

Liverworts and Hornworts of Rwanda

Eberhard Fischer



Volume 14 (2013)

Abc Taxa

the Series of Manuals
Dedicated to Capacity Building
in Taxonomy and
Collection Management

WITH THE SUPPORT OF
THE BELGIAN
DEVELOPMENT COOPERATION 

Editors

Yves Samyn - Zoology (non African)

Scientific Service of Heritage
Royal Belgian Institute of Natural Sciences
Rue Vautier 29, B-1000 Brussels, Belgium
yves.samyn@naturalsciences.be

Didier VandenSpiegel - Zoology (African)

Department of African Zoology
Royal Museum for Central Africa
Chaussée de Louvain 13, B-3080 Tervuren, Belgium
dvdspiegel@africamuseum.be

Jérôme Degreef - Botany

Belgian Focal Point for the Global Strategy for Plant Conservation
National Botanic Garden of Belgium
Domaine de Bouchout, B-1860 Meise, Belgium
jerome.degreef@br.fgov.be

Instructions to authors

<http://www.abctaxa.be>

ISSN 1784-1283 (hard copy) / ISSN 1784-1291 (on-line pdf)
ISBN 9789082179804 (hard copy) / ISBN 9789082179811 (on-line pdf)
NUR 910 / D/2013/0339/13

Liverworts and Hornworts of Rwanda



by

Eberhard Fischer

Institute for Integrated Natural Sciences, Department of Biology, University of
Koblenz-Landau, Universitätsstr. 1, D-56070 Koblenz, Germany
Email: efischer@uni-koblenz.de

Front cover. *Asterella khasyana* (Griff.) Pandé, K.P.Srivast. & Sultan Khan,
Cyamudongo Forest.

Half-title page. *Herbertus dicranus* (Tayl. ex Gottsche *et al.*) Trevis., Mt. Sabinyo.

Abstract

The book contains the first part of a bryophyte flora of Rwanda covering 262 liverworts and hornworts. General information on flora and vegetation of Rwanda, the history of bryological exploration, and the phytogeography of liverworts and hornworts are provided. Keys for all genera and species recorded from Rwanda are presented. An introduction to the morphology of liverworts and hornworts is given, and collecting techniques are described. The main part of the book deals with the foliose and thallose liverworts and the hornworts. Each species is represented by habit photographs and microscopic details.

Keywords – liverworts, Marchantiophyta, hornworts, Anthocerotophyta, Rwanda, Albertine Rift, endemics

Dedicated to Tamás Pócs on the occasion of his 80th birthday

Table of contents

1.	Purpose of this book	7
2.	Introduction	8
3.	History of bryological exploration	10
4.	Vegetation of Rwanda and bryophyte habitats	12
4.1.	Montane forests	12
4.2.	The Virunga Volcanoes and their altitudinal zonation	25
4.3.	Savanna Vegetation	25
4.4.	Gallery forests	31
4.5.	Agricultural landscape and plantations	31
5.	Diversity and phytogeography of bryophytes in Rwanda ..	35
6.	Systematics of Liverworts and Hornworts	38
7.	Collection of bryophytes	42
8.	Morphology and characters of Liverworts and Hornworts .	44
9.	Artificial key to groups	69
9.1.	Jungermanniopsida – Key to Families and Genera in Rwanda..	70
9.2.	Families of Leafy liverworts with ≥ 2 genera in Rwanda Keys to Genera in Rwanda	75
9.3.	Leafy liverwort genera – Keys to Species in Rwanda	82
9.4.	Thallose liverworts – Key to Families and Genera in Rwanda ..	110
9.5.	Families of Thallose liverworts with ≥ 2 genera in Rwanda Keys to Genera in Rwanda	112
9.6.	Thallose liverwort genera – Keys to Species in Rwanda	113

9.7.	Hornworts – Key to Genera and Species in Rwanda	119
10.	Descriptions of species from Rwanda	121
10.1.	Leafy liverworts	121
10.2.	Thallose liverworts	456
10.3.	Hornworts	525
11.	References	533
12.	Acknowledgements	544
13.	About the author	545
14.	Index to the scientific names	546

1. Purpose of this book

While most areas of the world are covered by a local flora of ferns and flowering plants, the situation is different for bryophytes. Many regions of the world do not yet have a bryophyte flora, including large parts of Africa. Most of the work on bryophytes in Africa has been done by non-Africans, usually Europeans (see chapter 3), many of whom travelled little or not at all in Africa but received collections made by explorers, or botanists specializing in vascular plants. The literature on these collections is copious but extremely scattered and usually not available to African students of bryophytes. The need for bryophyte floras covering tropical Africa is apparent and had already been stressed by O'Shea (2005). The lack of available literature, including floras and identification keys, means that local botanists are often unable to identify bryophyte specimens, and therefore bryophytes have usually been omitted from biodiversity studies. They have also been considered a 'difficult' group, which has been another obstacle to their study (O'Shea, 2005). However, bryophytes can be important in studies of biodiversity, as many species are sensitive bioindicators that respond quickly to environmental change. They are pioneer organisms growing, for example, on almost bare rock where they prepare the habitat for the colonization of flowering plants. They also contribute enormously to the water management and equilibrium of the forest because of their often large biomass. They intercept rain, swell up with the rainwater and accumulate water many times their weight (Pócs, 1980). Last, but not least, bryophytes are beautiful plants that enhance the aesthetic value of landscapes and habitats, notably when in dense masses in moss-draped forests or on rock-faces.

The publication of the present identification guide to liverworts and hornworts, as well as a guide to mosses (in prep.), is intended to greatly facilitate further bryological studies in Rwanda and adjacent countries. The guide is based on the author's observations and collections from Rwanda during 75 field trips since 1984. However, the identification of specimens would not have been possible without the numerous taxonomic papers available on African liverworts and cited in the Key section, especially the monumental series "African Hepatics" by E.W. Jones. These references have also been consulted for the compilation of species descriptions and identification keys (e.g. Jones, 1990). For writing the general chapters on morphology, anatomy and collecting, the publications of Schuster (1984), Gradstein & Pinheiro da Costa (2003) and Wigginton (2004) have been extensively used. Nomenclature and species concepts mainly follow Wigginton (2009) except for *Aphanolejeunea*, now included in *Cololejeunea* (Pócs & Bernecker, 2009), and *Leucolejeunea*, now included in *Cheilolejeunea* (Malombe, 2009). Where possible, fresh material from Rwanda has been illustrated, but for several taxa which were not available in the fresh state, herbarium material has been used.

2. Introduction

The Bryophytes of Tropical Africa are among the better studied groups, compared with those of Tropical America or Asia. Especially for Liverworts and Hornworts, numerous valuable taxonomic revisions, a modern catalogue (Wigginton & Grolle, 1996; Wigginton, 2009) and a modern flora for Western Tropical Africa (Wigginton, 2004) are available. The Liverworts of Katanga in South-Eastern D.R. Congo were studied by Vanden Berghen (1972a, 1978b). For mosses of Tropical Africa, only the today mostly outdated treatments for the Central African Republic (Potier de la Varde, 1928) and Gabon (Potier de la Varde, 1936) are available. For Southern Africa, a moss flora has been published (Magill, 1981, 1987; Magill & van Rooy, 1998), albeit not yet completed. The liverworts of Southern Africa are treated by a flora (Arnell, 1963) and a modern revision of the thallose hepatics (Perold, 1999). For the liverworts, E.W. Jones's "African Hepatics" series (Jones, 1952-1990) is an important source for identification. Numerous papers on African liverworts have been published by Vanden Berghen, and Pócs. All these papers, albeit very valuable, do not represent a Flora which can be used by the interested student to identify African bryophytes. The publication of Jones's Liverwort and Hornwort Flora of West Africa, edited by Wigginton (2004) and covering the countries from Senegal to Cameroon was a real milestone. For the mosses, De Sloover published a series of revisions on an African scale (e.g. De Sloover, 1973), the illustrations for which were later published in a separate volume (De Sloover, 2003). However, no complete bryophyte flora of a tropical African country including both liverworts and mosses yet exists. The attempt of the British Bryological Society to compile the "Bryophytes of Uganda" as a book, based on collections gathered during several expeditions of the British Bryological Society to this country finally resulted in publication of 13 families as separate papers (Váňa & Watling, 2004a,b,c; Hedenäs, 2005; Hedenäs & Watling, 2005; Bruggeman-Nannenga, 2006a,b; Ellis, 2007; Wilbraham, 2008; Frahm, 2012). The remaining 76 families are still to be treated which, with an output of 13 families in 9 years, may not be realised for some time. An identification guide to the bryophytes of Kenya was published by Chuah- Petiot (2003), but is not comprehensive, and covers mainly the most conspicuous taxa.

The present study is an attempt to provide a complete bryophyte flora for Rwanda, a small country situated near the Equator in the heart of Africa (Fig. 1). Since 1984, the author has visited the country more than 70 times with a special attention given to bryophytes. In 1991, the BRYOTROP-Expedition provided numerous additions to the flora. The genocide in 1994 interrupted all scientific activity, yet in 1996, cooperation could be resumed, and teaching started again at the National University in Butare. Due to an increased interest in ecology, the lack of a flora to assist in the determination of bryophytes became apparent. The idea of producing an identification guide had already arisen in 1988, but work on a guide was postponed for several reasons. However, some taxonomic papers were published subsequently (e.g. Fischer, 1995; Buchbender & Fischer, 2004; Fischer, 2007). With the rapid development of digital photography, it became much easier to publish

coloured illustrations, and it was decided to provide both habit photographs and also photographs of microscopic details in order to facilitate identifications. In the present volume, the liverworts and hornworts of Rwanda are fully covered, and a similar volume for the mosses is currently underway. However, the guides can be useful far beyond the borders of Rwanda, including for montane areas in tropical East Africa as a whole.



Fig. 1. Map of Rwanda.

3. History of bryological exploration

Until 1907, the flora and fauna of Rwanda was almost unknown. During the expedition of Graf von Götzen (1895) apparently no bryophytes were collected. Richard Kandt (see Bindseil, 2008) who lived in Rwanda as private naturalist from 1898-1902, 1905-1907 and later as the Imperial Resident for Rwanda until 1913 made some botanical collections, unfortunately only flowering plants.

In 1907 Adolf-Friedrich Herzog zu Mecklenburg began an expedition, with the intention of exploring Rwanda and the eastern Belgian Congo. He was accompanied by the geologist Egon Kirschstein, botanist Johannes Mildbraed, zoologist Hermann Schubotz, anthropologist Jan Czekanowski, Lieutenant and cartographer Max Weiss, physician and bacteriologist W. von Raven, as well as Lieutenant Walter von Wiese und Kaiserwaldau, Friedrich Weidemann, Sergeant Czeczotka and 25 Askari (Mecklenburg, 1909). They travelled by train to Lake Victoria, and marched to northeast Rwanda, where they collected at the Lake Mohasi (see Bamps, 1975). After having visited the court of King Yuhi V. Musinga, Mildbraed and Schubotz left the expedition for about two weeks in order to collect plants and animals in the Nyungwe forest (= Rugege Wald). Until March 1908, Mildbraed visited Lake Kivu and the Virunga Volcanoes, and afterwards the eastern Congo (Ituri, Aruwimi) and the Ruwenzori mountains. In May 1908 the expedition travelled down the river Congo by steam boat until they reached the western coast of Africa. They arrived in Hamburg on the 30th June 1908. The scientific results were published by 1925. The botanical volume, edited by Mildbraed in 1914 covered 718 pages. The hepatics were studied by Stephani (1914), who recognized 57 species collected during the expedition, among them 45 new species of liverworts and one new hornwort. He recorded 19 species for Rwanda, 17 of them described as new (Tab. 1). In addition, 28 species were recorded from Butagu valley on the Congolese side of the Ruwenzori, 23 of them described as new taxa. Many of these species from Ruwenzori were later also found in Rwanda. The genus *Sphagnum* was studied by Warnstorf (1914), covering 5 species of which 3 were described as new. The mosses finally were identified by Brotherus (1914), who described 57 new species from the 137 species recognized.

Their treatments would remain a classic work and the only bryological account for Rwanda and D.R. Congo (former Zaïre) for more than 30 years. It also was the basis for Demaret's checklists for Central Africa (see below). Stephani (1914) stated that "wie aus dem Vorstehenden ersichtlich ist, haben wir hier eine Sammlung von Lebermoosen vor uns, welche zu den interessantesten gehört, die jemals nach Europa gelangt sind; wenn diese Pflanzen sich auch an bekannte Gattungen anschließen, so zeigen doch die meisten der gesammelten Arten so überraschende Abweichungen, daß eine weitere Erforschung der ostafrikanischen Gebirge ein naheliegender Wunsch ist." (Stephani, 1914: 134) (*"As it can be seen from the previous treatment, we have here a collection of liverworts which is among the most interesting ones that ever reached Europe; even if these plants can be*

assigned to known genera, most of them show such surprising differences that a further exploration of the East African mountains is highly desirable”).

Stephani (1914)	Actual name	Locality
<i>Anastrophyllum calcaratum</i> Steph.	<i>Anastrophyllum auritum</i> (Lehm.) Steph.	Karisimbi, Rand des Hans-Meyer-Kraters, 3400 m
<i>Anthoceros myriandroecius</i> Steph.		Rugege-Wald: Waldmoor, 1800 m
<i>Fossombronina pulvinata</i> Steph.		Rugege-Wald: Waldmoor, 1800 m
<i>Isotachis renistipula</i> Steph.	<i>Isotachis aubertii</i> (Schwaegr.) Mitt.	Rugege-Wald: Waldmoor, 1800 m
<i>Isotachis conistipula</i> Steph.	<i>Isotachis aubertii</i> (Schwaegr.) Mitt.	Karisimbi, 3400 m
<i>Isotachis aspera</i> Steph.	<i>Isotachis aubertii</i> (Schwaegr.) Mitt.	Rugege-Wald: Waldmoor, 1800 m
<i>Lepidozia pulvinata</i> Steph.	<i>Lepidozia stuhlmannii</i> ssp. <i>pulvinata</i> (Steph.) Pócs	Karisimbi, Rand des Hans-Meyer-Kraters, 3400 m
<i>Lepidozia carnosa</i> Steph.	<i>Lepidozia stuhlmannii</i> var. <i>carnosa</i> (Steph.) Pócs & Lye	Karisimbi, Rand des Hans-Meyer-Kraters, 3400 m
<i>Metzgeria limbato-setosa</i> Steph.	<i>Metzgeria madagassa</i> Steph.	Rugege-Wald, 1900 m
<i>Plagiochila expallescens</i> Steph.	<i>Plagiochila kiaerii</i> Gottsche	Bugoier Bambus-Mischwald, 2000 m
<i>Plagiochila breviramea</i> Steph.	<i>Plagiochila squamulosa</i> Mitt.	Bugoier Wald, an Hagenia, ~2300 m
<i>Plagiochila lurida</i> Steph.	<i>Plagiochila squamulosa</i> Mitt.	Bugoier Bambus-Mischwald, trockene Waldwiese bei Kahama
<i>Radula stipatiflora</i> Steph.	<i>Radula voluta</i> Taylor ex Gottsche, Lindenb. & Nees	Rugege-Wald, 1800 m
<i>Jungermannia mildbraedii</i> Steph.	<i>Solenostoma mildbraedii</i> (Steph.) R.M.Schust.	Rugege-Wald, 1900 m
<i>Symphogyna rigida</i> Steph.	<i>Symphogyna podophylla</i> (Thunb.) Mont. & Nees	Rugege-Wald, feuchter Hohlweg, ~1900 m
<i>Arachniopsis coactilis</i> Spruce	<i>Telaranea coactilis</i> (Spruce) J.J.Engel & G.L.S.Merr.	Rugege-Wald: Waldmoor, 1900 m
<i>Lepidozia redacta</i> Steph.	<i>Telaranea redacta</i> (Steph.) J.J.Engel & G.L.S.Merr.	Rugege-Wald: Waldmoor, 1900 m
<i>Lepidozia trifida</i> Steph.	<i>Telaranea trifida</i> (Steph.) R.M.Schust.	Rugege-Wald: Waldmoor, 1800 m
<i>Chandonanthus quadrifidus</i> Steph.	<i>Tetralophozia cavallii</i> (Gola) Vana	Karisimbi, Rand des Hans-Meyer-Kraters, 3400 m

Table 1: Liverworts and Hornworts collected by J. Mildbraed in Rwanda 1907 (Stephani, 1914).

From 1926 to 1927, D.H. Linder of the Harvard Institute of Tropical Biology collected on the Virunga Volcanoes, the bryophytes being published by Theriot (1930). The French botanist Humbert was the first to collect on Mt. Kahuzi and Mt. Biéga in 1929, and also visited the Virunga volcanoes. His name is commemorated in the genus *Bryohumbertia* (Dicranaceae). From 1933 to 1935 the Belgian zoologist De Witte collected in the Albert National Parc (today Parc National Virunga in D.R. Congo and Parc National des Volcans in Rwanda), and so did the botanist Lebrun from 1937 to 1938. Based on these gatherings, a flora of the mosses of

Albert National Park was published by Demaret & Leroy (1944). Two years before, the first checklist of Central African mosses was published by Demaret (1940, supplément 1946), followed by a list of hepatics (Demaret, 1942). This first account of the bryophytes from Congo, Rwanda and Burundi presented a compilation of all data hitherto available. After the Second World War, botanical exploration was intensified. Demaret worked in the Ruwenzori from 1953 to 1957 and J.-J. Symoens collected in Rwanda and Congo from 1955 to 1958. He visited Nyungwe Forest as well as Tshibati and Lwiro, today part of the Kahuzi National Park. His hepaticological results were published by Vanden Berghen (1960, 1961, 1965).

After the independence of Rwanda and D.R. Congo (then Zaïre), only a few bryologists continued to work in this phytogeographically interesting region. In 1971 and 1974, J.-L. De Sloover collected in the Nyungwe Forest and on Mt. Karisimbi in Rwanda. He also made extensive collections on Mt. Kahuzi, Mt. Biéga and around the station Irangi. The hepatics were published by Vanden Berghen (1977) and the mosses by De Sloover (1973, 1975a-d, 1976a,b, 1977a,b, 1979, 1982, 1983, 1986, 1987) in the course of some revisions for the whole African continent. Some other botanists, who mainly collected phanerogams, made bryophyte gatherings as well (e.g. Bouxin, Lisowski, Malaisse, Petit). During botanical explorations for the "Flore du Rwanda, Spermatophytes", Troupin also collected some bryophytes.

In 1991, the BRYOTROP-Expedition (e.g. Fischer, 1993a,b), organized by the author, investigated the bryophytes along an altitudinal gradient from 850 to 4500 m in the Kahuzi-Biéga National Park, the Nyungwe National Park and Mt. Karisimbi. From 1984 to 2012 the author studied the bryophytes of Rwanda and eastern D.R. Congo and was the first to collect in remote sites (Cyamudongo Forest, Busaga Forest, Kagitumba, Ibanda Makera etc.) and bryologically undercollected regions.

4. Vegetation of Rwanda and bryophyte habitats

4.1. Montane Forests

The Nyungwe forest, situated at the eastern crest of the Central African Graben supports a remarkable vegetation. Only an overview is presented here, but more detailed descriptions are provided by Fischer & Hinkel (1992) and Fischer & Killmann (2008). Nyungwe forms part of the montane forests on the Congo-Nile-watershed, and supports a vegetation mosaic quite different from that of the lowland rainforests in adjacent D.R. Congo. Today, most of these forests in Rwanda have disappeared, and only Gishwati Forest (nearly completely destroyed), Busaga Forest, and Mukura Forest are still extant, as well as Nyungwe and Cyamudongo which are now protected as National Parks.

There exist strong and easily observable floristic discontinuities between different parts of Nyungwe Forest. On the one hand there is a distinction between the western and the eastern part of the forest, primarily for climatic reasons (rainfall)

and secondarily for geological or soil reasons. The boundary between these two regions is roughly a meridian going through the eastern slopes of Mt. Bigugu (a little east of Pindura junction). There is also a distinct altitudinal stratification, first described by Fischer & Hinkel (1990). From a botanical point of view, a lower zone can be observed between 1500 and 2100 m above sea level (“lower level of montane forest”), a medium zone between 2100 and 2600 m (“medium level of montane forest”) and an upper zone between 2600 and about 2900 m (“upper level of montane forest”). However, it should be noted that the exact level of these transitions can be 100 m (sometimes 200 m) above or below these ranges, depending on local topographic conditions. In the literature, the altitude range of Nyungwe National Park is often given as 1600 to 2950 m, but a sector of the forest in the extreme south west may extend as low as 1400 m, which could have some implications in terms of diversity. Unfortunately there has been no assessment of that rather inaccessible part of the forest up to now.



Fig. 2. Montane forest. **A.** Nyungwe National Park, Karamba. **B-C.** Gisakura, 1900 m.



Fig. 3. Epiphyllous bryophytes. Nyungwe National Park, Kamiranzovu.

Montane forest at lower altitude

In the lower montane forest belt, we find mountain forest communities with dominating *Parinari excelsa* and *Carapa grandiflora* as well as *Newtonia buchanani*-forest with 2-3 distinguishable tree layers, and an upper tree layer of 35-40 m. The endemic tree *Pentadesma reyndersii* (Clusiaceae) occurs here. The lower montane forest is mostly restricted to the western part of Nyungwe and is well developed at Gisakura, Karamba and between Pindura and Bweyeye (Fig. 2). Epiphyllous bryophytes are abundant (Fig. 3). Around the Kamiranzovu, a typical swamp forest with *Syzygium guineense* ssp. *parvifolium*, *Carapa grandiflora*, *Anthocleista grandiflora* and *Podocarpus falcatus* is developed (Fig. 4). Secondary forests in the lower montane forest belt are characterized by *Musanga leo-errerae*, *Myrianthus holstii*, *Newtonia buchanani* and *Polyscias fulva*. Of special importance is the isolated Cyamudongo Forest, comprising only about 300 ha, which formerly almost certainly formed part of Nyungwe. It extends over five hills surrounding the valley of River Nyamabuye between c.1500 and 2140 m. Numerous species, e.g. *Cyathodium africanum*, *Notothylias flabellata*, *Cololejeunea cuneifolia* are currently known in Rwanda only from that forest. According to the local population, Cyamudongo has been isolated for at least 100 years.

Montane forest at medium altitudes

The middle montane forest belt is well developed near Uwinka. Here, forest communities with *Ocotea michelsoni*, *Syzygium guineense*, *Beilschmiedia rwandensis*, *Macaranga kilimandscharica* and *Melchioria schliebenii* occur. In the eastern part of Nyungwe, forests with *Macaranga kilimandscharica* and *Neoboutonia macrocalyx* are dominant. Large areas of the south-eastern parts of the National Park near Nshili are occupied by bamboo-forests. Some of them are of anthropogenic origin, but are mainly outside the climatic bamboo zone. The bamboo *Sinarundinaria alpina*, which may reach a height of 25 m, forms either pure stands or grows intermixed with *Hagenia abyssinica* and *Polyscias fulva*. A herb layer is generally well developed (mainly herbs like *Panicum calvum* and various ferns).

Upper montane forest

The summit regions of the Bigugu massif, part of the upper montane forest belt up to 2800 m, are covered by a characteristic cloud forest of ± hard-leaved trees, which benefits from the high precipitation mainly as fog. Dominant trees are *Psychotria mahoni*, *Podocarpus latifolius* and *Syzygium guineense* ssp. *parvifolium*. An abundant shrub is *Mimulopsis solmsii*. The forest is characterized by the large number of epiphytes, especially bryophytes and lichens. The herb layer consists mainly of ferns.



Fig. 4. A-B. Montane forest. Nyungwe National Park, Kamiranzovu swamp, 2000 m.
C. Quartzitic rocks near Karamba, type locality of *Drepanolejeunea vandenberghenii*, 2000 m.



Fig. 5. A. Quartzitic rocks between Uwinka and Kamiranzovu, cushions of *Scopelophila ligulata*.
B. Quartzitic rocks at summit of Mt. Bigugu with *Campylopus* sp.



Fig. 6. A. Ericaceous shrub near summit of Mt. Bigugu, 2950 m. **B-C.** Ericaceous shrub at Rwasenkoko, 2400 m.

Ericaceous shrub

The upper montane forest belt otherwise consists mainly of ericaceous woodland. Below the summit of Bigugu, and in the western part of Rwasenkoko, a forest with *Erica bequaertii* and *Erica johnstoni* with a tree layer of 4-6 m height is developed (Fig. 6). It is characterized by large moss balls and a densely moss-covered soil (mainly *Breutelia* spp. and *Sphagnum* spp.). Between the bryophytes, *Deschampsia flexuosa* and *Lycopodium clavatum* are part of the herb layer. Among the epiphytes, large moss balls with *Plagiochila colorans*, *P. ericicola* and *Dicranum johnstoni* dominate. On small twigs of *Erica* spp. numerous Lejeuneaceae occur, e.g. *Colura saroltae* or *Colura berghenii*. The upper part of the canopy is mainly covered by *Usnea* species. The summit region of Mt. Bigugu is covered by a community dominated by *Erica bequaertii*. Other shrubs are *Vaccinium stanleyi*, *Struthiola thomsonii* and *Hedythyrus thamnoides*. The herb layer contains only a few vascular plants, e.g. *Hypoxis kilimandscharica*, or *Disa robusta* on open rocks (Fig. 5), and a dense bryophyte layer with dominant *Breutelia stuhlmannii*, *B. subgnaphalea*, *B. diffracta*, *Sphagnum strictum* ssp. *pappeanum* and *Leptodontium luteum*.

The open cliffs and the wet flush vegetation near Karamba, dominated by ericaceous shrubs are also remarkable and should be mentioned for their richness in bryophytes (e.g. *Sphagnum davidii*, *Breutelia stuhlmannii*, *Plicanthus hirtellus*, *Drepanolejeunea vandenberghenii* and *Anastrophyllum piligerum*). Due to the microclimate and the open quartzitic rocks, this type of vegetation occurs as low as 1900 m (Fig. 4, 5).

Swamps and moorland

The Rwasenkoko swamp, situated at 2400 m, is an example of a night-cold air lake. Here we find an inverse profile with *Syzygium-Podocarpus-Ocotea* forest on the summit of the hills, while the slopes bear *Andropogon shirensis*-grassland with scattered shrubs of *Hagenia abyssinica* and *Erica rugegensis*. In the valley, moorland and swamps can be observed. In the Rwasenkoko swamp, a nearly pure stand of *Erica rugegensis* with *Cyperus denudatus*, *Xyris valida*, *Osmunda regalis* and several *Sphagnum* species occurs. The small twigs of *Erica* spp. are covered by rare taxa, e.g. *Colura saroltae*, *Colura berghenii*, and *Lejeunea helenae*. Typical species in the more open parts of the swamp are *Alchemilla johnstonii*, *Lobelia mildbraedii*, *Cyperus denudatus* and *Cyperus latifolius*. Shrubs like *Hypericum revolutum* have only a scattered occurrence. Comparable swamp vegetation on more eutrophic soil is found at Rugenge near Pindura. Here, *Haplomitrium blumei* is found associated with *Anthoceros myriandroecius* and *Aneura pinguis*.



Fig. 7. *Hagenia-Hypericum* forest at Karisoke showing large bryophyte cushions, 3100 m.



Fig. 8. A-B. *Hagenia-Hypericum* forest at Karisoke, 3100 m. **C.** Large bryophyte cushions, e.g. *Plicanthus giganteus*.



Fig. 9. A-C. Ericaceous shrub on Mt. Sabinyo, 3300 m.



Fig. 10. Ericaceous shrub **A-B.** Mt. Muhabura, 3400 m; **C-D.** Mt. Sabinyo, 3300 m.

4.2. The Virunga Volcanoes and their altitudinal zonation

The Virunga Volcanoes are situated on the borders of D.R. Congo, Uganda and Rwanda. Mt. Karisimbi, at 4507 m, is the highest peak in Rwanda. From 2700 to 3000 m, a secondary *Dombeya*-forest with scattered *Hagenia* is developed, followed by a *Hagenia-Hypericum* belt from 3000 to 3300 m, where large epiphytic moss cushions of *Antitricha kilimandscharica*, *Plicanthus giganteus* and *Plagiochila colorans* are found (Fig. 7, 8). On the saddle of Karisimbi at 3400 m, a moorland with the giant groundsel *Dendrosenecio erici-rosenii* and *Erica johnstonii* occurs. Around Lake Muderu and in the crater of Mt. Gahinga, a *Sphagnum* peat bog with *Carex runssorensis* is developed (Fig. 12, 13). Above 3400 m, a *Dendrosenecio erici-rosenii-Hypericum revolutum* subparamo can be observed. The paramo can be divided into two types: the *Dendrosenecio erici-rosenii-Lobelia stuhlmannii*-paramo from 3600 to 3900 m, and the *Dendrosenecio erici-rosenii-Lobelia wollastoni*-paramo from 3900 to 4200 m (Fig. 11). Above 4200 m, no giant groundsel is found, and nearly pure meadows of *Alchemilla johnstonii* are developed (Fig. 14). The summit at 4500 m is covered by an alpine desert, where bryophytes and lichens dominate (Fig. 14, 15). Important species are *Andreaea mildbraedii*, *Campylopus nivalis* or *Apomarsupella africana*. On Mt. Bisoke, reaching 3711 m, the *Hagenia-Hypericum* zone is followed by a *Hypericum-Lobelia gibberoa*-zone from 3200 to 3350 m. Above, a *Hypericum-Lobelia stuhlmannii*-subparamo is found which reaches about 3500 m altitude. The afroalpine vegetation on Mt. Bisoke is mainly composed of *Dendrosenecio erici-rosenii*, *Lobelia stuhlmannii*, *Deschampsia flexuosa* and *Huperzia saururus*. On Mt. Sabinoy (3634 m), Mt. Gahinga (3474 m) and Mt. Muhabura (4127 m) a distinct ericaceous scrub is developed with *Erica johnstonii* and *Erica arborea* reaching up to 10-15 m (Fig. 9, 10). Large cushions of *Plagiochila colorans*, *Herbertus dicranus* and *Tetralophozia cavallii* occur as epiphytes.

4.3. Savanna Vegetation

The eastern part of Rwanda is covered by a mosaic of dry forest and savanna. Rock outcrops are either ferricretes with *Craterostigma plantagineum*, *C. lanceolatum*, *Louretia kagerensis* and *Microchloa kunthii* (Fig. 16), or quartzitic and granitic inselbergs (Fig. 17, 18). In small rock pools, a temporary vegetation with *Marsilea minuta*, *Rotala tenella*, *Schoenoplectus microglumis*, *Aponogeton stuhlmannii* and *A. vallisnerioides* is found, and numerous species of *Riccia* occur (Fischer, 1995). Large quartzitic outcrops can be observed in south-eastern Rwanda, where open rock surfaces and fissures are colonized by a diverse bryophyte and lichen flora (Fig. 18). Some specialists like the endemic *Streptocarpus bindseilii* and *Stemodiopsis ruandensis* and the shrubs *Parinari curatellifolia* and *Protea madiensis* are found. In rock fissures, *Targionia hypophylla* and *Exormothea pustulosa* occur. The main part of the Akagera National Park is covered by tree savanna with *Acacia sieberiana* var. *kagerensis*, *A. senegal*, *Lannea humilis*, *L. stuhlmannii*, *Entada*

abyssinica, *Rhamnus staddo*, *Ozoroa reticulata*, *Albizia petersiana* and *Rhus natalensis*. Dominant grasses are *Hyparrhenia* spp., *Sporobolus infirmus* and *Themeda triandra*. Small hillsides are covered by dense dry forests which are rich in epiphytes (e.g. *Usnea* spp., *Ramalina hoehneliana*, and orchids like *Aerangis verdickii* and *Microcoelia globulosa*). Epiphytic bryophytes include *Acrolejeunea emergens*, *Frullania ericoides*, *Brachymenium* spp. and *Fabronia* spp. Dominant trees are *Haplocoelum gallaense*, *Strychnos usambarensis*, *Canthium lactescens* and *Nuxia congesta*.



Fig. 11. A. *Dendrosenecio* paramo on Mt. Gahinga showing cushions of *Antitricha kilimandscharica*, 3400 m. **B.** *Dendrosenecio-Lobelia wollastonii* paramo on Mt. Karisimbi, 3900 m, with Mt. Mikeno in the background.



Fig. 12. A-B. Swamp in crater of Mt. Gahinga, 3400 m.



Fig. 13. A. *Carex runssorensis*-swamp on crater rim of Mt. Bisoke, 3650 m. **B.** Swamp in crater of Mt. Gahinga showing *Sphagnum* spp. and *Breutelia* spp., 3400 m.



Fig. 14. A. *Alchemilla johnstonii*-tussock, Mt. Karisimbi, 4400 m. **B.** Alpine desert near summit of Mt. Karisimbi, 4450 m.



Fig. 15. A-B. Rocks near summit of Mt. Karisimbi showing cushions of bryophytes (*Andreaea mildbraedii*, *Campylopus nivalis*) and lichens (*Umbilicaria* spp.), 4500 m.

4.4. Gallery forests

Gallery forests are developed along Akagera river and its lakes in areas subject to regular inundation. This forest type has a biogeographical resemblance to lowland rainforests of Uganda and Congo. Large stands still exist in Akagera National Park and at Ibanda-Makera north of Rusumo, but the important forests of Kagitumba are now destroyed. Important trees of the gallery forests are *Phoenix reclinata*, *Markhamia lutea*, *Pancovia golungensis*, *Ekebergia capensis*, *Ficus vallis-choudae*, *Ficus lutea*, *Allophylus macrobotrys*, *A. africanus*, *Grewia platyclada* and *Mimusops bagshawei*. Epiphytes found here include *Porella subdentata* and *Plagiochila squamulosa*.

4.5. Agricultural landscape and plantations

More than 80% of the land area of Rwanda is under agricultural use or bears other anthropogenic vegetation generally poor in bryophytes. However, *Cupressus* or *Pinus* plantations often harbour interesting bryophyte populations (Petit & Symoens, 1974). *Frullania socotrana*, *Frullania cafraria*, *Frullania spongiosa*, and *Acanthocoleus madagascariensis* have been recorded only in these plantations or in agroforestry systems around Huye (Butare) (Fig. 18) and are highly endangered due to widespread logging. Roadsides are generally an interesting habitat for bryophytes as the grass is regularly cut and open soil is available for pioneer species. Another habitat that is often neglected is that of roadside trees and tree-lined roads.



Fig. 16. A-B. Lateritic outcrops in Akagera National Park, 1500 m.



Fig. 17. A-B. Quartzitic outcrops at Lutete, Bugesera, 1400 m.

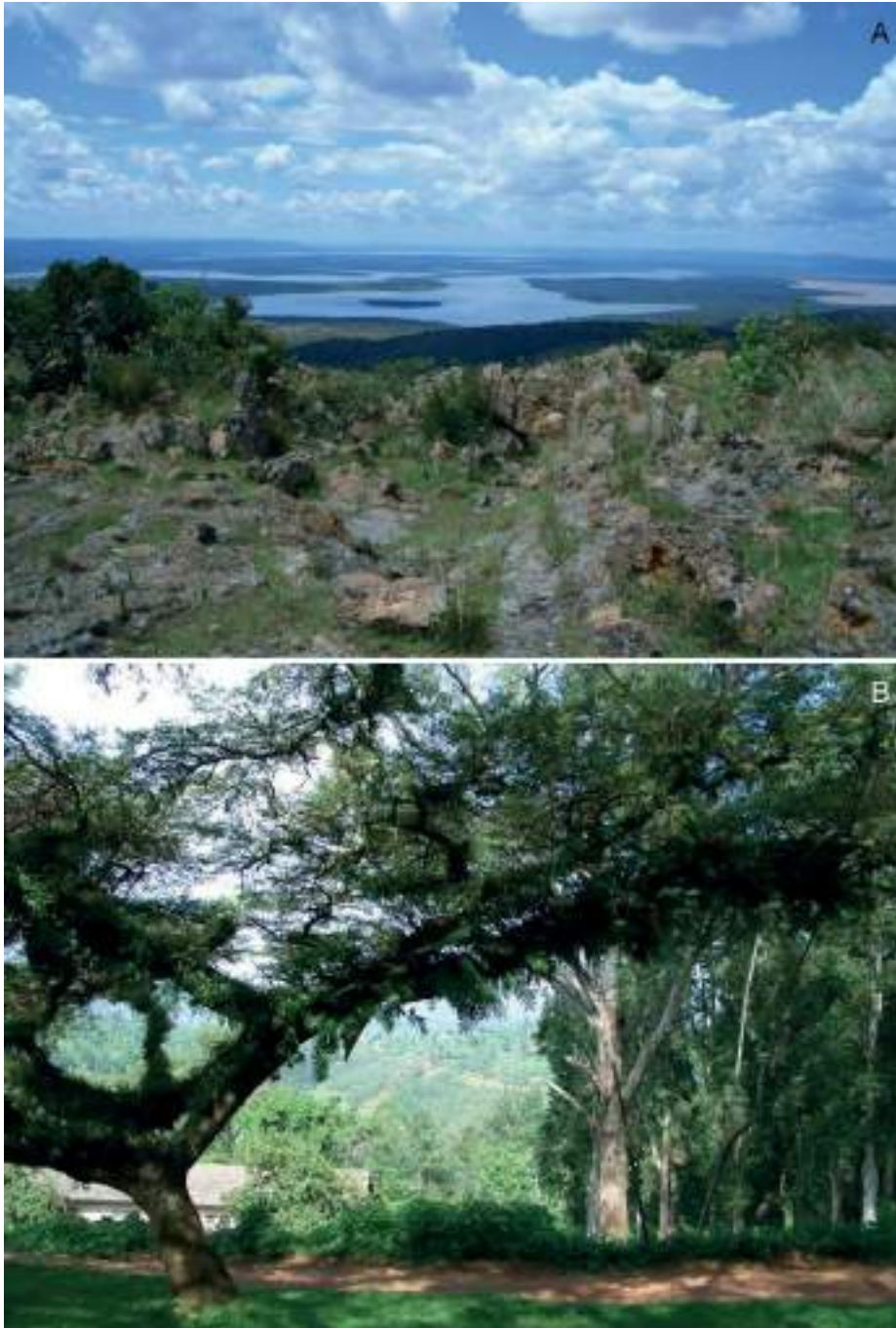


Fig. 18. A. Quartzitic rocks at Nyarubuye, 1800 m. **B.** Trees with epiphytes in IRST-Park, Huye, 1700 m.

5. Diversity and phytogeography of bryophytes in Rwanda

Rwanda is situated in the Albertine Rift and harbours a very diverse flora and vegetation due to a considerable geodiversity and a climatic gradient from west to east. The number of vascular plants is estimated at around 3000 species, which originate from different biogeographical regions. The Albertine Rift includes the mountains along the Lakes Tanganyika, Kivu, Edward and Albert, situated in eastern D.R. Congo (Itombwe Mountains, Kahuzi-Biega National Park, Ruwenzori), Rwanda (Nyungwe National Park, Volcano National Park), Burundi (Kibira National Park, Bururi) and western Uganda (Bwindi Impenetrable Forest, Budongo Forest). The diversity of bryophytes is much less well known than that of the vascular plants and it is therefore often difficult to assess the distribution of species. However, several characteristic distribution patterns among the liverworts and hornworts of Rwanda can be distinguished.

Guineo-Congolian: Species with predominantly western and central African distribution mainly found in lowland to mid-altitude rainforests: *Caudalejeunea yangambiensis*, *Ceratolejeunea diversicornua*, *Cololejeunea duvigneaudii*, *Cololejeunea obtusifolia*, *Cololejeunea pusilla*, *Colura digitalis*, *Cyathodium africanum*, *Lepidozia succida*, *Radula flaccida*, *Prionolejeunea grata*, *Odontolejeunea lunulata*.

Fromontane: Species occurring in the montane areas of tropical and South Africa, either restricted to East Africa or with disjunct distribution in the highlands of Cameroon and Eastern Africa: *Lethocolea congesta*, *Calypogeia afrocaerulea*, *Cephaloziella vaginans*, *Cylindrocolea gittinsii*, *Leptoscyphus hedbergii*, *Plagiochila colorans*, *Plagiochila ericicola*, *Herbertus dicranus*, *Andrewsianthus bilobus*, *Lophozia jamesonii*, *Plicanthus giganteus*, *Tetralophozia cavallii*, *Solenostoma mildbraedii*, *Syzygiella geminiflora*, *Cololejeunea grossepapillosa*, *Cololejeunea clavatopapillata*, *Caudalejeunea lewallei*, *Cheilolejeunea pocsii*, *Cololejeunea distalopapillata*, *Cololejeunea harrisii*, *Cololejeunea malanjae*, *Cololejeunea runssorensis*, *Cololejeunea zenkeri*, *Colura berghenii*, *Colura saroltae*, *Diplasiolejeunea aulae*, *Diplasiolejeunea deslooveri*, *Diplasiolejeunea kraussiana*, *Diplasiolejeunea runssorensis*, *Diplasiolejeunea symoensii*, *Phaeoceros fulvisporus*, *Anthoceros sambesianus*, *Anthoceros myriandroecius*, *Asterella abyssinica*, *Symphyogyna volkensisii*, *Symphyogyna podophylla*, *Riccardia compacta*, *Telaranea trifida*, *Lepidozia pearsonii*, *Lepidozia stuhlmannii*, *Kurzia irregularis*, *Bazzana roccatii*, *Bazzana nitida*, *Bazzana decrescens*, *Mastigophora diclados*, *Microlejeunea kamerunensis*.

Afroalpine: Species occurring in the high mountains of Africa usually above 3000 m: *Apomarsupella africana*, *Marsupella subintegra*, *Anastrophyllum auritum*, *Diplophyllum africanum*, *Jensenia spinosa*, *Microlejeunea nyandaruenensis*.

Sudano-Zambezi: Species occurring mainly in savanna and dry forests from West Africa to East and South-East Africa, usually absent or rare in rainforests:

Riccia moenkemeyeri, *Riccia lanceolata*, *Riccia congoana*, *Riccia atropurpurea*, *Lejeunea rhodesiae*.

Sudano-Zambezian-Arabian: Species of Sudano-Zambezian distribution in continental Africa extending into the Arabian peninsula: *Riccia okahandjana*.

East Africa-Himalaya: Species occurring in the mountains of East Africa and in the Himalaya: *Asterella khasyana*.

East Africa-Madagascar: Species occurring in the mountains of East Africa and in Madagascar: *Cololejeunea capuronii*, *Solenostoma borgenii*, *Cheilolejeunea krakammae*, *Diplasiolejeunea cornuta*, *Frullania imerinensis*.

Palaeotropical: Species occurring in tropical Africa and Asia: *Mnioloma fuscum*, *Anastrophyllum piligerum*, *Plicanthus hirtellus*, *Acrolejeunea emergens*, *Cololejeunea hildebrandii*, *Cololejeunea tenella*, *Colura tenuicornis*.

Pantropical: Species occurring in the tropics of America, Africa and Asia: *Frullania ericoides*, *Frullania arecae*, *Chiloscyphus muricatus*, *Cololejeunea cardiocarpa*, *Cololejeunea platyneura*, *Cheilolejeunea xanthocarpa*.

Cosmopolitan: Species distributed in extratropical and tropical regions all over the world: *Chiloscyphus coadunatus*, *Phaeoceros carolinianus*, *Anthoceros punctatus*, *Ricciocarpus natans*, *Lunularia cruciata*, *Marchantia polymorpha* ssp. *ruderalis*, *Pallavicinia lyellii*.

Mediterranean-Sudano-Zambezian: Species of Sudano-Zambezian distribution in continental Africa extending into the Mediterranean: *Targionia hypophylla*, *Exormotheca pustulosa*

South America Africa-Afromontane: Species of afromontane distribution in continental Africa extending into South America: *Isotachis aubertii*, *Chiloscyphus martianus*, *Syzygiella concreta*, *Tylimanthus laxus*, *Diplasiolejeunea cavifolia*, *Symphogyna brasiliensis*, *Riccardia amazonica* (Gradstein et al., 1983).

Pantropical-Afromontane: Species of afromontane distribution in continental Africa also present in mountains of South America and Asia: *Haplomitrium blumei*.

Atlantic European-Afromontane: Species of afromontane distribution in continental Africa extending into Western Europe: *Adelanthus decipiens*, *Adelanthus lindenbergianus*, *Colura calyptrifolia*, *Cololejeunea minutissima*, *Cololejeunea microscopica*, *Gongylanthus ericetorum*, *Calypogeia arguta*, *Calypogeia fissa*, *Cephalozia bicuspidata*, *Leptoscyphus infuscatus*, *Blepharostoma trichophyllum*, *Solenostoma sphaerocarpum*, *Tritomaria exsecta*, *Lepidozia cupressina*.

Endemic: Species restricted to Rwanda: *Amphicephalozia africana*, *Riccia vulcanicola*, *Cololejeunea augieri*, *Cololejeunea frahmii*, *Cheilolejeunea omphalogastris*, *Cololejeunea cardiocarpoides*, *Cololejeunea magna*, *Diplasiolejeunea cyanguguensis*.

Afromontane-Albertine Rift Endemics: Species restricted to mountains of eastern Congo, western Uganda, Rwanda, Burundi, and western Tanzania: *Drepanolejeunea vandenberghenii*, *Omphalanthus roccatii*, *Schiffneriolejeunea altimontana*, *Harpalejeunea fischeri*, *Cephalozia africana*, *Chiloscyphus muhavurensis*, *Cololejeunea fischeri*, *Cololejeunea heterolobula*, *Cololejeunea parva*, *Cololejeunea pseudo-obliqua*, *Cololejeunea sphaerocarpa*, *Cololejeunea tenuiparietata*, *Fossombronia rwanadaensis*.

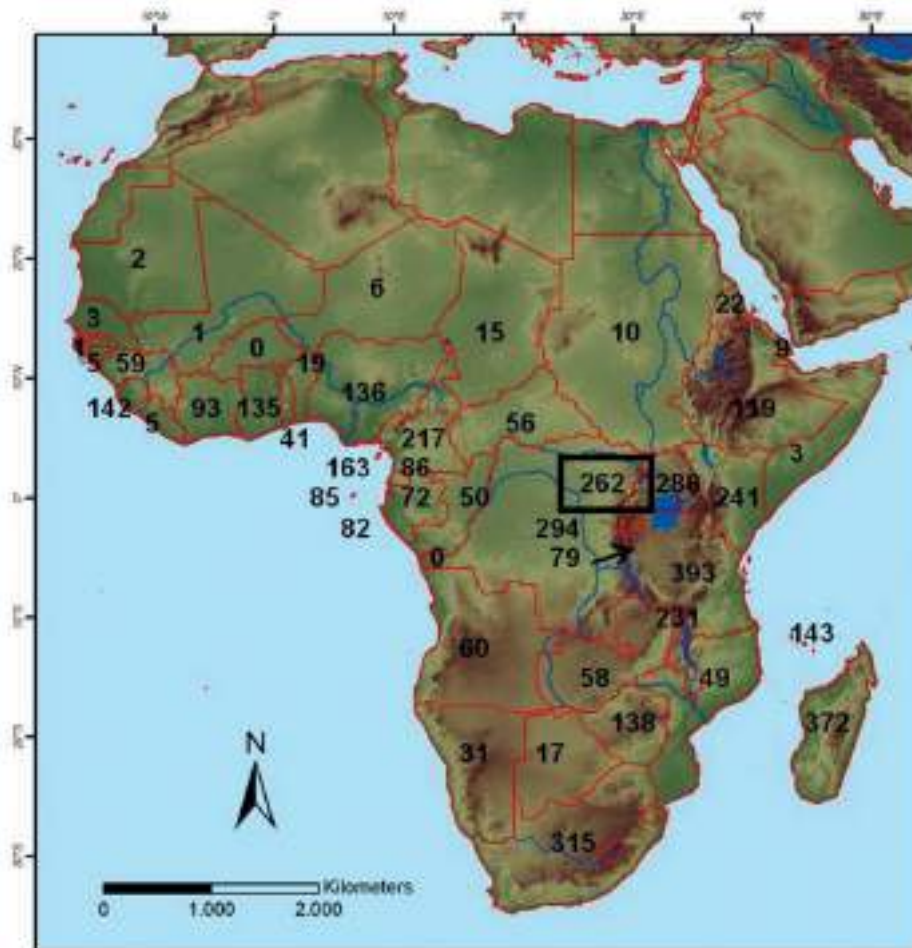


Fig. 19. Species numbers of liverworts and hornworts from Subsaharan Africa. Rwanda is indicated by bold rectangle. Numbers mainly after Wigginton (2009).

Rwanda is one of the bryologically better known African countries (see also Chapter 3), and 262 liverwort and hornwort species have so far been recorded. For an area not exceeding 27,000 km², this high number is remarkable and reflects the wide habitat diversity ranging from mid-altitude and montane rainforest to alpine habitats, and various savanna and dry forest types with lateritic outcrops.

In comparison, from the countries of the moist tropics in western Africa from Senegal to Cameroon covering more than 2.8 million km², only 292 species are known (Wigginton, 2004). With 262 liverwort and hornwort species (Fig. 19), Rwanda is among the 5 most species-rich countries in continental Africa, in current knowledge only exceeded by Uganda with 288, D.R. Congo with 294, South Africa with 315 and Tanzania with 393 species (Wigginton, 2009). These numbers, however, reflect the different degree of exploration. In Uganda, numerous new records have been provided by expeditions of the British Bryological Society (e.g. Wigginton *et al.*, 1999; Pócs & Lye, 1999). D.R Congo is underexplored, and the species-rich eastern parts of the Albertine Rift are still difficult to access due to political instability. The high number for Tanzania reflects the fact that T. Pócs lived there for many years and contributed numerous records (e.g. Pócs, 1985, 1990). The adjacent country of Burundi, also part of the Albertine Rift centre of endemism, is a good example of a much underexplored area, with only 79 species of liverworts and hornworts recorded (Wigginton, 2009). However, the habitat diversity is almost the same as in Rwanda, only lacking alpine habitats and providing Miombo-dry forests instead, and an estimated number of 230-250 hepatic species is likely to occur.

6. Systematics of Liverworts and Hornworts

The bryophytes consist of three major divisions, i.e. Marchantiophyta (liverworts), Anthocerotophyta (hornworts) and Bryophyta (mosses) (Frey *et al.*, 2009). Here we give an overview of the systematics of liverworts and hornworts, as the arrangement in the main part is mainly pragmatic, distinguishing thallose liverworts, foliose liverworts and hornworts. The systematic list provides information on families and genera recorded from Rwanda.

Division Marchantiophyta Stotler & Crand.-Stotl.

Class Haplomitriopsida Stotler & Crand.-Stotl.
Order Haplomitriales H.Buch ex Schljakov
Haplomitriaceae Dédécěk
Haplomitrium Nees

Class Marchantiopsida Cronquist, Takht. & W.Zimm.
Subclass Marchantiidae Engl.
Order Lunulariales D.G.Long
Lunulariaceae Klinggr.
Lunularia Adans.

Order Marchantiales Limpr. in Cohn
 Suborder Marchantiinae H.Buch ex Schljakov
 Aytoniaceae Cavers
Asterella P.Beauv.; *Mannia* Opiz; *Plagiochasma*
 Lehm. & Lindenb.
 Dumortieraceae D.G.Long
Dumortiera Nees
 Exormothecaceae Müll.Frib. ex Grolle
Exormotheca Mitt.
 Marchantiaceae Lindl.
Marchantia L.
 Suborder Corsiniinae R.M.Schuster ex Schljakov
 Cyathodiaceae Stotler & Crand.-Stotl.
Cyathodium Kunze
 Suborder Targioniinae R.M.Schust. ex Schljakov
 Targioniaceae Dumort.
Targionia L.
 Order Ricciales Schljakov
 Ricciaceae Rchb.
Riccia L.; *Ricciocarpus* Corda

Class Fossombroniopsida W.Frey & Hilger
 Order Fossombroniales Schljakov
 Fossombroniaceae Hazsl.
Fossombronia Raddi

Class Pallaviciniopsida W.Frey & Stech
 Order Pallaviciniales W.Frey & Stech
 Pallaviciniaceae Mig.
Jensenia Lindb.; *Pallavicinia* Gray; *Symphyogyna*
 Nees & Mont.

Class Jungermanniopsida Stotler & Crand.-Stotl.
 Subclass Jungermanniidae Engl.
 Superorder Jungermannianae Schljakov
 Order Perssoniellales Schljakov
 Schistochilaceae H.Buch
Schistochila Dumort. (incl. *Gottschea* Nees ex Mont.)
 Order Jungermanniales H.Klinggr.
 Suborder Balantiopsineae R.M.Schust.
 Balantiopsaceae H.Buch
Isotachis Mitt.
 Suborder Jungermanniinae R.M.Schust.
 Acrobolbaceae E.A.Hodgs.
Lethocolea Mitt.; *Tylimanthus* Mitt.
 Calypogeiaceae Arnell
Calypogeia Raddi; *Mnioloma* Herzog
 Gymnomitriaceae H.Klinggr.
Apomarsupella R.M.Schust.; *Gymnomitrium* Corda;
Marsupella Dumort.

- Jungermanniaceae Rchb.
 - Solenostoma* Mitt.; *Notoscyphus* Mitt.
- Order Jamesoniellales W.Frey & Stech
 - Adelanthaceae Grolle
 - Adelanthus* Mitt.
 - Jamesoniellaceae He-Nygrén *et al.*
 - Jamesoniella* (Spruce) F.Lees; *Syzygiella* Spruce
- Order Lophoziales Schljakov
 - Suborder Cephaloziineae Schljakov
 - Cephaloziaceae Mig.
 - Cephalozia* (Dumort.) Dumort.
 - Cephaloziellaceae Douin
 - Amphicephalozia* R.M.Schust.; *Cephalojonesia* Grolle; *Cephaloziella* (Spruce) Schiffn.; *Cylindrocolea* R.M.Schust.
 - Suborder Lophoziineae Schljakov
 - Lophoziaceae Cavers
 - Anastrophyllum* (Spruce) Steph.; *Andrewsianthus* R.M.Schust.; *Lophozia* (Dumort.) Dumort.; *Plicanthus* R.M.Schust.; *Tetralophozia* (R.M.Schust.) Schljakov.; *Tritomaria* Schiffn.
- Order Trichocoleales W.Frey & Stech
 - Blepharostomataceae W.Frey & Stech
 - Blepharostoma* (Dumort.) Dumort.
- Order Lepidoziales Schljakov
 - Lepidoziaceae Limpr.
 - Bazzania* Gray; *Kurzia* G.Martens; *Lepidozia* (Dumort.) Dumort. (incl. *Sprucella* Steph.); *Telaranea* Spruce ex Schiffn. (incl. *Arachniopsis* Spruce)
- Order Lepicoleales Stotler & Crand.-Stotl.
 - Herbertaceae Müll.Frib. ex Fulford & Hatcher
 - Herbertus* Gray
 - Mastigophoraceae R.M.Schust.
 - Mastigophora* Nees
- Order Lophocoleales W.Frey & Stech
 - Arnelliaceae Nakai
 - Gongylanthus* Nees
 - Lophocoleaceae Vanden Berghen
 - Leptoscyphus* Mitt.; *Chiloscyphus* Corda (incl. *Lophocolea* (Dumort.) Dumort.); *Clasmatocolea* Spruce
 - Plagiochilaceae Müll.Frib.
 - Plagiochila* (Dumort.) Dumort.
- Superorder Porellanae W.Frey & Stech
 - Order Porellales Schljakov
 - Porellaceae Cavers
 - Porella* L.
 - Order Radulales Stotler & Crand.-Stotl.
 - Radulaceae Müll.Frib.
 - Radula* Dumort.

Order Jubulales W.Frey & Stech

Frullaniaceae Lorch

Frullania Raddi

Lejeuneaceae Casares-Gil.

Subfam. Ptychanthoideae Mizut.

Acrolejeunea (Spruce) Schiffn.; *Caudalejeunea* Steph.; *Frullanooides* Raddi; *Lopholejeunea* (Spruce) Schiffn.; *Marchesinia* Gray; *Ptychanthus* Nees; *Schiffneriolejeunea* Verd.

Subfam. Lejeuneoideae (incl. Cololejeuneoideae Herzog)

Ceratolejeunea (Spruce) Schiffn.; *Cheilolejeunea* (Spruce) Schiffn. (incl. *Leucolejeunea* A.Evans); *Cololejeunea* (Spruce) Schiffn. (incl. *Aphanolejeunea* A.Evans); *Colura* (Dumort.) Dumort.; *Diplasiolejeunea* (Spruce) Schiffn.; *Drepanolejeunea* (Spruce) Schiffn.; *Harpalejeunea* (Spruce) Schiffn.; *Lejeunea* Lib.; *Leptolejeunea* (Spruce) Schiffn.; *Microlejeunea* Steph; *Odontolejeunea* (Spruce) Schiffn.; *Omphalanthus* Lindenb. & Nees; *Prionolejeunea* (Spruce) Schiffn.; *Taxilejeunea* (Spruce) Schiffn.

Subclass Metzgeriidae Barthol.-Began

Order Aneurales W.Frey & Stech

Aneuraceae H.Klinggr.

Aneura Dumort.; *Riccardia* Gray

Order Metzgeriales Chalaud

Metzgeriaceae H.Klinggr.

Metzgeria Raddi

Division Anthocerotophyta Rothm. ex Stotler & Crand.-Stotl.

Class Anthocerotopsida de Bary ex Jancz.

Subclass Anthocerotidae Rosenv.

Order Anthocerotales Limpr. in Cohn

Anthocerotaceae Dumort.

Anthoceros L.

Subclass Notothylatidae Duff, J.C.Villareal, Cargill & Renzaglia

Order Notothyladales Hyvönen & Piippo

Notothyladaceae Müll.Frib. ex Prosk.

Subfam. Phaeocerotoidae Hässel

Phaeoceros Prosk.

Subfam. Notothyladoideae Grolle

Notothylas Sull. ex A.Gray

7. Collection of bryophytes

Bryophyte specimens are invaluable in the study of a local flora as they provide material for comparison. A reference collection will be most helpful for every student of bryology. In order to obtain good specimens, it is necessary to prepare the collecting trip and take sufficient equipment into the field. An overview of bryophyte sampling is also provided by Vanderpoorten *et al.* (2010).

Collection Permits

Permits to collect specimens in protected areas (e.g. National Parks) must be applied for in advance from the Rwanda Development Board (RDB), Conservation and Tourism in Kigali.

Field equipment (Fig. 20)

Essential items are:

- A **hand-lens**, preferably with a magnification $\times 20$. In dense forests where light conditions are low, a $\times 10$ or $\times 12$ hand-lens should also be used.
- **Paper bags** to place each specimen in order to be dried adequately. Plastic bags should not be used as the specimens soon start to become mouldy or etiolated. Polyethylen bags are banned by law in Rwanda.
- A **sharp knife** to remove specimens from soil, rocks or bark.
- **Pencils or water-proof markers** to write locality and habitat details as well as collection number on the bag even under wet conditions in the forest.
- **GPS-equipment** for geographical coordinates and altitude of the locality.
- A small **digital camera** will be very useful for habitat photographs and to take close-ups of the specimens.

What to collect

Bryophyte collections should be of modest quantity as many species are endangered and collecting large amount may seriously deplete the often small populations. However, the specimen should consist of sufficient material to enable identification. Preferably fertile specimens should be collected but these may be rare. If possible pure stands and cushions should be collected, but often intermixed specimens cannot be avoided. Each recognizable species should be packed separately.

Each bag should be labelled with the necessary details and preferably be numbered. As a minimum the following information should be noted: Locality name and geographical coordinates; altitude; microhabitat (e.g. on soil, decaying wood, rock, bark (epiphytic) or on living leaves (epiphyllous); for epiphytic and epiphyllous species, the host (phorophyte) species should be noted); vegetation type; state of habitat (e.g. primary or secondary forest); date.

Epiphyllous bryophytes are collected by gathering the phorophyte leaves, which are lightly pressed in a herbarium press for vascular plants. The bryophyte bags should not be pressed but dried as soon as possible. They can be air-dried in the sun or on a table, or the bags held by pegs on a line, or, under very wet rainforest conditions, dried in an apparatus similar to that described by Frahm & Gradstein (1986). Large cushions can generally be squeezed to remove water before being placed in the paper bag.

Processing the specimens

For herbarium purpose, the collections (when completely dried) should be transferred to new packets folded from a sheet of paper (Fig. 20) and fully labelled. These packets can be stored in metal or wooden cabinets or cardboard shoe boxes. After identification they can be arranged either alphabetically or in systematic order. The bryophyte collection should be stored under dry and well ventilated conditions to avoid infections by fungi or insects.

8. Morphology and characters of Liverworts and Hornworts

Bryophytes comprise three groups of early land plants: Liverworts or hepatics (Marchantiophyta), hornworts (Anthocerotophyta) and mosses (Bryophyta) (Tab. 2).

Table 2: Distinguishing characters of Liverworts, Hornworts and Mosses.

	Liverworts	Hornworts	Mosses
Habit	Foliose (with leaves) or thallose	Thallose	Foliose
Leaves	In 2-3 rows, undivided or lobed, without midrib, apex rounded, if acute then leaf lobed	-	Spirally arranged, rarely in 2-3 rows, always undivided, with or without midrib, apex often acute
Cells	With numerous chloroplasts, pyrenoid lacking, trigones usually present, isodiametric	With 1 (-4) large chloroplasts, with or without pyrenoid, trigones lacking, isodiametric	With numerous chloroplasts, pyrenoid lacking, trigones usually lacking, isodiametric or elongated (prosenchymatous)
Oil bodies	Usually present	Lacking	Lacking
Sporophyte	Surrounded by calyptras and other protective organs (perianth, marsupium, involucre)	Partially surrounded by involucre, calyptra lacking	Upper part covered by calyptras, further protective organs lacking
Capsule	Rounded to cylindrical, with colorless fragile seta, or seta lacking, opening at once by (1-) 4 valves, elaters present, columella, stomata and peristome lacking	Cylindrical to elongate, opening from top to bottom by 2 valves, elaters present, columella present, with stomata, peristome lacking	Round to cylindrical, with firm colored seta, opening at once by an operculum or dehiscence irregular, elaters lacking, columella and stomata present, peristome usually present

Life cycle

The life cycle of bryophytes consists of an alternation of two generations: the haploid gametophyte which represents the assimilating green plant, and the diploid sporophyte, “parasitizing” on the gametophyte and consisting of the capsule with seta and foot. The sporophyte is permanently attached to the gametophyte. The gametophyte produces the male (antheridia) and female gametangia (archegonia). The antheridium is usually an ovoid body on a short stalk and produces the biflagellate spermatozoids. These spermatozoids swim chemotactically in a film of water to the archegonium, which is bottle-shaped and consists of a narrow neck and the egg cell. They fuse with the egg cell and produce a diploid zygote, which starts with cell divisions and develops into a basal foot, a seta and the capsule (i.e. the meiosporangium). Meiosis occurs in the spore development out of a diploid spore mother cell which develops into tetrads of 4 spores with usually different ornamentation on outer (distal) and inner (proximal) face. The then haploid spores are dispersed and germinate on humid substrate to a protonema which differentiates into the leafy or thallose gametophyte.

Leafy liverworts

Stems and branches

The stems of leafy liverworts consist of three rows of **merophytes**: two lateral and one ventral. Each merophyte comprises stem tissue and an associated leaf. The leaves of the ventral merophyte are the **underleaves** (amphigastria). Branches either have normal vegetative leaves or are lacking leaves. Branches with scale-like leaves are called **flagellae** (Fig. 21), those without leaves are **stolons**. **Intercalary** branches originate from inner cells of the stem and thus bear a small collar at base. **Terminal** branches originate from a leaf-initial cell or from stem-epidermis, and no collar is formed.

Leaves

Leaves are arranged in three rows: two lateral and one ventral. In *Haplomitrium* (Fig. 22) the leaves of each lateral row are of approximately equal size, while the ventral leaves (underleaves) are normally smaller (Fig. 23) or are sometimes lacking (e.g. in *Cololejeunea*). Leaf position may be incubous, succubous or transverse. Incubous arrangement means that the dorsal leaf margin is nearer to the shoot apex than the ventral margin (Fig. 22). Succubous means that the ventral leaf margin is nearer to the shoot apex than the dorsal margin (Fig. 22). A transverse insertion is perpendicular to the stem (Fig. 22). Leaves may be flat, concave or convex, and variously oriented from the stem. The lamina may be entire, dentate at margin, bilobed, 3-5-lobed or deeply dissected into filiform segments. In *Radula*, *Porella* and the Lejeuneaceae, the leaves are complicate-bilobed (i.e. having a 2-lobed leaf with the lobes folded together longitudinally). Usually the dorsal segment (lobe) is larger than the ventral

segment (lobule), but may be smaller in the Scapaniaceae (e.g. *Diplophyllum*). The lobule (ventral segment) is very diverse in shape, and may be attached to the lobe (dorsal segment) by few stalk-like cells (*Frullania*) (Fig. 23) or attached along most of the ventral side of the lobe (in Lejeuneaceae, Fig. 24). The line of attachment between lobe and lobule is called keel, and the margin of the lobule that is not attached to the lobe is called the free margin. There may be one to several teeth along the free margin. The outermost tooth is called apical tooth (Fig. 24). A tooth between the apical tooth and the stem is the proximal tooth. Sometimes there is a tooth between the apical tooth and the keel called distal tooth (Fig. 25). The apical tooth usually bears a hyaline papilla that may be inserted at the distal or the proximal face of the tooth (Fig. 23). In the carnivorous genus *Colura*, the lobule is strongly involute, so that its free margin is directed towards the keel, and the base of this sac is closed by a moveable valve which is in fact an extension of the apex of the lobule. The moveable valve allows ingress but not egress, and studies have shown that it is part of an apparatus for trapping small protozoa (Barthlott *et al.*, 2000). Underleaves usually differ in size and shape from the lateral leaves (Figs 23, 24). They are highly diverse, ranging from 3-5-lobed to bilobed or entire and rounded.

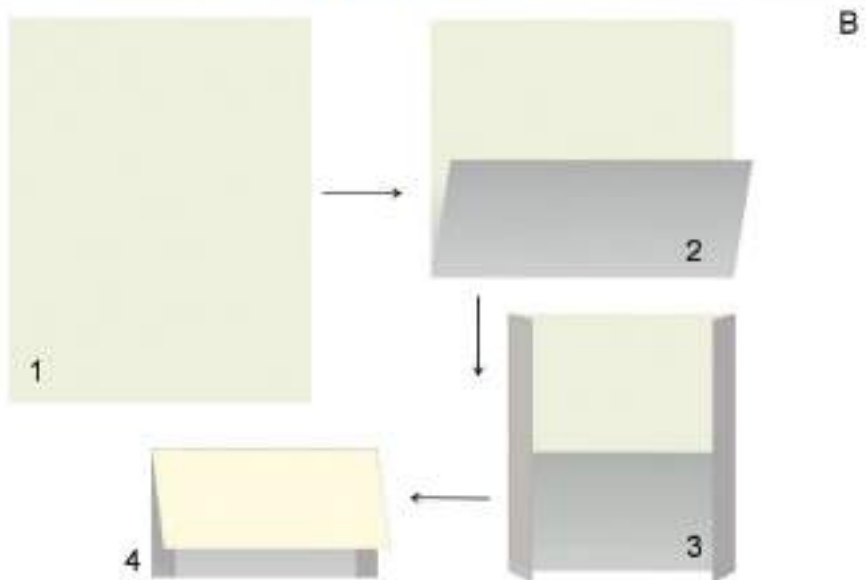


Fig. 20. A. Field equipment for bryophyte collection. 1. Paper bags. 2. Field book. 3. Pen. 4. Pencil. 5. Knife. 6. Pocket-knife. 7. Scissor for branches. 8. Handlens (10 x). **B.** Folding sequence for herbarium packets.

Leaf cells

Leaf cells are isodiametric to long rectangular. Cell walls are uniformly thin or thickened, or bear collenchymatous thickenings. These trigones may be cordate, triangular or nodulose, and may be separate or confluent (Fig. 26, 27). If the cell walls bear thickenings between the trigones these are called intermediate thickenings. In *Herbertus*, *Mnioloma*, *Bazzania* and some *Cololejeunea* spp. the lamina has rows of elongated cells called **vitta** (Fig. 28) which differs from the midrib of a moss in its unistratose structure.

Oil bodies

They are restricted to the liverworts. The number per cell, shape and chemical composition is variable. They consist of aggregated etheric oils easily recognizable by their refractive index which differs from that of the surrounding cell content. Some oil bodies produce a characteristic smell. The oil bodies provide important taxonomic characters but can only be observed in fresh specimens. In most species, they quickly disappear or disintegrate and lose their characteristic structure, some disappearing after only a few days (rarely, in a very few species, they may last for a few months). Kis & Pócs (1997) distinguished 9 types of oil bodies, of which two are mostly observed in ocelli and one in the thallose liverwort *Riccardia*:

- **Massula-Type:** Oil bodies homogeneous or 1-4-segmented, usually numerous and more than 8 per cell (*Porella*, *Cololejeunea*, *Lejeunea eckloniana*) (Fig. 26).
- **Bazzania-Type:** similar to Massula-Type but larger and less than 8 per cell (*Bazzania*, *Ptychanthus*) (Fig. 27).
- **Calypogeia-Type:** Oil bodies coarsely segmented of different globules. Size and number per cell variable (*Calypogeia*, *Frullania*, *Herbertus*, numerous Lejeuneaceae) (Fig. 26, 27).
- **Jungermannia-Type:** Oil bodies finely segmented, of numerous minute globules, finely granular (*Chiloscyphus*, Jungermanniaceae) (Fig. 26, 27).
- **Leucolejeunea-Type:** similar to Jungermannia-Type but very large, only 1-2 per cell (*Cheilolejeunea*) (Fig. 26).
- **Radula-Type:** Oil body 1 or few per cell, roughly granular (*Radula*) (Fig. 27).

In several Lejeuneaceae, e.g. *Diplasiolejeunea*, or *Drepanolejeunea*, specialized cells with one very large oil-body and without chloroplasts occur. They are called **ocelli** (sing. **ocellus**) (Fig. 28). In dried specimens where the oil bodies have already disappeared they can be recognized by their size.

Reproductive organs

Antheridia (male gametangia) are situated in the axils of specialized leaves, i.e. ♂ bracts, either on main shoot or on specialized branches. **Archegonia** (♀ gametangia) are protected by bracts or bracteoles. Often they are surrounded by a **perianth** (Fig. 30), a tubular organ originating by fusion of three leaves. The shape of the perianth, its ornamentation (e.g. horns, keels), the number of keels and their position (ventral or dorsal) provide important taxonomic characters. In Lejeuneaceae, the presence or absence of innovations, i.e. branches originating directly below the perianth, and the leaf sequence in the innovations are important taxonomic characters. In **lejeuneoid innovations** (Fig. 29) the first basal leaf is a lateral leaf. In **pycnolejeuneoid innovations** the first basal leaf is an underleaf (fig. 29).



Fig. 21. A. *Mastigophora diclados*. B. *Bazzania decrescens*. flag = flagellae.



Fig. 22. **A.** *Haplomitrium blumei*, isophyllous leaves. **B.** *Mnioloma fuscum*, succubous leaves. **C.** *Chiloscypus martianus*, incubous leaves. **D.** *Isotachis aubertii*, transverse leaves.

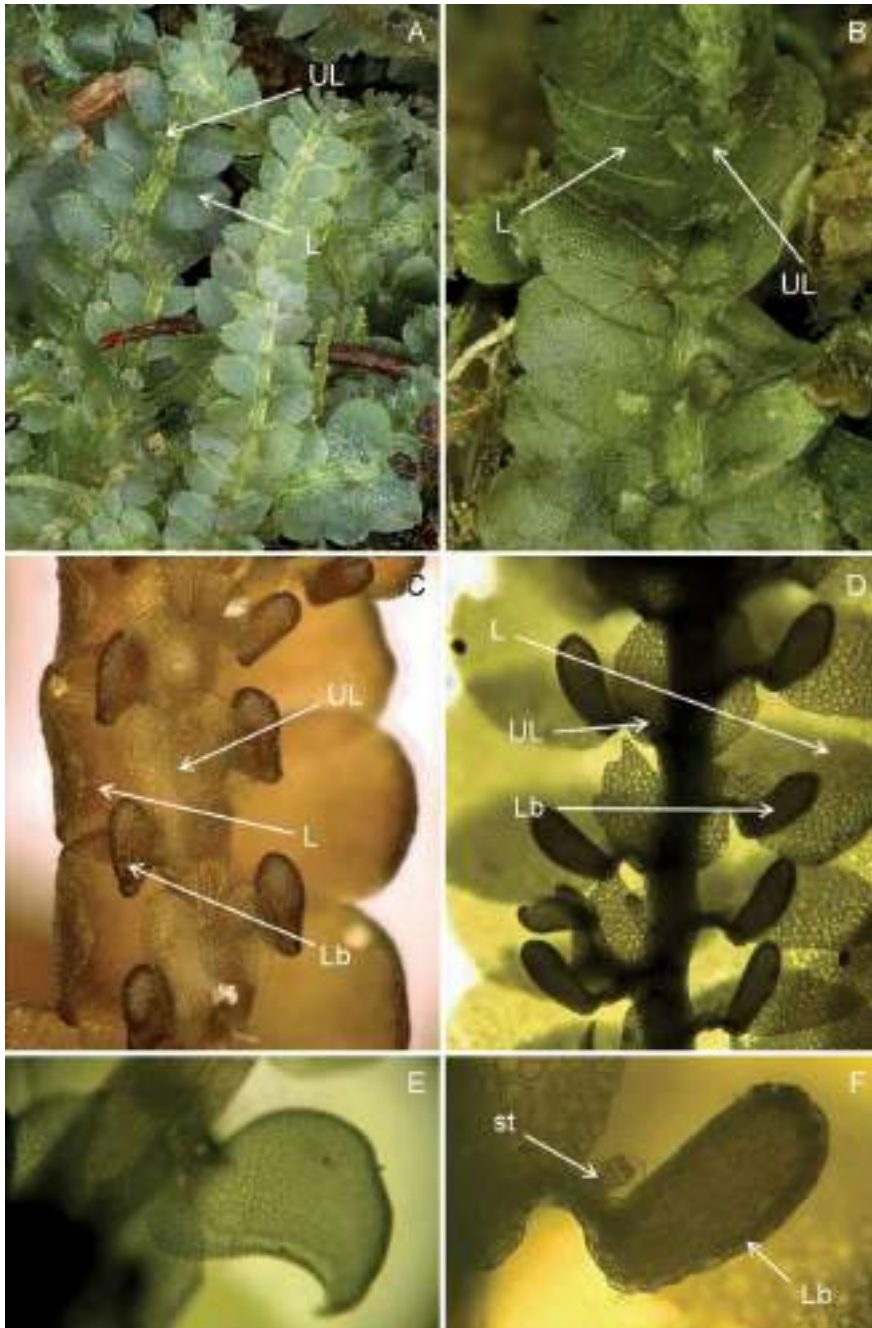


Fig. 23. A. *Calypogeia afrocaerulea*. B. *Calypogeia bidentula*. C. *Frullania apicalis*. D, F. *Frullania lindenbergiana*. E. *Frullania ericoides*. L = lateral leaf, UL = underleaf, Lb = lobule, st = stylus.

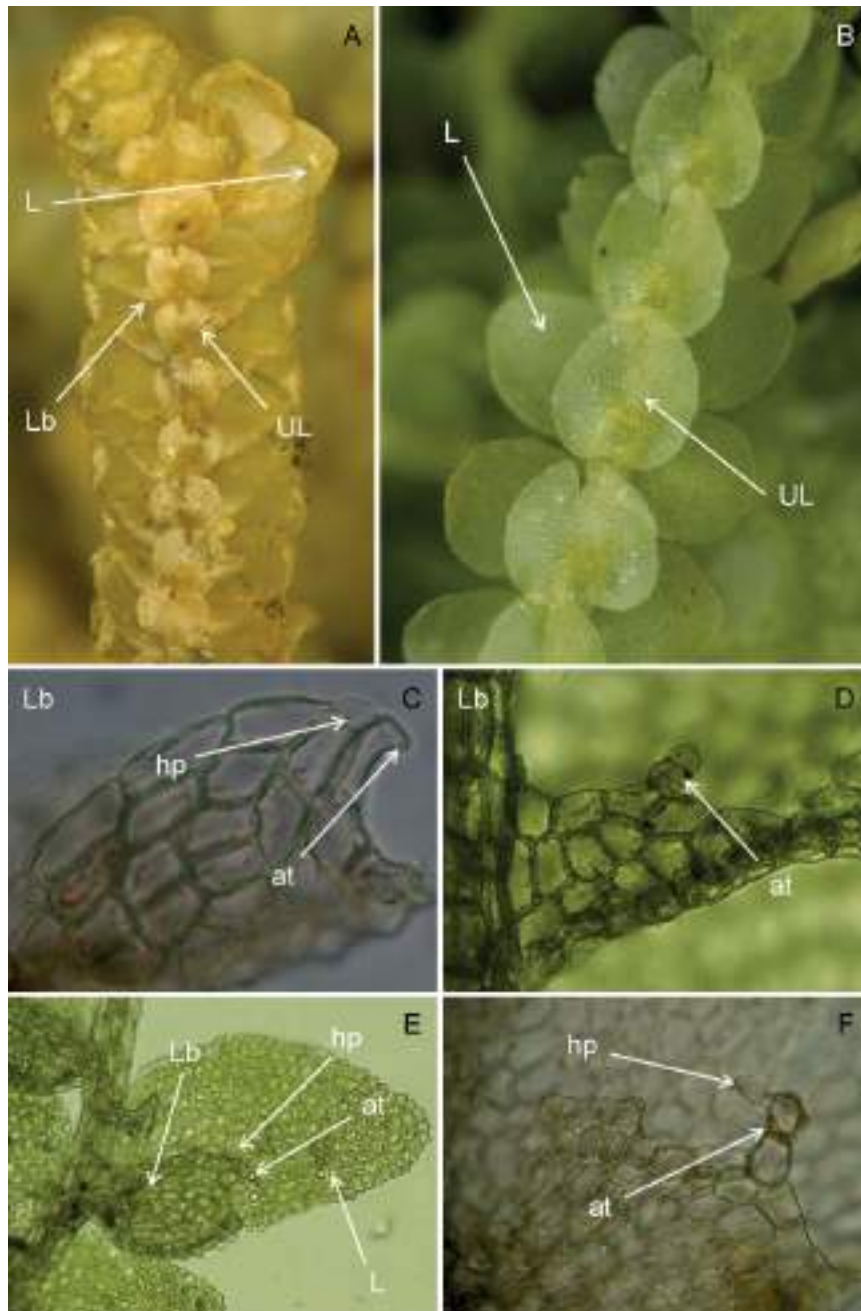


Fig. 24. **A.** *Cheilolejeunea cordistipula*. **B.** *Lejeunea isophylla*. **C.** *Drepanolejeunea vandenberghenii*, lobule. **D.** *Taxilejeunea conformis*, lobule. **E.** *Cololejeunea platyneura*. **F.** *Cololejeunea pseudo-obliqua*. L = lateral leaf, UL = underleaf, Lb = lobule, at = apical tooth, hp = hyaline papilla.

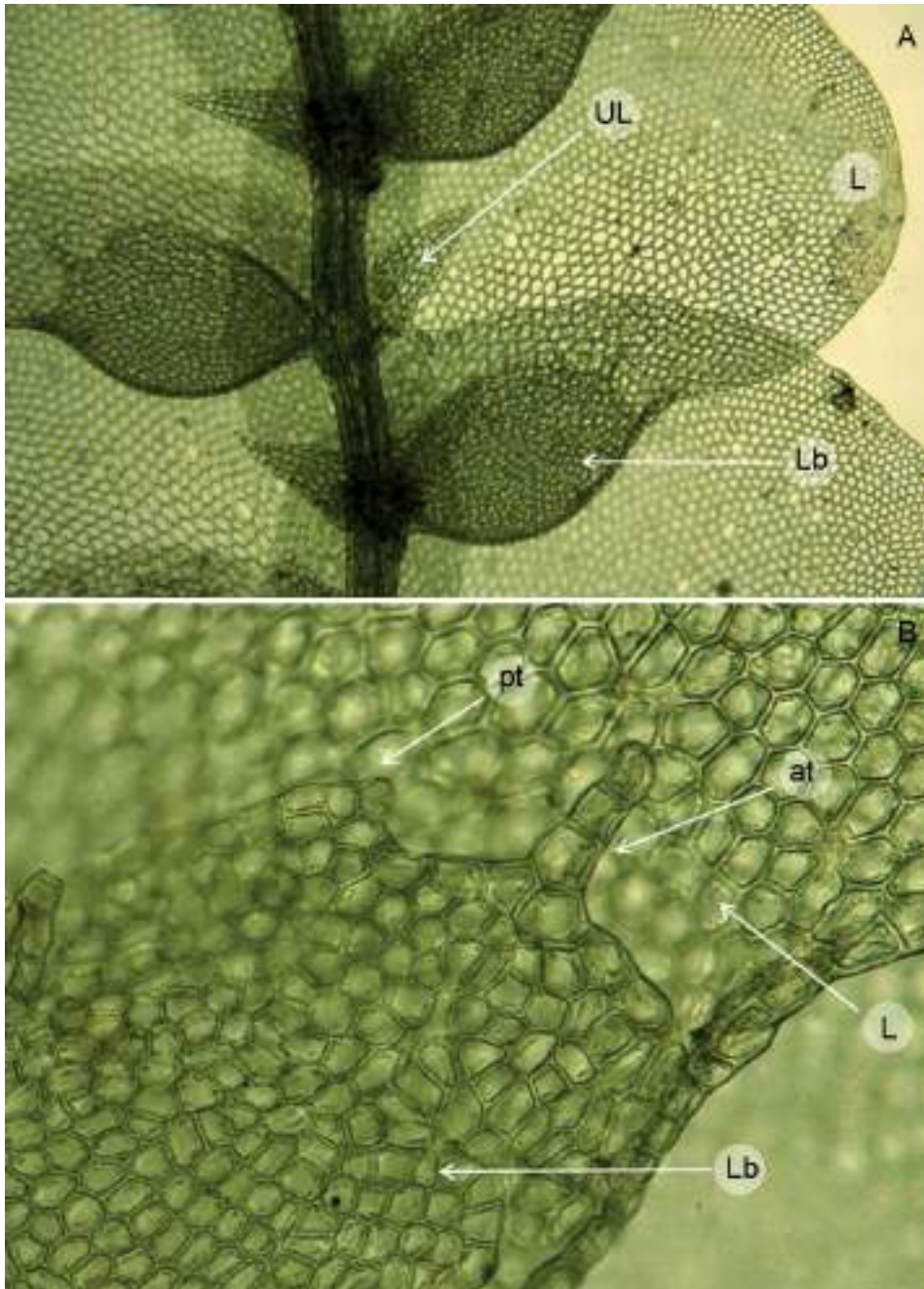


Fig. 25. *Diplasiolejeunea cavifolia*. **A.** Leaves and underleaves. **B.** Detail of lobule. L = lateral leaf, UL = underleaf, Lb = lobule, at = apical tooth, pt = proximal tooth.

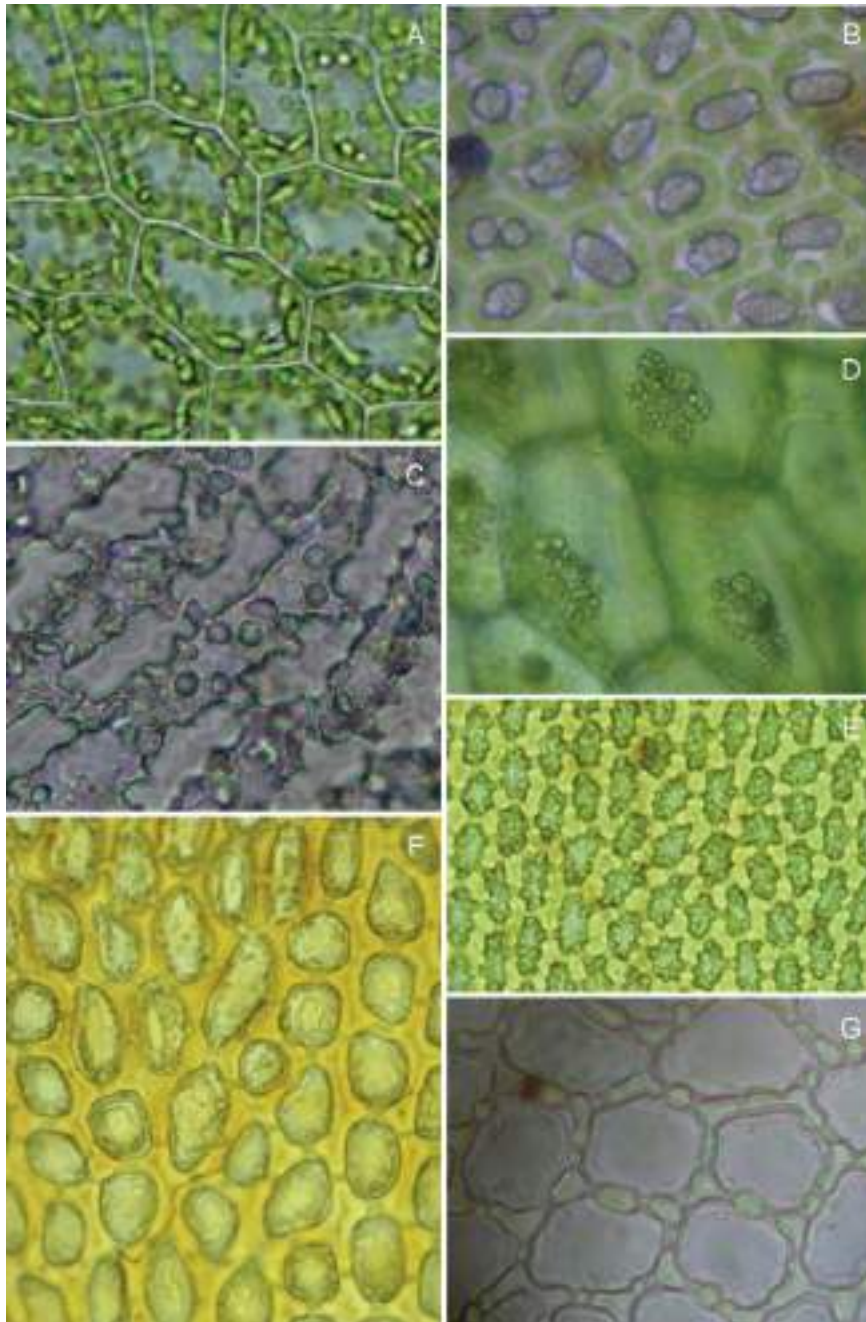


Fig. 26. Oil bodies and cell walls. **A.** *Cololejeunea obtusifolia*. **B.** *Cheilolejeunea xanthocarpa*. **C.** *Herbertus dicranus*. **D.** *Riccardia* sp. **E.** *Plicanthus hirtellus*. **F.** *Mastigophora diclados*. **G.** *Drepanolejeunea vandenberghenii*.

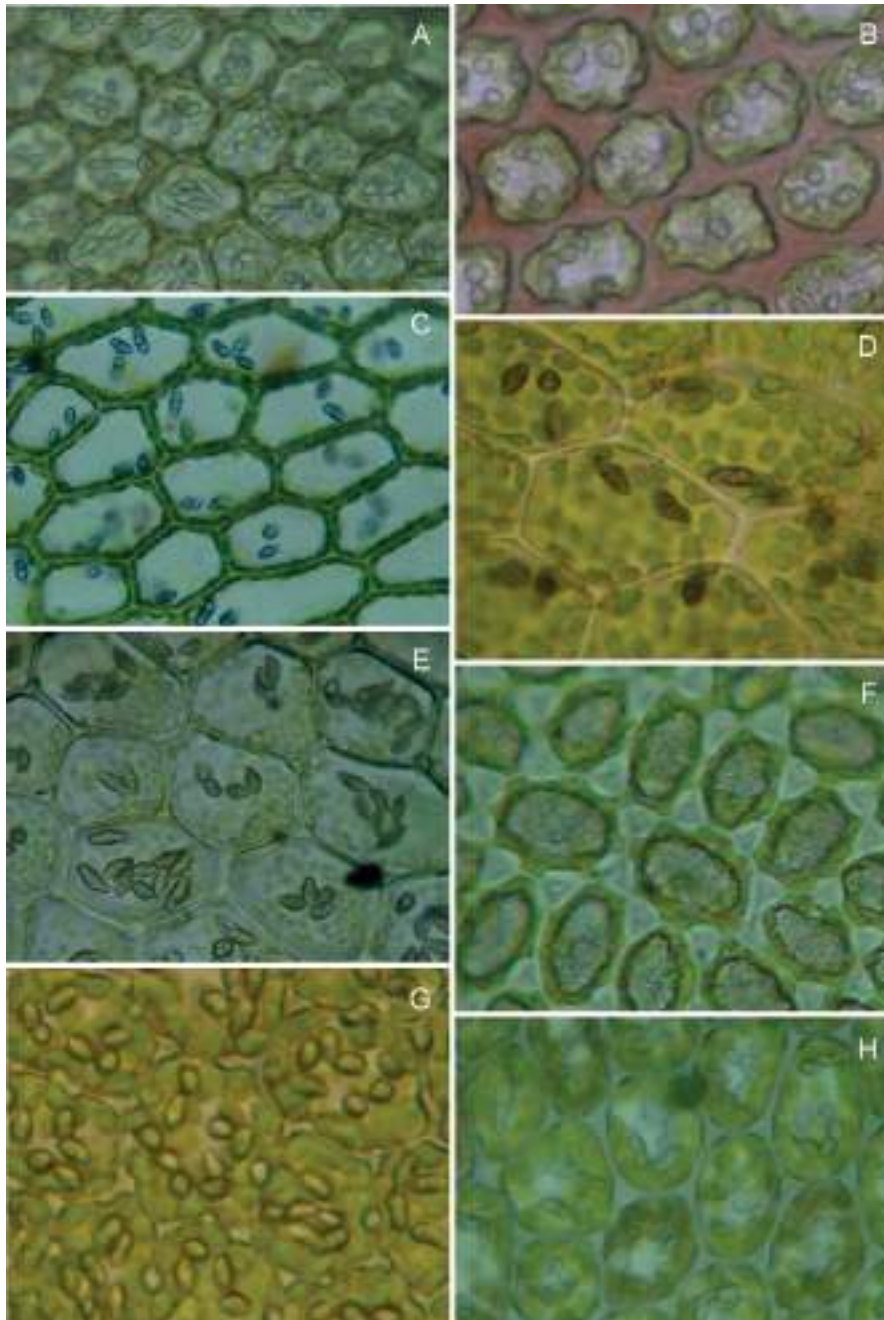


Fig. 27. Oil bodies. **A.** *Acrolejeunea emergens*. **B.** *Anastrophyllum piligerum*.
C. *Calypogeia afrocaerulea*. **D.** *Calypogeia fissa*. **E.** *Chiloscypus* sp. **F.** *Radula voluta*.
G. *Frullania spongiosa*. **H.** *Bazzania decrescens* ssp. *pumila*.



Fig. 28. A-B. *Bazzania nitida*. C. *Cololejeunea distalopapillata*. D. *Drepanolejeunea ruandensis*. E. *Drepanolejeunea cultrella*. Hm = hyaline margin, Oc = ocellus, Vi = Vitta.



Fig. 29. A. *Harpalejeunea fischeri*, lejeuneoid innovation. **B-E.** *Drepanolejeunea vandenberghenii*. **B.** Pycnolejeuneoid innovation. **C.** Capsule with valves and elaters. **D.** Valve with elaters. **E.** Elaters. **F.** *Plicanthus hirtellus*, perianth and sporophyte. L = Lateral leaf, UL = underleaf. P = perianth, S = seta, Ca = capsule, Va = Valve, E = elater, fb = female bract.

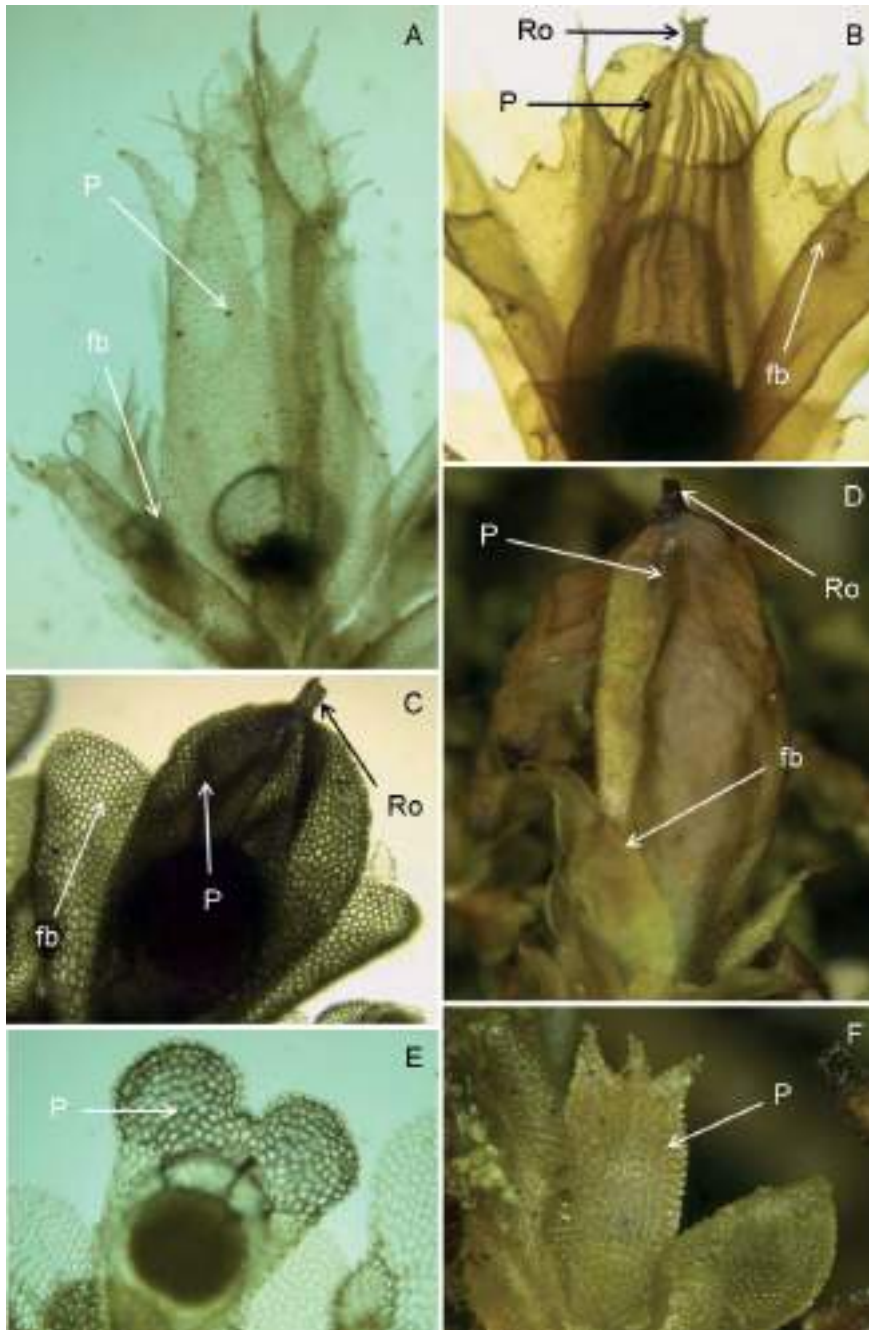


Fig. 30. Perianths. **A.** *Chiloscyphus difformis*. **B.** *Frullania arecae*. **C.** *Lejeunea tabularis*. **D.** *Frullania capensis*. **E.** *Cololejeunea harrisii*. **F.** *Colura berghenii*. P = perianth, fb = female bract, Ro = rostellum.



Fig. 31. Vegetative reproduction. **A.** *Cololejeunea malanjae*. **B.** *Radula quadrata*. **C-D.** *Bazzania decrescens* ssp. *pumila*. cl = caducous leaves, ge = gemmae.

Sporophyte

The young sporophyte is fully enveloped by the **calyptra** which derives from a fertilized archegonium. Some genera (e.g. *Adelanthus*) develop a shoot calyptra, i.e. a fleshy structure composed of stem and archegonial tissue. In several genera, tubular structures protecting the young sporophyte occur that entirely develop from stem tissue. This is called **perigynium** which may be erect (e.g. *Isotachis*) or pendent. If pendent, it is called **marsupium** (e.g. in *Calypogeia*, *Gongylanthus*, *Tylimanthus*). Then the perianth is usually reduced. The sporophyte consists of **foot**, **seta** and **capsule** (Fig. 29). The seta is colorless and ephemeral, and it rapidly elongates at capsule maturity. The capsule opens by four valves. Mature capsules contain spores and unicellular **elaters** (Fig. 29), which are elongated cells with one or more spirally thickened bands. They are hygroscopic and serve to loosen the spore mass.

Vegetative reproduction

Vegetative reproduction can be achieved by regeneration from leaf or stem cells, or by specialized diaspores (**gemmae**) produced on margin or surface of leaves. **Caducous leaves** regenerating to new plants are abundant in several taxa (e.g. *Lejeunea* spp., *Frullania* spp., *Bazzania* spp.) (Fig. 31).

Thallose Liverworts

Habit and structure

A thallus is a vegetative plant structure that is not differentiated into stem and leaves, and thus resembles a green ribbon. The Marchantiopsida are entirely thallose, and the thallus is **anatomically complex** consisting of different types of tissue. The upper layers are usually of a green, chlorophyllose **assimilating tissue** mostly located in **air-chambers** that open by specialized **pores** (Fig. 32) on the upper surface of the thallus. **Oil bodies** are usually located in specialized cells in the middle thallus layers. On the ventral side **ventral scales** are present in two or more rows. In the Pallaviciniopsida and Jungermanniopsida subclass Metzgeriidae the thallus is **anatomically simple**, either multistratose throughout (*Aneura*, *Riccardia*) or with a specialized multistratose midrib and unistratose thallus wings (e.g. *Symphyogyna*, *Metzgeria*) (Fig. 32).

Reproductive organs and sporophyte

Antheridia are produced on thallus surface either naked or surrounded by an involucre, or inside the thallus in specialized chambers. In *Marchantia* these chambers are located on stalked receptacles called **antheridiophores**. **Archegonia** are on thallus surface or embedded inside the thallus usually surrounded by an involucre. In *Asterella* and *Pallavicinia* there are two involucre around the archegonia, the inner one called **pseudoperianth** (Fig. 36). This structure only develops after fertilization and resembles the perianth of the Jungermanniopsida, but originates from the thallus and not from fused leaves. In *Aneura* and *Riccardia* the sporophyte

is surrounded by a fleshy **calyptra** (Fig. 33). In the Marchantiopsida the archegonia are located on lower surface of stalked **archegoniophores** (Fig. 35) or embedded in the thallus tissue (*Riccia*). The sporophyte consists of foot, seta and capsule (foot and seta lacking in *Riccia*). A shoot calyptra (see Leafy liverworts) is present in *Metzgeria*. The capsule opens by four valves in Metzgeriidae, Fossombroniopsida and Pallaviciniopsida. In Marchantiopsida it usually opens by a disc-like operculum or irregularly. Spores are often richly ornamented on the outer (distal) surface (e.g. *Fossombronia*, *Riccia*) (Fig. 34) and provide important taxonomic characters.

Vegetative reproduction

Often by specialized diaspores, e.g. gemmae on thallus surface (*Riccardia*, *Metzgeria*) or in cup-like structures (*Lunularia*, *Marchantia*) (Fig. 36).

Hornworts

Habit and structure

The thallus is anatomically simple and consists of thin-walled cells with usually 1 chloroplast (occasionally 2-4 in *Megaceros*, not present in the area). Each chloroplast has a pyrenoid which is involved in the synthesis of starch. Oil bodies are lacking. The ventral side of the thallus bears air-chambers with pores and contains colonies of symbiotic cyanobacteria (*Nostoc*).

Reproductive structures and sporophyte

Gametangia originate from subepidermal cells of thallus and not from epidermal cells as in liverworts and mosses. The **capsule** is elongate, slender and horn-like (Fig. 37), developing from an intercalary meristem. It bears **stomata** and lacks a seta. At first, the capsule is protected by a sheath-like involucre (Fig. 37), from which it emerges and elongates as it matures. The capsule has a central axis of sterile tissue called **columella** (Fig. 37) which is surrounded by sporogenous tissue. The **elaters** are unicellular or multicellular, then called **pseudoelaters** (Fig. 37). The capsule opens by 2 valves.

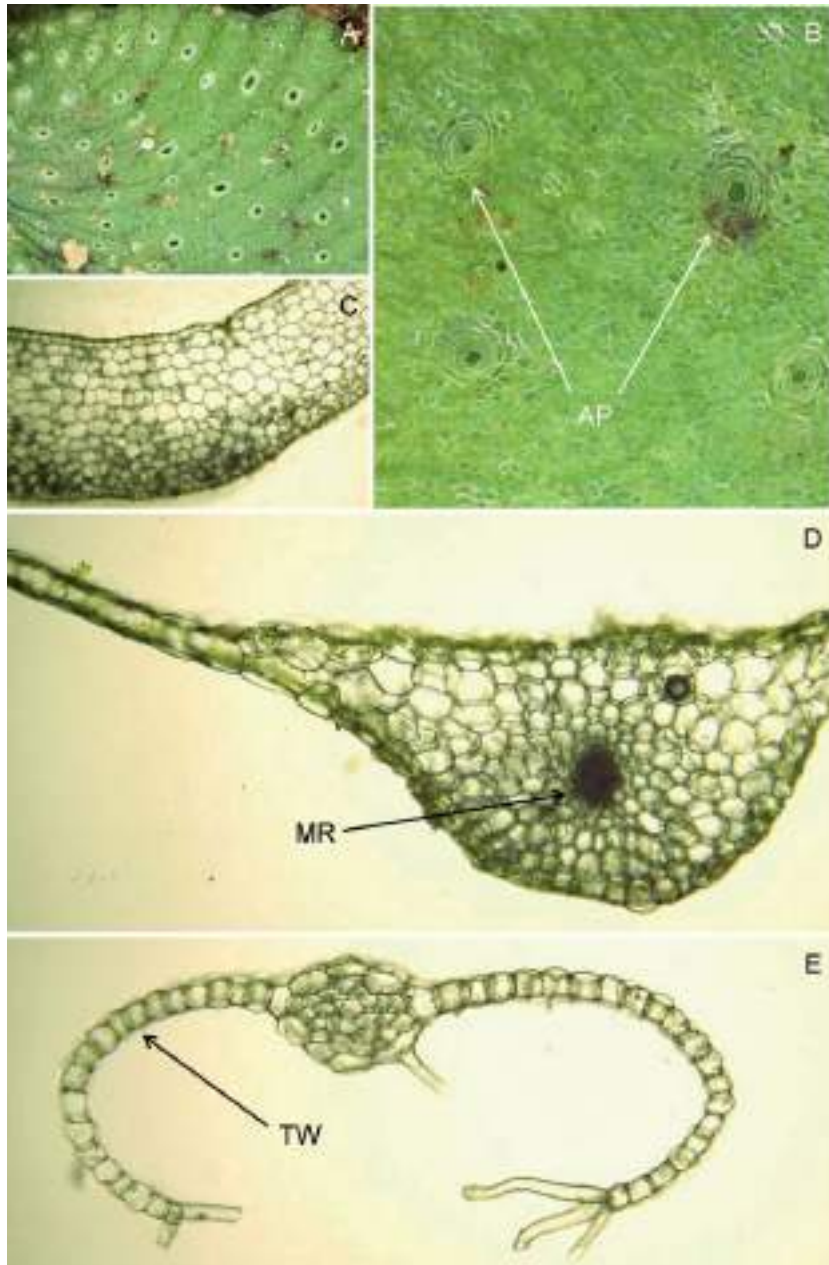


Fig. 32. **A.** *Marchantia pappeana*. Thallus surface with air pores. **B.** *Asterella abyssinica*. Thallus surface with air pores. **C.** *Aneura pinguis*. Transversal section of thallus. **D.** *Symphyogyna lehmanniana*. Transversal section of thallus showing midrib. **E.** *Metzgeria quadrifaria*. Transversal section of thallus. AP = air pores, MR = midrib, TW = thallus wing.



Fig. 33. Sporophytes of simple thallose liverworts. **A-B.** *Symphyogyna lehmanniana*. **C.** *Aneura pseudopinguis*. **D.** *Riccardia amazonica*. Ca = capsule. Cal = calyptra.



Fig. 34. Quillworts. **A-B.** *Fossombronia pusilla*. **A.** Thallus with sporophyte. **B.** Spore, distal face. **C.** *Fossombronia rwandaensis* with antheridia. Anth = antheridia, Ca = capsule, dis = distal, Th = thallus.



Fig. 35. A-B. *Marchantia pappeana*. **A.** Archegoniophore (Archp). **B.** Antheridiophore (Anthp). **C.** *Marchantia polymorpha* ssp. *ruderalis*, showing archegoniophores and antheridiophores.



Fig. 36. A. *Asterella abyssinica*, archegoniophores with pseudoperianth (Pp).
B. *Marchantia polymorpha* ssp. *montivagans*. Cup with gemmae. **C.** *Lunularia cruciata*.
 Cup with gemmae. cp = cup, ge = gemmae.

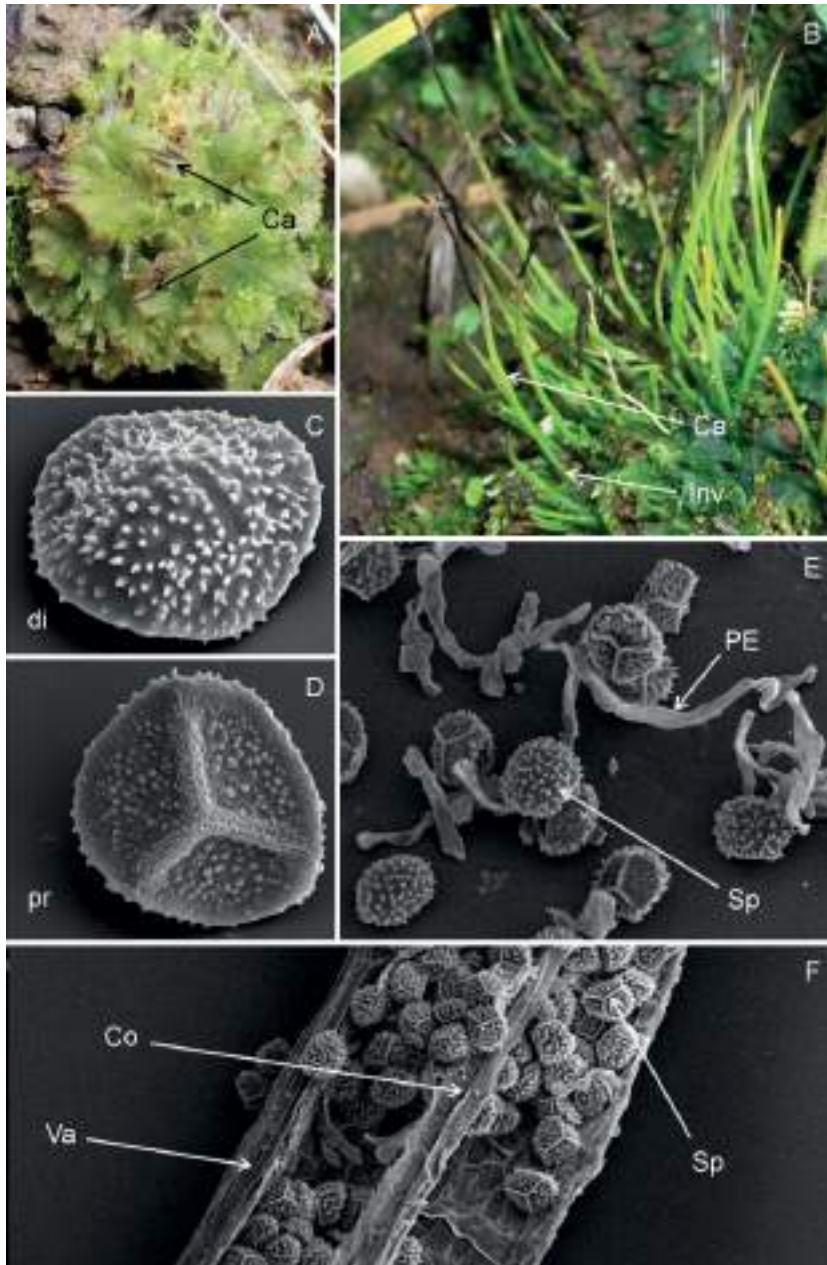


Fig. 37. Hornworts. **A.** *Notothylas orbicularis*, thallus with capsules. **B.** *Anthoceros sambesianus*, thallus with capsules. **C-D.** *Phaeoceros carolinianus*, spores. **C.** distal face (di). **D.** proximal face (pr). **E-F.** *Anthoceros myriandroecius*. **E.** Spores with pseudoelaters. **F.** Longitudinal section of sporophyte. Ca = capsule, Co = columella, Inv = involucre, PE = pseudoelaters, Sp = spore, Va = valve.

9. Artificial key to groups

1. Thallose plants, not differentiated into stem and leaves2
- 1*. Plants with stems and leaves, the leaves in two or three rows 7
2. Thallus several cells thick over most of transverse section 3
- 2*. Thallus one layer of cells thick, a pluristratose midrib clearly differentiated, thallus either dichotomously branched or resembling a filmy fern (*Hymenophyllum*) 6
3. One (-two) chloroplast per cell, colonies of cyanobacteria (*Nostoc*) present in the thallus, sporangium horn-like, long or short, dehiscing by longitudinal slits from the apex downwards**Hornworts - Anthocerotophyta** (p. 119)
- 3*. Many chloroplasts per cell, *Nostoc* colonies always absent, sporangium ovate to spherical, dehiscing by four valves or irregularly..... 4
4. Thallus with cavities (air chambers) or upper part with closely packed vertical filaments **Complex thalloid liverworts - Marchantiopsida** (p.110)
- 4*. Thallus solid 5
5. Thallus large, 8-10 mm x 40-100 mm, female inflorescences stalked
..... **Marchantiopsida (*Dumortiera*)** (p. 113)
- 5*. Thallus smaller, female inflorescence not stalked, sporangium on short seta, which elongates shortly before dehiscence, capsule opening with four valves, midrib poorly differentiated, thallus usually pinnately to bipinnately or palmately branched (except in *Aneura pseudopinguis*), male and female inflorescences on very short lateral branches.....
.....**Simple thalloid liverworts - Aneurales (Aneuraceae)** (p. 112)
6. Inflorescence on short branches below the midrib, thallus not more than 2 mm wide, with distinct midrib up to 120 µm wide, formed of 2-4 rows of large cortical cells on dorsal side and 2-6 rows of similar cells on ventral side and 3-7 medullary cells, mainly epiphytic.....
..... **Simple thalloid liverworts - Metzgeriales (Metzgeriaceae)** (p. 115)
- 6*. Inflorescence on upper surface of thallus, midrib 300-600 µm wide, of 10-15 cell layers in transverse section, tapering gradually into unistratose wings ..
Simple thalloid liverworts - Pallaviciniopsida (Pallaviciniaceae) (p. 112)

7. Plants essentially leafy, the leaves free or united, thus reduced to dorsal, transverse, leaf-like lamellae, gynoecea dorsal on surface or on branches, without involucre..... **Fossombroniaceae (*Fossombronia*)** (p. 114)
- 7*. Plants clearly leafy, but leaves always distinct, gynoecea terminal on main stem or branches, perianth and perigynium absent (*Haplomitrium*, then plants isophyllous) or present 8
8. Plants isophyllous, erect to suberect, with three transverse rows of identical, unlobed leaves, rhizoids absent.....
.....**Leafy liverworts - Haplomitriopsida (*Haplomitrium*)** (p. 96)
- 8*. Plants anisophyllous, prostrate to erect, with two obvious rows of lateral leaves and a third row of underleaves which may be reduced or lacking.....
.....**Leafy liverworts - Jungermanniopsida** (p. 70)

9.1. Jungermanniopsida – Key to Families and Genera in Rwanda

1. Leaves divided to base or nearly to base into 2-4 straight segments, the segments sometimes laciniate or branched, not more than 1-2 cells wide at base, underleaves similar to leaves 2
- 1*. Leaves undivided or divided into segments (not to base) which are wider than 1-2 cells, underleaves present or absent, if present usually different from leaves..... 3
2. Perianth at apex of short ventral branch, terminal or ventral flagellae usually present, plants delicate to robust, trigones absent
..... **Lepidoziaceae (*Kurzia, Telaranea*)**
- 2*. Perianth at apex of elongated lateral branch, flagellae absent, plants delicate, cells distinctly thickened at angles.....
..... **Blepharostomaceae (*Blepharostoma*)**
3. Leaves (3-)4(-5)-lobed from 1/4 to more than half their length; usually robust plants 4
- 3*. Leaves undivided, or simply 2-lobed or divided into a dorsal and a ventral lobe7
4. Pinnately or bipinnately branched with attenuate branches 5
- 4*. Branching not pinnate 6

5. Leaves transversely inserted, underleaves bilobed with additional laciniae, sexual organs at apex of non-specialized elongated branches with leaves **Mastigophoraceae (*Mastigophora*)**
- 5*. Leaves incubous, underleaves 4-lobed, without paraphyllia, female and often male sexual organs on specialized short branches, usually of ventral origin **Lepidoziaceae (*Lepidozia*)**
6. Leaves asymmetrically 3(-4)-lobed, obliquely inserted; leaf cells with large, bulging trigones **Lophoziaceae (*Plicanthus*)**
- 6*. Leaves symmetrically 4-lobed, transversely inserted; leaf cells with indistinct trigones **Lophoziaceae (*Tetralophozia*)**
7. Leaves with a complex structure, the lobe fused above to form a terminal sac or inflated horn, the base of the sac closed by a mobile valve **Lejeuneaceae (*Colura*)**
- 7*. Leaves simple or complex, with or without lobule but never with terminal inflated sac 8
8. Leaves divided into two often unequal parts (dorsal lobe and ventral lobule), lobule sometimes reduced to few cells or transformed to an open sac 9
- 8*. Leaves not divided into dorsal lobe and ventral lobule 15
9. Dorsal part of leaf (lobe) as large as ventral part or smaller, ventral part (lobule) never formed into a sac-like structure 10
- 9*. Dorsal part of leaf (lobe) distinctly larger than ventral part (lobule), lobule sometimes formed into a sac-like structure 11
10. Leaves dentate, with a mostly winged keel resulting from plication between lobe and lobule **Schistochilaceae (*Schistochila*)**
- 10*. Leaves not dentate, keel not winged, perianth usually dorsiventrally compressed **Scapaniaceae (*Diplophyllum*)**
11. Underleaves absent 12
- 11*. Underleaves present 13
12. Lobules broadly attached to stem; rhizoids on ventral lobule of leaves, not on stems, perianth with large apex **Radulaceae (*Radula*)**
- 12*. Lobules narrowly attached to stem by only 1-4 cells; rhizoids on stems, perianth with constricted apex **Lejeuneaceae (*Cololejeunea* incl. *Aphanolejeunea*)**

13. Ventral lobule attached to lobe by a keel equal in length to the lobule (or nearly so), lobule sometimes reduced to few cells, only one archegonium per inflorescence **Lejeuneaceae**
- 13*. Ventral lobule attached to lobe by a straight peduncle, several archegonia per inflorescence 14
14. Lobule usually helmet-like or cup-like, sometimes reduced to a ventrally concave lobe, underleaves bilobed or bidentate. **Frullaniaceae (*Frullania*)**
- 14*. Lobule plane or with revolute and decurrent margin, underleaves entire or irregularly dentate..... **Porellaceae (*Porella*)**
15. Leaves incubous (upper margin of a leaf covers lower part of leaf situated immediately above), underleaves present 16
- 15*. Leaves succubous (lower margin of leaf covers upper part of leaf situated immediately below), or transversely inserted on stem, underleaves present or absent 17
16. Leaves entire or shortly bidentate at apex, underleaves usually bilobed or bidentate or entire with an irregularly dentate margin, sporophyte developing in an hypogeic marsupium **Calypogeiaceae**
- 16*. Leaves with truncate, shallowly 2-3-lobed or truncate apices or entire, in that case underleaves bilobed or not, but at least 2 x as large as the stem, marsupium lacking **Lepidoziaceae (*Bazzania*)**
17. Underleaves present 18
- 17*. Underleaves absent or very small 24
18. Leaves and underleaves subequal, deeply divided for 2/3 of their length into two narrow secund lobes, acuminate at apex **Herbertaceae (*Herbertus*)**
- 18*. Leaves larger than underleaves, divided into two lobes for not more than half their length or undivided 19
19. Perianth reduced or absent, involucre bracts well developed, underleaves comparatively large, more than 2 x as wide as the stem, leaves often bilobed, strongly conduplicate, cuticle striate..... **Balantiopsaceae (*Isotachis*)**
- 19*. Perianth well developed, underleaves often small, rarely more than 2 times as wide as the stem, leaves 2-lobed or entire, rounded..... 20
20. All leaves distinctly bilobed with acute lobes, sometimes irregularly dentate to retuse **Lophocoleaceae (*Chiloscyphus*)**
- 20*. All leaves entire, rounded, sometimes dentate or slightly retuse 21

21. Perianth laterally compressed, the ventral face narrow, leaves and underleaves often with spiniform teeth, plants \pm brownish to fuscous pigmented **Lophocoleaceae (*Leptoscyphus*)**
- 21*. Perianth \pm symmetrically trigonous, the angles often winged, plants usually green, lacking brownish to fuscous pigmentation..... 22
22. Leaves convex, rarely plane, the apical part often decurved or deflexed, underleaves usually wider than the stem
..... **Lophocoleaceae (*Chiloscyphus concretus*)**
- 22*. Leaves moderately to deeply adaxially concave, the apical part not decurved or deflexed; underleaves usually narrower than the stem 23
23. Leaves rounded, leaf cells with thin walls, trigones lacking or small, underleaves not as large as the stem underleaf lobes often spreading, not lying close to each other, the apices, the lobes not touching
..... **Lophocoleaceae (*Clasmatocolea*)**
- 23*. Leaves oblong, rounded or retuse at apex, leaf cells with thickened walls, trigones large and often nodular, underleaves larger than stem, underleaf lobes parallel, often lying close to each other, the lobe apices sometimes touching **Notoscyphus**
24. Leaves distinctly to shortly bilobed 25
- 24*. Leaves entire, ovate or oblong, sometimes with dentate margin 32
25. Leafy shoots arise from prostrate stolons, leaves oblong, shortly bilobed, frequently producing rhizoids from the margin of leaves
..... **Acrobolbaceae (*Tylimanthus*)**
- 25*. Leafy shoots not arising from prostrate stolons, leaf margin without rhizoids 26
26. Perianth absent or strongly reduced, not exceeding the involucre bracts, leaf insertion like a closed V, the two parts of leaf approached to each other, worm-like plants from alpine habitats **Gymnomitriaceae**
- 26*. Perianth well developed, exceeding the involucre bracts, leaf insertion different 27
27. Plants minute, less than 0.5 mm wide, cells without trigones
..... **Cephalozellaceae**
- 27*. Plants larger, cells with or without trigones 29

28. Outermost stem cells in transverse section distinctly larger than inner cells (hyalodermis), cells without trigones **Cephaloziaceae (*Cephalozia*)**
- 28*. Outermost stem cells not distinctly larger than inner cells, cells with trigones 29
29. Leaves asymmetrically 2-(3)-lobed, gemmae present at leaf margin **Lophoziaceae (*Tritomaria*)**
- 29*. Leaves \pm symmetrically bilobed 30
30. Leafy shoots frequently becoming flagelliform, microphyllous, stoloniform distally; branches arising from dorsal side of stem (*Anomoclada*-type) **Lophoziaceae (*Andrewsianthus*)**
- 30*. Leafy shoots not becoming flagelliform and microphyllous; branches lateral or ventral, rarely dorsal 31
31. Leaf insertion transverse (except decurrent part), plants usually brownish .
..... **Lophoziaceae (*Anastrophyllum*)**
- 31*. Leaf insertion oblique, succubous, plants usually green to yellowish green
..... **Lophoziaceae (*Lophozia*)**
32. Perianths absent, marsupium terminal, long and cylindrical, cells conspicuously elongate along ventral margin of leaf, plants prostrate, usually yellow-greenish **Acrobolbaceae (*Lethocolea*)**
- 32*. Perianths present, cells not elongate along ventral margin of leaf, plants prostrate to ascending or erect, colour various 33
33. Leaves opposite, eventually connate dorsally or ventrally, rhizoids on stem in tufts 34
- 33*. Leaves alternate, not connate, rhizoids on stem dispersed 35
34. Perianth well developed, exceeding involucre bracts distinctly, sporophyte at apex of stem, leaves entire or paucidentate near apex, ovate-triangular or ovate-oblong **Jamesoniellaceae (*Syzygiella*)**
- 34*. Perianth much shorter than involucre bracts, sporophyte developing in a subcylindric hypogeic pocket (marsupium), leaves entire, suborbicular to ovate..... **Arnelliaceae (*Gongylanthus*)**
35. Leaf margin usually dentate, with at least 1-3 teeth 36
- 35*. Leaf margin entire 37

36. Leaves longly or shortly decurrent in upper and lower part, subentire to irregularly dentate, inflorescence terminal on leafy main stem or branches, perianth compressed laterally in upper part. **Plagiochilaceae (*Plagiochila*)**
- 36*. Leaves in lower margin sometimes decurrent, in upper part not or only shortly decurrent, leaves entire, bidentate, bilobed or irregularly lobed, sometimes dentate-ciliate, inflorescence on very short leafless branch near base of stem, perianth not laterally compressed or perianth absent
..... **Adelanthaceae (*Adelanthus*)**
37. Leaves, at least the upper ones, appressed face to face, leaf margins usually incurved, rhizoids scarce, underleaves very small, subulate
..... **Jamesoniellaceae (*Jamesoniella*)**
- 37*. Leaves spreading, leaf margins not incurved, usually with numerous rhizoids, underleaves bilobed or absent **Jungermanniaceae**

9.2. Families of Leafy liverworts with \geq two genera in Rwanda – Keys to Genera in Rwanda

Acrobolbaceae

1. Leaves entire, with entire margin, plants prostrate, usually yellow-greenish ***Lethocolea***
- 1*. Leaves \pm bilobed, with irregular teeth (up to 8), rarely entire margin, plants ascending to erect, dark green to blackish or brownish in dry state
..... ***Tylimanthus***

Calypogeiaceae

1. Leaf base longly decurrent, apex of leaves rounded, undivided, underleaves \pm orbicular, undivided, plants deep green to brown, gemmae lacking
..... ***Mnioloma***
- 1*. Leaf base not or only shortly decurrent, apex of leaves rounded, \pm bifid, underleaves bifid, plants pale green to bluish, gemmae frequent
..... ***Calypogeia***

Cephaloziellaceae

1. Leaves transversely inserted and oriented, slightly concave; leaf insertion extended quite to stem midline dorsally, perianth longly oblong-obovate, deeply plicate **Cephaloziella**
- 1*. Leaves succubous (lower margin of leaf on dorsal side of stem), incubous (upper margin of leaf on dorsal side of stem), obliquely to subhorizontally inserted, almost flat 2
2. Leaves incubous, dentate, sometimes 3-lobed **Cephalojonesia**
- 2*. Leaves succubous, obliquely to subhorizontally inserted, almost flat, 2-lobed 3
3. Underleaves conspicuous, undivided, perianths clavate, widest in upper third, mouth constricted, vegetative reproduction by gemmae at leaf-tips ...
..... **Amphicephalozia africana**
- 3*. Underleaves minute or absent, perianths cylindrical to obconical, mouth wide or narrowed, vegetative reproduction not known **Cylindrocolea**

Gymnomitriaceae

1. Plants greyish- to whitish-green, glaucous or pale brownish, shoots julaceous to nearly filiform, leaves appressed, rarely squarrose, leaf cells thick-walled, with absent or small trigones, perianth lacking, replaced by scales or laciniae **Gymnomitrium**
- 1*. Plants greenish, brownish or blackish, shoots never filiform, leaves spreading, clearly distinct, leaf cells thin- or thick-walled, with large to nodular trigones, perianth absent or present 2
2. Leaf margin revolute, leaves bilobed, leaflobes blunt, perianth absent
..... **Apomarsupella**
- 2*. Leaf margin plane, leaves bilobed or unlobed, leaflobes acute or blunt, perianth present **Marsupella**

Jamesoniellaceae

1. Leaves distinctly opposite with the leaf bases united dorsally and ventrally
..... **Syzygiella**
- 1*. Leaves alternate, leaf bases free, at least the upper leaves appressed face to face, leaf margins usually incurved **Jamesoniella**

Jungermanniaceae

- 1. Bilobed underleaves present **Notoscyphus**
- 1*. Underleaves lacking or very small, subulate **Jungermannia**

Lejeuneaceae

- 1. Underleaves lacking 2
- 1*. Underleaves present 3
- 2. Lobule usually small compared with the lobe, not exceeding half of lobe surface, reduced leaves absent or rare, innovations of the Lejeunea-type (with basal collar), small or medium-sized plants **Cololejeunea**
- 2*. Lobule large compared with the lobe, usually exceeding half of lobe, reduced leaves frequent, innovations without basal collar, very small delicate plants **Cololejeunea subg. Aphanolejeunea**
- 3. One amphigastrium per leaf 4
- 3*. One amphigastrium per leaf pair 5
- 4. Leaves with an inflated cylindric prolongation of the lobule, the opening of the pocket formed by the lobe closed by a moveable valvular cap, ocelli absent **Colura**
- 4*. Leaves (lobes and lobule) not inflated, without inflated prolongation and valvular cap, with normal lobe and lobule, sometimes ocelli present **Diplasiolejeunea**
- 5. Plants usually robust, underleaves entire, sometimes slightly retuse or emarginated at apex, never bilobed 6
- 5*. Plants generally small, underleaves all distinctly bilobed or bidentate..... 17
- 6. Hyaline papilla distal to the apical tooth 7
- 6*. Hyaline papilla proximal to or behind the apical tooth 8
- 7. Gynoecium without innovations beneath it, immersed in the cucullate bracts, underleaves inserted on four or more rows of stem cells, lobule subquadrangular, its free margin not incurved, not strongly constricted just below the apex, subalpine **Omphalanthus roccatii**
- 7*. Gynoecium with innovations, underleaves inserted on two rows of stem-cells, lobule strongly inflated with free margin incurved, sharply contracted below the mouth, submontane to montane **Cheilolejeunea montagnei**

8. Female inflorescence without innovations below it 9
- 8*. Female inflorescence with one or two innovations below it, becoming lateral or between dichotomic branches 12
9. Perianth with two lateral and two ventral keels, all, but the lateral keels, with dentate or laciniate wings, trigones triconvex or triconcave, cell walls brown, glossy brown or blackish plants **Lopholejeunea**
- 9*. Perianth different, trigones with one face concave and two faces convex, green or brown to blackish plants 10
10. Perianth compressed, with lateral keels only, or trigonous with an additional ventral keel, with a dentate or laciniate wing around apex, female bracts and bracteoles dentate, green plants with dimorphic shoots, fertile shoots ascending from sterile creeping shoots, leaves and underleaves usually dentate **Caudalejeunea**
- 10*. Perianth cylindrical or pyriform, bracteole sometimes notched at apex but otherwise female bracts, bracteoles and underleaves entire, mostly brown or blackish plants 11
11. Perianth with 5-10 longitudinal keels or folds, lobule with two or more teeth, oil bodies simple, male bracts weakly saccate, outermost cells of stem thin-walled, pale **Acrolejeunea**
- 11*. Perianth inflated, without keel or with 1-5 keels, lobule with one tooth, oil bodies compound, male bracts strongly saccate, outermost cells of stem thick-walled, becoming brownish **Schiffneriolejeunea**
12. Underleaves entire, leaves entire, sometimes with a few obscure teeth near apex, apex rounded or acuminate 13
- 12*. Underleaves dentate, leaves apiculate or dentate, female bracts dentate .16
13. Perianth compressed, biconvex in transverse section, with two keels 14
- 13*. Perianth with four or more keels 15
14. Perianth margins keeled but entire, not winged, underleaves inserted on 4-10 rows of stem cells, two innovations below female inflorescence
..... **Marchesinia**
- 14*. Perianth with a laciniate wing around apex, sometimes reduced to a few short laciniae or teeth, underleaves inserted on two rows of stem-cells
..... **Acanthocoleus**

15. Lobule with 2-6 teeth, trigones with two convex and one concave face, oil bodies simple, perianth with about 10 keels, female bracts with winged keels, brown plants **Frullanoides**
- 15*. Lobule with apical tooth only, trigones with all faces alike, oil bodies compound, perianth with five keels, innovating on one side, keels of bracts not winged, whitish green plants **Cheilolejeunea xanthocarpa**
16. Delicate prostrate plants, usually epiphyllous, leaves sharply dentate almost completely, underleaves sharply dentate, inserted on two rows of stem cells, stems soft, outermost cells thin-walled, much larger than inner cells, trigones triconvex, perianth compressed, with dentate or laciniate wing around apex **Odontolejeunea lunulata**
- 16*. Robust plants, often 3-5 cm long or more, not epiphyllous, not prostrate, regularly and distantly pinnately-bipinnately branched, pendulous, leaves obscurely dentate near apex, underleaves dentate on the truncate apices, stems rigid, with thick-walled outer cells similar in size to the inner cells, trigones with one concave side, perianth with about 10 smooth obtuse longitudinal cells **Ptychanthus africanus**
17. Underleaves with widely spreading (often subulate) straight lobes making an angle of 45-180° with each other, small to minute delicate green plants, often epiphyllous, perianths of many species horned, leaves often with ocelli 18
- 17*. Underleaves orbicular, obcordate, cordate or lunate, not subulate, the lobes more or less parallel or converging 19
18. Underleaves usually with obtuse, broad lobes, leaf cells not papillate, innovations lejeuneoid **Harpalejeunea fischeri**
- 18*. Underleaves usually with subulate, acuminate lobes (except *D. vandenberghenii* with obtuse lobes), leaf cells often papillate, innovations pycnolejeuneoid **Drepanolejeunea**
19. Red or dark brown plants with ocelli in the leaves, perianth with four horns at apex, medium-sized more or less robust plants, underleaves cordate or ovate, often large **Ceratolejeunea**
- 19*. Green plants, at least when fresh, ocelli present or absent, perianth never with four horns 20

- 20. Delicate thread-like plants with only three medullary cells in transverse section of stem, leaves distant, lobule large, inflated, nearly equalling or exceeding in area the free part of the lobe, apical tooth long, curved ***Microlejeunea***
- 20*. Plants more robust, stem with more than three medullary cells in transverse section, lobule much smaller, apical tooth smaller, usually not curved 21
- 21. Perianth strongly compressed, obcordate, without ventral or dorsal keels, borne on a very short lateral branch without any innovations below gynoecium
..... ***Prionolejeunea***
- 21*. Perianth not compressed or if compressed with dorsal and ventral keels, or with innovations below gynoecium ***Lejeunea s.l.***
- 22. Perianths in a row of (2-)3-6 on lateral branches, the innovations (1 per gynoecium) repeatedly fertile ***Taxilejeunea***
- 22*. Perianths single or maximally 2 in a row on lateral branches ***Lejeunea***

Lepidoziaceae

- 1. Leaves divided almost to base or at least more than half of their length, with 1-4 filaments of uniseriate elongate cells at least near apex 2
- 1*. Leaves either deeply lobed to more than half of their length, the lobes two or more cells wide over most of their length, or leaves entire or dentate at truncate apex 4
- 2. Plants minute and delicate (stem 100 µm in diameter, leaves 500-700 µm long), leaves of 2 segments, underleaves absent or rudimentary
..... ***Telaranea coactilis***
- 2*. Plants larger, leaves of 2-4 segments, underleaves present 3
- 3. Leaf lobes uniseriate throughout except sometimes for basal 1-2 cells, stem epidermis of 8-10 rows of pellucid thin-walled cortical cells which are much larger than inner cells, plants glistening ***Telaranea***
- 3*. Leaf lobes 2 cells wide except for apical 1-2 cells, stem epidermis of 8 rows of thick-walled cells which are scarcely or not larger than the inner cells, plants not glistening ***Kurzia***

- 4. Leaves 3-4(-5)-lobed, trigones not or hardly developed, branching pinnate or bipinnate **Lepidozia**
- 4*. Leaves with truncate, shallowly 2-3-lobed or truncate apices or entire, trigones prominent, branching more or less dichotomously or shortly pinnate
..... **Bazzania**

Lophocoleaceae

- 1. Perianth laterally compressed, the ventral face narrow, plants ± brownish to fuscous pigmented **Leptoscyphus**
- 1*. Perianth ± symmetrically trigonous, the angles often winged, plants lacking brownish to fuscous pigmentation 2
- 2. Leaves moderately to deeply adaxially concave, usually entire, rounded, underleaves not as large as the stem **Clasmatocolea**
- 2*. Leaves usually distinctly bilobed with acute lobes, sometimes irregularly dentate to retuse convex, rarely plane, the apical part often decurved or deflexed (in *C. concretus*), underleaves larger than stem **Chiloscyphus**

Lophoziaceae

- 1. Underleaves large; leaves mostly 2-4 lobed, more than 5/6 the leaf length .. 2
- 1*. Underleaves absent; leaves bilobed less than 5/6 the leaf length 3
- 2. Leaves asymmetrically 3(-4)-lobed, obliquely inserted; leaf cells with large, bulging trigones **Plicanthus**
- 2*. Leaves symmetrically 4-lobed, transversely inserted; leaf cells with indistinct trigones **Tetralophozia**
- 3. Leaves asymmetrically (2-)3-lobed **Tritomaria**
- 3*. Leaves ± symmetrically bilobed 4
- 4. Plants with *Anomoclada*-type filiform branches **Andrewsianthus**
- 4*. *Anomoclada*-type branching absent 5
- 5. Leaf insertion transverse (except decurrent part), plants usually brownish
..... **Anastrophyllum**
- 5*. Leaf insertion oblique, succubous, plants usually green to yellowish green ...
..... **Lophozia**

9.3. Leafy liverwort genera – Keys to Species in Rwanda

Acanthocoleus R.M.Schust.

Bull. Torrey Bot. Club 97: 339 (1970).

A pantropical genus with 7-8 species. Two species in Rwanda.

References: Kruijt (1988), Vanden Berghen (1978a).

1. Antheridia single in lobules of unmodified leaves, perianth usually only narrowly winged ***A. chrysophyllus***
- 1*. Antheridia in specialized bracts with reduced lobes forming androecia on short lateral branches, perianths usually distinctly winged, the wing bearing laciniae ***A. madagascariensis***

Acrolejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 128 (1893).

A pantropical genus with 15 species with highest diversity in Tropical Asia. One species in Rwanda.

References: Gradstein (1975).

Adelanthus Mitt.

J. Proc. Linn. Soc. Bot. 7: 243 (1864).

Southern hemispheran genus of ca. 15 species. Two species in Rwanda.

1. Leaves with 1 to 3 teeth at the margin, sometimes with entire margin ***A. decipiens***
- 1*. Leaf margin with numerous teeth ***A. lindenbergianus***

Amphicephalozia R.M.Schust.

Nova Hedwigia 22: 133 (1972).

Three species in Southern Chile (*A. amplexicaulis* R.M.Schust.), Madagascar (*A. geisslerae* Pócs & Váňa) and Rwanda (*A. africana* Váňa & Wigginton).

References: Váňa & Wigginton (2008).

Anastrophyllum (Spruce) Steph.

Hedwigia 31: 139 (1893).

About 35 species worldwide. Two species in Rwanda.

References: Váňa (1993), Váňa & Watling (2004c).

1. Plants large, dark reddish-brown, rigid. Stems up to 3-4 cm long, forming a large compact tuft. Leaves densely imbricate, strongly secund dorsally, ± asymmetrically 2-lobed to 0.5-0.65 of their length, 1.8-2.2 x 1.8-2.2 mm, leaf lobes triangular-ovate, apices subacute. Cells with wide trigones, 10-20 (-35) µm in diameter **A. piligerum**
- 1*. Plants small to medium sized, dark reddish-brown or purple. Stems up to 0.5-4 cm long, creeping to erect. Leaves succubous, contiguous to imbricate, ± asymmetrically 2-lobed to 0.25-0.5 of their length, 0.6-0.8 x 0.6 mm, leaf lobes strongly incurved. Cells with wide trigones, 10-20 µm in diameter **A. auritum**

Andrewsianthus R.M.Schust.
Rev. Bryol. Lichén. 30: 66 (1961)

A mainly austral genus with ca. 15 species. One species in Africa.

References: Váňa & Watling (2004c).

Apomarsupella R.M. Schust.
J. Hattori Bot. Lab. 80: 79 (1996)

Three species. One species in Africa and Rwanda.

References: Váňa (1985, 1993), Váňa & Watling (2004b).

Bazzania S. Gray
Nat. Arr. Brit. Pl. 1: 704 (1821).

Cosmopolitan genus with about 100 species mainly in the Northern Hemisphere and tropical mountains. Three species in Rwanda.

References: Jones (1975), Pócs (1994a).

1. Underleaves distinctly connate on both sides with the leaves, leaf-apices tridentate and usually more or less denticulate 2
- 1*. Underleaves always free or nearly so on both sides 3
2. Leaves caducous, small to medium-sized plants, shoot width never exceeding 2 mm, underleaves usually 2-lobed **B. decrescens ssp. pumila**
- 2*. Leaves not caducous, medium-sized to large plants, shoot width (1.6-)2-3.6(-4) mm, underleaves 2- or 4-lobed **B. decrescens ssp. decrescens**

3. Leaves with a vitta of 2-4 rows of large rectangular cells extending nearly to leaf-apex, underleaves not much wider than stem, cell walls colourless **B. nitida**
- 3*. Leaves lacking a vitta, underleaves usually 2.5 x as wide as the stem, cell walls with brown pigment **B. roccatii**

Blepharostoma (Dumort. emend. Lindb.) Dumort.
Recueil Observ. Jungerm.: 18 (1835).

Three northern hemispheric species. One species in Rwanda.

References: Váňa *et al.* (1979), Fischer (1993c).

Calypogeia Raddi

Mem. Soc. Ital. Sci. Modena 18: 31 (1818).

A cosmopolitan genus of ca. 90 species. Four species in Rwanda.

References: Bischler (1970), Jones (1976b), Fischer (1993c).

1. Leaves bilobed with divergent lobes and rounded sinus, underleaves with subulate lobes and teeth **C. arguta**
- 1*. Leaves entire or if bilobed the lobes non divergent and sinus narrow, underleaves bilobed 2
2. Underleaves 2-3 x as wide as the stem, always decurrent **C. bidentula**
- 2*. Underleaves 1.5-2 x as wide as the stem, not decurrent 3
3. Leaves triangular-ovate, narrowed gradually to apex, antical margin strongly arched proximally, nearly straight distally, oil bodies colourless **C. fissa**
- 3*. Leaves oblong-ovate, narrowed more abruptly to a somewhat rounded apex, antical margin nearly straight proximally, arched distally, oil bodies bright blue **C. afrocaerulea**

Caudalejeunea (Steph.) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1 (3): 129 (1893).

A pantropical genus of about 15 species. Two species in Rwanda.

References: Vanden Berghen (1984a).

1. Distinct erect propaguliferous branches present, their leaves and underleaves different from prostrate branches, leaves of propaguliferous branches longitudinally folded, underleaves of these branches as wide as the stem **C. yangambiensis**
- 1*. Distinct propaguliferous branches absent, all branches similar . **C. lewallei**

Cephalojonesia Grolle

In: Grolle & Vanden Berghen, *Rev. Bryol. Lichén.* 37: 763 (1970).

Genus with one species and two subspecies. One species in Rwanda. *Cephalojonesia incubata* Grolle & Vanden Berghen ssp. *incubata* is known from tropical Africa, ssp. *mexicana* Burghardt, Gradst. & Váňa from Mexico (Burghardt *et al.*, 2006).

References: Vanden Berghen (1972a), Jones (1987).

Cephalozia (Dumort.) Dumort.

Recueil Observ. Jungerm. 18 (1835).

About 30-40 mainly northern hemisphere species. Three species in Rwanda.

References: Váňa (1988).

1. Leaves ovate to ovate-rectangular, usually longer than wide, subtransversely inserted, never distinctly decurrent **C. bicuspadata**
- 1*. Leaves orbicular to quadrate-rotund, as wide as long, horizontally or very obliquely inserted, decurrent2
2. Leaves usually 8-12 cells wide, leaf lobes 3-5 cells wide at base, usually on soil or decaying wood..... **C. connivens ssp. fissa**
- 2*. Leaves usually 12-25 cells wide, leaf lobes 6-10 cells wide at base, on turf in afro-montane swamps **C. africana**

Cephaloziella (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1 (3): 98 (1893).

Cosmopolitan genus with about 40 species. Two species in Rwanda.

References: Wigginton (2004).

1. Leaves nearly transversely inserted, mostly remote, pectinately oriented; leaf cells more or less thick-walled **C. kiaeri**
- 1*. Leaves subtransversely inserted, not remote and pectinately oriented; leaf cells thin-walled **C. vaginans**

Ceratolejeunea (Spruce) J.B. Jack & Steph.
Hedwigia 31: 13, 16 (1892).

References: Vanden Berghen (1951).

Pantropical genus with about 30 species. One species in Rwanda.

Cheilolejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1 (3): 121 (1893).

Synonym: *Leucolejeunea* A. Evans, *Torreyia* 7: 225 (1907).

A pantropical genus with about 80 species. Seven species in Rwanda.

References: Jones (1954a,b, 1985a, 1988), Pócs (1994b), Malombe (2009).

1. Leaf lobes usually ovate, strongly convex, apices sharply acute and recurved, underleaves bilobed up to 1/3 of their length, usually not exceeding 4 x the width of the stem (except reniform underleaves of *C. omphalogastris*) 2
- 1*. Leaf lobes rounded to oblong, flat or shallowly convex, apices rounded, plane, hardly recurved, underleaves shortly bilobed to entire or retuse, reniform to orbicular 5
2. Lobule with apical tooth spiniform, unicellular, acute, free marginal cells usually up to 8, cell walls with distinct trigones, leaf lobes caducous, perianth keel 3-carinate, underleaves with sinus narrow, v-shaped..... ***C. pocsii***
- 2*. Lobule with apical tooth blunt or rounded, much reduced to multicellular, free marginal cells of ventral side usually up to 13-22, cell walls with trigones small or medium 3
3. Underleaves not exceeding 4 x the stem width, leaf lobe length and width ratio up to 1.2 ***C. krakammae***
- 3*. Underleaves at least 4 x the stem width, leaf lobe length and width ratio at least 1.3 or more 4
4. Leaf apex mucronate, underleaves reniform, 5-6 x as wide as the stem, base with auricles..... ***C. omphalogastris***
- 4*. Leaf apex acuminate to broadly rounded, underleaves rounded to obcordate, 3-5 x as wide as the stem ***C. cordistipula***
5. Lobule rectangular to oblong, usually more than 1/2 as long as the lobe, inflated, ventral free margin inrolled covering the apical tooth, oil bodies 1 per cell ***C. xanthocarpa***
- 5*. Lobule ovate to triangular, usually up to 2/5 as long as the lobe, oil bodies more than 1 per cell 6

- 6. Underleaves shortly 2-lobed, apex subacute, truncate or shallowly retuse, lobe apex broadly rounded, autoicous **C. trifaria**
- 6*. Underleaves entire, apex rounded, truncate or shallowly retuse, subacute, dioicous **C. montagnei**

Chiloscyphus Corda

Naturalientausch 12, *Beitr. Naturg.* 1: 651 (1829).

Synonym: *Lophocolea* (Dumort.) Dumort., *Recueil Observ. Jungerm.*: 17 (1835).

A genus with about 100-200 species, mainly in the tropics and the Southern Hemisphere. Five species in Rwanda.

References: Jones (1953c), Grolle (1959), Arnell (1956), Fischer (1993c).

- 1. Leaves obtuse or retuse, the apical part often decurved or deflexed **C. concretus**
- 1*. Leaves ± distinctly bilobed 2
- 2. Leaves oblong or bilobed with apiculate lobes, opposite to subopposite, apex rounded to truncate or retuse, entire or with several cilia, underleaves connate with leaves on both sides 3
- 2*. Leaves bilobed with more or less apiculate lobes, alternate, underleaves completely free from the leaves 4
- 3. Leaves robust, bilobed, nearly rectangular, often 2-3 mm long, margin without cilia **C. martianus**
- 3*. Leaves smaller, 0.5-1.8 mm long, rounded to orbicular or trapezoidal, margin with several cilia 5-8 cells long **C. muhavurensis**
- 4. Minute plants, perianth cylindrical, shortly lobed, exposed surfaces of leaf and perianth usually covered with 1-3 celled hairs **C. muricatus**
- 4*. Plants without hairs on the leaf and perianth surface 5
- 5. Small plants, leaves rarely more than 1 mm long, not very asymmetric, bilobed to not more than a sixth of their length, apiculi short .. **C. difformis**
- 5*. Large plants, leaves often 1.5 mm long or more, strongly asymmetric, with arched front margin and longly decurrent distal margin, the lobes with long fine apiculi **C. coadunatus**

Clasmatocolea Spruce

Trans. & Proc. Roy. Bot. Soc. Edinburgh 15: 440 (1885).

About 20 mostly Southern Hemisphere species. One species in Rwanda.

References: Grolle & Vanden Berghen (1970).

Cololejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 121 (1893).

Synonym: *Aphanolejeunea* A. Evans, *Bull. Torrey Bot. Club* 38: 272 (1911).

The genus *Aphanolejeunea*, accepted by Wigginton (2004) was not supported by molecular studies (Heinrichs *et al.*, 2005; Gradstein *et al.*, 2006; Wilson *et al.*, 2006). Subsequently Pócs & Bernecker (2009) transferred all former *Aphanolejeunea* taxa to *Cololejeunea*.

Cosmopolitan, with greatest diversity in montane rainforests, about 200 mainly epiphyllous species. 65 species in Africa and 31 in Rwanda.

References: Jones (1953a,b, 1954c), Vanden Berghen (1971, 1972b, 1977), Pócs (1975, 1984b, 1993), Tixier (1995).

1. Lobule large compared with the lobe, usually exceeding half of lobe, reduced leaves frequent, innovations without basal collar, very small delicate plants **Cololejeunea** subg. **Aphanolejeunea** 2
- 1*. Lobule usually small compared with the lobe, not exceeding half of lobe surface, reduced leaves absent or rare, innovations of the *Lejeunea*-type (with basal collar), small or medium-sized plants..... **Cololejeunea** s.str. 5
2. Vegetative leaves uniformly reduced to a sublinear or linear-lanceolate lamella only 2-3(-4) cells wide, lobule always reduced to a single cell, only male bracts with well developed lobule **C. minuscula**
- 2*. Vegetative leaves at least partly with well developed lobule 3
3. At least half of leaves elobulate, reduced leaves also on well developed shoots, apical and proximal tooth separated by a broad, one-celled sinus, well developed leaves much larger than 200 x 100 µm, lobule only half of lobe length and width **C. clavatopapillata**
- 3*. Well developed shoots with majority of leaves lobulate, apical tooth of lobule separated by a very narrow sinus from proximal tooth, the latter always blunt, with rounded apex, well developed leaves less than 240 x 90-140 µm, lobule usually more than half of lobe length and width 4

4. Lobule tooth 2(-3)-celled, falcately curved, lobe apex triangular, obtuse or apiculate, with entire or only slightly irregularly dentate margin, lobe with conical protuberances only at keel or throughout dorsal lobe surface and even on lobule, lobule 55-63% of lobe length, 8-13 cells broad ***C. microscopica***
- 4*. Lobule tooth 1-2-celled, straight and sometimes acute, ovate or broad triangular, margin crenulated by protruding cells, lobe evenly covered by conical or fingerlike mammillae, lobule 70-80% of lobe length, 12-16 cells broad ***C. grossepapillosa***
5. Hyaline margin present 6
- 5*. Hyaline margin absent 8
6. Hyaline margin long and conspicuous ***C. distalopapillata***
- 6*. Hyaline margin short and reduced, only at apex of lobe 7
7. Cells sometimes papillate at apex of lobe, pseudovitta (enlarged ocelli) short, at base of lobe, hyaline margin often reduced or absent ***C. cardiocarpoides***
- 7*. Cells never papillate, vitta or pseudovitta absent, hyaline margin reduced, but always present ***C. cardiocarpa***
8. Central vitta or pseudovitta present 9
- 8*. Central vitta or pseudovitta absent 13
9. Pseudovitta long ***C. platyneura***
- 9*. Pseudovitta short, more or less diffuse 10
10. Perianth spherical ***C. sphaerocarpa***
- 10*. Perianth ovoid 11
11. Large inflated lobules and small reduced lobules present ***C. heterolobula***
- 11*. All lobules small and reduced 12
12. Lobules triangular ***C. obtusifolia***
- 12*. Lobules linear, rectangular ***C. lobulilineata***

13.	Leaves ovate-lanceolate, acuminate, lobules entirely reduced or well-developed.....	14
13*.	Leaves of variable shape, if ovate-lanceolate and acuminate, then lobules well developed	16
14.	Two innovations below perianth, plant thus with dichotomic branching pattern	C. augieri
14*.	Only one innovation below perianth	15
15.	Lobules all reduced	C. pusilla
15*.	Well developed lobules and reduced lobules present	C. pseudopusilla
16.	Leaves broadly ovate to orbicular, obtuse	C. minutissima
16*.	Leaves of variable shape, never orbicular	17
17.	Cells of lobe not or only slightly papillate	18
17*.	Cells of lobe papillate, at least the marginal cells	26
18.	Lobe elongate, lanceolate	19
18*.	Lobe rounded	20
19.	Lobe margin dentate	C. malanjae
19*.	Lobe margin entire	C. hildebrandii
20.	Cell walls very delicate	21
20*.	Cell walls normal	23
21.	Reduced lobules present	C. tenuiparietata
21*.	Reduced lobules absent	22
22.	Perianth with protruding cells at mouth, first tooth of lobule with 2 cells, hyaline papilla at base of apical tooth cell	C. harrisii
22*.	Median tooth of lobule with 2 cells in a row and 3 cells at base, hyaline papilla at apex of apical tooth cell	C. magna
23.	Hyaline papilla at apex of median lobule tooth	C. duvigneaudii
23*.	Hyaline papilla at proximal base of median lobule tooth	24

24. Apical tooth of lobule prominent, with 4 cells **C. zenkeri**
- 24*. Apical tooth of lobule smaller, with only 1-2 cells, or indistinct, hardly visible 25
25. Apical tooth distinct **C. fischeri**
- 25*. Apical tooth indistinct, hardly visible **C. pseudoobliqua**
26. Medium-sized species, up to 1 mm large (including leaves) **C. runssorensis**
- 26*. Small species, up to 0.5-0.7 mm large (including leaves) 27
27. Median tooth of lobule arched **C. tenella**¹
- 27*. Median tooth of lobule different 28
28. Lobe rounded **C. capuronii**
- 28*. Lobe acuminate 29
29. Margin of lobule irregularly dentate **C. mocambiquensis**
- 29*. Margin of lobule with not more than 1-2 regular teeth 30
30. At least some lobules large, about 1/3 of the lobe **C. frahmii**
- 30*. All lobules small, consisting only of few cells and an obliquely erect apical tooth **C. parva**

Colura (Dumort.) Dumort.

Recueil Observ. Jung.: 12 (1835).

Pantropical genus with about 70 species. Five species in Rwanda.

References: Jones & Pócs (1987), Pócs (1991).

1. Leaf sac contracted at apex into a narrow horn, leaf cells with trigones large to very small or absent, intermediate thickenings absent 2
- 1*. Leaf sac rounded or conical, not forming a narrow horn, leaf cells usually with large trigones and intermediate thickenings 4
2. Leaf sac abruptly narrowed into a beak of c. 1/2 of total leaf length **C. tenuicornis**
- 2*. Leaf sac abruptly narrowed into a beak of 1/4 to 1/3 of total leaf length ... 3

¹ *Cololejeunea tenella* has been recorded by Tixier (1995). I have not seen any specimen, and the record may be *erroneous*. *C. tenella* is thus omitted from the special part.

3. Each cell of lobe and perianth distinctly papillose, walls with large nodular trigones ***C. berghenii***
- 3*. Cells of lobe and perianth not papillose, walls without trigones . ***C. calyptrifolia***
4. Leaves 1.1-1.8 mm long, valve ovate, bordered by 15-18 hyaline cells, underleaves acute, lobes 5-8 cells wide at base, epiphyllous or epiphytic
..... ***C. digitalis***
- 4*. Leaves 1.6-2 mm long, valve ligulate, bordered by 27-30 hyaline cells, underleaves with acute lobes 10-12 cells wide at base, exclusively epiphytic on small twigs of ericaceous shrubs ***C. saroltae***

Cylindrocolea R.M.Schust.

Bull. Natl. Sci. Mus. (Tokyo) 12: 666 (1969).

Pantropical genus with about 12 species from lower to medium altitudes. Two species in Rwanda.

References: Jones (1960), Arnell (1963), Váňa (1993).

1. Leaves distant; perianth contracted to the truncate mouth ***C. gittinsii***
- 1*. Leaves imbricate or spreading; perianth not contracted to the entire and lobed mouth ***C. atroviridis***

Diplasiolejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 118, 121 (1893).

Pantropical genus with about 65-70 species. Nine species in Rwanda.

References: Vanden Berghen (1960, 1977), Pócs (1993, 1994a), Tixier (1995).

1. Lobes of underleaves obtuse or subobtuse at apex, 6-12 cells wide at base . 2
- 1*. Lobes of underleaves acuminate or acute at apex, 2-10 cells wide at base ... 5
2. Leaf-lobe with large basal ocellus, stem with leaves 1.2-1.5 mm wide
..... ***D. deslooveri***
- 2*. Ocelli absent, stem with leaves 1.3-2.2 mm wide 3
3. Stem with leaves 1.3-1.5 mm wide, leaves with propagules different from remaining leaves, with cylindrically inrolled lobe ***D. aulae***
- 3*. Stem with leaves 1.5-2.2 mm wide, leaves with propagules absent or similar to remaining leaves, lobe sometimes involute at apex but never cylindrically inrolled 4

- 4. Median tooth of lobule double, each half 3-4 cells long, gemmae absent, plants usually epiphyllous ***D. cyanguguensis***
- 4*. Median tooth with a row of 2-3 cells in median position, gemmae present on dorsal face of lobe, plants usually epiphytic on twigs ***D. runssorensis***
- 5. Lobes of underleaves 8-10 cells wide at base, leaf-lobes without basal ocellus .
..... ***D. cavifolia***
- 5*. Lobes of underleaves 2-5 cells wide at base 6
- 6. Leaf lobes with isolated or grouped laminal ocelli, 1(-3) basal ocelli present
..... ***D. kraussiana***
- 6*. Leaf-lobes without laminal ocelli, 1-5 isolated or grouped basal ocelli present .. 7
- 7. Margin of lobe entire or slightly sinuate, not crenulated, median tooth of lobule with 3(-5) rows of 2 cells, sometimes prolonged by 1-2 cells at apex, keels of perianth not distally prolonged into a horn ***D. symoensii***
- 7*. Margin of lobe sometimes obtusely and irregularly paucidentate, crenulated, median tooth of lobule with 2-3 cells, keels of perianth distally prolonged into a short conical horn acuminate at apex, sometimes paucidentate ***D. cornuta***

Diplophyllum (Dumort.) Dumort.

Recueil Observ. Jungerm.: 15 (1835) *nom. cons.*

A genus of ca. 20 species in the Northern Hemisphere and tropical mountains. One species in Rwanda.

Drepanolejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 119, 126 (1893).

A pantropical genus of about 100 species. Six species in Rwanda.

References: Vanden Berghen (1961, 1977), Tixier (1995), Buchbender & Fischer (2004).

- 1. Lobule proximally of 1-2-celled apical tooth with wide sinus, proximal end of sinus separated by 2-3 marginal cells from base of apical tooth, distinctly developed as second tooth, ocelli 3-5, lobes of underleaves lanceolate to linear, ending in (2-)3-5(-6) uniseriate cells ***D. symoensii***
- 1*. Lobule proximally of 1-celled apical tooth with small, narrow sinus filled by hyaline papilla, proximal part of sinus separated from base of apical tooth by only 1 marginal cell, developed as minute and usually reduced tooth, ocelli 1-3, lobes of underleaves without row of uniseriate cells 2

- 2. Cells of lobe papillose on dorsal side 3
- 2*. Cells of lobe not papillose on dorsal side 4
- 3. Apex of lobe obtuse, underleaves usually ending in 2 adjacent cells, female bracts entire or only slightly dentate **D. vandenberghenii**
- 3*. Apex of lobe acuminate, underleaves ending with one single cell, female bracts distinctly dentate **D. physaefolia**
- 4. Lobe entire-sinuate, perianth with smooth keels **D. deslooveri**
- 4*. Lobe dentate, perianth with distinct horns on keel 5
- 5. Lobe with distinct tooth at outer margin at level of lobule apex
..... **D. ruandensis**
- 5*. Lobe without distinct tooth at outer margin **D. cultrella**

Frullania Raddi

Jungermanniografia Etrusca: 9 (1818).

Cosmopolitan with diversity centres in the tropics, about 200-300 species, 14 species in Rwanda.

References: Vanden Berghen (1976a), Fischer (1993c).

- 1. Lobules inflated throughout, the dorsal and ventral faces approximately equal in area, lobule connected to the lobe by a short fold at almost right angles to the stem 2
- 1*. Lobules inflated in the upper part only, the dorsal faces much larger than the ventral faces, with a large, flat region connected to the lobe by an arched fold, whose outer portions are subparallel to the stem (Subgenus *Chonantheria*) 13
- 2. Inflated lobules cylindrical, distinctly longer than broad (usually 1.5-3 x as long as broad (Subgenus *Frullania*) 3
- 2*. Inflated lobules caplike, very short and broad-cylindrical, often compressed at mouth, about as broad as long (lobules sometimes explanate and lanceolate) (Subgenus *Trachycolea*) 9
- 3. Lobules oblique in position to stem, forming with stem an angle between (20) 30-45°, in upper branches up to 60-90° **F. lindenbergii**
- 3*. Lobules arranged parallel to stem or forming with stem an angle less than 30°, sometimes apex of lobule directed towards stem in branches 4

4. Leaf lobes acuminate or apiculate 5
- 4*. Leaf lobes ± rounded-obtuse 8
5. Gynoecia at end of stem or prolonged branch, 1(-2) innovations, dorsal base of leaf lobe appendiculate, convex or truncate 6
- 5*. Gynoecia at end of short lateral branches, generally without innovations, dorsal base of leaf lobe convex or appendiculate 7
6. Dorsal base of leaf lobe distinctly convex, underleaves 3-5 x as large as the stem, frequently with decurved margins ***F. schimperi***
- 6*. Dorsal base of leaf lobe truncate or slightly convex, underleaves 2-3 x as large as the stem, with plane margins ***F. apicalis***
7. Primary branch appendage (hemiphyll) oval, not bilobed, leaf lobe apex generally exposed, lobe and lobule of female bracts ± entire, dioicous species ***F. angulata***
- 7*. Primary branch appendage bilobed, leaf lobe apex generally involute, lobe and lobule of female bracts densely laciniate or dentate ***F. serrata***
8. Gynoeceum at apex of a short lateral branch, without innovations, monoicous ***F. capensis***
- 8*. Gynoeceum at apex of an elongated branch, with 1(-2) innovations, dioicous ***F. imerinensis***
9. Perianth with 2-3(-5) ventral keels 10
- 9*. Perianth 3-carinate, with 1 ventral keel, rough with short processes 11
10. Plants with abundant propagules developing from the marginal cells, stylus small, lanceolate to ligulate, 2-3 cells wide at base ***F. obscurifolia***
- 10*. Plants usually lacking propagules, stylus large, ligulate, 3-6 cells wide at base ***F. socotrana***
11. Mid-leaf cells more than 30 µm long, robust plants, not squarrose in wet state, main shoots (1.3-)2-2.5(-2.8) mm wide, leaf lobule with an ± apiculate rostrum, underleaves with cordate base, perianth smooth ***F. caffraria***
- 11*. Mid-leaf cells less than 30 µm long, less robust plants, main shoots (0.7-) 0.85-1.8(-2) mm wide 12

12. Leaf lobes squarrose in wet state, leaf lobule without an apiculate rostrum, rarely projecting beyond lobe, underleaves longer than wide, perianth verrucose at base ***F. ericoides***
- 12*. Leaf lobes flat or slightly convex in moist state, leaf lobule with apiculate rostrum often projecting beyond lobe, underleaves wider than long, perianth smooth ***F. spongiosa***
13. Perianth (5-)8-10-carinate, female bracts longly connate, inflated part of lobule shorter than large flat region ***F. arecae***
- 13*. Perianth 4-carinate, female bracts only shortly connate, inflated part of lobule usually longer or as long as the flat region ***F. depressa***

Frullanoides Raddi

Critt. Bras.: 13 (1822).

A genus with 7 species mainly in the Neotropics. One species in Rwanda.

References: van Slageren (1985).

Gongylanthus Nees

Naturgesch. Eur. Leberm. 2: 405 (1836).

Five species, mainly Southern hemispheran. One species in Rwanda.

References: Jones (1964).

Gottschea Nees ex Mont.

Ann. Sci. Nat., Bot., ser. 2, 19: 245 (1843)

19 species mainly in the Palaeotropics. One species in Rwanda.

References: Jones (1976a).

Gymnomitrium Corda

In: Opiz, *Beitr. Naturk.* 1: 651 (1829).

About 15 species mainly in the Northern Hemisphere in dry, acidic montane habitats. One species in Rwanda.

References: Váňa & Watling (2004c).

Haplomitrium Nees

Naturg. Europ. Leberm. 1: 109 (1833) *nom. cons.*

Seven species in the Holarctic and tropical mountains, two species in Africa. One species in Rwanda.

References: Grolle (1993).

Harpalejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 119, 126 (1893).

Pantropical genus with about 20 species, mainly in the neotropics (10-15 species).
One species in Rwanda.

References: Tixier (1995), Buchbender & Fischer (2004).

Herbertus S.F. Gray

Nat. Arr. Brit. Pl. 1: 705 (1821).

About 40-50 species, widely distributed in the northern hemisphere and on tropical mountains. Two species in Rwanda.

References: Hodgetts (2008).

1. Vitta bifurcating just below sinus, or at least above half way up basal lamina **H. juniperoideus**
- 1*. Vitta bifurcating at or below half way up basal lamina..... **H. dicranus**

Isotachis Mitt.

In: Hooker, *Fl. Nov.-Zel.* 2: 148 (1854).

A Southern Hemisphere genus with ca. 15 species. In Rwanda only one species recognized.

References: Váňa (1982), Fischer (1993c).

Jamesoniella (Spruce) Carring

In: Lees, *London Catal. Brit. Moss. Hepat.*, ed. 2: 25 (1881).

14 species worldwide. One species in Rwanda.

References: Grolle (1970).

Kurzia G. Martens

Flora 53: 417 (1870).

Cosmopolitan genus with about 30 species mainly in the Northern Hemisphere and in tropical mountains. Two species in Rwanda.

References: Arnell (1963), Pócs (1984a).

1. Leaves up to 0.22 mm long, deeply 4-lobed, base of lobes 2 cells wide, underleaves 0.08-0.09 mm wide **K. capillaris**
- 1*. Leaves up to 0.27 mm long, deeply 4-lobed, base of lobes 3 cells wide, underleaves 0.1 mm wide **K. irregularis**

Lejeunea Libert

Annales Gén. Phys. Bruxelles 6: 372 (1820).

Mainly warm-temperate and pantropical, comprising about 100-150 species. 15 species in Rwanda.

References: Jones (1967, 1968, 1969, 1972, 1974a,b, 1985a,b, 1989), Pócs (1993, 1994a), Vanden Berghen (1961).

1. Leaf apex pointed to acuminate, perianths not compressed, with 5 equal keels 2
- 1*. Leaf apex rounded, perianths variable, compressed or not 5
2. Plants dioicous, usually elongate, little branched and free hanging, cell walls often thickened, with large nodulose trigones and intermediate thickenings ..
..... **L. acuta**
- 2*. Plants monoicous, prostrate, richly branched, cell walls thin, trigones and intermediate thickenings small or absent 3
3. Underleaves large, 3-5 x as wide as the stem, 2-lobed to 0.2 of their length, with a wide sinus, lobes of female bracts and bracteoles dentate
..... **L. amaniensis**
- 3*. Underleaves smaller, 2-3.5 x as wide as the stem, 2-lobed to 0.5 of their length, lobes of female bracts and bracteoles entire 4
4. Perianth keels abruptly expanded distally, forming widely spreading inflated wings, perianths on short lateral branches, with a short sterile or male innovation **L. lyratiflora**
- 4*. Perianth keels shallow, gradually expanded distally, not forming inflated wings, perianths on short innovations which usually bears other gynoecia
..... **Taxilejeunea**
5. Plants autoicous 6
- 5*. Plants dioicous 12
6. Perianths without keels, leaves large, rounded at apex, up to 0.35-0.48 mm long, cell walls thin, without or with very small trigones **L. capensis**
- 6*. Perianths at least with 2 lateral and 2 ventral keels or with 5 keels 7

7. Perianths compressed, cells thin walled, with trigones small or lacking ***L. caespitosa***
- 7*. Perianths terete or slightly compressed, with 4 equal keels (2 lateral, 2 ventral) or with 5 keels, the dorsal keel smaller than the other 4, cells with or without trigones 8
8. Leaf cell walls with large trigones and intermediate thickenings, underleaves large, ovate or cordate-ovate, 2-4 x as wide as the stem, sinus narrow, perianth with dorsal keel weaker than the others or lacking 9
- 8*. Leaf cell walls with small or absent trigones or intermediate thickenings, or, if trigones present then intervening walls thin, underleaves rounded or very small, 2-6 x as wide as stem, sinus wide, perianths with 5 equal keels 10
9. Leaves spreading from stem nearly at right angle, underleaves truncate at base, plants with creeping stems ***L. flava***
- 9*. Leaves erecto-patent, spreading from stem at more narrower angle (often 45-55°), underleaves distinctly cordate at base, stems erect and irregularly pinnate ***L. tabularis***
10. Underleaves 3-6 x as wide as the stem, insertion strongly arched, usually epiphytic on tree ferns ***L. cyathearum***
- 10*. Underleaves 2.5-3.5(-4) x as wide as the stem, insertion nearly straight, usually epiphytic on various species 11
11. Ventral margin of leaf forming deep sinus (-90°) with strongly arched keel, perianth tuberculate or irregularly dentate, sometimes with 2-3-celled processes ***L. villaumei***
- 11*. Ventral margin of leaf ± in line with, or making a wide sinus with gently arched keel, perianth keels usually smooth ***L. eckloniana***
12. Plants small or delicate, leaf cells with sharply defined medium-sized or small trigones, or trigones absent, underleaves 1.5-2.5 x as wide as the stem . 13
- 12*. Plants robust, leaf cells with large trigones and intermediate thickenings, underleaves 3-5 x as wide as the stem 15
13. Underleaves very small, to 1.5 x as wide as the stem, thin-textured and often imperfect, deeply 2-lobed with narrow lobes, antical base of lobe not crossing or scarcely crossing the midline of stem ***L. confusa***
- 13*. Underleaves larger, usually more than 1.5 x as wide as the stem, 2-lobed to 0.5 x of their length, antical base of lobe distinctly crossing the midline of stem 14

- 14. Leaf lobes caducous, laxly imbricate, underleaves 1.5-2(-3.5) x as wide as the stem, subcircular, slightly wider than long ***L. rhodesiae***
- 14*. Leaf lobes never caducous, approximate to distant, underleaves usually 2-2.5 x as wide as the stem, oval, slightly longer than wide ***L. helenae***
- 15. Perianths terete, lacking keels, underleaves nearly round, 4-5 x as wide as the stem, not equalling the leaves in size, the length not exceeding the width of adjacent leaves ***L. ramosissima***
- 15*. Perianths 4-5-keeled, underleaves nearly equaling the size of the leaves, 4-5 x as wide as the stem, their length exceeding the width of adjacent leaves ***L. isophylla***

Lepidozia (Dumort.) Dumort.

Recueil Observ. Jungerm.: 19 (1835).

Cosmopolitan genus with about 75 species mainly in the Northern Hemisphere and in tropical mountains. Five species in Rwanda.

References: Pócs (1984a, 1993).

- 1. Leaves obliquely to subtransversally inserted, (3-)4(-5)-lobed on stems and branches, lobes at least 0.3 x leaf length ***L. succida***
- 1*. Leaves longitudinally inserted, 3(-4)-lobed on stems and 2-lobed on branches, lobes not more than 0.25 x leaf length 2
- 2. Leaves very asymmetrical, dorsal base auriculate, exceeding the midline of the stem and concealing its dorsal side, additional teeth at leaf and underleaf base often present, largest lobes often more than 8 cells wide; leaf cells with evenly thickened wall; underleaf lobes elongate-acute to lanceolate, at 6 cells distance from apex never broader than 2 cells; oil bodies 3-5 per cell, coarsely granulated, plants medium-sized to large, yellowish-green to olive green ***L. cupressina***
- 2*. Leaves less asymmetrical, dorsal base never auriculate, and neither reaching the midline nor concealing the stem, additional teeth on leaf and underleaf never present, largest lobes always less than 6 cells wide; leaf cells thin or unevenly thickened with small trigones; underleaf lobes broad or narrow triangular, at 6 cells distance from apex always 3 or more cells broad; oil bodies 6-16 per cell, homogeneous or consisting of 2-5 segments, small to medium-sized, colour variable (pale to vivid or dull green) 3

3. Plants elongate, up to 6 cm long, pale green, weakly and irregularly branched, leaves lax, remote, asymmetric, usually 3-lobed; underleaves with low disc, wider than long but not wider than stem, at insertion 10-28 cells broad, inserted to 6-17 ventral merophyte cells; larger stems with 27-50 cortical and 100-230 medullary cell rows ***L. pearsonii***
- 3*. Plants small to medium-sized, up to 5 cm long but usually shorter, more regularly pinnately branched, leaves remote to imbricate, 3-4-lobed; underleaves with high disc (except *L. stuhlmannii* var. *abyssinica*), at insertion 8-15 cells broad, inserted to 4-9(-10) ventral merophyte cells; larger stems with 23-25 cortical and 58-63 medullary cell rows 4
4. Leaves distant to contiguous, concave, turned inwards towards the stem, shoot threadlike, cells with small trigones at least in the lobes, angle of branches about 60° to the stem, usually yellowish- to olivaceous green plants, underleaves round in outline, widest at their middle, usually much wider than the stem, the sinus between the underleaf lobes usually V-shaped
..... ***L. stuhlmannii***
- 4*. Leaves contiguous to imbricate, plane or slightly concave, only the lobes incurved, shoot flat, cells without small trigones or trigones only slightly visible, angle of branches about 70-90° to the stem, usually pale to dull or dark green plants, underleaves variable in outline, usually narrower or only slightly wider than the stem, the sinus between the underleaf lobes usually U-shaped. In Africa only on Mt. Kahuzi and Mt. Bigugu ***L. reptans***

***Leptoscyphus* Mitt.**

J. Bot. Kew Gard. Misc. 3: 358 (1851).

A genus with 18 to 20 species mainly in the Southern Hemisphere. Three species in Rwanda.

References: Arnell (1956), Jones (1953c), Grolle (1962), Fischer (1993c).

1. Leaves all with two or three spines at the margin, perianth and involucre leaves vesicarious (gibbous) at base ***L. infuscatus***
- 1*. Leaves mostly or all with entire margin, rarely some leaves with one or two spines, leaves ± asymmetric, perianth and involucre leaves not vesicarious2
2. Underleaves with 6-8 spines ***L. hedbergi***
- 2*. Underleaves with 2-4 (rarely 6) teeth or spines ***L. expansus***

Lethocolea Mitt.

In: Hooker, *Handb. New Zeal. Fl.*: 751 (1867).

Southern-temperate genus with ca. five to six species. In Rwanda one species.

Lopholejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 129 (1893).

Pantropical genus of 40 species, 19 species present in Africa and Madagascar. Three species in Rwanda.

References: Vanden Berghen (1984b), Tixier (1995).

1. Leaves with obtuse lobe, often apiculate at incurved apex **L. nigricans**
- 1*. Leaves with rounded lobe at incurved apex 2
2. Lobule of female bracts ciliate or dentate, underleaves nearly as wide as the leaf lobes **L. eulopha**
- 2*. Lobule of female bracts entire, underleaves smaller, less than 800 µm wide3
3. Perianth entirely or nearly entirely covered by female bracts .. **L. subfusca**
- 3*. Perianth longly exserted **L. nigricans**

Lophozia (Dumort.) Dumort.

Recueil d'observ. Jung.: 17 (1835).

Cosmopolitan genus with 50-60 species, mainly in the holarctic and few in tropical mountains. One species in Rwanda.

References: Váňa & Watling (2004c).

Marchesinia S. Gray

Nat. Arr. Brit. Pl. 1: 679 (1821).

A genus with 5 species from Atlantic Europe to Africa and South America. Two species in Rwanda.

References: Jones (1970), Vanden Berghen (1976b).

1. Lobule only with 1 tooth (apical tooth) **M. excavata**
1. Lobule with apical tooth and 2(-3) supplementary teeth **M. deslooveri**

Marsupella Dumort.

Com. bot.: 114 (1823).

About 45 species mainly in the northern hemisphere or in the tropics at high elevations. Two species in Rwanda.

References: Váňa (1985, 1993), Váňa & Watling (2004b).

- 1. Leaves ovate, mostly unlobed or retuse, rarely slightly bilobed, lobes blunt ***M. subintegra***
- 1*. Leaves orbicular, distinctly bilobed, lobes acute ***M. emarginata***

Microlejeunea Steph.

Hedwigia 27: 61 (1888).

Pantropical and warm-temperate genus with 20-30 species, one species extending into northern hemisphere. Three species in Rwanda.

References: Jones (1969), Vanden Berghen (1965, 1977), Pócs (1993, 2002).

- 1. Leaves of sterile shoots with ventral margin almost in line with keel ***M. africana***
- 1*. Leaves of sterile shoots with ventral margin arched, forming a distinct sinus with keel 2
- 2. Innovations below gynoecium simple, hyaline papilla entally proximal to apical tooth of lobule, ocelli in leaf lobe 1-2(-4) in a line . ***M. kamerunensis***
- 2*. Innovations below gynoecium paired, hyaline papilla entally distal to apical tooth of lobule, ocelli in leaf lobe (1-)2-6(-8) in irregular groups ***M. nyandaruenensis***

Mastigophora Nees

Naturg. Europ. Leberm. 3: 89 (1838).

Disjunct genus with about 10 species, mainly in the Southern Hemisphere, one species extending to atlantic Europe. One species in Rwanda.

Mnioloma Herzog

Ann. Bryol. 3: 119 (1930)

A mostly neotropical genus with about 10 species. Only one species (*M. fuscum*) in Africa and Rwanda.

References: Bischler (1970), Jones (1976b).

Notoscyphus Mitt.

Fl. Vit.: 407 (1873).

About five species in Asia and Africa. One species in Rwanda.

Odontolejeunea (Spruce) Schiffn.

In: Engl. & Prantl, Nat. Pflanzenfam. 1 (3): 127 (1893).

Three species, two of them restricted to the Neotropics. One species in Rwanda.

Omphalanthus Lindenb. & Nees

In: Gottsche et al., Syn. Hep.: 303 (1845).

Synonym: *Evansiolejeunea* Vanden Berghen, *Rev. Bryol. Lichén.* 17: 87 (1948).

Small genus with 4-5 species in the neotropics. One species known from the Albertine Rift region.

References: Vanden Berghen (1948b).

Plagiochila (Dumort.) Dumort.

Recueil Observ. Jung.: 14 (1835).

The largest genus of liverworts with about 400 species worldwide. In Rwanda 13 species.

References: Jones (1962), Vandenberghen (1981), Pócs (1993).

1. Shoots branching only by intercalary innovations, perianths unwinged but sometimes keeled 2
- 1*. Shoots with terminal branches, at least in distal part of plant, perianths with only dorsal, or dorsal and ventral wings 7
2. Leaves oblong-cuneate, bilobed or very rarely trilobed, caducous, lobes 0.2-0.4 x leaf length. **P. exigua**
- 2*. Leaves triangular-ovate, triangular, oval, obovate or oblong, never bilobed or trilobed 3
3. Leaves imbricate, triangular or triangular-ovate, widest at base, the insertion equalling about half of the base, leaf decurrent antically in a broad wing, postical base often ampliate and forming a strong crest, cells with nodular trigones 4
- 3*. Leaves approximate to distant, oval, obovate or oblong, 1.5-2 x as long as wide or more, widest usually near middle, antical bases of leaves scarcely concealing the stem, only shortly decurrent, cell walls with nodular trigones or equally thickened 5

4. Shoots to 3.5 mm wide, rigid, normally ciliate-dentate, postical base shortly decurrent ***P. barteri***
- 4*. Shoots up to 7-9 mm wide, very large, leaf apex closely and finely dentate, postical base longly decurrent in a broad wing ***P. colorans***
5. Leaves narrowly oval or oblong, more than 2 x as long as wide, usually widest near middle, approximate to distant, spreading at 50°-80°, shortly decurrent antically, cell walls strongly and equally thickened .. ***P. pectinata***
- 5*. Leaves oval, obovate or ovate, apex broad, obtuse, rarely more than 1.5 x as long as wide, antical bases of leaves scarcely decurrent, cell walls with nodular trigones 6
6. Leaf-insertion very oblique, mostly on the flank of the stems, not reaching the midline on the antical face, apex broadly rounded, leaf cuneate at base, the postical base diverging widely, antical margin of leaf only weakly convex, leaves shortly and closely serrate or almost entire, never caducous, cell walls thin, trigones small ***P. integerrima***
- 6*. Leaf-insertion nearly transverse, leaves triangular-ovate, widest below middle, distantly spinose-dentate, rather longly decurrent, with numerous microphyllous flagellae with caducous leaves, cell walls with large nodular trigones ***P. subalpina***
7. Dorsal leaf base decurrent in a broad wing inserted very close to and parallel to the midline of stem, thus concealing all or most of them dorsally, ventral base of leaf decurrent as long, often undulate wing, plants robust 8
- 7*. Dorsal leaf base longly or shortly decurrent, inserted obliquely to axis of stem, thus leaving most of stem exposed dorsally 9
8. Plants forming pendant brackets up to 12 cm long, margin sharply dentate, cell wall trigones not nodulose ***P. squamulosa***
- 8*. Plants 6-8 cm long, often pendulous, teeth irregular, cell wall trigones nodulose ***P. lastii***
9. Leaves ligulate, oblong or oval, fronds pinnately branched, dorsal leaf base rather longly but narrowly decurrent 10
- 9*. Leaves triangular-oval or triangular-ovate 11
10. Leaves usually with teeth on ventral margin, longitudinal and transverse cell walls equally thickened ***P. heterostipa***
- 10*. Leaves usually lacking teeth on ventral margin, cells elongate, usually with longitudinal walls thicker than transverse walls ***P. terebrans***

- 11. Teeth spiniform, of 3-4 uniseriate cells, leaves secund and deflexed, strongly spiniformly dentate around the whole of postical base, postical margin and apex, longly decurrent anticlinal in a tapering wing, robust plants ***P. ericicola***
- 11*. Teeth triangular, usually ending in 1-3 uniseriate cells, leaves not secund 12
- 12. Leaves small, usually less than 1.7 mm long, teeth on margin ± triangular, dorsal base of leaf strongly decurrent ***P. fusifera***
- 12*. Leaves large, usually 2-3.5 mm long, teeth on margin spiniform . ***P. kiaerii***

Plicanthus R.M. Schust.

Nova Hedwigia 74: 492 (2002).

Synonym: *Chandonanthus* Mitt., in Hook., *Hdb. N.Z. Flora* 2: 750 (1867) p.p.

5 species, from Indomalaysia to Japan, New Guinea, New Caledonia, British Columbia and Africa. Two species in Rwanda.

References: Vanden Berghen (1965), Váňa (1993), Váňa & Watling (2004c).

- 1. Large plants up to 10-12 cm long, stems with paraphyllia, leaf lobes with 15-20 cilia on each margin ***P. giganteus***
- 1*. Smaller plants up to 2-4 cm long, stems without paraphyllia, leaf lobes mostly with 5-7 cilia on each margin ***P. hirtellus***

Porella L.

Sp. Pl., ed. 1: 1106 (1753).

About 50-60 species worldwide. Two species in Rwanda.

References: Jones (1963), Fischer (1993c).

- 1. Underleaves 2-2,5 x the width of the stem, plant yellowish or brownish, leaves, lobules and underleaves entire, very robust, apex of lobule entire ***P. abyssinica***
- 1*. Underleaves 1-1,6 x the width of the stem, plant greenish, lobules irregularly dentate at apex, underleaves ± dentate ***P. subdentata***

Prionolejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 118, 127 (1893).

A genus of 10-20 species with highest diversity in the Neotropics. One species in Rwanda.

Ptychanthus Nees

Naturg. Europ. Leberm. 3: 211 (1838).

Two species in the tropics of the Old World. One in Africa and Rwanda.

Radula Dumort.

Commentat. Bot.: 112 (1822).

About 200 species worldwide. Eight species in Rwanda.

References: Jones (1977), Yamada (1993).

1. Leaf-lobes with gemmae on margins 2
- 1*. Leaf-lobes without gemmae on margins 3
2. Funnel-shaped gemmae occurring on dorsal margins of leaf lobes; leaf-lobules covering the stem for 1/4-1/3 of the stem-width ***R. flaccida***
- 2*. Discoid gemmae occurring on dorsal margins of leaf-lobes; leaf-lobules extending far beyond the farther edge of the stem ***R. quadrata***
3. Leaf-lobules with auriculate or volute base 4
- 3*. Leaf-lobules without auriculate or volute base 6
4. Leaf-lobules transverse wide rectangular with volute base ***R. voluta***
- 4*. Leaf-lobules with auriculate base 5
5. Leaf-lobules elliptical or bluntly triangular with strongly auriculate base; keels very short and sinuate; gynoecia terminal on short gynoecial branches
..... ***R. boryana***
- 5*. Leaf-lobules subquadrate with auriculate base; keels long and substraight or somewhat sinuate; gynoecia terminal on long ordinary branches and stems ***R. stipatiflora***
6. Leaf-lobules with reflexed apical or adaxial margins 7
- 6*. Leaf-lobules without reflexed margins ***R. ankefinensis***
7. Leaf-lobules covering the stem for 4/5-1/2 of the stem-width and with reflexed adaxial margins; cells of stem thin-walled with minute trigones
..... ***R. comorensis***
- 7*. Leaf-lobules extending far beyond the farther edge of the stem and with reflexed apical margins; cells of stem thick-walled with large trigones
..... ***R. appressa***

Schiffneriolejeunea Verdoorn

Ann. Bryol. 6: 89 (1933).

Pantropical genus with 14 species. Two species in Rwanda.

References: Gradstein & Vanden Berghen (1985), Vanden Berghen (1976b), Pócs (1993).

1. Perianth without keels or only slightly keeled in apical part, rostrum well developed, leaf-lobe obtuse, base of underleaves auriculate .. **S. pappeana**
- 1*. Perianth with 3 distinct keels in upper third, rostrum very small or absent, leaf-lobe apiculate, base of underleaves not auriculate **S. altimontana**

Solenostoma Mitt.

J. Linn. Soc. Bot. 8: 51 (1865).

Synonym: *Jungermannia* L., *Sp. Pl.* 1: 1131 (1753), *emend.* Dumort., *Recueil Observ. Jungerm.*: 16 (1835) *p.p.*

Solenostoma has usually been considered a subgenus of *Jungermannia* but recent molecular studies (Hentschel *et al.*, 2007) showed that it represents a genus of its own.

About 108 species, nearly cosmopolitan. Three species in Rwanda.

References: Váňa (1974), Váňa (1993).

1. Plants erect or suberect, paroicous **S. sphaerocarpum**
- 1*. Plants prostrate to creeping, paroicous or dioicous 2
2. Leaf cells mostly 30-45 μm ; cells with distinct trigones; plants dioicous
..... **S. borgenii**
- 2*. Leaf cells mostly 20-30 μm ; cells with trigones almost lacking; plants paroicous **S. mildbraedii**

Syzygiella Spruce

J. Bot. 14 (new ser. 5): 234 (1876).

A tropical-montane genus with about 20 species, 16 of them in the Neotropics. Two species in Rwanda.

References: Váňa (1985).

1. Leaves contiguous to imbricate, obliquely spreading, triangular-ovate
..... **S. geminifolia**
- 1*. Leaves distant to moderately contiguous, obliquely to nearly lanceolately spreading, oblong-ligulate or oblong **S. concreta**

Taxilejeunea (Spruce) Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 118, 125 (1893).

Mostly neotropical genus with 20-30 species. Two species in Rwanda.

References: Jones (1967, 1976b), Tixier (1995).

1. Underleaves 2-2.5 x as wide as the stem, perianth keels smooth **T. conformis**
- 1*. Underleaves less than 2 x as wide as the stem, perianth keels cristate with short, acute teeth or cilia **T. pulchriflora**

Telaranea Spruce ex Schiffn.

In: Engl. & Prantl, *Nat. Pflanzenfam.* 1(3): 103 (1895).

Synonym: *Arachniopsis* Spruce, *On Cephalozia*: 844 (1882).

A mainly southern-temperate genus with 98 species with one species (*T. europaea* J.J.Engl & G.L.S.Merr.) extending to atlantic Europe. Three species in Rwanda.

References: Fischer (1993c), Engel & Merrill (2004).

1. Plants minute and delicate (stem 100 µm in diameter, leaves 500-700 µm long), leaves of 2 lobes, underleaves absent or rudimentary ... **T. coactilis**
- 1*. Plants larger, leaves of 2-4 lobes, underleaves present 2
2. Leaves usually 2-lobed, lobes narrow, at base up to two cells large **T. nematodes**
- 2*. Leaves usually 3(-4)-lobed, lobes at base up to four cells large ... **T. trifida**

Tetralophozia (R.M. Schust.) Schljak.

Novit. Syst. Pl. Non Vasc. 13: 227 (1976).

Three to four species, arctic-alpine in Northern Hemisphere, Himalaya to Japan, East Africa. One species in Rwanda.

References: Váňa (1993), Váňa & Watling (2004c).

Tritomaria Schiffn. ex Loeske

Hedwigia 49: 13 (1909).

About 7 species mainly in Northern Hemisphere and tropical mountains. One species in Rwanda.

References: Váňa (1993), Váňa & Watling (2004c).

***Tylimanthus* Mitt.**

In: Hooker, *Handb. N. Zealand Fl.*: 751 (1867).

About 2-3 species mainly in tropical mountains. In Rwanda one species.

References: Jones (1980), Burghardt & Gradstein (2008).

9.4. Thallose liverworts – Key to Families and Genera in Rwanda

1. Thallus several cells thick over most of transverse section 2
- 1*. Thallus one layer of cells thick, a pluristratose midrib clearly differentiated, thallus either dichotomously branched or dendroid, resembling a filmy fern (*Hymenophyllum*) 13
2. Thallus solid, lacking air chambers and pores 3
- 2*. Thallus with cavities (air chambers) and compound pores, or upper part formed by closely packed parallel vertical filaments
..... **Complex thalloid liverworts** 4
3. Thallus large, 8-10 mm wide x 40-100 mm long, female inflorescences stalked ***Dumortiera***
- 3*. Thallus smaller, female inflorescence not stalked, sporangium on short seta, which elongates shortly before dehiscence, capsule opening with four valves, midrib poorly differentiated, thallus usually pinnately to bipinnately or palmately branched (except in *Aneura pseudopinguis*), male and female inflorescences on very short lateral branches
..... **Simple thalloid liverworts Aneurales (Aneuraceae)**
4. Upper stratum of thallus formed by closely packed parallel vertical filaments, sporangium spherical, embedded in the thallus, thallus star-like
..... **Ricciaceae (*Riccia* subg. *Riccia*)**
- 4*. Upper stratum of thallus with air chambers or air chambers throughout ... 5
5. Pores of air chambers in upper epidermis minute or absent, sporangium spherical, embedded in the thallus causing a bulging of dorsal surface, sometimes upper epidermis disintegrating and appearing spongy, aquatic plants or plants of humid habitats **Ricciaceae**
- 5*. Pores of air chambers in upper epidermis conspicuous and easily observable 6

6. Pores barrel-shaped in transverse section, polygonal markings on upper thallus surface, gemmae in cup-like involucre (gemma-cup), male receptacle stalked, female receptacle stalked, deeply lobed
..... **Marchantiaceae (*Marchantia*)**
- 6*. Pores not barrel-shaped in transverse section 7
7. Gemmae in half-lunulate gemma-cups on upper thallus surface, thallus with polygonal markings, cells of upper epidermis collenchymatous
..... **Lunulariaceae (*Lunularia*)**
- 7*. Gemmae absent 8
8. Thalli large, bluish-green, carpocephala dorsal on thallus, away from apex, stalk very short, without rhizoidal furrow ***Plagiochasma***
- 8*. Thalli smaller, often thin and delicate, never bluish-green, carpocephala on long or short stalk arising from apical notch of thallus or bifurcations 9
9. Thallus delicate, translucent, differentiated into midrib and thin wings, margins green below, ventral scales small and reduced, air chambers without filaments, plants of rainforests ***Cyathodium***
- 9*. Thallus delicate or firm, not differentiated into midrib and thin wings, ventral scales well-developed, air chambers with or without filaments, plants of montane to subalpine humid or dry habitats 10
10. Air chambers without filaments, sporangium surrounded by a conspicuous cage-like pseudoperianth of converging hyaline laciniae, plants of humid montane to subalpine habitats ***Asterella***
- 10*. Air chambers with numerous short green filaments lining their floors, plants of dry habitats 11
11. Plants large, 5-10 mm wide, upper surface of thallus smooth, epidermal cells with nodular thickenings..... ***Targioniaceae (*Targionia*)***
- 11*. Plants small, less than 5 mm wide 12
12. Air chambers not doomed, thallus with upper surface smooth ***Mannia***
- 12*. Air chambers strongly doomed, upper surface of thallus thus covered with pustules and “volcano-like” protuberances, each with a large pore at apex, cell walls thin ***Exormotheca***

13. Inflorescence on short branches below the midrib, thallus not more than 2 mm wide, with distinct midrib up to 120 µm wide, formed of 2-4 rows of large cortical cells on dorsal side and 2-6 rows of similar cells on ventral side and 3-7 medullary cells, mainly epiphytic.....
 **Simple thalloid liverworts Metzgeriaceae (*Metzgeria*)**
- 13*. Inflorescence on upper surface of thallus, midrib 300-600 µm wide, of 10-15 cell layers in transverse section, tapering gradually into unistratose wings
 **Simple thalloid liverworts Pallaviciniaceae**

9.5. Families of Thallose liverworts with ≥ two genera in Rwanda – Keys to Genera in Rwanda

Aneuraceae

1. Thallus prostrate, simple or scarcely branched, margins undulate or crisped, oil bodies more than 6 per cell, male branches with antheridia in 2-6 rows
 ***Aneura***
- 1*. Thallus prostrate or erect, irregularly or regularly pinnate, margins flat or somewhat undulate, oil bodies up to 5 per cell, male branches with antheridia always in 2 rows ***Riccardia***

Pallaviciniaceae

1. Thallus erect from a prostrate rhizome 2
- 1*. Thallus prostrate or slightly ascending, not erect 3
2. Archegonia surrounded by a ring of scales forming a cup-like involucre, after fertilization a tubular pseudoperianth several times longer than the involucre developing from within the involucre, thallus margin dentate-spinose
 ***Jensenia***
- 2*. Archegonia with a small scale inserted behind them, cup-like involucre and pseudoperianth lacking, thallus margin entire or dentate ***Symphyogyna***
3. Thallus margin with scattered slime hairs 2-4 cells long, midrib with one central strand, archegonia surrounded by a ring of scales forming a cup-like involucre, after fertilization a tubular pseudoperianth several times longer than the involucre developing from within the involucre ***Pallavicinia***
- 3*. Thallus margins without slime hairs (except *S. volkensis* with slime hairs disintegrating soon), midrib with 1-3 central strands, archegonia with a small scale inserted behind them, cup-like involucre and pseudoperianth lacking ..
 ***Symphyogyna***

Ricciaceae

1. Plants typically floating on water, with dorsal surface exposed to air, with long, serrate swordlike or lingulate ventral scales. Air chambers large, pores present. Oil cells in scales and thallus **Ricciocarpus**
- 1*. Plants terrestrial or floating under water surface, never with swordlike or lingulate ventral scales. Air chambers small to vestigial, pores typically lacking. Thallus and scales without oil cells **Riccia**

9.6. Thallose liverwort genera – Keys to Species in Rwanda

Aneura Dumort.

Commentat. Bot.: 115 (1822).

About 10 species worldwide. Two species in Rwanda.

References: Jones (1956), Meenks & Pócs (1985), Perold (2001).

1. Thallus dorsally concave, fleshy, in the middle (9-)10-20 cells thick **A. pinguis**
- 1*. Thallus flat, translucent, in the middle only 5-7(-9) cells thick **A. pseudopunguis**

Asterella P. Beauv.

Dict. Sci. Nat. 3: 257 (1805).

About 60 species worldwide. Two species in Rwanda.

References: Bischler-Causse & Long (1993), Long (2006).

1. Carpocephala above with large protruding wart-like air chambers **A. khasyana**
- 1*. Carpocephala above with small and not protruding pores **A. abyssinica**

Cyathodium Kunze

In: Lehmann, *Nov. Stirp. Pug.* 6: 17 (1834)

Pantropical genus with about 14 species. One species in Rwanda.

References: Jones (1952).

Dumortiera Nees

In: Reinw., Blume & Nees, *Nova Acta Phys.-Med. Acad. Caes. Leop.-Carol. Nat. Cur.* 12: 410 (1824).

Widespread tropical and warm-temperate genus with one or two species. One species in Rwanda.

References: Fischer (1993c).

Exormotheca Mitt.

In: Godman, *Nat. Hist. Azor. West. Isl.*: 326 (1870).

Three species in Africa in dry areas, mainly South-Eastern and South Africa. One species in Rwanda.

Fossombronina Raddi

Atti Soc. Sci. Modena 18: 40 (1818).

About 25 species, cosmopolitan. Three species in Rwanda.

References: Perold (1998).

1. Plants large, forming dense mats, stem up to 6 cm long, leaves imbricate, rounded, entire, 4 x 7 mm ***F. pulvinata***
- 1*. Plants smaller, stem not exceeding 2 cm of length, leaves entire to lobed, up to 1.5-2 mm long 2
2. Stems 0.3-1 cm long, plants solitary or gregarious but not forming dense mats, leaves entire to lobed, crisped towards apex, paroicous, spores with lamellae ...
..... ***F. pusilla***
- 2*. Stems up to 2 cm long, forming dense mats, leaves irregular rectangular, not crisped towards apex, dioicous, plants predominantly male, spores with ridges, loops or rarely reticulate, distal face with up to 13 areolae ***F. rwandaensis***

Jensenia Lindb.

Notiser Sällsk. Fauna Fl. Fenn. Förh. 9 : 13 (1867).

Tropical and Southern-Temperate genus with about 10 species. One species in Rwanda.

References: Grolle (1993).

Lunularia Adans.

Fam. Pl. 2: 15 (1763).

Monotypic genus.

Marchantia L.

Sp. Pl., ed. 1: 1137 (1753)

About 50 species worldwide. Three species in Rwanda.

References: Vanden Berghen (1954), Bischler-Causse (1993), Bischler-Causse & Long (1993).

1. Female receptacles (archegoniophores) dissected into 9-11 terete rays, gemmae cups with papillose outer surface (subgenus *Marchantia*) 2
- 1*. Female receptacles (archegoniophores) dissected into flat lobes, gemmae cups with smooth outer surface (subgenus *Chlamidium*) 3
2. Thallus bluish-green, without dark band, gametangiophores rare, plants of alpine habitats in paramo above 2700 m, native to Rwanda
..... ***M. polymorpha* ssp. *montivagans***
- 2*. Thallus dark green, with dark median band, gametangiophores abundant, plants of ruderal and anthropogenic habitats in gardens or on paths, below 2000 m, introduced ***M. polymorpha* ssp. *ruderalis***
3. Thallus c. 3-7.5 mm wide, dorsal side usually with a dark median band, median scale appendage small, cupule margins crenulated or with short cilia up to 3 cells long, female receptacle deeply dissected into lobes, margins of involucre entire or crenulated ***M. debilis***
- 3*. Thallus c. 6-10 mm wide, dorsal side without dark median band, median scale appendage large, cupule margins with cilia up to 6 cells long, female receptacle shallowly dissected into broad lobes, margins of involucre ciliate . ***M. pappeana***

***Metzgeria* Raddi**

Mem. Soc. ital. Sci. Modena 18: 45 (1820).

Cosmopolitan, about 100 species worldwide. Five species in Rwanda.

References: Vanden Berghen (1948a), Pócs (1993), So (2004).

1. Thallus branches of two forms, one strongly tapered with acute ends and the other non tapered with broad lamina and rounded ends. The thallus branches with tapering wing have both laminal gemmae (strongly concave or plane) concentrated along the tapering thallus ends and mucilaginous gemmae produced at thallus apices, 2 rows of cortical cells on both sides of the midrib (increasing up to 4 only near to the thallus apices) ***M. consanguinea***
- 1*. Thallus uniform consisting of only non tapered branches with broad lamina and rounded, obtuse or emarginated apices 2
2. Costa of mature thallus with 3-4(-5) rows of dorsal cortical cells and 3(4-6) rows of ventral cortical cells ***M. quadrifaria***
- 2*. Costa of mature thallus with 2 rows of dorsal cortical cells and 2-3(-4) rows of ventral cortical cells 3

- 3. Marginal hairs of thallus almost all single, rarely paired hairs present ***M. furcata***
- 3*. Marginal hairs of thallus often paired 4
- 4. Marginal hairs of thallus straight or weakly curved ***M. madagassa***
- 4*. Marginal hairs of thallus distinctly curved or falcate, usually geminate ***M. leptoneura***

Pallavicinia S. Gray

Nat. Arr. Brit. Pl. 1 : 775 (1821), *nom. cons.*

About 10 species worldwide. One species in Rwanda.

References: Grolle (1993).

Riccardia S. Gray

Nat. Arr. Brit. Pl. 1: 679, 683 (1821).

About 100 species worldwide. Five species in Rwanda.

References: Jones (1956), Meenks & Pócs (1985), Müller *et al.* (2000), Perold (2001, 2002, 2003).

- 1. Plants large, relatively robust, 15-40 mm long, not growing closely attached to the substrate, main axis or main branches 0.8-1.4 mm wide, thalli pinnate to bipinnate, thallus apices deeply dissected, main axis distinctly winged ... ***R. longispica***
- 1*. Plants small, relatively slender, 6-20 mm long, growing closely attached to the substrate, main axis or main branches 0.15-0.9 mm wide, thalli palmate to pinnate or irregularly branched 2
- 2. Thalli not winged or sometimes with 1 cell-wide wing of elongated cells, often lunate in cross-section, apices of branches usually gemmiferous ***R. spec.***
- 2*. Thalli at least along the branches with an unistratose 3-6 cells wide wing 3
- 3. Main axis not or only slightly winged, the wing cells of branches equal in size, branches tongue-like, palmate and often ending bifurcate ***R. amazonica***
- 3*. Main distinctly winged, the margin cells of wing distinctly smaller than the other cells branching pinnate, never bifurcate ***R. limbata***

Riccia L.

Spec. Pl., ed. 1: 1138 (1753).

About 150 species worldwide, mainly in drier tropical to temperate regions. Nine species in Rwanda.

References: Jones (1957), Fischer (1993d, 1995), Perold (1986, 1990, 1992, 1993, 1995).

1. Assimilative tissue composed of cell-pillars surrounded of very narrow interstitial air spaces. Frequently in dry habitats (Subgenus *Riccia*) 2
- 1*. Assimilative tissue composed of \pm large air-chambers, epidermis smooth or with age cavernous. Frequently in wet habitats or aquatic (Subgenus *Ricciella*) 7
2. Margin of thallus with long hyaline cilia 3
- 2*. Thallus margin and sporangia without cilia 4
3. Thallus branches 5 x 1-1.5 mm, margin of thallus with long hyaline cilia and a few shorter cilia on upper surface of thallus above sporangia, cilia never arching and channelled. Spores triangular-globose, 100-120 μ m in diameter ***R. crinita***
- 3*. Thallus branches 1-3 x 0.6-0.8 mm, margin of thallus with long hyaline cilia in several rows, crowded at apex, cilia arched and channelled. Spores triangular-globose, 80-92 μ m in diameter ***R. microciliata***
4. Ventral scales prominent, black, greatly exceeding the margin of thallus and usually inflexed over the thallus, at least at its apex, when dry. Thallus bluish green. Spores wingless, densely papillose ***R. okahandjana***
- 4*. Ventral scales not greatly exceeding the margin of thallus nor inflexed so as to cover the apex of thallus. Spores areolate 5
5. Ventral scales large and conspicuous, 0.9 x 0.8 mm, entirely dark violet or sometimes with hyaline base. Thallus bluish or greyish green, large, 6-12 (-15) x 3-5 mm. Spores yellowish brown, without wing and triradiate mark, surface with 6-8(-10) angular areolae across diameter ***R. congoana***
- 5*. Ventral scales smaller, up to 0.4 x 0.5 mm, deep violet with hyaline edges extending to thallus. Thallus glaucous green to green, smaller, 4-8.5 x 1.5-2.5 mm. Spores reddish brown to blackish brown, areolae thick walled or sometimes incomplete 6

- 6. Spores distinctly polar, winged, proximal face with well-defined triradiate mark, reddish brown, facets and distal face often with incomplete areolae .
..... ***R. lanceolata***
- 6*. Spores not distinctly polar, blackish brown with thick walled areolae
..... ***R. atropurpurea***
- 7. Thalli in partial rosettes, branches broadly subquadrate-obovate, rounded obtuse, 3-4 x 1.7-3 mm, becoming cavernous proximally. Spores with areolar walls on both faces and triradiate mark on proximal face
..... ***R. vulcanicola***
- 7*. Thalli not in rosettes, branches linear or lanceolate, air chambers inconspicuous, never cavernous 8
- 8. Thallus light green, with linear branches, 5-10(-15) x 0.5-0.8(-1.2) mm, distal face of spores with prominent areolae, proximal face with thick triradiate mark ***R. stricta***
- 8*. Thallus pale glaucous green, with violet ventral scales, branches lanceolate, 4-5 x 1.5-2.5 mm, spores with distal face regularly areolate, areolae on proximal face incomplete or absent ***R. moenkemeyeri***

Ricciocarpus Corda

In: *Opiz, Beitr. zur Naturg.*: 651 (1829).

Monotypic genus.

Symphyogyna Nees & Mont.

Ann. Sci. Nat., Bot., 2^e sér., 5: 66 (1836).

Tropical and Southern-Temperate genus with about 25 species. Three species in Rwanda.

References: Vanden Berghen (1965), Grolle (1993).

- 1. Dendroid, but less well-developed phases sometimes ascendent or almost procumbent, frond margin dentate with ± coarse, acute teeth; marginal slime-hairs lacking ***S. podophylla***
- 1*. Procumbent, frond margin entire (rarely with a few small broadly hump-shaped processes with a rounded tip) 2

2. Marginal slime-hairs lacking. Frond green to yellowish green, often slightly tinted with orange or red, with usually weakly-incurved margins, 2.5-4.5(-5.5) mm wide. Spores distally with many small short, ± curved ridges ... **S. brasiliensis**
- 2*. Marginal slime-hairs present (often, however, soon disappearing at some distance from shoot tip). Frond grass-green (without secondary pigmentation), usually flat, (3-)5-9(-10) mm wide. Spores distally with few coarse long sinuate ridges **S. volkensis**

Targionia L.

Sp. Pl., ed. 1, 2: 1136 (1753).

Subtropical-mediterranean genus of two or three species. One species in Rwanda.

9.7. Hornworts – Key to Genera and Species in Rwanda

1. Sporophytes short, usually less than 5 mm, lying more or less horizontally on thallus, almost entirely covered by involucre **Notothylas**
- 1*. Sporophytes long, usually more than 10 mm long, erect, much longer than involucre 2
2. Thallus with cavities, spores dark brown or black **Anthoceros**
- 2*. Thallus solid, spores yellow **Phaeoceros**

Anthoceros L.

Sp. Pl., ed. 1, 1: 1139 (1753).

Cosmopolitan. Due to lack of a modern revision, the exact number of species is difficult to estimate. Four species in Rwanda.

References: Hasegawa (1993), Fischer (2007).

1. Thallus-margin densely dissected into narrow rectangular, truncate lobes, spores 50-60 µm in diameter, distal surface with baculate to spinate up to 4 µm long tubercles, proximal surface covered with small subglobose tubercles **A. myriandroecius**
- 1*. Thallus-margin remotely or somewhat pinnately dissected into broad rectangular lobes, spores different 2

2. Spores 34-42 μm in diameter, distal surface covered with spinulate tubercles less than 3 μm long, often united at base, proximal surface with indistinct reticulate ridges and small subglobose tubercles..... **A. sambesianus**
- 2*. Spores 42-62 μm in diameter, distal surface either with numerous spines or tubercles, tubercles compressed and often divided distally or distal surface with short, often sinuate and shortly branched lamellae, or a network of lamellae forming ridges and peaks, proximal surface either foveolate and nearly smooth or with conspicuous trilete ridges and sinuate lamellae 3
3. Spores (42-)45-50(-55) μm in diameter, distal surface with short, often sinuate and shortly branched lamellae, or a network of lamellae forming ridges and peaks, proximal surface with conspicuous trilete ridges and sinuate lamellae **A. caucasicus**
- 3*. Spores 42-62 μm in diameter, distal surface with numerous spines or tubercles, tubercles compressed and often divided distally, proximal surface foveolate and nearly smooth **A. punctatus**

Notothyias Sull.

Mem. Amer. Acad. Arts & Sci. N.S. 3: 65 (1848).

Cosmopolitan genus with c. 20 species, Three to four species in Africa. One species in Rwanda.

Phaeoceros Prosk.

Bull. Torrey Bot. Club 78: 346 (1951).

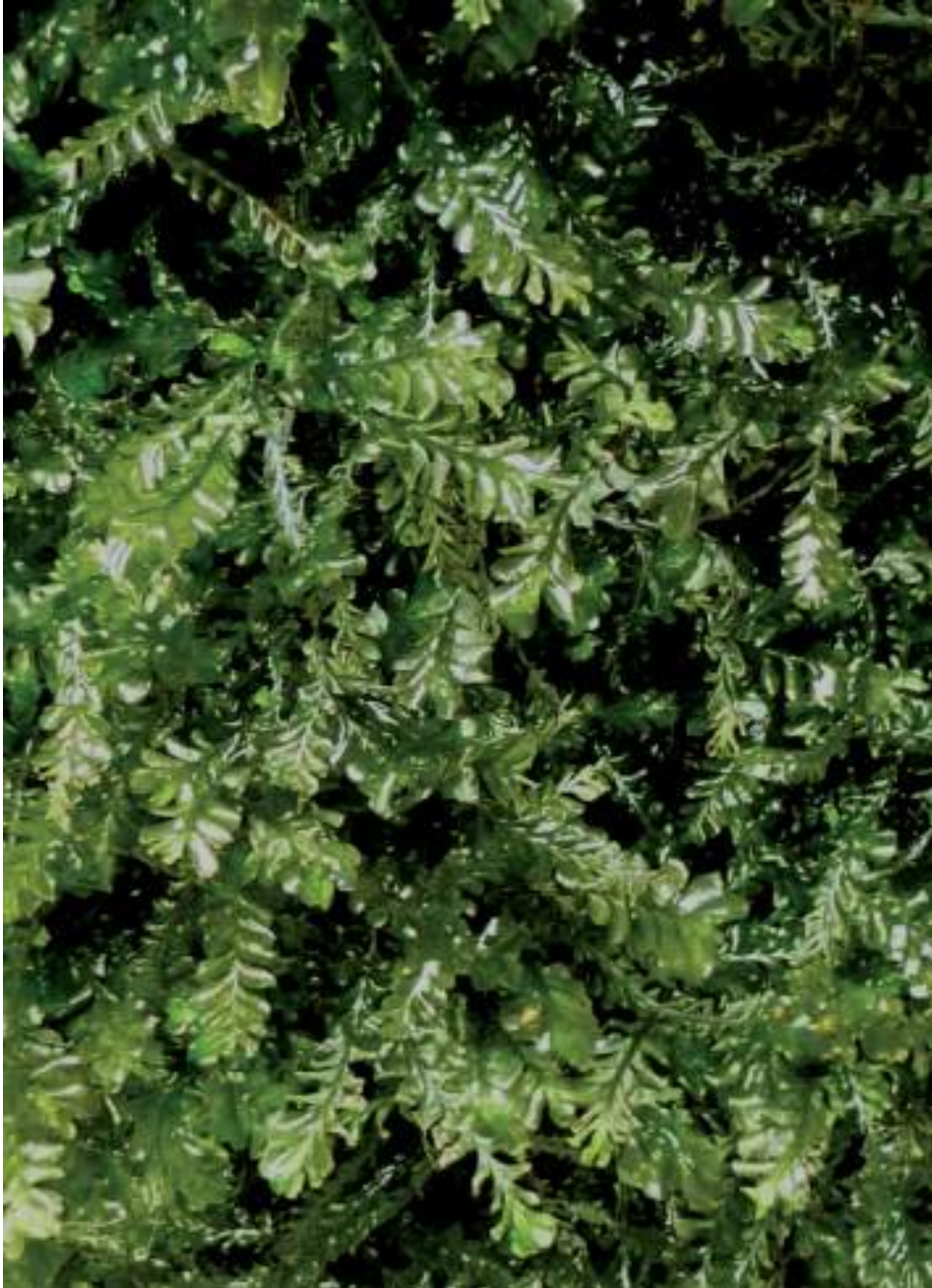
Cosmopolitan. The exact number of species is difficult to estimate. Two species in Rwanda.

References: Hasegawa (1993), Fischer (2007).

1. Spores with distal surfaces densely papillate to spinulate throughout **P. carolinianus**
- 1*. Spores with distal surfaces densely papillate with scattered lamellae consisting of several papillae united at base **P. fulvisporus**

10. Description of species from Rwanda

10.1. Leafy liverworts



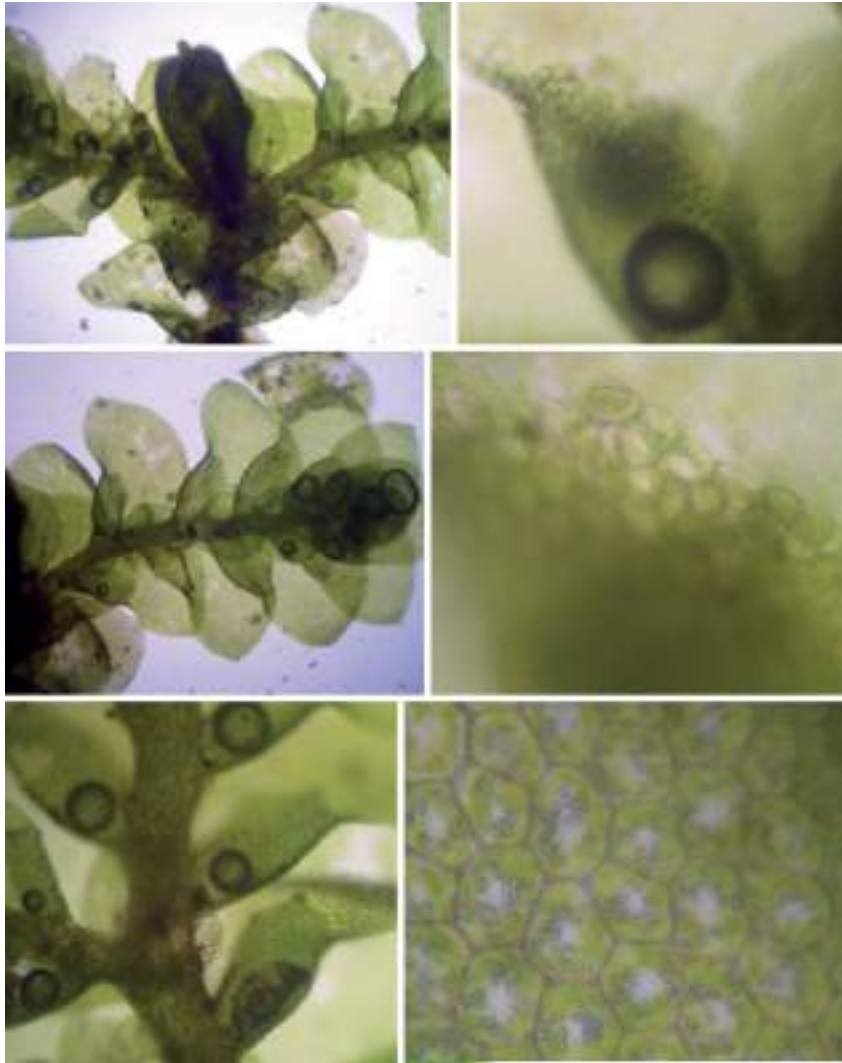


Fig. 38. *Acanthocoleus chrysophyllus* (Lehm.) Kruijt

Synonym: *Dicranolejeunea chrysophylla* (Lehm.) Grolle. Plants epiphytic, dark-green to brown, irregularly branched, 1-1.5 mm wide. Leaves alternate, loosely imbricate. Lobes wide-spreading, ovate, 0.75-1.1 x 0.5-0.7 mm, apex acuminate, margin entire or rarely dentate towards apex. Lobules about 0.35 of lobe length, often reduced, keel strongly arched, with 2 teeth, apical tooth often with 2 cells, second (proximal) tooth smaller, sometimes obscure. Underleaves undivided, 2.5-3.5 times as wide as the stem, margin entire. Autoicous. Perianths with narrow or almost lacking wing, laciniae, if present, only 1-3 on each side. **Habitat:** Epiphyte in montane forest, 2000 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura. **Distribution in Africa:** Cameroon, Nigeria, Uganda, Kenya, Tanzania, Zambia, Zimbabwe, South Africa. **Note:** Very similar to *A. madagascariensis* and only distinguished by the antheridia in unspecialized bracts below gynoeceium.



Figs 39 and 40 (next page). *Acanthocoleus madagascariensis* (Steph.) Kruijt.
 Synonym: *Dicranolejeunea madagascariensis* Steph. Plants epiphytic, dark-green to brown, irregularly branched, 1-1.5 mm wide. Leaves alternate, loosely imbricate. Lobes wide-spreading, convolute when dry, ovate, 0.75-1.1 x 0.5-0.7 mm, apex acuminate, margin entire or rarely dentate towards apex. Lobules about 0.35 of lobe length, often reduced, keel strongly arched, with 2 teeth, apical tooth often with 2 cells, second (proximal) tooth smaller, sometimes obscure. Underleaves undivided, 2.5-3.5 x as wide as the stem. Autoicous. Perianths compressed, pyriform, 0.7-0.9 x 0.4-0.6 mm, the apex truncate or cordate, usually winged and ciliate-laciniate near apex. **Habitat:** On the stem of planted exotic trees at 1700 m, also in montane forest at 1800 m. **Distribution in Rwanda:** Central Rwanda: Butare. **Nyungwe NP:** Cyamudongo. **Distribution in Africa:** Sierra Leone, Burundi, Tanzania, Zimbabwe, South Africa. Also Comoro Islands, Madagascar, Mauritius, Réunion.





Fig. 41. *Acrolejeunea emergens* (Mitt.) Steph.

Plants epiphytic, brownish-green to brown, about 1.5 mm wide, small, microphyllous shoots with tiny caducous leaves often present at the apex of main shoots. Leaves alternate, closely imbricate. Lobes subelliptic, entire, 0.8-1 x 0.4-0.8 mm, obtuse. Lobules ovate-triangular, 0.4-0.5 x length of the lobe, with (2-)3-4 small straight or curved teeth, each with 1-3 cells. Underleaves imbricate, reniform, entire, truncate at apex, about 3 x as wide as the stem. Autoicous or sometimes dioicous. Perianths hidden by involucre bracts, or only slightly exerted, pyriform, with 4-8(-10) keels all over its length.

Habitat: Epiphytic in dry forests in savanna habitats, 1300-1500 m. **Distribution in Rwanda:** Central Rwanda: N of Nyamata. **Akagera:** Lake Mpanga region, Lake Mihindi. **Distribution in Africa:** Senegal, Guinea, Sierra Leone, Côte d'Ivoire, Ghana, Benin, Nigeria, Rio Muni, Congo-Brazzaville, Central African Republic, DR Congo, Burundi, Uganda, Kenya, Tanzania, Angola, Malawi, Zambia. Also Cape Verde, Madagascar, Seychelles, Réunion, Mauritius, Rodriguez.

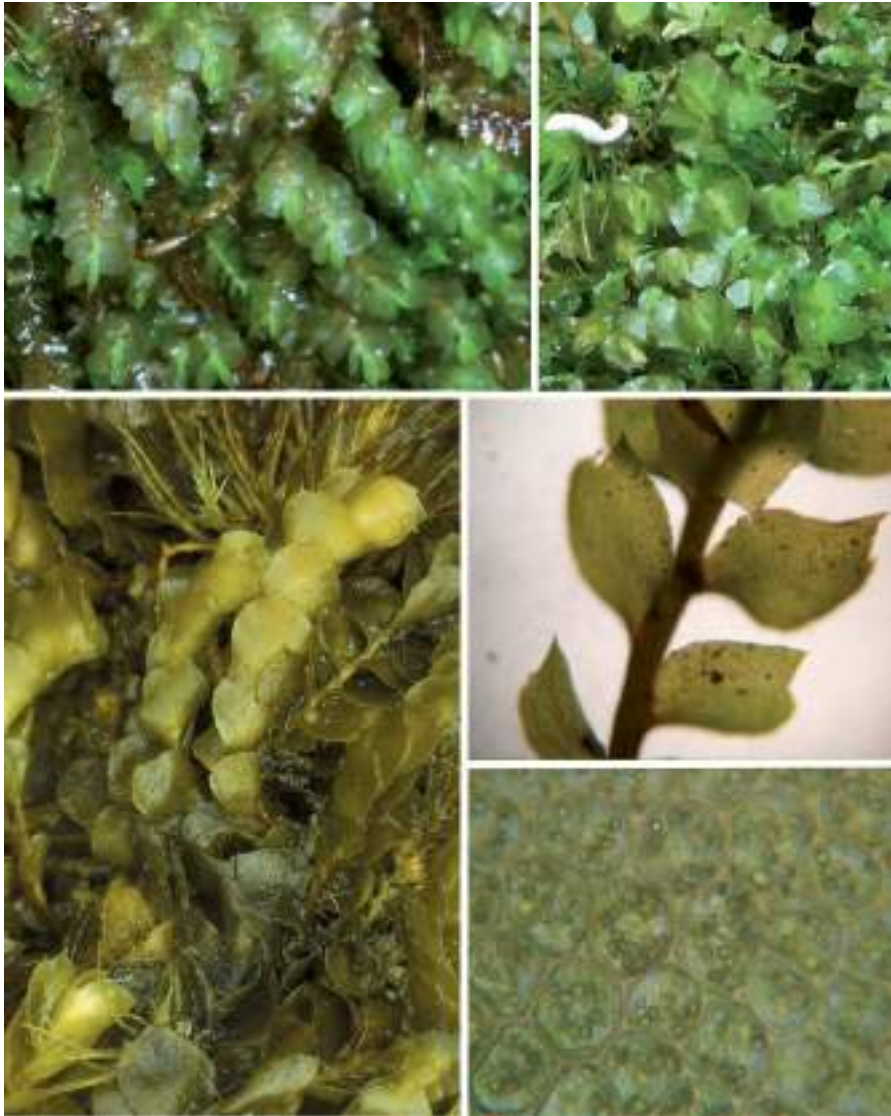


Fig. 42. *Adelanthus decipiens* (Hook.) Mitt.

Plants epiphytic or saxicolous, green to dark green. Stems erect to ascending, 5-15 mm long and 0.2-0.25 mm wide, unbranched. Leaves oval to rounded, about 1 mm long, dorsal margin entire, inflexed, decurrent, ventral margin typically with 2 teeth. Underleaves absent or rudimentary. Fertile plants not observed in Rwanda. **Habitat:** Epiphyte on bark of *Hypericum* and *Erica* and lithophyte on rocks between 2500 and 3700 m. **Distribution in Rwanda:** **Volcano NP:** Karisimbi, Karisoke, Sabinyo. **Nyungwe NP:** Rwasenkoko, Mt. Bigugu. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Ethiopia, Tanzania, Malawi, South Africa. Also Europe, Azores, Madeira, St. Helena, Tristan da Cunha, Caribbean, Costa Rica to Bolivia, Galapagos, Réunion, Mauritius.

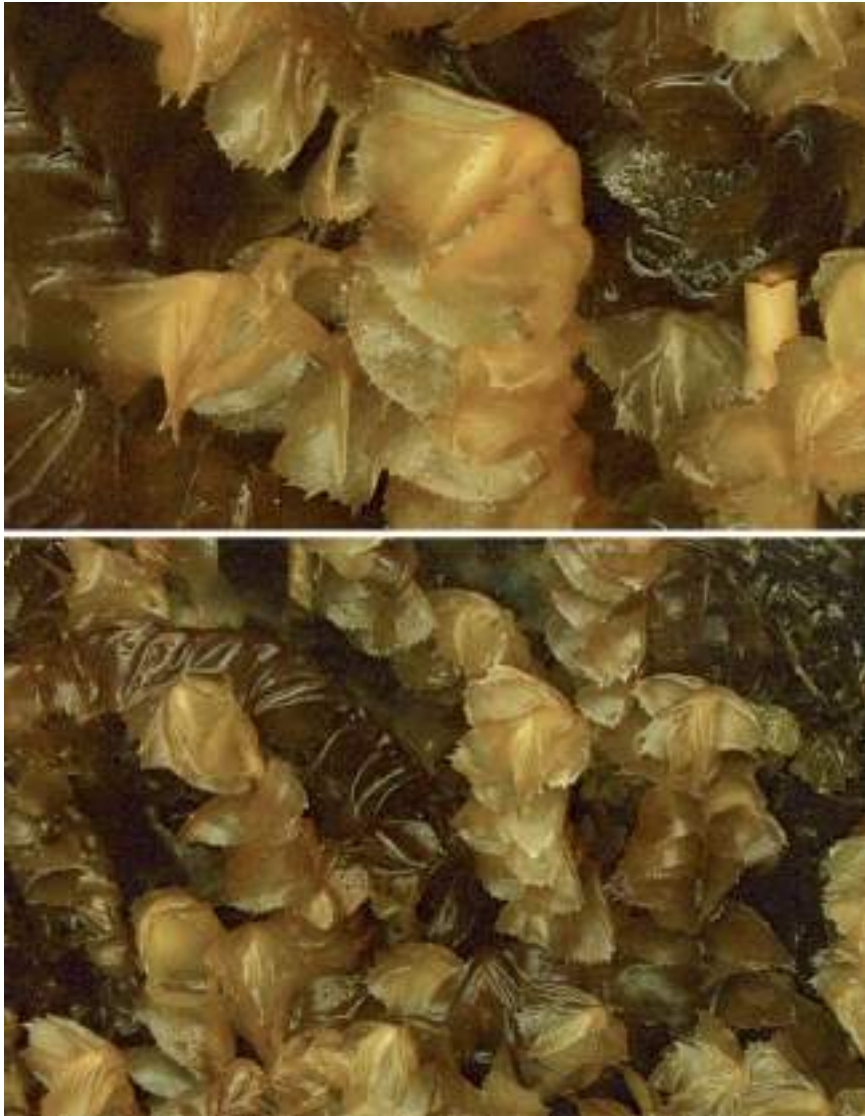
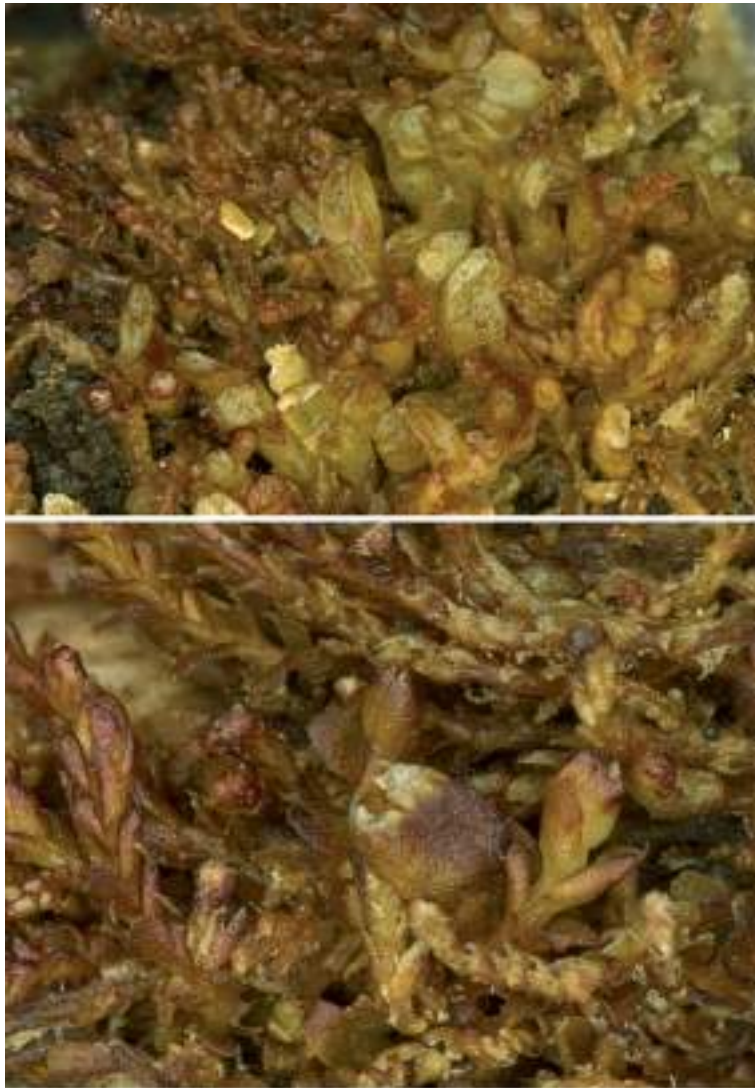


Fig. 43. *Adelanthus lindenbergianus* (Lehm.) Mitt.

Plants epiphytic, reddish-brown to brownish. Stems erect, 20-100 mm long and 0.2-0.25 mm wide, unbranched or sparsely branched. Leaves oval to rounded, ventrally secund, imbricate, decurrent, about 0.9-1.4 mm long and 0.7-1 mm wide, dorsal margin entire, inflexed, decurrent, ventral margin dentate from base to apex. Underleaves absent. Fertile plants unknown. **Habitat:** Epiphyte on bark of *Agauria* and *Erica*, occasionally on ground between 2400 and 3200 m. **Distribution in Rwanda:** Nyungwe NP: Uwinka. **Distribution in Africa:** DR Congo, Uganda, Kenya, Tanzania, Lesotho, South Africa. Also Europe, Mexico, Costa Rica, South America, Tristan da Cunha, South Georgia, Falkland Islands, Tierra del Fuego, Juan Fernandez Islands, Madagascar, Réunion, Mauritius.



Figs 44 and 45 (next page). *Amphicephalozia africana* Váňa & Wigginton

Plants minute, about 5-7 mm long and 0.25-0.35 mm wide. Stems procumbent. Leaves obliquely to subtransversally inserted and oriented, distant to imbricate, 0.15-0.43 x 0.25-0.49 mm, quadrate-rounded to ovate, bilobed to half of their length, the lobes triangular, subequal, 10-15 cells wide at base. Cells thick-walled, without trigones, 15-25 x 15-20 μ m. Underleaves undivided, variable, 2-6 cells wide and 3-15 cells long, c. 0.3-0.5 the width of the stem. Asexual reproduction by 1-2-celled gemmae on leaf lobe tips. Autoicous.

Perianths clavate, widest in upper third, 1.4-1.9 x 0.6-0.7 mm, deeply 3(-4)-plicate.

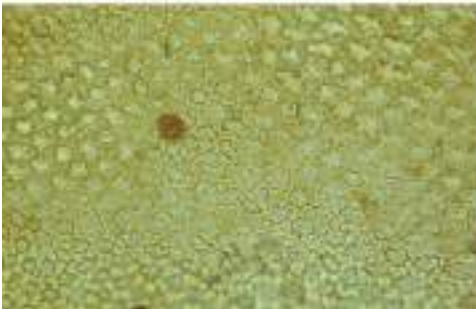
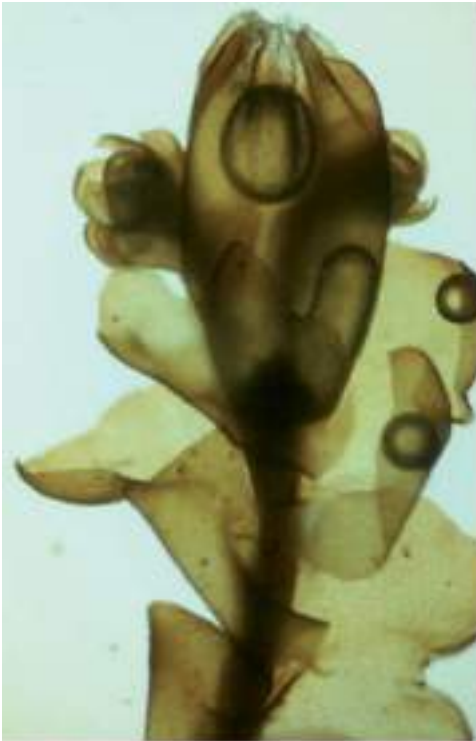
Habitat: *Dendrosenecio adnivalis*-*Lobelia stuhlmannii*-paramo, on decaying stems of *Dendrosenecio*, 3570 m, also in *Cyperus* swamp at 2540 m. **Distribution in Rwanda:**

Volcano NP: Karisimbi, E-slopes along trail to summit, foot of Mt. Gahinga.





Figs 46 and 47 (next page). *Anastrophyllum auritum* (Lehm.) Steph.
 Synonyms: *Anastrophyllum gambaragarae* Gola; *A. calcaratum* Steph.; *A. grossitextum* Steph. Plants small to medium sized, dark reddish-brown or purple. Stems up to 0.5-4 cm long, creeping to erect. Leaves succubous, contiguous to imbricate, ± asymmetrically 2-lobed to 0.25-0.5 of their length, leaf lobes strongly incurved. Cells with wide trigones, 10-20 µm in diameter. **Habitat:** Epiphytic or on rocks, 3000-4450 m. **Distribution in Rwanda: Volcano NP:** Karisimbi. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Ethiopia, Uganda, Kenya, Tanzania, Lesotho, South Africa. Also Réunion.



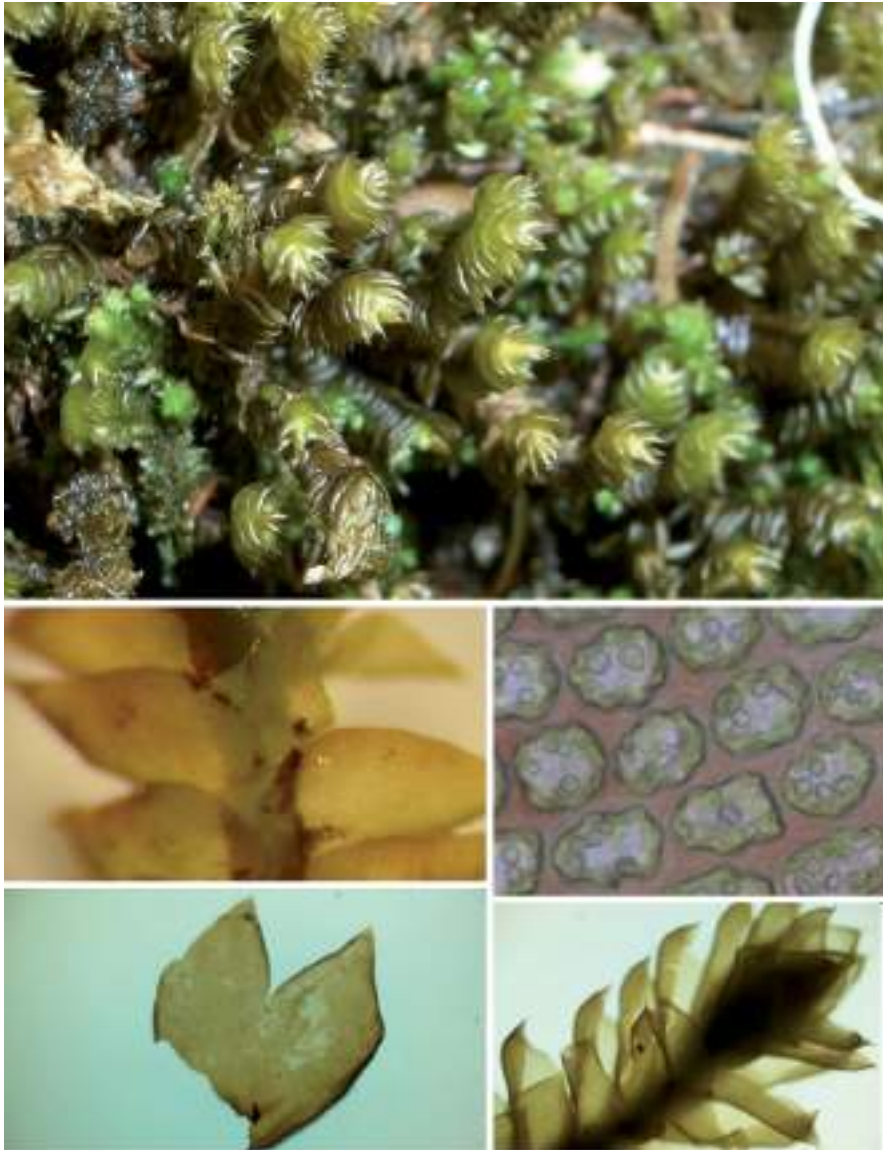


Fig. 48. *Anastrophyllum piligerum* (Nees) Spruce

Plants large, dark reddish-brown, rigid. Stems up to 3-4 cm long, forming a large compact tuft. Leaves densely imbricate, strongly secund dorsally, \pm asymmetrically 2-lobed to 0.5-0.65 of their length, 1.8-2.2 x 1.8-2.2 mm, leaf lobes triangular-ovate, apices subacute. Cells with wide trigones, 10-20 (-35) μ m in diameter. **Habitat:** Rocky slopes in ericaceous forest, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Karamba. **Distribution in Africa:** Tanzania, Zimbabwe. Also Ascension, Madagascar, Mauritius, Réunion, Seychelles, Cuba, Jamaica, Peru, Brazil, Sri Lanka, Thailand, Sumatra, Java, Borneo, Salomon Islands, New Caledonia, Samoa.

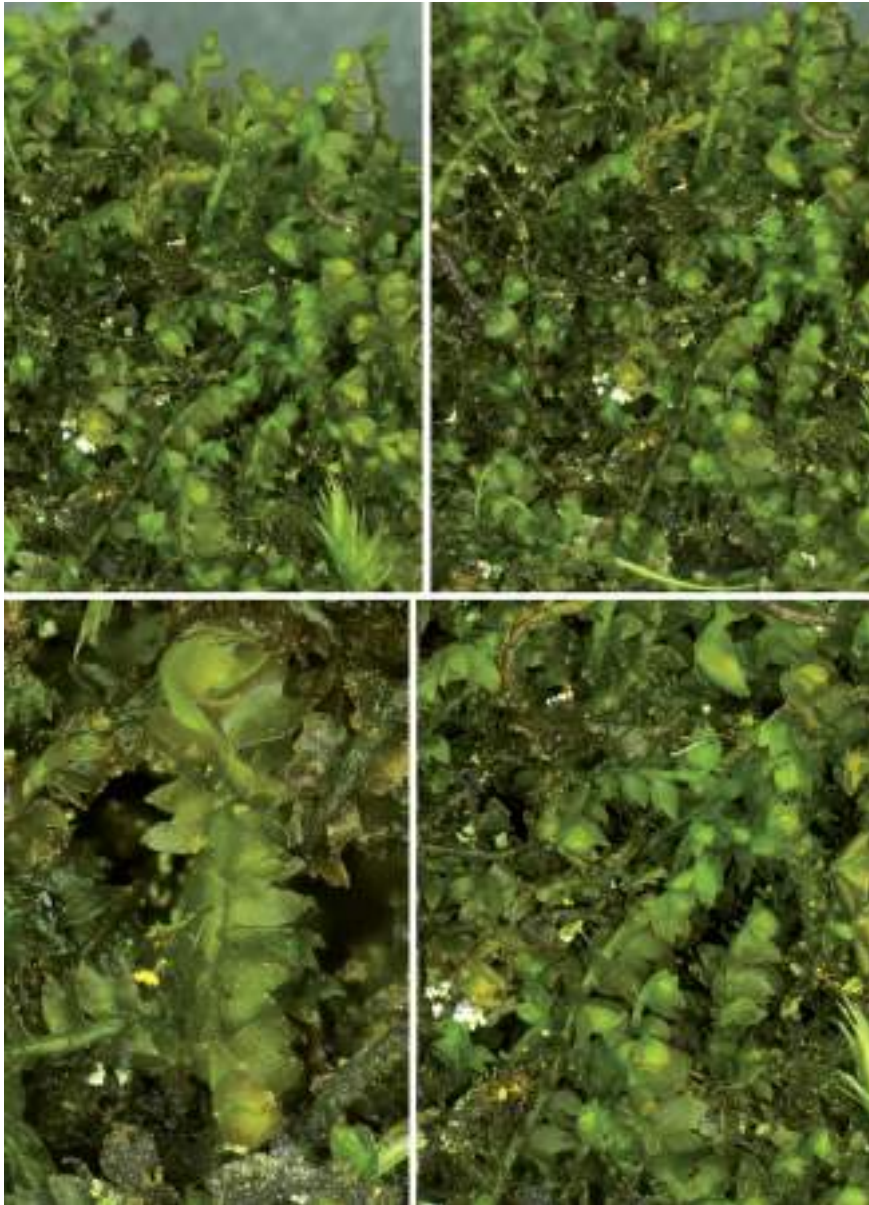


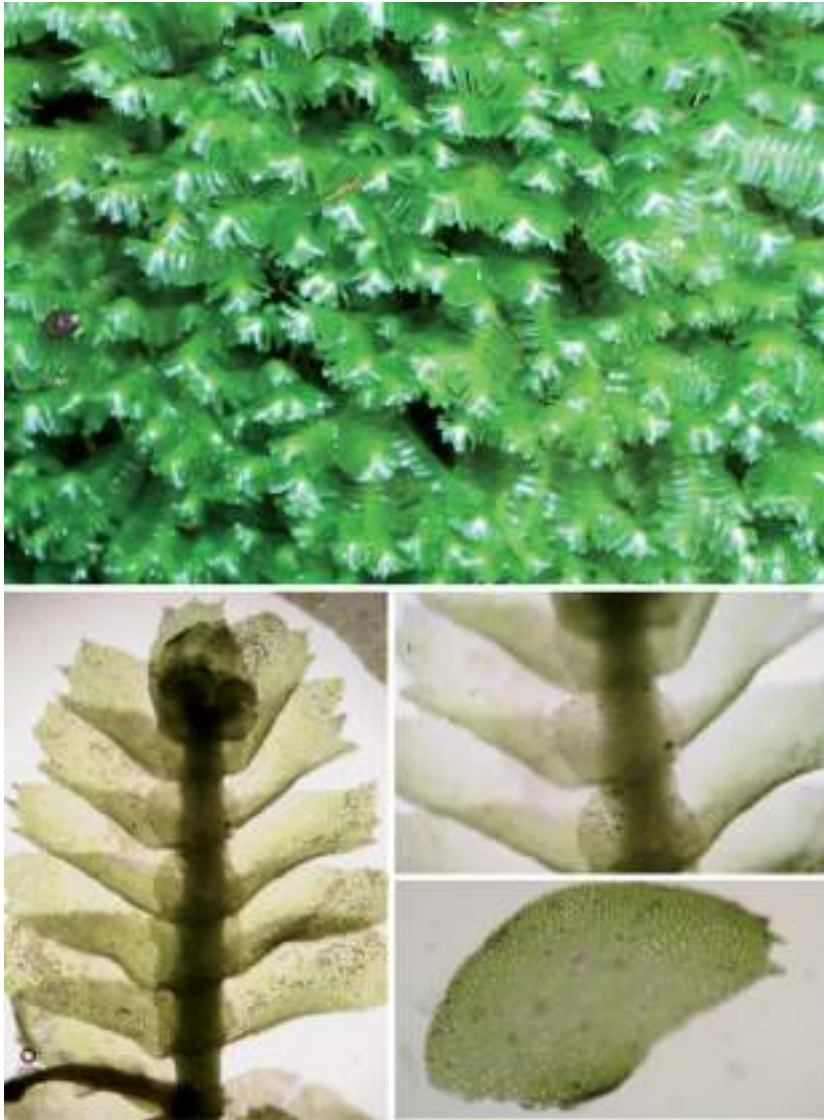
Fig. 49. *Andrewsianthus bilobus* (Mitt.) Grolle

Synonym: *Lophozia ruwenzorensis* S.W.Arnell. Plants epiphytic, c. 2 cm long and 0.11-0.18 cm wide, brownish. Leaves succubous, usually bilobed up to 1/3 of their length, margins edentate. Cells usually with distinct trigones, 20-25 μ m in diameter. **Habitat:** Epiphyte in montane forest and ericaceous shrub, also on rocks and boulders, 2500-3300 m. **Distribution in Rwanda:** **Volcano NP:** Karisimbi. **Nyungwe NP:** Rwasenkoko. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Ethiopia, Uganda, Tanzania.



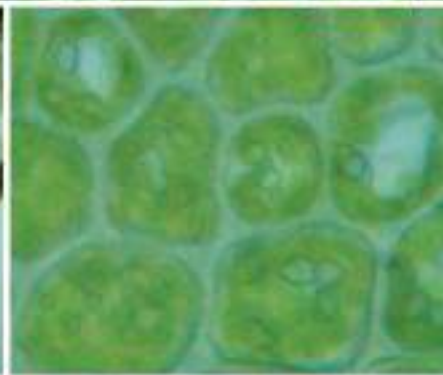
Fig. 50. *Apomarsupella africana* (Steph. ex Bonner) R.M.Schust.

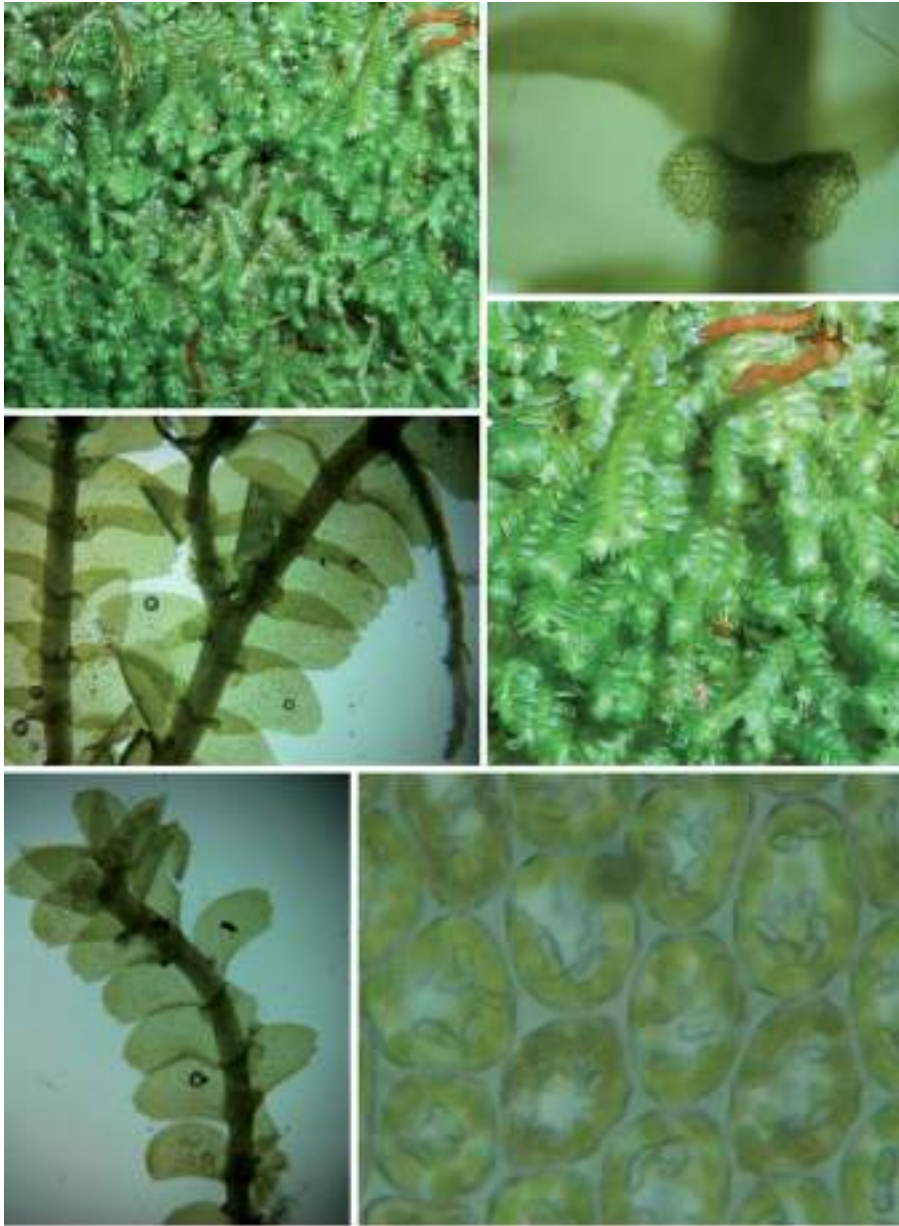
Synonym: *Marsupella africana* Steph. ex Bonner. Plants in dense tufts or patches, brownish or blackish, shoots 10-30 x 1.2-2 mm. Stems prostrate to ascending. Leaves imbricate, spreading, decurrent on both sides, bilobed, leaf lobes obtuse. Cells thick-walled, trigones large, (10-)20 x 15 μ m. **Habitat:** Rocks and boulders in the alpine belt, 4200-4450 m. **Distribution in Rwanda:** Volcano NP: Karisimbi. **Distribution in Africa:** DR Congo, Uganda, Kenya, Tanzania.



Figs 51 and 52 (next page). *Bazzania decrescens* (Lehm. & Lindenb.) Trev. ssp. *decrescens*

Plants bright green to olive-green, medium-sized to wide plants, shoot width (1.6-)2-3.6(-4) mm. Leaves not caducous, 0.6-1.3 mm long, 1.8-2.5 x as long as wide, apex truncate and divided into 3 wide teeth. Underleaves shallowly 2- or 4-lobed. **Habitat:** Epiphytic or on dead wood in montane rainforests, 1900-2300 m. **Distribution in Rwanda:** **Volcano NP:** Karisimbi. **Nyungwe NP:** Karamba, Kamiranzovu, Uwinka, Gisakura. **Distribution in Africa:** Bioko, Congo-Brazzaville, Gabon, DR Congo, Uganda, Kenya, Tanzania, Zambia, Zimbabwe, Malawi, Mozambique, South Africa. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.





Figs 53 and 54 (next page). *Bazzania descrescens* ssp. *pumila* (Mitt.) Pócs
 Synonym: *Bazzania pumila* Mitt. Similar to *Bazzania descrescens* ssp. *descrescens*. Leaves caducous, small to medium-sized plants, shoot width never exceeding 2 mm, underleaves usually 2-lobed. **Habitat:** Epiphytic or on dead wood, 1900-2500 m. **Distribution in Rwanda: Nyungwe NP:** Rwasenkoko, Karamba, Uwinka. **Distribution in Africa:** Bioko, DR Congo, Tanzania. Also Comoros, Madagascar.



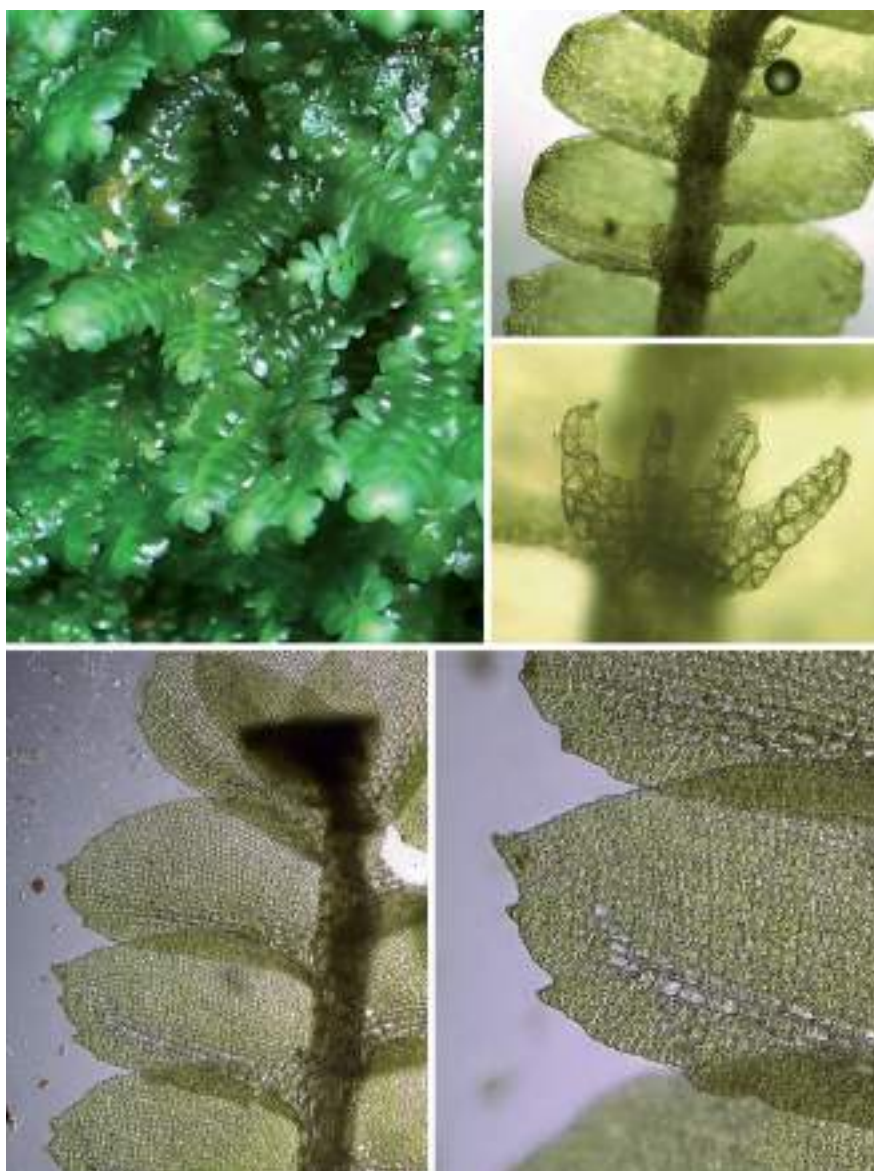


Fig. 55. *Bazzania nitida* (Web.) Grolle

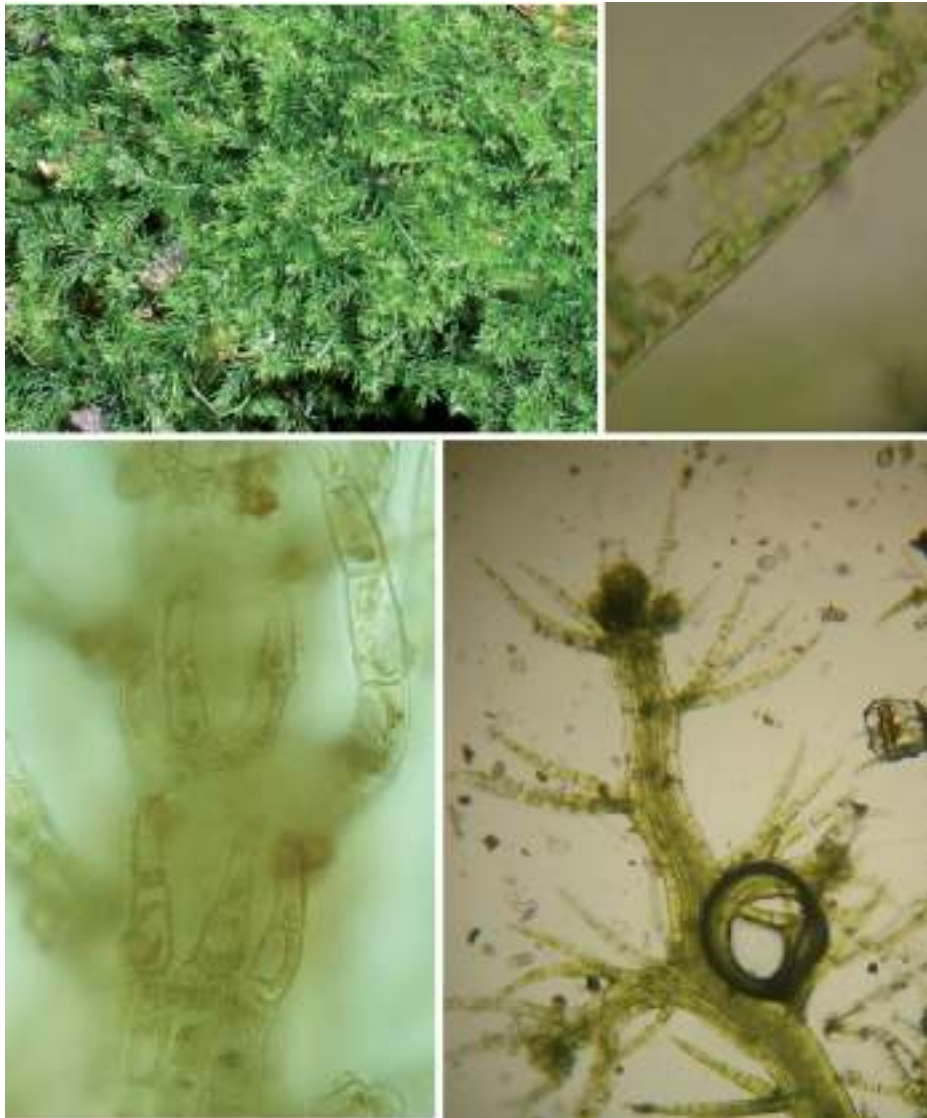
Plants green, glossy, shoots up to 1.8 mm wide. Leaves 0.9-1.3 x 0.5-0.7 mm, apex truncate, with 3 short decurved apiculi, with a vitta of 2-4 rows of wide rectangular cells extending nearly to leaf-apex. Underleaves not much wider than stem, 2-4-lobed to half of their length. Cell walls colourless. **Habitat:** Epiphytic or on dead wood, 1900-2100 m. **Distribution in Rwanda: Nyungwe NP:** Karamba, Kamiranzovu, Uwinka, Gisakura. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Burundi, Tanzania, Malawi, South Africa. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.



Fig. 56. *Bazzania roccatii* Gola

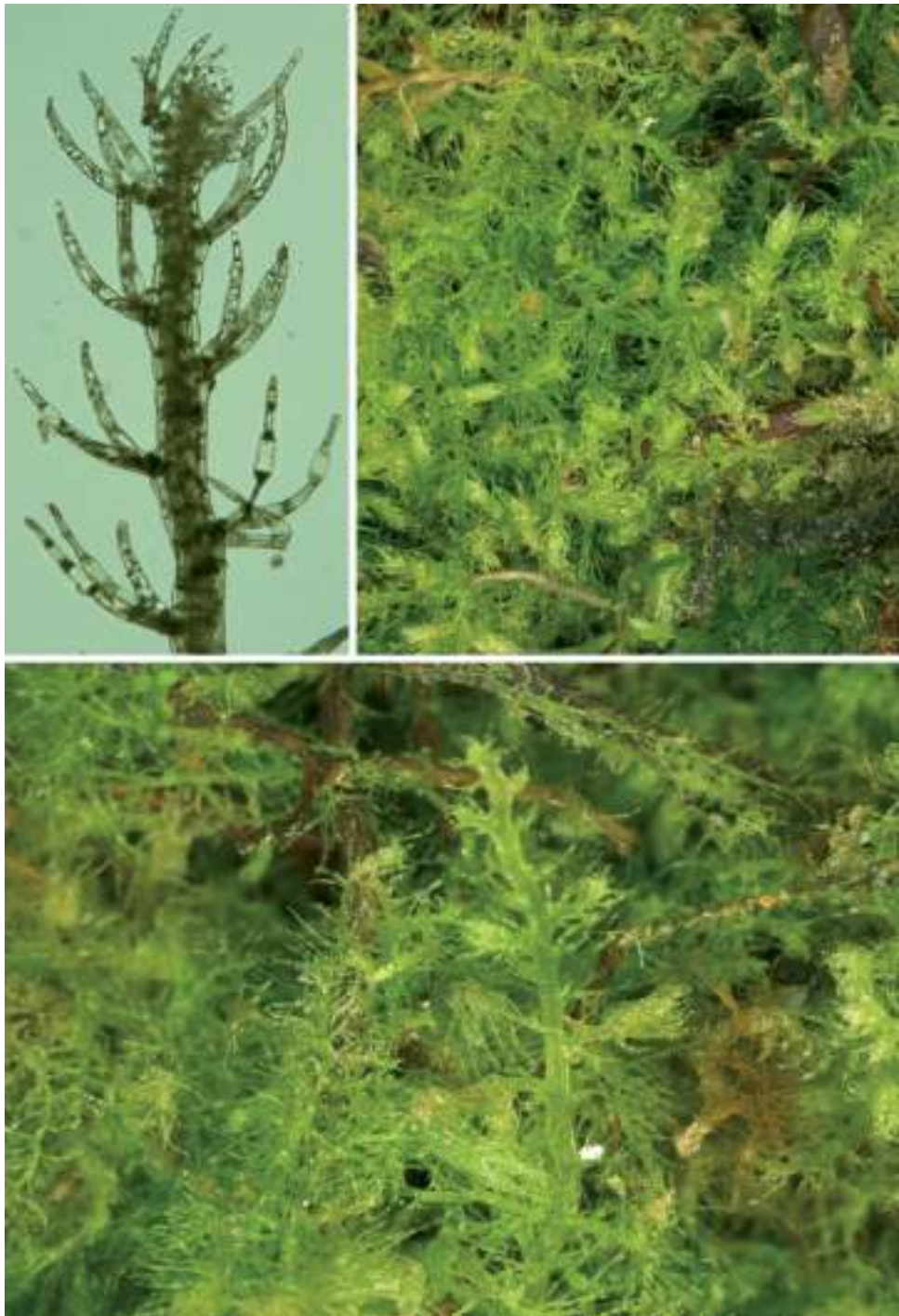
Synonym: *Mastigobryum laxifolium* Steph. Plants brown, glossy, with soft slender shoots up to 2 mm wide. Leaves ovate to ovate-oblong, apex narrow, with (2-)3(-4) teeth.

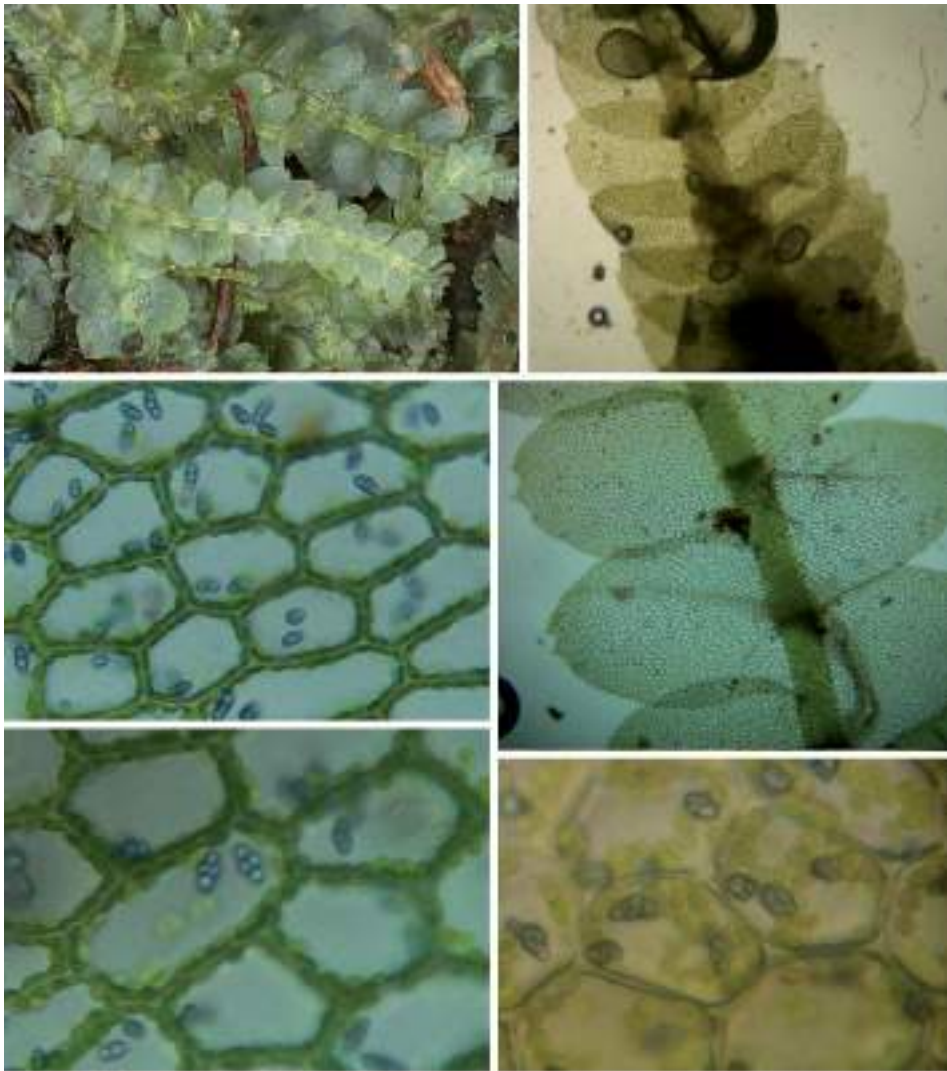
Underleaves orbicular, usually 1.5-2.5 x as wide as the stem, cell walls with brown pigment. **Habitat:** Epiphyte on *Erica* and *Hagenia*, 2800-3300 m **Distribution in Rwanda:** **Nyungwe NP:** Mt. Bigugu. **Volcano NP:** Karisimbi, Karisoke, Sabyinyo. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Uganda, Kenya, Tanzania, Malawi.



Figs 57 and 58 (next page). *Blepharostoma trichophyllum* (L.) Dumort.

Plants pale- to yellowish green, prostrate to ascending. Stems sparingly branched, 3-16 mm long. Leaves distant to approximate, divided to 0.9-0.95 of their length into (2-)3-4 uniseriate lobes 160-620 μm long, each of 7-13 cells. Cells rectangular, equally thick-walled, 27-53 μm long, oil bodies usually 4-8 per cell. Underleaves similar to lateral leaves, only slightly smaller, 3-4-lobed. Asexual reproduction by gemmae at apices of upper leaf lobes. **Habitat:** On ground and rotten wood from 2000 to 2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkoko, Karamba, Uwinka. **Distribution in Africa:** Uganda, Kenya, Tanzania. Widespread species found throughout the Northern Hemisphere.





Figs 59 and 60 (next page). *Calypogeia afrocaerulea* E.W.Jones

Plants usually terrestrial, up to 2.5-3 mm wide, bluish when fresh. Leaves imbricate, alternate, ovate to broadly oblong-ovate, 1-1.5 x 1-1.3 mm, apex rounded, shortly bifid, the sinus 40-90 μ m deep. Oil bodies compound (*Calypogeia*-type), blue, 2-8 per cell. Underleaves 1.5-2 x as wide as the stem, 0.35-0.45 mm wide, rounded, distinctly bilobed, sinus acute or obtuse, margin with few teeth. Autoicous. **Habitat:** Soil, along paths and roadcuts in montane forest, 2000-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Pindura, Gisakura. **Distribution in Africa:** São Tomé, Bioko, Cameroon, DR Congo, Burundi, Kenya, Tanzania. Also Réunion, Seychelles. **Note:** An easily distinguishable species in fresh state by the bright blue coloured oil bodies.



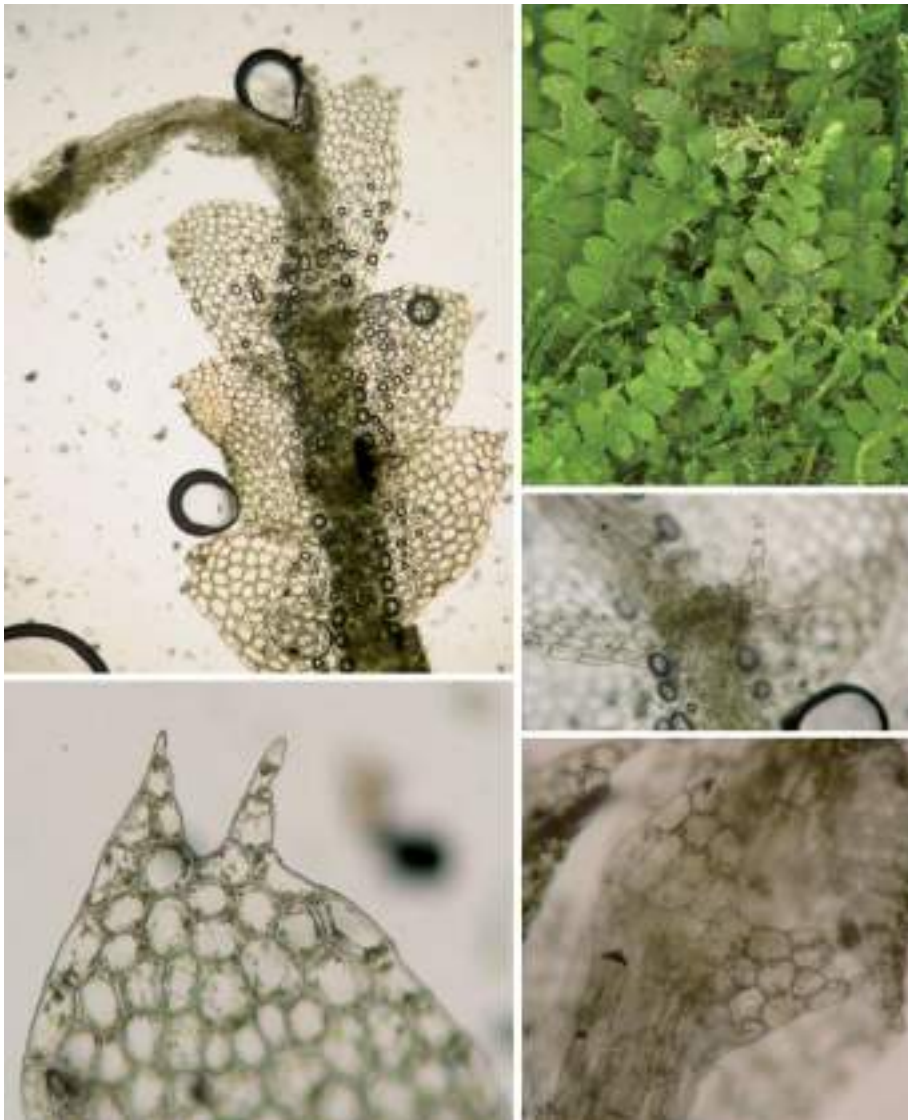


Fig. 61. *Calypogeia arguta* Nees & Mont.

Plants usually terrestrial, shoots up to 20 mm long, up to 1-2.5 mm wide, gemmiferous shoots ascending. Leaves distant, alternate, obliquely ovate, 0.7-1.2 x 0.4-1 mm, apex bilobed with divergent lobes, the sinus wide, up to 0.2 mm deep, lobes ending in 1-2 uniseriate cells. Underleaves not much wider than the stem, distinctly bilobed to within 1-2 cells of rhizoid area, sinus acute or obtuse, margin with subulate teeth. Dioicous.

Habitat: Soil, along paths and roadcuts in montane forest, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Uwinka. **Distribution in Africa:** DR Congo, Burundi, Tanzania, Malawi, Swaziland, South Africa. Also in Europe, Azores, Madeira, Canary Islands, Asia, Madagascar, Mauritius, Réunion.



Fig. 62. *Calypogeia bidentula* (Web.) Nees

Plants usually terrestrial, up 3 mm long. Leaves imbricate, alternate, ovate to broadly oblong-ovate, 1 x 0.9-1.2 mm, triangular, apex rounded, rather narrow, shortly bifid to emarginate, teeth obtuse. Oil bodies colourless. Underleaves 2-3 x as wide as the stem, 0.3-0.7 mm wide, rounded, arcuate, always decurrent, insertion strongly distinctly bilobed to 0.5 of their length, lobes triangular, sinus acute or obtuse, V-shaped, outer margin with a broad marginal tooth. **Habitat:** On soil or occasionally epiphyllous in montane forest, 2500 m. **Distribution in Rwanda: Nyungwe NP:** Uwinka. **Distribution in Africa:** Zimbabwe, Lesotho, South Africa. Also Madagascar, Mauritius, Réunion.

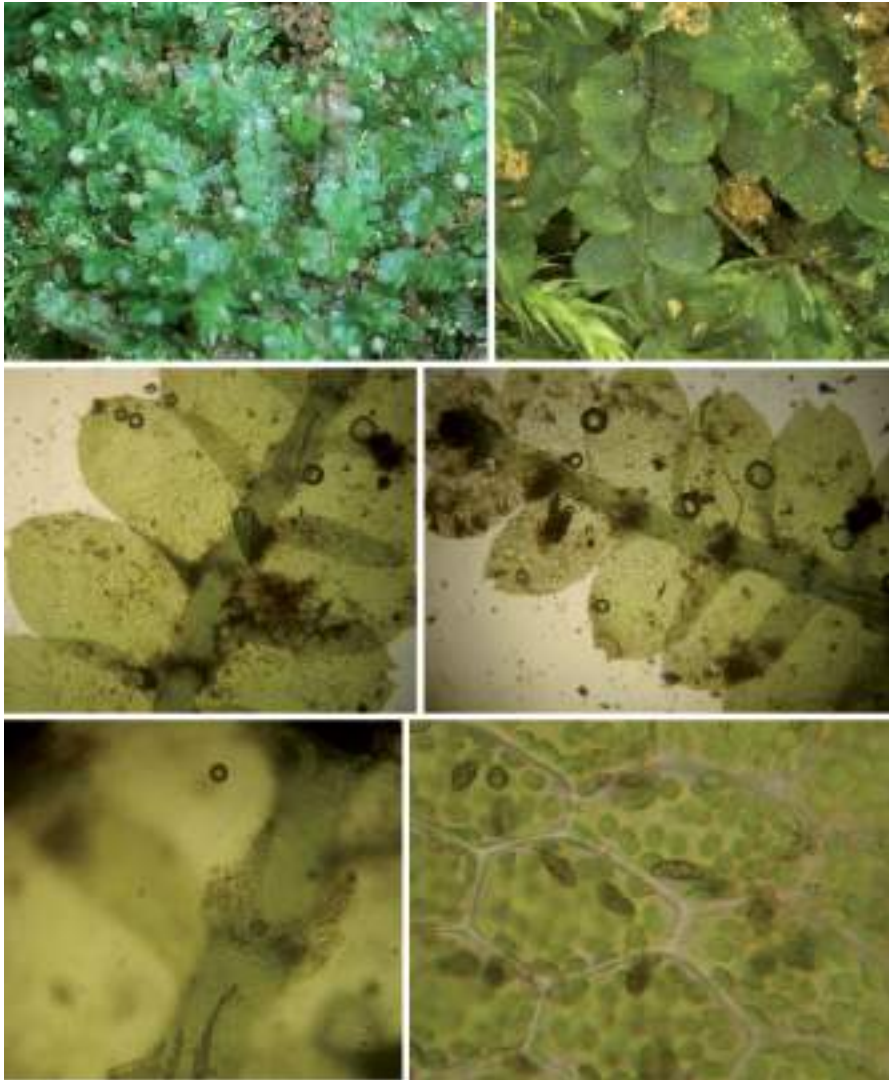


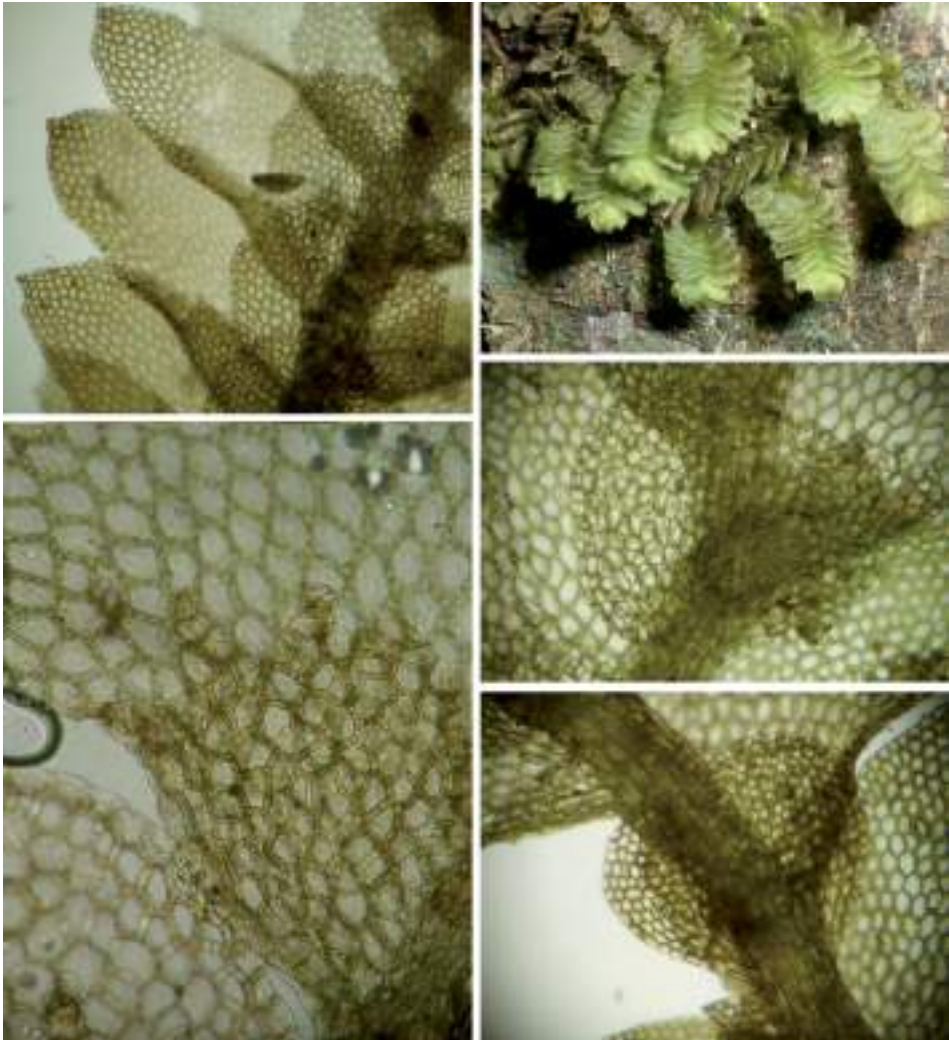
Fig. 63. *Calypogeia fissa* (L.) Raddi

Plants usually terrestrial, up to 1-4 mm wide. Leaves imbricate, alternate, ovate to broadly oblong-ovate, 1-1.8 x 0.9-1.4 mm, triangular, apex rounded, rather narrow, shortly bifid, the sinus sharp and narrow. Oil bodies colourless. Underleaves 1.5-2 x as wide as the stem, 0.3-0.7 mm wide, rounded, distinctly bilobed to 0.5 or more of their length, sinus wide, V-shaped, outer margin with one tooth. **Habitat:** On ground or on roadcuts, rarely as epiphyte, 2200-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Uwinka. **Distribution in Africa:** Sierra Leone, Annobon, São Tomé, Bioko, Cameroon, DR Congo, Angola, Zimbabwe, Swaziland, South Africa. Also widespread in the Northern Hemisphere, Comoros, Réunion. **Note:** In fresh state easily to distinguish from *Calypogeia afrocaerulea* by the colourless oil bodies.



Figs 64 and 65 (next page). *Caudalejeunea lewallei* Vanden Berghen

Plants epiphyllous. Stems 1-3 cm long, sterile branches appressed to substrate, propaguliferous branches and branches with gametangia erect. Lobes ovate, with obtuse or rounded apex, (0.5-)0.6-0.8(-0.9) mm x (0.9-)1-1.3(-1.5) mm, margin entire or near apex irregularly dentate. Lobules fusiform, (0.10-)0.13-0.18(-0.25) x (0.27-)0.3-0.4(-0.48) mm, inflated, with acute apical tooth, often 2 cells wide at base and ending with a row of 2 cells, free margin of lobule often involute, with a 1-2 celled tooth and often a second obtuse tooth. Underleaves of appressed branches distant to imbricate, 3-6 x as wide as the stem, in erect branches densely imbricate, 5-8 x as wide as the stem, suborbicular or emarginate. Asexual reproduction with disciform propagules. Dioicous. Perianths obovate-obcordate, 1-1.2 x 1.35-1.5 mm, compressed and trigonal, with acute ventral keel to base, lateral keels in upper half with irregularly lacinate wing, beak cylindrical. **Habitat:** Montane forest, epiphyllous, 2000-2100 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura. **Distribution in Africa:** DR Congo, Burundi, Ethiopia, Tanzania, Malawi, Zimbabwe. Also Madagascar.





Figs 66 and 67 (next page). *Caudalejeunea yangambiensis* (Vanden Berghen)
E.W.Jones

Plants epiphytic, sterile shoots prostrate, freely branching, the branches prostrate (sterile), or ascending-erect (gemmiferous or fertile). Leaves of sterile shoots imbricate.

Lobes 0.9-1.3 x 0.7-0.9 mm, spreading, concave, elliptical, entire, rounded at apex.

Lobules fusiform, inflated, the free margin incurved, apical tooth with 1-3 cells, Leaves of ascending gemmiferous shoots very different in form, strongly imbricate, conduplicate.

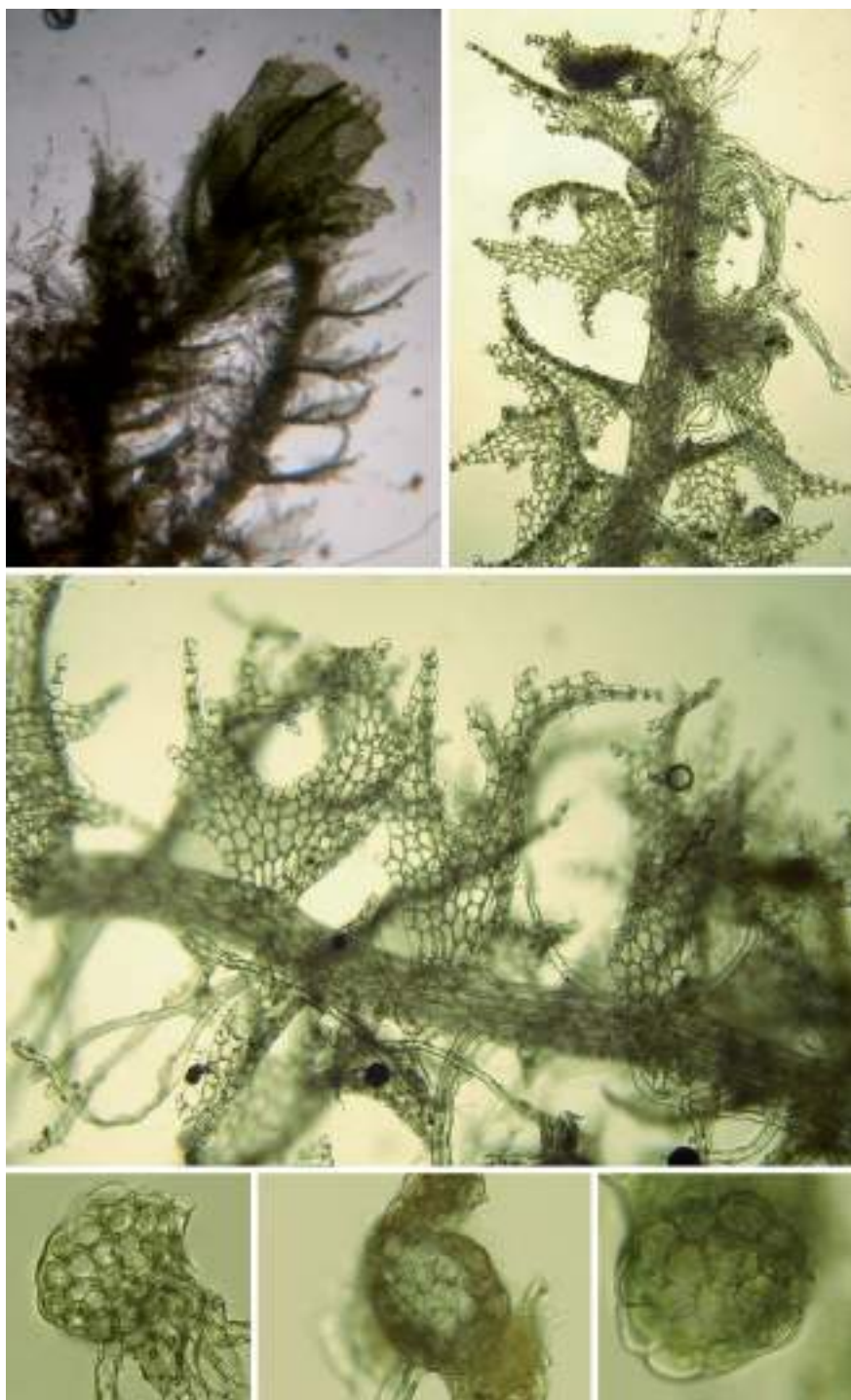
Lobules small, ± rectangular, not visible in situ. Underleaves imbricate, about 4-6 x as wide as the stem, 1.2 x 1.5 mm, suborbicular to elliptic, truncate or emarginate at apex, margins broadly reflexed. Asexual reproduction by propagules on upper leaves of erect stems. Probably dioicous. Perianths broadly ovate, obovate or pyriform, about 1 x 0.75-0.9 mm, with 3-4 sharp ventral keels and 2 lateral keels. **Habitat:** Epiphyte on exotic trees, 1700 m. **Distribution in Rwanda:** Central Rwanda: Butare. **Distribution in Africa:** Ghana, Cameroon, Congo-Brazzaville, DR Congo, Uganda.

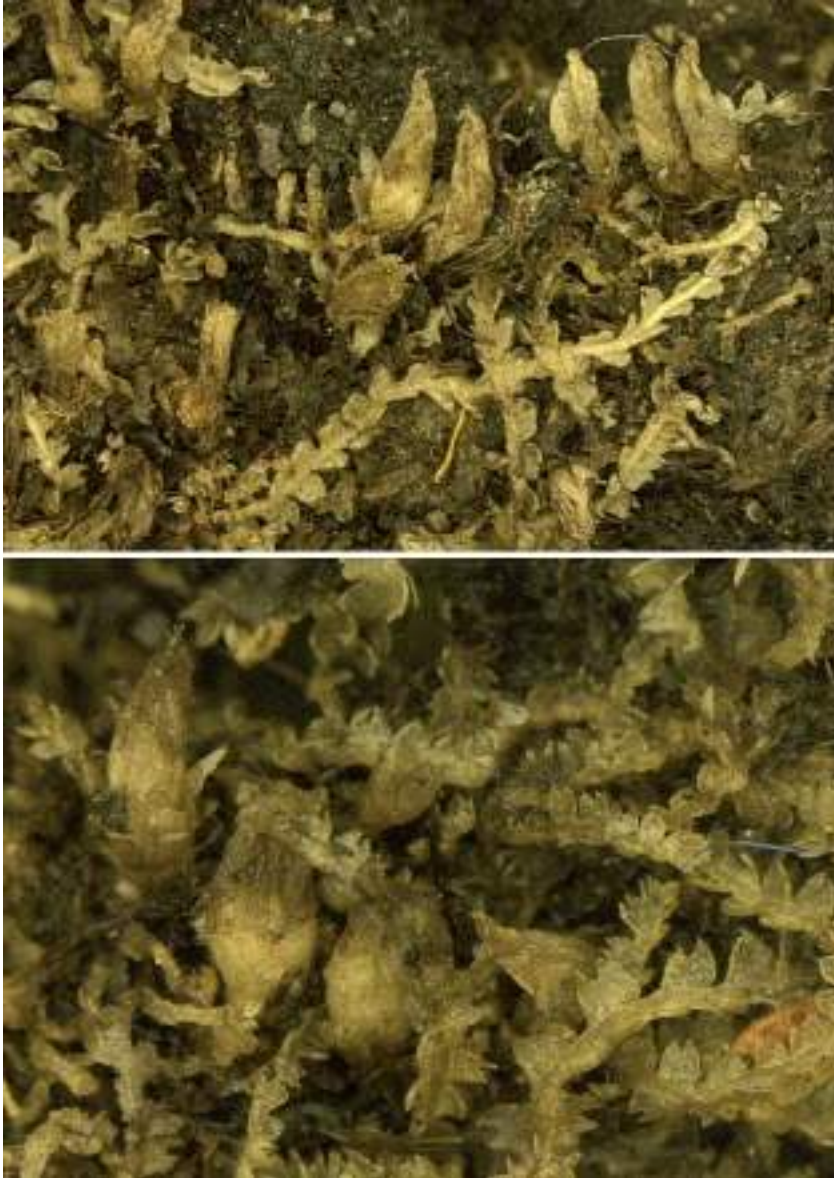




Figs 68 and 69 (next page). *Cephalojonesia incuba* Grolle & Vanden Berghen ssp. *incuba*

Plants epiphytic and on rotten wood, pale green. Stems irregularly branched, 70-90(-120) μm in diameter, 5-6 cells thick in section, cells thin-walled. Leaves cuneate with narrow base, bilobed to 1/3-3/5, sometimes 3-lobed, margin crenulate to irregularly dentate, 300-350 \times 350-480 μm , incubous. Cells thin-walled, without trigones, 15-22 \times 18-23 μm . Underleaves distant, setaceous, 2-3 cells wide, 24-45 \times 75-160 μm . Autoicous. Perianths subcylindrical, with mouth wide, truncate. **Habitat:** On rotten wood in montane forest, 1900 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo Forest. **Distribution in Africa:** Nigeria (Jos), DR Congo (Katanga), Kenya (Nandi). **Note:** *Cephalojonesia incuba* ssp. *mexicana* Burghardt, Gradst. & Váňa is known from Mexico.





Figs 70 and 71 (next page). *Cephalozia africana* Váňa

Plants medium-sized, pale green to brownish. Shoots procumbent to ascending, 1-1.6(-2) mm long. Leaves distant to contiguous, obliquely inserted, almost horizontally spreading, orbicular to ovate-quadrangle, 0.5-0.6(-0.8) × 0.5-0.6 mm, bilobed to 0.3-0.4 of their length, slightly decurrent dorsally, lobes straight, not connivent, broad, triangular, terminated by 1-2 cells. Median leaf cells 40-45 µm in diameter. Autoicous. Perianth inflated, trigonous above, mouth ciliate-dentate. **Habitat:** On soil in swamps, 2300-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rugera. **Distribution in Africa:** DR Congo (Kahuzi-Biega).





Fig. 72. *Cephalozia bicuspidata* (L.) Dumort.

Synonym: *Cephalozia vulcanicola* Steph. Plants slender, pale to dark green or brownish.

Shoots procumbent to ascending, 2-2.5 mm long. Lower leaves distant, upper leaves approximate to subimbricate, broadly ovate to ovate-quadrangle, concave, transversally inserted, 0.2-0.6 × 0.16-0.44 mm, bilobed to 1/2-2/3, lobes acute to acuminate, ending in 1-3(-4) uniseriate cells, lobes inflexed. Small underleaves sometimes present on fertile stems. Autoicous. Perianth fusiform, trigonous above, mouth ciliate-dentate. **Habitat:** On soil and dead wood, 2500-3600 m. **Distribution in Rwanda: Volcano NP:** Karisimbi.

Nyungwe NP: Rwasenkoko. **Distribution in Africa:** DR Congo, Uganda, Kenya, Tanzania, Malawi, South Africa. Also in Europe, Turkey, Caucasus, Siberia, N Africa, Azores, Madeira, Tenerife, N America, Greenland, Mexico.



Fig. 73. *Cephalozia connivens* (Dicks.) Lindb. ssp. *fissa* (Steph.) Váňa
 Synonym: *Cephalozia crassicaulis* Steph. Plants slender, pale green. Shoots procumbent, 2-2.5 mm long. Leaves approximate, broadly ovate to ovate-quadrate, concave, transversally inserted, 0.4-0.5 × 0.3-0.4 mm, bilobed to 1/2-2/3, lobes acute to acuminate, ending in 2-3 uniseriate cells, 3-5 cells wide at base. Autoicous. Perianth fusiform, trigonous above, mouth ciliate-dentate. **Habitat:** On soil or rotting wood, 1900 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo. **Distribution in Africa:** Ghana, Togo, Nigeria, Cameroon, Bioko, São Tomé, Príncipe, Rio Muni, Gabon, DR Congo, Uganda, Tanzania, Zambia, Zimbabwe, Malawi, South Africa. Also Madagascar, Réunion.



Fig. 74. *Cephaloziella kiaerii* (Austin) S.W.Arnell

Plants minute, usually green to reddish, about 0.4 mm wide. Stems procumbent, 80-100 μ m in diameter. Leaves obliquely-subtransversally inserted and oriented, distant, 0.1-0.2 mm long, not reaching the mid-line of the stem, ovate, leaf margins entire, with projecting verrucae, bilobed to half of their length, lobes widely pointed, ending in 1-2 short cells, 7-9 cells wide at base. Cells in mid-leaf 8-10 x 8-15 μ m, walls thick, trigones absent, cuticle rough, oil bodies *Jungermannia*-type, small, 1-7 per cell. Underleaves lacking. Asexual reproduction by 2-celled gemmae on leaf lobe tips. Autoicous. Perianths 1-1.4 x 0.4 mm, deeply 4-5-plicate, the mouth with hyaline, thick-walled cells, 35-40 x 6-8 μ m. **Habitat:** Peaty soil, 2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkokoko. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Kenya, Tanzania, Malawi, Mozambique, Lesotho, South Africa. Also Madagascar, Réunion, Seychelles.

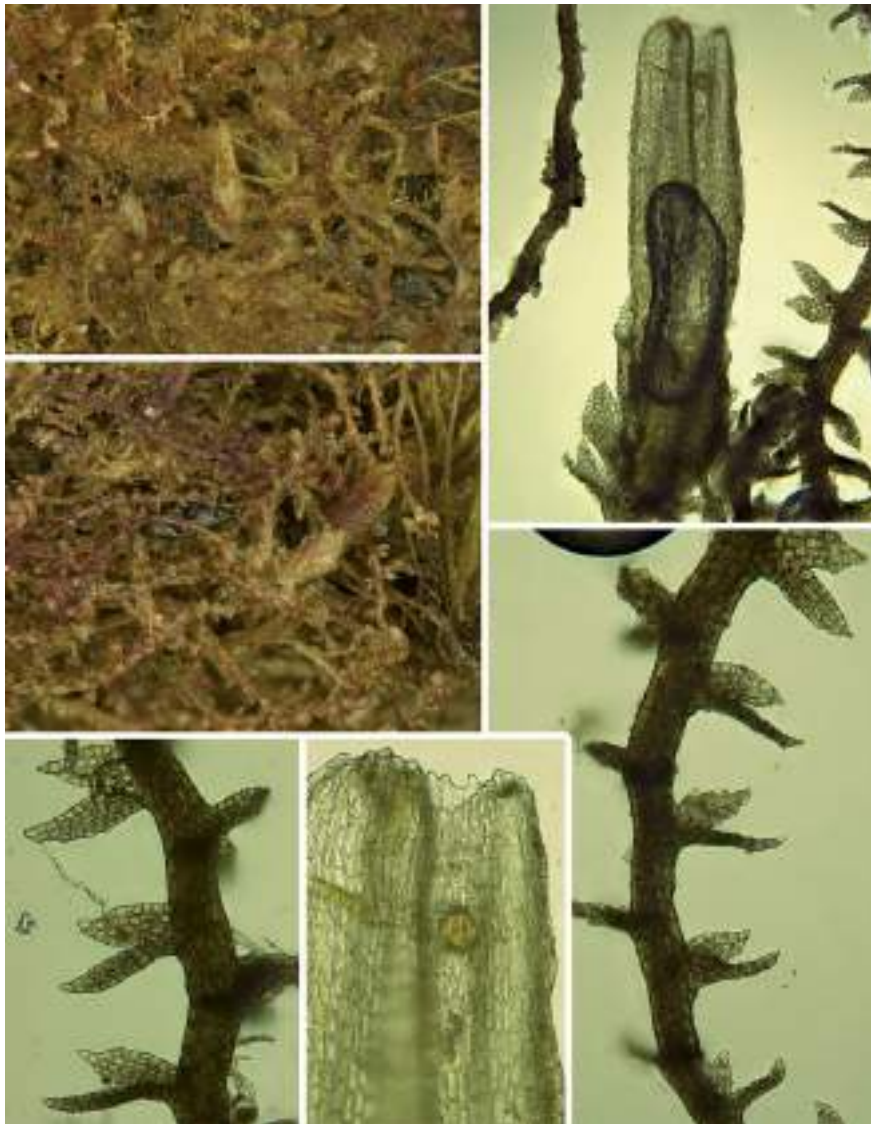
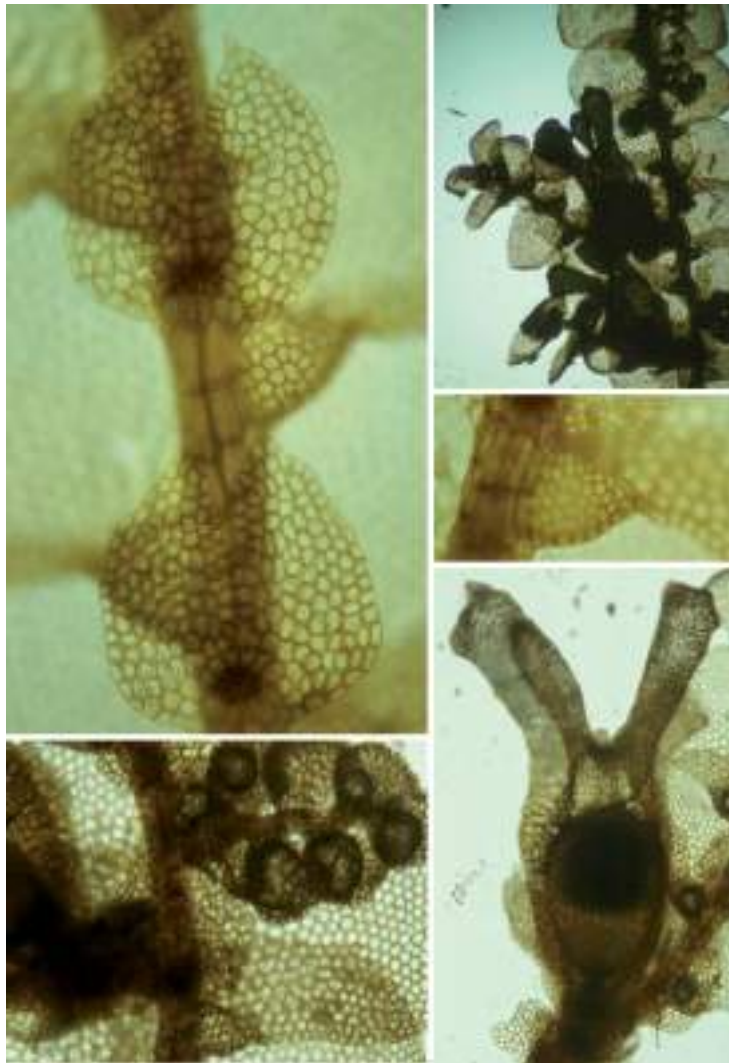


Fig. 75. *Cephaloziella vaginans* Steph.

Plants minute, about 0.4 mm wide. Stems procumbent. Leaves obliquely to subtransversally inserted and oriented, distant, 0.1-0.2 mm long, not reaching the mid-line of the stem, ovate, leaf margins entire, with projecting verrucae, bilobed to half of their length, the lobes widely pointed, ending in 1-2 short cells, 7-9 cells wide at base. Asexual reproduction by 2-celled gemmae on leaf lobe tips. Autoicous. Perianths 1-1.4 x 0.4 mm, deeply 4-5-plicate, the mouth with hyaline, thick-walled cells. **Habitat:** Mossy rocks in montane forest, 2000 m. **Distribution in Rwanda:** Nyungwe NP: Karamba. **Distribution in Africa:** Sierra Leone, Cameroon, DR Congo, Uganda, Tanzania, Malawi, Lesotho. Also Réunion.



Figs 76 and 77 (next page). *Ceratolejeunea diversicornua* (Steph.) Steph. Plants small to medium-sized. Leaves wide-spreading, 0.7-0.85 x 0.45-0.55 mm, ovate, the ventral margin straight, broadly rounded at apex, margins finely serrulate, with papilliform projecting cells, otherwise entire or with few teeth distally. Lobules inflated, 1/6 of lobe length, sometimes reduced, ovate to globose, with apical tooth 1-celled, the cell obtuse. Cells in mid-leaf 16-22 x 20-25 μ m, ocelli 1-5 near the base of the lobe, solitary or in 2 groups. Underleaves bilobed, small, distant, ovate or round, 2-3 x as wide as the stem. Autoicous. Female bracts with obtuse dentate lobes and acute dentate lobules. Perianths with 4 keels extended above into 4 obtuse, horn-like and inflated projections, 0.1-0.7 mm long. **Habitat:** Epiphytic or epiphyllous in montane forest, 1900 m. **Distribution in Rwanda:** Karamba. **Distribution in Africa:** Ghana, Cameroon, DR Congo.





Fig. 78. *Cheilolejeunea cordistipula* (Steph.) Grolle ex E.W.Jones

Plants pale green, appressed to slightly pendent, shoots 0.8-1.5 mm wide. Leaves imbricate, lobes ovate, strongly convex, 0.57-0.87 x 0.35-0.45 mm, apex narrow, rounded to acute, strongly decurved. Lobule large, triangular-ovate, inflated proximally, 0.28-0.46 mm long, 0.5-0.6 as long as the lobes, distal free margin flattened, apical tooth 1-2(-3) celled. Cells with very large trigones, 18-30 x 13-24 μ m. Underleaves 0.2-0.4 x 0.2-0.6 mm, usually wider than long, 3-5 x as wide as stem, rounded to obcordate, apex 2-lobed to 1/4 of their length. Autoicous. Perianth exserted, 0.8-1.3 x 0.3-0.8 mm, keels 5-10, rostrum 41-105 μ m long. **Habitat:** Epiphyte in montane forest, 2500-3000 m. **Distribution in Rwanda:** Volcano NP: Karisimbi, between Karisimbi and Bisoke. **Nyungwe NP:** Rwasekoko. **Distribution in Africa:** DR Congo, Ethiopia, Uganda, Kenya, Tanzania, Malawi.

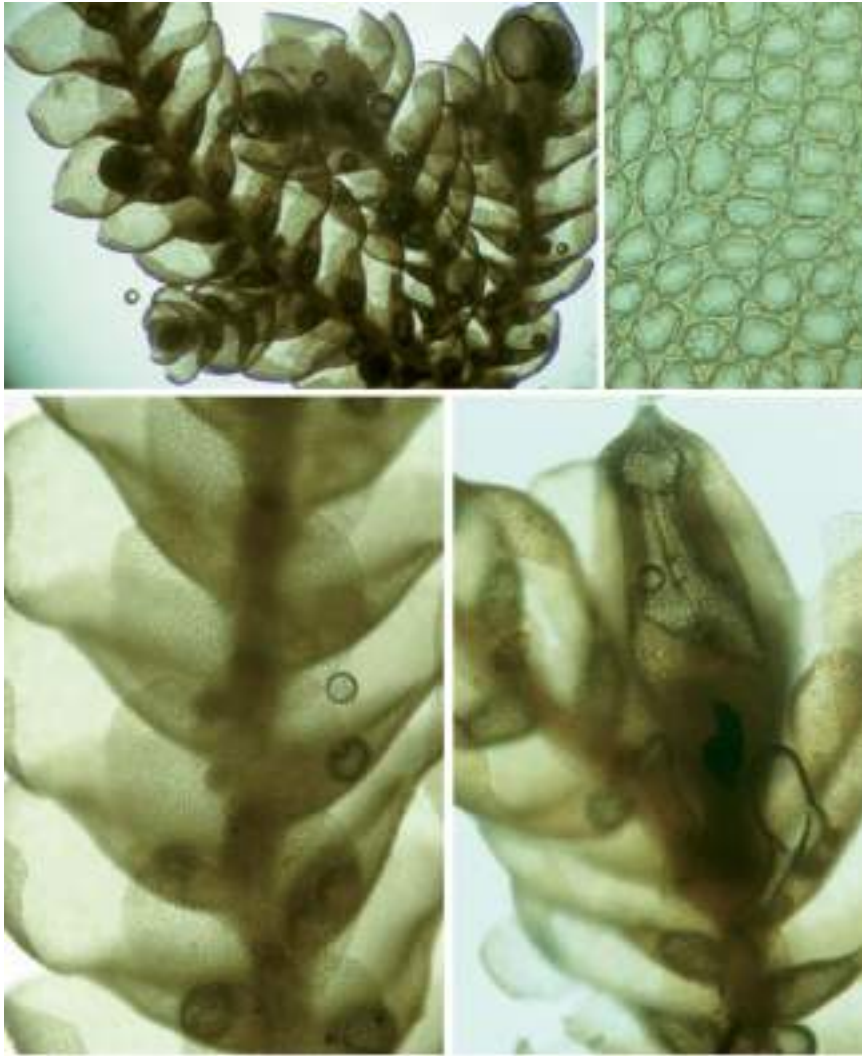


Fig. 79. *Cheilolejeunea krakammae* (Lindenb.) R.M.Schust.

Synonym: *Strepsilejeunea brevifissa* (Lindenb.) Steph. Plants yellowish green, shoots 0.6-1.25 mm wide. Leaves imbricate, lobes ovate, weakly to strongly convex, falcate, 0.42-0.7 mm long, apex subacute to sharply acute, recurved. Lobule ovate, inflated, 0.14-0.25 mm long, 1/5-2/5(-1/2) as long as the lobes, lateral free margin strongly incurved, keel arched, apical tooth 1(2-4) celled. Cells with small trigones, 17-28 x 11-19 μ m. Underleaves 0.17-0.36 x 0.17-0.43 mm, usually slightly wider than long, 2-4 x as wide as stem. Autoicous.

Perianth exserted, 0.47-0.86 x 0.3-0.58 mm, keels 3(4-5), rostrum 30-94 μ m long.

Habitat: Epiphyte in montane forest, 2000-3000 m. **Distribution in Rwanda:** Volcano NP: Karisimbi. **Nyungwe NP:** Kamiranzovu, Rwasenkoko, Uwinka. **Distribution in Africa:** DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe, South Africa. Also Comoros, Madagascar, Mauritius, Réunion.

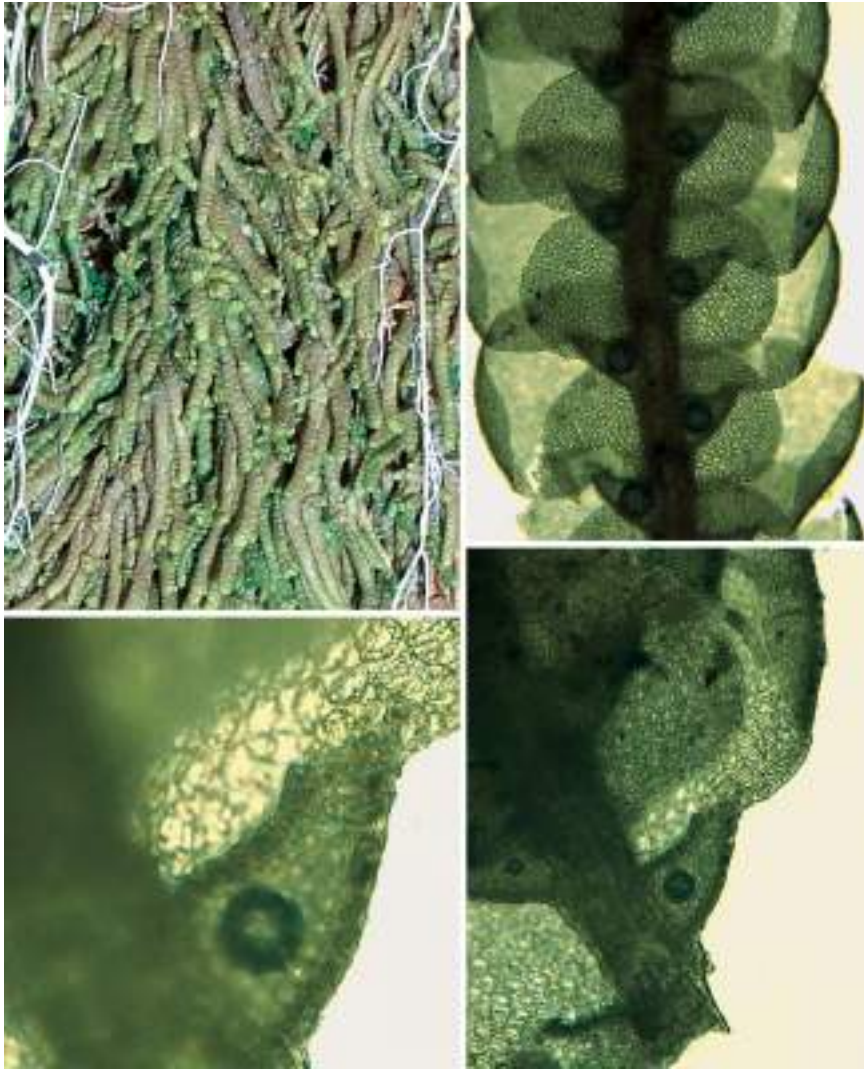


Fig. 80. *Cheilolejeunea montagnei* (Gottsche) R.M.Schust.

Plants pale green to glossy greenish-brown, 2-3(-7) cm long and 0.8-1.2 mm wide. Leaves imbricate, lobes broadly ovate, strongly convex with the rounded apices recurved, about 0.6-0.8 x 0.45-0.6 mm, dorsal base widely crossing stem. Lobules small, triangular, strongly inflated, 0.18-0.34 mm long, about 1/3-2/5(-1/2) of lobe length, the free margin incurved, with apical tooth 1(-4)-celled. Cells 20-26 x 16-22 μ m, trigones large, often irregularly nodulose. Underleaves reniform, wider than long, about 0.38-0.6 x 0.4-0.7 mm, 3.5-5.4 x as wide as the stem, the base broadly cuneate, the apex entire, rounded to very shallowly retuse. Dioicous. Perianths not observed in material from Rwanda. **Habitat:** Epiphyte in montane forest and ericaceous shrub, 2000-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Kamiranzovu, Karamba. **Distribution in Africa:** São Tomé, Bioko, DR Congo, Kenya, Tanzania. Also Comoros, Madagascar, Mauritius, Réunion.

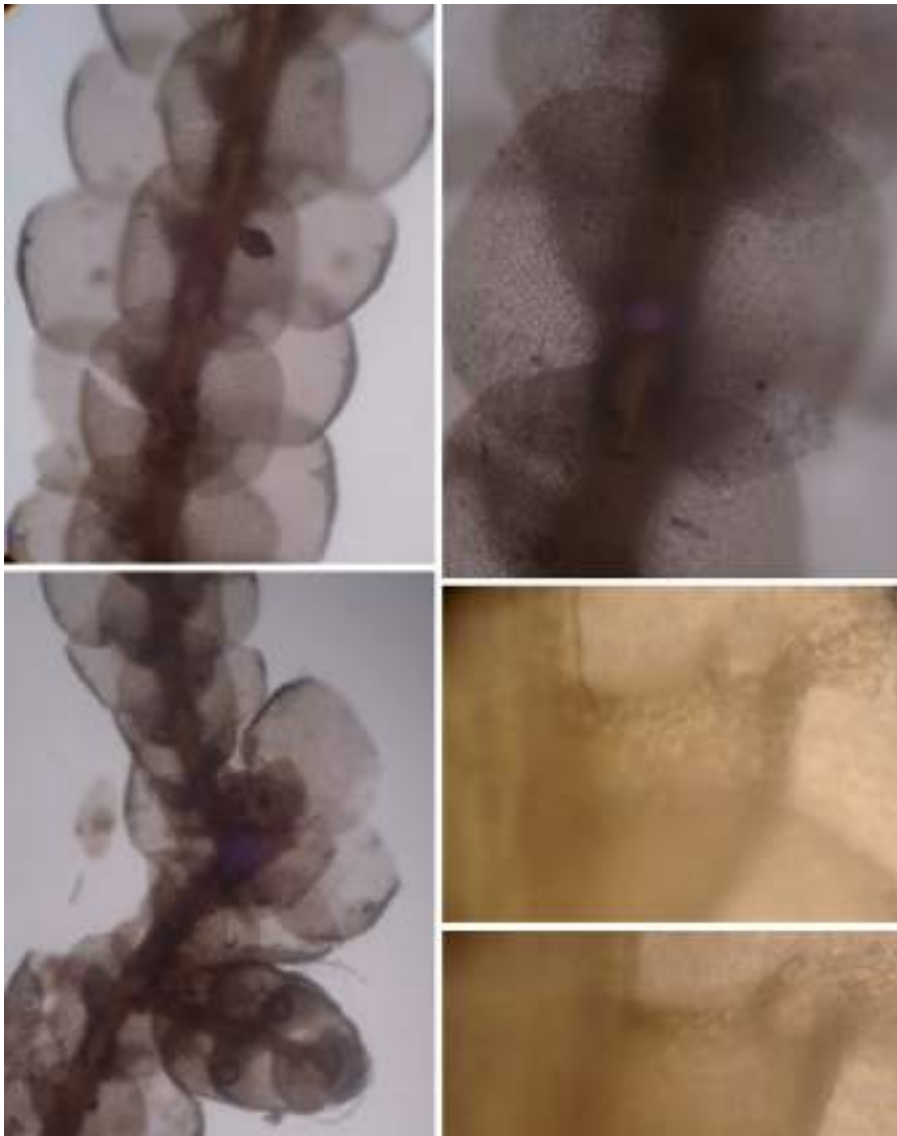


Fig. 81. *Cheilolejeunea omphalogastris* Pócs

Plants pale green, pendent on twigs, shoots 0.9 mm wide. Leaves approximate, lobes ovate, strongly convex, 0.6-0.65 x 0.4-0.5 mm, apex subacute. Lobule small, triangular, entirely inflated, 0.17-0.2 mm long, 0.3 as long as the lobes, apical tooth 1-3 celled. Cells with very large trigones, occasionally nodulose, 8-26 x 8-19 μ m. Underleaves large, 0.48-0.53 x 0.47-0.6 mm, wider than long, 5-6 x as wide as stem, orbicular, apex 2-lobed to 1/5- 1/4 of their length, sinus V-shaped, base cordate, with overlapping auricles. Dioicous.

Perianth unknown. **Habitat:** Pendent on small branches in the canopy of montane rainforest, 2000 m. **Distribution in Rwanda:** **Nyungwe NP:** Gisakura.



Fig. 82. *Cheilolejeunea pocsii* E.W.Jones

Plants yellowish green, shoots 0.7-1 mm wide. Leaves usually caducous, lobes ovate, strongly convex, 0.41-0.64 mm long, apex obtuse to subacute, strongly decurved. Lobule ovate, inflated proximally, contracted distally, 0.16-0.3 mm long, $(1/3-2/5-1/2)$ as long as the lobes, apical tooth 1-celled. Cells with very large trigones, nodulose, 20-24 x 14-17 μm . Underleaves 0.17-0.34 x 0.17-0.39 mm, usually wider than long, 1.8-4 x as wide as stem, sinus V-shaped. Dioicous or autoicous. Perianth exserted, pyriform, 0.7-0.85 x 0.45-0.49 mm, keels 3, rostrum 41-58 μm long. **Habitat:** Epiphyte in montane forest, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Gisakura. **Distribution in Africa:** Uganda, Kenya, Tanzania, Malawi, South Africa. Also Madagascar.

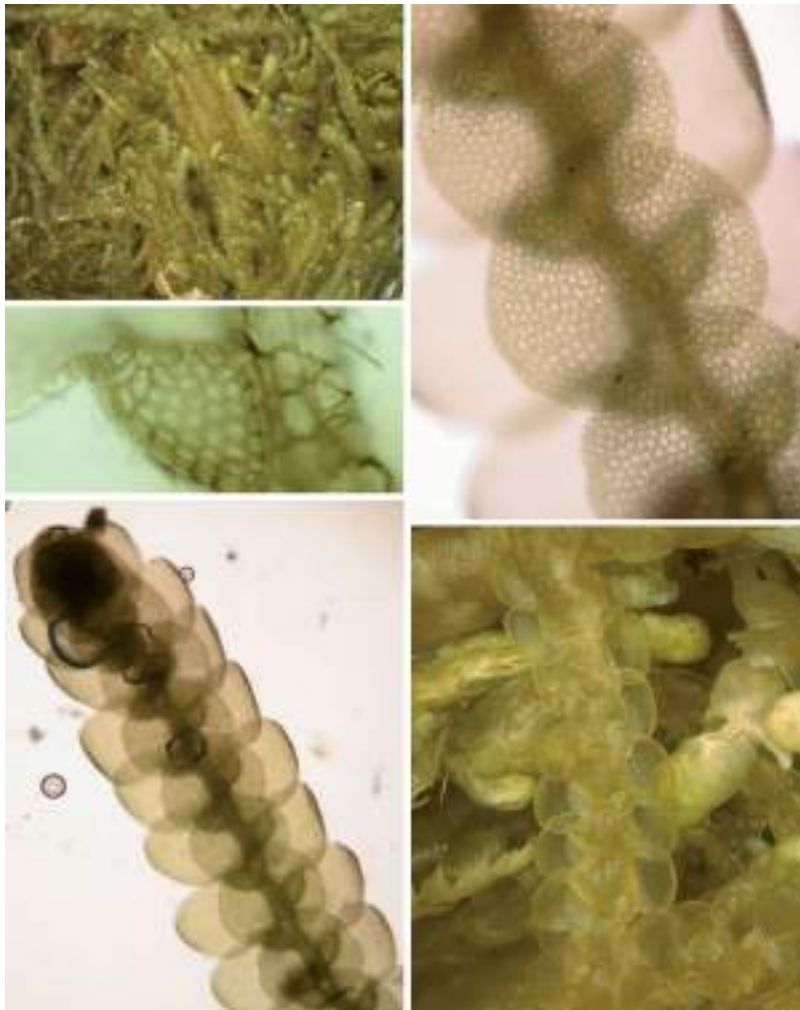


Fig. 83. *Cheilolejeunea trifaria* (Reinw. *et al.*) Mizutani

Plants epiphytic, green, up to 0.7-0.9(-1.0) mm wide. Leaves alternate, imbricate, moderately convex and deflexed or nearly flat. Lobes 0.45-0.7 x 0.45-0.55 mm, the dorsal base broadly rounded, often crossing the stem, rounded at apex. margins entire. Lobules inflated, triangular-quadrate, narrowed to the mouth, about 0.2-0.25 of lobe length, the keel strongly arched and forming an angle of about 90° with the arched ventral margin, with apical tooth straight, 1-celled, the cell short and obtuse. Cells in mid-lobe 15-22 x 20-30 μm. Underleaves ovate, wider than long, nearly as wide as the lobes, 0.4-0.65 x 0.35-0.5 mm, bilobed to 0.25-0.35 of their length, the sinus narrow, the base cordate, the insertion strongly arched. Autoicous. Perianths exserted from the bracts, with 5 smooth keels. **Habitat:** Epiphyte in montane forest, 2000m. **Distribution in Rwanda:** Nyungwe NP: Gisakura. **Distribution in Africa:** Sierra Leone, Ghana, Togo, São Tomé, Bioko, Cameroon, Central African Republic, Gabon, DR Congo, Uganda, Malawi, Zimbabwe. Also Madagascar, Mauritius, Réunion, Rodriguez, Seychelles.

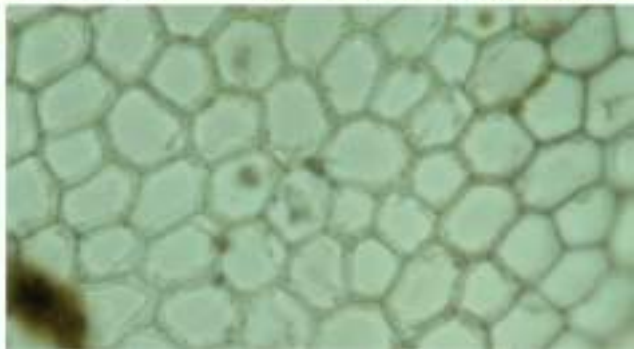
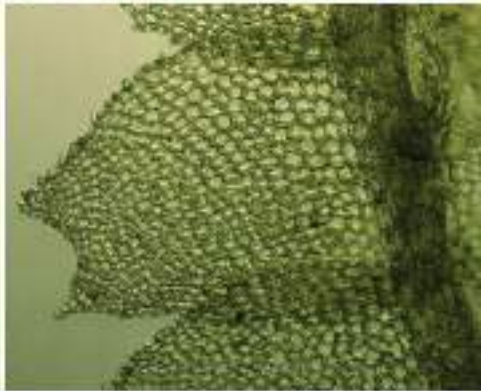


Figs 84 and 85 (next page). *Cheilolejeunea xanthocarpa* (Lehm. & Lindenb.) Malombe
 Synonym: *Leucolejeunea xanthocarpa* (Lehm. & Lindenb.) A.Evans. Plants pale glaucous
 to light green, shoots 0.9-1.8 mm wide. Leaves imbricate, lobes ovate, convex, 0.6-1
 x0.46-0.85 mm, apex rounded, together with ventral margin strongly involute. Lobule
 oblong to rectangular or ovoid, inflated, 0.3-0.5 mm long, 2/5-1/2 as long as the lobes,
 lateral free margin involute, apical tooth 1-celled. Cells with very large trigones, 18-24
 x 18-24 μm , oil bodies 1 per cell. Underleaves reniform, wider than long, 4-6 x as wide
 as stem, apex entire, base cordate. Autoicous. Perianth obovate, emergent, 0.8-1.3 x
 0.3-0.8 mm, keels 5, rostrum 104-198 μm long. **Habitat:** Epiphyte in montane rainforest,
 2000-2500 m. **Distribution in Rwanda:** Gishwati Forest: Gikungu. **Nyungwe NP:**
 Rwasekoko, Karamba, Uwinka; Gisakura. **Distribution in Africa:** Bioko, DR Congo,
 Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe, Mozambique, South Africa. Also Cape
 Verde, St. Helena, Comoros, Madagascar, Réunion. Almost pantropical.



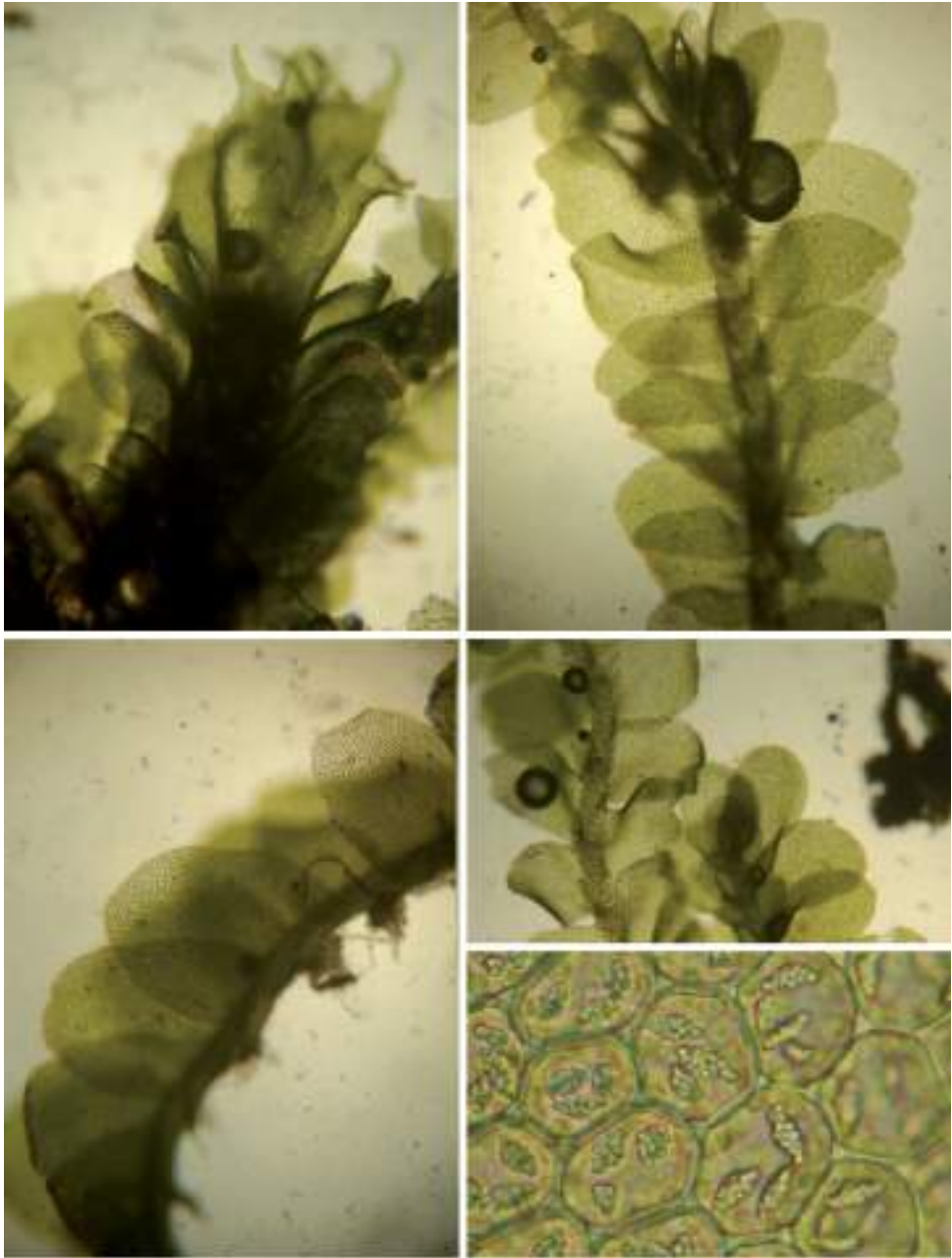


Figs 86 and 87 (next page). *Chiloscyphus coadunatus* (Sw.) J.J.Engel & R.M.Schust. Synonyms: *Chiloscyphus cuspidatus* (Nees) Engel & R.M.Schust.; *Lophocolea bidentata* (L.) Dumort.; *L. cuspidata* (Nees) Limpr. Plants large, yellowish-green or green, shoots 2-4 mm wide. Leaves asymmetric, 1-2 mm long, alternate, dorsal margin decurrent, deeply bilobed at apex, the lobes longly acuminate, acumen up to 8 cells long. Cells thin-walled, 25-45 μ m wide, trigones minute or absent. Underleaves bilobed, not connate with leaf base, with tooth on either side. Autoicous. Perianths longly emergent, trigonous above, keels winged, wings often with apical tooth, mouth wide, trilobed, lobes laciniate. **Habitat:** From gallery forest to montane forest and alpine habitats, ground, on buttresses of large trees, as epiphyte on bamboo and giant groundsels as well as on rocks, peat and rotten wood from 1300 to 3400 m. **Distribution in Rwanda:** **Volcano NP:** Karisimbi, Bisoke, Gahinga. **Gishwati Forest:** Gikungu. **Central Rwanda:** Butare. **Nyungwe NP:** Rwasenkoko, waterfall ca. 3 km E of Pindura, Gisakura, Karamba, Pindura-Bweyeye, Mt. Bigugu, Mt. Muzimu. **Akagera:** Ibanda-Makera. **Distribution in Africa:** Cape Verde, Annobon, Bioko, Cameroon, DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Malawi, South Africa. Also in the Northern Hemisphere, Madagascar, Mauritius, Réunion. **Note:** The most frequent species of *Chiloscyphus* in Africa.



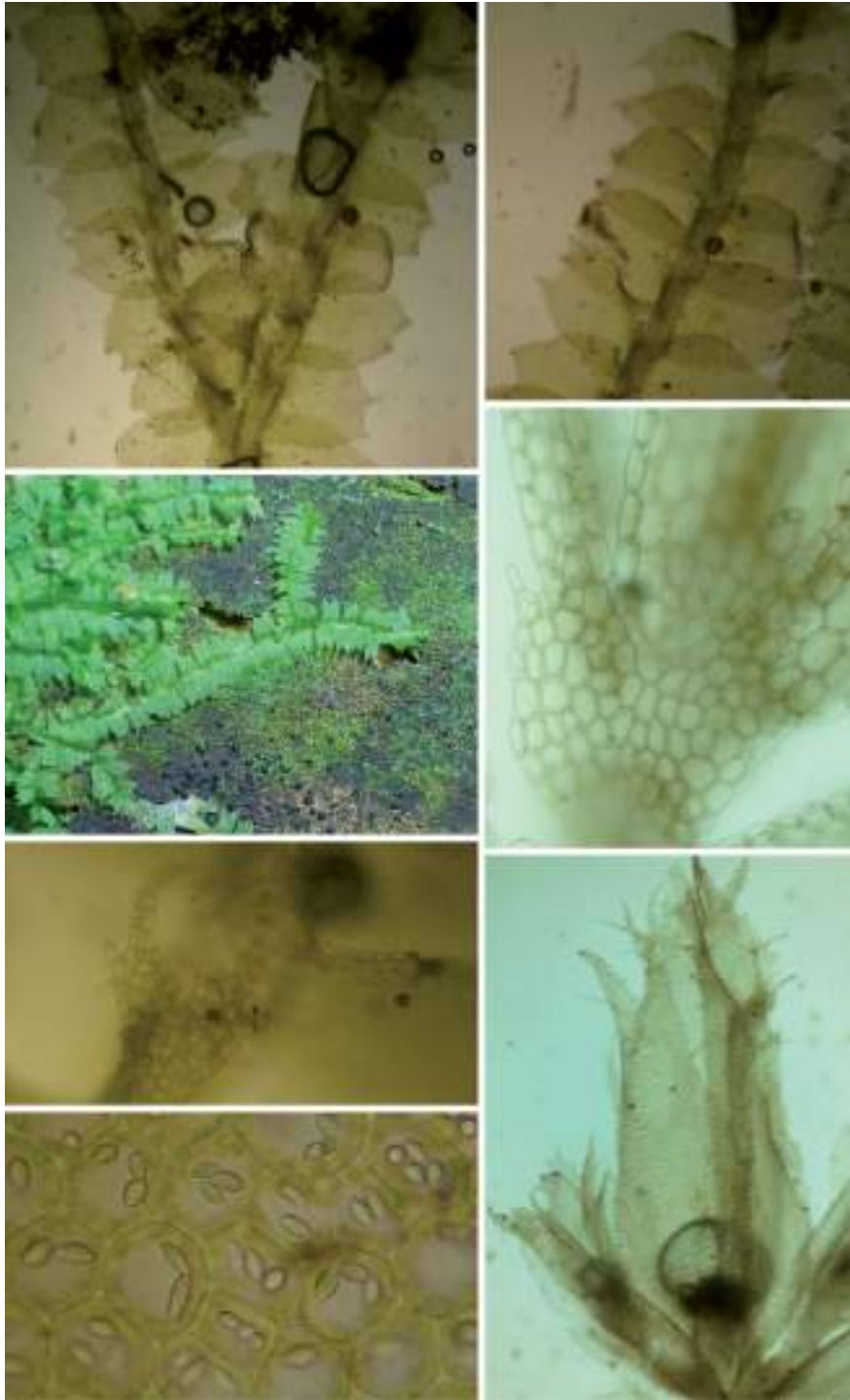


Figs 88 and 89 (next page). *Chiloscypus concretus* (Mont.) J.J.Engel & R.M.Schust.
 Synonym: *Lophocolea concreta* Mont. Plants medium-sized to small, yellowish-green, shoots 1.4-2.2 mm wide. Leaves asymmetric, ovate or oblong, scarcely contracted at base, 0.6-1 mm long, rounded or truncate to retuse at apex, rarely weakly bilobed. Cells thin-walled, 20-25(-30) μm wide, trigones usually distinct. Underleaves bilobed, not connate with leaf base, with coarse tooth on either side. Paroicous to autoicous. Perianths obconical, deeply lobed and lacinate. **Habitat:** In montane forest and plantations on soil and rotten wood, 1750-2100 m. **Distribution in Rwanda:** Nyungwe NP: Uwinka. **Central Rwanda:** Butare, Arboretum Ruhande. **Distribution in Africa:** Sierra Leone, Ghana, Togo, Nigeria, Annobon, DR Congo, Burundi, Kenya, Tanzania, Zambia, Zimbabwe, Malawi, Swaziland, South Africa. Also Madagascar, Mauritius, Réunion, Rodriguez.





Figs 90 and 91 (next page). *Chiloscypus difformis* (Nees) J.J.Engel & R.M.Schust.
 Synonym: *Lophocolea difformis* Nees in Gottsche, Lindenb. & Nees. Plants medium-sized to small, yellowish-green or green, shoots 1.5-2 mm wide. Leaves short and wide, 0.8-1 x 0.8-1 mm, alternate, shortly bilobed at apex, the lobes shortly and widely pointed, acumen lacking or up to 1-3 cells long, dorsal margin decurrent. Cells thin-walled, 25-34 μ m wide, trigones present or absent. Underleaves bilobed, not connate with leaf base, lobes broad, lanceolate, with tooth on either side. Dioicous. **Habitat:** On rotten wood and occasionally as epiphyte on the bark of *Agauria salicifolia*, 1750-2100 m. **Distribution in Rwanda:** **Nyungwe NP:** Karamba, Kamiranzovu, Uwinka. **Central Rwanda:** Butare. **Distribution in Africa:** Sierra Leone, Ghana, Togo, Nigeria, São Tomé, Bioko, Cameroon, Central African Republic, DR Congo, Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe, Malawi, South Africa. Also Madagascar, Mauritius, Réunion.





Figs 92 and 93 (next page). *Chiloscypus martianus* (Nees) J.J.Engel & R.M.Schust. Synonyms: *Lophocolea martiana* Nees; *L. congoana* Steph. Plants medium-sized to large, shoots 2.5-3.5 mm wide. Leaves subsymmetric, trapezoid, 1-1.5 mm long, alternate, dorsal base shortly decurrent, truncate at apex, 2-lobed, the lobes shortly acuminate. Cells thin-walled, 30-45 μm wide, trigones absent. Underleaves bilobed, narrowly connate with leaf base, with tooth on either side. Autoicous. Perianths longly emergent, trigonous above, keels winged, mouth wide, trilobed, lobes lacinate. **Habitat:** On vertical rock, decaying wood and on ground in montane rainforest, 1800-2100 m. **Distribution in Rwanda: Nyungwe NP:** Kamiranzovu, Uwinka. **Distribution in Africa:** Sierra Leone, Ivory Coast, Ghana, Togo, Nigeria, Principe, Bioko, Cameroon, Gabon, Rio Muni, Central African Republic, Congo-Brazzaville, DR Congo, Burundi, Tanzania, Zimbabwe, Swaziland, South Africa. Also Madagascar, Mauritius, Réunion, Seychelles.



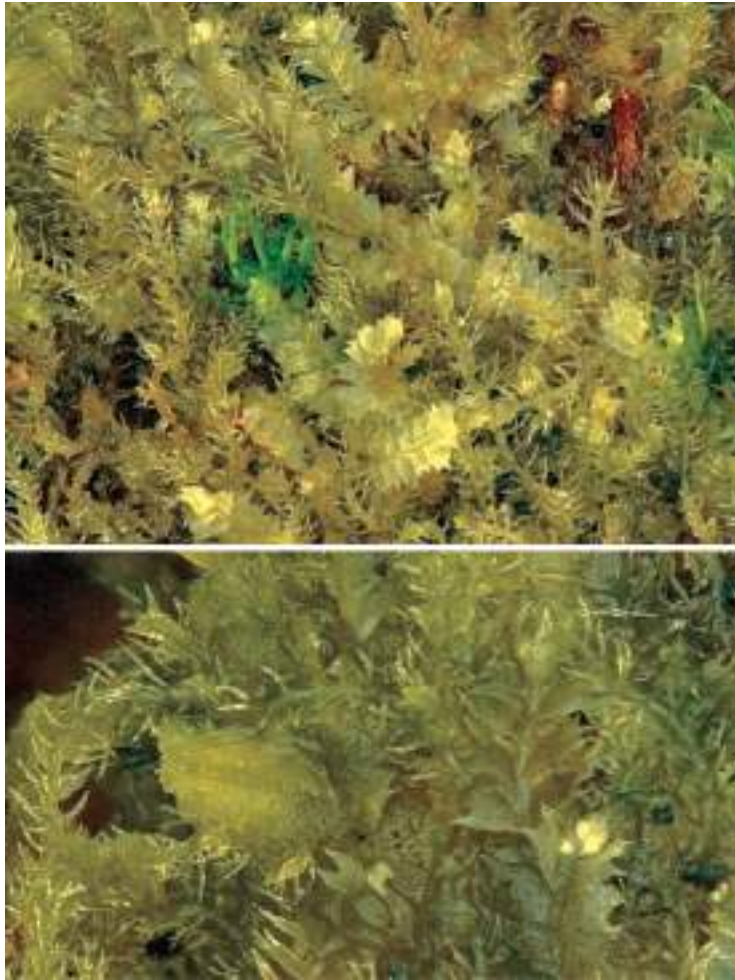


Figs 94 and 95 (next page). *Chiloscypus muhavurensis* S.W.Arnell

Synonym: *Lophocolea muhavurensis* (S.W.Arnell) S.W.Arnell ex Pócs. Plants medium-sized to large, shoots up to 5 cm long and 1-3 mm wide. Leaves subsymmetric, trapezoid to orbicular, 0.5-1.8 x 1-1.3 mm, alternate to subopposite, dorsal base shortly decurrent, 2-lobed, the lobes shortly acuminate, margin with several cilia up to 5-8 cells long.

Cells thin-walled, 36-40 µm wide, trigones conspicuous. Underleaves deeply bifid, with long tapering segments and with one to several teeth or cilia on each side, 2-3 as wide as the stem, narrowly connate with leaf base, with tooth on either side. Probably dioicous. Perianths not known. **Habitat:** On soil and rotten wood in subalpine *Erica* and *Dendrosenecio* Forest, 3000-3400 m. **Distribution in Rwanda: Volcano NP:** Sabinyo, Muhabura. **Distribution in Africa:** Uganda, Kenya, Tanzania.





Figs 96 and 97 (next page). *Chiloscypus muricatus* (Lehm.) Engel & R.M.Schust. Synonyms: *Lophocolea muricata* (Lehm.) Nees in Gottsche, Lindenb. & Nees; *L. spiniflora* Steph. Plants small, yellowish-green, shoots 1-2 mm wide. Leaves decurved, 0.5-1 mm long, alternate, bilobed or 3-lobed at apex, the lobes denticulate on both sides with sharp teeth 1-2 cells long, similar teeth on ventral and dorsal margin, short setae on dorsal side of leaves and on perianths. Cells thin-walled, 10-20 μm wide, trigones minute or absent. Underleaves bilobed, not connate with leaf base, lobe ending in an acumen up to 4 cells long, base dentate or lacinate. Autoicous. Perianths cylindrical to ovate, keels lacking, with 1-2-celled setae on surface. **Habitat:** On rotten wood, as epiphyte on living trees (*Agauria*, *Erica*, *Sinarundinaria*) as well as on litter or on roadcuts from montane forest at 2000 to 3700 m in *Dendrosenecio-Lobelia stuhlmannii* paramo. **Distribution in Rwanda:** **Volcano NP:** Karisimbi, on the E-slopes along trail to summit. **Nyungwe NP:** Kamiranzovu, along road to Bweyeye ca. 2 km S of Pindura, Uwinka. **Distribution in Africa:** Bioko, Cameroon, DR Congo, Burundi, Ethiopia, Uganda, Tanzania, Malawi, Zimbabwe, Mozambique, South Africa. Also Comoros, Madagascar, Réunion.





Fig. 98. *Clasmatocolea vermicularis* (Lehm.) Grolle

Plants small, pale green-brown. Stems prostrate, up to 3 cm long. Leaves imbricate, rounded, c. 0.3-1.5 mm long, dorsally concave, margin entire. Cells thin-walled, without trigones, 18-35 x 20-35 μ m, cuticle smooth. Underleaves narrower than stem, usually bilobed. Dioicous. Perianths rare, campanulate, the mouth 3-lobed. **Habitat:** On open soil or roadcuts in montane forest, 2000 m. **Distribution in Rwanda:** Gishwati Forest : Gikungu. **Nyungwe NP:** Karamba. **Distribution in Africa:** Nigeria, Cameroon, DR Congo, Burundi, Ethiopia, Tanzania, Zimbabwe, Malawi, Lesotho, South Africa. Also Madagascar, Mauritius, Réunion.

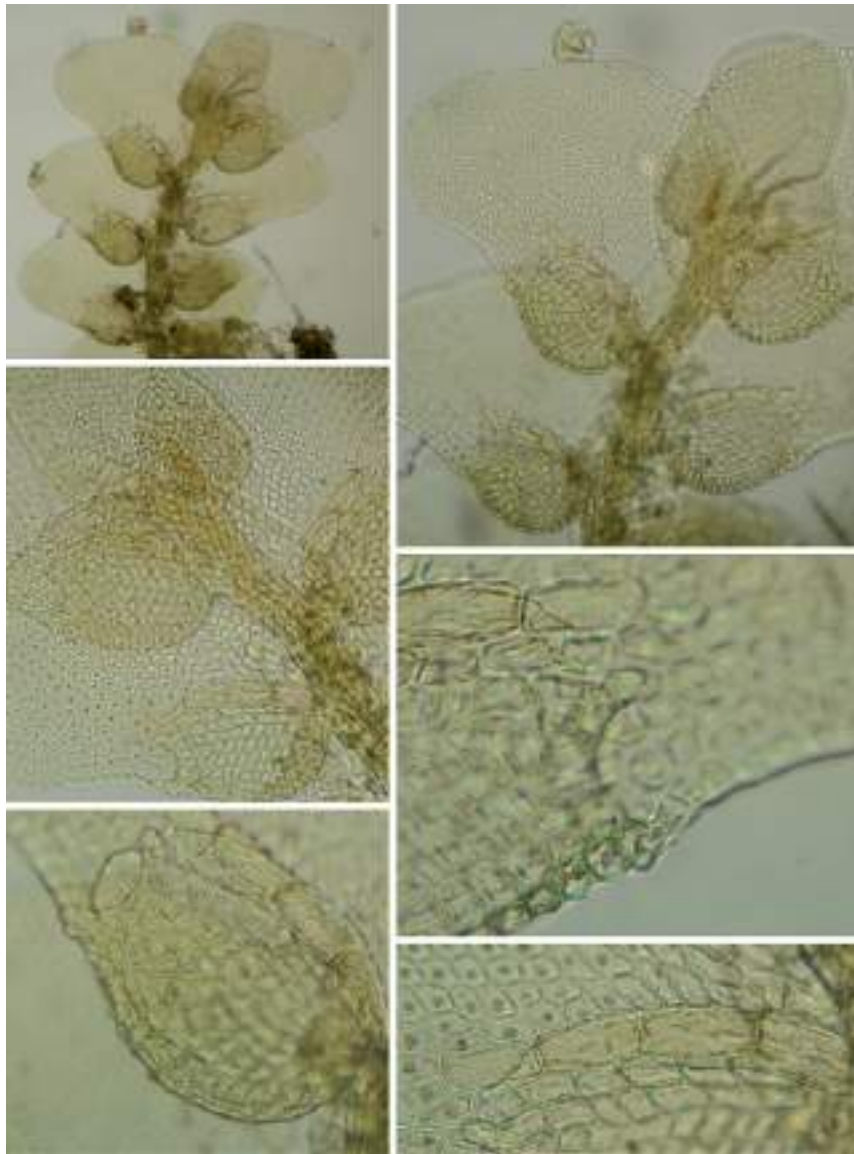


Fig. 99. *Cololejeunea appressa* (A. Evans) Benedix
 Plants small, shoots c. 0.5-0.7 mm wide. Leaves imbricate, spreading. Lobe ovate, 0.3-0.45 x 0.2-0.35 mm, margin crenulated, apex rounded. Cells papillose. Lobule 0.3-0.4 the length of the lobe, ovate, slightly inflated, apical tooth and distal tooth short, each consisting of 1 cell, hyaline papilla in the sinus between the teeth. Autoicous. Perianth obcordate, flattened. **Habitat:** Montane forest, epiphyllous, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Gisakura. **Distribution in Africa:** Sierra Leone, Ivory Coast, DR Congo, Uganda, Kenya, Tanzania, Malawi. Also Comoros, Madagascar, Réunion, Seychelles.

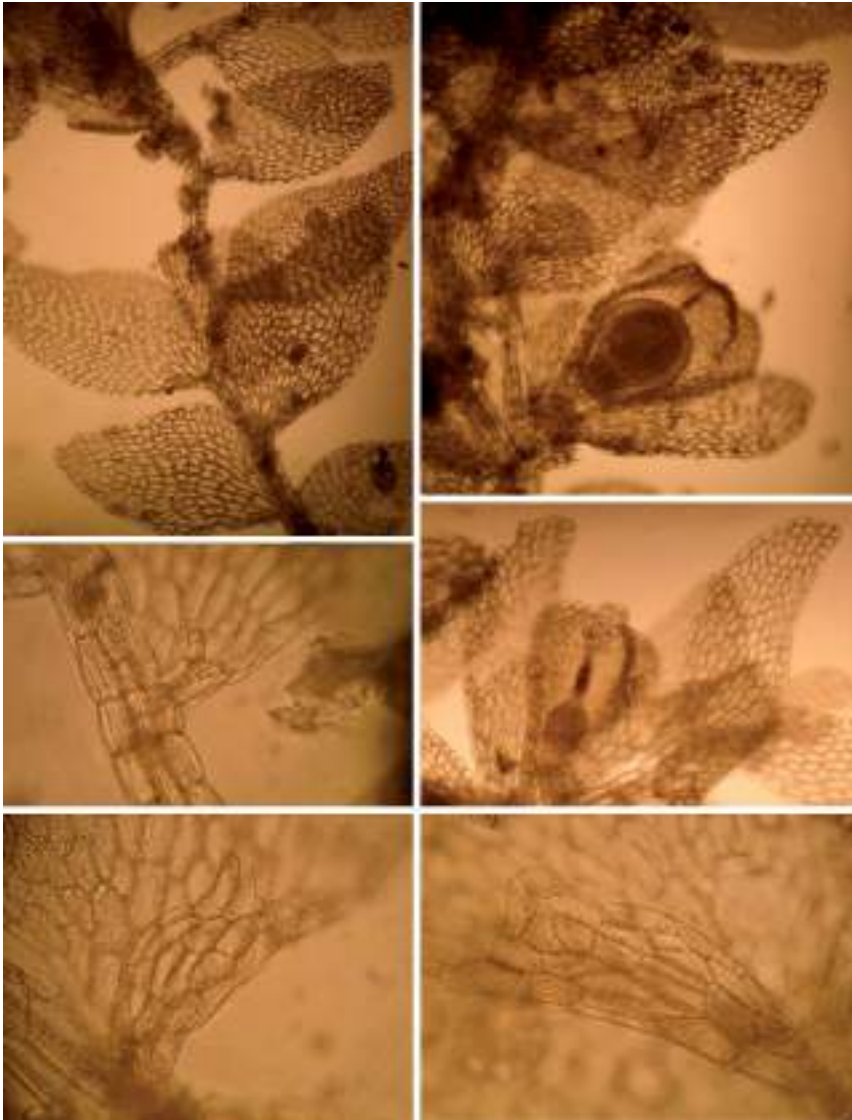


Fig. 100. *Cololejeunea augieri* Tixier

Plants small, up to 0.8 mm wide. Stems up to 1 cm long, branched. Leaves alternate, distant, with insertion at an angle of 60°. Lobes oblong, acuminate at apex, 0.5 mm long and 0.3 mm wide. Lobules saccate, inflated, more or less reduced, with 5-8 cells up to a lobular band, 150 µm long and 80 µm wide, with 1 unicellular tooth. Asexual reproduction with up to 16-celled gemmae. Dioicous. Perianths ovoid, apex rounded, without ventral keels, 0.5 mm long and 0.25 mm wide. **Habitat:** Montane forest, epiphyllous on *Marattia fraxinea*. 2000 m. **Distribution in Rwanda:** Nyungwe NP: Karamba. Only known from the type locality. **Note:** In Geneva, the type bears a wrong label (Kahuzi-Biéga, loc. 126), but the correct collection number (8506 n°6).

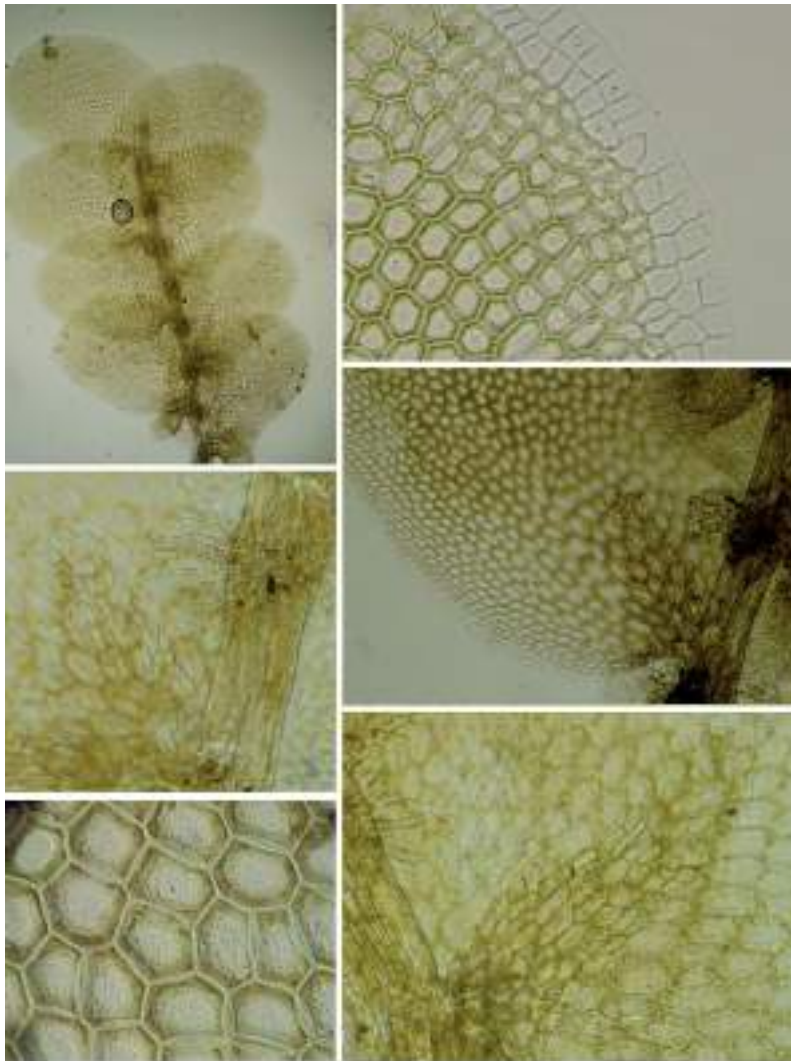
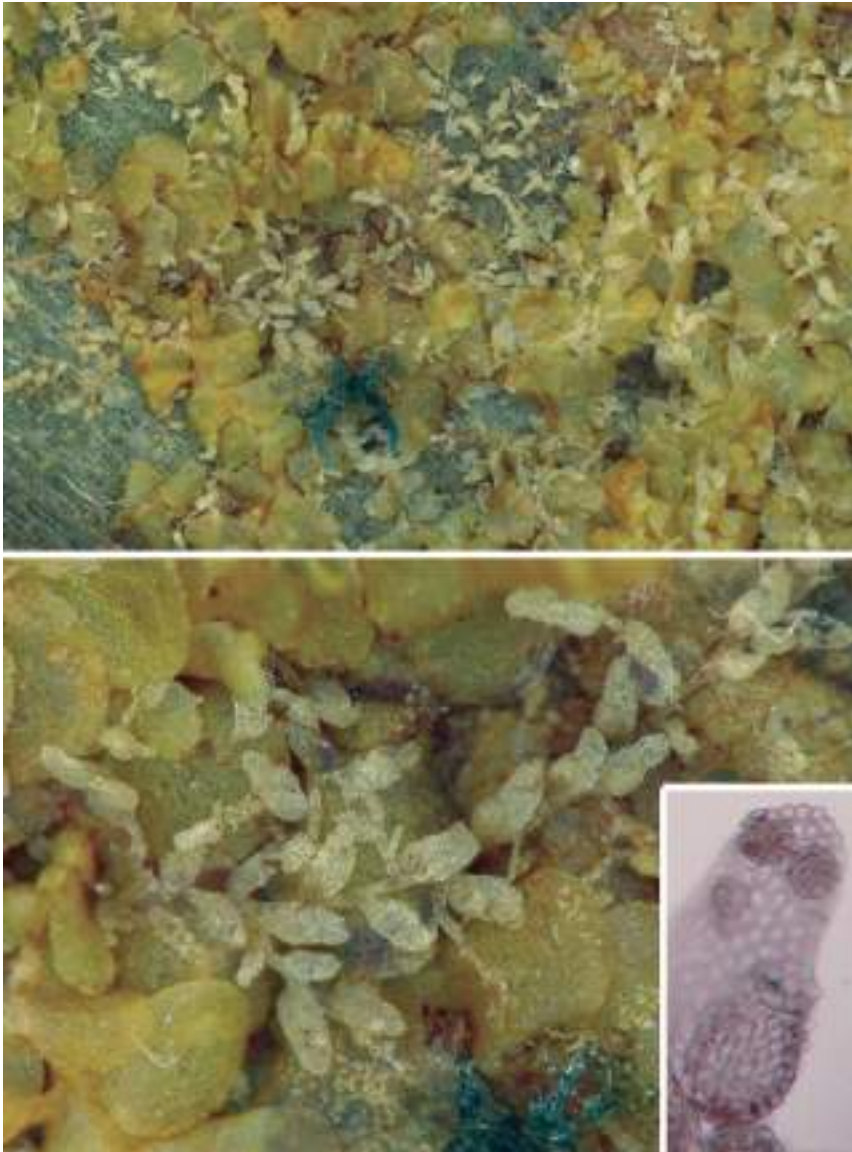


Fig. 101. *Cololejeunea bolombensis* (Steph.) Vanden Berghen

Plants medium-sized, shoots up to 1.8 mm wide. Lobe ovate or obovate, broadly rounded or narrow, (0.5-)0.7-1.1 x (0.4-)0.5-0.8 mm, apex rounded, hyaline margin entire, 2-3(-4) cells wide at apex of lobe, merging into a single row along the dorsal margin to the base, on ventral margin often abruptly ending. Chlorophyllose cells with papillose cuticle.

Lobule narrow, lingulate, 2-7 cells wide at middle, 0.2-0.35 mm long, widest at base, tapering towards apex, hyaline papilla large, at or near apex. Autoicous. Perianth pyriform, compressed, 0.5-0.6 mm long, without dorsal or ventral keels. **Habitat:** Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda: Nyungwe NP:** Cyamudongo Forest.

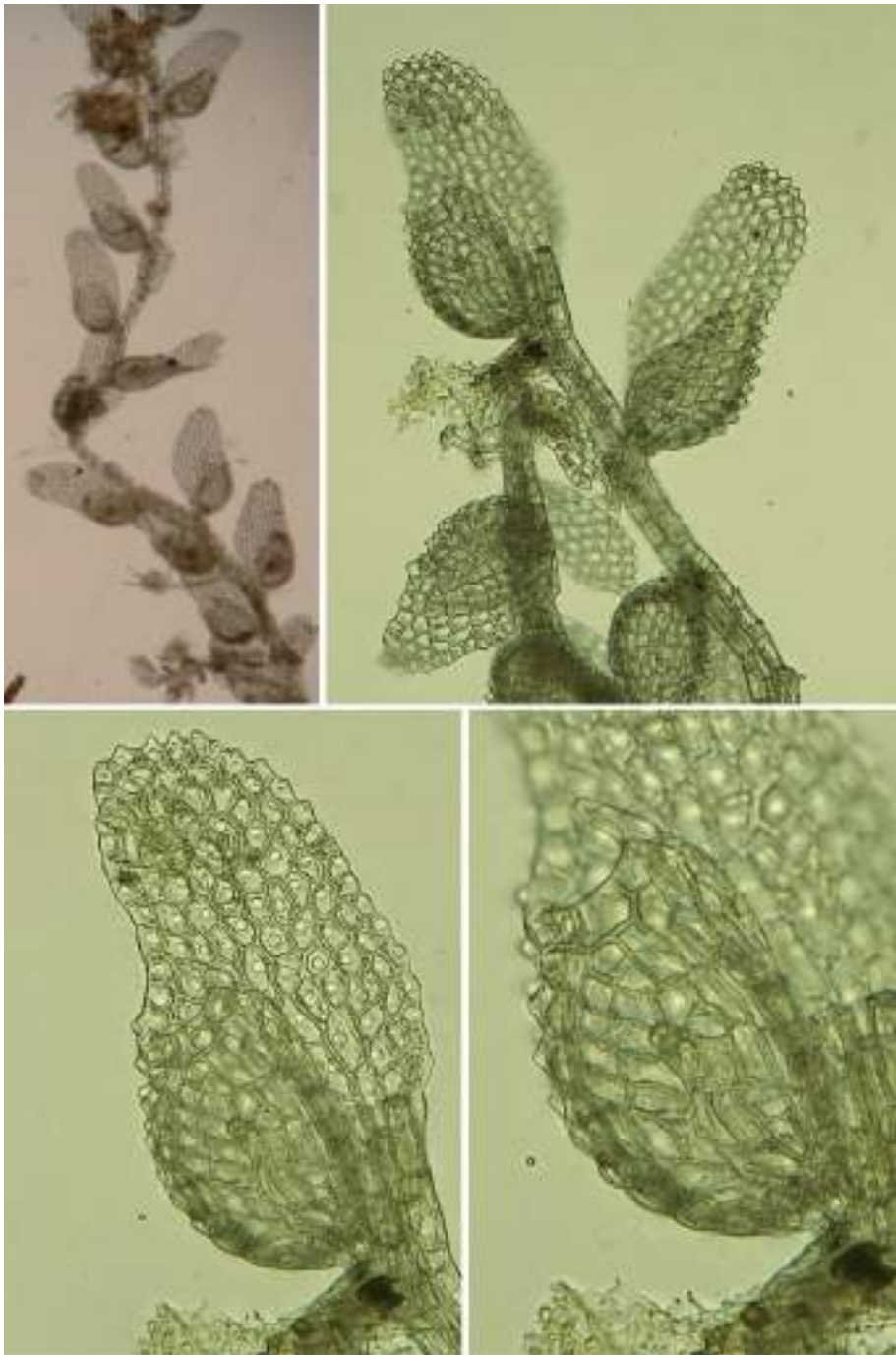
Distribution in Africa: Guinea, Sierra Leone, Ivory Coast, Nigeria, Bioko, Cameroon, Rio Muni, DR Congo, Burundi, Uganda, Kenya, Tanzania, Malawi, Zimbabwe. Also Comoros, Madagascar.



Figs 102 and 103 (next page). *Cololejeunea capuronii* Tixier

Plants minute, stem 0.3-0.35 mm wide, fully developed leaves with lobule and reduced leaves present. Lobes ovate to lanceolate, 0.24-0.26 x 0.1 mm, in reduced leaves 0.06-0.1 x 0.02-0.05 mm, surface papillose, margin crenulated with rounded papillae, apex rounded. Mid-leaf cells of lobe 26 x 12 μ m. Lobules inflated, 0.13 x 0.08 mm, with 1 apical tooth, the tooth 1-celled and often curved, 28 μ m long, cells of lobule 16 x 11 μ m.

Asexual reproduction by disciform gemmae on leaf-lobe surface. **Habitat:** Montane forest, epiphyllous on *Podocarpus*, 1970 m. **Distribution in Rwanda:** Nyungwe NP: Kamiranzovu. Also Madagascar.



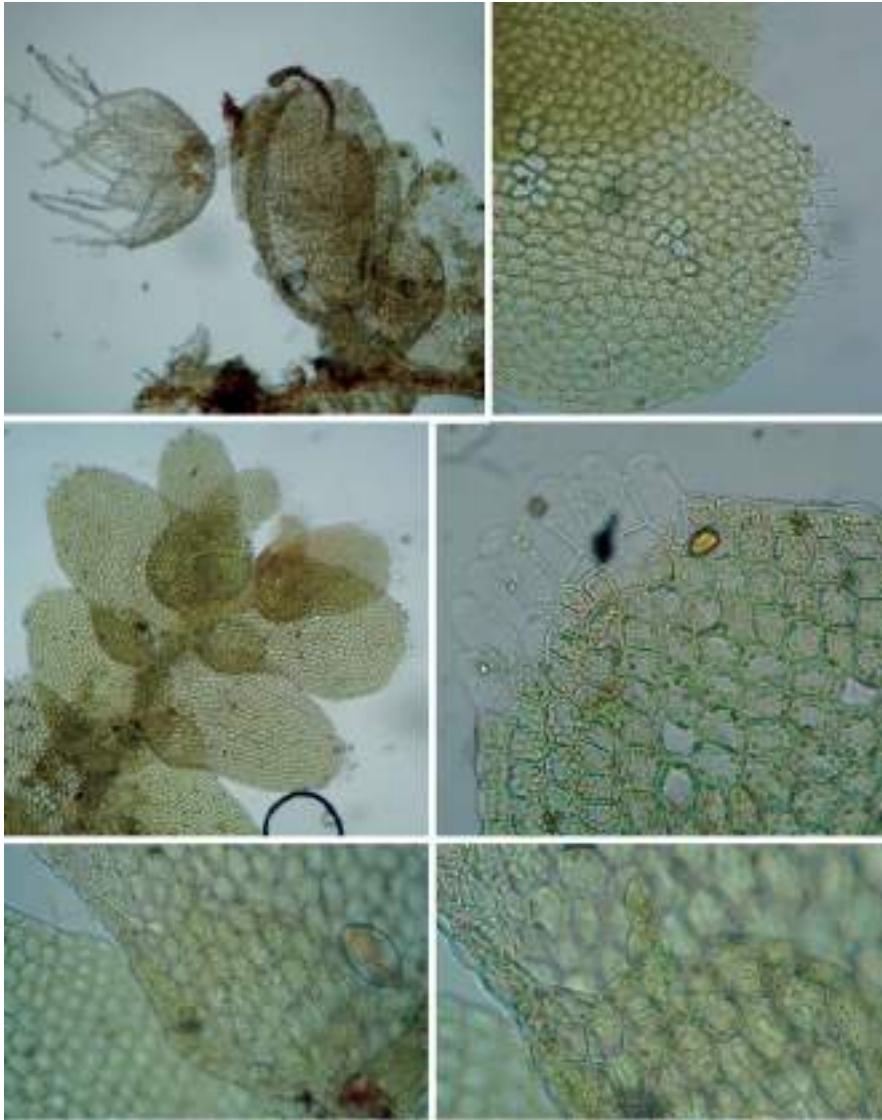
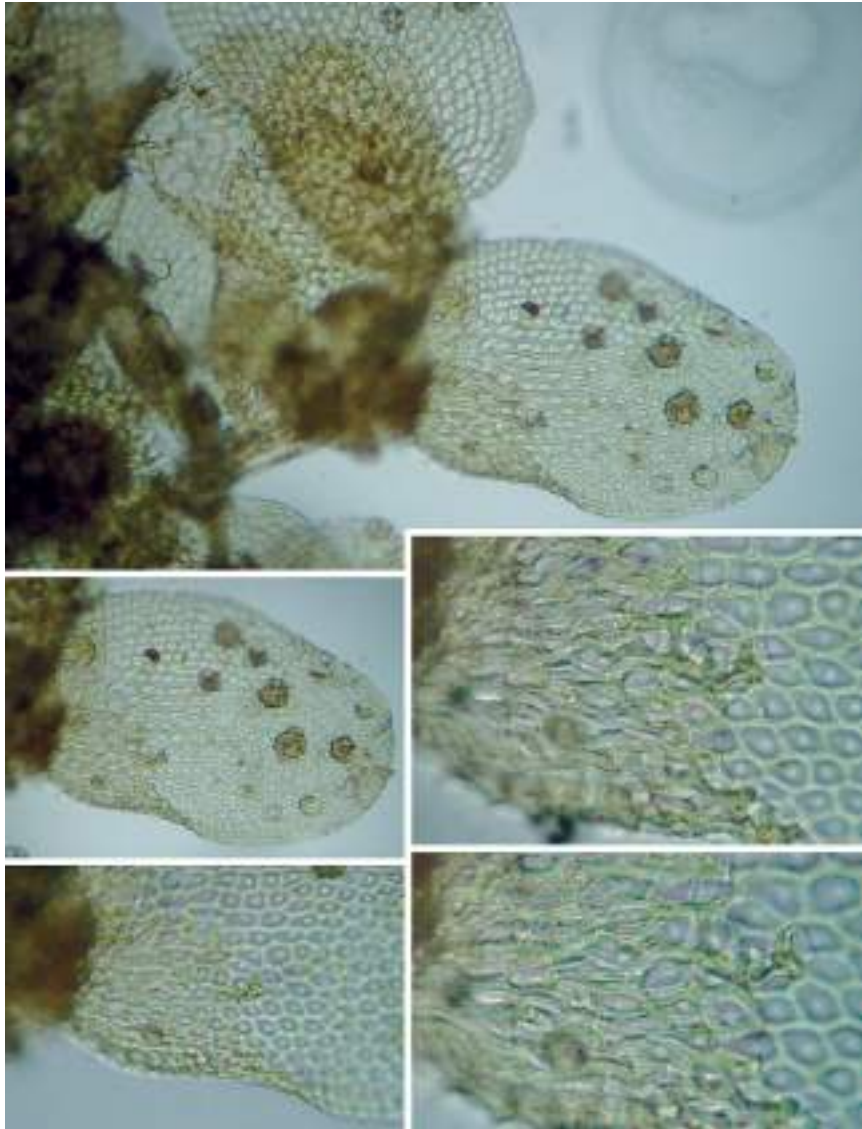


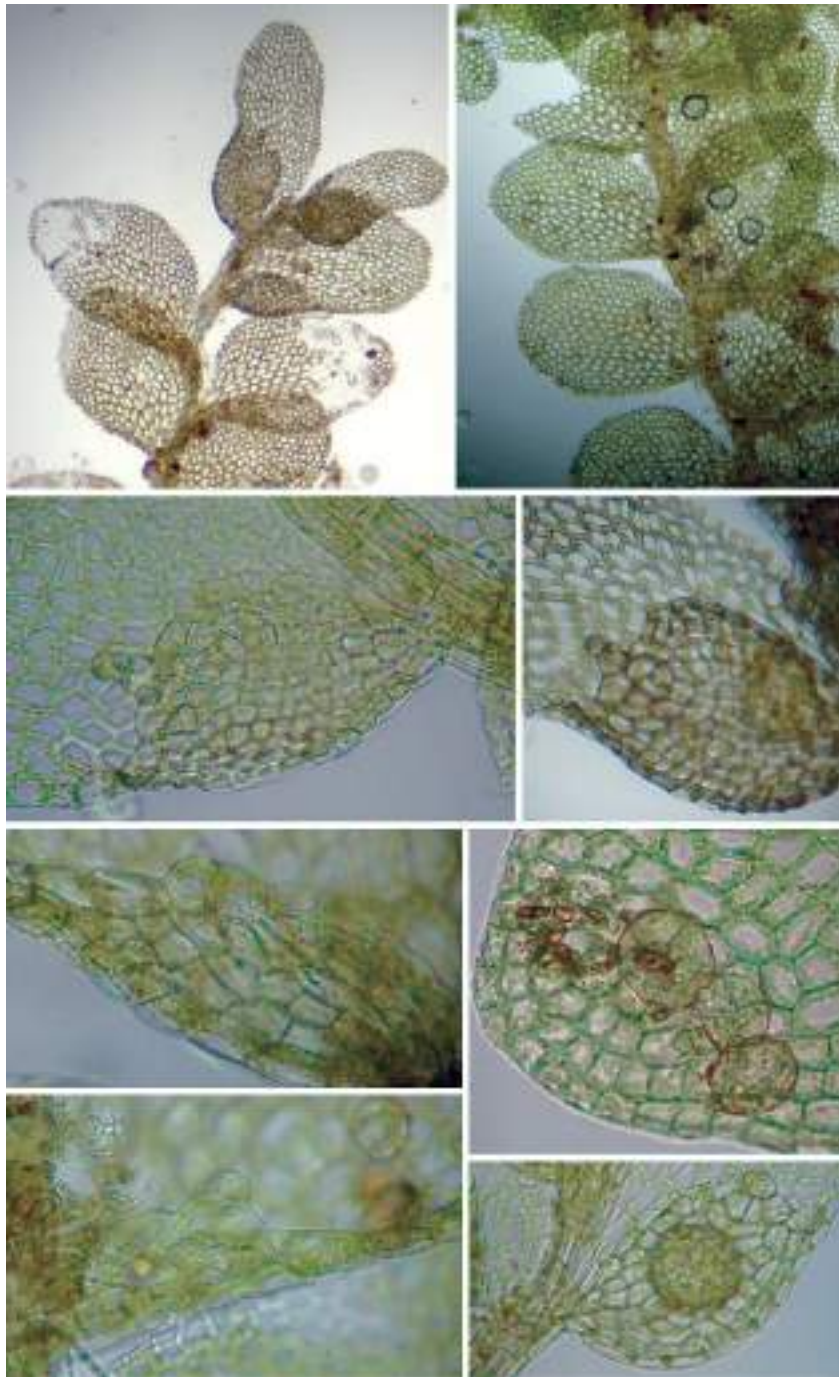
Fig. 104. *Cololejeunea cardiocarpa* (Mont.) R.M.Schust.

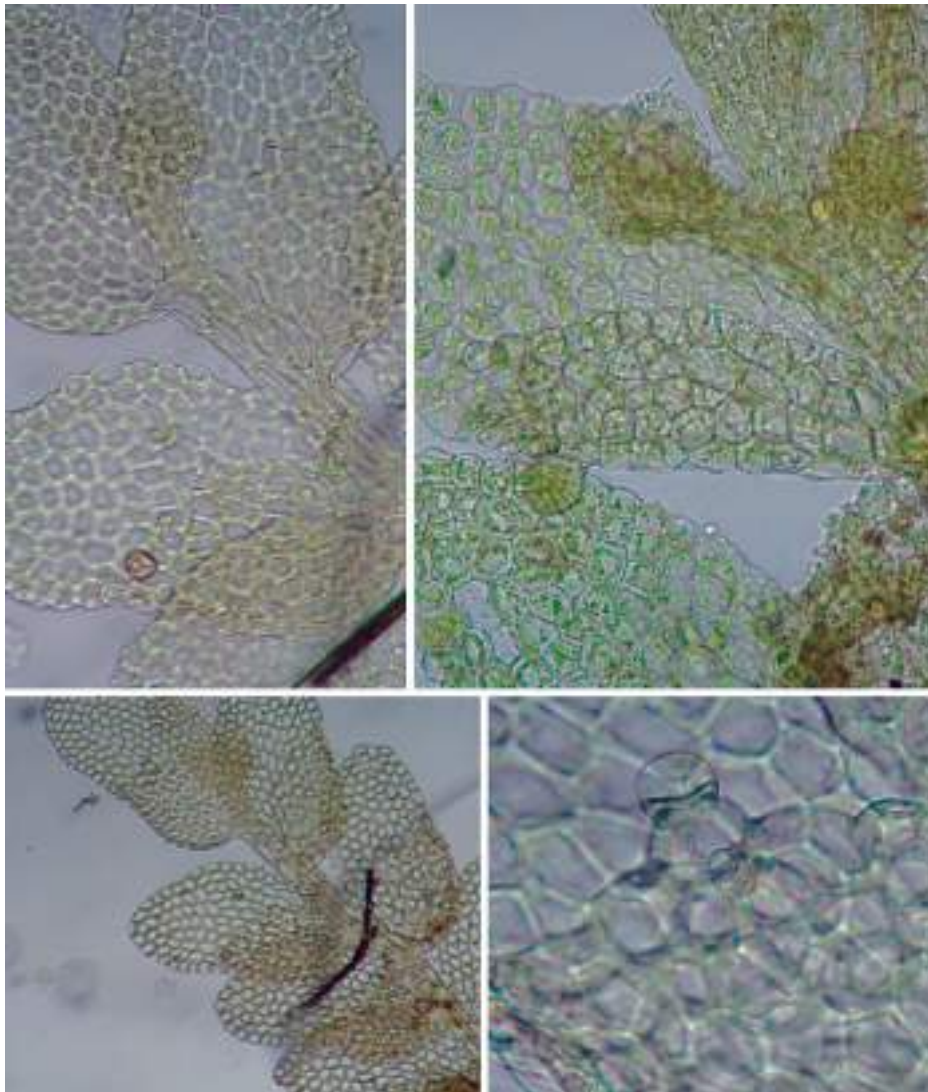
Plants small, shoots 0.5-0.9 mm wide. Lobe ovate, 0.4-0.7 x 0.25-0.45 mm, base broadly rounded, apex usually narrow, hyaline cells variable, usually a sharply demarcated group of 2-12 cells at lobe apex, sometimes also a line of hyaline cells extending towards the dorsal base. Lobule inflated, c. 0.4 the length of the lobe, often also reduced, apical tooth of 2 cells, with small spherical hyaline papilla. Monoicous. Perianth pyriform, compressed, 0.4-0.5 x 0.35-0.45 mm, with 2 long ventral keels. **Habitat:** Montane forest, epiphyllous, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Uwinka. **Distribution in Africa:** Sierra Leone, Cameroon, DR Congo, Burundi, Uganda, Kenya, Tanzania, Zimbabwe, Swaziland, South Africa. Also USA, Central and South America to Ascension, Madagascar.



Figs 105 and 106 (next page). *Cololejeunea cardiocarpoides* Tixier

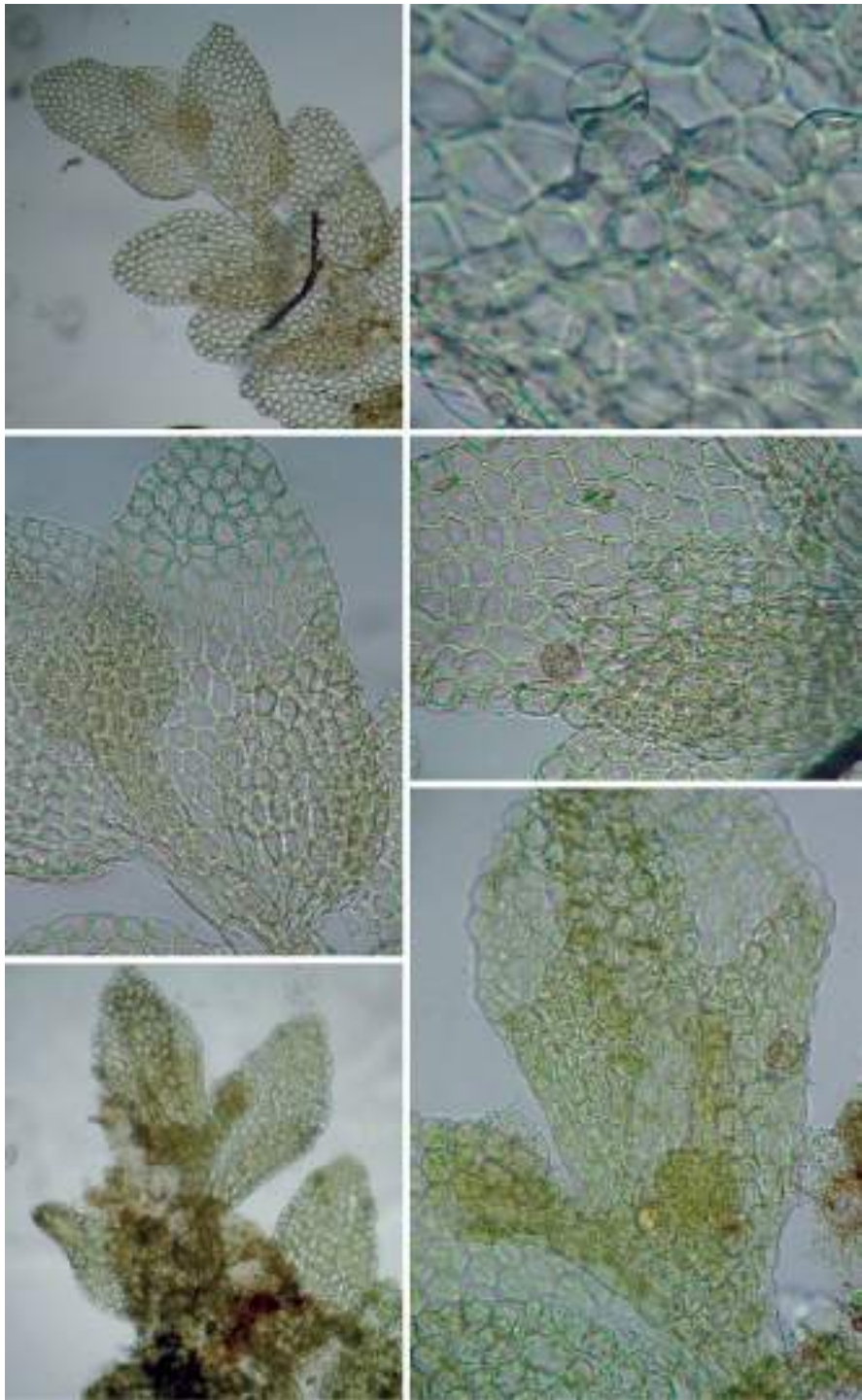
Plants delicate, up to 0.8 mm wide, epiphyllous, densely appressed to substrate. Stems up to 0.5 mm long, more or less branched. Leaves alternate, distant, with insertion at an angle of 90°. Lobes ovate, 0.3 mm long and 0.2 mm wide, hyaline margin at lobe apex with cells 20 x 10 µm, sometimes absent, pseudovitta short, at base of lobe. Lobules discoid, about 1/3 of lobe, 150 µm long and 100 µm wide, with 2 teeth, apical tooth often unicellular, median tooth 2-cellular, hyaline papilla spherical. Asexual reproduction with up to 20-celled gemmae. Dioicous (?). Perianths pyriform, with 2 ventral keels, up to 0.35 mm long and 0.2 mm wide. **Habitat:** Montane forest, epiphyllous, 2000 m. **Distribution in Rwanda:** Nyungwe NP: Uwinka.





Figs 107 and 108 (next page). *Cololejeunea clavatopapillata* Steph.

Synonyms: *Cololejeunea fadenii* Pócs; *Aphanolejeunea fadenii* (Pócs) Pócs. Plants small, shoots up to 5 mm long, 0.18-0.35 mm wide, epiphyllous. Lobes of lobulate leaves 0.3-0.35 x 0.15-0.18 mm, ovate to ovate-lanceolate, surface dorsally mammillate, elobulate reduced leaves few. Lobules inflated, as wide as lobe, and more than half the length of the lobe, with 1 apical tooth, 2-celled and strongly curved, proximal tooth very near, short, obtuse or lacking, cells smooth except the keel. Asexual reproduction by disciform gemmae on marginal cells of the lobe. Autoicous. Perianths inflated, broadly pyriform, about 0.4 x 0.3 mm, obscurely 5-keeled. **Habitat:** Montane forest, usually epiphyllous, 2250-2300 m. **Distribution in Rwanda:** Nyungwe NP: Uwinka. **Distribution in Africa:** Uganda, Kenya, Tanzania.



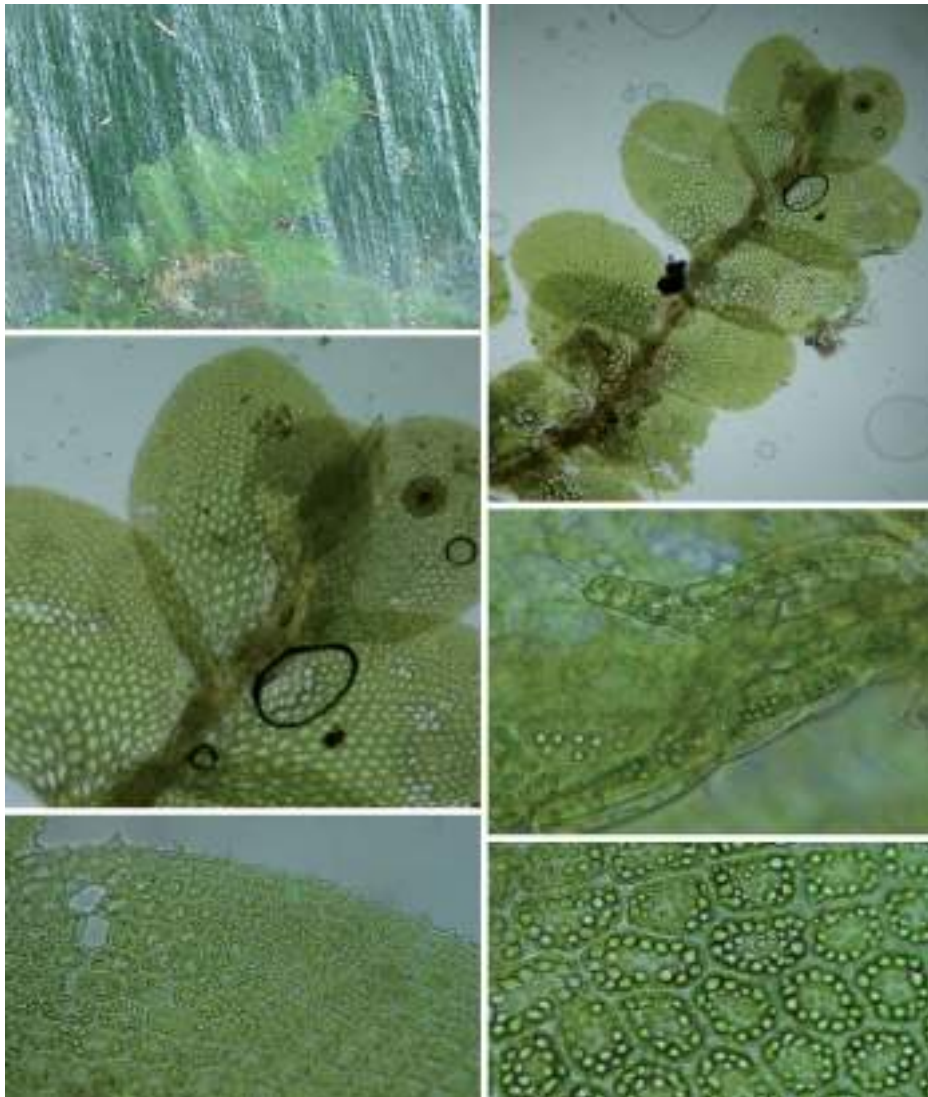


Fig. 109. *Cololejeunea cuneifolia* Steph.

Plants medium-sized, up to 1-1.5 mm wide. Leaves spreading. Lobes obovate, 0.6-0.8 x 0.45-0.6 mm, margin irregularly crenulate with asymmetrical teeth. Lobules small, often reduced, 0.1-0.25 the length of the lobe, apical tooth usually of 2 long cells, hyaline papilla pyriform, on the side or apex of the apical cell. Autoicous. Perianth longly exerted, narrowly obcordate, apex truncate, concave to cordate, with distinct lateral keels. **Habitat:** Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo Forest. **Distribution in Africa:** Guinea, Ivory Coast, Ghana, Nigeria, Cameroon, Rio Muni, DR Congo, Uganda, Tanzania.



Fig. 110. *Cololejeunea distalopapillata* (E.W.Jones) R.M.Schust.

Plants robust, vivid green, shoots (0.8-)1.2-1.6(-1.8) mm wide and several mm long. Lobe reniform or ovate, 0.56-0.7(-0.75) x (0.75-)0.8-1(-1.2) mm, margin with hyaline cells in 1 or 2 rows, ending 4-10(-16) cells from lobule. Lobule inflated, with arched keel, 0.2-0.23 x 0.22-0.35 mm, apical tooth consisting of 2 cells at base, prolonged by 1-2 cells, hyaline papilla at base of distal side, distal and proximal tooth each 1-celled. Gemmae present, star-shaped. Paroicous. Perianth exserted, compressed, with 2 ventral keels, rounded, truncate or retuse at apex, 0.45-0.68 x 0.55-1 mm. **Habitat:** Montane forest, epiphyllous or corticolous, 2100-2250 m. **Distribution in Rwanda:** Nyungwe NP: Uwinka. **Distribution in Africa:** DR Congo, Kenya, Tanzania, Zimbabwe. Also Comoros, Madagascar.



Fig. 111. *Cololejeunea duvigneaudii* E.W.Jones

Plants robust, shoots 1.2-1.6(-1.8) mm wide. Lobe reniform or ovate, 0.45-0.63(-0.7) x (0.6-) 0.7-0.96 mm, margin finely and irregularly denticulate. Lobule inflated, ovate, 0.1-0.24 x 0.21-0.35(-0.42) mm, sometimes reduced, apical tooth consisting of (1-)2(-3) cells, hyaline papilla at apex or just below apical cell. Gemmae present, star-shaped. Monoicous. Perianth exserted, without keels, rounded, truncate or retuse at apex, 0.3-0.36 x 0.55-0.72 mm. **Habitat:** Montane forest, epiphyllous or corticolous, 1900-2100 m. **Distribution in Rwanda:** Nyungwe NP: Karamba, Kamiranzovu, Uwinka, between Gisakura and Karamba. **Distribution in Africa:** Bioko, Rio Muni, Gabon, DR Congo, Kenya, Tanzania, Malawi, Zimbabwe. Also Comoros, Madagascar, Réunion.

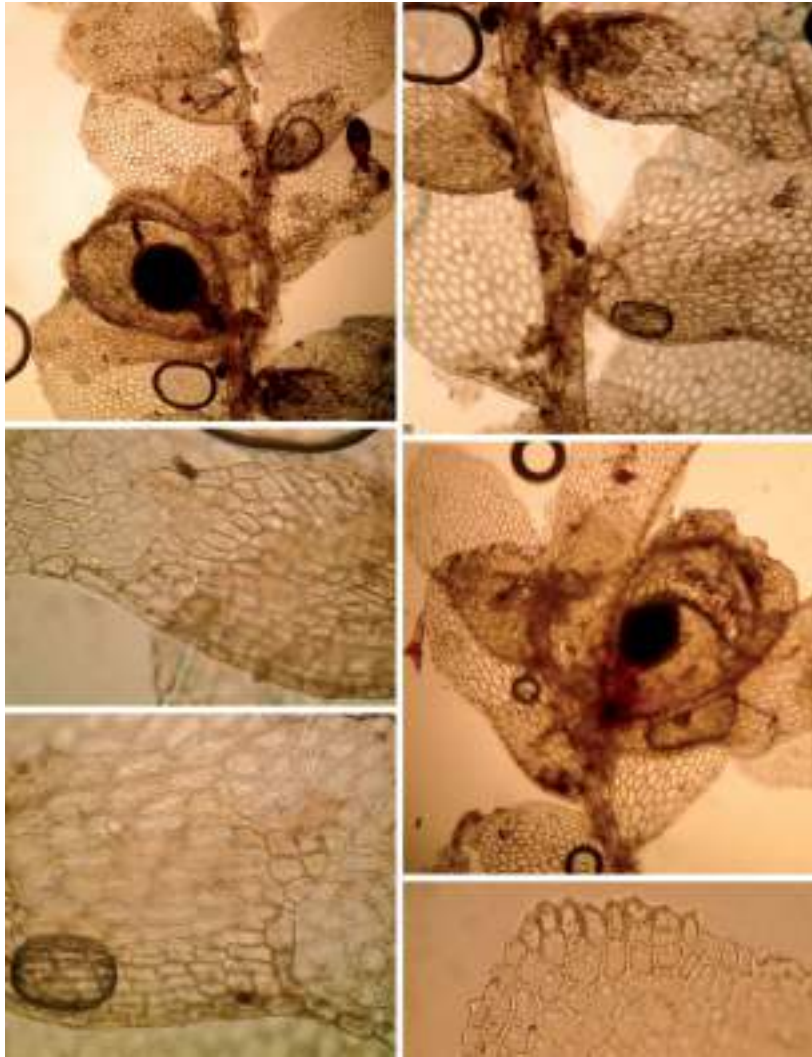


Fig. 112. *Cololejeunea fischeri* Tixier

Plants medium-sized, up to 1 mm wide. Stems up to 1 cm long, branched. Leaves alternate, distant, with insertion at an angle of 80°. Lobes obovate, apex rounded, 0.35 mm long and 0.35 mm wide. Lobules saccate, inflated, truncate at apex, 250 µm long and 150 µm wide, with 2 teeth, apical tooth unicellular, hardly visible, median tooth 2-cellular, hyaline papilla at median tooth. Asexual reproduction with up to 16-18-celled gemmae. Monoicous. Perianths ovate, apex truncate, with 2 ventral keels and short rostrum, 0.5 mm long and 0.3 mm wide. **Habitat:** Montane forest, epiphyllous, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Kamiranzovu. **Distribution in Africa:** DR Congo. **Note:** Tixier (1995) cites erroneously "DR Congo, Station Irangi" as type locality, but indicates the correct collection number from the type locality in Rwanda. Geissler (1996) published a correction of the type data.

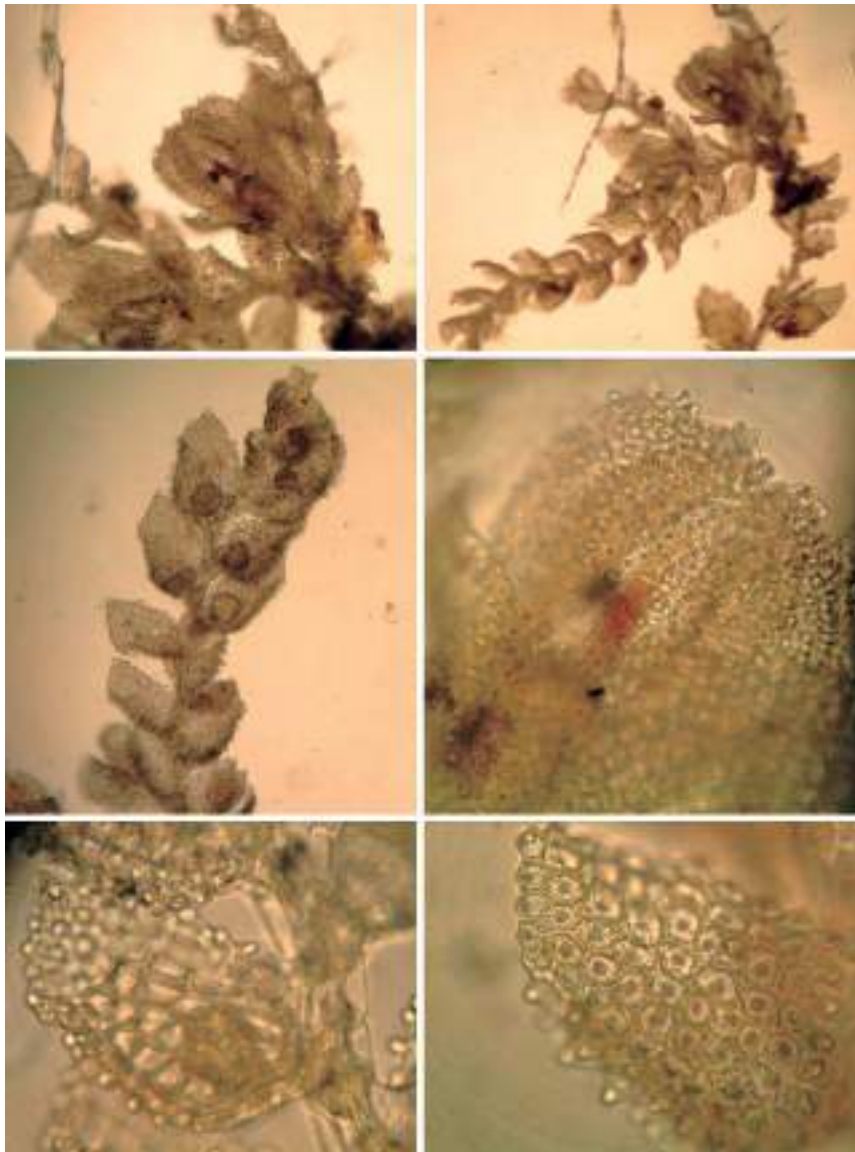
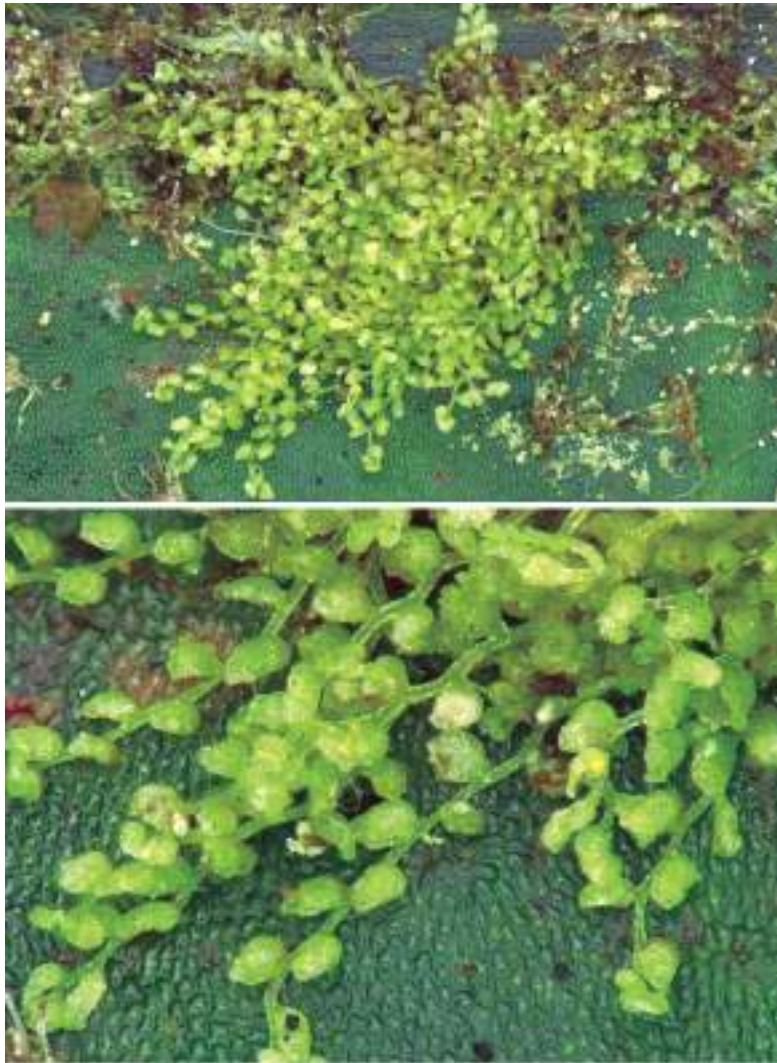


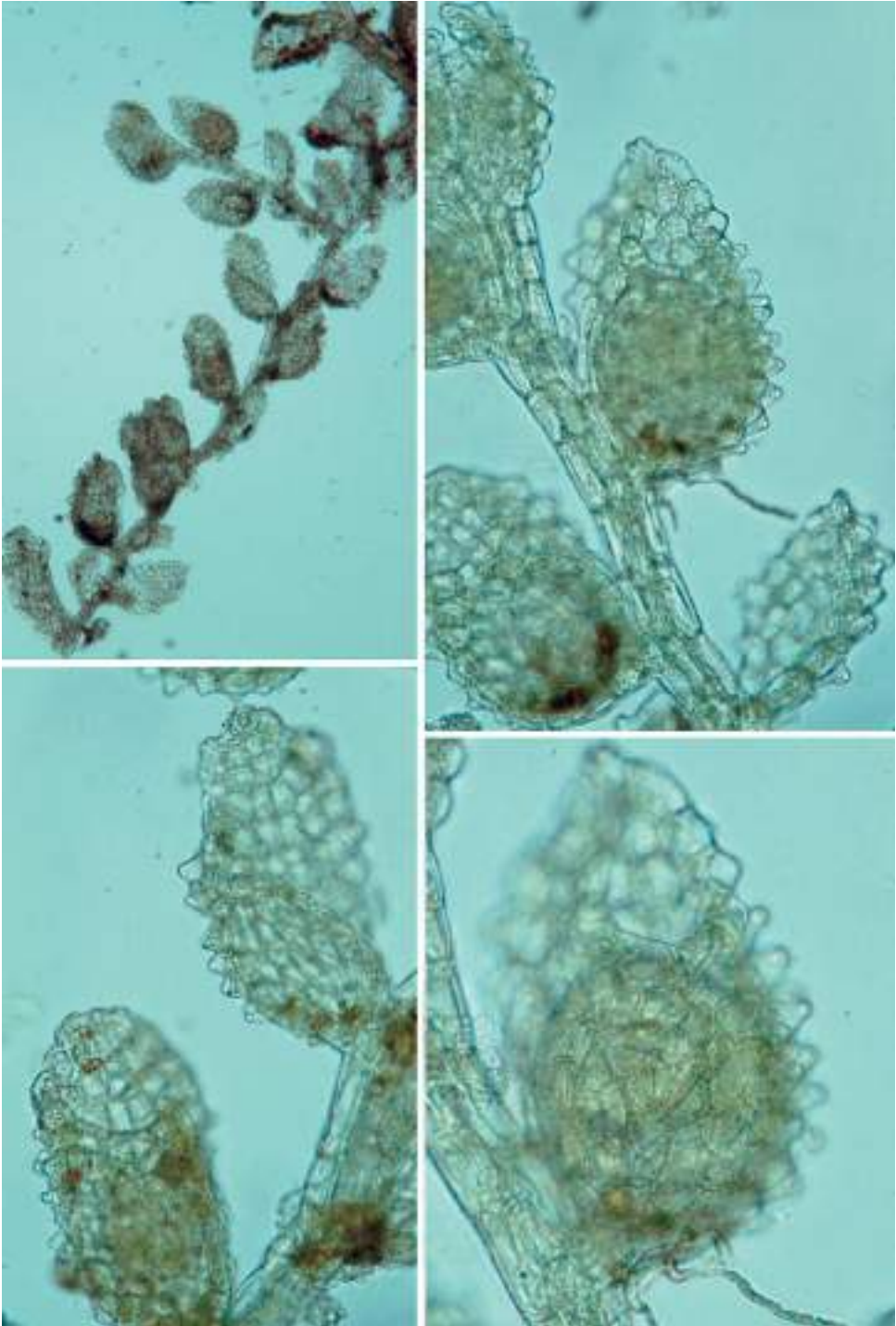
Fig. 113. *Cololejeunea frahmii* Tixier

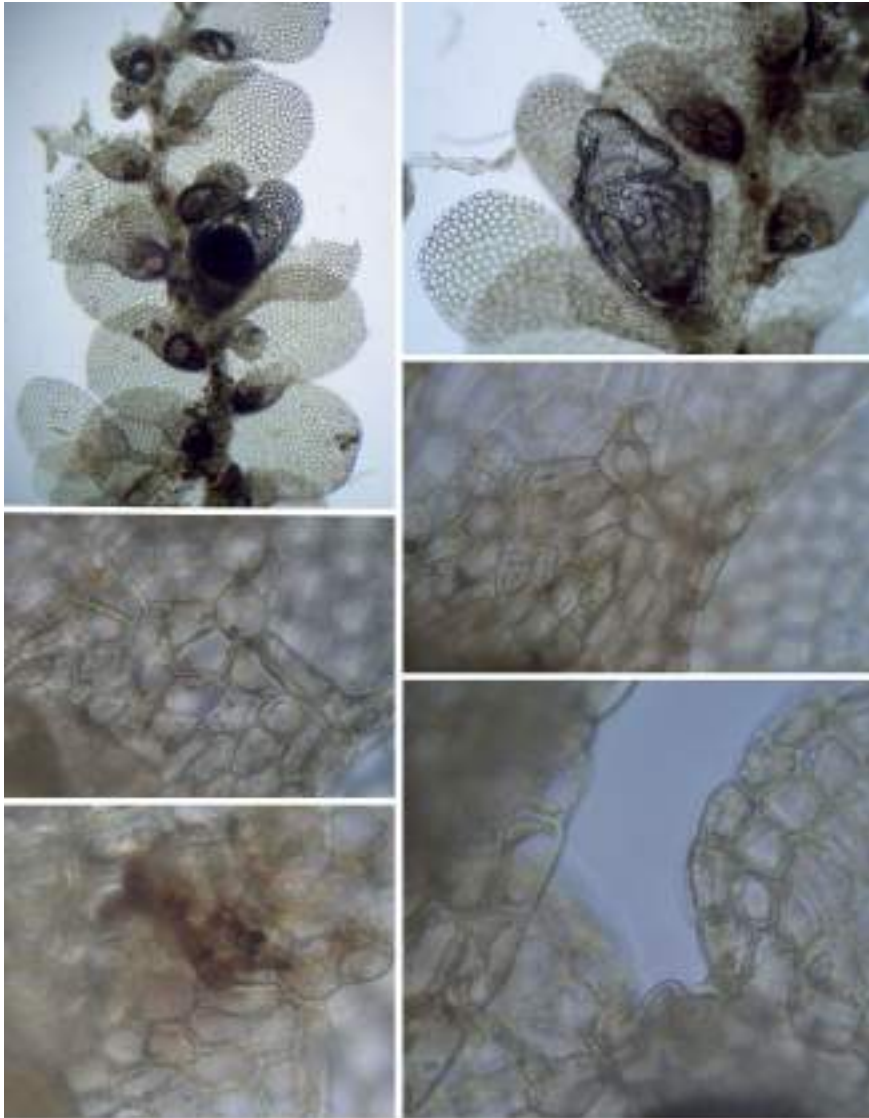
Plants small, up to 0.8 mm wide, with papillose cells. Stems up to 0.5 cm long, richly branched. Leaves alternate, distant, with insertion at an angle of 90°. Lobes lanceolate-ovate, apex acuminate, 150 μ m long and 180 μ m wide. Lobules saccate, inflated, keel rounded, crenulate, 80 μ m long and 100 μ m wide, truncate towards apex, with unicellular apical tooth, reduced lobules sometimes present. Synoicous. Androecia lateral. Perianths obovate, papillose, apex rounded, with ventral keels and short rostrum, 0.25 mm long and 0.15 mm wide. **Habitat:** Montane forest, epiphyllous on *Saintpauliopsis lebrunii*, 2100 m.

Distribution in Rwanda: Nyungwe NP: Uwinka.



Figs 114 and 115 (next page). *Cololejeunea grossepapillosa* (Horik.) Pócs
 Synonyms: *Cololejeunea capensis* S.W. Arnell; *Aphanolejeunea capensis* (S.W. Arnell) S.W. Arnell; *A. mammillata* auct. non (Aongstr.) Steph. Plants minute, shoots 0.3-0.45 mm wide, epiphyllous. Lobes ovate to lanceolate, 0.09-0.18(-0.21) × 0.25(-0.3) mm, surface papillose, margin crenulated with rounded papillae, apex rounded to acuminate. Lobules inflated, 0.1-0.13 × 0.12-0.23 mm, with 1 apical tooth or 2 teeth, the teeth 1-2-celled and often curved, hyaline papilla at inner base of apical tooth. Asexual reproduction by disciform gemmae on leaf-lobe surface. Paroicous. Perianths inflated, 5-keeled, papillose, 0.2-0.28 × 0.3-0.53 mm. **Habitat:** Montane rainforest, epiphyllous, 1950-2300 m. **Distribution in Rwanda:** Gishwati Forest: Gikungu. tRwankuba, Uwinka. **Distribution in Africa:** DR Congo, Burundi, Tanzania, Zimbabwe, Malawi, South Africa.





Figs 116 and 117 (next page). *Cololejeunea harrisii* Pócs

Plants medium-sized, forming dense mats, shoots (0.9-)1-1.3(-1.6) mm wide. Lobe entire, asymmetrically ovate-reniform, apex rounded, (0.37-)0.4-0.6 x (0.48-)0.6-0.9 mm. Lobule variable, if well developed rather long, 0.14-0.22 x 0.2-0.35 mm, ovate, inflated, apical tooth with 2 cells, hyaline papilla at base of apical tooth, free margin of lobule usually with obtuse tooth, lobule sometimes reduced. Monoicous. Perianth exerted, heart-shaped, compressed, laterally with 2 rounded auricles, 0.4-0.5 x 0.5-0.6 mm, beak conical, with protruding cells. **Habitat:** Montane forest, epiphyllous on *Marattia fraxinea*, 1900-2000 m. **Distribution in Rwanda:** Nyungwe NP: Kamiranzovu, Uwinka. **Distribution in Africa:** Burundi, Tanzania.



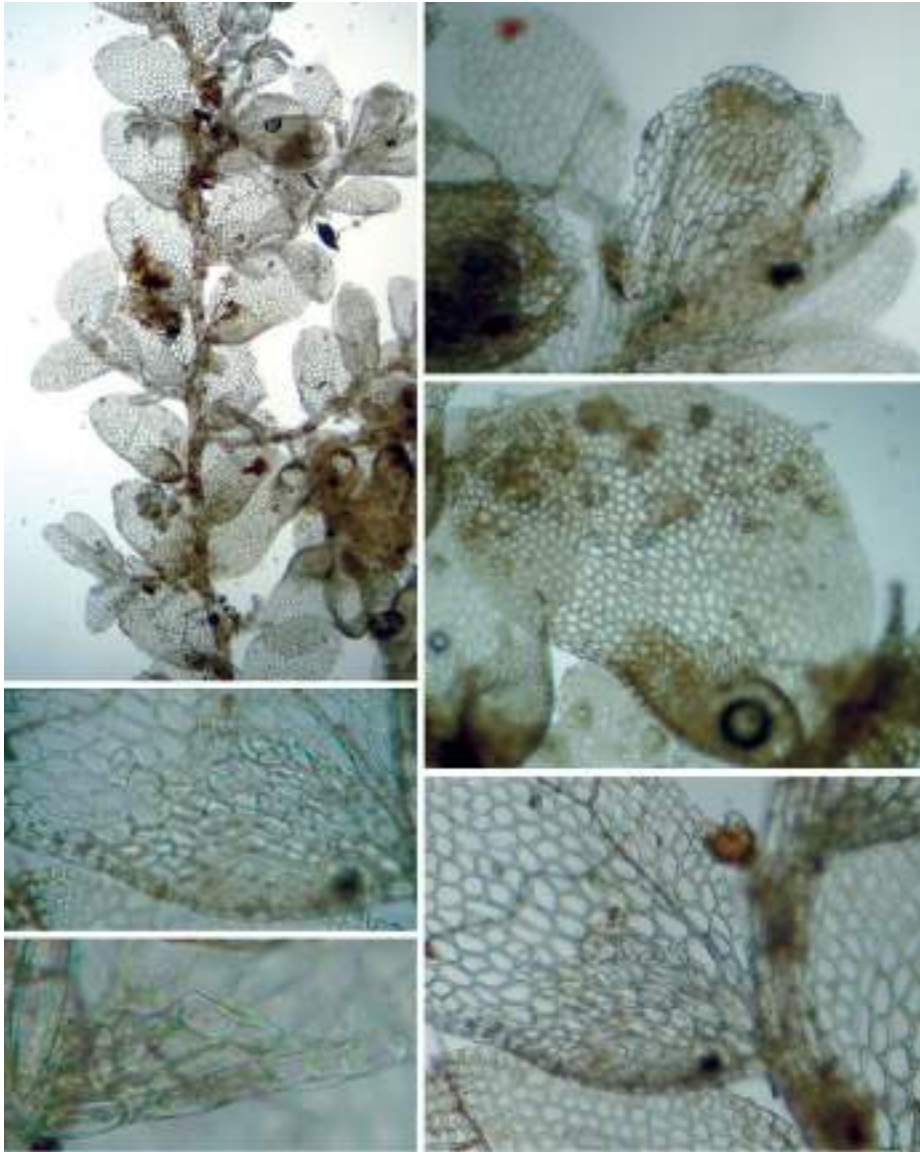


Fig. 118. *Cololejeunea heterolobula* Tixier

Plants small, epiphyllous, densely appressed to substrate, up to 0.8 mm wide. Stems up to 1 cm long, branched. Lobes ovate, apex rounded, 0.5 mm long and 0.3 mm wide, pseudovitta short, at base of lobe. Lobules saccate, inflated, keel straight, 0.2 mm long and 0.15 mm wide, with 2 teeth, apical tooth unicellular, hardly visible, median tooth 2-cellular, reduced lobules sometimes present. Asexual reproduction with up to 20-celled. Monoicous. Perianths ovoid, apex rounded, with ventral keels and short rostrum, 0.35 mm long and 0.2 mm wide. **Habitat:** Montane forest, epiphyllous, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Kamiranzovu. **Distribution in Africa:** DR Congo.

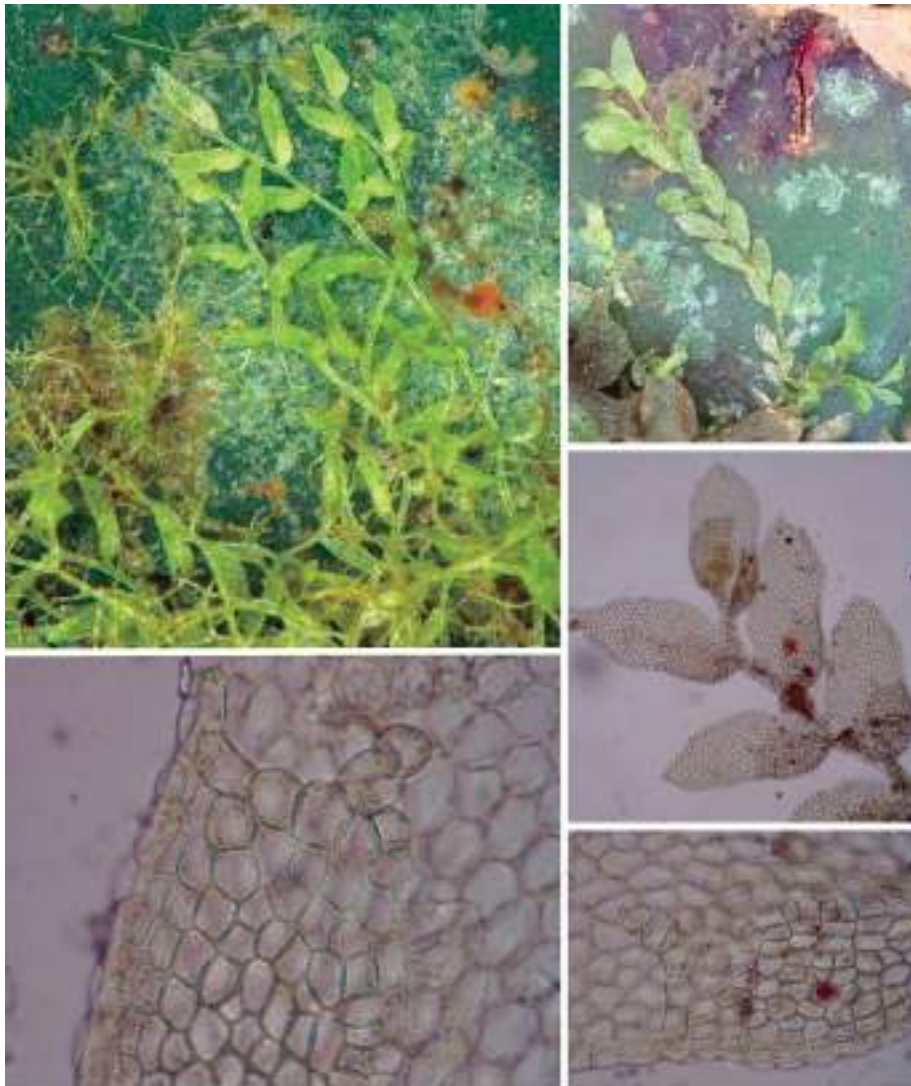


Fig. 119. *Cololejeunea hildebrandii* (Aust.) Steph.

Synonym: *Cololejeunea filicaulis* Steph. Plants small. Leaves distant. Lobes narrowly ovate or oblong, 0.3-0.6 x 0.12-0.2 mm, base cuneate, apex tapering to rounded or subacute point, margins entire to crenulate. Lobule about 0.3-0.5 the length of the lobe, sometimes reduced to few cells, inflated, apex flat, truncate, apical tooth of 2-3 cells, inserted in the middle of apex, hyaline papilla at base of apical tooth. Asexual reproduction by gemmae mainly from marginal cells. Autoicous. Perianths 0.5-0.7 x 0.3-0.4 mm, obconical, smooth or slightly mammillose. **Habitat:** Montane forest, epiphyllous, 1900-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkoko, Karamba, Kamiranzovu, Uwinka. **Distribution in Africa:** Cameroon, DR Congo, Ethiopia, Kenya, Tanzania. Also Comoros, Madagascar, Réunion.

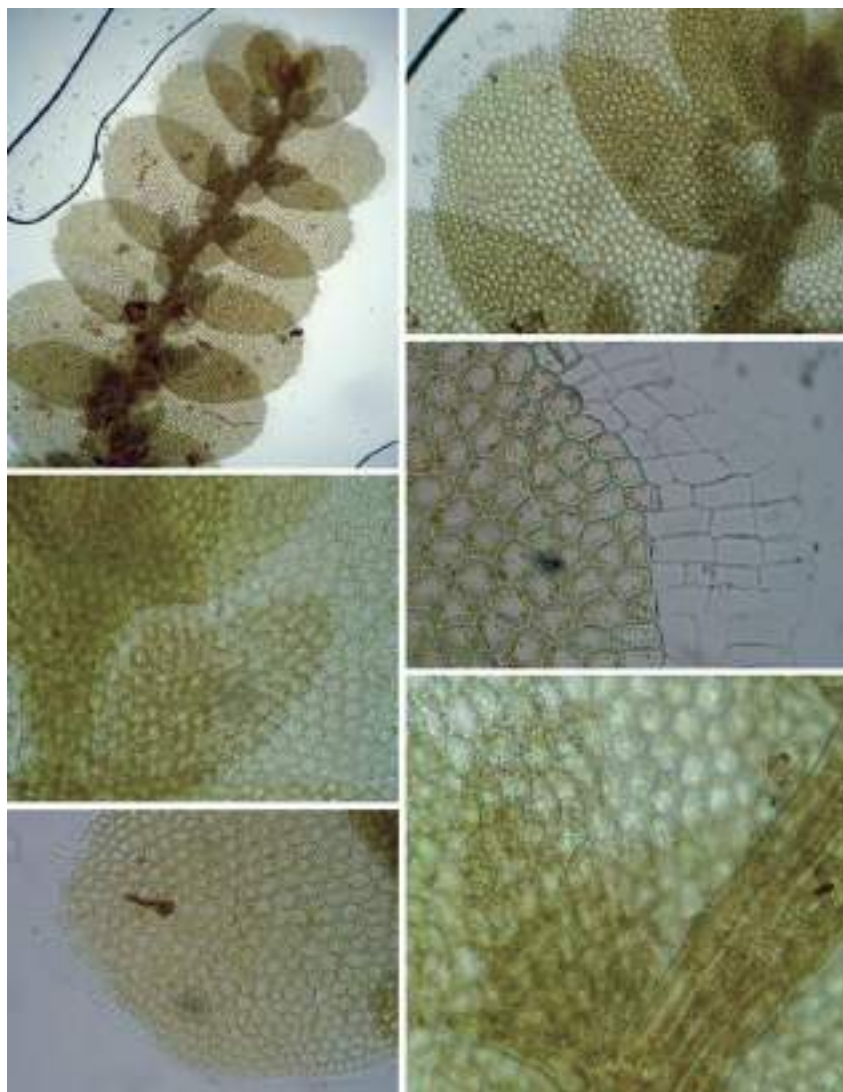


Fig. 120. *Cololejeunea latilobula* (Herzog) Tixier

Synonym: *Cololejeunea himalayensis* (Pandé & Misra) R.M.Schust. Plants medium-sized, shoots up to 1-1.6 mm wide. Lobe ovate, broadly rounded at dorsal base, 0.7-1 x 0.6-1 mm, apex broadly rounded, hyaline margin entire, 2-3 cells wide at apex of lobe, merging into a single row along the dorsal margin extending nearly to stem, on ventral margin often abruptly ending. Chlorophyllose cells without papillose cuticle. Lobule narrow, ovate to ovate lanceolate or ovate-triangular, 8-15 cells wide at middle, apex obtuse, hyaline papilla in a notch near apex. Gemmae on lobes. Autoicous. Perianth pyriform, compressed.

Habitat: Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo Forest. **Distribution in Africa:** Nigeria, Cameroon, Rio Muni, DR Congo, Burundi, Uganda, Tanzania, Malawi, Zambia. Also Comoros, Seychelles extending to Asia (Himalaya, Japan).

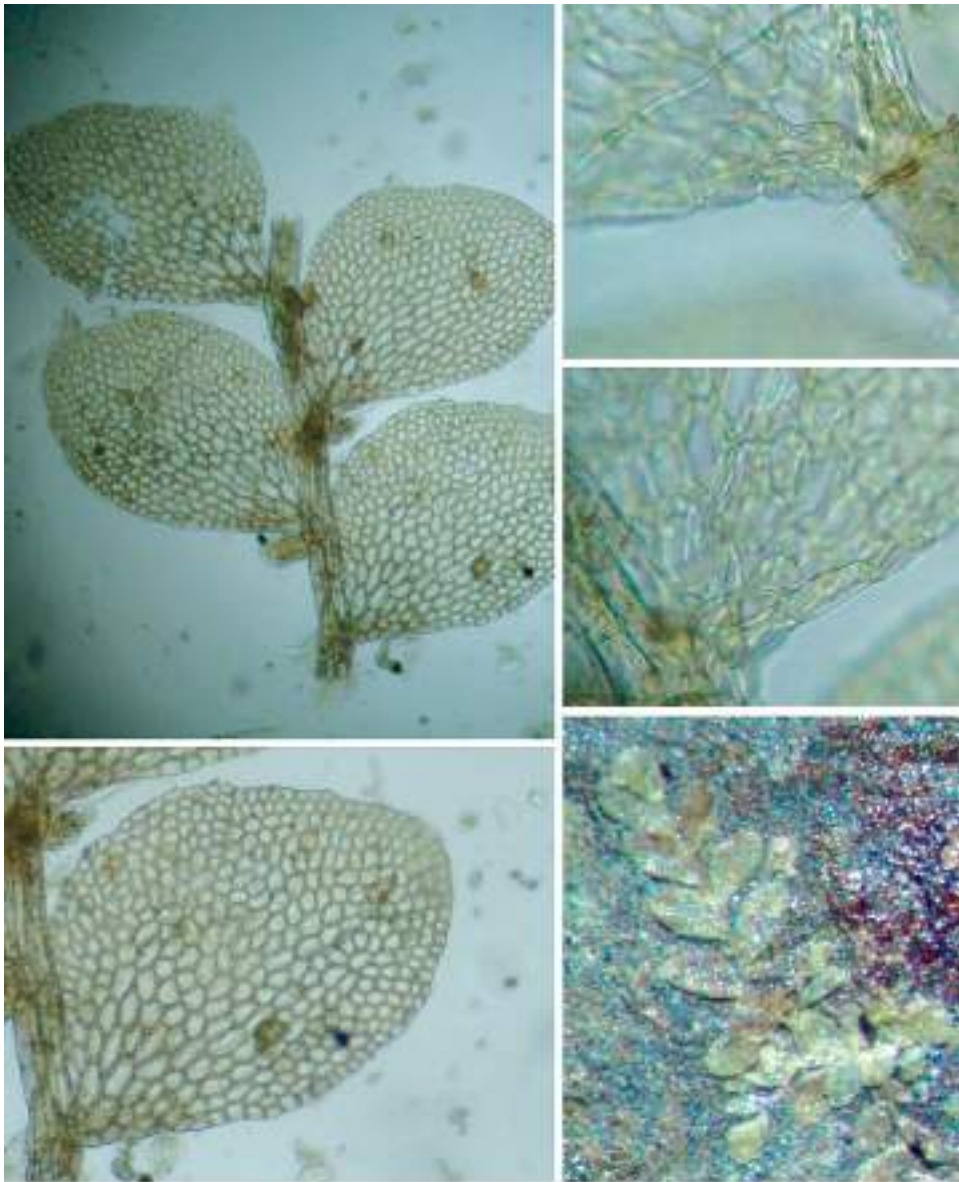


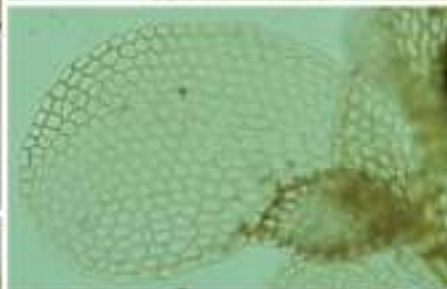
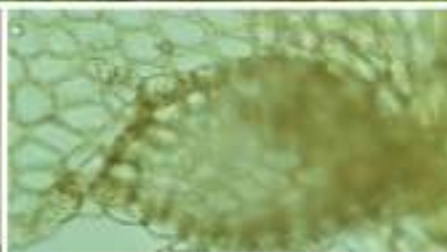
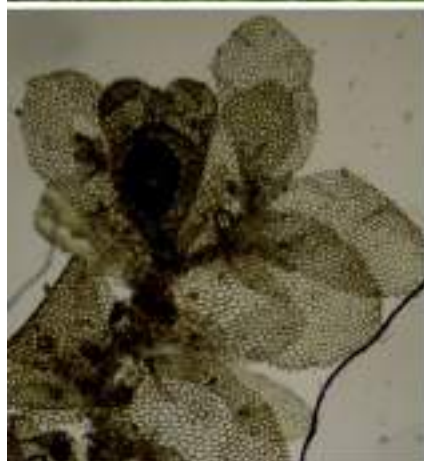
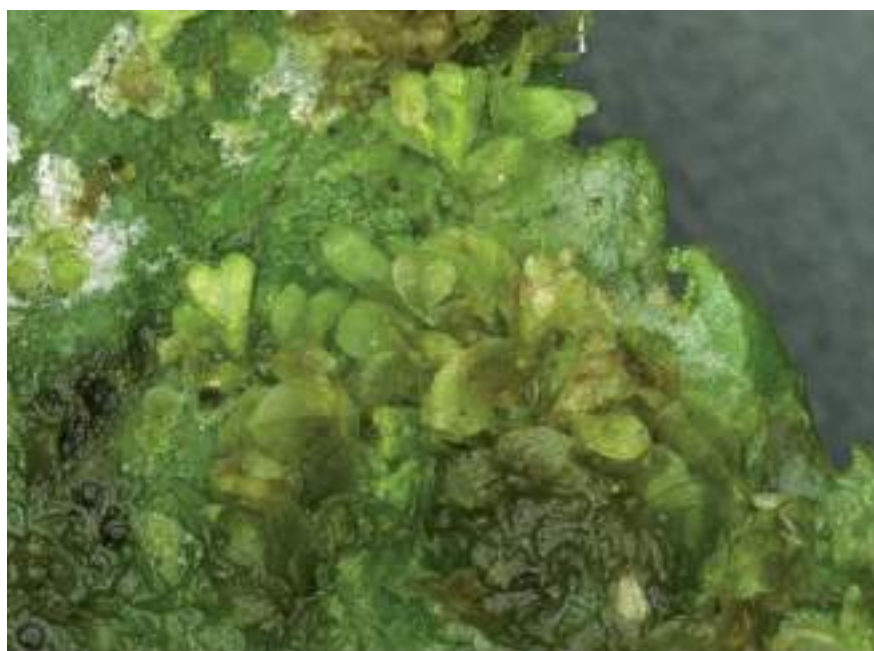
Fig. 121. *Cololejeunea lobulilineata* Tixier

Plants small, up to 0.7 mm wide. Stems up to 0.5 cm long. Lobes rounded-ovate, apex rounded, 0.4 mm long and 0.35 mm wide, pseudovitta short, at base of lobe. Lobules reduced to an rectangular band of 5 cells length and 2 cells width, with apical tooth hardly visible. Asexual reproduction with up to 16-20-celled gemmae. Monoicous. Perianths ovoid, apex rounded, with ventral keels and short rostrum, 0.3 mm long and 0.2 mm wide. **Habitat:** Submontane rain forest, epiphyllous, 1950 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura. **Distribution in Africa:** DR Congo.



Figs 122 and 123 (next page). *Cololejeunea magna* (Tixier) Infante & Heras

Synonyms: *Cololejeunea harrisii* var. *magna* Tixier; *C. harrisii* sensu Vanden Berghen. Plants medium-sized, forming dense mats, shoots (0.9-)1-1.3(-1.6) mm wide. Lobe entire, asymmetrically ovate-reniform, apex rounded, (0.37-)0.4-0.6 x (0.48-)0.6-0.9 mm. Lobule variable, if well developed rather long, 0.14-0.22 x 0.2-0.35 mm, ovate, inflated, apical tooth with 1-2 cells, hyaline papilla at apex of apical tooth, free margin of lobule usually with obtuse tooth, lobule sometimes reduced to a rectangular-ovate row, 0.09-0.12 x 0.14-0.25 mm, distally prolonged into long apical tooth of 2-3 cells width at base, hyaline papilla at apex. Monoicous. Perianth exserted, heart-shaped, compressed, laterally with 2 rounded auricles, 0.7-0.9 x 0.7-1 mm, beak conical, lacking protruding cells. **Habitat:** Montane forest, epiphyllous on *Marattia fraxinea*, 1700-2300 m. **Distribution in Rwanda:** **Nyungwe NP:** Karamba, Kamiranzovu, Uwinka, Rwankuba, km 22 Pindura-Bweyeeye, Gisakura.



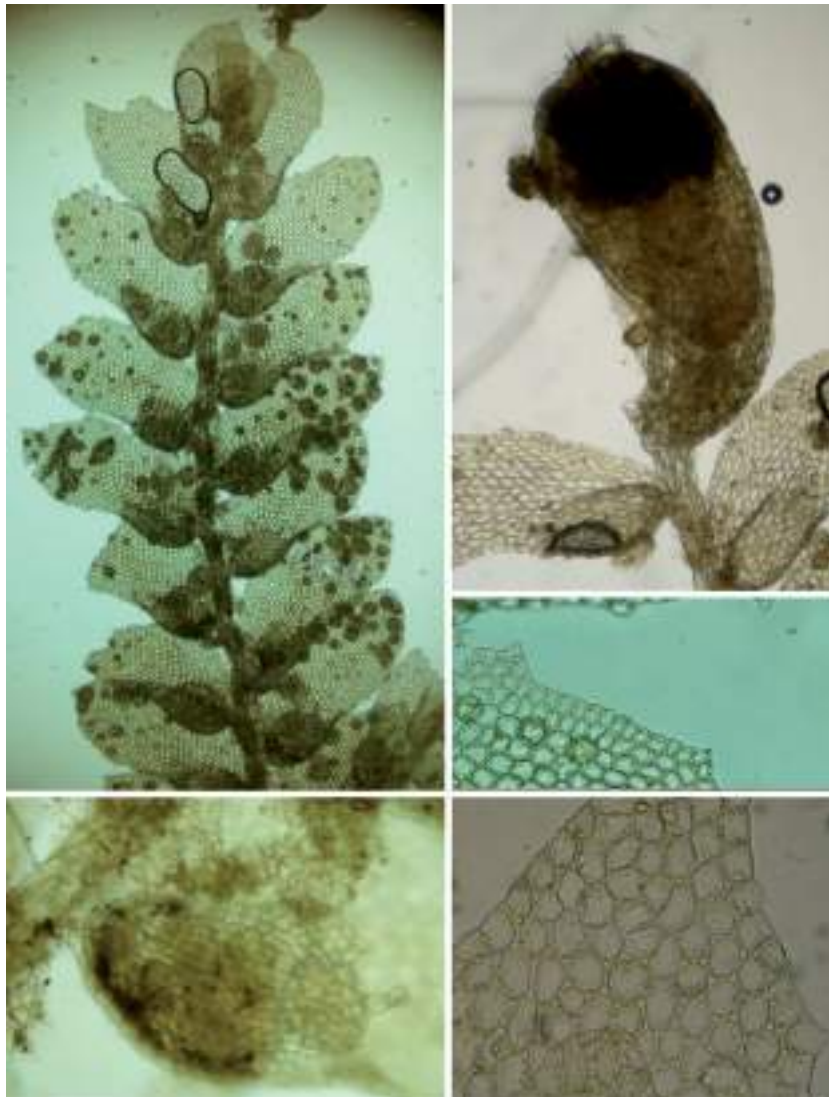
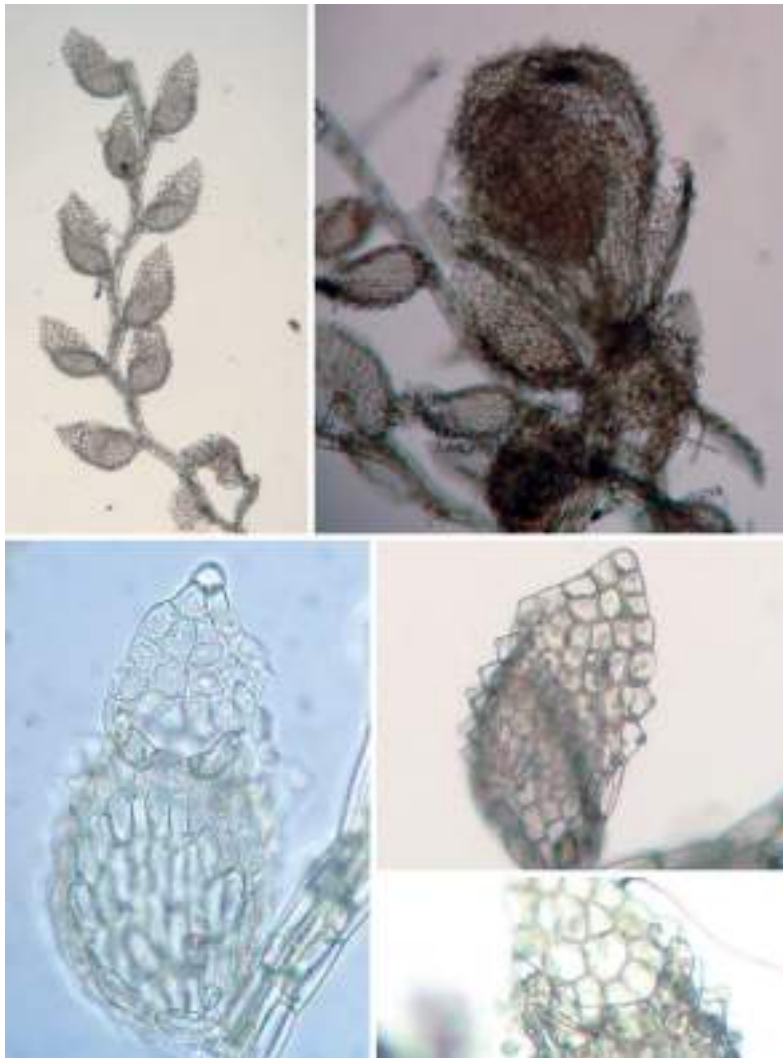


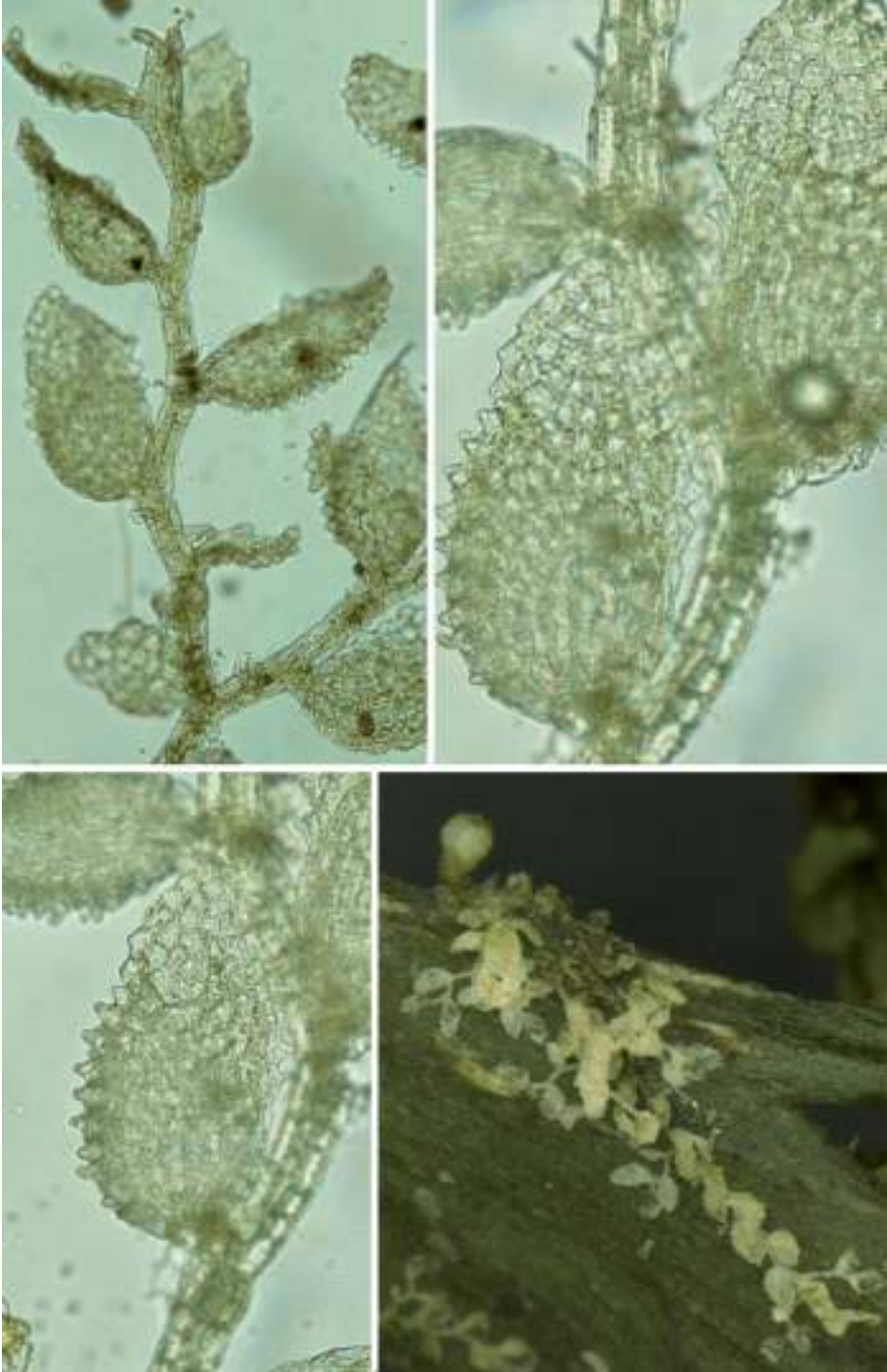
Fig. 124. *Cololejeunea malanjae* Steph.

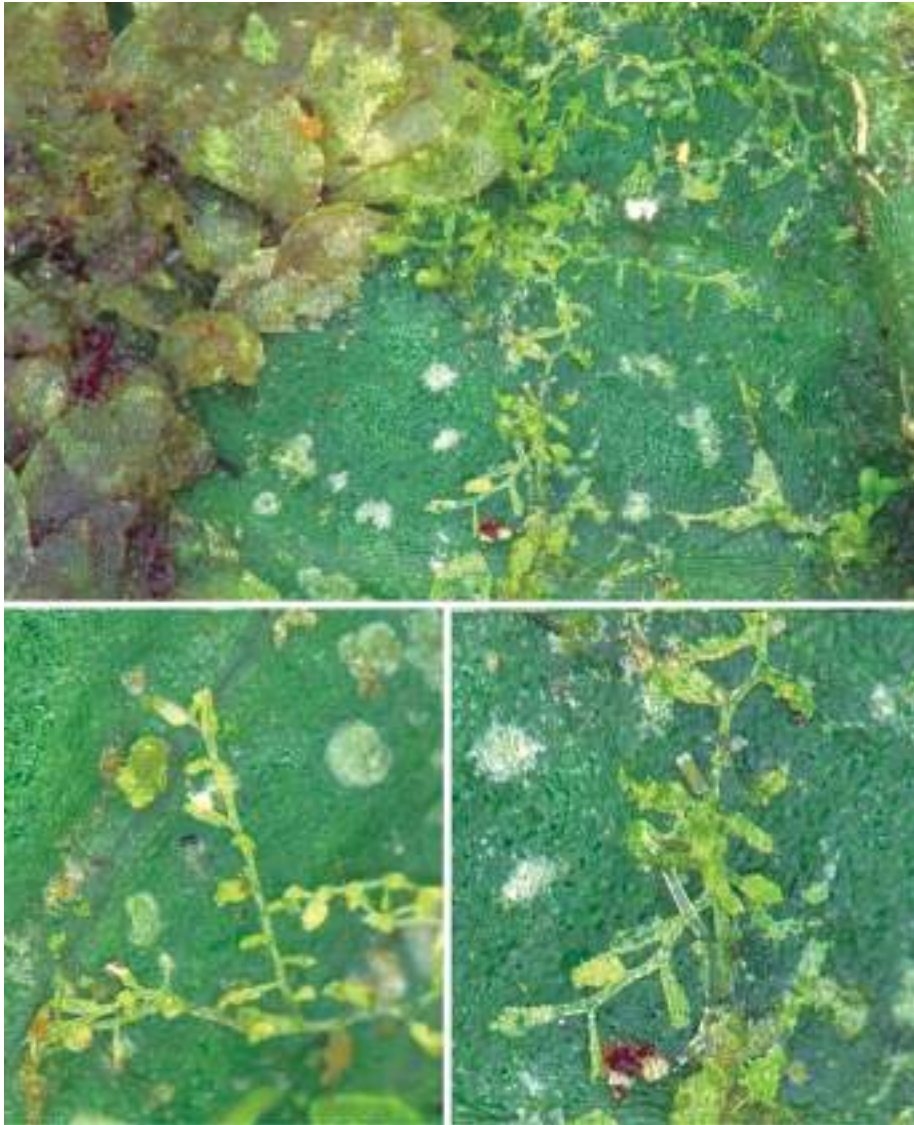
Synonym: *Cololejeunea grossidens* (Steph.) Steph. ex E.W.Jones. Plants small. Leaves distant. Lobes narrowly ovate or oblong, 0.3-0.6 x 0.12-0.2 mm, base cuneate, apex tapering to rounded or subacute point, margins dentate. Lobule about 0.3-0.5 the length of the lobe, sometimes reduced to few cells, inflated, apex flat, truncate, apical tooth of 2-3 cells, inserted in the middle of apex, hyaline papilla at base of apical tooth. Asexual reproduction by gemmae mainly from marginal cells. Autoicous. Perianths 0.5-0.7 x 0.3-0.4 mm, obconical, smooth or slightly mammillose. **Habitat:** Montane forest, epiphyllous, 1900-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Karamba, Kamiranzovu, Uwinka. **Distribution in Africa:** DR Congo, Burundi, Uganda, Kenya, Tanzania, Zimbabwe, Malawi.



Figs 125 and 126 (next page). *Cololejeunea microscopica* (Taylor) A.Evans var. *africana* (Pócs) Pócs & Bernecker

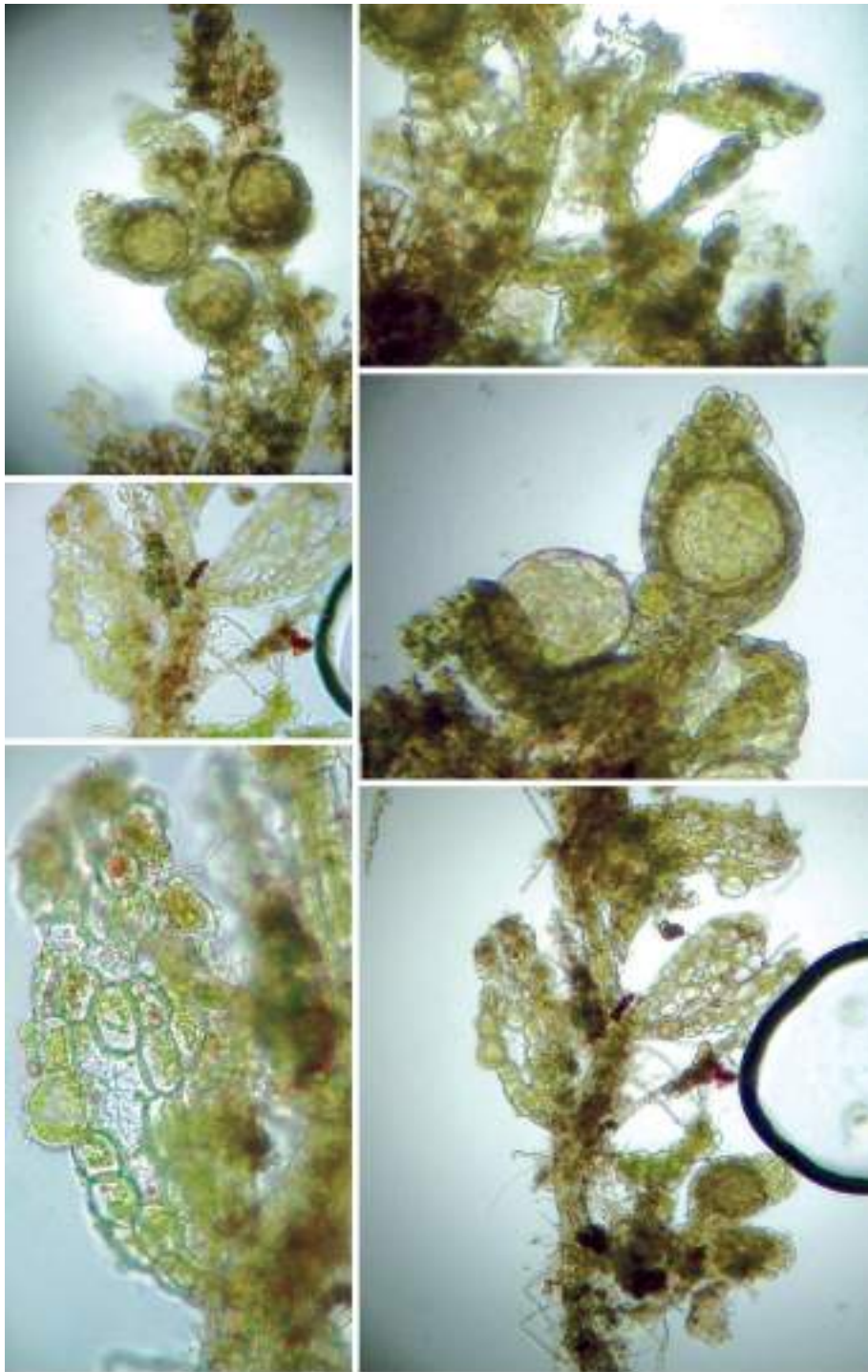
Synonyms: *Aphanolejeunea exigua* A. Evans var. *africana* Pócs; *A.microscopica* var. *exigua* (A.Evans) A.Lücking & Pócs. Plants minute, 0.18-0.35 mm wide, epiphytic or epiphyllous. Lobes of lobulate leaves 0.14-0.24 x 0.09-0.13 mm, ovate to ovate-lanceolate, surface smooth, marginal cells of keel and lobe strongly conical, elobulate leaves few. Lobules inflated, as wide as lobe, and 0.65-0.75 the length of the lobe, with 1 apical tooth, 2-celled and strongly curved. Asexual reproduction by disciform gemmae on marginal cells of the lobe. Autoicous. Perianths inflated, broadly pyriform, about 0.25 x 0.25 mm, obscurely 5-keeled. **Habitat:** Ramicolous on ericaceous shrubs, at base of trees or epiphyllous, 2000-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkoko, Uwinka. **Distribution in Africa:** Ivory Coast, DR Congo, Kenya, Tanzania.





Figs 127 and 128 (next page). *Cololejeunea minuscula* Pócs

Synonym: *Aphanolejeunea minuta* R.M.Schust. Plants extremely minute, resembling a terrestrial alga, 2-5 mm long and 0.13-0.19 mm wide, with remote linear-lingulate to lanceolate elobulate leaves, epiphyllous. Lobes of lobulate leaves 85-130 x 26-40 μ m, ovate to ovate-lanceolate, surface smooth, marginal cells of keel and lobe strongly conical, elobulate leaves with lobule reduced to single cell. Lobules usually only on bracts, inflated, as wide as lobe, and 0.5-0.6 the length of the lobe, with a 1-celled apical tooth. Asexual reproduction by disciform gemmae on marginal cells of the lobe. Dioicous. **Habitat:** Montane forest, usually epiphyllous, 2250-2300 m. **Distribution in Rwanda:** Nyungwe **NP:** Gisakura. Also USA (Florida).



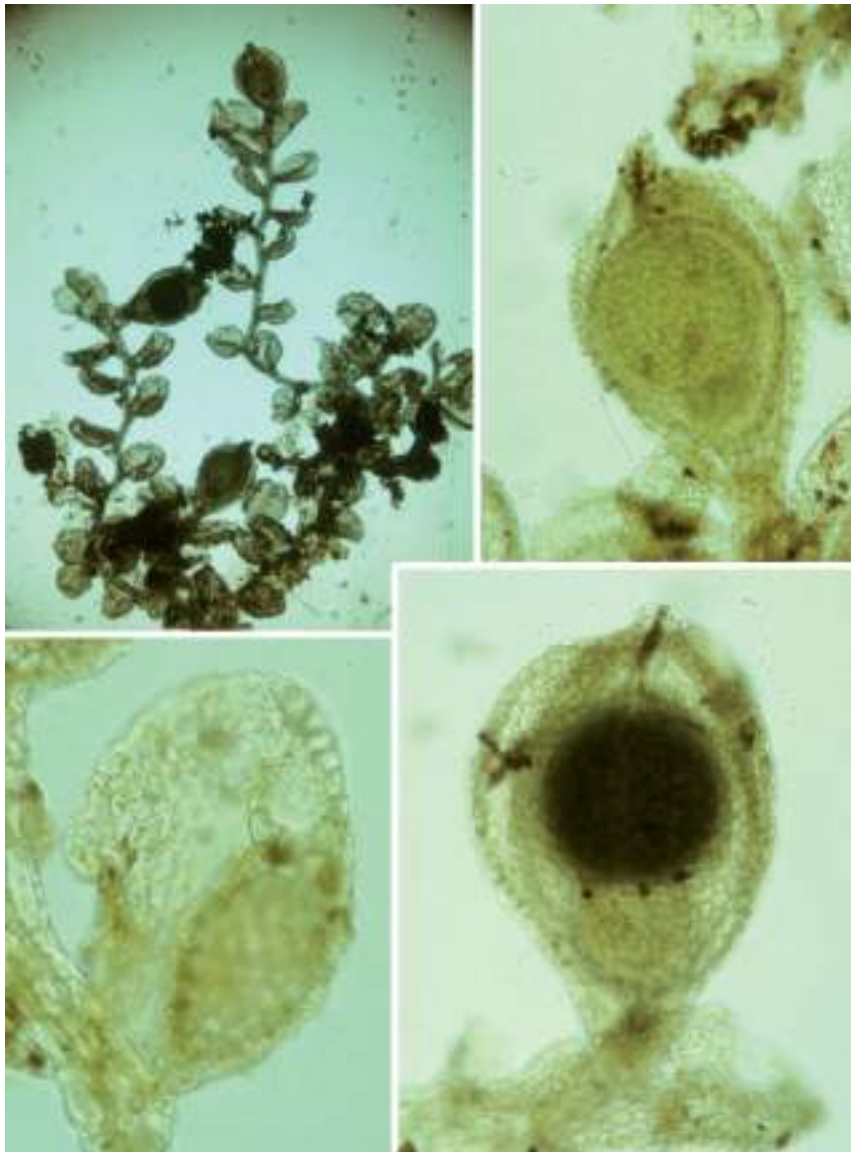


Fig. 129. *Cololejeunea minutissima* (Sm.) Schiffn. ssp. *minutissima*

Plants very small, shoots 0.25-0.6 mm wide. Leaves distant to contiguous, complicate. Lobe 0.2-0.38 x 0.17-0.25 mm, strongly convex, apex rounded. Lobule inflated, 0.8-0.95 of lobe length, apical tooth prominent, long or short, with hyaline papilla at base. Autoicous.

Female bracts with well developed lobule. Perianth exserted, pyriform, 0.3 x 0.27 mm.
Habitat: Epiphyte on small twigs in montane rainforest and ericaceous shrub, 2500-2900 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkoko. **Distribution in Africa:** Ivory Coast, DR Congo, Uganda, Kenya, Tanzania, Malawi, Zimbabwe, South Africa. Also Western Europe, North America, Cape Verde, Madagascar, Réunion, Rodriguez.

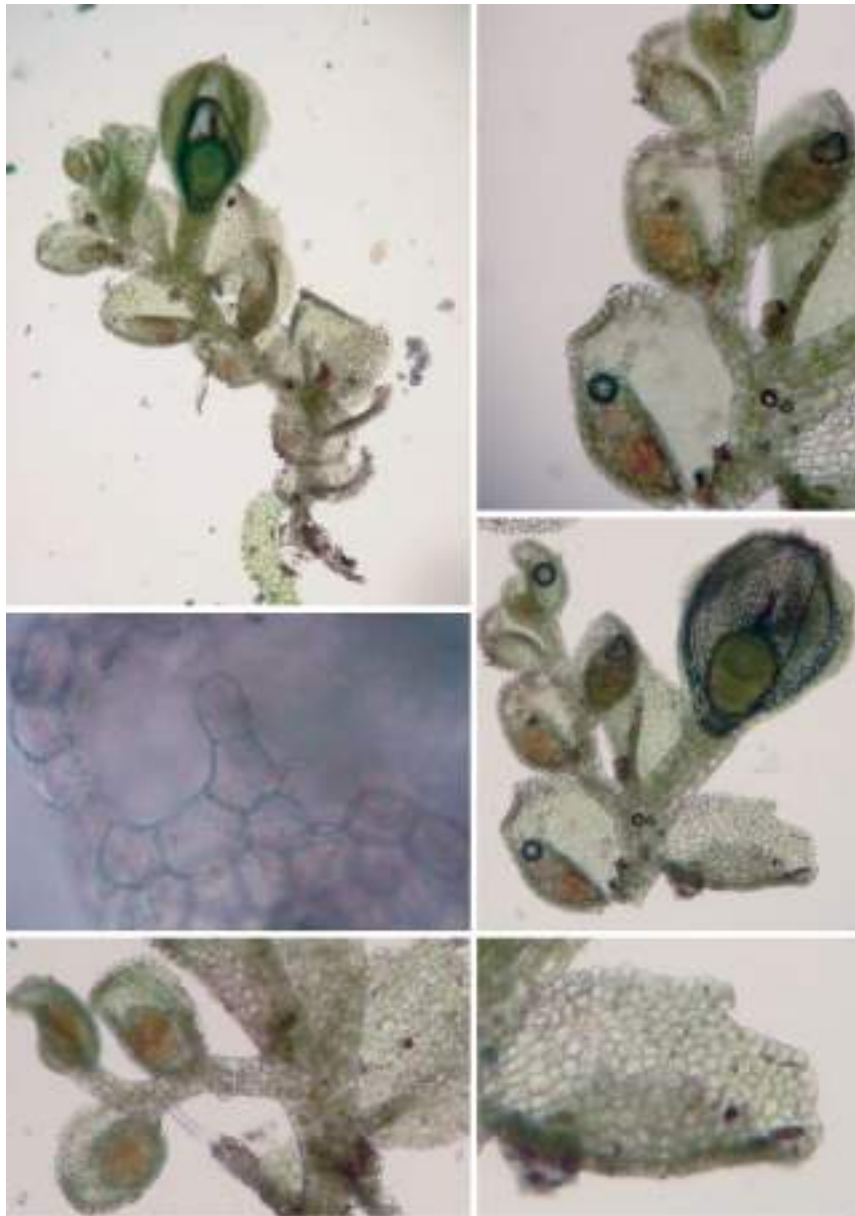


Fig. 130. *Cololejeunea minutissima* ssp. *utriculifera* Vanden Berghen

Similar to *Cololejeunea minutissima* ssp. *minutissima*, but differs in the utriculiferous leaves where the leaf is transformed into a globose utricule with the lobule as large as the lobe, and the stipitate perianth. **Habitat:** Epiphyte on small twigs in montane rainforest and ericaceous shrub, 2000-2400 m. **Distribution in Rwanda:** **Gishwati Forest:** Gikungu.

Nyungwe NP: Rwasenkoko. **Distribution in Africa:** Burundi, Tanzania.

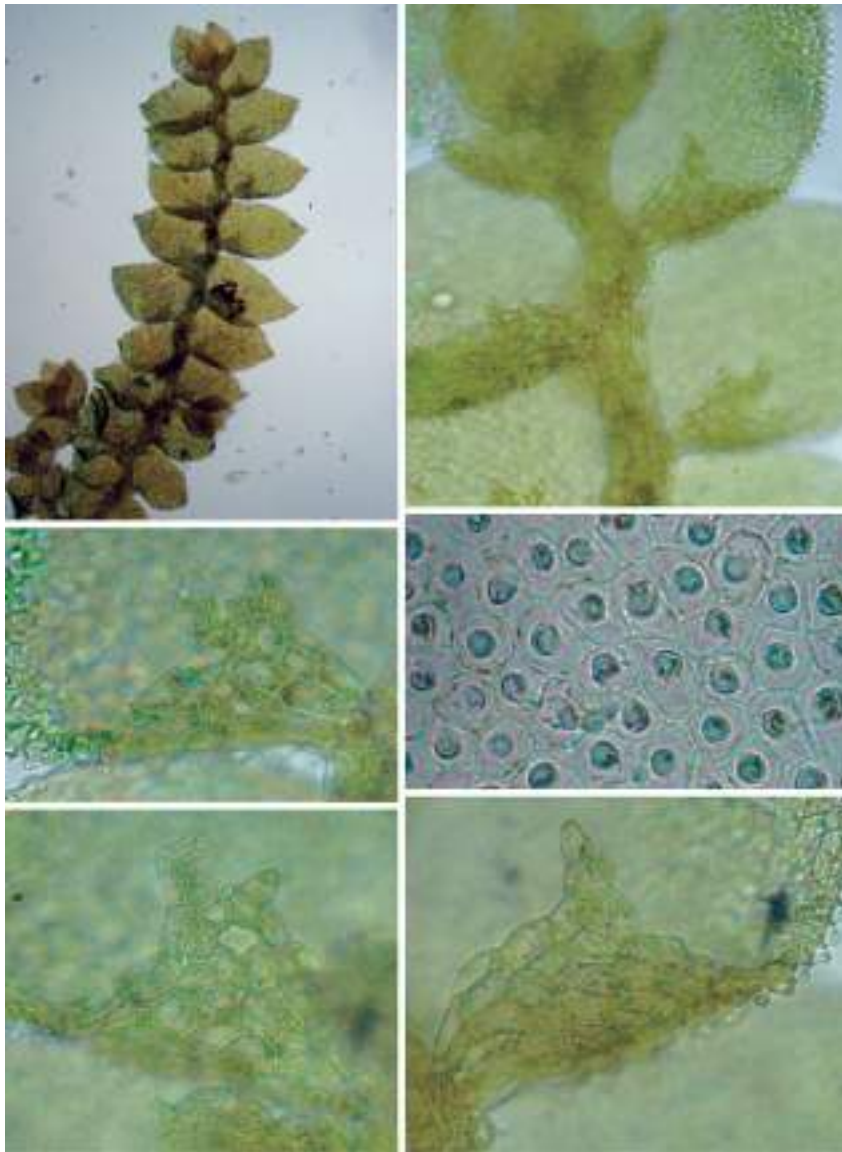


Fig. 131. *Cololejeunea mocambiquensis* S.W.Arnell

Plants small, shoots 0.3-0.5 mm wide and 2 mm long. Lobe subquadrate, acute at apex, dorsal base truncate, densely denticulate at margin by acute papillose cells, 0.15-0.18 x 0.21-0.25 mm, dorsal cells with straight conical papilla. Lobule irregularly dentate, half the size of the lobe. Cells about 10 μ m in diameter, trigones lacking. Dioicous. Male bracts similar to vegetative leaves. **Habitat:** Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda: Nyungwe NP:** Cyamudongo Forest. **Distribution in Africa:** Uganda, Kenya, Tanzania, Malawi, Mozambique, South Africa. Also Madagascar.

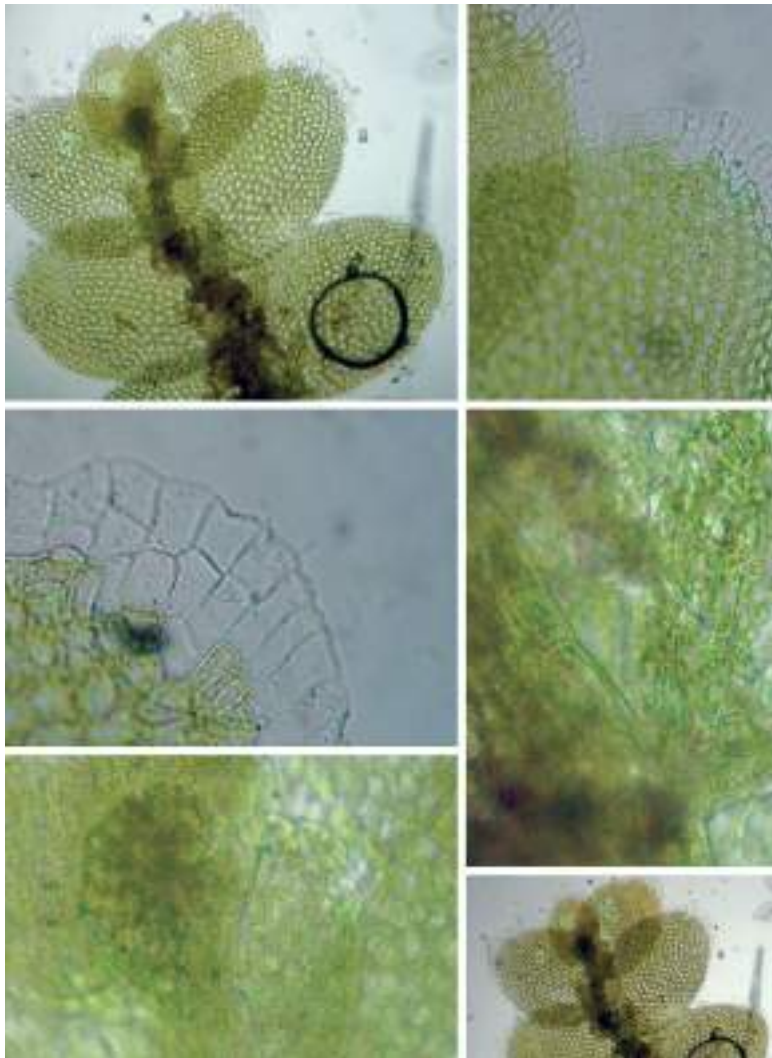


Fig. 132. *Cololejeunea nigerica* (E.W.Jones) R.M.Schust.

Plants medium-sized, shoots 1.4-1.8 mm wide. Lobe ovate, 0.7-1 x 0.45-0.7 mm, base auriculate, apex usually narrowed, hyaline cells in 2-3 rows, usually a sharply demarcated group at lobe apex, ending abruptly at the distal end of the ventral margin, on the dorsal margin either ending abruptly or extending as a single narrow line. Lobule narrow, lingulate, 8-9 cells wide proximally, 2-6 cells wide distally, often narrowed at a tooth near the narrower distal part, thus appearing sometimes bifid, stylus in the form of a papilla. Autoicous. Perianth pyriform, compressed, 0.6-0.75 mm long, without dorsal keels or with a short median keel on dorsal side, ventrally scarcely keeled. **Habitat:** Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda: Nyungwe NP:** Cyamudongo Forest. **Distribution in Africa:** Sierra Leone, Ivory Coast, Ghana, Togo, Nigeria, Cameroon, DR Congo, Uganda, Tanzania.

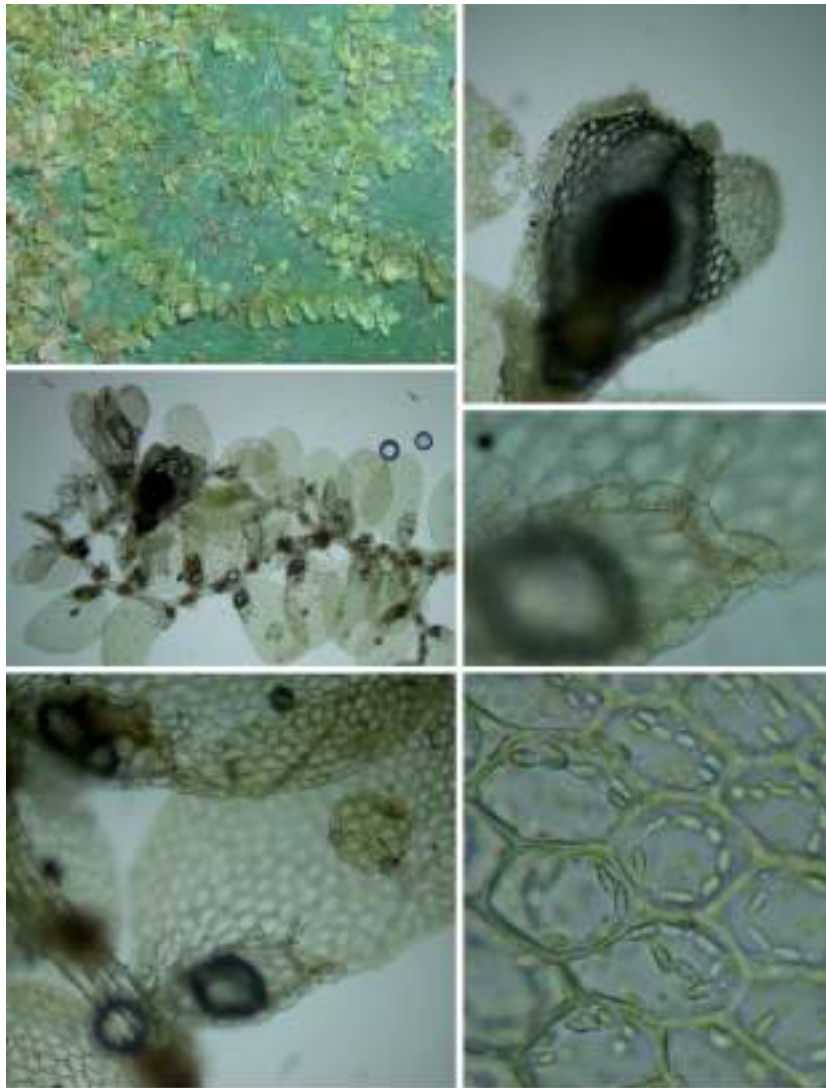
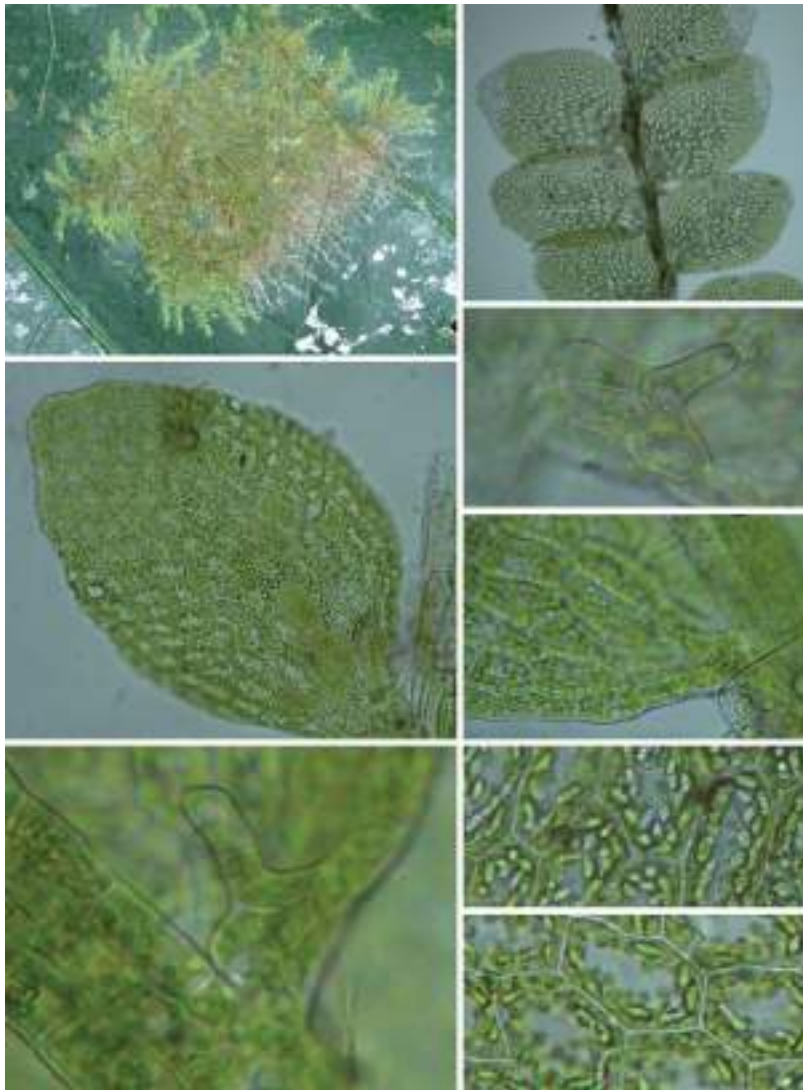
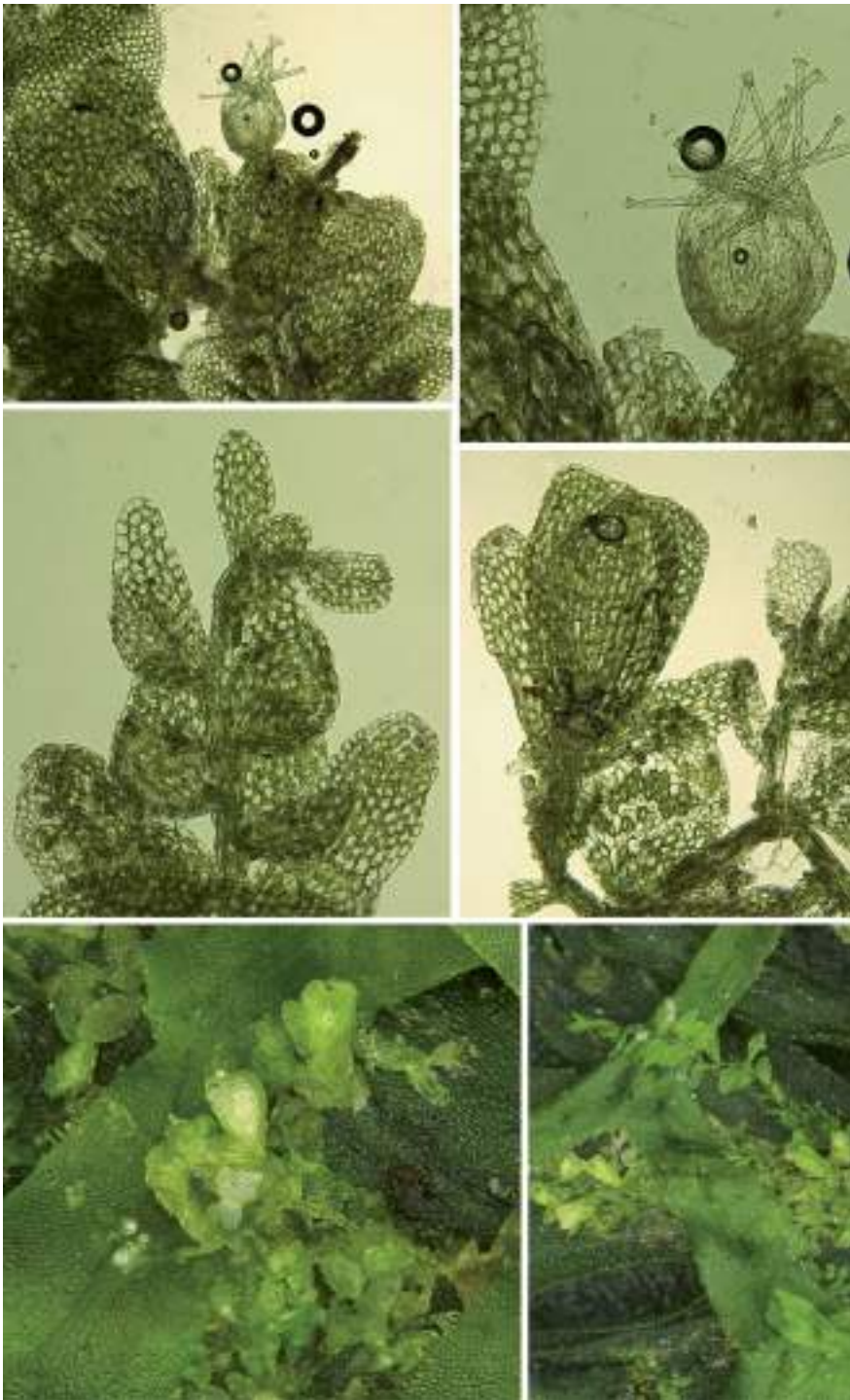


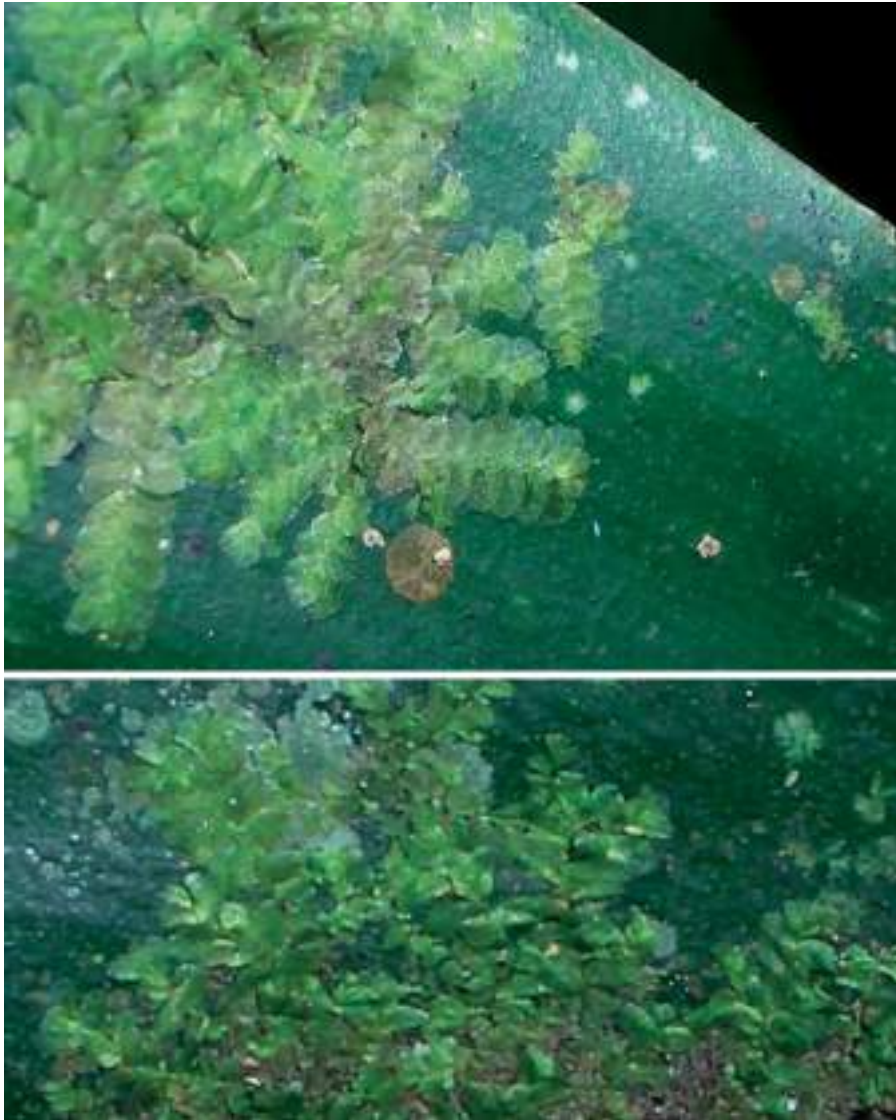
Fig. 133. *Cololejeunea obliqua* (Nees & Mont.) Schiffn.

Plants medium-sized, shoots up to 0.9-1.5(-2) mm wide. Leaves spreading at (45-)60-90° to the stem. Lobes ovate to oblong-ovate, 0.6-1.2 x 0.4-0.7 mm, base rounded or truncate, margin crenulated with papillate cells. Lobule 0.25-0.3 the length of the lobe, apical tooth of 2 short cells, with spherical hyaline papilla at the base or the middle of its proximal side, proximal tooth on free margin of lobule 1-celled, variable. Gemmae on both sides of the leaf. Autoicous. Perianths c. 0.7 x 0.5 mm, obcordate, compressed, ventrally inflated. **Habitat:** Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo Forest. **Distribution in Africa:** Guinea, Sierra Leone, Ivory Coast, Ghana, Togo, Nigeria, São Tomé, Bioko, Rio Muni, Cameroon, DR Congo, Burundi, Uganda, Tanzania, Zambia. Also Comoros, Madagascar, Réunion, Mauritius, Seychelles.

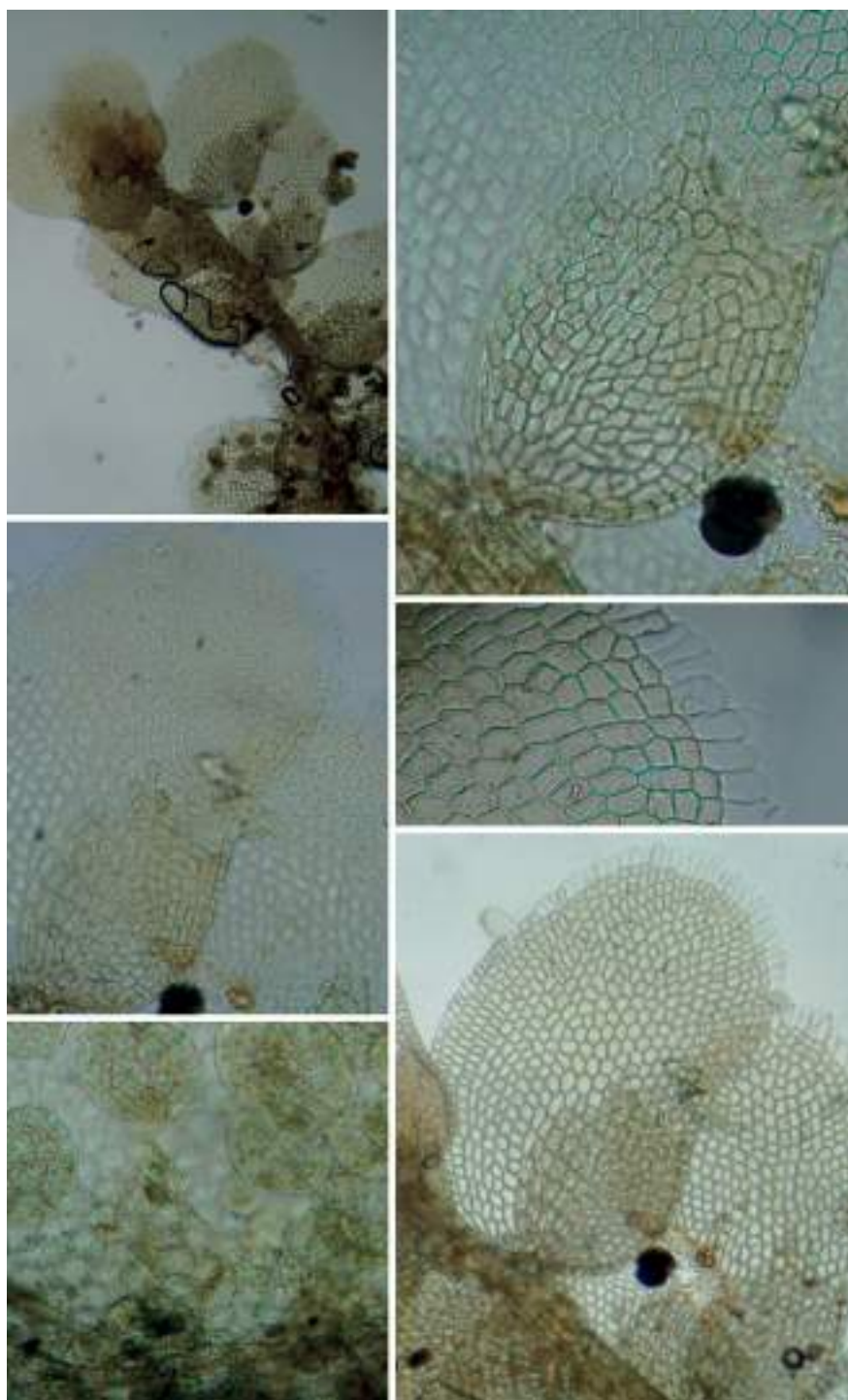


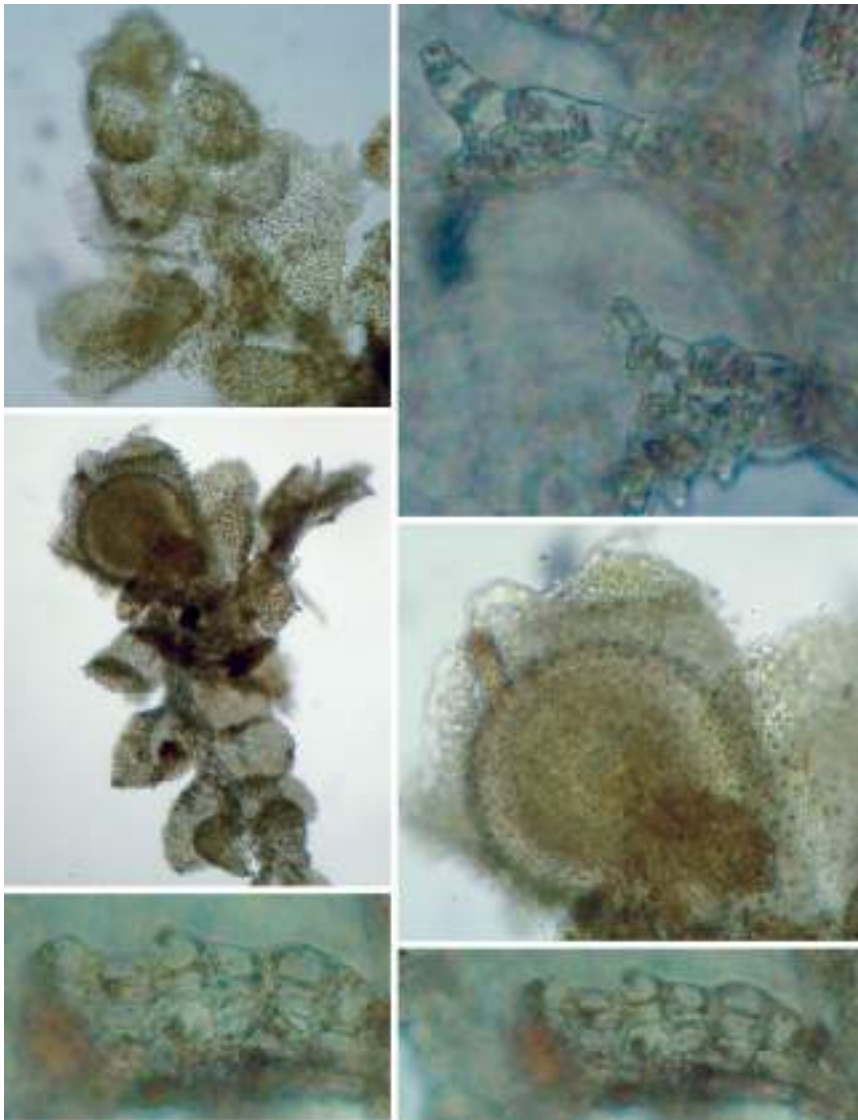
Figs 134 and 135 (next page). *Cololejeunea obtusifolia* (E.W.Jones) Tixier
 Synonym: *Cololejeunea pusilla* var. *obtusifolia* E.W.Jones. Plants small, shoots 0.5-0.8(-1) mm wide. Leaves approximate, spreading at 50-80° to the stem. Lobe up to 0.4-0.6 mm long, ovate, with broad rounded apex. Lobule reduced to a few (4-8) cells, 36-55 x 22-40 µm. Gemmae on non-marginal lobe cells. Autoicous. Perianth pyriform and terete, 0.4-0.6 x 0.3-0.4 mm, with 5 keels. **Habitat:** Epiphyllous in submontane and montane forest, 1600-2000 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo Forest, Kamiranzovu, Uwinka, Gisakura. **Distribution in Africa:** Guinea-Bissau, Guinea, Sierra Leone, Ivory Coast, Ghana, Nigeria, Bioko, Cameroon, Rio Muni, DR Congo, Burundi, Ethiopia, Kenya, Tanzania. Also Madagascar.



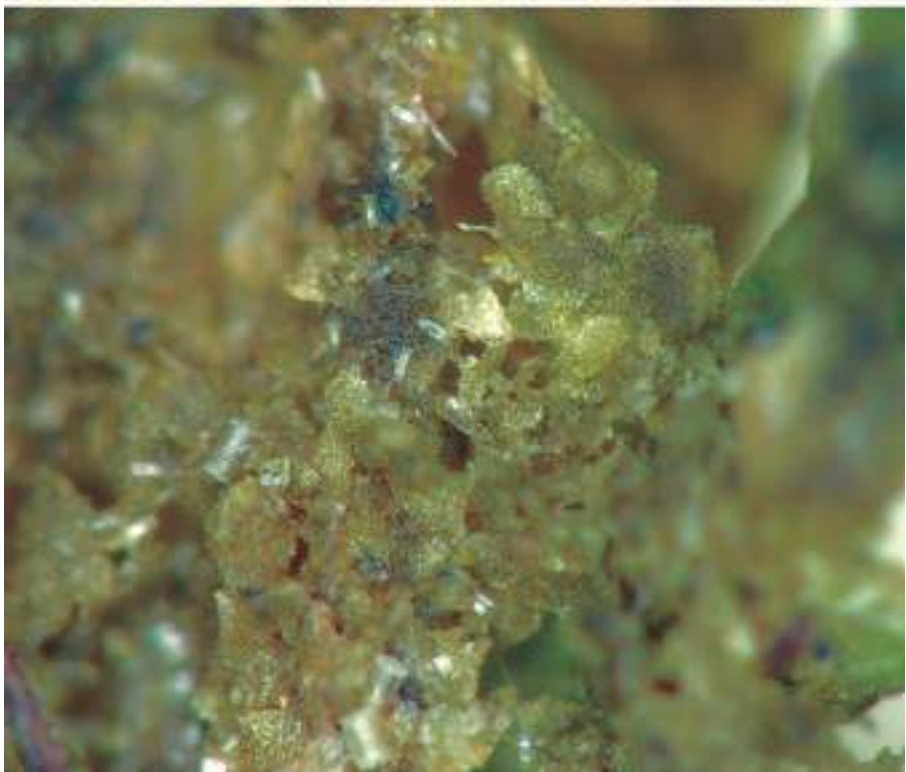


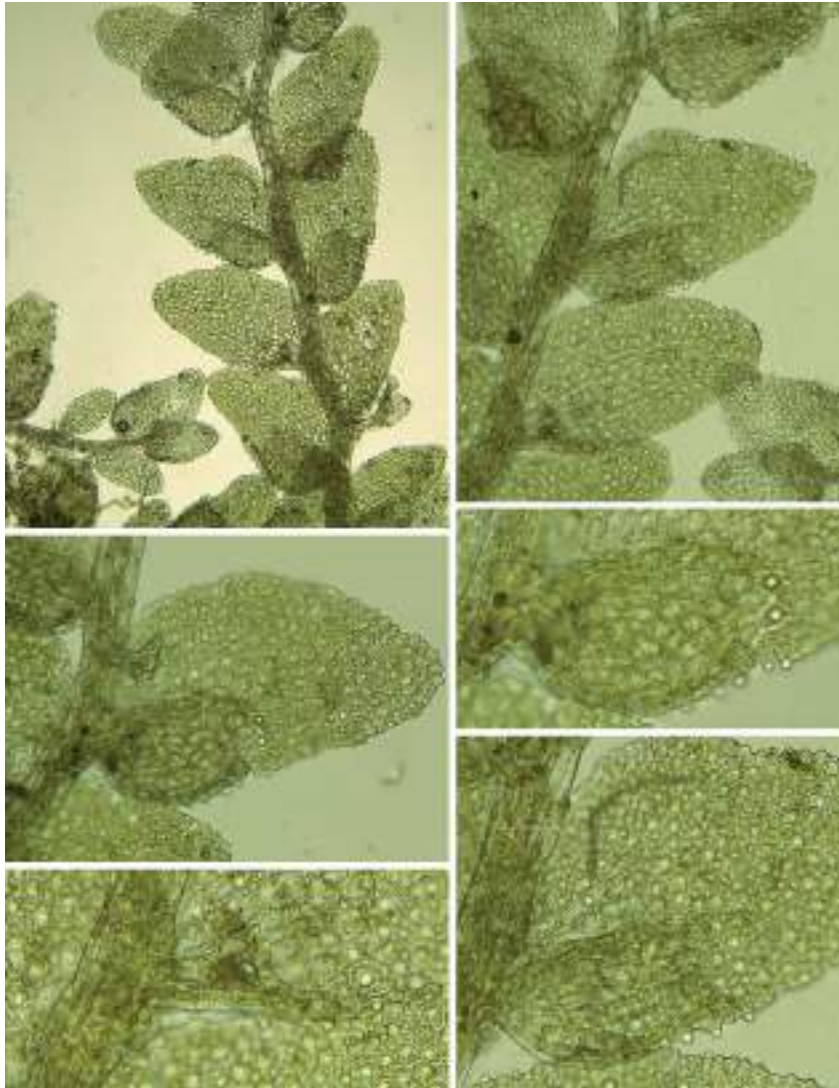
Figs 136 and 137 (next page). *Cololejeunea occidentalis* (E.W.Jones) Vanden Berghen
 Plants medium-sized to large, shoots (1.5-)1.8-2 mm wide. Lobe ovate-reniform, c. 0.9-1.2 x 0.65-0.85 mm, apex broadly rounded, hyaline margin fimbriate, forming a border 1 row wide around most of the lobe, abruptly ending on ventral margin. Lobule ovate, 0.4-0.55 x 0.25-0.3, distal margin with 2 teeth, the apical tooth with a globose or clubshaped hyaline papilla at the side or base of the apical cell. Chlorophyllose cells with smooth cuticle. **Habitat:** Montane forest, epiphyllous, 1700 m. **Distribution in Rwanda:** Nyungwe NP: Cyamudongo Forest. **Distribution in Africa:** Nigeria, Kenya, Tanzania, Zimbabwe, Malawi, South Africa.



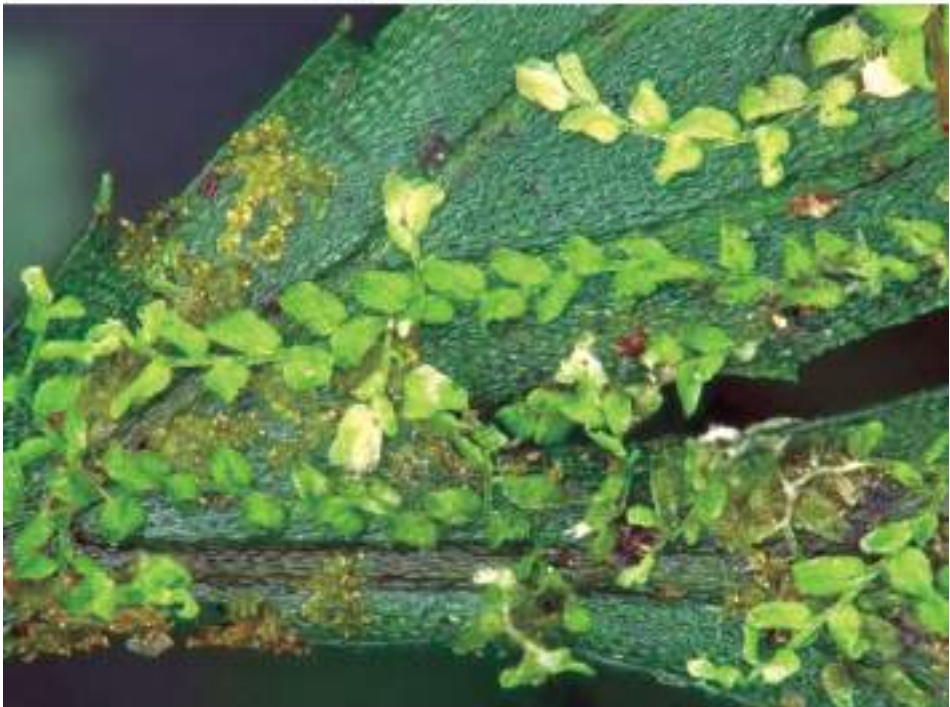


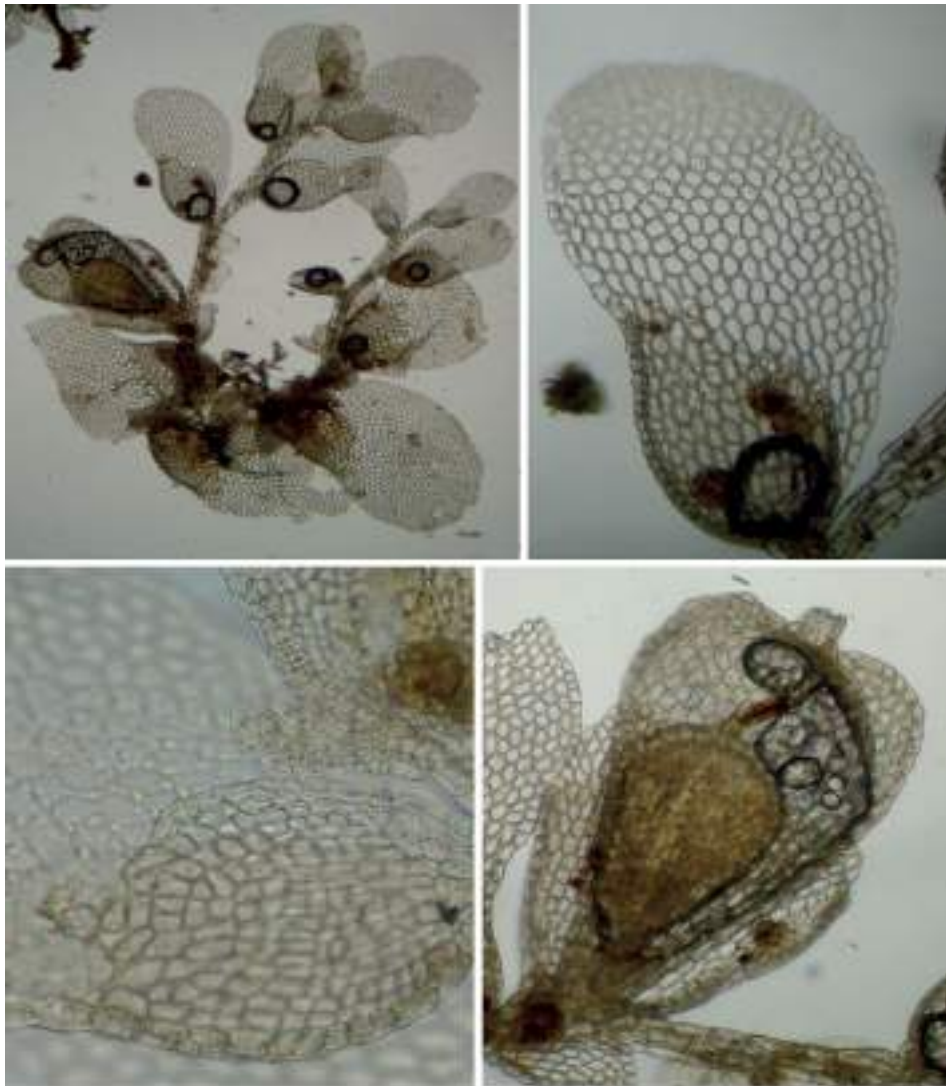
Figs 138 and 139 (next page). *Cololejeunea parva* Vanden Berghen
 Plants small, shoots 0.38-0.53 mm wide. Lobe ovate, acute at apex, dorsal base truncate, densely denticulate at margin by acute papillose cells, 0.15-0.185 x 0.21-0.27 mm, dorsal cells with straight conical papilla. Lobule variable, often rather small, forming a few-celled row, 0.036-0.045 x 0.045-0.075 mm, ending in an acute apical tooth, consisting of 1 cell or 2 adjacent cells surmounted by 1 cell, hyaline papilla at apex of apical tooth. Monoicous. Perianth exserted, inflated, clubshaped, rounded or truncate at apex, with 2 ventral keels, papillose, 0.25-0.36 x 0.42-0.55 mm. **Habitat:** On mosses and epiphyllous in montane forest, 2000-2200 m. **Distribution in Rwanda: Gishwati Forest:** Gikungu, vallée Bikeneko. **Distribution in Africa:** Uganda.





Figs 140 and 141 (next page). *Cololejeunea platyneura* (Spruce) S.W.Arnell
 Synonym: *Cololejeunea usambarica* E.W.Jones. Plants small, shoots 0.4-0.6 mm wide. Lobe convex, decurved, ovate, slightly falcate, 0.25-0.32 x 0.15-0.18 mm. Cells papillose, vitta 3-4 cells long, in 1-2 rows, usually not clearly demarcated, bordered by elongate papillose cells intermediate in size, vitta cells without papilla. Lobule 0.4-0.5 the length of the lobe, inflated, distal cell of free margin projecting as an acute tooth, apical tooth of 2 cells, usually overlapping with distal tooth. Monoicous (?). Perianth pyriform, ventrally inflated, papillose. **Habitat:** Epiphyllous in submontane forest, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Kamiranzovu. **Distribution in Africa:** Guinea, Sierra Leone, Nigeria, DR Congo, Tanzania. Also Madagascar.





Figs 142 and 143 (next page). *Cololejeunea pseudo-obliqua* Tixier

Plants medium-sized, up to 0.8 mm wide. Stems up to 1 cm long. Lobes ovate, apex rounded, 0.5 x 0.3 mm. Lobules saccate, inflated, reaching middle of lobe, with 2 teeth, apical tooth unicellular, hardly visible, median tooth 2-cellular, hyaline papilla at median tooth. Asexual reproduction with up to 24-celled gemmae. Monoicous. Perianths ovoid, apex truncate, without ventral keels, 0.5 x 0.3 mm wide, papillose at apex. **Habitat:** Epiphyllous in montane forest, 2000 m. **Distribution in Rwanda:** Nyungwe NP: Karamba, Kamiranzovu. **Distribution in Africa:** DR Congo. **Note:** Tixier (1995) cites erroneously DR Congo, Kahuzi-Biéga as type locality (misspelled as 'Kahuzi Riega', 'forêt à *Cootea ussambarica*' = *Ocotea usambarensis*), but indicates correctly the collection number of the type locality in Rwanda.





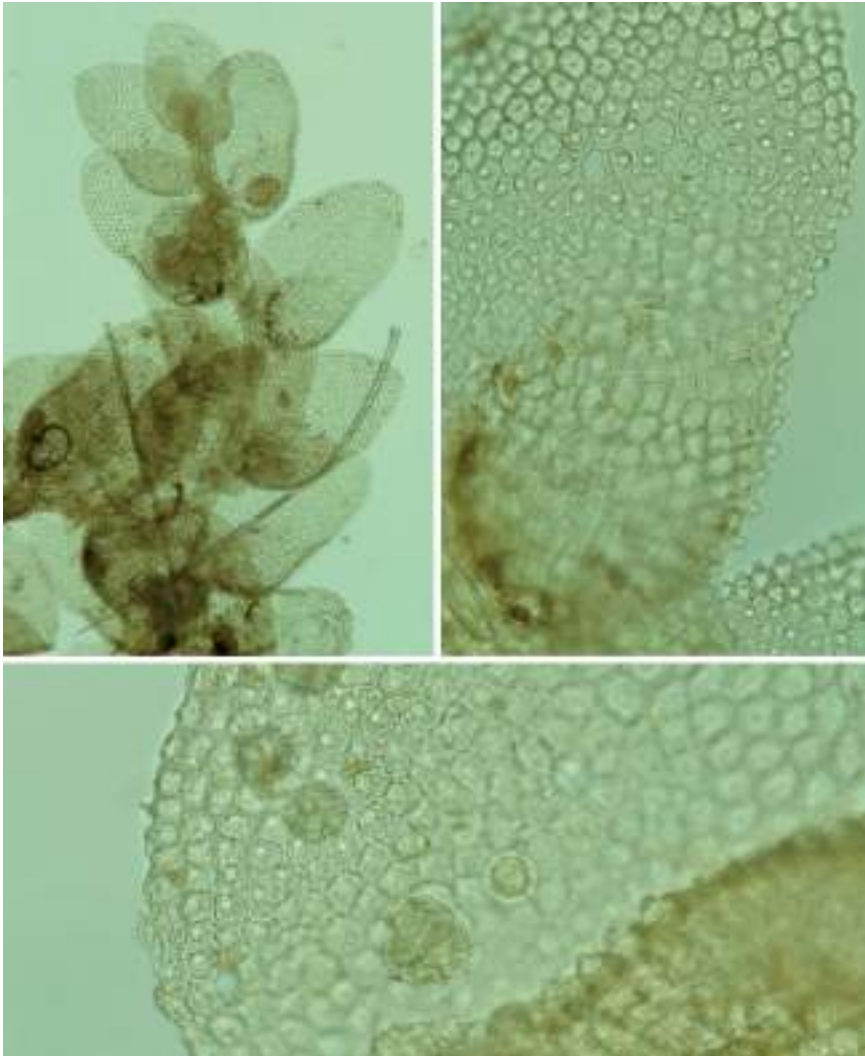
Fig. 144. *Cololejeunea pseudo-pusilla* Tixier

Plants small, up to 0.7 mm wide. Stems up to 0.5 cm long, up to 60 μ m in diameter. Lobes ovate, acuminate at apex, 0.3 mm long and 0.2 mm wide. Lobules saccate, inflated, well developed or reduced, well developed lobule 150 μ m long and 100 μ m wide, with apical tooth hardly visible, median tooth 2-cellular, hyaline papilla at base of median tooth. Asexual reproduction with up to 22-24-celled gemmae. Monoicous. Perianths ovoid, apex rounded, without ventral keels, 0.4 mm long and 0.2 mm wide. **Habitat:** Submontane rain forest, 1950 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura. **Distribution in Africa:** DR Congo.



Fig. 145. *Cololejeunea pusilla* Steph.

Synonym: *Cololejeunea pusilla* Steph. var. *pusilla*. Plants small, shoots 0.5-0.8(-1) mm wide. Leaves approximate, spreading at 50-80° to the stem. Lobe up to 0.4-0.6 mm long, ovate-lanceolate, with acute apex. Lobule reduced to a few (4-8) cells, 36-55 x 22-40 µm. Gemmae on non-marginal lobe cells. Autoicous. Perianth pyriform and terete, 0.4-0.6 x 0.3-0.4 mm, with 5 keels. **Habitat:** Epiphyllous in montane forest, 2000-2100 m. **Distribution in Rwanda:** Nyungwe NP: Karamba, Uwinka. **Distribution in Africa:** Guinea, Ghana, Togo, Nigeria, Bioko, Cameroon, Gabon, Rio Muni.



Figs 146 and 147 (next page). *Cololejeunea runssorensis* (Steph.) Pócs
 Synonyms: *Cololejeunea leonardii* Vanden Berghen; *C. elegans* auct. non Steph. Plants medium-sized, shoots 0.8-1.2 mm wide. Stem 2-5 mm long. Lobe elliptical, rounded at apex, crenulate at margin by papillose cells, 0.3-0.4(-0.5) x 0.54-0.64 mm. Lobule well developed, c. 1/3-2/5 of lobe length, 0.13-0.18 x 0.2-0.27 mm, sometimes inflated in basal part, with 2 teeth, apical tooth consisting of 1-3 cells, proximal tooth of 1 cell, sometimes lobule reduced to a few cells and then only 1 tooth developed. Cells of lobe each with papilla on dorsal side. Monoicous. Perianth exserted, compressed, obovate, 0.375 x 0.6 mm, lateral keels slightly auriculate, ventral keel obtuse, cells papillose. **Habitat:** Epiphyllous in montane forest, 1900-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkoko, Karamba, Kamiranzovu, Rwankuba, Uwinka, Gisakura. **Distribution in Africa:** DR Congo, Burundi, Uganda, Kenya, Malawi.

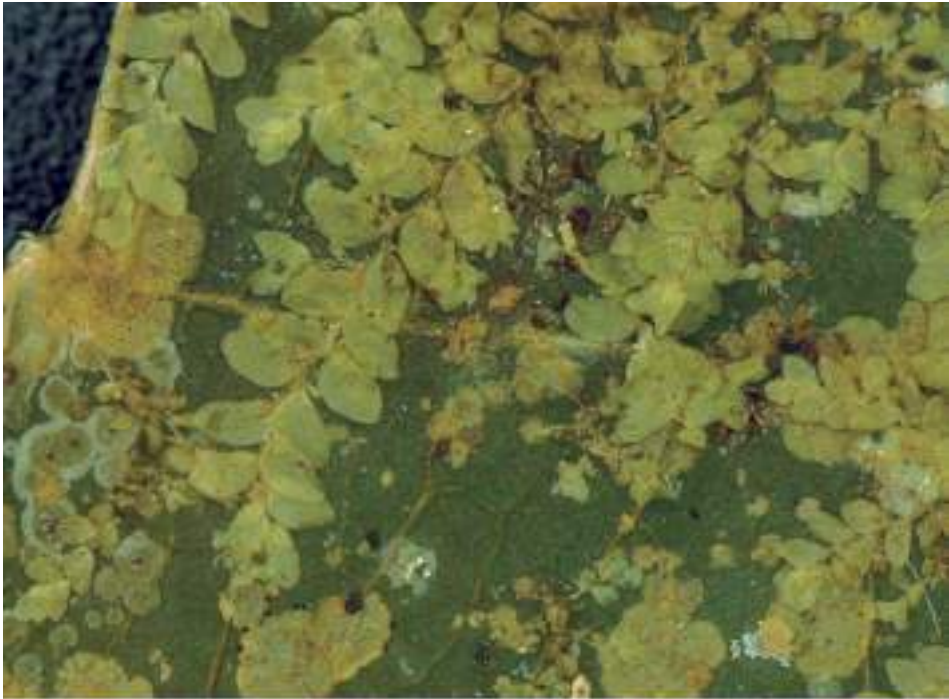


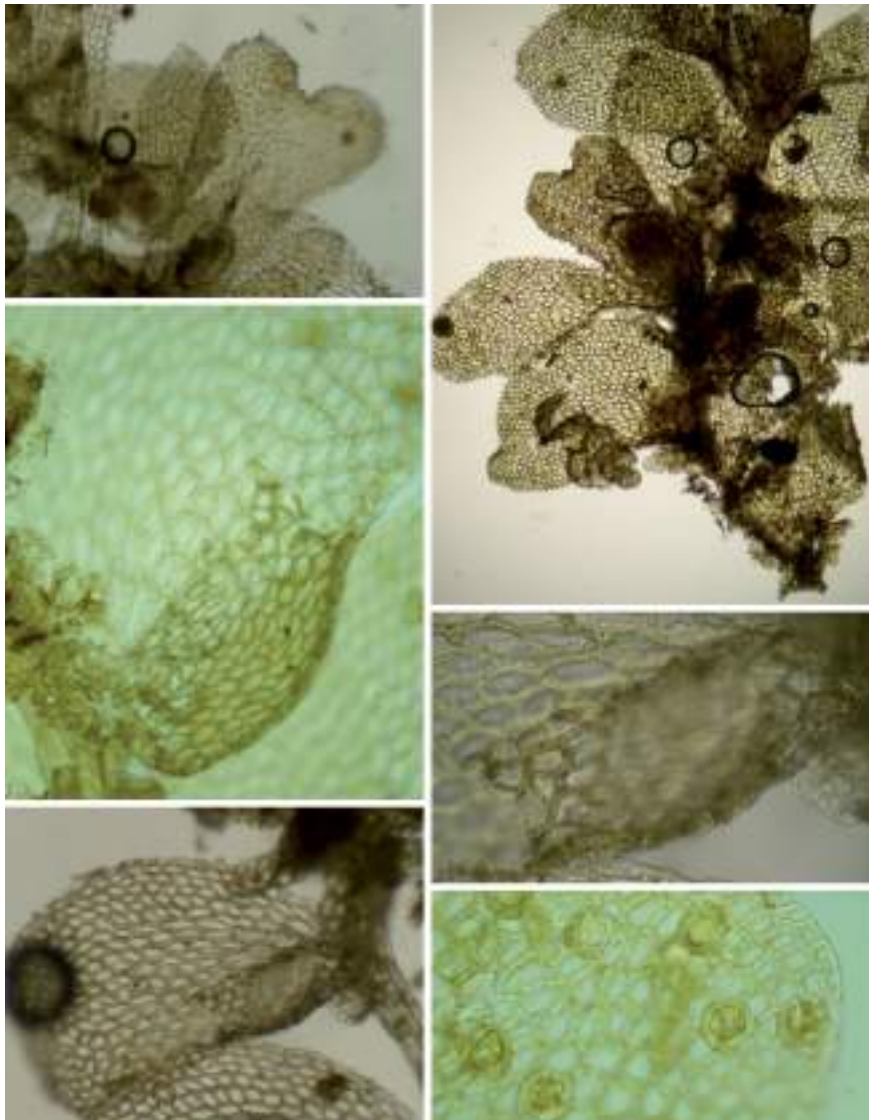


Fig. 148. *Cololejeunea sphaerocarpa* Tixier

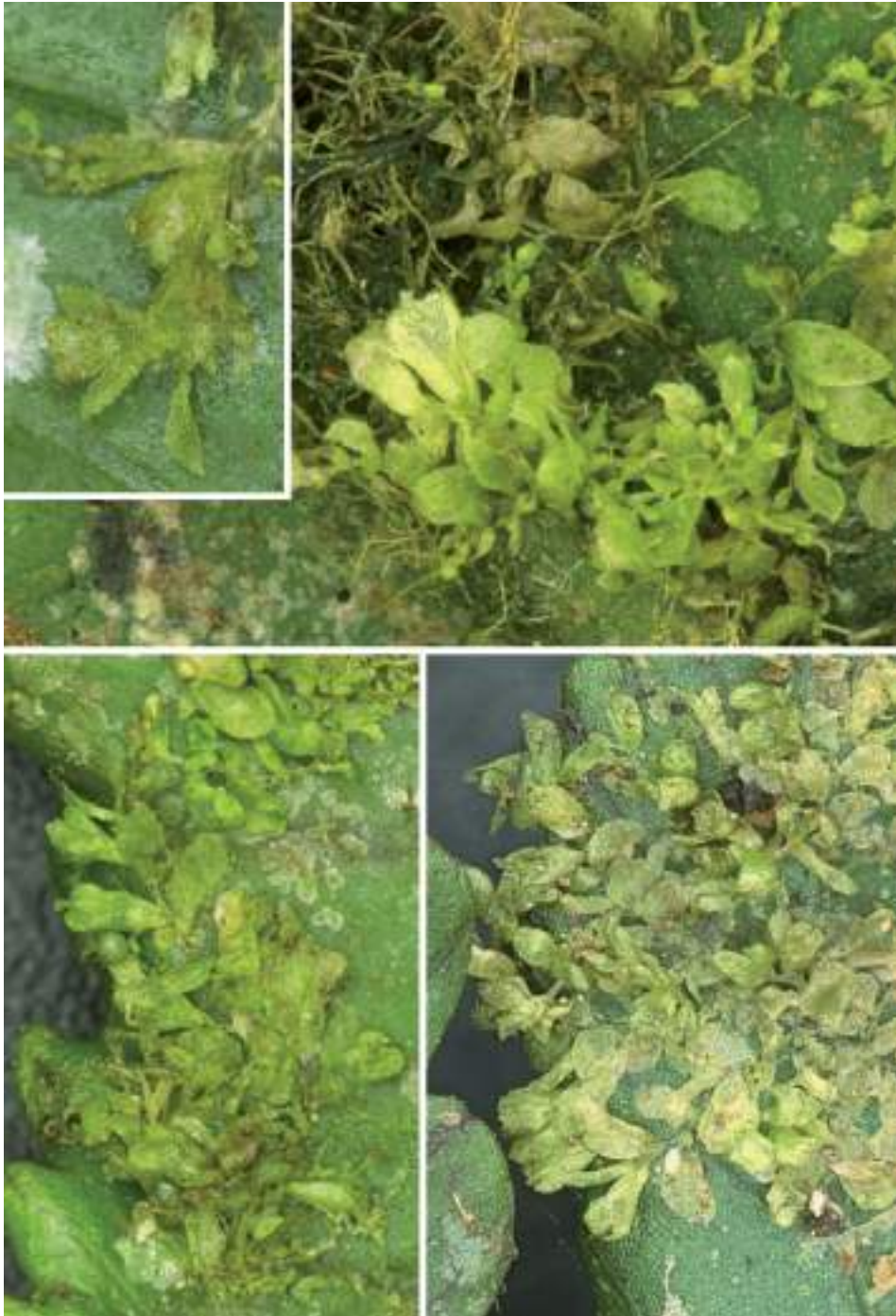
Plants small, up to 0.5 mm wide. Stems up to 1 cm long, branched, up to 60 µm in diameter. Lobes rounded-ovate, apex rounded, pseudovitta short, at base of lobe. Lobules usually reduced, triangular, keel straight, with apical tooth unicellular, well developed lobules sometimes present. Asexual reproduction with up to 24-celled gemmae.

Monoicous. Perianths spherical, apex rounded, with indistinct ventral keels and short rostrum, 0.25 mm long and 0.2 mm wide. **Habitat:** Epiphyllous in montane forest, 2100 m.

Distribution in Rwanda: Nyungwe NP: Uwinka. **Distribution in Africa:** DR Congo.



Figs 149 and 150 (next page). *Cololejeunea tenuiparietata* Tixier
 Plants medium-sized, up to 1.7 mm wide. Stems up to 1 cm long. Lobes elongate, slightly rectangular, apex rounded, 1 mm long and 0.6 mm wide, pseudovitta short, at base of lobe. Lobules saccate, about 1/5 of lobe length, keel straight, 0.2 mm long and 0.15 mm wide, with 2 teeth, apical tooth unicellular, hardly visible, median tooth 3-cellular, with 2 basal and 1 apical cell. Asexual reproduction with up to 20-22-celled gemmae. Monoicous. Perianths compressed, with wide and rounded wings, with ventral keels and short rostrum, 0.7 mm long and 0.35 mm wide. **Habitat:** Epiphyllous in montane forest on *Marattia fraxinea*, 2000-2100 m. **Distribution in Rwanda: Nyungwe NP:** Uwinka, Gisakura. **Distribution in Africa:** DR Congo.



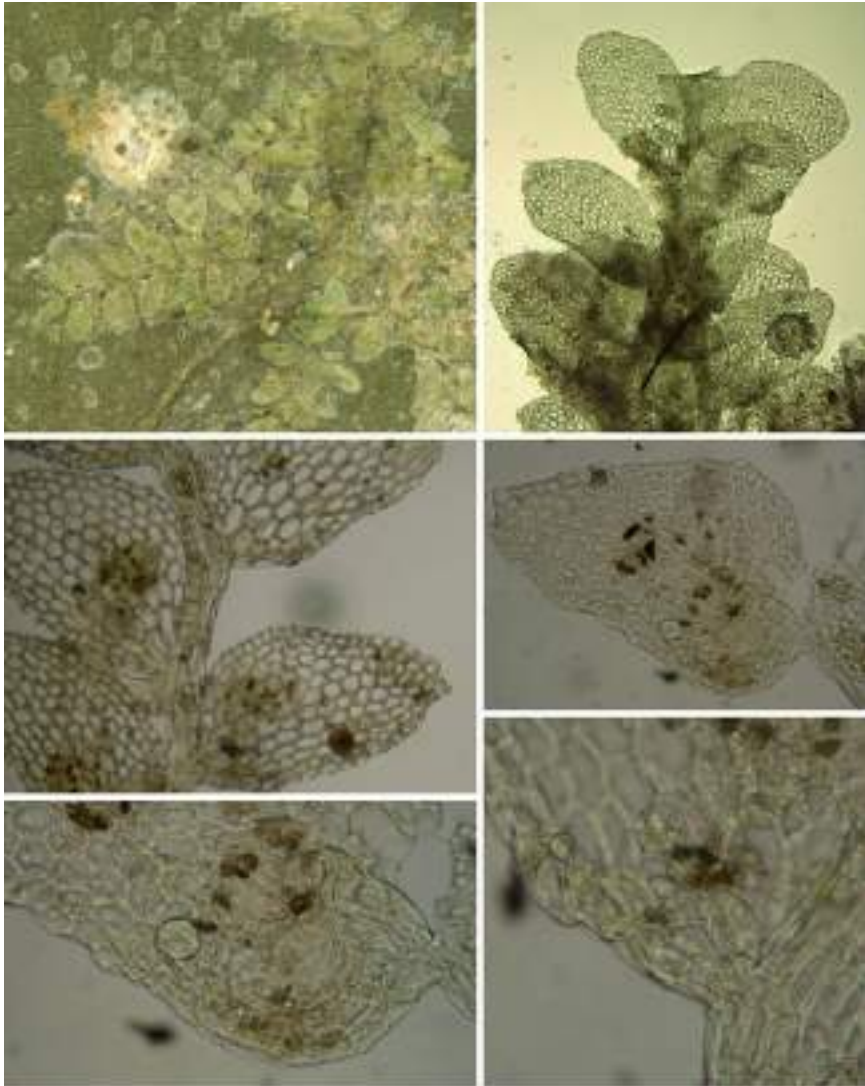


Fig. 151. *Cololejeunea zenkeri* (Steph.) E.W.Jones

Plants medium-sized, shoots up to 1-1.4 mm wide. Leaves approximate, in an angle of c. 60° to the stem. Lobe 0.55-0.8 x 0.4-0.55 mm, ovate, apex obtuse, margin irregularly serrate with conically protuberant cells. Lobule c. 0.35-0.5 the length of the lobe, sometimes reduced to a few cells, apical tooth with 2 short cells, hyaline papilla spherical, at base of apical tooth. Gemmae present. Autoicous. Perianth pyriform, strongly inflated, lateral keels narrow, at papillose apex. **Habitat:** Epiphyllous or epiphytic in montane rainforest, 2000-2300 m. **Distribution in Rwanda:** **Gishwati Forest:** Gikungu. **Nyungwe NP:** Karamba, Kamiranzovu, Uwinka. **Distribution in Africa:** Sierra Leone, Principe, Bioko, Cameroon, Rio Muni, DR Congo, Burundi, Uganda, Tanzania. Also Madagascar, Réunion.



Figs 152 and 153 (next page). *Colura berghenii* Jovet-Ast

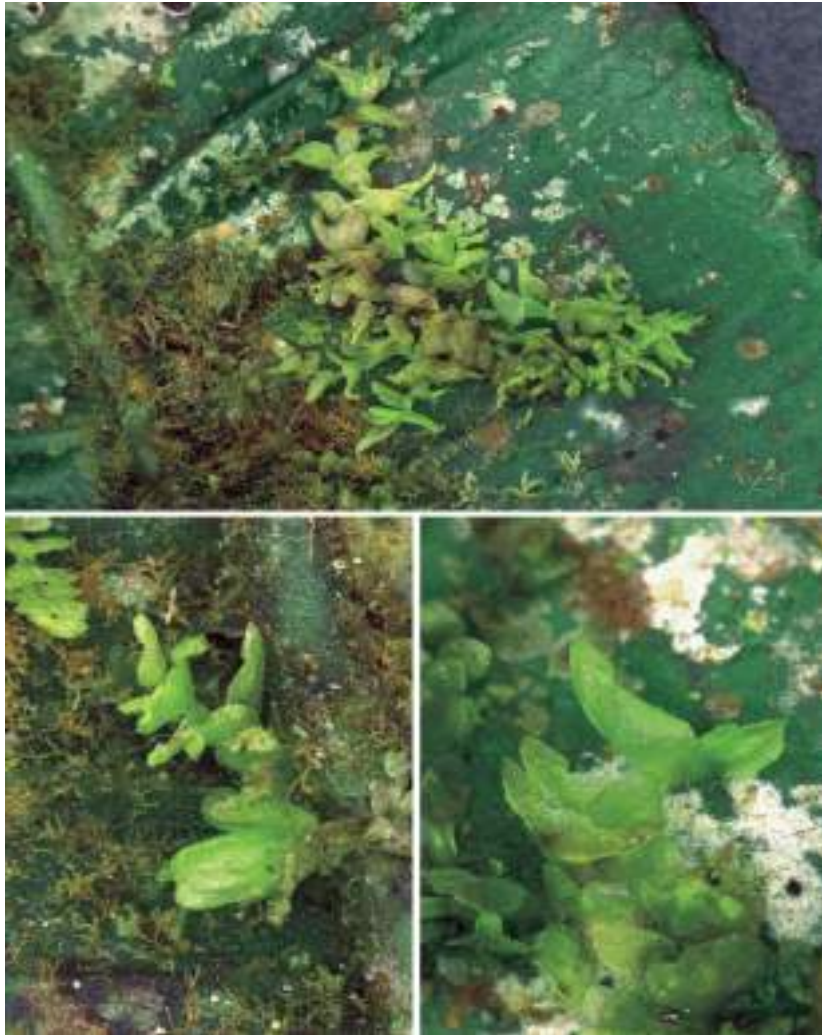
Plants pale green, resembling *C. calyptrifolia*. Leaves distichous, ascending to erect, 0.7-1.4 mm long, all possessing a claviform sac, dorsal lobe smaller than ventral lobe, ovate to orbicular, overlapping stem and decurved, ventral lobe ovoid, sac-like, abruptly narrowed into a beak of 1/4 to 1/3 of total leaf length. Cells of lobe 16-24 x 20 μ m, each cell distinctly papillose, walls with large nodular trigones. Autoicous. Perianth densely papillose, narrowly pyriform with five spreading 0.15 mm long horns, 1.5 mm long and 0.5 mm wide. **Habitat:** Epiphyllous (?) or on small dead twigs of ericaceous shrub in montane forest, 2000-2950 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura, Mt. Bigugu, Rwasekoko. **Distribution in Africa:** Ethiopia (Bale Mts.), Tanzania (Kilimanjaro, Rungwe). **Note:** First recorded by Tixier (1995) based on a depauperate and doubtful specimen from rather low altitude. On Mt. Bigugu at 2950 m and in Rwasekoko Swamp at 2450 m the plant is well developed and fertile.





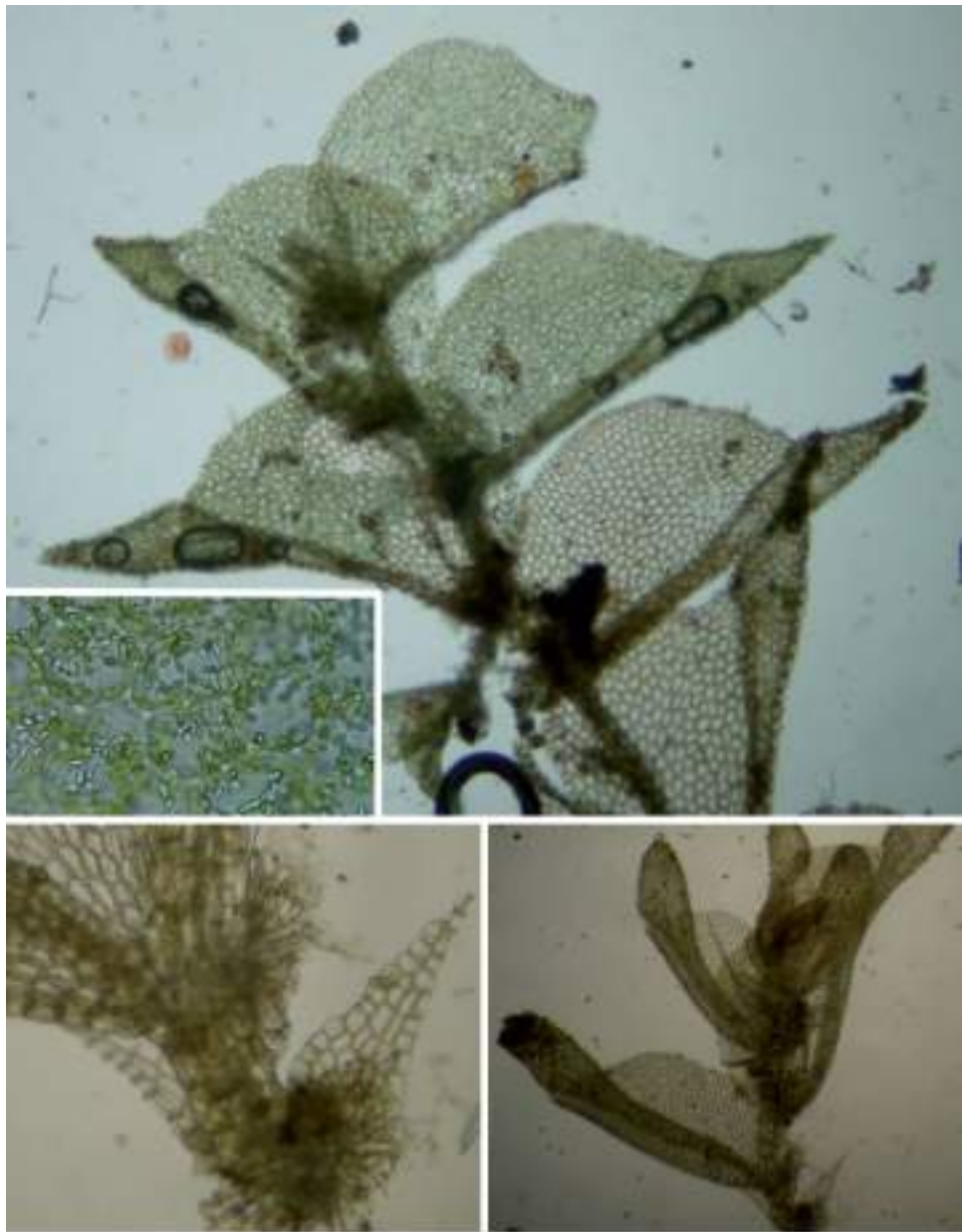
Fig. 154. *Colura calyptrifolia* (Hook.) Dumort.

Plants epiphytic on twigs of ericaceous shrubs or epiphyllous, pale green. Stems up to 4 mm long. Leaves distichous, ascending to erect, 0.7-1.4 mm long, all possessing a claviform sac, dorsal lobe smaller than ventral lobe, ovate to orbicular, overlapping stem and decurved, ventral lobe ovoid, sac-like, abruptly narrowed into a beak of 1/4 to 1/3 of total leaf length. Cells of lobe 16-24 x 20 μ m, walls without nodular trigones Valve movable, ovate, bordered by c. 16-18 hyaline cells, the central tissue of c. 10-12 cells with uniformly thickened walls. Underleaves bilobed, about 0.5 mm long, with subulate lobes up to 2 cells wide at base. Autoicous. Perianth lateral on the main axis, narrowly pyriform with five weak papillose spreading 0.15 mm long horns, 1.5 mm long and 0.5 mm wide, rostrum short, 1-celled. **Habitat:** Epiphyllous or epiphytic on dead twigs of ericaceous shrubs in montane forest, 2000-2450 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura, Rwasekoko. **Distribution in Africa:** DR Congo, Burundi, Tanzania, Malawi, Zimbabwe, South Africa. Also Central and South America, Western Europe, Azores, Madeira, Canary Islands, Mauritius, Réunion.



Figs 155 and 156. (next page) *Colura digitalis* (Mitt.) Steph.

Plants epiphyllous, pale green. Stems up to 6 mm long. Leaves distichous, 1.1-1.8 mm long, lobe c. 0.65 the length of the leaf, 0.35-0.75 mm wide, sac about 0.3 the length of the leaf, apex rounded. Cells of lobe 20-30 x 35-40 μm , walls with nodular trigones and intermediate thickenings. Valve ovate, bordered by 15-18 hyaline cells, the central tissue of 16-18 cells with uniformly thickened walls. Underleaves bilobed, about 0.8 mm long, with acute lobes, 5-8 cells wide at base. Autoicous. Perianth 1.3 mm long and 0.8 mm wide, 3-winged distally. **Habitat:** Epiphyllous in montane forest, 1950-2000 m. **Distribution in Rwanda: Nyungwe NP:** Karamba, Gisakura, Rwankuba, Kamiranzovu. **Distribution in Africa:** Guinea, Sierra Leone, Ghana, Nigeria, Principe, Annobon, São Tomé, Bioko, Cameroon, Gabon, Rio Muni, Central African Republic, Congo-Brazzaville, DR Congo, Burundi, Uganda, Tanzania. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.

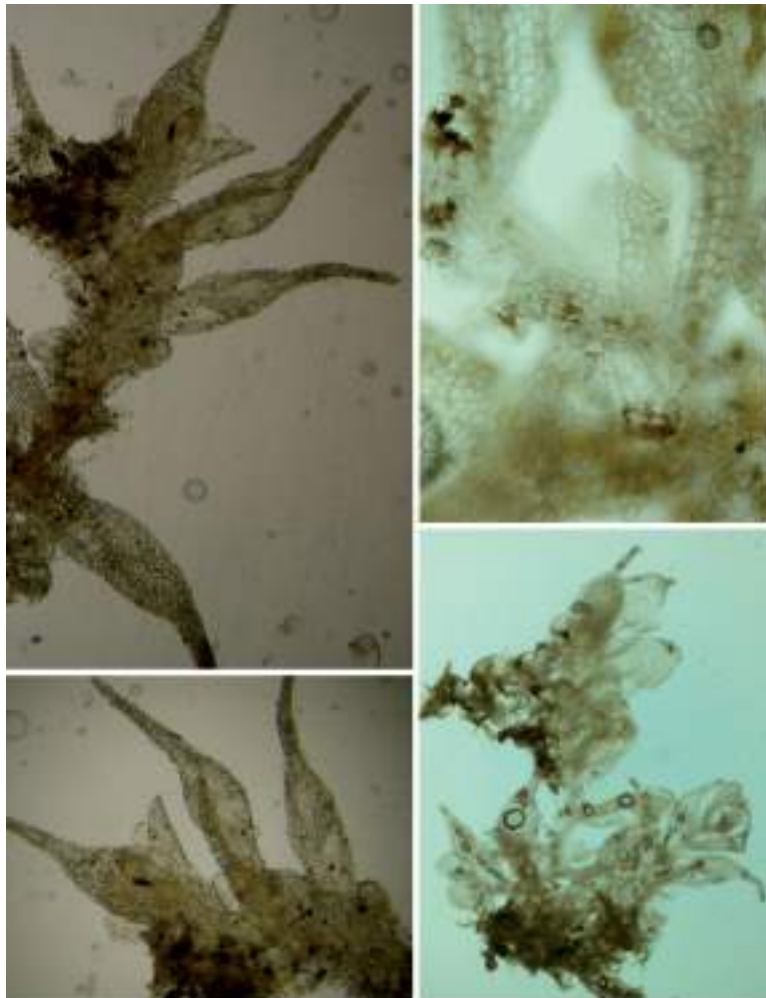




Figs 157 and 158 (next page). *Colura saroltae* Pócs

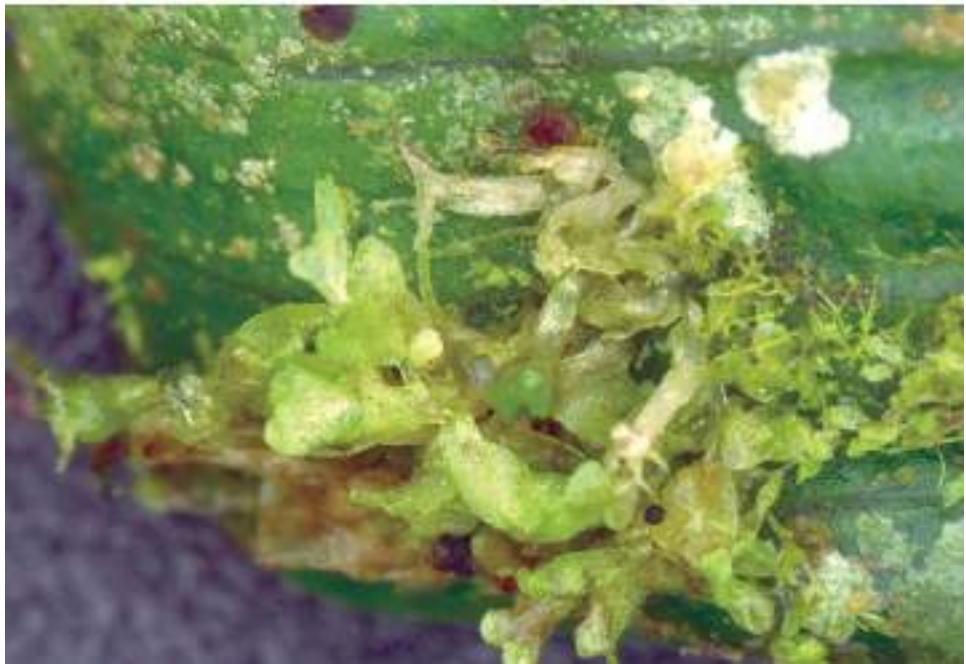
Plants epiphytic on twigs of ericaceous shrubs, pale green, in patches of 1.5-3 cm wide. Stems up to 15 mm long. Leaves distichous, 1.6-2 mm long, all possessing a claviform sac, free part 0.1 mm long and wide, with rounded apex. Lobe 0.6-1 mm wide, margin plane, crenulate towards apex. Cells of lobe 5 x 30 μm , walls with nodular trigones and intermediate thickenings. Valve not detachable, ligulate, up to 200 μm long and 150 μm wide, bordered by 27-30 hyaline cells, the central tissue of 64-73 cells with uniformly thickened walls. Underleaves bilobed, about 1 mm long, with acute lobes 10-12 cells wide at base. Dioicous. Perianth lateral on the main axis, narrowly pyriform with five weak keels, 1.5 mm long and 0.8 mm wide, rostrum lacking. **Habitat:** Ericaceous shrubs in swamp vegetation of montane forest, on small branches, 2000-2950 m. **Distribution in Rwanda: Nyungwe NP:** Rwasekoko, Mt. Bigugu. **Distribution in Africa:** Tanzania (Kilimanjaro).

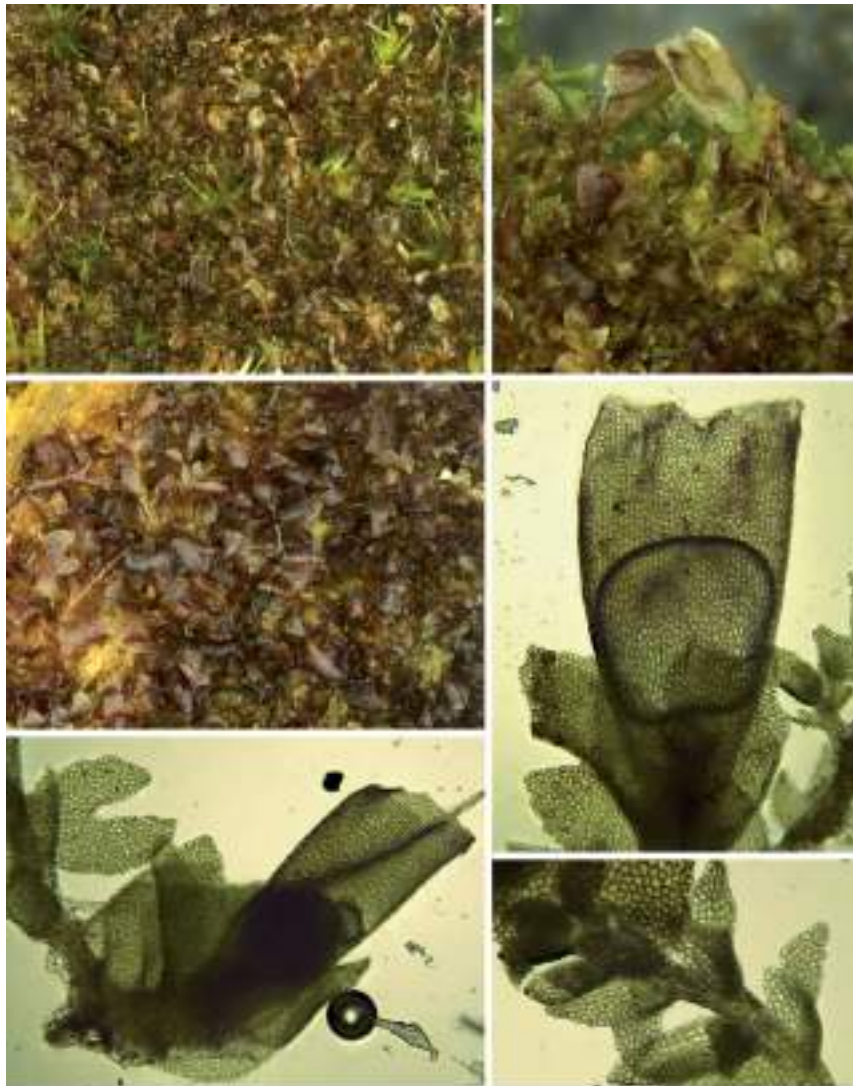




Figs 159 and 160 (next page). *Colura tenuicornis* (A.Evans) Steph.

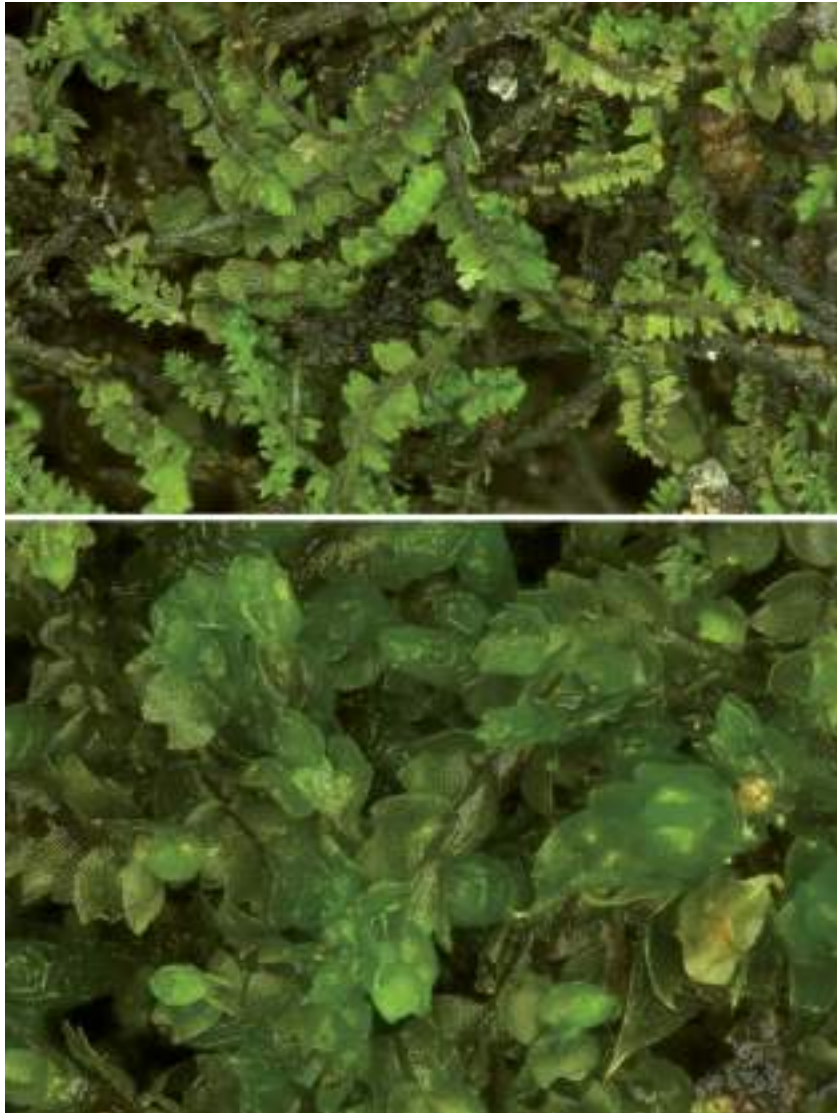
Plants pale green. Stems up to 4 mm long. Leaves distichous, ascending to erect, 0.7-1.4 mm long, all possessing a claviform sac, dorsal lobe smaller than ventral lobe, ovate to orbicular, overlapping stem and decurved, ventral lobe ovoid, sac-like, abruptly narrowed into a beak of c. 1/2 of total leaf length. Cells of lobe 16-24 x 20 μm , walls without nodular trigones Valve movable, ovate, bordered by c. 12-15 hyaline cells, the central tissue of c. 8-11 cells with uniformly thickened walls. Underleaves bilobed, about 0.5 mm long, with subulate lobes up to 2 cells wide at base. Autoicous. Perianth lateral on the main axis, narrowly pyriform with 5 narrow acute papillose spreading 0.2-0.25 mm long horns, 1.5 mm long and 0.8 mm wide, rostrum short, 1-celled. **Habitat:** Epiphyllous or epiphytic on twigs of ericaceous shrubs in montane forest, 2000-2500 m. **Distribution in Rwanda:** **Nyungwe NP:** Rwasekoko, Karamba, Uwinka, Kamiranzovu. **Distribution in Africa:** Sierra Leone, São Tomé, Cameroon, Gabon, DR Congo, Burundi, Kenya, Tanzania, South Africa. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.



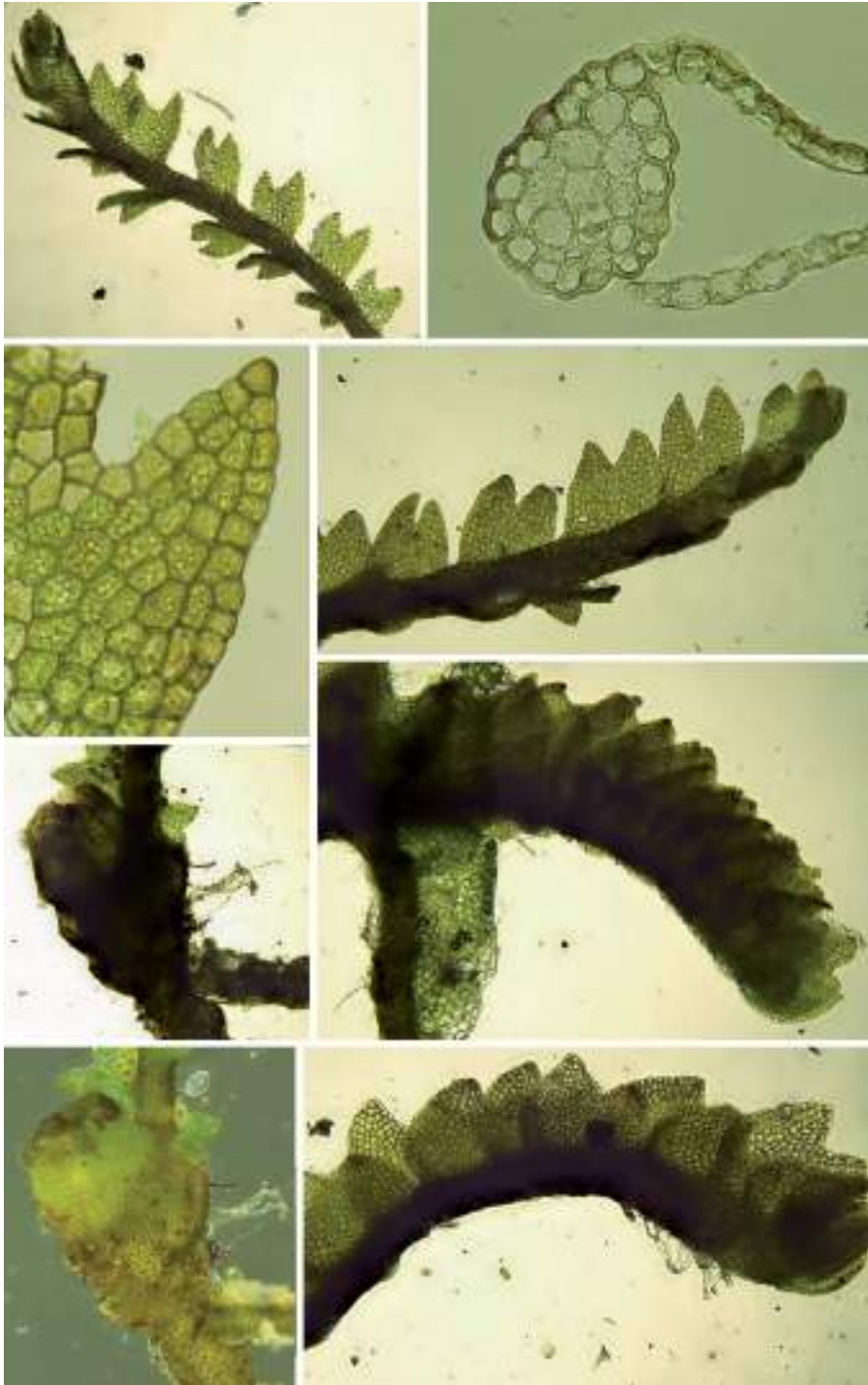


Figs 161 and 162 (next page). *Cylindrocolea atroviridis* (Sim) Váňa
 Synonym: *Cephaloziella atroviridis* (Sim) E.W.Jones. Plants pale green to brown or reddish. Stems irregularly branched, 60-105 μm in diameter, 6-7 cells thick in section, cells thin-walled. Leaves obtuse with narrow base to triangular-ovate, bilobed to 1/3-1/2, 250-380 \times 200-320 μm , obliquely to nearly transversely inserted, insertion not reaching the dorsal midline of the stem, lobes with acute to somewhat obtuse apices. Cells thin-walled, without trigones, 15-18 \times 20 μm . Underleaves lacking. Autoicous. Perianths conical to conical-cylindrical, with mouth wide, truncate. **Habitat:** On rotten wood in montane forest, 2500 m. **Distribution in Rwanda: Nyungwe NP:** Uwinka. **Distribution in Africa:** Sierra Leone, Ghana, Nigeria, Cameroon, Central African Republic, DR Congo, Zimbabwe, Mozambique, Lesotho, South Africa. Also Madagascar.





Figs 163 and 164 (next page). *Cylindrocolea gittinsii* (E.W.Jones) R.M.Schust. Plants terrestrial, vivid green. Stems irregularly branched, 70-85 μm in diameter, 4-8 mm long. Leaves distant, subrectangular, bilobed to 1/3-2/5, 80-120 \times 90-160 μm , obliquely to nearly transversely inserted, insertion not reaching the dorsal midline of the stem, lobes with acute to somewhat obtuse apices. Cells thin-walled, without trigones, 10-12 \times 10-14 μm . Underleaves lacking. Monoicous. Perianths conical to conical-cylindrical, with mouth narrowed at apex. **Habitat:** On earth in *Eucalyptus* plantations and rock fissures in dry forest, 1650-1800 m. **Distribution in Rwanda:** Central Rwanda: Huye (Butare). **Akagera:** Nyarubuye. **Distribution in Africa:** Cameroon, Uganda, Kenya.



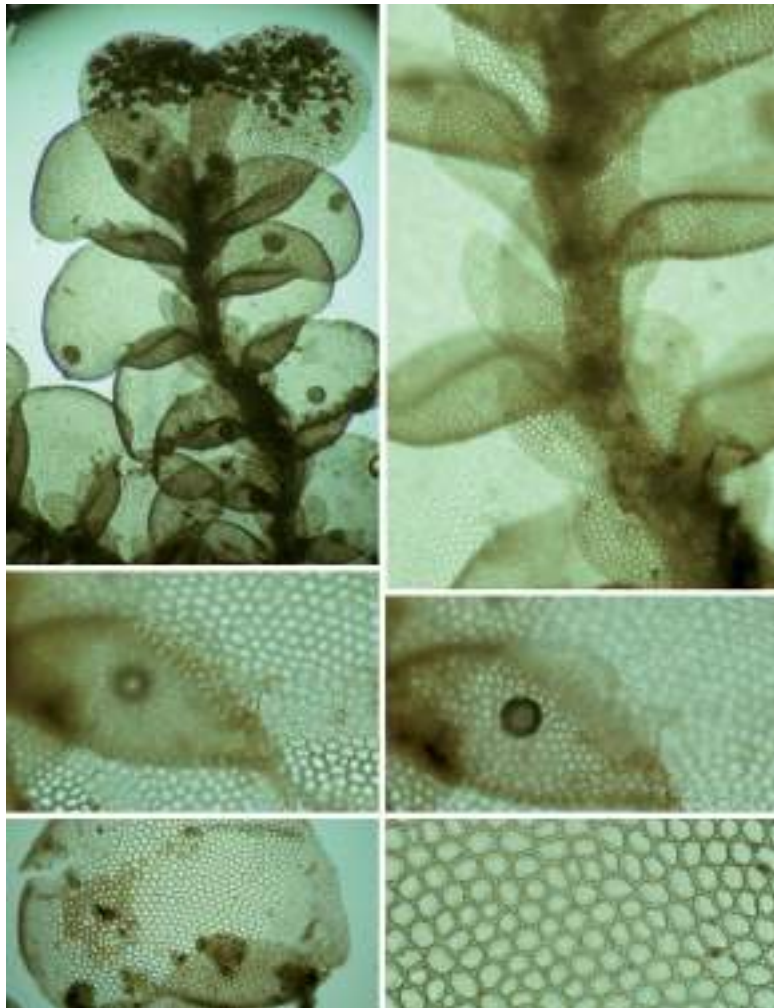
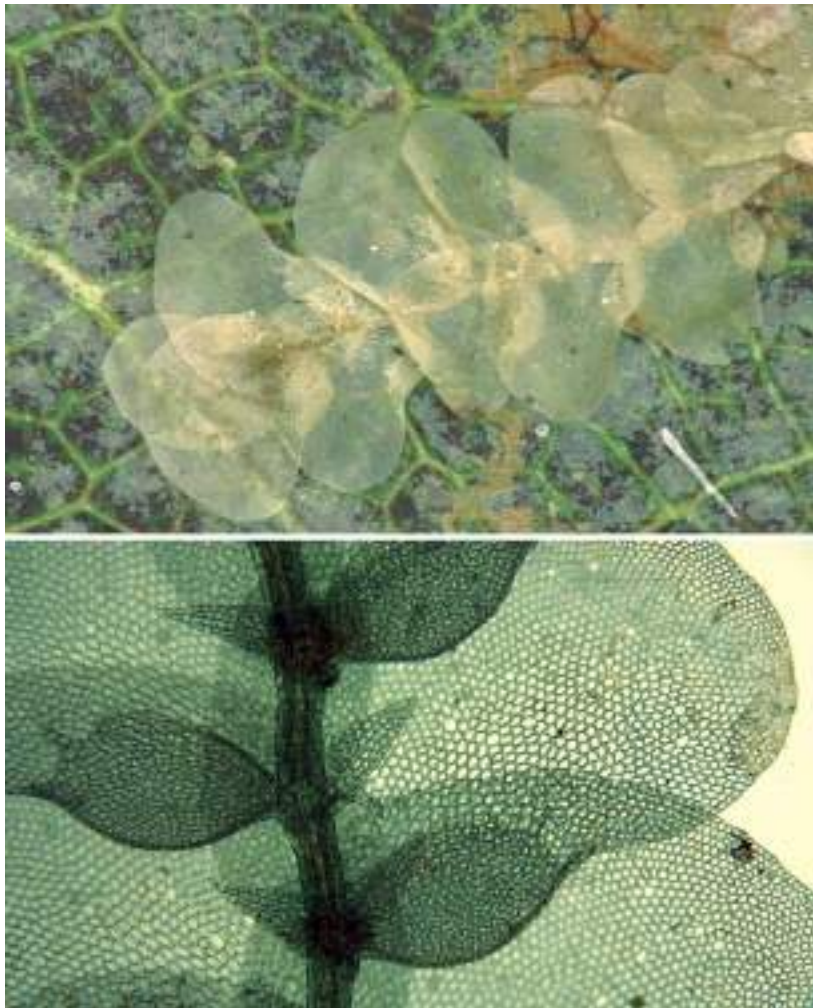


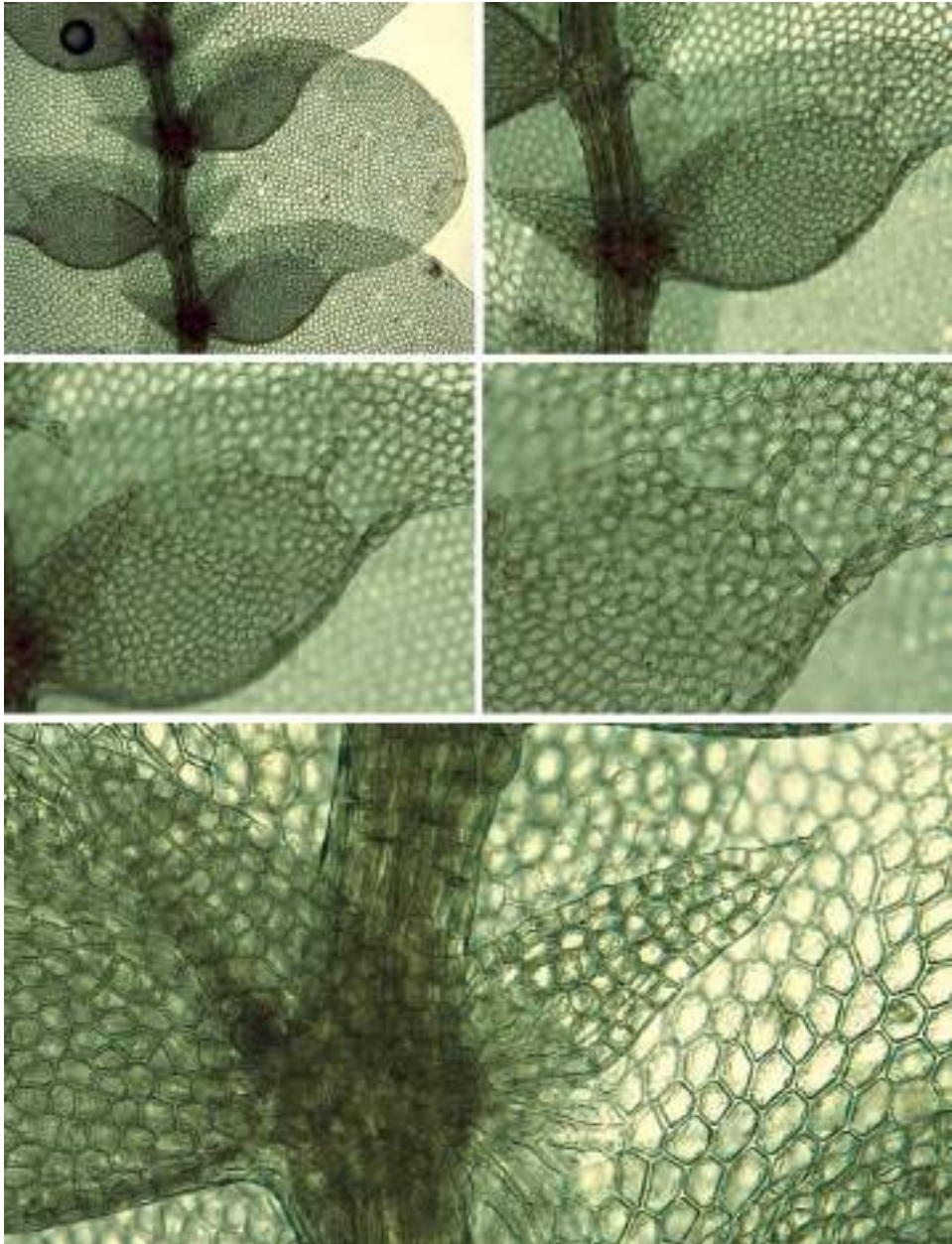
Fig. 165. *Diplasiolejeunea aulae* E.W.Jones

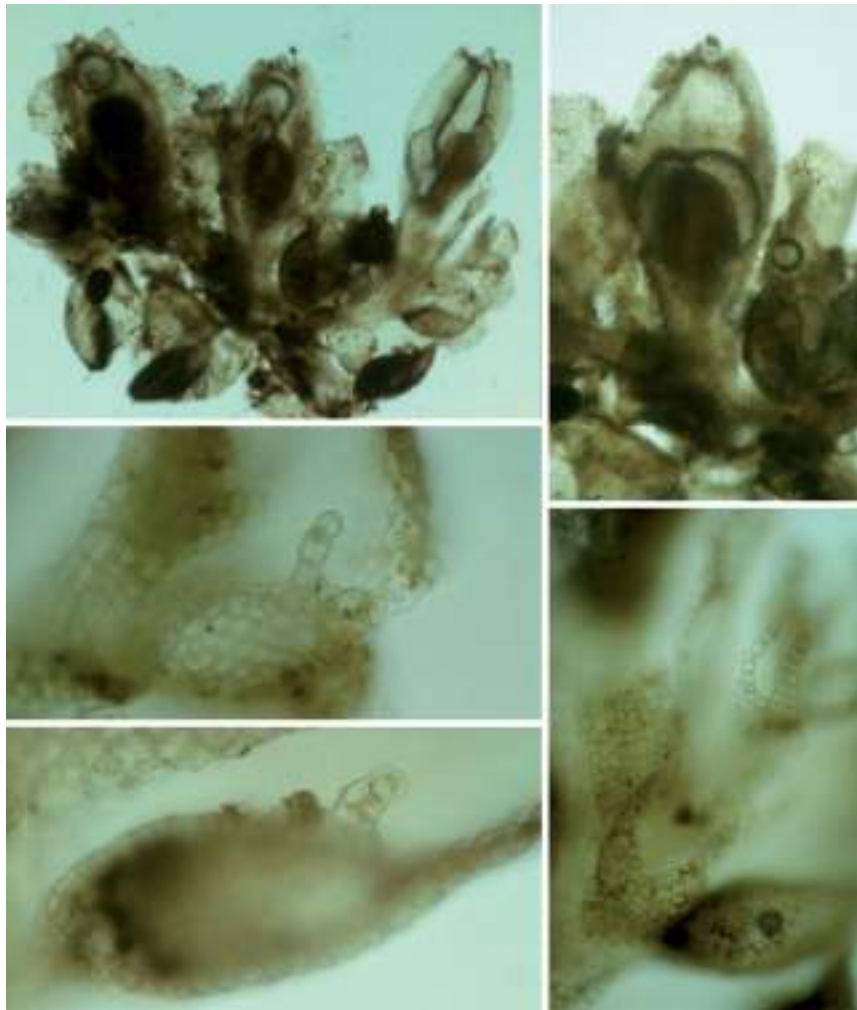
Plants medium-sized, 1.3-1.5 mm wide. Sterile leaves imbricate, alternate. Lobes ovate to obovate, rounded at apex, 0.9 x 0.6-0.7 mm, dorsal margin convex, ventral margin forming a wide but distinct angle with the weakly arched keel. Lobules inflated proximally and along the keel, ovate, c. 0.5 the length of the lobe, apical tooth 2-4 cells long, partly or entirely of 2 ranks of cells, proximal tooth of 1-2 cells on the angle, often incurved, usually also a small tooth at the base of the apex of the lobule close to its junction with the lobe. Underleaves bifid, 4-5 x wider than stem, lobes 0.3-0.35 μm long, 8-10 cells wide at base, apex obtusely pointed or rounded. Gemmiferous leaves of a shoot, 1.3-1.6 x 0.6 mm, dorsal and ventral margin usually deflexed, lobule long, narrow, fusiform. **Habitat:** Epiphyllous or epiphytic on small branches in montane forest, 2000 m. **Distribution in Rwanda: Nyungwe Forest:** Gisakura. **Distribution in Africa:** Ghana, Uganda. Also Madagascar.



Figs 166 and 167 (next page). *Diplasiolejeunea cavifolia* Steph.

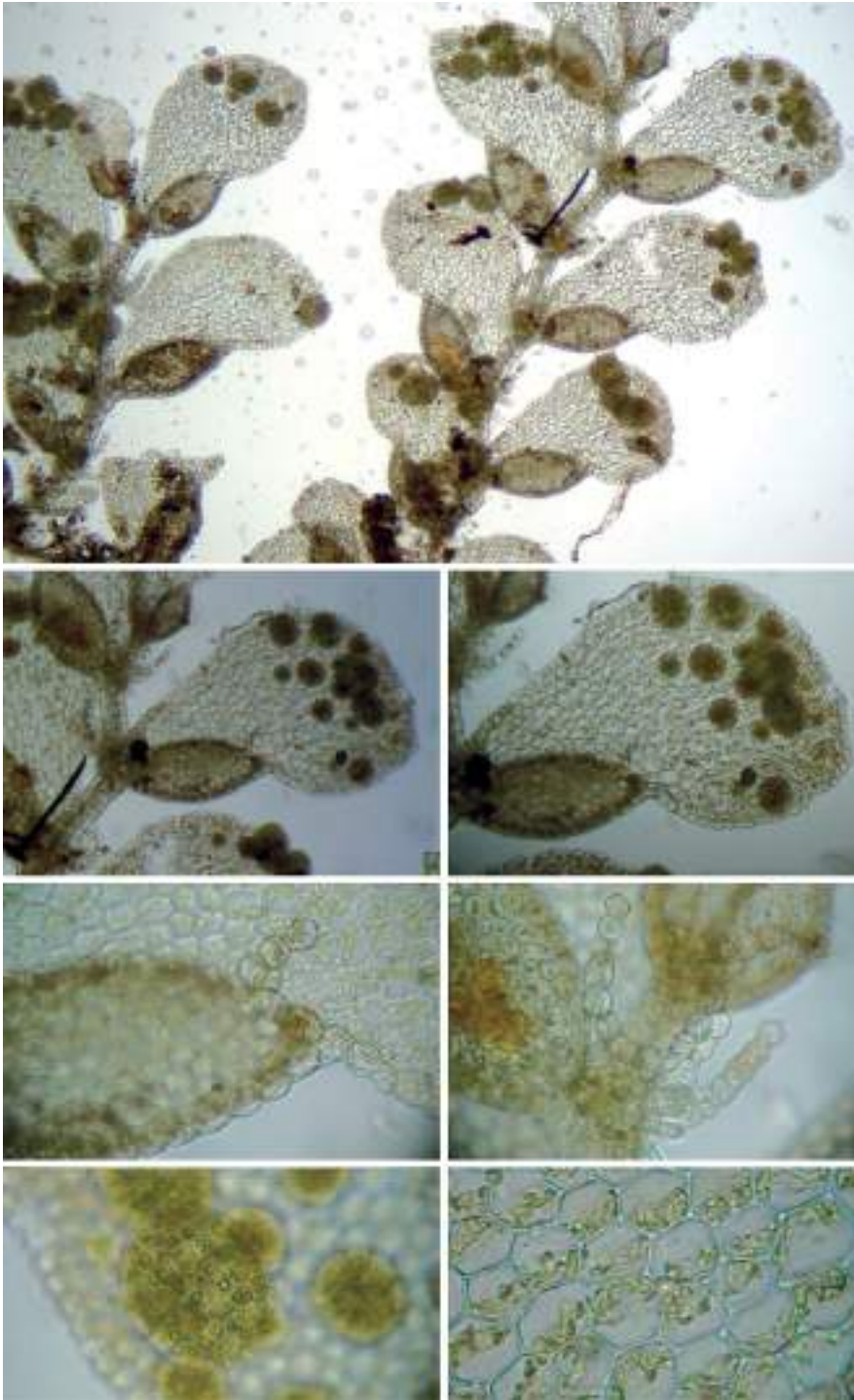
Synonym: *Diplasiolejeunea brachyclada* A.Evans. Plants epiphyllous, medium-sized, 2-2.5 mm wide, pale green. Leaves slightly imbricate, alternate. Lobes entire, ovate to subelliptic, rounded at apex, 0.85-1.25 x 1.2-1.6 mm, dorsal margin distinctly convex, ventral margin slightly convex. Lobules only slightly inflated, ovate, 0.28-0.4 x 0.45-0.68 mm, apical tooth terminated by one or two cells, median tooth 40-60 μ m long, consisting of one cell or 2 cells in a row, bearing 1 larger cell (rarely 2-3) forming the letter T. Cells with small trigones, ocelli numerous, dispersed and isolated. Underleaves bifid, 4-5 x wider than stem, lobes 0.3-0.35 μ m long, 9-10 cells wide at base, terminated by 1 or 2-3 adjacent cells. Dioicous (?). Perianths longly exserted, subcylindrical, with 5 keels, 0.7-0.12 x 0.375-0.6 mm, beak short, 15-30 μ m long. **Habitat:** Epiphyllous or epiphytic in montane forest, 2500 m. **Distribution in Rwanda: Nyungwe NP:** Rwasekoko. **Distribution in Africa:** Ghana, Nigeria, São Tomé, Rio Muni, DR Congo, Uganda, Kenya, Tanzania, South Africa. Also Comoros, Madagascar, Mauritius.

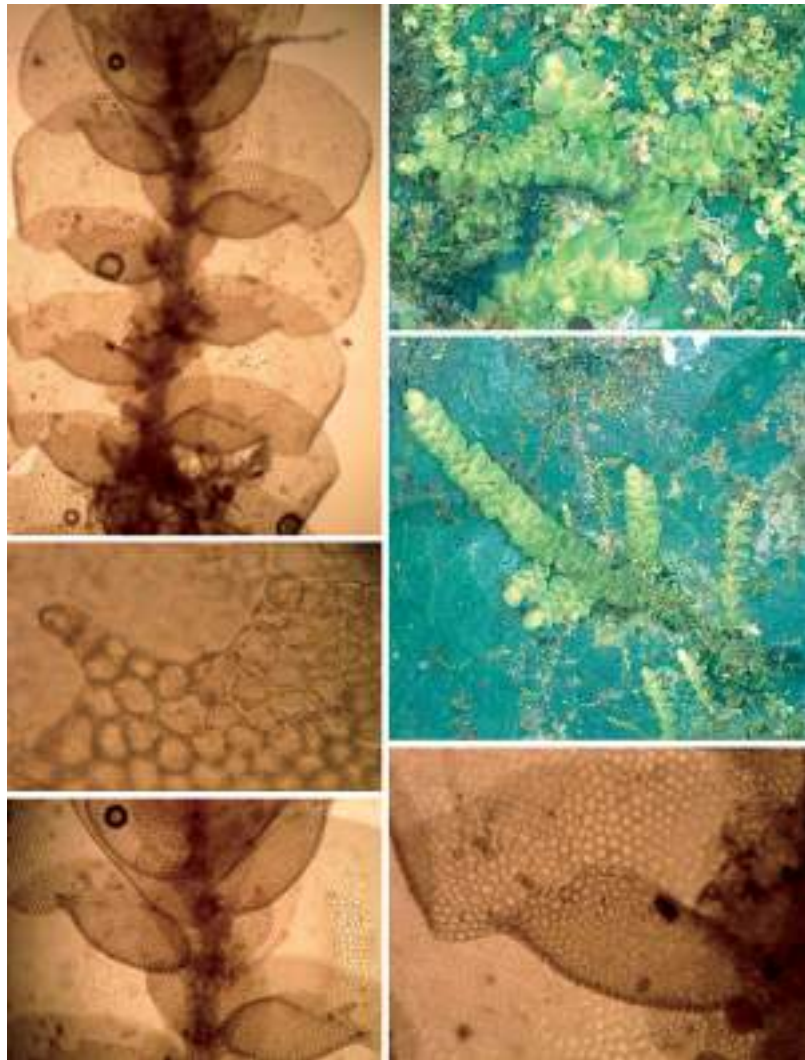




Figs 168 and 169 (next page). *Diplasiolejeunea cornuta* Steph.

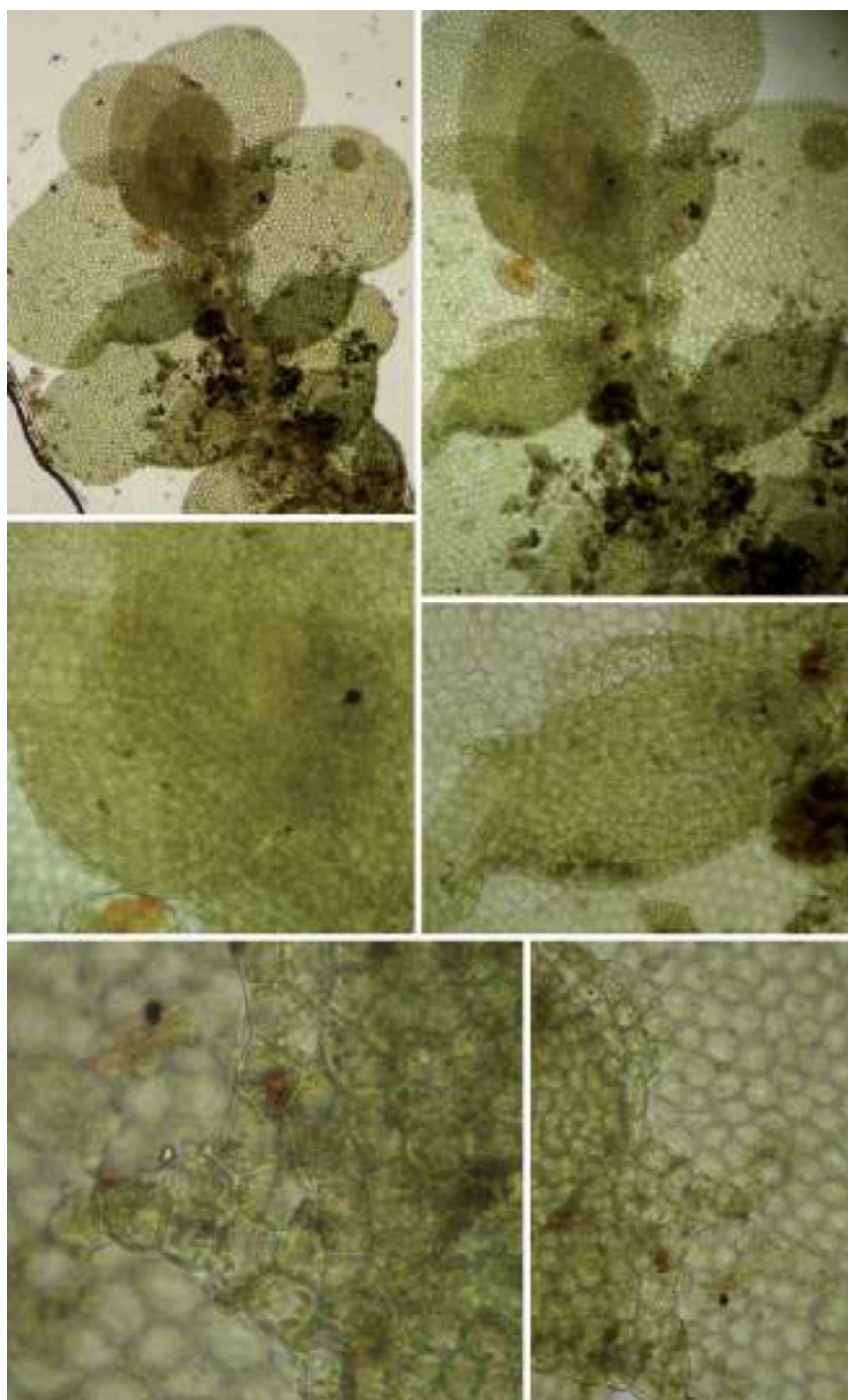
Plants epiphytic or epiphyllous, small, 1.2 mm wide, pale green to pale brown. Leaves distant to slightly imbricate, alternate. Lobes entire, ovate, asymmetrical, rounded or slightly apiculate at apex, 0.55-0.73 x 0.35-0.54 mm. Lobules inflated, fusiform, 0.25-0.33 x 0.1-0.2 mm, generally with 2 teeth, apical tooth with 2 cells, median tooth arched, with 2 cells in a row, 25-50 μ m long, hyaline papilla inserted at internal face of lobule. Cells thin-walled, with small trigones, central cells 20-26 x 18-24 μ m, ocelli numerous, dispersed and isolated, basal ocelli often present, 40 x 60 μ m. Underleaves bifid, 2-3 x wider than stem, lobes acicular, 0.08-0.11 mm long, 2-3 cells large at base, ending with a row of 2-6 cells. Monoicous. Perianths longly exserted, obovate to subcylindrical, 0.675 x 0.375 mm, with 5 keels, prolonged to horns, beak 50 μ m long. **Habitat:** Epiphyllous or epiphytic in montane forest, 2000-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Karamba, Kamiranzovu, Gisakura. **Distribution in Africa:** Ghana, DR Congo, Kenya, Tanzania, Malawi, Zimbabwe. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.

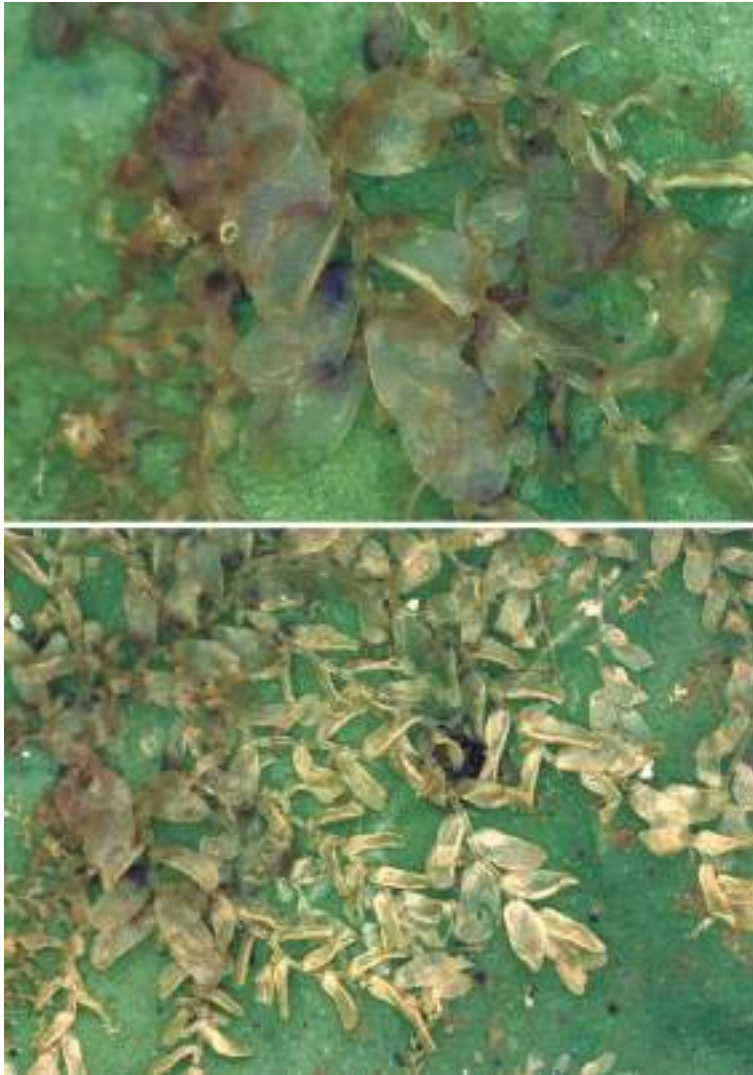




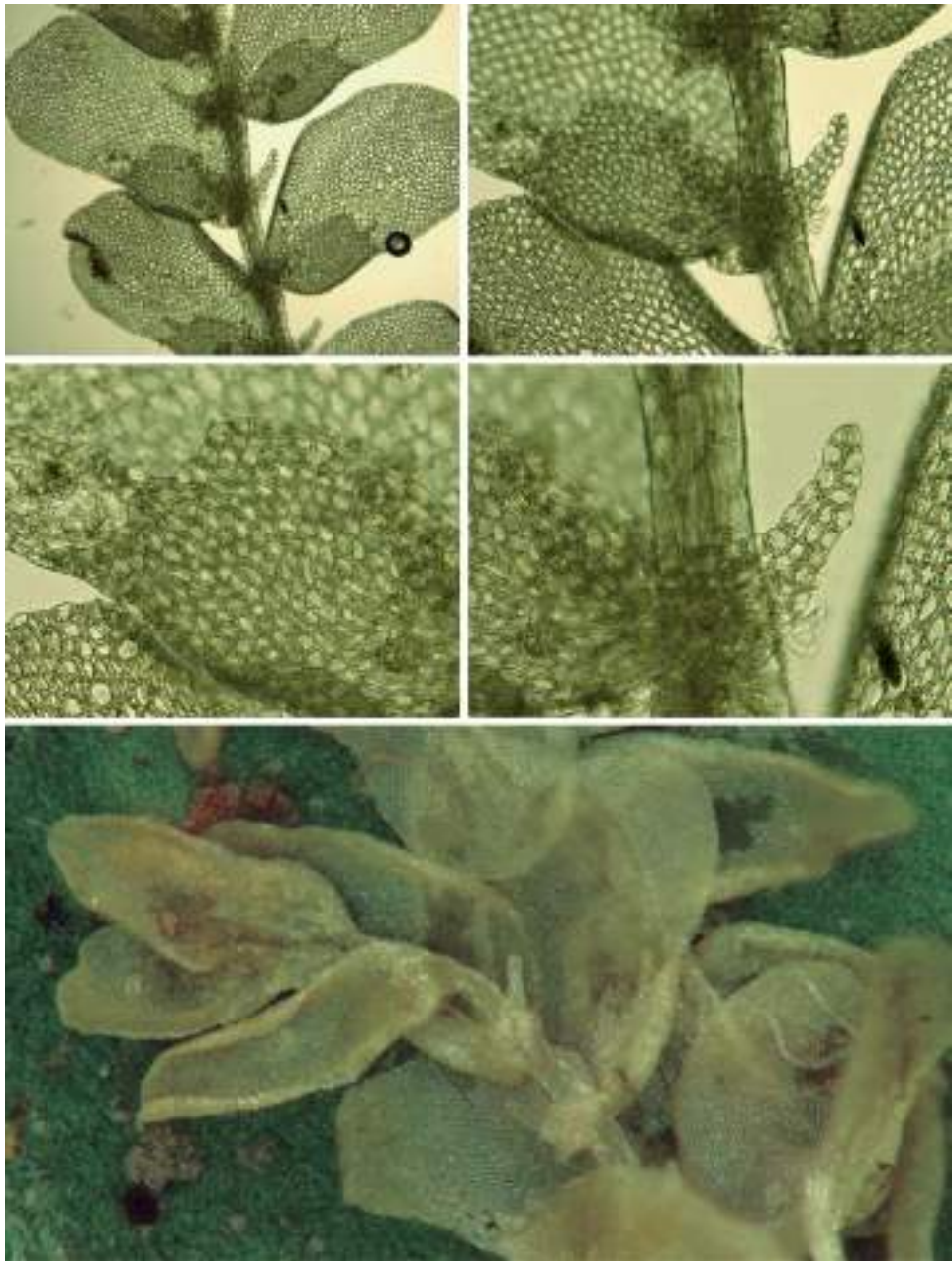
Figs 170 and 171 (next page). *Diplasiolejeunea cyanguguensis* Tixier

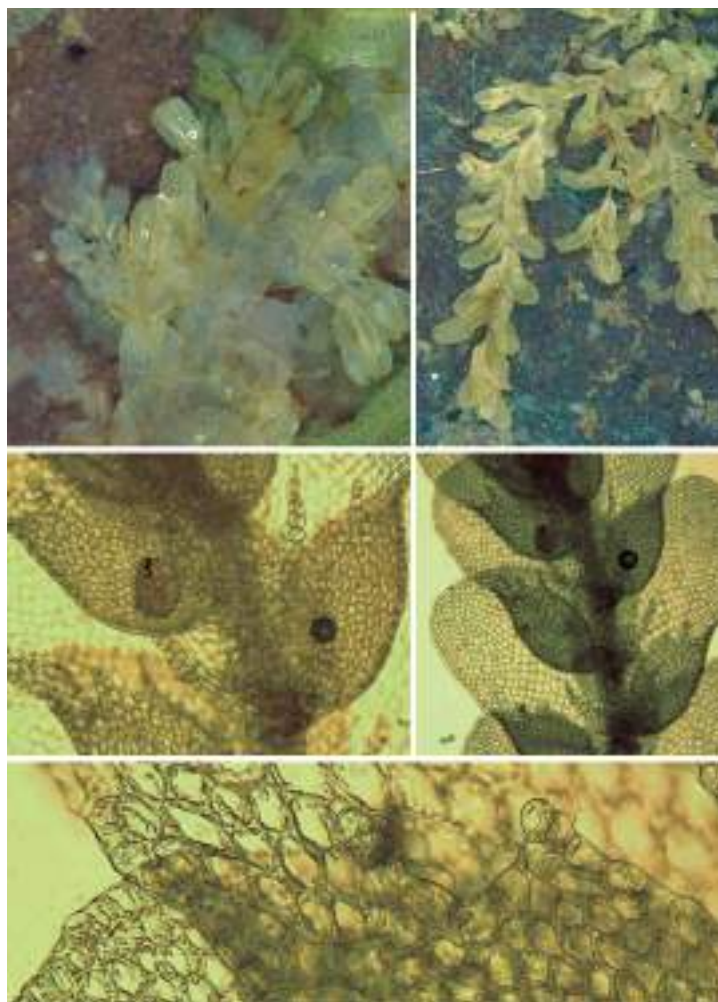
Plants epiphyllous, medium-sized, pale green to yellowish, up to 1 cm long, up to 1.6 mm large. Leaves densely imbricate, alternate, inserted at angle of 90°. Lobes entire, ovate, rounded at apex, not covering stem, up to 1 mm long and 0.8 mm large. Lobules large, only slightly inflated, reaching half of lobe length, 0.5 mm long and 0.3 mm wide, truncate at apex, with 2 teeth, apical tooth hardly visible, median tooth elongated, doubled at apex, both half-teeth 3-4 cells long, submedian tooth more or less arched, long or short, hyaline papilla not observed. Cells thin-walled, ocelli absent, marginal cells 15 µm in diameter, basal cells 40 x 15 µm. Underleaves at each lateral leaf, bifid, each lobe 0.3 mm long, obtuse at apex, up to 10 cells large at base and 3 cells large at apex. **Habitat:** Epiphyllous in montane forest, 1900-2000 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura.



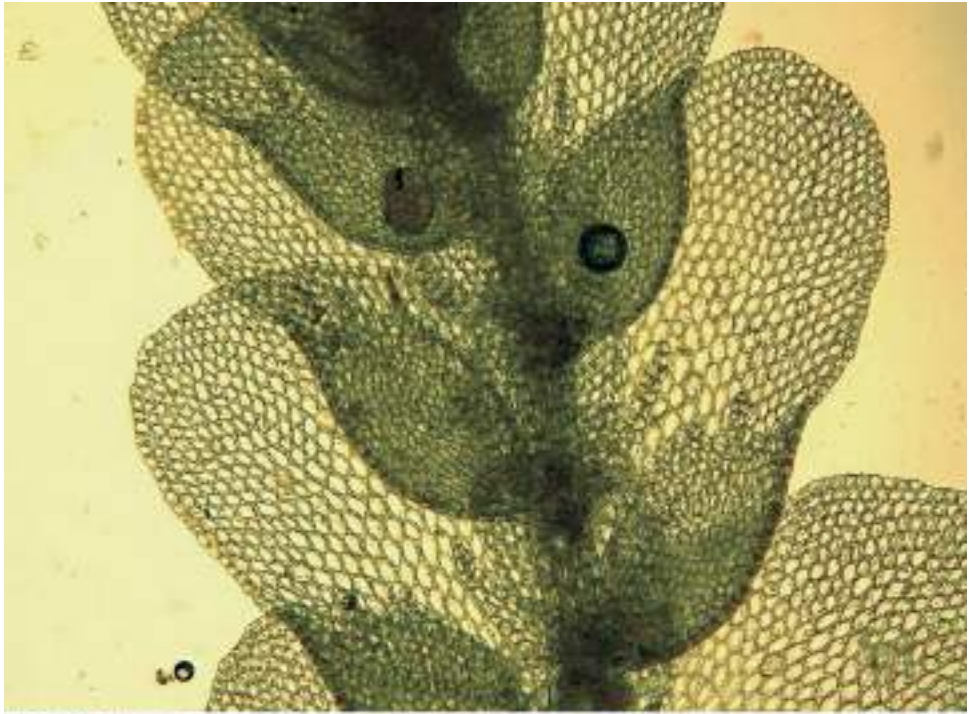


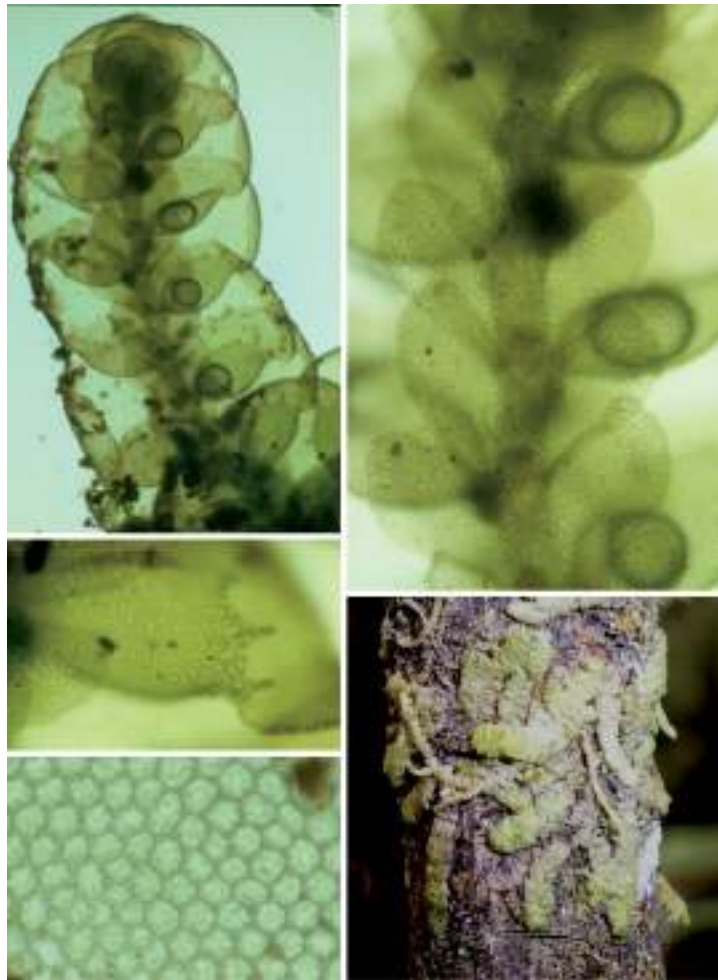
Figs 172 and 173 (next page). *Diplasiolejeunea deslooveri* Vanden Berghen
 Plants epiphyllous, shoots 1.2-1.8 mm wide. Leaves distant or contiguous. Lobe ovate, apex rounded or subtruncate, 0.35-0.55 x 0.65-0.9 mm. One basal ocellus and (2-)3-6(-10) single ocelli present. Lobule large, 0.18-0.24 x 0.3-0.42 mm, inflated, free margin arched, with obtuse tooth, apical tooth triangular, with 2-4 rows of cells, rows at base with 2-4 cells, the two ultimate rows usually unicellular, tooth sometimes ending with a cell bearing 2 joined cells at apex. Underleaves distant, 3-4 x as wide as the stem, 0.18-0.22 0.25-0.42 mm, sinus rounded, lobes 0.15 mm long, at base 6-8 cells wide, ending in 1-2 cells, obtuse. Monoicous. Perianth subcylindric, with truncate apex and 5 cells dilated to auricles, 0.4-0.6 x 0.9-1 mm. **Habitat:** Epiphyllous in montane forest, 1950-1970 m. **Distribution in Rwanda:** Nyungwe NP: Rwankuba, Kamiranzovu. **Distribution in Africa:** Tanzania. Also Madagascar, Mauritius.





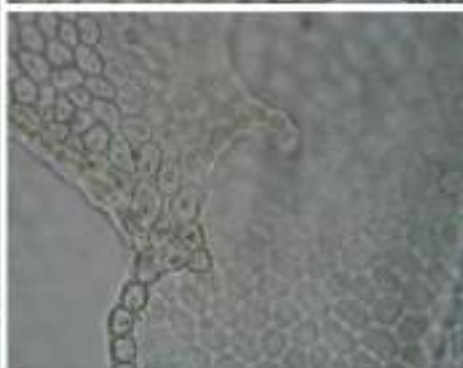
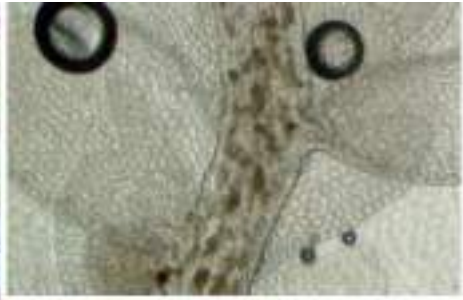
Figs 174 and 175 (next page). *Diplasiolejeunea kraussiana* (Lindenb.) Steph. Plants epiphytic or epiphyllous, small, 1.2 mm wide, pale green to pale brown. Leaves distant to slightly imbricate, alternate. Lobes entire, ovate, asymmetrical, rounded or slightly apiculate at apex, 0.55-0.73 x 0.35-0.54 mm. Lobules inflated, fusiform, 0.25-0.33 x 0.1-0.2 mm, generally with 2 teeth, apical tooth with two cells, median tooth arched, with two cells in a row, 25-50 μ m long, hyaline papilla inserted at internal face of lobule. Cells thin-walled, with small trigones, central cells 20-26 x 18-24 μ m, ocelli numerous, dispersed and isolated, basal ocelli often present, 40 x 60 μ m. Underleaves bifid, 2-3 x wider than stem, lobes acicular, 80-110 μ m long, 2-3 cells large at base, ending with a row of 2-6 cells. Monoicous. Perianths longly exerted, obovate to subcylindrical, 0.67 x 0.37 mm, with 5 keels, prolonged to horns, beak 50 μ m long. **Habitat:** Epiphyllous or epiphytic in montane forest, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Karamba, Kamiranzovu. **Distribution in Africa:** DR Congo, Burundi, Uganda, Tanzania, Malawi, Zimbabwe, South Africa. Also Madagascar.

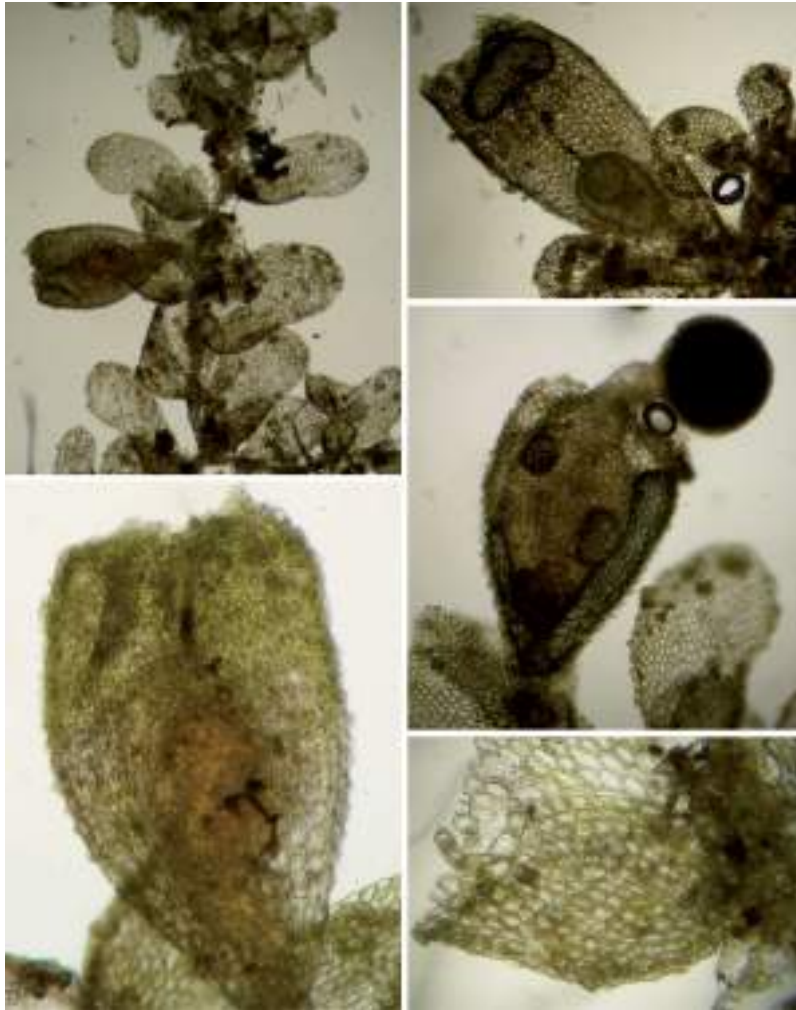




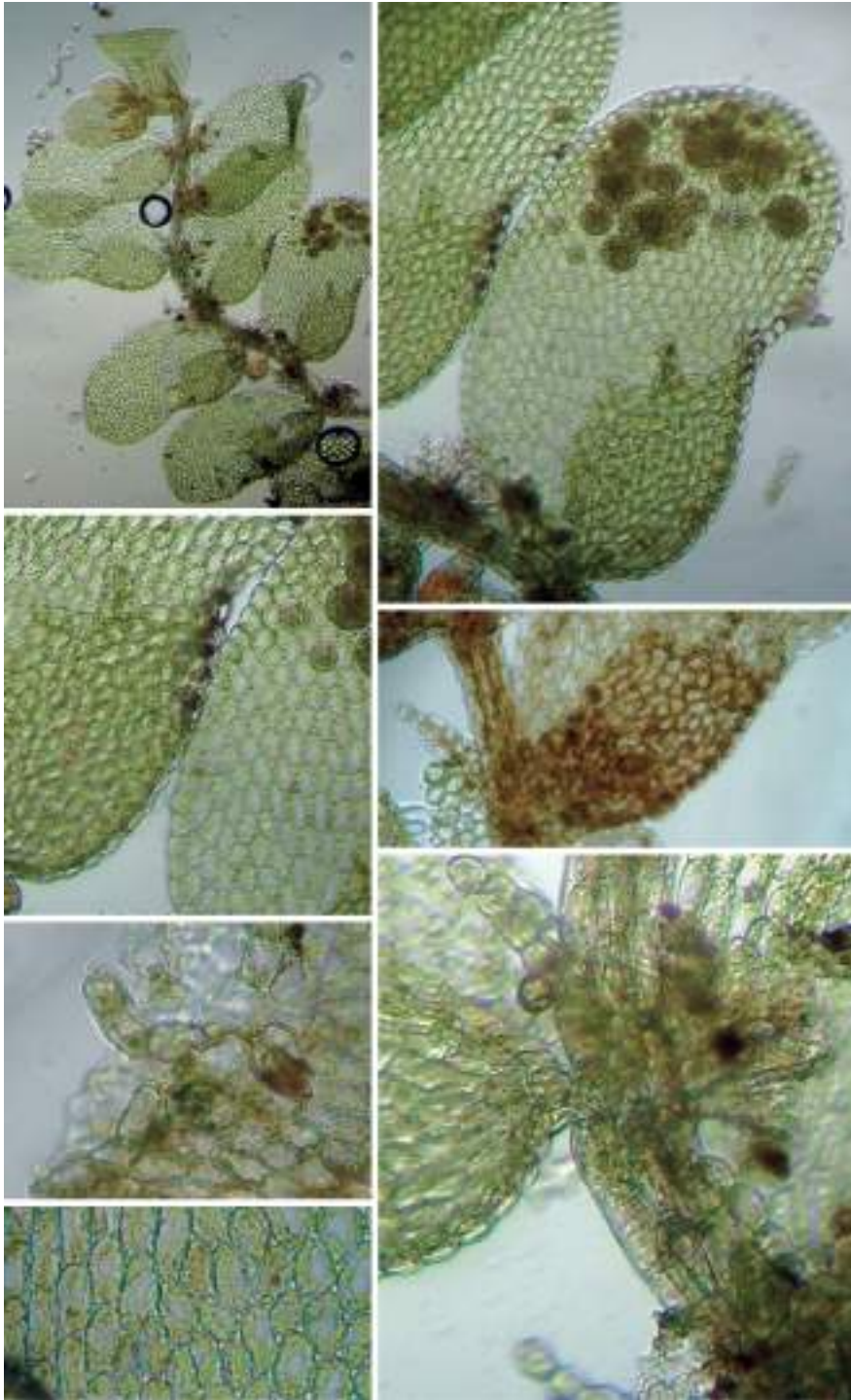
Figs 176 and 177 (next page). *Diplasiolejeunea runssorensis* Steph.

Plants epiphytic or epiphyllous, medium-sized, 1.6-1.8 mm wide, olive green to pale brown. Stems 1-2 cm long. Leaves densely imbricate, alternate. Lobes entire, convex, ovate, rounded and incurved at apex, 0.9-1.4 x 0.8-1.15 mm. Lobules ovate, basal part inflated, fusiform, 0.42-0.5 x 0.25-0.3 mm, apical tooth acute to obtuse, median tooth acute, 40-60 μ m long, ending with a row of 2-3 cells, obtuse submedian tooth distinct close to keel, hyaline papilla inserted at internal face of lobule. Cells with thin or uniformly thickened walls with small trigones, central cells 22-29 x 20-26 μ m, ocelli absent. Underleaves bifid, 3 x as wide as the stem, 0.315-0.5 x 0.3-0.4 mm, lobes rounded at apex, 9-12 cells wide at base, separated by a sinus of 60-100°. Asexual reproduction by gemmae inserted on dorsal face of lobe. Monoicous. Perianths longly exserted, obovate to clavate, 1-1.2 x 0.6-0.75 mm, with 5 slightly winged keels, beak 25 μ m long. **Habitat:** Epiphyllous or epiphytic on small twigs in montane forest, 1950-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Karamba, Gisakura, Rwankuba. **Distribution in Africa:** DR Congo, Burundi, Uganda, Kenya, Tanzania. Also Madagascar.





Figs 178 and 179 (next page). *Diplasiolejeunea symoensii* Vanden Berghen
 Plants small, 1.2-1.8 mm wide, pale green. Leaves distant to slightly imbricate. Lobes entire, asymmetrical, ovate, rounded to truncate at apex, 0.65-1 x 0.3-0.6 mm. Lobules only slightly inflated, ovate to subrectangular, 0.42-0.45 x 0.27-0.3 mm, apical tooth 50-90 μ m long, with two rows of 3-5 cells, ending in an isolated cell or 2 adjacent cells. Cells with small trigones, central cells 17-22 x 23-30 μ m, 1-3 ocelli at base of lobe. Underleaves bifid, 3 x wider than stem, lobes 120-180 μ m long, 3-5 cells wide at base, terminated by 1 or 2 uniseriate cells. Vegetative propagation by gemmae comprising c. 38 cells. Monoicous (?). Perianths longly exserted, stipitate, clavate, with 5 keels, 750 x 330-345 μ m. **Habitat:** Epiphyllous or epiphytic in montane forest and *Hagenia-Hypericum* forest, 1950-3300 m. **Distribution in Rwanda:** **Volcano NP:** Karisimbi, in the saddle between Bisoke and Karisimbi. **Nyungwe NP:** Karamba, Kamiranzovu, Gisakura, Rwankuba. **Distribution in Africa:** DR Congo, Burundi, Uganda, Kenya, Tanzania, Malawi. Also Comoros, Madagascar.

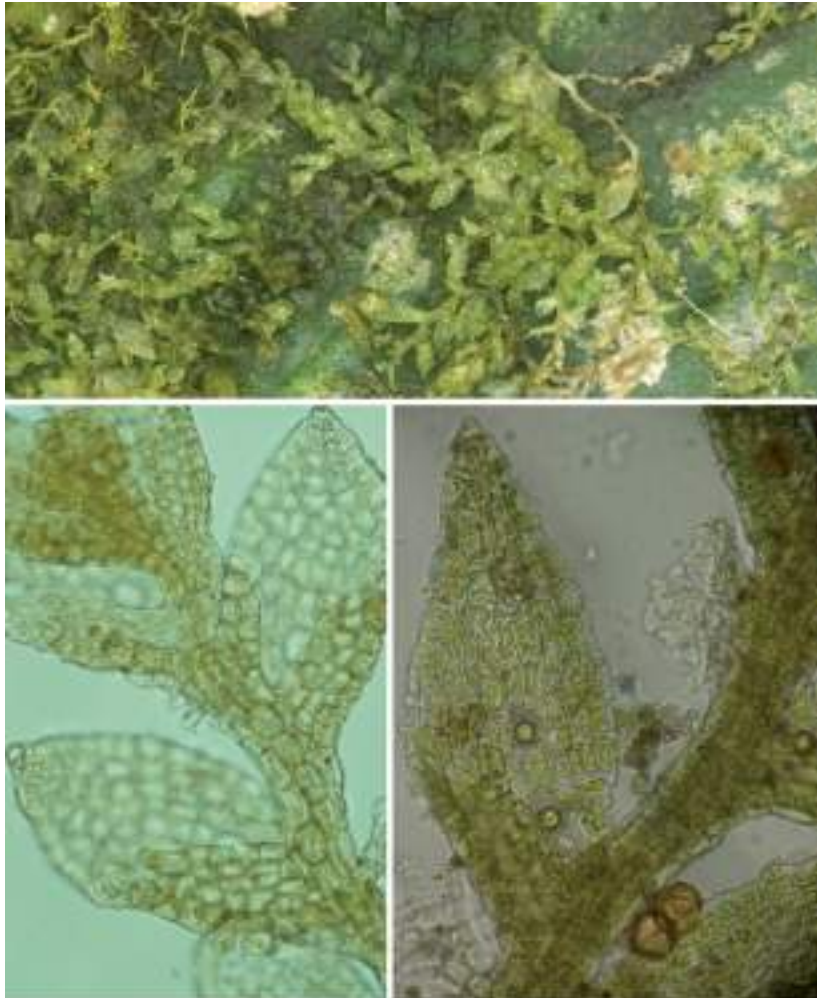




Figs 180 and 181 (next page). *Diplophyllum africanum* S.W.Arnell

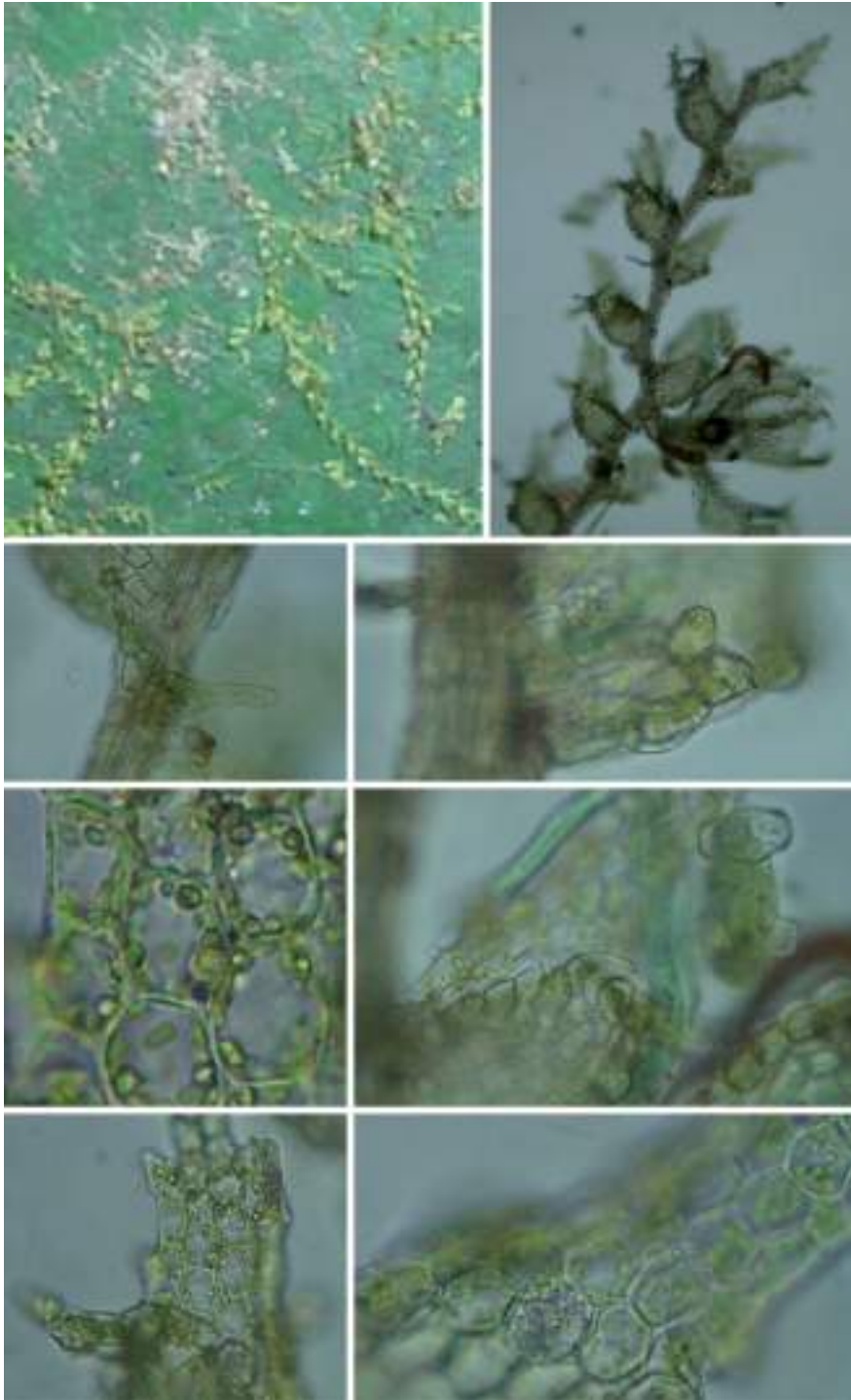
Plants small, rupicolous, pale green, in loose tufts. Stems prostrate to suberect, usually simple, to 1 cm long. Leaves about 0.39 x 0.84 mm, distant to subimbricate, bilobed, lobes conduplicate, margin slightly denticulate. Lobes of similar shape as ventral lobules, appressed to lobule, about 0.7 of its length, apex rounded except when gemmiferous, acute or obtuse and apiculate, keel curved. Cells isodiametric to slightly elongate in vitta region, 10 x 15 μ m. Underleaves absent. Asexual reproduction by brown, unicellular gemmae on deformed lobe apices of upper leaves, 25-33 μ m long. **Habitat:** On rocks and moist ground in Paramo from 3500 to 3700 m. **Distribution in Rwanda: Volcano NP:** Bisoke. **Distribution in Africa:** Kenya, Tanzania.

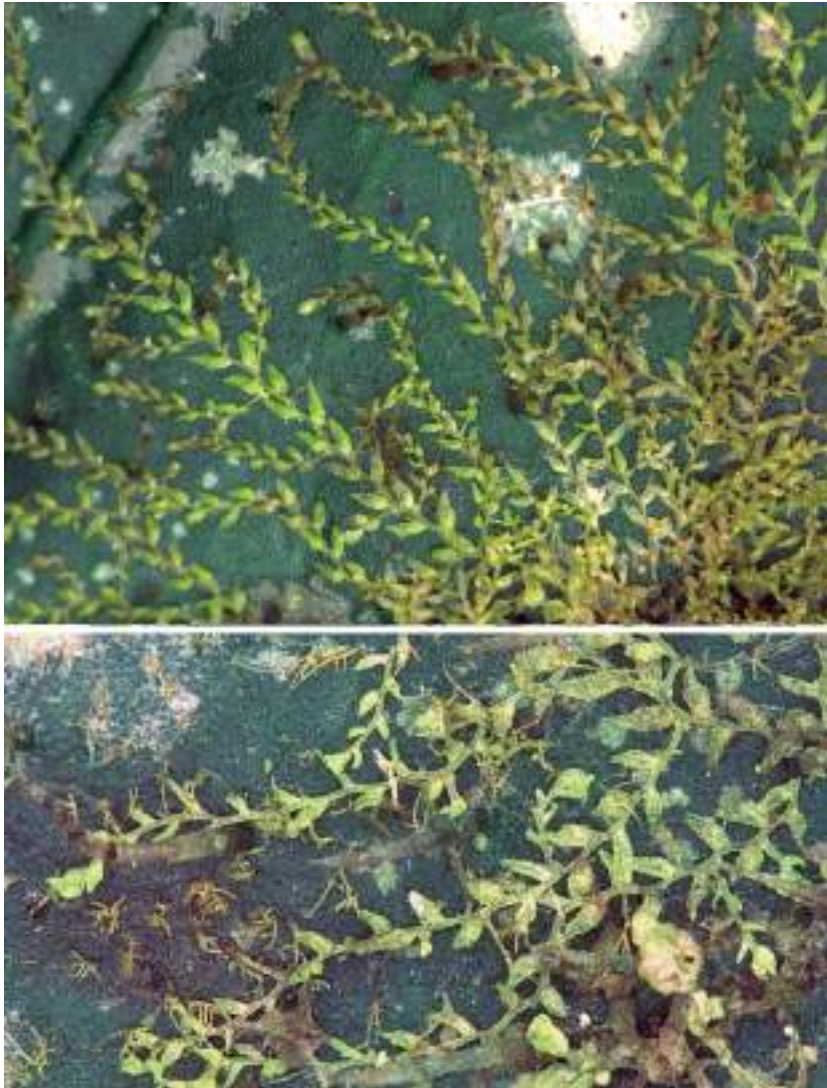




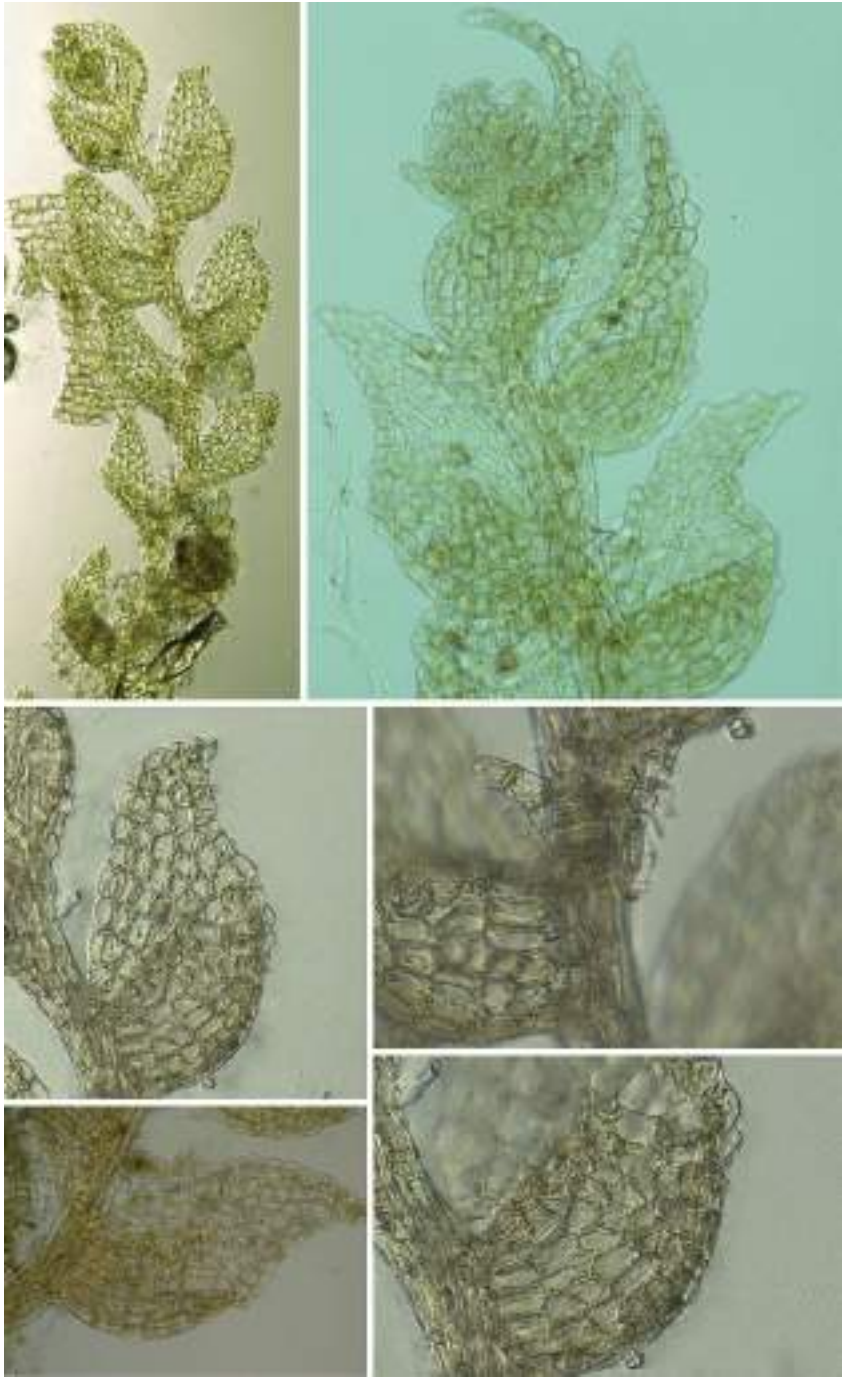
Figs 182 and 183 (next page). *Drepanolejeunea cultrella* (Mitt.) Steph.

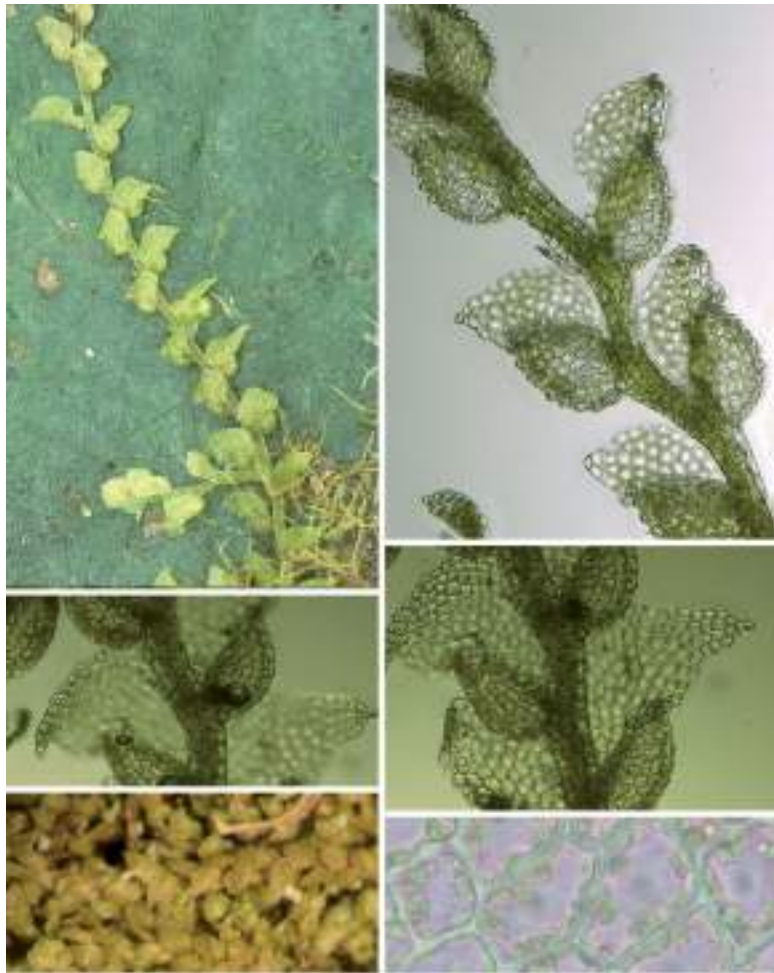
Plants small, shoots 0.3-0.45 mm wide and several mm long. Leaves distant to contiguous, with short insertion line. Lobe lanceolate, distinctly convex on dorsal side and nearly straight on ventral side, entire on dorsal margin, ventral margin with strong triangular tooth at its base and occasionally some spiniform teeth, asymmetrical, slightly falcate, apex acuminate, 0.12-0.16 x 0.2-0.35 mm. Lobule inflated, fusiform, 0.3-0.5 the length of the lobe, apical tooth 1-celled, curved. 1-3 scattered ocelli present. Underleaves distant, with triangular lobes, 0.06-0.07 mm long, at base 2-3 cells wide, followed by a uniseriate lobe. Autoicous. Perianth obconical, dentate, the lobes acuminate, with 5 keels, 0.2 x 0.45 mm, short and acute horns present. **Habitat:** Epiphyllous or epiphytic in montane forest, 1900-2000 m. **Distribution in Rwanda:** Nyungwe NP: Karamba, Gisakura, km 106 Butare-Cyangugu, Kamiranzovu. **Distribution in Africa:** Guinea, Sierra Leone, Ivory Coast, São Tomé, Cameroon, DR Congo, Burundi, Kenya, Tanzania. Also Comoros, Madagascar.



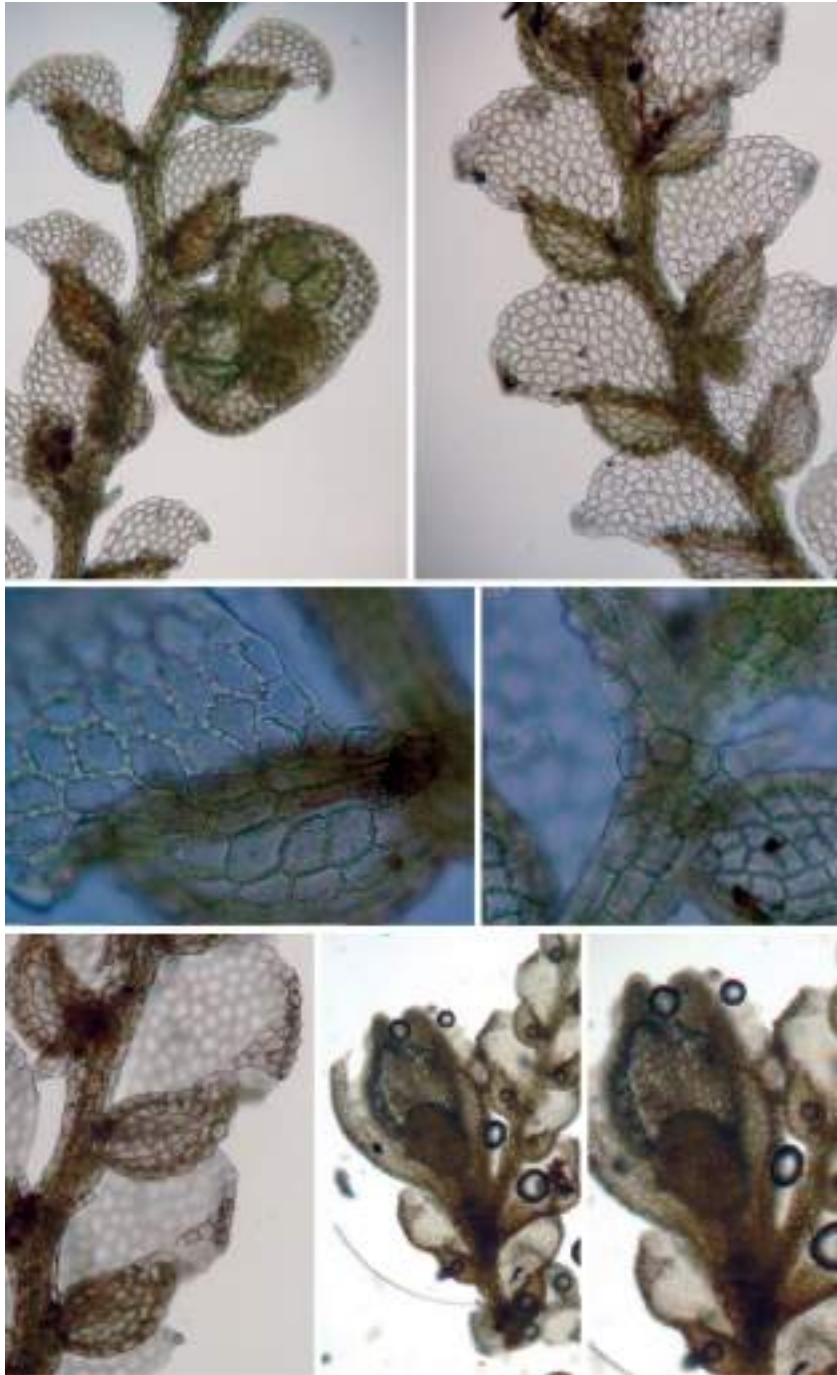


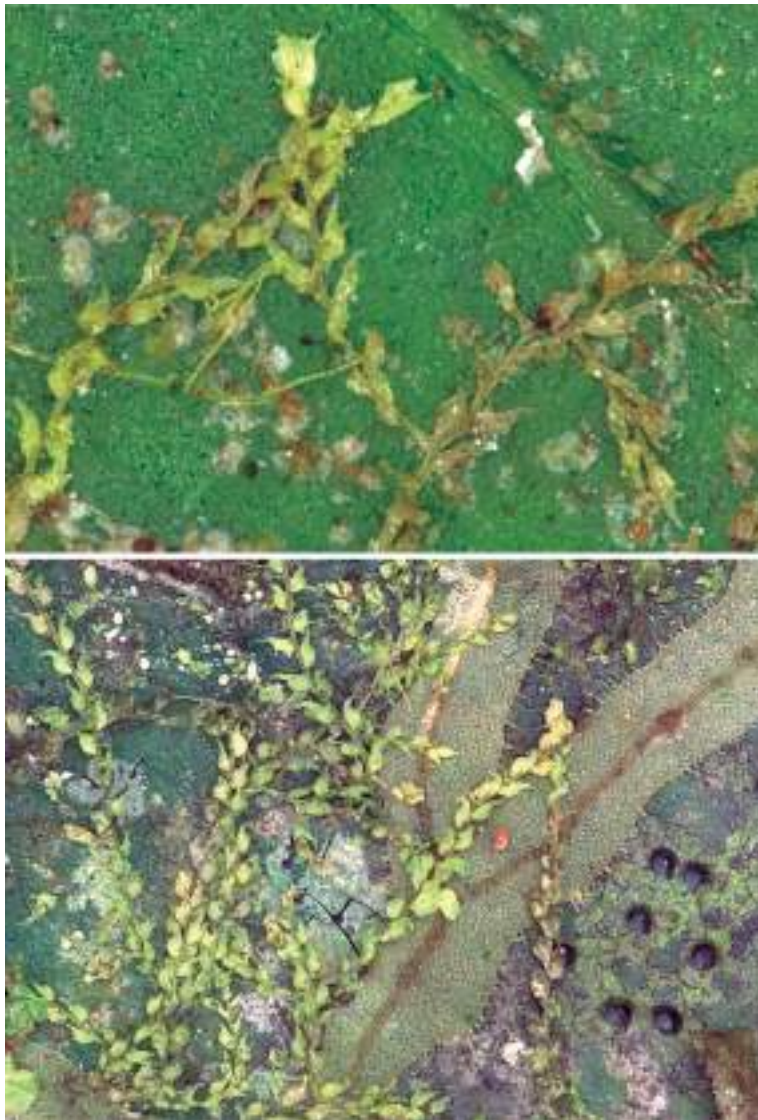
Figs 184 and 185 (next page). *Drepanolejeunea deslooveri* Vanden Berghen
 Synonym: *Drepanolejeunea hamatifolia* auct. non (Hook.) Schiffn. Plants small, shoots 0.32-0.52 mm wide. Leaves slightly imbricate. Lobe distinctly concave on ventral side, forming an angle of 10-40° with the stem, entire or sinuate, asymmetrical, subtriangular-lanceolate, slightly falcate, apex acuminate, 0.09-0.13 x 0.27-0.36 mm. Lobule inflated, fusiform, apical tooth 1-celled, hyaline papilla subglobose, 0.05-0.085 x 0.1-0.15 mm. 1-2 ocelli present. Underleaves distant, with subulate lobes, 0.05-0.07 mm long, at base 2 cells wide. Monoicous. Perianth turbinate, with 5 keels, 0.3-0.36 x 0.45-0.52 mm, horns absent. **Habitat:** Epiphyllous or epiphytic in montane forest, 2500 m. **Distribution in Rwanda: Nyungwe NP:** Rwasenkoko. **Distribution in Africa:** DR Congo, Zimbabwe, Mozambique, South Africa.





Figs 186 and 187 (next page). *Drepanolejeunea physaefolia* (Gottsche) Steph.
 Synonyms: *Drepanolejeunea friesii* Vanden Berghen; *D. vesiculosa* auct. non (Mitt.) Steph. Plants yellowish to light-brownish green, 4-5.5(-7) mm long and 0.35-0.45 mm wide. Leaves mostly imbricate, (0.25-)0.28-0.29 x 0.22-0.25 mm, with strongly decurved acute pointed apex. Basal ocelli present in most leaves, 2 in a row, containing one large oil body. Lobules \pm ovate in shape, 0.14-0.160 x 0.08-0.09 mm, 0.5 the length of the lobe, apical tooth 1-celled, curved towards lower margin of lobe. Underleaves 1.2-2 x as wide as the stem, 0.070-0.088 x (0.06-) 0.07-1 mm, with widely diverging, small triangular lobes ending in a one-celled apex. Perianths 0.5-0.55(-0.7) x 0.25-0.28 mm, obovoid with five long deep equal keels and a strong rostrum. **Habitat:** Epiphytic or epiphyllous in montane forest, 1900-2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasenkoko, Karamba, Kamiranzovu, Gisakura, Uwinka. **Distribution in Africa:** Guinea, Ivory Coast, Principe, Bioko, São Tomé, Cameroon, Rio Muni, DR Congo, Uganda, Kenya, Tanzania, Zimbabwe, Malawi, Mozambique, South Africa. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.



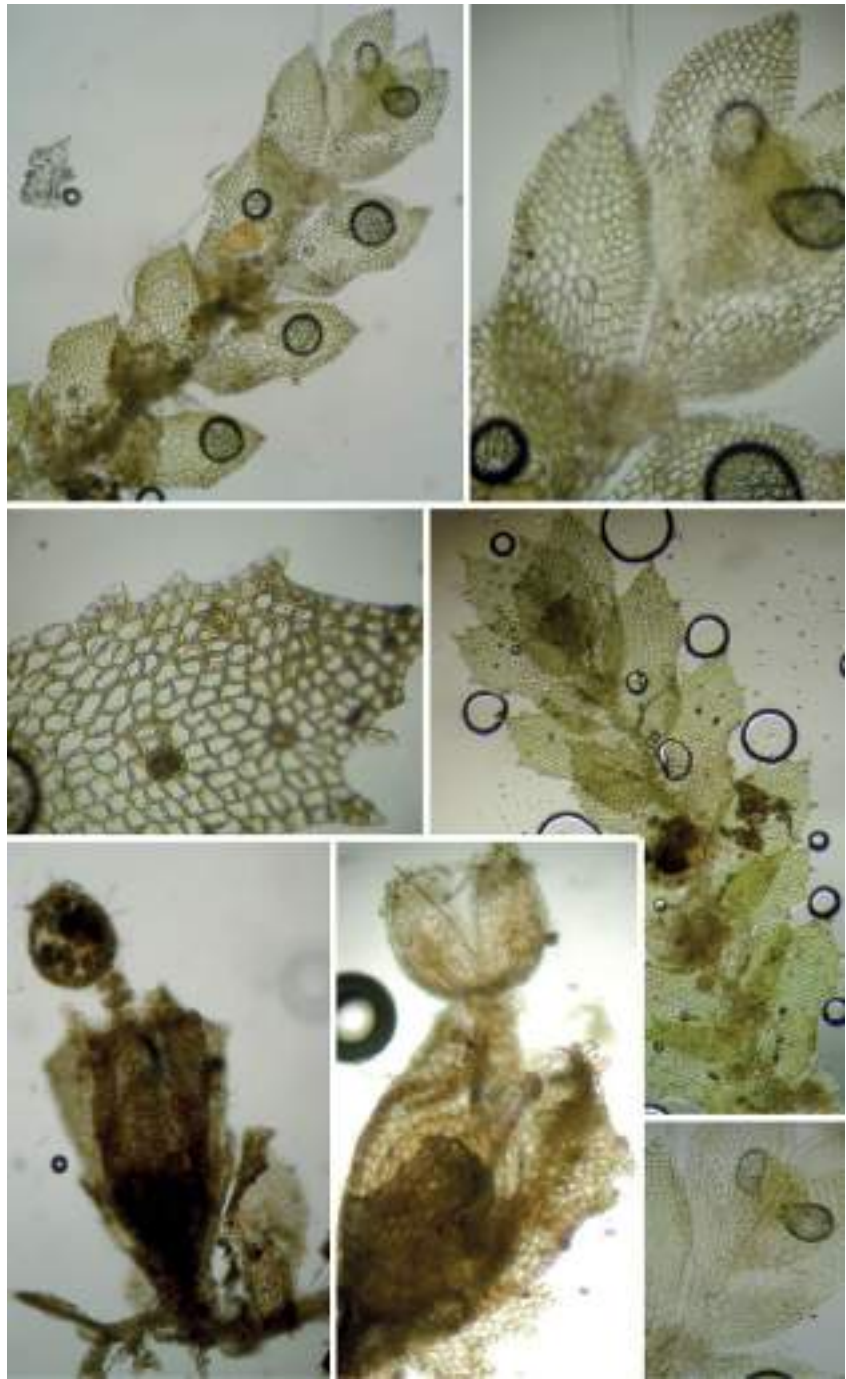


Figs 188 and 189 (next page). *Drepanolejeunea ruandensis* Vanden Berghen
 Plants small, shoots 0.3-0.4 mm wide and several mm long. Leaves distant to contiguous, with short insertion line. Lobe lanceolate, distinctly convex on dorsal side and nearly straight on ventral side, irregularly dentate, asymmetrical, slightly falcate, apex acuminate, 0.1-0.15 x 0.2-0.37 mm. Lobule inflated, fusiform, 0.07-0.09 x 0.13-0.17 mm, apical tooth 1-celled, arched, keel convex and mamillate. 1-3 scattered ocelli present. Underleaves distant, with triangular lobes, 0.06-0.07 mm long, at base 2-3 cells wide. Monoicous. Perianth turbinate, with 5 keels, 0.3-0.37 x 0.5-0.6 mm, short horns present. **Habitat:** Epiphyllous or epiphytic in montane forest, 2000 m. **Distribution in Rwanda:** Nyungwe **NP:** Karamba, Kamiranzovu. **Distribution in Africa:** DR Congo.





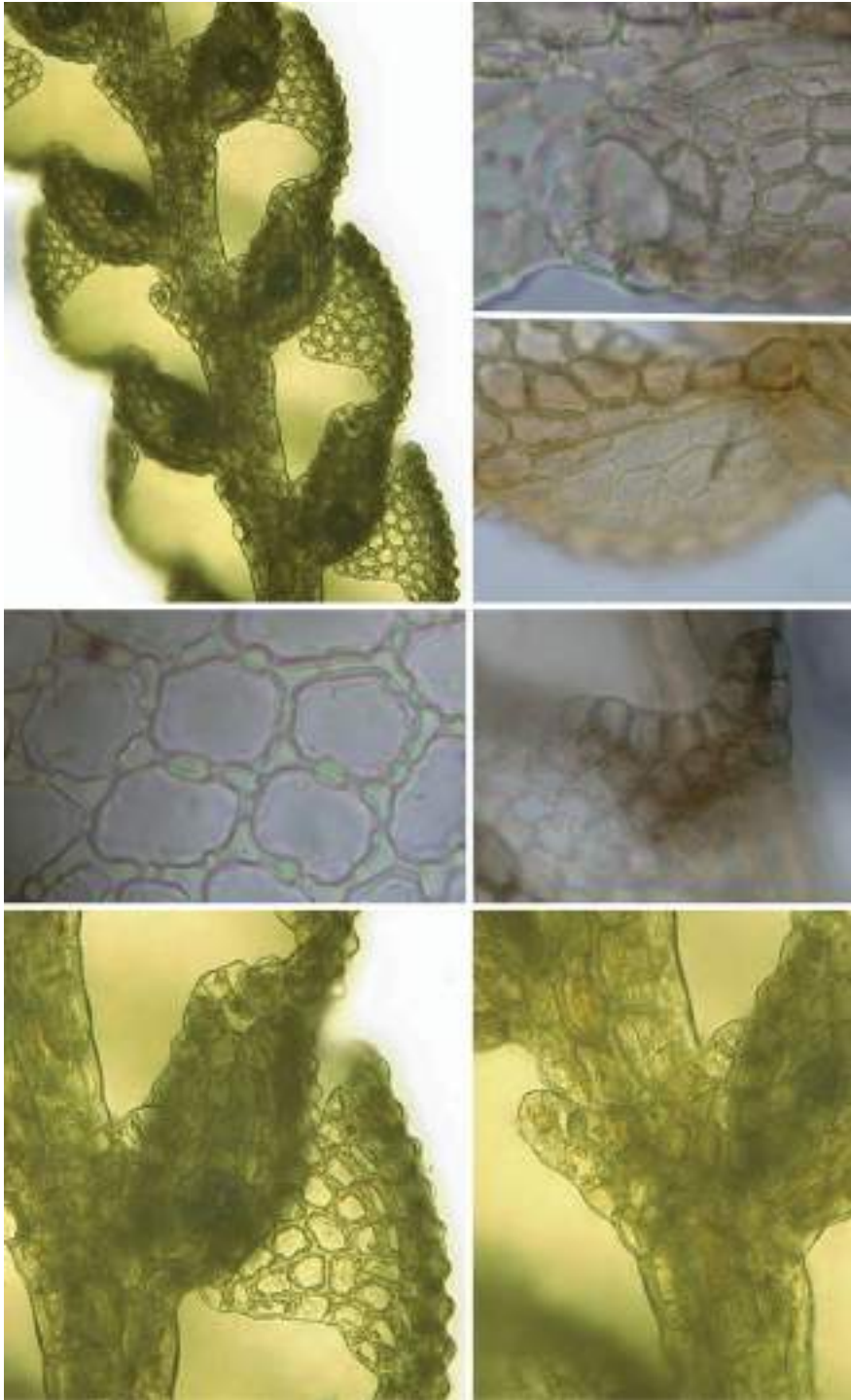
Figs 190 and 191 (next page). *Drepanolejeunea symoensii* (Vanden Berghen) Grolle
 Synonym: *Leptolejeunea symoensii* Vanden Berghen. Plants small, shoots 0.32-0.52 mm wide and 2-4 mm long. Leaves distant or contiguous. Lobe lanceolate-rhombical, subsymmetrical, margin entire or with few teeth, apex acuminate, 0.16-0.26 x 0.45-0.67 mm. Lobule subquadrangular, 0.06-0.13 x 0.15-0.27 mm, apical tooth 1-2-celled, hyaline papilla subglobose. 1-3 scattered ocelli present. Underleaves distant, with basilar disc, and subulate lobes, 0.08-0.16 mm long, at base 2 cells wide, followed by a row of 1-5 cells. Dioicous. Perianth turbinate, with 5 keels, 0.45 x 0.75 mm, horns absent. **Habitat:** Epiphyllous in montane forest, 1950-2000 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura, Rwankuba, Kamiranzovu. **Distribution in Africa:** DR Congo, Burundi, Uganda.





Figs 192 and 193 (next page). *Drepanolejeunea vandenberghenii* Buchbender & Eb.Fisch.

Plants yellowish to light-brownish green, up to 14 mm long and 0.45-0.6 mm wide. Leaves mostly imbricate, $(0.37-0.4-0.45 \times 0.37-0.4(-0.42))$ mm, with strongly decurved rounded to acute but rather widely pointed apex. Lobules \pm ovate in shape with the upper border being more straight than the lower, $0.16-0.175(-0.188) \times 0.087-0.1$ mm, 1/2 of the length of the lobe, with apical tooth curved towards lower margin of lobe. Underleaves $1.5-2 \times$ as wide as the stem, $0.087-0.1 \times (0.112-0.125-0.138)$ mm, obtrapeziform with widely diverging, small triangular lobes ending mostly in a two-celled apex, separated by a shallow to rectangulate sinus. Perianth $0.7(-0.9) \times 0.35(-0.4)$ mm, obovoid with 5 long deep equal keels and a strong rostrum. **Habitat:** Quartzitic rocks with *Sphagnum* and *Breutelia* in montane forest, also epiphytic on small twigs of *Symphonia globulifera* in the canopy, 1900-2020 m. **Distribution in Rwanda:** Nyungwe NP: Karamba, along old road to Ntendezi, between Gisakura and Karamba, E Karamba. **Distribution in Africa:** Malawi.





Figs 194 and 195 (next page). *Frullania angulata* Mitt.

Plants dark brown, laxly pinnate, forming pendent fronds up to 10-20 cm long. Leaf lobes 1-1.3(-2) x 0.7-0.9(-1.5) mm, spreading when moist, rolled around stem when dry, mucronate or apiculate at apex, auriculate at base. Lobules 0.2-0.35 mm long, 2.5-4 x as long as wide, mouth not projecting beyond lobe margin. Underleaves 2-3(-4) x as wide as the stem, bilobed for 0.3-0.4 of their length, lobes acute, margins revolute, auricled at base. Dioicous. Perianths claviform-cylindrical, trigonous, smooth. **Habitat:** Epiphyte on small branches in montane forest, 2000-2500 m. **Distribution in Rwanda:** Nyungwe **NP:** Rwasekoko, Uwinka, Gisakura, Kamiranzovu, Ntendezi. **Distribution in Africa:** Nigeria, Annobón, São Tomé, Bioko, Cameroon, DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Angola, Malawi, Zimbabwe, Mozambique. Also Comoros, Madagascar, Mauritius, Réunion.





Fig 196. *Frullania apicalis* Mitt.

Plants dark brown to black, irregularly pinnate. Leaves distant to almost imbricate. Leaf lobes 0.5-0.8(-1) x 0.4-0.65(-0.75) mm, rounded at apex, truncate to weakly rounded at base. Lobules 0.2-0.3 mm long, 1.6-2.5 x as long as wide, mouth projecting beyond lobe margin. Underleaves 2-3 x as wide as the stem, bilobed for 0.25-0.35 of their length.

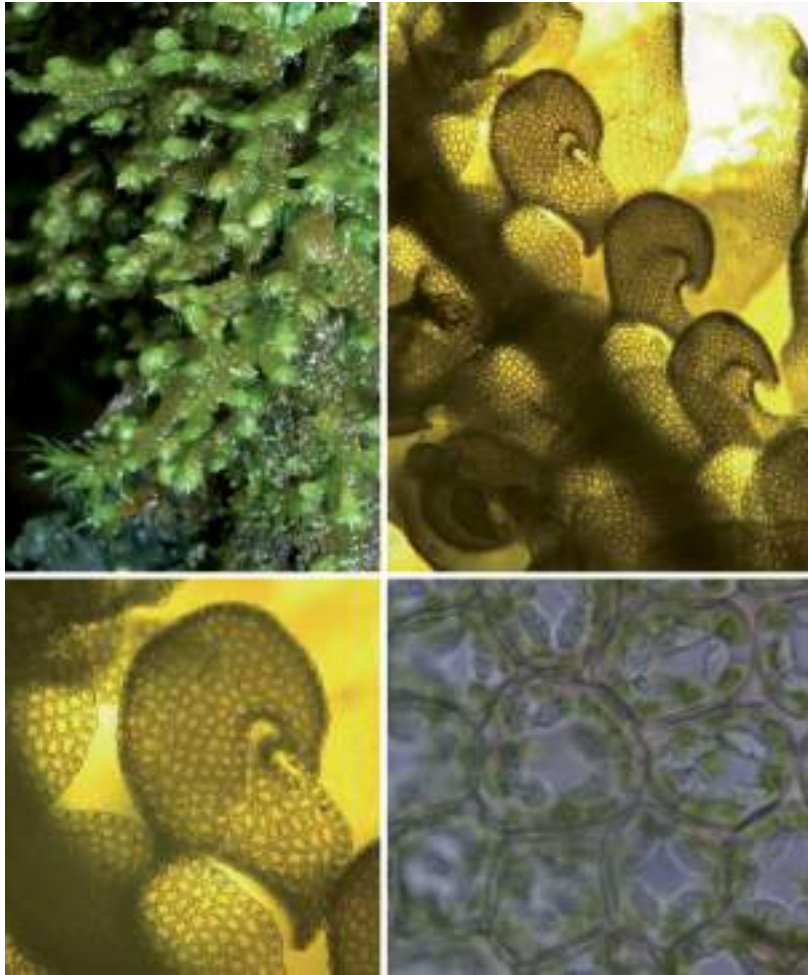
Dioicous. Perianths claviform or fusiform, trigonous in upper part, terete below, smooth.

Habitat: Epiphyte, rarely on rocks, 2020-2650 m. **Distribution in Rwanda:** Volcano NP: Sabinyo. **Nyungwe NP:** Karamba, Uwinka. **Distribution in Africa:** Guinea, Liberia, Sierra Leone, Ivory Coast, Ghana, Nigeria, Annobón, São Tomé, Bioko, Rio Muni, DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe, Mozambique. Also Comoros, Madagascar, Mauritius, Réunion, Rodriguez, Seychelles.

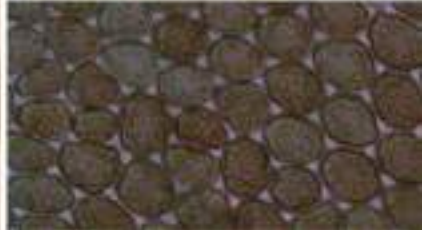


Figs 197 and 198 (next page). *Frullania apiculata* (Reinw., Blume & Nees.) Dumort. Plants dark brown to reddish, regularly pinnate-bipinnate, main axes forming fronds up to 2-5 cm long. Leaves imbricate. Leaf lobes oval, 0.5-0.8(-1) x 0.35-0.65(-0.8) mm, rounded and mucronate at apex, truncate at base. Lobules 0.18-0.25 mm long, 2-2.6 x as long as wide, on a stalk equalling or exceeding in length the diameter of the lobule, parallel to the stem, mouth projecting beyond lobe margin. Underleaves 2-3 x as wide as the stem, bilobed for 0.25-0.35 of their length. Autoicous. Perianths claviform, trigonous, smooth. **Habitat:** Epiphytic in montane forest, 2000 m. **Distribution in Rwanda :** **Nyungwe NP:** Karamba, Kamiranzovu, Uwinka. **Distribution in Africa:** Guinea, Ghana, Cameroon, Gabon, Rio Muni, DR Congo. Also Comoros, Madagascar, Mauritius, Réunion, Seychelles.





Figs 199 and 200 (next page). *Frullania arecae* (Spreng.) Gottsche
 Plants olive-green to reddish- or purplish brown, irregularly pinnate, main axes forming fronds up to 10 cm long. Leaves imbricate. Leaf lobes broadly ovate, 1-1.6 x 1.4-1.8 mm, convex, with basal auricle, rounded at apex, extending across stem. Lobules 0.55-1.5 x 0.2-0.5 mm, parallel to the stem, saccate portion helmet-shaped, rostrum large or small, decurrent, sometimes laminal portion longer than saccate part or lobule entirely laminal. Underleaves orbicular, 4-5 x as wide as the stem, bilobed for 0.1 of their length, base cordate or auriculate. Autoicous. Perianths cylindrical, with 8-10 long and smooth keels. **Habitat:** Epiphyte, e.g. on *Sinarundinaria*, *Erica* and *Dendrosenecio erici-rosenii*, occasionally on ground or roadcuts, 2330-3600 m. **Distribution in Rwanda:** **Volcano NP:** Karisimbi, in the saddle between Bisoke and Karisimbi, on the E-slopes along trail to summit. **Nyungwe NP:** Rwasekoko, along road from Butare to Cyanguu at border of Rusizi District. **Distribution in Africa:** Sierra Leone, Ghana, Nigeria, São Tomé, Bioko, Cameroon, DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Malawi, Zimbabwe, Mozambique, South Africa. Also Madagascar, Mauritius, Réunion.



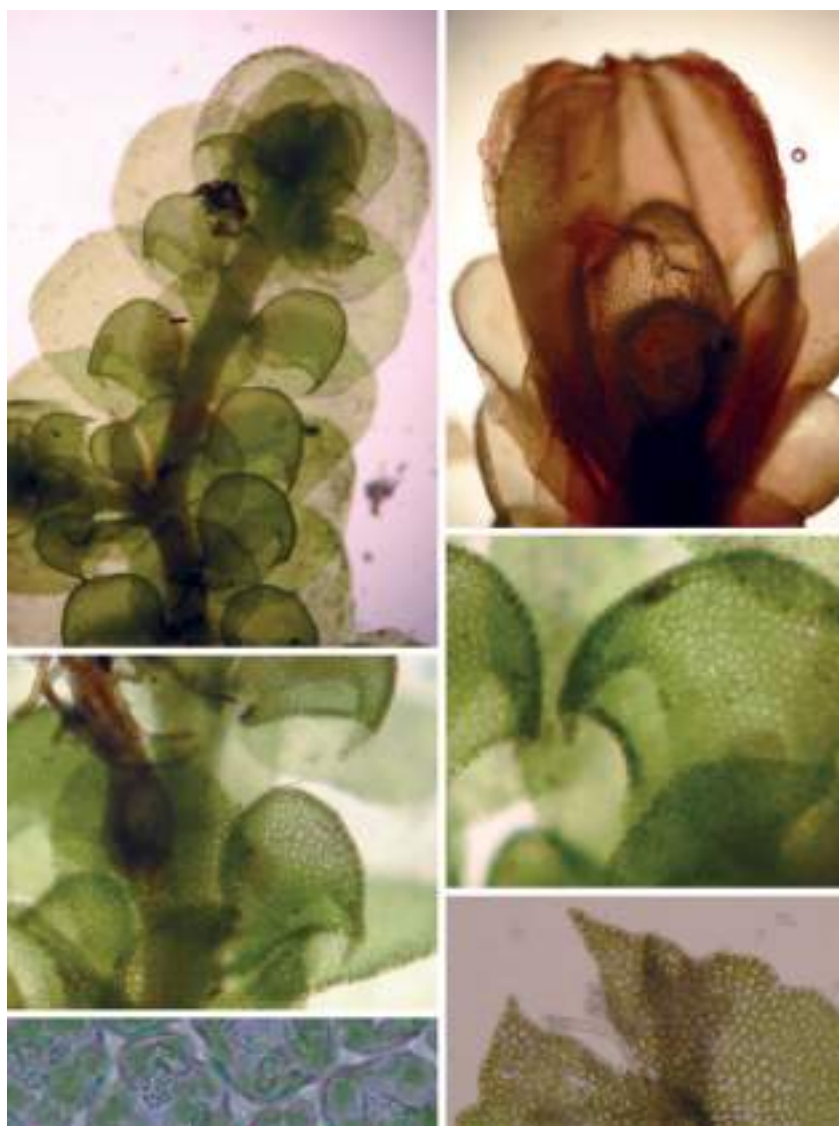


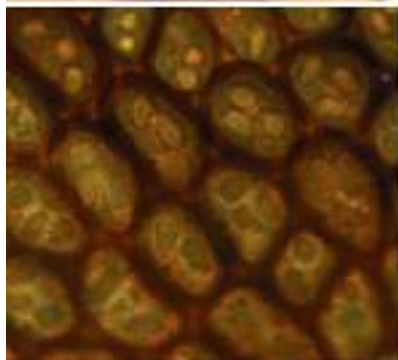
Fig. 201. *Frullania cafraria* Steph.

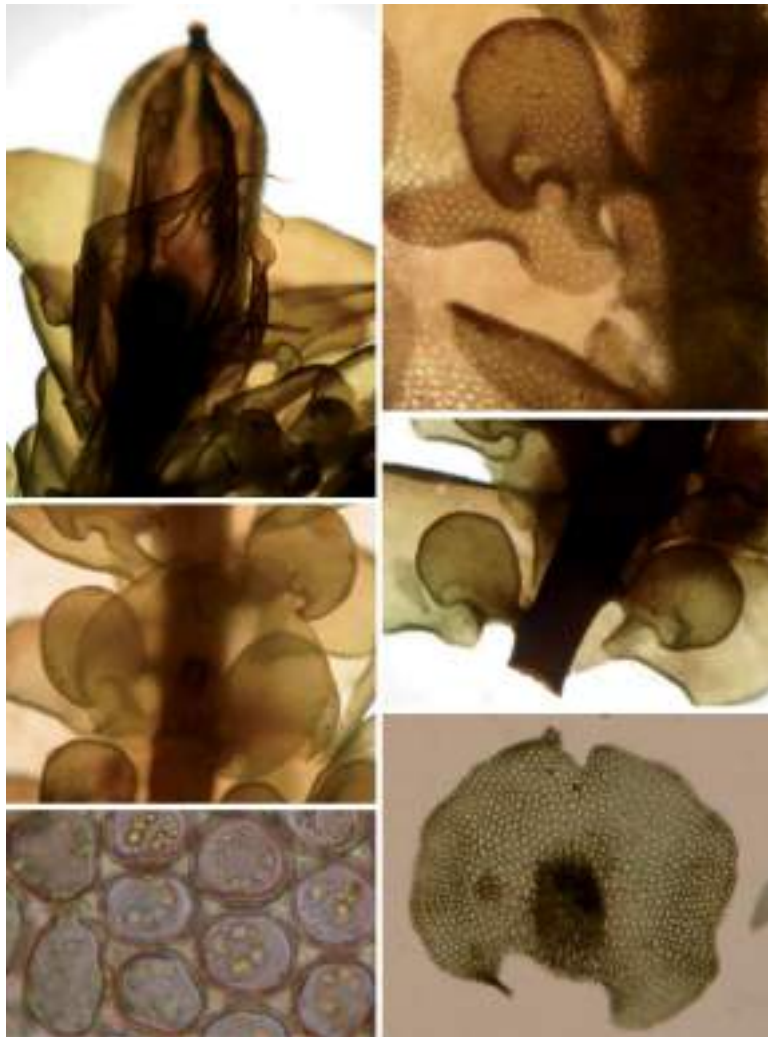
Plants olive-green to reddish- or purplish brown, large, irregularly pinnate, main axes forming lax mats. Leaves imbricate. Leaf lobes circular, 1-1.6(-2) x 1-1.25(-1.6) mm, convex, with basal auricle, rounded at apex. Lobules 0.4-0.65 mm long, helmet-shaped to widely bell-shaped, always with a curved apiculus. Underleaves suborbicular, 3-5 x as wide as the stem, very shortly bilobed. Dioicous. Perianths trigonous, claviform, smooth or with narrow verrucose keels. **Habitat:** Epiphytic in montane forest, also on planted trees. **Distribution in Rwanda: Central Rwanda:** Huye (Butare). **Distribution in Africa:** Nigeria, Bioko, Cameroon, Rio Muni, Eritrea, Ethiopia, Djibouti, Uganda, Kenya, Tanzania, Angola, Malawi, Zambia, Zimbabwe, South Africa. Also Madagascar, Mauritius, Réunion.



Figs 202 and 203 (next page). *Frullania capensis* Gottsche

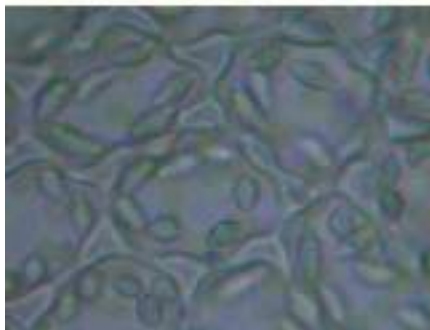
Plants dark reddish- or purplish brown to black, regularly pinnately branched. Leaves distant to slightly imbricate. Leaf lobes concave, ovate-renaliform, 0.4-0.6 x 0.6-0.75(-0.8) mm, rounded at apex. Lobules clavate, attenuate at base, parallel to stem or, in branches, with apex directed to stem, 0.1-0.3 x 0.18-0.22 mm. Underleaves 1.2-2 x as wide as the stem, bilobed for 1/4-1/3 of their length, base cuneate. Monoicous. Perianths clavate, trigonous. **Habitat:** On quartzitic rocks in montane forest, 2000 m. **Distribution in Rwanda: Nyungwe NP:** Karamba. **Distribution in Africa:** Tanzania, Zimbabwe, Mozambique, South Africa. Also Madagascar, Réunion.

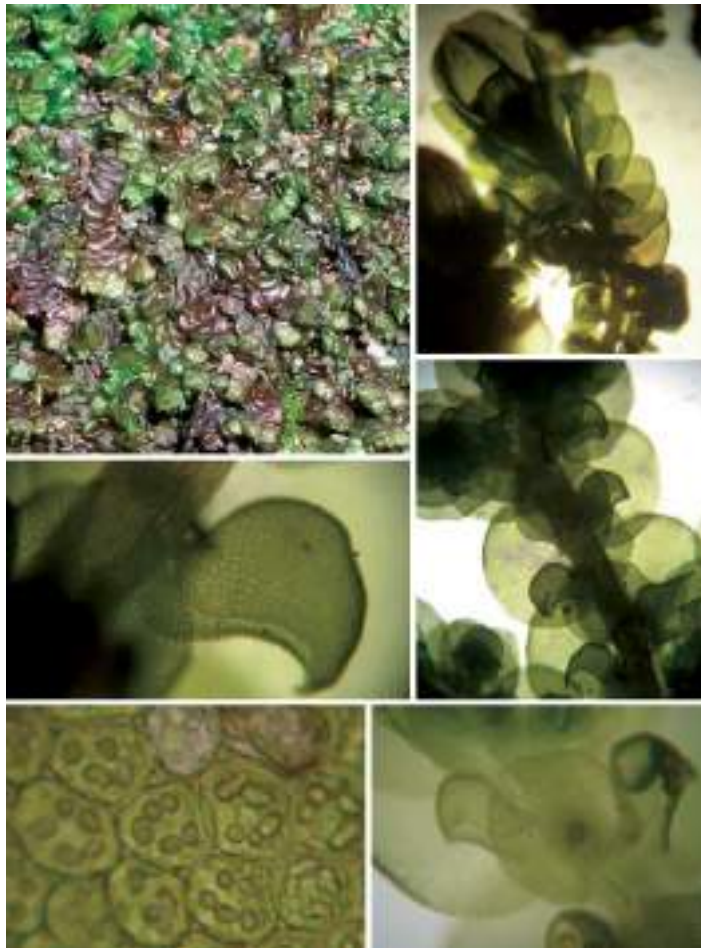




Figs 204 and 205 (next page). *Frullania depressa* Mitt.

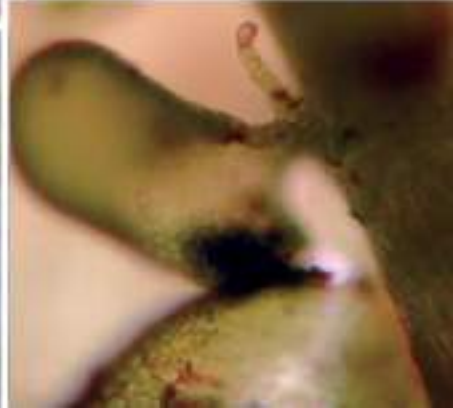
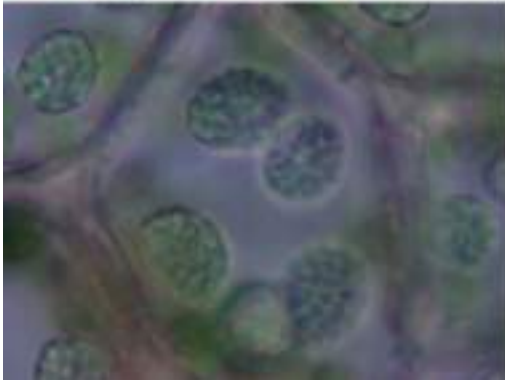
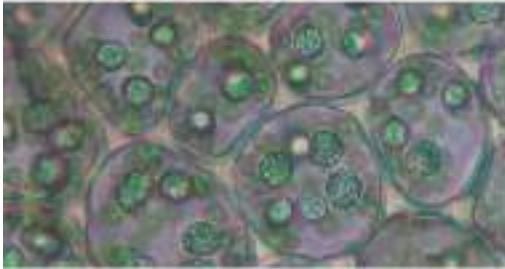
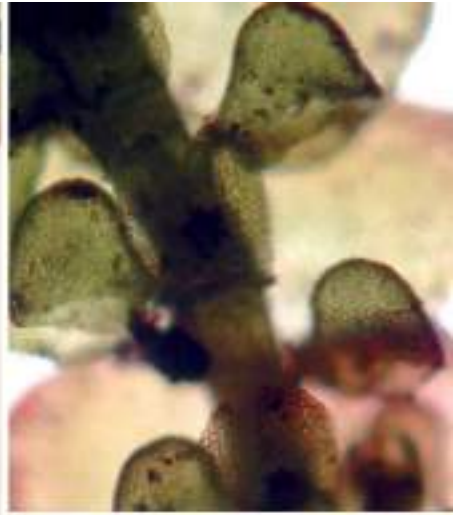
Plants brown to nearly purple-black, irregularly pinnate, main axes forming mats. Leaves imbricate. Leaf lobes oval or ovate, 0.8-1.4(-1.8) x 0.6-1(-1.25) mm, with basal auricle, rounded at apex. Lobules (0.35-)0.6-0.7(-0.8) x 0.3-0.4(-0.6) mm, diverging obliquely from the stem, inflated around apex, forming a rostrum on distal side, compressed towards mouth. Underleaves suborbicular, 3-5 x as wide as the stem, bilobed for 0.1-0.2 of their length, base rounded to cordate. Autoicous. Perianths subcylindrical, compressed, with 2 lateral and 2 ventral keels, dorsal face plane or with 1-3 low keels. **Habitat:** Epiphyte, e.g. on bark of *Erica* between 2330 and 2500 m. **Distribution in Rwanda:** Nyungwe NP: Rwasekoko, Uwinka, along road from Butare to Cyangugu at border of Rusizi District. **Distribution in Africa:** Sierra Leone, Nigeria, Bioko, Cameroon, DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Malawi, Zimbabwe, Lesotho, South Africa. Also Comoros, Madagascar.

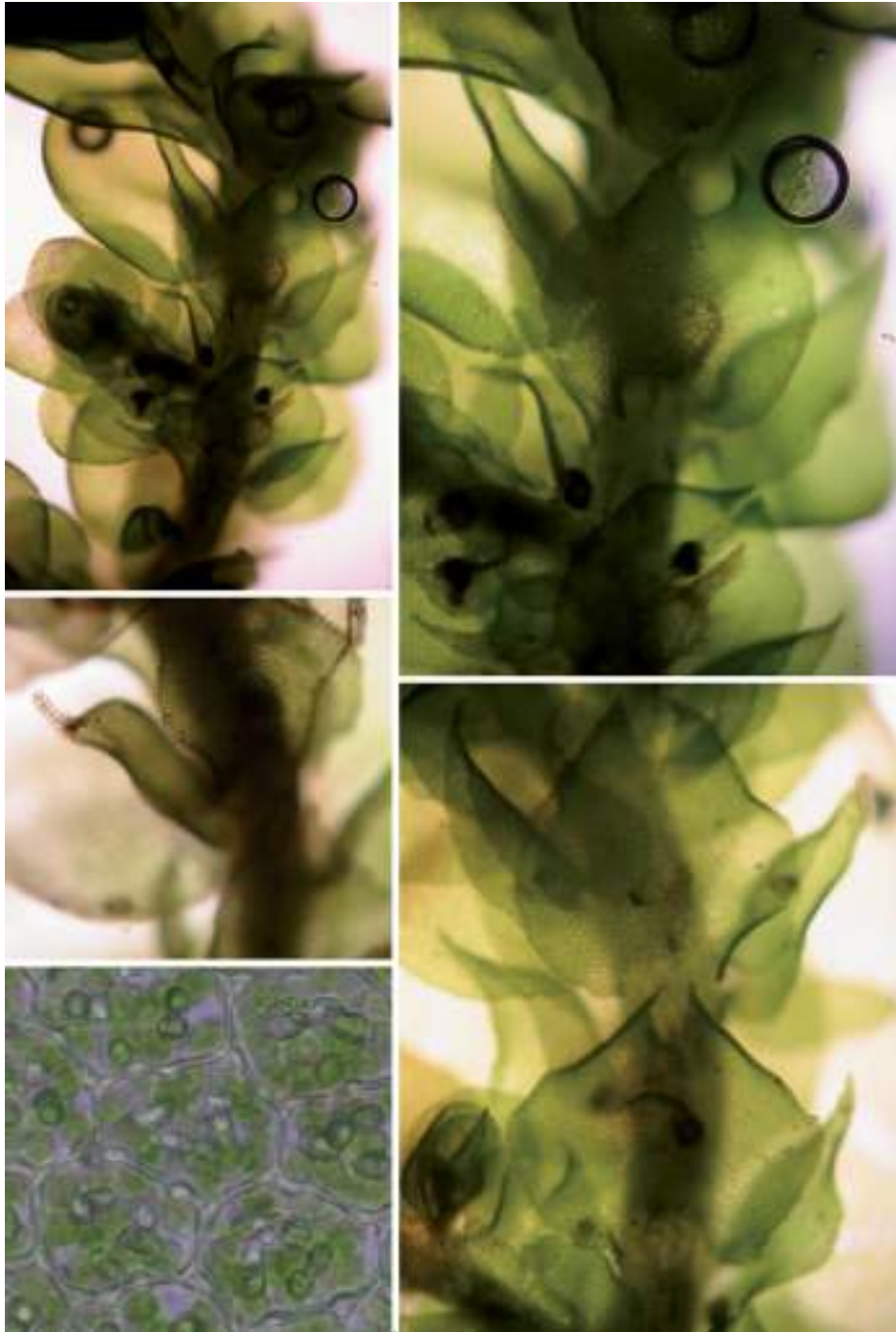




Figs 206, 207 and 208 (next pages). *Frullania ericoides* (Nees) Mont.

Plants dull green to dark brown, irregularly pinnate. Leaves laxly imbricate when dry, curved upwards and squarrose when moist. Leaf lobes oval to round, 0.9-1.1 x 0.6-0.7(-0.95) mm, with basal auricle, rounded at apex, extending across stem. Lobules 0.2-0.38 mm long, very variable in size, well developed about as long as wide, sometimes lobule entirely laminal. Underleaves 2-4 x as wide as the stem, longer than wide, bilobed for 0.15-0.35 of their length, base cuneate. Dioicous. Perianths claviform or cylindrical, trigonous, sometimes with 1-2 weak supplementary keels, upper part with short processes. **Habitat:** On rocks and on bark of trees in montane forest, savanna and cultivated landscape, 1300-2500 m. **Distribution in Rwanda:** Gishwati Forest: W of Gakarara. **Nyungwe NP:** Rwasenkoko. **Central Rwanda:** Butare, Rubona, Songa. **Akagera:** Lake Ihema, Lake Mpanga region. **Distribution in Africa:** One of the most widespread species. Guinea, Sierra Leone, Ghana, Togo, Nigeria, Annobon, Bioko, Cameroon, Congo-Brazzaville, Central African Republic, Gabon, DR Congo, Burundi, Ethiopia, Uganda, Kenya, Tanzania, Angola, Zambia, Zimbabwe, Malawi, Mozambique, South Africa. Also Canaries, Cape Verde.





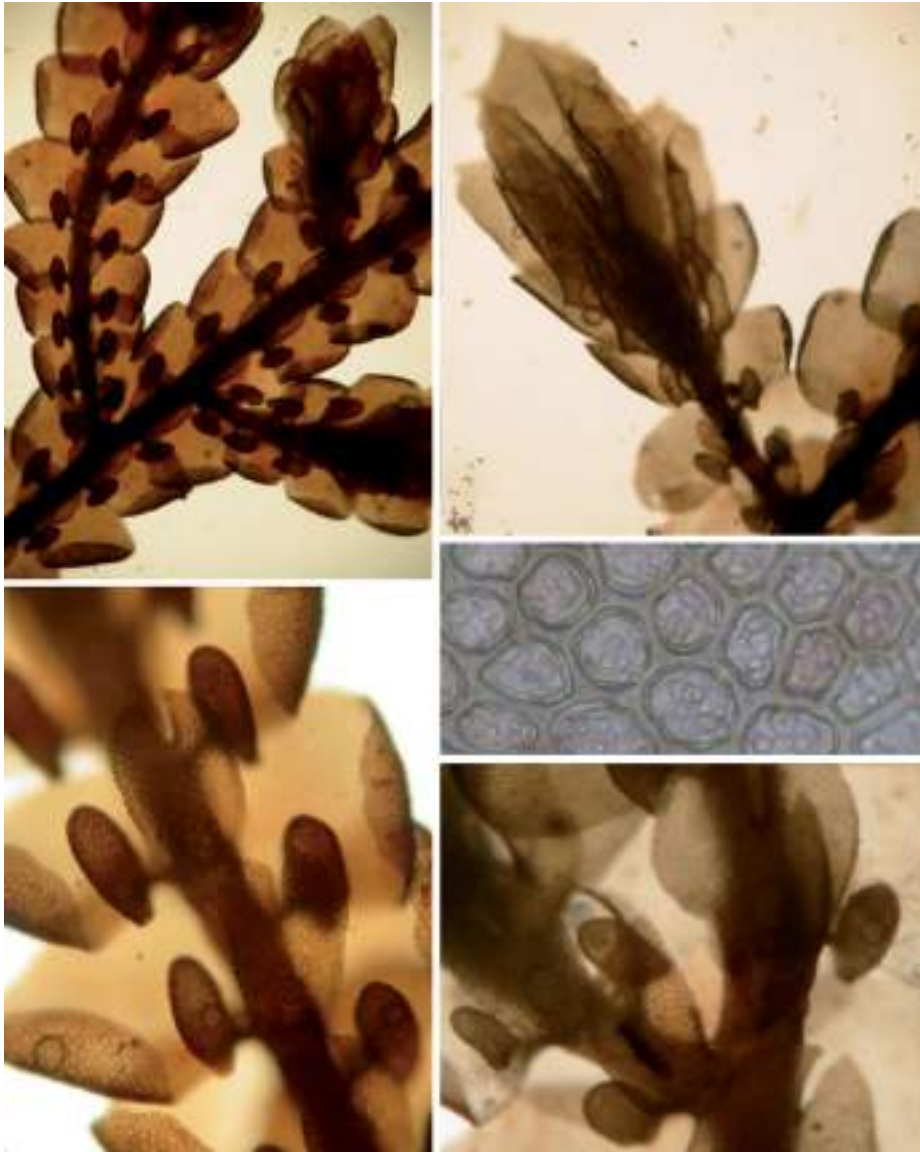


Fig. 209. *Frullania imerinensis* Steph.

Plants brown, regularly pinnate or bipinnate. Shoots 2-4(-6) cm long and 0.9-1.1(-1.5) mm wide. Leaves imbricate. Leaf lobes 0.75-1 x 0.58-0.75 mm, rounded at apex, concave, ovate to reniform, obtuse to rounded at base, incurved at apex. Lobules clavate, 0.25-0.45 mm long, 2-2.5 x as long as wide, arranged parallel to the stem, mouth attenuate. Underleaves 2.5-3 x as wide as the stem, bilobed for 0.25-0.35 of their length. Dioicous. Perianths claviform or fusiform, trigonous, smooth, 2-2.1 x 0.6-0.8 mm. **Habitat:** Epiphytic in montane forest. **Distribution in Rwanda: Nyungwe NP:** Recorded by De Sloover without precise locality. **Distribution in Africa:** Madagascar, Seychelles.

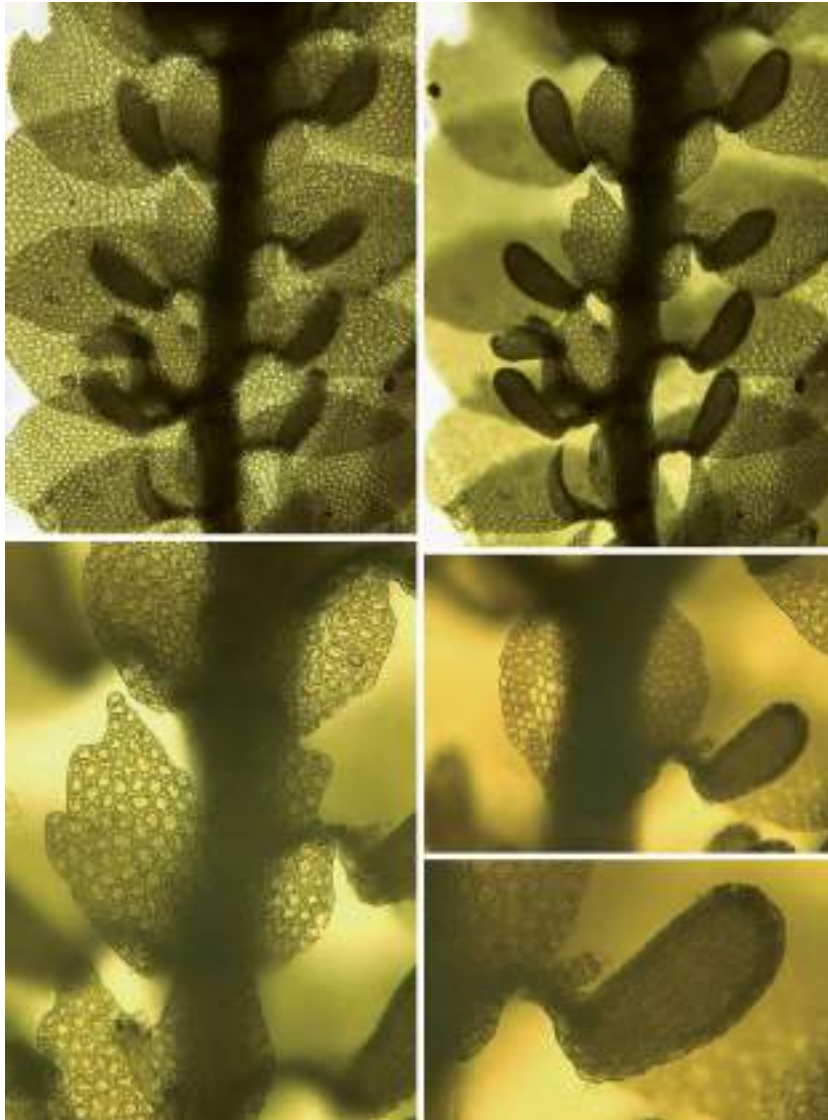
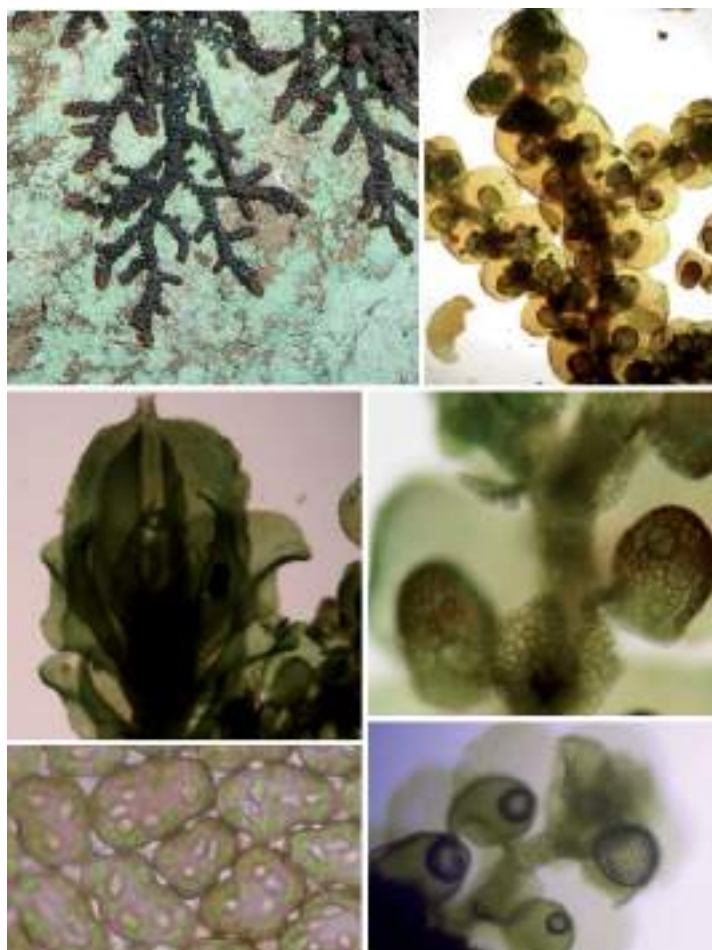


Fig. 210. *Frullania lindenbergii* Lehm.

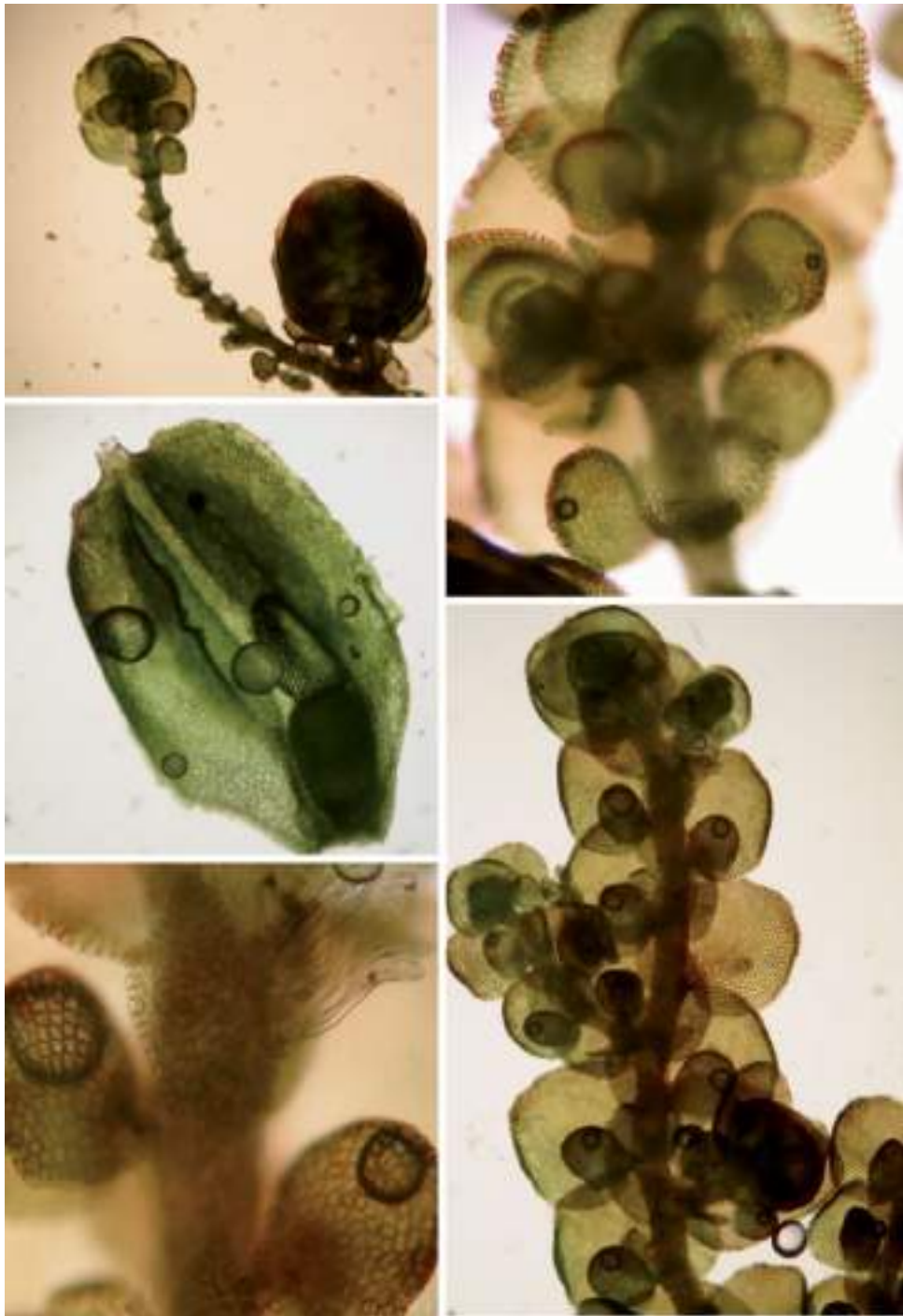
Plants pale-green, yellow-brown to carmin-brown, regularly bipinnate. Leaves imbricate, squarrose when moist. Leaf lobes ovate, 0.6-0.9(-1.2) x 0.9-0.1.2(-1.5) mm, rounded to obtuse at apex. Lobules with distinct peduncle, cylindrical-clavate, attenuate at base, forming an angle of (20-)30-45° with stem, up to 90° in young branches, 0.1-0.2 x 0.24-0.45 mm. Underleaves (2-)3-5 x as wide as the stem, bilobed for 1/4-1/3 of their length, lobes acute, usually with 1-2 teeth at lateral side. Monoicous. Perianths clavate, trigonous.

Habitat: Epiphytic in montane forest, 2000 m. **Distribution in Rwanda:** Nyungwe NP: Gisakura. **Distribution in Africa:** Tanzania, Zimbabwe, Mozambique, South Africa. Also Réunion.



Figs 211 and 212 (next page). *Frullania obscurifolia* Mitt.

Plants dark reddish- or purplish brown to black, irregularly branched. Leaves distant to slightly imbricate, squarrose when moist, sometimes caducous. Leaf lobes ovate, 0.3-0.6 x 0.28-0.45 mm, with basal auricle, rounded at apex. Lobules large relative to lobe, often 0.5 or more of lobe length, 0.2-0.3 x 0.12-0.2 mm. Underleaves 1.2-2 x as wide as the stem, bilobed for 0.5-0.75 of their length, base cuneate. Dioicous or autoicous. Perianths ovoid, with 5 principal keels. **Habitat:** Epiphytic, rarely rupicolous in montane forest, savanna, gallery forest and cultivated landscape, 1300-2500 m. **Distribution in Rwanda:** **Lake Kivu:** Rubavu (Gisenyi). **Gishwati Forest:** W of Gakarara. **Nyungwe NP:** Rwasekoko. **Central Rwanda:** Lac Bulera. **Akagera:** Bugesera, Lake Ihema, Lake Mpanga region. **Distribution in Africa:** Sierra Leone, Ghana, Nigeria, Annobón, Cameroon, Congo-Brazzaville, DR Congo, Burundi, Ethiopia, Djibouti, Uganda, Kenya, Tanzania, Angola, Malawi, Zambia, Zimbabwe, Mozambique, Lesotho, Swaziland, South Africa. Also Comoros, Madagascar, Mauritius, Réunion, Rodriguez, Seychelles. **Note:** *De Sloover* 13548, cited by Vana *et al.* (1979) from Rwanda as *F. variegata* has numerous propagules and thus represents typical *F. obscurifolia*.



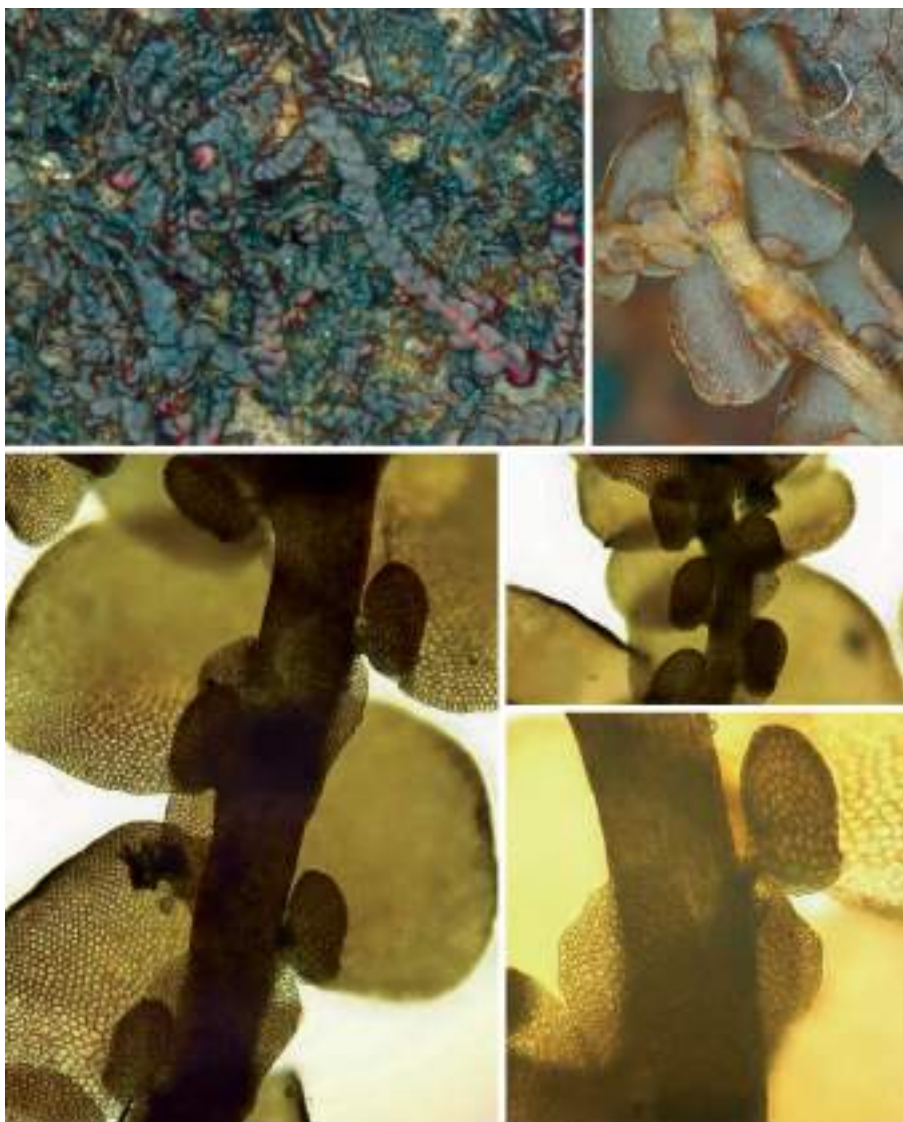
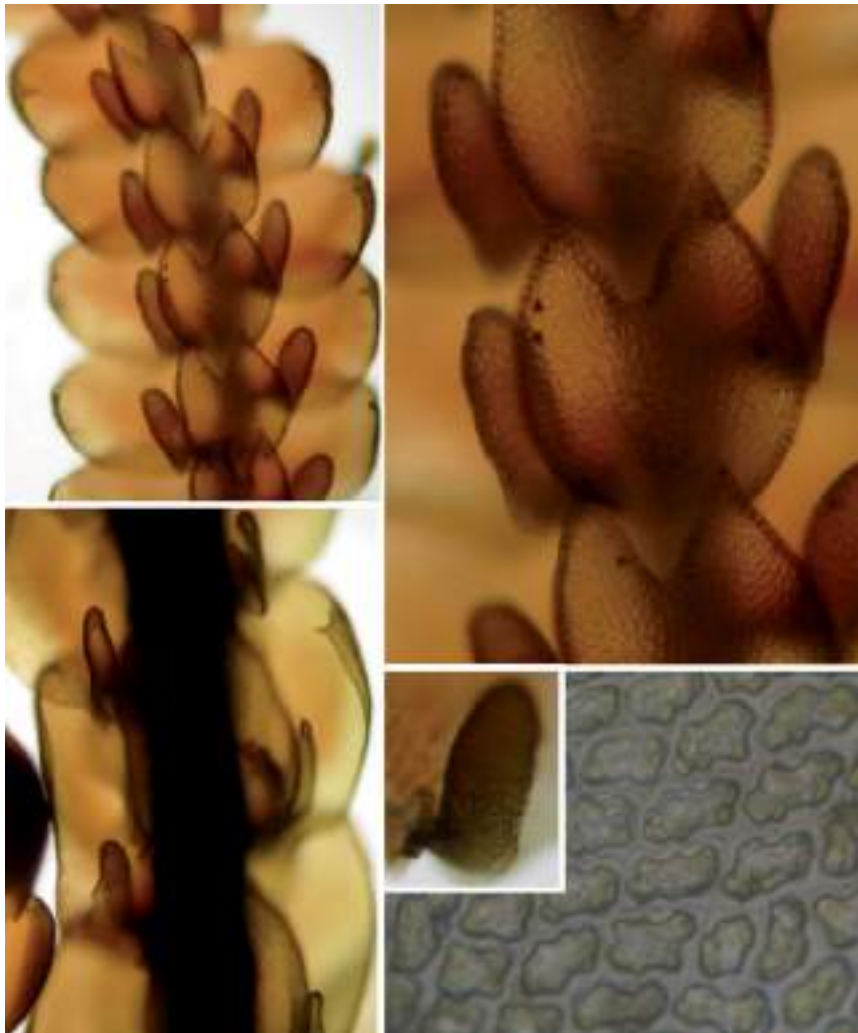


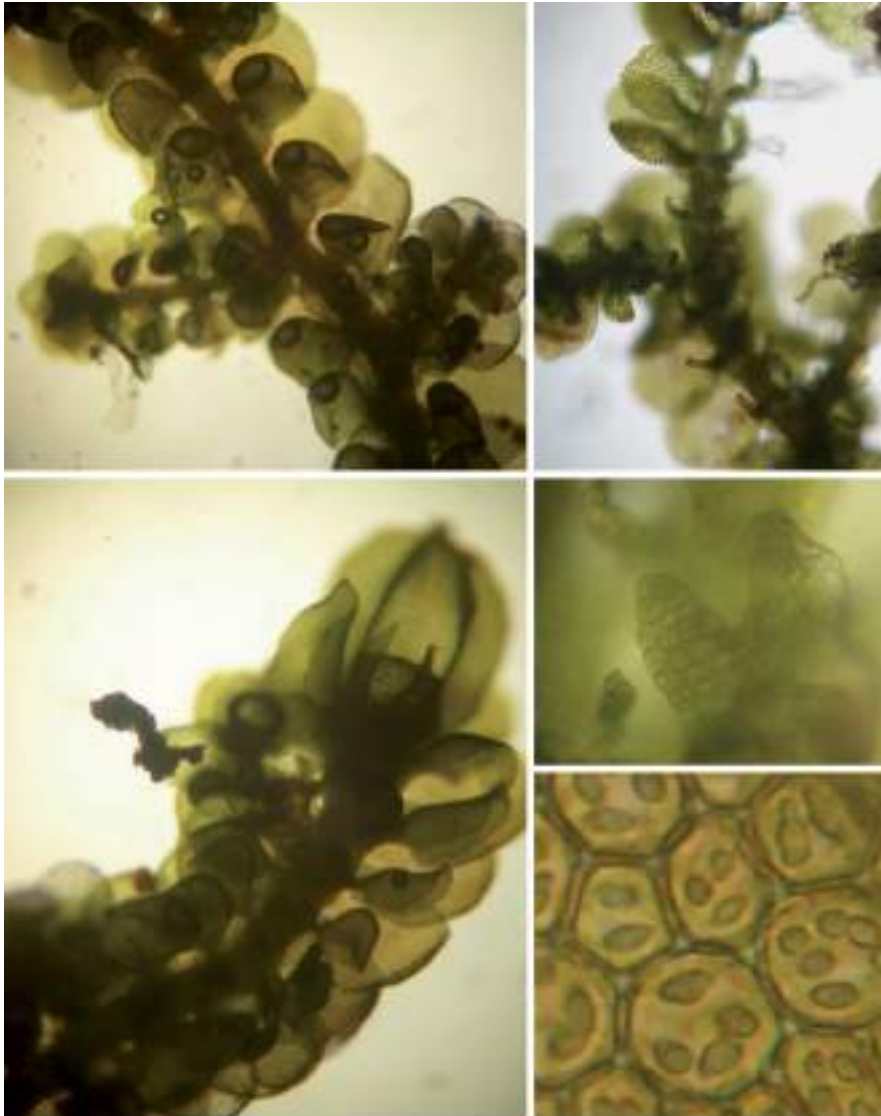
Fig. 213. *Frullania schimperi* Nees in Gottsche, Lindenb. & Nees
 Plants brown to nearly black, regularly or irregularly pinnate to bipinnate, 4-6 cm long. Leaves imbricate. Leaf lobes concave, ovate-reniform, 0.8-1 x 0.6-0.9(-1) mm, rounded or apiculate at apex. Lobules 0.2-0.3 mm long, 2 x as long as wide, claviform, nearly parallel to stem, narrowed at base. Underleaves suborbicular to oval, 3-5 x as wide as the stem, bilobed for 0.25 of their length. Dioicous. Perianths claviform or fusiform, trigonous. **Habitat:** Epiphytic on roadside trees, probably also in montane forest, 1400 m. **Distribution in Rwanda:** Lake Kivu: Rubavu (Gisenyi). **Distribution in Africa:** Cameroon, Burundi, Ethiopia, Kenya, Tanzania. Also Madagascar.



Figs 214 and 215 (next page). *Frullania serrata* Gottsche

Synonym: *Frullania mildbraedii* Steph. Plants olive-green to dark brown, pinnate-bipinnate, fronds 5-10 cm long in loose tufts. Leaves imbricate. Leaf lobes concave, oval, 1-1.2 x 0.75-0.85(-1.2) mm, rounded and obtuse at apex, usually apiculate, auriculate at base. Lobules claviform-cylindrical, 0.24-0.36 mm long, 2.5-3.5 x as long as wide, often hidden by underleaves. Underleaves 4-5 x as wide as the stem, bilobed for 0.3 of their length. Autoicous. Perianths fusiform, trigonous, smooth. **Habitat:** Epiphyte on trunks of trees, on branches and occasionally on rocks, in montane forest and cultivated landscape, 2000-2700 m. **Distribution in Rwanda:** **Lake Kivu:** Rubavu (Gisenyi). **Nyungwe NP:** Rwasenkoko, waterfall c. 3 km E of Pindura, Karamba, along abandoned road to Burundi. **Distribution in Africa:** São Tomé, Cameroon, DR Congo, Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe, Malawi, Mozambique, South Africa. Also Comoros, Madagascar, Mauritius, Réunion.





Figs 216 and 217 (next page). *Frullania socotrana* Steph.

Plants small, greenish-brown, irregularly branched, main axes forming fronds up to 10 cm long. Leaves contiguous to imbricate. Leaf lobes ovate, 0.4-0.65(-0.75) x 0.3-0.5(-0.65) mm, flat or concave, rounded at apex. Lobules large relative to lobe, 0.17-0.3(-0.4) mm long, usually contracted towards mouth, 1-1.4 x as long as wide. Underleaves small, 0.12-0.22 mm long, 1.5 x as wide as the stem, bilobed for 0.4 of their length. Autoicous.

Perianths ovoid, with 2-3(-5) ventral keels, 2 lateral keels and 0-3 obscure dorsal keels.
Habitat: Epiphytic on exotic trees, probably also in montane forest, 1750 m. **Distribution in Rwanda:** Central Rwanda: Huye (Butare). **Distribution in Africa:** Cameroon, Kenya, Tanzania. Also Cape Verde, Socotra, Madagascar.