TRINOCLADUS EXOTICUS, A NEW DASYCLADACEAN ALGA FROM THE UPPER CRETACEOUS OF BORNEO

by GRAHAM F. ELLIOTT

ABSTRACT. A new species of the dasycladacean alga *Trinocladus* is described as *T. exoticus* sp. nov.; it comes from the Upper Cretaceous of Borneo. Other *Trinocladus* spp. are Cretaceous and Eocene of the circum-Mediterranean, Middle East, and Caribbean.

THE Chert-Spilite Series of Sabah (North Borneo) shows a variety of rocks including spilite, basalt, agglomerate, tuff, chert, sandstone, shale, limestone, and marl: it is considered to be of Upper Cretaceous–Lower Eocene age (Fitch 1955, 1961).

Thin-sections of six limestone samples were sent to me by Mr. Leong Khee Meng of the Geological Survey, Borneo Region of Malaysia. They proved on examination to be richly algal, containing a new species of the dasycladacean genus *Trinocladus*, associated with crustose solenoporacean algae referable to *Parachaetetes* and *Petrophyton* or a very similar genus. These three algae are considered to indicate an Upper Cretaceous age for these samples. The *Trinocladus*, abundant and well-preserved, is described below.

Of the occurrence, Mr. Leong Khee Meng writes:

> The *Trinocladus* specimens occur in the matrix of the calcareous conglomerate which occurs as lenses admixed with amygdaloidal basalt typical of the Chert-Spilite Formation. The calcareous conglomerate also contains subangular to subrounded, varied sized fragments of similar amygdaloidal basalt. The basaltic rocks apparently formed islands, around which the conglomerate was deposited in very shallow marine waters more or less contemporaneously with the basaltic eruption. (Unpublished letter, November 1971). The locality is shown on Text-fig. 1.

ALGAE: CHLOROPHYTA
Family DASYCLADACEAE Kützing 1843
orth. mut. Hauck 1884
Tribe THYRSOPORELLEAE Pia 1927
Genus TRINOCLADUS Raineri 1922

Diagnosis (after Elliott). Calcified tubular dasyclad showing successive verticils of radial branches, each branch showing outwardly widening primaries giving rise to several similar-shaped secondaries, and these in turn to bunches of tertiaries: branches of the lower verticils may not show the full detail. Branches usually not alternate in position from verticil to verticil. Type-species: *T. tripolitanus* Raineri, Upper Cretaceous of North Africa.

[Palaeontology, Vol. 15, Part 4, 1972, pp. 619–622, pl. 120.]

Trinocladus exoticus sp. nov.

Plate 120, figs. 1–6

Diagnosis. Large Trinocladus in which terminal branch-thickening is only conspicuous in the primaries, and with conspicuous annular waxing and waning of proportionally narrow stem-cell diameter.

Description. This is a thick-walled dasycladacean, and a large species of its genus. The maximum length observed was 4·16 mm, but this is incomplete and in the living plant this dimension may well have been double or more. The maximum observed external diameter was 1·38 mm, with an internal diameter varying from 0·182–0·234 mm, giving a d/D ratio of 13–16%. Smaller examples are common. The stem-cell cavity in longitudinal section shows a regular 'waxing-and-waning' in diameter, widening at verticil-levels and constricting between. The verticils occur regularly at about 0·286 mm apart: each verticil shows eight branches, set at right angles to the long (vertical) axis of the stem-cell. Each branch shows a flask-shaped primary, paddle-shaped in section, commencing with a thin insertion at the stem-cell boundary and swelling rapidly to a rounded-triangular termination: these primaries occupy the inner half of the wall thickness. From each termination a clump of about eight thin secondaries diverges outwards: each secondary thickens very slightly outwards, but regularly and not normally to a swollen termination. The secondaries extend through most of the outer half of wall-thickness. At their terminations, near the outer surface, each secondary divides into six to eight short, very thin tertiaries, whose terminations occasion the pore-pattern on the outer surface of the fossil.

The thin branch-systems of each verticil are clearly spaced apart in the wall-thickness, so that the only zone of overlap is peripherally with the tertiary branchlets.

Holotype. The specimen figured in pl. 120, fig. 6, from the Chert-Spilite Formation ('calcareous lenses apparently intermixed with volcanic rocks typical of this formation'); Upper Cretaceous. Kuamat-Malabuk Malua area, Darvel Bay, Sabah, Malaysia. BMNH, V. 56285.

Paratypes. The specimens figured in pl. 120, figs. 1–5, same locality and horizon. BMNH, V. 56282, V. 56283, V. 56286.

Discussion. T. exoticus is closest in structure (detail and proportions) to the Upper Cretaceous type-species *T. tripolitanus* Raineri (Pia 1936, Elliott 1968), rather than to the Maestrichtian *T. radoicicae* Elliott or to *T. perplexus* Elliott from the Palaeocene. In size, however, *T. exoticus* is much larger and approaches that of *T. pinarensis* Keijzer (Upper Cretaceous of Cuba). This is the largest species, differing however in some

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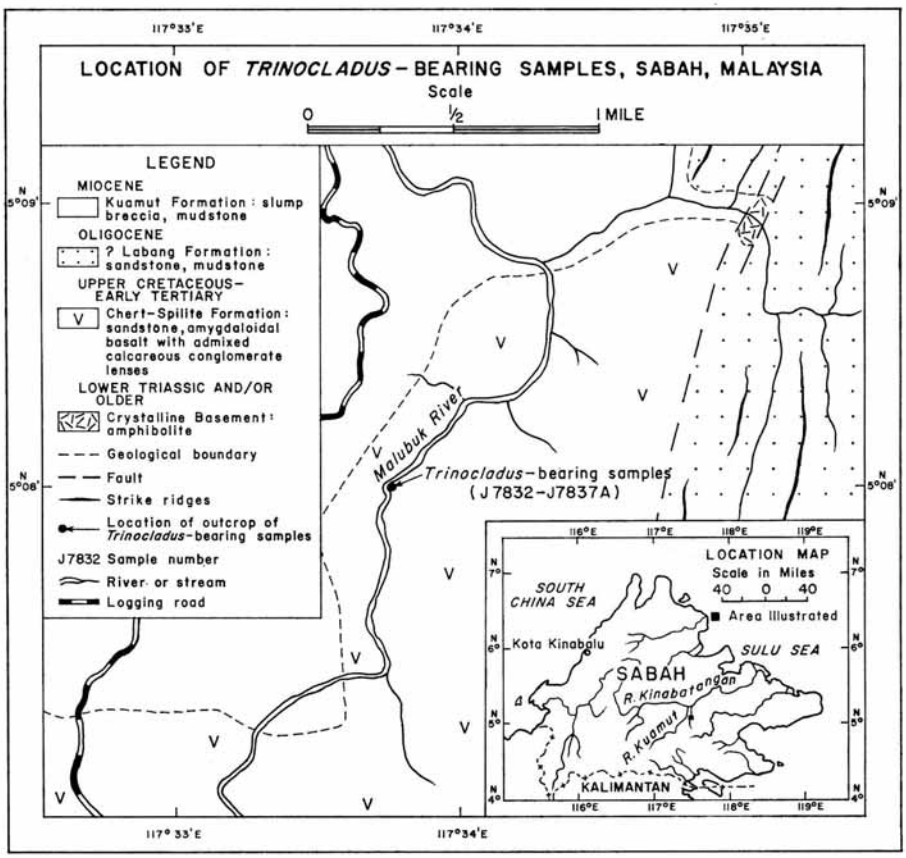
EXPLANATION OF PLATE 120

Figs. 1–6. *Trinocladus exoticus* sp. nov.; Chert-Spilite Formation, Upper Cretaceous; Kuamat-Malabuk Malua area,,Darvel Bay, Sabah, Malaysia. Reg. nos. are those of British Museum (Natural History), Dept. of Palaeontology, London. 1. Oblique-vertical section, paratype, ×17; V. 56286. 2. Transverse section, paratype, ×28; V. 56283. 3. Vertical-tangential section, paratype, ×22; V. 56282. 4. Transverse cut of broken example to show branch-structure, paratype, ×42; V. 56282. 5. Fragment to show branch-structure, paratype, ×64; V. 56283. 6. Longitudinal section of large example, holotype, ×19; V. 56285.

dimensions, proportions and detail from the other two Upper Cretaceous species. Dimensions and structures of these three species are set out below for comparison.

In *T. tripolitanus* the lower branches may not show the full branch detail: this may well have been the case in the Borneo fossil, but has not been noted by me. The swollen



TEXT-FIG. 1. Geological map of sample locality.

primaries probably served as sporangia in life, and such later parts of the plant are usually the most heavily calcified and would stand the best chance of being fossilized.

T. exoticus is abundant in the thin-sections examined: in life it would have grown in warm very shallow marine waters as do the living *Neomeris* and *Bornetella* in the Indo-Pacific.

The Borneo fossil shows that in Upper Cretaceous times *Trinocladus* probably had either a circum-global distribution in the right environment: Caribbean, Mediterranean,

Trinocladus spp.

	L	D	d	d/D	V	p	s	t
pinarensis	3·8+	1·5–2·0	0·35 or less	18–23%	0·2	12–13 short, swollen	10–12 elongate	10 short, slim
tripolitanus	3·36+	0·47–0·68	0·16–0·19	28–34%	0·1	8 club-shaped	5–6 club-shaped	6 short, slim
exoticus	4·16+	1·38	0·182–0·234	13–16%	0·86	8 club-shaped	8 elongate	6–8 short, slim

L = length (incomplete), D = outer diameter, d = internal diameter (stem-cell cavity), V = distance apart of successive verticils, p = number and description of primary branches, s = number and description of secondary branches, t = number and description of tertiary branches. Dimensions in mm. These fossils are plants and therefore the detail set out above may vary.

Middle East and Indonesia, or alternatively, if one accepts the concept of continental drift, that all the species were relatively adjacent in a much smaller Tethyan area.

The genus survived into the older Tertiary, when along with other cladospore forms such as the related *Thyrsoporella* and *Belzungia*, and also *Broeckella*, it became extinct.

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Typescript received 17 November 1971

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