Ulota panchengiana, a new species from China and notes on the taxonomy of *U. morrisonensis* Horik. & Nog. (Orthotrichaceae)

Qing-Hua WANGa & Yu JIAB

State Key Laboratory of Systematic and Evolutionary Botany, Institute of Botany, Chinese Academy of Sciences, Beijing, 100093, China

**Abstract** – *Ulota panchengiana* Q.H.Wang & Y.Jia is described and illustrated as a new species from China. It is characterized by both stomata that are scattered throughout the urn and by naked calyptra, two remarkable characters that are rarely found in *Ulota* species from the northern Hemisphere. *Ulota panchengiana* is easily recognized by the combination of the following characters: lanceolate leaves with an ovate base, the presence of a few rows of hyaline cells at the basal leaf margin, and long seta. The ecology, geographical distribution, variation, and morphological comparison with related taxa are discussed. *Ulota morrisonensis*, endemic to Taiwan, is easily misidentified as *U. crispa*. However, based on a study of an isotype of the former species and in response to a recent reevaluation of the circumscription of *U. crispa*, we confirm its rank as a species and discuss obvious morphological differences between the two species. A revised key to Chinese *Ulota* species is provided.

**Morphology / Mosses / Stomata / Taxonomy / Ulota crispa**

**INTRODUCTION**

As per Garilleti *et al.* (2015), the genus *Ulota* Mohr contains 65 species worldwide, of which three species in the *U. crispa* complex were recently recognized by Caparrós *et al.* (2016). However, seven new synonyms were simultaneously proposed by Wang & Jia (2016) in their taxonomic revision of *Ulota* species from Central and South America. *Ulota* species often grow in cushions on tree trunks or branches, and are rarely found on rocks. Important diagnostic characters for this genus are: 1) leaves that are usually flexuose, twisted or crisped when dry; 2) leaves in lanceolate shape with a broad base; 3) one or more rows of hyaline cells at the basal leaf margin; and 4) exserted capsules bearing only phaneroporous stomata.

In 1892, Bescherelle reported the first *Ulota* species found in China: *Ulota bellissima* Besch. (= *U. robusta* Mitt.). Later, Brotherus (1929) described *Ulota macrocarpa* Broth. (= *U. crispa* (Hedw.) Brid.) found in Hunan and Sichuan. *Ulota morrisonensis* Horik. & Nog. was found in Taiwan and described by Noguchi (1937). The first record of *Ulota crispa* in China was also from Taiwan (Nakanishi, 1963). In 2004, *Ulota curvifolia* (Wahlenb.) Lilj. and *U. gymnostoma* S.L.Guo, Enroth & Virtanen were reported as a new record and a new name, respectively (Guo *et al.*, 2004; Mamtimin *et al.*, 2004). Guo *et al.* (2010) also later added two

* Correspondence and reprints: yjia@ibcas.ac.cn.

In the study of *Ulota* presented in this paper, we describe a new species from Southwest China, and reevaluate the morphology of *Ulota morrisonensis*, which is often confused with *U. crispa*. Finally, we provide an amended key for all Chinese *Ulota* species.

*Ulota panchengiana* Q.H.Wang & Y.Jia, *sp. nov.*

**Type:** CHINA. Sichuan, Wenchuan Co., Weizhouzhen, Qipangoucun, Mt. Guangguangshan, 31°24′13″ N, 103°35′55″ E, 2400 m, on tree trunk, 27 Aug. 2002, Y. Jia 06671b (holotype: PE!; isotype: MO!).

**Diagnosis:** Plant forming cushions, leaves strongly crisped when dry, wide concave bases with few marginal hyaline rows of cells. Vaginule with uniseriate hairs, long setae, dry capsules not constricted or constricted toward the mouth, and stomata are scattered throughout the urn. Exothecial cells differentiated into bands of three to four cell wide that reach the mouth of the capsule. Exostomes often united into 8 pairs, and sometimes lie on the exothecium. Endostome segments 8, robust. Operculum usually with a reddish basal rim, calyptra naked, medium to large spores. Plants 1-3 cm tall, in moderately dense cushions, yellowish green to olive-green above, dark brown to black below. Rhizoids reddish-brown, smooth, densely growing at stem base. Stems usually branched. Leaves strongly crisped when dry, erect-patent to patent when moist, (1.6-) 2.2-3.7 (-4.3) mm long, leaf lamina lanceolate, unistratose; leaf base wide, ovate, distinctly concave; apex long acuminate; leaf margin weak and irregularly recurved on one or both sides; costa strong, ending shortly below the apex. Upper and middle laminal cells irregularly rounded, (5-) 7-9 (-11) × (6-) 8-9 (-12) µm, thick-walled, often with two low simple papillae per cell, rarely branched; basal inner cells linear, rectangular to vermicular, (8-) 14-20 (-44) × (3-) 5-6 (-11) µm, with thick wall, smooth; basal marginal cells weakly differentiated, no more than four rows, hyaline, quadrate to rectangular, with only thickened transverse walls.

Cladautoicous. Perichaetal leaves somewhat longer, 4.1-5.2 mm. Vaginula strongly hairy, 0.4-0.7 mm, uniseriate, smooth, hyaline. Seta (1.5-) 4-6 (-8) mm long, twisted anticlockwise when dry. Capsule long exserted. Urn cylindrical, (1.1-) 1.4-1.7 (-2.3) mm long, yellow to brown, more or less constricted below the mouth when dry and empty, eight furrows along the entire length, with prominent ribs alternately, yellow to brown. Neck short, abruptly narrowed to the seta. Exothecial cells distinctly differentiated into eight bands, almost as long as urn, three to four cells wide, differentiated cells with only extremely thickened longitudinal walls. Stomata superficial, scattered throughout the urn. Preperistome
Ulota panchengiana sp. nov. from China


not seen. **Peristome** double. **Exostome teeth** 16, often united into 8 pairs, variably recurved when dry, sometimes lying on the exothecium, lanceolate, densely papillose on the outside, striate and papillose on the inside. **Endostome segments** 8, rarely with eight additional intermediate, shorter processes, principal segments linear-lanceolate, 180-230 μm tall, 2/3 to almost reaching the exostome teeth, uniseriate.
upper, irregularly biseriate at the base, hyaline, variably incurved when dry, smooth on the outside surface, slightly scabrous on the inside surface. **Opercula** plane to convex, rostrate, yellowish, usually with a reddish basal ring. **Calytra** conic, naked, plicate. **Spores** spherical, finely papillose, (16.5-) 22.9-32.7 (-45.6) \( \mu \text{m} \) in diameter.

**Etymology:** The specific epithet *panchengiana* is named after Pan-Cheng Wu, for his outstanding contribution to Chinese Bryology.

**Ecology and distribution:** *Ulota panchengiana* is epiphytic on tree trunks and branches, the only phorophyte recorded is *Populus*. The elevation range is from 1720 to 3470 m. This new species has so far only been found in the Midwest region of Sichuan Prov. and the southernmost part of Gansu Prov. (Fig. 29). These areas are in the northeastern part of the Hengduan Mountains and the western part of the Qinling Mountains, respectively. They are ecologically unique and therefore possess a high degree of biological diversity. Thus, it is not surprising that new species are found in this region, such as the recently described species *Ulota gigantospora* and *U. yunnanensis* (Caparros et al., 2011).

**Discussion:** *Ulota panchengiana* is a unique species, and differs considerably from its Chinese congeners in the distribution of stomata. In addition, *U. panchengiana* has lanceolate leaves with an ovate base, weakly differentiated basal cells at the leaf margin, long setae (often > 4.5 mm, sometimes up to 8 mm), stomata scattered all over the urn (Fig. 25), and naked calyptra. In most cases, the setae are more than 4.5 mm in length but may sometimes be only 1.5 mm (in specimen of Q. Li 1005). In addition, endostome segments are often eight, rarely sixteen (in specimen of N.R. Gaowa Z650). To date, most *Ulota* species found in the northern Hemisphere have stomata restricted to the basal part of the urn or to the transition zone between the urn and neck, while several species in the southern Hemisphere have stomata present at the upper part of the urn, such as *U. fuegiana* Mitt., *U. macrocalycina* Mitt., and *U. pusilla* Malta. A species with stomata occurring at the central and upper part of the urn has been reported only once in the northern Hemisphere, i.e. *Ulota rhytiore* (B.H.Allen) F.Lara, Garilleti, Albertos & Mazimpaka. However, this species is easily distinguished from *Ulota panchengiana* by the presence of distinctly differentiated basal cells (up to eight rows) at the leaf margin, fusiform capsules, and densely hairy calyptra, as well as the absence of the peristome. Naked calyptra are also rarely found in the northern Hemisphere, and are present on only one species, *Ulota rehmannii* (Wang & Jia, 2012). However, this species has more rows (up to seven) of hyaline cells at the leaf base, as well as remarkable ornamentation of semitransparent and strongly striolate exostome teeth, and stomata located at the junction between the urn and neck. Naked calyptra are relatively more common in *Ulota* species from the southern Hemisphere, such as *Ulota fuegiana* and *U. macrocalycina*. Moreover, *Ulota panchengiana* is also unusual because it has leaves with few (<4) rows of hyaline cells at the base, and this character is also less common in *Ulota* species in the northern than in the southern Hemisphere.

Within China, *Ulota panchengiana* resembles *U. gigantospora* in having few rows of hyaline cells at the leaf base, but the latter species has stomata scattered throughout the lower part of the urn and in the neck, as well as fragile endostome segments and multicellular spores. In addition, *Ulota panchengiana* shares many characters with *U. yunnanensis*: both have twisted leaves, more or less inconspicuous hyaline cells at the leaf base, densely hairy vaginula, and eight well-developed narrow endostome segments. However, *Ulota yunnanensis* has stomata located along the neck or at the urn base, exostome teeth with obvious striate in the upper half, multicellular spores, and hairy calyptra. Furthermore, the long seta of *Ulota panchengiana* resemble those of *U. latisegmenta* and *U. robusta*, but *U. panchengiana*
Ulota panchengiana sp. nov. from China

is distinguished by weakly differentiated cells at the leaf base, stomata scattered throughout the urn, narrow endostome segments, and naked calyptra. Among species outside China, *Ulota panchengiana* seems most closely related to *U. splendida*, a species endemic to Papua New Guinea. These species superficially look alike, and share strongly crisped leaves, weakly differentiated cells at the leaf base, long setae, and somewhat constricted cylindric capsules. However, *Ulota splendida* reaches a larger overall plant size ((2-) 3.5-7 (-9) cm), and has lanceolate leaves with a narrower base, longer capsules (2-3 mm), stomata located at the base of capsules, finely papillose endostome segments, and densely hairy calyptra (Wang & Jia, 2012).

**Additional specimens studied (Paratypes):** CHINA. Gansu, Wen Co., Y. Jia 09278b (PE01417683), 09288 (PE), 09326(3) (PE01743775). Sichuan, Dujiangyan, M.Z. Wang 49928 (PE00650246), P.C. Wu 25350 (PE00650267); Mianning Co., Y. Jia 08188 (PE01087967); Tianquan Co., N.R. Gaowa Z650 (PE02123095), Q. Li 1005 (KUN0878548); Wenchuan Co., Y. Jia 06817 (PE00656566).


**Type:** CHINA. Taiwan, Tainan, Mt. Yushan (Japanese name: Mt. Niitaka), alt. ca. 3300 m, 19 Aug. 1932, A. Noguchi 5985 (holotype: HIRO (n.v.); isotype: NICH!).

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Fig. 29. Distribution of *Ulota panchengiana* Q.H. Wang & Y. Jia.
Ulota panchengiana sp. nov. from China

Description: see Wang & Jia (2012).

Ecology and distribution: epiphytic, reported only from Taiwan of China.

Discussion: Two species of Ulota were hitherto reported from Taiwan: U. crispa and U. morrisonensis (Noguchi, 1937; Nakanishi, 1963). The former is a widespread species, and the latter has been found only in Taiwan at two recorded locations (i.e. Mt. Yushan, Tainan and Mt. Notaka, Taizhong). In the recent revision of Asian Ulota (Wang & Jia, 2012), U. morrisonensis was distinguished from U. crispa mainly by the number of endostome segments, which is sixteen in the former and usually eight in the latter. The segment number in Ulota crispa varies: in most cases there are eight, but sometimes more (up to sixteen), and this can easily lead to it being confused with U. morrisonensis. This confusion necessitates a re-appraisal of the relationship between Ulota morrisonensis and U. crispa.

Noguchi (1937) stated that Ulota morrisonensis was closely related to U. intermedia Schimp., but was distinct from U. intermedia in the only 3-4 rows of hyaline cells at the basal part of the leaf margin, attenuated inner perigonal leaves, an oblong-cylindrical capsule with a longer neck, and endostome segments consisting of two rows of cells. Historically, Ulota intermedia had been generally considered to be an unimportant form or merely a synonym of U. crispa for a long time (Grout, 1935; Nyholm, 1956; Smith & Hill, 1975; Rosman-Hartog & Touw, 1987; Smith & Proctor, 1993). Recently, Caparrós et al. (2016) used molecular data and a complete morphological comparison to reassess the status of Ulota intermedia, and in doing so they reinstated its species rank. According to their description, Ulota intermedia has much in common with U. morrisonensis, which we examined the type material (see Figs 30-38). In both taxa the leaves are crisped when dry, the leaf bases are mostly obovate and distinctly concave, the capsule urn is oblong-cylindrical when dry and empty, exothecal bands are separated from the mouth by a ring of small round cells, the exostome teeth tend to split after being recurved, endostome segments are robust and incurved when dry, and an operculum without a differentiated basal rim is present. But these two species are still substantially different, as Ulota morrisonensis has leaves that gradually narrow into the lamina (Fig. 38), while those in U. intermedia abruptly narrow into the lamina. U. morrisonensis also has slightly constricted capsules when dry and empty, but these are not constricted in U. intermedia; moreover, the endostome segments are always finely papillose throughout in U. morrisonensis, but are smooth to finely papillose below and reticulate above in U. intermedia. Moreover, there are several quantitative characters that differ between these two species, i.e. only 3-6 rows of hyaline basal leaf cells (Fig. 37) are present in U. morrisonensis, but 3-14 rows in U. intermedia, and long sporophytes (6.5-7.5 mm in length) are present in U. morrisonensis but the ones present in U. intermedia are relatively shorter (3.2-6.5 mm).

As mentioned above, Ulota morrisonensis was thought to differ from U. crispa only in the number of endostome segments (Wang & Jia, 2012). However, the morphology of Ulota crispa was thoroughly discussed by Caparrós et al. (2016), who argued that the U. crispa complex represents three closely related but independent species, i.e. U. crispa, U. crispula, and U. intermedia. Based on this recent clarification of the circumscription of Ulota crispa, we found that the common characters it shares with U. morrisonensis are similar to those shared between U. intermedia and U. morrisonensis; these characters include crisped leaves, an obovate and concave leaf base, a cylindrical to ellipsoid capsule (when dry) that is full of spores, robust and incurved endostome segments, and an operculum without a differentiated basal rim. Moreover, distinguishing Ulota morrisonensis from U. crispa is possible not merely by the number of segments of the endostome, since...
morphological comparisons revealed many other differences between them. Among qualitative characters, we found that *Ulota crispa* has exothecial bands that either reach the mouth (or nearly do), exostome teeth that remain tightly fused in pairs in empty capsules and are bordered by a hyaline halo, as well as endostome segments which are narrowly triangular to subulate. In contrast, in *Ulota morrisonensis* the exothecial bands are separated from the mouth by a visible ring of small round cells, the exostome teeth split in empty capsules and have no hyaline halo, and the endostome segments are linear with a more or less widened base. Among quantitative characters, we found that *Ulota crispa* has leaves with (5-) 7-16 (-20) rows of hyaline basal cells, exothecial bands formed by 4-6 rows of cells, and relatively smaller spores with a diameter ranging from 14-23 µm. In contrast, in *Ulota morrisonensis* the leaves have only 3-6 rows of hyaline basal cells, exothecial bands
are formed by 3-4 rows of cells, and spores are larger, having a diameter ranging from 24-26 μm.

Although *Ulota morrisonensis* does not resemble *U. crispula* as much as it does *U. crispa* and *U. intermedia*, they have a few characters in common. These include a leaf base that gradually narrows into the lamina, and narrow marginal bands with differentiated cells along the leaf base. However, *Ulota morrisonensis* differs from *U. crispula* mainly by its longer sporophytes (6.5-7.5 mm), cylindrical
Table 1. Morphological comparison between *Ulota morrisonensis*, *U. crispa* and *U. intermedia*. All the description of *U. crispa* and *U. intermedia* are from Caparrós *et al.* (2016). Characters in bold indicate the main distinctions between three species.

<table>
<thead>
<tr>
<th>Characters</th>
<th><em>U. crispa</em></th>
<th><em>U. intermedia</em></th>
<th><em>U. morrisonensis</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>habit and aspect when dry</td>
<td>medium to large cushions, generally strongly crisped</td>
<td>medium to large cushions, markedly crisped</td>
<td>small to large cushions, moderately to strongly crisped</td>
</tr>
<tr>
<td>leaf shape when dry</td>
<td>tortuose or circinate, occasionally falcate-tortuose</td>
<td>tortuose or circinate, occasionally falcate-tortuose or circinate</td>
<td>tortuous</td>
</tr>
<tr>
<td>leaf base</td>
<td>mostly obovate, distinctly concave, abruptly narrowing into the lamina</td>
<td>mostly obovate, distinctly concave, abruptly narrowing into the lamina</td>
<td>mostly obovate, distinctly concave, gradually narrowing into the lamina</td>
</tr>
<tr>
<td>width of band with differentiated leaf basal cells</td>
<td>broad, (5-) 7-16 (-20) cell rows</td>
<td>narrow to broad, (2-) 3-14 (-16) cell rows</td>
<td>narrow, 3-6 cell rows</td>
</tr>
<tr>
<td>sporophyte total length (mm)</td>
<td>(3-) 3.2-6.8 (-7.4)</td>
<td>(3-) 3.2-6.5</td>
<td>6.5-7.5</td>
</tr>
<tr>
<td>spore size (µm)</td>
<td>(12-) 14-23 (-25)</td>
<td>(15-) 18-35 (-38)</td>
<td>(21-) 24-26 (-27)</td>
</tr>
<tr>
<td>capsule shape when dry and full of spores</td>
<td>cylindrical to ellipsoid</td>
<td>ellipsoid to cylindrical-ellipsoidal, rarely long ovoid</td>
<td>cylindrical to cylindrical-ellipsoidal</td>
</tr>
<tr>
<td>urn shape when dry and empty</td>
<td>urceolate</td>
<td>cylindrical, oblong-cylindrical, obconic or elongate-ovoid</td>
<td>cylindrical to oblong cylindrical</td>
</tr>
<tr>
<td>constriction below mouth when dry and empty</td>
<td>strongly constricted</td>
<td>not constricted</td>
<td>slightly constricted</td>
</tr>
<tr>
<td>width of capsule furrows when dry and empty</td>
<td>commonly uniformly narrow, collapsed at the constricted area of the urn</td>
<td>broad, not collapsing anywhere</td>
<td>often broad, not collapsing anywhere</td>
</tr>
<tr>
<td>number of cell rows of exothecial bands</td>
<td>4-5 (-6)</td>
<td>2-4 (-5)</td>
<td>3-4</td>
</tr>
<tr>
<td>cell colour of exothecial bands</td>
<td>evenly yellow to pale orange</td>
<td>hyaline with pale yellow incrassated lateral walls</td>
<td>evenly golden yellow</td>
</tr>
<tr>
<td>differentiation at capsule mouth</td>
<td>nearly reaching the mouth or vaguely separated by a ring of small, thin-walled cells in 1-3 (-4) layers</td>
<td>not reaching the mouth, visibly separated by a ring of small, thin-walled cells in (1-) 2-6 (-7) layers</td>
<td>not reaching the mouth, visibly separated by a ring of small round cells in 5-7 layers</td>
</tr>
<tr>
<td>tendency of teeth pairs to split</td>
<td>no, most teeth remain tightly fused in pairs even in old capsules</td>
<td>yes, teeth tend to split after being recurved</td>
<td>yes, teeth split easily after being recurved</td>
</tr>
<tr>
<td>Characters</td>
<td><em>U. crispa</em></td>
<td><em>U. intermedia</em></td>
<td><em>U. morrisonensis</em></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>external visibility of principal peristomial layer (PPL) at marginal parts of teeth</td>
<td>yes, as a smooth hyaline halo</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>endostome segment appearance and durability</td>
<td>robust and persistent</td>
<td>robusta and usually persistent</td>
<td>robusta and often persistent</td>
</tr>
<tr>
<td>endostome segment position when dry</td>
<td>incurved</td>
<td>incurved</td>
<td>incurved</td>
</tr>
<tr>
<td>endostome segment shape</td>
<td>long triangular to subulate</td>
<td>broadly linear with a more or less widened base or subulate</td>
<td>linear with a more or less widened base</td>
</tr>
<tr>
<td>endostome segment cell pattern at the inner peristome layer (IPL)</td>
<td>uniseriate, with transversal walls variably incrassate</td>
<td>uniseriate, with incrassate and prominent transversal walls</td>
<td>uniseriate or irregularly biseriate, with prominent transversal walls</td>
</tr>
<tr>
<td>internal ornamentation (IPL) of endostome segment</td>
<td>smooth to finely papillose below, variably papillose above, but never opaque because of the papillae density</td>
<td>smooth to very finely papillose below, variably reticulate above, but never opaque because of the ornamentation density</td>
<td>finely papillose</td>
</tr>
<tr>
<td>operculum colour</td>
<td>yellowish, without a differentiated basal rim</td>
<td>yellowish, without a differentiated basal rim</td>
<td>yellowish, without a differentiated basal rim</td>
</tr>
</tbody>
</table>
dry capsules, robust and persistent endostome segments, which are finely papillose inside and always incurved when dry, and its operculum, which is without a differentiated basal red rim. In *U. crispula*, the sporophytes are distinctly shorter (2-3.8 mm), the capsule is short and cylindrical to urnceolate when dry and empty, the endostome segments are slender and fragile, and are sometimes incurved when dry and covered by a reticulum inside, and its operculum usually has a differentiated basal red rim. In addition, several more subtle distinctions exist between these species, such as the fact that *U. crispula* has 2-4 layers of small round cells around the capsule mouth, but this number increases to 5-7 in *U. morrisonensis*.

Here, we describe twenty-one characters of *Ulota morrisonensis* (Table 1) that correspond to the characters of the table in Caparrós et al. (2016) and compared them to *U. crispa* and *U. intermedia*. Furthermore, the observable distinctions between *Ulota morrisonensis* and *U. crispa*, *U. crispula*, or *U. intermedia* confirm its rank as a species.

**Additional specimens studied:** *U. crispa*: CHINA. Taiwan, Mt. Taiheizan, S. Suzuki s.n. (H3205517); Mt. Yu, J. R. Chen 97467 (PE00353581); Tainan, M. Tagawa s.n. (KYO); Taizhong, Q. Gao&T. Cao 980200 (IFP00038863). *U. delicata*: CHINA. Taiwan, Mt. Nan-hu-ta shan, C. C. Chuang 1791 (UBC-B58028). *U. morrisonensis*: CHINA. Taiwan, Mt. Notaka, K. Sawada s.n. (TNS14606).

**A revised key to *Ulota* species in China**

1. Stomata scattered over the urn, sometimes only the central and lower part of urn; few rows (≤ 4) of hyaline cells at marginal leaf base; naked calyptra ..........................................................6 *U. panchengiana*
2. Spores large, 78-115 μm, multicellular......................................................3
3. Capsules subglobose, not constricted when dry; peristome single..............5 *U. yakushimensis*
4. Leaves mainly curved and falcate when dry; only 1-2 rows of hyaline cells at the leaf basal margin; vaginula naked or hairy; exostome teeth densely papillose ...........................................................................7 *U. gigantospora*
5. Capsules cylindrical, sometimes ovoid, with 8 furrows along almost the entire length when dry; peristome present ..............................................6 *U. curvifolia*
6. Upper leaf cells often with tall and branched papillae; exostome teeth with obvious vertical striolae in the upper half; grow on rocks..............7 *U. gymnostoma*
7. Upper leaf cells often with short papillae; exostome teeth mostly with dense papillae, rarely striolate on the upper half; grow on trees .........
7. Endostome segments very broad; few rows of hyaline cell at the basal leaf margin, often ≤ 4 rows.................................................8
7. Endostome segments narrow; many rows of hyaline cells at the basal leaf margin, usually > 4 rows................................................9
8. Capsules cylindrical, usually constricted when dry; endostome segments 16, often 8 long 8 short; leaves strongly crisped when dry ............U. latisegmenta
8. Capsules obovoid, not constricted when dry; endostome segments 8; leaves flexuose, sometimes moderately crisped when dry........................................U. robusta
9. Exostome teeth often semitransparent along the upper half and strongly striolate with variable orientation; calyptra almost naked; leaves flexuose, sometimes moderately crisped when dry...........................................U. rehmannii
9. Exostome teeth usually densely papillate, not semitransparent; calyptra densely hairy; leaves strongly crisped when dry...........................................10
10. Seta short, 0.5-0.7 mm; capsules emergent to short exserted, subglobose when moist, slightly constricted......................................U. perbreviseta
10. Seta long, 1.5-6 mm; capsules long exserted, cylindrical when dry or moist, often moderately to strongly constricted.............................11
11. Endostome segments 16, alternative 8 often caducous, filiform, slender, densely papilllose; exostome teeth strongly papilllose..........................U. delicata
11. Endostome segments usually 8 or 16 and are linear or narrow lanceolate, not slender, smooth, slightly scabrous or finely papilllose; exostome teeth with relatively weak papillae ................................................12
12. Leaves with only 3-6 rows of hyaline basal cells; exothecial bands formed by 3-4 rows of cells, separated from the mouth by a visible ring of small round cells; exostome teeth sometimes split in empty capsules, without a hyaline halo; spores are comparatively large (24-26 μm) ..............................U. morrisonensis
12. Leaves with often 7-16 rows of hyaline basal cells; exothecial bands formed by 4-6 rows of cells, reaching the mouth or nearly so; exostome teeth always tightly fused in pairs in empty capsules, bordered by a hyaline halo; spores are relatively small (14-23 μm) ..................................................................................U. crispa

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