

On the smuts of the genus *Ustilago* on *Calamagrostis* species in Finland

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According to LIRO (1924 pp. 68—71, 382—385), three species of *Ustilago* parasite on *Calamagrostis* species, viz., (1) *U. scrobiculata* Liro on *C. arundinacea*, (2) *U. calamagrostis* (= *calamagrostidis*) (Fuck.) Clint. on *C. epigeios*, *C. lanceolata* (= *canescens*), *C. purpurea*, *C. lapponica*, *C. neglecta*, and on some foreign species, and (3) *U. corcontica* (Bub.) Liro on *C. halleriana* (= *villosa*), which host does not occur in Fennoscandia. In 1938 LIRO (p. 519) transferred the Finnish finds of the smut on *C. epigeios* under *U. scrobiculata*.

U. calamagrostidis was originally described as *Tilletia calamagrostis* by FÜCKEL (1867, 1869) on *C. epigeios*, *U. corcontica* as *Tilletia corcontica* by BUBAK (1912, 1916) on *C. halleriana*, and *U. scrobiculata* by LIRO (1924) on *C. arundinacea*. Of these three smuts, *U. scrobiculata* is quite easy to recognize on the basis of the spore wall ornamentation, which is formed by irregular ridges, which fuse together into a network of meshes. The other two with spore wall with regular spines or warts without ridges have caused more confusion. Thus the smuts which LIRO included to *U. calamagrostidis*, are a rather heterogeneous group, as stated, e.g., by LIRO himself (1924 pp. 383—384). Recently NANNFELDT (1959) has transferred the smuts with warty spores under *U. corcontica* leaving only the *epigeios* smut under *U. calamagrostidis*, of which there are no records from Fennoscandia. According to NANNFELDT (p. 156) *U. scrobiculata* is known on *C. arundinacea*, *C. epigeios*, and *C. canescens*; *U. calama-*

grostidis on *C. epigeios*; and *U. corcontica* on *C. purpurea*, *C. canescens*, *C. lapponica*, *C. neglecta*, and on some foreign species.

I have examined the Finnish smut collections on *Calamagrostis* species in H, HPP, KUO, OULU and TUR. Hereby it was found, that two collections from Ahvenanmaa (Åland) in southwestern Finland on *C. epigeios* represented *U. calamagrostidis*; this is thus the first locality of this species in Fennoscandia. *U. scrobiculata* was found also on *C. purpurea* in two collections from northern Finland; *C. purpurea* is a matrix nova of this species. In the following list are mentioned all the localities from Finland known to the writer. ! = material examined by the writer, MF = Mycotheca Fennica (LIRO 1934 and 1939, ROIVAINEN 1953). The numbers in brackets refer to the Table I. For practical reasons, the codes of the herbaria are not written in capitals.

Ustilago scrobiculata Liro

On *Calamagrostis arundinacea* (L.) Roth
N, Tuusula, Järvenpää, 19.9.1909 J. I. Liro (H! [3], LIRO 1924 p. 68); Pornainen, Paiansuo, 6.8.1916 Tauno Putkonen & J. I. Liro (H! [4]); Pornainen, Kirveskoski, 9.8.1916 Tauno Putkonen & J. I. Liro (LIRO 1924 p. 68).

On *Calamagrostis epigeios* (L.) Roth
N, Helsinki, Lapinlahti, 28.7.1929 J. I. Liro (MF 346, Tur! [53]); Espoo, Lill Bodö, 12.9.1915 E. Kitunen (Tur! [62], Kuo!) and Suvisaaret, Lillbodö, 12.9.1915 E. Kitunen & J. I. Liro (H! [6], LIRO 1924 p. 70).

K1, Sortavala, Tuohitiinlahti, 31.7.1929 V. Heikinheimo & J. I. Liro (H! [5], LIRO 1938 p. 519).

- On *Calamagrostis purpurea* (Trin.) Trin. (matrix nova)
 Ob, Karunki, Kukkolanoski, 21.7.1960 Laila & H. Roivainen (H! [8]).
- Le, pars NW, Keski-Urtasjärvi, 730 m s.m., 11.8.1955 H. Roivainen (H! [11]).
- Ustilago calamagrostidis* (Fuckel) Clinton
- On *Calamagrostis epigeois* (L.) Roth
 Al, Maarianhamina, 6.9.1956 (Tur! [45]) and 10.9.1956 (Tur! [44]) Lauri E. Kari. The material is distributed in Fungi Exsiccati Fennici (N:o 702).
- Ustilago corcontica* (Bubak) Liro
- On *Calamagrostis canescens* (Web.) Roth
 N, Pornainen, Kirveskoski, Insel beim Ruskeapää and Pappila, 11.7.1915 J. I. Liro (MF 345, Tur! [54], LIRO 1924 p. 70 and 1938 p. 519).
- Ta, Tampere, Järvensivu, Iidesjärvi, 25.8.1953 Yrjö Mäkinen (Tur! [49]); Vesijärvi, Vääksey, —. 9.1902 J. I. Liro (LIRO 1924 p. 70).
- Sb, Maaninka, Patalahti, 30.7.1937 H. Roivainen & J. I. Liro (H! [16], LIRO 1938 p. 519).
- Li, Utsjoki, Karigasniemi, Pasijärvi, 11.7.1954 Yrjö Mäkinen (Tur! [48]).
- On *Calamagrostis neglecta* (Ehrh.) G., M. & Sch.
 Ab, Turku, Ruissalo, Vikberg, 10.7.1957 Lauri E. Kari (Tur! [46]). The material is distributed in Fungi Exsiccati Fennici (N:o 703). Turku, Ispois, Katariinanlaakso, —.7.1916 J. I. Liro (LIRO 1924 p. 70).
- N, Helsinki, Lapinlahti, 19.8.1915 J. I. Liro (H! [18]) and —.9.1916 J. I. Liro (LIRO 1924 p. 70); Helsinki, Drumsö, 29.8.1915 E. Kitunen (H! [19]); Espoo, Alberga, 25.7.1915 E. Kitunen & J. I. Liro (H! [21]), on several localities near Alberga and Hagalund (LIRO 1924 p. 70); Porvoo, 22. 8.1915 E. Kitunen, J. I. Liro and Tauno Putkonen (several collections in H! [17, 20], Kuo!, Oulu! [1] and Tur!, LIRO 1924 p. 70).
- Ob, Maakrunni, 6.8.1933 J. I. Liro (H! [24]) and 5.8.1933 H. Roivainen & J. I. Liro (LIRO 1924 p. 70).
- Le, Muonionjoki, Jatuni, 13.8.1934 J. I. Liro (H! [22]); Iitto, 21.7.1936 H. Roivainen & J. I. Liro (H! [23]); Kelottijärvi, Ylitalo, 9.8.1939 J. I. Liro & H. Roivainen (H! [25]); Kelottiluspa, 17.7.1936 H. Roivainen & J. I. Liro (H! [27]); Hirvasvuopio, 10.8.1935 H. Roivainen & J. I. Liro (H! [28]); Könkämäeno, Vikkuri, 16.7.1936 H. Roivainen & J. I. Liro (H! [29]) and Lammaskoski, 7.8.1939 J. I. Liro & H. Roivainen (H! [30]) (LIRO 1938 p. 520).
- Li, Utsjoki, Leppänen, 1.8.1920 Aarne Rainio (H! [26], LIRO 1924 p. 70).
- On *Calamagrostis lapponica* (Wg) Hartm.
 Ob, Ranua, 2 kms NW of the church, 11.7.1943 A. V. Auer (Tur! [36, 59]); Tervola, Romsis, 4.8.1864 M. Brenner (LIRO 1924 p. 70).
- Ks, Salla, Vuorijärvi, Sairasmaja, 21. & 24.7. 1939 Matti Laurila (Tur! [60], Hpp!).
- Le, Pyhäkero, Muurivaara, 25.7.1933 H. Roivainen & J. I. Liro (MF 204, Tur! [56]); Iitto, 8.8.1939 J. I. Liro & H. Roivainen (H! [31]); Könkämäeno, Maunu, Mustavaaran Viilo, 16.7.1936 H. Roivainen (H! [33]); Ylä-Lammaskoski, 21.7.1936 H. Roivainen & J. I. Liro (H! [35]); Kilpisjärvi, Siilastupa, Jauhoniemi, 21.7.1934 J. I. Liro (H! [32]); NW-Enontekiö, Perfevanghi, 750 m., 8.8.1936 H. Roivainen & J. I. Liro (H! [34], LIRO 1938 p. 519); Kilpisjärvi, Jehkats, 26.7.1946 Lauri E. Kari (Tur! [38]).
- Li, Inari, Ivalo, near the Tourist House, 27.7.1925 Lauri E. Kari (Tur! [47]), the host determined by KARI (1936 p. 18) as *C. lanceolata* = *C. canescens*; Törmänen and Inari village, in July—August 1920 A. Rainio (LIRO 1924 p. 70); Utsjoki, Tshieskuljoki, 18.7.1957 Yrjö Mäkinen (Tur! [64]); Utsjoki, Kevojoki, 28.8.1958 Yrjö Mäkinen (Tur! [65]).
- On *Calamagrostis purpurea* (Trin.) Trin.
 N, Tuusula, Järvenpää, 20.7.1902 J. I. Liro (H! [7], MF 344, Tur! [55], LIRO 1924 p. 70).
- Ks, Salla, Tuuntsajoki, Näppäräheitonkoski, 18.7. 1937 M. Laurila (Hpp! [63], LIRO 1938 p. 519).
- Lk, Muonio, 23.7.1933 J. I. Liro (H! [9]); Kittilä, Pallastunturit, Fatikuru, 20.7.1925 Lauri E. Kari (Tur! [43], Hpp!, KARI 1936 p. 18, LIRO 1938 p. 519).
- Le, Miekonjärvi, 28.7.1935 H. Roivainen & J. I. Liro (H! [10]) and Miekonjärvi, Annelanji, 3.8.1935 H. Roivainen & J. I. Liro (H! [12]); Porojärvet, Meekonjärvi, in Saliceto, ca. 620 m s.m., 27.7.1935 H. Roivainen (Tur! [52]); NW-Saanajärvi 650 m, 14.8.1936 H. Roivainen & J. I. Liro (H! [15]); Kilpisjärvi, Kitsijärvi, 26.7.1936 H. Roivainen & J. I. Liro (H! [14]); Urtasvanghi, 8.8.1936 H. Roivainen & J. I. Liro (H! [13]); Terbmisjauri, 2.8.1934 J. I. Liro & H. Roivainen (MF 791, Tur! [57]) (LIRO 1938 p. 519); Anjaloodi, on S-slope, 19.7.1947 Aarne Vuorisalo (Tur! [37]); NW-Enontekiö, Urtasvaarri, 21.7.1961 Ilkka Kukkonen (Tur! [61]).
- Li, Utsjoki, Tshieskuljoki, 30.8.1958 Yrjö Mäkinen (Tur! [66]).
- Lps Petsamo, Kalastajasaarento, Pummanki, southern peninsula, 12.8. 1925 Lauri E. Kari (Tur! [39]), Pumminginniemi, 12.8.1925 Lauri E. Kari (Tur! [40]), Haminantunturi, 11.8.1925 Lauri E. Kari (Tur! [41]), Lotamukka, 20.7.1931 Lauri E. Kari (Tur! [58]); Vaitolahti, 23.7. 1931 Lauri E. Kari (Tur! [42]) (KARI 1936 p. 18, LIRO 1938 p. 519).

Ustilago scrobiculata and *U. calamagrostidis* are quite clear and well definable species, but *U. corcontica* on *C. canescens*, *C. purpurea*, *C. lapponica*, and *C. neglecta* remains a rather polymorphic complex. To obtain a little more clarification into this complex the length and breadth of 25 spores from every collection was measured; also the morphological features of the spores were examined in detail. The results of the measurements are given in Table I, which includes also

the spore sizes of *U. scrobiculata* and *U. calamagrostidis*. The figures in parentheses refer to the previous list.

Table I.

Ustilago scrobiculata on *C. arundinacea*
 (3) 14.25 ± 0.18 × 12.91 ± 0.13
 (4) 13.93 ± 0.24 × 12.52 ± 0.21

U. scrobiculata on *C. epigeios*
 (5) 14.83 ± 0.17 × 14.20 ± 0.14
 (6) 14.01 ± 0.19 × 12.86 ± 0.16
 (53) 14.59 ± 0.28 × 12.99 ± 0.17
 (62) 14.30 ± 0.29 × 12.09 ± 0.22

U. scrobiculata on *C. purpurea*
 (8) 15.55 ± 0.30 × 14.11 ± 0.20
 (11) 14.06 ± 0.35 × 12.43 ± 0.21

U. calamagrostidis on *C. epigeios*
 (11) 15.59 ± 0.24 × 12.91 ± 0.23
 (45) 14.64 ± 0.28 × 13.29 ± 0.20

U. corcontica on *C. canescens*
 (16) 13.96 ± 0.19 × 12.09 ± 0.18
 (48) 12.82 ± 0.24 × 10.52 ± 0.18
 (49) 13.92 ± 0.26 × 11.18 ± 0.14
 (54) 13.48 ± 0.22 × 11.76 ± 0.17

U. corcontica on *C. neglecta*
 (1) 12.43 ± 0.19 × 11.95 ± 0.16
 (17) 13.34 ± 0.16 × 11.47 ± 0.15
 (18) 12.96 ± 0.22 × 10.65 ± 0.14
 (19) 13.58 ± 0.22 × 11.85 ± 0.18
 (20) 12.97 ± 0.22 × 11.23 ± 0.16
 (21) 12.99 ± 0.17 × 10.84 ± 0.16
 (22) 11.85 ± 0.23 × 10.75 ± 0.13
 (23) 12.52 ± 0.28 × 11.04 ± 0.18
 (24) 12.91 ± 0.22 × 11.42 ± 0.14
 (25) 12.38 ± 0.17 × 10.75 ± 0.16
 (26) 12.86 ± 0.12 × 11.23 ± 0.17
 (27) 12.33 ± 0.15 × 11.71 ± 0.17
 (28) 13.63 ± 0.18 × 11.28 ± 0.21
 (29) 13.15 ± 0.22 × 11.13 ± 0.32
 (30) 13.00 ± 0.22 × 11.42 ± 0.22
 (46) 13.15 ± 0.23 × 10.56 ± 0.20

U. corcontica on *C. lapponica*
 (31) 12.28 ± 0.15 × 11.23 ± 0.18
 (32) 12.72 ± 0.19 × 12.00 ± 0.19
 (33) 12.33 ± 0.18 × 11.18 ± 0.23
 (34) 13.72 ± 0.26 × 11.71 ± 0.17
 (35) 13.24 ± 0.25 × 11.23 ± 0.18
 (36) 12.67 ± 0.17 × 11.61 ± 0.20
 (38) 12.28 ± 0.27 × 11.04 ± 0.20
 (47) 12.38 ± 0.14 × 10.84 ± 0.16
 (56) 12.91 ± 0.18 × 11.25 ± 0.20
 (59) 12.04 ± 0.11 × 11.04 ± 0.20

(60) 11.52 ± 0.17 × 11.04 ± 0.18
 (64) 13.38 ± 0.13 × 11.87 ± 0.17
 (65) 12.99 ± 0.16 × 11.46 ± 0.16

U. corcontica on *C. purpurea*

(7) 13.96 ± 0.19 × 12.19 ± 0.21
 (9) 12.81 ± 0.24 × 11.13 ± 0.12
 (10) 13.29 ± 0.13 × 12.19 ± 0.19
 (12) 12.86 ± 0.17 × 11.47 ± 0.17
 (13) 13.00 ± 0.17 × 11.56 ± 0.19
 (14) 12.09 ± 0.19 × 10.99 ± 0.19
 (15) 12.62 ± 0.20 × 11.04 ± 0.21
 (37) 12.57 ± 0.22 × 10.51 ± 0.15
 (39) 12.57 ± 0.21 × 10.65 ± 0.15
 (40) 12.04 ± 0.19 × 10.40 ± 0.19
 (41) 11.66 ± 0.18 × 10.46 ± 0.21
 (42) 12.28 ± 0.18 × 10.60 ± 0.14
 (43) 12.52 ± 0.14 × 11.13 ± 0.14
 (52) 12.76 ± 0.19 × 10.46 ± 0.16
 (55) 13.96 ± 0.24 × 12.09 ± 0.17
 (57) 12.00 ± 0.18 × 10.99 ± 0.19
 (58) 11.47 ± 0.15 × 10.51 ± 0.23
 (61) 12.14 ± 0.14 × 10.27 ± 0.17
 (63) 12.46 ± 0.13 × 10.98 ± 0.16
 (66) 12.77 ± 0.14 × 11.49 ± 0.17

The means for the length and breadth are presented graphically in Fig. 1. It is obvious from Table I and Fig. 1, that the spores of *U. calamagrostidis* and *U. scrobiculata* are markedly greater than those of *U. corcontica*. The material is too small for that any differences could be found between the different host species of *U. scrobiculata*, if such differences does at all exist. The material of *U. corcontica* is large enough to allow to draw some observations and conclusions.

C. neglecta — *C. lapponica*. If the spore lengths on *C. neglecta* and *C. lapponica* are compared, no clear differences are found. The variation ranges on these two hosts cover each other almost completely. The mean length of the spores on *C. neglecta* is 12.70 ± 0.06 and on *C. lapponica* 12.55 ± 0.07. The Student's test gives $t = 1.63$ with the probability level of ca. 0.1. Thus in a larger material a significant difference between these hosts could perhaps be detected. However, the spores on *C. neglecta* are, on an average, relatively longer than the spores on *C. lapponica*. The mean value of the ratio length/breadth for the spores on *C. neglecta* is 1.16 and for spores on *C. lapponica* 1.11. Their difference is significant at the 0.02 probability level.

C. purpurea. As Fig. 1 reveals, many specimens on *C. purpurea* are very small-spored, and, on the other hand, some of the largest spore means belong also to smuts on *C. pur-*

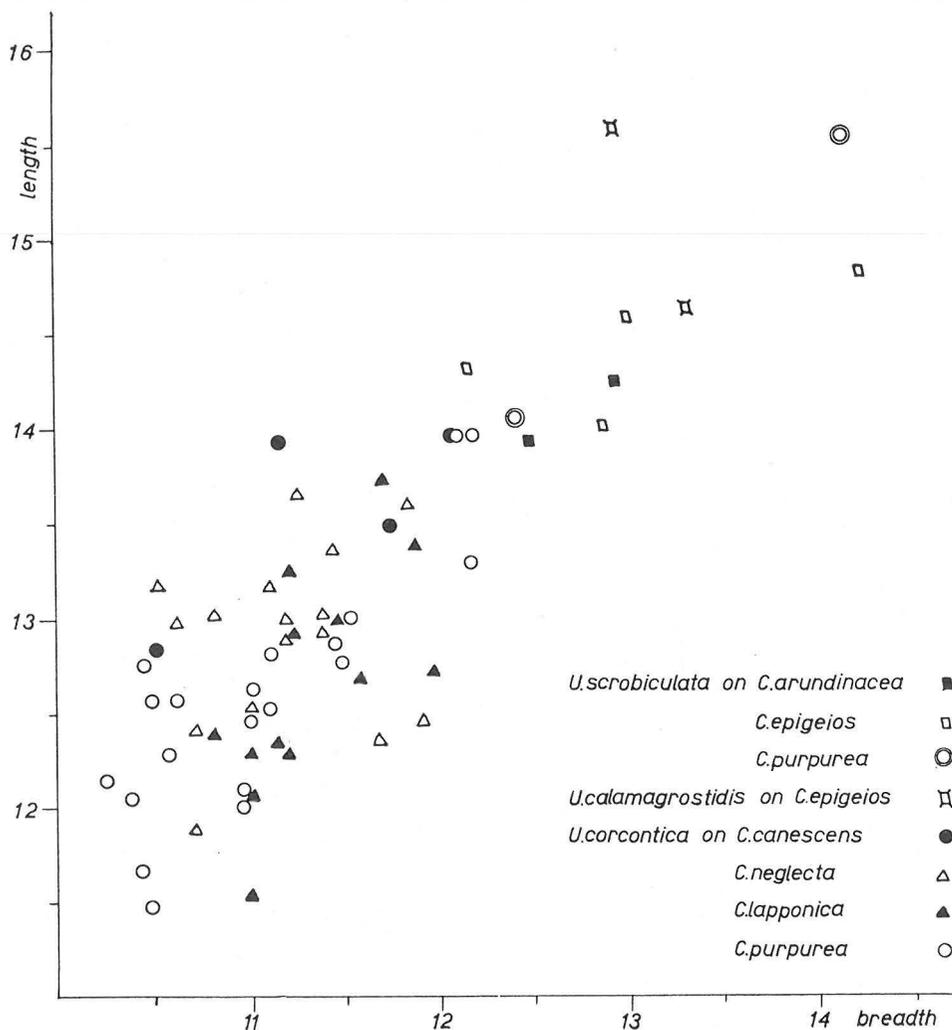


Fig. 1. Size in μ of *Ustilago* spores on *Calamagrostis* species.

purea. The mean length 12.60 ± 0.05 does not differ significantly from that of smuts on either *C. neglecta* or *C. lapponica*. On the basis of the Fig. 1, the variance of the *purpurea* sample would seem to be greater than the variance of either *neglecta* or *lapponica* samples. However, the calculations showed it to be only 0.99 as compared with 1.19 of *neglecta* and 1.33 of *lapponica* sample. This obvious discrepancy is easily explained. The dots in Fig. 1 represent means of each collection, and the variance 0.99 was calculated on the basis of all the variates (spores). If the means plotted in Fig. 1 are treated as variates, the variances will be the following: *purpurea* 1.60, *lapponica* 0.36, *neglecta* 0.22. The variance of the *purpurea* sample

is now at the 0.05 probability level significantly greater than that of the *lapponica* sample showing the greater heterogeneity of the samples. This heterogeneity is obscured, if the variance is calculated on the basis of the individual spore lengths.

If the collections on *C. purpurea* are divided into two groups, according if they have been collected in southern ($60-61^\circ$) or northern ($66-70^\circ$) part of Finland, only one collection in Espoo belongs to the southern group. The Espoo locality is represented in Fig. 1 by two dots from two different specimens (7,55). Although no analysis can be made between this one locality in southernmost and the other in northern Finland, the difference in size may be real: in the

first two specimens the length is 13.96 ± 0.19 and 13.96 ± 0.24 , whereas the greatest mean of the northern group is 13.29 ± 0.13 (Table I). This difference is also joined to the differences in the spore wall morphology (see below). In the first place, some climatic factors could be set into connection with this difference. To examine this possibility, a similar comparison was made between the finds on *C. neglecta* from southern part ($60-61^\circ$) and northern part ($68-70^\circ$) of Finland (one locality in Ob at ca. 65° (24) was omitted). The comparison showed that no difference in size exists between the northern and southern population (in Table I, numbers 1, 17-21, 46 belong to the southern and 22, 23, 25-30 to the northern group). Accordingly, the possible difference in size on *C. purpurea* is probably due to some other factors.

C. canescens. Only 4 collections are known from Finland. The mean, 13.55 ± 0.13 is significantly different from the means on *C. purpurea*, *C. neglecta*, and *C. lapponica* at a probability level of less than 0.001. Divided into two groups, the means 13.96, 13.92 and 13.48 represent the southern group ($60-63^\circ$), and only one collection (mean 12.82) belongs to the northern group ($69-70^\circ$). The possible difference in size between the southern and northern group cannot be certainly demonstrated; however, such a difference is suggested.

Conclusion: The spore lengths of smuts on *C. neglecta*, *C. lapponica* and *C. purpurea* do not differ significantly, whereas the spores on *C. canescens* are significantly longer. In relation to the breadth, the spores on *C. neglecta* are longer than the spores of *C. lapponica*. On *C. neglecta* (and *C. lapponica*, which in Finland is a northern species), no differences between the southern and northern localities exist, but on *C. purpurea* and *C. canescens* the spore size in the southern group may be greater. This difference is probably not due to the climatic factors.

Spore wall morphology. The Figures 2-10 reveal that there are differences also in the spore wall ornamentation. *U. scrobiculata* is easily separated, as mentioned above. The spores of *U. calamagrostidis* are often dark and irregular and have long (ca. $1.0-1.2 \mu$) conical spines. The young spores are occasionally scrobiculate resembling *U. scrobiculata*; however, the ripe spores have never any

scrobiculate ornamentation. The spores of *U. corcontica* on *C. neglecta* and *C. lapponica* are in all discernible characters identical, and also in some collections on *C. purpurea* from northern Finland the spores seem to resemble exactly the spores of *U. corcontica* on its type host (in a specimen collected by Dr. R. Picbauer in Moravia (Tur), see NANNFELDT 1959 p. 155). However, in many collections even from northern part of Finland, the spores on *C. purpurea* are clearly darker and more irregular than in typical *U. corcontica*, and also the warts are longer. Especially the collections from southern Finland on both *C. purpurea* (7, 55) and *C. canescens* (16, 49, 54) deviate from *U. corcontica* by possessing dark, often more or less irregular spores with warts ca. $0.5-0.8$, occasionally until 1μ long. These differences in spore wall morphology fall well together with the differences in spore size.

From evolutionary point of view, *U. scrobiculata* must perhaps be considered as the most elementary of the three species. Irregular ridges are found occasionally also in young spores of *U. corcontica* and *U. calamagrostidis*. The two last mentioned species represent two different species or complexes of minor species, in which the spore wall structure has developed further. *U. calamagrostidis* is decidedly more southern in its distribution, *U. corcontica* more northern, although it occurs in Central Europe (cf. NANNFELDT 1959 p. 155 and p. 11). In Finland, the distribution of the typical *U. corcontica* is limited on *C. neglecta*, *C. lapponica*, and northern localities of *C. purpurea* and *C. canescens*. The typical *U. calamagrostidis* is known only from two collections in southernmost Finland on *C. epigeios*. Collections with spores more or less resembling *U. calamagrostidis* as to the size and morphology are known in southern Finland on *C. purpurea* and *C. canescens*. They could perhaps be transferred under *U. calamagrostidis*. However, *U. calamagrostidis* is as now a very natural and uniform species, so that a better solution would be the separation of these types as a species of their own. However, more detailed morphological, biometrical, biological, and distributional studies are needed, before such a separation can be done.

The relatively large variation of *U. corcontica* on *C. purpurea* can be set into connection with the polymorphic nature of this host

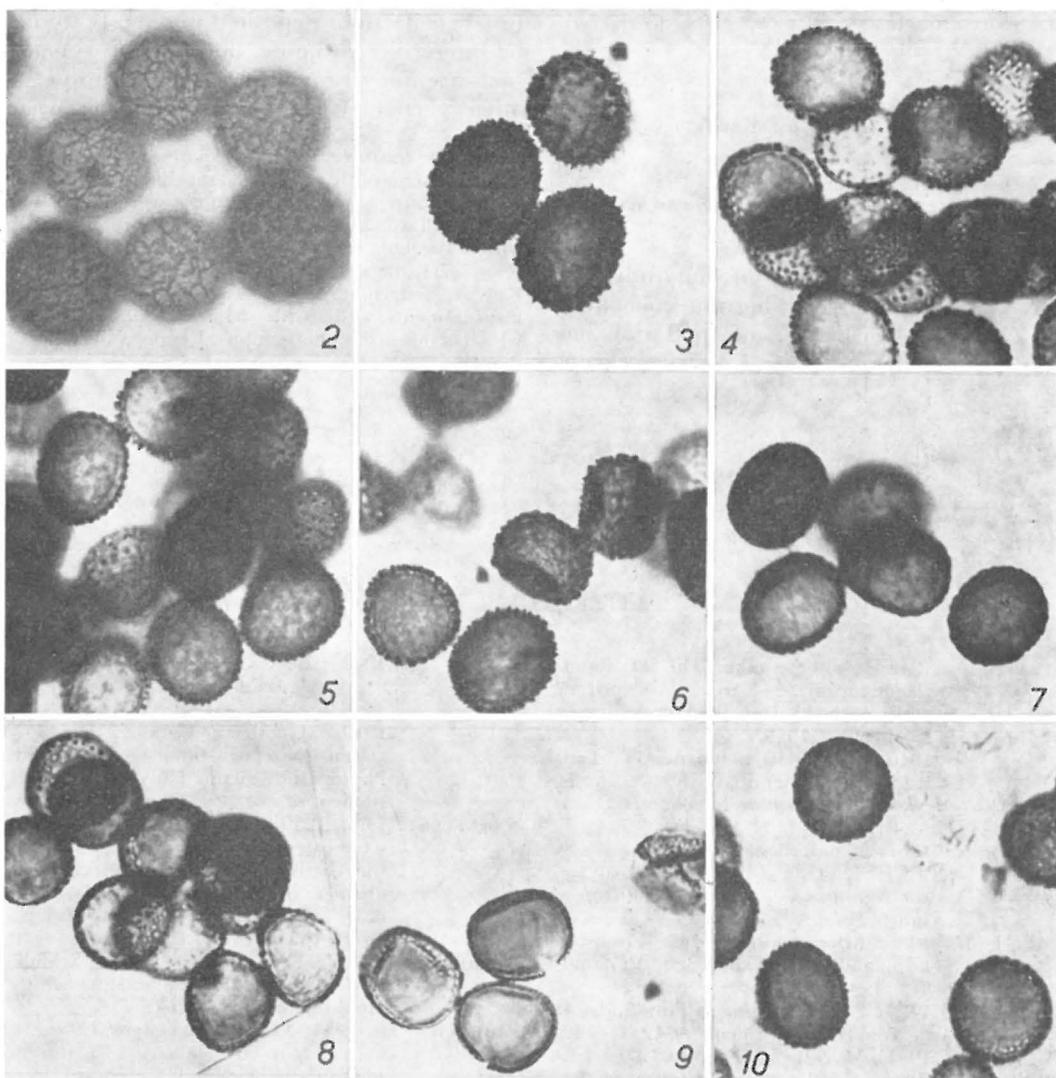


Fig. 2—10. 2: *Ustilago scrobiculata* on *Calamagrostis purpurea* [8]; 3: *U. calamagrostidis* on *C. epigeios* [44]; 4: *U. corcontica* on *C. purpurea* [7]; 5: *U. corcontica* on *C. canescens* [16]; 6: *U. corcontica* on *C. canescens* [54]; 7: *U. corcontica* on *C. purpurea* [13]; 8: *U. corcontica* on *C. neglecta* [18]; 9: *U. corcontica* on *C. neglecta* [25]; 10: *U. corcontica* on *C. lapponica* [33].

species. According to NYGREN (1946 p. 207) *C. purpurea* is arisen by at least four different ways: (1) from *C. canescens* through a doubling of the chromosome number, (2) through hybridization between *C. canescens* and *C. epigeios*, (3) from the hybrid between *C. canescens* and *C. neglecta*, (4) from the hybrid *C. arundinacea* × *C. canescens*. Through a hybridization between *C. epigeios* and *C. canescens* the smut of the *U. calamagrostidis* type has then also been able to transfer on *C. purpurea* and

further on *C. canescens*, if not as a pure species, so at least by hybridization so that some of its genes inside *U. corcontica* are now a source of variation into the *calamagrostidis*-direction.

On the basis of the foresaid, the *U. corcontica* complex can be divided into groups according to the following schema:

- a. Spores 12—16 μ long (mean ca. 14 μ), generally dark, more or less irregular, warts 0.5—1.0 μ long on *C. canescens* and *C. purpurea* in southern Finland

- aa. Spores 10—15 μ long (mean ca. 12.6—12.7 μ), warts 0.4—0.6 μ long
- b. Spores by a small enlargement smooth, light, regular
on *C. neglecta*, *C. lapponica*; on *C. purpurea* in northern Finland
- bb. Spores dark, regular or irregular
on *C. canescens* and *C. purpurea* in northern Finland

As the original purpose of my study was only to revise the Finnish smut collections on *Calamagrostis* species, no material has been examined from other countries, except

th few collections deposited in Tur. It would be interesting to know, how far my conclusions are in agreement with the conditions in other, particularly in Scandinavian countries.

For the measurements the spores were warmed in lactophenol. All the sizes are given in microns. The standard errors and variances were calculated in Turun Laskukeskus (Computing Centre of Turku) with a Wegematic 1000 computer using the program N:o 527/1, deposited at the Centre. To Mr. Esa Koivistoinen, B.Sc., who has made a part of the measurements, and to Mr. Matti Sulkinoja, M.Sc., who has taken the photographs, I express my sincere thanks.

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