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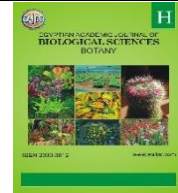
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## Confirmation of Doubtful Moss Records of *Fissidens fontanus*, *Grimmia orbicularis* and *Schistidium apocarpum* from Egypt

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### ABSTRACT

The documentation of moss diversity from Egypt dates back to Delile in 1812. By now the moss flora of Egypt comprises approximately two hundred taxa. Twenty-six of these moss taxa were primarily collected before 1904 as a single record, by foreign scientists, without herbarium specimens, illustration, and description. Expeditions to different phytogeographical territories in Egypt were projected to confirm old reports and record undiscovered taxa. Upon investigation, it was determined that three moss species out of the 26 single records have been confirmed to be present after a century. *Fissidens fontanus* (Bach. Pyl.) Steud., was the only taxon reported with no locality, in this work, it is reported from Nile Nubia territory raising the total number from this territory to 10. *Grimmia orbicularis* Bruch ex Wilson and *Schistidium apocarpum* (Hedw.) Bruch & Schimp are reported from the mountains of South Sinai establishing their habitats in this territory. In addition, the precise locations, descriptions, and photographs of those three taxa are provided.

### INTRODUCTION

Historically, the reporting of moss diversity in Egypt started back in 1812 by Delile, followed by many intermitted works performed by foreign scientists till 1966 when Boulos collected and described three moss taxa (El-Saadawi *et al.* 1999). Then In 1972, Imam and Ghabbour published the first alphabetical list of mosses with 69 taxa, followed by another list by El-Saadawi and Badawi (1977). After that, the work has continued until now with recording 201 moss taxa (El-Saadawi *et al.*, 2015; Hassan *et al.*, 2017; El-Sakaty *et al.*, 2018; Khalil and Farag 2018; Taha 2020; Abou-Salama *et al.*, 2021; Lashin *et al.*, 2022; Isaak *et al.*, 2023). The old records from 1812 to 1966 were not present in the CAIA herbarium section Bryophyta, which was founded in 1972 (Vitt *et al.* 1985).

During the updating of the moss flora of Egypt, previous works, and checklists of Egyptian Bryoflora showed that some taxa haven't been recorded since 1904. These taxa had no herbarium specimens nor photos and one of them had no locality. Based on El-Saadawi *et al.* (1999) and Ros *et al.* (2013), 26 moss taxa were collected mainly before 1904 as a single record. Continuous work decreased this number to nineteen taxa: *Brachythecium umbilicatum* Jur. & Milde, *Bryum schleicheri* Lam. & Dc., *Drepanocladus aduncus* (Hedw.) Warnst., *Entosthodon curvi-apiculatus* Müll. Hal., *Fissidens fontanus* (Bach. Pyl.) Steud., *Funaria anomala* Jur., *F. microstoma* Bruch ex Schimp., *F. nubica* Müll. Hal., *F. sickenbergeri* Müll. Hal., *Grimmia laevigata* (Brid.) Brid, *Grimmia orbicularis* Bruch ex Wilson, *Philonotis fontana* (Hedw.) Brid., *Pohlia korbiana* (Müll. Hal.) Wijk & Margad.,

*Racomitrium aciculare* (Hedw.) Brid., *Rhynchostegiella tenella* (Dicks.) Limpr., *Schistidium apocarpum* (Hedw.) Bruch & Schimp., *Syntrichia rigescens* (Broth. & Geh. in Broth.) Ochyra, *Tortula kneuckeri* Broth. & Geh., *Weissia longifolia* Mitt. fid. Crundw. & Nyholm. Ten out of them are recorded from South Sinai territory (S.), three from Oasis, two from Cairo and one from each of Nile Nubia (Nn.), Nile Vally and the west Mediterranean coast. Only *Fissidens fontanus* without any particular locality in the original publications (Brotherus 1924), is cited only as Egypt. (El-Saadawi *et al.* 2015, Taha & Khalil 2023).

This work aims to confirm and provide descriptions, natural photographs, habitats, and distribution in the world of three of such single recorded taxa namely: *Fissidens fontanus*, *Grimmia orbicularis* and *Schistidium apocarpum*, which in-rich the moss flora of Egypt and solve the doubtful about these ancient records.

## MATERIALS AND METHODS

Plant materials of these three taxa were observed between samples, which were collected by the second author from different phytogeographical territories (Nile Delta, Nile Nubia, Nile Valley, Oasis, and Sinai). Excursions were done between April 2021 and April 2023.

The Three taxa are described in detail to demonstrate the range of variation in morphological and anatomical features. Measurements were taken using an ocular micrometer of whole plants, stems, leaves and sporophyte (if present) either on a stereomicroscope for plant habit or a compound microscope for other plant organs and cross sections.

Distribution in the phytogeographical territories of Egypt was based on El-Saadawi *et al.* (2015) and distribution in the world was given from global biodiversity information facility data (GBIF) (GBIF 2024), floristic regions of the world was based on Index Muscorum (Crosby & Bauer 1983). Names of taxa were validated using the Tropicos database (Tropicos 2024).

## RESULTS AND DISCUSSION

The careful examination resulted in the recording of three taxa: *Fissidens fontanus*, *Grimmia orbicularis* and *Schistidium apocarpum*. *F. fontanus* was reported by Brotherus (1924) as a previous collection from Egypt with no precise location. *G. orbicularis* was reported by Lorentz (1867), while *Schistidium apocarpum* was reported by Hart (1891) and both taxa were from South Sinai. This confirmed the presence of *S. apocarpum* in Egypt where it was reported as a single record and doubtful collection before 1962 by Ros *et al.* (2013). Determining the locality of *F. fontanus* increased the number of recorded taxa from Nile Nubia to 10. The following are the descriptions, habitats, and distribution.

### *Fissidens fontanus* (Bach. Pyl.) Steud. (Fig.1)

Plants aquatic, large, available part 25 mm long, green to yellowish green, feather-like. Stem sub-round, central strand absent, inner cortical cells large, irregularly thickened at corners, outer cortical cells small, incrassate, 150-200 µm in diameter. Leaves distant, spreading wet and dry; lanceolate to linear-lanceolate, (2.5) 5-7 mm L x 0.5-0.7 mm W; acute to obtuse; margins ± entire, not bordered; costa ending many cells before apex, 50-75 µm wide; dorsal laminal cells narrowing toward leaf base, not reaching stem; vaginant lamina less than half the length of leaf, equal or termination of one blade submarginal. upper and middle laminal cells unistratose, quadrate to short-oblong to hexagonal, smooth, slightly bulging, ± incrassate, 17.5 – 25 µm L x 15-17 µm W in dorsal and ventral laminae, juxtacostal cells larger than middle laminal cells.

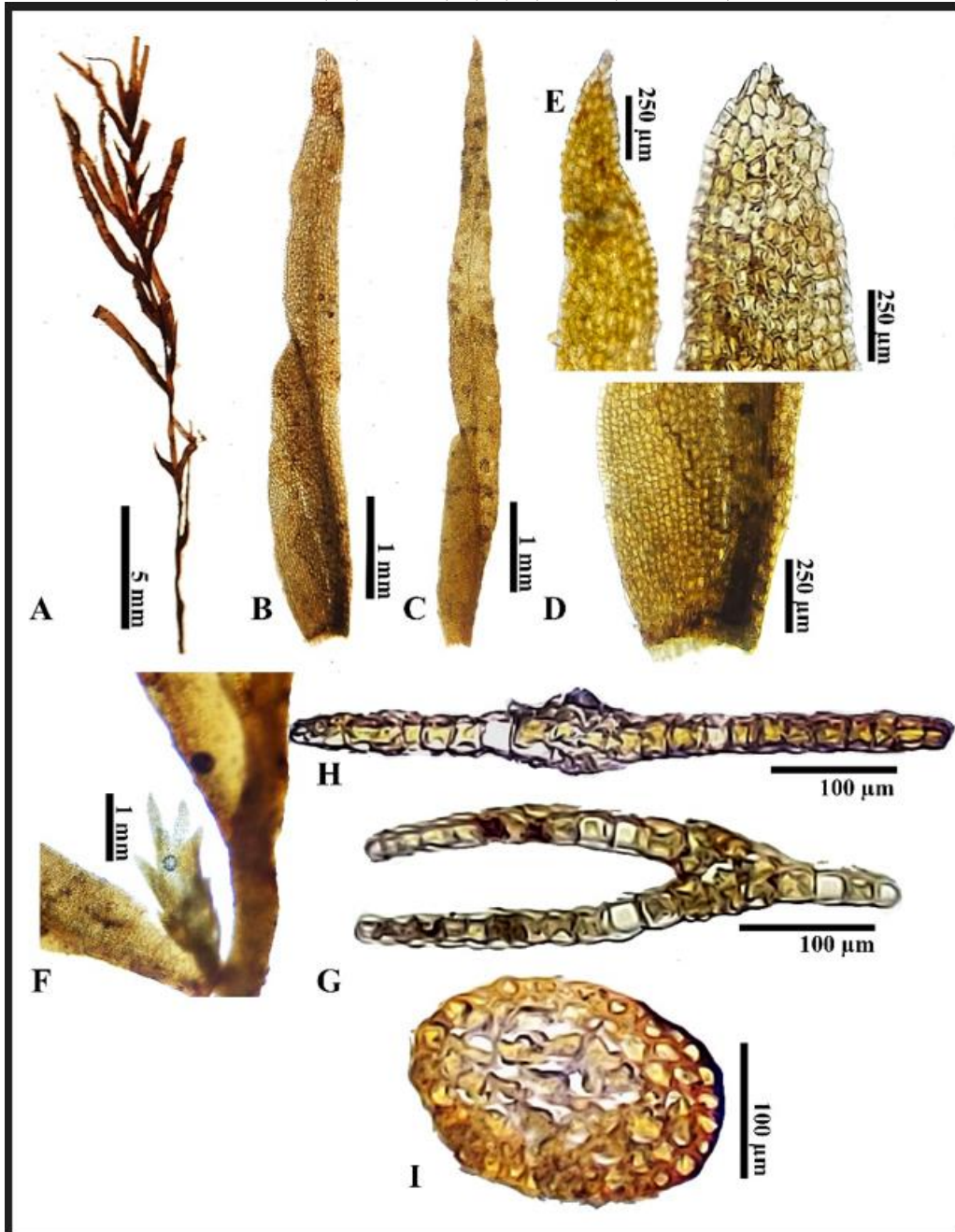
### Confirmation of Three Moss Taxa From Egypt.

Locality: 24°05'04.6"N – 32°53'23.3"E, Feryal Ferry Boat, Aswan. Herbarium no.: CAIA-Nn-78.

Habitat: shaded, submerged in the river Nile polluted with boat wastes, on the walls of the Ferry.

Distribution in phytogeographic territories in Egypt: unknown, Now Nn.

Distribution in the world: Afr. 1, 4; Am. 1, 2, 3, 5; As. 5; Austr. 1, 2 and Eur.



**Fig. 1:** A. plant; B & C. Stem leaves; D. Leaf base; E. Leaves apices; F. Short lateral branch; G. Section at vaginant lamina; H. Section of apical lamina; I. Stem cross-section.

#### *Grimmia orbicularis* Bruch ex Wilson (Fig.2)

Dusty greenish black hoary when dry, up to 1 cm high. Leaves erect, appressed when dry, erect-patent when moist, lanceolate-elliptical to lanceolate, keeled, abruptly narrowed to hyaline point in upper leaves; margins recurved on one or both sides at middle of leaf; hyaline points  $\frac{1}{2}$  - 1 length of lamina, smooth or slightly denticulate; costa well

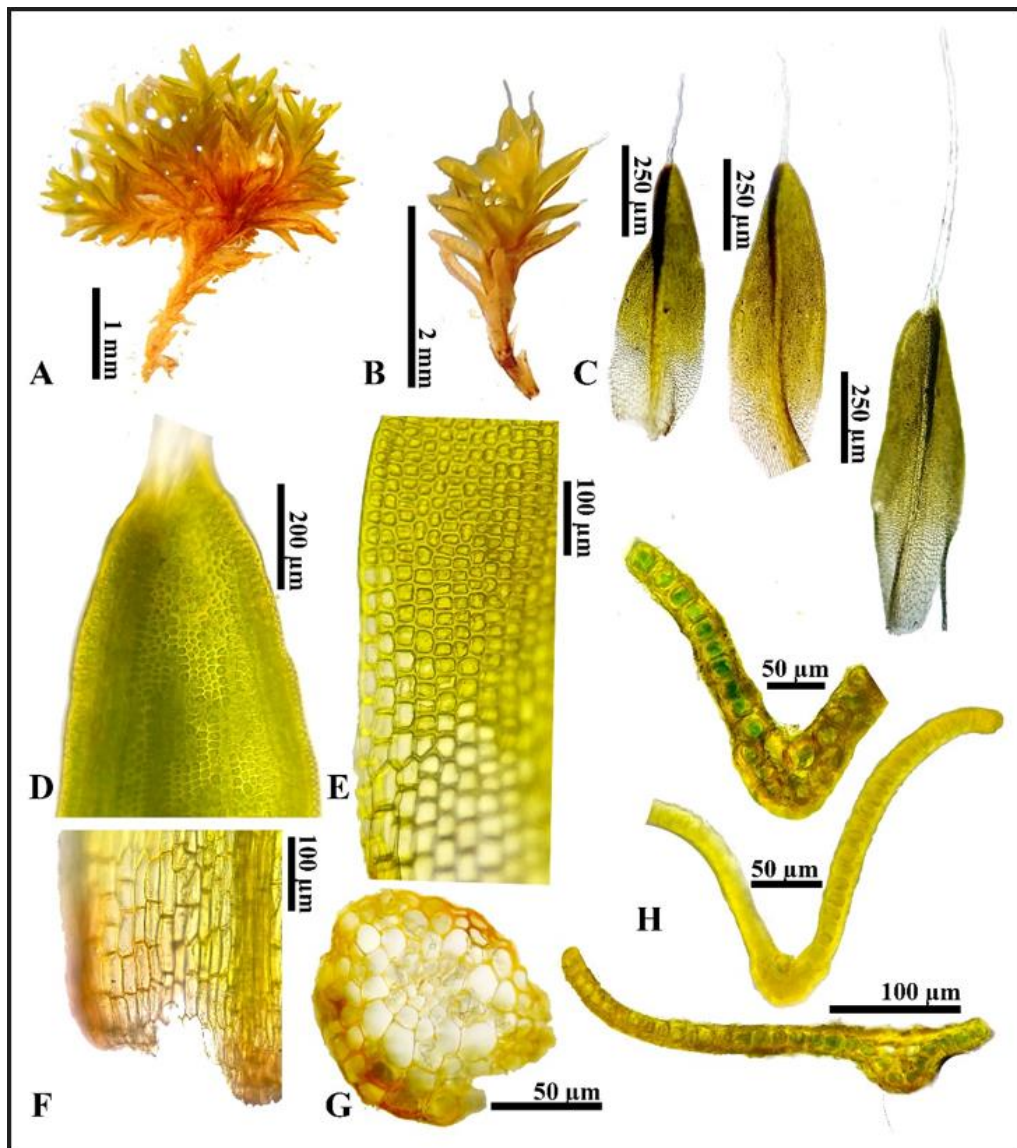
defined, in section 2 cells wide adaxially; basal cells rectangular 3-5 times as long as wide middle laminal cells quadrate or quadrate-rectangular, incrassate, sinuose, unistratose sometimes bistratose at margin, pellucid, 10–12  $\mu\text{m}$  wide in mid-leaf.

Locality: 28°32'55.0" N – 33°58'54.8" E, the road to Saint Katherine Mountain, near Saint Katherine Monastery, South Sinai. Herbarium no.: CAIA-S-325 & CAIA-S-326.

Habitat: on the sand in a shaded place below a large rock.

Distribution in phytogeographic territories in Egypt; S

Distribution in the world: Afr1, 4; Am1; As 3, 5; Austr 1, 2; Eur.



**Fig. 2:** A. Plant; B. Single branch; C. Stem leaves; D. Apical laminal cells; E. Middle laminal cells; F. Basal laminal cells; G. Stem cross-section; H. Leaf cross-sections.

***Schistidium apocarpum* (Hedw.) Bruch & Schimp. (Fig.3)**

Plant 0.6 – 1.0 cm, with central strand. Epidermal cells of stems strongly incrassate with small lumens. Leaves erect or curved, sometimes subsecund when dry, ovate-lanceolate to lanceolate, sharply keeled above, 1.4 – 1.8 mm length x 0.35 – 0.5 mm width, bistratose in striae distally; margins recurved  $\pm$  throughout or to just before the apex, entire or sparsely bluntly toothed towards apex; apices acute or sub-obtuse; costa percurrent, occasionally decurrent; costa smooth or with sparse low papillae on abaxial side above; basal marginal cells quadrate at margins to rectangular near costa, 25 – 42.5  $\mu\text{m}$  length x 10-12.5  $\mu\text{m}$  width,

### Confirmation of Three Moss Taxa From Egypt.

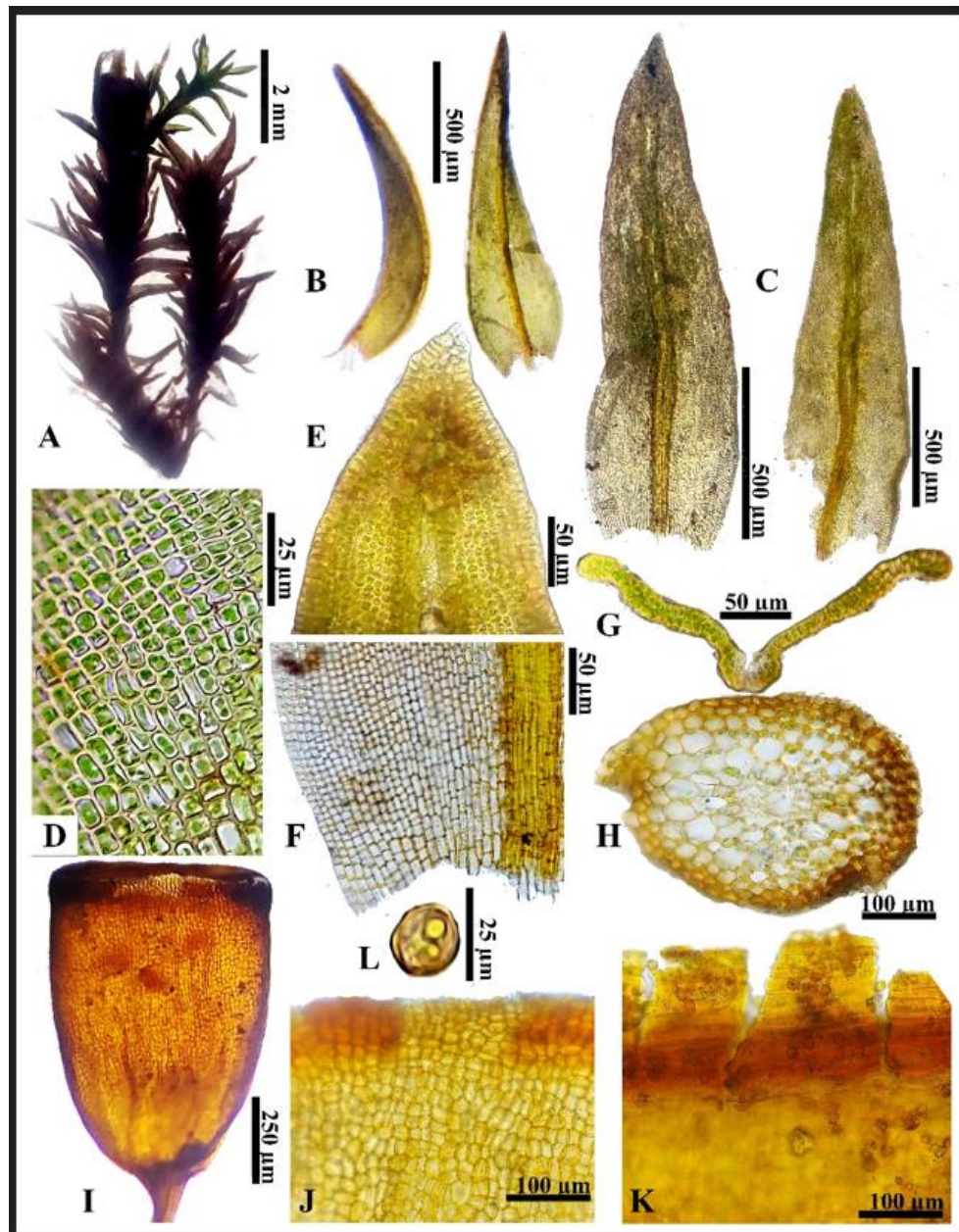
smooth, sinuose towards margin. Middle laminal cells rounded-quadrate to shortly rectangular, incrassate, usually sinuose, smooth mostly 8–10  $\mu\text{m}$  wide. Sporophyte present: capsule immersed inside gametophyte, dark red to brown, short-cylindric, widest at the mouth, 0.8 mm; exothecial cells usually quadrate, sometimes mixed with short-elongate or oblate cells, thin-walled, usually trigonous; stomata present; peristome patent to slightly incurved, twisted, 230 – 350  $\mu\text{m}$ , red, densely papillose, usually perforated. Spores 12.5  $\mu\text{m}$ , granulose or smooth.

Locality: 28°32'52.8" N – 33°58'12.0" E, Farsh El-Louza, Saint Katherine Mountain, South Sinai. Herbarium no.: CAIA-S-338c & CAIA-S-339c

Habitat: on rocks in a slightly wet shaded place, inside mountain crevices.

Distribution in phytogeographic territories in Egypt; S

Distribution in the world: Afr 1, 2, 3, 4; Am 1, 2, 3, 4, 6; Antarctica; As 1, 2, 5; Austr 1, 2; Eur.



**Fig. 3:** A. Plant; B & C. Stem leaves; D. Middle laminal cells; E. Leaf apex; F. Leaf Base; G. Leaf cross-section; H. Stem cross-section; I. Capsule; J. Exothecial cells; K. Peristome teeth; L. Spore.

**Declarations:**

**Ethical Approval:** Ethical Approval is not applicable.

**Competing interests:** The authors declare no conflict of interest.

**Authors Contributions:** All authors contributed equally to the study, sample preparation, photographing and identification. All authors read, revised, and approved the final manuscript.

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**Availability of Data and Materials:** All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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### ARABIC SUMMARY

تأكيد تسجيل *Fissidens fontanus*, *Grimmia orbicularis* and *Schistidium apocarpum* غير المؤكد تواجدهم ضمن الحزازيات القائمة المصرية

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يعود تاريخ توثيق تنوع الحزازيات القائمة في مصر إلى 1812 Delile. وتضم الفلورا الحزازية في مصر الآن ما يقرب من مائتي نوع. ستة وعشرون نوع منهم سُجل مرة واحدة فقط قبل عام 1904- من قبل علماء أجانب- وكانت هذه العينات بدون سجل معشبي أو صور توضيحية أو وصف. ومن خلال إجراء رحلات استكشافية إلى مناطق جغرافية نباتية مختلفة في مصر لتأكيد التسجيلات القديمة وتسجيل الأنواع غير المكتشفة. تم التحقق من وجود ثلاثة أنواع من أصل 26 نوع سالفه الذكر، وقد تم التأكد من وجودها في البيئة المصرية بعد قرن من الزمان. كان *Fissidens fontanus* (Bach. Pyl.) Steud هو النوع الوحيد المسجل بدون موقع محدد، وفي هذه الدراسة، تم تسجيل وجوده في منطقة نوبيا النيل مما رفع العدد الإجمالي من هذه المنطقة إلى عشرة أنواع. في حين تم تسجيل *Grimmia orbicularis* Bruch ex Wilson و *Schistidium apocarpum* (Hedw.) Bruch & Schimp من جبال جنوب سيناء و بهذا تعتبر منطقة أساسية لوجود هذه الأنواع. بالإضافة إلى ذلك، تم ذكر الموقع الدقيق والوصف والصور الفوتوغرافية لهذه الأنواع الثلاثة.