MOSSES OF DAQAHLLIA PROVINCE WITH ONE NEW RECORD FOR AFRICA AND THREE NEW RECORDS FOR EGYPT

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Abstract

Thirty-six moss species were recorded from Daqahlia province, Nile Delta. Weissia perligulata Flow. (Pottiaceae) was a new record to Afr1. In addition, Hyophila involute (Hook.) Jaeg., (Pottiaceae), Ptychostomum arcticum (R. Brown) J. R. Spence ex Holyoak & N. Pederson and P. cyclophyllum (Schwagr) J. R. Spence (Bryaceae) were new records for Egypt. Fifteen species were new to Nile delta. This raised the number of identified moss taxa recorded from Egypt up to 192 taxa, from Nile Delta 51 taxa and Daqahlia province 39 taxa. Data on the up-to-date classification, habitats, voucher specimens and distribution of the enumerated species and the descriptions of the new records including the photos have been provided.

Introduction

Number of moss taxa now from Egypt has been quietly increased in the last decade into 188 taxa belonging to 59 genera, 17 families and 10 orders (El-Saadawi et al., 2013 a,b; Ibrahim et al., 2013; Hassan et al., 2017; El-Sakaty et al., 2018; Khalil and Farag, 2018; Taha, 2020). The distribution of the 188 moss taxa in the 11 surveyed phytogeographical territories of Egypt (out of 13 territories) showed that Southern Sinai, Western Mediterranean Costal Land, Cairo, and Isthmic Desert of Egypt are the richest territories regarding the number of recorded moss taxa (El-Saadawi et al., 2015).

A total of 59 genera and 188 taxa are known from this country (El-Saadawi et al., 2015; Hassan et al., 2017; El-Sakaty et al., 2018; Khalil and Farag, 2018).

The last study on the Bryoflora of Daqahlia province was accomplished more than 34 years before by El-Saadawi et al., (1986) as a part of Nile delta moss flora. The present study was aimed to explore the current status of the bryoflora of Daqahlia province, Nile Delta and Egypt.

Materials and Methods

Daqahlia province is located at the north-east of Nile Delta and bounded by El-Sharkia province on the east, El-Gharbia and Kafir El-Sheikh provinces on the west, Domietta province on the north-east, El-Qalyobia province on the south and the Mediterranean coast on the north. It is located in between longitudes 30.5° N and 31.5° N, and latitudes 30° E and 32° E (Figs. 1-2).

Daqahlia has a mild climate that tends to be warm in winter with little rain, which increases in the coast, and is hot in summer, where the average annual temperature ranges between 14 and 28°C.

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Two hundred and sixty four moss samples were collected from 11 districts of Daqhlia province during October 2017 to December 2019, covering all seasons, viz. winter (110 samples), spring (88 samples), autumn (39 samples) and summer (27 samples). All were numbered and kept in CAIA. Identification of the samples were confirmed by comparisons with authentic specimens kept in CAIA, relevant literatures on the moss flora of Egypt and with reference texts of some standard moss floras (Flowers, 1973; Refai, 1985; Lashin, 1990; Ibrahim, 2006; Taha, 2010, 2014; Hamouda, 2016).

Fig. 1. Map showing the location of the districts of El Daqahlia province (after Mandour, 2013).
Results and Discussion

The investigation of 264 samples revealed the occurrence of 36 moss species belonging to 19 genera under six families and four orders in Daqahlia province. By adding three moss species, namely, *Fissidens viridulus* (Sw.) Wshlenb. (Fissidentaceae), *Brum radiculosum* Brid. (Bryaceae) and *Pohlia melanodon* (Brid.) A.J. Shaw (Mniaceae), recorded previously by El-Saadawi et al. (1986) but not recorded by the present study, the number of moss elements of Daqahlia province was increased to 39 moss species under 20 genera. Pottiaceae is the largest family (19 species, 10 genera), followed by Bryaceae (11 species, three genera) and Funariaceae (four species, three genera), Fissidentaceae (three species, one genus), and Mniaceae and Baratramiaceae (one species, one genus each).

Three species, namely, *Hyophila involute* (Hook.) Jaeg., *Ptychostomum arcticum* (R. Brown) J.R. Spence ex Holyoak & N. Pederson, and *P. cyclophyllum* (Schwagr) J.R. Spence found in Daqahlia province during this study, are the new records for the bryoflora of Egypt, whereas *Weissia perliligulata* Flow found in this province is new to Africa.
Five out of 36 species (about 13.9%), namely *Tortula inermis*, *Entothodon mucilaginosum*, *Funaria hygrometica*, *Physcomitrium niloticum* and *P. pyriforme* are fruit yielding, six species (about 16.7%), namely *Barbula indica*, *Bryophyllum recurvirostrum*, *Didymodon luridus*, *Gymnostomum aeruginosum*, *Syntrichia fragilis* and *P. pyriforme* are fruit yielding, six species (about 16.7%), namely *Barbula indica*, *Bryoerythrophyllum recurvirostrum*, *Didymodon luridus*, *Gymnostomum aeruginosum*, *Syntrichia fragilis* and *Trichostomum brachydontium* are female and one species (about 2.8%), namely *Fissidens bryoides*, is monoecious with out fruit, while the remaining 24 species (about 66.7%) are sterile.

All of the 39 moss species are taxonomically listed, and their voucher specimen(s), locality(ies), habitats, distribution in Egypt (El-Saadawi et al., 2003), Afr1 (Ros et al., 2013) and the world (Wijk et al., 1959-1969) are given with descriptions and photos of new records. The recorded taxa are briefly described below.

**Order: Fissidentales, Family: Fissidentaceae**

**Genus: Fissidens Hedw.**

1. *F. arnoldii* R. Ruthe
   

   

3. *F. viridulus* (Sw.) Wshlenb.
   

**Order: Pottiales, Family: Pottiaceae**

**Genus: Barbula Hedw.**

   

5. *B. convoluta* Hedw.
   

   
7. **B. unguiculata** Hedw.

Genus: **Bryothyrophyllum** Chen.

8. **B. recurvirostrum** (Hedw.) Chen.

Genus: **Didymodon** Hedw.

9. **D. luridus** Hornsch.

10. **D. tophaceus** (Brid.) Lisa

11. **D. vinealis** (Brid.) R. H. Zander

Genus: **Gymnostomum** Nees & Hornsch

12. **G. aeruginosum** Sm.

13. **G. calcareum** Nees & Hornsch.

Genus: **Hyophila** Brid.

14. **H. involutae** (Hook.) Jaeg. (Plate 1)
    Plants sterile, olive green, up to 5.5 mm high. Stem branched or unbranched, central strand poorly developed, sclerodermis well differentiated. Leaves erecto-patent to spreading when moist, oval to oblong, 2.5 to 2.9 mm long, 1 to 1.2 wide, larger leaves at stem apex; apex
narrowly acute; margin plane, irregularly notched or irregularly toothed; costa ending below apex by 2-3 cells, superficial cells quadrate to elongated, irregular, oval in cross section, with ± two equal stereid bands, with 6 guides, dorsal superficial cells slightly papillose; upper lamina cells quadrate, pentagonal, rounded, basal lamina cells rounded, quadrate to sub-quadrate.


Plate 1. *Hyophila involuta* (Hook.) Jaeg.: 1- Dry plant (X6), 2- Fresh plant (X9), 3 & 4- Leaves (X18, X19), 5- Leaf apex (X83), 6- Upper leaf cells (X235), 7- Basel leaf cells (X93), 8 & 9 - T.S. of leaf (X66, X712), 10- T.S. of stem (X68).

Genus: *Oxystegus* (Hook. & Taylor) A.J.E. Sm.

15. *O. tenuirostris* (Hook. & Taylor) A.J.E. Sm.

Genus: Splachnobryum Müll. Hal.


Genus: Syntrichia Brid.

17. S. fragilis (Taylor) Ochyra

Genus: Tortula Hedw.

18. T. inermis (Brid.) Mont.

19. T. muralis Hedw.
   Distribution in the World: Afr1, Afr4, As2, As5, Eur, Am1, Am6.

Genus: Trichostomum Bruch

20. T. brachydontium Bruch

21. T. crispulum Bruch

Genus: Weissia Hedw.

22. W. periligulata Flow. (Plate 2)

Plants sterile, green to olive green above, yellowish brown to brown below, up to 4.5 mm high. Stem usually unbranched, central strand poorly developed, scleroderms poorly differentiated. Leaves erecto-patent to patent when moist, concave, ovate to oblong, with ± decurrent base, 1.5 to 1.7 mm long, 0.5 to 0.6 mm wide; apex rounded; margin plane, strongly papillose above, entire below; costa percurrent, superficial cells oblong, semicircular in cross section, with two unequal stereid bands usually ventral one smaller, with 4 guides; upper lamina cells quadrate, rounded, papillose, basal lamina cells elongate to short rectangular.

Order: Funariales, Family: Funariaceae

Genus: Entosthodon Schwägr.

23. *E. muehlenbergii* (Turner) Fife


![Images of *E. muehlenbergii*](image1)

Genus: Weissia Flw.


Genus: Funaria Hedw.


Genus: *Physcomitrium* (Brid.) Brid.


26. **P. pyriforme** (Hedw.) Bruch & Schimp.

Order: *Bryales*, Family: *Bryaceae*

Genus: *Bryum* Hedw.

27. **B. argenteum** Hedw.

28. **B. dichotomum** Hedw.

29. **B. gemmiparum** De. Not.

30. **B. kunzei** Hornsch.

31. **B. radiculosum** Brid.

32. **B. subapiculatum** Hampe

Genus: *Imbribryum* N. Pederson

33. **I. alpinum** (Huds. Ex With.) N. Pederson

Genus: Ptychostomum Hornsch.

34. *P. archangelicum* (Beusch & Schimp.) J. R. Spence


Plants sterile, yellowish green to olive green, up to 3.7 mm high. Stem unbranched, angular in cross section, with central strand, sclerodermis highly differentiated. Leaves erect appressed to slightly spreading when moist, crowded at stem apex, broadly ovate, orbicular, 1.5 to 1.8 mm long, 0.6 to 0.7 mm wide, upper lamina cells vermicular at margin, rhomboidal to hexagonal toward costa, basal lamina cells vermicular to linear at margin, oblong and sun-quadrate toward costa, lamina cells chlorophyllose; margin plane, sometimes serrate towards apex, entire below, bordered (2-3 cells) throughout; costa stout, wider downward, excurrent, superficial cells linear-vermicular above, elongated to oblong below, semicircular in cross section, homogenous.

36. *P. capillare* (Hedw.) Holyoak & N. Pederson.

37. *P. cyclophyllum* (Schwägr) J. R. Spence

Syn. *Bryum cyclophyllum* (Schwägr) Bruch & Schimp; *Bryum tortifolium* Brid.

Plate 4. *Ptychostomum cyclophyllum* (Schwägr) J. R. Spence; 1- Dry plant (X3), 2- Fresh plant (X6), 3 & 4- Leaves (X43, X46), 5- Leaf apex (X107), 6- Upper leaf cells (X215), 7- Basal leaf cells (X115), 8 & 9 T.S. of leaf (X105, X250), 10 & 11- T.S. of stem (X117, X125).

Plants sterile, pale green above, yellowish brown below, up to 2 cm high. Stem unbranched, rounded or angular in cross section, central strand absent, sclerodermis highly differentiated. Leaves tumid when moist, strongly concave, ovate or ligulate, 1 to 1.2 mm long, 0.6-0.7 mm wide; apex acute; margin plane, entire; costa ending below apex by 1 to 2 cells, superficial
cells linear, semicircular in cross section, costa homogenous; upper cells rhomboidal and angular, basal cells oblong and rectangular.


Family: Mniaceae
Genus: Pohlia Hedw.
38. P. melanodon (Brid.) A. J. Shaw
   Syn. Mniobryum delicatulun (Hedw.) Dixon
   Previously recorded, not collected during the present study.

Family: Bartramiaceae
Genus: Philonotis Brid.
39. P. hastata (Duby) Wijk & Margad

Comparison and concluding remarks
The enumerated bryoflora of the study area, which is a part of Nile delta, is nearly similar to that of Sinai and Cairo, each consists of 22 taxa, than that of the other territories of Egypt (El-Saadawi et al., 2003). Comparison between the enumerated moss elements of the study area and that of Afr1 countries (Ros, et al., 2013) showed that the highest similarity was with Algeria and Morocco, each of which with 28 taxa, and Tunisia with 24 taxa, while the lowest similarity was with Mali, housing two taxa only (El-Saadawi et al., 2013b; Ros et al., 2013).

Similarity between bryoflora of Europe and the study area may be attributed to the northern wind crossing Mediterranean Sea carrying moss propagules from Europe (Zanten and Pòcs, 1981). In this regard, El-Saadawi et al. (2003) mentioned that 81% of the moss flora of Egypt occur in Europe, while similarity with As5 might be due to the rapprochement in the floristic composition (Ayyad et al., 2000).

The moss species Weissia perligulata, newly recorded for Afr1 and consequently for Egypt, was supposed to be disjunct element from Am3. Twelve disjunct taxa of bryoflora were recorded earlier in Egypt; six from Mediterranean coast of Egypt (El-Sakaty, 2009; Shabbara, 1990), two from Isthmic Desert (Shabbara, 1999) and four from Nile Delta (Ibrahim, 2006; Taha, 2010). This study shows that the disjunct taxa are now increased to 13. To explain these disjunction, there are some factors like continental drift, the fragmentation of a once more continuous distribution and long-distance dispersal (Schofield and Crum, 1972) and transfer of propagules (within geographical belt) via air currents.

In spite of the recent intensive collection, some taxa, which were recorded 35 years ago by El-Saadawi et al. (1986), were not appeared during this study. This may be rendered to the disappearance of some taxa and new appearance of the others as a natural phenomenon in all living organisms (Okasha, 2010). Recently, this variation was increased by the fast ecological
changes and long-term impacts of threats, such as changing habitats by urbanization, road construction, changing soil contents and its acidity and air pollution, affecting all biological resources including mosses (Hallingback and Hodgetts, 2000; Taha, 2010).

Sterility does not obstruct the reproduction in all mosses, because many mosses have the ability to reproduce by vegetative fragmentation of gametophyte, which is a very effective mean of propagation. Rarity of fruiting is famous in mosses, as well as, the presence of a single sex is due to limitation of both ecological tolerance and capacity to adapt to environmental change, including that induced by human activity. Rarity of sporophytes in dioecious mosses generally results from spatial separation of male and female plants, often combined with rarity or absence of antheridia, archegonia, or both (Longton and Schuster, 1983). A hypothesis that would explain this rarity is consistent with the low taxonomic diversity and the disjunct, possibly relict, distribution patterns noted among species. Also, early production of asexual propagules was a very effective mean of reproduction, play a key role in dispersal ecology and habitat colonization and have a great significance in the dynamic processes of bryophyte communities. In addition, asexual propagules provide possibilities for survival of unfavourable life conditions, and support re-establishment in a habitat after changes in the environmental conditions (Frey and Kürschner, 2011).

NOTE: Afr- Africa (Afr 1- N. Africa, Madeira, Azores, Canary Islands; Afr 2- Central Africa, St. Helena Islands; Afr 3- Madagascar, Mauritius, Reunion Islands; Afr 4- S. Africa, Kergulen Islands), ALG- Algeria, Am- America (Am 1- N. America, Greenland, Allutian Islands, Bermudez; Am 2- Central America; Am 3- West Indian Islands; Am 4- Venezuela, Colombia, Peru, Bolivia, Ecuador, Galapagos Islands; Am 5- Brazil, Paraguay, Guinea, Trinidad; Am 6- Chile, Argentina, Uruguay, Falkland Islands, Continent of Antarctica), As- Asia (As 1- N. Asia including Sakhalin; As 2- China, Mongolia, Japan, Korea, Formosa; As 3- India, Pakistan, Bangladesh, Ceylon, Burma, Siam, Indo-China; As 4- Indonesia, Malaya, Philippine Islands, Newguinea; As 5- Asiatric Part of The Middle East, Including Cyprus), Austral- Australia (Austral 1- Australia, Tasmania; Austral 2- New Zealand), Cai- Cairo, CAIA- Ain Shams University Herbarium, CN- Canary Islands, Di- Isthmic Desert, EGY- Egypt, Eur- Europe, GE- Gebal Elba, LIB- Libya, MLI- Mali, Mm- Western Mediterranean Costal Land of Egypt, MOR- Morocco, Nd- Nile Delta, NF- Nile Fayium, Nn- Nile Nubia, NV- Nile Vally, O- Oases of the Western Desert, Oc- Pacific Ocean Islands, S- Southern Sinai, TUN- Tunisia.

References


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