INTRASPECIFIC VARIATION IN **STRIATITES** SPORES*

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**ABSTRACT**

Undispersed spores from sporangia of *Arberiella* were isolated to study variations in their form caused by compression and maceration in order to assess the systematic importance of such variations in the demarcation of species of *Spolae dispersae*. The effect of maceration was also studied in spores of two living conifers *Pinus roxburghii* and *Cedrus deodara*. A new species of *Arberiella*, viz., *A. thomasii* is described.

**INTRODUCTION**

ALTHOUGH a large number of sporomorphs have been described from the Lower Gondwanas of India, yet the range of size and form within an individual species of these sporomorphs is often determined arbitrarily on the basis of dispersed spores. It was, therefore, thought that a better method of determining the range within any species could be based on the study of the variations inside undehisced sporangia which contained a particular sporomorph. Accordingly, we decided to investigate the range of size and form in *Striatites* type of spores which are known to occur in undehisced sporangia of *Arberiella* (Pant, 1958 and Pant & Nautiyal, 1960). Other reasons for selecting the sporangia of *Arberiella* for the present investigation are their common occurrence in the Lower Gondwana rocks and the diverse aspects in which their spores are compressed.

**MATERIAL AND METHODS**

The material used in the present investigation consists of coaly shales collected from the Raniganj coalfield. They are referable to the Raniganj Stage. Some pieces of shale were treated with hydrofluoric acid and the residue was washed in water. Sporangia of *Arberiella* were now sorted out of the residue and treated with Shulze's fluid. Other pieces of the shale were directly macerated in Shulze's fluid, and sporangia were again picked out of the residue. Chemical effects of maceration were noted by varying the duration of treatment with nitric acid and alkali.

For the sake of comparison, pollen grains of *Pinus roxburghii* and *Cedrus deodara* were subjected to chemical treatment similar to those of the fossils but it was not possible to imitate the changes which the pollen grains of *Arberiella* must have undergone during fossilization.

**OBSERVATION**

Sporangia

The genus *Arberiella* was originally made for compressed unilocular and stalked sporangia (Pant & Nautiyal, 1960). The sporangia may occur isolated or in groups

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TEXT-FIG. 1
TEXT-FIG. 2
where they are borne terminally on branches of slender stalks. The surface cells of sporangial wall are elongated and their dehiscence is longitudinal. Undehisced sporangia contain spores of Striatites type. Pant & Nautiyal (1960) have reported two species of Arberiella viz. A. vulgaris, from Raniganj coalfield, India and A. africana from Mhukuru Coalfield, Africa. The two species are based on spore size which is 40-55 \( \mu \times 25-30 \mu \) in A. africana and 50-85 \( \mu \times 30-55 \mu \) in A. vulgaris. During the present investigation we extracted not only typical sporangia referable to A. vulgaris (Plate 1, Figs. 1, 2) but sporangium-shaped masses of Striatites type of spores of distinctly larger size. These masses lack a surrounding jacket. We assume that their sporangial wall was rather delicate and it was either destroyed during fossilization or on the assumption that their wall dissolved in Schultze's fluid since these were obtained only in bulk maceration residues of the shale. We are unable to think of any other reason for the absence of the surrounding sporangial jacket and it is difficult to imagine that dispersed spores of Arberiella type could once again cluster into compact masses of the same shape as the sporangia of Arberiella. These spore clusters are, therefore, assigned to a third species of Arberiella, viz., A. thomasii. The spore clusters are thick and dark brown in colour and they gradually become thinner towards the margin where the outlines of some spores, compressed in different planes, can be seen.

**Spore**

The spores of A. vulgaris were taken out of undehisced sporangia. The other kind of spores were separated from sporangium-shaped clusters herein referred to A. thomasii. Both kinds of spores are of Striatites type, having a corpus with parallel striations and two lateral sacci. All the spores are invariably compressed and we can recognize the following main forms among them:

1. Spores showing a circular strongly striated body with the two wings attached laterally in para position. A relatively wider portion of the striate body is exposed (Text-fig. 1 — A, B, D, E, H-M; Text-fig. 2 — D, G, I, L). We regard all these spores as compressed mainly in or almost in the dorsiventral plane with the dorsal side upwards (Text-fig. 3-B).

2. Spores with striated central body showing more or less asymmetrically tilted lateral wings. The side of the body towards which the wings are tilted, as a rule, does not show any striations (Text-fig. 1 — N, O; Text-fig. 2 — E, F, N-Q). These spores are presumably compressed more or less nearly in the anterioposterior plane (Text-fig. 3E).

3. Spores whose wings are separated by a narrow nonstriated intervening portion of the body. Fine focusing shows that the wings overlap the body and striations can sometimes be seen at a lower focus (Text-fig. 1 — C, F; Text-fig. 2 — A, B, C). We believe that these spores are compressed in the dorsiventral plane similar to those of type (1) but with the opposite (ventral) side upwards (Text-fig. 3C).

4. Spores exposing only a small portion of the body and the wings partly or completely overlap each other (Text-fig. 1 — G; Text-fig. 2 — H, J, K, L, M). These are regarded as more or less laterally compressed spores (Text-fig. 3-D).

There are numerous other types of spores which present combinations or distorted...
views of the above four types and we regard them as compressed in intermediate planes or with their parts twisted or folded in different ways.

The margins of wings of all spores are smooth but their surface shows reticulate thickenings. The corpus of the spores shows micro-reticulations between the striations. It is not possible to say whether these ornamentations which appear micro-retticate are thickenings of that kind or microverrucose since they sometimes seem to be microverrucose. In spores of type (3) above, the surface of the corpus which lacks striations, may even appear laevigate.

Over-maceration of the spores tended to make the striations of the corpus indistinct, and prolonged over-maceration could even wipe them out completely. In very highly macerated spores the entire cuticle of the corpus dissolves and the two sacci separate out from each other. The two free sacci of such spores are often without any mark
of the body and they appear like a reticulately sculptured rounded spore (Plate 3, Figs. 3-7; Text-fig. 1-P).

Prolonged maceration of two winged pollen grains of two extant conifer species viz., Pinus roxburghii and Cedrus deodara show that their outer exine ruptures after becoming bulged out on one side and thereafter the contents of the corpus come out wrapped in the inner exine (Plate 2, Figs. 18 and 22). The outer exine of the corpus is more resistant towards the wings but elsewhere it dissolves readily (Plate 2, Figs. 17 and 21).

Arberiella thomasii sp. nov.

Plate L Figs. 4 and 5

Diagnosis — Sporangium shaped masses, 0.6 to 1.95 mm long and 0.5 to 1 mm broad containing spores of Striatites type. Size of spores ranging from 70-176 μ in length, 50-116 μ in width and 77-86 μ in height. Number of striations 6 to 11. Size of the corpus 52-108 μ in length, Size of the wing 39-69 μ in length, 51-69 μ in width and 77-86 μ in height

Holotype: Slide No. D-30
Locality and Horizon: Ghusic seam, Raniganj coalfield, Raniganj Stage, India

SUMMARY AND CONCLUSIONS

Larger spores of Striatites type which occur in sporangium shaped clusters are referred to a A. thomasii sp. nov. The differences between the spores of A. vulgaris, A. africana and A. thomasii are of the same order as those between the spores of Pinus roxburghii and Cedrus deodara which were also investigated side by side.

The present study also shows that spores obtained from undehisced sporangia of A. vulgaris and A. thomasii appear to have four main types of forms due to their flattening and presenting four aspects, viz., proximal (Type 1), antero-posterior (Type 2), distal (Type 3) and lateral (Type 4).

Mechanical and chemical action sometimes separates the wings from the body and some of our detached wings seemingly resemble previously described spores like Sulcatisporites (Bharadwaj, et al. 1965, Fig. 26), and Reticulatisporites (Bharadwaj 1962, Fig. 64). However, we are unable to confirm these observations without making a first hand comparison with the types of the above sporomorphs.

Oblique striations appearing over the corpus of some spores (Plate 2, Figs. 1-4; Text-fig. 1 — I, J, K, L; Text-fig. 2 — I) seem to be the result of a slight torsion in the corpus during flattening and Striapollevelites saccatus Bharadwaj (1962), Satriapollevelites obliquus Bharadwaj & Saluja (1964) are presumably spores of this kind.

Some of our spores (Plate 2, Fig. 5, Text-fig. 1 — D) appear like Distriatites (Bharadwaj, 1962). It is possible that such spores showing criss-crossed striations are formed due to the imprint of the striations of adjacent spores during compression and fossilization. Even the wings of some of our spores show imprints of striations (Plate 2, Fig. 7, Text-fig. 1-M). In this connection, it is interesting to note that Pant and Nautiyal (1960) have also described impressions of seeds and sporangia over leaf cuticles and Pant & Gupta (1971) found imprints of the lower cuticle and stomata of a leaf over a nonstomatiferous cuticle. Some other Distriatites spores may represent two crossed spores compressed against each other and sticking together (see Plate 2, Fig. 6, Text-fig. 1-H). The presence of a variable number of wings in these spores may also be accounted for by this assumption.

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REFERENCES


EXPLANATION OF PLATES

PLATE 1


PLATE 2

All X 500

A. vulgaris

1-4. Spores showing oblique striations. Sl. No. 20.
6. A Distriatiles type of structure apparently showing 3 or 4 wings and criss-crossed striations. Sl. No. 38.
7. Spores showing imprints of striations over the wing on the lower side. Sl. No. 38.
10. Spore apparently compressed and folded along the lateral plane. Sl. No. 13.
11. Dorsiventrally compressed spore with the dorsal side up. A small portion of the wing overlaps the corpus. Sl. No. 13.
12. Anterioposteriorly compressed spore with the wings brought closer due to slight lateral compression. Sl. No. 13.
13. Dorsiventrally compressed spore also showing slight lateral compression and folded wings.
14. Dorsiventrally compressed spore showing a collapsed wing in such a way that it lies over the striated portion. Sl. No. 13.

Pinus roxburghii

15. Mounted pollen grain. Sl. No. 10 N.

Cedrus deodara

19. Unmacerated pollen grain. Sl. No. 2.
20. Macerated pollen grain showing outer exine swollen and ruptured on one side. Sl. No. 6.

PLATE 3

All X 500

1-2. Macerated spores of Arberiella thomasi showing initial stages in the dissolution of the corpus. Sl. No. 8 and 10 respectively.
3. A wing showing an artifact resembling a trilete mark. Sl. No. 3.
4. Separated saccus after dissolution of corpus. Sl. No. 3.
5. A mechanically separated wing looking like a spore. Sl. No. 3.
6. A wing looking like a spore. Sl. No. 4.
7. A wing appearing as reticulately sculptured rounded spore. Sl. No. 4.