



## The Moss Flora of Ismailia Governorate, Egypt with Three New Records

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### Abstract

A total of 29 species of mosses are reported from Ismailia governorate, among these three species and two genera represent as a new records for Egypt. *Bryoerythrophyllum* and *Oxystegus* are a new genera to Egypt and the three species are: *Bryoerythrophyllum inaequalifolium*, *Oxystegus tenuirostris* and *Trichostomum planifolium*. Notes on habitats, reproductive organs and fruiting of the examined species are given.

**Key words:** Moss flora, New records, Ismailia, Egypt.

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### Introduction

The Ismailia governorate is located in the eastern part of Egypt at the middle part of Suez Canal. It is a part of the East Nile Delta region (Nd), Galala Desert (Dg) and Isthmic Desert (Di) and is bounded at the east by North Sinai and Suez Canal (that penetrates Tamsah Lake and Bitter Lake), Sharkia governorate at the west, Port Said governorate at the north and Suez governorate at the south. It is located between 31° 40' to 32° 40' E Longitude, and 30° 15' to 30° 57' N Latitude. The total area of Ismailia governorate is about 5,067 km<sup>2</sup> and consists of seven regions (marākiz). These are Ismailia, Fayed, El Tal El Kabier, Abou Sweir and El Kassaseen, East Kantara, West Kantara (Map 1).

According to the Köppen-Geiger classification (BWh) and the Holdridge life zones system of bioclimatic classification, Ismailia governorate has a subtropical desert / low-latitude arid hot climate. Also it is situated in or near the subtropical desert biome (<http://www.ismailia.climatemp.com>).

Since 1972, only three studies of mosses had been done from Galala desert. These are:

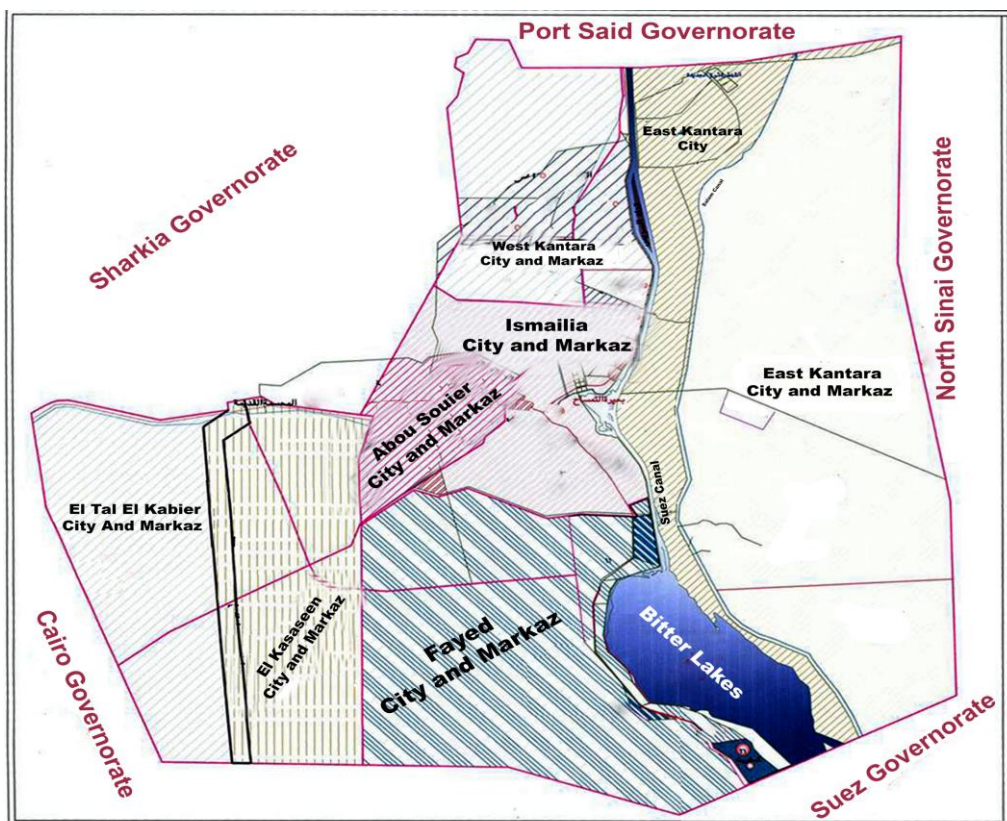
Imam & Ghabbour (1972), Lashin (1990) and Shabbara (2006). They recognized 30 species belonging to 14 genera (including genus *Leptobarbula* Schimp. which was recorded only in this territory), 5 families and 4 orders.

Recently, El-Saadawi et al. (2015) mentioned that the number of moss taxa recorded in Galala desert (30 taxa), Nile Delta (36 taxa) and Isthmic Desert (46 taxa) were relatively small in comparable with the number recorded in other territories e.g. Southern Sinai massive Sinai proper (S) 95 taxa, Western Mediterranean coastal land (Mma) 65 taxa and Cairo (Cai) 51 taxa.

Lashin (1990) in his study on the bryoflora of Suez Canal Region reported 29 moss taxa, out of these 26 taxa identified to the specific level and 3 entities only to generic level (*Barbula* sp, *Semibarbula* sp and *Funaria* sp).


This study aims to revise systematically the bryoflora of Ismailia governorate, recording any new moss taxa and offer a recent account of the bryoflora elements recorded in this governorate and Egypt.

# The Moss Flora of Ismailia Governorate



**Ismailia Governorate**



- |   |   |   |                                     |
|---|---|---|-------------------------------------|
|  | <b>Ismailia City and Markaz</b>         |  | <b>Abou Souier City and Markaz</b>  |
|  | <b>El Tal El Kabier City and Markaz</b> |  | <b>West Kantara City and Markaz</b> |
|  | <b>El Kassaseen City and Markaz</b>     |  | <b>East Kantara City and Markaz</b> |
|  | <b>Fayed City and Markaz</b>            |   |                                     |

<http://www.ismailia.gov.eg/tamir-al3tar/Pages/ismailia-map.aspx> accessed in 15/10/2016).

**Map 1. The administrative division of Ismailia governorate.**

## *Material and Methods*

To achieve the aim of the present study, three hundred and ten samples were collected during 15 excursions covering the period from November 2014 to August 2016 from Ismailia cities, marākiz, villages, sub-villages and ezbeets in Ismailia governorate. Mosses were mostly collected from both shaded and / or sunny places borders of irrigation canals,

water wheels, water reservoirs, water basins or walls of bridges. They occurred mainly on red bricks, walls covered by cement and / or mud.

Specimens were examined, sectioned according to Abou Salama (1985) and Wilson (1990). The studied specimens were identified by being matched with the pre-

identified Egyptian moss specimens from different phytogeographical territories of Egypt. In addition, the identification process was further confirmed by using moss floras of the different countries of the world. Adaptation to diverse habitats was taken into consideration in determining precise identification. Detailed information about all collected samples is available in herbarium packets kept at the Herbarium of the Suez Canal University (SCU-I) Ismailia, Faculty of Science, Botany Department.

## Results

The updated species list of the moss flora of Ismailia includes 29 species. These species belong to 13 genera, 4 families and 4 orders, as listed below.

Division: Bryophyta (Musci)

Class : Bryopsida

Sub class: Bryidae

Order 1: Fissidentales

Family: Fissidentaceae

### ***Fissidens* Hedwig**

*Fissidens bryoides* Hedwig

Order 2: Pottiales

Family: Pottiaceae Schimp.

Subfamily 1: Merceyoideae

### ***Barbula* Hedwig (J. K. A. Müller)**

Brotheru

*Barbula bolleana* (J. K. A. Müller)

Brotherus

*Barbula convoluta* Hedwig

*Barbula indica* ((Hooker) Sprengel

*Barbula unguiculata* Hedwig

### **\**Bryoerythrophyllum* P. C. Chen**

\**Bryoerythrophyllum inaequalifolium*

(Taylor) R.H. Zander

### ***Didymodon* Hedwig**

*Didymodon fallax* (Hedwig) R. H.

Zander

*Didymodon luridus* Hornsch.

*Didymodon spadiceus* (Mitt.) Limpr.

*Didymodon tophaceus* (Bridel) Lisa

*Didymodon vinealis* (Bridel) R. H.

Zander

### ***Gymnostomum* Nees & Hornschuch**

*Gymnostomum aeruginosum* Smith

*Gymnostomum calcareum* Nees & Hornschuch

*Gymnostomum viridulum* Bridel

Subfamily 2: Pottioidae

### ***Splachnobryum* Müller Hal.**

*Splachnobryum obtusum* (Bridel)

Müller Hal.

Subfamily 3: Trichostomoideae

### **\**Oxystegus* (Broth.) Hilp.**

\**Oxystegus tenuirostris* (Hook.

&Taylor) A.Smith

### ***Trichostomum* Bruch**

*Trichostomum brachydontium* Bruch

*Trichostomum crispulum* Bruch

\**Trichostomum planifolium* (Dixon) R.

H. Zander

Order 3: Funariales

Sub-order: Funariineae

Family: Funariaceae Schwägrer.

### ***Entosthodon* Schwägrichen**

*Entosthodon fascicularis* (Hedwig)

Müller Hal.

### ***Funaria* Hedwig**

*Funaria hygrometrica* Hedwig

Order 4: Bryales

Family: Bryaceae Schwägrichen

### ***Bryum* Hedwig**

*Bryum argenteum* Hedwig

*Bryum funkii* Schwägrichen

*Bryum gemmiparum* De Notaris

*Bryum radiculosum* Bridel

*Bryum subapiculatum* Hampe

### ***Imbribryum* N. Pedersen**

*Imbribryum alpinum* (Hudson ex

Withering) N. Pedersen.

### ***Ptychostomum* Hornschuch**

*Ptychostomum imbricatulum* (Müller

Hal.) D.T. Holyoak & N. Pedersen

*Ptychostomum pseudotriquetrum*

(Hedwig) J. R. Spence & H. P.

Ramsay ex Holyoak & N. Pedersen

**Note:** \* = New record to Egypt.

Data about localities, Microhabitat, sterility or fertility, any reproductive structure and distribution in phytogeographical territories in Egypt (for explanation of abbreviations see Map 2) are all given below.

## Moss species of Ismailia governorate

**1-\*\**Fissidens bryoides* Hedwig Sp. Musc. Frond. 153. 1801.**

Collected from: Fayed

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Microhabitat: On a thin layer of mud on a red brick wall of a water basin in shaded area.

Fertility: Female Plants

Distribution in Egypt: Nd, Cai, Dg, Di, Mm.

2-\*\**Barbula bolleana* (J. K. A. Müller)  
Brotherus in A. Engler, Nat. Pfl. Ed. 2: 10. 1924.

Collected from: El Kassaseen

Microhabitat: On a thin layer of mud on a wall of a small bridge and on a brick wall beside water pump in shaded area.

Fertility: Plants sterile

Distribution in Egypt: Nn, Nv, Nd, Nf, Cai, S, Mm.

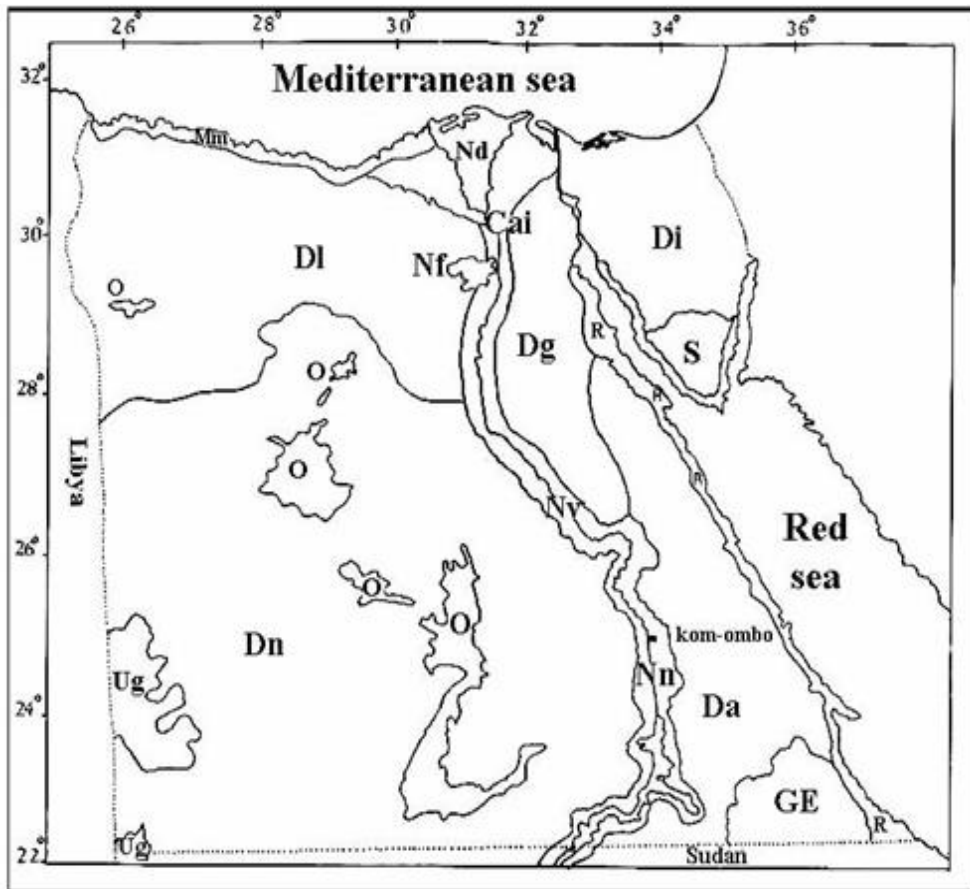
3-*Barbula convoluta* Hedwig Sp. Musc. Frond. 120. 1801.

Collected from: Abou Sweir

Microhabitat: On thin layer of mud on a red brick wall of a small irrigation water canal or a water well in shade area.

Fertility: Plants sterile

Distribution in Egypt: Nn, Nd, Dg, S.



**Map 2.** The phytogeographical territories of Egypt (after **El-Saadawi et al. 2015**; with little modification). **Cai:** Cairo area; **Da:** Arabian desert; **Dg:** Galala Desert; **Di:** Isthmic Desert; **Di:** Libyan Desert; **Dn:** Nubian Desert; **GE:** Gebel Elba; **Mma:** western Mediterranean coastal land (Mareotic sector); **Nd:** Nile Delta; **Nf:** Nile Fayoum; **Nn:** Nile Nubia, from Kom Ombo southwards to Egyptian boundaries with the Sudan including the areas now inundated by the waters of Lake Nasser since 1965; **Nv:** Nile Valley, from Cairo-Giza to Kom Ombo; **O:** Oasis of the Nubian and Libyan Desert; **R:** Red Sea coastal plains; **S:** Southern Sinai massive (Sinai proper i.e. relatively high mountains, south of Isthmic desert); **Ug:** Gebel Uweinat.

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**4-\****Barbula indica* (Hooker) Sprengel in E. G. Steudel, Nomencl. Bot. 2: 72. 1824

Collected from: El Kassaseen and West Kantara

Microhabitat: On a thin layer of mud on a wall of a small bridge or a small irrigation water canal and on a red brick of a water basin in shaded area.

Fertility: Plants sterile

Distribution in Egypt: Nv, Nd, Cai.

**5- *Barbula unguiculata* Hedwig Sp. Musc. Frond. 118. 1801**

Collected from: El Kassaseen, Abou Sweir, El Tal El Kabier, West Kantara, Ismailia and Fayed.

Microhabitat: On a thin layer of mud on a red brick wall of a small bridge or a small irrigation water canal or a wall of Zeer, on a red brick wall of a water basin and on a red brick wall beside a water pump in shaded or sunny area.

Fertility: Female Plants

Distribution in Egypt: Nv, Nd, Nf, Cai, Dg, Mm.

**6- *Bryoerythrophyllum inaequalifolium* (Taylor) R. H. Zander, Bryologist 83: 232. 1980.** Collected from: El Tal El Kabier

Microhabitat: On a red brick wall of a water basin in shaded area

Fertility: Female Plants

Distribution in Egypt: New record to Egypt. (Figure1)

**7-\****Didymodon fallax* (Hedwig) R. H. Zander, Phytologia, 41: 28. 1978.

Collected from: Abou Sweir, West Kantara and East Kantara

Microhabitat: On a thin layer of mud of a red brick wall of a small irrigation water canal or a water basin or a wall of water reservoir in shaded.

Fertility: Female Plants

Distribution in Egypt: Nd, Nf, Di, S, O, Mm.

**8- *Didymodon luridus* Hornsch., Syst. Veg. (Sprengel) 4 (1): 173. 1827.**

Collected from: El Kassaseen, Abou Sweir, El Tal El Kabier, West Kantara and Fayed

Microhabitat: On a thin layer of mud on a wall of a small irrigation water canal and on a red brick wall of a water basin in shaded area.

Fertility: Plants Sterile.

Distribution in Egypt: Nd, Nf, Cai, Dg, S, Mm.

**9- *Didymodon spadiceus* (Mitt.) Limpr. Laubm. Deutschl. 1: 556.1888.**

Collected from: El Kassaseen

Microhabitat: On a red brick wall of a small irrigation water canal or a water basin in shaded area.

Fertility: Plants Sterile.

Distribution in Egypt: Dg, S.

**10-*Didymodon tophaceus* (Bridel) Lisa, Elenco Musch. 31. 1837.**

Collected from: El Kassaseen

Microhabitat: On a red brick wall of a water basin in shaded area.

Fertility: Female Plants.

Distribution in Egypt: Nn, Nv, Nd, Nf, Cai, Dg, S, GE, O, Mm.

**11-\****Didymodon vinealis* (Bridel) R. H. Zander, Phytologia 41: 25. 1978.

Collected from: Abou Sweir and East Kantara

Microhabitat: On a red brick wall beside a water pump and on a red brick wall of a water basin in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: Nd, Di, S, O, Mm.

**12-\****Gymnostomum aeruginosum* Smith, Fl. Brit. 3: 1163. 1804.

Collected from: Abou Sweir and East Kantara

Microhabitat: On a thin layer of mud of a red brick wall of a small irrigation water canal or a wall of a water basin in shaded area.

Fertility: Female Plants

Distribution in Egypt: Nd, Nf, Cai, S, O.

**13-*Gymnostomum calcareum* Nees & Hornschuch in C. G. D. Nees et al., Bryol. Germ. 1: 153, plate 10, fig. 15.1823.**

Collected from: Abou Sweir

Microhabitat: On a red brick wall of a water basin in shaded area.

Fertility: Female Plants

Distribution in Egypt: Nv, Nd, Nf, Dg, S, GE, Mm.

**14-*Gymnostomum viridulum* Bridel, Bryol. Univ. 1: 66. 1826.**

Collected from: Ismailia

Microhabitat: On a red brick wall of a water basin in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: Nv, Cai, Dg, Di, S, Mm.

**15-\****Splachnobryum obtusum* (Bridel) Müller Hal., Verh. K.K. Zool.-Bot. Ges. Wien 19: 504. 1869.

Collected from: El Tal El Kabier

Microhabitat: On a red brick wall of a water basin in shaded area.

Fertility: Plants female.

Distribution in Egypt: Nd.

**16-\****Oxystegus tenuirostris* (Hook. & Taylor) A. Smith, J. Bryol. 9: 393. 1977.

Collected from: Abou Sweir, El Tal El Kabier, West Kantara and Ismailia

Microhabitat: On a red brick wall of a water basin and on a thin layer of mud on a wall of a small irrigation water canal in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: New recorded to Egypt (Figure 2)

**17-\****Trichostomum brachydontium* Bruch, Flora. 12: 393. Pl. 3-393.1829.

Collected from: El Kassaseen, Abou Sweir, El Tal El Kabier, Ismailia and Fayed.

Microhabitat: On a red brick wall of a water basin and on a thin layer of mud on a wall of a small irrigation water canal in shaded area.

Fertility: Plants female

Distribution in Egypt: Nd, Di.

**18-\****Trichostomum crispulum* Bruch, Flora. 12: 395. 4 - 395. 1829.

Collected from: El Kassaseen and Fayed.

Microhabitat: On a thin layer of mud on a wall of a small irrigation water canal in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: Nd, Di, S, Mm.

**19-\****Trichostomum planifolium* (Dixon) R. H. Zander, Bull. Buffalo Soc. Nat. Sci. 32: 92. 1993.

Collected from: Abou Sweir, El Tal El Kabier, West Kantara, Ismailia, Fayed and East Kantara.

Microhabitat: On a thin layer of mud of a wall of a small irrigation water canal or a small bridge and on a red brick wall of a water basin in shaded or sunny area.

Fertility: Plants sterile.

Distribution in Egypt: New record to Egypt (Figure 3).

**20-\****Entosthodon fascicularis* (Hedwig) Müller Hal. , Syn. Musc. Frond. 1: 120. 1848.

Collected from: Abou Sweir and Ismailia.

Microhabitat: On a thin layer of mud of a red brick wall of a water basin or a wall of Zeer in shaded or sunny area.

Fertility: Plants sterile.

Distribution in Egypt: Cai, Di, S.

**21-\****Funaria hygrometrica* Hedwig, Sp. Musc. Frond. 172.1801.

Collected from: Abou Sweir, El Tal El Kabier, West Kantara, Ismailia, Fayed and East Kantara.

Microhabitat: On a thin layer of mud of a red brick wall of a water basin or a wall of Zeer or a small irrigation water canal or a small bridge or a water reservoir and on sand beside a water pump in shaded or sunny area.

Fertility: Plants fruiting.

Distribution in Egypt: Nn, Nv, Nd, Nf, Cai, Dg, Di, S, O, Mm

**22-\****Bryum argenteum* Hedwig, Sp. Musc. Frond. 181. 1801.

Collected from: Abou Sweir and Ismailia.

Microhabitat: On a thin layer of mud of a red brick wall of Zeer, on a red brick wall of a water basin and on sand beside a water pump in shaded or sunny area.

Fertility: Plants sterile.

Distribution in Egypt: Cai, Dg, Di, S, O, Mm.

**23-\****Bryum funkii* Schwägr., Sp. Musc. Frond. Suppl. 12: 89. pl. 69.1816

Collected from: Abou Sweir

Microhabitat: On a thin layer of mud on a wall of Zeer in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: Dg, Di, S, O.

**24-\****Bryum gemmiparum* De Notaris, Comment. Soc. Crittog. Ital. 2(2): 211. 1866.

Collected from: Abou Sweir

Microhabitat: On a thin layer of mud of a red brick wall of a small irrigation water canal or a wall of Zeer or a wall of a water basin and on a red brick wall beside a water pump in shaded or sunny area.

Fertility: Plants sterile.

Distribution in Egypt: Nf, Cai, S, O, Mm.

**25-\****Bryum radiculosum* Bridel, Muscol. Recent. Suppl. 3: 18-19. 1817.

Collected from: El Kassaseen, Abou Sweir, El Tal El Kabier, West Kantara and Ismailia.

Microhabitat: On a red brick wall of a water basin or a water wheels, on sand beside a water pump and on a thin layer of mud on

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wall of a small irrigation water canal or a small bridge or a wall of Zeer in shaded area. Fertility: Plants sterile. Distribution in Egypt: Nd, Cai, Di, S, O, Mm.

**26-\****Bryum subapiculatum* Hampe, *Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn* 4(1-5): 51-52. 1872.

Collected from: El Tal El Kabier, West Kantara and Fayed.

Microhabitat: On a red brick wall of a water basin and on a thin layer of mud of a red brick wall a small irrigation water canal in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: Nv, Cai, S, O.

**27-\****Imbribryum alpinum* (Hudson ex Withering) N. Pedersen, *Bryologist*. 108: 449. 2005.

Collected from: El Kassaseen, Abou Sweir, El Tal El Kabier, West Kantara, Ismailia and East Kantara.

Microhabitat: On a thin layer of mud on a wall of a small irrigation water canal and on a red brick wall of a water basin in shade or sunny area.

Fertility: Plants sterile.

Distribution in Egypt: Nn, Nf, Cai, S.

**28-\****Ptychostomum imbricatum* (Müller Hal.) D.T. Holyoak & N. Pedersen, *J. Bryol.* 29: 120. 2007.

Collected from: Abou Sweir and Ismailia.

Microhabitat: On a red brick wall of a water basin and beside a water pump in shaded area.

Fertility: Plants sterile.

Distribution in Egypt: Nd, Cai, Dg, Di, S, O, Mm

**29-\****Ptychostomum pseudotriquetrum* (Hedwig) J. R. Spence & H. P. Ramsay ex Holyoak & N. Pedersen, *J. Bryol.* 29: 120. 2007. Collected from: Fayed.

Microhabitat: On a red brick wall in shaded place.

Fertility: Plants sterile.

Distribution in Egypt: S, O.

\* new to Egypt - \*\* new to the study area

### General Remarks:

The largest family in the study area, is Pottiaceae (62.1%) being represented by 18 species within 7 genera. Bryaceae came

second (27.5%), being represented by 8 species within 3 genera, followed by Funariaceae represented by two species within two genera, then Fissidentaceae represented by one species.

Out of the thirteen reported genera the largest were: *Bryum* and *Didymodon* (5 species each), *Barbula* (4 species), *Gymnostomum* and *Trichostomum* (3 species each), followed by *Ptychostomum* (2 species), while seven genera: *Fissidens*, *Bryoerythrophyllum*, *Splachnobryum*, *Oxystegus*, *Entosthodon*, *Funaria* and *Imbribryum* were represented by one species each.

*Barbula unguiculata* had the highest percentage of occurrence of all recorded species in the study area, followed by *Funaria hygrometrica*. Abou Sweir region is characterized by high diversity due to the presence of 18 species, followed by Ismailia region and El Tal El Kabier region (11 species each). This is due to favourable climatic conditions, good soil with low salinity and the first start of Ismailia canal as the fresh water source. But East Kantara region was poor in mosses (6 species) due to the high salinity and gypsum soil apparently hinder the growth of mosses.

Fruiting in mosses of the study area was uncommon. It was observed only in the cosmopolitan moss *Funaria hygrometrica*. Eleven species carried axillary gemmae, while 8 species carried rhizoidal gemmae. Whereas, axillary bulbils were observed in *Bryum gemmiparum* only and axillary sterile hairs were recorded in *Gymnostomum viridulum* only.

The floral similarity is largest between Ismailia governorate and the Sinai (S), where 21 species are in common to both areas, followed by Nile Delta (Nd) sharing 17 species. On the other hand, both Nile Nubia (Nn) and Gebel Elba (GE) showed the lowest bryofloral similarity (5 species & 2 species respectively) in comparison with the study area (El-Saadawi *et al.*, 2003).

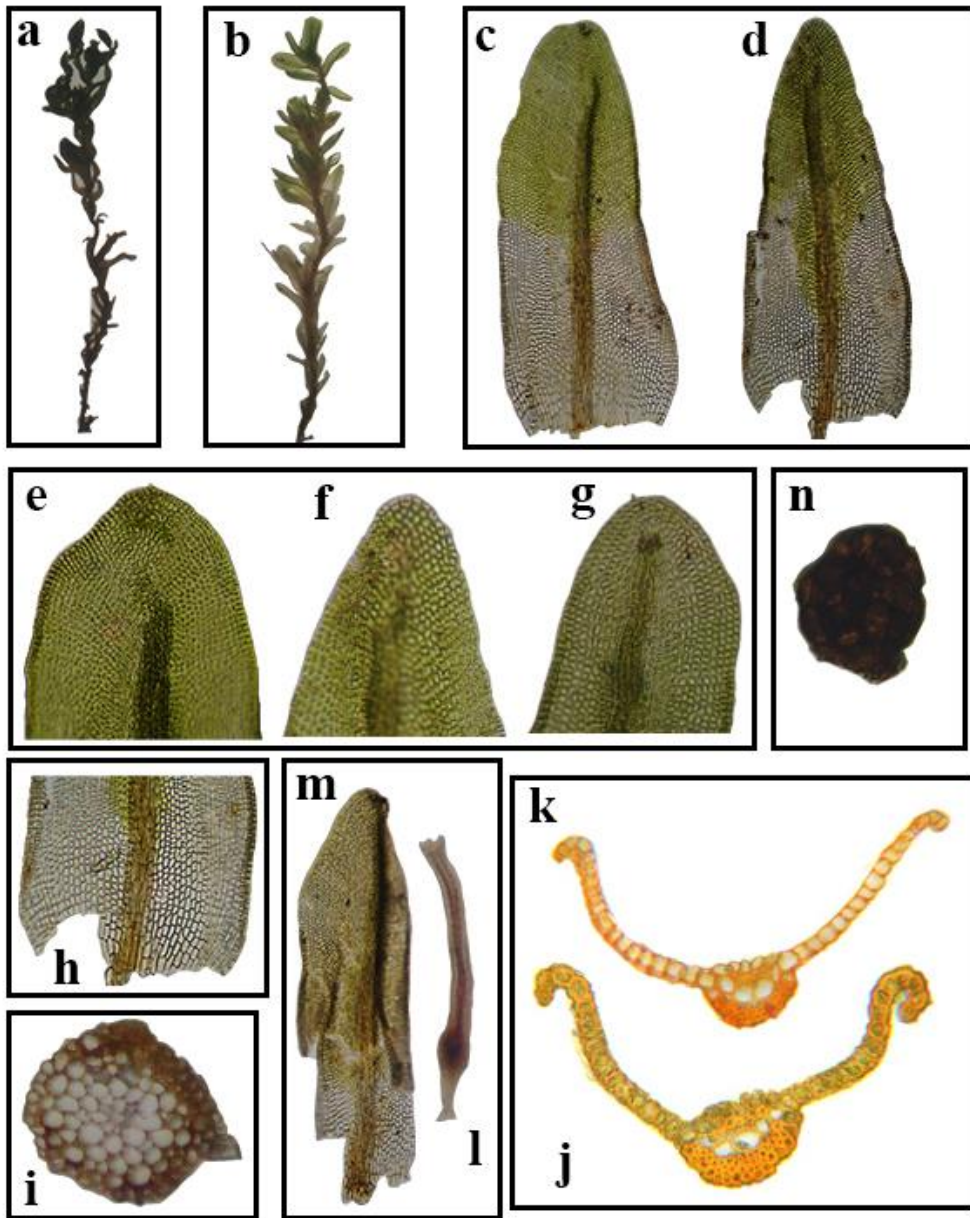
The present study added to our knowledge the following: *Bryoerythrophyllum* and *Oxystegus* as a new genera to the moss flora of Egypt. Three species as new records to Egypt

namely; *Bryoerythrophyllum inaequalifolium*, *Oxystegus tenuirostris* and *Trichostomum planifolium*, raising the total number of mosses recorded in Egypt to 184 species. Seventeen species as new records to the moss flora of the study area.

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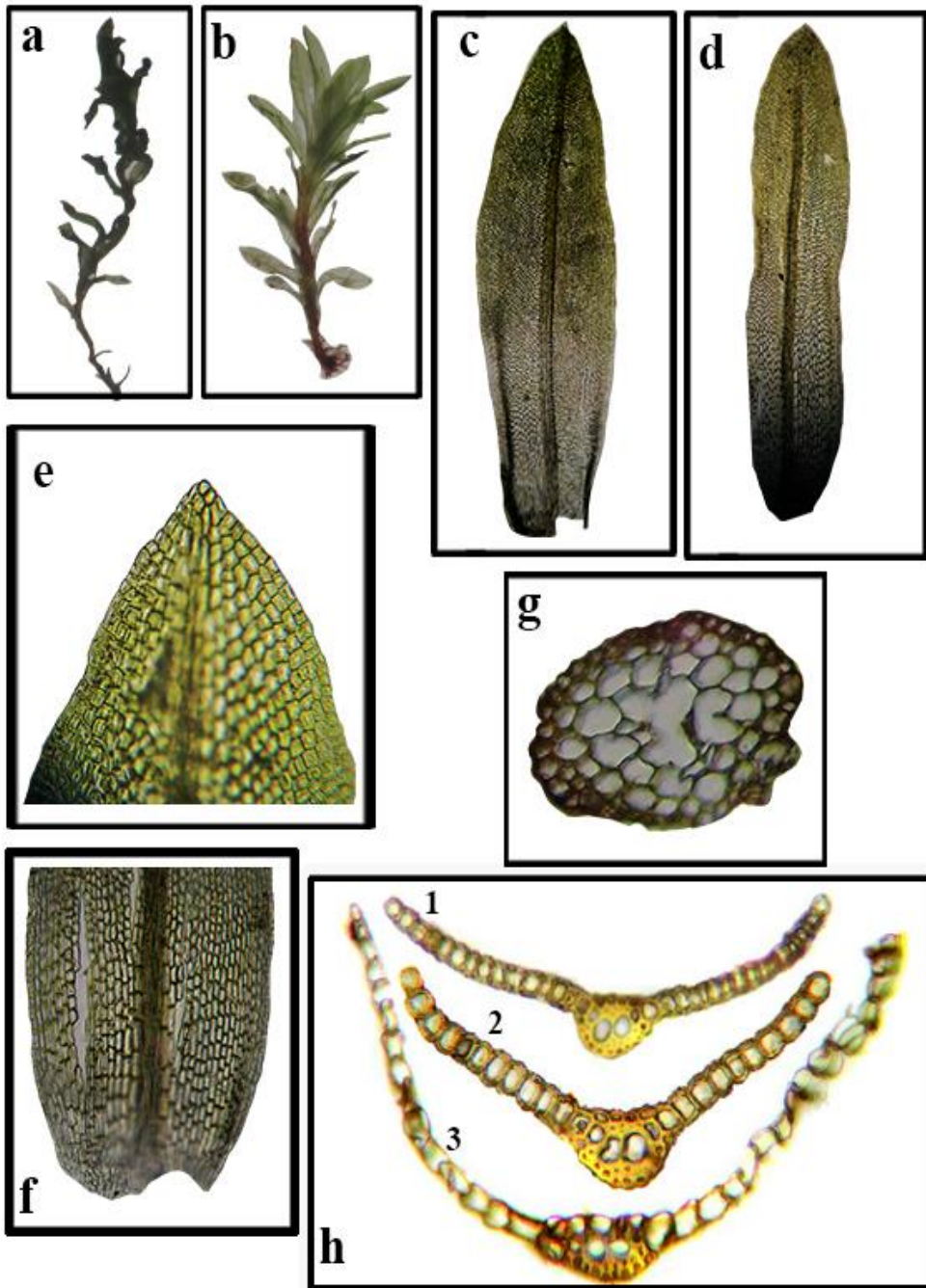
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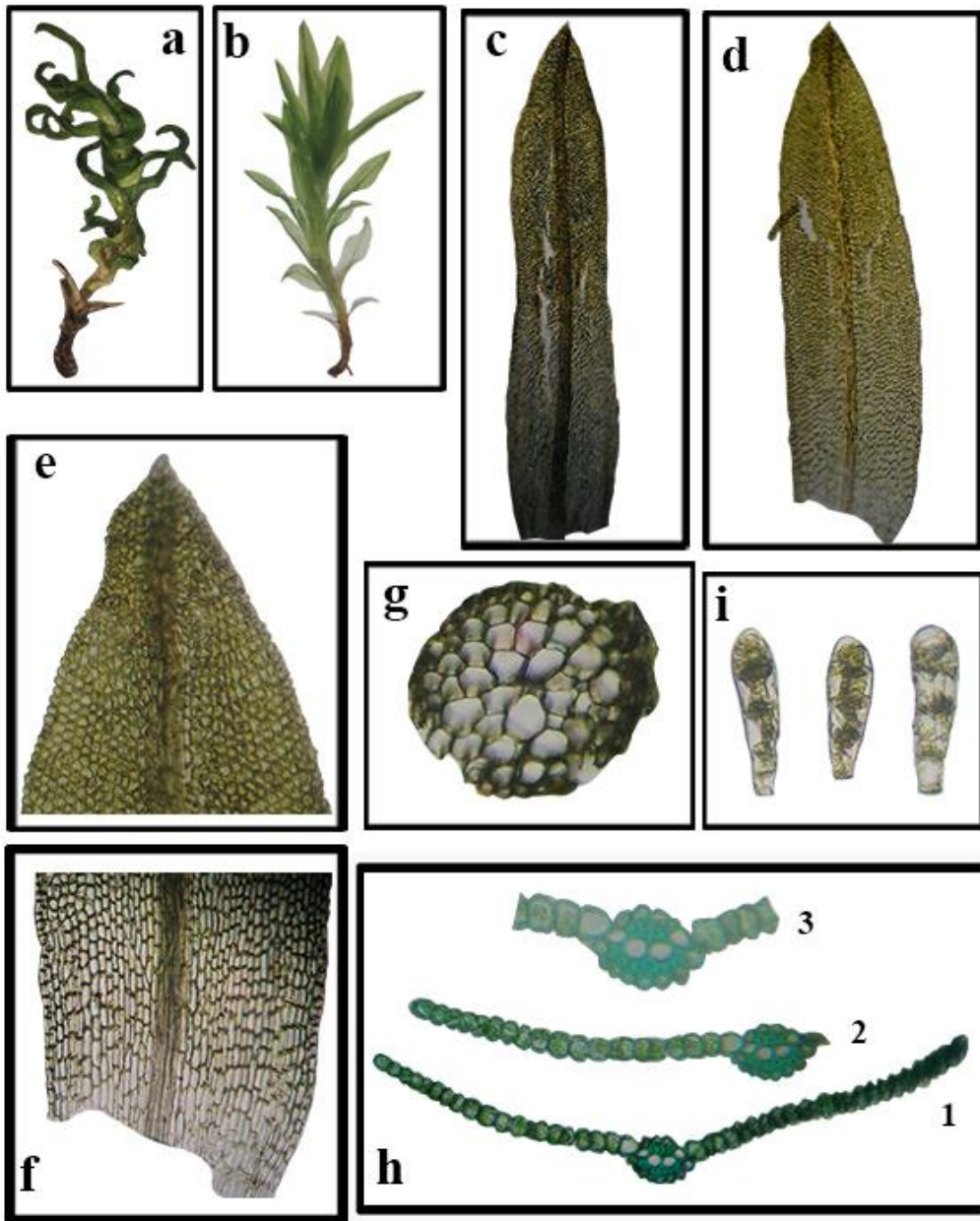
**Figure 1.** *Bryoerythrophyllum inaequalifolium* a. Dry Plant (x 5.5), b. Wet Plant (x 5.5), c. and d Leaf (x 61 & 60 respectively), e. Leaf Apex (x100), f & g Leaf Apex (x 93), h. Leaf Base (x 100), i. T.S of Stem (x 110), j. T.S of basal part of Leaf (x 160), k. T.S of mid-Leaf (x 155), l. Archegonium (x 126), m. Perichaetial Leaf (x 68.7), n. One Rhizoidal gemma (x 153).

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**Figure 2.** *Oxystegus tenuirostris* a. Dry Plant (x 6), b. Wet Plant (x 6), c & d Leaf (x 38), e. Leaf Apex (x 90), f. Leaf Base (x 70), g. T.S of Stem (x 120), h. 1-T.S of upper part of Leaf (x 148), 2- T.S of mid-Leaf (x 150), 3- T.S of basal part of Leaf (x 147).

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**Figure 3.** *Trichostomum planifolium* a. Dry Plant (x 2.5), b. Wet Plant (x 2.5), c & d Leaf (x 33), e. Leaf Apex (x 76), f. Leaf Base (x 76), g. T.S of Stem (x 130), h. 1- T.S of mid-Leaf (x 142), 2- T.S of basal part of Leaf (x 145), 3- Part of T.S of Leaf showing costa (x 200), i. Axillary Gemmae (x 140).