On a fossil wood from the Garu Formation (Permian) of Arunachal Pradesh, India

Usha Bajpai & Trilochan Singh

Bajpai Usha & Singh T 1997. On a fossil wood from the Garu Formation (Permian) of Arunachal Pradesh, India. *Palaeobotanist* **46**(3) : 73-78.

The paper records for the first time a silicified fossil wood from the Garu Formation (Early Permian) exposed in Arunachal Pradesh. The wood is characterised by the presence of distinct growth zones, endarch primary xylem and a single, large, circular to oval, irregularly oriented pit in the cross-field; these features are diagnostic of the genus *Megaporoxylon*. As the wood does not match with any of the known species of the genus, it is given a new name, *Megaporoxylon maheshwarii* sp. nov.

Key-words — *Megaporoxylon*, Wood anatomy, Garu Formation, Permian, Arunachal Pradesh, India.

Usha Bajpai, Birbal Sahni Institute of Palaeobotany, 53 University Road, G.P.O. Box 106, Lucknow 226 001, India.
Trilochan Singh, Wadia Institute of Himalayan Geology, General Mahadeo Singh Road, Dehradun 248 001, India.

सारांश

अरुणाचल प्रदेश (भारत) के गारु शैल-समूह से एक अश्मित काष्ठ

ऊषा बाजपेयी एवं त्रिलोचन सिंह

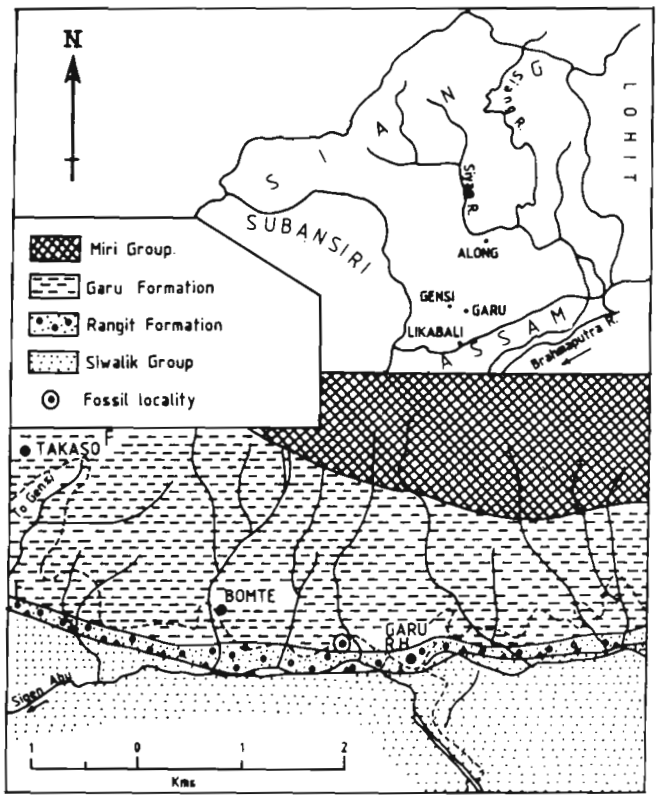
इस शोध-पत्र में अरुणाचल प्रदेश के गारु शैल-समूह (प्रारम्भिक परमियन) से प्राप्त एक सिलिकाभूत काष्ठ का पहली बार वर्णन किया गया है। इस काष्ठ में स्पष्ट वृद्धि मंडलों, मध्यादिदारुक, आदिदारु तथा क्रासित क्षेत्र में एक बड़ा गोलाकार से अंडाकार अनियमित रूप से वितरित गर्त्त विद्यमान है जो कि *मैगापोरॉक्सीलॉन* प्रजाति के नैदानिक लक्षण हैं। चूँकि यह काष्ठ अभी तक वर्णित किसी भी अश्मित काष्ठ से नहीं मिलती अतःएव इसे *मैगापोरॉक्सीलॉन माहेश्वराई* नव जाति से नामाँकित किया गया है।

THOUGH a large number of fossil woods have been reported from the Permian Gondwana sediments of the Indian peninsula, yet there is hardly any record of a fossil wood from the Gondwana equivalent sedimentaries of the Himalayan regions. We record here, for the first time, a fossil wood, collected by one of us (TS), from an exposure of the Garu Formation about 1.25 kilometre from PWD Inspection Bungalow at Garu on Garu-Gensi Road, just crossing the Garu Nala, in Siang District, Arunachal Pradesh (Map 1).

Permian sediments exposed in the region of Arunachal Himalaya comprise three distinct litho-units, namely, Rangit, Garu and Bhareli Formations, in ascending order (Singh, 1993). The plant fossil record comprises palynofossils from Rangit and Garu Formations (Singh, 1979) and leaf-impressions and axes from Bhareli Formation (Singh & Bajpai, 1990).

The Garu Formation is represented mainly by black carbonaceous shale and brown ferruginous shale with thin bands of fine-grained sandstone. Thin lenses of coal and a few tuffaceous beds also occur in this formation. A number of concretionary nodules, many of which contain fossils, occur in the black shale unit. These concretions are believed to be faunal coal balls by Prakash, Singh and Srivastava (1988). Palynofossils have also been recorded from these concretionary nodules (Srivastava, Prakash & Singh, 1987). The fossil wood documented here comes from such a concretionary nodule embedded in the black shale unit.

The specimen and the slides are preserved in the repository of the Wadia Institute of Himalayan Geology, Dehradun, India.



Map 1 — Map of a part of the area showing the location of specimen.

DESCRIPTION

Megaporoxylon maheshwarii sp. nov.

Pl. 1, figs 1-9; Pl. 2, figs 1-8

The specimen (Pl. 1, fig. 1) is a small piece of silicified fossil wood with partially preserved pith and primary xylem, surrounded by a crushed secondary wood. In cross-section the wood is broadly oval in shape and measures 4.3 x 3 cm. The wood and the pith most probably were circular in outline in the living state, and became oval only during diagenesis due to the overlying sediments. The growth zones are usually distinct (Pl. 1, figs 2-3) but at places become obscure due to distortion (Pl. 1, fig. 4). In cross-section the autumn wood zone is 3-6 cells wide; the cells are rectangular with narrow lumen, 14-20 μm in radial diameter. The spring wood zone is 16-35 cells wide, the tracheids are thick-walled, oblong-polygonal in cross-section, and measure 25 x 45 μm in radial diameter. The tangential diameter of tracheids is 25 x 42 μm.

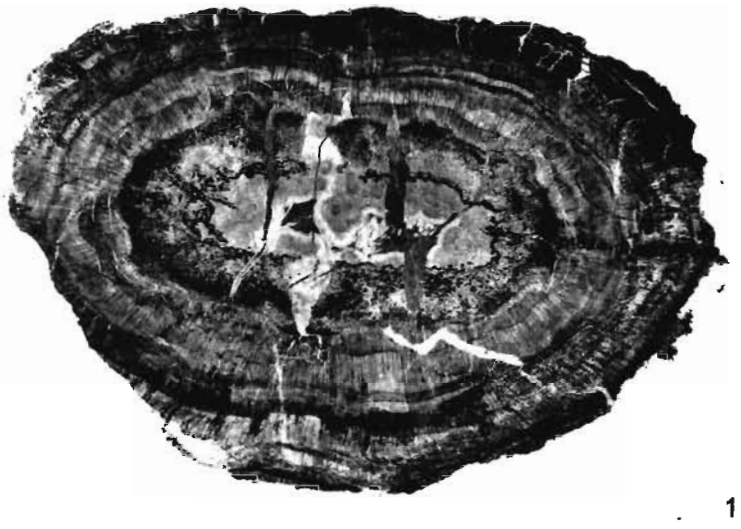
The pith is not well-preserved. It is irregularly oval in shape, large in size, measures 2.5 x 1.3 cm. The pith tissue is parenchymatous, homogeneous. Portions of the pith illustrated here (Pl. 1, figs 5-6) show homogeneous, thin-walled, more or less isodiametric cells, measuring 45.5-180.8 μm in transverse sections becoming comparatively smaller near the periphery of pith. Radially the pith cells are at places irregularly arranged. These cells are almost rectangular in shape, arranged in longitudinal sections and tend to be in end-to-end longitudinal series. They measure 135-540 μm in length.

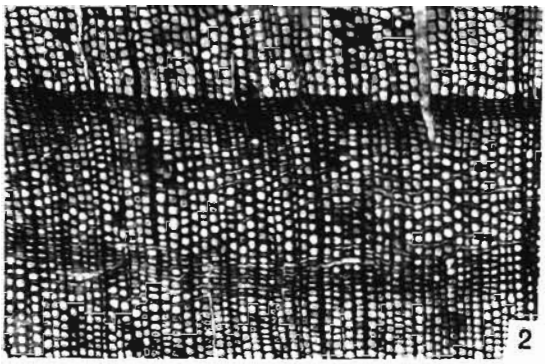
Primary xylem is distinct in transverse section, forms wedges into the pith, giving a lobed appearance to the latter. In the longitudinal section the elements of the primary xylem are very clear and demonstrate its endarch nature. The primary xylem shows annular thickenings towards the pith (Pl. 1, fig. 7). The tracheids with annular thickenings are followed by those with spiral (Pl. 1, fig. 8), scalariform (Pl. 1, fig. 9; Pl. 2, fig. 1) and reticulate thickenings (Pl. 2, fig. 2), and subsequently passing into tracheids of the secondary xylem.

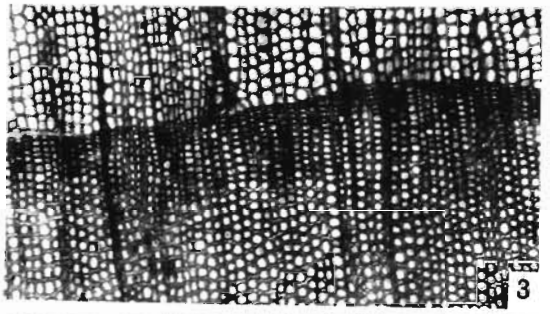
About seven distinct growth rings are seen in the cross-section. The growth rings are apparently 3-5 mm wide. In longitudinal section the ends of the

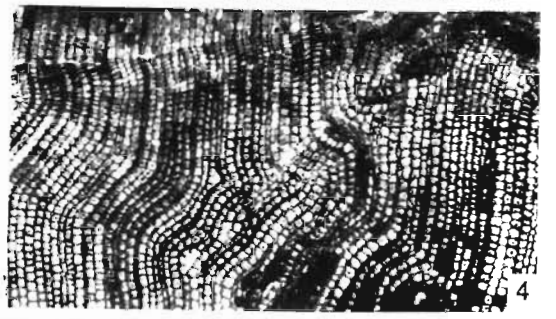
PLATE 1 ⟶

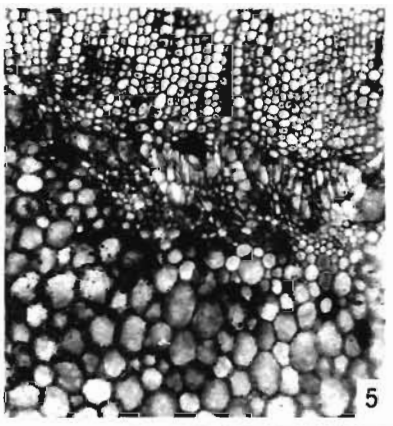
1. Cross-section of the fossil wood, showing a large ovoid pith, and a partly crushed secondary wood with apparent growth rings. Slide no. WIMF/A4, x 2.
2-3. Cross-section of the fossil wood enlarged to show growth rings. Note a false growth ring in the lower half of figure 2.Slide no. WIMF/A4, x 100.
4. Cross-section of the fossil wood showing crumpled tracheids of the secondary wood. Slide no. WIMF/A4, x 100.
5-6. Primary xylem wedged in cross-section, and a part of the homogeneous pith. Slide no. WIMF/A4, x 100.
7. Longitudinal radial section near the periphery of the pith showing elements of primary xylem with annular thickenings. Slide no. WIMF/A2, x 100.
8. Spiral thickenings on the elements of primary xylem. Slide no. WIMF/A3, x 100.
9. Spiral to scalariform thickenings on primary xylem elements. Slide no. WIMF/A3, x 100.

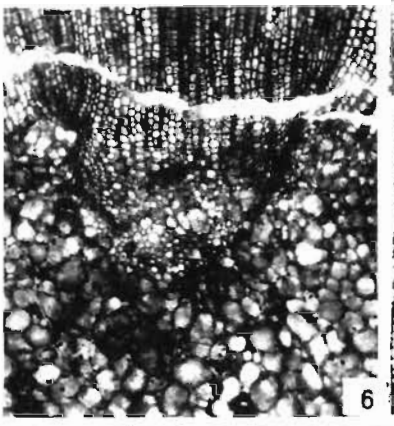


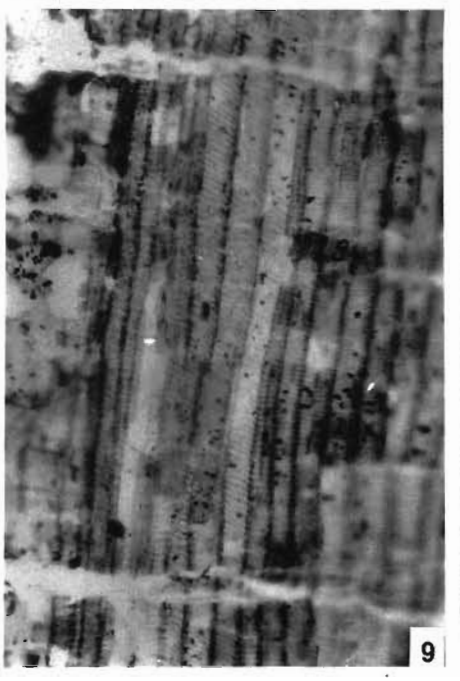












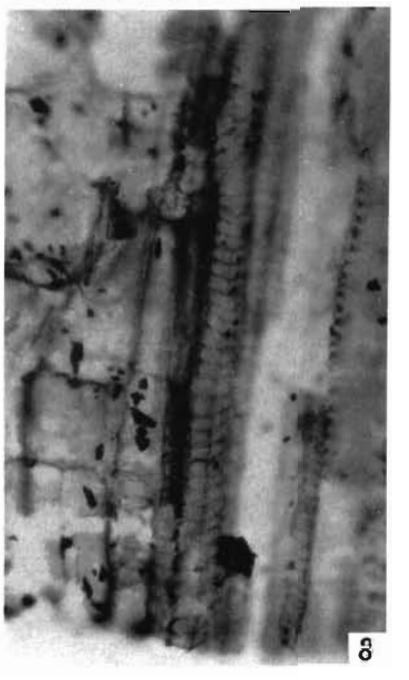


PLATE 1

Table 1 — Comparative account of diagnostic features of different species of the genus *Megaporoxylon*

SPECIES	PITH XYLEM	PRIMARY RAYS	XYLEM PITTING	RADIAL PITS	CROSS-FIELD RINGS	ANNUAL
M. antarcticum Maheshwari 1972	oval and large; cells in T.S. iso-diametric, thin-walled, homogeneous	wedge-shaped bundle, endarch	uniseriate, 2-7 cells high	1-3(4) seriate, araucarioid	one, large, oval or elliptical, oblique in orientation	distinct
M. canalosum Maheshwari 1972	1.8 cm in diameter, heterogeneous with secretory cells	wedge-shaped bundle, endarch	uniseriate, 1-8 cells high	1-2(3) seriate, bordered, alternate, contiguous and hexagonal, pit pore centric and circular to broad oval	single, oval, or elliptical, oblique in orientation	distinct
M. kaokense Kräusel 1956	1 cm in diameter, cells rounded in T.S., rectangular in L.S.	endarch	uniseriate, 1-14 cells high	uniseriate, pits bordered, circular-oval	one or two large, simple pit	distinct
M. scherzi Kräusel 1956	large 2x3 cm	endarch	uniseriate, 1-25 cells high	uniseriate, sometimes biseriate	1 large, rarely 2, oval, oblique	distinct
M. zeilleri Kräusel 1956	lobed, 1.4 cm	endarch	uniseriate, 1-12 cells, rarely 18 cells high	1-3 seriate, araucarioid	one round-squarish	distinct
M. maheshwarii sp. nov.	very large, oval, cells in T.S. isodiametric, placed end to end in L.S., heterogeneous	endarch, wedge-shaped	uniseriate, 1-12 cells high	1-2 seriate, pits bordered alternate, contiguous and hexagonal	simple, single pit almost circular to oval	distinct

tracheids are either tapering (Pl. 2, fig. 8) or truncated (Pl. 2, fig. 4).

The pits on the radial walls of tracheids are bordered, usually uniseriate (Pl. 2, fig. 3), sometimes biseriate (Pl. 2, fig. 4), very rarely triseriate (Pl. 2, fig. 5). In the last condition, the pitting simulates that of the araucarioid-types, the pits being alternate, contiguous and hexagonal. The pit pore where seen is almost circular in outline.

In the cross-field, a large simple pit fills up the entire field. The pit is circular (Pl. 2, fig. 6) to oval (Pl. 2, fig. 7) in shape, and irregularly oriented. The circular pits are up to 26 μm in diameter but oval pits measure 14-26 μm in length and 6-10 μm in width.

The xylem rays are homogeneous, uniseriate, 1-12 cells high. The ray cells in tangential section are somewhat rounded-oval and measure 18.5-38.5 μm in longer axis and 14-28 μm in width.

COMPARISON

The most characteristic feature of the present wood is the presence of a single, large, simple pit in the cross-field, a diagnostic feature of certain Permian woods from the Gondwana Supercontinent placed under the genus *Megaporoxylon* Kräusel 1956. So far, five species of the genus are on record from Antarctica (Maheshwari, 1972), India (Maheshwari, 1966) and South Africa (Kräusel, 1956a, 1956b). A comparison of these fossil woods with the present wood is tabulated in Table 1. Due to differences in the nature of the pith,

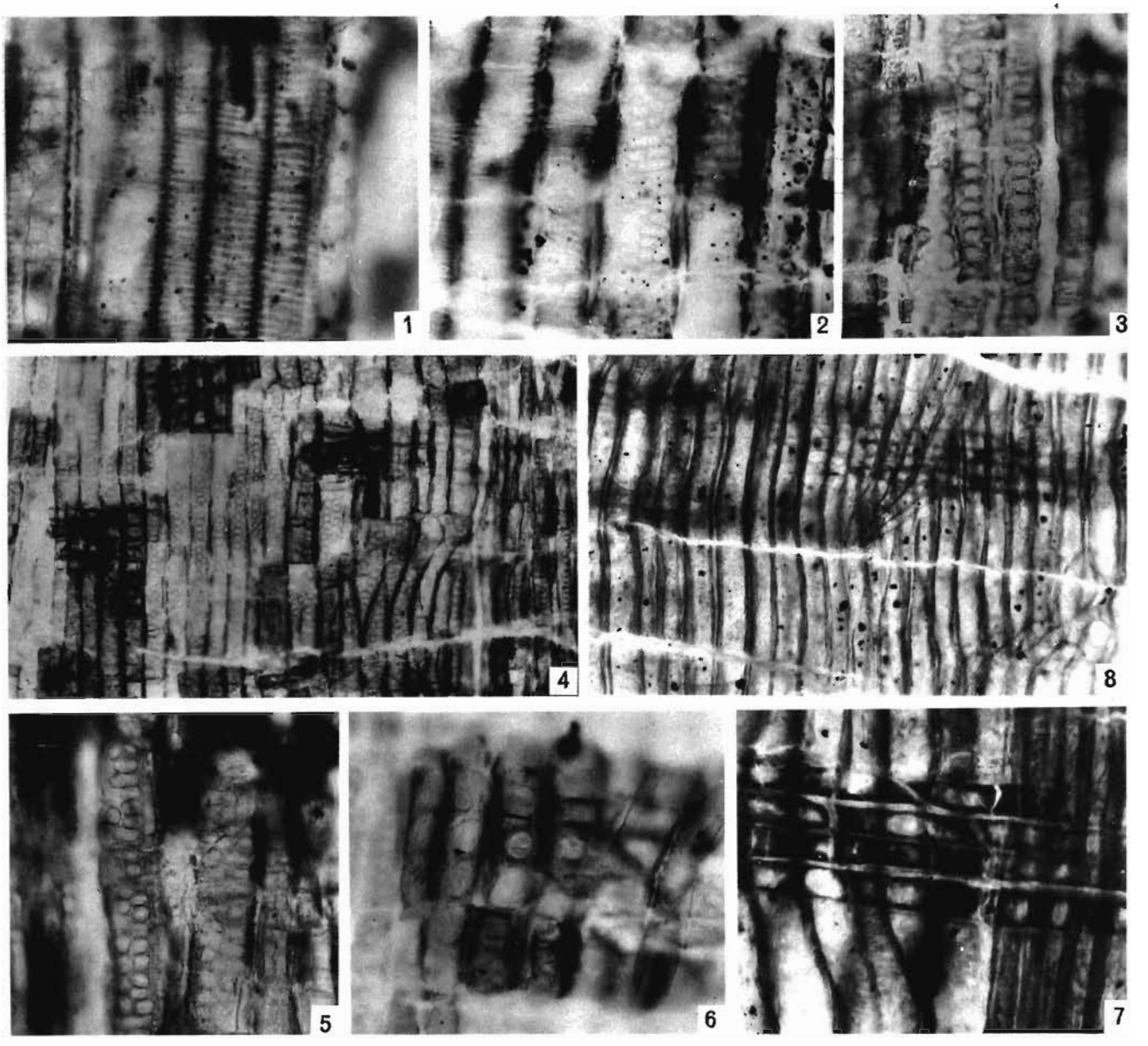


PLATE 2

1-2. Scalariform to reticulate thickenings on the primary xylem elements. 1, Slide no. WIMF/A1, x 250; 2, Slide no. WIMF/A3, x 250.

3. Uniseriate, bordered pits on the radial walls of secondary wood tracheids. Slide no. WIMF/A1, x 250.

4. Uni- to bi-seriate bordered pits on the radial walls of tracheids. Note truncated ends of some of the tracheids. Slide no. WIMF/A3, x 100.

5. Bi- to tri-seriate radial wall pits. Slide no. WIMF/A1, x 250.

6-7. Pits in the cross-field. Slide no. WIMF/A3, x 250.

8. Radial longitudinal section showing tracheids with tapering ends. Slide no. WIMF/A3, x 100.

the primary xylem and the orientation of the cross-field pits, the Garu specimen is assigned to a new species. The wood is named after Dr H.K. Maheshwari who has made notable contributions to the knowledge of the genus.

Specific Diagnosis—Wood with growth rings distinct; pith homogeneous, apparently lobed; primary xylem endarch, having elements with annular, spiral, scalariform and reticulate thickenings; secondary wood tracheids generally showing radial walls with uniseriate bordered pits; cross-field pits circular to oval in shape, irregular in orientation.

Holotype—Specimen no. WIF/A 100, Slide nos. WIMF/A1-9, Wadia Institute of Himalayan Geology, Dehradun, India; Garu Formation, Early Permian; about 1.25 kilometre from PWD Inspection Bungalow at Garu on Garu-Gensi Road, Siang District, Arunachal Pradesh.

ACKNOWLEDGEMENT

This report is an outcome of the collaborative research between Birbal Sahni Institute of Palaeobotany, Lucknow and Wadia Institute of Himalayan Geology, Dehradun. The authors thank the Directors of the two institutions for their constant encouragement and providing necessary facilities. The authors also thank Dr H.K. Maheshwari, Deputy Director, BSIP for kindly going through the manuscript and for generous help with literature.

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