SOME SCALE LEAVES AND SPORANGIA FROM THE RANIGANJ COALFIELD, INDIA

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ABSTRACT

Two types of fertile scales are described. One is *Eretmonia* type and the other is placed under a new genus *Scirroma*. Two species are described under *Scirroma, S. ventilebra* and *S. angusta*. Cuticles of all the three fertile scales are described. Further details of the sporangium *Arberiella vulgaris* Pant & Nautiyal are given.

SOME scale leaves and sporangia were found preserved as carbonized compressions on the shales which yielded *Glossopteris* fructifications, we described earlier. A few sporangia were also found in isolated groups, some of which were preserved near scale leaves of *Eretmonia* type. Although there is no evidence of their attachment, we presume that these sporangia were borne on *Eretmonia* scales, as Surange and Maheshwari (1970) and Surange and Shaila Chandra (1974, 1975) have already reported such attachment to *Eretmonia* type of scale leaves. Earlier Pant and Nautiyal (1960) described isolated sporangia which they referred to three form genera, *Arberiella, Lithangium* and *Polytheca*. Our sporangia are referable to *Arberiella* group and contained two winged spores. The scale leaves also yielded cuticles and they are described below.

DESCRIPTION

Scale Leaves

Text-fig. 1 A-I illustrates two types of scale leaves, distinguished on the basis of their shape and size. One is lanceolate in shape (Text-fig. 1 E-I) but differ in size. The other is broad, deltoid or orbicular in shape and large in size (Text-fig. 1 A-D). The first we refer to *Eretmonia* and the second to a new genus *Scirroma*.

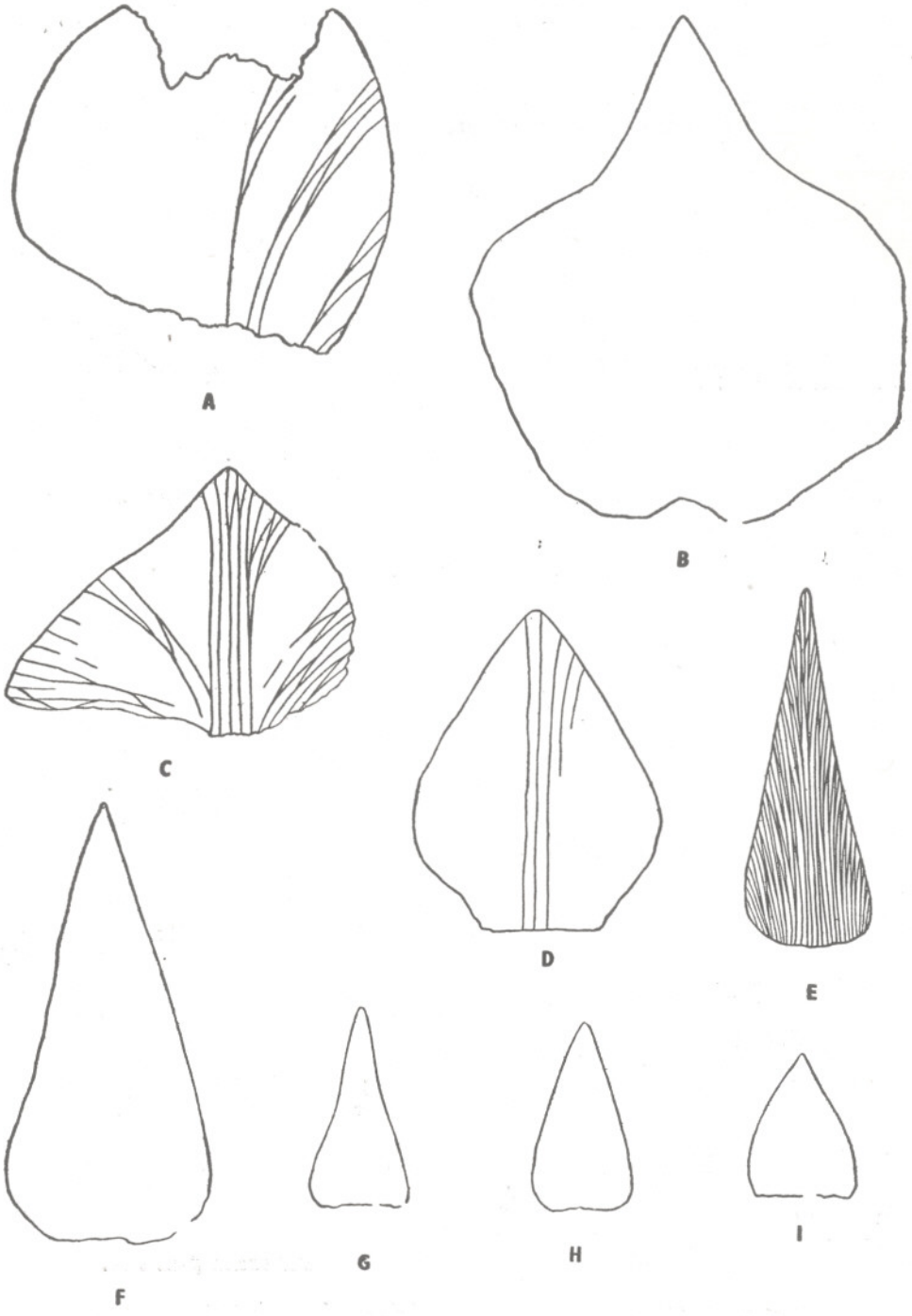
Eretmonia Type

Text-fig. 1 E-I, illustrates the variation in size and shape of these scale leaves. The venation is almost similar in all and it is shown in Text-fig. 1 E. We believe that this specimen represents only the lamina, the stalk to which it was attached had been shed off alongwith the sporangia which were attached on it. Most of the scale leaves are found preserved without their stalks. The lamina is broadest at the base and attenuates to an acute apex. Large number of veins enter into the lamina from the expanded base; there is no midrib but the central veins run straight upwards, divide a few times and enter the apex. Other side veins diverge to the margin, dividing once or twice. The bifurcations meet the adjoining veins and form meshes. This type of venation is distinct from the typical *Glossopteris* leaf venation. Most of the scale leaves has this type of venation with some variation.

The scale yielded thick cuticle (Pl. 2, figs. 1, 2). Text-fig. 2 A-C illustrates the epidermal cells of the *Eretmonia* type of scale leaf which must have been a thick and stiff organ. Text-fig. 2 A and B and Pl. 1, figs. 1, 2 represent cells on two surfaces of the scale. Cells on both surfaces are short and thick-walled, but those on one surface (Text-fig. 2 B) are much more thickened. In under macerated cuticles, the cells show a very small lumen in the centre. These cells are almost isodiametric, square, rectangular or oval in shape. The cells of the other surface are short, tetragonal or pentagonal and the cell walls are straight (Text-fig. 2A; Pl. 1, fig. 2). Vein and mesh areas are marked. Text-fig. 2C shows cells over the veins. They are long, thick-walled, elongated and arranged end to end. We have not been able to locate stomata or hair bases on any of these cuticles.

Scirroma gen. nov.

Diagnosis — Scale leaf large, broad, rhomboidal in shape; middle veins prominent, persisting upto apex, other veins arch out towards margin bifurcating and uniting to



TEXT-FIG. 1

form meshes; cuticles thick, one side much more thick than other side; cells of thicker cuticle with thick-walled cells.

Scirroma angusta sp. nov.

Diagnosis — Scale leaf small, rhomboidal in shape, 3-4 veins in centre run straight upwards, side veins diverge towards margin, branching, dividing and forming few meshes; surface cells thick on one side, comparatively thin on the other side.

This specimen yielded one very thick cuticle (Pl. 1, fig. 6) and the other comparatively thin cuticle. The thick cuticle has small, oval to isodiametric cells and the cell walls are thickened. Some of the cells contain thick, opaque substance. The thin cuticle has tetragonal to pentagonal cells, but the cells are mostly obscure. Here again we could not locate stomata.

Holotype — B.S.I.P. no. 35282.
Locality — Raniganj Coalfield.
Horizon — Raniganj Stage.

Scirroma ventilebra sp. nov.

Diagnosis — Scale leaf very large in size; veins strong, few central veins going straight up, side veins diverge towards margin, branching, fusing and forming meshes; epidermal cells on one side with very thick walls, those on other side comparatively thinner; vein and mesh areas faintly marked.

Text-fig. 2 D-F represents epidermal cells of the scale leaves illustrated in Text-fig. 1 C, D. In this case one cuticle is very thick and the other is thin (Pl. 1, figs. 3, 4, 5). Thick surface (Text-fig. 2 D; Pl. 1, figs. 3, 4) has isodiametric to oval cells with very thick walls, much more thicker than those of *Eretmonia*. Text-fig. 2 E and Pl. 1, fig. 5 show cells on the other surface, faintly divided into vein and mesh areas. The cells are tetragonal, pentagonal, hexagonal or oval with slightly thickened cell walls. They are quite characteristic in appearance. Cells over the veins are rectangular and arranged end to end (Text-fig. 2 F). No stomata could be located on any of the two surfaces.

Holotype — B.S.I.P. no. 35283.
Locality — Raniganj Coalfield.
Horizon — Raniganj Stage.

SPORANGIA

Arberiella vulgaris Pant & Nautiyal

In some cases partly preserved scales have been macerated alongwith sporangial groups. It is difficult to say what type of scales they were as we do not know their shape. But in one case, concavity in the lamina was observed and this feature has been noted in some *Eretmonia* type of scales. The sporangial group was situated inside the concavity of the scale lamina. This was macerated which yielded pieces of scale cuticles alongwith the sporangia and spores.

Text-fig. 3 A shows a carbonized group of sporangia on the shale which was also macerated. The macerated sporangia are shown in Text-fig. 5. Text-fig. 3B shows three sporangia, one partly preserved sporangium is attached to a stalk and two sporangia are seen in such a position as if they were attached on one stalk or bifurcations of a stalk. Pant and Nautiyal (1960) have also shown sporangia of *Arberiella vulgaris* type borne terminally on branched stalks. In any case, it becomes quite clear that the sporangia containing two winged pollen grains are attached terminally on a repeatedly branched pedicel as has already been shown by Surange and Shaila Chandra (1974, 1975). Text-fig. 3C shows a torned half

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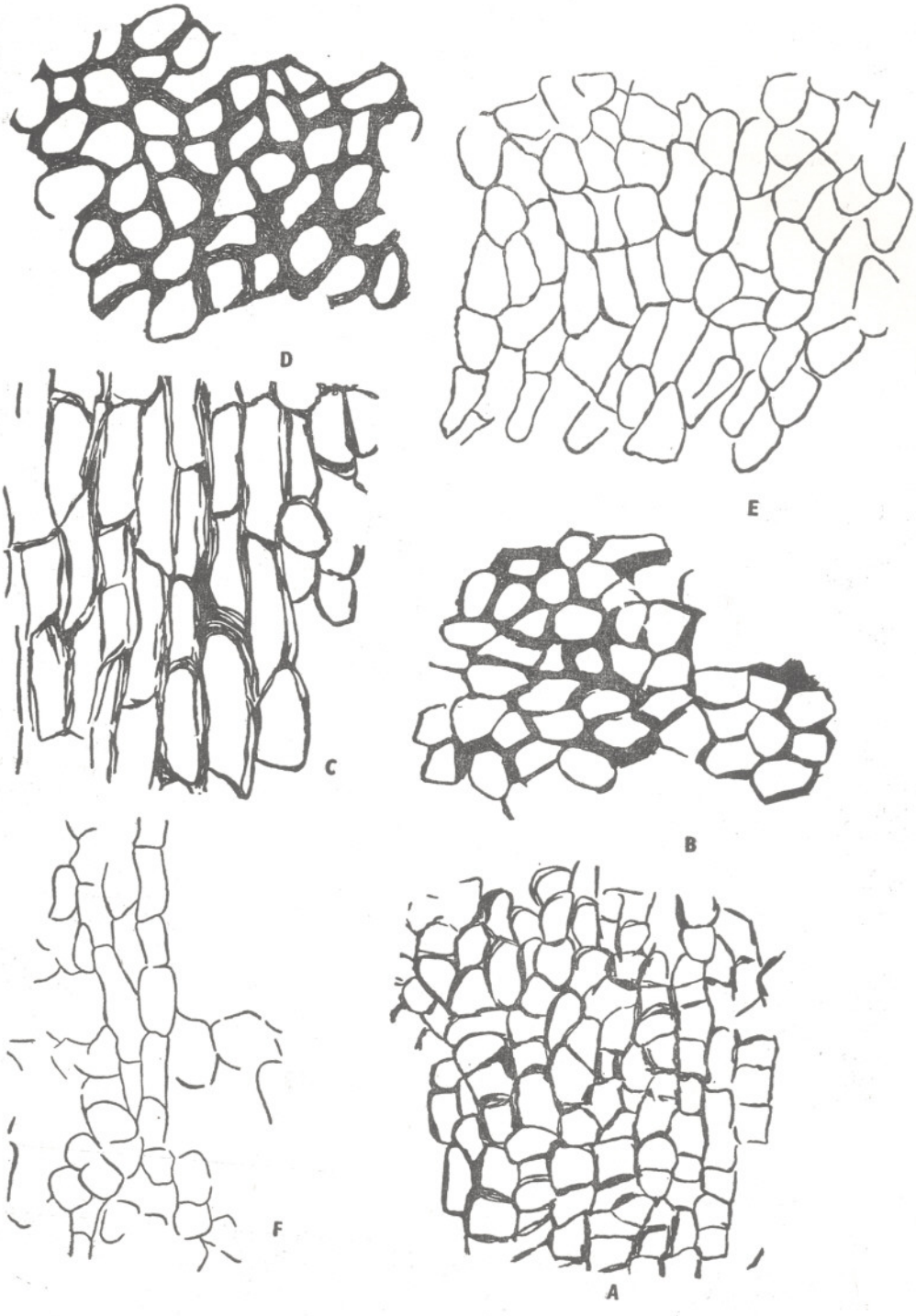
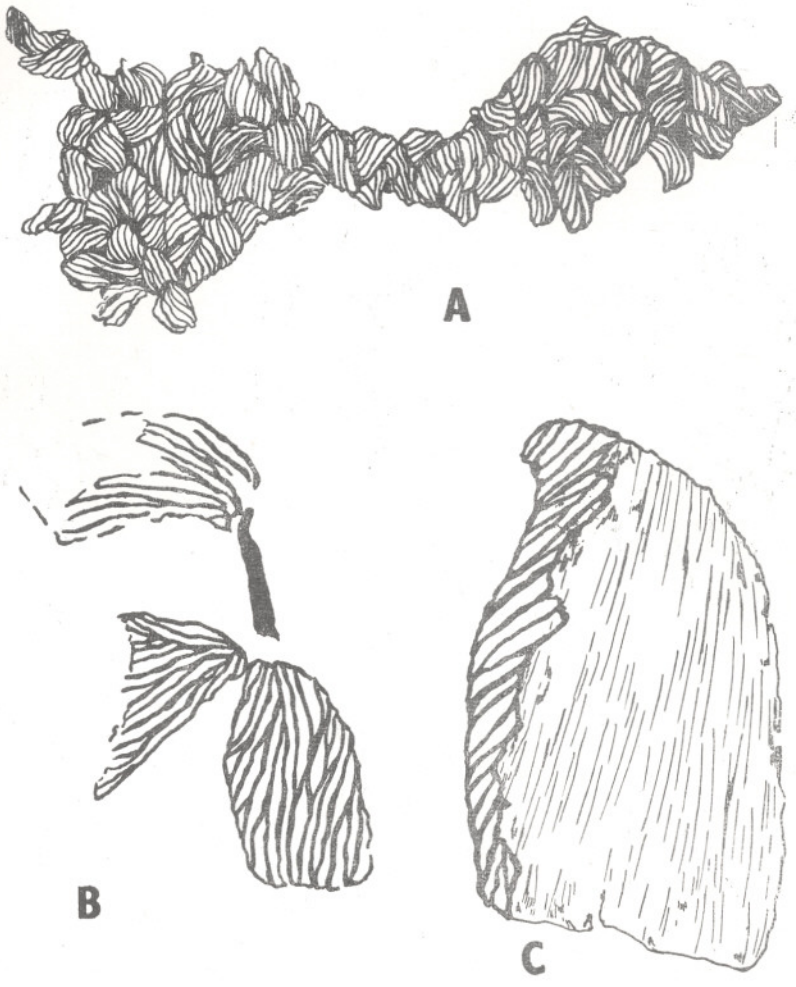
TEXT-FIG. 1 — A-D, scale leaves of *Scirroma*. There is no midrib, but strong veins in the centre run straight upwards, the outer veins giving out branching secondary veins. However, all the secondary veins do not arise from the central bundles. They diverge right from the base, branching and fusing on their way to the margin. B, *Scirroma ventilebra*, Holotype no. 35284; D, *Scirroma angusta*, Holotype no. 35283 × 2. E-I, scales of *Eretmonia* type. Stalk is not preserved. Note the venation in E arising from the base and diverging to the margin. They branch less frequently and the branches fuse occasionally. × 2. E, Holotype no. 35282.



TEXT-FIG. 2



TEXT-FIG. 3 — A, sporangial group of *Arberiella* type × 4. B, one sporangium attached to a thin stalk. Two sporangia lying in such a way as if attached on a stalk × 20. C, a torned sporangium showing the inside of the sporangial wall. Elongated, thickened outer cells of the sporangial wall seen on the left × 50.

of an empty sporangium, exposing interior of the sporangial wall. Thick-walled outer cells of the sporangium are seen on the left while delicate, elongated lines (cell walls ?) are seen on the inside wall of the sporangium. Does this sporangium has more than one

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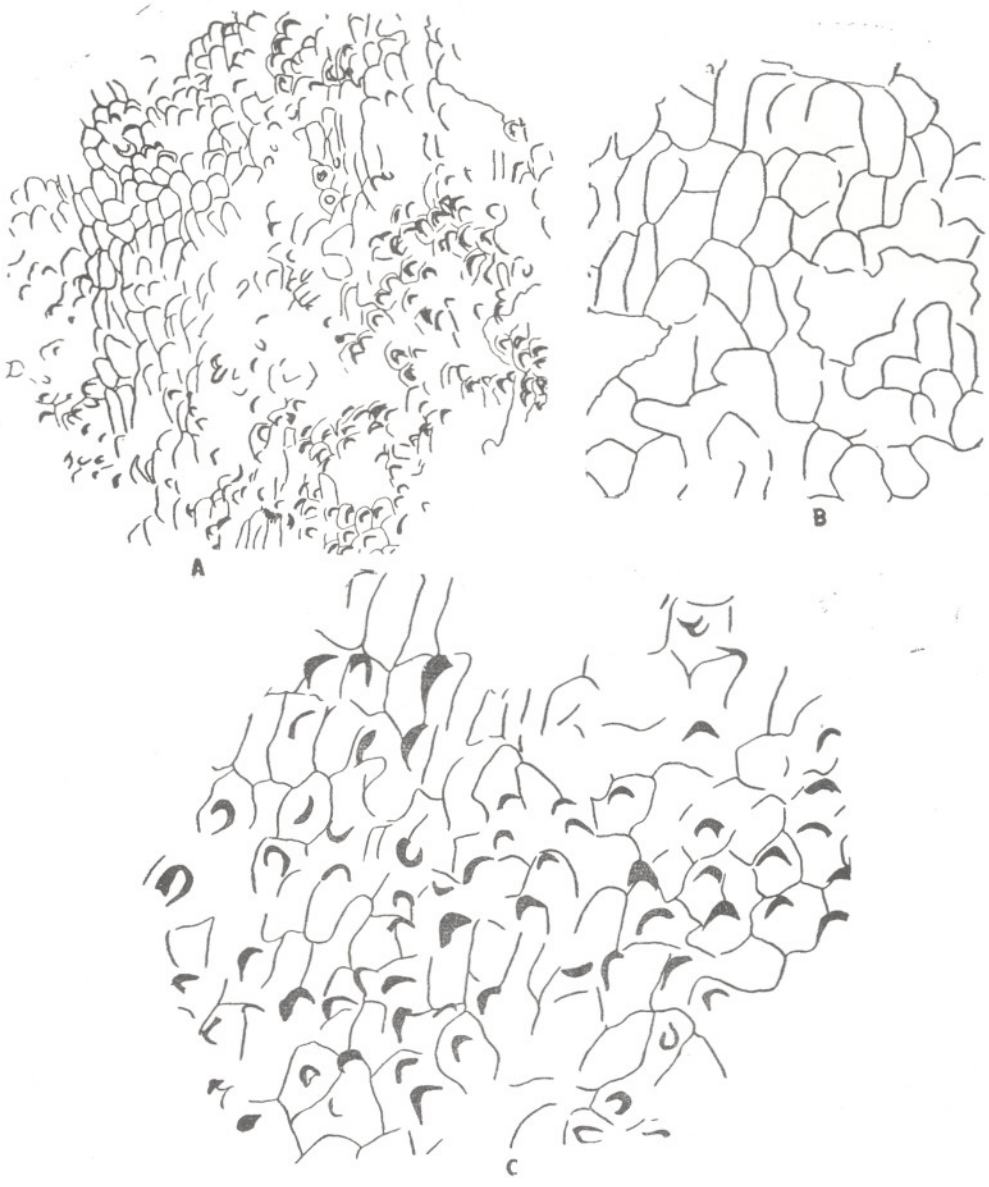
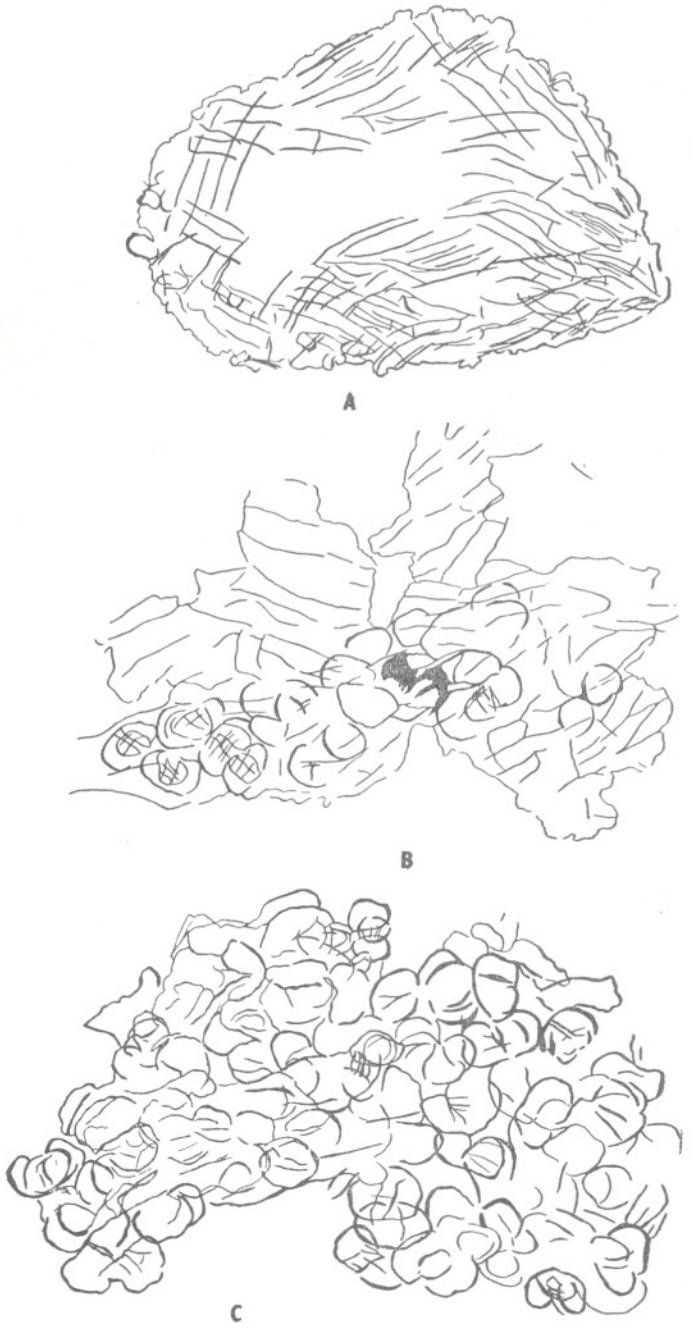
TEXT-FIG. 2 — A-C, cuticles of *Eretmonia* type of scale leaf; A, shows cells of one surface; B, thickened sclerenchymatous cells of the other surface; C, cells over the veins. D-F, cuticles of *Venustostrobus* type of scale leaf; D, sclerenchymatous cells of one surface; E, cells with thickenings dissolved; F, thin-walled cells of the other surface. Note the elongated cells over the vein and shorter, tetragonal cells with rounded corners of the mesh area. A-F × 175.



TEXT-FIG. 4 — A, papillate cells on one surface of the *Eretmonia* type of scale leaf. Non-papillate cells on the left are those over a vein. The same cells are magnified in C. Each cell contain one crescent-shaped papilla × 175. C, non-papillate cells from the other side of the protective bract × 175.

layer ? The dehiscence appears to be longitudinal, but how exactly it occurs, we have not been able to observe.

Macerated sporangia are shown in Text-fig. 5 A, B, C and Pl. 2, figs. 1-3. Text-fig. 5 A and Pl. 2, fig. 1 show a sporangium with outer wall almost intact with elongated thick-walled cells twisted in various fashions. More sporangia are illustrated in Text-fig. 5 B and C and Pl. 2, figs. 2, 3 macerated to various degrees. The outer surface cells are more clearly seen with a mass of spores



TEXT-FIG. 5 — A, one under macerated sporangium showing criss-crossing elongated cells from the outer surface of the sporangial wall and spores × 65. B & C, macerated sporangia containing two winged pollen grains. Note surface cells of the sporangia × 175.

contained in the sporangia. Next to the spore mass is seen a tissue with extremely thin-walled cells (Pl. 2, fig. 4). The spores are two winged and of different sizes (Pl. 1, fig. 7). The spores show straight attachment of the sacci and can be referred to *Faunipollenites* type. The body shows horizontal stripes. These spores are identical with those figured by Pant and Nautiyal (1960) for *Arberiella vulgaris* type of sporangia from the Raniganj Coalfield.

One type of cuticle associated with these sporangia is shown in Text-fig. 4. It came from the scale lamina with sporangial group preserved in its concavity. It means that the cuticles belong to *Eretmonia* type of male fructification.

The slide shows two types of cuticles which can be ascribed to the upper and lower surface of scale leaf. The slide also shows elongated surface cells of the sporangia and pieces of a very thin, granular tissue with mass of two winged spores sticking onto it. This perhaps represents the inner layer of the sporangial wall, next to the mass of spores. The sporangial wall thus appears to consists of more than one layer.

The cuticle of one surface of the scale lamina is thick and that of the other surface is very thin. The thick cuticle shows vein and mesh areas clearly and almost all the cells are papillate (Text-fig. 4A). Cells over the veins are more long than broad, tetragonal, straight-walled and arranged end to end. Most of them possess a crescent-shaped papilla in each cell (Text-fig. 4C). The cells in the mesh areas are rectangular with straight walls and a crescent-shaped papilla in each cell. The whole cuticle is papillate and all crescent-shaped papillae point in one direction. This papillate cuticle somewhat recalls, the cuticle of the receptacle of *Venustostrobus indicus* Shaila Chandra and Surange (in Press). The cuticle of the other surface is very thin and consists tetragonal or pentagonal cells with straight walls. Sometimes sporangia are found sticking on the surface, which thus perhaps represents the abaxial side of the scale leaf.

DISCUSSION

We have described in this short paper the cuticular structure of two types of scales. One shown in Text-fig. 1 A, B is quite large in size and is tough, thick and leathery. This is a new genus *Scirroma* which is represented by two species. The largest scale leaf has been put under *Scirroma ventilebra* which has distinct type cuticle than the smaller scale leaves which are placed under *Scirroma angusta*. No sporangia has been found associated with them. We do not yet know whether sporangia or seeds are borne on them, if at all they are the fertile leaves. The other scale leaf, no doubt, belongs to *Eretmonia* type (Text-fig. 1 E-I) but we have found no sporangia associated with it. The scale lamina is tough and the epidermal cells, atleast on one side, are very thick. The laminar part is thus well preserved after sporangia, alongwith the stalk on which they are borne, are shed off.

The other *Eretmonia* cuticle (Text-fig. 4 A-C) is quite different and is preserved with sporangia sticking to it. The concavity in the lamina containing sporangial group helps in identifying this partly preserved specimen as *Eretmonia* type but the specific identification cannot be done. The cuticle is not so thick as in the previous scale leaf. Further, the cells are short and possess crescent-shaped papillae. The sporangia associated with this scale leaf is *Arberiella vulgaris* Pant & Nautiyal type and the two winged pollen grain belongs to the genus *Faunipollenites* of the sporae dispersae. The spores also vary a good deal in size and are preserved in various positions, presenting different views to the viewer.

Arberiella type of sporangium shows ridges and furrows or longitudinal lines on its surface which are perhaps caused by the thick, elongated cells on the outer surface of the sporangium. The inner cuticle consists of a fine, delicate granular tissue with faint outlines of tetra-to pentagonal cell walls. This tissue lies next to the spore mass. Thus the sporangium wall consists of more than one layer of cells.

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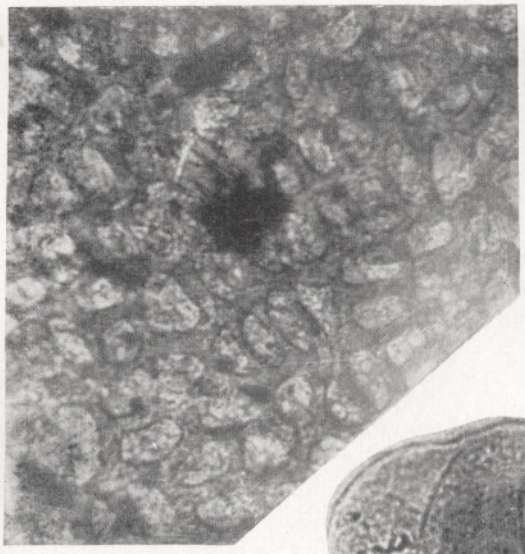

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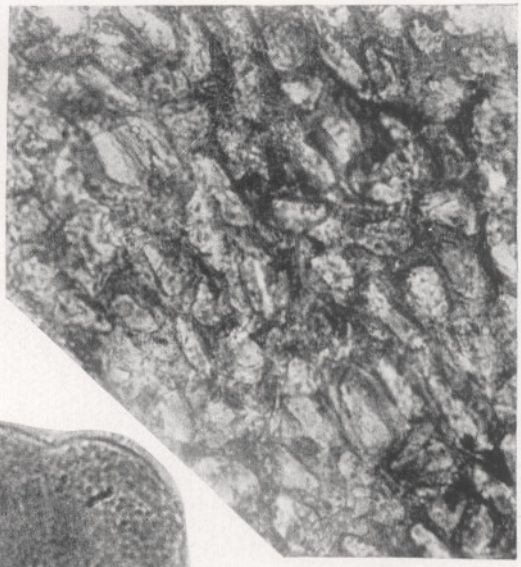

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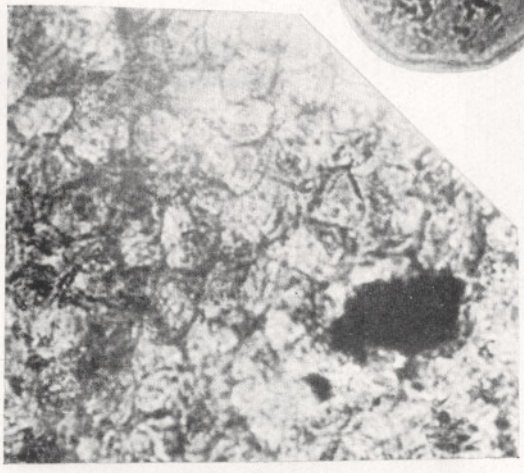

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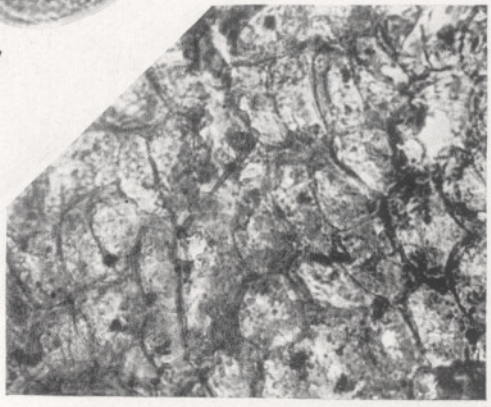

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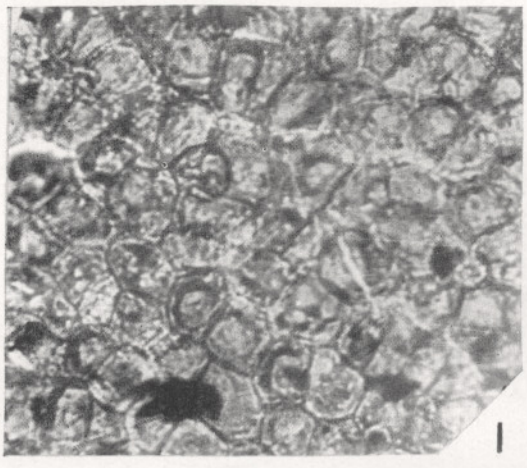

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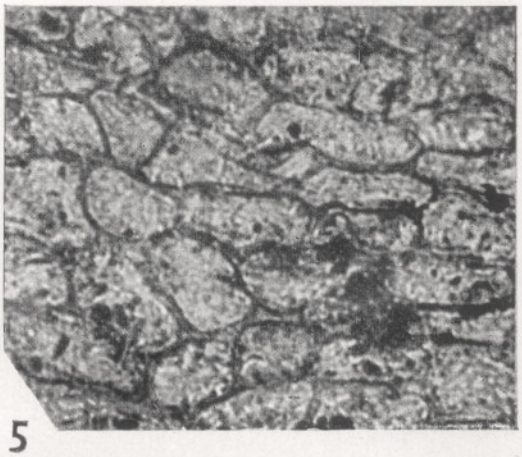

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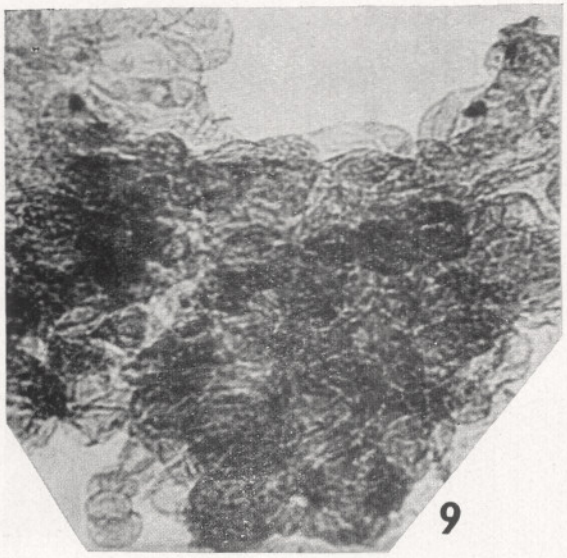

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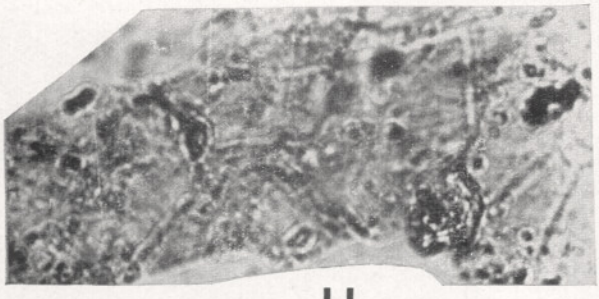

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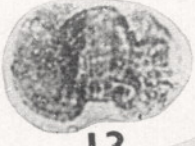

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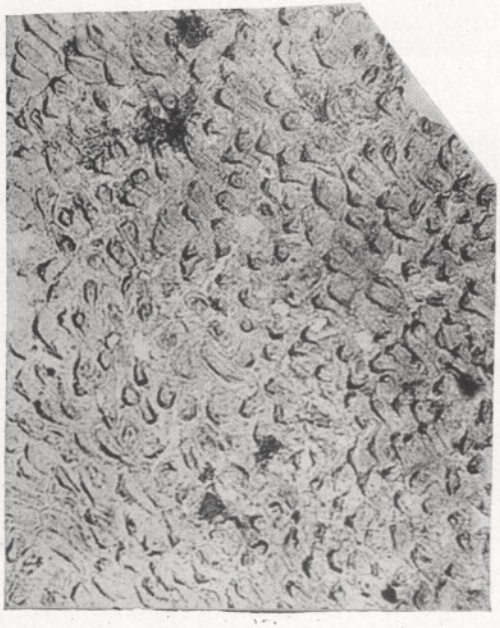

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EXPLANATION OF PLATES

PLATE 1

1. Thickened cells from one surface of *Eretmonia* type of scale leaf. × 200. Sl. no. 1/35282.

2. Comparatively thinner cells from the other surface of *Eretmonia* type of scale leaf. × 200. Sl. no. 2/35282.

3 & 4. Thickened cells from one surface of *Scirroma angusta* gen. et sp. nov. Scale leaf. × 200. Sl. no. 1/35283.

5. Cells from the other surface of *Scirroma angusta* scale leaf. × 200. Sl. no. 2/35283.

6. Thickened cells from one surface of *Scirroma ventilebra* sp. nov. scale leaf. × 200. Sl. no. 1 & 2/35284.

7. A pollen grain from one of the *Arberiella vulgaris* Pant & Nautiyal type of sporangium. × 1000. Sl. no. 5/35286.

PLATE 2

8. Under macerated sporangium of *Arberiella vulgaris* containing two winged pollen grains and showing criss-crossing surface cells of the sporangium. × 75. Sl. no. 1/35286.

9. A mass of two winged spores from a sporangium. × 200. Sl. no. 5/35286.

10. Elongated cells from the outer surface of the sporangial walls. × 200. Sl. no. 1/35285.

11. Thin-walled cells from one surface of *Eretmonia* type of scale leaf. × 200. Sl. no. 1/35285.

12. Papillate cells from the other surface of *Eretmonia* type of scale leaf. Sporangia were present in the concavity of this scale leaf, some of which are shown in figs. 8, 9, 10. × 100. Sl. no. 1/35285.

13. *Faunipollenites* type of two winged pollen grain contained in the *Arberiella vulgaris* type of sporangia. Note its small size. × 500. Sl. no. 5/35286.