The identity of *Cintractia carpophila* var. *kenaica*: reclassification of a North American smut on *Carex micropoda* as a distinct species of *Anthracoidea*

Marcin Piątek

Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland; corresponding author e-mail: m.piatek@botany.pl

**Abstract:** *Cintractia carpophila* var. *kenaica*, a neglected taxon described from Alaska more than half a century ago, is re-described and illustrated. Its nomenclature and taxonomic status are discussed. This smut species is characterised by small spores with a very finely verruculose surface rarely enclosed by a thin, hyaline, mucilaginous sheath, a wall with 2–5 distinct internal swellings, and parasitism on *Carex micropoda* (*Carex* sect. *Dornera*). It is reallocated to the genus *Anthracoidea* as a distinct species, *Anthracoidea kenaica* comb. nov., and assigned to *Anthracoidea* section *Leiosporae* which includes species having smooth or very finely verruculose spores. Morphological and biological characteristics of the five most similar *Anthracoidea* species are contrasted and discussed.

**Key words:** *Anthracoidea* *Carex* *Cintractia* *Historical collections* North America Smut fungi *Ustilaginales*

**ARTICLE**

**INTRODUCTION**

*Anthracoidea* is the most species-rich genus of smut fungi on *Cyperaceae*. Currently, 106 species are accepted in this genus (Denchev & Denchev 2011a, 2011b, 2012, Vánky & Abbasi 2011, Vánky 2012, Savchenko et al. 2013), but this is certainly not a final number. The magnitude of host plants reported in different publications for some putative species complexes suggests that more species are likely to exist, some of which may be well-delimited morphological species, while others are probably cryptic species that could be uncovered by molecular methods. Some species of *Anthracoidea* were recently included in molecular systematic studies (Hendrichs et al. 2005, Begerow et al. 2007, Bauer et al. 2007, Lutz et al. 2012, Savchenko et al. 2013, Vánky et al. 2013), but sequence data are not available for the vast majority. Distinct species could still be hidden under different generic names, especially under historical names that have not been reassessed in recent years (Piątek 2012). Such historical names should be critically re-examined in addition to any comprehensive molecular studies directed to the description of novel *Anthracoidea* species.

*Cintractia carpophila* var. *kenaica* is such a neglected taxon name and a likely candidate to be a distinct member of *Anthracoidea*. This smut was described from a specimen of *Carex pyrenaica* subsp. *micropoda* collected in the Kenai Peninsula of Alaska. That sedge is now accepted as a distinct species, *Carex micropoda*, belonging to *Carex* sect. *Dornera* (syn. sect. *Callistachys*) (Murray 2002a). Savile (1952) provided the following description of *Cintractia carpophila* var. *kenaica*: “Teliospores 16.0–23.5 × 11.5–19.5 µm, compressae, ellipsoideae, nunquam angulater. Episporium 0.6–1.3 µm, castaneum, leve; saepius interne gibberibus 2–5 munitum.” Zambettakis (1978) included it in *Anthracoidea*, as “*Anthracoidea heterospora* Kukkonen var. *kenaica* (Saville) nov. comb.”, but without any indication of the basionym or a reference to the place of its valid publication, rendering the combination invalid (Art. 41.5). Likewise, Kukkonen (1963) and Piepenbring (2000) considered this fungus to be a member of *Anthracoidea*, but again without further treatment and any formal nomenclatural and taxonomic decisions. Vánky (2012) included this smut in two places in his monograph: first as a synonym of *Anthracoidea heterospora* and later under excluded or invalidly published taxa, in both cases without detailed observations.

The aim of the present work is to clarify the nomenclatural and taxonomic status of *Cintractia carpophila* var. *kenaica*, and to provide a detailed characterization of this smut fungus as it lacks a detailed description and any iconography.

**MATERIALS AND METHODS**

Sori and spore characteristics were studied using dried herbarium material deposited in DAOM, S, and WRLS. Specimens were examined either by light microscopy (LM) and scanning electron microscopy (SEM) or only by light microscopy (LM).

For light microscopy (LM), hand-cut sections of sori or small pieces of sori were mounted in lactic acid, heated
to boiling point and cooled, then examined under a Nikon Eclipse 80i light microscope. LM micrographs were taken with a Nikon DS-FI1 camera. Spores were measured using NIS-Elements BR v. 3.0 imaging software. Spore size range, mean spore size, and standard deviation of 50 measured spores of each investigated specimen were calculated (Table 1). The species description includes combined values from all measured specimens. The spores were measured in plane view and measurements were adjusted to the nearest 0.5 µm. Spore size ranges were assigned to one of the three size groups distinguished by Savile (1952): (1) small-sized spores, 13–21(–23) × 9–17(–20) µm; (2) medium-sized spores, 15–25(–27) × 10–21 µm; and (3) large-sized spores, 18–33 × 13–28 µm.

For scanning electron microscopy (SEM), spores taken directly from dried specimens were dusted onto carbon tabs and fixed to an aluminium stub with double-sided transparent tape. The stubs were sputter-coated with carbon using a Cressington sputter-coater and viewed under a Hitachi SEM. The very fine ornamentation of spores was probably outside the limits of resolution of Savile’s light microscope. In general, the present examination confirms the decision of Savile (1952) to consider this smut as distinct. However, a specific status seems to be appropriate for this taxon. This is in line with the conclusion of Kukkonen (1963), who, however, did not formally make the transfer. Accordingly, a new combination is necessary.

### TAXONOMY

**Anthracoidea kenaica** (Savile) M. Piątek, **comb. nov.**

**MycoBank:** MB804512

(Figs 1–2)

**Basionym:** *Cintractia carpophila* var. *kenaica* Savile, Can. J. Bot. **30:** 419 (1952).

**Synonym:** *Anthracoidea heterospora* var. *kenaica* (Savile) Zambett., Bull. trimest. Soc. mycol. Fr. **94:** 177 (1978), nom. inval. (Art. 41.5).

**Type:** USA: Alaska: Kenai Peninsula, Head of Palmer Creek Valley, 60°49’N, 149°33’W, on *Carex micropoda* (syn. *Carex pyrenaica* subsp. *micropoda*), 26 July 1951, J.A. Calder 6229 (DAOM 28108 – holotype, S F-36682 – isotype).

**Description:** Sori in all or single ovaries of the inflorescence, black, globose or ovoid, about 1–1.5 mm diam, at first covered by a silvery membrane and perigynium that later ruptures revealing agglutinated spores, powdery on the surface, the sori are partly hidden by the perigynium and scales. Sori develop around reduced achenes that are consecutively surrounded by a thin dark layer of the remnants of achene epidermis, a hyaline layer of sporogeneous hyphae with young spores, a layer of gradually maturing dark spores, and a thin membrane of host origin. Spores usually more or less flattened, chestnut brown, reddish brown to dark brown, quite regular in shape and size, globose, subglobose or broadly ellipsoidal, small, (14.0–)15.0–20.5(–22.0) × (11.5–)12.0–17.5(–18.5) µm [av. ± SD, 18.5 ± 1.5 × 15.6 ± 1.7 µm, n = 200(4)], rarely enclosed by a thin, hyaline, mucilaginous sheath; wall even, 1.0–1.5 µm thick, somewhat darker than the rest of the spore, without protuberances and light-refractive spots, but with 2–5 distinct internal swellings; surface smooth or very finely punctate in LM, spore profile smooth, surface very finely verruculose in SEM.

---

### RESULTS

Detailed morphological characteristics of the holotype, isotype, and two non-type specimens of *Cintractia carpophila* var. *kenaica* are embraced in the species description and illustrated (Figs 1–2). The internal soral structure in the holotype was typical of species of *Anthracoidea* in that the spores were produced directly on the outer surface of the achene, and not within U-shaped cavities embedded in sterile stroma, a characteristic of *Cintractia* (Kukkonen 1963, Kukkonen & Vaissalo 1964, Piepenbring 2000). This indicated this smut fungus was better placed in *Anthracoidea*, as was suggested in other studies (Kukkonen 1963, Zambettakis 1978, Piepenbring 2000). The spores were uniform in shape and size ranges between collections (Table 1). My examination of specimens of *Cintractia carpophila* var. *kenaica* matched well the short description given by Savile (1952), although the spore surface was not smooth as stated in the protologue, but smooth or very finely punctate in LM, and very finely verruculose in

### Table 1. Spore size range, and mean spore sizes with standard deviation of *Anthracoidea kenaica* specimens examined in this study.

| Spore size range (µm) | Average spore size with standard deviation (µm) | Specimen |
|-----------------------|-----------------------------------------------|----------|
| (14.5–)15.0–20.5(–21.5) × 12.0–17.5(–18.5) | 18.1 ± 1.6 × 15.2 ± 1.7 | USA, Alaska, Kenai Peninsula, Head of Palmer Creek Valley, 26 July 1951, J.A. Calder 6229 (DAOM 28108 – holotype) |
| 17.0–20.5(–22.0) × 12.0–18.0(–20.5) | 19.2 ± 1.3 × 16.1 ± 1.8 | Same locality, date and collector (S F-36682 – isotype) |
| (14.0–)15.0–20.5(–21.0) × (11.5–)12.0–17.5(–18.5) | 18.2 ± 1.7 × 15.2 ± 1.8 | USA, Alaska, St. Paul, Pribilof Island, 22 Aug. 1914, J.M. Macoun (DAOM 66925) |
| (14.5–)17.0–20.5(–22.0) × 13.5–18.5(–19.0) | 18.5 ± 1.2 × 15.9 ± 1.4 | Canada, British Columbia, Bella Coola, Mt. Fougner, 23 Aug. 1956, J.A. Calder, J.A. Parmelee & R.L. Taylor (DAOM 70101) |
Anthracoidea kenaica comb. nov. on Carex micropoda

Additional specimens examined: Canada: British Columbia: Bella Coola, Mt. Fougner, on Carex micropoda, 23 Aug. 1956, J.A. Calder, J.A. Parmelee & R.L. Taylor (DAOM 70101). – USA: Alaska: St. Paul, Pribilof Island, on Carex micropoda, 22 Aug. 1914, J.M. Macoun (DAOM 66925).

Host and distribution: On Carex micropoda (Carex sect. Dornera); Canada (British Columbia) and USA (Alaska).

Notes: The nomenclature of Cintractia carpophila var. kenaica needs some clarification. The name Uredo carpophila
Schum. (Schumacher 1903) was introduced as superfluous replacement of *Uredo caricis* Pers. (Nannfeldt & Lindeberg 1965) and is therefore illegitimate and to be rejected (Art. 52.1). Consequently, the name *Cintractia carpophila* (Schum.) Liro (Liro 1938), based on *Uredo carpophila*, is also illegitimate. Also, Liro’s treatment cannot constitute a valid description of a new species to be attributed to him alone due to the absence of a Latin diagnosis (Nannfeldt & Lindeberg 1965), required in the period 1 January 1935 to 31 December 2011 (Art. 39.1). Vánky (2012) considered *Uredo carpophila* as an illegitimate name, which is correct, but also as a *nomen nudum*, which is not correct, since Schumacher (1903) provided a short description of this species: “*U. carpophyla, pulvere nigro capsulas subnude ambiente. Ured. Caricis Pers. Synops. pag. 225. In capsulis Caricis caespitosae. Julio*”.

Furthermore, Vánky (2012) considered the name *Cintractia*
Anthracoidea kenaica comb. nov. on Carex micropoda

ARTICLE

and from Mt Fougner in British Columbia; this last collection here the smut is newly reported from Pribilof Island (AK) two other collections from the same region (Savile 1952). reported from the type locality on the Kenai Peninsula and Anthracoidea kenaica & Denchev 2012). Carex micropoda verrucose, unlike spores of specimens on and they are distinctly from a specimen on Zambettakis (1978) included two SEM pictures of spores and with a smooth or very finely verruculose (not papillate) surface:

The type host of A. kenaica is Carex micropoda, but in addition Savile (1952) assigned a single smut collection on Carex deweyana (in Carex sect. Deweyanae; Naczí 2002) to his concept of Cintractia carphophila var. kenaica. Indeed, the Anthracoidea on Carex deweyana represents a distinct species — Anthracoidea deweyanae (Denchev & Denchev 2012). Anthracoidea kenaica was previously reported from the type locality on the Kenai Peninsula and two other collections from the same region (Savile 1952). Here the smut is newly reported from Pribilof Island (AK) and from Mt Fougner in British Columbia; this last collection represents the first record of this species in Canada.

DISCUSSION

Cintractia carphophila var. kenaica cannot be treated as a synonym or variety of Anthracoidea heterospora since this species is different in having spores with better developed ornamentation, thicker walls (1–2.5 µm), and occurs on host plants belonging to Carex sect. Phacocystis (Vánky 2012). It can be assigned to Anthracoidea sect. Angulosporae (Kukkonen 1963). In contrast, the morphology of Anthracoidea kenaica is characteristic of members of Anthracoidea sect. Leiosporae, which includes species with smooth or very finely verruculose spores (Kukkonen 1963). Within this section, Anthracoidea kenaica may be comparable only to five Anthracoidea species having spores similar in size and with a smooth or very finely verruculose (not papillate) surface: A. elynae, A. externa, A. macranthae, A. nardinae, and A. scirpi. The main morphological differences between these species include differences in wall thickness, the presence and the number of internal swellings, and the presence of a hyaline mucilaginous sheath enclosing the spores. Furthermore, all of them are restricted to host species belonging to different sections of Carex, or to different genera (Kobresia, Trichophorum), which could be used as supportive taxonomic characters. Characters used to discriminate these five species of Anthracoidea from A. kenaica (Table 2) are contrasted and discussed below.

Anthracoidea elynae is distinguished from A. kenaica by the mostly smooth spores with a thicker wall, fewer internal swellings, a more or less evident mucilaginous sheath, and occurrence on Kobresia. The internal swellings in A. elynae are weakly visible in LM (Savile 1952, Kukkonen 1961, Vánky 1994, 2012), and recent TEM studies of spores from a Romanian collection did not report internal swellings (Parvu et al. 2009). In fact, the spore presented in figure 3 of the latter study has a shallow thickening on the lower flattened side, which may be interpreted as a weak internal swelling. By contrast, internal swellings of Anthracoidea kenaica are prominent and clearly visible in LM. Anthracoidea externa is morphologically distinct in having absolutely smooth spores surrounded by a thick mucilaginous sheath, a thicker spore wall without internal swellings, and occurrence on species of Carex sect. Filifoliae (Mastrogiuseppe 2002). Anthracoidea macranthae differs from A. kenaica as it has completely smooth spores with prominent and common hyaline caps (a mucilaginous sheath) on the flattened sides, an absence of internal swellings, a somewhat thinner spore wall, and in occurring on Kobresia (Guo & Wang 2005). Although not discussed in the protologue, the occurrence of a mucilaginous sheath in the form of hyaline caps is the most valuable diagnostic character of Anthracoidea macranthae. The combination of characters seen places this species close to A. externa.

Anthracoidea nardinae appears to be most similar to A. kenaica. It is distinguished by nearly smooth spores, a thicker spore wall, fewer internal swellings, and occurrence on Carex sect. Nardinae (Murray 2002b). The type host of A. nardinae is C. nardina, but Kukkonen (1963) assigned this smut to two collections on C. elynoides, which belongs to a different Carex section (sect. Filifoliae). The examination of one collection of Anthracoidea on C. elynoides ["Plants of Southern Colorado, Carex elynoides Holm n. sp., near Pagosa Peak, Aug. 1899, leg. C.F. Baker", WRSI n. sp., extracted from the isotype of C. elynoides in WRSL (phanerogamic herbarium)], had globose, subglobose to broadly ellipsoidal spores, (14.5–15.0 × 11.0–17.5 µm, av. ± SD, 17.2 ± 1.2 × 14.8 ± 1.7 µm, n = 50, wall even, 1.0–1.5 µm, without internal swellings, surface smooth without mucilaginous sheath), though different from those studied by Kukkonen, revealed a complete absence of internal swellings typical of A. nardinae. It could be yet another distinct species or a form of A. externa without a hyaline sheath.

Anthracoidea scirpi is distinguished from A. kenaica by the minutely punctate spores, which are usually surrounded by hyaline, mucilaginous sheaths on the flattened sides, a thicker spore wall, the absence of internal swellings, and occurrence on Trichophorum species (Vánky 1994, 2012).

Differences between smut specimens in the ovaries of Carex micropoda and all aforementioned Anthracoidea species from sect. Leiosporae support A. kenaica as a distinct species specialised to a host in Carex sect. Dornera. Except for the host of A. scirpi, host plants of these Anthracoidea species are placed in one of the four/five major clades of the tribe Careceae, the so called "Core Unispicate Clade", which includes Carex subgen. Pysllophora p.p., Kobresia, and Uncinia (Starr & Ford 2009). Whether this may indicate a close evolutionary relation between members of Anthracoidea sect. Leiosporae is uncertain, and the problem remains open for future studies using molecular methods. In a recent molecular phylogenetic study, by Hendrichs et al. (2005), the only accessioned smooth-spored species, A. elynae, was recovered as sister to the verruculose-spored species A. curvulae on Carex curvula, which is also a member of the "Core Unispicate Clade".
| Species                     | Host plants (s)                          | Spores (µm) | Wall (µm) | Internal swellings     | Spore ornamentation         | Muclaginous sheath         | References                  |
|----------------------------|------------------------------------------|-------------|-----------|------------------------|-----------------------------|----------------------------|-----------------------------|
| Anthracoida elynae        | *Kobresia humilis, K. laxa, K. macrolepis, K. myosuroides, K. schoenoides, K. sibirica, K. smirnovii* | (14–)(16–)22(–25) × (9–) 10–20(–22)  (14–)16–22(–26) 17–22(–25) × (14–)15–18.5 1–2.5(–3) 17–22(–25) × 11–20 17–21 × 15–20 | 1–2.5(–3) 2–3 1–2.5(–3) 0.7–2.5 0.8–1.5 1–1.5 0.5–1 1 1–3 1.5–2 | frequent 1–2(–3) weak internal swellings weak but frequent smooth to finely punctate on the flat sides absent 2–5 distinct internal swellings 1–1.5 0.5–1 1 1–3 1–3 clearly seen 1.5–2 | smooth, seldom dotted almost smooth, only dotted smooth to very finely punctate in LM, verruculose in SEM smooth | usually covered by a gelatinous sheath no data more or less evident hyaline sheath present in most of the spores present on the flattened sides and often around the entire spore absent smooth or rarely very slightly verrucose | Kukkonen (1963) Nannfeldt (1979) Vánky (1994, 2012) Vánky (2012) Nannfeldt (1979) Vánky (2012) |
| Anthracoida externa       | *Carex filifolia* (Carex sect. Filifoliae) | 15–22(–23) × 11–20 | 0.7–2.5 0.8–1.5 | absent 2–5 distinct internal swellings | absolutely smooth present | absent smooth | always covered by a gelatinous sheath | Kukkonen (1963) |
| Anthracoida kenaica       | *Carex micropoda* (Carex sect. Domera)   | (14–)(15–)20(–22) × (11.5–)12–18.5(–20.5) | 1–1.5 | 1–2.5(–3) | smooth to very finely punctate in LM, verruculose in SEM | 1–2(–3) more or less clear internal swellings | more or less evident hyaline sheath | Vánky (1994, 2012) |
| Anthracoida macranthae    | *Kobresia macranthaa*                    | 15–18–(19.5) × 13–17.5 | 0.5–1 1 | absent 2–5 distinct internal swellings | smooth | 1–3 always 1–3 more or less clear internal swellings | hyaline caps common on the flattened side | Guo & Wang (2005) |
| Anthracoida nardinae      | *Carex nardina* (Carex sect. Nardinae), ? Carex elynoides (Carex sect. Filifoliae) | 15–(16–)22(–23) × (10–) 11–20(–21) (15–)16–23 × 13–20(–21) (15–)16–22(–23) × 13–20(–21) | 1–3 1–3 1.5–2 | 1–3 1–3 1.5–2 | smooth, sometimes obscurely dotted almost smooth, only dotted by hardly discernible dots almost smooth or sometimes obscurely punctate | 1–1.5 1–3 1–3 | absent, or at most, rare | Kukkonen (1963) Nannfeldt (1979) Vánky (2012, 2014) |
| Anthracoida scirpi        | *Trichophorum cespitosum, T. pumilum*    | (16–)17–24(–25) × 12–20(–23) 17–23 × 14–21 | 1–2.5(–3) 1.5–2 | absent 1–2.5(–3) 1–2.5(–3) | smooth or rarely very slightly verrucose smooth or very minutely punctate | 1–2.5(–3) | absent | Kukkonen (1963) Vánky (1994, 2012) |

1 Host plants taken from Vánky (2012), but at least some of them may harbour different Anthracoida species.
ACKNOWLEDGEMENTS

I thank Andrew M. Minnis (Center for Forest Mycology Research, Madison, USA) for nomenclatural advice, Anna Łatkiewicz (Kraków, Poland) for her assistance with the SEM micrographs, and the curators of DAOM, S, and WRSL for the loan of specimens. This study was supported in part by the Polish Ministry of Science and Higher Education (grant no. 2 P04G 019 28) and through the statutory fund of the W. Szafer Institute of Botany of the Polish Academy of Sciences, Kraków, Poland.

REFERENCES

Bauer R, Lutz M, Piątek M, Vánky K, Oberwinkler F (2007) Flamingomyces and Parvuulago, new genera of marine smut fungi (Ustilaginomycotina). Mycological Research 111: 1199–1206.

Begerow D, Stoll M, Bauer R (2007) [‘2006] A phylogenetic hypothesis of Ustilaginomycotina based on multiple gene analyses and morphological data. Mycologia 98: 906–916.

Denchev CM, Denchev TT (2011a) Anthracoidea eburneae, sp. nov. (Anthracoideaceae). Mycologia Balcanica 8: 83–85.

Denchev CM, Denchev TT (2011b) Anthracoidea melanostachyae sp. nov. (Anthracoideaceae). Mycologia Balcanica 8: 153–155.

Denchev CM, Denchev TT (2012) New records of smut fungi. 7. Mycotaxon 121: 425–434.

Guo L, Wang SR (2005) A new species and a new record of Anthracoidea (Ustilaginales) from China. Mycotaxon 93: 159–162.

Hendrichs M, Begerow D, Bauer R, Oberwinkler F (2005) The genus Anthracoidea (Basidiomycota, Ustilaginomycetes): a molecular phylogenetic approach using LSU rDNA sequences. Mycological Research 109: 31–40.

Kukkonen I (1961) The smuts of the genus Cintractia parasitizing Kobresia species. Canadian Journal of Botany 39: 155–164.

Kukkonen I (1963) Taxonomic studies on the genus Anthracoidea (Ustilaginales). Annales Botanici Societatis Zoologicae Botanicae Fennicae ‘Vanamo’ 34(3): 1–122.

Kukkonen I, Vaissallo T (1964) An electron microscope study on spore formation in a smut. Annales Botanici Fennici 1: 236–249.

Liro JI (1938) Die Ustilagineen Finnlands. II. Annales Academiae Scientiarum Fennicae, Serie A, 42(1): 1–720.

Lutz M, Vánky K, Piątek M (2012) Shivasia gen. nov. for the Australasian smut Ustilago solida that historically shifted through five different genera. IMA Fungus 3: 143–154.

Mastrogiuseppe J (2002) Carex Linnaeus sect. Filifoliae (Tuckerman) Mackenzie in N.L. Britton et al. In: Flora of North America North of Mexico 23: 566–568. New York: Oxford University Press.

Murray DF (2002a) Carex Linnaeus sect. Domera Heuffel. In: Flora of North America North of Mexico 23: 528–530. New York: Oxford University Press.

Murray DF (2002b) Carex Linnaeus sect. Nardinae (Tuckerman) Mackenzie in N.L. Britton et al. In: Flora of North America North of Mexico 23: 568–569. New York: Oxford University Press.

Naczzi RFC (2002) Carex sect. Deweyanae (Tuckerman ex Mackenzie) Mackenzie in N.L. Britton et al. In: Flora of North America North of Mexico 23: 321–325. New York: Oxford University Press.

Nannfeldt JA (1977) The species of Anthracoidea (Ustilaginales) on Carex subgen. Vignea with special regard to the Nordic species. Botaniska Notiser 130: 351–375.

Nannfeldt JA (1979) Anthracoidea (Ustilaginales) on Nordic Cyperacea-Caricoideae, a concluding synopsis. Symbolae Botanicae Upsalienses 22(3): 1–41.

Nannfeldt JA, Lindeberg B (1965) Taxonomic studies on the ovariicolous species of Cintractia on Swedish Caricoideae. II. The species on Carex sect. Acutae Fr. sensu Kük. Svensk Botanist Tidskrift 59: 189–210.

Parvu M, Parvu AE, Craciun C, Barbu-Tudoran L, Puscas M (2009) Ultrastructure and development of Anthracoidea elynae ustilospores. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 37: 41–44.

Piątek M (2012) The identity of Cintractia disciformis: reclassification and synonymy of a southern Asian smut parasitic on Carex sect. Aulocystis. IMA Fungus 3: 39–43.

Piepenbring M (2000) The species of Cintractia s.l. (Ustilaginales, Basidiomycota). Nova Hedwigia 70: 289–372.

Savchenko KG, Lutz M, Piątek M, Heluta VP, Nevo E (2013) Anthracoidea carici-meadii is a new North American smut fungus on Carex sect. Paniceae. Mycologia 105: 181–193.

Savile BO (1952) A study of the species of Cintractia on Carex, Kobresia, and Scirpus in North America. Canadian Journal of Botany 30: 410–435.

Schumacher CF (1803) Enumeratio plantarum in partibus Saellandiae septentrionalis et orientalis. Part 2. Copenhagen: Brummer.

Starr JR, Ford BA (2009) Phylogeny and evolution in Cariceae (Cyperaceae): current knowledge and future directions. Botanical Review 75: 110–137.

Vánky K (1994) European Smut Fungi. Stuttgart: G. Fischer Verlag.

Vánky K (2012) Smut Fungi of the World. St. Paul, MN: American Phytopathological Society Press.

Vánky K, Abbasi M (2011) Anthracoidea spongica sp. nov. on Carex spongica from Iran. Rostanha 12: 181–185.

Vánky K, Shivas RG, Barrett MD, Lutz M (2013) Eriocortex eriocauli, gen. et sp. nov. (Ustilaginomycetes) from Australia. Mycobiota 1: 9–16.

Zambettakis C (1978) Les Anthracoidea des Carex et les Ustilaginées aberrantes. Bulletin de la Société Mycologique de France 94: 109–260.