

## Taxonomy, host spectrum and global distribution of *Anthracoidea siderostictae* (Ustilaginomycetes)

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The first record of *Anthracoidea siderostictae* Kukkonen from Russia provides the background to review the taxonomy, host spectrum and world distribution of this rare smut fungus. The Russian collection is fully described and illustrated with drawings of the infected plant, and with LM and SEM micrographs of spores. *Anthracoidea siderostictae* is now known from six localities in China, Japan and Russia, where it infects representatives of *Carex* sect. *Siderostictae*. The global distribution of *A. siderostictae* is mapped.

Key words: *Anthracoidea*, host range, mycogeography, smut fungi, taxonomy

The smut fungus *Anthracoidea siderostictae* is one of the few species of *Anthracoidea* described by Ilkka Kukkonen from outside of Europe, during his extensive studies on the genus (Kukkonen 1963, 1964a, 1964b). When describing this species Kukkonen (1964b) designated as a holotype a specimen on *Carex siderosticta* from Japan, and in addition enumerated three other specimens on *C. siderosticta* and *C. ciliatomarginata* from China and Japan. Kukkonen (1964b) described this species based on observations under light microscope (LM) and transmission electron microscope (TEM). He also included illustrations of spores made in TEM. Later, Guo (1994) recorded *A. siderostictae* from another locality in China, provided a short description and illustrated the spores by a scanning electron microscope (SEM) micrograph. Since then no additional records of this species were reported in the literature and *A. siderostictae* appears to

be a very rare East Asian smut fungus. During the course of a study of various collections of *Anthracoidea* I examined a specimen collected in Primorski Krai in Russia, infecting *Carex siderosticta* and identified as “*Cintractia subinclusa* (Körn.) Magnus”. The specimen appeared to represent typical *Anthracoidea siderostictae* that, accordingly, is new to Russia. This new collection prompted me to provide a detailed description and illustration of the smut fungus and to discuss its taxonomy, host spectrum and world distribution.

### ***Anthracoidea siderostictae* Kukkonen (Figs. 1–3)**

*Ann. Bot. Fennici* 1: 174. 1964. — TYPE: Japan. On *Carex siderosticta*, Prov. Shinano, Nobeyama, 18.VI.1948 *Shibuya, Shinkai & Hirota* (holotype ZT in Herb. Hiratsuka 5, not seen).



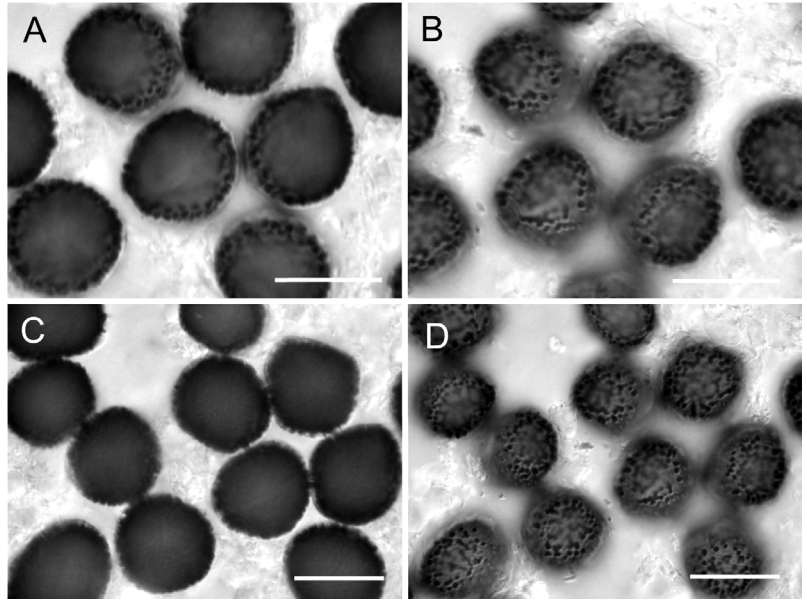
**Fig. 1.** Sori of *Anthracoidea siderostictae* in the ovaries of *Carex siderosticta* (from KW 55860). Habit, and two enlarged sori. Scale bars: 10 mm for habit of infected plants; 5 mm for detail drawing of two sori.

Sori in ovaries, scattered in inflorescences, as black, subglobose or ovoid, hard bodies around ovaries, 2–3 mm in diameter, composed of agglutinated spores, partly hidden by scales. Spores medium-sized, flattened, yellowish-brown, in side view 10–15  $\mu\text{m}$ , in plane view globose to subglobose or sometimes elongated, (18–)20–23(–24)  $\times$  (16–)18–20(–22)  $\mu\text{m}$ ; wall evenly thickened, 0.7–1.5  $\mu\text{m}$ , without protuberances, light-refractive spots and internal swell-

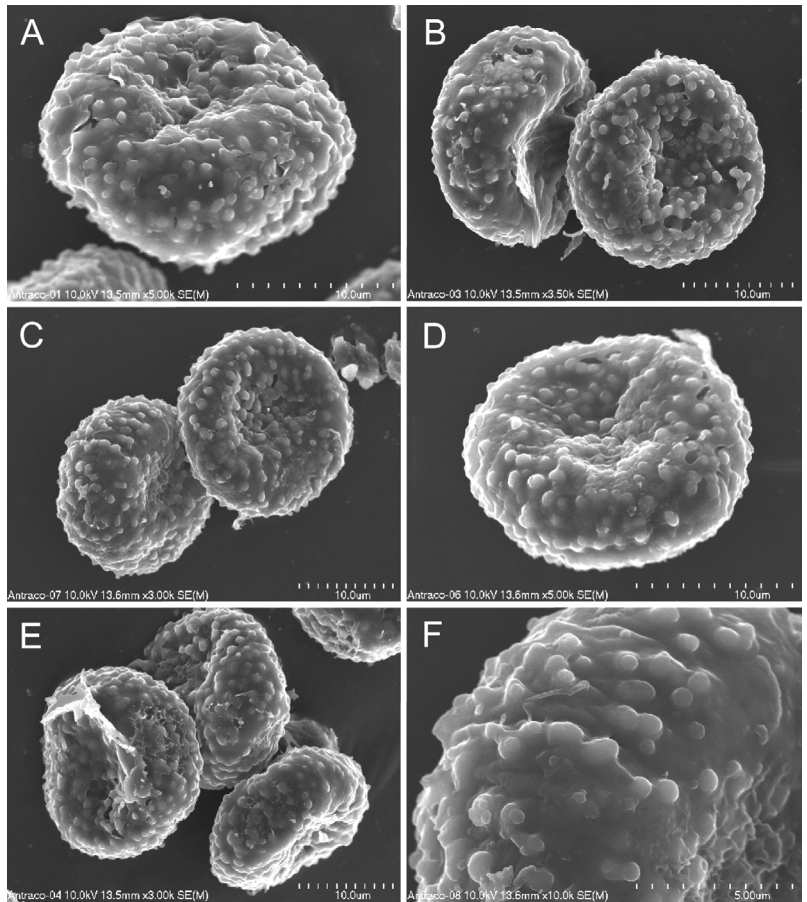
ings; surface verrucose, spore profile papillate, in SEM provided with more or less irregularly and moderately spaced warts, wall between warts minutely dotted; warts isolated or sometimes confluent, rounded, 0.5–1.5  $\mu\text{m}$  in diameter, 0.5–1.0  $\mu\text{m}$  high; spore surface usually covered on larger part by remnants of a thin membrane. Germination unknown. On Cyperaceae: *Carex ciliatomarginata*, *C. siderosticta* (*Carex* sect. *Siderostictae*).

**SPECIMEN EXAMINED:** — Russia. On *Carex siderosticta*, Primorski Krai, Hasanskii R.-N., Zapovidnik Kedrovaya Pad, dubniak na Sopci no. 512, 21.VI.1957 E. Z. Koval (KW 55860).

*Anthracoidea siderostictae* is a characteristic species with verrucose spores, placed by Kukkonen (1964b) in section *Echinosporeae* of *Anthracoidea*, and confined to hosts of *Carex* section *Siderostictae*. When describing it, Kukkonen (1964b) wrote that the spores are covered by spines. Actually the spore ornamentation should rather be termed as verrucose, because the warts are always lower than broad. Typical spines are present *inter alia* in *Anthracoidea echinospora*, *A. intercedens*, *A. inclusa* and *A. subinclusa*. Almost all known collections of *A. siderostictae* have been originally identified as *Cintractia subinclusa* (see Liro 1938, Ling 1953, Zundel 1953, Nannfeldt & Lindeberg 1957, Kukkonen 1963), which is now *Anthracoidea subinclusa*. However, this latter species has slightly smaller (15–22  $\times$  12–18  $\mu\text{m}$ ), echinate spores with typical spines, and occurs on host plants belonging to sections *Carex*, *Paludosae*, *Pseudocypereae*, *Spirostachyae*, *Tumidae* and *Vesicariae* (Vánky 1994). It is not excluded that *A. subinclusa* is a collective species because of the wide host range. Such supposition is in part supported by molecular studies (Hendrichs *et al.* 2005), which showed that specimens of *A. subinclusa* on *Carex vesicaria* (sect. *Vesicariae*), and specimens on *C. hirta* (sect. *Carex*) and *C. riparia* (sect. *Tumidae*) are only distantly related, and most probably belong to two different species. In the protologue, Kukkonen (1964b) compared *A. siderostictae* with *A. calderi*, which has a similar verrucose spore surface, but the spores are larger, 23–32  $\times$  19–26  $\mu\text{m}$ , and the only host plant of this smut, *Carex backii* belongs to sect. *Phyllostachyae*.



**Fig. 2.** *Anthracoidea siderostictae*. Spores as seen with LM (from KW 55860). Scale bars: 20  $\mu$ m.



**Fig. 3.** *Anthracoidea siderostictae*. Spores as seen with SEM (from KW 55860). Scale bars: 10  $\mu$ m for A–E; 5  $\mu$ m for F.



**Fig. 4.** Global distribution of *Anthracoidea siderostictae* (black circles) on the background of distribution of *Carex* sect. *Siderostictae* (marked as dark grey area; modified from Egorova 1999).

*Anthracoidea siderostictae* was hitherto reported on *Carex ciliatomarginata* and *C. siderosticta*, the latter being the principal host. Both these host plants were treated by Kükenthal (1909) as one species, *C. siderosticta*, and included by him in *Carex* sect. *Careyanae*. In the classification scheme of this author, sect. *Careyanae* is defined very broadly and represented by numerous species in North America and East Asia. Vánky and Alexander (in Vánky 2005), describing a new species, *Anthracoidea blanda* from North America, attributed his only host plant, *Carex blanda*, just to sect. *Careyanae*. Recent revisions of Cyperaceae–Caricoideae in Asia and North America changed the circumscription of sect. *Careyanae*, which is now restricted to a small group of eight species occurring exclusively in North America (Bryson & Naczi 2002b). *Carex ciliatomarginata*, *C. siderosticta* and seven other species are included in *Carex* sect. *Siderostictae*, which, according to Egorova (1999), is restricted to East Asia, including China, Korea, Japan, and Primorski Krai of Russia. On the contrary *C. blanda* is considered to be a member of sect. *Laxiflorae* distributed in North and Central America (Bryson & Naczi 2002a). Thus, *Anthracoidea siderostictae* is known on sect. *Siderostictae*, while *A. blanda* on sect. *Laxiflorae*, as the only recognized *Anthracoidea* species on the respective sections of *Carex*. However, it should be noted that in the literature there is another report of *Anthracoidea* species on a representa-

tive of sect. *Laxiflorae*, namely the record of *A. heterospora* on *Carex leptonevria* (Zambettakis 1978). The identity of this *Anthracoidea* species is not known, although it does not belong to *A. heterospora*. No species of *Anthracoidea* has been reported on representatives of a narrowly defined sect. *Careyanae* until now.

The geographical distribution of *Anthracoidea siderostictae* lies within the borders of occurrence of *Carex* sect. *Siderostictae*, and especially follows the principal host *C. siderosticta*. However, the distribution of *A. siderostictae* is much more scattered than that of its host plants (Fig. 4). Two localities are known from Japan, one in Nobeyama in Shinano Province, which is the type locality, and the second in Uri-toge in Mikawa Province (Kukkonen 1964b). A further three localities were reported from China, one in Shensi (= Shanxi) Province, the second in Huan-ton-san in Shanxi Province (Kukkonen 1964b) and the third in Tonghua in Jilin Province (Guo 1994). The present report in the Zapovidnik Kedrovaya Pad in Primorski Krai in Russia expands the known distribution of *A. siderostictae*. It is now known from six localities, but it is very likely that further occurrences will be discovered as a result of field studies or examination of herbarium specimens, especially those originally identified as *Anthracoidea (Cintractia) subinclusa*.

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