THE NOTOCALAMITACEAE, A NEW FAMILY OF UPPER PALAEOZOIC EQUISETALEANS

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ABSTRACT

Notocalamites askosus gen. et sp. nov. is erected for a fructification consisting of simple sporangia arranged in whorls on stems of *Paracalamites*. The species appears to belong to an arborescent equisetalean, and is placed in the family *Notocalamitaceae* fam. nov. It occurs in the Tubarão Group of Santa Catarina, Brazil.

INTRODUCTION

EQUISETALEAN remains, both of stems of *Paracalamites australis* and of foliage of various species of one or other of *Phyllotheca*, *Schizoneura*, *Stellotheca*, *Umbellaphyllites*, and *Raniganjia* are very common throughout the Upper Palaeozoic of Gondwanaland. The only known attached sporangia form the fructification of certain *Phyllotheca*. Fructifications of an entirely new type that belong to the Equisetales have been found in Brazil. They do not belong to any described family, so are used to form the basis of the family *Notocalamitaceae*.

All specimens come from the Bainha locality, near Criciuma, state of Santa Catarina, Brazil. The locality was discovered by Dolianiti (1954), who, along with many others since then has reported a wide variety of fossil plants from this locality.

DESCRIPTION

Order *Equisetales* Dumortier 1829.

Family *Notocalamitaceae* fam. nov.

Diagnosis — Equisetalean family having open fructifications of simple, more or less sessile sporangia borne in whorls at nodes of stems with ribbing opposite, not alternate at nodes. Sterile bracts or leaves between fertile whorls absent. Sometimes associated leaves compound.

Comparison — Using the classification given by Boureau (1964) only the families *Archaeocalamitaceae* and *Autophyllaceae* have forked leaves. The leaves in *Koretrophyllites* are not forked but sometimes form in segments of a whorl with the intermediate segments leafless. Other equisetalean families include plants with simple leaves only.

Pothocites in the *Archaeocalamitaceae* is a closely packed strobilus of compound sporangia. Stalked sporangia are arranged into whorls on a fertile axis in *Autophyllites*. *Koretrophyllites* in the *Sorocaulaceae* has simple sporangia arranged into two or three whorls between sterile whorls. The fructification, *Notocalamites*, is similar except that it lacks sterile whorls. The *Notocalamitaceae* represent a more or less parallel development in the Upper Palaeozoic Gondwanas to the *Sorocaulaceae* in Angaraland, but they are not related.

Type Genus — *Notocalamites* gen. nov.

Notocalamites gen. nov.

Diagnosis — Equisetalean fructifications consisting of an open strobilus of large, unbranched sac-like sporangia arranged in whorls at nodes on a stem having indistinct nodes. Adjacent whorls of the strobilus fertile, neither separated by nor combined with sterile members.

Comparison — As the family is monotypic at present, no generic comparison is possible.

Origin of Name — Greek νοτος south — the southern calamite.

Type Species — *Notocalamites askosus* sp. nov.

Notocalamites askosus sp. nov.

Plate 1, Text-fig. 1

Diagnosis — Fructification having unbranched, simple sporangia arising in whorls on stems of *Paracalamites*, whorls not separated longitudinally by bracts or sterile appendages. Sporangia separated, erect, or somewhat pendulous, slightly constricted basally, expanded into a somewhat ovoid apical termination, ornamenta-

tion simple, of reticulate longitudinal striations. Spores unknown. Supporting stem possibly of arborescent proportions.

Description — Six specimens, two with counterparts, have been recognized. These are axes clothed by sporangia most of which appear to arise in whorls at nodes. It is thought that the few that appear to arise between nodes (PL. 1, FIG. 2) also arose at nodes during life but were compressed into the internode during burial. Sporangia arise thickly around each whorl, there may even be more than one sporangium per rib. Some sporangia appear to be branched, but this is caused by an overlying sporangium being strongly compressed into an underlying one during burial; one of these is shown near the top of specimen DGP 7/1056 (PL. 1, FIG. 2). The whorled arrangement shows more distinctly on the counterpart of the type specimen (PL. 1, FIG. 4) where some sporangia arise at the same level.

The sporangia are bulbous towards their apical end, or occasionally more or less strap shaped. The following dimensions are based on 14 complete sporangia selected from all specimens. The dimension within brackets represents the average, the other figures represent the extremes. Length of sporangia: 7·5-(5·75) 5·0 mm. Maximum breadth of the sporangia: 2·3-(1·9)-1·6 mm, which is distant 2·0-(1·3)-0·6 mm from the apex of the sporangium. The narrowest part of the sporangium is towards the base: 2·0-(1·5)-1·0 mm wide. Four sporangia are uniform in breadth throughout their length.

The type specimen, DGP 7/1054 (PL. 1, FIGS. 1, 3; TEXT-FIG. 1) has been selected as it is the most complete specimen, and also as it is the only specimen to show stem and foliar characteristics. The stem is of *Paracalamites australis* RIGBY, with nodes closely spaced and poorly defined. The stem varies from 9 to 8 mm in width, with 7 or 8 ribs visible. Nodes appear to be spaced at 1·5, 7, 10·5, 14, 18, and 20·5 mm measured from the uppermost node, which is the foliage — bearing node. *Paracalamites* is a form genus common to a number of equisetalean families.

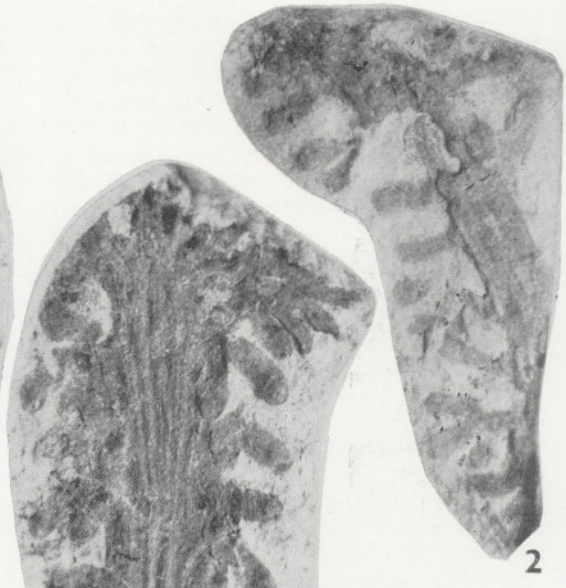
The leaves do not closely resemble the leaves of any known equisetalean species. No new species is proposed for their reception as they are thought to represent considerably modified leaves associated with fertile structures. The branched leaf shown lowermost on FIG. 3, PL. 1 appears to have a sporangium — like structure on its lower branch, and form a normal leaf on its upper branch; this particular leaf

TEXT-FIG. 1 — Restoration of *Notocalamites askosus* gen. et sp. nov., approximately natural size to suggest the arrangement of the sporangia in specimen DGP 7/1054.

will be discussed further in the next paragraph. Most of the leaves are once branched, broad, having a midrib but are of unknown length. They are about 2·5 mm broad at their base, taper to the branching, become thinner, then continue to taper towards their broken ends. The longest fragment preserved is 26 mm long, and 1·3 mm wide at its broken end.

The structure of the lowermost of the branched leaves, referred to in the previous paragraph (near the top of PL. 1, FIG. 3) suggests one postulate for the origin of the strobilus. Originally each leaf at every node developed as a modified leaf, a branched fertile leaf. One branch developed into a sporangium, whilst the other half became lost. This may explain the apparently pendulous nature of some sporangia. Against this hypothesis is the presence of the remaining dichotomously branched sterile leaves forming a crown at the top of the type specimen (PL. 1, FIG. 1). The observed position of sporangia at nodes is to be expected if the sporangia develop either from modified leaves, or by replacement of leaves. Fertile structures often develop along the internodes in equisetaleans.

1



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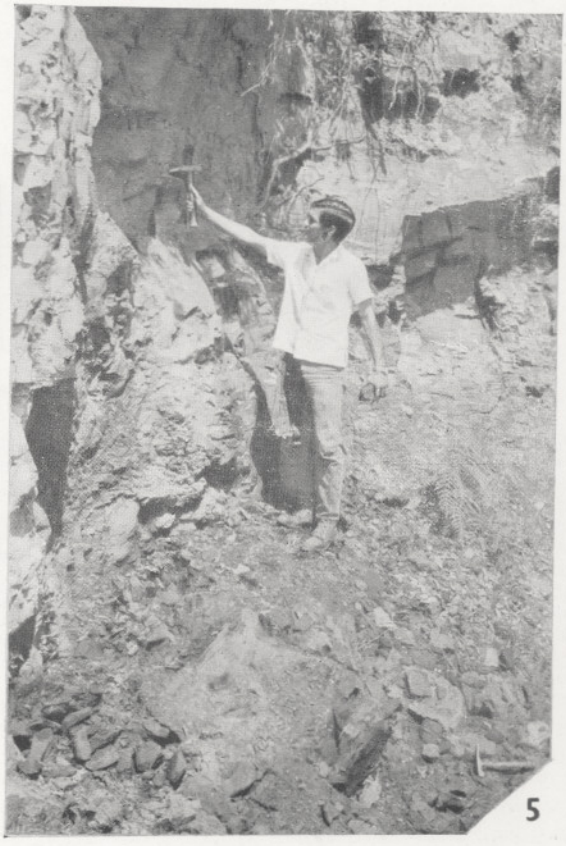

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Other stems present in the collection are narrower, 4 to 5 mm wide, with the ribbing difficult or impossible to see (PL. 1, FIG. 2). These stems may have been terminal, although the type specimen must have grown somewhat below the end of axis because of the width of its stem.

Text-fig. 1 shows a restoration of the fructification based on the type specimen.

Comparison — At present the genus is monotypic, hence no specific comparison is possible.

Origin of Name — Greek ασκος a bladder or wineskin, referring to the shape of the sporangium.

Occurrence — All specimens were found at the Bainha locality, Criciuma, Santa Catarina, Brazil, in mudstones of the Camada Irapuá, Rio Bonito Formation, Tubarâo Group, of Lower Gondwana age. The locality is in a cutting in Rua Dr. João Pessôa approximately 1150 metres from the corner of Praça Dr. Nereu Ramos. PL. 1, FIG. 5 shows the maximum thickness of the outcrop which extends for about 50 metres further along Rua Dr. João Pessôa from this point. Plants are distributed throughout the mudstone bed, not segregated into layers. The plant remains lie horizontally. Many specimens are fairly complete, and are not folded. Criciuma is situated at approximately 28° 41′ S, 49° 23′ W.

Specimens — All specimens are housed in the Palaeontology Collection, Instituto de Geociências, Universidade de Sâo Paulo, Sâo Paulo, Brazil.

DGP 7/1054 (PL. 1, FIGS. 1, 3) (type sepcimen), DGP 7/1055 (PL. 1, FIG. 4) (counterpart to the type specimen), DGP 7/1056 (PL. 1, FIG. 2), DGP 7/1057 (two specimens), DGP 7/1058, one other specimen.

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EXPLANATION OF PLATE 1

Notocalamites askosus gen. et sp. nov.

1. Holotype. The sporangia appear to clothe the stem, but are segregated into whorls at weakly defined nodes. The leaves forming the crown appear stiff. Specimen DGP 7/1054. × 2.

2. Paratype. Sponrangia arranged on a slender axis. What appears to be a branched sponrangium is formed by two sponrangia being compressed on top of one another. Specimen DGP 7/1056. × 2.

3. Portion of the holotype showing typical sporangia, and a bifurcated leaf with the lower lobe forming what might have developed into a sporangium. Specimen DGP 7/1054. × 6.

4. Counterpart of the type specimen. The continuity of ribs at nodes is so strongly developed that nodes are not apparent. Specimen DGP 7/1055. × 2.

5. Outcrop of the fossiliferous horizon. Plant remains are distributed throughout this mudstone bed of the Camada Irapuá, Rio Bonito Formation, Bainha, near Criciuma, Santa Catarina, Brazil. The man is standing on the base of the horizon and is indicating the top of the horizon with his hammer. The blocky nature of the mudstone is shown by the boulders on the ground. There is a tendency for the rock to fracture into tabular slabs because of the presence of the fossils.