

A small remarkable bryophyte collection from the Ibb province (Yemen), with eleven new records for the bryoflora of Yemen

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Abstract – Based on a recent small bryophyte collection from the western escarpment mountains of Yemen in the vicinity of Ibb (Ibb Governorate), 36 mosses are reported, among them 11 new to the bryoflora of the country. *Gemmabryum nanoapiculatum* (Ochi & Kürschner) Kürschner *comb. nov.* is collected for the first time since the type collection. Beside some hygrophytic taxa, growing in the vicinity of water pools and runnels, most of the recorded species belong to drought adapted, xerophytic taxa and fit into the expected bryophyte spectrum for the Arabian Peninsula. Together with pantropical and Afromontane species they indicate a common floral history and past and present migration routes.

Arabian Peninsula / bryophyta / distribution patterns / floral history / mosses

INTRODUCTION

Bryophyte collections from the Arabian Peninsula and in particular from the Republic of Yemen still are hard to obtain, as travelling and field work is limited at present and only a few local scientists work with this group of interesting organisms. Any collection from the area therefore is highly interesting, as it may enlarge our knowledge on the species occurrence, distribution and bryodiversity of the country. Although already 37 liverworts, 106 mosses, and one hornwort are known from the Yemen mainland (total number of species: 144; cf. Kürschner & Frey, 2011; Kürschner & Ochya, 2014), novelties are still to be expected, due to the broad and varied ecological conditions and niches offered by the Yemen Highland and the often inaccessible western and southwestern escarpment mountains. This becomes obvious by a recently made collection of 36 mosses from the area of Ibb and surroundings. Among this collection, 11 taxa turned out to be recorded for the first time for the bryophyte flora of Yemen, increasing the present number of bryophytes to 155 taxa. They are, together with the whole collection, presented in the following.

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STUDY SITE

Ibb, the capital of Ibb Governorate is situated in the western escarpment mountains of the Yemen Highlands between 1850 m and 2000 m a.s.l. These mountains run along a North-South axis parallel to the Red Sea and form a more or less unbroken, very steep chain of escarpments and jagged ridges. Highest peak in this mountain chain is the Jabal An Nabi Shu'ayb (3766 m a.s.l.), north of the Ibb area. Geologically, the area is highly diverse. The mountains exist of a basement of Precambrian crystalline rocks (old Nubo-Arabian block of granites, gneisses, quartzites) which has been lifted and often bear a cap of Jurassic and Cretaceous sand- and limestone. Additionally, large areas are overlain by extensive outflows of volcanoes of Tertiary age.

Natural plant formations are difficult to name, because of a thousands of years of grazing, cleaning and wood cutting. Only a few woodland relics remains left in mostly inaccessible, strongly dissected and steep ravines and gullies. To name are semi-evergreen (sclerophyllous) woodlands and scrub, dominated by *Barbeya oleoides* and *Olea europaea* subsp. *africana*, originally forming a narrow belt between 1600 m and 2200 m a.s.l. They are replaced at the highest parts by an evergreen needle-leaved woodland dominated by the Afromontane *Juniperus procera*, which today is completely destroyed in the surrounding of Ibb and replaced by extensive terraced agriculture and isolated stands of various *Acacia* species (e.g., *A. gerrardii*, *A. origena*) indicating former drought-deciduous thorn-woodlands on the eastern slopes. The rain-shadow areas of plateau sites and east-facing slopes are dominated by mixed formations of *Acacia* spp., *Dracaena* spp. (e.g., *D. ombet*), *Euphorbia ammak* and a dwarf-shrubland of *E. balsamifera* subsp. *adenensis* (Al-Hubaishi & Müller-Hohenstein, 1984; Kürschner, 1998).

Climatologic, the Yemen Highland belongs to one of the wettest region in Arabia, with most rain during the summer and peaks in April/May and July/August (summer monsoon influence). Rainfall strongly varies, with mostly a total amount of 600-800 mm/year, reaching locally 1000 mm/year or more around Ibb. In addition, cloud and mist formation are very frequent throughout the year, lowering the risk of desiccation during summer time for bryophytes. The mean annual temperatures are about 16°C and regular frost during winter time exist (Al-Hubaishi & Müller-Hohenstein, 1984; Miller & Cope, 1996; Kürschner, 1998).

All these site ecological conditions create perfect and numerous niches for the growth and diversity of bryophytes which, however, till present were mostly neglected.

MATERIAL & METHODS

The mosses were collected in the city of Ibb, its surroundings and adjacent areas of the Ibb Governorate (Fig. 1) between June 2013 and February 2014. Altogether 97 moss specimens have been collected on soil, soil covered rocks, bark, house walls and roofs which can be assigned to 36 species. Eleven of them turned out to be new records for the bryoflora of Yemen. They are marked with an asterisk (*) in the following list. Two records are remarkable and pointed by two asterisks (**). For the new records, the closest localities in S.W. Asia or across the Red Sea were given.

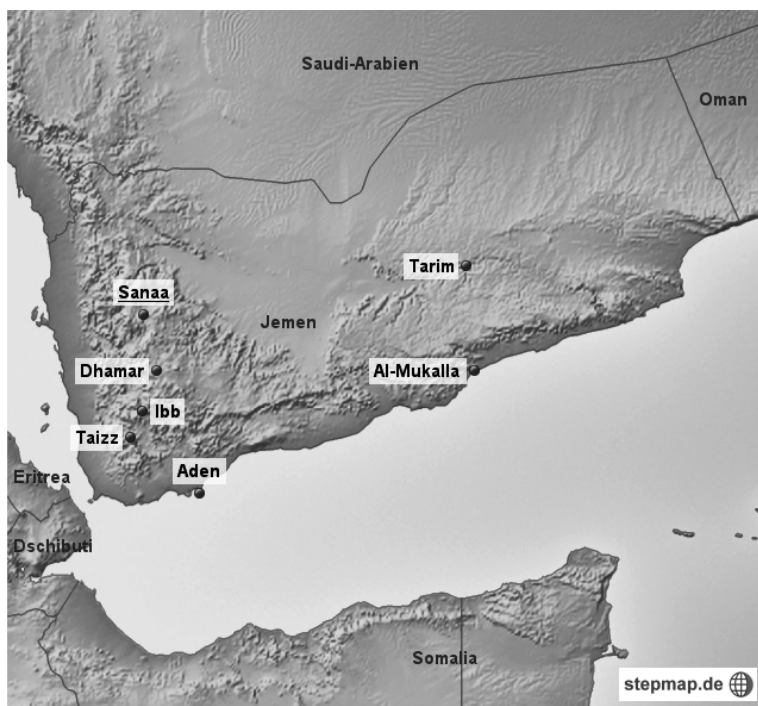


Fig. 1. Yemen. Ibb main collection site (source: www.stepmap.de).

To avoid unnecessary repetitions, the locality data for all records are listed in an appendix. Voucher specimens are kept at the herbarium of the University of Aden, with duplicates in the herb. H. Kürschner (Berlin). The nomenclature of species follows Kürschner & Frey (2011).

RESULTS AND DISCUSSION

In the following list, 36 records of mosses from Ibb city and surrounding are reported, providing first insights in the diversity of the bryoflora of the area. They mostly fit well in the expected spectrum of species and are widely distributed in the western escarpment mountains of the Arabian Peninsula. Interestingly, 11 mosses are new for the Yemen bryoflora, illustrating nice range extensions and possible migration routes during past geological periods.

Many of the new records have their closest localities along the western escarpments mountains of the Arabian Peninsula [e.g., Asir Mts., Jabal Fayfa (Saudi Arabia)], the northern continuation of the Rift Valley (e.g., Sinai Peninsula, Arava and Jordan valley) or the neighbouring E Africa (Eritrea, Ethiopia). From there, migration via the highlands of Edom, the Midian and Hijaz Mts. or across the Red Sea is possible, as demonstrated by various vascular plants and many Palaeotropical and Afromontane bryophytes (Kürschner, 1998; 2008).

An accidental transport by migrating birds on their way to Africa along the large bird migration route (“Vogelzugstraße”), however, cannot be excluded, especially in species growing in wet and damp areas (e.g., waterfalls, water pools, mountain springs and runnels).

List of species (for numbers of localities see appendix)

Bartramiaceae

**Philonotis capillaris* Lindb. (*P. arnellii* Husn.) – Locality 25; on damp soil.
Range: Europe [widely distributed in the Mediterranean area (Ros *et al.*, 2013)], N. America, S.W. Asia.
Closest locality in S.W. Asia: Upper Jordan valley, Park Ha Yarden (Herrnstadt *et al.*, 1982).

Brachytheciaceae

**Rhynchostegium riparioides* (Hedw.) Cardot [*Platyhypnidium riparioides* (Hedw.) Dixon] – Locality 29; on damp soil
Range: Africa, C., N. and northern S. America, S.W. Asia (Frey & Kürschner 1988).
Closest locality in S.W. Asia: Asir Mts. of Saudi Arabia, Raidah escarpment, Jabal Sawdah near Abha (Kürschner, 1989).

Bryaceae

The generic relationships within the Bryaceae have drastically changed recently by molecular and morphological studies (e.g., Cox & Hedderson, 2003; Frey & Stech, 2009; Spence & Ramsay, 2005). These studies have shown that there have been multiple instances of convergent evolution of characters which give evidence to split *Bryum* s.l. into several genera (e.g., *Gemmabryum* J.R.Spence & H.P.Ramsay; *Imbriobryum* N.Pederson; *Plagiobryoides* J.R.Spence; *Ptychostomum* Hornsch.; *Rosulabryum* J.R.Spence). The following list is based on the concept of Spence (2014).

Brachymenium nepalense Hook.f. in Schwägr. – Locality 23; on soil covered rock.
Range: A palaeotropical taxon, known from Africa and Asia (Frey & Kürschner, 1988).

Bryum lanatum (P.Beauv.) Brid. [*B. argenteum* Hedw. complex (“lanatum” form of *B. argenteum* Hedw.), incl. *B. arachnoideum* Müll.Hal.] – Localities 2, 6, 12, 14, 16, 19, 20, 21, 22; on soil and soil covered rocks.

Although Frahm (2002) considered *B. lanatum* and *B. arachnoideum* as separate taxa, the taxonomic status of both remains doubtful. Most authors treated *B. lanatum* solely as an ecotypic (xeric) variety of *B. argenteum* (“lanatum” form; cf. Hill *et al.*, 2006).

Concerning the African *B. arachnoideum* it remains unclear if it is conspecific with the so-called “lanatum” form of *B. argenteum*, as the type is sterile (Ochi, 1972). The costa, however is long-excurrent and often denticulate at tip and the leaves are broadly ovate to orbicular.

Range: Subcosmopolitan (?). The whole range is still insufficiently known, as the species has been often combined with *B. argenteum*.

**Gemmabryum acuminatum* (Harv. ex Hook.) J.R.Spence & H.P.Ramsay (*Brachymenium acuminatum* Harv. ex Hook.) – Locality 3; on soil.

Range: Africa, S America, Asia, Australia (Ochi, 1972). A pantropical species, widely distributed across the Red Sea in E Africa (Eritrea, Ethiopia, Sudan) and Africa (O'Shea, 2006). Reported from the Arabian Peninsula by a small collection from the Ru'us al-Jibal (United Arab Emirates; cf. Shabbara & El-Saadawi, 2001).

Gemmabryum caespiticium (Hedw.) J.R.Spence (*Bryum caespiticium* Hedw.) – Locality 20; on soil.

Range: Subcosmopolitan (Flora of North America Editorial Committee, 2014).

Gemmabryum exile (Dozy & Molk.) J.R.Spence & H.P.Ramsay [*Brachymenium exile* (Dozy & Molk.) Bosch & Sande Lac.] – Localities 3, 5; on soil.

Range: Africa, C., N. and S. America, Asia (Flora of North America Editorial Committee, 2014).

**Gemmabryum kunzei* (Hornsch.) J.R.Spence [*Bryum caespiticium* Hedw. var. *kunzei* (Hornsch.) Braithw.; *B. caespiticium* Hedw. var. *imbricatum* Bruch & Schimp.; *B. kunzei* Hornsch.] – Locality 1; on soil.

Range: Asia, N. America, Europe (Flora of North America Editorial Committee 2014).

Closest locality in S.W. Asia: Jordan (Frey & Kürschner, 1992).

***Gemmabryum nanoapiculatum* (Ochi & Kürschner) Kürschner, **comb. nov.**, Basionym: *Bryum nanoapiculatum* Ochi & Kürschner, *Nova Hedwigia* 47: 359. 1988. – Locality 1, 7; on soil.

1st record since type. Type locality: Yemen. Kaukaban, in direction to Shibbam, 2800 m, on soil (Ochi & Kürschner, 1988).

Range: Endemic to the Arabian Peninsula.

Ptychostomum funkii (Schwägr.) J.R. Spence (*Bryum funkii* Schwägr.) – Locality 2; on soil and soil covered rock.

Range: Africa, Asia, and Europe (Frey & Kürschner, 1988).

Ptychostomum pseudotriquetrum (Hedw.) J.R.Spence & H.P.Ramsay ex Holyoak & N.Pedersen [*Bryum pseudotriquetrum* (Hedw.) P.Gaertn., B.Mey. & Scherb.] – Locality 4; on damp soil and rock.

Subcosmopolitan. Absent only from the subtropics and tropics (Flora of North America Editorial Committee, 2014).

**Rosulabryum elegans* (Nees) Ochyra (*Bryum elegans* Nees) – Locality 1; on damp soil.

Range: Asia, Europe (Ros et al., 2013).

Closest localities in S.W. Asia: Sinai Peninsula (El-Saadawi et al., 1999) and Jordan (El Oqlah et al., 1988).

Fabroniaceae

Fabronia abyssinica Müll.Hal. – Locality 10; on bark and soil covered rocks.

Range: Africa, S.W. Asia. A palaeotropical species with Afrotropical distribution (Frey & Kürschner, 1988).

Fissidentaceae

Fissidens arnoldii R.Ruthe – Localities 7, 9, 20; on soil and rock fissures.

Range: Africa, Europe, S.W. Asia (Frey & Kürschner, 1988).

Fissidens crispus Mont. – Localities 6, 7, 10, 13; on soil and soil covered rocks.

Range: C., N. and S. America, Asia. A pantropical species (Flora of North America Editorial Committee, 2007).

***Fissidens pellucidus* Hornsch. – Locality 20; on soil.

Range: Africa, C. and S. America, Asia (Flora of North America Editorial Committee, 2007). A pantropical species new to the monsoon influenced escarpment mountains of mainland Yemen.

Closest locality in S.W. Asia: Socotra Island (Kürschner, 2006).

Fissidens viridulus (Sw. *ex anon.*) Wahlenb. – Locality 11; on soil covered rock.

Range: Africa, C., N. and S. America, Asia, and Europe (Flora of North America Editorial Committee, 2007).

Leskeaceae

Pseudoleskea plagiostoma Müll.Hal. var. *attenuata* Müll.Hal. – Locality 10; on soil covered rock.

Range: Africa (Eritrea) and S.W. Asia. A palaeotropical species with Afromontane distribution (Frey & Kürschner, 1988; O'Shea, 2006).

Mniaceae

**Pohlia wahlenbergii* (F.Weber & D.Mohr) A.L.Andrews – Locality 25; on damp soil.

Range: Africa, N America, Asia, and Europe (Flora of North America Editorial Committee, 2014).

Closest locality in S.W. Asia: Judean Desert, Dead Sea area (Herrnstadt et al., 1982).

Orthotrichaceae

**Zygodon viridissimus* (Dicks.) Brid. – Locality 25; on soil and rock.

Range: Africa, C. and N. America, Asia, and Europe (Flora of North America Editorial Committee, 2014).

Closest locality in S.W. Asia: Judean Mts., Aqua Bella (Bilewsky, 1959).

Pottiaceae

Barbula bolleana (Müll.Hal.) Broth. [*B. ehrenbergii* (Lorentz) M.Fleisch.; *Hydrogonium ehrenbergii* (Lorentz) A.Jaeger] – Locality 24; on damp soil and rock.

Range: Africa, N America, Asia, Australia, and Europe (Flora of North America Editorial Committee, 2007).

**Barbula unguiculata* Hedw. – Locality 2; on soil.

Range: Subcosmopolitan. A common and widely distributed taxon in S.W. Asia and the Mediterranean (Ros et al., 2013; Fojcik & Stebel, 2014).

Closest locality in S.W. Asia: Jordan valley, environs of Jericho (Bilewsky & Nachmony, 1955).

Didymodon acutus (Brid.) K.Saito – Localities 1, 2, 5, 6, 7, 18, 19, 22; on soil and soil covered rocks.

Range: N. Africa, Asia, and Europe (Frey & Kürschner, 1988).

Didymodon cordatus Jur. – Locality 20; on soil.

Range: S.W. Asia and Europe. Widely distributed in the Mediterranean (Ros et al., 2013).

****Didymodon validus*** Limpr. [*D. rigidulus* Hedw. var. *validus* (Limpr.) Düll; *D. acutus* (Brid.) K.Saito var. *validus* J.-P.Frahm] – Locality 17; on soil.

Range: New to S.W. Asia and the Arabian Peninsula. The species was recently reported from Ethiopia (Tigray province), just across the Red Sea (Kürschner & Neef, 2012).

Eucladium verticillatum (With.) Bruch & Schimp. – Localities 4, 26; on damp soil and rock.

Range: Africa, C. and N. America, Asia, and Europe (Flora of North America Editorial Committee, 2007).

Gymnostomum viridulum Brid. – Locality 14; on soil covered rock.

Range: Africa, N. America, Asia, and Europe (Flora of North America Editorial Committee, 2007).

Hyophila involuta (Hook.) A.Jaeger – Localities 7, 9, 22; on soil and soil covered rocks.

Range: Africa, C., N. and S. America, Asia, Australia, and Europe (Flora of North America Editorial Committee, 2007).

Oxystegus tenuirostris (Hook. & Taylor) A.J.E.Smith [*Trichostomum tenuirostris* (Hook. & Tayl.) Lindb.] – Locality 1; on damp soil

Range: Subcosmopolitan.

****Pseudocrossidium replicatum*** (Taylor) R.H.Zander [*Barbula acutata* Müll.Hal.] – Locality 7; on soil.

Range: Africa, N and S America, and S.W. Asia. An Afromontane species, widely distributed in E. Africa (Ethiopia, Somalia, Sudan; cf. O'Shea, 2006).

Closest locality in S.W. Asia: Asir Mts. and Jabal Fayfa (Saudi Arabia), close to the Yemen border (Frey & Kürschner, 1988).

Syntrichia fragilis (Taylor) Ochyra – Localities 2, 6, 10, 15, 19, 22; on bark, soil and soil covered rocks.

Range: Africa, C., N. and S. America, Asia, and Europe (Flora of North America Editorial Committee, 2007).

Timmiella barbuloides (Brid.) Mönk. – Locality 9; on soil.

Range: Widely distributed in the dry regions of the Northern Hemisphere, except N. America (Frey & Kürschner, 1988).

Tortella smithii C.C.Townsend – Locality 27; on soil.

Range: Endemic to the Arabian Peninsula and Socotra Island.

****Tortula marginata*** (Bruch & Schimp.) Spruce – Localities 8, 10, 11, 18, 19; on soil, rock and house walls.

Similar to the widespread *T. muralis* Hedw., but distinguished by bordered leaves and a short costa, excurrent in a yellowish point.

Range: S.W. Asia and Europe. Known in S.W. Asia from Iraq, Israel, Lebanon and Turkey (Kürschner & Frey, 2011) and the Mediterranean (Ros et al, 2013).

Closest locality in S.W. Asia: Judean Mts., Battur (Bilewsky & Nachmony, 1955).

Weissia condensa (Voit) Lindb. – Locality 28; on soil.

Range: Africa (Cape Verde), S.W. Asia, and Europe (Frey & Kürschner, 1988; O’Shea, 2006).

Splachnobryaceae

Splachnobryum aquaticum Müll.Hal. – Locality 1; on damp soil.

Range: Africa and Asia (Frey & Kürschner 1988; O’Shea, 2006).

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APPENDIX: COLLECTION SITES

- 1 IBB: Mashannah waterfall resort, 13°58'24.9"N, 44°11'50.2"E, 2137 m, leg. L. Al-Khwilani & A.N. Al-Gifri, 13.6.2013
- 2 IBB: Between Al-Akabah and Jabal Ba'dan, 13°57,802N, 44°11,132E, 2317 m, leg. L. Al-Khwilani & A.N. Al-Grifri, 13.6.2013
- 3 IBB: Between Al-Midan and Jabal Ba'dan, 13°57,488N, 44°12,660E, 2565 m, leg. L. Al-Khwilani & A.N. Al-Gifri, 13.6.2013
- 4 IBB: Between Shathebah and Jabal Ba'dan, 13°57,668 N, 44°12,478E, 2551 m, leg. L. Al-Khwilani & A.N. Al-Gifri, 13.6.2013
- 5 IBB: Between Hol Hajar and Jabal Ba'dan, 13°57,735N, 44°12,424E, 2530 m, leg. L. Al-Khwilani & A.N. Al-Gifri, 13.6.2013
- 6 IBB: Ibb, Al-Jabanah, 13°58'37.9"N, 44°11'14.5"E, 1501 m, leg. L. Al-Khwilani, 27.9.2013
- 7 IBB: Ibb, Al-Jabanah, Al-Wasta, 13°58'13.1"N, 44°11'3.2"E, 1992 m, leg. L. Al-Khwilani, 20.7.2013
- 8 IBB: Ibb, Al-Jabanah, Al-Wasta, 13°58'18.7"N, 44°11'13.4"E, 2080 m, leg. L. Al-Khwilani, 14.8.2013
- 9 IBB: Ibb, Al-Jabanah, Al-Wasta, 13°58'24.8"N, 44°11'6.8"E, 1501 m, leg. L. Al-Khwilani, 27.9.2013

- 10 IBB: Ibb, Al-Jabanah, Al-Swphla, 13°58'11.8"N, 44°11'4.1"E, 2005 m, leg. L. Al-Khwilani, 10.8.2013
- 11 IBB: Ibb, Al-Jabanah, Al-Swphla, 13°58'14.1"N, 44°11'3.6"E, 2006 m, leg. L. Al-Khwilani, 24.9.2013
- 12 IBB: Ibb, Al-Jabanah, Al-Swphla, 13°58'21.3"N, 44°11'19.1"E, 2006 m, leg. L. Al-Khwilani, 28.9.2013
- 13 IBB: Ibb, Al-Jabanah, 13°58'19.7"N, 44°11'15.1"E, 2004 m, leg. L. Al-Khwilani, 14.8.2013
- 14 IBB: Ibb, Al-Jabanah, Al-Walia, 13°58'10.8"N, 44°11'8.3"E, 2041 m, leg. L. Al-Khwilani, 14.8.2013
- 15 IBB: Ibb, Al-Gomari, 13°57'42.8"N, 44°11'11.2"E, 1971 m, leg. L. Al-Khwilani, 7.9.2013
- 16 IBB: Ibb, Al-Shuba, 13°58'24.9"N, 44°11'21.1"E, 2202 m, leg. L. Al-Khwilani & A.N. Al-Gifri. 7.9.2013
- 17 IBB: Ibb, Al-Shabah, 13°58'24.9"N, 44°11'21.1"E, 2202 m, leg. L. Al-Khwilani, 7.9.2013
- 18 IBB: Ibb, 13°58'23.1"N, 44°11'12.3"E, 1933 m, leg. L. Al-Khwilani, 14.8.2013
- 19 IBB: Ibb, 13°58'25.1"N, 44°11'21.2"E, 2036 m, leg. L. Al-Khwilani, 7.9.2013
- 20 IBB: Ibb, 13°57'44.8"N, 44°11'08.9"E, 1958 m, leg. L. Al-Khwilani, 7.9.2013
- 21 IBB: Ibb, 13°58'21.6"N, 44°11'19.2"E, 1967 m on the roof, leg. L. Al-Khwilani, 28.9.2013
- 22 IBB: Ibb, 13°58'17.5"N, 44°11'10.4"E, 1999 m, surfaces, leg. L. Al-Khwilani, 6.10.2013
- 23 IBB: South of Ibb, 13°53'18.9"N, 44°11'8"E, 2028 m, leg. L. Al-Khwilani, 10.8.2013
- 24 IBB: West of Ibb, Wadi Anah, 13°58'20.2"N, 43°57'1.3"E, 1067 m, leg. L. Al-Khwilani, 26.9.2013
- 25 IBB: West of Ibb, Wadi Anah, 13°57'36.1"N, 44°05'25.3"E, 1670 m, leg. L. Al-Khwilani, 4.11.2013
- 26 IBB: North of Ibb, Wadi Al-Janat, 14°02'7.5"N, 44°11'25.3"E, 1627 m, leg. L. Al-Khwilani, 2.11.2013
- 27 IBB: North of Ibb, near Al-Ozlah - Al-Oden, 14°02'7.7"N, 44°11'25.2"E, 1632 m, leg. L. Al-Khwilani, 4.11.2013
- 28 IBB: Al-Rabadi, 13°9,841N, 44°1,312E, 2574 m, leg. L. Al-Khwilani, 18.1.2014
- 29 IBB: East of Ibb, between Al-Shair and Wadi Bana, 14°07,427N, 44°36,222E, 1766 m, leg. L. Al-Khwilani, 9.2.2014