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Closing a gap – first records of bryophytes from the Qatar Peninsula

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Abstract – The ephemeral or annual mosses *Entosthodon fascicularis* (Funariaceae), *Microbryum starckeanum* (Pottiaceae) and *Pohlia melanodon* (Mniaceae) were found in the understorey of natural *Ziziphus nummularia* shrubland in Qatar. These are the first records of bryophytes from the Qatar Peninsula, hence bridging the distribution gap on the Arabian Peninsula. Their site ecology, establishment and habitat maintenance conditions in the desert landscape of Umm Al Shukhoot are discussed.

Arabian Peninsula / desert mosses / Funariaceae / life strategies / Mniaceae / Pottiaceae

INTRODUCTION

Bryophytes belong to an often neglected or overlooked group of plants that can contribute significantly to the phytodiversity of various ecosystems. This applies even in most of the arid to semi-arid landscapes of the Arabian Peninsula, where around 50 to 60 byrophyte species exist and are able to survive the harsh site conditions. Many of these are important initial colonisers of bare rocks, crusts and soil surfaces and are therefore forerunners of vascular plant colonisation and succession (Kürschner & Frey, 2011).

Until now, the Qatar Peninsula has seemed to be a true 'bryophyte desert' since, despite various field studies, no bryophytes have been reported in the area (Kürschner & Frey, 2011). The main reasons for this absence of bryophytes may reside in unfavourable site conditions generated by a unique combination of (i) a hyper-arid climate (less than 100 mm rainfall per year, with an extraordinary, severe and prolonged summer drought), (ii) low to moderately undulating relief (lacking steep mountain ridges with deep wadi cuts) and (iii) unfavourable geomorphological conditions (mainly flat, carstic table landscapes or moving sands). This generally results in a dry, unstable environment that is unsuitable for the establishment (spore germination) and habitat maintenance of most bryophytes.

Depressions that collect runoff water and accumulate soil after rainfall are of ecological importance in desert landscapes. A few weeks later after such a rainfall

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event, the soil surface within depressions is covered by denser vegetation consisting of ephemeral vascular plants (Batanouny, 1981).

The discovery of the first bryophytes in one such depression in the Qatar Peninsula was a major surprise and closes a gap concerning the plant diversity of the country.

STUDY AREA

The Qatar Peninsula is part of the large Arabian Peninsula and lies at the centre of the western coast of the Arabian Gulf. It covers an area of approx. 11,430 km^2 between 24°40' and 26°10'N and 50°45' and 51°40'E. The north-south axis is almost 180 km in length, and the east-west axis at its widest point is 85 km. The majority of the peninsula is less than 40 m a.s.l., with a surface of low to moderate relief. The coastline presents an uneven outline with numerous inlets, islands, reefs, bays and extensive areas of salty-sandy depressions (*sabkhas*) or saline coastal playas (Fig. 1).

In former times the Qatar Peninsula was an island connected by a small uplift to the rest of the Arabian Peninsula, creating a gentle, undulating landscape in the centre with rocky and conglomerate hamadas (*i.e. hazm*, *misfah*), rocky ridges (e.g. Jabal Dukhan in the south-west of the country), depressions (*rodat*, *rawda*), wadis and runnels, sand formations and sabkhas. The highest point is Qurain Abu-l Baul, reaching 103 m a.s.l. (Batanouny, 1981). Because of the gentle relief, no pronounced drainage system has developed, but numerous depressions act as individual catchment areas receiving runoff water after rainfall and thunderstorms.

Qatar lies within the vast desert belt extending from North Africa to Central Asia and is one of the most arid landscapes in the world. Water is therefore one of the major limiting ecological factors. The whole area lies within the Köppen climate region BWhsn (hot desert climate with winter rainfall and high relative humidity).

Rainfall is scanty and is confined to October to May. The period from June to September is rainless. At Doha, mean annual rainfall is less than 100 mm. Rainfall in November, known locally as *wasmi* (*i.e.* rainfall that wets the soil surface), is of great ecological importance in affecting the life of plants. In general, rainfall is irregular, variable in both time and space and extremely unpredictable. For example, Batanouny (1981) reported temporal fluctuations in rainfall for Doha ranging from 0.4 mm in 1962 to 302.8 mm in 1964, while the average annual rainfall was 78.1 mm.

A remarkable feature are sudden cloudbursts which bring torrential rainfall. Heavy localised, very patchy downpours on one day may exceed mean annual rainfall. Examples of such events are described by Pike (1978). These torrential rain events often lead to floods and inundation for short periods, favouring episodic and ephemeral plant growth.

Throughout the year, the climate is sticky, humid and hot. The winters are mild, without frost, and the summers very hot. Temperatures fluctuate between 35°C and 45°C in summer, and between (10) 20°C and 30°C in winter (December-February). However, the severe drought period covers the whole year and the uppermost soil layers are dry almost all year round (with the exception of *wasmi* periods). Germination of spores and vascular diaspores is therefore hampered. As evaporation exceeds mean average rainfall and dry north-western summer winds (*schamal*) serve to increase an already high evapotranspiration rate, the climate results in highly unfavourable site conditions for plant life (Babikir, 1986). This applies also for bryophyte growth.

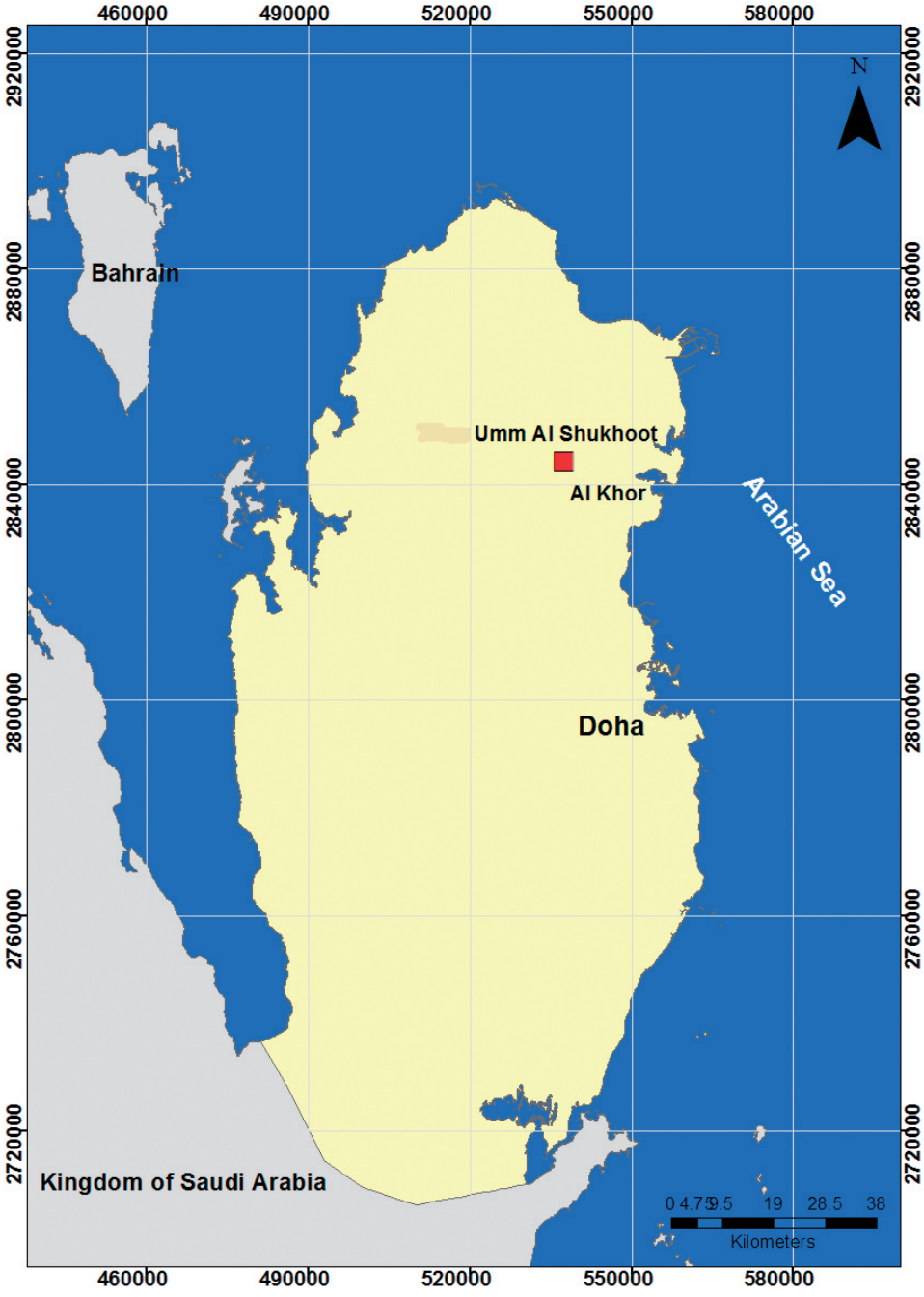

Fig. 1. Map showing the location of the novel finds of *Entosthodon fascicularis* (Funariaceae), *Microbryum starckeanum* (Pottiaceae) and *Pohlia melanodon* (Mniaceae) in Qatar.

RESULTS AND DISCUSSION

After an unusual period of heavy rainfall on 25-28th November 2016, when Qatar received up to 50 mm rain, many of the typical depressions in central Qatar were flooded with water, leading a few weeks later to dense luxuriant growth of ephemeral vascular plants. In depressions in the Umm Al Shukhoot area, west of Al Khor (Fig. 1), after this unusual amount of rainfall three mosses, *Entosthodon fascicularis* (Funariaceae), *Pohlia melanodon* (Mniaceae) and *Microbryum starckeanum* (Pottiaceae), were found to occur. These are the first records of this group of organisms in the Qatar Peninsula. They were found growing under thickets of *Ziziphus nummularia* and *Lycium shawii* in a depression (*rawda*) that gathers runoff water after rainfall. The depression has a deposit of colluvial soil made up of calcareous and sandy loam accumulated as water-borne and wind-blown sediment, offering better soil quality than the surrounding higher ground (*hamada*). The natural vegetation in such rawdas is generally shrub or woodland communities (*Ziziphus nummularia* community; sensu Batanouny, 1981), while the surrounding higher ground lacks vegetation (rock desert) (Alsafran, 2015; Batanouny, 1981).

Although the three moss species discovered are widespread in the Mediterranean and Near and Middle East (Kürschner & Frey, 2011; Ros *et al.*, 2013), they may often be overlooked to their ephemeral life cycle and short life span. They can only be observed within a short period after runoff-generating rain events. Therefore, the discovery of these species from Qatar Peninsula was a major surprise.

Entosthodon fascicularis (Hedw.) Müll.Hal. (Funariaceae)

Specimen examined: Qatar. Central Qatar, Al Shamal road near the Umm Al Shukhoot area, west of Al Khor (25.714723 N, 51.373488 E), ~18-20 m a.s.l., on wet colluvial calcareous and sandy loam in a depression (*rawda*) in the understorey of *Ziziphus nummularia* shrubland, 17 January 2017, *J.M. Alatalo s.n.* (B. herb. Kürschner).

A small ephemeral plant, widely distributed on damp soil, banks and. waste ground; life form: short turf; life strategy: annual shuttle species [AnS] (During, 1979; Kürschner & Frey, 2013); spore size of local sample: 24-28 µm in diameter.

Recorded in the United Arab Emirates (Ru'us al-Jibal, 6 km from al-Rams to Sha'am (Shabbara & El-Saadawi, 2001) and Yemen (Kürschner & Frey, 2011).

Pohlia melanodon (Brid.) A.J.Shaw (Mniaceae)

Specimen examined: Qatar. Central Qatar, Al Shamal road near the Umm Al Shukhoot area, west of Al Khor (25.714723 N, 51.373488 E), ~18-20 m a.s.l., on wet colluvial calcareous and sandy loam in a depression (*rawda*) in the understorey of *Ziziphus nummularia* shrubland, 17 January 2017, *J.M. Alatalo s.n.* (B, herb. Kürschner).

A small annual to short-lived plant, usually growing on clay soils, disturbed clay or sandy soils by banks of ditches of streams; life form: short turf; life strategy: colonist with high sexual reproductive effort [Cs] (During, 1979; Kürschner & Frey, 2013); in addition, Porley (2008) recorded rhizoidal tubers for this species, indicating a colonist strategy with high sexual and asexual reproductive effort (Cs,as), at least for the European populations; spore size in local sample: 14-18 (22) µm in diameter.

Records from the Arabian Peninsula include Saudi Arabia (Tayma area, Kürschner & Frey, 2011) and United Arab Emirates (Ru'us al-Jibal, 30 km from Ra's al-Khaimah) (Shabbara & El-Saadawi, 2001), which is the closest site to the Qatar location.

Microbryum starckeanum (Hedw.) R.H. Zander (Pottiaceae)
[Syn. *Pottia starckeana* (Hedw.) Müll.Hal.]

Specimen examined: Qatar. Central Qatar, Al Shamal road near the Umm Al Shukhoot area, west of Al Khor (25.714723 N, 51.373488 E), ~18-20 m a.s.l., on wet colluvial calcareous and sandy loam in a depression (*rawda*) in the understorey of *Ziziphus nummularia* shrubland, 17 January 2017. *J.M. Alatalo s.n.* (B, herb. Kürschner).

Very small gregarious ephemeral plant found on disturbed sites with open soil, by roadsides and pathsides; tolerates eutrophication by grazing (meso- to euhemerobic species; Dierßen, 2001); life form: short turf; life strategy: annual shuttle species [AnS] (During, 1979; Kürschner & Frey, 2013); spore size: 19-42 µm in diameter (Smith , 2004).

Widely distributed on the Arabian Peninsula and recorded in Kuwait, Oman, Saudi Arabia, United Arab Emirates and mainland Yemen (Kürschner & Frey, 2011). The closest sites of *M. starckeanum* from the Qatar site are in Fujayrah (Fujayrah-Sharja road; Shabbara & El-Saadawi, 1999) and Oman (Jabal Akhdar, Sayq Plateau; M.J. Wigginton 12/OM6, unpubl.).

Ecology and site ecology remarks

The discovery of *Entosthodon fascicularis*, *Microbryum starckeanum* and *Pohlia melanodon* in flooded depressions (*rawda*) after considerable rain is not accidental. These rawda sites collect runoff water loaded with fine sediments and accumulate soil. Thus, they offer perfect ecological niches for the growth of ephemeral and annual bryophytes.

As bryophytes have been unknown in Qatar until now, this raises the question of how population establishment of the three moss species occurred: It may have taken place by germination of a spore bank which was dormant for a long period in the soil in the depression, or by germination of wind-blown spores over a longer distance (long-range dispersal) from more south-easterly sites in the United Arab Emirates.

Entosthodon fascicularis and *Microbryum starckeanum* both follow an annual shuttle life strategy and are characterised by relatively large spores (24-28 µm and 19-42 µm in diameter, respectively). In most cases these spore sizes indicate low-range dispersal (achorous tendency) and production of a soil spore bank in close proximity to the 'mother plant' for habitat maintenance (During, 1979; Kürschner & Frey, 2013). The species can alternate ('shuttle') between two neighbouring sites when site conditions allow effective germination and establishment of a population. By contrast, the small spores [(14-18 (22) µm in diameter] of *Pohlia melanodon* are suited to both long-range and short-range dispersal (chance dispersal). This species follows a colonist life strategy with high sexual reproductive effort, as is typical for many short-lived, acrocarpous mosses.

The question of which of these dispersal modes brought the mosses to Qatar remains unsolved at present. However, as the next closest locations of all three species are to the south-east (United Arab Emirates), spore dispersal by wind over longer distances (long-range dispersal) cannot be excluded. With all probability, the unique establishment of the populations in Qatar is the result of long-range dispersal.

Phytosociologically, all three mosses are typical components of the *Psoretea decipientis* Matt. *ex* Follm. (syn.: *Barbuletea unguiculatae* Mohan 1978) vegetation class, which comprises the terrestrial cryptogamic vegetation of dry disturbed and undisturbed areas, including a wide range of ephemeral bryophyte communities (Dierßen, 2001). Whether the three moss species recorded will re-occur in future at the Umm Al Shukhoot site in Qatar, or at other sites, remains to be seen.

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REFERENCES

ALSAFRAN M., 2015 — *Environmental determinants of the ecology and distribution of Acacia tortilis under arid conditions in Qatar*. PhD thesis, Newcastle University.

BABIKIR A.A.A., 1986 — Some aspects of climate and economic activities in the Arab Gulf States. *Geojournal* 13: 211-227.

BATANOUNY K.H., 1981 — *Ecology and Flora of Qatar*. Doha, University of Qatar, 245 pp.

DIERSSEN K., 2001 — Distribution, ecological amplitude and phytosociological characterization of European bryophytes. *Bryophytorum bibliotheca* 56: 1-289.

DURING H.J., 1979 — Life strategies of bryophytes: a preliminary review. *Lindbergia* 5: 2-18.

KÜRSCHNER H. & FREY W., 2011 — Liverworts, mosses and hornworts of Southwest Asia (Marchantiophyta, Bryophyta, Anthocerotophyta). *Nova Hedwigia, Beihefte* 139: 1-240.

KÜRSCHNER H. & FREY W., 2013 — Life strategies in bryophytes: a prime example for the evolution of functional types. *Nova Hedwigia* 96: 83-116.

PIKE J.G., 1978 — The Agroclimatology of Qatar. *Technical Note (New Series) No. 1 (UTFN/QAT/003/QAT)*.

PORLEY R., 2008 — *Arable Bryophytes: A Field Guide to the mosses, liverworts and hornworts of cultivated land in Britain and Ireland*. Buckinghamshire, Pemberley Books, 140 pp.

ROS R.M., MAZIMPAKA V., ABOU-SALAMA U., ALEFFI M., BLOCKEEL T.M., BRUGUÉS M., CROS R.M., DIA M.G. , DIRKSE G.M., DRAPER I., EL SAADAWI W., ERDAĞ A., GANEVA A., GABRIEL R., GONZÁLEZ-MANCEBO J.M., GRANGER C., HERRNSTADT I., HUGONNOT V., KHALIL K., KÜRSCHNER H., LOSADA-LIMA A., LUÍS L., MIFSUD S., PRIVITERA M., PUGLISI M., SABOVLJEVIĆ M., SÉRGIO C., SHABBARA H.M., SIM-SIM M., SOTIAUX A., TACCHI R., VANDERPOORTEN A. & WERNER O., 2013 — Mosses of the Mediterranean, an annotated checklist. *Cryptogamie, Bryologie* 34: 99-283.

SHABBARA H.M. & EL-SAADAWI W.E., 1999 — Contributions to the bryoflora of the United Arab Emirates (UAE). *Taeckholmia* 19: 183-192.

SHABBARA H.M. & EL-SAADAWI W.E., 2001 — Our present knowledge of the bryoflora of the United Arab Emirates. *Taeckholmia* 21: 173-186.

SMITH A.J.E., 2004 — *The moss flora of Britain and Ireland, 2nd edition*. Cambridge, Cambridge University Press, 1012 pp.