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Mosses of different phytogeographical territories of Egypt

Abstract

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Recent bryological research in Egypt, resulted in a remarkable enlargement of our knowledge about the moss flora of this country which constitutes part of Afr 1 and part of As 5. The distribution of the 175 moss taxa, hitherto, reported from Egypt, in the world, indicates the existence of various bryofloristic elements reflecting the diversity of the flora. The 175 taxa represent 145 species belonging to 45 genera, 14 families and nine orders; all under class Bryopsida and all are reported from 12 out of the 15 phytogeographical territories to which the country is divided. References to variations in floristic aspects of moss floras of studied phytogeographic territories as well as to parameters believed to be responsible for these variations are made.

Introduction

Since the publication of the updated list of Egyptian mosses by El-Saadawi & al. (1999), several more recent papers appeared which added considerably to our knowledge about the moss flora of this country particularly to two out of its 15 phytogeographical territories namely; the Isthmic Desert (Di) in northern Sinai and the Oases (O) in the deserts west of the Nile. As a result of these recent works the number of mosses known from the Oases territory is increased from four to 29 (Abou-Salama & El-Saadawi 2001b; Refai 2001), that of the Isthmic Desert from eight to 32 (Refai & El-Saadawi 2000; Abou-Salama & El-Saadawi 2001a) and that of the whole country from 167 to 175. New data pertaining to distribution of 40 taxa in different phytogeographic territories of Egypt resulted also from these recent works. The aim of the present paper is, therefore, to bring all scattered data together in one piece of literature easily accessible to researchers in the Mediterranean area, to present a new list of Egyptian mosses, to throw more light on the moss flora of each of the 11, hitherto, relatively reasonably surveyed phytogeographic territories and comment on relevant floristic aspects far beyond the elementary information given by Shabbara & al. (2000).

Phytogeographic territories of Egypt

Earlier works pertaining to phytogeographic and chorologic affinities of Africa and of

Egypt have been recently briefly reviewed by El-Hadidi (2000). The phytogeographic map of Egypt presented by El-Hadidi and Fayed (1994/95) which is modified from that of Täckholm (1974) had been used in the presentation of the updated list of Egyptian mosses by El-Saadawi & al. (1999). In this map 15 phytogeographic territories were recognized. Further modifications, based on recent approaches in African chorology (Friis 1998) and on intensive studies of distribution patterns of many flowering plant species represented in the flora of Egypt, were introduced in the phytogeographic map of Egypt by El-Hadidi (2000). The introduced modifications may be justified regarding flowering plants, however, regarding bryophytes we are going to adopt a small part of these modifications but stick mainly to the phytogeographic map used in the presentation of the earlier updated list of Egyptian mosses (1999) not only for convenience but also because it seems to largely suit the, hitherto, known distribution patterns of mosses in different parts of Egypt.

Territories studied

Mosses have been reported from 12 out of 15 phytogeographic territories of the country (Fig. 1). The Red Sea Coastal plains territory (R) is mentioned among the 12 surveyed territories yet only one moss (*Eucladium verticillatum*) is known from it. The number of mosses reported from the 11 better surveyed territories ranges between eight in Nile Nubia (Nn) and 85 in Southern Sinai Massif (S). The three, as yet, unexplored territories are: the Arabian Desert (Da), Nubian Desert (Dn) and Libyan Desert (Dl), (Fig. 1).

Topography, climate and substrate

Dakhla & Kharga oases (Fig. 1) belong (geologically) to the southern sub-province which is covered by Nubian sandstone whereas Frafra and Bahariya lie in the limestone plateau of the middle sub-province (Said 1990). The general level of these four oases ranges from under 50 m to 200 m a. s. l. (cf. Issawi & al. 1999). The climate of the Nubian Desert, including the oases, is hyperarid. Air temperature is moderate in winter and the coldest month is January when temperature may fall to -5 °C as an extreme minimum. Mean daily maximum in July is ca 40 °C and maxima slightly exceeding 52 °C have been recorded. Mean annual rainfall is usually under 1 mm. The Oases are fed by water from a number of hot natural springs and drilled wells which derive their water from the underground Nubian Artesian Basin. Bryophytes grow on moist walls lining the sides of artesian wells, water basins and irrigation channels and less frequently on shaded muddy banks of irrigation channels.

Siwa Depression lies in the Libyan Desert (Fig. 1) and is mainly -14 to -18 m b. s. l., however at some spots it is elevated forming small mountains reaching 40 m a. s. l. or more. The climate of the Libyan Desert ranges from semi-arid near the Mediterranean Sea to arid southwards. The maximum temperature in Siwa in July is ca 38 °C and the minimum in January is ca 15 °C. Annual rainfall is slightly under 10 mm, however, the main source for irrigation is underground water. Mosses grow in shaded sheltered niches (e.g. rock crevices) in small mounts, however, more usually on moist fine alluvium in shaded areas of irrigation channels banks.

Mareotis sector of Mediterranean coastal land (Mm) is mainly a desert with small hills and rocky grottoes. Soil is mainly oolitic sand and underground freshwater in the area is at sea level. The annual precipitation is 220 mm at Sallum in the extreme west and decreases eastwards to 180 mm at Alexandria. The mean minimum and maximum temperatures are 9 °C and 19 °C in January whereas in July they increase to 22 °C and 29 °C respectively. Mosses grow on ground and rock surfaces as well as between rocks while some grow on moist silt covering red-bricks and large drinking pottery pots (zeers).

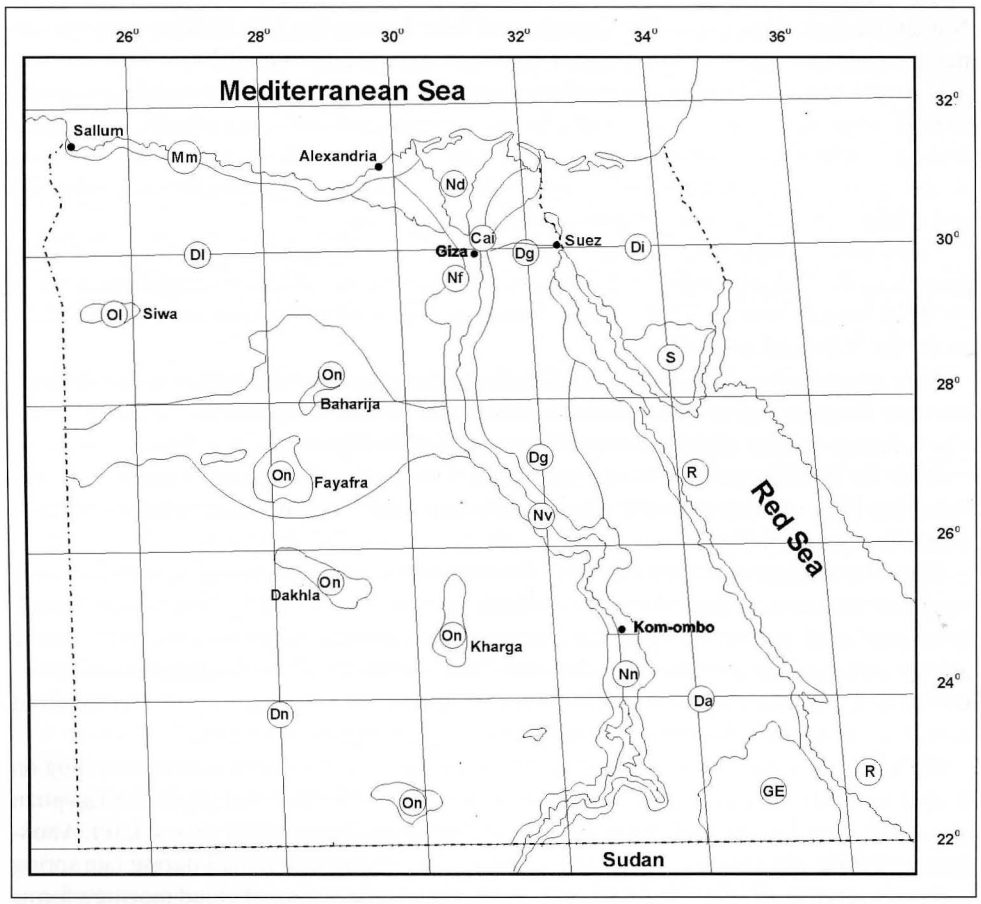

Fig. 1. Phytogeographical territories in Egypt (After Täckholm, 1974; El- Hadidi & Fayed 1994/95; El-Hadidi, 2000). **Cai**: Cairo area; **Da**: Arabian Desert; **Dg**: Galala Desert; **Di**: Isthmic Desert; **Dl**: Libyan Desert; **Dn**: Nubian Desert; **GE**: Gebel Elba; **Mm**: Western Mediterranean coastal land (Mareotic sector); **Nd**: Nile Delta; **Nf**: Nile Faiyum; **Nn**: Nile Nubia, from Kom-Ombo southwards to Egyptian boundaries with the Sudan including the areas now inundated by the waters of Lake Naser since 1965; **Nv**: Nile Valley, from Cairo-Giza to Kom-Ombo; **On & Ol**: Oases of the Nubian and Libyan Deserts; **R**: Red Sea costal plains; **S**: Southern Sinai massive (Sinai proper i.e. relatively high mountains, south of Isthmic desert).

Nile Nubia, Nile Valley and Nile Delta together form the Nile land which is mainly a cultivated land studded with an intricate network of irrigation channels and drains. The Nile land includes in addition the reclaimed areas bordering the Nile Delta in the north and the Nile Valley in the south (with its two sectors the Nile Nubian sector (Nn) and the Nile Valley sector (Nv). The Nile land alluvial sediments have been formed by the deposition of overbank deposits (sand, silt & clay). Nile Nubia is extremely hot and temperature decreases gradually towards north. Annual rainfall (on the contrary) declines from about 150 mm in the northern reaches of the Delta to ca 50 mm in its central part to only about 23 mm at Delta apex. The annual rainfall in the northern part of the Nile valley (i.e. south of Giza) is ca 10 mm but decreases sharply to the south becoming almost nil in the Nile Nubian territory. However, after formation of lake Nasser, the Nile Nubian territory witnessed winter showers, with rainfalls of 10-20 mm/year (cf. El-Hadidi 2000). Habitats suitable for the growth of mosses in the three territories (Nn, Nv & Nd) are mainly thin layers of mud covering moist red-brick walls, limestone walls, sides of water wheels, water reservoirs and outer surface of large drinking pottery pots (zeers). Mosses grow also in damp shaded places such as muddy banks of the Nile, its branches, irrigation channels and drains and sometimes on soil between grasses and under bridges.

Cairo area includes the Barrages, many bridges, botanic gardens, plant nurseries and green houses. Annual rainfall is 10-20 mm. Minimum and maximum temperatures are 8-20 °C in January and 21-32 °C in July. Substrates upon which mosses grow are the same as for the Nile land territories.

Nile Faiyum is fed by Nile waters through Bahr Yousef, in addition to freshwaters obtained from natural springs. Annual rainfall is ca 10 mm. Temperature values are ± like Cairo, however, with slightly lower minima and slightly higher maxima. Sites or substrates suitable for inhabitation by mosses are like in Nile land territories and Cairo in addition there is a large number of water wheels with deep wells and continual splaches of water furnishing good habitats.

Only the northernmost part of Galala desert (north to Cairo-Suez desert road) has been surveyed for mosses. This surveyed northern section is irrigated by Nile water through Ismailiya Canal and its branches and, therefore, has habitats similar to those of reclaimed areas to the east and west of the Nile Delta. Temperature ranges and annual rainfall are ± similar to Cairo area. Substrates suitable for the growth of mosses are similar to Nile land especially to reclaimed areas where sand percentage is higher in the soil.

Gebel (or mount) Elba is an extensive granite coastal mountainous terrain extending on both sides of the easternmost part of the Sudano-Egyptian border (Fig. 1). In the Egyptian side this terrain includes seven mountains ranging from 220 m to 1911 m a. s. l. (cf. Abou-Salama 2000). The climate is arid with considerable amounts of rainfall during late spring and early summer (El-Hadidi 2000). The orographic condensation of cloud moisture forms an essential source of water for the plants in this territory. Sites inhabited by mosses are sheltered niches, rock crevices, sides of water tracks water runnels etc.

Southern Sinai territory consists of a complex system of high (up to 2642 m a. s. l.) and very rugged igneous and metamorphic mountains that are dissected by deep wadis (Said 1990; Abou-Slama 2001). Temperature ranges and annual precipitation vary greatly between low land and tops of the high mountains where the effect of altitude masks that of the latitude. Mean monthly temperature at the high tops of the mountains, as an example,

ranges from -1 °C to 2 °C in winter and 17 °C to 19 °C in summer whereas as at low land, temperatures are much higher being ± like those for Cairo. Precipitation, likewise, varies from less than 25 mm/year in low land to 150-250 mm/year at mount tops (cf. Abou-Salama 1991). Mosses grow on fine granite soil in rock crevices, under hanging boulders and on surface of rocks; sometimes capping them and covering relatively wide areas. Some mosses grow in shallow freshwater pools resulting from gathering rain water and melting snow.

Isthmic desert consists of a heterogeneous assemblage of land forms. It comprises the Northern Sandy Desert and the limestone central plateau of Sinai Peninsula, the latter ranges from 1,600 to 750 m a. s. l. from south to north. The mountains in the hilly district in the Northern Desert range between 400 and 1,000 m a. s. l. but may reach 1,100 m at their highest. The climate ranges from semi-arid in the north to hyperarid in the central plateau. Annual rainfall is from 50-100 mm in the north (Shabbara 1999) and decreases greatly southwards towards the central plateau. However, annual rainfall in the north may average 300 mm in one year and 30 m in another year (Danin 1983). Summer fog and dew are frequent in the desert north to the central plateau. Mean annual temperature in the Northern desert is 16-20 °C (Shabbara 1999). Mosses grow on alluvium and fine sediments derived from withered limestone rocks in grooves, pockets, crevices under hanging boulders particularly on north-facing slopes and on edges of pools formed from rain waters.

Floristic composition, distribution of taxa and floristic features of surveyed territories

The, hitherto, known moss flora of Egypt consists of 175 entities representing 145 species belonging to 45 genera, 14 families and nine orders; all under class Bryopsida. It may be worth mentioning that hepatics are quite rare in Egypt, up till now only 13 taxa (mainly species of *Riccia* and *Marchantia*) have been reported (El-Saadawi & al., under publication). The number of moss entities representing each of the nine orders in each of the 11, hitherto, surveyed phytogeographic territories is given in table 1.

Table 1 shows that order Pottiales is dominant (ca 42%). Other subdominant orders in descending order are: *Bryales* (ca 25%), *Funariales* (ca 15%), *Hypnales*, *Fissidentales* and *Grimmiales* (ca 5%). The three remaining orders together form 3%. Table 1 further indicates that the two orders *Grimmiales* (8 entities) and *Encalyptales* (2 entities) are restricted (in Egypt) to Southern Sinai (S). *Dicranales* (only 3 taxa) is mainly present in depressed areas in the Western Desert (Nf and O). *Fissidentales*, though represented by only nine entities (like *Hypnales*), yet it is almost as wide spread as the three predominant orders. It is clear also that acrocarpic mosses are predominant over pleurocarpic ones. It must be mentioned that the difference in the total number of moss taxa present in the 11 territories, from eight in Nn to 85 in S is the result of i) availability of suitable habitats which varies considerably between territories and ii) uneven collection from territories.

The predominant family, as shown in table 2, is *Pottiaceae* (71 taxa) followed by *Bryaceae* (38 taxa), *Funariaceae* (24 taxa) and *Fissidentaceae* (9 taxa). The 10 other families are comparatively quite small (1-8 taxa each). The two subfamilies *Pottioideae* and *Merceyoideae* stand almost on equal foot (32 and 30 taxa respectively). *Pottioideae* has

Table 1. The number of moss entities representing each of the nine orders in each of the 11 surveyed territories and in Egypt. Explanations of abbreviations are as given in Fig. 1.

Orders	No. of taxa	Nn	Nv	Nd	Nf	Cai	Dg	Di	S	GE	O	Mm
1. Pottiales	73	3	8	10	11	12	12	19	41	4	11	31
2. Bryales	43	1	2	11	7	17	9	5	20	-	14	12
3. Funariales	26	3	3	3	3	12	8	7	4	4	3	2
4. Fissidentales	9	1	2	3	2	5	2	1	2	2	-	2
5. Hypnales	9	-	1	1	-	3	-	-	7	-	-	-
6. Grimmiales	8	-	-	-	-	-	-	-	8	-	-	-
7. Dicranales	3	-	-	-	2	1	-	-	-	-	1	-
8. Encalyptales	2	-	-	-	-	-	-	-	2	-	-	-
9. Orthotrichales	2	-	-	-	1	-	-	-	1	-	-	-
Total	175	8	16	28	26	50	31	32	85	10	29	47

better representation in Mm than S. On the contrary *Merceyoideae* is much better represented in S than Mm and has good representation in Nf. *Trichostomoideae* and *Timmielloideae* are of relatively low representation especially the latter (only one taxon). *Bryaceae* has its best representation in S followed by O whereas *Funariaceae* and *Fissidentaceae* are best represented in Cai. *Cinclidotaceae* (*Pottiales*) is also locally restricted to S.

The present results are similar to results from other areas of the world with similar climatic conditions and latitude. The predominance of *Pottiaceae* among mosses (together with *Ricciaceae* and *Marchantiaceae* among hepatics in some countries) is known for example from Iraq (Agnew & Vondracek 1975), Texas (Magill 1976), Kuwait (El-Saadawi 1976), Spain (G-Zmora & al. 1998), United Arab Emirates (Shabbara & El-Saadawi 1999). Frey and Kürschner (1983) and G-zamora & al. (1998) mentioned that the commoness of members of family *Pottiaceae* and of order *Marchantiales* in arid regions of the world is an evidence of their higher degree of adaptation to these habitats.

Among the 45 genera represented in the Egyptian moss flora, *Bryum* is the largest with 29 taxa, followed by *Didymodon* (14 taxa), *Tortula* and *Funaria* (13 taxa each) then *Fissidens*, *Barbula*, *Entosthodon* and *Crossidium* with nine, eight, seven and six taxa respectively. The 37 remaining genera are represented by five taxa (four genera), four taxa (four genera), three taxa (two genera), two taxa (eight genera) and one taxon (19 genera) (Table 3). However some of these smaller genera are more widespread in Egypt than for example *Crossidium* (six taxa in four territories). Examples of these small widespread genera are: *Gymnostomum* (five taxa in 10 territories) and *Micropoma* (one taxon in seven territories).

Table 3 shows the distribution of the 175 taxa in the 11 surveyed phytogeographic territories of Egypt. It shows also which species are endemic, near-endemic, disjunct, most frequent or widespread (present in at least 5 territories). The last count 14 taxa. This means that 161 taxa (92%) are relatively locally restricted in distribution, being present in four territories (nine taxa), three territories (24 taxa) two territories (34 taxa) or only one territory (94 taxa). It has to be mentioned that the exact territory for four out of the 94 taxa is

Table 2. Number of moss entities representing each of the 14 families (and subfamilies of *Pottiaceae*) and their distribution in the 11 surveyed territories. Explanations of abbreviations are as given in Fig. 1.

Families	No. of taxa	Nn	Nv	Nd	Nf	Cai	Dg	Di	S	GE	O	Mm
1. Pottiaceae	71	3	8	10	11	12	12	19	39	4	11	31
Pottioideae	32	-	-	2	-	2	1	10	15	-	5	19
Merceyoideae	30	3	7	8	11	9	10	6	21	2	5	10
Trichostomoideae	8	-	1	-	-	1	1	3	2	1	1	2
Timmielloideae	1	-	-	-	-	-	-	-	1	1	-	-
2. Bryaceae	38	1	2	9	4	13	7	5	20	-	13	12
3. Funariaceae	24	3	3	3	2	12	8	7	4	4	3	1
4. Fissidentaceae	9	1	2	3	2	5	2	1	2	2	-	2
5. Grimmiaceae	8	-	-	-	-	-	-	-	8	-	-	-
6. Brachytheciaceae	7	-	1	1	-	2	-	-	5	-	-	-
7. Bartramiaceae	5	-	-	2	3	4	2	-	-	-	1	-
8. AMBLYSTEGIACEAE	2	-	-	-	-	1	-	-	2	-	-	-
9. Cinclidotaceae	2	-	-	-	-	-	-	-	2	-	-	-
10. Dicranaceae	2	-	-	-	1	1	-	-	-	-	1	-
11. Encalyptaceae	2	-	-	-	-	-	-	-	2	-	-	-
12. Orthotrichaceae	2	-	-	-	1	-	-	-	1	-	-	-
13. Splachnobryaceae	2	-	-	-	1	-	-	-	-	-	-	1
14. Ditrichaceae	1	-	-	-	1	-	-	-	-	-	-	-

not known because they were not referred to any particular territory in the original publication; but only Egypt (see Table 3).

Table 3 shows also that the moss floras of the six territories (Nn, Nv, Nd, Nf, Cai & Dg) irrigated by Nile waters, not only show differences between them but also similarities. Each of them has at least two of the species *Funaria hygrometrica*, *Fissidens viridulus*, *Barbula unguiculata* and *Barbula bolleana* among its most frequent taxa. Species of *Philonotis* and *Micropoma niloticum* occur also mainly in these six territories.

Each surveyed oasis has a small but more of less distinct assemblage of mosses. Bryaceae is the predominant family in the oases Kharga, Dakhla and Farafra especially the last one where eight of 12 reported taxa belong to *Bryum*. But *Pottiaceae* in Siwa, like in most other territories in Egypt is the predominant family. In Dakhla and Kharga oases the most frequent species belong also to genus *Bryum*. This is different from all other studied territories in Egypt including Farafra and Siwa Oases where species of genera other than *Bryum* are the most frequent. The moss flora of Siwa Oasis is more similar to that of Mm and Di than to any other territory in Egypt including the other three surveyed oases. The moss flora of the four studied oases (29 taxa) has over 85% of its taxa in common with Northern Africa (cf. Ros & al. 1999).

Almost each of the 11 territories has a number of taxa that do not occur in any other territory. This number is 39 out of 85 in Sinai. Gebel Elba seems to be more related floristically to Southern Sinai (S) territory; some taxa are shared (in Egypt) by only these two territories e.g. *Timmiella barbuloides* and *Didymodon tophaceus* var. *humilis*. Members of the

Table 3: Distribution of the 175 moss taxa in the 11 surveyed phytogeographic territories. +=present, * = endemic, ♦ = near-endemic, # = disjunct, • = locality not mentioned; only Egypt, ▲ = widespread, ◙ = most frequent, **Cai**: Cairo, **Da**: Arabian Desert, **Dg**: Galala Desert, **Di**: Isthmic Desert, **Dl**: Libyan Desert, **Dn**: Nubian Desert; **GE**: Gebel Elba, **Mm**: Western Mediterranean coastal land (Mareotic sector), **Nd**: Nile Delta, **Nf**: Nile Faiyum, **Nn**: Nile Nubia, **Nv**: Nile Valley, **O**: Oases of the Western Desert (Nubian & Lybian Deserts), **S**: Southern Sinai. The single representative of *Bartramiaceae* (a species of *Philonotis*) in the O territory is taken into account in tables 1 and 2 but excluded from table 3 because it requires revision at specific level.

Taxa	Nn	Nv	Nd	Nf	Cai	Dg	Di	S	GE	O	Mm
ORDER: FISSIDENTALES											
Family: Fissidentaceae Schimp											
1. *Fissidens arnoldii* R. Ruthe							+	+	+		
2. *F. bryoides* Hedw.			+		+	+					
3. *F. bryoides* Hedw. var. *gymnandrus* (Büse) R. Ruthe				+							
4. *F. crassipes* Wilson ex Bruch, Schimp. & W. Gümbel					+						
5. *F. crassipes* Wilson ex Bruch, Schimp. & W. Gümbel ssp. *warnstorfii* (M. Fleisch.) Brugg.-Nann.			+								
• 6. *F. fontanus* (Bach. Pyl.) Steud.											
7. *F. limbatus* Sull.		+			+			+			+
▲8. *F. viridulus* (Sw.) Wahlenb.	◙	◙	◙	+	◙	◙			+		+
9. *F. viridulus* (Sw.) Wahlenb. var. *bambergeri* (Schimp.) Waldh.					+						
ORDER: DICRANALES											
Family: Ditrichaceae Limpr.											
10. *Ceratodon purpureus* (Hedw.) Brid. var. *rotundifolius* Berggr.				+							
Family: Dicranaceae Schimp.											
① Subfamily: Anisothecioidea											
11. *Dicranella rufescens* (With.) Schimp.				+							
② Subfamily: Cynodontoideae											
12. *Dichodontium pellucidum* (Hedw.) Schimp.					+					+	
ORDER: ENCALYPTALES											
Family: Encalyptaceae Schimp.											
13. *Encalypta intermedia* Jur.								+			
14. *E. vulgaris* Hedw.								+			
ORDER: POTTIALES											
Family: Pottiaceae Schimp.											
① Subfamily: Timmielloideae											
15.*Timmiella barbuloides* (Brid.) Mönk.								+	◙		
② Subfamily: Trichostomoideae											
16. *Eucladium verticillatum* (Brid.) Bruch, Schimp.& W. Gümbel					+			◙			
17. *Tortella humilis* (Hedw.) Jenn.							+				
18. *T. inclinata* (R. Hedw.) Limpr.										+	
19.*T. inflexa* (Bruch) Broth.											+
20.*T. nitida* (Lin db.) Broth.		+							+		+
21. *T. tortuosa* (Hedw.) Limpr.						+					

22. *Trichostomum brachydontium* Bruch							+				
23. *T. crispulum* Bruch							+	+			
③ Subfamily: Merceyoideae											
▲24. *Barbula bolleana* ((Müll. Hal.) Broth.	◙	+	+	◙	+			◙			
25. *Barbula convoluta* Hedw.	+					+		◙			
26. *B. indica* (Hook.) Spreng.		+	+		+						
▲27. *B. unguiculata* Hedw.		◙	◙	+	+	◙					
28. *B. unguiculata* Hedw. fo. *cuspidata* (Schultz) Mönk..				+		+					
29. *B. unguiculata* Hedw. fo. *obtusifolia* Mönk.			◙		+						
# 30. *B. unguiculata* Hedw. fo. *robusta* (Lindb.) Podp.				+							
31. *Didymodon aaronis* (Lorentz) J. Guerra						+	+	◙			
32. *D. fallax* (Hedw.) R.H. Zander				+				+		+	
33. *D. ferrugineus* (Schimp. Ex Besch.) M.O. Hill											+
34. *D. luridus* Hornsch.						+		+			+
35. *D. rigidulus* Hedw.							◙	+		+	
36. *D. rigidulus* Hedw. var. *gracilis* (Schleich. ex Hook. & Grev.) R.H. Zander				+			+	+			+
37. *D. sinuosus* (Mitt.) Delogne.				+							+
38. *D. spadiceus* (Mitt.)Limpr.						+		+			
39. *D. tectorum* (Müll. Hal.) K. Saito.											+
▲40. *D. tophaceus* (Brid.) Lisa	◙	◙	+	+	+	+		◙		◙	+
41. *D. tophaceus* (Brid.) Lisa var. *brevifolius* (Bruch, Schimp. & W. Gümbel) Warnst.								+			
42. *D. tophaceus* (Brid.) Lisa var. *humilis* (Schimp.) Warnst.								+	◙		
• 43. *D. tophaceus* (Brid.) Lisa fo. *lingulatus* (Boulay) Mönk.											
▲44. *D. vinealis* (Brid.) R.H. Zander .			+	+	+		+	+		+	+
45. *Gymnostomum aeruginosum* Sm.				+	+			+		+	
▲46. *G. calcareum* Nees & Hornsch.		+	+	+		+		+	+		+
47. *G. calcareum* Nees & Hornsch. var. *muticum* Boulay								+			
48. *G. mosis* (Lorentz) Jur. & Milde							◙	+			
▲49. *G. viridulum* Brid. fid. Whitehouse & Crundw.		+			+	+	◙	+			+
50. *Gyroweisia reflexa* (Brid.) Schimp.			+		+	+		+			
51. *G. tenuis* (Hedw.) Schimp.								+			
52. *Hymenostylium recurvirostrum* (Hedw.) Dixon								+			
53. *Pseudocrossidium hornschuchianum* (Schultz) R.H. Zander		+						+			+
④ Subfamily: Pottioideae											
54. *Aloina aloides* (Schultz) Kindb.							+	+			+
55. *A. aloides* (Schultz) Kindb. var. *ambigua* (Bruch, Schimp. & W. Gümbel) E.J. Craig							◙	+			+
56. *A. bifrons* (De Not.) Delgad.							◙				+
57. *A. rigida* (Hedw.) Limpr.										+	+
58. *Crossidium aberrans* Holz. & E.B. Bartram							+	+			+
59. *C. crassinerve* (De Not.) Jur.										+	+
# 60. *C. geheebii* (Broth.) Broth.								+			

61. *C. laevipilum* Thér. & Trab.							+				+
62. *C. squamiferum* (Viv.) Jur.							◙	+		+	
63. *C. squamiferum* (Viv.) Jur. Var. *pottioideum* (De Not.) Mönk.								+			
64. *Hennediella stanfordensis* (Steere) Blockeel			+								
65. *Microbryum starckeanum* (Hedw.) R.H. Zander							◙	+			+
66. *M. starckeanum* (Hedw.) R.H. Zander var. *brachyodus* (Bruch, Schimp. & W. Gümbel) R.H. Zander					+			+			
67. *Pterygoneurum subsessile* (Brid.) Jur.							+				
68. *Syntrichia inermis* (Brid.) Bruch								◙			
♦69. *S. rigescens* (Broth. & Geh. in Broth.) Ochyra								+			
70. *Tortula atrovirens* (Sm.) Lindb.							◙	+			+
71. *T. brevissima* Schiffn.								+			
72. *T. canescens* Mont.								+			
* 73. *T. kneuckeri* Broth. & Geh.								+			
74. *T. marginata* (Bruch & Schimp.) Spruce											+
75. *T. modica* R.H. Zander											◙
▲76. *T. muralis* Hedw.			+		+	+	+				+
77. *T. muralis* Hedw. fo. *incana* (Bruch, Schimp. & W. Gümbel) Sapjegin											+
78. *T. muralis* Hedw. var. *obcordata* (Schimp.) Limpr.											+
79. *T. pallida* (Lindb.) R.H. Zander var. *longicuspis* (Warnst.) R.H. Zander											+
# 80. *T. plinthobia* (Sull. & Lesq.) Austin										+	+
81. *T. vahliana* (Schultz) Mont.											+
82. *T. wilsonii* (Hook.) R.H. Zander											+
83. *Weissia controversa* Hedw.								+			
84. *W. controversa* Hedw. var. *crispata* (Nees & Hornsch.) Nyholm										+	
85. *W. longifolia* Mitt.											+
Family: Cinclidotaceae (Broth.) Mönk.											
86. *Cinclidotus mucrontus* (Brid.) Guim.								+			
87. *C. riparius* (Brid.) Arn.								+			
ORDER : GRIMMIALES											
Family: Grimmiaceae Arnold											
88. *Grimmia anodon* Bruch & Schimp.								◙			
* 89. *G. anodon* Bruch & Schimp. var. *sinaitica* Renauld & Cardot								+			
90. *G. crinita* Brid.								◙			
91. *G. laevigata* (Brid.) Brid.								+			
92. *G. orbicularis* Bruch								+			
93. *Racomitrium aciculare* (Hedw.) Brid.								+			
94. *Schistidium agassizii* Sull. & Lesq.								+			
95. *S. apocarpum* (Hedw.) Bruch & Schimp.								+			
ORDER: FUNARIALES											
❶Suborder: Funariineae											
Family: Funariaceae Schwägr.											
96. *Entosthodon attenuatus* (Dicks.) Bryhn							◙	+			
* 97. *E. curvi-apiculatus* Müll. Hal.		+									
98. *E. durieui* Mont.					+			+	+		

99. *E. fascicularis* (Hedw.) Müll. Hal.					+		+				
*100. *E. niloticus* Schimp.					+	+					
101. *E. obtusus* (Hedw.) Lindb.					+						
#102. *E. plano-convexus* (E.B. Bartram) Grout							+				
103. *Funaria anomala* Jur.					+						
104. *F. convexa* Spruce								◙			
105. *F. handelii* Schiffn.					+	+					
▲106. *F. hygrometrica* Hedw.	◙	◙	◙	◙	◙	◙	+	+		+	+
107. *F. hygrometrica* Hedw. var. *calvescens* (Schwägr.) Mont							+			◙	
108. *F. hygrometrica* Hedw. var. *intermedia* Warnst.						+					
*109. *F. hygrometrica* Hedw. var. *minor* (Delile) Brid.					+						
110. *F. hygrometrica* Hedw. var. *muralis* Hueben						+					
•111. *F. microstoma* Bruch ex Schimp.											
112. *F. muhlenbergii* Turner					+				+		
*113. *F. nubica* Müll. Hal.	+										
114. *F. pulchella* H. Philib.							+		+		
*115. *F. sickenbergeri* Müll. Hal.										+	
▲116. *Micropoma niloticum* (Delile) Lindb.		+	+	+	+	+			+		
117. *Physcomitrium eurystomum* Sendtn.					+	+					
118. *P. immersum* Sull.							+				
119. *P. pyriforme* (Hedw.) Brid.	+		+		+	◙					
❷Suborder : Splachineae **Family: Splachnobryaceae A. Kop.** #120. *Splachnobryum limbatum* D.H. Norris & R.H. Zander											+
121. *S. obtusum* (Brid.) Müll. Hal.				+							
ORDER: BRYALES **Family: Bryaceae Schwägr.** 122. *Brachymenium* cf. *angustirete* Ochi			+								
123. *B. exile* (Dozy. & Molk.) Bosch & Sande Lac.								+		+	+
124. *B.* cf. *longicolle* Thér.			+								
125. *B.* cf. *sikkimense* Renauld & Cardot								+			
126 *Bryum. alpinum* Huds. ex With.				+	+			+			
127. *B. alpĩnum* Huds. ex With. var. *viride* Husn.	+										
128. *B.* cf. *apiculatum* Schwägr.			+							◙	
129. *B. argenteum* Hedw.					+		+	+			+
130. *B. argenteum* Hedw. var. *lanatum* (P. Beauv.) Hampe						+		+			
▲131. *B. bicolor* Dicks.		+	+	+	+	+	◙	+		+	+
▲132. *B. caespiticium* Hedw.			+		+		+	+		◙	+
133 *B. caespiticium* Hedw. var. *badium* Brid.					+	+		+			+
▲134. *B. capillare* Hedw.					+	+	+	+		+	
135 *B. cellulare* Hook.					+	+					
136. *B. comense* Schimp.			+		+						+
137. *B. creberrimum* Taylor								+			
138. *B. elegans* Nees				+				+		+	
139. *B. funkii* Schwägr						+	+	+			
140. *B.* cf. *gedeanum* Bosch & Sande Lac.			+								
141. *B. gemmiparum* De Not.				+	+			+		+	
142..*B. inclinatum* (Brid.) Bland										◙	

143. *B. kunzei* Hornsch.					+						+
144. *B. pseudotriquetrum* (Hedw.) P. Gaertn.								+			
145. *B. pseudotriquetrum* (Hedw.) P. Gaertn. var. *bimum* (Brid.) Lilj.								+			
▲146. *B. radiculosum* Brid.			+		+			+		+	+
* 147. *B. remelei* Müll. Hal.		+									
• 148. *.B. ruderale*											
149. *B. schleicheri* Lam. & Dc.								+			
150. *B. subapiculatum* Hampe										◙	
151. *B. syriacum* Lorentz								+			
152. *B. syriacum* Lorentz var. *humile* Schiffn.											+
153. *B. torquescens* Bruch ex De Not.						+				+	
154. *B. turbinatum* (Hedw.) Turner								+		+	
155. *Leptobryum pyriforme* (Hedw.) Wilson			+		+						+
156. *Pohlia atropurpurea* (Wahlenb.) Lindb.								+			
* 157. *P. korbiana* (Müll. Hal.) Wijk & Margad.										+	
158. *P. melanodon* (Brid.) A.J. Shaw.											+
159. *P. nutans* (Hedw.) Lindb.					+						+
Family: Bartramiaceae Schwägr. #160. *Philonotis evanidinervis* M. Fleisch.			+	◙		+					
161. *P. fontana* (Hedw.) Brid.					+						
162. *P. hastata* (Duby) Wijk & Margad.			+	◙	+	+					
163. *P. marchica* (Hedw.) Brid.				+	+						
#164. *P. marchica* (Hedw.) Brid. fo. *rivularis* (Warnst.) Mönk.					+						
ORDER: ORTHOTRICHALES **Family: Orthotrichaceae Arnold** 165. *Orthotrichum rupestre* Schleich								+			
166. *Zygodon obtusifolius* Hook				+							
ORDER: HYPNALES **Family: Amblystegiaceae G. Roth** 167. *Amblystegium riparium* (Hedw.) Bruch, Schimp. & W. Gümbel					+			+			
168. *Drepanocladus aduncus* (Hedw.) Warnst.								+			
Family: Brachytheciaceae Schimp. 169. *Brachythecium rivulare* Bruch, Schimp.& W. Gümbel			+		+						
170.*B. umbilicatum* Jur. & Milde								+			
171. *B. velutinum* (Hedw.) Bruch, Schimp.& W. Gümbel								+			
172. *B. velutinum* (Hedw.) Bruch, Schimp.& W. Gümbel var. *venustum* (De Not.) Arcang.								+			
173. *Eurhynchium pumilum* (Wilson) Schimp		+			+						
174. *Rhynchostegiella tenella* (Dicks.) Limpr.								+			
175. *Rhynchostegium riparioides* (Hedw.) Cardot.								+			

genera *Aloina, Crossidium* and *Tortella* are characteristic of Mareotis sector of the Mediterranean Coast.

It may be said briefly that comparisons of mosses reported from the 11 territories showed that the moss floras to the east and west of the Nile are more similar to each other than to that of the Nile-irrigated lands (six territories) which lie in-between. These Nile irrigated lands of Egypt have more in common with the eight other Nile Basin countries, which share Nile waters with Egypt. Examples are *Barbula indica, Micropoma niloticum* and *Bryum alpinum* var. *viride*. Moss entities brought, over the ages from the south are, therefore, believed to have interrupted the once presumably continuous flora of the land of Egypt before Nile.

World distribution of the 175 taxa composing the, hitherto known, moss flora of Egypt indicates that most of them (87 %) occur in at least one Mediterranean country besides Egypt. This percentage is (81 %) for Eur, (78 %) for As5, (72 %) for Afr 1, (57 %) for Am 1, (44 %) for Afr 2, (43 %) for As 1, (37 %) for As 2 and other areas have lower percentages (Wijk & al. 1959/69; Zander 1993). As would be expected the diverse composition of species forming the moss flora of Egypt is likewise reflected by diverse floristic elements representing different patterns of distribution, thus there are: Circum-tethyan (27 taxa) and Northern (19 taxa) elements according to Frey & Kürschner (1988); Cosmopolitan and Sub-cosmopolitan (18 taxa) and Mediterranean-Atlantic (8 taxa) elements according to Hill & Preston (1998). There are nine endemic, one near-endemic and seven disjunct taxa (Table 3).

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