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Porotrichum saotomense sp. nov. (Neckeraceae) and other additions to the moss flora of São Tomé & Príncipe, Gulf of Guinea, West Africa

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Abstract: *Porotrichum saotomense* Enroth & Shevock (Neckeraceae) is described as a new species from the Republic of São Tomé & Príncipe. It is morphologically closest to *P. quintasii* Broth., differing primarily in the non-complanate and nearly symmetric leaves, much stronger, spinose costa, longer seta and longer exostome teeth and endostome processes. Other additions to the moss flora of São Tomé & Príncipe are *Homaliodendron piniforme* (Brid.) Enroth, *Calyptothecium acutifolium* (Brid.) Broth. var. *breviusculum* (Müll. Hal.) Argent, and *Symphyodon pygmaeus* (Broth.) S. He & Snider. *Neckeropsis disticha* (Hedw.) Kindb. is new to the island of São Tomé.

Sumário: *Porotrichum saotomense* Enroth & Shevock (Neckeraceae) é descrita como uma espécie nova para a República de São Tomé & Príncipe. Esta espécie é mais próxima morfologicamente á *P. quintasii* Broth., diferindo principalmente nas folhas não-niveladas e quase simétricas, parte posterior espinhosa, seta mais longa, dentes no exóstoma e processos do endóstoma mais longos. Outras adições para a flora de musgo de São Tomé & Príncipe são *Homaliodendron piniforme* (Brid.) Enroth, *Calyptothecium acutifolium* (Brid.) Broth. var. *breviusculum* (Müll. Hal.) Argent, e *Symphyodon pygmaeus* (Broth.) S. He & Snider. *Neckeropsis disticha* (Hedw.) Kindb. é uma espécie nova para a ilha de São Tomé.

Keywords: biodiversity, bryophytes, morphology, new species, taxonomy, tropics.

Introduction

This paper is based on specimens collected by the second author in São Tomé & Príncipe during February and March 2010. The specimens belonging or thought to belong in the moss family Neckeraceae were sent to the first author for identification. Here we report one species of *Porotrichum* new to science, three species new to the country of São Tomé & Príncipe, and one species new to the island of São Tomé.

De Sloover (1983) revised the genera *Porotrichum* and *Porothamnium* in Africa, recognizing five species in the former and two in the latter. Enroth & Hodgetts (1996) however resurrected *Porotrichum dentatum* Gepp, endemic to Mulanje Mountain in Malawi, that was treated as a taxonomic synonym of *P. madagassum* Kiaer *ex* Besch. by De Sloover (1983).

The generic taxonomy of this group of mosses has undergone and is undergoing profound changes. Sastre-De Jesús (1987) did not recognize *Porothamnium* but included its species in *Porotrichum*, a notion sustained by Buck (1998, 2003) and Enroth (2004). Subsequently it has been shown that *Porotrichum* in any current or previous circumscription is polyphyletic, in fact "seriously" so, as some of the species fall outside of the Neckeraceae altogether in a clade as yet formally unnamed (Olsson et al. 2009, Quandt et al. 2009). Of the African species, at least *P. usagarum* Mitt. and *P. stipitatum* (Mitt.) W.R. Buck, as well as *Homaliodendron piniforme* (Brid.) Enroth, belong in that clade, and *P. madagassum* actually belongs in *Porotrichodendron* (Olsson et al. 2011). Since the phylogenetic studies of *Porotrichum* are not yet completed or the necessary nomenclatural changes made, we employ the current generic concepts here.

Porotrichum saotomense Enroth & Shevock, ***sp. nov.*** **(Figs. 1-3).**
Holotype: São Tomé & Príncipe, São Tomé Island: Obô National Park, along Caminho de Fugido Trail along ridge toward Lagôa Amelia via Morro Provaz below junction with trail toward Contador Valley, 00°17'25''N, 06°34'34.0'' E, elev. 1375 m, mixed hardwood forest with fern understory, on hardwood trunk in filtered light, *Shevock, Daniel, Drewes & Soares 34555* (H; isotypes BOL, CAS, DE, LISU, MO, NY, STPH).

Species ad habitu *Porotricho quintasi* fere similis, sed costa foliorum manifeste crassiore, seta longiore etc. differt.

Plants gregarious, darkish-green or partly brownish, dull, stipitate-frondose, mostly 2– 6 cm tall. Stolons creeping, bearing small, ovate-acuminate leaves and tufts of smooth, brownish-orange, sparsely branched rhizoids just below leaf insertions; stolons transforming heteroblastically into stems consisting of a proximal, unbranched stipe and a distal, branched frond. Fronds irregularly to fairly densely and pinnately branched, complanate, sometimes with a few slender, flagelliform branchlets. Stipe distinct, green, in cross section with a cortex consisting of 6–8 layers of very thick-walled cells grading into larger medullary cells with thinner walls; central strand present. Well-differentiated stipe leaves numerous, spreading, from an ovate base narrowed at 2/3 of leaf length into a lanceolate acumen, c. 1.3 × 0.6 mm; margins recurved from base of leaf to base of acumen, entire or with few small teeth in acumen; costa distinct, tapering and vanishing in lower part of acumen. Leaves distinctly plicate when dry, not complanate, symmetric or nearly so, erect-spreading, imbricate, often somewhat concave, keeled by costa. Stem leaves ovate, c. 1.6–2.0 × 0.8–1.1 mm, apex acute or obtuse and mucronate; margins plane to slightly recurved in lower leaf half, entire near base, becoming serrulate upwards, in upper leaf half serrate by distinct, uni- or bicellular teeth; costa strong, single, reaching to 9/10 of leaf length, spurred and/or spinose above, occasionally bifurcate near tip. Leaf cells smooth, walls eporose; apical laminal cells fairly thick-walled, mostly rhombic, some rather elliptic or hexagonal, 10–20 × 5–8 µm, median laminal cells thinner-walled, fusiform to irregularly penta- or hexagonal, 15–30 × 5–8 µm, basal laminal cells narrowly fusiform to linear-rectangular, 20–40 × 5–8 µm; marginal cells in 1–3 rows distinctly shorter than corresponding laminal cells, rhombic to subquadrate at midleaf, linear-rectangular near leaf base; alar cells fairly distinct, thick-walled, subquadrate or subrounded to irregularly angular, clearly shorter than basal laminal cells. Pseudoparaphyllia few, foliose, somewhat asymmetrically lanceolate, to 0.2 mm long.

Dioicous. Perigonia bud-like, on branches and stems; inner perigonial bracts largest, on stems to c. 1.4 mm long, on branches to c. 1.1 mm long, faintly costate, ovate, above midleaf narrowed to a lanceolate-acuminate tip; paraphyses hyaline, uniseriate, filiform. Perichaetia on stems; pre-fertilization perichaetial leaves to 2 mm long, from an ovate, sheathing base narrowed approximately at midleaf to a lanceolate, spreading acumen; costa single, faint, reaching to lower part of acumen at most; margins entire except weakly denticulate near apex; post-fertilization perichaetial leaves to 3 mm long, otherwise as pre-fertilization ones; post-fertilization paraphyses much longer than pre-fertilization ones, hyaline, filiform, mostly uniseriate, few biseriate. Vaginula c. 1.5 mm long, bearing numerous paraphyses and some archegonia. Seta to 2.8 cm long, greenish-yellow, smooth throughout or slightly mammillose below capsule. Capsule erect or inclined, c. 2.0 × 1.0 mm when wet, cylindric; exothecial cells irregular, mostly penta- to heptagonal, transverse or isodiametric to elongate, c. 15–50 × 15–25 µm; apophysal stomata several, phaneroporous. Peristome



Figure 1. Habit of *Porotrichum saotomense* (from the holotype). Scale bar = 1 cm. (Photo by Markku Lehtonen)

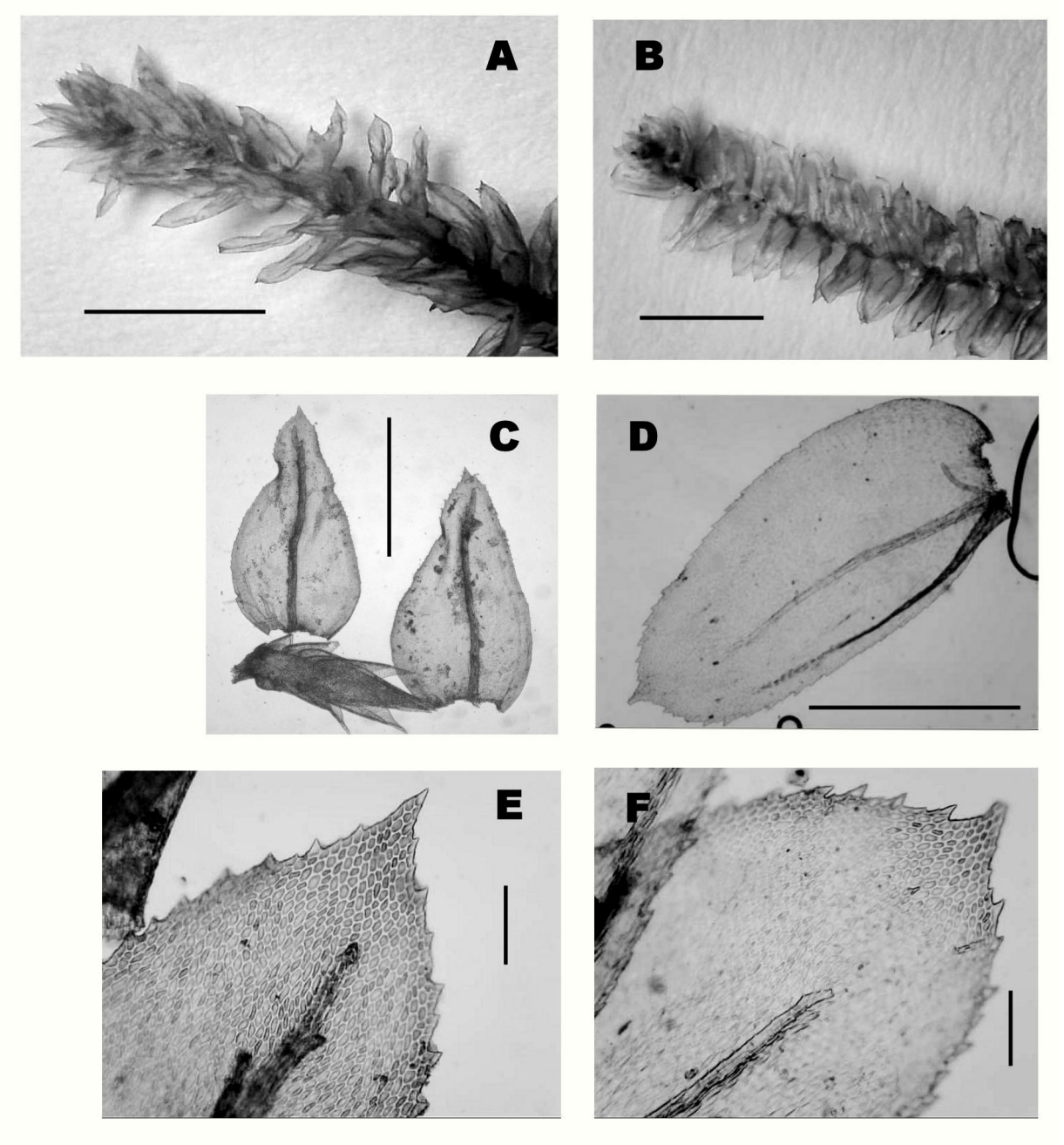


Figure 2. A, C and E: *Porotrichum saotomense* (from the holotype). B, D and F: *P. quintasii* (from *F. Müller B434*, herb. J. Enroth). A and B: Branch tips. C: Stem leaves. D: Stem leaf. E and F: Stem leaf tips. Scale bars: A, C and D = 1 mm; B = 0.5 mm; E and F = 50 µm.

double; exostome teeth c. 1 mm long, lanceolate, grayish yellow, dorsal surface lamellate, near base cross-striolate and spiculose-papillose, above densely spiculose-papillose, median line weakly zig-zag, ventral face trabeculate and densely spiculose-papillose; endostome basal membrane c. 170–180 µm high, segments c. 800 µm long, subulate, grayish yellow, densely spiculose-papillose throughout, with narrow median perforations. Spores 12–15 µm diameter, faintly papillose (many of them collapsed). Operculum and calyptra not seen.

Several features, such as the habit, leaf shape and dentition, and leaf areolation and smooth leaf cells suggest *P. saotomense* is closely related to *S. quintasii* Broth. The latter is known from several countries in West and central Africa, including São Tomé & Príncipe. However, *P. saotomense* is very distinct by

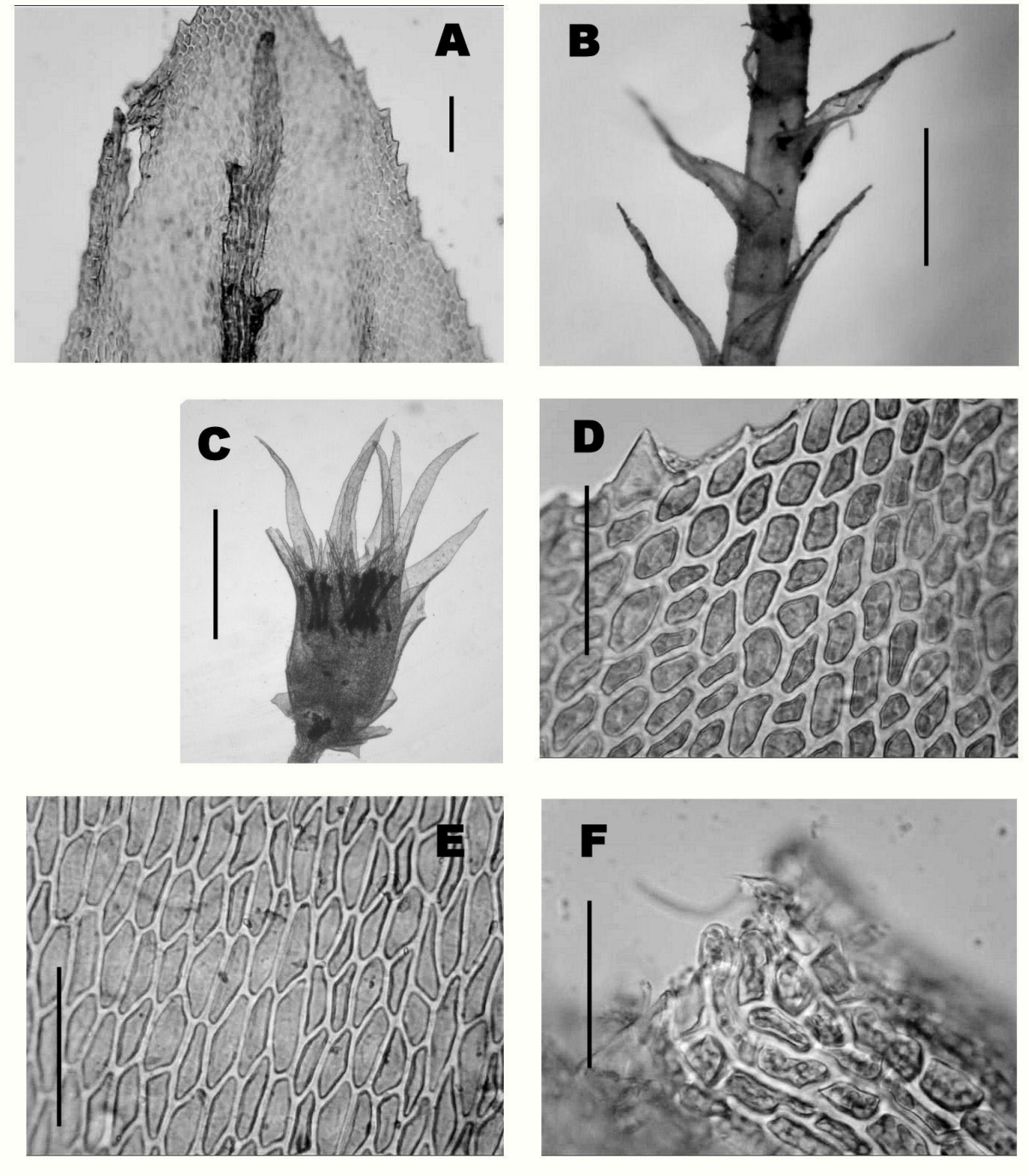


Figure 3. *Porotrichum saotomense* (from the holotype). A: Tip of stem leaf. B: Stipe leaves. C: Perichaetium. D: Apical leaf cells. E: Median leaf cells. F: Alar cells. Scale bars: A and D–F = 50 µm; B and C = 1 mm.

the spreading, more symmetric and hardly complanate leaves; by the strong and long, abaxially toothed costa; and by the very long seta (to 2.8 cm). In *P. quintasii* the seta is c. 1.5–2.0 cm long, and the costa reaches c. ¾ of the leaf length. In fact, the costa is as strong as in *P. saotomense* only in some forms of *P. usagarum* (syn. *P. molliculum* Broth., cf. Enroth 1991, 1992; Enroth & Hodgetts 1996). The latter is mainly distributed in East Africa, but has also been reported from Cameroun, Río Muni and Gabon. It differs from *P. saotomense* by the clearly relatively wider, more asymmetric leaves with broader apices, and by the 1.0–1.5 cm long seta (cf. De Sloover 1983, as *P. molliculum*).

There are several species of *Porotrichum* in the Neotropics, with which *P. saotomense* may also be compared. According to my own observations as well

as the descriptions and keys in Sastre-de Jesús (1987), Buck (1998) and Allen (1994), the costa of *P. saotomense* is distinctly longer and more strongly toothed than in any of the Neotropical species. It might be noted that only one species of *Porotrichum*, *P. stipitatum* (Mitten) W.R. Buck, is distributed both in the Neotropics and Africa (Enroth 1996, Buck 2003), the rest of the species being restricted to one of the two regions.

Porotrichum saotomense was collected between 1170 and 1566 m. Two of the specimens were growing on rotten hardwood logs, while the rest were epiphytic on hardwood: seven on trunks, one on exposed roots, and one on fallen branches.

Additional specimens examined of **Porotrichum saotomense** (paratypes, all in H, CAS). São Tomé & Príncipe. São Tomé Island: Obô National Park, on hardwood trunk in filtered light to partial shade, *Shevock, Daniel & Drewes 34253* (STPH); 1300 m, on exposed hardwood root along forest floor in filtered light to partial shade, *Shevock, Daniel & Drewes 34254* (LISU, MO, NY); 1310 m, on hardwood trunk in filtered light to partial shade, *Shevock, Daniel & Soares 34279* (BOL, EGR, NY) ; 1480 m, on hardwood trunk in partial shade, *Shevock, Daniel & Soares 34295* (BOL, NY); 1170 m, on hardwood trunk in filtered light, *Shevock, Daniel & Soares 34327* (BOL, KRAM, NY); 1566 m, on hardwood trunk in filtered light, *Shevock, Daniel & Soares 34429A*; 1250 m, on hardwood trunk in filtered light, *Shevock, Daniel & Soares 34480* (with sporophytes, BOL, NY); 1340 m, on rotten hardwood log in filtered light, *Shevock, Daniel , Drewes & Soares 34536* (BOL, LISU); 1480 m, on rotten hardwood log in filtered light, *Shevock, Daniel & Soares 34756* (BOL, KRAM, LISU, MO, NY); 1390 m, on fallen hardwood branches in filtered light, *Shevock, Daniel & Soares 34786* (BOL, DE, EGR, LISU, MO, NY). – ***Selected specimens examined for comparison***. *Porotrichum usagarum* (all H). Zaire: *Pócs 7115*. Burundi: *Reekmans 5880*. Rwanda: *De Sloover 18.758*. Ethiopia: *Friis et al. B128a*. South Africa: *van Rooy 1884*. *Porotrichum quintasii*. São Tomé & Príncipe: "Afr. occ., ins. S. Thomé", *Quintas* (holotype, H-BR 3376019). Equatorial Guinea: Bioko, *F. Müller B434*, *B347* (herb. J. Enroth, ex herb. F. Müller; *B347* is mixed with *Porotrichum caudatum*).

Homaliodendron piniforme (Brid.) Enroth
This is an amphi-Atlantic species, known from South America and sub-Saharan Africa (cf. Enroth 1990). It has a wide distribution in West and Central Africa, from Sierra Leone to Comoros and Madagascar (O'Shea 2006). Closest to São Tomé & Príncipe, it has been reported from the island of Bioko (Müller 1996).

Representative specimens (total 8). São Tomé Island: Obô National Park, along Pico de São Tomé Trail about 1 km from summit of Pico Calvario beyond trail junction to Nova Ceicao and Bom Baim, 00°16'30.0''N, 6°34'59.0''E, elev. 1360 m; mixed hardwood forest at seepy bank over volcanic rock, on hardwood trunk in filtered light, *Shevock, Daniel & Alamo 34409* (BOL, CAS, H, LISU, MO, NY). Príncipe Island: South coast, National Park of Príncipe, Ribiera de São Tomé about 350 meters above confluence with the ocean, 1°33'42.8''N, 7°21'22.0''E, elev. 50 m; mixed hardwood forest with palms, on volcanic boulders along river in filtered light, *Shevock, Daniel & Drewes 34737* (BOL, CAS, H, LISU, MO, NY).

Habitat ecology. 50–1360 m. S. Tomé specimens (1300–1360m) epiphytic, Príncipe (50–325 m) on volcanic rocks.

Neckeropsis disticha (Hedw.) Kindb.
Previously known from Príncipe (Enroth 1993), new to São Tomé. *Neckeropsis disticha* is fairly common and widely distributed in West and Central Africa, but rare in the eastern parts of the continent. Its total distribution area is tropical amphi-atlantic, as it has a wide distribution also in the Neotropics (e.g. Buck 1998).

Representative specimens (total 6). São Tomé Island: Along road EN-2 paralleling Atlantic Ocean south of São Tomé between km markers 26–27 and between village of Riberia Alfonso and town of São João dos Angolares, 00°10'49.7''N, 6°41'02.7''E, elev. 40 m; disturbed secondary hardwood forest with scattered cultivation with palm trees, On breadfruit trunk in filtered light, *Shevock & Daniel 34367* (BOL, CAS, H, LISU). Príncipe Island: Along dirt road along the east side of Príncipe at Agua da Ponte between Santo Antonio and Infante Henrique, 1°36'02.4''N, 7°25'56.8''E, elev. 150 m; mixed hardwood forest at intermittent streamlet, volcanic rock wall of boulder in filtered light, *Shevock, Daniel & Drewes 34620* (BOL, CAS, H, LISU).

Habitat ecology. 30–415 m. Tree buttresses, trunks and volcanic rock.

Calyptothecium acutifolium (Brid.) Broth. var. ***breviusculum*** (Müll. Hal.) Argent
This taxon has been reported from Cameroun and Togo (Argent 1973, Tixier 1989, O'Shea 2006). Its distinction from the other varieties of *C. acutifolium* was discussed in detail by Argent (1973), and we used his key in the identification.

São Tomé Island: Obô National Park, along trail toward Lagôa Amelia at junction with trail to Pico de São Tomé, 00°16'56.2''N, 6°35'47.0''E, elev. 1400

m; mixed hardwood forest, on fallen hardwood branch in filtered light, *Shevock, Daniel & Soares 34754* (BOL, CAS, H,LISU, STPH); along trail toward Lagôa Amelia between park boundary and junction with trail to Pico de São Tomé, 00°16'56.0''N, 6°35'44.0''E, elev. 1310 m, *Shevock, Daniel & Soares 34282* (BOL, CAS, H, LISU, MO, NY).

Symphyodon pygmaeus (Broth.) S. He & Snider
In Africa this species was previously known from Ethiopia, Madagascar, Malawi, Mozambique and Réunion Island (He & Snider 2000, O'Shea 2006), so the São Tomé report represents a remarkable westward extension of its known distribution. *Symphyodon pygmaeus* has a wide and disjunct distribution in the tropics, being also known from several countries in southern Asia and from Hawaii (He & Snider 2000). The identity of the current specimen was kindly confirmed by Si He.

São Tomé Island: Obô National Park, along Pico de São Tomé Trail about the summit of Pico Calvario well beyond trail junction to Nova Ceicão and Bom Baim, 00°16'11.0''N, 6°34'35.7''E, elev. 1566 m; mixed hardwood forest along ridge with fern understory, on hardwood trunk in filtered light, *Shevock, Daniel & Alamo 34429* (BOL, CAS, H, LISU, MO, NY, STPH).

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