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New Bryophyte Records from Turkey and Southwest Asia

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Abstract

Five bryophytes collected during bryological forays to the Ordu and Burdur regions of Turkey were of particular interest. Among them, *Orthotrichum hookeri*, *Plagiothecium neckeroideum* and *Thamnobryum neckeroides* were found to be new to Turkey. *Orthotrichum hookeri* and *Plagiothecium neckeroideum* are also new to Southwest Asia. Descriptions, illustrations, ecology, geographic distribution and comparisons with morphologically similar taxa are presented. Two species, *Hookeria acutifolia* and *Orthotrichum sordidum,* were recorded only for the second time in Turkey.

Introduction

In recent years, a surprising number of bryophyte taxa new to Turkey have been collected during detailed bryological field surveys in a diverse range of geographical locations (Batan and Özdemir 2013a, 2013b, Batan et al. 2013a, 2013b, Can et al. 2013, Ezer et al. 2013, Kirmaci and Kürschner 2013, Tonguç-Yayıntaş 2013, Uyar and Ören 2013, Abay and Keçeli 2014, Özdemir and Batan 2014, Ursavaş and Çetin 2014, Ezer et al. 2014). However, more studies are needed to adequately represent the complete bryophyte flora. The geography and climate of Turkey (Anatolia) varies remarkably across the country. Turkey has three main floristic regions: Euro-Siberian; Mediterranean and Irano-Turanian. Bryological surveys were carried out in southwest Turkey, in the vicinity of Burdur (Mediterranean Region), and in Northeast Turkey in the vicinity of Ordu (Euro-Siberian floristic region) near the shores of the Black Sea (Figs 1–3).

Burdur is situated in the Taurus Mountain range and has a typical Mediterranean climate characterised by hot, dry summers and cool, wet winters. Burdur in Turkey has a continental Mediterranean climate with cold, snowy winters and very hot, long and dry summers. The mean annual temperature is 15°C and the temperature ranges from -16°C to 39°C. The mean annual rainfall is about 468 mm and the average humidity is 51.2% (Akman 1999). The researched areas, Bucak district is mountainous with much forest dominated by *Abies*, *Cedrus*, *Ficus*, *Fraxinus*, *Juniperus*, *Olea*, *Pinus*, *Pistacia, Prunus*, *Quercus*, *Rhus* species and alternating streams, lakes, dams (e.g. Karacaören dam in Bucak district). The underforest flora is very abundant in these areas where the bedrock consists mainly of marble (Yazici et al. 2013).

In contrast Ordu is situated within the Euxianian section of the Euro-Siberian floristic region. In the Ordu region (Turnasuyu Valley and Emine Pınarı), the area enjoys an oceanic rainfall regime with no dry season. The mean annual maximum temperature in the Ordu region is 27.5°C (in August), with mean minimum temperature equal to 3.9°C (February). The mean precipitation per year is 1029.2 mm, the highest precipitations occur in October and December and the lowest in May and July (Atalay 1994, Akman 1999, Özdemir and Batan 2014).

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Fig. 1. The collection sites of reported taxa and phytogeographical regions in Turkey. Burdur, (▲) Ordu (■).

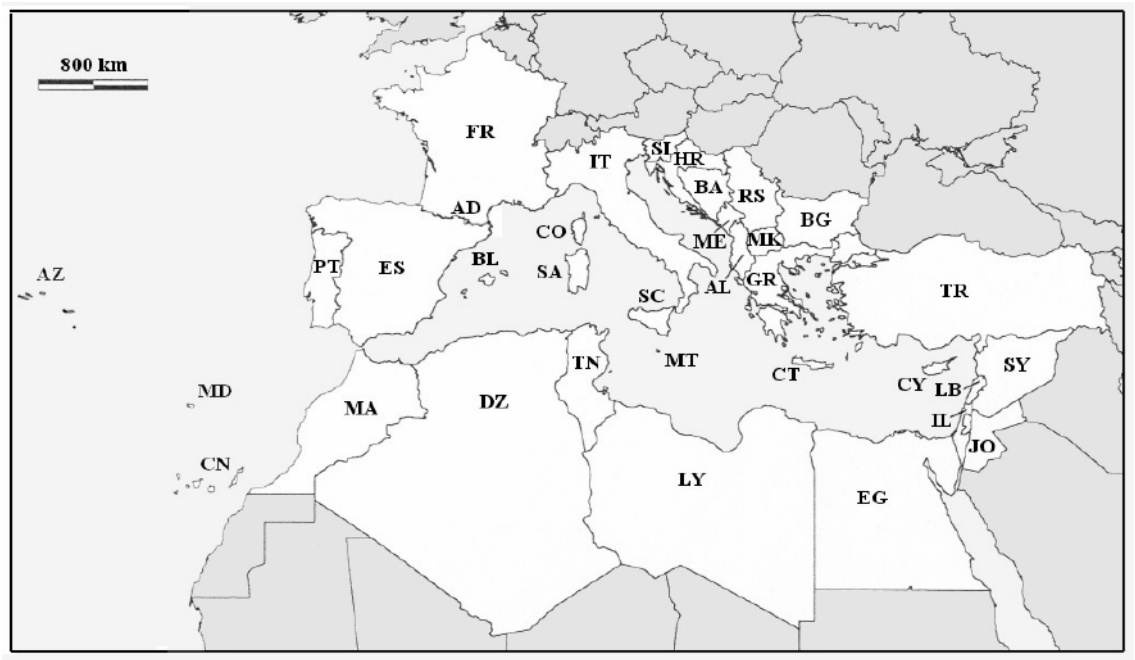

Fig. 2. The position of Turkey in Mediterranean. Abbreviations: AL (Albania), DZ (Algeria), AD (Andorra), AZ (Azores), BA (Bosnia- Herzegovina), BG (Bulgaria), CN (Canary Islands), CO (Corsica), CT (Crete), HR (Croatia), CY (Cyprus), EG (Egypt), FR (France), GR (Greece), IL (Israel), IT (Italy, JO (Jordan), LB (Lebanon), LY (Libya), MK (Macedonia), MD (Madeira), MT (Malta), ME (Montenegro), MA (Morocco), PT (Portugal), SA (Sardinia), RS (Serbia), SC (Sicily), SI (Slovenia), ES (Spain), SY (Syria), TN (Tunisia), TR (Turkey).

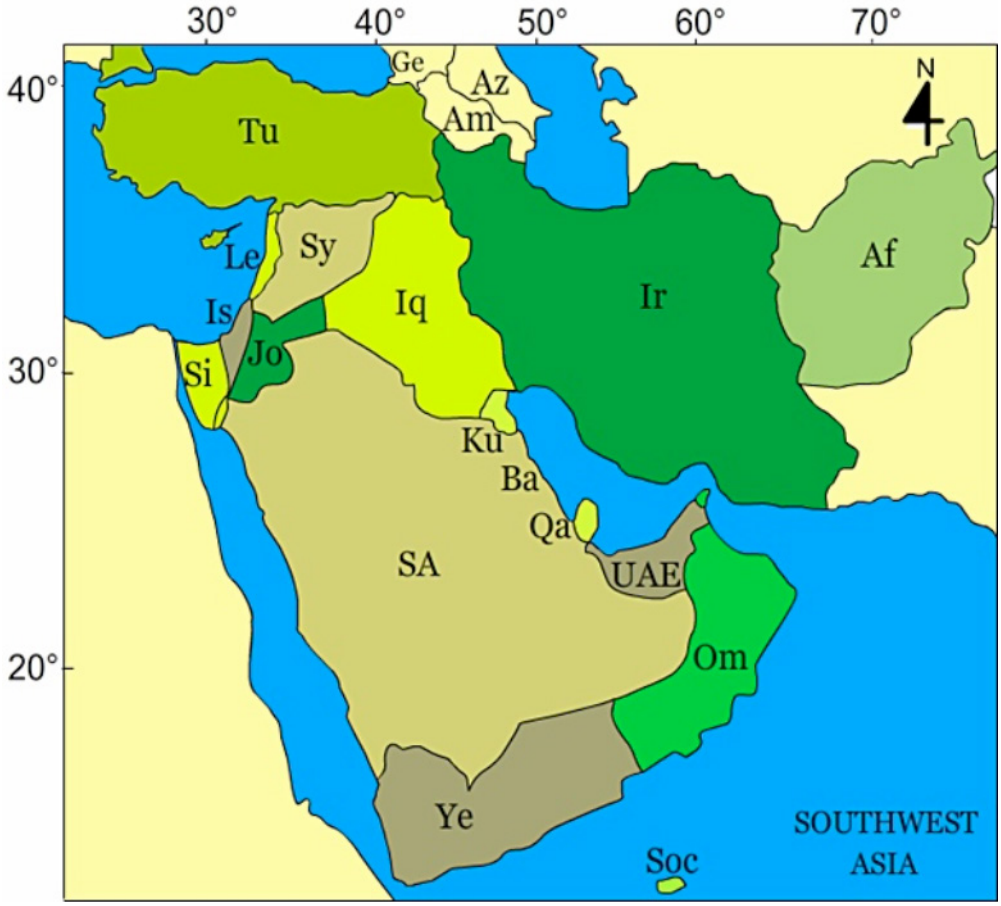

Fig. 3. The position of Turkey in SW Asia. Abbreviations: Af: Afghanistan; Ba: Bahrain; Ir: Iran; Iq: Iraq; Is: Israel; Jo: Jordan; Ku: Kuwait; Le: Lebanon; Om: Aman; Qa: Qatar; SA: Saudi Arabia; Si: Sinai Peninsula/Egypt; Soc: Socotra/Yemen; Sy: Syria; Tu: Turkey; UAE: United Arab Emirates; Ye: Yemen.

Material and Methods

Orthotrichum specimens were collected during bryological research forays held in the Burdur region from the 18 July–09 April 2013. *Thamnobryum*, *Plagiothecium* and *Hookeria* specimens were collected from four localities in the region of Ordu between 29 June 2012 and 25 October 2013. The status of these taxa was evaluated by reviewing the related literature for Turkey (Uyar and Çetin 2004, Kürschner and Erdağ 2005, Kürschner and Frey 2011), the Mediterranean (Ros et al. 2013) and Southwest Asia (Kürschner and Frey 2011).

Voucher specimens have been deposited in the Herbarium of the Biology Department, Faculty of Science, Karadeniz Technical University, Turkey (KTUB)

Results

Orthotrichaceae

1. *Orthotrichum hookeri* Mitt. Figs 4, 5

Plants medium-sized in loose tufts, olive-green to yellowish green above, brown to black below. Stems densely foliate, 1.8–4.3 cm long, simple or branched and with rhizoids only at the base. Leaves erect, ovate-lanceolate, flexuose when dry, 2–3.4 x 0.5–0.8 mm, acute or long acuminate. Leaf margin inflexed or reflexed, recurved at least near the base, rarely plane. Leaf apex acuminate or acute. Gemmae reddish-brown, occurring on tips of leaves. Nerve subpercurrent. Cells rounded-quadrate or rounded-rectangular in the upper part of the leaf, thick-walled, with 1 or 2 simple or branched papillae per cell; cells gradually becoming narrower toward the apex; cells elongate-rectangular or rhomboidal, thick-walled, porose in the lower part of the leaf, becoming shorter and wider toward the base, shortly rectangular at the basal margins. Alar cells sometimes differentiated,

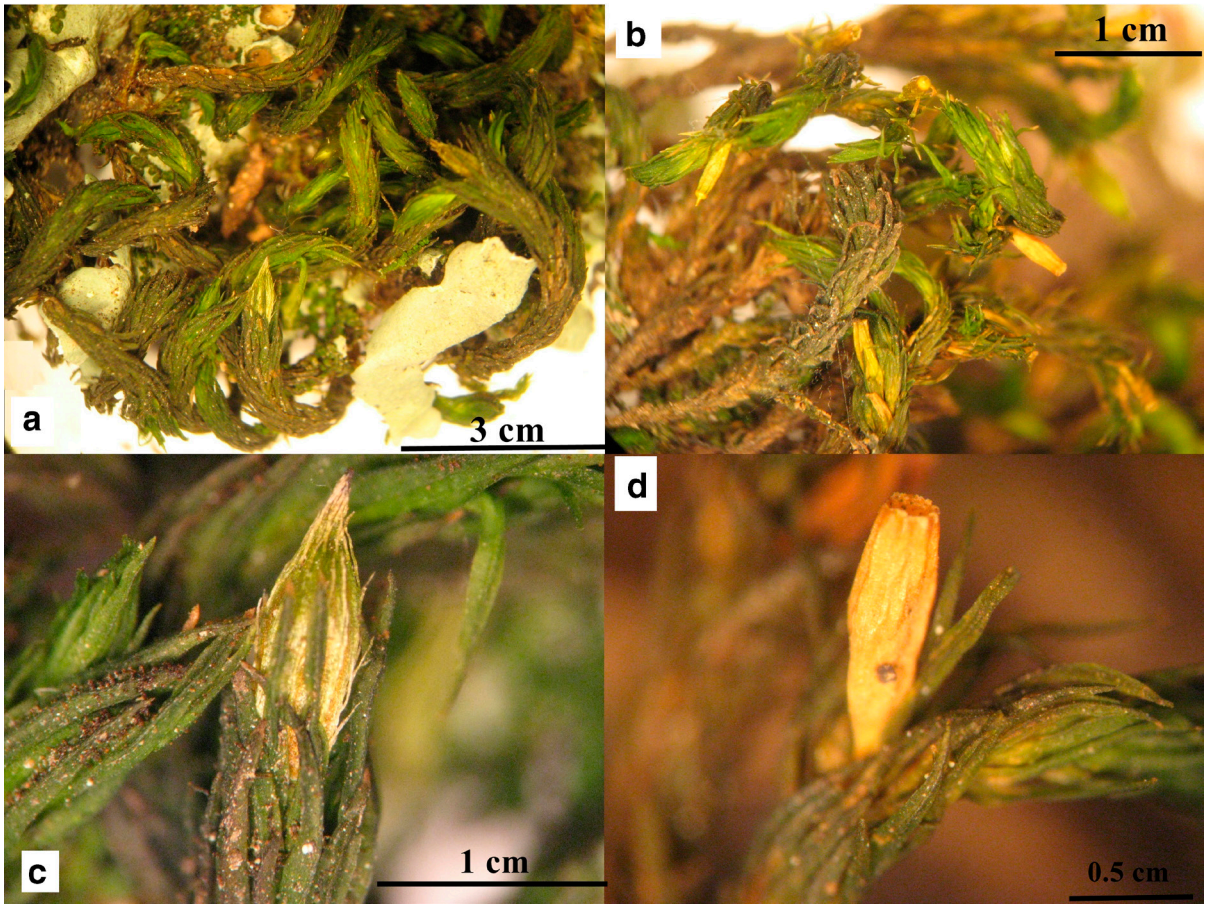

Fig. 4. *Orthotrichum hookeri*: **a,b,** Habit; **c,** Immature capsule; **d,** Lateral view of the mature capsule.

consisting of large, red cells. Perichaetial leaves similar to stem leaves. Setae c. 1.5 cm long; capsule long exserted, oblong-ovoid to cylindrical, smooth or furrowed when dry; peristome double; exostome teeth in 8 pairs, reflexed when dry, densely papillose on outside. Calyptrae mitrate, hairy or rarely naked.

Specimens examined: TURKEY (Burdur): Bucak district, Yukarı Kuyubaşı Valley, 37°21'51.07"N, 30°42'15.03"E, on trunk of *Abies*, 975 m, 24 Aug 2012, *N. Batan (KTUB 1580)*, det. Y. Jia.; Bucak district, 37°27'44.96"N, 30°34'55.84"E, on trunk of *Juniperus*, 915 m, 18 Jul 2012, *N. Batan (KTUB 1581)*, det. Y. Jia.

Twenty-nine species of *Orthotrichum* were recorded for Turkey by Uyar and Çetin (2004) and Kürschner and Erdağ (2005), and additional species have been recorded subsequently by Lara et al. (2010) and Ezer et al. (2014); fifty-eight taxa are recorded for the broader Southwest Asia region (Kürschner and Frey 2011). *Orthotrichum hookeri* is distinguished from other *Orthotrichum* species by the lack of a puckered capsule mouth; double peristome, reflexed to recurved when dry; acute to acuminate leaf tips; reflexed leaf margins, recurved, rarely plane, near the base; very long exserted capsules. Lewinsky (1992) stated that gemmae were unknown from this species, but gemmae were found on leaves of the material from Turkey. Gemmae are normally produced the leaf apex, but only become discernible under a microscope. Gemmae are reddish-brown and uniseriate, linear to ellipsoid, 5–7 celled, thick-walled, 50–60 µm long.

Ecology: *Orthotrichum hookeri* was collected on the trunk of *Abies cilicia* and *Juniperus oxycedrus*. Accompanying bryophyte species; *Porella cordaeana* (Huebener) Moore, *Radula complanata* (L.) Dumortier, *Hypnum cupressiforme* var. *cupressiforme* Hedw, and *Hypnum cupressiforme* var. *resupinatum* (Taylor) Schimp.

Distribution: *Orthotrichum hookeri* is previously reported from China, Bhutan, Nepal and India (Jia et al. 2011); new to Turkey (Uyar and Çetin 2004, Kürschner and Erdağ 2005), the Mediterranean (Ros et al. 2013) and Southwest Asia (Kürschner and Frey 2011).

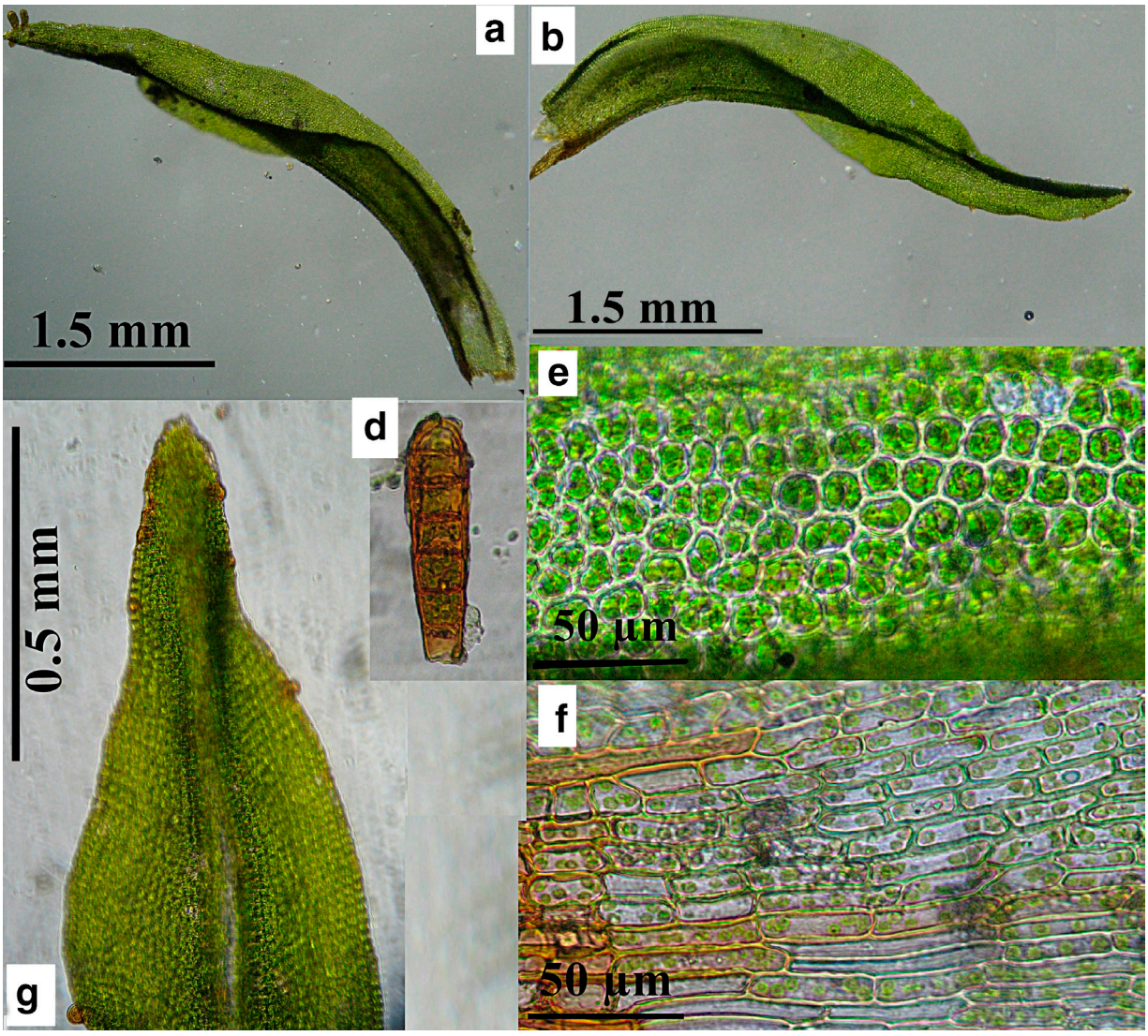

Fig. 5. *Orthotrichum hookeri:* **a–b,** Leaves; **c,** Apex of leaf; **d,** Gemma; **e,** Median leaf cells; **f,** Basal leaf cells.

Plagiotheciaceae

2. *Plagiothecium neckeroideum* Schimp. Figs 6, 7

Plants glossy, pale-green, julaceous or subjulaceous, up to 4–8 cm long, resembling a species of *Neckera*. Stems and branches complanate-foliate at least at the base. Stems with few branches, attenuate at shoot tip; branches complanate-foliate, 2.5–3 mm wide; leaves at middle of branches and 1.5–2 cm long. Leaves distinctly complanate, spreading, usually asymmetrical, rarely symmetrical, pale green or yellowish green, 2–3.5 mm long, weakly undulate and plant then subjulaceous with concave leaves. Leaf apex acute, acuminate or gradually long acuminate. Leaf base narrowly decurrent, consisting of rectangular or elongate cells. Leaves have fasciculate fusiform gemmae at apex. Leaf margin entire. Nerve short and forked. Cells at leaf apex narrowly elongate, 30–60 × 3–4 µm; mid-leaf cells linear, 65–80 × 4–5 µm; basal leaf cells narrowly elongate, 40–80 × 5–6 µm,. Sporophytes were not seen in these specimens in Turkey.

Specimens examined: TURKEY (Ordu): Turnasuyu Valley, 40°52'20.37"N, 40°02'25.27"E, onwet rock, 68 m, 20 May 2012, *N. Batan and O. Özcan (KTUB 1582)*, det. N. Batan & T. Özdemir; Çambaşı High Plateau, Emine Pınarı Promenade Area, 40°43'32.83"N, 37°56'12.58"E, on wet rock and tree trunk, 1575 m, 25 Oct 2013, *N. Batan and T. Özdemir (KTUB 1583)*, det. N. Batan and T. Özdemir.

Plagiothecium neckeroideum differs from other *Plagiothecium* species in the very distinctive and unusual fasciculate fusiform gemmae at the tips of the leaves, rhizoids at apex and its very large size. It resembles a species of *Neckera*. *Plagiothecium neckeroideum* is characterized by the strongly complanate and ± julaceous leafy stems, branches with often undulate leaves, the clear differentiation of lateral, dorsal and ventral leaves, and asymmetric leaves.

Fig. 6. *Plagiothecium neckeroideum*: Habit (**a,** wet; **b,** dry)

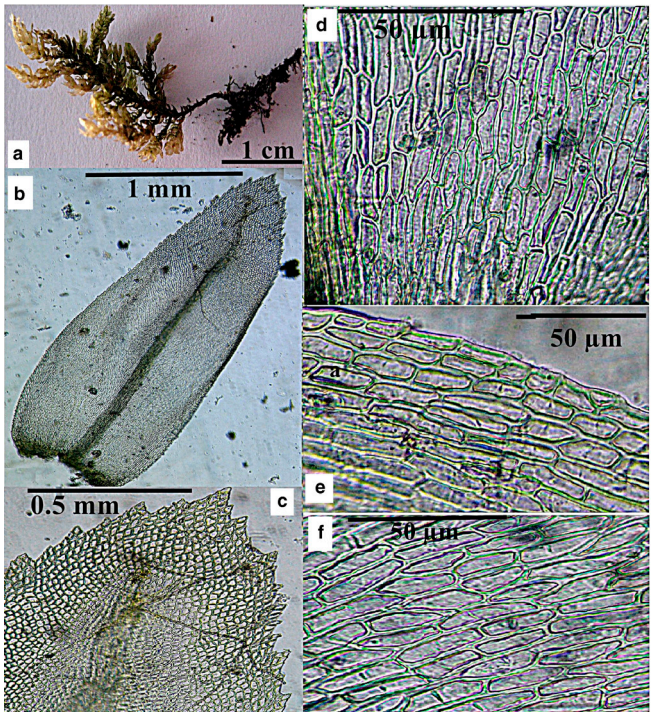

Fig. 7. *Plagiothecium neckeroideum*: **a–b,** Stem (Branches with leaves); **c–d,** Leaves; **e,** Apex of leaf (with gemmae).

Ecology: Accompanying bryophyte species; *Pellia endiviifolia* (Dicks.) Dumortier, *Conocephalum conicum* (L.) Dumortier, *Fissidens taxifolius* Hedw., *Hygrohypnum luridum* (Schimp.) Broth., *Plagiomnium rostratum* (Schrad.) T.J.Kop. and *Hookeria acutifolia* Hook. et Grev.

Distribution: *Plagiothecium neckeroideum* is previously known from Japan, China, Taiwan, Himalaya, Nepal, Thailand, Philippines, Malaysia, Indonesia, Papua New Guinea, Ethiopia, Democratic Republic of Congo, Russian Far East, Switzerland, Austria (Noguchi et al. 1994, Li and Ireland 2008, Ochyra and Bednarek-Ochyra 2012). New to Turkey (Uyar and Çetin 2004, Kürschner and Erdağ 2005), Mediterranean (Ros et al. 2013) and Southwest Asia (Kürschner and Frey 2011).

Neckeraceae

3. *Thamnobryum neckeroides* (Hook.) E. Lawton Fig. 8

Plants green to dark green, slightly glossy, dendroid, 3–3.5 cm long. Growth habit similar to that of *Isothecium* spp.. Shoots sparsely to pinnately branched, commonly branched near the apex; branches 8–12 mm long. Stem leaves 1.6–2.2 mm long, ovate to widely ovate, with broadly acute to subobtuse apex. Branch leaves resembling stem leaves but smaller and usually bent towards stem, generally carinate near the apex. Nerve stout, bent, gradually narrowing distally, usually toothed at back with 1–3 celled teeth, ending near the leaf apex. Leaf margins plane, roughly serrate near the apex, serrulate in mid-leaf and nearly entire at base of leaf. Median laminal cells mostly rhombic, 15–30 × 6–10 μm, moderately thick-walled and smooth. Mid-leaf cells near the costa with longest axes mostly parallel to costa. Basal laminal cells near costa elongate, rectangular, thick-walled; basal marginal cells indistinctly shorter. Sporophytes not seen in this Turkish specimen.

Specimen examined: TURKEY (Ordu): Turnasuyu Valley, 36°56'59.32"N / 29°27'40.68"E, on soil, rocky area, 1373m, 29 Jun 2012, *N. Batan and O. Özcan (KTUB 1584)*, det. N. Batan.

Thamnobryum neckeroides is very similar to *T. alopecurum*, *T. coreanum* and *T. subserratum*. *T. neckeroides* is distinguished from *T. alopecurum* in having more strongly concave leaves, widely acute to subobtuse leaf apices; costa dorsally serrate, often with multicellular lamellate projections (Ignatova and Ignatov 2011). *Thamnobryum neckeroides* resembles *T. coreanum* in terms of habit, plant size, leaf shape and costal structure. Plants of *T. neckeroides* are glossy; those of *T. coreanum* are dull. Leaf cells of *T. neckeroides* have clear areolation and are smooth; areolation of *T. coreanum* is obscured by mamillose laminal cells (Ignatova and Ignatov 2011). *T. neckeroides* is difficult to separate from *T. subserratum* but trapezoidal or rhomboidal laminal cells with longest axes mostly parallel to costa in *T. neckeroides* help to differentiate this species from *T. subserratum* which has elongate rectangular laminal cells in mid-leaf near the costa, forming oblique angles to the costa. Additionally *T. subserratum* is autoicous; *T. neckeroides* is dioicous (Ignatova and Ignatov 2011).

Ecology: Accompanying moss species: *Brachythecium rutabulum* (Hedw.) Schimp., *Anomodon viticulosus* (Hedw.) Hook. & Taylor, and *Neckera complanata* (Hedw.) Huebener.

Distribution *Thamnobryum neckeroides* is previously reported from western and eastern North America, South Korea, China, Russian Far East, India, southern Siberia, one disjunct locality in the north of Eastern Siberia, Abkhazia, Ukraine, Europe including the Czech Republic, Germany, Austria, Latvia and Italy, and New Zealand in the southern hemisphere (Mastracci 2003, Frey et al. 2006, Ignatova and Ignatov 2011). New to Turkey (Uyar and Çetin 2004, Kürschner and Erdağ 2005, Kürschner and Frey 2011).

Orthotrichaceae

4. *Orthotrichum sordidum* Lesq. & James

O. sordidum is a panholarctic disjunct species reported from eastern and western North America (including, Alaska), Greenland, China, Kazakhstan, Japan and Armenia, (Lara et al. 2010; Jia et al. 2011). This is the second record of *O. sordidum* from Turkey, collected in Burdur Province of south west Anatolia where it was growing on *Juniperus* sp.

The first record of *O. sordidum* from Turkey (Trabzon province, in north eastern Anatolia) was made by Lara et al. (2010).

Specimen examined: TURKEY (Burdur): Bucak district, Yukarı kuyubaşı Valley, 37°21'51.07"N, 30°42'15.03"E, on trunk of *Juniperus*, 975 m, 24 Aug 2012, *N. Batan (KTUB 1585)*, det. Y. Jia.

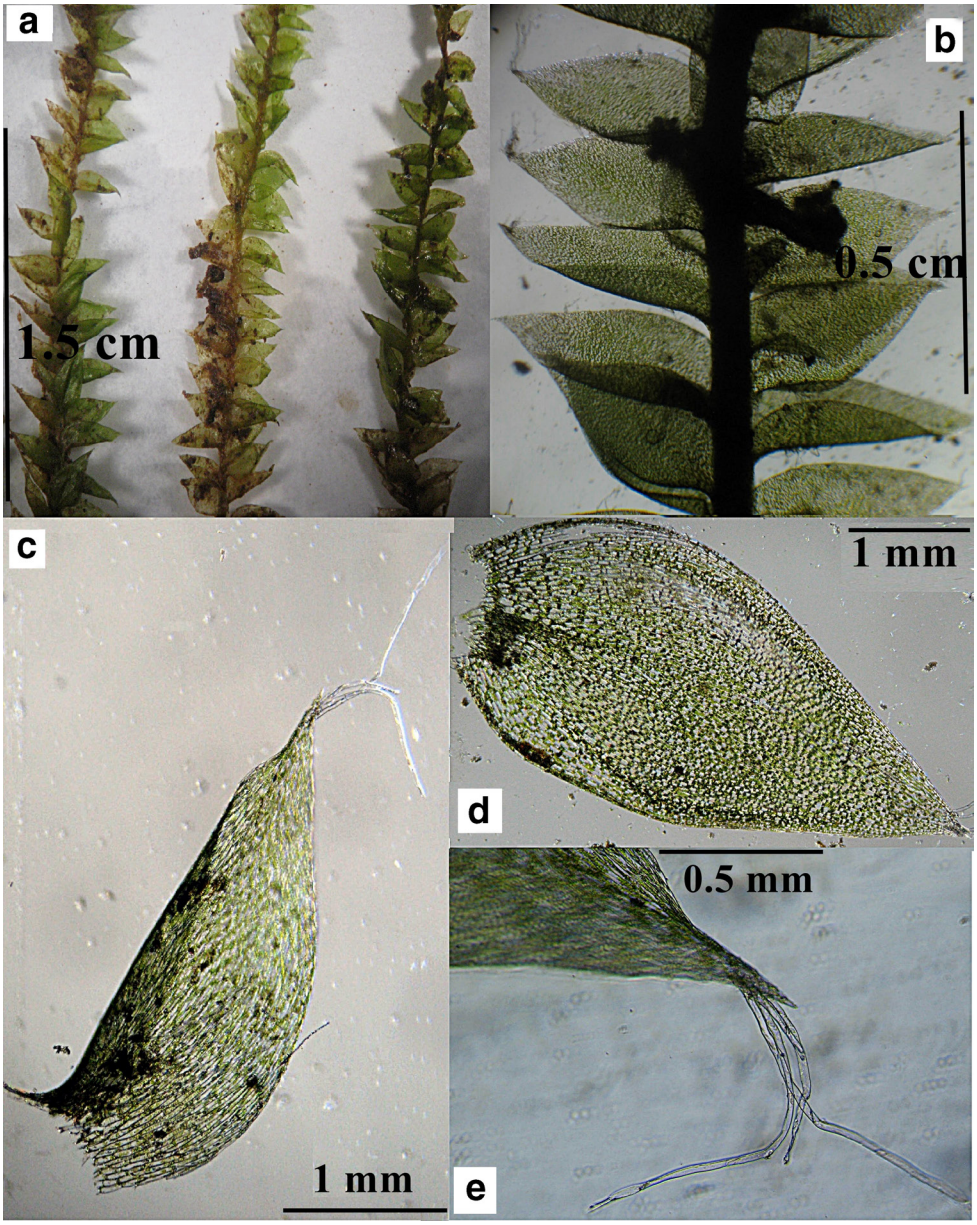

Fig. 8. *Thamnobryum neckeroides*: **a,** Habit; **b,** Leaf; **c,** Apex of leaf; **d,** Basal leaf cells; **e,** Laminal cells; **f,** Median leaf cells.

Hookeriaceae

5. *Hookeria acutifolia* Hook. et Grev.

Hookeria acutifolia is a warm-temperate species and is previously reported from north, central and south America, widely dispersed throughout south-east Asia, Russia, Georgia, Turkey and is curiously lacking from north Africa and Europe. *H. acutifolia* was noted for the first time from the northeast of Turkey (Trabzon, Çamburnu) by Uyar and Ören (2013). Our collection of *H. acutifolia* is only the second record from Turkey (Ordu Province).

Specimen examined: TURKEY (Ordu): Çambaşı high plateau (Emine pınarı), 40°43'37.42"N, 37°55'41.98"E, on wet rock, 1612 m, 25 Oct 2013, *N. Batan and T. Özdemir (KTUB 1586)*, det. N. Batan and T. Özdemir.

Acknowledgments

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CORRIGENDUM
(added 12 December 2014)

Figure 2 (p. 338) Legend: add BL (Balearic Islands)

Misplacement of images – Figure 7 (p. 342) and Figure 8 (p. 444): the image included with the legend of Figure 7 is that of Figure 8, and the image associated with Figure 8 is that of Figure 7.