

Mosses from Pakistan Collected by Botanical Expedition of National Science Museum, Tokyo in 1990. 3. Orthotrichaceae

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Abstract Three genera and ten species in the family Orthotrichaceae are recognized based on the collections from Pakistan in 1990. Among them *Orthotrichum diaphanum* is newly recorded from Pakistan. A key to the species of Orthotrichaceae in Pakistan is provided.

Key words: bryophytes, mosses, Orthotrichaceae, Pakistan.

This paper deals with the orthotrichaceous mosses collected in Pakistan from July to September 1990 (cf. Higuchi, 1992). The specimens examined are deposited in the herbarium of National Science Museum, Tokyo (TNS), and some duplicates in the herbarium of Pakistan Museum of Natural History (PMNH). A key to the species of Orthotrichaceae in Pakistan is provided. For each species, collection localities, specimen numbers, distribution and some morphological and taxonomical notes are also provided.

Orthotrichaceae

Higuchi & Nishimura (2003) lists three genera and eight species, *Amphidium* (1 sp.), *Drummondia* (1 sp.) and *Orthotrichum* (6 spp.), in the family Orthotrichaceae as occurring in Pakistan. Lewinsky (1992) reported that *Orthotrichum affine* Brid., *O. pallens* Brid. and *O. striatum* Hedw. occurred on Pakistan, and Lewinsky (1993) noted that *O. crenulatum* Mitt. was also recorded from Pakistan. Recently Schäfer-Verwimp & Gruber (2002) added *Orthotrichum obtusifolium* Brid. to the moss flora of Pakistan. The Orthotrichaceae presently known from Pakistan includes 13 species in three genera. By the examination of forty eight specimens collected, ten species in three genera were recognized. Among them *Orthotrichum diaphanum* Schrad.

ex Brid. is reported for the first time from Pakistan.

Key to the genera of Orthotrichaceae in Pakistan

1. Stems creeping, freely branched, with numerous, erect branches; capsules not sulcate, smooth. *Drummondia*
1. Stems erect or ascending, simple or sparsely branched; capsules strongly sulcate when dry. 2
2. Leaves usually strongly crisped when dry; calyptra cucullate; capsules without peristome. *Amphidium*
2. Leaves appressed, straight, rarely slightly contorted when dry; calyptra mitrate or campanulate; capsules with peristome. *Orthotrichum*

Drummondia thomsonii Mitt., J. Linn. Soc. Bot. Suppl. 1: 46, 1859.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Utrot, 2250 m, on trunk of *Quercus dentata*, Aug. 15, 1990, Higuchi 19720, 19725; Kaghan Valley, Shinu, 1450 m, on tree trunk, Sept. 2, 1990, Higuchi 20230, 20232.

Distribution. Afghanistan, West Pakistan, Kashmir, northwestern India and Tibet (cf. Vitt, 1972).

Notes. Although Vitt (1972) noted that this

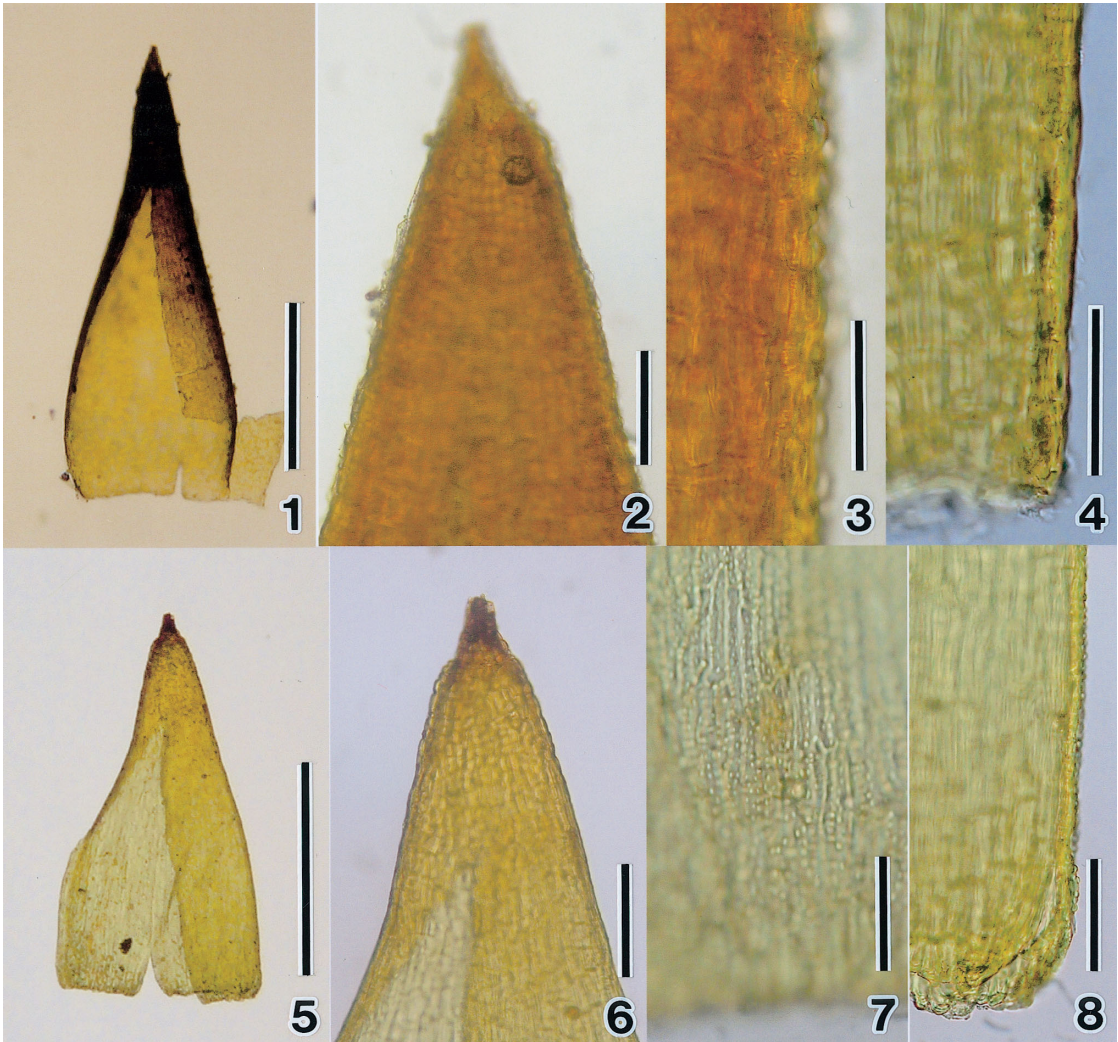


Fig. 1. Calyptrae of *Amphidium lapponicum* (1–4 taken from Higuchi 19643) and *A. cyathicarpum* (5–8 taken from Deguchi 25773 in TNS). 1, 5. Calyptrae when wet. 2, 6. Upper parts of calyptra. 3. Upper margin of calyptra. 4, 8. Basal margins of calyptra. 7. Basal cells of calyptra. Scale bars for 1 & 5=0.5 mm; 2 & 6=100 μ m; 3, 4, 7, 8=50 μ m.

species seems to grow most often on saxicolous substrates, it grows on tree trunk or rarely on boulder in Pakistan (cf. Nishimura *et al.*, 1993). The plants (Higuchi 20230) bear many young sporophytes which are applicable to the ECI stage in Greene (1960). Sporophytes of this species seem to be matured in late autumn in the northern Pakistan.

Amphidium lapponicum (Hedw.) Schimp., Coroll. **39**, 1856.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Gabral, 2300 m, on rock-cliff, Aug. 13, 1990, Higuchi 19643; Matiltan, 2450 m, on rock crevice, Aug. 11, 1990, Higuchi 19591; Lake Mahodand (north of Matiltan), 2900 m, on rock crevice, Aug. 10, 1990, Higuchi 19554.

Distribution. Widely distributed in the Northern Hemisphere.

Notes. Lewinsky (1976) firstly observed papillae on the surface of the calyptra of *Amphidium cyathicarpum*, and pointed out that the occurrence of papillose calyptra in *Amphidium* indicates relationship to the Orthotrichaceae rather than to the Dicranaceae (Rhabdoweisiaceae). I also observed papillose calyptra in the plants (Higuchi 19643) of *A. lapponicum*. In *Amphidium lapponicum* the papillae are restricted on the upper part of the calyptra (Fig. 1: 3, 4), while in *A. cyathicarpum* they are on the lower part (Fig. 1: 7, 8).

Twelve species of *Orthotrichum* including *O. diaphanum* newly added here are known from Pakistan. The following key is revised from Lewinsky (1992, 1993) and Schäfer-Verwimp & Gruber (2002). The species with asterisk (*) are not present in this collection.

Key to the species of *Orthotrichum* in Pakistan

1. Leaves with a hair-point of hyaline cells. *O. diaphanum*
1. Leaves without hyaline hair-points. 2
 2. Stomata immersed. 3
 2. Stomata superficial. 8
3. Exostomes erect-spreading when dry; preperistomes present; most commonly growing on rocks. 4
3. Exostomes reflexed, recurved or revolute when dry; preperistomes present or absent; most commonly growing on tree trunks. 5
 4. Capsules exserted on a long seta. *O. anomalum*
 4. Capsules immersed to emergent; setae short. *O. cupulatum*
5. Calyptra with papillose hairs reaching to the top. *O. alpestre*
5. Calyptra naked. 6
 6. Leaves broadly obtuse, rounded acute or acute; margins crenulate near the apex. *O. crenulatum*
 6. Leaves acute or rounded acute; margins entire or very rarely sharply dentate near the apex. 7
7. Segments 16, well developed; leaves lanceolate to oblong-lanceolate; stomata almost uncovered by subsidiary cells. *O. pallens**
7. Segments 8, or rarely with 8 rudimentary segments in between; leaves ovate-lanceolate; stomata half to almost completely covered by subsidiary cells. *O. pumilum**
8. Plants dioicous; leaf margins erect-incurved to incurved; leaf apices broadly obtuse. *O. obtusifolium**
8. Plants not with the combination of characters mentioned above. 9
9. Exostomes erect to spreading when dry. 10
9. Exostomes reflexed, recurved or revolute when dry. 11
 10. Capsules immersed to emergent, oblong, often furrowed when dry; endostome often missing; calyptra with hairs reaching over the top. *O. rupestre*
 10. Capsules long exserted, cylindrical, smooth when when dry; endostome well developed; calyptra with hairs reaching over the top *O. laevigatum* var. *japonicum*
11. Endostome of 16 lanceolate segments. *O. striatum*
11. Endostome of 8 triangular segments. *O. affine**

Orthotrichum alpestre Hronsch. ex B. S. G., Bryol. Eur. 3: 75, 1849.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Gabral, 2300 m, on boulder, Aug. 13, 1990, Higuchi 19631 (+*Orthotrichum laevigatum*); Matiltan, 2400 m, on tree trunk, Aug. 7, 1990, Higuchi 19431, 19434; 2450 m, Aug. 11, 1990, Higuchi 19586; Kaghan Valley, Kamal Ban Forest (southwest of Kaghan), 2050 m, on tree trunk, Sept. 2, 1990, Higuchi 20176; Naran, 2430 m, on trunk of *Juglans* sp., Aug. 26, 1990, Higuchi 19828 (+*Orthotrichum crenulatum*); Batakundi, 2600 m, on rock-cliff, Aug. 26, 1990, Higuchi 19864 (+*Orthotrichum cupulatum*). Mt. Nanga Parbat, Rupal-Nanga Parbat Base Camp, 3330 m, on tree trunk, Sept. 13, 1990, Higuchi 20369; 3400 m, on boulder, Higuchi 20406.

Distribution. Western North America, Green-

land, Svalbard, North & Central Europe, Siberia, northern Pakistan and northern India (cf. Lewinsky, 1992, 1993).

Orthotrichum anomalum Hedw., Spec. Musc. **162**, 1801.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Matiltan, 2100 m, on boulder, Aug. 9, 1990, *Higuchi 19502*; 2250 m, on boulder, Aug. 7, 1990, *Higuchi 19413*; Matiltan – Lake Mahodand, 2250 m, on rock-cliff, Aug. 8, 1990, *Higuchi 19450*; Desan Forest (south of Utrot), 2400 m, on rock-cliff, Aug. 14, 1990, *Higuchi 19704*; Kaghan Valley, Kawai, 1600 m, on boulder, Sept. 1, 1990, *Higuchi 20119, 20137*; Sharan, 2370 m, on boulder, Sept. 3, 1990, *Higuchi 20286*. Mt. Nanga Parbat, Nanga Parbat Base Camp, 4450 m, on boulder, Sept. 18, 1990, *Higuchi 20522*.

Distribution. North & Central America, Haiti, Europe, North Africa, North & Central Asia, northeastern Afghanistan, northern Pakistan, India, Tibet, northern Yunnan, central East China and Japan (cf. Lewinsky, 1992, 1993).

Orthotrichum crenulatum Mitt., J. Linn. Soc. Bot. Suppl. **1**: 48, 1859.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Matiltan, 2240 m, on trunk of *Juglans* sp., Aug. 7, 1990, *Higuchi 19412*; on rock-cliff, *Higuchi 19420* (+*Orthotrichum laevigatum*); 2250 m, on trunk of *Juglans* sp., Aug. 11, 1990, *Higuchi 19571*; Utrot, 2250 m, on trunk of *Quercus dentata*, Aug. 15, 1990, *Higuchi 19727*; Gabral, 2300 m, on tree trunk, Aug. 13, 1990, *Higuchi 19623*; Kaghan Valley, Shinu, 1450 m, on tree trunk, Sept. 2, 1990, *Higuchi 20231* (+*Orthotrichum diaphanum*); Shogran, 2200 m, on tree trunk, Aug. 31, 1990, *Higuchi 20083*; Naran, 2430 m, on trunk of *Populus* sp., Aug. 26, 1990, *Higuchi 19827*; on trunk of *Juglans* sp., *Higuchi 19828* (+*Orthotrichum alpestre*).

Distribution. Turkestan, Kasachstan, Tadjikistan, northeastern Afghanistan, northern Pakistan, northern India, western Tibet (cf. Lewin-

sky, 1992, 1993).

Orthotrichum cupulatum Hoffm. ex Brid., Musc. Rec. **2**(2): 25, 1801.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Matiltan, 2250 m, on boulder, Aug. 11, 1990, *Higuchi 19575*; Kaghan Valley, Naran, 2400 m, on rock-cliff, Aug. 25, 1990, *Higuchi 19805*; Batakundi, 2600 m, on rock-cliff, *Higuchi 19864* (+*Orthotrichum alpestre*).

Distribution. Central and western North America, Mexico, southern South America, Europe, Caucasus, North Africa, Central Asia, Afghanistan, northern India, Turkestan, Uzbekistan, New Zealand and southeastern Australia (cf. Lewinsky, 1992, 1993) and Pakistan (cf. Blatter & Fernandez, 1931; Schäfer-Verwimp & Gruber, 2002).

Notes. Schäfer-Verwimp & Gruber (2002) cited that the first and single previous record of *Orthotrichum cupulatum* from Pakistan is “Blatter & Fernandez (1929).” Probably they confused Dixon (1929) with Blatter & Fernandez (1931), which were based on the same collection.

Orthotrichum diaphanum Schrad. ex Brid., Musc. Rec. **2**(2): 29, 1801. (Fig. 2)

Plants in small, dense or sparse turf up to 7 mm tall, brownish below, yellowish green to dark-green above; stems simple or sometimes branched, usually growing by innovation. Leaves erect, appressed, somewhat contorted, reflexed at the upper part when dry, 2.0–2.8×0.5–0.6 mm long, ovate-lanceolate, gradually acuminate to a serrulate, hyaline hair-point (which is longer in the upper leaves); costa excurrent into the hair-point, channeled; margins almost entire, revolute nearly to the base of the hair-point; median laminal cells 14–34×10–16 μm, quadrate to rectangular, thin-walled, smooth or weakly papillose; cells of hair-point linear to vermicular, papillose, thick-walled; basal cells smooth and pale, rectangular toward the costa, quadrate at the margins. Gemmae commonly present on both leaf surfaces, filamentous, rarely branched, (3–)5–8(–12) cells long.

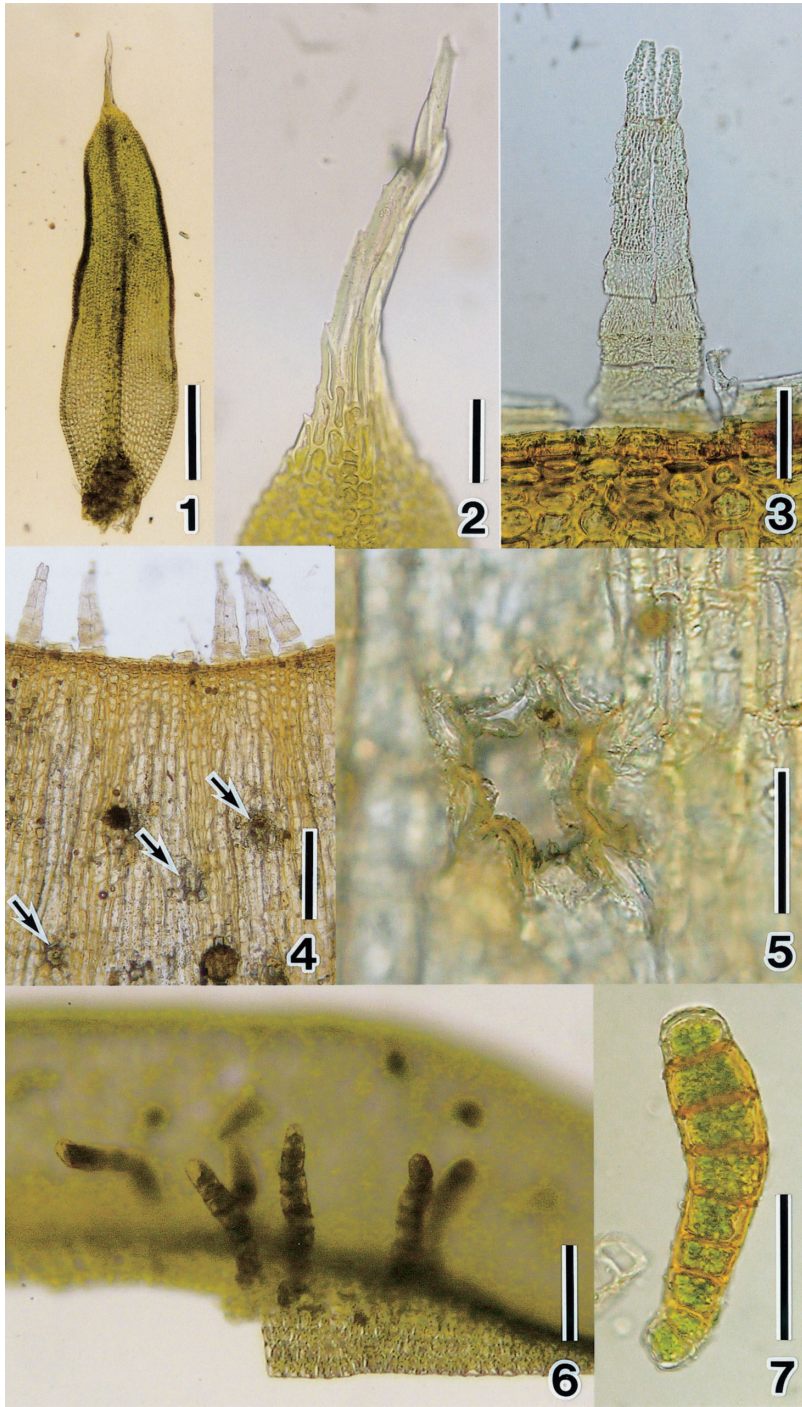


Fig. 2. *Orthotrichum diaphanum*. 1. Leaf. 2. Apical part of leaf. 3. Exostome. 4. A part of capsule. Arrows show stomata. 5. Immersed stoma. 6. Gemmae on leaf. 7. Gemma. All taken from Higuchi 19401. Scale bars for 1=0.5 mm; 2 & 6=100 μ m; 3, 5 & 7=50 μ m; 4=200 μ m.

Autoicous. Perigonia often on separate branches. Perichaetial leaves not differentiated. Setae seen above vaginula very short, 0.2–0.4 mm long. Capsules immersed or emergent, 1.4–1.6 mm long, oblong-cylindric, moderately furrowed when dry; exothecial cells differentiated into 8 brownish bands and 8 hyaline bands; stomata immersed, below the middle part of the capsule. Peristome double; exostome 16, lanceolate, erect-spreading when young and dry, reflexed when old and dry, densely papillose on the outer surface, densely papillose or papillose-striolate on the inner surface; endostome segments 16, narrow lanceolate, consisting of 1 row of cells, finely papillose. Spores 14–20 μm . Calyptra not seen.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Saidu Sharif, 930 m, on tree trunk, Aug. 6, 1990, *Higuchi 19398, 19399, 19401*; Kaghan Valley, Shinu, 1450 m, on tree trunk, Sept. 2, 1990, *Higuchi 20231* (+*Orthotrichum crenulatum*).

Distribution. North America, Mexico, Ecuador, Hawaii, Europe, Canaries, North, East & South Africa and Western Asia (cf. Lewinsky, 1993). New to Pakistan.

Notes. The above description is based on the plants from Pakistan. This species is characterized by having immersed or slightly emergent capsules, immersed stomata, reflexed exostomes when dry, linear-lanceolate endostome segments, leaves with a hairpoint of hyaline cells and filamentous gemmae (Fig. 2). As compared with other species of *Orthotrichum* in Pakistan, *O. diaphanum* grows on tree trunk in lowland. This species is easily recognized in the field by its hyaline hair-point of leaves, which might cause to confuse with pottiaceous species such as *Tortula* when in sterile condition.

Orthotrichum laevigatum J.E.Zetterst. var. *japonicum* (Z.Iwats.) Lewinsky, J. Hattori Bot. Lab. **72**: 42, 1992.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Matiltan, 2240 m, on rock-cliff, Aug. 7, 1990, *Higuchi 19420* (+*Orthotrichum crenulatum*); Gabral, 2300 m, on boulder, Aug. 13,

1990, *Higuchi 19631* (+*Orthotrichum alpestre*).

Distribution. Northwest India, Nepal, Southeast Tibet, Japan (cf. Lewinsky, 1992) and Pakistan (cf. Schäfer-Verwimp & Gruber, 2002).

Notes. Lewinsky (1992) stated that *Orthotrichum laevigatum* var. *japonicum* differs from var. *laevigatum* by having the well developed, strongly ornamented segments and larger spores (18–22 μm). Although the plants (*Higuchi 19420*) have the combination of the characters such as capsules long exserted, cylindric, smooth when dry and calyptra with hairs reaching over the top, they also have smooth, narrow lanceolate segments and smaller spores (12–16 μm). As discussed by Schäfer-Verwimp & Gruber (2002), the plants from Pakistan do not show typical form of the var. *japonicum*. *Orthotrichum laevigatum* was firstly reported from Pakistan by Brotherus (1898 as *O. schlotthaueri*) and Robinson (1965). Nishimura *et al.*, (1993) also reported *O. laevigatum* fo. *macounii* from Pakistan.

Orthotrichum rupestre Schleich. ex Schwaegr., Spec. Musc. Suppl. **1**(2): 27, 1816.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Matiltan, 2100 m, on boulder, Aug. 9, 1990, *Higuchi 19497* (+*Orthotrichum anomalum*); Gabral, 2300 m, on boulder, Aug. 13, 1990, *Higuchi 19627*; on rock-cliff, *Higuchi 19636*; Kaghan Valley, Naran, 2400 m, on boulder, Aug. 25, 1990, *Higuchi 19817*; Batakundi, 2600 m, on rock-cliff, Aug. 26, 1990, *Higuchi 19858*. Mt. Nanga Parbat, Rupal, 3070 m, on boulder, Sept. 12, 1990, *Higuchi 20352*.

Distribution. Western North America, South America, South Greenland, Iceland, Europe, North and East Africa, North and Central Asia, Northwest India, West China, Hawaii, Southeast Australia, New Zealand and Antarctica (cf. Lewinsky, 1992, 1993).

Orthotrichum striatum Hedw., Spec. Musc. **163**, 1801.

Specimens examined. N. W. Frontier Prov.: Swat Valley, Utrot, 2250 m, on trunk of *Quercus dentata*, Aug. 15, 1990, *Higuchi 19728*; Matiltan–

Lake Mahodand, 2370 m, on tree trunk, Aug. 8, 1990, *Higuchi 19474*.

Distribution. Northwestern North America, Europe, northern Africa, northern Pakistan, Kashmir and Northeast China (cf. Lewinsky, 1992, 1993).

Notes. This species can be distinguished from other species in Pakistan by its not distinctly furrowed capsules, reflexed and yellow 16 exostome teeth and broad 16 endostome segments with irregular margins. The variation of spore size have been reported: 17–31 μm in diameter from North America (Vitt, 1973), 24–28 μm from Fennoscandia (Nyholm, 1974), 31–35 μm from Southeast Asia (Lewinsky, 1992) and 24–28 μm from Pakistan (Schäfer-Verwimp & Gruber, 2002). The spores in the plants (*Higuchi 19728*) are 18–24 μm and smaller than those reported.

Acknowledgements

This study was supported in part by Grant-in Aid (no. 13640707) from the Ministry of Education, Culture, Sports, Science and Technology, Japan, and collection of plants was no. 02041091.

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