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)

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 µm, in plane view globose to subglobose or sometimes elongated, (18–)20–23(–24) × (16–)18–20(–22) µm; wall evenly thickened, 0.7–1.5 µm, without protuberances, light-refractive spots and internal swellings; 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 µm in diameter, 0.5–1.0 µm 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., Zapovednik 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 Echinosporae 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 × 12–18 µm), echinate spores with typical spines, and occurs on host plants belonging to sections Carex, Paludosae, Pseudocyperae, 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 × 19–26 µm, 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 µm.

Fig. 3. *Anthracoidea siderostictae*. Spores as seen with SEM (from KW 55860). Scale bars: 10 µm for A–E; 5 µm for F.
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 blandia 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 representative of sect. Laxiflorae, namely the record of A. heterospora on Carex leptonervia (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 Uritoge 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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References

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