

Smut Fungi from Yunnan Province, China, Collected in 1998*

Makoto Kakishima¹, Cvetomir M. Denchev², Xuan Zhou³ and Mu Zang³

¹ Institute of Agriculture and Forestry, University of Tsukuba,
Tsukuba, Ibaraki 305–8572, Japan

² Institute of Botany, Bulgarian Academy of Sciences,
23 Acad. G. Bonchev Str., BG-1113 Sofia, Bulgaria

³ Kunming Institute of Botany, Academia Sinica,
Kunming, Yunnan 650204, China

Abstract Seven species of smut fungi are reported based on the specimens collected during Botanical Expedition to Yunnan, China in 1998. Among these species, *Microbotryum cordae*, *M. nepalense*, *M. polygoni-alati* and *Sphacelotheca polygoni-senticosi* were newly recorded from Yunnan Province. New host plants were also reported in *Liroa emodensis*, *Microbotryum cordae* and *Sphacelotheca polygoni-senticosi*.

Key words: *Liroa*, *Microbotryum*, *Sphacelotheca*, smut fungi, Ustilaginomycetes, *Ustilago*, Yunnan

Previous compilations of published records included about 190 species of smut fungi belonging to 24 genera from China (Ling, 1953; Wang, 1963; Tai, 1979; Guo, 1992). Among them, only about 30 species have been reported in Yunnan. However, we believe that more smut fungi are distributed in this area and these species parasitize on many host plant species since vegetation of this area is very rich and diverse. Therefore, more extensive field survey and collections are required for better understanding of the flora of smut fungi.

We report here 1 species of *Ustilago*, 1 species of *Liroa*, 3 species of *Microbotryum* and 2 species of *Sphacelotheca* based on the specimens collected during Botanical Expedition carried out mainly in Zhantong and Nujiang Districts, Yunnan Province, China in 1998. Among 7 species of smut fungi reported here, *Microbotryum cordae*, *M. nepalense*, *M. polygoni-alati* and *Sphacelotheca polygoni-senticosi* were newly recorded from Yunnan Province. New host plants were also reported in *Liroa emodensis*, *Microbotryum cordae* and *Sphacelotheca polygoni-senticosi*.

* Contribution No. 149, Laboratory of Plant Pathology and Mycology, Institute of Agriculture and Forestry, University of Tsukuba.

Materials and Methods

The dry specimens were examined under light (LM) and scanning electron microscopy (SEM). For LM observations, the ustilospores were mounted in lactophenol solution on glass slides by gently heating to the boiling point and then cooling. The measurements of ustilospores were given in the form: min-max (mean $\pm$ standard deviation). In the description, a symbol 'n/x=' was used to indicate the total numbers of measured specimens and ustilospores, respectively. For SEM, the ustilospores were attached to specimen holders by double-sided adhesive tape and coated with platinum-palladium with Hitachi E-1030 Ion Sputter. The surface structure of ustilospores was observed with a Hitachi S-4200 SEM.

All the specimens cited in this paper were deposited in the following herbaria: the Mycological Herbarium of the Institute of Agriculture and Forestry of University of Tsukuba, Japan (TSH), the Mycological Herbarium, Department of Botany, National Science Museum, Tokyo, Japan (TNS), the Cryptogamic Herbarium, Kunming Institute of Botany, Kunming, China (HKAS), the Mycological Herbarium, the Institute of Microbiology, Academia Sinica, Beijing, China (HMAS).

Enumeration of Species

Fam. Ustilaginaceae

1. ***Ustilago maydis* (DC.) Corda**, *Icones Fung.*, **5**: 3, 1842. (Fig. 1)

Sori in various parts of the host (stems, leaves, male and female inflorescences), evident as small to large (sometimes more than 10 cm long), irregular galls, at first covered by a thin, silvery, later brown peridium which ruptures irregularly to expose the spore mass. **Spore mass** powdery, dark brown. **Ustilospores** globose, subglobose or ovoid, sometimes slightly irregular, $10\text{--}14.5 \times 9\text{--}13$ ($12.0 \pm 0.8 \times 11.2 \pm 0.8$) μm ($n/1=100$), reddish-brown; wall (without ornaments) $0.5\text{--}0.7$ μm thick, rather densely echinate; the spines $0.6\text{--}1.5$ μm high, under SEM interspersed with a few minute warts.

Specimen examined: on *Zea mays* L. (cult.), Yunnan Province, Zhaotong District, near Mugan, Sept. 19, 1998, leg. M. Kakishima, CH-40 (TSH-S1107, TNS-F-107954, HKAS 34499, HMAS).

Hosts and distribution: *Euchlaena* spp. and *Zea mays* L., worldwide.

Fam. Microbotryaceae

2. ***Liroa emodensis* (Berk.) Cif.**, *Nuovo Giorn. Bot. Ital.*, N. S., **40**: 264, 1933. (Fig. 2)

Sori in the flowers, irregularly globose, up to 7 mm in diameter, at first covered by a hard peridium and greenish, later purplish. **Spore mass** powdery, purple slate,

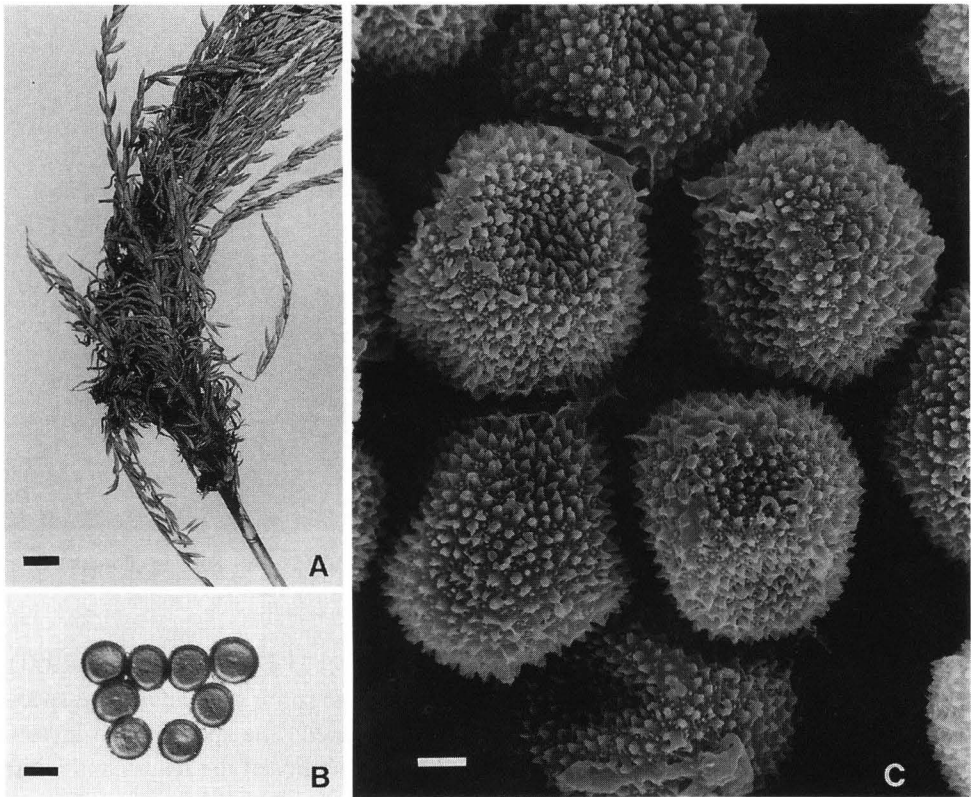


Fig. 1. *Ustilago maydis* on *Zea mays* (TSH-S1107). A. Sori in flowers. B. Ustilospores observed by LM. C. Ustilospores observed by SEM. Bar: A=20 mm, B=10 μ m, C=2 μ m.

intermixed with poorly ramified, irregular filaments of host tissue origin. **Ustilospores** globose, subglobose or ovoid, $6-9.5 \times 5.5-9$ ($7.2 \pm 0.6 \times 6.7 \pm 0.6$) μ m ($n/1=50$), unusually elongate ones up to 11 μ m in length, light brown; wall reticulate, under SEM finely and densely irregularly reticulate, 12–16 meshes per spore diameter, under lower magnifications the spore profile appearing as verruculose.

Specimen examined: on *Persicaria nepalensis* (Meisn.) H. Gross (= *Polygonum nepalense* Meisn.), Yunnan Province, Nujiang District, Pianma, N $25^{\circ}59'429''$ E $98^{\circ}39'750''$, alt. 2335 m, Sept. 29, 1998, leg. M. Kakishima, CH-146 (TSH-S1115, TNS-F-107955, HKAS 34507, HMAS).

Hosts and distribution: *Persicaria* spp., South and Southeast Asia (India, Nepal, Mainland and Taiwan of China, Sri Lanka, Indonesia, Philippines).

Lirioea emodensis has been reported from China only from Yunnan Province on *P. chinensis* (L.) Nakai (= *Polygonum chinense* L.) (Wang, 1963; Guo, 1988). *Persicaria nepalensis* is a new host for this smut fungus. The ustilospore variability of both

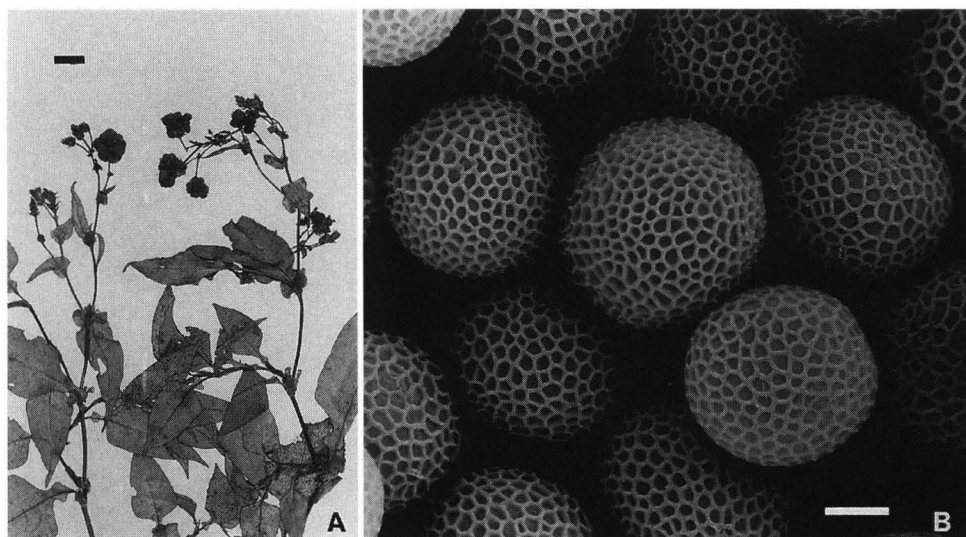


Fig. 2. *Liroa emodensis* on *Persicaria nepalensis* (TSH-S1115). A. Sori in flowers. B. Ustilospores observed by SEM. Bar: A=10 mm, B=2 μ m.

length (CV=8.3%) and width (8.9%) is at a modal level (5.1–10%, Denchev, 1993). Because Ling (1953: 319) showed high variability of the spore size, additional specimens from Taiwan, India and Sri Lanka were investigated. The spores of all investigated specimens are more or less uniform and the variability of the length and width is at a modal level, excluding the length of the specimen from Sri Lanka with variability evaluated at an increased degree (10.1–15%). The spore mass colour of all specimens is purple slate.

Further specimens on *P. chinensis* examined: Taiwan, Apr. 12, 1924, K. Sawada (SAPA), stem (obtained spore measurements) and floral infection, ustilospores $6.5\text{--}8.5 \times 6\text{--}7.5$ ($7.2 \pm 0.4 \times 6.7 \pm 0.4$) μ m ($n/1=30$), CV=5.5%, respectively 6.0%; India, Tamil Nadu, Mt. Palni Hills, pr. pag. Kadaikanal, alt. 1200–1600 m, Jan. 29, 1980, K. Vánky (Vánky, Ust. 399), floral infection, ustilospores $7\text{--}9 \times 6\text{--}8$ ($7.8 \pm 0.4 \times 7.3 \pm 0.4$) μ m ($n/1=30$), CV=5.1%, respectively 5.5%; Sri Lanka, Mt. Toptapola, pr. oppid. Nuwara Eliya, alt. ca. 1800 m, Mar. 18, 1975, K. Vánky (Vánky, Ust. 181), floral infection, ustilospores $6.5\text{--}9.5 \times 6\text{--}8$ ($7.8 \pm 0.8 \times 7.0 \pm 0.5$) μ m ($n/1=30$), CV=10.3%, respectively 7.1%.

3. ***Microbotryum cordae* (Liro) G. Deml & Prillinger** in Prillinger *et al.*, Bot. Acta, **104**: 10, 1991 (*sensu lat.*, incl. *Ustilago bungeana* W. Y. Yen). (Fig. 3)

Sori in the swollen and deformed flowers, protected by the perianths, filled by a powdery, dark reddish-brown spore mass. Infection systemic. **Ustilospores** globose, subglobose, ovoid or broadly ellipsoidal, $9.5\text{--}13 \times 8.5\text{--}12.5$ ($11.3 \pm 0.7 \times 10.5 \pm 0.7$)

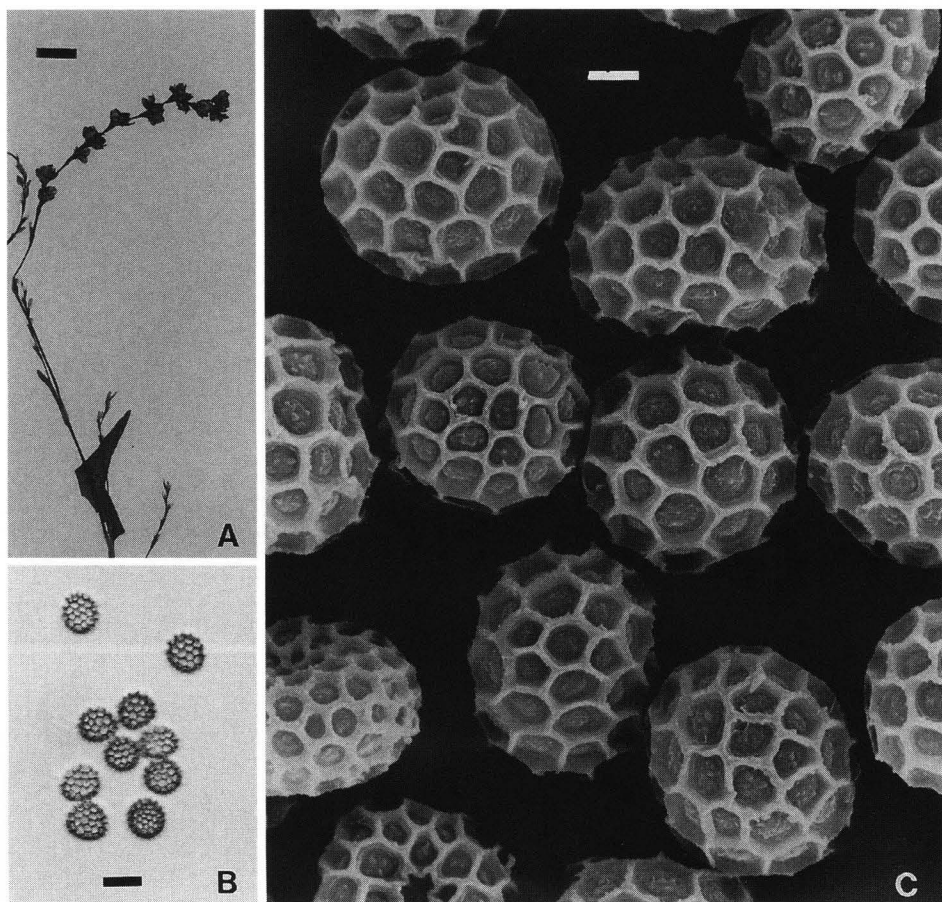


Fig. 3. *Microbotryum cordae* on *Persicaria yokusaiana* (TSH-S1109). A. Sori in flowers. B. Ustilospores observed by LM. C. Ustilospores observed by SEM. Bar: A=5 mm, B=10 μ m, C=2 μ m.

μ m ($n/1=50$), light yellowish-brown; wall reticulate; 4–6 meshes per spore diameter, muri 0.9–1.2 μ m high, under SEM the interspace of the meshes with a coarsely verrucose tuberculum.

Specimen examined : on *Persicaria yokusaiana* (Makino) Nakai (= *Polygonum caespitosum* Blume), Yunnan Province, Zhaotong District, Yiliang, Xiaocaoba, N 27°47'391" E 104°14'437", alt. 1760 m, Sept. 17, 1998, leg. M. Kakishima, CH-18/2 (TSH-S1109, TNS-F-107956, HMAS).

Hosts and distribution : *Persicaria* spp., worldwide.

This species is a new one for the Yunnan Province. *Persicaria yokusaiana* is a new host for this smut fungus.

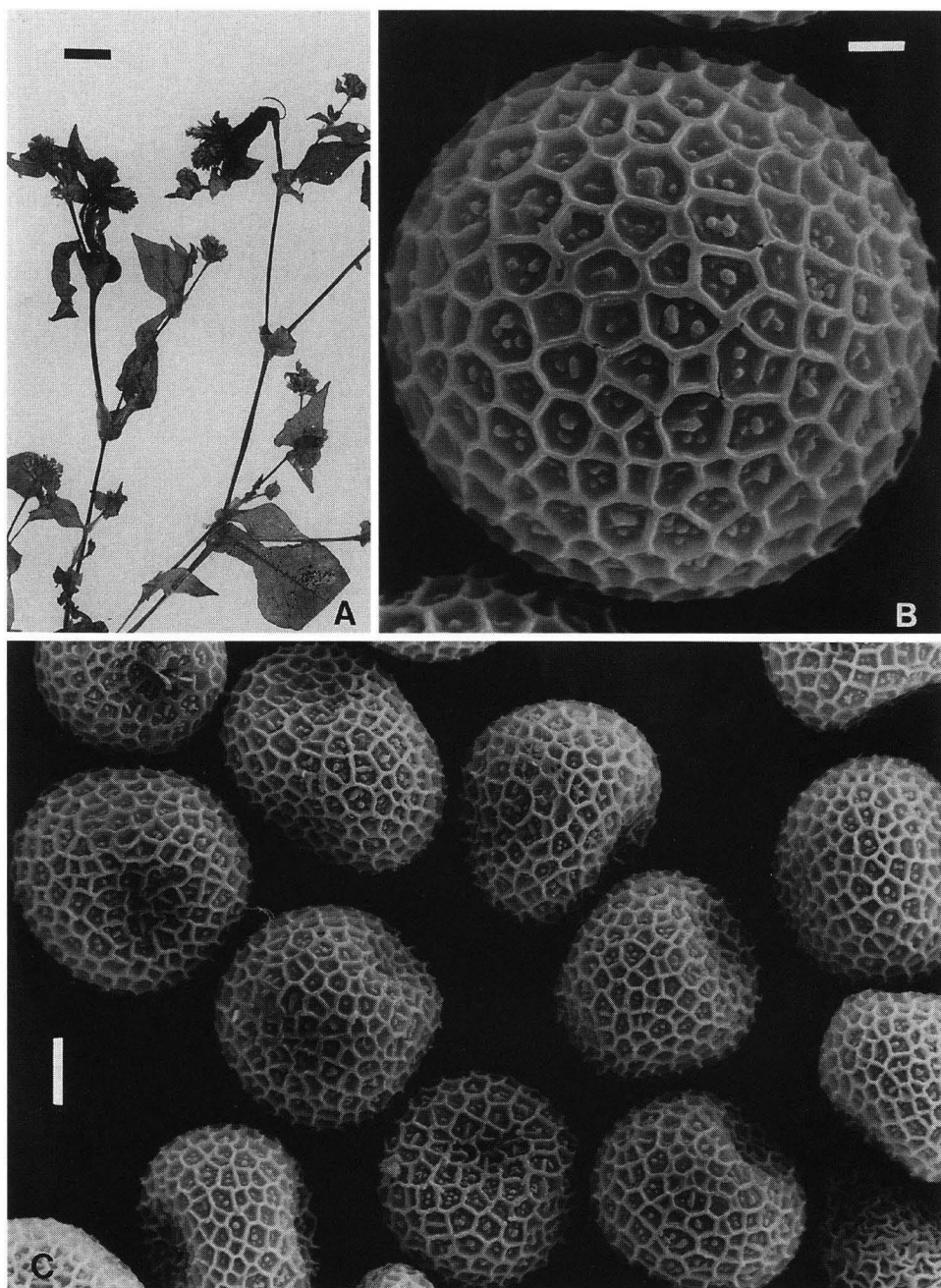


Fig. 4. *Microbotryum nepalense* on *Persicaria nepalensis* (TSH-S1113). A. Sori in stems. B, C. Ustilospores observed by SEM. Bar: A = 10 mm, B = 1 μ m, C = 3 μ m.

4. **Microbotryum nepalense (Liro) Vánky**, Mycotaxon, **67**: 47, 1998. (Fig. 4)

Sori as spindle-shaped, 0.8–2 cm long swellings in the stems, situated closely below the intact inflorescence. **Spore mass** powdery, dark reddish-brown; numerous fibrous fascicles of host tissue origin through the spore mass present. **Ustilospores** subglobose, globose or ovoid, rarely broadly ellipsoidal, $10.5\text{--}13.5 \times 10\text{--}12$ ($12.0 \pm 0.6 \times 11.0 \pm 0.5$) μm ($n/1=50$); wall very finely and densely reticulate, sometimes incompletely reticulate; 10–15 meshes per spore diameter, muri low (0.3–0.6 μm), under SEM the interspace of the meshes verruculose, under lower magnifications the spore profile is finely serrulate.

Specimen examined: on *Persicaria nepalensis* (Meisn.) H. Gross (= *Polygonum nepalense* Meisn.), Yunnan Province, Nujiang District, Pianma, N $25^{\circ}59'429''$ E $98^{\circ}39'750''$, alt. 2335 m, Sept. 29, 1998, leg. M. Kakishima, CH-145/1 (TSH-S1113, TNS-F-107957, HKAS 34505, HMAS).

Host and distribution: *Persicaria nepalensis* (Meisn.) H. Gross, Asia (China, Nepal, Pakistan, India, Tadzhikistan, Japan, Far East of Russia).

This species is a new one for the Yunnan Province.

5. **Microbotryum polygoni-alati (Thurum. & Pavgi emend. L. Guo) Vánky**, Mycotaxon, **67**: 49, 1998. (Fig. 5)

Sori in the flowers as globoid or reniform swellings, a few mm up to 1 cm long, at first covered by a greenish, later to rosy vinaceous membrane which ruptures irregularly to expose the spore mass. **Spore mass** powdery, dark purple. **Ustilospores** subglobose, broadly ellipsoidal or globose, $9.5\text{--}13 \times 9.5\text{--}12$ ($11.5 \pm 0.6 \times 10.9 \pm 0.6$) μm ($n/1=50$), light reddish-brown; wall ca. 1 μm thick, reticulate, sometimes incompletely reticulate, under SEM with tubercles on the muri; interspace of the meshes tuberculate and foveolate (0–3, sometimes up to 5 cavities per interspace).

Specimen examined: on *Persicaria nepalensis* (Meisn.) H. Gross (= *Polygonum nepalense* Meisn.), Yunnan Province, Nujiang District, Pianma, N $25^{\circ}59'429''$ E $98^{\circ}39'750''$, alt. 2335 m, Sept. 29, 1998, leg. M. Kakishima, CH-145/2 (TSH-S1114, TNS-F-107958, HKAS 34506, HMAS).

Host and distribution: *Persicaria nepalensis* (Meisn.) H. Gross, China, India.

This species has been previously recorded from China only once (Sichuan: Guo, 1993). The present record is a new one for the Yunnan Province.

6. **Sphacelotheca hydropiperis (Schumacher) De Bary**, Verh. Morphol. Biol. Pilze, Mycetozen & Bact., p. 187, 1884. (Figs. 6 and 7)

Sori in the swollen ovaries, forming oblong or ovate bodies, 2.5–4 mm in length, at first covered by a greyish-brown peridium; with a central columella. **Spore mass** powdery, dark purplish-brown or purple slate; sterile cells usually present amongst the ustilospores being derived from the peridium or columella. Infection systemic. **Sterile cells** of the peridium and columella variable in shape and size, globose, sub-

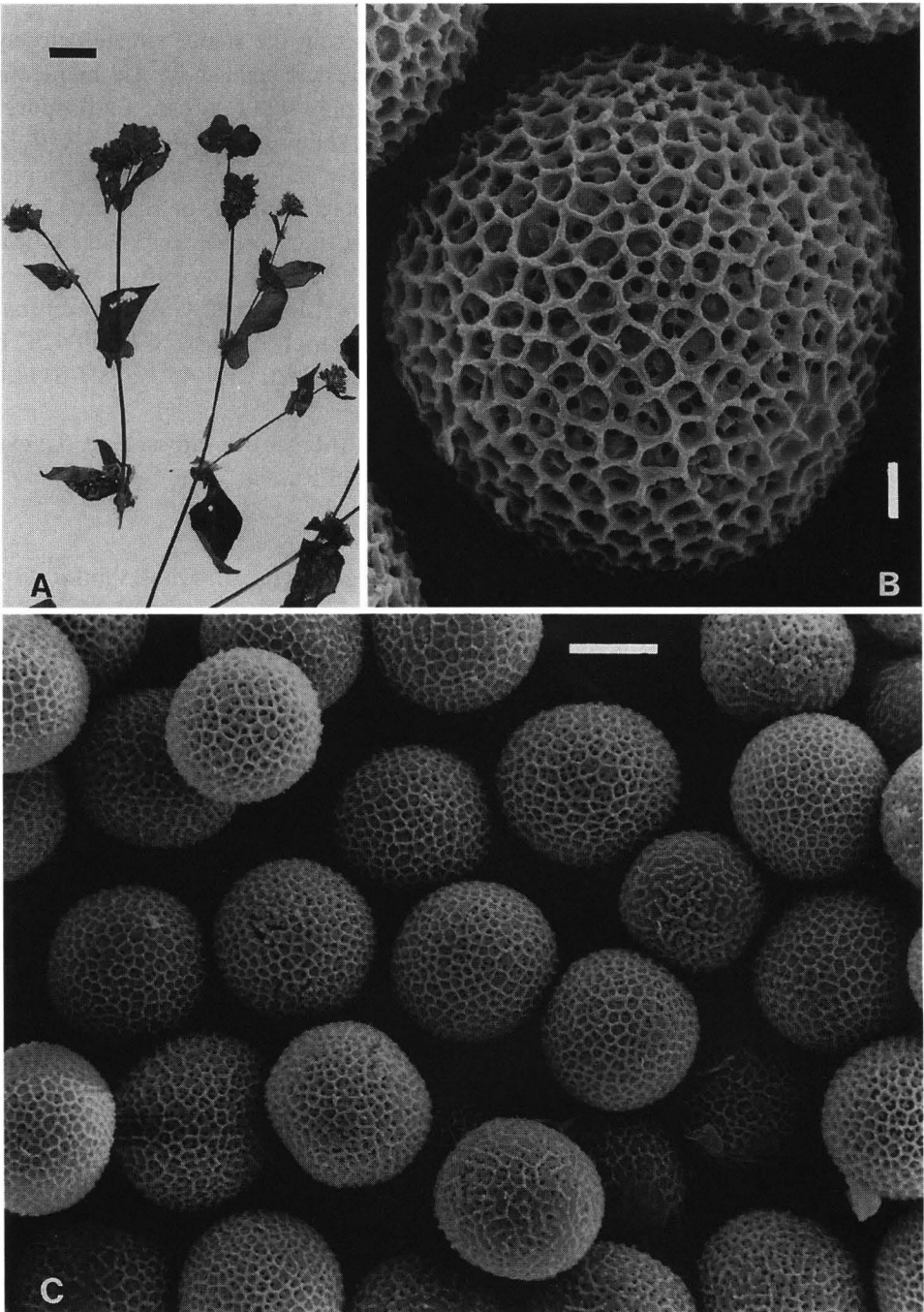


Fig. 5. *Microbotryum polygoni-alati* on *Persicaria nepalensis* (TSH-S1114). A. Sori in flowers. B, C. Ustilospores observed by SEM. Bar: A=10 mm, B=1 μ m, C=5 μ m.

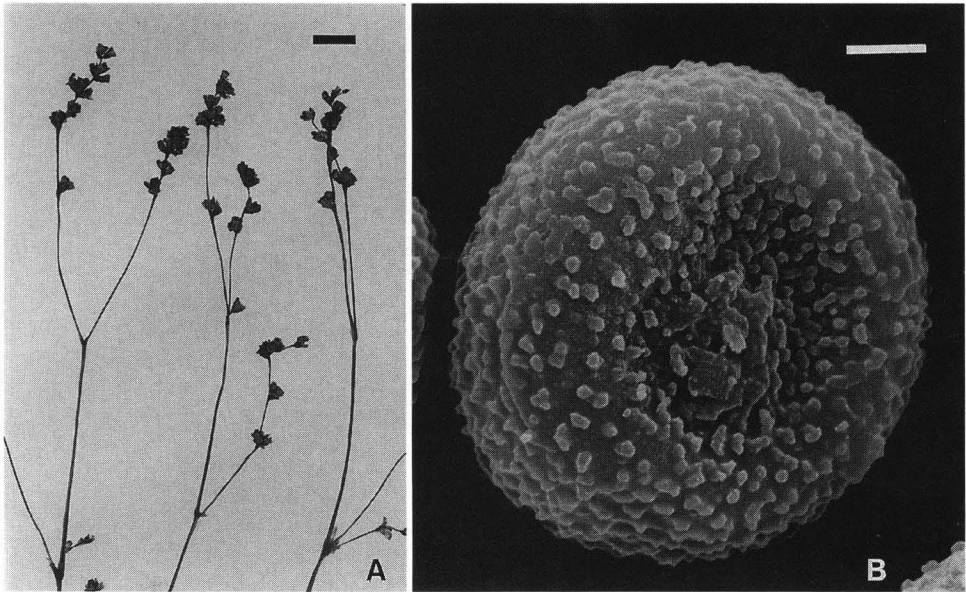


Fig. 6. *Sphacelotheca hydropiperis* on *Persicaria* aff. *praetermissa* (TSH-S1110). A. Sori in flowers. B. Ustilospores observed by SEM. Bar: A=10 mm, B=2 μ m.

globose, broadly ellipsoidal, or slightly irregular, $7\text{--}13.5 \times 5.5\text{--}11.5\text{ }\mu\text{m}$, smaller than or equal to the size of the ustilospores, hyaline. **Ustilospores** more or less flattened, in plane view subcircular, broadly elliptical, ovate or slightly irregular, $9\text{--}16.5 \times 8\text{--}14.5$ ($11.8 \pm 1.0 \times 10.5 \pm 0.9$) μm ($n/3=150$); middle reddish-brown; wall verruculose, often some warts connecting (2 or 3 warts per group). Young spores near the base of the sorus in chains, separated by small disjunctors. Mature spores single; the disjunctors remaining as small, hyaline, oppositely situated appendages.

Specimens examined: on *Persicaria* aff. *praetermissa* Hook. f., Yunnan Province, Zhaotong District, Mugan, Sanchanco, N $28^{\circ}12'610''$ E $103^{\circ}56'686''$, alt. 1695–1720 m, Sept. 20, 1998, leg. M. Kakishima, CH-41 (TSH-S1110, TNS-F-107959, HKAS 34502, HMAS); on *P. hydropiper* (L.) Spach (= *Polygonum hydropiper* L.), Yunnan Province, Nujiang District, Pianma, N $26^{\circ}00'561''$ E $98^{\circ}37'524''$, alt. 1987 m, Sept. 28, 1998, leg. M. Kakishima, CH-97 (TSH-S1112, TNS-F-107960, HKAS 34504, HMAS); Yunnan Province, Zhaotong District, Mugan, Sanchanco, N $28^{\circ}13'778''$ E $103^{\circ}56'710''$, alt. 1700–1885 m, Sept. 21, 1998, leg. M. Kakishima, CH-65 (TSH-S1111, TNS-F-107961, HMAS).

Hosts and distribution: *Persicaria* spp. and *Polygonum* spp., worldwide.

7. *Sphacelotheca polygoni-senticosi* (Henn.) Miyabe & Takah. ex S. Ito, Trans. Sapporo Nat. Hist. Soc., 14: 90, 1935. (Fig. 8)

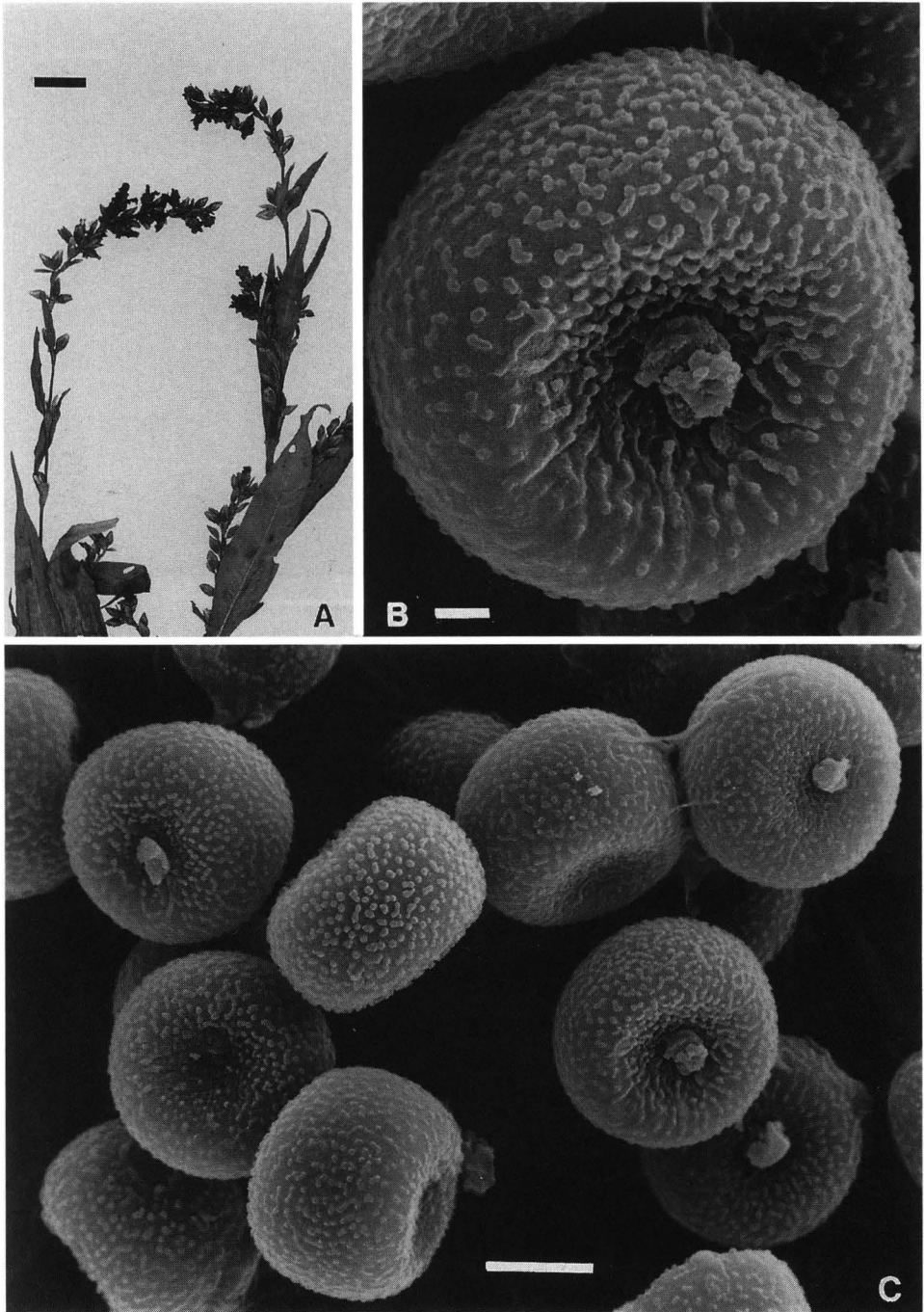


Fig. 7. *Sphacelotheca hydropiperis* on *Persicaria hydropiper* (TSH-S1111). A. Sori in flowers. B, C. Ustilopsores observed by SEM. Bar: A=10 mm, B=1 μ m, C=5 μ m.

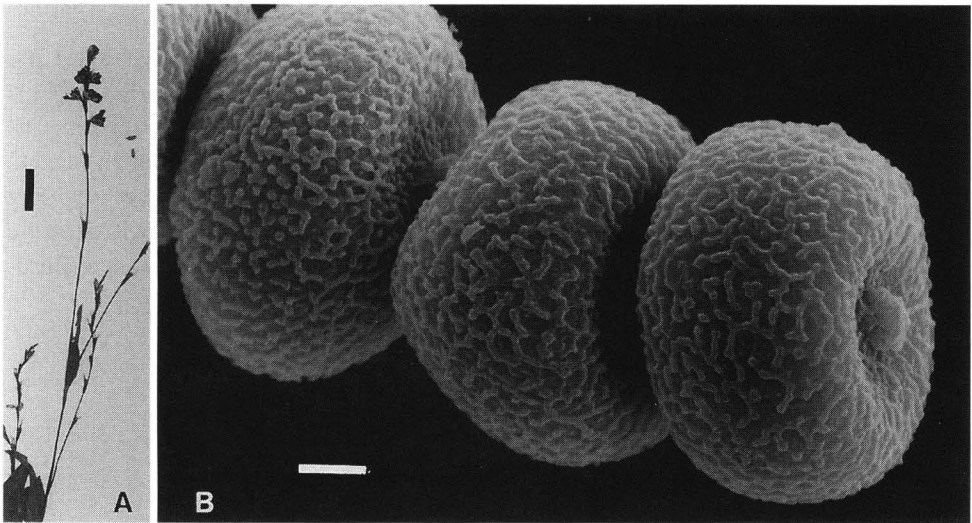


Fig. 8. *Sphacelotheca polygoni-senticosi* on *Persicaria yukusaiana* (TSH-S1108). A. Sori in flowers. B. Ustilospores observed by SEM. Bar: A = 10 mm, B = 2 μ m.

Sori in the swollen ovaries, forming oblong or ovate bodies, 2–3.5 mm in length, with a central, unbranched columella, at first covered by a greyish-brown peridium. **Spore mass** powdery, dark reddish-brown; sterile cells usually present amongst the ustilospores. **Sterile cells** globose, subglobose, broadly ellipsoidal, ellipsoidal or slightly irregular, 5–19.5 $\times$ 4.5–14 μ m, hyaline. **Ustilospores** more or less flattened, in plane view subcircular, broadly elliptical, ovate or slightly irregular, 9–14 $\times$ 8.5–12.5 ($11.6 \pm 1.1 \times 10.3 \pm 0.9$) μ m ($n/1=50$); middle reddish-brown; wall verruculose with warts often arranged in rows, incompletely reticulate or incompletely cerebriform. Young spores in chains, separated by small disjunctors. Mature spores single; the disjunctors remaining as small, hyaline, oppositely situated appendages.

Specimen examined: on *Persicaria yokusaiana* (Makino) Nakai (= *Polygonum caespitosum* Blume), Yunnan Province, Zhaotong District, Yiliang, Xiaocaoba, N 27°47'391" E 104°14'437", alt. 1760 m, Sept. 17, 1998, leg. M. Kakishima, CH-18/1 (TSH-S1108, TNS-F-107962, HKAS 34500, HMAS).

Hosts and distribution: *Persicaria* spp. and *Polygonum* spp., China, Japan.

Sphacelotheca polygoni-senticosi has been reported from China on *Persicaria longiseta* (De Bruyn) Kitag. (= *Polygonum longisetum* De Bruyn) and *Polygonum posumbu* Hamilt. (Guo, 1992). This record is a new one for the Yunnan Province. *Persicaria yokusaiana* is a new host for this smut fungus.

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