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Calopadia erythrocephala, a new foliicolous lichenized fungus from Brazil

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Abstract: The foliicolous lichenized fungus *Calopadia erythrocephala* Farkas, Elix & Flakus, is described as new to science from the Atlantic submontane rainforests in Brazil. The species is very similar to *C. puiggarii*, but is distinguished by the presence of a red pigment in the campylidia, the darker apothecial discs and larger conidia. Fusarubin, the red pigment produced by the new species, is reported for the first time from foliicolous lichens. A world-wide key to foliicolous species of *Calopadia* with single, muriform ascospores is presented.

Key words: foliicolous lichens, key, Neotropics, *Pilocarpaceae*, taxonomy

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Introduction

A zoological expedition was organized in early 1995 by the Project Itatuba supported by the Károly Kögl family, who founded a Private Nature Conservation Reserve near São Paulo, Brazil. During fieldwork the Hungarian botanist Professor Attila Borhidi collected leaves covered with epiphyllous bryophytes and lichens. Among these collections we discovered a species of *Calopadia* Vězda (*Pilocarpaceae*) with a unique combination of characters (especially those of the red-pigmented campylidia) which we describe as new to science. Although the foliicolous lichen flora of Brazil is relatively well known (e.g. Lücking *et al*. 1998; Cáceres *et al*. 2000; Lücking & Kalb 2000; Lücking 2008) it is not surprising that such a conspicuous new species should be found given the biodiversity and size of the country.

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The paper is dedicated to Professor Attila Borhidi, academician, Hungarian botanist and ecologist, specialist of tropical flora and vegetation especially in Cuba and Mexico, monographer of the family *Rubiaceae*, on the occasion of his 80th birthday.

Material and Methods

The lichen material was collected by Professor Attila Borhidi (Hungary) and deposited in VBI, with duplicates in CANB, F, PRA-V and hb. Flakus. The morphology and the anatomy were examined using standard stereo microscopes (Olympus SZX9, Nikon SMZ 800) and compound microscopes (Olympus BX50, Nikon Eclipse 80*i*). Hand-cut sections and squash mounts were examined in water, 10% solution of potassium hydroxide, and Lugol's solution. All measurements were made on material mounted in tap water. Chemical analyses were carried out using HPLC following the methods described in Elix & Wardlaw (2002).

The Species

Calopadia erythrocephala Farkas, Elix & Flakus sp. nov.

Mycobank: MB 563146

Calopadia puiggarii affinis sed campylidiis rubropruinosis differt.

Typus: Brazil, Estado São Paulo, São Roque, Cascada sobre la Laguna Sapucaia, in Atlantic submontane rainforest, *c.* 800 m, on leaves of a vascular plant, 2 January 1995, *A. Borhidi* s. n. (VBI-L 06001—holotypus; CANB, F, PRA-V, herb. Flakus—isotypi).

(Fig. 1)

Thallus foliicolous, continuous or dispersed into patches along the margins, up to 15 mm wide, 20–30 μm thick, ecorticate, smooth,

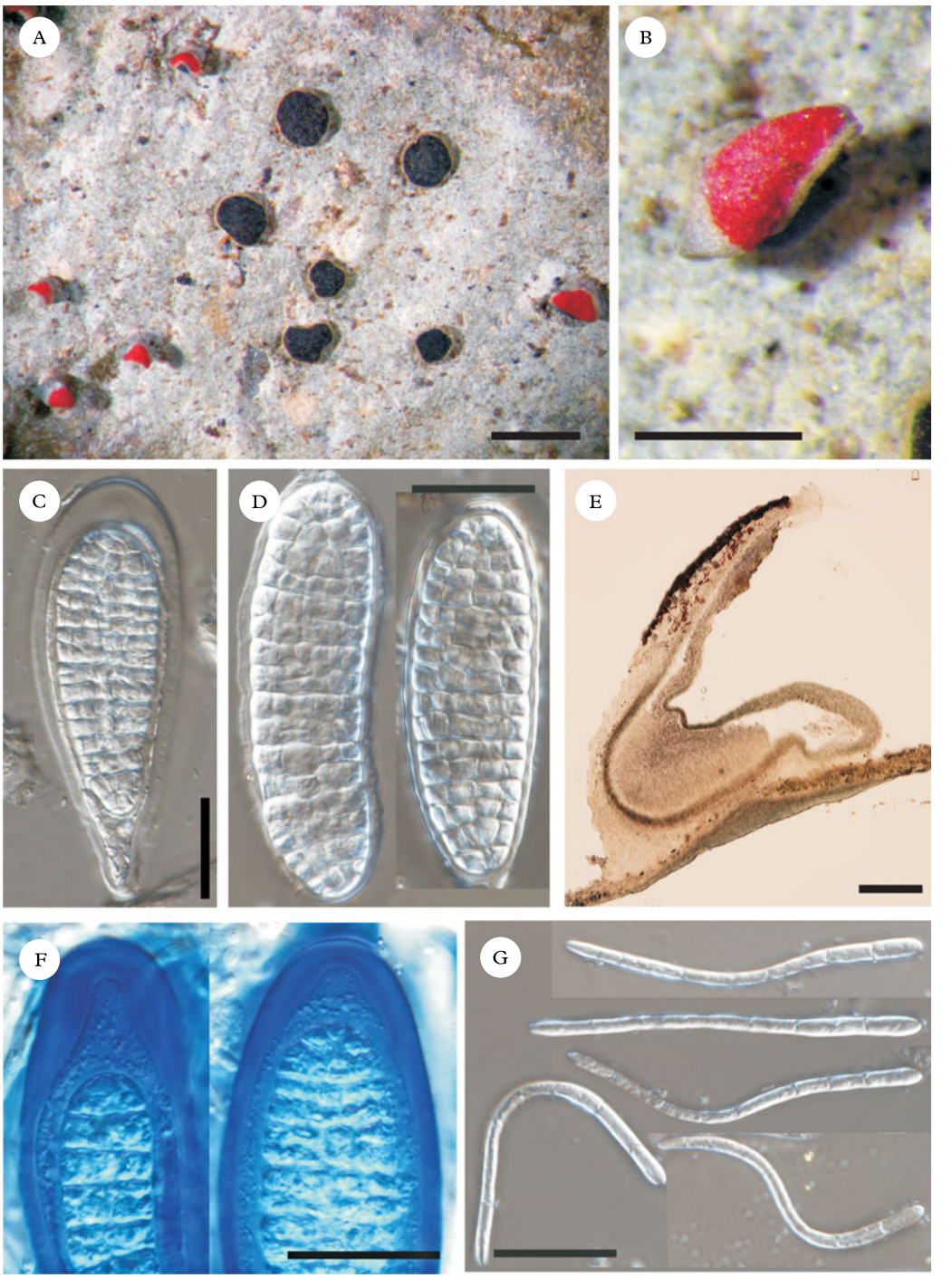

FIG. 1. *Calopadia erythrocephala* (holotype). A, thallus with apothecia and campylidia; B, a campylidium; C, ascus with a single ascospore; D, ascospores; E, section of a campylidium; F, *Sporopodium*-type ascus apex (in K/KI); G, conidia. Scales: A = 1 mm, B = 0·5 mm, C, D, F & G = 20 μm, E = 100 μm.

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pale grey. *Photobiont* chlorococcoid, cells up to 12 µm diam.

Apothecia rounded to undulate, 0·3–0·6 mm diam., 220–240 µm high; *disc* flat to slightly convex in old apothecia, dark brown to almost black, epruinose; *margin* distinct, greyish white. *Excipulum* 30–50 µm wide, 50–60 µm high (below hymenium), hyaline to pale greyish brown, paraplectenchymatous, composed of cells 3–10(–15) µm diam. *Hymenium* 100–120 µm high, colourless. *Hypothecium* 20–40 µm high, dark olive-brown, K–, a thin hypothecioid tissue developed inside the marginal part of the excipulum. *Apothecial base* aeruginous. *Asci Sporopodium*-type, 80–100 × 20–30 µm. *Ascospores* single in ascus, oblong-ellipsoid to broadly-ellipsoid, muriform, colourless, 45–80 × 15–30 µm.

Campylidia sessile, 0·4–0·6(–1·0) mm broad; lobe well-developed, hood-shaped, pale grey to aeruginose grey, distinctly red pruinose in upper part. *Conidia* filiform with clavate apex, slightly to strongly sigmoid or curved, 3–7 septate, 45–65 × 1·5–2·0 µm (2·0–3·5 µm broad at the wider apex), without associated algal cells.

Chemistry. Campylidia contain fusarubin; no additional substances detected in the thallus by HPLC.

Etymology. The new species is named after the characteristic red pigment covering the upper hood-shaped part of the campylidia, thus resembling the fairy tale figure of Little Red Riding Hood.

Notes. *Calopadia erythrocephala* is most similar to *C. puiggarii* (Müll. Arg.) Vězda (for detailed description see Lücking, 2008), but differs in having red-pigmented campylidia, darker apothecial discs and longer but somewhat similar conidia [45–65 × 1·5–2·0 µm (2·0–3·5 µm broad at the wider apex) for *C. erythrocephala* versus 30–50 × 1·0–1·5 µm (1·5–3·0 µm at apex) for *C. puiggarii*]. The new species is distinguished from other related members of *C. fusca*-group in the key below.

The most remarkable character of the new species, the red colour of the upper part of campylidia, is due to the naphthaquinone fusarubin (Fig. 2), not previously recorded in *Calopadia* (e.g. Lücking 2008; Elix & Øvstedal 2009). This pigment was previously known from two species of pathogenic fungi, *Fusarium javanicum* Koor. and *F. solani* (Mart.) Sacc., and from the lichen, *Xanthoparmelia endomiltodes* (Nyl.) Hale (e.g. Elix & Wardlaw 2002; Lugauskas 2005). *Calopadia erythrocephala* is the first foliicolous lichen known to produce fusarubin.

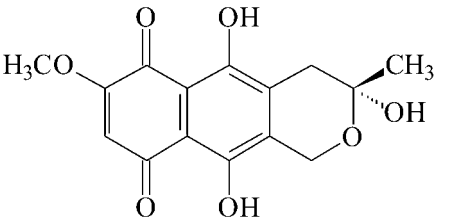

FIG. 2. Fusarubin.

Loflammia epiphylla (Fée) Lücking & Vězda is another species with pale orange to red-pigmented campylidia, but is distinguished by the typically bright red apothecia, small, non-septate conidia and by the presence of atranorin, stictic and hypostictic acids (Vězda 1986; Lücking 2008).

Distribution and ecology. The new species has been found on the leaves of vascular plants (3–4 different species, among them an *Ilex* species, most probably *Ilex paraguariensis*) in the Atlantic, submontane rainforests of Brazil. So far it is known only from three neighbouring localities visited on different days during the collecting trip. The following components of the vegetation were noted by the collector: *Allophylus edulis, Bauhinia forficata, Carpotroche brasiliensis, Cecropia glaziovii, Cedrela fissilis, Chrorisia speciosa, Cupania vernalis, Myrciaria tenella, M. trunciflora, Nectandra lanceolata, Piptadenia gonoacantha, Psidium cattleianum, Schinus terebinthifolius, Securinega guaraiuva, Trichilia claussenii, T. hirta, Urera baccifera* and *Zanthoxylum rhoifolium*.

The number of endemic species and biodiversity of the Atlantic rainforest of Brazil is considered to be especially high (Brown 1987; Groombridge 1992; Heywood 1995). Consequently the occurrence of a rare foliicolous lichen, possibly with specific microcli-

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matic requirements, in such a habitat is not surprising. Unfortunately, such microhabitats in the Atlantic rainforests are critically endangered posing a threat to species such as *C. erythrocephala* (cf. Tabarelli *et al.* 1999, 2005; Myers *et al.* 2000; Galindo-Leal & Câmara 2003; Cáceres *et al.* 2008).

Additional specimens examined. **Brazil:** *Estado São Paulo*: São Roque, entre la Laguna Sapucaia y la Lagunita, Atlantic submontane rainforest, alt. ca 800 m, 3 i 1995, *A. Borhidi* s. n. (VBI); *ibid.*, São Roque, al Oeste de la Cascada, sobre la Laguna de Sapucaia, Atlantic submontane rainforest, 7 i 1995, *A. Borhidi* s. n. (VBI).

Specimens of Calopadia *puiggarii examined.* **Brazil:** *Estado São Paulo*: São Roque, Cascada sobre la Laguna Sapucaia, Atlantic submontane rainforest, alt. *c.* 800 m, 2 i 1995, *A. Borhidi* s. n. (VBI).—**Costa Rica:** *Las Cruces*: 5 km südlich von San Vito, 1000 m, viii 1988, *R. Lücking* s. n. (PRA-V 12911). *Limon province*: Cahuita, *c.* 140 km ESE of San José and 45 km SE of Limon at the Atlantic coast, 9°44′N 82°50′W, sea level, lowland rainforest zone, anthropogenic vegetation (fruit trees) around Cahuita village, on leaves of *Citrus* sp., 1992, *R. Lücking* 92-4066, (R. Lücking *Lichenes Foliicoli Exsiccati* 86; VBI).—**Tanzania:** *West Usambara Mts.*: NW of Mazumbai village, montane rainforest along the north headwaters of Kambi stream, with many tree ferns, 1780 m, epiphyllous, 1984, *T. Pócs* 8405/BA (VBI).

A word-wide key to the foliicolous species of *Calopadia* with single, muriform ascospores

1 Ascospores 80–110 µm long 2
Ascospores 45–85 µm long 4

2(1) Apothecial disc pale brown; strongly yellow to pale brownish pruinose . . . . . ***C. perpallida* (Nyl.) Vězda**
Apothecial disc (reddish) brown to dark brown; epruinose 3

3(2) Thallus with vermicular cephalodia (chamois coloured); New Guinea, Philippines . . . . . ***C. vermiculifera* (Vain.) Sér.**
Thallus without cephalodia; mostly corticolous, muscicolous, occasionally foliicolous; Brazil, Puerto Rico, Seychelles . . . . . ***C. subfusca* Kalb & Vězda**

4(1) Campylidia red-pigmented (fusarubin) in the upper part . . . . . ***C. erythrocephala* Farkas *et al.***
Campylidia lacking red pigment 5

5(4) Thallus pale orange-yellow (K+ pale wine-red) with bright orange-red fluorescence (UV 366 nm); apothecia dark greyish-brown, epruinose, margin orange-grey . . . . . ***C. aurantiaca* Lücking**
Thallus grey, pale grey to whitish grey 6

6(5) Thallus with yellow to orange fluorescence (UV 366 nm) 7
Thallus without UV fluorescence 8

7(6) Apothecia brownish grey to dark grey, white pruinose (with a purplish tinge in part); ascospores 50–70 × 12–18 µm; conidia 3–5-septate, 40–50 × 1·8–2 µm (up to 3·0–3·5 µm wide at apex); thallus dispersed but single patches partly confluent; foliicolous; Africa . . . . . ***C. lucida* Lücking & R. Sant.**
Apothecia orange-brown to brown, white pruinose when young; ascospores 55–75 × 20–22 µm; conidia multiseptate, 25–31 × 3 µm, often strongly curved; thallus continuous, often with a discontinuous white prothallus; corticolous, rarely foliicolous; Florida . . . . . ***C. schomerae* F. Seavey & J. Seavey**

8(6) Apothecia (at least when young) greyish black to black; hypothecium aeruginose 9
Apothecia pale to dark brown; hypothecium pale to dark brown 10

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9(8) Apothecia epruinose . . . . . ***C. subcoerulescens* (Zahlbr.) Vězda**
Apothecia densely and persistently white pruinose . . . . . ***C. cinereopruinosa* Bungartz & Lücking**

10(8) Apothecia pale brown; pruina intense yellow to cream . . . . . ***C. editae* Vězda *ex* Chaves & Lücking**
Apothecia pale to dark brown; epruinose 11

11(10) Apothecia pale to reddish brown; hypothecium pale yellowish-brown . . . . . ***C. fusca* (Müll. Arg.) Vězda**
(incl. ***C. schaeferi*** Vězda, see Lücking 2008: 741)
Apothecia greyish brown to dark brown; hypothecium dark brown . . . . . ***C. puiggarii* (Müll. Arg.) Vězda**

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