



## Illustration and Description of the Recent Bryaceae Records from Bahariya Oasis – Egypt

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**T**WO species of Bryaceae are recent records for the bryoflora of Egypt from Bahariya Oasis (Western Desert): *Bryum klinggraeffi* Schimp. and *B. valparaisense* Thér. In addition, *Bryum dichotomum* Hedw. is recorded for the first time from the study area. Thus the number of mosses known from Egypt becomes 188 and from Bahariya oasis 14. The two recently recorded species are described and illustrated and details are given of the collection sites and habitats. Notes are also given on their wider distributions along with some floristic remarks.

**Keywords:** Bahariya Oasis, Bryaceae, *Bryum klinggraeffi*, *Bryum valparaisense*, Egypt, Moss flora.

### Introduction

The Egyptian moss flora currently includes 186 taxa belonging to 59 genera, 17 families and 10 orders (El-Saadawi et al., 2015; Khalil & Farag, 2018). Thirty two taxa are now known from the Oases of the Western Desert belonging to 14 genera, 6 families and 4 orders. These taxa include: eleven from Bahariya, ten from Farafra, nine from Siwa, eight from Kharga and five from Dakhla Oasis. Five taxa (out of 186 taxa in Egypt) were restricted to Oasis territory: *Funaria microstoma* Bruch ex Schimp. (Bahariya Oasis), *F. sickenbergeri* Müll. Hal. (Dakhla Oasis), *Pohlia korbiana* (Müll. Hal.) Wijk & Margad. (Dakhla Oasis), *Tortella inclinata* (R. Hedw.) Limpr. (Siwa Oasis), *Weissia controversa* var. *crispata* (Nees & Hornsch.) Nyholm (Kharga Oasis). Moss taxa are known from these oases based on old reports by Müller (1874), Sickenberger (1901) and more recent papers on moss collections kept at CAIA by El-Saadawi et al. (1999), Abou-Salama & El-Saadawi (2001, 2003), Refai (2001), Refai et al. (2002).

Bryaceae is a large acrocarpous moss family (ca. 500 species worldwide) with cosmopolitan distribution (Spence, 2014). Bryaceae is the second largest moss family in Egypt (after

Pottiaceae 89 taxa) and is the largest one in Oasis (particularly in Bahariya Oasis); this may be attributed to Bryaceae have large ability to grow in different habitats, including disturbed open soils (Spence, 2014).

In Egypt, Bryaceae includes 28 taxa representing 15% of the Egyptian moss flora (El-Saadawi et al., 2015). In the oasis, Bryaceae includes 15 taxa representing about 47% of the total moss flora (followed by Pottiaceae 11 taxa). Bryaceae represent 70%, ca. 64%, 40%, 37.5% and 22% of the moss flora at Farafra, Bahariya, Dakhla Kharga, Siwa Oasis respectively.

The moss flora of Bahariya Oasis consists of 11 taxa (*Brachymenium exile*, *Bryum argenteum*, *B. funkii*, *B. turbinatum*, *Didymodon vinealis*, *Funaria hygrometrica*, *F. microstoma*, *Philonotis hastata*, *Ptychostomum imbricatum*, *P. pseudotriquetrum*, *P. torquescens*) belonging to 3 orders, 4 families and 6 genera. Bryaceae is the largest family in Bahariya Oasis (7 taxa). El-Saadawi et al. (1999) recorded *Philonotis hastata* (Duby) Wijk & Margad. from Bahariya Oasis and the other ten taxa were recorded by Refai et al. (2002).

During examination of herbarium specimens

the author noticed a large number of preserved unidentified samples (in CAIA) from different Egyptian territories. The current work resulted in identification of some of these samples which were collected previously from Bahariya Oasis. It is expected that in future more investigation will add many new records for the country.

It is worth mentioning that these two Bryaceae records were recently published by the author in a collected work entitled “New national and regional bryophyte records”. This includes many new records from different countries around the world, but without illustrations, descriptions

or discussion. Consequently, the author finds it necessary, in the present work, to illustrate and describe these records in more detail and gave some additional floristic remarks.

#### Study area

Bahariya Oasis is one of the Western Desert oases in Egypt, lying between longitudes  $28^{\circ} 30'$  and  $29^{\circ} 10'$  E and latitudes  $27^{\circ} 48'$  and  $28^{\circ} 30'$  N (Fig. 1) (Refai et al., 2002). It is located in the north-western part of the Western Desert, of Giza Province (ca. 365 km southwest of Giza), and its capital town is Al-Bawiti (Shehata et al., 2012).

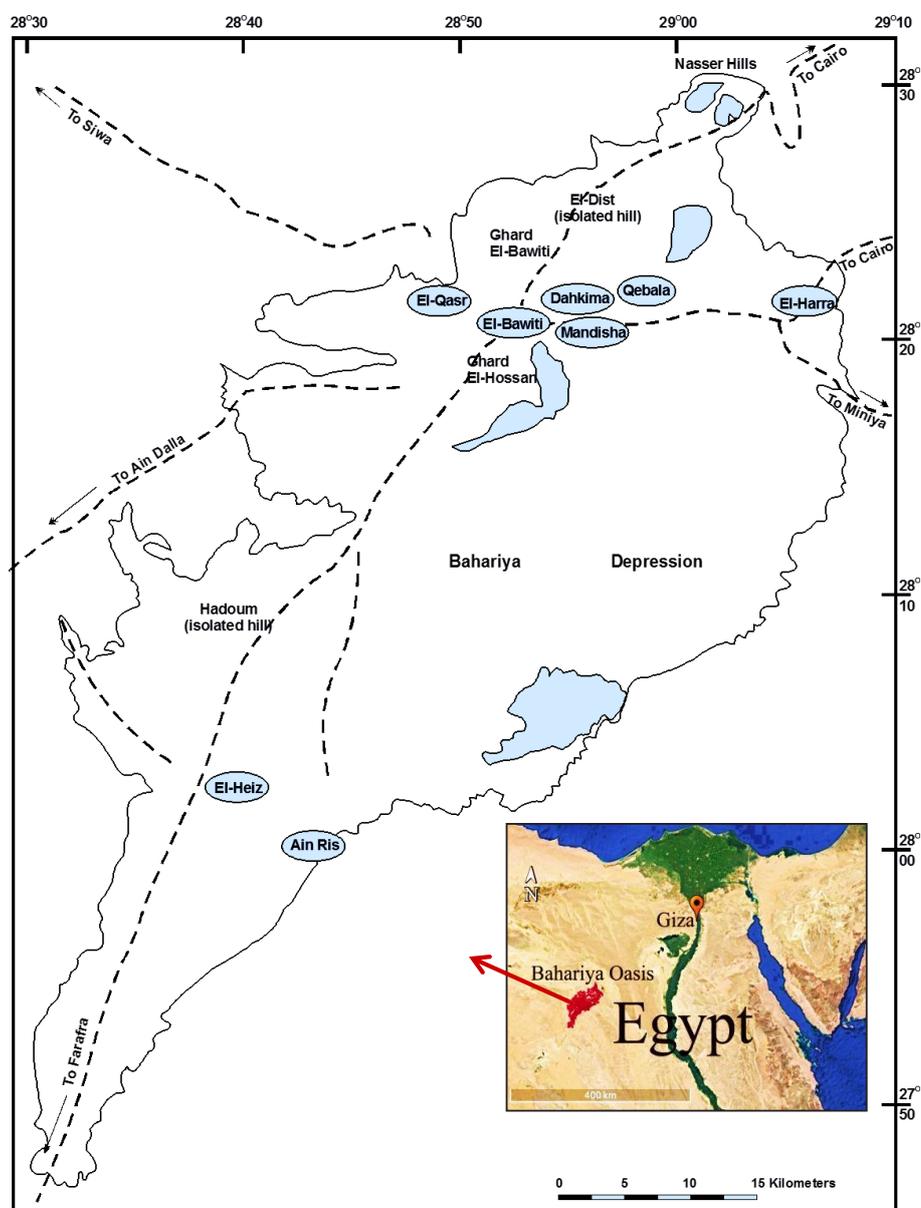


Fig. 1. Bahariya Oasis map showing of the main sites of collections after Refai et al. (2002).

Bahariya Oasis is a roughly oval valley representing the Bahariya depression which covers an area of about 2000km<sup>2</sup>, 94km in length×42km width, (Svoboda, 2004; Baghdady et al., 2018); with an elevation at base varying between 120 and 130m above sea level (Svoboda, 2004). The floor of Bahariya depression includes springs, lakes, Sabkhas (saline lands in the deepest areas in the depression), human settlements with cultivated areas, other settlements (e.g., El-Harra, El-Heiz, El-Qasr Mandisha, Qebala), and numerous fossil deposits (Refai et al., 2002; Svoboda, 2004; Baghdady et al. 2018). The depression is surrounded by high scarps (ca. 175m height above the floor), several hills (between 240 and 361m a.s.l.), mountains and sand dunes (Refai et al., 2002; Yehia et al., 2017; Baghdady et al., 2018).

The climate of Bahariya Oasis is hyper-arid with the total annual rainfall only ca. 4mm (Elnaggar, 2014). While the evaporation rate ranges between 4.91 and 13.17mm/day, and the humidity between 21 and 53% (Gad, 2014). The mean annual air temperatures ranges between 13.7 and 29.6°C (Elnaggar, 2014).

The Bahariya Oasis soil types are different in cultivated, uncultivated and Sabkhas areas (Baghdady & Gad, 2013) which are mainly sand and clayey sand in the study area. These soils were formed from the sedimentary succession of Late Cretaceous-Oligocene age, mainly basaltic rocks formed by volcanism in the Miocene (which resulting the scarps of the depression) and Quaternary surficial deposits (Baghdady & Gad, 2013). Mineralogically, these soils consist of albite, anhydrite, bassanite, calcite, dolomite, gypsum, halite, kainite, kaolinite, microcline, quartz and sylvite (Baghdady & Gad, 2013). Soils of some places in Bahariya Oasis have reddish brown color which has resulted from precipitation of iron present in the ground water (Refai et al., 2002).

Although Bahariya depression occupies a relatively large area, its cultivated area does not exceed of 4%, located in a few separate localities e.g. (Qebala, El Bawiti, El Qasr, El Harra, Mandisha and El Heiz), mainly around water sources (Refai et al., 2002; Gad, 2014). The remaining spaces are uncultivated. This is due to the ground water which is the main source of water supplying this arid region being present only in limited sites and the old water wells are also deteriorating.

## Materials and Results

Herbarium material of 14 moss specimens from Bahariya Oasis was obtained from 6 localities (Ain Wadi “El-Harra”, Ain Gomaa and Ain Ris “El-Heiz”, El-Qasr, Mandisha, Qebala) in May 2001 by U.Y. Abou-Salama (Professor in Faculty of Science, Ain Shams University). All material has been kept in CAIA without identification.

The fourteen moss samples were identified as two Bryaceae species (*Bryum klinggraeffi* Schimp. and *B. valparaisense* Thér.) new to the Egyptian moss flora. Thus the number of mosses known from Egypt has increased to 188.

The two new records were recently published (by the author) as new additions by mentioning them in a collected work which included numerous new records from around the world, include Egypt, (Taha & Holyoak in Ellis et al., 2019). The recent records were published there without full descriptions and illustrations, so the main aim of the current work on these two Bryaceae records is to illustrate and describe them and give distributional and some floristic remarks.

Nearly all studied samples contained only a single moss species (13 out 14 sample), except one sample was growing associated with *Bryum dichotomum* Hedw. which is a new record to moss flora of Bahariya oasis. Thus the number of mosses known from Bahariya Oasis has been raised from 11 to 14.

All data about the 14 studied samples: species name, herbarium numbers, locality of collection, habitats and date of collections, latitudes and altitudes are given in Table 1 below.

*Bryum klinggraeffi* Schimp. (Plate 1: Figs. 1- 9)

*Description:* Gametophyte small, up to 6mm high, yellowish brown to reddish brown. Stem branched or unbranched. Leaves imbricate, crisped when dry, erect to erecto-patent when moist. Leaves ovate, oblong lingulate to oblong lanceolate, 0.8-1.2mm long, 0.2-0.4mm wide; often decurrent at base; margins unbordered, entire, usually plane throughout; apex usually acute, rarely acuminate; costa rather stout, ending in or below the apex; upper lamina cells usually rhomboidal, shortly rectangular, smooth, firm-walled, 16-25 (30)×8-12 (14)µm; basal lamina cells quadrate, sub-quadrate, ± short rectangular, smooth, ± lax.

Rhizoids smooth,  $\pm$  hyaline, pale yellowish brown. Rhizoidal gemmae "Tubers" abundant, on long rhizoids,  $\pm$  spherical, deep bright red, outlines protuberant by few cells (project obviously from the surface), (63)80-122(208) $\mu$ m in diameter (the biggest one was ovoid).

*Sample number:* WM50

*Distribution:* Commonly known from Europe (e.g. Albania, Bulgaria, Germany, Montenegro, Netherlands, Serbia); Africa (e.g. Morocco); S., W. & E. Asia (e.g. China, Georgia, India, Iran, Japan, Turkey); N. America (United States), S. America (Argentina), Australia and New Zealand (Crundwell & Nyholm, 1964; Ros et al., 2000; O'Shea, 2006; Ros et al., 2013; Spence, 2014; Kalníková et al., 2018).

*Bryum valparaisense* Thér. (Plate II: Figs. I- 11)

*Description:* Gametophyte up to 10mm high, yellowish green above, reddish brown below. Stem usually branched. Leaves densely, imbricate, crisped, and sometimes twisted when

dry, erect-patent to patent when moist. Leaves vary over a wide range of length and width (length to width ratio 3.0-5.5), 1.0-1.5 (2.0)mm long, 0.2-0.4mm wide, linear, narrowly lanceolate, sometimes ovate-lanceolate,  $\pm$  decurrent base; margins usually bordered with obviously longer and narrow cells (in 1-2 rows), entire, sometimes slightly serrate above, often plane throughout; apex usually acuminate, sometimes acute; costa percurrent to short excurrent; upper lamina cells usually rhomboidal, rectangular, smooth, firm-walled, (14) 16-30 (40)  $\times$  (8) 10-12 (14) $\mu$ m; basal lamina cells sub-quadrate,  $\pm$  elongate rectangular, smooth, lax. Rhizoids multicellular, smooth, pale yellowish brown, sometimes hyaline. Rhizoidal gemmae "Tubers" abundant, (38)55-71 $\mu$ m in diameter,  $\pm$  spherical to ovoid, yellowish brown, surficial cells not protuberant.

*Sample numbers:* Thirteen samples were collected from five localities as shown in Table 1 above; WM2, 8, 18, 19, 20, 22, 25, 35a, 42, 43, 44, 46, 47.

**TABLE 1. Data on the 14 studied samples: species name, herbarium numbers, locality of collection, habitats and date of collections, latitudes and altitudes.**

Species	Herbarium no. of samples	Locality of collection	Date and Habitat of collections	Latitudes and Altitude
<i>Bryum klinggraeffii</i> Schump.	WM50	El-Qasr	3 May 2001, on a wet limestone wall lining hot spring, in cultivated area surrounded by human settlements	28°21' N and 28°51' E, ca. 345 m a.s.l.
	WM46, 47	Ain Gomaa "El-Heiz"	3 May 2001, on a thick layer of alluvium, on an irrigation canal wall, in shade, near wells surrounded by cultivated areas and human settlements	28°01' N and 28°42' E, ca. 320 m a.s.l.
<i>Bryum valparaisense</i> Thér.	WM2, 8	Ain Ris "El-Heiz"	2 May 2001, on a thin layer of alluvium, on side of an irrigation canal, in shade of date palms	27°59' N and 28°42' E, ca. 370 m a.s.l.
	WM18, 19, 20, 22, 25	Ain Wadi "El-Harra"	2 May 2001, on a thin layer of alluvium on the side of an irrigation canal, in shade of date palms, near a well surrounded by cultivated areas	28°19' N and 29°13' E, ca. 830 m a.s.l.
	WM 42, 43, 44	Mandisha	3 May 2001, on a shaded wet wall	28°21' N and 28°55' E, ca. 1050 m a.s.l.
	WM35a	Qebala	3 May 2001, on a water basin wall, grows with <i>Bryum dichotomum</i> Hedw. (a new record to Bahariya oasis)	28°21' N and 28°55' E, ca. 1138 m a.s.l.

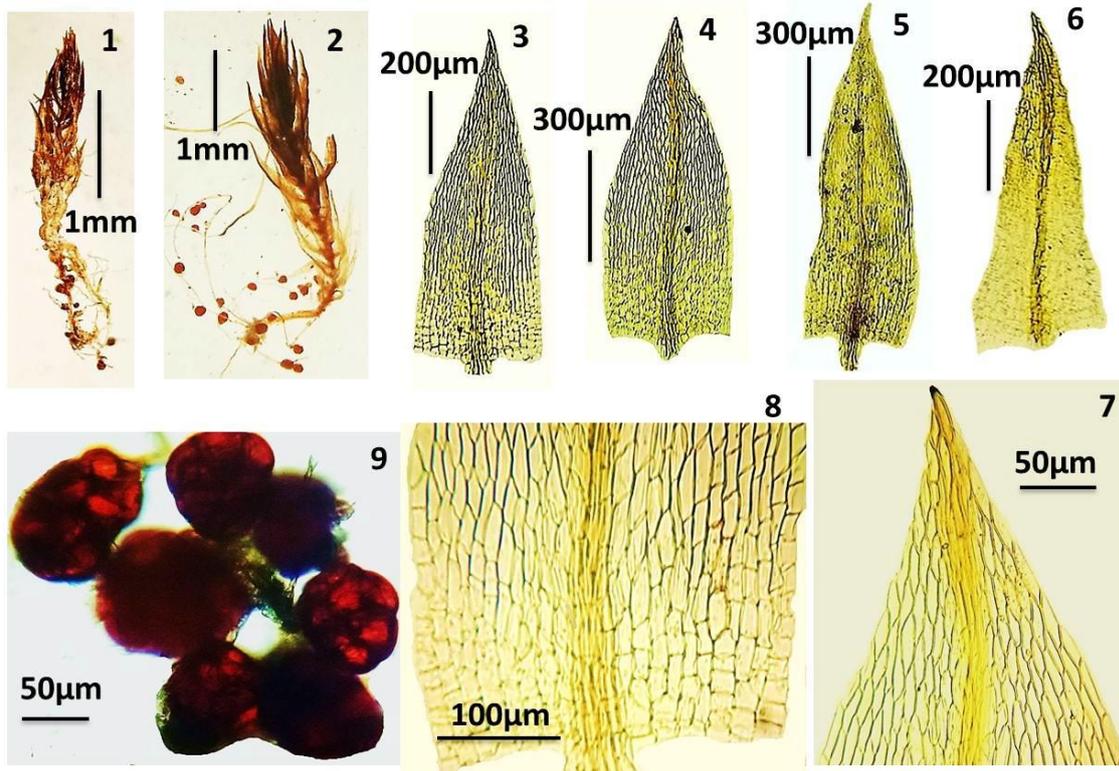


Plate I; Figs. 1-9. *Bryum klinggraeffi* Schimp.; Fig. 1 Dry gametophyte; Fig. 2 Wet gametophyte; Figs. 3-6 Different leaves; Fig. 7 Upper part of leaf; Fig. 8 Basal part of leaf; Fig. 9 Rhizoidal gemmae.

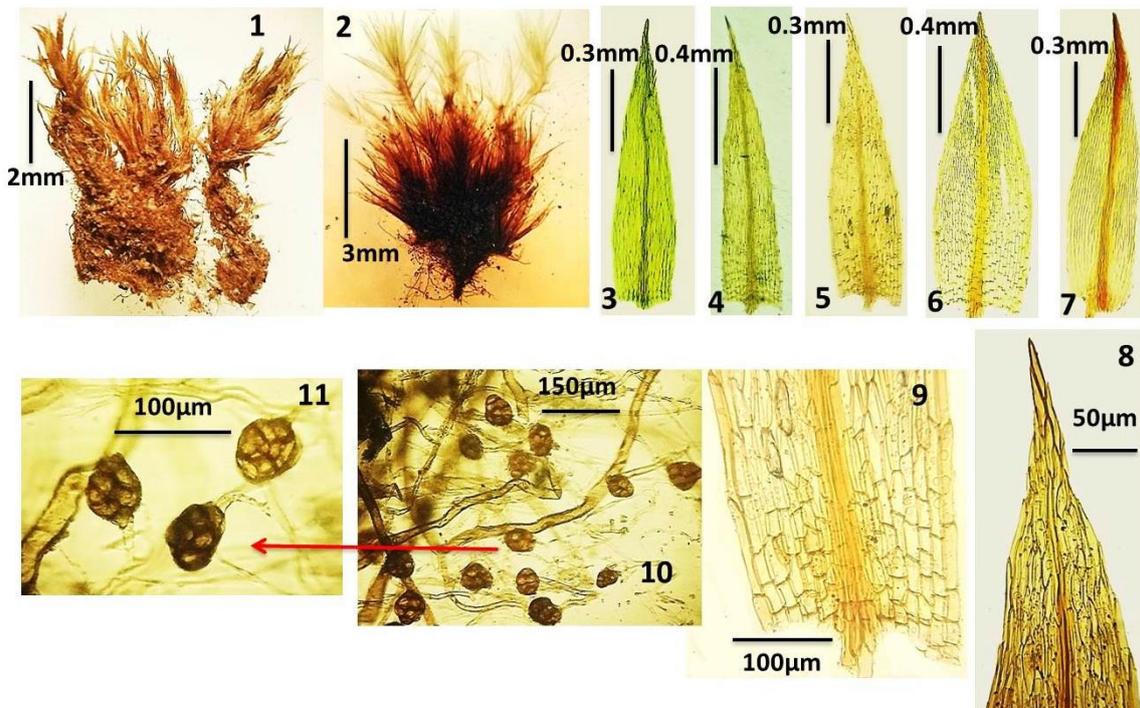


Plate II; Figs. 1-11. *Bryum valparaisense* Thér.; Fig. 1 Dry gametophytes; Fig. 2 Wet gametophytes; Figs. 3-7 Different leaves; Fig. 8 Upper part of leaf; Fig. 9 Basal part of leaf; Figs. 10, 11 Rhizoidal gemmae.

*Distribution:* Africa (Libya, Sudan); N. and S. America (United States in Utah, Mexico, Chile); Atlantic Islands (Canary Islands); Europe (SW. England on Isles of Scilly, Portugal, Spain), (Ochi, 1982; Arts et al., 1995; Finch & Preston, 2006; Ros et al., 2013; Spence, 2014).

### **Discussion**

Bryaceae species have a remarkable formation of asexual reproductive structures, maybe more than in any other moss family (Spence, 2014). So the identification of Bryaceae taxa (in most moss floras) nowadays relies greatly on shape and color of vegetative propagules (bulbils, tubers) and color of rhizoids, as well as sporophyte characters; gametophyte characters such as borders and shapes of leaf margins are of less importance in most identification keys.

During the last decade numerous nomenclatural changes have been proposed for the family Bryaceae and ongoing molecular studies are producing more revisions. Spence (2007, 2014) based his treatments almost entirely on morphological characters, but European authors have found that molecular data show these are unreliable in indicating relationships (e.g. Holyoak & Pedersen, 2007). Consequently, European lists do not adopt the genus *Gemmabryum* J.R. Spence & H.P. Ramsay, 2005 because it is polyphyletic.

*Bryum klinggraeffii* is a widespread moss in Europe with records from other continents (Kalníková et al., 2018). The studied sample was found on a moist limestone wall near cultivated areas which correlated with the habitat of some North American samples (Spence, 2014), although mostly *Bryum klinggraeffii* grows on bare ground in damp disturbed open habitats (Spence, 2014; Kalníková et al., 2018).

In fact, Morocco (at Jbel Toubkal) is the only African country for which *B. klinggraeffii* has been confirmed (Ros et al., 2000); since a report from Sudan (in Khartoum) by Pettet (1967) was re-identified (as *B. valparaisense*) by Arts et al. (1995).

*Bryum valparaisense* leaves in all the studied samples were typically longer and narrower (length to width ratio 3.0-5.5) than those of this species recorded from Europe (Guerra et al. in Guerra & Cros, 2010). Arts et al. (1995) commented on the narrower leaves, of the synonymous *B. pyriferum*

Crundw. & H. Whitehouse, from the Canary Islands (ratio ca 3.0) compared to the Chilean isotype of *B. valparaisense* (ratio ca 1.5).

*B. valparaisense* is well known from Europe, N. and S. America, whereas in Africa it has been recorded only from Fezzan in the Libyan Sahara and from Khartoum in Sudan (Arts et al., 1995). The report of this species in Bahariya Oasis resembles that from the Fezzan (Libya) locality, since the two areas have similar habitats and climate, similar presence of many oases, similar water sources from ground water and similar arid climates (Youssef et al., 2017; Taha, 2019).

This species was found in shaded moist areas at springs on a film of alluvium or on walls of wells or water basins or irrigation canals. All of these habitats resemble American reports at calcareous springs or other seepy sites (Spence, 2014). In contrast, most of the few specimens from S. and W. Europe were found in disturbed habitats which they probably reached as anthropogenic introductions (Finch & Preston, 2006).

### **Conclusion**

The current work added descriptions and illustrations of two recently records for the Egyptian bryoflora (*Bryum klinggraeffii* and *B. valparaisense*) and added one new record (*Bryum dichotomum*) to Bahariya Oasis. Thus the number of mosses known from Egypt and Bahariya Oasis is 188 and 14 respectively. The fourteen mosses belonging to 4 families. The four families can be arranged in a descending order according to their number of species, as follows: Bryaceae 10, Funariaceae 2, Bartramiaceae and Pottiaceae one each. This paper also provides relevant information about distribution, regional variation and some floristic remarks for the two studied species.

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### تصوير ووصف لتسجيلات حديثة من فصيلة البرايصي من الواحات البحرية – مصر

مي أحمد طه

قسم النبات – كلية العلوم – جامعة عين شمس – القاهرة - مصر.

تم تسجيل نوعان مؤخرًا من البرايصي للفلوره الحزازية المصرية من الواحات البحرية وهما:  
*B. valparaisense* Thér و *Bryum klinggraeffi* Schimp. بالإضافة إلى ذلك سجل الـ  
*Bryum dichotomum* Hedw لأول مره من منطقة الدراسة. وبذلك يصبح عدد الحزازيات  
المعروفة من مصر 188 ومن الواحات البحرية 14. تم وصف وتصوير النوعين المسجلين مؤخرًا  
مع ذكر تفاصيل عن مواقع التجميع والموائل. وايضا ذكرت ملاحظات على توزيعاتها على نطاق  
أوسع جنبًا إلى جنب مع بعض الملاحظات الفلورية.