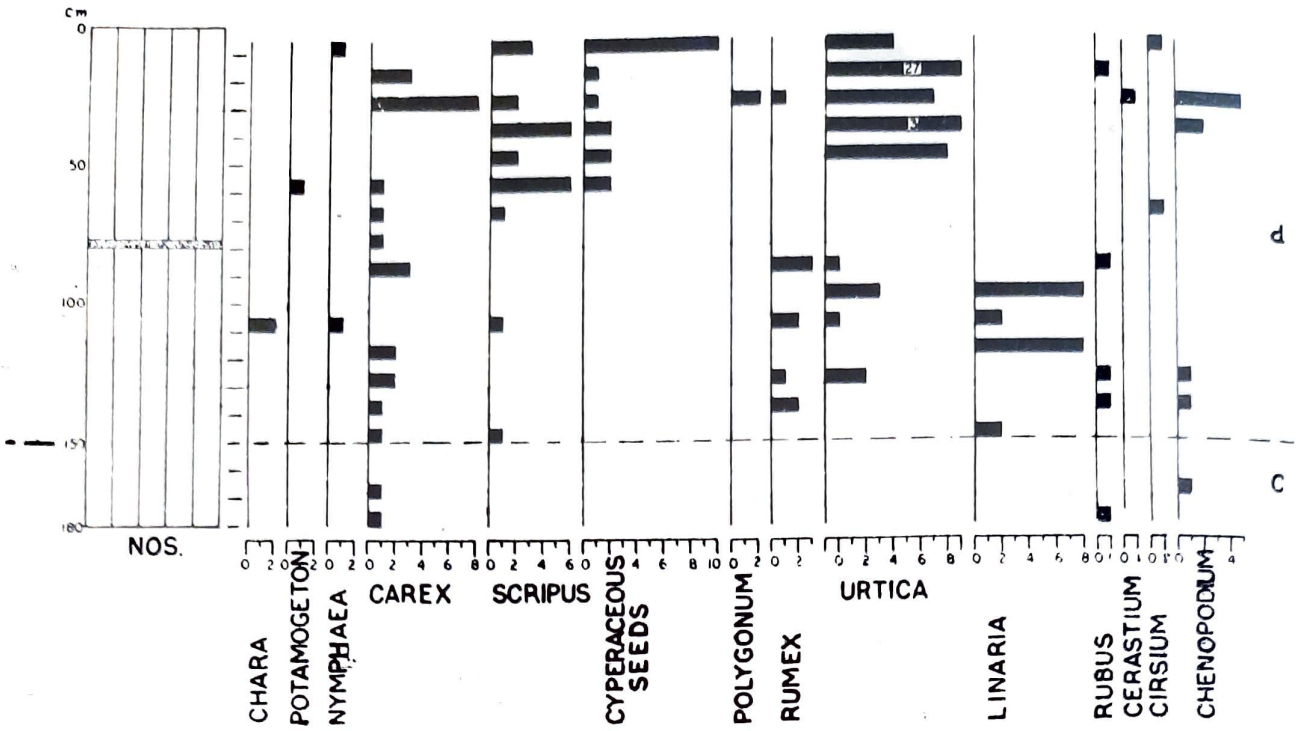
Pl. 1, Figs. 4-5

The subfossil fruit stones comparable with *Rubus sexatilis* are kidney shaped, measuring 1-2 mm in length, margin uneven and sub-circular, depressions homogeneoulsy distributed all over the surface, on both sides.

In the Bhim Tal profile the fruit stones of *Rubus sexatilis* are less farquent and the number of seeds per sample does not exceed more than 1-2 but in the Naukychiya Tal profile they occur in fair abundance. The number of seeds per sample during Zones-c and d reaches 6-7 but it is sporadic in the preceding zones.



Text-fig. 1—Plant macrofossil diagram from Naukuchiya Tal, Naini Tal—showing the number of seeds and fruits in each sample.



Text-fig. 2—Plant macrofossil diagram from Bhim Tal Naini Tal—showing the number of seeds and fruits in each sample.

The fruit-stones of *Rubus* are well preserved and are known to be transported by birds. The *Rubus* seeds have been reported to be present in Boreal period from Ireland (GODWIN, 1956).

SCROPHULARIACEAE

Linaria vulgaris Mill

Pl. 1, Fig. 2

The seeds of *Linaria* are winged and circular, measuring 2 mm in diameter. The wings are prominently ornamented with chess-board pattern whereas the corpus of the seeds is solid and without any ornamentation. In most of the seeds a long thin and smooth stalk is observed but a few of them are devoid of it.

The *Linaria* seeds are abundant throughout the Bhim Tal profile while they are sporadic in Naukuchiya Tal deposits.

CARYOPHYLLACEAE

Cerastium sp.

The seeds are heart-shaped and provided with wart-like projections distributed all over the body of the seeds. They are about 0.9 mm in size. The genus is represented only by two seeds one each from Bhim Tal and Naukuchiya Tal.

Most of the species of *Cerastium* are known to occur in waste lands.

POLYGONACEAE

Rumex hastatus D. Don

Pl. 1, Fig. 3

The fruits of *Rumex* with intact perianth are fairly large in size. The perianth with serrate margins is coarsely reticulate. The *Rumex* fruits are present sporadically in Bhim Tal deposits while absent from Naukuchiya Tal.

Polygonum glabrum Wild.

Pl. 2, Fig. 27

The seeds are oval with a prominent neck. They are found in the upper samples of the profiles. *Polygonum glabrum* is amphibious in distribution and generally grows along the margins of ponds and lakes.

URTICACEAE

Urtica dioica L.

Pl. 1; Figs. 8-9

The seeds are pitcher-shaped with prominent neck and short stalk about 1.4 mm in length. These seeds are very abundant in Bhim Tal profile where number reaches 20-25 seeds per sample but they are not so frequent in the Naukuchiya Tal profile.

CHENOPODIACEAE

Chenopodium album L.

Pl. 1, Fig. 7

Seeds are small and sub-circular about 0.4 mm in diameter. They are present in high frequencies in Bhim Tal.

COMPOSITAE

Cirsium sp.

Pl. 1, Fig. 6

The seeds are more or less elliptical in shape with basal portion broad and the upper portion narrow. They are found in Bhim Tal only.

CYPERACEAE

Carex sp.

Pl. 1, Fig. 12

The subfossil seeds of *Carex* are trihedron and utriculate in shape measuring 1.22 mm in length.

Carex pseudocyperus L.

Pl. 1, Fig. 1

The seeds are elongated with a prominent stalk. The perianth of the seeds is ornamented with chess-board pattern. Their occurrence in Naukuchiya Tal deposits is very meagre.

Scripus sp.

Pl. 2, Fig. 28

The *Scripus* seeds can readily be identified by their long and prominent hairs attached on the top of the neck of seeds. They measure 2.4 mm in length and 2.0 mm. in diameter at the centre. The frequencies of seeds are quite high both in Bhim Tal and Naukuchiya Tal deposits.

Cyperaceous seeds

Pl. 1, Fig. 13

Two types of seeds of which generic identity could not be ascertained. These seeds are largely confined to Zones a, b & c.

POTAMOGETONACEAE

Most of the Potamogetons are well preserved in the fossil state and their fruit-stones are comparatively more abundant than any other aquatics. Based on pollen morphology it is rather difficult to distinguish species but fruit-stones for their morphology and size allow a fairly precise recognition of species to be made. And therefore, a good number of *Potamogeton* fruit-stones encountered from the deposits have been referred to nine different types but the identification to their respective species could not be ascertained because of the paucity of comparable material. A tentative identification of some seeds has been indicated below. RUDOLF (1935) has recorded the occurrence of fruit-stone of *Potamogeton* sp. from L. Tertiary in N. Bohmen.

Type 1—*Potamogeton praelongus?* (Pl. 2, Fig. 19)
,, 2—*P. natans?* (Pl. 2, Fig. 25)
,, 3—*P. pectinatus?* (Pl. 2, Fig. 24)
,, 4—*P. sp.* (Pl. 2, Fig. 18)
,, 5—*P. alpinus?* (Pl. 2, Fig. 22)
,, 6—*P. octandrus?* (Pl. 2, Fig. 23)
,, 7—*P. sp.* (Pl. 2, Fig. 20)
,, 8—*P. sp.* (Pl. 2, Fig. 21)
,, 9—*P. sp.* (Pl. 2, Fig. 26)

BRYOPHYTES

A fairly large number of moss fragments have been encountered. They seem to be of five different types but their identifications could not be determined owing to the non-availability of comparative material. Besides the moss fragments, four nicely cut sections looking like that of bryophytes have also been recovered.

ALGAE

Chara sp.

Pl. 1, Figs. 10, 11

The *Chara* nucules have been frequently encountered throughout the vegetational zones in Naukuchiya Tal deposits.

DISCUSSION AND CONCLUSION

During Zone-a the lake vegetation was poorly developed. The *Chara*-nucules are consistently present in low frequencies throughout Zone-a. At present most Charas grow in deep water lakes and may go as deep as 200 cm.

During Zone-b there was an abundant flora of submerged and floating aquatics. The Chara nucules increase right at the base of Zone-b and after showing a fall in the middle of the zone further rise tremendously towards the top of the zone. Potamogetons are fairly abundant in the upper half of the Zone-b. The marshy and land plants are found sporadically except for *Scripus* which shows increasing tendency at the top of Zone-b. The lake except for minor fluctuations was probably much deeper during zone-b. The stray occurrences of near shore plants such as *Carex* and *Scripus* in Zone-b further suggests deepening of the lake. The moss fragments are found to occur in the middle of Zone-b and increase in number towards the top of the zone. The occurrence of mosses and other bryophytic remains obviously indicates an increase in humidity.

At the bottom of Zone-c the decline in almost all the water plants is noted which corresponds with the abundant appearance of *Carex* sp., *C. pseudocyperus*, *Scripus* and other Cyperaceae. *Chara* declines gradually right from the base of Zone-c except for the fluctuatingly increased values at the upper part of the Zone-c. Potamogetons show steep decline throughout Zone-c. *Nymphaea* is sporadic as in the preceding zones but tends to increase in the upper part of Zone-c. Frequency of mosses is fairly high throughout Zone-c. The reduced values of submerged and free floating plants and corresponding increase in marshy vegetation indicate temporary shallowing of the lake. The *Rubus* seeds are consistently abundant throughout Zone-c. The tremendous increase in the values of *Rubus* seeds is presumably due to cooling of the climate. Since *Rubus* fruit-stones are known to be transported by birds (Godwin, 1956) and hence their abundance during Zone-c can also be explained as transported one. At the top of Zone-c the water volume of the lake must have been very much fluctuating either because of the torrential rains or flooding episode as evidenced by slight increase in the water plants and corresponding decline in the marshy vegetation. The moss fragments are consistently high in Zone-c of Naukuchiya Tal deposits suggesting much more humid climate and high precipitation.

During Zone-d there is an overall increase in the water plants viz., *Chara*, *Potamogeton* and *Nymphaea*. Rise in *Urtica* is also noticeable during this zone. *Rubus* remains to continue in fairly high frequency. The overall increase in the values of aquatics and *Urtica* and *Rubus* suggests deepening of lake and cold climate respectively. In Bhim Tal during Zone-d the Cyperaceae, *Polygonum*, *Urtica*, *Rumex*, *Linaria* and *Chenopodium* are present in high numbers.

Climatic interpretation based on micro-organisms (Vishnu-Mittre *et al.*, 1967) is duly attested by plant macrofossils from Naukuchiya Tal and Bhim Tal. During Zone-a no seed/fruit, except for few charas, has been encountered and therefore indicates the warm and dry conditions. The overall increase in *Chara*, *Potamogeton* and commencement of *Nymphaea*, *Carex* and *Scripus* etc. during Zone-b suggest much warm and moist conditions. The high values for *Carex*, *Scripus*, *Rubus* and mosses suggest onset of cool climate which perhaps became much cooler and wetter during Zone-d as it is evidenced by increase in aquatics and marsh plants.

Thus the whole sequence of micro- and macroscopic plant remains indicate that during Zone-a the climate was warm and dry, during Zone-b it became warm and moist and optimal conditions of climate were presumably reached during Zone-b. The climate became moist and cool during Zone-c and probably much cooler in Zone-d.

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EXPLANATION OF PLATES

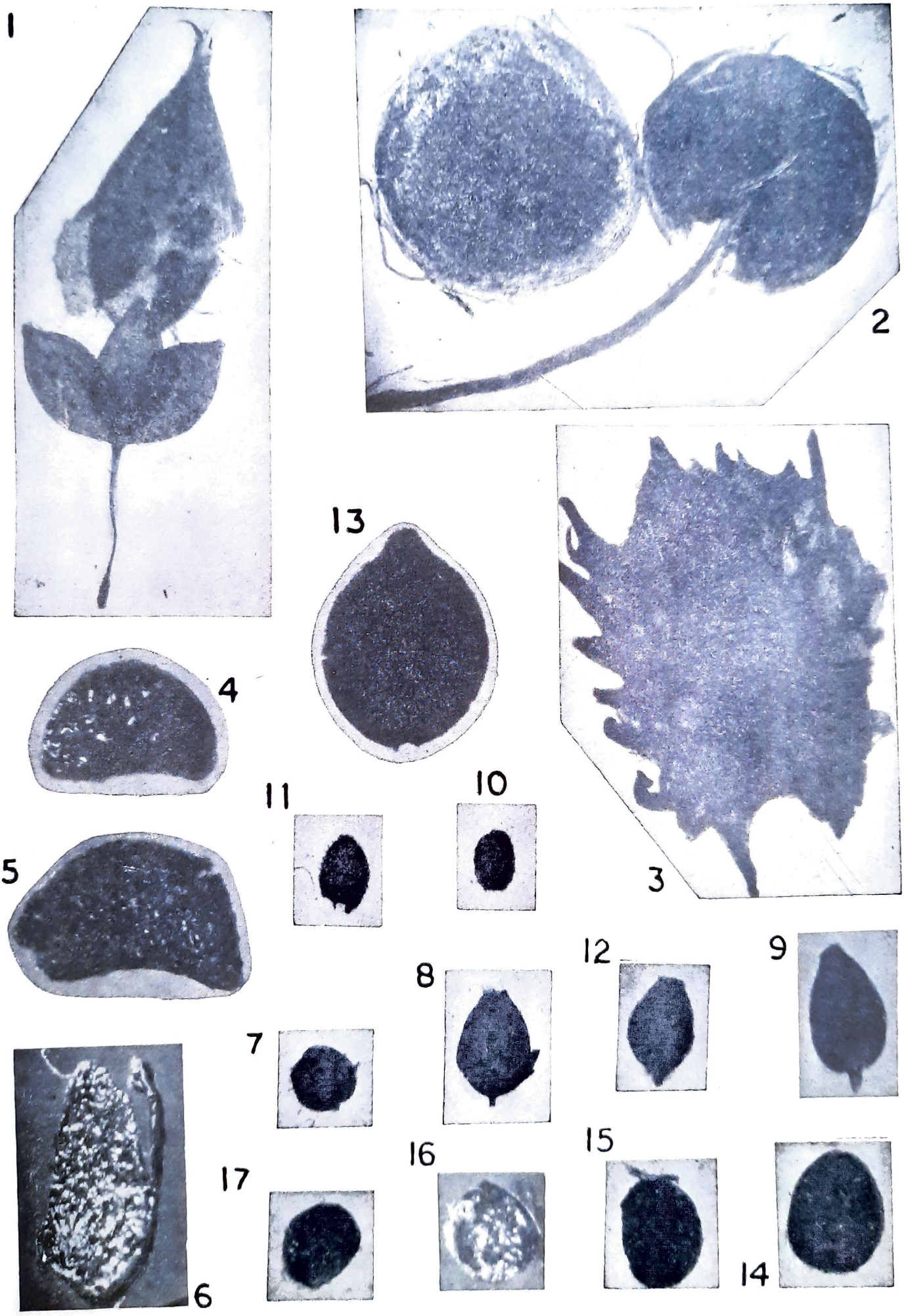
(All figures ×15)

PLATE 1

1. *Carex pseudocyperus.*
2. *Linaria vulgaris.*
3. *Rumex hastatus.*
4-5. *Rubus sexatilis.*
6. *Cirsium* sp.
7. *Chenopodium album.*
8, 9. *Urtica dioica.*
10-11. *Chara* sp.
12. *Carex* sp.
13. Cyperaceous seed.
14-15. *Ranunculus sceleratus.*
16-17. *Nymphaea alba.*

PLATE 2

18. *Potamogeton* sp.
19. *P. Praelongus.*
20–21. *Potamogeton* spp.
22. *P. alpinus.*
23. *P. octandrus.*
24. *P. pectinatus.*
25. *P. natans.*
26. *P.* sp.
27. *Polygonum glabrum.*
28. *Scripus* sp.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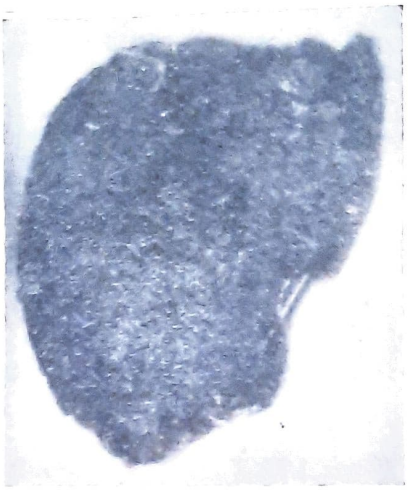

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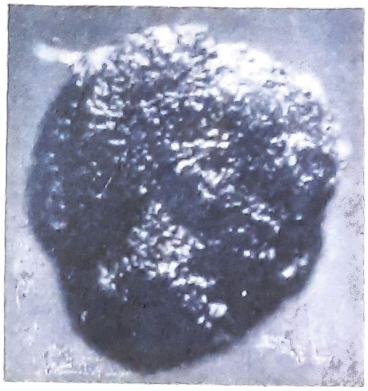

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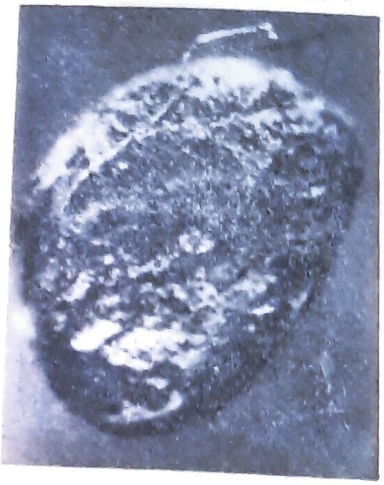

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Gupta—Plate 2