

Studies on African *Riccardia* types and related material

Catherine REEB^{a*} & Jacques BARDAT^b

^a MNHN, UMR7207, CP. 39, 57 rue Cuvier, 75231 Paris Cedex 05, France

^b MNHN, UMR7205 OSEB CP. 39, 57 rue Cuvier, 75231 Paris Cedex 05, France

Abstract – The genus *Riccardia*, Aneuraceae is often considered as puzzling by bryologists, because of its great polymorphism, and African species have not been studied as a whole for several years. A type revision of the African species assigned to *Riccardia* is presented in order to get a clear view of the historical background before examination of recent material. Among the type material, two new citations are reported for Africa: *Riccardia inconspicua* (Steph.) Reeb et Bardat belonging to the subgenus *Thornoneura* and *Lobatiriccardia* cf. *coronopus* (De Not.) Furuki belonging to the closed genus *Lobatiriccardia*, not known before for Africa. Some synonyms have been corrected. The major taxonomical decisions will only be presented with the future revision of the African genus, after complete examination of variations based on recent collections or herbaria specimen, and on the results given by complementary tools, such as molecular and architectural analysis.

Liverworts / Taxonomy / Aneuraceae / *Riccardia* / Types / Africa

Résumé – Le genre *Riccardia* (Aneuraceae) est très polymorphe et souvent considéré comme difficile par les bryologues. Les espèces africaines n'ont pas été étudiées dans leur ensemble depuis de nombreuses années. Nous proposons un examen des spécimens types afin de disposer d'une base historique claire pour la révision du genre pour l'Afrique. Deux nouvelles citations pour l'Afrique ont été effectuées à partir des spécimens types : *Riccardia inconspicua* (Steph.) Reeb et Bardat appartenant au sous-genre *Thornoneura* et *Lobatiriccardia* cf. *coronopus* (De Not.) Furuki appartenant au genre proche *Lobatiriccardia*, taxon inconnu jusque-là pour l'Afrique. Quelques synonymies ont été revues. Les décisions taxonomiques majeures ne seront proposées qu'après l'examen de l'ensemble de la variation spécifique à partir de collectes récentes ou d'herbier et les résultats fournis par des outils complémentaires comme les analyses moléculaires ou architecturales.

Hépatiques / Taxonomie / Aneuraceae / *Riccardia* / Types / Afrique

INTRODUCTION

Among the thalloid family Aneuraceae, the genus *Riccardia* is the largest, with more than 300 names listed in Tropicos (<http://www.tropicos.org/>), which should be restricted to a hundred of accepted species after greatly-needed revision (Preussing, 2010). Most of these species are confined to the tropics, with only five species inhabiting European temperate regions. *Riccardia* is often

* Correspondence and reprints: reeb@mnhn.fr

considered as puzzling and confusing for bryologists, because of its very polymorphic morphology. Comprehensive studies have been conducted for different parts of the world, such as Hässel de Menendez (1972) for southern America, Hewson (1970) and Brown & Braggins (1989) for Australasia and Furuki (1991) for Japan, but no recent synthesis has been presented on African *Riccardia*.

This study focuses on type specimens and is preliminary work as a part of the further revision of the genus for Africa. We present updated examination of all the African types (minus two) for the recognized species of *Riccardia*, according to Wigginton (2009) check-list. Supplementary material, collected by the collector of the type specimens at the same time and the same place, was also included.

According to recent authors (Grolle, 1995; Wigginton, 2009) twenty-three species are represented by sixty-two names, because of synonymy and reassignments. Among these twenty-three species, sixteen species of *Riccardia* are cited with their epithet and seven species of *Aneura* are reassigned to *Riccardia*, but with the epithet “sp.” (Wigginton, 2009). Thirty-five types were finally studied. The types and the associated species are presented in Table 1 demonstrating the new synonymy clearly emerging from this study.

A detailed historical background of the family Aneuraceae is presented by Hewson (1970) and should be consulted for complete information. Here, we focus only on the African history of the family.

Lehman (1829) described *Jungermannia fastigiata* Lehm. from Ecklon's collections then moved to *Riccardia fastigiata* (Lehm.) Trevis (Trevisan de Saint Léon, 1877). Stephani (1886) cited *Aneura pinguis* from Sao Tomé and between years 1887-1917, he described twenty-three new species of *Aneura* for Africa later included in *Riccardia* (Stephani, 1890; 1891; 1900; 1917). During the same period, Gola (1914) described *Aneura keniae* Gola from Kenya and Pearson (1921) described *Aneura trivisiana* Pearson from Cameroon.

Such bryological developments ceased until Arnell (1952, 1959, 1963) and Jones (1956) studies, the latter being completed by Wigginton after Jones' death (Jones, 2004). Arnell (1952) described five new species of *Aneuraceae* from South Africa (*R. submarginata*, *R. obtusa*, *R. capensis*, *R. rhodesiae*) and made two new combinations (*R. compacta*, *R. saccatiflora*), followed by the description of *R. kili-manjarica* (Arnell, 1959). *R. submarginata* will be recognized later as a synonym of *A. pinguis* (Wigginton, 2009). Always in the fifties, Jones (1956) studied most of the types of African Aneuraceae, in the context of his revision of tropical African *Riccardia*. He did not describe species, but published new combinations (*R. longispica*, *R. holstii*, *R. limbata*, *R. stephanii*, *R. erosa*) and for three other species considered then as restricted to the Mascareignes (*R. comosa*, *R. caespitans*, *R. ramosissimus*) but these last combinations were further designed as nom. inval. by Grolle (1995). Jones considered the african *Riccardia* as closely related to each other and to *R. multifida*, but informally, he distinguished two groups of closely related species: on one hand the largest *Riccardia* (*R. longispica*, *R. holstii*, *R. fastigiata*) and on the other hand the smaller ones (*R. limbata*, *R. stephanii* and *R. erosa*).

Arnell published “Hepaticae of South Africa” in 1963 (Arnell, 1963), including some changes from his previous paper (for example, *R. stephanii* (Besch.). E.W. Jones was introduced as a correct species).

The two genus *Aneura* and *Riccardia* were considered as a single one until the early 20th century, however the name *Riccardia* was recognized before *Aneura*, but spelled in the masculine (“*Riccardius*”) which was inadmissible by the early author (before the Code of Nomenclature) for a genus name. It is not before the

Table 1. List of the types of African *Riccardia* (basionym), valid name according to Grolle (1995) and Wigginton (2009), names presented in this publication and authors who studied the types since 1950

Types of African <i>Riccardia</i>	Species according to Grolle (1995), Wigginton (2009), Furuki (2013)	Species designed in this publication, if different from previous column	Authors who studied the types since 1950
1 <i>Aneura amazonica</i> Spruce	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking		Meenks & Pöcs (1985)
2 <i>Aneura angusticosta</i> Steph.	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking		Jones (1956)
3 <i>Aneura caespitans</i> Steph.	<i>Riccardia</i> sp.	Dubious name	
4 <i>Aneura comosa</i> Steph.	<i>Riccardia</i> sp.	<i>Lobatiriccardia</i> cf. <i>cornopus</i> . (De Not.) Furuki	
5 <i>Aneura compacta</i> Steph.	<i>Riccardia compacta</i> (Steph.) S.W. Arnell		Meenks & Pöcs (1985) Perold (2001, 2002, 2003)
6 <i>Aneura congoana</i> Steph.	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking	<i>Riccardia longispica</i> (Steph.) Pearson	
7 <i>Aneura congoensis</i> Steph.	<i>Riccardia longispica</i> (Steph.) Pearson	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking	Jones (1956) Perold (2001, 2002, 2003)
8 <i>Aneura corbieri</i> Steph.	<i>Riccardia</i> sp.	<i>Riccardia ramosissima</i> comb. nov.	
9 <i>Aneura dismieri</i> Steph.	<i>Riccardia</i> sp.	<i>Riccardia saccatiflora</i> (Steph.) Arnell	
10 <i>Aneura erosa</i> Steph.	<i>Riccardia erosa</i> (Steph.)		Jones (1956)
11 <i>Aneura exigua</i> Steph.	<i>Riccardia tenuicostata</i> Schiffn.	<i>Riccardia inconspicua</i> comb. nov.	Furuki (2013)
12 <i>Aneura grosselimbata</i> Steph.	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking	<i>Riccardia limbata</i> (Steph.) E.W. Jones	Jones (1956); Perold (2001, 2002, 2003)
13 <i>Aneura holstii</i> Steph.	<i>Riccardia holstii</i> (Steph.) E.W. Jones	<i>Riccardia limbata</i> (Steph.) E.W. Jones	Jones (1956)
14 <i>Aneura inconspicua</i> Steph.	<i>Riccardia erosa</i> (Steph.) E.W. Jones	<i>Riccardia inconspicua</i> comb. nov.	Jones (1956)
15 <i>Aneura keinia</i> Gola	<i>Riccardia</i> sp.		
16 <i>Aneura lepervanchei</i> Steph.	<i>Riccardia</i> sp.	<i>Riccardia longispica</i> (Steph.) Pearson	
17 <i>Aneura limbata</i> Steph.	<i>Riccardia limbata</i> (Steph.) E.W. Jones		Jones (1956)
18 <i>Aneura longispica</i> Steph.	<i>Riccardia longispica</i> (Steph.) Pearson		Jones (1956)
19 <i>Aneura nudiflora</i> Steph.	<i>Riccardia nudiflora</i> (Steph.) Grolle	Dubious name	

Table 1. List of the types of African Riccardia (basionym), valid name according to Grolle (1995) and Wigginton (2009), names presented in this publication and authors who studied the types since 1950 (*continued*)

	Types of African Riccardia	Species according to Grolle (1995), Wigginton (2009), Furuki (2013)	Species designed in this publication, if different from previous column	Authors who studied the types since 1950
20	<i>Aneura papulosa</i> Steph.	<i>Riccardia tenuicostata</i> Schiffn. Furuki (2013)	Dubious name	
21	<i>Aneura piliiflora</i> Steph.	<i>Riccardia longispica</i> (Steph.) Pearson		Jones (1956)
22	<i>Aneura ramosissima</i> Steph.	<i>Riccardia ramosissima</i> (Steph.) Grolle	<i>Riccardia ramosissima</i> comb. nov.	
23	<i>Aneura reticulata</i> Steph.	<i>Riccardia limbata</i> (Steph.) E.W. Jones		Jones (1956)
24	<i>Aneura saccatiflora</i> Steph.	<i>Riccardia saccatiflora</i> (Steph.) S.W. Arnell		Perold (2001, 2002, 2003)
25	<i>Aneura stephanii</i> Besch.	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking		Jones (1956) Perold (2001, 2002, 2003)
26	<i>Aneura tenera</i> Steph.	<i>Riccardia erosa</i> (Steph.) E.W. Jones		Jones (1956)
27	<i>Aneura travisiana</i> Pearson	<i>Riccardia amazonica</i> (Spruce) ex Graddstein et Hekking		Jones (1956)
28	<i>Jungermannia fastigiata</i> Lehm.	<i>Riccardia fastigiata</i> (Lehm.) Trevis.		
29	<i>Jungermannia multifida</i> L.	<i>Riccardia multifida</i> (L.) Gray		
30	<i>Riccardia campanuliflora</i> S.W. Arnell	<i>Riccardia campanuliflora</i> S.W. Arnell		Arnell (1952) described holotype
31	<i>Riccardia capensis</i> S.W. Arnell	<i>Riccardia capensis</i> S.W. Arnell	<i>R. amazonica</i> (Spruce) Schiffn. ex Gradst. et Hekking	Arnell (1952) described holotype
32	<i>Riccardia keniae</i> Gola	<i>Riccardia keniae</i> Gola	?	
33	<i>Riccardia kilimandjarica</i> S.W. Arnell	<i>Riccardia kilimandjarica</i> S.W. Arnell	<i>Riccardia ramosissima</i> (Steph.) Grolle	Perold (2001, 2002, 2003) (S)
34	<i>Riccardia obtusa</i> S.W. Arnell	<i>Riccardia obtusa</i> S.W. Arnell		Arnell (1952) described holotype Perold (2001, 2002, 2003)
35	<i>Riccardia rhodesiae</i> S.W. Arnell	<i>Riccardia rhodesiae</i> S.W. Arnell	<i>Riccardia saccatiflora</i> (Steph.) S.W. Arnell	Arnell (1952) described holotype

synthesis by Meenks & Pócs (1985) that the two genera are clearly distinguished. They made new combinations and synonymy; *Riccardia amazonica* (Spruce) Schiffn. ex Gradst. et Hekking was lectotypified from Spruce's collections.

After Jone's death, Wigginton (2004) published Jone's work on West African Liverwort, taking into account Meenks proposals. At the beginning of the 21st century, Perold (2001; 2002a,b; 2003) has presented very complete revisions of four South African species (respectively *Riccardia multifida*, *R. obtusa*, *R. compacta* and *R. amazonica*).

MATERIAL AND METHODS

We examined almost all the types of recognized African *Riccardia* species, according to Grolle (1995) and Wigginton (2009), all material has been kindly loaned by European and African herbaria (see Acknowledgements). When a specimen cited was not seen, the abbreviation n.v. was added after the citation. We could not access the type specimen of *Riccardia kenyae* Gola, and that of *Riccardia multifida* L.

Preparing the thalli

Most of the type specimens, excepted the five Arnell's species, are older than 1910 and some date back to the first part of the 19th century. In herbarium paper-bags, the specimens are often glued to each other, fragile and brittle: it is impossible to separate the thalli without making irrecoverable damages. For these reasons, Meenks (1987) stated not to observe plants older than 10-20 years: “*older herbarium material becomes almost useless for critical examination, especially as to anatomical features*” (Meenks & Pócs, 1985). Important characters for the descriptions of *Riccardia* focus on cross-section features, but cross-section on a 150 years old thallus is not possible, even if re-hydrated (Fig. 1). On the contrary, Perold wrote: “*Type specimen however far older generally, yet one needs to be study them to compare them with fresh, living collections, however difficult that may be.*”

With the authorization of the different herbaria, we used a modified approach of Rico's protocol (Rico, 2011), called “Bleach and Blue” coloration (Fig. 2), which surprisingly re-inflates the thalli. It has been applied on 1-2 thalli from each type, in order to make the study of them efficient (Fig. 3). The colored thalli have been included in the original herbarium voucher, so that they can be used again simply by being re-hydrated.

Numerical pictures of each colored thallus, in total and cross-section have been taken with a Nikon Coolpix P6000, through binocular lens or under microscope, following when possible the views presented in Appendice 2. The collection of numerical pictures with caption is added to each specimen. Drawings were produced from these images using a Wacom Intuos drawing tablet and the Open-source Vector Graphic Editor Inkscape.

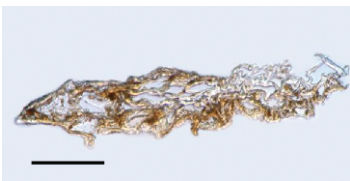


Fig. 1. Cross section made in the main axis of a re-hydrated thallus of *Aneura reticulata*. Dusén 72 holotype, G-0067571. Scale bar 100 μ m.

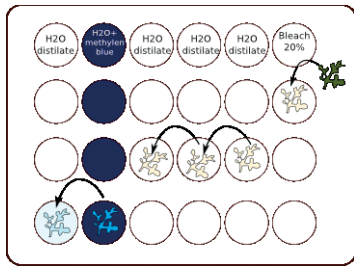


Fig. 2. Bleach and Blue preparation, adapted from (Rico, 2011). A thallus is re-hydrated in lukewarm distilled water for 30' to 60'. Then a crystal cell cultivation plate 24 wells (6×4), in order to organize the successive baths (6 baths, 4 specimens are treated in a plate). Two or three thalli are extracted very carefully, with Dumont N° 5 tweezers and doused in well 1, containing bleach 20%, for 10-15' until the discoloration is complete, followed by three successive rinses of a few minutes in wells 2-3-4. Then the thalli are doused in well 5, containing a diluted methylene blue solution (20% of a 1% methylene blue solution, 80% distilled water), for 1-3' (we recommend a clear blue coloration). After the last rinse bath, the thalli retrieve almost an actual consistence. The bleach has the property of reinflating the old collapse thalli, and the methylene blue rigidifies them, making possible nice cross sections.

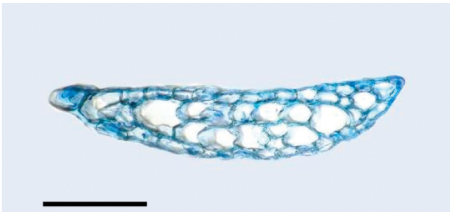


Fig. 3. Cross section of the main axis of a thallus of the type of *Aneura reticulata* treated by the "Bleach and Blue" protocole. Dusén 72 holotype, G-0067571. Scale bar 100 μ m.

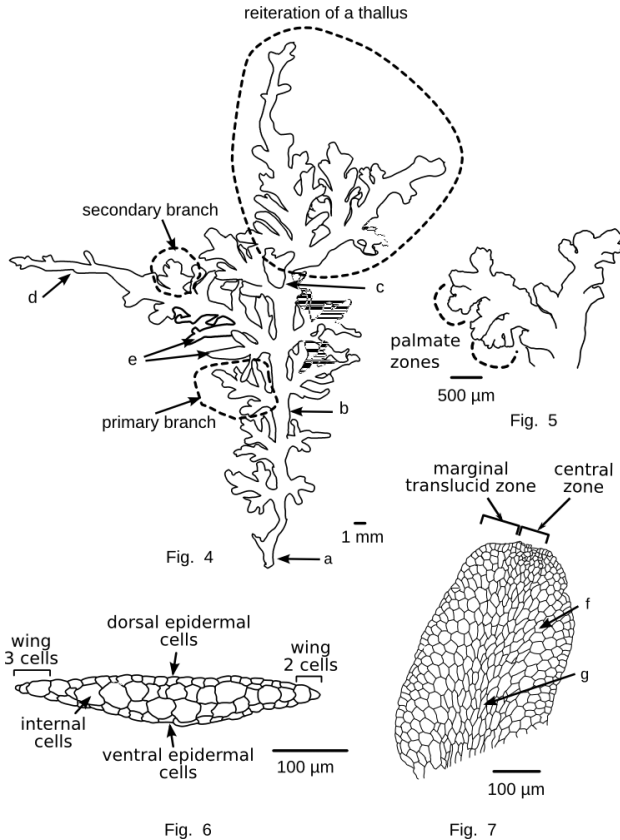
Characters definition

The very plastic morphology of *Riccardia* needs special care when observing morpho-anatomical features. Some characters could be observed, depending on the thallus, or even on the branch in a given thallus. The state of a character also depends on the age of the part of the thallus observed; this is particularly true with ultimate branches, reproductive branches and calyptra characters. It is recommended to observe well developed organs, not too young but not too old (for example, mature calyptras with the capsule still contained inside should be examined, because ornamentation greatly changes between young calyptra and old ones).

There were no opportunities to observe oil bodies, lost a few hours after collection and unfortunately we never saw oil bodies on type material.

Sometimes, usually in old material, thalli are broken and it is impossible to know if the thallus is a complete representation of an individual or only a broken part. However, the general habit is generally retained even if measurements may differ at different levels.

The morphological features are just used as a reminder (Figs 4-7), for a general proposal, of the descriptive characters of *Riccardia*, see Hewson (1970) & Furuki (1991).



Figs 4-7. **4.** *Riccardia limbata*, Dusén 33, holotype G-00067566. A thallus is the set of axis and branches (Reeb & col. in prep). (a) basis of the thallus; (b) main axis. A reiteration is the repetition of the architecture of the thallus and differs from a branch by its basis (c), narrow and rounded in cross section, that usually differs clearly from the basis of branches, which are mostly planoconvex-concave to biconvex. (d) dormant notches; (e) ultimate branches. **5.** *Riccardia obtusa*. The apical parts of the branches show numerous palmate zones, consisting of 3 or more ultimate branches of quite the same length, and arising very close from each other. Arnell 1602 isotype S-B20192. **6.** *Riccardia limbata*, type cross section of the main axis. Dusén 33, holotype G-00067566. **7.** *Riccardia amazonica*, Ultimate branch showing the central pluricellular zone (g) and the translucent marginal zone (f), often 1-2 cells thick. Spruce lectotype C1680 MANCH-EM71223.

RESULTS

Species of *Riccardia* are presented in alphabetic order, including previous accepted species and new combinations; they are followed by the presentation of a presumed *Lobatirricardia* species (*Lobatirricardia* cf. *coronopus*). The citation of the species is followed by its basionym and then by the synonymy. Dubious names are cited at the end of the publications.

The descriptions are updated from literature, using new characters or correcting previous descriptions. Note that **the description of a type does not**

represent the whole range of variation of a species, especially for numeric characters and the description provided here cannot supply complete species descriptions. Complete descriptions, major taxonomical decisions for African *Riccardia* will be presented and discussed in the integrative revision of the genus for Africa.

***Riccardia amazonica* (Spruce) Schiffner ex Gradts. et Hekking,
J. Hattori Bot. Lab. 45: 129, 1979.**

Basionym: *Aneura amazonica* Spruce, *Trans. Proc. Bot. Soc. Edinburgh* 15: 545, 1885. **Type:** BRAZIL, San Carlos del Rio Negro, iin trunco putridoï, s.d. *Spruce* H16, (lectotype, C1680 MANCH-EM71234, designated by Meenks (1985)); *Spruce* s.n. San Carlos on rotten trunks (isolectotype, CC1679 MANCH-EM71223, designated by Meenks (1985)), *Spruce* s.n. San Carlos Amazon forest (isolectotype, CC1687 MANCH-EM71310, designated by Meenks (1985)).

Synonyms:

Aneura stephanii Besch., *Rev. Bryol.* 20: 60, 1893. **Type:** CONGO, 1892 *Thollon* s.n. (holotype, G-00067578).

Aneura angusticosta Steph., *Denkschr. Kais. Akad. Wiss. Math. Nat. Cl. Wien.* 88: 724, 1913. **Type:** TANZANIE, Usambara, s.d. *Brunnthaler* Fond Steph. 027076 (holotype, G-00067547).

Aneura congoana Steph., *Sp. Hepat.* 6: 23, 1917, *vide* Jones (1956). [Stephani's description is based on the type specimen *Aneura congoensis* Steph. In species *Hepaticarum* n° 6, the two species are presented side by side page 25 with the following labels: *Aneura congoana* "Hab. Africa oriental. Congo bellicum. (Lerat legit.)" and *Aneura congoensis* "Hab. Congo Belgicum. Bolombo. (Laurent legit.)". The original labels of the type specimens are inverted, the valid informations are: *Aneura congoana* G-00067550 collected by Laurent, 1903 and *Aneura congoensis* G-00067551 collected by Le Ret, A.J., 1908. See also discussion for *R. longispica*]. **Type:** CONGO BELGE, Bolongo, 1903 *Laurent* s.n. (holotype, G-00067550; isotype, PC-0101739).

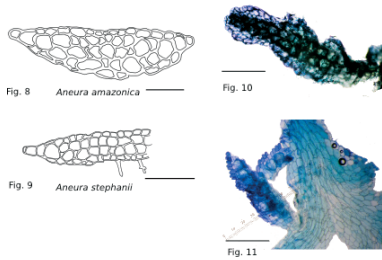
Aneura trivisiana Pearson, *Mem. Proc. Manchester Lit. Phil. Soc.* 65: 1, 1921. **Type:** CAMEROUN, "On ebony logs from Cameroun" *Travis*. Ex Hb Pearson 761a. (holotype, MANCH, CC2068).

Riccardia capensis S.W. Arnell, *Bot. Not.*, 1952. **Type:** SOUTH AFRICA, Cape Province, Knysna, Deep Wall forest reserve 2/11/1951 *Arnell* 1790 (?type, S-B20193).

We comment on a group of 6 types specimens, considered as synonyms in the recent check lists, but that's appears unclear after examining the types of the South American species *Riccardia amazonica* and the African species considered as synonym of *R. amazonica*.

Riccardia stephanii (Besch. ex Steph.) E.W.Jones 1956. *nom. illeg.* is a junior homonym of *Riccardia stephanii* S. Hatt. 1944.

Thalli < 15 mm long, creeping. Dioicous. Branches pinnate to irregularly bipinnate, alternate to subopposite, often presenting an asymmetrical development, branching on one side of the thallus more developed than on the other. Main axis 350-600 µm wide. In cross section, main axis plano-convex, (4-)5-8 cells high, with an acute and often winged margin consisting of 1-2(-3) cells; main axis cells with clearly thickened cell walls (Fig. 8); upper epidermal cells 1-3 smaller than the internal cells. Ultimate branches in surface view with a pluricellular median zone of 3-6(-7) rows of elongated cells, bordered on each side by a translucent zone of 4-6 rows of quadrate cells, gradually becoming smaller to the margin; half of the opaque median zone is equal to the adjoining translucent zone;



Figs 8-10. **8.** Cross-section of main axis of *Aneura amazonica*. Spruce lectotype C1680 MANCH-EM71223. **9.** Cross section of the main axis of *A. stephanii*. Thollon holotype G-00067578. **10.** Male branch of *A. amazonica*. Spruce lectotype C1680 MANCH-EM71223. **11.** Male branch of *A. stephanii*, showing the typical bulging cells of the wing. Thollon holotype G-00067578. Scale bars 100 μ m.

with or without oblique rows of cells leaving the central strand of elongated cells; in cross section 3-4 cells high, margins winged consisting of 3-4(-5) cells of the same size as the internal cells, except cells of the external row which is smaller. Male branches bearing up to 12 antheridial pairs, some branches terminating with a growth-like restart; wing undulate but entire. Female branches with scaly paraphyses. Calyptra with an umbo of cells at the top.

Spruce (1885) described precisely this material, but some new observations are made here. Two morphotypes are encountered in the material: the first one is elongated, smaller, with linear ultimate branches, generally male. The second morphotype is more compact, with relatively large tongue-like ultimate branches, generally bearing female branches. They occur together in the intricate mats, and it could be an argument for the dioecy of this species. The hypothesis of the existence of two species, represented only by male thalli belonging to one species and by female thalli belonging to a second species is improbable compared to the hypothesis that the two morphotypes belong to the same species, showing sexual heterothallism.

In their study on African Aneuraceae, Meenks & Pócs (1985) wrote that the “*most striking features of R. amazonica is the absence of wings along the main axis*”. But we observed a 1-2(-3) cells wide wing, often asymmetrical, on the main axis of the South-American type of *R. amazonica* (Fig. 8), if we consider that a wing is a marginal extension of the thallus, one cell thick and more than 1 cell width. The absence of wing is probably an exception due to a cross section in the very basal part of the thallus or perhaps in an asymmetrical zone, quite frequent, where the wing appears only on one side of the cross section (Perold, 2003). However, this character remains ambiguous for this species.

Thirteen collections, including two specimens from Pearson's leg. collections, are localized “Parà” or with the additional note “San Gabriel, San Carlos, ad R. negro” in Manchester Herbarium. All the Spruce's collection bearing the geographical indications “*per totam sylvam Amazonicam, in truncus prostratis semiputridis, frequens; sc.propre Parà; ad San Gabriel et S. Carlos in fluvii Negro ripis*” shows the same characters. The three specimen designed as lectotype and isolectotype by Meenks (1985) fit Spruce's description perfectly.

The type of *Aneura stephani* shows conspicuous differences with *R. amazonica* (Table 2). It is much smaller, with a mean length 6-8 mm; the median zone pluricellular zone of ultimate branches is 2-4 cells width and the translucent zone larger than the semi pluricellular and opaque median zone (Fig. 10). Main axis 4(-5) cells height in cross section, the thickened cells walls of *Riccardia amazonica* cannot be seen (Fig. 9); only male thalli are present in the type material, male branches often grouped by 2, with a crenulate wing, one bigger cell bulging at the top of the wing. With age, the branches are curved and up to 15 antheridial pairs.

Table 2. Comparison between type specimens *Aneura amazonica* and *Aneura stephanii*

Characters	<i>Aneura amazonica</i> Spruce	<i>Aneura stephanii</i> Steph.
	Dioicous	
Thallus morphology	Heterothallism, female thallus stronger and larger than male thallus.	Homothallism, no difference in size between male and female thalli.
	Asymmetrically pinnate to bipinnate	
	250-500 µm width	
Main axis	Cross section 4-7(-8) cells high with thickened cells walls, especially in internal cells	Cross section 3-4 cells high, without thickened cells
	Wing in cross section 1-2 cells, the external cell smaller, and the other as large as the internal cells of the thallus.	Wing in cross section 1-2(-3) cells of the same size as the internal cells, or half their size.
	Tong like or linear	
	Half of the median pluricellular zone <= each translucent marginal zone	
Ultimate branches	Opaque pluricellular zone 3-7 cells width, translucent zone 4-5 cells width	Opaque pluricellular zone 2-3 (-4) cells width, translucent zone (4-) 5-6 cells width.
	Apex without lunate zones of active division (future propagules)	Apex often presenting a lunate zone of active division (future propagules)
Male branches	On main axis, axis of primary branches and ultimate branches; sometimes at the end of an ultimate branch or a vegetative growth restart at the top of a male branch	
	7-8 antheridial pairs	Up to 18 antheridial pairs
	Wing undulate and entire	Wing crenulate with an enlarged and bulging apical cell, often separated from other cells.
Female branches	On main axis and axis of primary branches; paraphyses laciniate; up to 10 archegonial pairs	
Sporophytes	Calyptra up to 2 mm at maturity; with a developed umbo, and some isolated papilla near the top	

Perold (2003) remarked the presence of “*dark stained infestation in several apices of the ultimate segments...*”; we observed them in the type of *A. stephanii*. It is not an infestation, but a zone of active division which evolves in bicellular propagules.

Aneura angusticosta Steph. is represented by very small thalli < 1 cm long, all the characters are similar to those of *A. stephanii*. Jones & Harrington (1983) cited *R. angusticosta* for the Sierra Leone and Ghana, and gave *R. stephanii* (Bescherelle) E.W. Jones as a synonym, but based on the *nom. illeg.*

Aneura congoana Steph. is similar to *A. stephanii*, with a short tongue like ultimate branches. The thalli are female, with a smooth calyptra and an umbo of striated cells. There has been confusion between *A. congoana* and *A. congoensis*. From the original descriptions, *A. congoensis* = *R. longispica* and *A. congoana* = *R. amazonica*.

Aneura travisiana Pearson is also similar to *A. stephanii*, with a thin habit, including cross-section of the main axis 4 cells high, and a large ultimate branch wing up to 5 cells, the same size as the internal cells; some scattered thickened internal cells are observed. The description given by Pearson (1921) is short but very precise and suits exactly to the type material.

The description given by Arnell (Arnell, 1963) for *Riccardia capensis* recovers exactly the characters of *Aneura stephanii*, which is surprising, Arnell having described also *Riccardia stephanii* (Besch.) E.W. Jones at the following page 92. We agree with Vanden Berghen (1972) that Arnell's description and illustration of *R. stephanii* are not based on the same specimen of *R. stephanii* described by Jones, who saw and annotated the type specimen.

There is no doubt that the African types of *Aneura stephanii*, *A. angusticosta*, *A. congoana*, *A. travisiana* and *Riccardia capensis* are similar and may be considered as synonyms. Similarities between *A. stephanii* and *R. amazonica* were noted by Jones (1956), and Meenks & Pócs (1985) who decided that they were synonyms. They also assert that *R. amazonica* was monoicous, but we saw only dioicous specimens in the type materials of all the African synonyms. A set of characters differ between the two materials, presented in Table 2. Main differences of *A. stephanii* compared to *R. amazonica* are (1) homothallism, (2) width of the main axis, which seems to be always smaller in African species, (3) no thickened internal cells walls, (4) smaller relative width of the median zone regarding the translucent marginal zone, and smaller number of rows of the central zone, (5) greater number of antheridial pairs and (6) strongly crenulate margin terminating with a large bulging cell of the antheridial branches.

The African and southern American specimen of *Riccardia amazonica* must be studied from fresh material and compared from molecular analysis results, to confirm that they belong to the same species. The consideration of two different species, African and south American, could be highly supported by the results of spore viability of *R. amazonica* (Zanten & Gradstein, 1988): a very low survival to dehydration, and a short germination potential, imply that *R. amazonica* is a low disperser. Therefore it could be difficult to explain its potential colonization of Africa by dispersion.

Supplementary material examined: *Aneura amazonica* BRAZIL: Pará, 07/1849 Spruce H15 (CC1677 MANCH-EM71201); Spruce H14 (CC1678 MANCH-EM71212). San Carlos on rotten trunks, Spruce H33c (CC1679 MANCH-EM71223). Spruce H16 (CC1681 MANCH-EM71245). San Carlos, Spruce s.n. (CC1683 MANCH-EM71267, CC1684 MANCH-EM71278). San Gabriel River Negro, Marabitanas, amazon forest, Spruce H17 (CC1675 MANCH-EM71179); Spruce KK960 (CC1685 MANCH-EM71289, CC1686 MANCH-EM71300).

***Riccardia compacta* (Steph.) Arnell, Bot. Not., 1952.**

Basionym: *Aneura compacta* Steph., *Hedwigia* 32: 19, 1893. **Type:** SOUTH AFRICA. Hab. Caput bonae spei. leg. Jelinek in expeditione Novarae. (Herb. Vindobon.). *Jelinek* s.n. (holotype, G-00067549; isotype, PC-0101714, S-B20511).

Thallus rigid, crowdy < 15 mm, inferior ultimate branches tend to be longer than the upper one, giving the idea of a sort of corymbe (Fig. 12), main axis 200-460 µm width, cross section of the main axis rounded to elliptic, up to 10 cells height, without any wing. Primary branches axis and ultimate branches linear with parallel margins, same width and habit than the main axis, without wing. In cross section, all internal cells with constant and thickened cells walls, visible *in toto* through a darker central line (Fig. 13). Reproductive branches on main axis, inserted irregularly. Male branch solitary, rarely in sympodial pairs, often pedunculated or prolonging a shorter ultimate branch, bordered by a crenulate wing consisting in a terminal inflated and conical cell. Antheridial cavities surrounded by 2-3 rows of cells. Female branch not seen on type material.

A very complete description of the species is given by Perold (Perold, 2002b). In the type specimens, the general habit is well preserved. This material could be confused with *Riccardia ramosissima* comb. nov., as will be discussed later when examining this species (see also Table 3).

Table 3. Comparison between the type specimens of the *R. compacta*, *R. kilimanjarica*, *R. ramosissima*

	Type of <i>R. compacta</i> = <i>Aneura compacta</i>	Type of <i>R. kilimanjarica</i>	Type of <i>R. ramosissima</i> = <i>Aneura ramosissima</i>
Thallus morphology	Branches reaching the apex of the main axis "corymbe" habit	More irregularly branched	Branches reaching the apex of the main axis "corymbe" habit
	Branches linear, with parallel margins		
	Rounded, elliptic to plano-convex plano convex		plano-convex
Main axis and ultimate branches	Internal cells walls with obvious thickened cell walls, forming a central dark line on the axis on surface view	No thickened cell walls	
	No wings		
Sexual branches	Male only seen on the type	Not seen	Female only seen on the type

Table 4. The problem of *Aneura caespitans*: comparison between Stephani's publications

Publication or Icon	Specimen associated	Vegetative thallus description	Calyptra description
Icon 236	Dusén	Description = 1 st column of Icon 236	Description = 2 nd column of Icon 236
Stephani (1891) & Stephani (1892)	Bourbon leg. Rodriguez	Description = 1 st column of Icon 236	Female branches very young "Flores feminei juniores solum vidi"
Stephani (1900)	Dusén	Mixed of the two columns of icon 236	

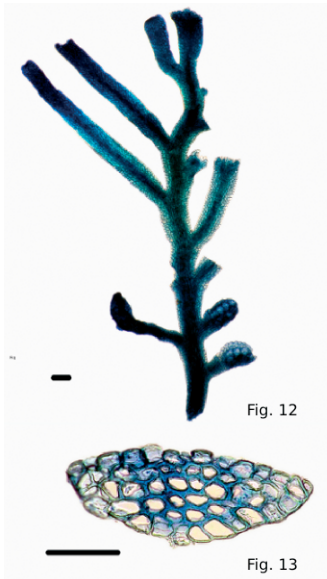
***Riccardia erosa* (Steph.) E.W. Jones**, *Trans. Brit. Bryol. Soc.* 3: 83, 1956.

Basionym: *Aneura erosa* Steph., *Hedwigia* 30: 269, 1891. **Type:** St. THOMÉ, 1889 *Quintas* 7 (holotype, G-00067552).

Synonym: *Aneura tenera* Steph., *Sp. Hepat.* 6: 43, 1917. **Type:** TANZANIA, Africa orientalis, Usambara. *G. Baur* legit. (lectotype designed here, 01/1906 *Baur* 5118 G-0067579; isoelectotype, 01/1906 *Baur* 5118 G-00067580).

Thalli < 5 mm, main axis < 300 µm width. In cross section 3(-5) cells height, with a conspicuous wing of 2-3 cells wide (Fig. 14). Linear ultimate branches bordered by an irregular margin, with bulging cells not becoming smaller at the margin and a narrow median pluricellular zone, 1-3 rows wide irregular in size, regarded as translucent marginal zone. Reproductive branches look like buds when young, then appear large compared with the thallus size: male branches are up to 1,2 mm with a maximum of 15 antheridial pairs and a strongly crenulate wing terminating with an inflated and longer cell; female branches are up to 500 µm, large and inflated, bordered by ciliated paraphyses. Thalli propaguliferous.

The type of *R. erosa* is one of the smallest of the genus *Riccardia* in Africa. Stephani drew a monoicous thallus on Icon N°330, but some male thalli bear both young and mature antheridial branches. Young antheridial branches



Figs 12-13. **12.** *Riccardia compacta*. Scale bar 500 μm . **13.** Cross section of the main axis. Scale bar 100 μm . Jelinek holotype G-00067549.

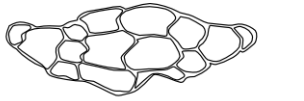


Fig. 14 *Aneura erosa*

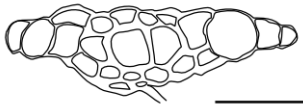


Fig. 15 *Aneura tenera*

Figs 14-15. **14.** Cross section of the main axis of *Riccardia erosa*. Quintas 7 holotype G-00067552. **15.** Cross section of the main axis of *Aneura tenera*, synonym of *R. erosa*. Baur 5118 isoelectotype G-00067580. Scale bars 100 μm .

look like a female bud or like a young calyptra, and mature are elongated, more than 1 mm long. If not well placed under the microscope, they may be confused with a female branch, thus the thallus appear monoicous. Every thallus observed was male or female and the whole populations appear dioicous, confirming Jones (1956) and Meenks & Pócs (1985) observations.

Jones presented *Aneura tenera* Steph. as a synonym of *R. erosa* (Jones, 1956). In the specimen G-0067580, the thalli are slightly larger than those of *R. erosa* and the main axis is thicker in cross section; in the specimen G-000675579 (and in supplementary material under the label Baur) the main axis is only 3 cells thick, like *R. erosa*. All of the specimen present scattered thickened cell walls on the internal cells of the main axis (Fig. 15) and are very propaguliferous. All of the other characters being similar to those of *R. erosa*, we confirm *R. tenera* as a synonym of *R. erosa*.

Aneura inconspicua Steph. was considered as a synonym of *R. erosa* by Jones (Jones, 1956, Wigginton, 2009) but was not cited in (Grolle, 1985). It is now considered as a separate species, *Riccardia inconspicua* comb. nov., (see below),

because of the presence of marginal trifurcate papilla. It is therefore excluded from the synonyms of *R. erosa*.

Meenks & Pócs (1985) wrote that the presence of a wing is a good character to distinguish *R. erosa* from *Riccardia amazonica*, from which it could be a depauperate form; but we also observed a wing in *R. amazonica*, especially in African specimens. The characters that distinguishes the types of *Riccardia erosa* from those of *R. amazonica* are particularly based on dimensions: (1) main axis < 300 µm width, (2) ultimate branches only 3 cells thick, with a 2-3 celled wing, (3) large reproductive branches in comparison to the size of the thallus, 0.5 to 1 as long as the ultimate branches. Based on these characters we maintain *R. erosa* as a separate species, which has to be confirmed by recent material examination.

Supplementary specimens examined: *Aneura tenera* Usumbara, s.d. Baur s.n. G-00067581.

Riccardia fastigiata (Lehm.) Trevis., *Mem. Real. Ist. Lombard. Sci. Mat. Nat.* Ser 3, 4: 431, 1877.

Type: (lectotype designed here, S-B104928).

Basionym: *Jungermannia fastigiata* Lehm. *Linnaea* 4: 370. 1829. **Type:** Montis Teufelsberg et in vertice montis Tafelberg. promont. Bonae Spei. (Ecklon in Hb. L. & Lg.) (isotype, G-0067556).

Synonym: *Aneura fastigiata* (Lehm.) Lehm. et Lindenb. *Syn. Hepat.* 500. 1846.

Thallus strap like, soft and flexible, up to 2.5(-3) cm, bipinnate to tripinnate, not closely attached to the substratum; main axis 0.6-1.2(-1.4) mm wide, in cross section 5-7 cells thick, the epidermal cells 2-6 times smaller than larger internal cells; margin acute, consisting of a wing of 1-3 cells. Branches remaining large, even if slightly decreasing in width. Ultimate branches short 1.5-2.5 mm, if longer they always show the beginning of new ramifications, 600-800 µm wide, primarily parallel edges and enlarged or truncated apex, like a fan; in surface view the width of the translucent area is always much smaller than half of the median pluricellular area, no rows of cells obliquely oriented regarding the main axis; in cross-section biconvex or planoconvex, 4-5 cells thick in the middle, margin acute, consisting of a wing 3-4(-5) cells wide. Ventral epidermal cells are smaller than the dorsal epidermal cells. Male branches short straight, max 6 antheridial pairs, bordered by a regular, entire or undulate wing 2-3 cells height. Female branches bud shape when young, straight and bordered by lacinia 1-2(-3) cells wide at the basis when mature. Calyptra bearing an apical umbo of cells and some large and scattered cellular expansions on the sides of the calyptra, this is lost in old material.

As it is written in the original description of *Jungermannia fastigiata*, and repeated in *Synopsis Hepaticarum*, when it was reassigned to *Aneura*, this species is considered very polymorphic.

Nine specimens from Tafelberg mountains collected by Ecklon were labeled as types (syntypes) of *Riccardia fastigiata* in Stockholm herbarium. Eight of them were originally labeled as *Jungermannia* (or *Aneura*) *multifida* (S-B104930, S-B189826, S-B104933) or as a *Jungermannia multifida* var *pinna-tifida* (S-B104925, S-B104929, S-B104932) or var. *crispa* (S-B104928).

Specimens S-B104928 and S-B104931 (in a bad state of conservation) are the larger of the specimens collected, and show monoicous branches.

The specimens also present some differences in the regularity of the architecture: in S-B104929, some thalli are very regular, and that could explain the first label *Riccardia multifida*. Specimen S-B104931 shows a very regular and tripinnate thallus, branches arising with obtuse angles and is probably *R. multifida*

(Perold, 2001). The specimens are not homogeneous, and some of them have to be reattributed to *Riccardia multifida*.

In the material, *Riccardia fastigiata* differs from *R. multifida* by (1) very soft thallus (2) inconstant translucent area on each side, (3) truncated or fan like apices, (4) short and mostly irregular ultimate branches, and stair like ultimate branches with numerous notches in young sections.

We choose the specimen S-B104928 as the lectotype.

Supplementary material examined: *Jungermannia fastigiata*: SOUTH AFRICA, Cape Province, Tafelsberg leg. Ecklon, Herb. Musci Palit. Vintob 8038 (G-00067558). *Riccardia fastigiata* SOUTH AFRICA, Cape Province, Tafelberg Mts, 01/01/1924, Ecklon s.n. (S-B104921, S-B104925, S-B104827, S-B104929, S-B104930, S-B104931, S-B104932, S-B104933, S-B18982).

Riccardia inconspicua (Steph) Reeb *et* Bardat, **comb. nov.**

Basionym: *Aneura inconspicua* Steph., *Hedwigia* 32: 23, 1893. **Type:** CAMEROUN, *Jugner* 5 (holotype, G-G00067564; isotype, S-B20523).

Synonyms:

Riccardia tenuicostata Schiffn., *Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss.* 67: 166, 1898. *Aneura tenuicostata* (Schiffn.) Steph., *Sp. Hepat.* 1: 245, 1899. non *Riccardia tenuicostata* Schiffn., *Arch. Hydrobiol. Suppl.* 21: 390, 1955 (syn. of *Riccardia crenulata*, Schiffn. illeg.). **Type:** JAVA, “Insula Singapore in monte Bukit Timat, alt. 100-150m”, 6-11-1893, *Schiffner* 142 (lectotype, W (Furuki, 2013)).

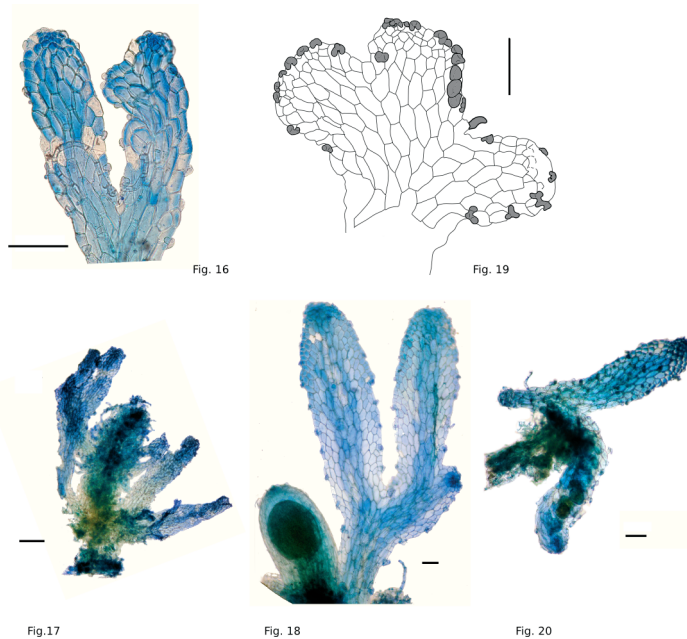
Aneura exigua Steph., *Sp. Hepat.* 6: 25, 1917. **Type:** SEYCHELLES, 1911 leg. *Gardiner* s.n. (holotype, G-00067553). In Furuki (2013), the old herbarium number is given (G-17336), and not the Barcode number.

Riccardia babindae Hewson, *Proc. Linn. Soc. New South Wales* 95: 85, 1970. **Type:** AUSTRALIA, North Queensland., The Boulders, Babinda, 8-1964, *Hewson* 460 (holotype, NSW; isotype, BRI). Type n.v.

Dioicous. Thallus very small < 2 mm long (Figs 16, 17, 18). Branching pinnate to bipinnate, branching alternate to subopposite. All the margins, including reproductive branches, are bordered by mucilage papilla, 2-3 branched (Figs 18, 19, 20). Main axis biconvex to biconvex, in cross section 3-4(-5) cells thick, 5-6 cells wide, 100-250 µm wide, margin acute consisting in a wing of 1-2 cells wide. Ultimate branches up to 1,5 mm, in cross section 3 cells thick, winged 3-5(-6) cells in width. Large reproductive branches: male branches up to 1,5 mm, with up to 20 antheridial pairs (Fig. 20); female branches up to 1,5 mm, 5-22 archegonial pairs, bordered with long paraphyses 75-250 µm long (Fig. 17). Calyptra 625-800 µm long, smooth (Fig. 18). Numerous bicellular gemmae. Numerous fungus filaments on the type material, very closed and/or integrated to the thallus.

When examining the type of *Aneura inconspicua*, using the Bleach and Blue technique, trifurcated papilla clearly appear along margins and reproductive branches. The thalli are really inconspicuous, explaining the name of the species. The general aspect is closed to *R. erosa* from which it has been considered as a synonym; but the presence of the marginal papilla, still remain after more than one hundred years, leading no doubt for the presence of a different species than *R. erosa*.

As published by Furuki (2013), *Aneura exigua* is very similar to *A. inconspicua*, and it is difficult to understand why they have been considered as a synonym of *Riccardia longispica* (Grolle, 1995; Wigginton, 2009).



Figs 16-20. *Riccardia inconspicua*. **16.** Ultimate branches showing marginal lobate papilla. Scale bar 100 µm. **17.** Large female branch, compared to the branches size. **18.** Calyptra and ultimate branches. **19, 20.** Male branch, also bearing papilla. Dusén 841 G-00264075. Scale bars 100 µm.

Furuki (2013) presents *Aneura papulosa* as a *syn. nov.* for *Riccardia inconspicua*, but the type material of Gardiner 35 (see suppl. spec. exam.) is in very small quantity (only a few segments of thalli are left) and very fragile. Stephani described a 12 mm long thallus, irregular, with a biconvex section and a very papillate calyptra. The three thalli that we could observe did not present the habit of *R. inconspicua*, with a larger main axis, the thalli are very fragile, broken easily by manipulation and we did not see marginal papilla. Due also to the lack of material, we do not retain *A. papulosa* as a synonym of *R. inconspicua*.

All the type specimens under the names *Aneura inconspicua* and *A. exigua* present the typical branched mucilaginous papilla of the subgenus *Thornoneura* as described by Furuki (1991, 1994, 2013). Stephani (1893) already observed that margins of female branches were densely papillate, but it seems quite impossible to see the marginal papilla on branches without bleach-blue preparation. It is probably because of the intricate mats, that Stephani saw this species as monoicous. The type material appears clearly dioicous on our preparations.

The characters of the type specimens fit the description of *Riccardia tenuicostata* Schiff., based on their small size, the presence of marginal papilla, the whitish color in herbaria material (well seen on isotype PC0101721) and all the cells dimensions. The drawing and description of *Riccardia babindae* (Hewson, 1970) are also similar to *A. inconspicua*, but we have not seen this material.

Supplementary specimens examined: *Aneura inconspicua* CAMEROUN Ekundu N'dene, 16/03/1892, leg. Dusén 841 (G-00264075, PC-0101721). *Riccardia tenuicostata* Schiffn. 1955:

JAVA occ. res. Priangan, G. Gegerbentang in silvis, in decliv. orient., in ligno putrido, alt. 1800 m, 8/1930, leg. *Verdoorn* 3203 (PC). *Aneura papulosa* Steph. *Sp. Hepat.* 6: 36 1917. Type: SEYCHELLES, *Gardiner* 35 (holotype, G-00047243).

Riccardia limbata (Steph.) E.W. Jones, *Trans. Brit. Bryol. Soc.* 3: 78, 1956.

Basionym: *Aneura limbata* Steph., *Hedwigia* 30: 204, 1891. **Type:** CAMEROUN, Lower Bomania 7/12/1890 *Dusén* 33 (holotype, G-00067566).

Synonyms:

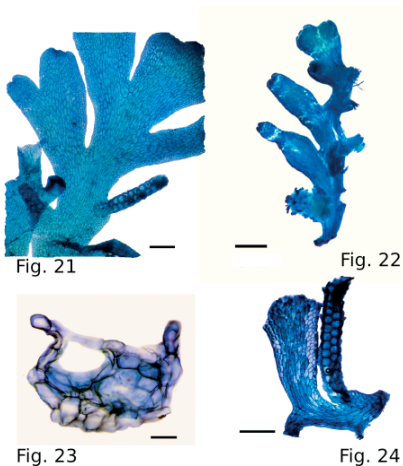
Aneura reticulata Steph., *Hedwigia* 30: 204, 1891. **Type:** CAMEROUN, Ekundu N'dene 22/08/1890 *Dusén* 72 (holotype, G-0067571).

Aneura grosselimbata Steph., *Sp. Hepat.* 5: 29, 1917. **Type:** TANZANIA, Usambara Amani, 1902 *Engler* 635 holotype, G-00067562).

Aneura holstii Steph., *Sp. Hepat.* 6: 31, 1917. **Type:** TANZANIA, Usambaras, *Holst* 695 (holotype, G-00067563).

Thalli large, measured up to 3 cm long (2 cm in Stephani's description), densely bipinnate or tripinnate, and stoloniferous (Fig. 4). Main axis 730-1300 μm wide; in cross section planoconvex, 4-5 cells thick, margin acute consisting in a wing 2-4 cells wide, wing cells larger than other epidermal cells; dorsal epidermal cells 2-4 times smaller than internal cells and ventral epidermal cells 4-7 smaller than internal cells (Fig. 6). Ultimate branches oblong, up to 4 mm long, 400-800 μm wide, 3-4 cells thick, becoming smaller at each order of ramification, with the marginal cells arranged in rows oblique to the axis especially in well-developed ultimate branches; half-median pluricellular zone always to the translucent external zone; in cross sections wing 3-6 cells wide, cells of the same dimensions as internal cells. Mature female branches typically recurved and rejected on the ventral side, bordered by scaly or lacinate paraphyses. In type material, male branches contain less than 14 antheridial pairs (Figs 21, 24) and are bordered by a low wing, only 1-2 cells high (Fig. 23). Calyptra with an umbo of cells at the top, and some blowzy and ciliate paraphyses on the higher part (Fig. 22).

Stephani described only female plants of *Aneura limbata* and ignored male thalli, as it can be observed on the type G-0067566. Other specimens collected by Dusén, such as G-0067567 (see suppl. spec. exam.) contain only male branches.



Figs 21-24. **21.** *Riccardia limbata* showing a male branch, with low wing. **22.** *Aneura grosselimbata* showing the ornamented calyptra. Engler 635, holotype, G-00067562. **23.** Cross section of the male branch. Dusén 33 holotype G-00067566. Scale bar 100 μm . **24.** Male branch of *A. grosselimbata*, similar to those of *R. limbata*. Scale bar 500 μm . Engler 635, holotype, G-00067562. Scale bars 1 mm (Figs 21, 22, 24); 100 μm (Fig. 23).

Aneura grosselimbata was considered as a synonym of *Riccardia amazonica* (Jones, 1956), but even if the material is poor, it appears closer to *R. limbata*. The type material includes male and female thalli, confirming a dioicous state. They are fragile, much broken, and smaller than *A. limbata* in length. Male and female thalli have the same appearance, with ultimate branches of the same width and shape, no heterothallism such as in *R. amazonica* is shown; the half-median zone is clearly to the small translucent zone. Male branches are bordered by a continuous wing, and do not show the terminal bulging cell founded in *R. amazonica* (Fig. 24). The calyptra has an umbo at the top and blowzy ciliate paraphyses in the higher part (Fig. 22).

Aneura holstii shows some monoicous thalli and Stephani described parioicous inflorescences (not seen). The size of the thalli is also larger than those of *Aneura limbata*, with the main axis width up to 1.4 mm. If the monoicous state could be confirmed by recent collections, the polyploidy should be also studied, because it could be a reason for the larger size (Berrie, 1966). All the other characters are similar to those of *R. limbata*. It is richly fertile, and the female branches could also be close to those of *R. fastigiata*. Even if modern authors cite the similarity between *A. holstii* and *R. longispica*, it is clearly closer to *R. limbata* than to *R. longispica*. An ecological survey of the specimens in herbaria material labeled with the names of the three species (*R. limbata*, *R. holstii* and *R. longispica*) will help make a final decision for the position of this type specimen.

Aneura reticulata presents also the same characters as *Riccardia limbata*, with minor differences: the main axis of *A. reticulata* is 6-8 (10 in original description; probably measured at rounded basis of a reiteration?) cells thick and the male branches can total 25 antheridial pairs. The diagnosis character cited by Arnell (1952) for *Aneura reticulata* is a reticulated and characteristic cuticle. We agree with Jones (1956) who was unable to find the striae on the cuticle, either on West African plants including the type. This probably needs more observations on recent South African material.

Regarding the general habit of the types closed to *Riccardia limbata*, it is difficult to maintain that *R. limbata* and associated types could be a form of *Riccardia amazonica*, as suggested by authors (Jones, 1956; Arnell, 1963; Jones & Harrington, 1983; Meenks & Pócs, 1985; Perold, 2002a) in their discussions about the puzzling species *Riccardia amazonica-erosa-limbata*.

Some characters are certainly similar, but they are dubious: the oblique rows of cells leaving the main axis towards the margin, noticed by Jones (1956) and Meenks & Pócs (1985) as characteristic for the species are not constant, even in a single thallus. They can however, be observed on well- developed ultimate branches of *R. amazonica*.

Even if the size is not always a good discriminant features, due to the influence of ecological and nutritional conditions, the type specimen of *R. limbata* shows more than twice the size of *R. amazonica*. Some strong characters can confirm that *R. limbata* is an individual species: (1) the tripinnate branched habit on most developed thalli, (2) the half-median opaque zone always larger than the translucent marginal zone on ultimate branches, (3) the recurved female branches, (4) the male branch which always appears small compared to the ultimate branches and (5) the calyptra with an apical umbo.

Supplementary specimens examined: CAMEROUN, Prope Boangolo 2/2/1891 *Dusén* 33 (G-00067567). It is surprising that the holotype G-00067566, collected in 1890 and this specimen collected in 1891 are labelled with the same collection number “*Dusén* 33”.

Riccardia longispica (Steph.) Pearson, *Forth. Vidensk.-Selsk. Kristinia* 14: 4, 1893.

Basionym: *Aneura longispica* Steph. *Bot. Gaz.* 15: 281, 1890. **Type:** LA RÉUNION Boivin, s.n. (holotype, G-00067568).

Synonyms:

Aneura congoensis Steph., *Sp. Hepat.* 6: 23, 1917 [sensu Jones (1980) but Stephani's description is based on the type specimen *Aneura congoana* Steph. (see discussion in *R. amazonica*). *Aneura congoana* G-00067550 was collected by Laurent, 1903 and *Aneura congoensis* G-00067551 was collected by Le Ret, A.J., 1908.] **Type:** CONGO, 1908, Le Ret (written Le Rat on the label and the description), s.n. (holotype, G-00067551).

Aneura lepervanchei Steph., *Sp. Hepat.* 1: 255, 1899. **Type:** LA RÉUNION, Lepervanche, s.n. (holotype, G-00045032).

Aneura piliflora Steph., *Sp. Hepat.* 6: 38, 1917. **Type:** MADAGASCAR, Betsileo Villaume 153 (holotype, G-00067570).

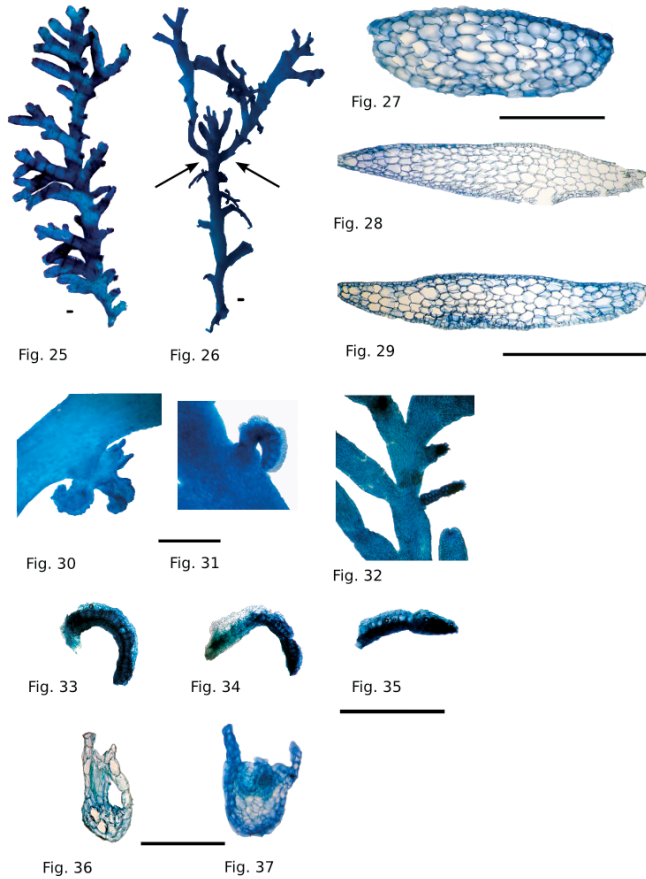
Dioicous. Large thallus, very rigid and leathery, dark brown in herbaria, up to 40 mm. Branching asymmetrical, often with stolons on one side, bipinnate above (Figs 25, 26). Reiterations of the thallus, growing from a rounded axis, emerge 1-2 times on old thalli. Main axis up to 1-1.2 mm wide, in cross section biconvex especially at the basal portions of thallus or reiterations 12-15(-18) cells high (Fig. 27), to slightly plano-convex in the central section, 8-10 cells high, margin acute, sometimes 1-2 cells winged (Figs 28, 29); epidermal cells much smaller than internal cells. Ultimate branches linear, with overlapping apices or at least deeply excavated; elliptic in cross section, margin more acute in *A. longispica*, much rounded and not winged in *A. lepervanchei*. Male branches typically grouped in clusters of 2-3 (-4) (Fig. 30), however some can be solitary (Figs 31, 32), < 1 mm, small compared to the thallus, typically very recurved in young material (Figs 33, 34, 35), and bordered by 3-6 cells high (Figs 36, 37), of continuous and crenulate wing, 3-12 antheridial pairs, separated by 2 cells. When becoming older, that is only seen in the material of *A. longispica*, male branches become elongated and bear up to 20 antheridial pairs (Fig. 35). Female branches short. Calyptra with an umbo of cells and pachydermal cells, armed with a tiny striation.

Riccardia longispica is one of the largest African *Riccardia*. Numerous specimens are labeled with this name in collections, but many of those are probably misidentified. The type specimen from La Réunion, and the new synonym *Aneura lepervanchei*, in a good conservation state, enables consideration of a morphologically well-defined species, even if some minor differences may be observed between them. Type specimens of *Riccardia longispica* possess both male and female branches, *A. lepervanchei* only male ones. Female thalli seem more crowded than male ones. Stephani's description fits well the material observed (Fig. 25).

Aneura lepervanchei Steph. was dedicated to the collector, Lépervanche (Paul Lépervanche and his daughter, Berthe Lépervanche, who have collected all bryophytes they encountered during their stay on the island).

Vanden Berghen (1972) considered *Riccardia fastigiata* and *R. longispica* as synonyms and in Jones & Harrington (1983), similarities between *R. limbata* and *R. longispica* were highlighted. If a deductive reasoning is followed, *R. fastigiata* should be considered similar to *R. limbata*! These opinions could be due to the lack of observation of the type material, leading to misidentified specimen.

Riccardia longispica differs from *R. fastigiata* by: (1) a really more rigid and fleshy thallus, (2) much thicker thallus, (3) shape of the apex with overlapping lobes or deeply excavated on most (but not all) ultimate branches of *R. longispica*



Figs 25-37. Types of *R. longispica* and *A. lepervanchei*. *A. longispica* Boivin holotype G-00067568; *A. lepervanchei* Lepervanche holotype G-00045032. **25.** In toto *A. longispica*. **26.** In toto, *A. lepervanchei*; arrows shows reiterations of the thallus, born from a rounded axis. Scale bar: 1 mm. **27.** Cross section of the main axis basis (or the basis of a reiteration). **28.** Cross-section of the main axis, middle of *A. longispica*. **29.** Cross section of the main axis, middle of *A. lepervanchei*. **30-31.** recurved male branches, grouped in cluster or solitary *A. lepervanchei*. **32.** Older linear male branch. **33-35.** Different forms of male branches in *A. longispica*. **36-37.** Cross section of male branches in *A. longispica* and *A. lepervanchei*, respectively. Scale bars 1 mm (Figs 25-35), 100 μm (Figs 36-37).

(emarginate in *R. fastigiata*). This character is not constant and depends of the age of the branches, (4) longer ultimate branches without growing notches and (5) numerous stolons along the main axis.

Aneura congoensis is very similar to *Riccardia longispica*.

Aneura piliflora is one of the taxa presented as *Riccardia* sp. in Grolle (1995). Only 5 thalli are left in the envelope, with one male branch and several female branches. We did not apply the “Bleach and Blue” preparation, in order to preserve the material. The thalli are morphologically similar to *R. longispica*.

As mentioned above, *Aneura exigua* Steph. *Sp. Hepat.*, 6: 25 (1917) was considered as a synonym of *Riccardia longispica* (Grolle, 1995), but it is very different. It is given here as a *syn. nov.* of *R. inconspicua*, following Furuki (2013).

Riccardia obtusa Arnell, *Bot. Not.* 105: 142, 1952.

Type: SOUTH-AFRICA, Cape province, Knysna, Deepwall Forest Reserve, on a wet sandstone slope. Arnell 1602 (holotype, UPS; isotype, BOL, S-B20192). holotype n.v.

Synonym: *Aneura papulosa* Steph., *Sp. Hepat.* 6: 36, 1917 *nom. illeg.* [non Steph. *Hedwigia* 32: 35 1893]. **Type:** SEYCHELLES, Gardiner 35 (holotype, (G-00047243).

One can refer to Perold (2002a) which described very completely this species from the isotype kept in BOL herbarium. The only difference we noticed with Perold's description is the position of the female branches, that are clearly ventral on the type specimen, that Perold described as arising laterally.

The general habit is closed to those of *Riccardia saccatiflora*, with numerous palmate branches, but the following characters distinguish them: (1) thallus very fleshy and very adherent to the substratum, and to each other (Fig. 6), almost fragile and easily broken by manipulating the thallus, (2) in cross section, the main axis is not winged, (3) ultimate branches are biconvex, not very different in shape than the axis, showing two forms: in young, palmate and apical parts, rounded ultimate branches without wings; near basis or in older parts, shortly elongated ultimate branches, with an irregular wing 1-2 (-3) cells, (4) dioicous.

One may also notice that only Arnell (1952) and Perold (2002a) studied *R. obtusa*. Jones (1956); Meenks & Pócs (1985); Jones (2004) only referred to *R. saccatiflora*. The type specimen of *R. obtusa* is from South Africa, and those of *R. saccatiflora* from La Réunion. Grolle (1995) excluded *R. obtusa* from East African Islands.

***Riccardia ramosissima* (Steph.) Grolle**

Basionym: *Aneura ramosissima* Steph., *Bull. Soc. Roy. Bot. Belgique* 30: 196, 1891.

Type: LA RÉUNION, Rodriguez s.n. (holotype, G-00045033). *Riccardia ramosissimus* (Steph.) E.W. Jones *nom. inval. fide* Grolle (1994).

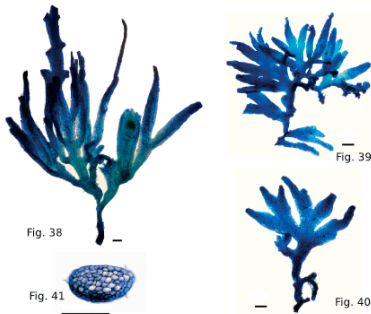
Synonym: *Aneura corbieri* Steph., *Sp. Hepat.* 6: 23, 1917. **Type:** MADAGASCAR, 1898 *Leloutre* 126a (holotype, G-00045028).

Riccardia kilimanjarica Arnell, *Svensk. Bot. Tidskr.* 53: 543 (1959).

Type: TANZANIA Tanganyika, Mt. Kilimanjaro, Peter's Hut, wet shaded face at a waterfall in a rocky stream, *Esterhuysen* 27249 (S-B43610).

Characterized by long and thin ultimate branches, born from a same point, but clearly individual, with a large common basis (Figs 38, 39, 40). In cross section, main axis either elliptical or convexo-plane, the convex part being dorsal, 6-7 cells thick, margin rounded (Fig. 41) to acute in central sections, with only 1 cell of wing. Ultimate branches with a pyramidal or triangular shape, a small marginal translucent zone, always < to central opaque zone; in cross section the dorsal face always convex, the section convexo-plane or convexo-concave, 4-5 cells thick and bordered by 2 cells of wing. Few female branches are present on the type specimen, showing a low wing and inconspicuous paraphyses. Sporophytes show a naked calyptra bearing only a small umbo of cells at the apex.

Aneura corbieri was transferred to *Riccardia sp.* by Grolle (1985) and only a small quantity of material is left (only a dozen thalli), but it was in a good conservational state. The size and habit are very close to those of *R. ramosissima*. The triangular shape of the ultimate branches is very regular, as well as the clusters of ultimate branches (Fig. 39). Recurved female branches are present, but no sporophytes.



Figs 38-41. **38.** Habit of *Aneura ramosissima*.

Rodriguez holotype G-00045033.

Scale bar 500 μ m. **39.** *Aneura corbieri*.

Leloutre 126a holotype G-00045028.

40. Material of the *Aneura nudiflora*

G-00064569. Scale bar 500 μ m. **41.** Cross section

of the axis of *A. ramosissima*. Rodriguez holotype G-00045033. Scale bar 100 μ m.

Riccardia kilimanjarica was put in synonymy with *R. compacta* by Meenks & Pócs (1985). The specimen is fragile, light colored, without a dark line in the middle on the axis, and without this “corymbe” habit of branches of *R. compacta* and *R. ramosissima*. It presents no wing, cross sections of axis are plano-convex, and dorsal epidermal cells of the same width as internal cells, ventral epidermal cells are smaller.

The comparison of these morphologically close types (*Riccardia compacta*, *R. ramosissima*, *R. kilimanjarica*) is presented Table 3. We agree with Perold (2002b) who hesitated to accept *R. kilimanjarica* as a synonym of *R. compacta*. The type specimen of *R. kilimanjarica* lives at higher altitudes than that of *R. compacta*, and no indication is given for *A. ramosissima*, only known from type material. The ecological range given by other collections would also give important indications for species preferendum. However it is clearly closer to *R. ramosissima* than to *R. compacta* and we present *R. kilimanjarica* as a synonym of the former species.

Riccardia saccatiflora (Steph.) Arnell, *Bot. Not.* 105: 144, 1952.

Basionym: *Aneura saccatiflora* Steph., *Bot. Gaz.* 15: 282, 1890. **Type:** LA RÉUNION, Rodriguez 186 (lectotype designed here, PC-102136; isolectotype G-00067576).

Synonyms: *Aneura dismieri* Steph., *Sp. Hepat.* 6: 24, 1917. **Type:** MADAGASCAR, Rotereau 915 (lectotype designed here, G-00045029).

Riccardia rhodesia Arnell, *Bot. Not.* 105: 150, 1952. **Type:** Zimbabwe, 11/11/1951, Arnell (holotype, S-B20191).

Thallus rather compact, irregularly branched, 1-1.5 cm. Monoicous. Main axis often in fan between two branches, marginal translucent zone not obvious; in cross-section, biconvex to plano-convex with an irregular wing of 1-2 cells, often present only on one side. Ultimate branches crisp and ventrally recurved on dry specimens, translucent zone always narrow, width of the half median zone obviously > to the translucent zone; in cross section, convexo-concave (reflecting its crisp habit when dry) margin acute with a 2-3 cells of wing. Male branches solitary or grouped by 2-3, each bordered with a continuous wing of 3-4 cells high, antheridial chambers separate by 2 cells, number of antheridial pairs < 8. Female branches in a ventral position, bordered with long paraphyses. Calyptra very hirsute.

Stephani's description (Stephani, 1890) is very complete for this type specimen. We design PC-102136 as the lectotype because it is the only fertile specimen among all the Rodriguez material. The specimen G-0067576 is preserved well but contains only a small piece of bark with *Riccardia saccatiflora*.

The habit and characters of *Aneura dismieri* are similar to those of *Riccardia saccatiflora*, except the monoicous state, not observed. No male branches could be found and they are not described by Stephani.

Riccardia rhodesiae is monoicous or paroicous and shows the same palmate branches and other characters as *R. saccatiflora*. Known only from the type, it shows the same characters. We suggest the synonymy, but are waiting for more collections.

Supplementary material examined: *A. saccatiflora* Steph.: LA RÉUNION Rodriguez s.n. (G-00067572, G-00067573), Rodriguez 182 (G-00067574), Rodriguez 183 (G-00067575), Rodriguez 178 (G-00067577). *A. dismieri* Steph.: Rotereau 908 (G-00045030).

Lobatiriccardia cf. *coronopus*

Lobatiriccardia coronopus (De Not.) Furuki, *J. Hattori Bot. Lab.* 100: 90, 2006.

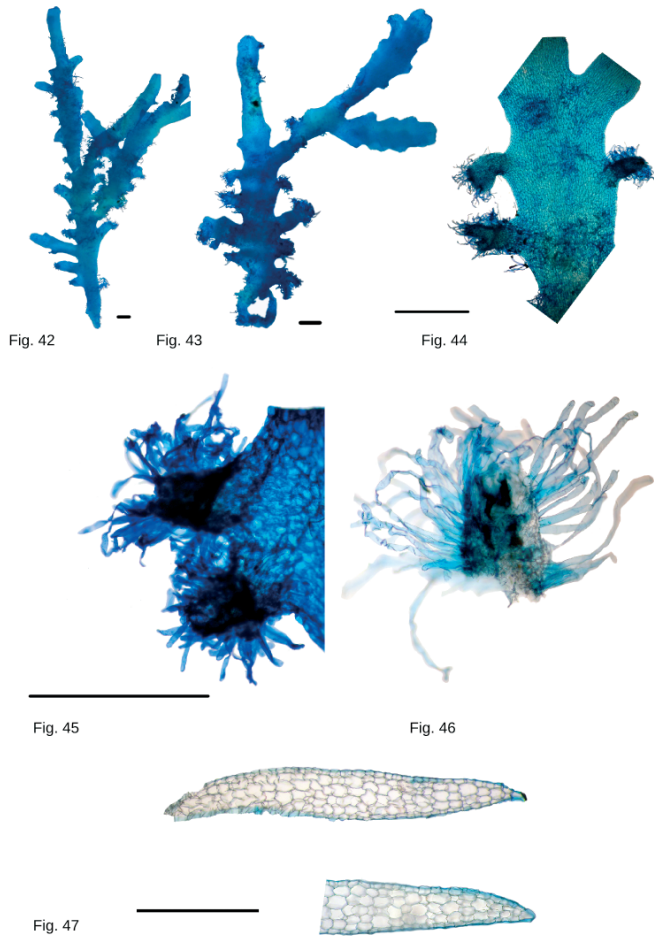
Basionym: *Aneura coronopus* De Not., *Hedwigia* 31: 19, 1893. **Type:** BORNEO, Beccari s.n. (holotype, G-24124 n.v.).

Aneura comosa Steph., *Bot. Gaz.* 15: 281, 1890, **syn. nov.** **Type:** LA RÉUNION, Rodriguez, s.n., (holotype, G-00045027). 1889, Rodriguez, s.n. (isotype, PC-0103522). *Riccardia comosa* (Steph.) E.W. Jones, *Trans. Brit. Bryol. Soc.* 3: 83, 1956. nom. inval. fide Grolle (1995).

Dioicous. Thallus up to 70 mm, creeping and growing loosely in mats. Branching mostly pinnate to bipinnate, alternate to subopposite with sometimes 1-2 reiterations, often asymmetrical, stolons absent or not seen (Figs 42, 43). Rhizoids numerous and occupying the whole width of the ventral face when they are present (Fig. 44). Main axis mostly biconvex to plano-convex, in the basal part and central section, 2-4 mm large, 6-8(-10) cells thick, margin acute, consisting in a wing of 1(-2) cells in cross section (Fig. 47). Epidermal cells thin walled. In cross section, epidermal cells 0.5-1 times smaller than internal cells. Terminating branches have a length of up to 8 mm, 800-2000 µm wide, elongate with mostly parallel edges, crenulate, cells becoming smaller at the margin, 4-5 cells thick in the central part of the branch; margins winged, the wing 3-4(-6) cells wide, and in surface view the width of the translucent area always much smaller than the central pluricellular area, cells generally not, or only slightly bulging; apex rounded or truncate and with little dissection (dissection up to 130 µm). Mucilaginous papilla 20 persistent and present at the apex and in four ventral rows.

Male branches not seen. Female branches present on the main axis of the thallus and on primary branches, mostly lateral in position, solitary or grouped, 460-800 µm long. Dense unicellular cilia like paraphyses, up to 25 to 680 µm, all along the branch (Figs 45, 46). Sporophyte and calyptra not seen.

Aneura comosa was transferred to *Riccardia* by Grolle (1995), and kept as *Riccardia* sp. by Wigginton (2009). It is known by the type specimens from La Reunion and some old records showing the same patterns, only with female branches. This large species shows characteristic features of the genus *Lobatiriccardia* (Furuki, 1991, 1996; Preussing, 2010): (1) rhizoids present on all of the ventral widths of the thallus, (2) large width of the axis, and lobed margins, (3) margin slightly incurved. (4) Characteristic paraphyses of female branches. Unfortunately it was impossible to see calyptra and male branches, which could confirm the diagnosis. The only *Lobatiriccardia* showing ciliate and unicellular paraphysis is *L. coronopus*. Whilst waiting for putative recent material, we suggest that *A. comosa* is closed to *L. coronopus*.



Figs 42-46. **42-43.** *Aneura comosa*, in toto. **44.** Ventral view showing the large zone of rhizoids. Scale bar 2 mm. **45-46.** Close view of female branches with ciliate paraphyses. Scale bar 500 μ m. **47.** Cross-section of the main axis in middle part. Rodriguez holotype G-00045027. Scale bar 300 μ m.

Known only from Australasia (Furuki, 1991; Preussing, 2011), this citation from Indian Ocean will extend its area, if the species is confirmed.

Supplementary material examined: *Aneura comosa* Steph. LA RÉUNION, G. de l'Isle 220 sur les mousses, source pétrifiante de Hell-Bourg (PC).

CONCLUSIONS

Before this study, all the species of African *Riccardia* belonged to the subgenus *Riccardia* (with two rows of ventral papilla). After examination of the types specimen of African *Riccardia*, one sub-genus, *Thornoneura* (*R. incons-*

picua comb. nov.) and one genus, *Lobatiriccardia*, these genera have been discovered as being new for Africa. Ten taxa of *Riccardia* are recognized at the specific rank level, seven accepted species are confirmed (*Riccardia compacta*, *Riccardia erosa*, *Riccardia fastigiata*, *Riccardia limbata*, *Riccardia longispica*, *Riccardia obtusa*, *Riccardia saccatiflora*), one new combination are presented (*Riccardia inconspicua*).

Riccardia amazonica is maintained as the valid name for five African species (*Aneura stephanii*, *A. angusticosta*, *A. congoana*, *A. travisiana*, *R. capensis*), with the hope that further analysis could clarify these unclear relationships between a South-American and an African species.

These results show once again the great importance of historical herbarium collections, despite being older than one hundred years, and sometimes using very tiny plant material. The on-line information presented by Geneva Herbarium was of great help for daily researches, even if it is difficult to take advantage of images for such plants, because of their small size and the sticky aggregation of the thallus.

For the moment, *Riccardia inconspicua*, *R. ramosissima* (and *Lobatiriccardia* cf. *coronopus*, not belonging to *Riccardia*) are just known from the old type material, and have not been collected again in recent explorations. Their re-discovery could be a goal for future researches on the field and for studies of indeterminate herbarium specimens. Nevertheless, these results also show the necessity to maintain sampling efforts on the field. Even if recent explorations of La Reunion (Ah-Peng & Bardat, 2005, Ah-Peng *et al.*, 2012) have been conducted, some taxa were not collected recently (*R. inconspicua* and *Lobatiriccardia* cf. *coronopus*). Is it an effect of the natural rarity of the species, or of the anthropogenic pressures of the last century on fragile ecosystems?

Dubious name: *Aneura nudiflora* Steph., *Hedwigia* 31: 199, 1892.

Type: MAURICE, *Robillard*, s.n. (G-0037569).

The type specimen of *Aneura nudiflora* in the Geneva Herbarium is from Maurice, leg. Rebillard, and all of the characters are similar to those of *A. corbieri* described above, with triangular ultimate branches. The type specimen seems to be constituted by numerous broken thalli. The discussion in Jones (1956) p. 80 reveals a problem with the type specimen of *A. nudiflora*: “There is, however great doubt as to what constitutes the type of *Aneura nudiflora*, for the only specimen from Bourbon (the type locality) under this name was gathered by Balfour, not by Rodriguez who is cited as the collector of the type”. Stephani (1892) cited three different locations for *A. nudiflora*: la Réunion, Maurice and Madagascar. The first citation, from Bourbon is collected by Rodriguez (Stephani, 1892), and only female branches are described, but as noticed by Jones, the specimen is collected by Balfour and not Rodriguez; then, in *Sp. Hepat.* (1900), the description is modified and the species habit is given from Maurice and Madagascar. Jones (1956) rejected the name *A. nudiflora*, but Grolle (1995) maintained it and transferred it to the genus *Riccardia*, as *Riccardia nudiflora* (Steph.) Grolle. We think that it more reasonable to put the name as “*nomen dubium*” and to reject it.

Dubious name and type non seen: *Aneura caespitans* Steph., *Bull. Soc. Roy. Bot. Belgique* 30: 194, 1891. **Type (?)**. *Riccardia caespitans* (Steph.) E.W. Jones, *Trans. Brit. Bryol. Soc.* 3: 74-84, 1956 nom. inval. *vide* Grolle (1995).

Additional material examined: CAMEROUN Buea, 13/07/1891 *Dusén* 251 (?type, G-00067548).

The type specimen of *A. caespitans* is puzzling (Table 3): it has been described by Stephani first in 1891 (Stephani, 1891), but the specimen cited is from “Bourbon, Leg. Rodriguez”. The Stephani's Icon N°236 referred to a specimen from Cameroun, “Dusén 251” and the description is given in two columns: the first one is exactly the description of the vegetative thallus printed in Stephani (1891), but the second column describes the mature calyptra and is not been printed on the original description, which furthermore mentions that the female branches are very young. In 1892, Stephani published exactly the same description, associated with the Bourbon specimen from Rodrigez (Stephani, 1892). Finally, a third publication of *Aneura caespitans* was completed in Sp. Hepat. (Stephani, 1900) which mixed the icon 236 and the 1891 & 1892 publications and referred this time to Dusén 251! This specimen, is absolutely not the thallus described by Stephani, both in the icon or the publication (Stephani, 1891). DusÈn's specimen is similar to *Riccardia obtusa*: dense, very palmate, main axis asymmetrically winged 1-2 cells, 5-6(-8) cells thick, calyptra with laminate expansions. It seems less fleshy than *Riccardia obtusa*, but the old age of the specimen could explain this. We could not find the Bourbon specimen from Rodrigez in the material we studied.

Even if we focus on type specimens, let us consider that many african material labelled “*Riccardia caespitans*” belong indeed to other species. At the for-front of this confusing situation, we present that *Aneura caespitans* has become an invalid name and that the collections labelled with this name have to be identified again.

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APPENDIX

Appendice 1 – List of the type specimens for valid *Riccardia* species, according Grolle, 1995, Wigginton, 2009.

<i>Name of the type</i>	<i>Herbarium</i>	<i>Col. Number</i>	<i>Status</i>	<i>BarCode or HB number</i>	<i>Date of collection</i>	<i>Location</i>	<i>Collector</i>
<i>Aneura amazonica</i> Spruce	MANCH	CC1679	isolectotype Meenks (1985)	EM71223		Brazil, Para	Spruce
	MANCH	CC1680	lectotype Meenks (1985)	EM71234		Brazil, San Carlos	Spruce
	MANCH	CC1687	isolectotype Meenks (1985)	EM71310		Brazil, Para	Spruce
<i>Aneura angusticosta</i> Steph.	G	27076	holotype	G00067547	1909	Tanzanie, Usambaras Mts	Brunnthaler
<i>Aneura caespitans</i> Steph.	G	??	??				?
<i>Aneura comosa</i> Steph.	G	17653	holotype	G00045027		Réunion (Ile de la)	Rodriguez
<i>Aneura compacta</i> Steph.	G	19560	holotype	G00067549	s.d.	South Africa, Cape Tafelberg	Jelinek
	S	s.n.	isotype	B20511	s.d.	South Africa, Cape Tafelberg	Jelinek
	PC	s.n.	isotype	PC-0101714	s.d.	South Africa, Cape Tafelberg	Jelinek
<i>Aneura congoana</i> Steph.	G	27075	holotype	G00067550	12/31/02	Congo (Brazzaville)	Laurent
<i>Aneura congoensis</i> Steph.	G	Cardot 289	holotype	G00067551	1908	Congo (Brazzaville), Bolombo	Le Rat
<i>Aneura corbieri</i> Steph.	G	Leloutre 126a	holotype	G00045028	1898	Madagascar	Leloutre
<i>Aneura dismeri</i> Steph.	G	915	lectotype designed here	G00045029	s.d.	Madagascar	Rotereau
<i>Aneura erosa</i> Steph.	G	Quintas 7	holotype	G00067552	1889	Sao Tomé	Quintas
<i>Aneura exigua</i> Steph.	G	s.n.	holotype	G00067553	s.d.	Seychelles (République des)	Gardiner
<i>Aneura grosselimbata</i> Steph.	G	Engler 635	holotype	G00067562	1902	Tanzanie, Usambaras Mts	Engler
<i>Aneura holstii</i> Steph.	G	Holst 695	holotype	G00067563	s.d.	Tanzanie, Usambaras Mts	Holst, C.H.E.
<i>Aneura inconspicua</i> Steph.	G	J.R.5	holotype	G00067564	s.d.	Cameroun	Jungner
	P, PC	s.n.	isotype	PC0101721	1892	Cameroun	–
	S	s.n.	isotype	B20523	s.d.	Cameroun	Jungner
<i>Aneura lepervanchei</i> Steph.	G	s.n.	holotype	G00045032	s.d.	Réunion (Ile de la)	Lepervanche
<i>Aneura limbata</i> Steph.	G	93	isotype	G00067566	07/12/1890	Cameroun, Lower Bomama	Dusén

<i>Aneura longispica</i> Steph.	G	s.n.	holotype	G00067568	s.d.	Réunion (Ile de la)	Boivin
<i>Aneura nudiflora</i> Steph.	G	27086	??	G00067569	10/01/88	Maurice (Ile), Raoul Island	Robillard
<i>Aneura papulosa</i> Steph.	G	Gardiner35	holotype	G00047243	s.d.	Seychelles (République des)	Gardiner
<i>Aneura piliflora</i> Steph.	G	Villaume153	holotype	G00067570	1917	Madagascar, Pays Betsileo	Villaume
<i>Aneura ramosissima</i> Steph.	G	s.n.	holotype	G00045033	s.d.	Réunion (Ile de la)	Rodriguez
<i>Aneura reticulata</i> Steph.	G	72	holotype	G00067571	22/08/1890	Cameroun, Ekundu N'Dene	Dusén
<i>Aneura saccatiflora</i> Steph.	PC	186	lectotype	PC-102136	s.d.	Réunion (Ile de la)	Rodriguez
	G	10700-186	isolectotype	G00067576	s.d.	Réunion (Ile de la)	Rodriguez
<i>Aneura stephanii</i> Besch.	G	s.n.	holotype	G00067578	1892	Congo (Brazzaville)	Thollon
<i>Aneura tenera</i> Steph.	G	Baur5118	lectotype	G00067580	1906	Tanzanie, Usambaras Mts	Baur
	G	Baur5118	isolectotype	G00067579	1906	Tanzanie, Usambaras Mts	Baur
<i>Aneura travisiana</i> Pearson	MANCH	761a CC2068	holotype	EM74033	s.d.	Cameroun	Trevis
<i>Jungermannia fastigiata</i>		??			s.d.	South-Africa	Ecklon
<i>Riccardia capensis</i> S.W. Arnell	Inconnu	1790	holotype	B20193	28/11/1951	South Africa, Cape Province, Knysna	Arnell
<i>Riccardia kilimandjarica</i> S.W. Arnell	S	Esterhuysen 27249	holotype	B43610	10/08/1957	Tanzanie, Kilimanjaro Mts	Esterhuysen
<i>Riccardia obtusa</i> S.W. Arnell	S, BOL	Arnell1602	holotype	B20192	28/11/1951	South Africa, Cape Province, Knysna	Arnell
<i>Riccardia rhodesiae</i> S.W. Arnell	S		holotype	B20191	11/11/51	Zimbabwe	Arnell

Appendice 2 - Numeric views taken for each type specimen of *Riccardia*.

CS = cross section.

In toto
Main axis: close-view and CS
Ultimate branch: close-view, apex and CS
Male branch: close-view and CS
Female branch: close-view