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Studies on *Barbula consanguinea* (Thw. & Mitt.) Jaeg. sensu Eddy, a pan-tropical species

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Abstract. *Barbula consanguinea* (Thw. & Mitt.) Jaeg. sensu Eddy is considered as a pan-tropical species. This taxon is reported new for several central African countries, the Arabian peninsula, and Middle America. This variable species is shortly discussed and compared with (most) related taxa. *Hymenostylium crispulum* Broth. & Par. and *Barbula obscura* Sull. (= *Barbula wrightii* Sauerb.) are considered as synonyms of *Barbula consanguinea*.

Introduction

Over the last few years, the author has studied many herbarium collections, mainly held in L, which belong to *Barbula consanguinea*, mostly collected in tropical Asia.

Eddy (1990: 178) realized that *Barbula consanguinea* is a (very) variable species. Furthermore, the species is rather commonly distributed, at least in tropical Asia.

Type material of this taxon was also studied, viz. the isotypes present in BM, GRO, H. In several cases, the isotype material consisted of mixtures of two (related) taxa, viz. *Barbula javanica* Dozy & Molk. and *Barbula consanguinea* sensu Eddy (Eddy 1990).

Furthermore, the isotype material in the Brotherus herbarium (H) is very sparse. This collection was annotated by B.C. Tan in 1983 as *Barbula indica* (Hook.) Spreng. However, in my opinion, this material is better referred to a smaller (younger) state of *Barbula consanguinea* (sensu Eddy).

In addition, the holotype of *Barbula consanguinea* was studied (NY!). I agree with Saito (1975: 495), that the plants belong to *Barbula javanica* Dozy & Molk. No admixture is present in the studied holotype material.

However, the concept presented in the Asian floras of Bartram (1939), Chen (1941), Fleischer (1904), Gangulee (1972) is consistent and different. This is the reason why I follow this line, also present in Eddy's flora, so sensu Eddy.

For the moment, *Barbula consanguinea* is the oldest name for several taxa which are closely related, in my opinion idential.

Material and method

In total, about 200 collections were studied, filed and often annotated. All the material present in herbarium L was examined.

Furthermore, most plants were studied several times.

In addition, selected material from the herbaria

BM, CANB, H-BR., MELU-Stone, NSW, NY was inspected.
Various type collections, belonging to this -*Hydrogonium*-group, were also examined.
All the material was studied wet under the microscope. Field survey on this species, were done in 1993 in Australia (Queensland) and the Philippines (Luzon).

Description, discussion, figures
This species is well described, discussed and illustrated especially by Eddy (1990: 178-180).
Furthermore, *Barbula consanguinea* is well described and figured by Fleischer (1904: 348-350), although no gemmae are mentioned.
Hilpert (1933: 625, 627) discusses *Barbula consanguinea* shortly.
The species is not illustrated here.
Bartram (1939: 119) gave a good, but rather short description.
The figure (plate 9, fig. 142) is very concise.
Chen (1941: 240, Abb. 45, 1-3) gave only a short discussion and a plate. However, in the text below several -*Hydrogonium*- taxa, Chen (l.c.) compared several species with each other and with *Barbula consanguinea*.
Gangulee (1972: 729) gave a good description and figure.
Saito (1975: 493) gave mainly a good description, illustration and discussion as *Barbula subcomosa* Broth. However, in his description (p. 493) the phrases "laminal cells ... rarely smooth ..." and "costa ... ending below apex ..." are not appropriate for this taxon. In Saito (1972: 11) the observed variation on the gemmae is especially discussed and illustrated (also as *Barbula subcomosa*). Furthermore, in my opinion, *Barbula subcomosa* Broth. is identical with *Barbula consanguinea* sensu Eddy.
In Noguchi (1988: 299-301) *Barbula subcomosa* Broth. is described as laminal cells "... mammillose ..."(idem in the key and also fig. 125, A). However, this is not correct. The laminal cells in this taxon are clearly pluripapillose.

Norris and Koponen (1989: 118-119) listed *Barbula consanguinea* as a synonym below *Barbula javanica*. They followed Saito (1975: 495), without any further comment. In their discussion (l.c. p. 119) below *Barbula javanica*, they suggested that "... *Barbula javanica* is questionably distinct from *Barbula subcomosa* ...".
However, in my opinion, both taxa are clearly distinct. In *Barbula javanica* the laminal cells are clearly mammillose, the cells pellucid. In *Barbula subcomosa*, on the contrary, the laminal cells are clearly pluripapillose and obscure, especially in the upper parts of the (upper) leaves, among other differences between these two taxa.
The description, key characters and also the illustration (fig. 9, 1-o) in Norris and Koponen (1989) clearly refer to *Barbula javanica* Dozy & Molk.

Illustrations
Akiyama (1996), p. 159, fig. 1; Bartram (1939), plate 9, fig. 142; Chen (1941) p. 240, fig. 45: 1-3, as *Hydrogonium consanguineum*; Gao (1996), p. 208, fig. 71: 1-3, as *Hydrogonium consanguineum*; Eddy (1990), p. 179, fig. 278; Fleischer (1904), p. 349, fig. 63; Gangulee (1972), p. 733, fig. 348, as *Hydrogonium consanguineum*.

Variation
Most variation was seen in:
1. general tinge
The plants are commonly tan coloured, more rarely (dull) green in the upper part.
2. height
Commonly about 1.5 cm. Ranging from c. (0.5) 1 to 3 cm, rarely larger (up to c. 5 cm).
3. general leaf outline
Commonly lingulate to triangular. The better developed leaves ofter tapering from near base to apex; in younger leaves not so pronounced.
4. leaf length
Commonly about 2 mm long. Ranging from rather small to longer c. 1.5 - 2.2 mm. The variation here is sometimes considerable even in one tuft.
5. apical region of the leaves
Commonly circa cuspidate. Ranging from broadly rounded (mucronate) to small acute. The variation can be present in one tuft, more rarely even on one plant.
6. narrowly revolute leaf margins just above leaf base
Commonly narrowly recurved just above leafbase, at least in some leaves; more rarely

narrow recurved to about halfway up (in some leaves). Rather rarely most leaves plane or nearly so.

7. density of the laminal papillae in the upper part of the (upper) leaves.

The laminal cells in this region are clearly densely pluripapillose, obscuring the lumen. However, there is some variation present - especially between collections- in the density of the laminal papillae.

8. excurrent part of the costa

Commonly shortly excurrent: (1) 2-4 smooth cells. Sometimes hardly excurrent on several leaves and/or broken, especially on older leaves.

9. extreme leaf apex (entire- indented- somewhat denticulate)

Commonly entire to somewhat indented or (slightly) denticulate in this region. However, this condition is often variably expressed in collections examined.

10. back of the costa

Commonly strongly papillose and also partly double papillose, from apex to near base. More rarely, the papillae are not so pronounced (on some leaves).

11. axillary gemmae

They are constantly present, although sometimes scarce. Commonly stalked ovoid, ellipsoid, clavate, or fusiform, multicellular, greenish to (dark) brownish with age. More rarely also locally bulging/knobby, to forked/branched.

Part of the observed variation is discussed and illustrated by Saito (1972:11), as *Barbula subcomosa* Broth.

Interesting collection studied:

Australia, Queensland, (W. of Cairns), Mungana, on earth, near mine, 19 Aug. 1979, I.G. Stone 15.933, det. Ph. Sollman, Jan. 1999, hb. MELU. This number shows a remarkable variation in gemmae shapes.

Tab. 1: Differences between *Barbula indica* and *B. consanguinea.*

Barbula indica	*Barbula consanguinea*
general height: to about 1 cm; small plants	plants commonly larger, to about 3 cm; seldom somewhat higher
general tinge: commonly dull (darker) green	commonly tan coloured
leaf margins parallel	leaf margins commonly tapering from near base to apex
leaf margins often narrowly recurved from near base to halfway, or more	leaf margins often only slightly narrowly recurved below, at least in some (larger) leaves; sometimes almost plane
leaf apex broadly rounded	leaf apex commonly more acute (acuminate-cuspidate), in some younger states often more broadly rounded
excurrent point of the costa very short, mostly 1 cell	excurrent point of the costa often, more pronounced: (1) 2-4 cells
peristome teeth about straight	peristome teeth clearly twisted

12. fragility of the leaves
More or less fragile plants occur rather regularly, especially the older parts. Sometimes this condition is rather pronounced, with almost only the costa intact.
Plants encrusted with lime occur also now and then.

Comparison
Some, small non-fruiting states of *Barbula consanguinea* resemble *Barbula indica* (Hook.) Spreng., sometimes rather closely. Using tab. 1 scheme,one can separate difficult collections.

Furthermore there are habitat differences between the two taxa. *Barbula indica* very often grows in built-up areas, on stone, e.g., boulders, brickwork, masonry etc. often with *Hyophila involuta* (Hook.) Jaeg. (nearby), regularly rather dry. *Barbula consanguinea*, on the contrary, grows in more natural habitats (e.g., boulders, rocks, etc. along water), often (much) wetter than *Barbula indica*.

Some states of *Barbula consanguinea* resemble *Barbula unguiculata* Hedw., sometimes rather closely. However, the latter lacks axillary gemmae, which are constantly present in *Barbula consanguinea*, although sometimes scarce.
Furthermore, there are clearly differences in the density of the papillae on the back of the costa. In *Barbula unguiculata* they are (very) low, mostly present in the apex region (only). On the contrary, in *Barbula consanguinea* they are commonly far more pronounced, from apex to near base.

In addition, the geographical ranges of both taxa are different. *Barbula unguiculata* is mainly present in the temperate region. *Barbula consanguinea* is mainly a pantropical species. However, in some regions their ranges can come close or overlap partly, e.g., parts of Australia, China, Japan, USA. Furthermore, *Barbula unguiculata* is (sometimes) introduced in countries with soil.

In Australia, *Barbula consanguinea* has been confused sometimes with *Barbula subcalycina* C. Muell. For a discussion on this species, see Stone (1990: 265-266).
In non-fruiting collections of *Barbula subcalycina*, the costa is (far) stronger, the laminal papillae (far) more pronounced (*Tortella* type), tomentum is present and the details of the leaf base are different. Furthermore, gemmae are not known in *Barbula subcalycina*.

In tropical America it is possible that especially *Barbula orizabensis* C. Muell. is mistaken for *Barbula consanguinea*.
Tab 2 will separate the two taxa.

Barbula seramensis H. Akiyama is also near

Tab. 2: Differentiationof *Barbula orizabensis* and *B. consanguinea*.

Barbula orizabensis	*Barbula consanguinea*
gemmae commonly globose, small	gemmae commonly stalked ovoid to club-shaped, often also fusiform, larger
excurrent part of the costa: clearly shortly excurrent	commonly only weakly excurrent (1) 2-4 cells, smooth
leaf margins recurved from near base to apex	leaf margins recurved from near base only narrowly recurved in lower part of the leaves, rarely to about halfway

Barbula consanguinea.
For a discussion and illustration, see especially Akiyama (1996).

Recognition
I recognize *Barbula consanguinea* as follows:
1. the leaf outline commonly tapering from a broader base to a smaller (often cuspidate) apex;
2. the laminal cells in the upper part of the (upper) leaves clearly densely pluripapillose, obscuring the lumina;
3. leaf margins often narrowly recurved below, just above leaf base, at least in some (larger) leaves;
4. gemmae are constantly present, although sometimes scarce;
5. back of the costa commonly papillose to partly double papillose, from apex to near base;
6. costa commonly shortly excurrent, about (1) 2-4 cells, at least in some (larger) leaves;
7. peristome teeth twisted.

Habitat
This species grows especially in areas with -at least some- lime and water present, or nearby. Along water, (seasonal) rivers, rivulets, creeks, mudpools, gullies, springs, near waterfalls (sprayzone), cascades, cataracts. On stony substrata with -at least- some soil covering, permanently, or periodically moist to wet, such as: (lime) stone, cliffs, boulders, travertine, (dripping) rocks, concrete, sandstone, (concreted) walls, gorge walls. Furthermore, also terrestrial on soil, sand, clay, mud, gravel, (compacted) banks, along tracks, roadsides, along rice-fields, soil walls, waterchannels.
This species grows sometimes (partly) submerged and is then often encrusted with lime; rarely also tufa-forming. Very rarely on tree bases -with some soil cover- e.g., coconut.
In tropical Asia commonly growing in partial shaded situations to more open, exposed, more rarely in heavy shade.

Altitude
Most collections studied came from sealevel to about 1000 m., more seldom (somewhat) higher.

New reports
Barbula consanguinea is reported new for:

Central Africa
Burundi, route de Bujumbura à Rumonge, près de Kitanza, mousse incrustante dans un tuf au bord de la route, sterile, with gemmae, alt. c. 800 m., 16 Sept. 1974, J.L. de Sloover 19.200, det. Ph. Sollman, March 1997, hb. L, de Sloover.
Notes.
1. In herbarium present as *Hydrogonium* spec.

Cape Verde Islands
Brava, Ribeira da Faja da Agua, an feuchter, sehr sandiger Böschung, W. exponiert, sterile, with gemmae, alt. 35-50 m., 28 Jan. 1995, A. Lindlar 68 + 70, det. Ph. Sollman, Jan. 1997, hb. L, DUIS.
Notes.
1. These collections were also listed in Frahm et al. (1996), as cf identifications.

Guinea
Guinea gall., cercle de Kourroussa, pr. pagum Banka, ad rupes fontium, sterile, with gemmae, Jun. 1903, H. Pobeguin s.n., ex hb. E.G. Paris, L 910.115.172.
Notes.
1. This collection is isotype material of *Hymenostylium crispulum* Broth. & Par. The material agrees well with the description in the protologue (Revue Bryol. 31: 42. 1904). Some *Hyophila involuta* as admixture is present. No other admixture was found.
2. This collection agrees well with *Barbula consanguinea* (Thw. & Mitt.) Jaeg. sensu Eddy.

Nigeria
Niger Prov., Bonu Abuja Distr., waterfalls on the river Gurara, on hard steep rocks, in dry channels that carry water in times of flood, sterile,s. alt., 19 April 1958, E.W. Jones 994-A, ex hb. C.C. Townsend, det. Ph. Sollman, Dec. 1996; idem Jan. 1997, hb. L.
Notes.
1. Material separated from *Hyophila involuta*. A-number given by the author.

Arabian peninsula
Oman, on rocks, in flowing water, Wadi Hinna, below the Baobab car park, sterile, with gemmae, alt. c. 200 m., lat. 17° 03'N, 54° 36'E, 24 Sept. 1992, H.D.V. Prendergast B 33, B 38, det. Ph. Sollman, 1997; hb. Townsend, L.

Notes.
1. Part of the material with fragile/broken leaves.

Oman, on rocks, shaded, Wadi Tobruk, sterile, with gemmae, alt. c. 100 m., lat. 17° 05' 47"N, 054° 19' 37" E, 25 Sept. 1992, H.D.V. Prendergast B 40, det. Ph. Sollman, 1997, hb. Townsend, L.

Tropical Middle America
Cuba, dry banks, Wright 31, det. Ph. Sollman, 1993, hb. L 909. 335.93.
Notes.
1. This is an isotype collection of *Barbula obscura* Sull. (= *B. wrightii* Sauerb.). See also Zander, 1979: 186. Zander (l.c.) treats this taxon as *Barbula indica* (Hook.) Spreng. However, this collection agrees well -in my opinion- with *Barbula consanguinea* material studied from tropical Asia.
2. Gemmae are present.

USA
Florida, Walton County, Lake Wood Park, highest point in Florida, c. 0.7 m. S. of Alabama - Florida State line, along Walton Co. road 1087, on calcareous soil along road, alt. 345 ft, fruiting, with gemmae, 30 Nov. 1988, B.H. Allen 7541, det. Ph. Sollman, 1999, hb. L 988.051.332, MO.
Notes.
1. Det. B. Allen, 1989 as *Barbula unguiculata* Hedw.

Florida, Jackson County, Florida Caverns State Park, three miles north of Marianna, on ground in a path in woods along Chipola River, sterile, with gemmae, s. alt., 4 Jan. 1949, F. Drouet, C.S. Nielsen c.s. (s.n.?), det. Ph. Sollman, 1999, hb. L 952.83. 197.
Notes.
1. Det. M. Feigley, 1950 (no. 10.348) as *Barbula unguiculata* Hedw.

Hawaii, Oahu, Waianae Mts., summit Koala Metrosideros -Cheirodendron moss forest, partially submerged in intermittent roadside puddles, sterile, with gemmae, alt.c. 4000 ft, 22 Feb. 1975, W.J. Hoe 3347.0, det. Ph. Sollman, 1999, hb. L 976.198.657.
Notes.
1. Det. K. Saito as *Barbula unguiculata* Hedw.
2. Bryophyta Hawaiica Exsic., Ed. by W.J. Hoe, Ser. I: Musci no. 22. *Barbula unguiculata* Hedw.

Australia
Tropical parts of Australia, viz. Queensland, Northern Territory, W. Australia. About 60 collections were studied. The material is mainly present in the herbaria BM, CANB, H-BR., L, NSW, MELU-Stone.

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