SHORT COMMUNICATIONS

CONE-BEARING SHOOTS OF ELATOCladUS
HALLE FROM GANGAPUR FORMATION
(LOWER CRETACEOUS) OF
ANDHRA PRADESH, INDIA

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A rich collection of vegetative shoots of conifers
along with at least three specimens with lateral
shoots terminated by a fructification or cone is
obtained from the Gangapur Formation of Upper
Mesozoic sequence in Adilabad District, Andhra
Pradesh, India. The fossils are preserved as impression
ions in mudstone and siltstone. The leafy shoots
compare well with Elatocladus heterophylla Halle\(^1\)
in the morphology of the leaf laminae and this is the
first report in organic connection with the reproductive
part.

Gangapur Formation\(^2\,3\) constitutes part of the
Upper Gondwana sequence developed in the
Pranhita-Godavari graben and comprises con-
glomerate, pebbly sandstone, siltstone and mud-
stone of typical fluvialite regime. It has a maximum
thickness of 380 m and is divisible into three
members. Gangapur Formation unconformably
overlies the Kota Formation of Lower Jurassic age.
In the adjoining areas, it is overlain by the Chikiala
and Lameta formations and finally by the Deccan
Trap Volcanics. Kutt\(^2\) assigns a Lower Cretaceous
age to Gangapur Formation on faunal and floral
evidences. The present find of the cone-bearing
coniferous shoots is from the upper clayey member
of Gangapur Formation about 1 km south-east of
Khondapalli village (72°23':19°10').

The shoots (4.7 cm \(\times\) 0.25 cm) bear leaves
arranged helically throughout. The leaves are elongated
and dorsiventrally flattened where the base of
the leaf is contracted but apparently not petiolate.
There is a single vein in the lamina.

The leafy shoot preserved in specimen No. PS5/582
(figure 1a) and its counterpart, specimen No. PS5/583
(figure 1b), is 4.7 cm long and 0.25 cm wide; leaves
are 0.7 cm long with a maximum width 0.1 cm near
the middle of the lamina; the leaf tapers gradually
beyond the middle ending in an acute apex, but
among these a few may show somewhat obtusely
rounded tips; the leaves emerge from the axis at an
angle of about 20° the angle gradually increases as
the leaf grows outward.

Figure 1a–c. a. The cone of Elatocladus; b. Same, counterpart; c. Megasporophylls of Elatocladus (GSI
type nos. 20220, 20221 and 20222 respectively).
Halle\(^1\) instituted the genus *Elato cladus* with the remarks that "the difficulty of finding, in many cases, a suitable generic designation for sterile coniferous branches has been the reason for creating here a new generic name, *Elato cladus*. This genus has since been reported from the Upper Mesozoic sequence of numerous localities in the northern as well as southern hemisphere. However, the affinity of this well-distributed genus still remains an enigma as the reproductive structure of *Elato cladus* (sensu Halle) is unknown. Harris\(^4,5\), Miller\(^6\) and Stewart\(^7\) reviewed the problems of Mesozoic conifers in recent years and referred *Elato cladus* as *Incertainae sedis* under *Coniferopsida*.

Three specimens in the present collection show short lateral shoots emerging out of the vegetative shoots of *Elato cladus* at an angle of about 20\(^\circ\) and terminated by fructification. Figures 1a and b show fructification terminal on the short lateral shoot emerging at an angle of about 20\(^\circ\). The fructification is small, about 2.3 cm × 0.7 cm in size consisting of 13–14 oval bodies each spirally borne on adaxial side of a bract. The fructification with these bodies, each borne at the axil of a bract-like structure appears to be an aggregate of male cones. However, no pollen grains or any nucellus could yet be recovered.

In the other specimen (NO. P5/584, figure 1c), 1–3 separate, somewhat oval or rounded bodies are seen each at the axil of a scale-like structure which may be ovule/seeds in a female cone. However, the micropyle or chalaza are not discernible to confirm if the fructification is a female cone.

Obviously, this species of *Elato cladus* used to bear terminal cones on short lateral shoot. Nothing of this kind has been described earlier in any species of *Elato cladus* and the genus includes only sterile shoots. The solitary specimen of *Conites sripernaturenensis* Sahni\(^8\) described as a probable female cone of *Elato cladus plana* Feistmantel\(^9\) by Bose and Maheswari\(^10\) has been found to be different from the attached cone of *Elato cladus* being described in the present paper. Sahni\(^8\) mentioned about detached seed-like bodies in Feistmantel's specimen (GSI type No. 4/918) containing *Elato cladus jubal- purenensis* (Feist.). But since the organic connection of these seed-like bodies with the leafy shoot is doubtful, he preferred to describe them as *Strobilites swardi*. In the solitary specimen of *Stachyoxaenus sampathkumarani* Rao\(^11,12\), the connection of the terminal fertile part with the vegetative shoot is missing. The leaves also morphologically differ from those of *Elato cladus* by its lenticular shape and phyllotaxy. Recently, Bose *et al*\(^13\) mentioned badly preserved megasporophylls in one specimen of *Elato cladus confertus* bearing circular or oval bodies considered as seeds.

It may be mentioned that somewhat similar leafy shoots with attached reproductive structure were included under a separate genus *Marskea* Florin. Recently, Harris\(^4\) attempted to put *Marskea* under the form-genus *Elato cladus*. The leaves are arranged in opposite decussate manner in the case of *Marskea* whereas these are spiral in *Elato cladus*. The leaves emerge at an angle of 45\(^\circ\) in the former but in *Elato cladus*, this angle varies between 15\(^\circ\) and 20\(^\circ\). The leaves in *Marskea* are distinctly petiolate differing from the sessile leaves of *Elato cladus*. In *E. heterophylla* Halle, the type species of *Elato cladus*, the leaves are, in fact, sessile as emphasized by Harris\(^4\). The leaf lamina in *Marskea* is lanceolate but it is oblong in *Elato cladus*. The size of the leaf also differs very much in the two genera. It is about 2–2.5 cm × 2–2.5 mm in *Marskea* whereas, in almost all the species of *Elato cladus*, the leaves are 0.7–1 cm × 1 mm. In respect of the reproductive structure also the present specimens differ from *Marskea jurassica* Florin. The male or the female cone of *Marskea* is represented by a solitary ovule or by a solitary male cone enclosed by scale leaves. The presently described specimens, on the other hand, show aggregation of 12–14 staminate or pistillate strobili. *Poteridion* Harris or *Trulla* Harris which are detached fructifications consisting of solitary cones show no vegetative structure and, as such, their inclusion within the form-genus *Elato cladus* is questionable. In their morphology, the present attached cones of *Elato cladus* are entirely different from these two specimens. The genus *Poteridion* with the single species *P. hallei* is the name given for a solitary, conical dwarf female shoot in which the ovules (supposed to be rounded) are fully concealed by scale leaves. *Trulla*, on the other hand, is a detached fragmentary female cone, supposedly containing several oval, flat seeds in a globose mass terminal on a shoot. These have nothing similar with the fructifications described here.

At the moment, however, it is not possible to comment on the exact affinity of *Elato cladus* within *Coniferopsida* because the morphology of the cones and their parts is not yet fully understood as the fossils are not carbonised.

The specimens were collected by the first author in January, 1985. The specimens have since been deposited with the Central Palaeontological Repository of the GSI and Type numbers have been obtained as follows:
GOLD-QUARTZ-SULPHIDE REEFS OF MANGALUR, GULBARGA DISTRICT, KARNATAKA

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Gold-quartz-sulphide reefs of Mangalur deposit are situated within the metabasic volcanic rocks in the south central part (near Mukangavi) of the Mangalur greenstone belt (figure 1). Exploration by the Geological Survey of India (GSI) and development of the mine by Hutti Gold Mines during recent years have resulted in establishing a sizable gold ore reserve of 70,000 metric tons of an average grade of 3 g/ton of gold. The mine was reopened in 1981 and developed by Hutti Gold Mines Co. Ltd.

The investigated area is characterized mainly by different variants of metavolcanic rocks such as coarse-grained amphibolite, banded amphibolite and schistose amphibolite. The rock types are involved in deformation which is evident from minor structures. Gold mineralization occurs within the metavolcanic rocks which were tholeiitic basalts regionally metamorphosed under medium to low-grade greenschist facies. There exists a geochemical similarity of these Archaean gold-bearing metabasic volcanic rocks of Mangalur with the oceanic tholeiites generated at marginal basin tectonic environment. The parent rocks have undergone some fractionation and appear to be derived from melts generated by 10 to 25% melting of the mantle.

The Mangalur gold deposit includes two gold-quartz-sulphide reefs. The main reef is almost N-S and dips at a steep angle 80° due west. This reef extends over a strike length of 350 m with an average width of 3 m. There is a shaft on the reef namely, Holman shaft. The mining depth is about 190 m in the main reef. Another gold-bearing quartz-sulphide reef is delineated over a strike length of 190 m with a width of 2–2.5 m. This reef runs nearly parallel to the main reef. However, this reef is not mined. The distance between the two reefs varies from 35 to 40 m. The reefs occur within shear zones. The host metabasic volcanic rocks in the shear zones are chloritized, biotitized and carbonitized. The reefs are conformable to the regional trend of the greenstone belt, showing bifurcation at places.

Gold-quartz-sulphide reefs of Mangalur deposit are characterized by the presence of disseminated streaks and grains of sulphides in the schistose amphibolites associated with thin quartz veins parallel to schistosity and abundant biotite, chlorite, sericite and carbonates (ankerite + calcite) indicating wall-rock alterations suggestive of the broad mechanism underlying gold mineralization in the area. Gold-bearing quartz is present in the form of parallel and/or enechelon bands, veins, lenses and stringers emplaced parallel to sub-parallel to the schistosity of amphibolite. Observations of quartz bodies underground reveal that gold-bearing quartz veins are controlled by linearly extending shear zones and based on their morphology and internal structure, they can be classified as mineralized zones. Most of the reefs are localized where the schist of the shear zones has been highly dragged and contorted particularly at gentle flexures in strike...