

## Further observations on *Cycadinorachis omegoides* Sharma from the Rajmahal Formation, India

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Suthar, O. P., Bohra, D. R. & Sharma, B. D. (1987). Further observations on *Cycadinorachis omegoides* Sharma from the Rajmahal Formation. *Palaeobotanist* 35(3) : 297-300.

A petrified *Cycadinorachis omegoides* is reported from Sonajori in the Rajmahal Hills, Bihar. The number of bundles in the omega gradually reduces while the distinction of centripetal and centrifugal xylems increases towards the apex of the rachis (leaf). The ground tissue possesses mucilage ducts. The lamina has parallel veins and a more or less homogeneous mesophyll. Tracheids possess scalariform and contiguous bordered pits. Relationship of *Cycadinorachis* with allied extinct and extant plants is discussed.

**Key-words**—Gymnosperms, Morphology, Anatomy, *Cycadinorachis*, Rajmahal Formation (India).

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### सारांश

राजमहल शैल-समूह (भारत) से प्राप्त साइकेडिनोरेकिस ओमैगॉयडिस शर्मा पर कुछ और प्रेक्षण

ओ० पी० सुथार, डी० आर० बोहरा एवं बी० डी० शर्मा

बिहार में राजमहल पहाड़ियों में सोनाजोरी से अश्मीभूत साइकेडिनोरेकिस ओमैगॉयडिस अभिलिखित किया गया है। ओमैगा में बंडलों की संख्या क्रमशः कम होती जाती है जबकि प्राक्ष में ऊपर की ओर अभिकेन्द्री एवं अपकेन्द्री दारु में भिन्नता बढ़ जाती है। भरण उत्तक में श्लेष्मक नाल विद्यमान हैं। स्तरिका समानान्तर शिराओं तथा प्रायः एक समांगी मध्यमपर्ण से युक्त हैं। बाहिनिकाओं में सोपानवत् एवं संलग्न परिवेशित गर्त विद्यमान हैं। इसके अतिरिक्त सम्बन्धित विलुप्त एवं वर्तमान पौधों से साइकेडिनोरेकिस की बन्धुता भी विवेचित की गई है।

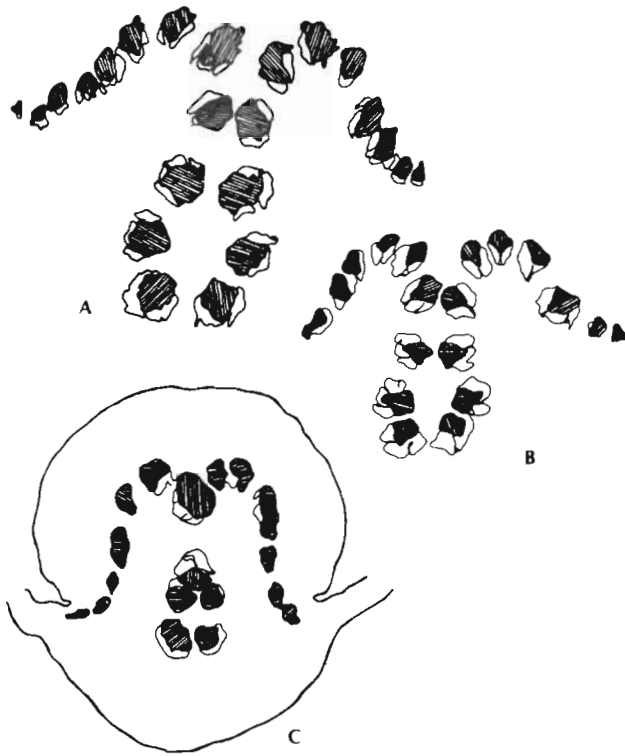
SHARMA (1973) described an isolated petrified rachis—*Cycadinorachis omegoides* Sharma bearing mesarch bundles arranged in an omega from the fossiliferous locality of Amarjola. The species is now reported in a chert from Sonajori near Pakur.

### DESCRIPTION

Each of the three specimens of *Cycadinorachis omegoides* has 2-5 rachides or portions of leaves embedded in different planes. The largest specimen is nearly 10 cm long and has a portion of lamina attached to it. The lamina is lateral and has parallel, simple or branched veins. The thickest portion of rachis is 7 mm in diameter. It has 23 collateral, conjoint and mesarch bundles arranged in an omega-shaped manner (Pl. 1, figs 1-3; Text-fig. 1). The xylem is more or less triangular (Pl. 1, fig. 4)

with the phloem (unpreserved) towards the outer (centrifugal) side. The direction of phloem varies with the change in positions of the bundles in the omega (Pl. 1, fig. 2). The centarch xylem comprises compactly arranged tracheids (Pl. 1, fig. 3). In addition to main bundles there are 3-4 smaller bundles in a line in the cavity of omega, i.e. medullary vascular bundles (Pl. 1, fig. 4). The ground tissue is parenchymatous with a few mucilage ducts (Pl. 1, fig. 6). The hypodermis patches are distinct, sclerenchymatous and 5 to 7 cells thick.

A cross section of the rachis from the level little above than the one described in Plate 1, fig. 1 shows reduction in the number of bundles (Pl. 1, fig. 2; Text-fig. 1B) and this continues towards the apex of the frond (rachis). The reduction in bundles is due to the fusion of adjacent bundles in the rounded



**Text-figure 1A-C**—*Cycadinorachis omegoides*: **A**, cross section through basal portion of rachis with omega-shaped arrangement of bundles.  $\times 24$ ; **B**, cross section of rachis little above the base.  $\times 24$ ; and **C**, cross section of the upper portion showing fusion of central bundles.  $\times 24$ .

portion of the omega (Text-fig. 1C). The bundles thus produced are larger in size and show differentiation of centripetal and centrifugal xylems (Pl. 1, fig. 5). The tracheids of the former are comparatively wide. The medullary strands disappear in the upper portion of rachis.

Laminae arise on either side of the upper portion of rachis (Text-fig. 1C) and a 3-5 cells thick layer of parenchyma develops outside the hypodermis on the dorsal surface (Pl. 1, fig. 6). The neck of the omega disappears and the bundles in the open arms are arranged more or less in a straight line to supply the laminae. A cross section through the veins of the lamina shows distinction of upper

and lower epidermis. The latter possesses stomata. The mesophyll is homogeneous and undifferentiated into spongy and palisade tissues. The bundles are enclosed by a sheath and are connected with the upper and lower epidermis by sclerenchyma strands (Pl. 1, fig. 7). Details of the bundles are not preserved. In between the bundles there are transversely elongated, large cells which probably acted as transfusion cells, similar to those found in *Dioon spinulosum* (Bierhorst, 1971) and *Cordaites* (Coulter & Chamberlain, 1910).

#### REMARKS

In the present material the bundles are collateral, conjoint and mesarch while in holotype of *Cycadinorachis omegoides* Sharma these were described as concentric with mesarch protoxylem. The medullary vascular strands and mucilage ducts in the ground tissue also could not be seen in the type specimen. Some of these minor differences may be due to preservational factors in Amarjola material.

The omega-shaped arrangement of bundles in the petiole/rachis has been described in *Cycas* and *Dioon* (Mettenius, 1861). The present specimens differ in the structure of the bundles and existence of medullary bundles. The mucilage ducts are ill-defined which are quite distinct in the extant genera. The anatomy of the lamina is identical to that of *Dioon spinulosum* (Bierhorst, 1971; fig. 20-4D). The vascular bundles hang in the undifferentiated mesophyll by sclerenchyma bands from both the surfaces.

None of the cycadean fronds from Rajmahal Formation is known in petrification and hence the comparison with the present specimens is not possible. Petrified material of *Taeniopteris spatulata* collected from Nipania (Rao, 1943) were associated with the Pentoxyleae and named as *Nipaniophyllum raoi* Sahni (1948). The midrib of petrified leaves of *Nipaniophyllum raoi* from Nipania (Rao, 1943; Sahni, 1948) possesses diploxylic bundles arranged in a differently shaped simple arc unlike the omega of the present material.

#### PLATE 1

1. Cross section of rachis from base with omega-shaped arrangement of bundles  $\times 24$ .
2. Cross section above the base.  $\times 24$ .
3. Cross section showing a few bundles enlarged to show mesarch protoxylem.  $\times 120$ .
4. Cross section showing bundles and a medullary strand.  $\times 120$ .

5. Cross section showing upper portion of rachis with lateral laminae and origin of parenchyma layer dorsal to hypodermis.  $\times 24$ .
6. Section showing presence of mucilage ducts in ground tissue  $\times 120$ .
7. Cross section of the lamina with two bundles and homogeneous mesophyll.  $\times 120$ .

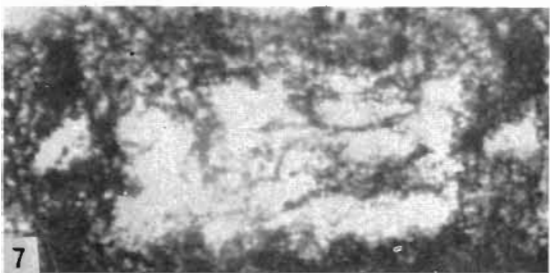
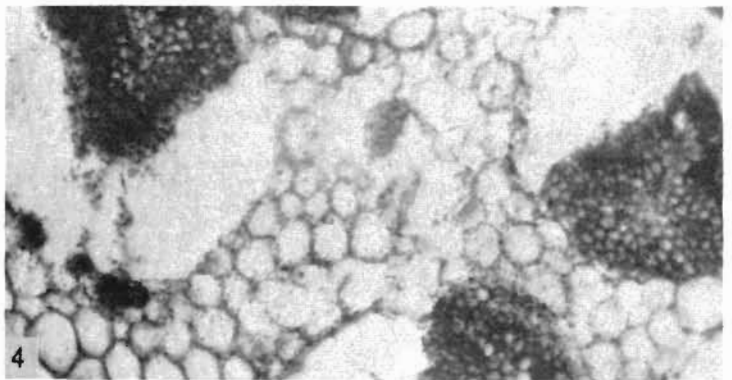
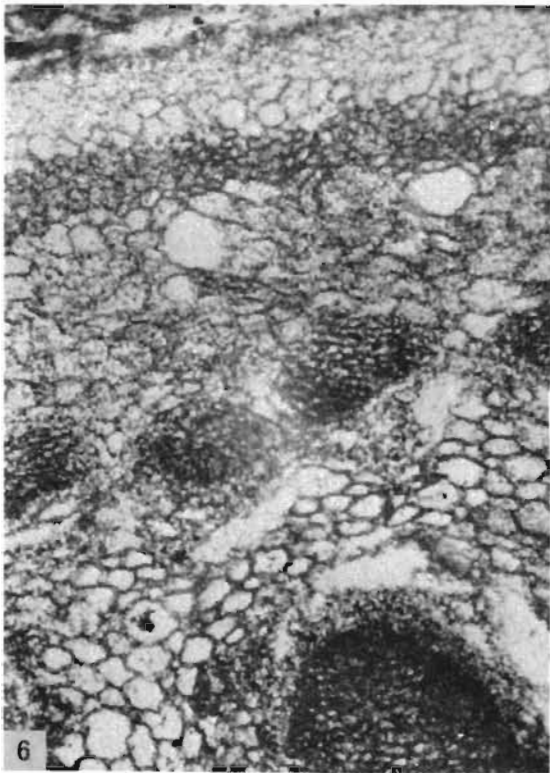
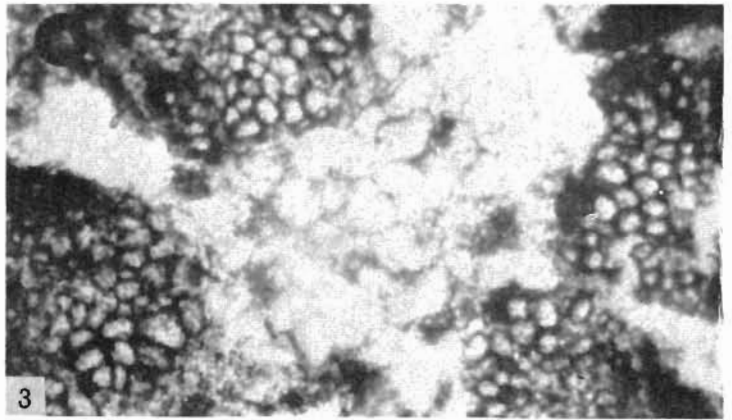
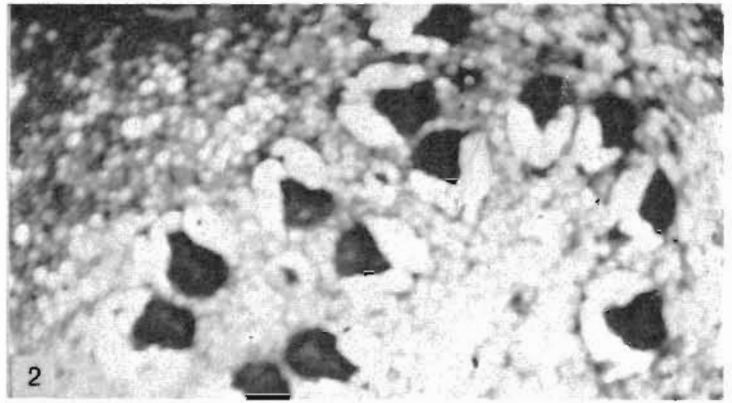


PLATE 1

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