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KANWAR NARAIN  
K. REKHA DEVI  
J. MAHANTA\*

*Regional Medical Research Centre,  
N.E. Region, Indian Council of Medical  
Research,  
Post Box # 105,  
Dibrugarh 786 001, India  
\*For correspondence.  
e-mail: icmrredc@hub.nic.in*

## First record of charophytes from the Permian Barakar Formation of the Talchir Gondwana Basin, Orissa

The Gondwana deposits in the Talchir Basin, Orissa are subdivided into Talchir, Karharbari, Barakar, Barren Measure and Kamthi formations in ascending order. Of these, the Barakar Formation is economically most important for its coal reserves and is the best studied. It contains about 100 m exposed sequence of alternating sand, silt, clay and coal horizons. There are four regional coal seams within this unit. The present charophytes are obtained from the calcareous siltstone beds which occur exposed between the 3rd and 4th regional coal seams in the upper part of the middle Barakar Formation near the Koshala Village, Angul District, Orissa (Figure 1).

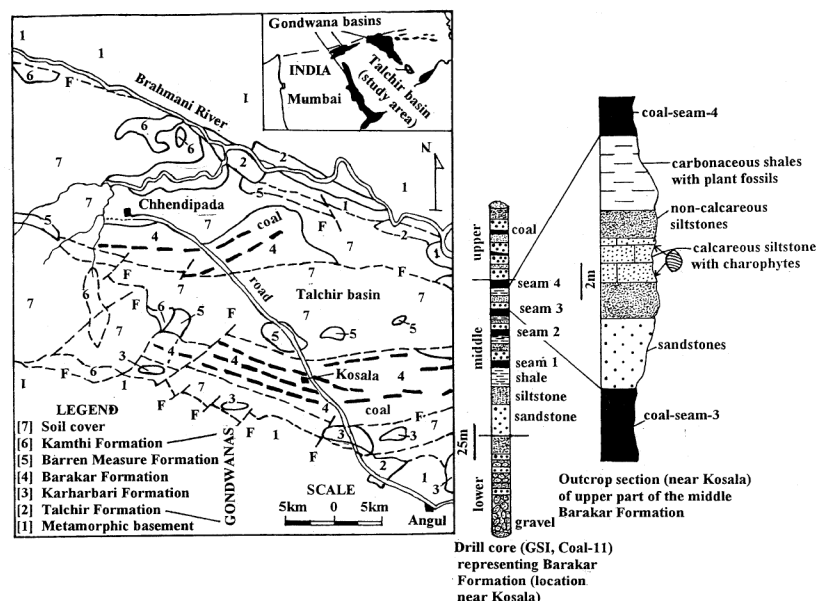
Charophytes constitute an important fossil group in continental ecosystems and biostratigraphy. This group is least explored for palaeoenvironmental interpretations in the branches of palaeobotany and micropalaeontology. Moreover, Permian charophytes are relatively rare in the world. Thus, any new recognition in their taxonomy, especially from Permian, is very important. I report here the taxonomic recognition of two new forms (species) of charophytes from the Talchir Gondwana Basin as the first record of Permian charophytes from India and second from Gondwana. The specimens are stored in the Repository Section of the Geological Survey of India, Kolkata, India.

Order Charales Mädlar, 1952, Family Porocharaceae Grambast, 1962, Subfamily Cuneatocharoideae Wang *et* Huang, 1978 (ref. 1) Genus *Paracuneatochara* Wang, 1984 (ref. 2). Type species

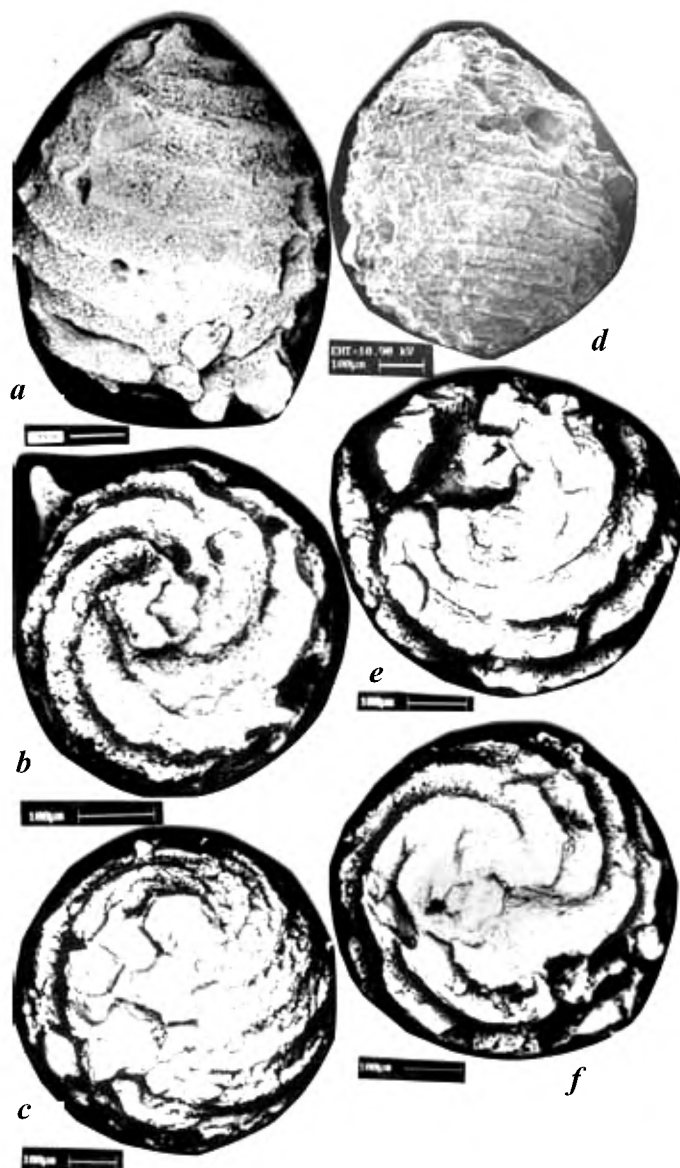
*Paracuneatochara jinxiensis* Wang, 1984 (ref. 2). *Paracuneatochara talchirensis* sp. nov. (Figure 2 a–f). Etymology: The species is named after the basin from where it is recovered. Materials: Five specimens (CD/chara/1–5); CD/chara/1 is the holotype and the rest are paratypes.

The fossils are from a calcareous siltstone unit occurring between the 3rd and 4th regional coal seams (upper part of the middle Barakar Formation) exposed near Kosala village, Angul District, Orissa (Figure 1). Gyrogonites are bulbiform (650–700 µm in length and 450–600 µm in width) with sharp but small

conical apex and rounded base, five sinistrally-coiled spiral cells (80 µm to 100 µm across), concave, equatorial angle usually 10° to 15°, apical pore absent, basal plate clearly divided. The generic characteristics of *Paracuneatochara*<sup>2</sup> such as bulbiform shape, conical apex, rounded base, five sinistrally-coiled spiral cells and low equatorial angle are observed in this form. This form possesses subtle differences in morphology from the type species *P. jinxiensis* Wang, in having less conical apex, divided basal plate and non-pyramidal but bulbiform shape. It is also



**Figure 1.** Geological map of a part of the Talchir Basin, Orissa showing the fossil locality and local stratigraphic section marked with the fossil beds.



**Figure 2.** *Paracuneatochara talchirensis* sp. nov. **a**, holotype, side view, sp. no. CD/chara/1; **b**, holotype, basal view, sp. no. CD/chara/1; **c**, holotype, apical view, sp. no. CD/chara/1; **d**, paratype, side view, sp. no. CD/chara/2; **e**, paratype, apical view, sp. no. CD/chara/2; **f**, paratype, basal view, sp. no. CD/chara/2.

unlike the other known species of *Paracuneatochara*. *P. bellatula* Lu et Luo has sharper apex, smaller size and higher length/breadth ratio. *P. bellatula* f. *elliptica* Lu et Luo has still higher length/breadth ratio and smaller size. *P. elliptica* Lu et Luo is rather more elliptical than the present form which is bulbiform. *P. jimsarensis* Lu et Luo, *P. xinjiangensis* Lu et Luo, *P. gansuensis* Wang and *P. nanopiaoensis* Wang have too projected apex to be compared with the present form. An un-named form belonging to the genus *Paracuneato-*

*chara*<sup>3</sup> from the Upper Permian-Triassic of Xinjiang (China) has some similarity with the present form. Although recently the genus *Paracuneatochara* has been considered as a junior synonym<sup>4,5</sup> of *Leonardosia* Sommer<sup>6</sup>, the Barakar forms contrast in size (larger) and lateral view (sharp with small apical zone) with Lu Hui-nan's forms.

*Paracuneatochara kosalensis* sp. nov. (Figure 3a–d). Occurrence: As for the above species. Etymology: Named after the nearest village Kosala, Angul Dis-

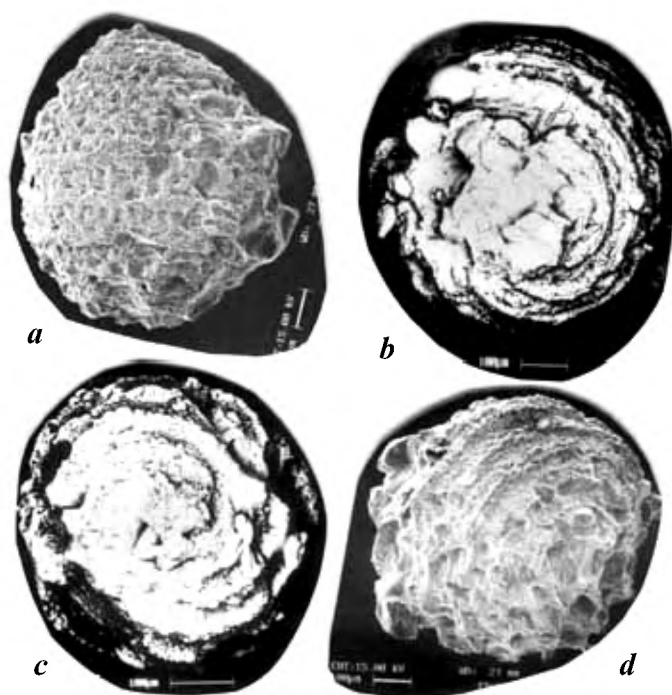
trict, Orissa. Holotype specimen number-CD/chara/6; Paratype specimen number-CD/chara/7.

Gyrogonites are ovoid to bulbiform (800  $\mu$ m to 900  $\mu$ m long and 600  $\mu$ m to 700  $\mu$ m wide) with conical small excentric apex and broad rounded base, five sinistrally-coiled spiral cells (each 70–80  $\mu$ m wide), equatorial angle typically less than 10°, basal plate divided, spiral cells characteristically possess paired and equidistant pits of same size and shape arranged all along the spires that gives the form an external pitted appearance.

The representatives of the Late Palaeozoic–Early Mesozoic genera belonging to the Family Porocharaceae Grambast and Subfamily Cuneatocharoideae Wang et Huang, such as *Cuneatochara* Saidakovsky, *Stenochara* Grambast and *Paracuneatochara* Wang, have many of the morphological features common with the present form excepting the pit system in the spiral cells. The pits are arranged so orderly along the spiral cells that they are most unlikely the product of permineralization and recrystallization for which the mineralogical evidences are lacking. Moreover, the present form is comparatively larger in size and more bulbous in shape.

The host sediments (Barakar Formation) from palynofloral and megaplant contents are traditionally known to be Permian in age<sup>7,8</sup>. Reports of charophytes in India are many, but the majority of them are from post-Palaeozoic sequences<sup>9–13</sup>. The known post-Palaeozoic Indian gyrogonites have little or no resemblance with the present Barakar forms. Since the present forms bear strong resemblance with the known Permian gyrogonites of China and have a very restricted occurrence in the Permian Barakar Formation, they belong to Permian. They constitute the first record of Permian charophytes from India and second from Gondwana<sup>14</sup>.

The Barakar charophytes hold significant ecological and environmental bearings on the inter-coal seam depositional setting. It is evident that the inter-coal seam calcareous siltstones hosting charophytes, ichnogenus *Mermia* and parallel laminations mark the development of a freshwater lake in the Talchir Basin wherein a small group of freshwater bushy plants preferably belonging to Thallophyta grew profusely, especially in the deeper and quieter parts. The overlying and underlying coal seams with charophyte-



**Figure 3.** *Paracuneatochara kosalensis* sp. nov. **a**, holotype, side view, sp. no. CD/chara/6; **b**, holotype, basal view, sp. no. CD/chara/6; **c**, holotype, apical view, sp. no. CD/chara/6; **d**, paratype, side view, sp. no. CD/chara/7.

bearing unit in-between probably suggest a cyclic change in environment, geomorphology (shallow fluvio-lacustrine–deep lacustrine–shallow fluvio-lacustrine) and ecosystem (thick forest–small bushy plants–thick forest) with time in the heart of the Talchir Gondwana Basin during Permian.

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CHIRANANDA DE

*Geological Survey of India,  
CHQ, Pal-1, 15 KYD Street,  
Kolkata 700 016, India  
e-mail: gsi@gems.vsnl.net.in*