

Our present knowledge of the bryoflora of United Arab Emirates

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Seventeen, out of 29 mosses, and two hepatics, recently collected from the United Arab Emirates (UAE), are new records for the country and the total number of bryophytes is raised to 61 entities (51 mosses & 10 hepatics). Eight mosses are new records to the whole Arabian Peninsula including three mosses which are new records to South-West Asia. Habitats and distribution of the 31 collected taxa are given together with an artificial key to all recorded mosses.

Key words: bryophytes, hepatics, mosses, United Arab Emirates.

Introduction

Shabbara & El-Saadawi (1999) added 25 new records (one hepatic & 24 mosses) to the relatively small number of bryophytes known from the United Arab Emirates (UAE); which made the total known from this country 42 taxa, (eight hepatics and 34 mosses, El-Saadawi & Shabbara 2000). This represented then a good contribution to the bryoflora of that area of the Arabian Peninsula (which was till quite recently almost unknown bryofloristically) and was the result of collecting specimens from sites in Hajjar Mountains that were not explored earlier by other workers (cf. Shabbara & El-Saadawi, 1999).

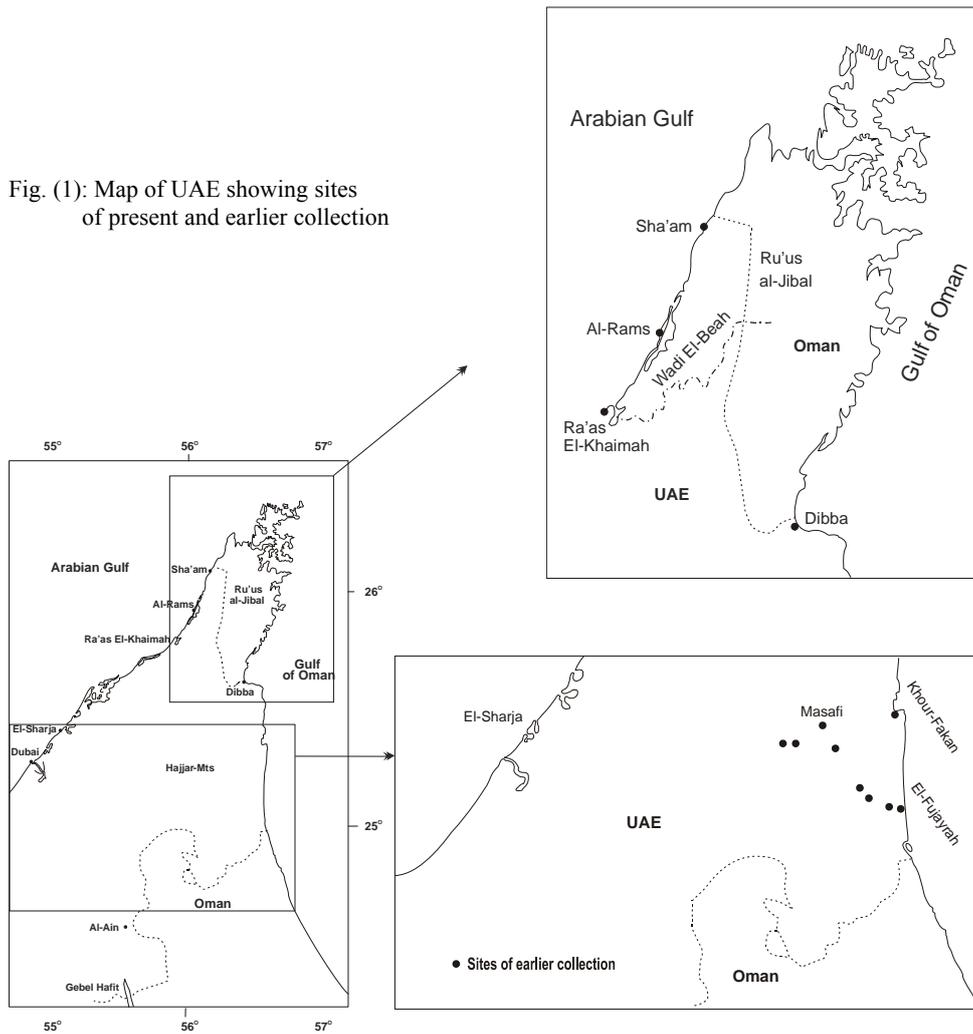
The present paper reports a considerable number of new records to the bryoflora of the United Arab Emirates as a result of recent collections (Feb.2001), from sites in Ru'us Al-Jibal (=heads of mountains.) and Gebel (=mountain) Hafit (Fig.1) that were not explored earlier. This enabled the authors to update our knowledge of the bryoflora of UAE.

Study area and Materials

Ru'us Al-Jibal with the highest peak over 2000 m, a.s.l., is a mountainous region situated between the Arabian Gulf and Gulf of Oman. Its major part is an Omani territory while a narrow coastal strip in the west belongs to UAE. Mountains are grey or dusty. Geologically they are sedimentary rocks, of Triassic age. Gebel Hafit, which lies 10 km

to the south of Al-Ain City, is calcareous of Lower Eocene age and reaches 1162 m, a.s.l. at its highest point.

Fig. (1): Map of UAE showing sites of present and earlier collection



Our present knowledge of the bryoflora of United Arab Emirates

Both Ru'us Al-Jibal and Gebel Hafit (Fig.1) were explored by the second author during February 2001, when he collected 21 samples from the former and two samples from the latter as comes below (samples are kept in CAIA) .

Locality	Altitude M, a.s.l.	Number of collected samples
<u>Ru'us Al Jibal</u>		
i- Mountains opposite El-Rams city	15-20 m	8
ii- Wadi El-Beah	60-120 m	7
iii- Mountains opposite Sha'am city	15-20 m	6
<u>Gebel Hafit</u>		
i-lat. 24° 05' 06" N, long 55° 45' 55" E	760 m	1
ii-lat. 24° 05' 06" N, long 55° 45' 55" E below the Qasr.	950 m	1
Total		23

Results

A total of 31 taxa are identified including 29 mosses and two hepatics. The two hepatics (*Fossombronina ?caespitifformis* & *Mannia androgyna*) and 17 of the mosses are new records to the bryoflora of UAE. This makes the total known from this country 61 taxa (51 mosses & 10 hepatics).

Eight out of the 17 new records namely: *Brachymenium acuminatum*, *Bryum canariense*, *B. klingraeffii*, *Entosthodon fascicularis*, *Funaria convexa*, *Pohlia melanodon*, *Pseudosymblepharis angustata* and *Weissia willisiana*, are new records to Arabian Peninsula, while three of them, viz. *Brachymenium acuminatum*, *Pseudosymblepharis angustata* and *Weissia willisiana*, are new to South-West Asia (As5).

All the collected taxa and their families are listed below, new records are asterisked. Sites of collection, habitat, altitude relative to sea level and distribution of these taxa in Arabian Peninsula, As5 and the world (for new records to Arabian Peninsula) are mentioned. Fertility or the presence of reproductive structures is also given. The distribution of taxa is based on: Wijk *et al.* (1959-69), Frey & Kürschner (1991), Zander (1993), Kürschner (1996), O'Shea (1999), Kürschner (2000), and Arts (2001). Abbreviation of countries in Arabian Peninsula are; Ku: Kuwait, Om: Oman, SA: Saudi Arabia, Ye: Yemen; other countries in AS5 are: Af: Afghanistan, Iq: Iraq, Ir: Iran, Is: Israel, Jo: Jordan, Le: Lebanon, Sy: Syria, Tu: Turkey, and only Soc: Socotra, in Afr2.

Musci:

I-Fissidentaceae:

1-Fissidens arnoldii R. Ruthe

RU'US AL-JIBAL: Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m.

Earlier record: Shabbara & El-Saadawi (1999: 188); Ku, Om, SA, Ye; Jo & Ir.

II-Pottiaceae

***2-Anoetangium aestivum** (Hedw.) Mitt.

RU'US AL-JIBAL: Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel 15-20 m; Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20m.

New record to UAE; Ye; Ir.

3-Crossidium crassinerve (De Not.) Jur.

GEBEL HAFIT; lat. 24° 05' 06" N, long 55° 45' 55" E, on sandy soil, 760 m. Fruiting.

Earlier records: Shabbara & El-Saadawi (1999: 188), Kürschner & Böer (1999: 415); Ku, Om, SA, Ye; Iq, Ir, Is, Jo & Sy.

***4-C. laxefilamentosum** Frey & Kürschner

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m.

New record to UAE; Om, SA & Ye.

5-C. squamiferum (Viv.) Jur. **var. pottioideum** (De Not.) Mönk.

RU'US AL-JIBAL: ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m.

Earlier record: Kürschner & Böer (1999: 415); Ku, Om, SA, Ye; Af, Iq, Ir, Is, Jo, Le & Tu.

6-Gymnostomum mosis (Lor.) Jur.

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m; Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m.

Earlier record: Kürschner & Böer (1999: 415), Shabbara & El-Saadawi (1999: 188); Om, SA; Af, Iq, Ir, Is & Jo.

7-*G. viridulum* Brid.

RU'US AL-JIBAL: ca 18 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil among rocks, 105 m. Sometimes with axillary gemmae.

Earlier record: Shabbara & El-Saadawi (1999: 188); Om, SA, Ye & Jo.

***8-*Gymnostomum* sp.**

RU'US AL-JIBAL: Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel, 15-20 m.

New record to UAE.

9-*Gyroweisia reflexa* (Brid.) Schimp.

RU'US AL-JIBAL: Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m. Female, sometimes with rhizoidal gemmae.

Earlier record: Shabbara & El-Saadawi (1999: 188), Kürschner & Böer (1999: 415); SA, Ye; Jo & Tu.

10-*Microbryum davallianum* var. *commutatum* (Limpr.) Zand.

RU'US AL-JIBAL: Sha'am Mts. (30 km from Ra'as El-khaimah); at base of a shady dry runnel, 15-20 m. Fruiting.

Earlier record: Shabbara & El-Saadawi (1999: 188); Iq, Ir, Is, Jo, Le, Sy & Tu.

11-*Pseudosymblepharis angustata (Mitt.) Hilp.

RU'US AL-JIBAL: ca 18 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil among rocks, 105 m. With protonema.

New record to AS5; Soc; AS2-4.

12-*Timmiella barbuloidea* (Brid.) Mönk

RU'US AL-JIBAL: ca 18 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil among rocks, 105 m; Sha'am Mts. (30 km from Ra'as El-khaimah); at base of a shady dry runnel, 15-20 m.

Earlier record: Kürschner & Böer (1999: 416), Shabbara & El-Saadawi (1999:188); Ku, Om, SA, Ye; Af, Iq, Ir, Is, Jo, Le, Sy & Tu.

***13-*Timmiella* sp.**

RU'US AL-JIBAL: ca 20 km from Ra'as El-khaimah to Wadi El-Beah; on muddy soil in shade of big rocks of a dry runnel, 120 m.

New record to UAE.

14-*Tortella nitida* (Lindb.) Broth.

GEBEL HAFIT; lat. 24° 05' 06" N, long. 55° 45' 55" E, below the Qasr, on sandy soil, 950 m.

Earlier record: Kürschner & Böer (1999: 417); Ye; Is, Jo, Le & Tu.

15-*Trichostomum tenuirostre (Hook. & Tayl.) Lindb.

RU'US AL-JIBAL: Sha'am Mts. (30 km from Ra'as El-khaimah); at base of a shady dry runnel, 15-20 m.

New record to UAE; Om, Ye; Ir, Le & Tu.

16- *Wiessia willisiana (Sainsb.) Catcheside

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m; ca 18 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil among rocks, 105 m; ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m; ca 6 km from Al-Rams to Sha'am, in a dry runnel, 15-20 m; Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m. With protonema.

New record to AS5; Austr1.

***17-Pottiaceae plant.**

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah; on muddy soil in shade of big rocks, 60 m.

III-Funariaceae

18-*Entosthodon attenuatus* (Dicks.) Bryhn

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m; ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m; Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel 15-20 m; Sha'am Mts. (30 km from Ra'as El-khaimah); at base of a shady dry runnel, 15-20 m. Fruiting.

Earlier record: Shabbara & El-Saadawi (1999:188); Om, SA, Ye; Af, Iq, Ir, Is, Jo, Le & Tu.

19-*E. fascicularis (Hedw.) Müll. Hal.

RU'US AL-JIBAL: Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel, 15-20 m, Rarely fruiting.

New record to Arabian Peninsula; Is, Jo, Le, Tu; Soc; Eur, Afr1& AS1.

20- *Funaria convexa Spruce.

RU'US AL-JIBAL: ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m; in Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m.

New record to Arabian Peninsula; Is, Le, Tu; Eur, Afr1,2...

21-*Funaria muhlenbergii* Turner.

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m; Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m. Sterile, with rhizoidal gemmae.

Earlier record: Shabbara & El-Saadawi (1999:188), Kürschner & Böer (1999: 417); SA; Iq, Ir, Is, Jo, Le, Sy & Tu .

22-*F. pulchella* H.Philib.

RU'US AL-JIBAL: ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m; Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel, 15-20 m.

Earlier record: Shabbara & El-Saadawi (1999:188); Om, SA, Ye; Jo & Tu.

V-Bryaceae

***23- *Brachymerium acuminatum* Harv.**

RU'US AL-JIBAL: ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m.

New record to As5; Afr2-4, AS3,4.

***24- *Bryum caespiticium* Hedw.**

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m.

New record to UAE; SA, Ye; Af, Iq, Ir, Is, Jo, Le & Tu.

***25- *B. canariense* Brid.**

RU'US AL-JIBAL: Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel, 15-20 m.

New record to Arabian Peninsula; Is, Tu; Eur, Afr1, 2, 4, Am1.

***26- *B. klingraeffii* Schimp.**

RU'US AL-JIBAL: ca 20 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks of a dry runnel, 120 m; Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry runnel, 15-20 m.

New record to Arabian Peninsula; Tu; Eur, Af2.

***27- *B. turbinatum* (Hedw.) Turner.**

RU'US AL-JIBAL: Al-Rams Mts., ca 6 km from Al-Rams to Sha'am, in a dry runnel, 15-20 m.

New record to UAE; SA; Ir, Sy and Tu.

28- *B. sp.

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m; ca 18 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil among rocks, 105 m.

***29- *Pohlia melanodon* (Brid.) A.J. Show**

RU'US AL-JIBAL: Sha'am Mts. (30 km from Ra'as El-khaimah), at base of a shady dry tunnel, 15-20 m.

New record to Arabian Peninsula; Tu; Eur,Afr2.

Hepaticae:

I. Fossombroniaceae:

***30- *Fossombronia ?caespitiformis* De Not.**

RU'US AL-JIBAL: ca 10 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil in shade of big rocks, 60 m.

New record to UAE; Om, SA; Cy, Ir, Is, Jo, Le & Tu .

II. Aytoniaceae:

***31- *Mannia androgyna* (L.) Evans**

RU'US AL-JIBAL: ca 18 km from Ra'as El-khaimah to Wadi El-Beah, on muddy soil among rocks, 105 m.

New record to UAE; Om, SA, Ye; Af, Ir, Is, Jo, Le & Tu.

Composition of the Flora

The 51 moss taxa, hitherto, reported from UAE belong to 21 genera and five families (Table 1). The largest family is Pottiaceae (33 taxa), followed by Bryaceae (11 taxa), Funariaceae (5 taxa) and Fissidentaceae and Splachnaceae (one taxon each). The largest genus is *Bryum* (9 entities), followed by *Microbryum* (5 entities) then *Crossidium*, *Gymnostomum* and *Weissia* (4 entities each), *Funaria*, and *Trichostomum* (3 entities each) and *Anoectangium*, *Entosthodon*, *Timmella* and *Tortella* (2 entities each). The other ten genera are represented by one entity each. The 10 reported hepatics belong to seven genera and five families. The largest family is Ricciaceae (*Riccia*, four taxa), followed by Targioniaceae and Aytoniaceae (two taxa each). All genera except *Riccia* are represented by one taxon each.

The present new records (19 taxa) to the bryoflora of UAE led to a change in the percentages of the elements composing this flora in comparison with percentages reported earlier by Kürschner (2000). The highest percentage remains, however, for Circum-Tethyan element, with a slight decrease from 47.6 % to 45.6 %. This is followed by Northern element with an increase from 14.3% to 22.8%, while Xerothermic-Pangaen element is decreased from 23.7% to 10.5% and became in the third position. Five Cosmo-subcosmopolitan elements representing 8.8% of the flora is a newly added element, whereas *Weissia willisiana* represents a disjunction with Australia.

Distribution of Taxa

The distribution of all of the recorded bryophytes in the three surveyed areas of UAE is given in Table (1). A *Bryum* sp. collected from cultivated land in Al-Ain is excluded.

Table (1) shows that the moss flora of Ru'us Al-Jibal is quite distinct from that of Hajjar Mountains; only nine taxa in common. Most of the mosses (80%) reported from Hafit Mountain occur also in Hajjar Mountains. Thirty-nine out of the 50 moss taxa were collected from only one area each, while *Gymnostomum mosis* and *Timmia barbuloidea* were collected from the three areas.

This distinction is not only appearing at species level but also at generic and familial level. Thus *Microbryum* and *Weissia* (except *M. davallianum* var. *commutatum* and *W. willisiana*) are confined to Hajjar Mountains while Bryaceae (except *Bryum bicolor* & *B. pseudotriquetrum*) are confined to Ru'us Al-Jibal.

Moreover, Hajjar Mountains. have more taxa in common with other countries in AS5 than Ru'us Al-Jibal except for Tu which obviously has more taxa in common with Ru'us Al-Jibal than with Hajjar Mountains. *Bryum klinggraeffii* and *Pohlia melanodon* are known to occur only in Ru'us Al-Jibal and Turkey.

The distinction between Ru'us Al-Jibal and Hajjar Mountains. is even more sharp regarding hepatics; no hepatics are common to the two areas (Table 1).

Table (1): Distribution of the recorded bryophytes in the three surveyed areas in UAE based on Long (1987), Frey & Kürschner (1988), Kürschner & Böer (1999) and Shabbara & El-Saadawi (1999), * = new record.

Taxa	Surveyed areas in UAE		
	Ru'us Al-Jibal	Hajjar Mts.	Gebel Hafit
Mosses:			
I-Fissidentaceae:			
1- <i>Fissidens arnoldii</i>	+	+	
II-Pottiaceae			
2- <i>Aloina ambigua</i>	+		
3- <i>Anoetangium handelii</i>		+	
*4- <i>A. aestivum</i>	+		
5- <i>Crossidium crassinerve</i>		+	+
6- <i>C. laevipilum</i>		+	
*7- <i>C. laxefilamentosum</i>	+		
8- <i>C. squamiferum</i> var. <i>pottioideum</i>	+		
9- <i>Didymodon aaronis</i>	+		
10- <i>Gymnostomum aeruginosum</i>		+	
11- <i>G. mosis</i>	+	+	+
12- <i>G. viridulum</i>	+	+	
*13- <i>G. sp.</i>	+		
14- <i>Gyrowesia reflexa</i>	+	+	
15- <i>Microbryum davallianum</i>		+	
16- <i>M. davallianum</i> var. <i>commutatum</i>	+	+	
17- <i>M. davallianum</i> var. <i>conicum</i>		+	
18- <i>M. starckeanum</i> var. <i>starckeanum</i>		+	
19- <i>M. starckeanum</i> var. <i>brachyodus</i>		+	
20- <i>Pseudocrossidium porphyreoneurum</i>		+	
*21- <i>Pseudosymblypharis angustata</i>	+		
22- <i>Timmia barbuloidea</i>	+	+	+

Table (1): continued

Taxa	Surveyed areas in UAE		
	Ru'us Al-Jibal	Hajjar Mts.	Gebel Hafit
*23- <i>T. sp.</i>	+		
24- <i>Tortella inclinata</i>		+	
25- <i>T. nitida</i>		+	+
26- <i>Tortula lanceolata</i>		+	
27- <i>Trichostomum brachydontium</i>		+	
28- <i>T. crispulum</i>		+	
*29- <i>T. tenuirostre</i>	+		
30- <i>Weissa condensa</i>		+	
31- <i>W. latiuscula</i>		+	
32- <i>W. rutilans</i>		+	
*33- <i>W. willisiana</i>	+		
*34- Pottiaceae sp.	+		
III-Funariaceae			
35- <i>Entosthodon attenuatus</i>	+	+	
*36- <i>E. fascicularis</i>	+		
*37- <i>Funaria convexa</i>	+		
38- <i>Funaria muhlenbergii</i>	+	+	
39- <i>F. pulchella</i>	+	+	
IV-Splachnobryaceae			
40- <i>Splachnobryum aquaticum</i>		+	
V- Bryaceae			
*41- <i>Brachymerium acuminatum</i>	+		
42- <i>Bryum bicolor</i>		+	
*43- <i>B. caespiticium</i>	+		
*44- <i>B. canariense</i>	+		
45- <i>B. funkii</i>			+
*46- <i>B. klinggraeffii</i>	+		
47- <i>B. pseudotriquetrum</i>		+	
*48- <i>B. turbinatum</i>	+		
*49- <i>B. sp.</i>	+		
*50- <i>Pohlia melanodon</i>	+		
Total no of taxa	29	29	5
Hepaticae:			
I. Fossombroniaceae			
* 1- <i>Fossombronia ? caespitifformis</i>	+		
II. Targioniaceae			
2- <i>Cyathodium cavernarum</i>		+	
3- <i>Targionia hypophylla</i>		+	
III. Aytoniaceae			
4- <i>Asterella persica</i>	+		
*5- <i>Mannia androgyna</i>	+		
IV. Exormothecaceae			
6- <i>Exormotheca pustulosa</i>		+	
V. Ricciaceae			
7- <i>Riccia atromarginata</i>	+		
8- <i>R. atro. Var. Jovit-astii</i>		+	
9- <i>R. crenatodentata</i>	+		
10- <i>R. subbifurca</i>		+	
Total no of taxa	5	5	

Key to the recorded mosses

This key is constructed for all recorded taxa. A *Bryum* sp. collected by Kürschner & Böer (1999) is excluded. The description and specimens of this taxon are not available to us. The key is based mainly on gametophytic characters, in a few cases sporophytic characters were considered.

- 1.a. Plants minute, leaves distichous in a single plane, each leaf consists of dorsal, terminal and vaginant laminae, leaves oblong-ovate to ovate, obtuse sometimes apiculate, unbordered *Fissidens arnoldii*
- b. Leaves not distichous, vaginant laminae absent 2
- 2.a. Leaves carrying chlorophyllose filaments on the ventral side of lamina 3
- b. Chlorophyllose filaments absent 7
- 3.a. Leaves rigid, strongly infolded, chlorophyllose filaments not restricted to the costa but extended beyond it *Aloina ambigua*
- b. Leaves not infolded, filaments restricted to costa 4
- 4.a. Leaves deltoid ovate, cell wall very thick above *Crossidium squamiferum* var. *pottioideum*
- b. Leaves lingulate to ovate 5
- 5.a. Upper leaf cells quadrate, margin \pm denticulate above, costa weak, with only two stereid layers *Crossidium laevipilum*
- b. Upper leaf cells hexagonal, costa with more than two stereid layers 6
- 6.a. Plant bud shaped, leaves ovate, filaments dense, rhizoids long and wide, ca 75 μ with few branches *Crossidium laxefilamentosum*
- b. Leaves lingulate ovate, if ovate, above combination absent *Crossidium crassinerve*
- 7.a. Lamina bistratose above, nerve broad, with sheathing base, cells bulging-mamillose on the upper surface 8
- b. Above combination absent 9
- 8.a. Leaves large, toothed near apex, costa distinct and shining dorsally when dry, ventral laminal cells mamilllose *Timmiella barbuloides*
- b. Leaves small, entire, costa not distinct when dry, stereid band narrow, ventral laminal cells flask shaped *Timmiella* sp.
- 9.a. Upper leaf cells \pm papillose, isodiametric 10
- b. Upper leaf cells smooth, mostly not isodiametric 35
- 10.a. Costa with one stereid band, if stout it is longly excurrent, leaf margin unistratose 11
- b. Costa homogenous or with two stereid bands, if with one stereid band above combination absent 17
- 11.a. Costa strong, longly excurrent, cuspidate, dorsal epidermal cells absent *Pseudocrossidium porphyreoneurum*
- b. Costa percurrent or shortly excurrent, dorsal epidermal cells present 12
- 12.a. Plants minutes, ca. 0.5 mm, lamina cells 14-17 μ wide, spores papillose *Microbryum davallianum*
- b. Above combination absent, plants mostly fruiting 13
- 13.a. Peristome teeth absent, spores tuberculate ... *Microbryum starckeanum* var. *starckeanum*
- b. Peristome teeth present 14
- 14.a. Peristome teeth rudimentary 15
- b. Peristome teeth well developed 16
- 15.a. Leaves ligulate ovate, capsule large and wide .. *Microbryum starckeanum* var. *brachyodus*

b.	Not so	<i>Microbryum davallianum</i> var. <i>conicum</i>	
16.a.	Pistome teeth short, divided into 2 segments and densely papillose, annulus not distinct ...	<i>M. davallianum</i> var. <i>commutatatum</i>	
b.	Pistome teeth long ca. 150 μ , annulus present	<i>Tortula lanceolata</i>	
17.a.	Leaf base hyaline or pellucid.....		18
b.	Not so.....		23
18.a.	Basal hyaline cells arise to margin forming v shape.....		19
b.	Not so		20
19.a.	Leaf keeled, costa strong and apiculate, dorsal steried band thick and crescent-shaped, lamina cells densely papillose with high hollow papillae	<i>Tortella inclinata</i>	
b.	Above combination absent, costa shining dorsally when dry	<i>Tortella nitida</i>	
20.a.	Leaf apex cuculate, apiculate.....	<i>Trichostomum crispulum</i>	
b.	Leaf apex plane.....		21
21.a.	Costa percurrent, leaf margin often sinuose	<i>Trichostomum tenuirostre</i>	
b.	Above combination absent.....		22
22.a.	Costa strong with two stereid bands	<i>Trichostomum brachydonium</i>	
b.	Costa strong, cuspidate, stereids absent, rarely present as a very weak dorsal stereid band	Pottiaceae plant	
23.a.	Leaves linear lanceolate, upper lamina tubulose, strongly fragile, base sheathing	<i>Pseudosymblypharis angustata</i>	
b.	Above combination absent.....		24
24.a.	Leaves lingulate to ovate, upper leaves longer, ventral steried band weak or with only one dorsal stereid band, margin bistratose	<i>Didymodon aaronis</i>	
b.	Above combination absent		25
25.a.	Leaf margin plane.....		26
b.	Leaf margin incurved.....		32
26.a.	Leaves ovate to ovate lanceolate.....		27
b.	Leaves lingulate to ligulate.....		31
27.a.	Leaves acute.....	<i>Anoetangium aestivum</i>	
b.	Leaves obtuse to subacute.....		28
28.a.	Nerve weak, not exceed 35 μ .wide.....	<i>Gymnostomum viridulum</i>	
b.	Nerve 40-55 μ wide.....		29
29.a.	Leaves carinate.....	<i>Anoetangium handelii</i>	
b.	Leaves concave or plane.....		30
30.a.	Leaves small, dorsal costal epidermal cells small.....	<i>Gymnostomum mosis</i>	
b.	Leaves larger, dorsal epidermal cells large.....	<i>Gymnostomum</i> sp.	
31.a.	Apex rounded-acute, costa ending below apex, leaf ligulate.....	<i>Gyrowisia reflexa</i>	
b.	Apex acute mostly apiculate.....	<i>Gymnostomum aeruginosum</i>	
32.a.	Leaves ovate, rigid, cells strongly papillos.....	<i>Weissia condensa</i>	
b.	Above combination absent.....		33
33.a.	Leaves obovate, fragile, protonema always present	<i>Weissia willisiana</i>	
b.	Leaves oblong to lanceolate		34
34.a.	Leaves oblong to narrowly oval, leaf size gradually increasing upward	<i>Weissia latiuscula</i>	
b.	Leaves lanceolate from broader base, margin less incurved	<i>Weissia rutilans</i>	
35.a.	Leaves broad, ovate- spatulate to elliptic, cells parenchymatous, ca. 20-30 μ wide, oblong-hexagonal to rectangular		36
b.	Leaves ovate- lanceolate to narrowly lanceolate, median leaf cells thin or thick walled, prosenchymatous, hexagonal, rhomboidal or linear near the apex, 15-100 μ long		41
36.a.	Leaves elliptic, with rounded obtuse apex; costa ending far below apex, margin \pm crenulate at the apex	<i>Splachnobryum aquaticum</i>	

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b.	Leaves ovate lanceolate to obovate.....	37
37.a.	Leaves ovate lanceolate, margin serrulate	<i>Entosthodon fascicularis</i>
b.	Leaves obovate.....	38
38.a.	Leaves long, basal cells well differentiated	<i>Entosthodon attenuatus</i>
b.	Leaves short, basal cells not well differentiated	39
39.a.	Margin entire, apiculate cell short	<i>Funaria pulchella</i>
b.	Margin serrulate	40
40.a.	Apex acuminate, ending by long apiculate cell	<i>Funaria muhlenbergii</i>
b.	Apex rapidly contracted to a very short point	<i>Funaria convexa</i>
41.a.	Leaves narrow lanceolate, costa ending below apex, apex acuminate margin entire, not bordered	<i>Pohlia melanodon</i>
b.	Above combination absent	42
42.a.	Leaves ovate to ovate lanceolate, broadest part at or near base	43
b.	Leaves lanceolate, broadest part at or near middle	48
43.a.	Widest part of leaf in the lower 1/3	44
b.	Not so	45
44.a.	Leaf base strongly decurrent	<i>Bryum pseudotriquetrum</i>
b.	Leaf base not decurrent	<i>Bryum klingraeffii</i>
45.a.	Costa ending below apex, marginal cells not distinct, median cells narrow	<i>Brachymenium acuminatum</i>
b.	Costa mainly excurrent, rarely percurrent	46
46.a.	Margin bordered, at middle cells pointed to margin	<i>Bryum caespiticium</i>
b.	Margin unbordered	47
47.a.	Margin plane, apex shortly excurrent, upper laminal cells ca. 15µ broad	<i>Bryum funkii</i>
b.	Margin recurved, apex longly excurrent, upper laminal cells ca 10µ broad .	<i>Bryum bicolor</i>
48.a.	Costa excurrent, margin unbordered, upper laminal cells 50- 60x15µ	<i>Bryum canariense</i>
b.	Costa percurrent or ending below apex	49
49.a.	Margin serrulate near apex, middle laminal cells ca. 30x15µ	<i>Bryum turbinatum</i>
b.	Margin entire, cells narrow at middle, ca 60x17µ	<i>Bryum</i> sp.

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