

**RESEARCH ARTICLE**

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**Additional Pottiaceae Records from Omayed Protected Area, Egypt**

**ABSTRACT:**

In the present study 21 Pottiaceae species are recorded from the Omayed Protected Area (OPA). Only one genus; *Acaulon* Müller Hal. and two species; *Acaulon triquetrum* (Spruce) Müll. Hal. and *Pseudocrossidium obtusulum* (Lindb.) H.A. Crum & L.E. Anderson are new records on bryoflora of Egypt. The last species is also a new record to North Africa. Two species; *Aloina rigida* (Hedw.) Limpr. and *Gymnostomum calcareum* Nees & Hornsch. are new records to OPA. Thus, number of moss taxa and moss genera recorded from Egypt are increased to 186 and 59 respectively, while no. of Pottiaceae taxa is increased to 89. Descriptions and illustrations of these new records together with geographic distribution in Egypt and occurrence in the Mediterranean countries of all recorded taxa are given.

**KEY WORDS:**

Bryoflora, Egypt, New records, Omayed Protected Area, Pottiaceae

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**ARTICLE CODE: 34.02.18**

**INTRODUCTION:**

Pottiaceae is one of the largest known acrocarpous moss family. It consists of 138 genera and 3,223 accepted species names from the whole world (<http://www.theplantlist.org>). It is widely distributed in a great diversity of environments, mainly in temperate and mountainous regions. Many of its taxa are specially adapted to dry climates and are often the dominant mosses in arid regions of the world (Zander, 1993).

In Egypt, Pottiaceae is the largest moss family having 26 out of a total of 58 genera and 87 out of a total of 184 species known from this country (El-Saadawi *et al.*, 2015; Hassan *et al.*, 2017; El-Sakaty *et al.*, 2018).

Only two bryofloral studies have been done on Omayed Protected Area (OPA). Kassas *et al.* (2002) recorded two taxa; *Aloina bifrons* (De Not.) Delgad. (Pottiaceae) and *Bryum dichotomum* Hedw. (Bryaceae) outside Khashm El-Aish plateau (the study area). While El-Saadawi *et al.* (2013) recorded twenty-nine moss taxa from Khashm El-Aish plateau in OPA one of them recorded earlier by Kassas *et al.* (2002). Sixteen of them represented new records to the western Mediterranean coast (Mm) and six to Egypt. Consequently, the total number of moss taxa known from OPA is thirty taxa. Twenty-three of them belonged to family Pottiaceae.

The present paper aimed to update our knowledge about Pottiaceae records in OPA after 10 years from the last collection.

**STUDY AREA AND MATERIAL:**

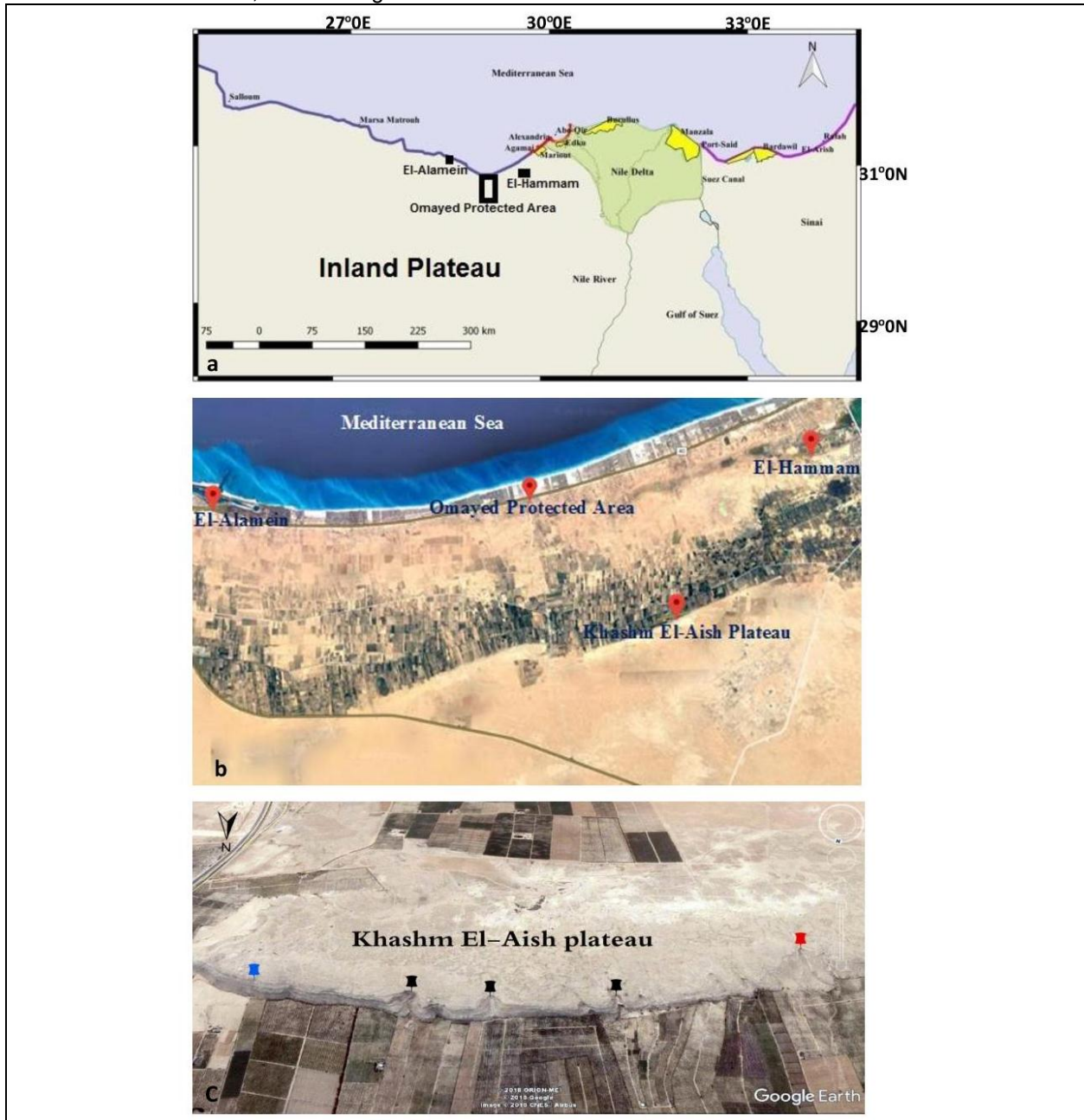
The OPA is located in the north-western Mediterranean coastal region of Egypt. It extends about 30 km along the Mediterranean coast from El Hammam in the east to El-Alamein in the west. The OPA lies between lat. 30°38'-30°52'N and long. 29°00'-29°18'E (Shabaka, 2018). It occupies an area of about 700 km<sup>2</sup> (Fig. 1a).

The climate of the OPA is characterized by the sub-desert climate. It has a variety of habitats attributed mainly to the obvious geomorphological, topographic (Fig. 1b) and edaphic variations. These habitats support the

diverse of both flora and fauna (Kassas *et al.*, 2002).

Khashm El-Aish plateau is one of the three major physiographic systems in OPA, which run parallel to each other and to the seashore. Each of these systems has a number of habitats, microhabitats and with a characteristic plant cover (Ayyad and Le Floc'h, 1983). Khashm El-Aish plateau lies between lat. 30°44'20"-30°45'18"N and long. 29°08'23"-29°12'17"E, extending to five km

length and 110 m height. It is characterized by shaded and humid microhabitats for having small caves with silted soils between large boulders (named by Bedouins "Al-Agr"). Mosses are copious at Khashm El-Aish plateau only on its northern side, away from direct sunlight and facing the prevailing north-westerly cool winds at an altitude ranging between 53 m and 91 m above sea level (Fig. 1c).



**Fig. 1.** a) Location of Omayed protected area in the north-western coastal region of Egypt (after Shabaka, 2018; with little modification); b) Google earth satellite image of Omayed protected area (showing habitats diversity) and Khashm El-Aish plateau; c) Google earth satellite image mention Khashm El-Aish plateau; blue, black and red points represent east, middle and west area of plateau, respectively.

Thirty moss samples were collected by the second author during one excursion on the 24<sup>th</sup> of February 2017 from the northern face of Khashm El-Aish plateau. These samples were highly mixed. After examination, taxa of Pottiaceae only were

isolated and identified. They were deposited at CAIA (Bryology section, Herbarium of Botany Department, Faculty of Science, Ain Shams University). All available information about herbarium specimens is given in the results below.

## RESULTS AND DISCUSSION:

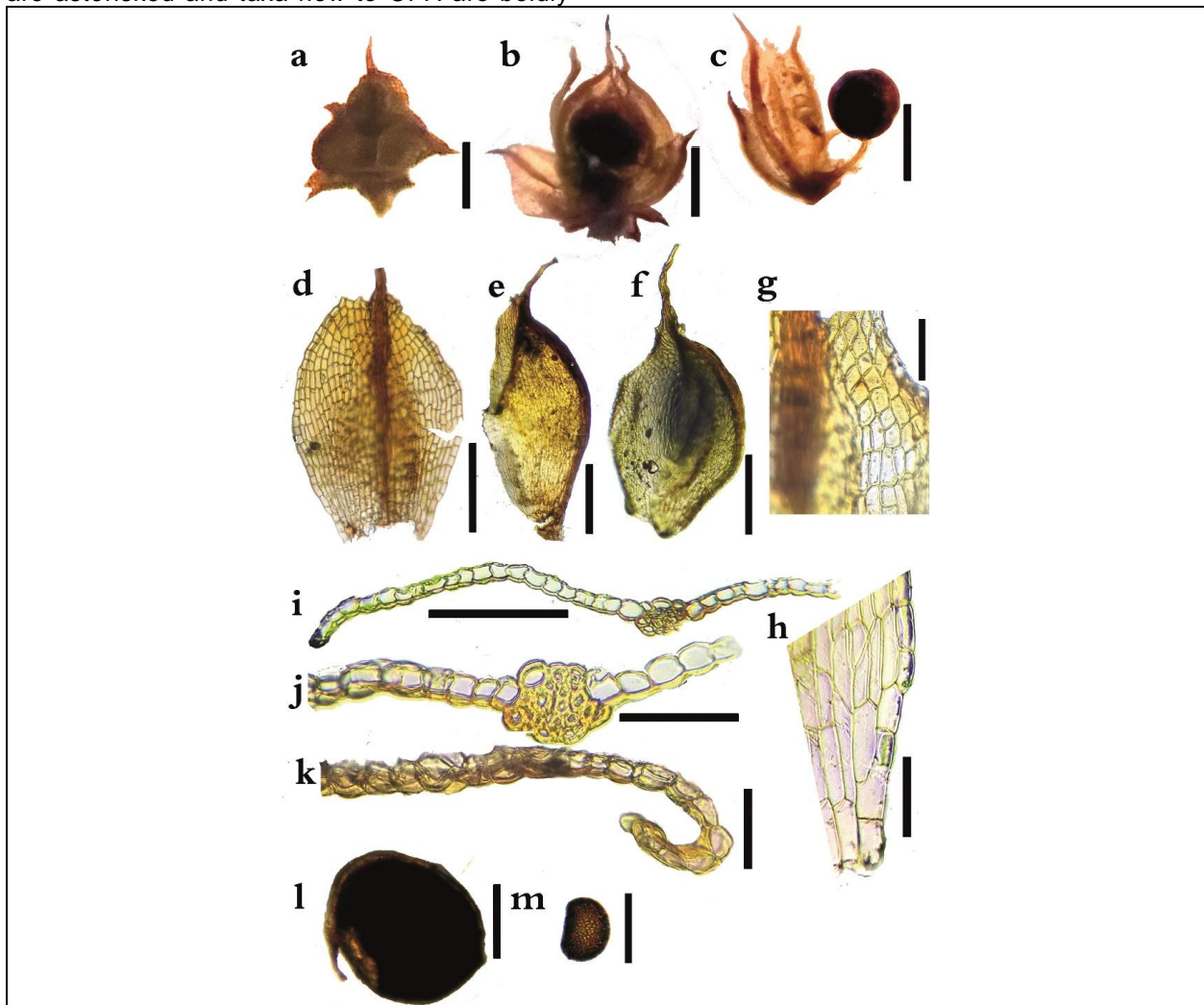
The investigation of 30 samples showed that they separated into 68 herbarium specimens having 21 Pottiaceae taxa. Most of these taxa were mixed with others of Bryaceae, Fissidentaceae and Funariaceae (not included in this study). This study added four taxa as new records to OPA (Kassas *et al.*, 2002; El-Saadawi *et al.*, 2013), two taxa to Egypt (El-Saadawi *et al.*, 2015; Hassan *et al.*, 2017; El-Sakaty *et al.*, 2018) and one taxon to North Africa (<http://www.gbif.org>). This raise up the no. of Pottiaceae taxa in OPA to 27 and total number of moss taxa to 34, while no. of taxa of Mm and Egypt were raised to 65 and 186 respectively.

The 21 taxa recorded from Khashm El-Aish plateau in OPA are listed below. Their habitat and distribution in other phytogeographic territories of Egypt (El-Saadawi *et al.*, 2015) and Mediterranean region (Ros *et al.*, 2013) are mentioned. Taxon new to North Africa is under-lined, taxa new to Egypt are asterisked and taxa new to OPA are boldly

typed. Descriptions and illustrations are given for only the two new records to Egypt. The herbarium number includes year of collection "17" then serial of taxa in the herbarium "000", followed by name of collector "MF= Mohamed Farag" and site of collection "O = Omayed".

Phytogeographic territories (after El-Saadawi *et al.*, 2003) are abbreviated as follows: **Cai**: Cairo area; **Da**: Arabian desert; **Dg**: Galala Desert; **Di**: Isthmic Desert; **DI**: Libyan Desert; **Dn**: Nubian desert; **GE**: Gebel Elba; **Mm**: 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 Naser since 1965; **Nv**: Nile Valley, from Cairo-Giza to Kom Ombo; **On & Ol**: 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).

\****Acaulon triquetrum* (Spruce) Müll. Hal.** (Fig. 2).



**Fig. 2.** a-m, *Acaulon triquetrum*: a-Dry gametophyte carrying embedded sporophyte; b- Wet gametophyte carrying sporophyte; c- Lateral view of gametophyte carrying sporophyte; d, e, f- Leaves; g- Upper laminal cells; h- Part of leaf base; i, j, k- Different cross sections of a leaf; l- Capsule; m- Spore; Scale bar: a-c= 0.5 mm; d-f = 250  $\mu$ m; g= 60  $\mu$ m; h = 80  $\mu$ m; i= 125  $\mu$ m; j = 60  $\mu$ m; k = 50  $\mu$ m; l= 200  $\mu$ m; m = 20  $\mu$ m.

Four gatherings, at the east of Khashm El-Aish plateau, between rocks (17001MFO-17003MFO) and in rock crevices (17004MFO).

**Distribution:**

New record to Egypt and in 22 out of 34 the Mediterranean countries.

**Description:**

Plants yellowish brown to brown, minute, bud-like, up to 1.3-1.4 mm high. Leaves appressed to imbricate when dry, erect to spreading when moist, few, crowded, concave, three uppermost leaves strongly keeled when dry, making plants appear triangular when viewing from above, ovate, 0.55 - 1 mm long, 0.4 - 0.7 mm wide; apex acuminate; margins plane to slightly recurved in upper part, entire, weakly dentate near apex; costa excurrent into a reflexed apiculus 196 µm in upper leaves, in lower leaves only shortly excurrent, semicircular in cross section, no guide cells, epidermis differentiated ventrally and little differentiated dorsally; upper laminal cells subquadrate, hexagonal to rhomboidal, 30 - 48 µm long, (12)18 - 30 µm wide, bulging and not papillose on both sides, thin walled on upper surface, thick walled on lower surface; basal laminal cells rectangular, 90 - 100 µm long, 6 - 12 µm wide, smooth, with thin walls. Seta very short, up to 70 µm long, ca. 2/3 the length of a capsule, thin, arcuate; capsule immersed, orange brown, its diameter approx. 400 µm; peristome not formed. Spore, brown, papillose, 18 µm in diameter.

*Aloina ambigua* (Bruch & Schimp.) Limpr.

Three gatherings, at the middle of Khashm El-Aish plateau, on semi-shaded soil on an inclined surface of a calcareous rock (17005MFO-17006MFO) and in the shade of higher plants (17007MFO).

**Distribution:**

Di, S, and Mm in Egypt and in 32 out of 34 the Mediterranean countries.

*A. rigida* (Hedw.) Limpr.

Two gatherings (17008MFO-17009MFO), at the middle of Khashm El-Aish plateau, on semi-shaded coarse soil where water flows.

**Distribution:**

Di, O, and Mm (New to Omayed) in Egypt and in 30 out of 34 the Mediterranean countries.

*Crossidium laevipilum* Thér. & Trab.

Three gatherings, at the middle of Khashm El-Aish plateau, on semi-shaded soil between rock and ground (17010MFO-17011MFO) and in rock crevices (17012MFO).

**Distribution:**

Di and Mm in Egypt and in 8 out of 34 the Mediterranean countries.

*C. laxifilamentosum* W. Frey & Kürschner

Two gatherings (17013MFO-17014MFO), at the middle of Khashm El-Aish plateau, on semi-shaded soil between rock and ground.

**Distribution:**

Di and Mm in Egypt and in 5 out of 34 the Mediterranean countries.

*Didymodon acutus* (Brid.) K. Saito

Two gatherings (17015MFO-17016MFO), at the middle of Khashm El-Aish plateau, in shade of a higher plant, facing north.

**Distribution:**

Di, S, and Mm in Egypt and in 33 out of 34 the Mediterranean countries.

*D. fallax* (Hedw.) R. H. Zander

Three gatherings (17017MFO-17019MFO), at the middle of Khashm El-Aish plateau, in rock crevices and in a semi-shaded place between rock and ground.

**Distribution:**

Nd, Nf, Di, S, O, and Mm in Egypt and in 32 out of 34 the Mediterranean countries.

*D. luridus* Hornsch.

Four gatherings (17020 MFO - 17023MFO), at the middle of Khashm El-Aish plateau, inside a calcareous rock groove.

**Distribution:**

Nd, Nf, Cai, Dg, S, and Mm in Egypt and in 33 out of 34 the Mediterranean countries.

*D. rigidulus* Hedw.

Three gatherings (17024MFO-17026MFO), at the middle of Khashm El-Aish plateau, on semi-shaded coarse soil where water flows and in a semi-shaded site between rock and ground.

**Distribution:**

Di, S, O, and Mm in Egypt and in 33 out of 34 the Mediterranean countries.

*D. tophaceus* (Brid.) Lisa

Three gatherings (17027MFO-17029MFO), at the middle of Khashm El-Aish plateau, inside rock crevices.

**Distribution:**

Nn, Nv, Nd, Nf, Cai, Dg, S, GE, O, and Mm in Egypt and in 33 out of 34 the Mediterranean countries.

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

Two gatherings (17030MFO- 17031MFO), at the middle of Khashm El-Aish plateau, on semi-shaded coarse soil where water flows.

**Distribution:**

Nd, Di, S, O, and Mm in Egypt and in 33 out of 34 the Mediterranean countries.

*Gymnostomum calcareum* Nees & Hornsch.

Three gatherings, at the middle of Khashm El-Aish plateau, inside rock crevices (17032MFO-17033MFO) and on semi-shaded coarse soil where water flows (17034MFO).

**Distribution:**

Nv, Nd, Nf, Dg, S, GE, and Mm (New to Omayed) in Egypt and in 33 out of 34 the Mediterranean countries.

*G. vridulum* Brid.

Six gatherings, at the middle of Khashm El-Aish plateau, inside rock crevices (17035MFO-17037MFO); in the shade of higher plants (17038MFO); inside a rock groove (17039MFO) and on semi-shaded coarse soil where water flows (17040MFO).

**Distribution:**

Nv, Cai, Dg, Di, S, and Mm in Egypt and in 29 out of 34 the Mediterranean countries.

*Microbryum davallianum* (Sm.) R. H. Zander

Three gatherings, at the middle of Khashm El-Aish plateau, in a semi-shaded site on an inclined surface of a rock (17041MFO-17042MFO) and on rock surfaces (17043MFO).

**Distribution:**

Di and Mm in Egypt and in 30 out of 34 the Mediterranean countries.

*M. starckeanum* (Hedw.) R. H. Zander

Four gatherings, at the middle of Khashm El-Aish plateau, on rock surfaces (17044MFO-17045MFO) and in rock crevices (17046MFO-17047MFO).

**Distribution:**

Cai, Di, S, and Mm in Egypt and in 29 out of 34 the Mediterranean countries.

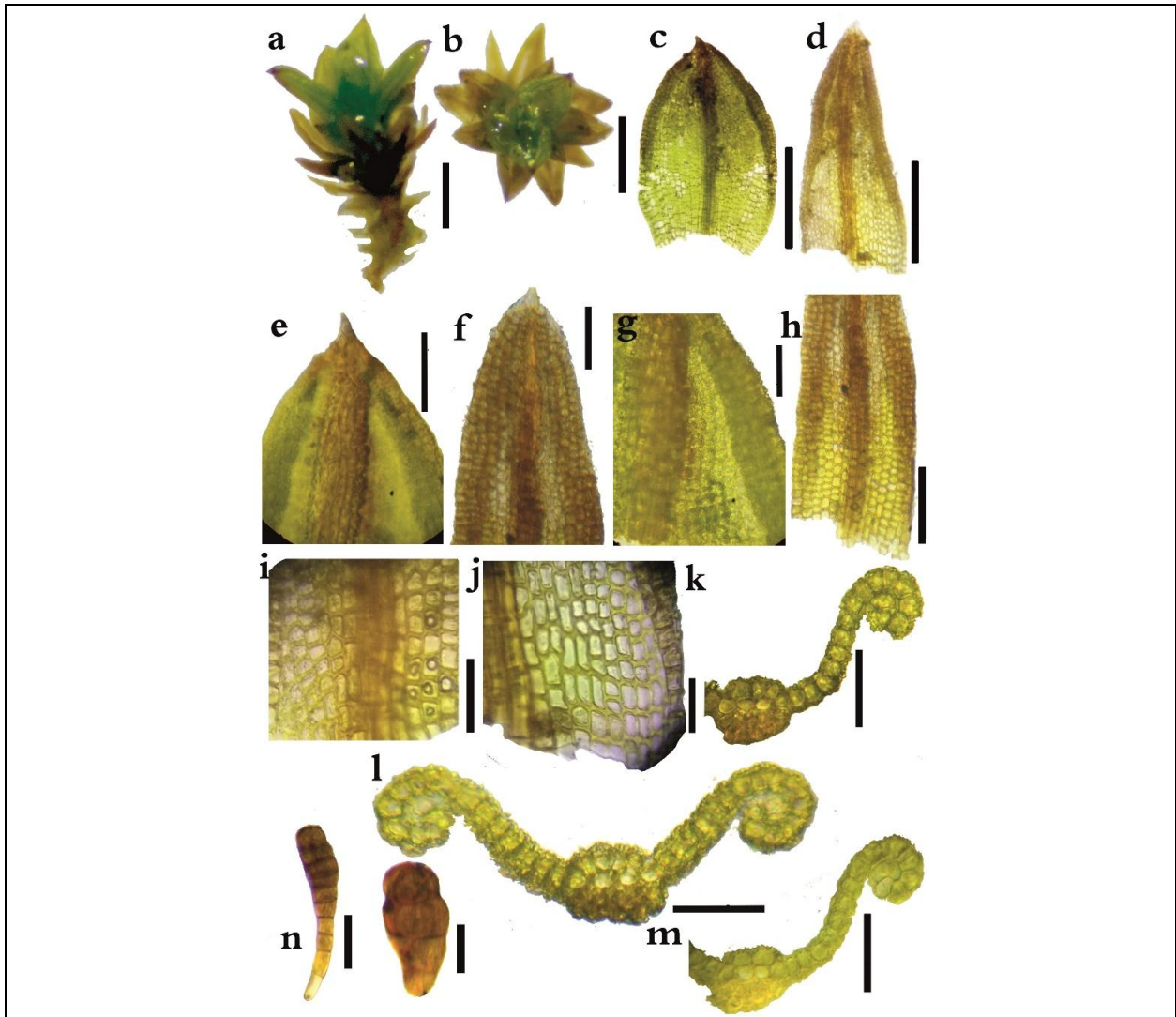
*Pseudocrossidium hornschuchianum* (Schultz) R. H. Zander

Three gatherings, at the middle of Khashm El-Aish plateau, on semi-shaded soil on an inclined surface of a calcareous rock (17048MFO-17049MFO) and on soil in a small cave (17050MFO).

**Distribution:**

Nv, Di, S, and Mm in Egypt and in 31 out of 34 the Mediterranean countries.

***\*P. obtusulum* (Lindb.) H.A. Crum & L.E. Anderson (Fig. 3).**



**Fig. 3.** a-n, *Pseudocrossidium obtusulum*: a,b- Wet gametophyte; c,d- Leaves; e,f- Leaves apices; g- Marginal cells below leaf apex; h- Middle laminal cells; i,j- Cells at leaf base; k,l,m- Different cross sections of a leaf; n- Gemmae; Scale bar: a-b = 1 mm; c-d = 0.3 mm; e-f = 50 µm; g = 25 µm; h = 200 µm; i-j = 25 µm; k-m = 50 µm; n = 15 µm.

Two gatherings, at the middle of Khashm El-Aish plateau, on semi-shaded soil on an inclined surface of a calcareous rock (17051MFO-17052MFO).

**Distribution:**

New record to Egypt and in 4 out of 34 the Mediterranean countries.

**Description:**

Plants green above to yellowish brown below, small, up to 5 mm high. Stems up to 3 mm high. Leaves crowded, appressed when dry, weakly spreading when moist, ovate to ovate-lanceolate, 0.65 - 0.75 mm long, 0.25 - 0.35 mm wide; apex broadly acute to obtuse; margins once-revolute, and revolute only in distal 2/3 of leaf, ± entire; costa strong, widened in distal half of leaf, shortly excurrent and forming small apiculus, shining, brownish, smooth on dorsal side, circular to semicircular in cross section, 2 - 3 guide cells, epidermis differentiated ventrally and little differentiated dorsally, strongly papillose on ventral side, slightly papillose to smooth on dorsal side in distal part of leaf; upper laminal cells subquadrate to rhomboidal, 6 - 8 µm long, 4 - 6 µm wide, slightly thick walled; basal laminal cells quadrate to rectangular, (6)10 - 12 µm long, 6 - 7(8) µm wide, smooth, strongly thick walled. Gemmae multicellular, elliptic or clavate, 30 - 45 µm, born on a stem in leaf axil.

*Tortella flavovirens* (Bruch.) Broth.

Five gatherings, at the middle of Khashm El-Aish plateau, in shaded place inside rock crevices (17053MFO-17055MFO) and in a semi-shaded place on a rock (17056MFO-17057MFO).

**Distribution:**

Mm in Egypt and in 27 out of 34 the Mediterranean countries.

*T. nitida* (Lindb.) Broth.

Three gatherings, at the middle of Khashm El-Aish plateau, in shaded place on inclined side of a rock (17058MFO-17059MFO) and in rock crevices (17060MFO).

**Distribution:**

Nv, GE, and Mm in Egypt and in 33 out of 34 the Mediterranean countries.

*Tortula brevissima* Schiffn.

Three gatherings, at the middle of Khashm El-Aish plateau, in rock crevices (17061MFO) and on rock surfaces (17062MFO-17063MFO).

**Distribution:**

S and Mm in Egypt and in 14 out of 34 the Mediterranean countries.

*T. muralis* Hedw.

Five gatherings, at the middle of Khashm El-Aish plateau, on semi-shaded place on inclined side of a rock (17064MFO-17066MFO) and inside rock crevices (17067MFO-17068MFO).

**Distribution:**

Nd, Cai, Dg, Di, and Mm in Egypt and in all 34 the Mediterranean countries.

**ACKNOWLEDGMENTS**

Thanks for UNESCO to fund this research under MAP for young researchers. In addition, all thanks to Dr. Sahar El-Sakaty for her advises and help during this work.

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## تسجيلات إضافية للفصيلة البوتياوية من محمية العُميد، مصر

منال إبراهيم خليل، محمد فرج ابو الحمد على

قسم النبات، كلية العلوم، جامعة عين شمس، القاهرة، مصر

Nees Hornsch. أيضا إضافات جديدة على محمية العُميد. وبهذه الدراسة يزداد عدد أصناف الحزازيات المسجلة من مصر إلى 186، والأجناس إلى 59، كما زاد عدد أنواع الفصيلة البوتياوية إلى 89 حزاز. وتم وصف وتصوير النوعين الجديدين مع الإشارة إلى التوزيع الجغرافي في مصر والتواجد في دول البحر المتوسط لكل الأنواع التي تم رصدها.

تتضمن هذه الدراسة تسجيل 21 نوعًا للفصيلة البوتياوية من محمية العُميد، منها جنس *Acaulon* Müller Hal والنوعين *Acaulon triquetrum* (Spruce) Müll. Hal و *Pseudocrossidium obtusulum* (Lindb.) H.A. Crum و L.E. Anderson إضافة جديدة على الفلورا الحزازية المصرية. كذلك يعتبر *Pseudocrossidium obtusulum* إضافة جديدة على شمال أفريقيا. وكذلك النوعان *Aloina* و *Gymnostomum calcareum* و *rigida* (Hedw.) Limpr.