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The *Indotriradites dolianitii* Morphon, a distinctive group of miospore species from the Lower Carboniferous of Gondwana

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Abstract

An emended diagnosis and generic reallocation are proposed for the trilete miospore *Indotriradites dolianitii* (Daemon, 1974) Loboziak et al., *comb. nov.* A new species, *I. daemonii* Loboziak et al., *sp. nov.*, from Viséan strata of Western Gondwana, is erected. These two species, together with *I. zosteriformis* (Playford et Satterthwait) Playford, 1991 from the Viséan of Australia, belong to a cohesive morphological miospore category, here termed the *Indotriradites dolianitii* Morphon, which is evidently restricted to the Lower Carboniferous of Gondwana.

Keywords: miospores; systematics; Gondwana; Lower Carboniferous

1. Introduction

Daemon (1974, p. 572, pl. 8, figs. 7, 8) described *Hymenozonotriletes dolianitii* from the Amazon and Parnaíba basins of northern Brazil. He tentatively compared this species with *Radiizonates* sp. no. 2922 which had been illustrated, but not described, by Lanzoni and Magloire (1969, pl. II, figs. 14, 15) from the Viséan of the Grand Erg occidental, Algerian Sahara. This comparison formed part of his arguments to demonstrate a strong similarity between Early Carboniferous palynomorph assemblages from South America and North Africa.

Detailed examination, by one of us (S.L.), of Daemon's type material housed in Museu Nacional, Rio de Janeiro, Brazil, and of other well preserved miospores from the Lower Carboniferous of northern Brazilian basins, casts some doubt on the putatively close similarity between the above-mentioned species.

The main purpose of this paper is therefore to redefine the nomenclatural and systematic status of Daemon's and Lanzoni and Magloire's related species and to assess their relationship with a morphologically comparable species from the Viséan of northern Australia.

2. Taxonomic descriptions

Original diagnosis of *Hymenozonotriletes dolianitii* Daemon, 1974 (translated from Daemon, 1974, p. 572):

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Trilete spores with subtriangular outline. Distal surface of central body is covered with small verrucae and conical pointed spines, which decrease in number towards the equator of the spore, including the zona. The membranous, diaphanous zona seems to be attached by means of plications to the central body, becoming slightly thicker close to the latter. Sparser sculpture and the plication impart a radiate appearance to the zona, with characteristic bands and darker and lighter dots. The zona margin is typically crenulated, irregular. Trilete mark restricted to central body; triradiate folds may attain the equatorial region of spore.

Remarks: The holotype figured by Daemon (1974) possesses larger and more closely spaced elements on or about the inner margin of the zona than elsewhere on the spore. Because this feature is seen in all Brazilian specimens examined so far, we suggest it be added to the species circumscription.

As discussed in detail by Playford (1976, p. 36; 1991, pp. 103–104), *Hymenozonotriletes*, as used by Naumova (1953) and other Russian authors, is of little practical value as a form genus. So the retention of Daemon's species within this genus is no longer acceptable. An assignment to the genus *Indotriradites* is now proposed.

Indotriradites Tiwari emend. Foster, 1979

Type: *I. korbaensis* Tiwari, 1964.
Diagnosis (after Foster, 1979, p. 55):

Spores radial, trilete, zonate, cavate. Amb circular to roundly subtriangular. Distal surface hemispherical (lateral view), proximal face low pyramidal to almost flat (± in same plane as zona). Laesurae labrate, reaching to outer margin of zona. Exine two-layered; intexinal layer thin, often folded, apparently unstructured, separated (at least distally and equatorially) from exoexine by a distinct, broad or narrow cavum, exoexine infrastructured, surface pattern appears scabrate or granulate; proximal face laevigate, distal surface (often including that of zona) bearing apiculate sculptured elements. Elements include coni, spinae, broad based mammoid elements, low bacula and verrucae; their bases may be partly vacuolate. Zona distinct, broad; inner margin often markedly thicker than remainder; with translucent appearance; outer edge continuous or notched.

Indotriradites dolianitii (Daemon, 1974) Loboziak et al., *comb. nov.* et emend. (Plate I, 6–14)

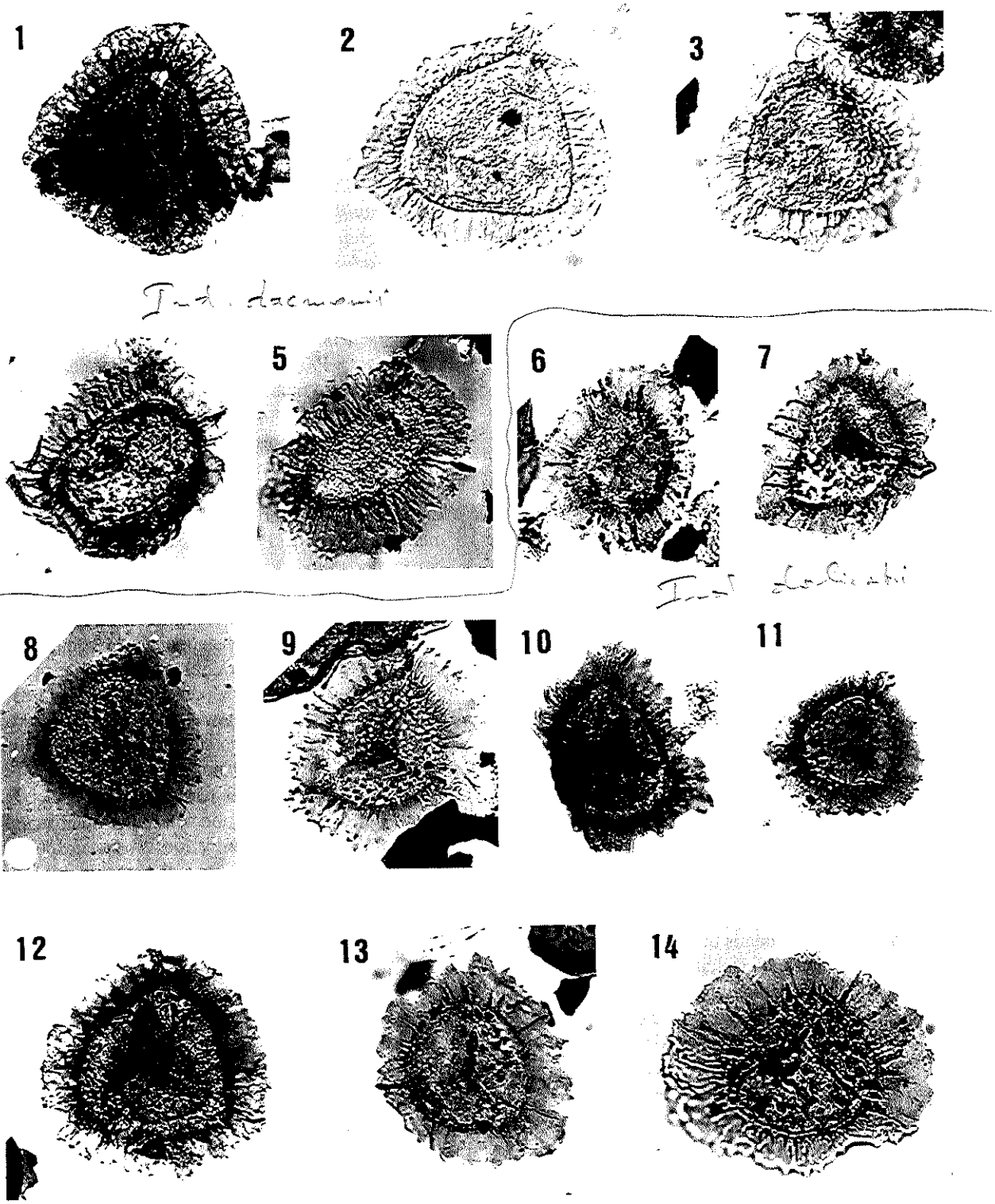
Basionym: Hymenozonotriletes dolianitii Daemon,

PLATE I

Slide 9181/DESUL no. 5233-I.M.N. is housed at the Department of Geology and Paleontology (D.G.P.) of National Museum, Rio de Janeiro, Brazil. Other slides from well 2-IZ-1-MA and slides from well 1-CA-1-MA are housed in the palynological slide collection of the Biostratigraphy and Paleoecology Section of Petrobras Research Centre (Cenpes/Divex/Sebipe), Rio de Janeiro, Brazil. Slides from wells 2-LF-1-AM and 2-PM-1-MA are housed in the palynological collection of the Laboratory of Paleobotany and Paleopalynology, Université de Liège, Belgium. Miospore locations on slides are based on England Finder graticules. Magnification of illustrated specimens ×500.

1–5. *Indotriradites daemonii* Loboziak et al., *sp. nov.*
1. Slide 23(1): P25/2, well 2-LF-1-AM, core 23 at 2178.10/2180.10 m, Amazon Basin.
2. Holotype. Slide 9507450: G66/2, well 1-CA-1-MA, cuttings sample at 408 m, Parnaíba Basin.
3. Slide 9507458: G61, well 1-CA-1-MA, cuttings sample at 462 m, Parnaíba Basin.
4. Slide 15(1/1): J28/4, well 2-LF-1-AM, core 15 at 2151.50/2156.60 m, Amazon Basin.
5. Slide 31(1): V27/2, well 2-PM-1-MA, core 31 at 864.40/867.4 m, Parnaíba Basin.
6–14. *Indotriradites dolianitii* (Daemon, 1974) Loboziak et al., *comb. nov.*
6. Slide 940071 bis: R42/4, well 2-IZ-1-MA, core 333 at 1389/1392 m, Parnaíba Basin.
7. Slide 940069: L58, well 2-IZ-1-MA, core 329 at 1377 m, Parnaíba Basin.
8. Holotype after Daemon (1974, pl. 8, fig. 8), rephotographed. Slide 9181/DESUL, no. 5233-I.M.N., well 2-IZ-1-MA, core 324, Parnaíba Basin.
9. Slide 9405928: R29, well 2-IZ-1-MA, core 334(?)/335 at 1392/1398 m, Parnaíba Basin.
10. Slide 21(1): T34/1, well 2-LF-1-AM, core 21 at 2173.80/2176.10 m, Amazon Basin.
11. Slide 940070: M40/3, well 2-IZ-1-MA, core 333 at 1389/1392 m, Parnaíba Basin.
12. Slide 21(1): W31/4, well 2-LF-1-AM, core 21 at 2173.80/2176.10 m, Amazon Basin.
13. Slide 940069 bis: V45/2, well 2-IZ-1-MA, core 333 at 1386/1389 m, Parnaíba Basin.
14. Slide 9405929: T26, well 2-IZ-1-MA, core 334/335 at 1392/1398 m, Parnaíba Basin.

PLATE I



1974, An. Acad. Brazil. Ci. 46 (3–4), p. 572, pl. 8, figs. 7, 8.

Synonymy:

1998 *Radiizonates* sp. cf. *Hymenozonotriletes dolianitii* Daemon in Loboziak et al. (partim), pl. 1, fig. 2, non fig. 1.

Holotype: Slide 9181/DESUL, no. 5233-I.M.N. (Daemon, 1974, pl. 8, fig. 8; refigured as Plate I, 8 herein). Petrobras well 2-IZ-1-MA, core 324, Poti Formation, Parnaíba Basin, Brazil.

Repository: Departamento de Geologia e Paleontologia (D.G.P.), Museu Nacional, Rio de Janeiro, Brazil.

Emended diagnosis: Spores radial, trilete, cavate. Amb subtriangular, equatorial margin usually undulant. Laesurae extending to inner margin of zona, accompanied, and often obscured, by straight to sinuous, very narrow elevated lips up to 10 μm high. Exoexine extended equatorially as a zona of more or less uniform width and darker around its inner margin. Distal surface, including that of zona, with varied apiculate sculpture. Distal central area densely sculptured with coni or bulbous-based elements bearing short and rather thin spinae (up to 4 μm in total height and width), often basally coalescent. Distal zona generally less densely sculptured with coni and rare spinae (up to 2 μm high and wide at base). Larger (up to 7 μm high) and closer spaced elements on or around inner margin of zona. Faint radial plication sometimes present on the zona. Intexine perceptible to indistinct, laevigate, very thin, slightly contracted from intexine.

Equatorial diameter: 54 (69) 90 μm (based on 15 specimens).

Comparison with the North African species: The illustrations of *Radiizonates* sp. no. 2922 by Lanzoni and Magloire (1969, pl. 2, figs. 14, 15) show several characters which differ from the above diagnosis. The sculptural elements are smaller and thinner, the inner margin of the zona is thinner and the radial plication is much more conspicuous. The 'Spore trilete zonale no. 3203' as illustrated by Lanzoni and Magloire (1969, pl. 3, fig. 10) seems to correspond more closely to the description of *Indotriradites dolianitii*.

Specimens resembling the illustrated ones of *Radiizonates* sp. no. 2922 occur in the late Viséan material of the Faro and Poti formations of the Amazon and Parnaíba basins, respectively. These are described below as a new species.

Indotriradites daemonii Loboziak et al., *sp. nov.* (Plate I, 1–5)

Synonymy:

1969 *Radiizonates* sp. no. 2922 of Lanzoni and Magloire, pl. 2, figs. 14, 15.

1994 *Radiizonates* sp. no. 2922 Lanzoni and Magloire in Ravn et al., pl. 2.A.2, fig. 6.

1998 *Radiizonates* sp. cf. *Hymenozonotriletes dolianitii* Daemon in Loboziak et al. (partim), pl. 1, fig. 1, non fig. 2.

1999 *Radiizonates* sp. cf. *Hymenozonotriletes dolianitii* Daemon in Melo et al., pl. 3, figs. 1, 2.

Holotype: Slide 9507450: G66/2 (Plate I, 2).

Repository: Palynological slide collection of the Biostratigraphy and Paleoecology Section, Petrobras Research Centre (Cenpes/Divex/Sebipe), Rio de Janeiro, Brazil.

Type locality: Poti Formation, cuttings sample at 408 m, well 1-CA-1-MA, Parnaíba Basin, Brazil.

Etymology: In memory of Roberto F. Daemon, former palynologist at Petrobras, who passed away on 2 November 1996.

Diagnosis: Spores radial, trilete, cavate. Amb subtriangular, equatorial margin usually undulant. Laesurae extending to inner margin of zona, sometimes accompanied by straight to sinuous lips up to 2 μm high. Exoexine extended equatorially as a zona of more or less uniform width and slightly darker around inner margin. Distal surface, including that of zona, sculptured with minute coni and spinae (up to 2 μm wide and ca. 3 μm high), not wider but longer (up to 6 μm high) on or around inner margin of zona. Dense radial plication on zona. Intexine usually perceptible, laevigate and very thin.

Equatorial diameter: 46 (72) 94 μm (based on 45 specimens).

3. The *Indotriradites dolianitii* Morphon

Three closely related species have very comparable characters: *I. dolianitii*, *I. daemonii*, *I. zosteriformis* (Playford et Satterthwait) Playford, 1991. *Indotriradites daemonii* has thinner and smaller sculptured elements than *I. dolianitii* and *I. zosteriformis* which differ one from the other by the degree of

plication on the zona. The zona is more strongly plicated in *I. daemonii* and *I. zosteriformis* than in *I. dolianitii*.

These three species are linked by a continuous variation of morphological characters to the extent that attribution of intermediate forms to any one of them is sometimes problematical. For this reason we decided to group them into a single morphological category or morphon (sensu Van der Zwan, 1979, p. 11), here termed the *Indotriradites dolianitii* Morphon.

Two other *Indotriradites* species described from the Namurian of northern England, *I. ornatus* (Neves) Higgs, 1996 and *I. echinatus* (Owens, Mishell et Marshall) Higgs, 1996, also possess ornate sculptural elements more or less regularly distributed over the entire distal surface. But these elements are stouter and not confluent on or around the inner margin of zona as is seen in species belonging to the *Indotriradites dolianitii* Morphon.

4. Stratigraphic and geographic distribution

Indotriradites dolianitii is commonly found in the late Viséan Faro and Poti Formations of the Amazon and Parnaíba basins respectively, in northern Brazil (Daemon, 1974; Melo et al., 1999). The species also occurs in the uppermost part of the Oriximiná Formation of late middle to early late Tournaisian age [*S. pretiosus–R. clavata* (PC) Biozone] in the Amazon Basin (S. Loboziak and J.H.G. Melo, unpubl. data). This species could also be present (as 'Spore trilete zonale no. 3203') in the Viséan palynological subzones M4 to the lower part of M6 of the Grand Erg occidental, Algerian Sahara (Lanzoni and Magloire, 1969, table I).

Specimens assignable to *I. daemonii* have been recorded from Viséan strata of North Africa, the Middle East and Brazil:

— in subzones M5 to M7 of the Grand Erg Occidental (Lanzoni and Magloire, 1969, table I);

— in the Upper Assemblage of eastern Syria (Ravn et al., 1994, figs. 2, 3);

— in Petrobras' *Reticulatisporites* cf. *magnidictyus* (XII) regional biozone, equivalent to the *P. tessellatus–S. campyloptera* (TC)–*Tripartites vetustus–R. fracta* (VF) zonal range of Western European biozonation, in northern Brazilian basins (Melo et al., 1999, fig. 2).

Indotriradites zosteriformis has been described from the Viséan of the Bonaparte Gulf Basin, northwestern Australia (Playford and Satterthwait, 1988).

5. Conclusion

The *Indotriradites dolianitii* Morphon appears to be restricted geographically to Gondwanan areas, and stratigraphically to the Lower Carboniferous. *Indotriradites dolianitii*, which first occurs in the late Tournaisian, and *I. daemonii*, which appears later (in the Viséan) have been so far recorded only in Western Gondwana, whereas *I. zosteriformis* is known only in the Viséan of Eastern Gondwana. It should be emphasized, however, that early–middle Viséan palynomorph-bearing strata are probably missing in Western Gondwana (Loboziak et al., 1998) while Tournaisian palynomorphs are poorly documented in Eastern Gondwana. Therefore, no evolutionary trends linking these taxa can currently be recognized.

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