

ANTHROPOGENIC ORIGIN OF THE SMUT FUNGUS *ANTHRACOIDEA CARICIS* POPULATION IN THE GORCE MTS (POLAND)

ANDRZEJ CHLEBICKI

Abstract. The paper presents data suggesting that the smut fungus *Anthracoidea caricis* (Pers.) Bref. noted on *Carex pilulifera* L. in the Gorce Mts (Poland) is of anthropogenic origin, describes its distribution there, and briefly discusses its habitats.

Key words: *Anthracoidea*, smut fungi, *Carex pilulifera*, distribution, man-made habitats, Carpathians

Andrzej Chlebicki, Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland; e-mail: a.chlebicki@botany.pl

INTRODUCTION

In the past, the smut fungus *Anthracoidea caricis* (Pers.) Bref. was treated very broadly and included collections from diverse *Carex* species. Nannfeldt (1977, 1979), Vánky (1979) and others separated a number of species from this species complex. In its current narrow sense, *Anthracoidea caricis* is restricted to species occurring on sedges from sect. *Acrocystis*, in Europe on *Carex pilulifera* L. and *C. montana* L. In Poland, *A. caricis* was noted by Schroeter (1887), Starmachowa (1963), Kućmierz (1968), Kochman and Majewski (1973), Sałata *et al.* (1984), Vánky (1985) and Chlebicki (2008). All of its published localities noted on *Carex pilulifera* in Poland were reviewed by Chlebicki (2008), including a single locality from the Gorce Mts.

The host plant of this smut fungus, *Carex pilulifera*, is a common sedge in Poland (Zajac & Zajac 2001). It occurs mostly in open areas such as hill pastures, dry meadows, *Calluna* heaths, also along dirt mountain paths, and rarely in dry pine forests. In the Gorce Mts the sedge is frequently noted from 800 m a.s.l. to summits at 1310 m a.s.l. (Kornaś 1957). It is an important component of semi-natural associations and communities from the order *Nardetalia*, and rarely, as a sporadic species, in associations from the orders *Arrhenatheretalia* and *Calamagrostietalia villosae* (Table 1). It also occurs in transformed *Gladiolo-Agrostietum*

fresh meadow communities in the poor mat-grass-dominated association *Hieracio-Nardetum* (Kozak 2007). The origin of the host plant in the Gorce Mts is not known.

Originally the whole Gorce Mts area was covered by forest (Popko-Tomasiewicz 2006). The present-day glades and meadows in the mountains are associated with past pastoral management. The formation of glades was begun by the Valachians, new settlers from the Balkan Peninsula who arrived there in the 14th century (Kurzeja 2006; Popko-Tomasiewicz 2006). Meadows reached their maximum size in the 18th and 19th centuries, after which time expansion was limited (Jarosz 1935). After the Tatra Mts the Gorce Mts were the second most important pasturing area in the Western Carpathians. Pastoral management declined in the last forty years (Michalik 2006), leading to changes in the plant composition and size of the meadows. Now the glades are dominated by poor grasslands such as mat grass (*Hieracio-Nardetum*) or bilberry communities (Michalik 2006). The plant composition of these recently developed mat grass communities includes *Carex pilulifera*.

This paper reports the localities of *Anthracoidea caricis* in the Gorce Mts (Western Carpathians) and discusses the possible origin of these stations.

Table 1. Constancy coefficients of the differential species *Carex pilulifera* in non-forest communities in the Gorce Mts according to Kozak (2007).

Community	Constancy
<i>Gladiolo-Agrostietum</i> typicum	I
<i>Gladiolo-Agrostietum</i> anthyllidetosum	II
<i>Gladiolo-Agrostietum</i> deschampsietosum	I
<i>Gladiolo-Agrostietum</i> with <i>Leontodon hispidus</i>	+
<i>Gladiolo-Agrostietum</i> with <i>Festuca rubra</i>	+
<i>Gladiolo-Agrostietum/Hieracio-Nardetum</i>	III
<i>Calluno-Nardetum strictae</i>	V
<i>Hieracio-Nardetum</i>	V
Community with <i>Vaccinium myrtillus</i>	(IV)*
<i>Poo-Veratretum</i> lobeliani	II
Community with <i>Rubus idaeus</i>	I
Community with <i>Pteridium aquilinum</i>	+

**C. pilulifera* is lacking in the investigated patches of bilberry-dominated community (author's observations).

MATERIAL AND METHODS

Mountain meadows were selected with the help of the Gorce Mts map in a monograph of Gorce National Park (Różański 2006). Each meadow was studied in detail during the flowering season of the sedge *Carex pilulifera*. Collected specimens were examined with a NIKON SMZ 1500 stereomicroscope and then with an Nikon Eclipse 801 light microscope. Specimens were collected in 2006–2009 and are deposited in the fungal herbarium of the W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków (KRAM F). The localities of *Anthracoidea caricis* are presented on a map obtained from Gorce National Park.

RESULTS AND DISCUSSION

Investigations conducted on 33 meadows in the Gorce Mts indicated that *Anthracoidea caricis* occurs on 25 meadows (Fig. 1). The localities with smut and those where it was not recorded are listed below. All specimens were collected by A. Chlebicki.

LOCALITIES WITH SMUT. 1 – Gorce Troszacki Mt., on meadow near summit, 15 July 2006 (KRAM F-55786); 2 – Czoło Turbacza Mt., meadow near dirt path, 22 July 2007 (KRAM F-56595); 3 – meadow above Sołtysówka in Jamne stream valley, 15 July 2007 (KRAM F-56586); 4 – Trzy Kopce Mt., small meadow near summit, near Ga-

browska Duża meadow, 15 July 2007 (KRAM F-56587); 5 – Jaworzyna Kamienicka meadow, near Kapliczka Bulandy wayside shrine 15 July 2007 (KRAM F-56588); 6 – Gorce Kamieniecki Mt., meadow at summit, 8 July 2007 (KRAM F-56565); 7 – Przysłop Dolny meadow, 8 July 2007 (KRAM F-56561); 8 – Świnkówka meadow, 8 July 2007 (KRAM F-56564); 9 – Deforested summit of Gorce Mt., 8 July 2007 (KRAM F-56566); 10 – Turbacz Mt., at side of dirt path in forest near wayside shrine and Długie Młaki mire, 30 June 2007 (KRAM F-56544); 11 – Bukowina Miejska Mt., on meadow, 30 June 2007 (KRAM F-56545); 12 – Turbaczyk Mt., on meadow near summit, 22 July 2007 (KRAM F-56596); 13 – Wolnica meadow, ca 200 m E of shelter, 15 July 2007 (KRAM F-56585); 14 – Chyzikowa meadow, 8 July 2007 (KRAM F-56562); 15 – Gabrowska Duża meadow, near forest, 15 July 2007 (KRAM F-56584); 16 – Przysłop Górny meadow, 8 July 2007 (KRAM F-56563); 17 – Hala Młyńska meadow near Kiczera Mt., 15 July 2007 (KRAM F-56589); 18 – Polana Ruśnakowa meadow, 30 June 2007 (KRAM F-56546); 19 – Kudłoń Mt., Polana Figurki meadow, 17 June 2007 (KRAM F-56510); 20 – Polana Stawieniec meadow, 17 June 2007 (KRAM F-56509); 21 – Gorce Troszacki Mt., on meadow, 17 June 2007 (KRAM F-56508); 22 – Chyżnioka meadow, 8 July 2007 (KRAM F-56567); 23 – Obidowiec Mt., 30 June 2007 (KRAM F-56549); 24 – Meadow between Obidowiec Mt. and Turbacz Mt., 30 June 2007 (KRAM F-56547); 25 – Polanczyca Meadow near Przysłop Mt., 30 June 2007 (only noted in the field).

STUDIED MEADOWS WITHOUT SMUT. 1 – Cerla Hanulowa meadow near black-coded hiking trail to Kudłoń Mt.; 2 – Przysłop Górny meadow, covered by *Vaccinium myrtillus*; 3 – Średniak meadow, covered by *Vaccinium myrtillus* and some spruces; 4 – Szałasisko meadow, near blue-coded hiking trail to Turbacz Mt.; 5 – Średnie meadow, near blue-coded hiking trail to Turbacz Mt.; 6 – Hrube meadow near Hrube Mt. near black-coded hiking trail to Obidowa; 7 – Polana Rożnowa meadow near black-coded hiking trail to Obidowa; 8 – meadows near black-coded hiking trail from Kudłoń Mt. to Kudłoński Baca rock.

Before the glades were made by settlers in the Western Carpathians, *Carex pilulifera* possibly occurred in canopy gaps in ancient spruce forests of the upper montane zone. Natural disturbances of subalpine spruce forest and weakening factors such as the leaf-eating insect *Cephalcia alpina* (Klug 1808) and the bark beetle *Ips typographus* (L.)

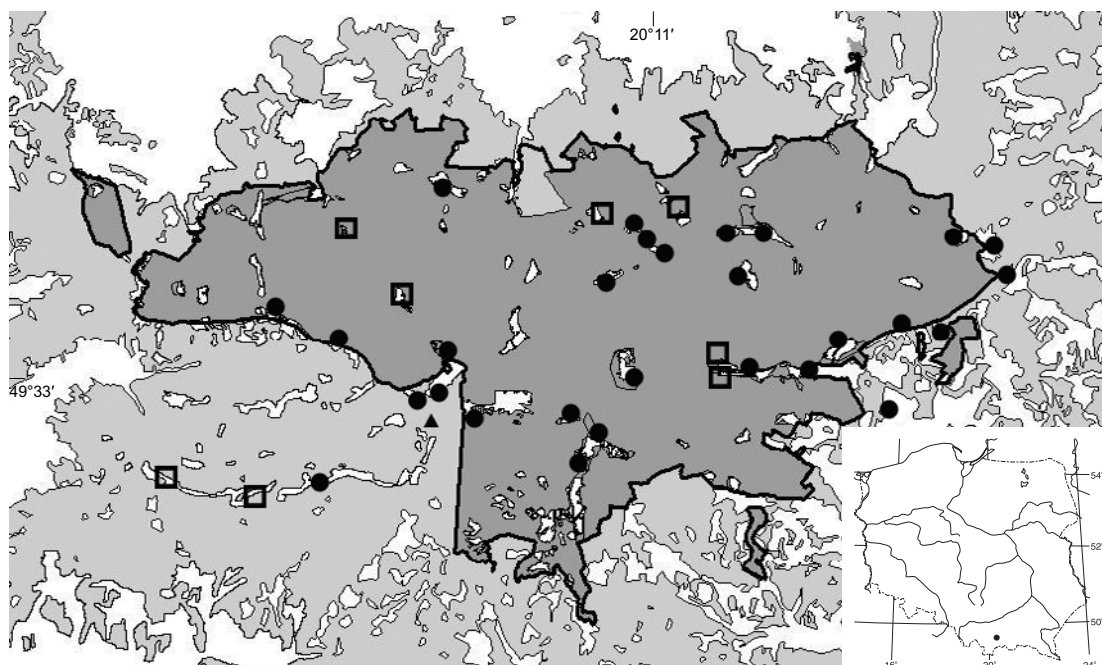


Fig. 1. Distribution of *Anthracoidea caricis* (Pers.) Bref. in Gorce Mts meadows: ● – presence of smut; ■ – absence of smut. Shaded area – forest, black line – boundary of Gorce National Park.

may have accelerated destruction of the forest and the creation of wide open areas. The sedge has been noted in such open areas formed due to insect invasions in forests on Kudłoń Mt., Gorce Mt. and Turbacz Mt. (A. Chlebicki, pers. observ.) as well as in forests in communities with *Pteridium aquilinum* (L.) Kuhn and in a transitional community with *Rubus idaeus* L. (Kozak 2007). The simultaneous occurrence of the smut *A. caricis* on such a small number of sedges seems unlikely, however. A study of fungal symbionts in declining host plant populations indicated that these symbionts are absent when the host plant population falls below a critical size (Chlebicki & Olejniczak 2007). According to Zadoks (1987), biotrophic fungi fructify best when the host grows in optimal condition. This explains the occurrence of *Anthracoidea caricis* in large sedge populations.

Patches with the host plant *Carex pilulifera* growing in the Gorce Mts can be recognized as ecological islands, but my observations indicate that the smut invaded most the sedge plants in open areas in only a few cases (Stawiska meadow, Gorce

Troszacki Mt. and Bieniowe meadow). This means that the smut's effect on *C. pilulifera* population density probably is limited. Note, however, that another smut, *Ustilago violacea* (Pers.) Rousel (at present *Microbotryum lagerheimii* Denchev) was found to be capable of effectively sterilizing the host plant *Lychnis vulgaris* (Jennersten *et al.* 1983).

The localities of the smut nearest to the Gorce Mts lie in the Tatra Mts (Kućmierz 1968; Sałata *et al.* 1984). A possible vector, the smut beetle *Phalacrus substriatus* (Gyll.), was observed in some sori of *Anthracoidea caricis* gathered in the Gorce Mts. According to Michalik (2006), light-demanding plants can be dispersed to the mountains by wind, sheep and people after the formation of meadows, as also suggested by Moe (2011). The occurrence of the host and its smut was connected with plant communities of the class *Nardetalia* formed as a result of traditional pasturing. Neither the host nor the smut occurred in recently grazed and manured glades. They preferred places long left fallow, with acid soil (Fig. 2). These



Fig. 2. *Carex pilulifera* L. with *Anthracoidea caricis* (Pers.) Bref. Polanczyca meadow with path covered by *Hieracio-Nardetum* surrounded by patches with *Vaccinium myrtillus* L.

communities, however, are quickly transformed to bilberry-dominated communities where the pill sedge disappears. This means that both sedge and smut should keep moving to new areas of abandoned glades. Probably the smut colonized the host plant after the glades formed. Colonization was probably maintained through long-distance transport by wind or by epizootic transport by sheep, smut beetles and people.

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