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# Fossil dicotyledonous liana *Anamirta pfeifferi* sp. nov. (Menispermaceae) from the Deccan Intertrappean beds of India

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A fossil dicotyledonous woody liana, *Anamirta pfeifferi* sp. nov., showing anomalous secondary growth has been described from the Deccan Intertrappean beds of Nawargaon-Maragsur area, district Wardha, Maharashtra, India. The wood exhibits pluriseriate secondary growth with alternate concentric rings of xylem and phloem, vascular bundles in a ring separated by broad primary xylem rays, differentiated pith and endarch primary xylem. Pluriseriate type of anomalous secondary growth in a fossil dicotyledonous wood has been described here for the first time.

**Key-words**— Xylotomy, *Anamirta*, Menispermaceae, Deccan Intertrappean beds, Uppermost Cretaceous, India.

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## सारांश

भारत की दक्खन अन्तर्द्वीपी संस्तरो से अश्मित द्विबीजपत्री बन्ध-लता—*एनामिर्टा फिफेराई* नवजाति

सुरेश डी० बोंडे

महाराष्ट्र में वर्धा जनपद में नवरगाँव-मारगसूर क्षेत्र के दक्खन अन्तर्द्वीपी संस्तरो से द्वितीयक वृद्धि युक्त एक अश्मित द्विबीज पत्री बन्ध-लता—*एनामिर्टा फिफेराई* नव जाति का वर्णन किया गया है। इस अश्मित काष्ठ में दारु एवं पोषवाह के एक के बाद एक वलयों से युक्त अनेक पंक्तिक द्वितीयक वृद्धि, चौड़ी दारु किरणों से पृथक्कृत एक वलय में विन्यस्त वाही बंडल, मज्जा तथा अन्तःमुखी आदि दारु विद्यमान हैं। अश्मित काष्ठों में इस प्रकार की अनेक-पंक्तिक द्वितीयक वृद्धि का यह पहला अभिलेख है।

THE Deccan Intertrappean beds exposed in Nawargaon-Maragsur area (21°01', North & 78°35', East), district Wardha, Maharashtra are rich in angiospermic remains. Of them, *Aristolochtoxylo prakashti* Kulkarni & Patil 1977, *Ardistoxylon indicum* Shete & Kulkarni, *Heterophragmoxylon indicum* Shete & Kulkarni, *Aeschynomenoxylo nawargaoensis* Shete & Kulkarni, *Evoditium intertrappeum* Shete & Kulkarni 1982, *E. indicum* Bande & Prakash, *Amooroxylo deccanenensis* Bande & Prakash 1984, *Sonnerattoxylo preapetalum* Awasthi (= *S. caeseolartoides* Shete & Kulkarni 1982; = *S. nawargaoensis* Bande & Prakash 1984 emend. Mehrotra 1988), *Gmelina tertiara* Bande 1986 and *Paraphyllanthoxylo palaeoembla* Prakash et al. 1986 are the dicotyledonous woods and *Unonaspermum corneri* Bonde 1993, an anonaceous seed, described from these beds. In addition to

these, number of monocotyledonous plants have been reported from these beds (Bonde, 1995).

## SYSTEMATIC DESCRIPTION

**Family**—Menispermaceae

**Genus**—*Anamirta* (L.) W.&A.

*Anamirta pfeifferi* sp. nov.

Pl. 1, figs 1-10

**Material**—The present species is based on a small piece of permineralized wood consisting of a central pith surrounded by a ring of primary xylem and secondary wood collected from Nawargaon-Maragsur area. The wood is 6.5 cm long and 1.0 x 1.7 cm in diameter. The axis shows spirally twisted ribs and furrows (Pl. 1, fig. 1).

**Diagnosis**—Axis spirally twisted with ribs and furrows; *primary xylem* poles sixteen, placed in a ring around the pith; each pole consisting of 1-4 protoxylem and 6-10 metaxylem elements. *Pith* small, compressed, 1.0 x 1.3 mm, differentiated; central parenchymatous cells large with intercellular spaces; peripheral compact cells small, polygonal. *Secondary wood* pluriseriate with alternate concentric rings of xylem and phloem. Vascular bundles in a ring separated by broad primary rays. *Vessels* small to large, solitary, round. Small vessels 45 x 106  $\mu\text{m}$  (average 75 x 75  $\mu\text{m}$ ), large vessels 166-257x150-300  $\mu\text{m}$  (average 225 x 195  $\mu\text{m}$ ), 252-468  $\mu\text{m}$  (340  $\mu\text{m}$ ) long with truncate ends; perforation simple, intervessel pitpairs contiguous, polygonal. *Parenchyma* (i) conjunctive-broad bands forming concentric rings capping phloem from cortical side, stone cells present; (ii) apotracheal diffuse in short tangential lines, one cell wide, 2-4 cells per strand, longitudinally elongated. *Interfascicular xylem rays* broad and long, not continuous radially from one ring of bundles to the next, 8-16 cells wide; cells procumbent, squarish, homogeneous. Fascicular rays occasional, narrow, homogeneous with upright cells, 1-2 cells wide and 1-10 cells tall. *Fibres* libriform in radial rows, 6.8-17.0 x 8.5-22.0  $\mu\text{m}$  (average 14x12  $\mu\text{m}$ ), 119-238  $\mu\text{m}$  long; interfibre pits bordered in rows, pits 5.1  $\mu\text{m}$ . *Phloem* tangentially elongated bands forming concentric rings alternate to xylem rings.

**Holotype**—N80, Botany Unit, Plant Science Division, Agharkar Research Institute, Pune.

**Locality**—Nawargaon-Maragsur, Wardha District, Maharashtra, India.

**Horizon**—Deccan Intertrappean beds.

**Age**—Uppermost Cretaceous.

**Topography**—The wood in cross section is pluriseriate (*Corpus lignosum circumvallatum*) having alternate concentric rings of xylem and phloem (Pl. 1, fig. 2). *Primary xylem* having sixteen poles arranged in a ring at the periphery of the pith. Each primary xylem group consists of 1-4 circular, 10.0-27.0  $\mu\text{m}$  long protoxylem elements and 6-10 round to radially elongated metaxylem vessels, t.d. 31.0-48.0  $\mu\text{m}$  and r.d. 41.0-61.0  $\mu\text{m}$ . Pith 1045 x 1382  $\mu\text{m}$ , differentiated into central and peripheral zones. Central zone is much wider with large parenchyma cells, 68x75-85x112  $\mu\text{m}$  with stone cells and small intercellular spaces. Peripheral zone 14-18 cells wide, composed of small polygonal 24x27-48x48  $\mu\text{m}$  cells (Pl. 1, figs 3-4).

*Wood* diffuse porous. *Growth rings* distinct, consisting of 16 and 24 vascular bundles in the first two rings respectively. Other four rings are incomplete. *Vessels* small to large, nearly all solitary, sometimes filled with dark contents; round to oval in cross section. Small vessels 45 x 106  $\mu\text{m}$  (average 75 x 75  $\mu\text{m}$ ); large vessels t.d. 166-257  $\mu\text{m}$ , r.d. 150-300  $\mu\text{m}$  (average 225x195  $\mu\text{m}$ ), wall 6.8  $\mu\text{m}$  thick; vessel members 252-468  $\mu\text{m}$  long with truncate ends, perforations simple; intervessel pit pair contiguous, polygonal, pits 6.8x6.8-12.2x13.6  $\mu\text{m}$  in size (Pl. 1, fig. 10). *Parenchyma* apotracheal, diffuse, occasionally in short tangential lines, one cell wide, 2-4 cells per strand. The cells are tubular to rectangular or longitudinally elongated; radial width 10.2-20.4  $\mu\text{m}$ , tangential width 10.2-17.0  $\mu\text{m}$  and length 34.0-51.0  $\mu\text{m}$ ; with simple, circular 2.0-4.0  $\mu\text{m}$  pits. *Conjunctive parenchyma* present between successive ph-

## PLATE 1

### *Anamitra pfeifferi* gen. et sp. nov.

1. Fossil wood showing twisted axis x 0.85.
2. Cross section showing central pith, primary xylem and pluriseriate secondary wood with six alternate rings of xylem and phloem x 6.
3. Cross section showing pith and endarch primary xylem x 45.
4. Cross section showing primary xylem groups and first ring of vascular bundles x 60.
5. Cross section showing vascular bundles in a ring separated by broad primary xylem rays x 60.
6. Tangential section showing very broad and long primary xylem rays x 6.
7. The same x 60.
8. Secondary xylem rays x 60.
9. Wood fibres with uniseriate bordered pits x 600.
10. Intervessel pittings x 150.

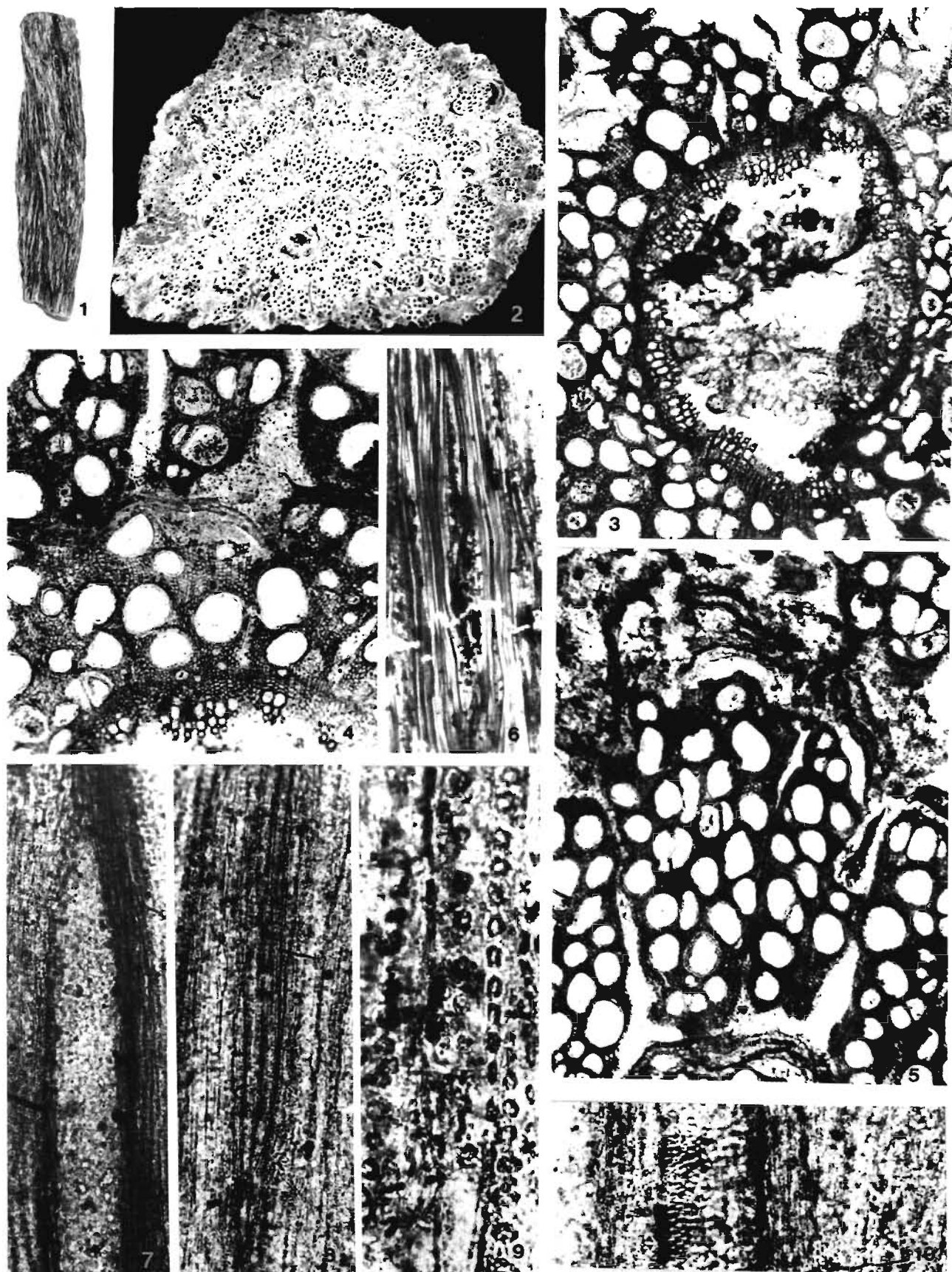


PLATE 1

loem and xylem rings; isodiametric to radially elongated 2-3 layered stone cells present, usually 2-5 cells in a row, sometimes with dark bodies. *Xylem rays* (i) interfascicular very broad and long; not contiguous radially from one ring of bundles to the successive rings, almost homogeneous; 8-16 cells wide, cells procumbent with little distinction between central and marginal cells (Pl. 1, figs 5-7); (ii) fascicular rays very occasional, narrow, 1-2 cells wide and 1-10 cells tall of upright cells only; cells 34.0 x 6.8-82.0 x 10.2  $\mu\text{m}$  (Pl. 1, fig. 8). *Fibres* libriform, aligned in radial rows; t.d. 8.5-22.0  $\mu\text{m}$ , r.d. 6.8-17.0  $\mu\text{m}$ , wall 1-2  $\mu\text{m}$  thick, length 119.0-238.0  $\mu\text{m}$ ; interfibre pits distinctly bordered, 5.1  $\mu\text{m}$  in diameter, both on radial and tangential walls (Pl. 1, fig. 9). *Phloem* in tangential concentric bands alternate to the xylem bands.

### DISCUSSION

The important features of the present wood are (i) longitudinally twisted ribbed axis, (ii) pluriseriate secondary wood consisting of alternate concentric rings of xylem and phloem, (iii) a ring of conjunctive parenchyma capping the phloem ring from the cortical side; (iv) broad primary xylem rays; (v) vessels small to large, solitary; (vi) fibres with bordered pits in a row, both on radial and tangential walls; (vii) endarch primary xylem, and (viii) differentiated pith. These characters suggest anomalous secondary growth in the present wood. Gaudichaud (1833), Schenk (1893, 1895), Pfeiffer (1926), Radlkofer (1931-34), Chalk and Chattaway (1937) and Obaton (1960) have given the comprehensive survey of anomalous structures in woody plants. Pfeiffer has recognized eight types of anomaly in woody plants depending upon the organization and activity of the cambium.

The present fossil exhibits concentric rings of phloem embedded in the secondary xylem (*Corpus lignosum circumvallatum*). Such rings are formed because the cambium is short lived and replaced by successive cambia originating in the pericyclic or cortical region and repeating the structure of a young stem. Such type of pluriseriate secondary growth has been recorded in Amaranthaceae,

Ampelidaceae, Buxaceae, Capparidaceae, Caryophyllaceae, Chenopodiaceae, Compositae, Connaraceae, Convolvulaceae, Dilleniaceae, Ficoidaceae, Flacourtiaceae, Hippocrateaceae, Leguminosae, Loranthaceae, Menispermaceae, Nyctaginaceae, Phytolaccaceae, Plumbaginaceae, Polygalaceae, Polygonaceae, Rubiaceae, Rutaceae and Umbelliferae of dicotyledons and Gnetaceae of Gymnosperms (Metcalf, 1983; Metcalfe & Chalk, 1950; Obaton, 1960; Pfeiffer, 1926).

Amaranthaceae, Capparidaceae, Caryophyllaceae, Chenopodiaceae, Compositae, Hippocrateaceae, Loranthaceae, Phytolaccaceae, Plumbaginaceae, Rubiaceae, Rutaceae, Umbelliferae and Verbenaceae differ from the present fossil in having small to very small vessels in radial multiples or in groups and simple pits on their fibres (Loranthaceae and Rubiaceae have bordered pits). Moreover, interfascicular rays in Amaranthaceae are continuous from pith to cortex. Loranthaceae has 1-3 celled wide xylem rays, while Rubiaceae possesses aliform-confluent parenchyma and Caryophyllaceae has scanty inter-fascicular rays. Nyctaginaceae differs in having storied fibres with simple pits; Connaraceae, Convolvulaceae, Ficoidaceae and Polygalaceae differ due to scanty and narrow interfascicular rays in them. Flacourtiaceae and Polygonaceae differ in having vasicentric parenchyma; Dilleniaceae and *Tetrastigma* of Ampelidaceae possess storied parenchyma; Leguminosae varies in having aliform-confluent parenchyma whereas in Buxaceae wood parenchyma is lacking. *Gnetum* of Gymnospermae resembles the fossil wood in general but the vessels endplate in *Gnetum* have a row of perforations. Moreover, *Gnetum* does not show distinct primary xylem groups (Maheshwari & Vasil, 1961; Rao & Keng, 1975).

In Menispermaceae, *Cocculus*, *Arcangelista*, *Tillacora*, *Mentispermum* and *Abuta* show near resemblance with the present fossil wood. However, the wood of *Cocculus* differs from the fossil in having very small to moderate-sized vessels. *Arcangelista* differs in having very small to large vessels, while *Tillacora* differs in having vessels in

tangential rows. *Menispermum* differs due to thick walled vessels with pitted tyloses. Whereas, *Abuta* differs in having irregular fibres with large lumina, adjoining the vessels. The present fossil resembles closely the wood of *Anamirta* Colebr. On examination of the published literature (Santos, 1931; Zamora, 1966) as well as the thin sections of *A. cocculus* (L.) W. & A. show a close resemblance with the fossil in having (i) pluriseriate secondary growth with alternate concentric rings of xylem and phloem, (ii) a ring of conjunctive parenchyma capping the phloem ring from cortical side, (iii) broad interfascicular xylem rays and occasional narrow fascicular rays, (iv) small to large solitary vessels, (v) endarch primary xylem in groups, and (vi) differentiated pith.

*Aristolochioxylon prakashtii* Kulkarni & Patil 1977 is the only fossil dicotyledonous liana described so far. It differs from the present wood in having a single ring of vascular bundles and vasicentric parenchyma. Moreover, fascicular rays are absent in *A. prakashtii*.

*Anamirta* is a monotypic genus with a single species, *A. cocculus* (L.) W. & A. (syn. *A. paniculata* Colebr.). It is a large climbing shrub at low and medium altitudes distributed in the Indo-Malayan region (Forman, 1978). It occurs in Oudh in Bangladesh, Myanmar, Khasia Hills, Assam, Orissa and in the Deccan in Cuddapah and Mysore, Western Ghats, Cochin and Travancore (Hooker, 1875; Gamble, 1922, 1935).

As far as the author is aware, this is the first record of a fossil dicotyledonous liana with pluriseriate type of secondary growth. It has been named as *Anamirta pfeifferi* sp. nov. The specific epithet is after Dr H. Pfeiffer who has done extensive work on anatomy of woody lianas.

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