SPICULE-LIKE MICROFOSSILS FROM THE TALCHIR FORMATION, DALTONGANJ COALFIELD, BIHAR

K. M. LELE AND A. K. SRIVASTAVA

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

Some peculiar microfossils recalling calcareous sponge spicules have been for the first time recovered from the Talchir sediments of the Daltonganj Coalfield, Bihar. The microfossils occur as individual bodies as well as in composite aggregates. Four distinct types have been recognised on the basis of their morphographic and structural features.

INTRODUCTION

Recently LELE AND CHANDRA (1972) discovered microplanktons and spores in the marine intercalation near Manendragarh and Umaria. In view of these findings, it was thought worthwhile to take up similar investigations in the Daltonganj Coalfield, where the Talchir Formation is known to lie in the Permian marine transgression zone (SASTRY & SHAH, 1964). This is corroborated by the evidence of *Fenestella* (DUTT, 1965) and other marine invertebrates in the beds (in JHINGRAN, 1967).

The Talchir Formation in the Daltonganj Coalfield (Survey of India, Topo sheet, 72 D/4) is well exposed in the Libji (or Lobjee) Nala. About 1/2 km. north of Rajhara the Talchir strata pass upward into the younger coal-bearing formation. Further northwards successively older beds of the Talchir Formation are exposed for about 2 km. in the Libji Nala. The dips are generally southerly.

In the lower part of the Talchir (away from Rajhara), there are typical Khaki siltstones, claystones and needle-shales overlying the Boulder Bed. Some samples of a Khaki-silt shale (Regd. No. 1312P/5, Field sample L 4) in this sequence contained fragmentary plant remains showing net-venation and stem-like impressions. On maceration of this sample, a few spores were also found. Otherwise, the sequence is generally unproductive for plant spores and pollen grains.

In the upper part of the Talchir (near Rajhara), a few beds of white to fawn-coloured clays (sometimes calcareous) and some light-grey calcareous silt-shales are interbedded with fine-grained Talchir ; andstones. Spores and pollen are not found in these beds but in the calcareous soft clays and shales a profuse quantity of peculiar acicular bodies have for the first time been discovered. These bodies recall the calcareous spicules of sponges and are described in this paper owing to their morphological interest.

It may be noted in this context that the bryozoon *Fenestella* was also discovered from the Talchir Formation of the Libji Nala by DUTT (1965). His fossils are reported to have come from "a two or three metres thick band of greenish-gray calcareous siltstone occupying an intermediate position in the Talchir sequence". It is not possible to ascertain whether the location wherein the present microfossils occur is the same as that of DUTT, but the two spots are possibly not far removed from each other.

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While the Daltonganj material was being macerated, some material of the typical Talchir siltstones (calcareous) collected from the Jayanti Coalfield was also treated only with hydrofluoric acid. Fortunately in one case, a large number of comparable microfossils were observed. These bodies are also calcareous.

Microfossils comparable with those found by us have recently been recorded a 'acicular bodies' from different levels in the Lower Gondwana subsurface drill core from the Korba Coalfield (Bharadwaj & Srivastava, 1973). Similarly a few samples belonging to the "Carbonaceous horizon of Lower Himalaya of Kameng district" (Precambrian—Lower Gondwana) which were received from the Director, G. S. I. NEFA circle for examination also yielded similar microfossils. These evidences, especially from the three different Lower Gondwana coalfields, converged to point out the consistent nature and presence of the microfossils. Detailed study and comparisons have led us to the view that these bodies are in all probability biological entities showing close morphological resemblance to the calcareous spicules of sponges.

As we know, spicules vary considerably in shape and size in the same animal. Besides, some of the simpler types of spicules show a very wide vertical range. Thus it is almost impossible to identify the animal or the strata on the basis of spicules alone. Considering these limitations, we have refrained from using a binomial nomenclature for these bodies. It seems best to recognise them as distinct types for the present in order to place them on record. Further work in this direction may reveal some useful data on the stratigraphic occurrence and affinities of these structures which may enable a more precise nomenclature.

MATERIALS AND METHODS

Samples detailed below were collected in ascending order from the Talchir Formation exposed in the Libji Nala (or Lobjee Nala of some anthors) for about 2 km north of Rajhara.

Field No.	*Regd. No.*	
L1	1312P/1	Light grey weathered, silt-shale (Microfossil type 1 predominant).
L2	1312P/2	Fawn, soft, light, calcareous clay; resembling chalk. (Microfossil Type 2 predominant).
L3	1312P/3	Dull white, calcareous shaly clay (Microfossil Type 4 predominant).
L3a	1312P/4	Fawn, soft, light, calcareous clay; comparable with L2. (Microfossil Type 3 predominant).
L4	1312P/5	Khaki silt-shale with fragmentary plant remains and few miospores. (Spicule-like bodies absent).
L5	1312P/6	Khaki Needle shale (Miospores or spicule-like bodies absent).
L6	1312P/7	Khaki siltstone Miospores or spicule-like bodies absent).
L7	1312P/8	Khaki, calcareous, hard siltstone (Miospores or spicule-like bodies absent).
L8	1312P/9	Khaki mudstone (Miospores or spicule-like bodies absent).

As the material was often more or less calcareous, only hydrofluoric acid was used for maceration. The treatment lasted for one or two days during which time the rock broke down to a fine residue. The residue was washed several times in distilled water to remove traces of the acid. Such residues, if further treated with hydrochloric acid, were almost completely dissolved leaving no trace of microfossils. Even some of the rocks gave reaction with hydrochloric acid and left only a meagre residue. It was thus evident that the microfossils were calcareous. The microfossils were also observed in simulated motion in a drop of dilute glycerine which indicated their three-dimensional nature.

DESCRIPTION OF MICROFOSSILS

Type 1 (Pl. I, Figs. 1-3; Text-figs. 1-A to E)

Description—The body is characteristically lens-shaped in outline, both ends being symmetrical and pointed (Pl. 1, Figs. 1, 2; Text-figs. 1-A to C). It is crystalline in appearance and ± colourless. Its length is generally about 4-5 times the width, the general range being 100—250 ×20—50 μ. The bodies are thicker in the middle, and appear to have a ± oval to elliptical cross-section. The surface and outline of the body is ± smooth in well-preserved examples but more often there are dense fine punctations (Pl. 1, Fig. 3) which may be modified by corrosion making the surface and body outline rough.

The middle ± one-third part of the body is differentiated into an oval area which is often bordered by darker, semicircular to crescentic patches along the longer axis (Pl. 1, Fig. 1; Text-fig. 1-A). In some examples (Text-fig. 1-C) there is another concentric zone, dark or light in colour, within the oval area. The lateral patches may be faintly marked (Pl. 1, Fig. 2) or irregularly developed (Text-fig. 1-B) and occasionally they are not decipherable at all. These modifications appear to be related to the states of preservation.

In the present preparation this type is found mostly as descrete individuals. Composite bodies are rarely present. These may be four-rayed, cruciate structures (Text-fig. 1-D) or multi-rayed, stellate aggregates (Text-fig. 1-E). In these composite bodies the central oval area is also correspondingly modified in shape.

Comparison—Calcareous sponge-spicules having lens-shaped forms are known to occur as monoaxons (diacts) in fossil state. Comparable shapes are found in the Jurassic genus *Protosycon* Zittel (MOORE, 1955, p. E96; p. E26, Fig. 1a).

Type 2 (Pl. 1, Figs. 4-8; Text-figs. 1-F to K)

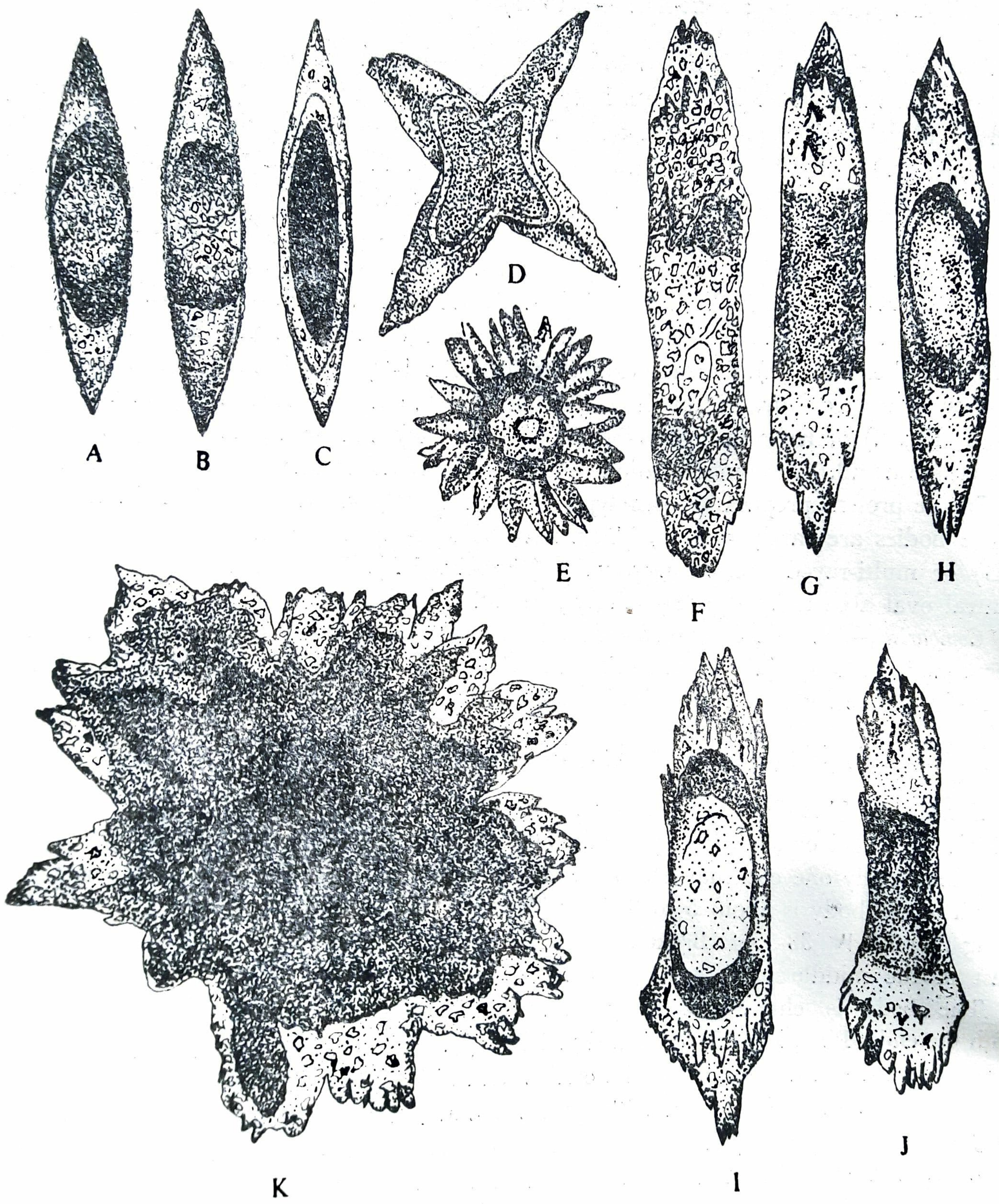
Description—The body is ± lenticular, crystalline and nearly colourless. The longer sides are parallel or slightly depressed. Both the ends are generally conical and pointed, but occasionally one end may be somewhat blunt and asymmetric (Text-figs, 1-I, J). The length of the body is about 5 to 6 times its width (in the middle), the general size range being 260-365 μ ±38-55 μ. Broken specimens suggest that the bodies may be hollow (at least in the middle part) and ± oval in cross-section.

The body is characterized by small spinose sculpture which is distinctly seen at both the ends (Pl. 1, Figs. 5, 6; Text-figs. 1-F to J). The spines tend to decrease in size and become crowded near the base of the conical ends. Very reduced elements may also spread over the remainder of the body. The surface and outline of the body generally appear rough, but this is possibly not so much due to ornament as due to different states of preservation and corrosion. Rare examples do have a nearly smooth surface and outline except in the region of the sculpture.

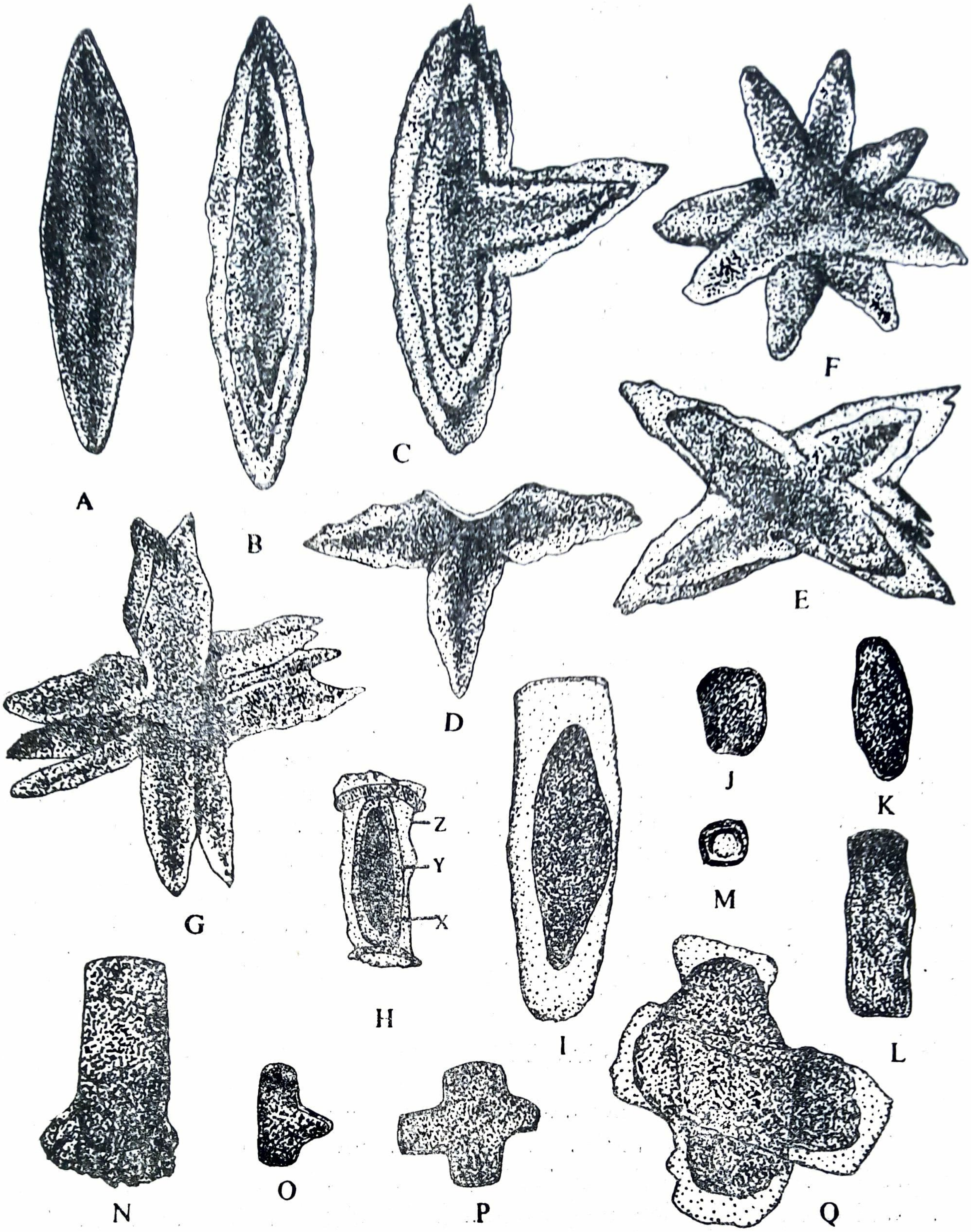
Well-preserved bodies (Text-fig. 1-H) show a lighter oval area in the middle part as in the case of Type 1. However, in the majority of examples, the outline of this area is hardly detectible (Text-fig. 1-F) and may be sometimes replaced by a darker patch (Pl.

1, Fig. 4; Text-figs. 1-G, I). Where present, the central oval area covers nearly 1/3 part of the total length and extends along the whole width of the body.

The bodies mostly occur as individuals but composite aggregates forming multi-radiate, star-like or flower-like bodies are not uncommon. In these aggregates a central dark area is often noticeable from which the individuals arise radially. (Pl. 1, Figs. 7, 8; Text-fig. 1-K). The oranmentation of the composite bodies is comparatively more reduced and fused. The composites range in size from 100-400 μ and indicate various stages in development.



Text-fig. 1A—K. MICROFOSSIL TYPE 1. Individuals (A—C) show variations in the central oval area. Composite bodies have cruciate (D) or stellate (E) appearance. 1-A, B, ×122. 1-C to E, ×102; MICROFOSSIL TYPE 2. Individuals (F—J) show variations in the central area and overall shape. Composite bodies (K) have rosette-like appearance. 1-F, K, ×122; 1-G—J, ×102.



Text-fig. 2A—Q, MICROFOSSIL TYPE 3. Individuals may be simple (A) or have more than one concentric layers (B). Composite bodies (C—G) in different stages of growth may have three to many-rayed rosette-like) appearance. All figures ×200. MICROFOSSIL TYPE 4. Complete individuals (H, I) have two or three layers. Naked inner-most layer (body) (J—L) and terminal hat-like structure (M) seem to result from the detachment of the various layers. The hat-like structure shows deep clefts (N). 2-H, J—M, O, P, ×122; 2-I, N, Q, ×200.

Comparison—This type shows some resemblance with Type 1 in the presence of a central oval area, but it is easily distinguishable by its shape and the spinose sculpture near the two ends. This latter feature is also absent in other types described here. The rosette like composite bodies recall the polyaxon spicules of sponges, e.g. as in the Cambrian genus *Asteractinella* Hinde (in MOORE, 1955, p. E 93; fig. 77-36) although that genus excludes calcareous spicules.

Type 3 (Pl. 1, Figs. 9-14; Text-figs. 2-A to G)

Description—This type is also boat-shaped like Type 1 but does not possess the central oval area. Most examples are translucent yellow in colour. The size ranges from 95-115 μ in length and 15-30 μ in width. The surface is smooth to finely punctate or roughened by corrosion. Parts of the bodies may wear out or dissolve due to states of preservation (Pl. 1, Fig. 10). The bodies are suspected to be more or less hollow and oval to elliptical in cross-section. This is suggested by broken specimens or by such examples as in Pl. 1, Fig. 9 in which a longitudinal crack is developed on one side, but it does not affect the other side of the body. The three-dimensional nature of the bodies becomes evident when the objects are moved to and fro in water. These bodies are associated with golden-yellow masses of gelatinous appearance whose real nature is still unknown. Sometimes, a large number of these particular spicule-like bodies are apparently adhering to such masses suggesting some relationship.

The bodies occur both as separate individuals and composite structures built up of four or more aggregates arising from a central point (Text-figs. 2-E to G). The four-rayed aggregates look like a cross or plus mark and often reveal what may be the axial canal along the median line. (Pl. 1, Fig. 11). Aggregates with several raidating rays appear like rosette (Pl. 1, Fg. 13, Text-fig. 2-F). Occasionally the individuals from a composite structure seem to have been detatched, leaving a scar or depression (Pl. 1, Fig. 14; Text-fig. 2-D). The composite bodies range in size from 75 μ to 150 μ in diameter.

Comparisons—Some of the composite structures are closely comparable in shape with tetractine spicules, as for example in the genus *Kiwetinokia* Walc. (Moore 1955, p. E69, Fig; 3a) which is known from the Cambrian to the Ordovician strata and in *Phragmodictya* Hall (Moore, 1955, p. 73; Fig. 2b) of Devonian age. The rosette-like composite structures are akin to polyaxon spicules of some sponges.

Some bodies (Text-figs. 2-B, C, E) otherwise closely comparable to Type-2 in size, shape and colour show one or more concentric lines (? layers). However there are not enough examples of the kind to ascertain whether these structures are different from Type- 3.

Type 4 (Pl. 1, Figs. 15-21; Text-figs. 2-H to Q)

Description—This type is peculiar and somewhat more complex than others described previously. The bodies are ± rectangular in outline, about 55-100 μ × 22-40 μ in size and generally translucent yellow in colour. The longer sides may be slightly convex towards the middle part and constricted below the two ends (Pl. 1, Fig. 15; Text-fig. 2-H). The bodies are generally built up of 2 or more distinct layers. In most cases 3 layers could be made out. The innermost layer or body is thick, about 55-70 μ × 15—25 μ in size, rectangular to lenticular in shape (X in Pl. 1, Figs. 15-17; Text-figs. 2-H, I) and finely punctate or smooth. The middle layer (Y in same Figs.) is also thick and closely surrounds the inner layer. The outer layer (Z in same Figs.) is thin, granulose, membranous and rather loose in appearance. It is seldom preserved completely but its remains are often visible in close association with the bodies (Pl. 1, Fig. 17). In addition to the three layers, at either end of the body a hat-like structure is developed which slightly overhangs the terminal part (C in Pl. 1, Figs. 15-17; Text-fig. 2-H). The surface of the hat may show deep clefts or notches (Pl. 1, Figs. 15, 16; Text-fig. 2-N). The rim of the hat is slightly thicker than the central area and girdles around the terminal part of the body (Pl. 1, Fig. 16, lower end).

There is evidence to indicate that the three layers get detached from each other to various degrees. Quite often the outer filmy membrane is lost, but it seems that the middle layer also separates out from the inner layer (or body). A large number of simple elliptical to rectangular bodies (Pl. 1, Fig. 18) present in the slides have almost certainly resulted from such a detachment. These naked structures (Pl. 1, Fig. 18; Text-figs. 2-J to L) compare closely in size and shape with the inner bodies of complete specimens (Pl. 1, Figs. 15, 16).

The hat-like structure on either side of the body also shows evidence of easy detachment. Such separated caps are common in the same preparation (Pl. 1, Fig. 17-c). These caps (Pl. 1, Fig. 19; Text-fig. 2-M) appear ± squarish (about 20-36 μ) showing generally two or sometimes three concentric layers. The innermost layer, which probably fitted over the end of the body, is the thinnest. It is surrounded by a slightly thicker layer which may be compared with the rim of the hat. A thin filmy layer is also evident in Pl. 1, Fig. 19 which may correspond with the outermost membrane of the bodies. The dimensions of detached caps and the thickness of the layers closely agree with those found in the caps of complete specimens.

It may be at first sight suspected that the detachment of the body layers and hat-like structures might have been caused by preservation or maceration factors. Yet there is a striking regularity in the manner of detachment, for example, the caps appear to have separated out quite clean from the rest of the body. Further evidences would seem necessary to clarify these interesting aspects. The bodies generally occur as separate individuals, but a few composite structures form a four-rayed cruciate pattern (Pl. 1, Fig. 20,; Text-figs. 2-P, Q). The individual units of this aggregate are somewhat unequal and asymmetric. This feature is much more pronounced in another specimen (Pl. 1, Fig. 21) in which a small body appears to bud out from only one s de of a full-sized body. The latter shows at least the inner and middle layers but in the young outgrowth the middle layer has not completely developed. Possibly the composite structures figured here indicate different stages of development (see also Text- figs. 2-O to Q).

DISCUSSION

The assemblage of microfossils described here has revealed at least four distinct morphological types. It is interesting to observe that generally one of the types is found to predominate in a particular sample, other types being rare or even missing (see under Materials & Methods). Repeated macerations of the various samples further indicate that the microfossil recovery is rather irregular. Probably both these aspects tend to indicate the localised nature of the microfossils.

Another point of interest which still needs a satisfactory explanation is that two of the types are nearly colourless and transparent (Types 1 & 2) while the other two (Types 3 & 4) are light to golden yellow in colour and translucent. The colouration is hard to explain for calcareous bodies, unless one presumes that it might have resulted from some impurity or from the deposition of some other substance on the calcareous bodies.

That the microfossils are calcareous has been verified from their reaction in hydrochloric acid which corrodes and dissolves them. The rocks could yield residues in hydrofluoric acid only and the microfossils also stayed in that. Thus it was also clear that the bodies were not siliceous. Petrological examination of the bodies under cross-nicols gave interference colours recalling calcite. However, the transparent, colourless microfossil types responded much more prominently than the yellow types; in the latter the colours were weak and only here and there. In the colourless types also, some areas (especially the central oval area) which sometimes appeared pale yellow, did not give as bright interference colours as the remaining part of the microfossils. Perhaps colouration of the microfossils, whatever its cause, appeared to interfere with cross-nicol optics. At any rate, the petrological and chemical tests leave little doubt as to the calcareous nature of the microfossils in general.

When the bodies were first encountered the question of their affinities was somewhat puzzling. Closer studies, however, revealed that the bodies possessed a very definite shape, size-range, sculpture, structure and organization. The structures are evidently much more than mere crystals or crystal aggregates. It is thus natural to assume that the bodies represent some biological entities composed of mineral matter. Among such entities, the silicoflagellates, nannoplanktons, diatoms, forams and sponge spicules are well known. However among these, the sponge spicules, only have, the composltion and from that bears some relevance to the present findings. The sponge spicules, in their make up, may be siliceous, calcareous or horny. They form part of the skeleton which supports and protects the canals of sponges. Spicules may occur as simple individual structures or may form composite aggregates characterized by a number of rays given out from a central growing point. Depending on the number of rays end their axial directions the spicules may be recognised as monoaxons, triaxons, tetraxons, polyaxons etc. or monactine, diactine and so on (Woodward, 1911; in Moore, 1955; Woods, 1963). An elaborate terminology exists for describing the spicules as these structures are of diagnostic value in the identification of sponges.

From comparisons, it becomes clear that the present finding offer maximum, if not complete, resemblance with the spicules of calcareous sponges. Some of the types, occurring as individuals or in composite aggregates can be closely matched with the monoaxons, tetraxons (tetractine) or polyaxons of sponges. Many of the bodies are about 100μ or more in length and may fall in the range of megascleres (Moore, 1955, p. E27). Smaller bodies also occur but they are possibly developmental stages. Associated with these micro fossils are some indeterminate objects, either as individuals or in masses, whose relationship with the spicule-like bodies is not known.

We have chosen to call the microfossils 'spicule-like' because certain points are still not clear. For example, it is curious that two of the types (Tpye 1 & 2) are colourless and transparent whereas the other two types (Type 3 & 4) are yellow in colour. Secondly, only some of the microfossils reveal the axial canal as in spong spicules; otherwise mostly they have a central oval area (Type 1 & 2). The organization of Type 4 is, above all, quite puzzling in having a number of successive layers which are easily detachable.

The present studies are of a preliminary nature and are presented mainly with the object of drawing the attention of palynologists and palaeontologists on these curious microfossils which are entirely new to the Lower Gondwana sediments of India. Even in other Gondwana lands our knowledge of Permian sponges is very meagre (Teichert, 1951). It is therefore hoped that such objects, when studied more extensively and intensively might provide some clues as to their affinities, stratigraphical distribution and palaeoecological background. At present, the evidence is insufficient to establish the existence of sponges in the Talchir times near Daltonganj. However, such a possibility is not altogether excluded, especially when marine environments are known to have prevailed there during the deposition of the Talchir Formation.

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EXPLANATION OF PLATE 1

The type material and figured slides (Regd. Nos. 4472-4477) are preserved in the Museum, Birbal Sahni Institute of Palaeobotany, Lucknow.

1. Microfossil type 1; several specimens in low magnification. The larger specimen shows the central oval area with dark semi-lunar patches on either side. Slide Regd. No. 4472; ×88.
2. Microfossil type 1; The central oval area is clear but the lateral dark patches are obscure. The rough appearance of the surface is largely accentuated by corrosion. Slide Regd. No. 4472; ×250.
3. Microfossil Type 1; central part magnified to show punctate surface. Slide Regd. No. 4476; ×500.
4. Microfossil Type 2; several specimens in low magnification. The larger specimen faintly show the central oval area. Slide Regd. No. 4473; ×88.
5. Microfossil Type 2; The two ends show a number of spines, some fused on the right hand side in the upper part of the figure. The central oval area is not clear. Slide Regd. No. 4473; ×250.
6. Microfossil Type 2; One end of the specimen enlarged to show the nature of spinose sculpture Slide Regd. No. 4473; ×500.

7-8 Microfossil Types 2; Composite bodies forming a rosette-like pattern. The central region is often dark. Slide Regd. No. 4477; ×88.

9. Microfossil type 3. A curved longitudinal crack has developed on the surface The two ends are slightly broken. Slide Regd. No. 4475; ×500.
10. Microfossil Type 3. Corrosion has partly affected the surface towards the right hand side of the body. Slide Regd. No. 4475; ×220.

11-14. Microfossil Type 3; composite bodies showing cross-like (tetractine) or rosette-like (polyactine) pattern· In Fig. 13, probably one ray has been lost leaving a scar. Regd. Slide No. 4475; ×220.

15-16. Microfossil Type 4; Two specimens showing outer layer (x), middle layer (y) and inner layer of body (z). The cap (c) at both ends shows deep notches. Slide Regd. No. 4474; ×500.

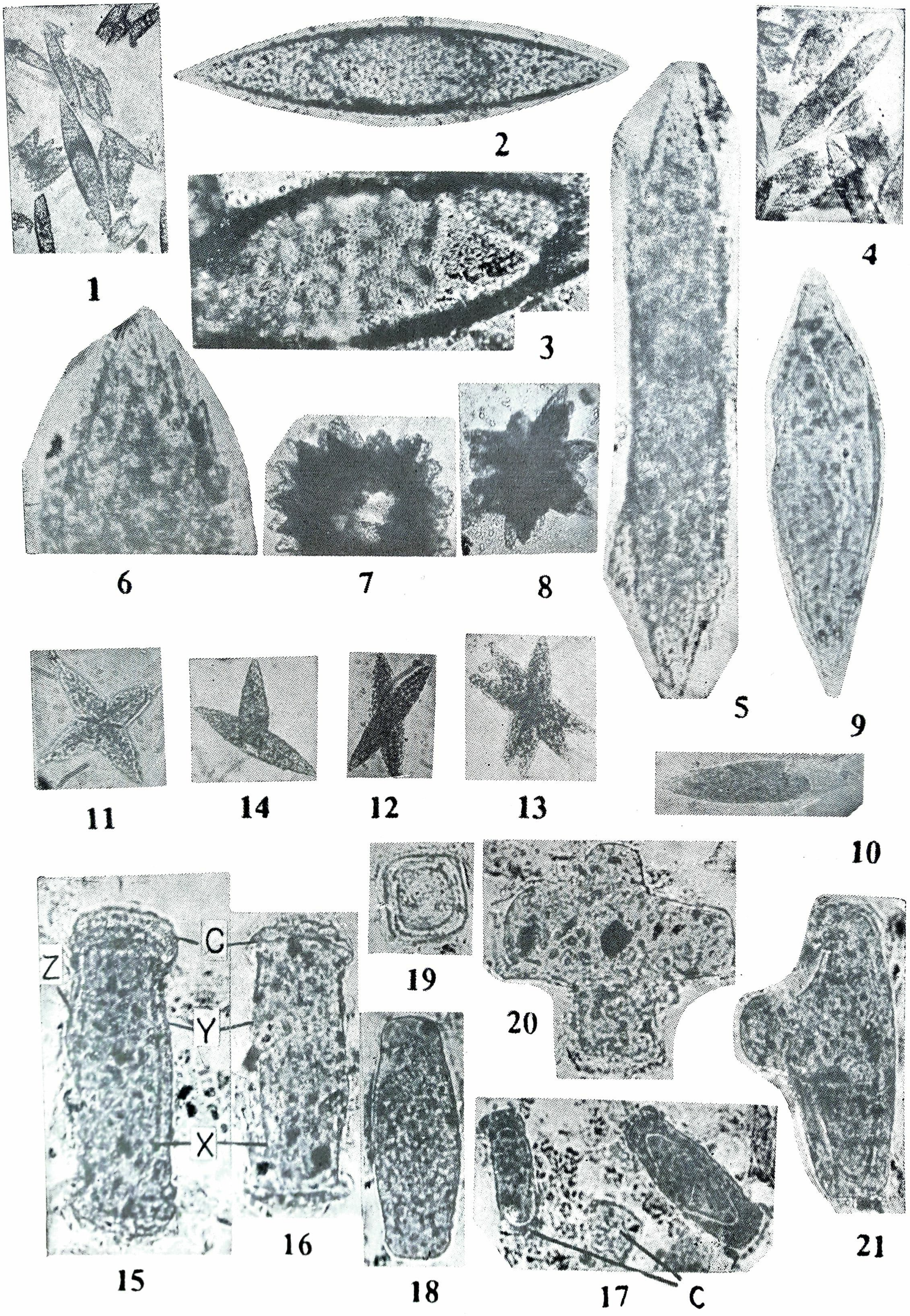
17. Microfossil Type 5; Two specimens showing different degree of layer detachment. In the righ- example the outer layer has been lost. In the left example the outer and middle layers have detached leaving the inner layer (body) almost naked. In both specimens the caps are, however present on both ends. A detached cap (c) is also seen in the middle. The debris in the close neighbourhood of the bodies probably represents disintegrated layers. Slide Regd. No. 4474; ×250.

18. Microfossil Type 5; Naked inner layer (or body). Slide Regd. No. 4474; ×250.

19. Microfossil Type 5; Detached hat-like structure or cap showing three layers. Slide Regd. No. 4474; ×250.

20. Microfossil Type 5; composite bodies forming a cruciate pattern The inner and middle layers can be made out. Slide Regd. No. 4474; ×250.

21. Microfossil Type 5; Composite body showing a bud-like asymmetrical growth on one side The larger individual has the middle and inner layers but in the bud the middle layer has apparently not completely developed. Slide Regd. No. 4474; ×250.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