MEDDELELSER OM GRØNLAND

Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Herink (*Fungi, Basidiomycota, Hygrocybeae*) in Greenland

Torbjørn Borgen and Eef Arnolds

BIOSCIENCE 54 · 2004

Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Herink (*Fungi*, *Basidiomycota*, *Hygrocybeae*) in Greenland

Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Herink (*Fungi*, *Basidiomycota*, *Hygrocybeae*) in Greenland

Torbjørn Borgen and *Eef Arnolds*

Meddelelser om Grønland · Bioscience 54

Torbjørn Borgen and Eef Arnolds: Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Herink (*Fungi, Basidiomycota, Hygrocybeae*) in Greenland. Meddelelser om Grønland, Bioscience Vol. 54. Copenhagen, the Danish Polar Center, 2004.

Cover front: *Hygrocybe rubrolamellata* spec. nov. Type collection DB 86.21 from Narsarsuaq 7 August 1986
Cover back: *Hygrocybe conica* var. *aurantiolutea* var. nov. Collection TB 85.212, Paamiut 20 August 1985 (from the same site as the type collection).

Publishing editor Kirsten Caning
Printed by Specialtrykkeriet Viborg a-s

Scientific Editor:
David Boertmann, National Environmental Research Institut, Frederiksborgvej 399, P.O. Box 358, DK-4000 Roskilde, Denmark. Phone (+45) 4630 1937, fax (+45) 4630 1914, e-mail dmb@dmu.dk

About the monographic series *Meddelelser om Grønland Bioscience*
Meddelelser om Grønland, which is Danish for *Monographs on Greenland*, has published scientific results from all fields of research in Greenland since 1879. *Bioscience* invites papers that contribute significantly to studies of flora and fauna in Greenland and of ecological problems pertaining to all Greenland environments. Papers primarily concerned with other areas in the Arctic or Atlantic region may be accepted, if the work actually covers Greenland or is of direct importance to continued research in Greenland. Papers dealing with environmental problems and other borderline studies may be referred to any of the series *Geoscience, Bioscience* or *Man & Society* according to emphasis and editorial policy.

For more information and a list publications, please visit the web site of the Danish Polar Center *http://www.dpc.dk*

All correspondence concerning this book or the series *Meddelelser om Grønland* (including orders) should be sent to:
Danish Polar Center
Strandgade 100 H
DK-1401 Copenhagen
Denmark
tel +45 3288 0100
fax +45 3288 0101
email dpc@dpc.dk

Accepted November 2003
ISSN 0106-1054
ISBN 87-90369-68-8

Contents

Abstract

Borgen, Torbjørn and Arnolds, Eef. 2004. Taxonomy, Ecology and Distribution of *Hygrocybe* (Fr.) P. Kumm. and *Camarophyllopsis* Herink (*Fungi*, *Basidiomycota*, *Hygrocybeae*) in Greenland. – Meddelelser om Grønland Bioscience 54, Copenhagen, Danish Polar Center, 2004. 64 pp.

This revision is based on critical macroscopic and microscopic studies of about 450 Greenlandic collections of the tribus *Hygrocybeae*, in Greenland represented by the genera *Camarophyllopsis* and *Hygrocybe (s.l.)*. The collections are assigned to 29 taxa. *Hygrocybe rubrolamellata* and *H. conica* var. *aurantiolutea* are described as new. *H. coccinea* (Schaeff.: Fr.) P. Kumm., *H. marchii* (Bres.) F.H. Møller and *H. coccineocrenata* (P.D. Orton) M.M. Moser are excluded from the Greenlandic basidiomycota. The concepts of *H. salicis-herbaceae* Kühner, *H. biminiata* Kühner, *H. coccineocrenata* (P.D. Orton) M.M. Moser, *H. rhodophylla* Kühner, *H. substrangulata* (P.D. Orton) P.D. Orton & Watling and *H. turunda* (Fr.: Fr.) P. Karst. are revised.

The phenology, ecology and distribution patterns of all species are discussed. The grassland slopes in S Greenland and the oceanic dwarf-shrub heaths and fens in S and SW Greenland are two centres of distribution. The species composition of tribus *Hygrocybeae* in Greenland shows much affinity to that of the Alps and NW Europe.

Keywords: Greenland, *Camarophyllopsis*, *Hygrocybe*, taxonomy, ecology, distribution, phenology.

Torbjørn Borgen, Botanical Museum, Gothersgade 130, 1153 Copenhagen K, Denmark (mailing address: Sensommervej 142, DK-8600 Silkeborg).
Eef Arnolds, Holthe 21, 9411 TN Beilen, the Netherlands.

Introduction

This revision deals with the two genera *Hygrocybe* (sensu lato) and *Camarophyllopsis*, comprising the tribus *Hygrocybeae*, in Greenland. Lange (1955) made the first revision of the genus *Hygrocybe* in Greenland, considering also older records (Rostrup 1888, 1891, 1894). He described seven taxa of *Hygrocybe* from S and W Greenland. Later Kobayasi *et al.* (1971) reported five taxa from E Greenland. Boertmann (1990) revised Sect. *Oreocybe*, accepting three taxa from Greenland. Finally, Boertmann (1995) added a number of *Hygrocybe*-taxa new to Greenland, based on collections made by him and other mycologists, including information from an earlier draft of this paper. Taxa from the genus *Camarophyllopsis* have not been recorded from Greenland before. The present paper is part of a revision of the Greenlandic basidiomycota (Borgen *et al*. in prep.).

Material and methods

The present revision is based on about 450 Greenlandic collections, including all Greenlandic material housed in the herbarium, Botanical Museum of Copenhagen (C), and a large number of collections from private herbaria. Furthermore, about 90 collections, including several types, from Denmark, England, the Faeroe Islands, France, Finland, the Netherlands, Norway, Scotland, Sweden, Switzerland, Russia and USA have been studied for comparison. Unless stated otherwise, the mentioned collections are preserved at C. The collections from E Greenland published by Kobayasi *et al.* (1971) have not been studied, but references are made when the descriptions could be interpreted safely. In a few cases taxa documented only by colour-slides or field descriptions are included. They are marked with *, whenever they could be interpreted safely.

Collections were received on loan from the herbaria of Berne (BERN), Copenhagen (C), Edinburgh (E), Geneva (G), Lyon (LY), New York State Museum (NYS), Oslo (O) and Wageningen (WAG), or made available from private herbaria. The collections of Arnolds (EA) are stored at WAG. Norwegian collections of Gulden & Lange (GG & ML) and a few others are at O. The collections of Kühner, communicated by Lamoure and Clerc, are now at G, while those of Senn-Irlet (BSI) are at BERN. The collections of H. Dissing (HD), S.A. Elborne (SAE), H.F. Gøtzsche (HFG), H. Knudsen (HK), D. Lamoure (DL), M. Lange (ML), T. Læssøe (TL), J.H. Petersen (JHP) and P.M. Petersen (PMP) are all at C. The collections of T. Borgen (TB), B. Nielsen (BN), J. Vesterholt (JV) and a few others are at C, unless stated otherwise. Finally the collections made by D. Boertmann (DB), E. & P.E. Brandt (EPB), R. Kristiansen (RK), E. Rald (ER), F. Rune (FR) and M. Strandberg (MS) are in the collectors' private herbaria, unless stated otherwise.

The collection sites are listed in Appendix 1 and shown in Figure 4.

The descriptions of the macroscopic features are based on fresh material, occasionally completed with notes from colour-slides or exsiccata. Four colour codes were used, viz. Kornerup & Wan-

scher (1978), abbreviated K. & W., Munsell (1975), abbreviated Mu., Colour identification Chart (Henderson *et al.* 1969), abbreviated CIC, and Cailleux (1981), abbreviated Caill. The notation (L=18-38(-45), l=1-3) means that the number of entire lamellae vary from 18 to 38, exceptionally to 45, and the lamellulae from 1-3 within the studied collections.

Microscopic studies were made on exsiccata. Within critical groups or taxa new to Greenland, most collections were studied in detail, especially in sect. *Oreocybe* and subsect. *Squamulosae*. At least 10 spores were measured in side- and frontal view, but both measurements are only specified, when they differed from each other (as in *H. miniata*). The spore measurements were mainly taken from preparations of the lamellae and the apiculus is not included. Except for type-studies, the spore measurements are rounded to the nearest half of a mikrometre. The percentage of constricted spores (usually n=40), was determined.

The average and the quotients between spore-length and width (Q), as well as the average quotients (Qav) were calculated. In the notation: spores (9.5-)10.0-12.5(-13.5) x 6.0-7.0(-7.5) µm, numbers representing less than 10% of the total variation within the studied collections are given in brackets. The same holds true for average measurements, quotients and average quotients. This notation is also used when measurements of terminal elements of pileipellis and stipititrama elements are given.

D. Lamoure (*in. litt.*) counted the number of nuclei in the spores (in giemsa) of about 25 important collections within subsect. *Squamulosae*. L. Olson (pers. comm.) stained a number of extralimital collections to count nuclei. Furthermore, T. Borgen and B. Senn-Irlet (*in litt.*) counted the nuclei in a number of collections with the acetic-carmine method and with the aid of a fluorescence microscope, respectively. The acetic-carmine method was initially used in accordance with Henderson *et al.* (1969), but ultimately the "FBV-method" (Clemençon 1978, pers. comm.) gave better results.

Hymenial characters were studied in detail in many cases, viz. presence/absence of cheilocystidia, size, shape of basidia and number of sterigmata, shape and size of the elements in the hymenophoral trama. Within subsect. *Squamulosae* the terminal elements of the pileipellis were described, measured and the average calculated, and the colour and kind of pigmentation was investigated. In about 90 representative collections within subsect. *Squamulosae* the stipititrama elements were measured and the average calculated. This was also achieved in a few collections of sect. *Oreocybe*, sect. *Coccineae* and sect. *Glutinosae*. The measurements were made under an oil immersion lens, but the stipititrama elements have sometimes been studied at lower magnification, < x 1000. The results of microscopic studies by both of us on the same collections are fully comparable.

An ammoniacal solution of Congo-red was usually preferred as dye in the microscopic preparations, but when the pigmentation was important, for instance presence or absence of greyish pigments in the pileipellis, only H_20, NH_40H or KOH was used. When the stipititrama elements were investigated, part of the stipe was soaked in Congo-red, and after 1/2-1 hour the material was torn apart by needles, and subsequently heated a few seconds.

Full descriptions are given, based on

Greenlandic material for new, little known or critical taxa, or if the material is deviating.

Author names are abbreviated in accordance to Brummit & Powel (1992), see also the website: http://www.indexfungorum.org/AuthorsOfFungalNames.htm. The nomenclature is in accordance with Boertmann (2002), except in *H. conica*, where Kuyper (pers. comm. 2002) is followed.

Names of vascular plants follow Böcher *et al.* (1978). Those frequently mentioned are abbreviated: *Alchemilla alpina* = *Alchemilla*; *Betula glandulosa* = *B. glandulosa*; *Betula nana* = *B. nana*; *Betula pubescens* = *B. pubescens*; *Campanula gieseckiana* = *Campanula*; *Deschampsia flexuosa* = *Deschampsia*; *Dryas integrifolia* = *Dryas*; *Empetrum nigrum* ssp. *hermaphroditum* = *Empetrum*; *Loiseleuria procumbens* = *Loiseleuria*; *Polygonum viviparum* = *Polygonum*; *Potentilla tridentata* = *Potentilla*; *Salix arctophila* = *S. arctophila*; *Salix glauca* = *S. glauca*; *Salix herbacea* = *S. herbacea*; *Thalictrum alpinum* = *Thalictrum*; *Thymus praecox* ssp. *arcticus* = *Thymus* and *Vaccinium uliginosum* = *Vaccinium*.

Following abbreviations are used throughout the revision: coll. = collections, E = East, f. = forma, imm. = immersion Lens, N = North, NW = Northwest, S = South, SE = Southeast, sect. = sectio, subsect. = subsectio, SW = Southwest, W = West, var. = varietas. The herbaria abbreviations are given in the Material section above.

Some critical characters within subsect. *Squamulosae*

It was known previously that the taxa of subgen. *Hygrocybe* had very large elements in the stipititrama (Arnolds 1974), but it appeared that the character has not been investigated systematically in subsect. *Squamulosae* before. Only in the diagnosis of *H. helobia* (Arnolds) Bon, the hyphae were described as "very long and tubular" (Arnolds 1974). We have investigated the Greenlandic and some related extralimital taxa from subsect. *Squamulosae*. The taxa could be divided in two groups. The first has small or fairly small elements, in average (51-)55.5-132(-137.5) x (8-)8.5-17(-18) µm. This group includes *H. miniata*, *H. biminiata* and *H. substrangulata* (incl. var. *rhodophylla*) (Figures 1, 2). Four species of subsect. *Coccineae*, viz. *H. ceracea*, *H. constrictospora*, *H. reidii* and *H. phaeococcinea* (Arnolds) Bon were studied and found to be identical in this aspect. The second group has large elements, in average (129-)141-275(-296) x 12.5-21.5 µm. This group includes *H. coccineocrenata, H. turunda*, *H. cantharellus* and *H. helobia* (Figures 1, 2).

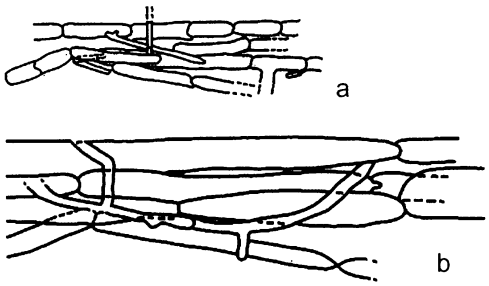

Figure 1. Stipititrama elements: a: *H. substrangulata*, TB 91.107, x 160 – b: *H. coccineocrenata*, Denmark: 24.08.1985, ER, x 160.

D. Boertmann (*pers. comm.*) and P.D. Orton (*pers. comm.*) have suggested that our observations might be explained by differences in ecology (occurrence in mosses incl. *Sphagnum* or on mineral soil), age, or that they are dependent on the part of the stipe where the elements were measured. However, this seems not to be the case. We have attempted to take our measurements from the inner part of mature basidiocarps. In some cases the collections consisted of young, very small, but at least partly ripe basidiocarps (Figure 2, collections marked

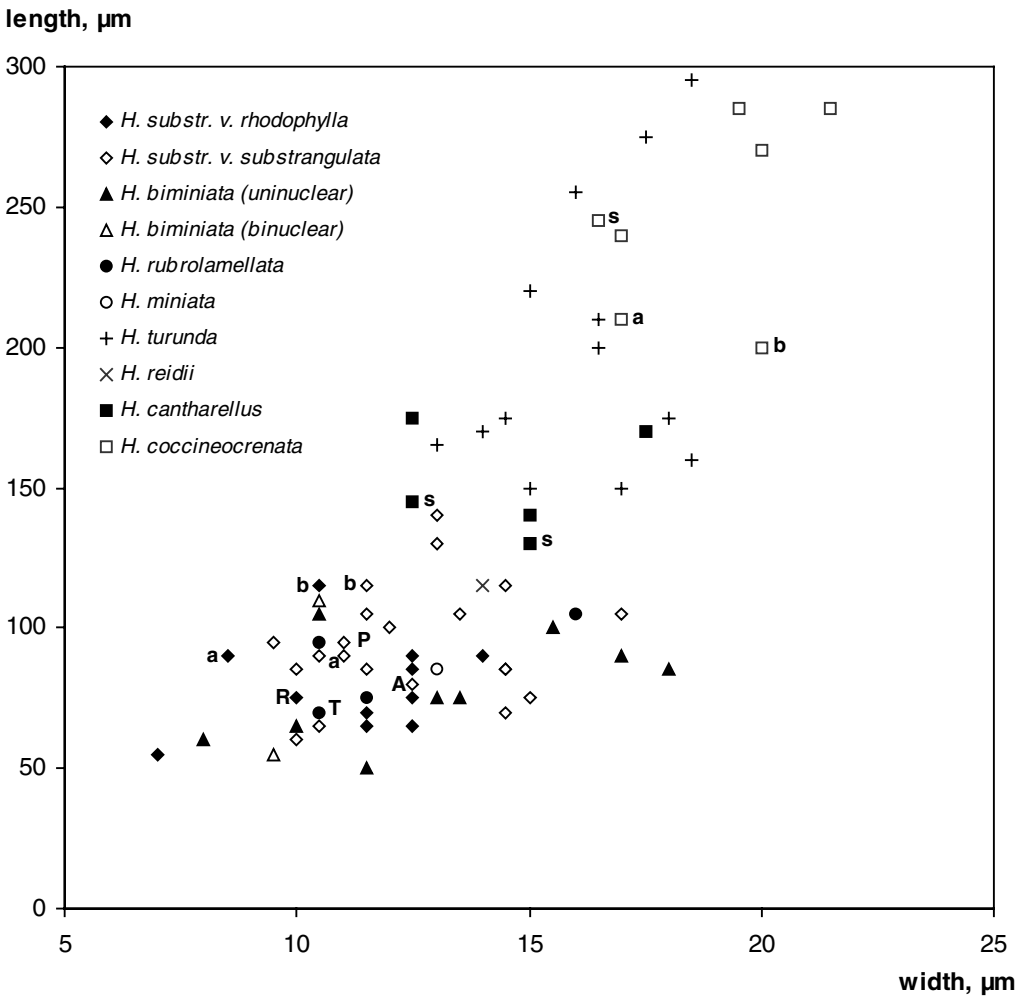

Figure 2. Variation in average size of the stipititrama elements within *Hygrocybe* subsect. *Squamulosae* (at least 10 elements measured per basidiocarp). *H. biminiata* with predominantly uninucleate spores: n = 9 from Greenland. *H. biminiata* with predominantly binucleate spores: n = 2 from Greenland. *H. rubrolamellata*: n = 4 incl. holotype (= T) from Greenland. *H. cantharellus*: n = 1 from Greenland, 1 from Denmark and 2 from the Netherlands. *H. coccineocrenata*: n = 3 from Denmark, 2 from France and 1 from Switzerland. *H. miniata*: n = 1 from Greenland, 1 from Denmark. *H. reidii*: n = 1 from Greenland. *H. substrangulata* var. *substrangulata*: n = 7 from Greenland, 7 from Denmark, 1 from Finland, 1 from France (holotype of *H. coccineocrenata* f. *ambigua* = A), 2 from Norway, 1 from Scotland and 1 from USA (holotype of *Hygrophorus miniatus* var. *sphagnophilus* = P). *H. substrangulata* var. *rhodophylla*: n = 13 from Greenland and 1 from France (holotype = R). *H. turunda*: n = 3 from Greenland, 2 from Denmark, 2 from the Faeroe Islands, 4 from Norway, 1 from Scotland and 1 from Sweden. 'a' and 'b' respectively indicate small and large basidiocarps from the same collection and 's' indicates measurements from very small and young basidiocarps.

with 's'). In other cases stipes of small and large basidiocarps from a single collection were compared, with the first objection in mind (Figure 2, collections marked with 'a' and 'b'). However, the differences were consistent. In order to test the impact of differences in size of basidiocarps, stipe/pileus ratio, stipe length/width ratio and average size of stipititrama elements more accurately, eight collections of *H. turunda* were compared (Table 1). It appears that no positive correlation exists between stipe dimensions, stipe/pileus ratio and stipititrama elements (Table 1). Most of these collections were made on mesic to dry soil, but the size is comparable with those of six collections of *H. coccineocrenata*, occurring in *Sphagnum* bogs (Figure 2).

No.	Pileus, mm	Stipe, mm	Stip./pil.	Stip. L/W	Stip.tr., µm
EA 23.08.1985	15-32	20-38 x 2-3.5	1.2-1.5	11	219 x 15
TB 87.50	20-25	30-35 x 3-3.5	1.4-1.5	10	174 x 14
HK et al. 27	10-18	20-40 x 1.5-3	2.0-2.2	13	169 x 14
F.H. Møller	12.5-25	25 x 4	2.0	6.3	152 x 17
DB 85.221	17-19	22 x 2.5	1.2-1.3	8.8	158 x 18
RK 26.80	8-20(-30)	32-40 x 2-3	1.3-4.0	13-16	151 x 15
RK 25.80	20-35	25-35 x 3-5	1-1.3	7-8	211 x 17
Rald, Medelpad	15-30	35-65 x 2.5-3	1.2-2.1	14-22	201 x 16

Table 1. Relation between size of pileus and stipe and the average dimensions of the stipititrama elements (stip.tr.) in *H. turunda*.

P.A. Moreau (*pers. comm.*) informed us that he had noted broad hairs in stipe-apex of the types of *H. rhodophylla*, *H. coccineocrenata* f. *ambigua* and *Hygrophorus miniatus* var. *sphagnophilus*. The authors then studied about 45 collections of *H. miniata*, *H. biminiata*, *H. rubrolamellata* and *H. substrangulata* (incl. var. *rhodophylla*), including the types of *H. biminiata* and *H. rubrolamellata*, and observed an interesting variation: In *H. miniata*, *H. rubrolamellata* and *H. biminiata* the average width of the hairs in stipe-apex is within 3.5-5.5 µm, while it is within 6.5-11.5 µm in *H. substrangulata* (incl. var. *rhodophylla*). The feature is thus taxonomically relevant and gives an additional difference between *H. biminiata* and *H. substrangulata s. l.*

There is a large variation concerning presence/absence of greyish scales on the pileus in subsect. *Squamulosae*: In *H. turunda* the presence of grey-brown scales appears to be constant, although concolorous scales have been observed in a young specimen from Norway (Arnolds unpubl.). In *H. coccineocrenata* the presence of greyish scales is apparently not constant (Arnolds unpubl.). In the material of *H. substrangulata* (incl. var. *rhodophylla*), the whole range of variation from collections with concolorous scales, over scales slightly greyish in age, to distinctly dark grey-brown scales were observed. The remaining species have mainly concolorous scales, but a few collections of *H. biminiata* and *H. rubrolamellata* had very pale brownish scales when observed under a binocular lens. The same holds true for a deviating collection of *H. cantharellus*. Consequently, in our opinion the presence/absence of grey-brown scales has limited value as a taxonomic character at specific level.

The size of the terminal elements of the pileipellis was investigated systematically within subsect. *Squamulosae* (Figure 3). The many collections of *H. biminiata* and *H. substrangulata* (incl. var. *rhodophylla*) indicate that the size is an additional separating character. In the remaining taxa figured, viz. *H. reidii*, *H. miniata*, *H. rubrolamellata*, no conclusions can be drawn, due to the limited material studied. However, the results of Arnolds (1995) on several collections of *H. reidii* and *H. miniata* var. *miniata* are in accordance with our observations.

Except for the data on the hairs in stipe apex, the presented information has been gathered over several years, and the authors have permitted other mycologists to quote them, viz. Arnolds

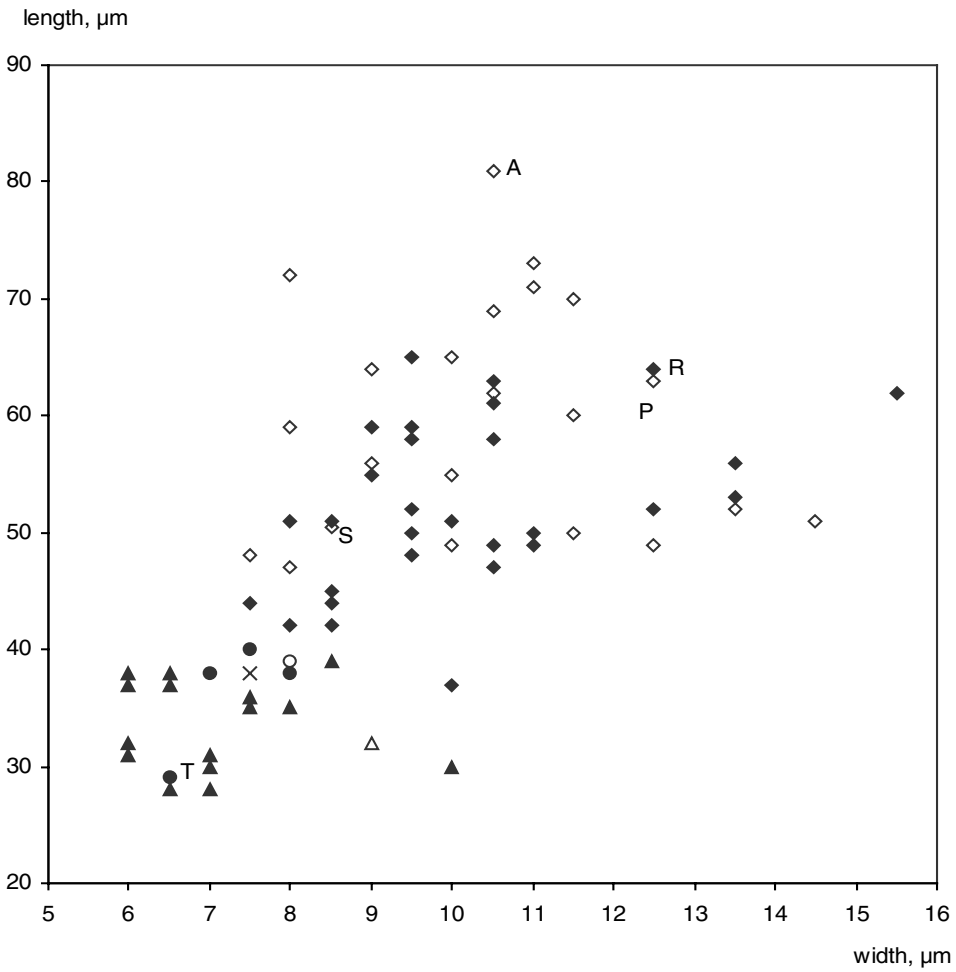

Figure 3. Variation in average size of the terminal elements of the pileipellis, within *Hygrocybe* subsect. *Squamulosae*. For symbols see legend to Figure 2. *H. biminiata* with predominantly uninucleate spores: n = 15 from Greenland. *H. biminiata* with predominantly binucleate spores: n = 1 from Greenland. *H. rubrolamellata*: n = 4 from Greenland, incl. holotype (= T). *H. miniata*: n = 2 from Greenland. *H. reidii*: n = 1 from Greenland. *H. substrangulata* var. *substrangulata*: n = 8 from Greenland, 8 from Denmark, 1 from England (isotype = S), 1 from Finland, 1 from France (holotype of *Hygrocybe coccineocrenata* f. *ambigua* = A), 2 from Norway, 1 from Scotland and 1 from USA (holotype of *H. miniatus* var. *sphagnophilus* = P). *H. substrangulata* var. *rhodophylla*: n = 28 from Greenland and 1 from France (holotype = R).

(1995), Borgen & Senn-Irlet (1995), Boertmann (1995) and Candusso (1997).

Distribution patterns

The distribution of *Hygrocybeae* in Greenland seems to be restricted to the middle, low and subarctic zones. Several mycologists have informed us that they did not observe any species of *Hygrocybe* in the high arctic part of Greenland. The northernmost records are: *H. conica s. l.* from Mestersvig, 72°15′N (Watling 1983); an unidentified species (probably close to *H. citrinopallida*) north of Upernavik, 73°45′N (Watling 1977); *H. substrangulata* var. *rhodophylla* from Tasiusaq on Nutaarmiut in Upernavik District (72°35′N) (Loc. 17) and four taxa, *H. citrinopallida*, *H. conica* var. *aurantiolutea*, *H. biminiata* and *H. substrangulata* var. *substrangulata* from Jameson Land, 71°N (Locs 21, 22). All these records are from the middle arctic zone (Figure 4).

In other parts of the Arctic, in Svalbard (G. Gulden *pers. comm.*) and in Alaska (Laursen *et al.* 1987) the tribus *Hygrocybeae* is rare.

It is well known that complete knowledge on the macrofungi in any area can be obtained only after repeated observations in many different (micro-) habitats (Petersen 1977). With this in mind only the localities 1, 5, 6, 7, 9, 11 and 14, all situated in S and W Greenland, may be considered as fairly well investigated. From E Greenland (Locs 18-22) only about 20 collections (six species) of *Hygrocybe* have been avail-

able. Much more fieldwork is thus necessary in E Greenland to provide a fair comparison.

Eleven taxa, viz. *Camarophyllopsis foetens*, *Hygrocybe russocoriacea*, *H. lacmus*, *H. acutoconica*, *H. psittacina*, *H. ceracea*, *H. constrictospora*, *H. insipida*, *H. reai*, *H. reidii* and *H. cantharellus* are in Greenland restricted to the subarctic zone (Table 2 group 1, Figure 4) which obviously is a distribution centre for the tribus *Hygrocybeae*. These species have their main distribution in temperate areas of Europe, although *H. virginea*, *H. acutoconica, H. psittacina* and *H. reidii* are widely distributed also in the subalpine and subarctic zones.

The low arctic, oceanic parts of Greenland constitute another centre of distribution of *Hygrocybe* (Table 2, Figure 4), as indicated already by Lange (1955). *H. cinerella*, *H. citrinopallida*, *H. lilacina, H. xanthochroa* and *H. biminiata* (Table 2, groups 2, 3) have their main distribution here. Other taxa, like *H. conica* var. *chloroides*, *H. conica* var. *aurantiolutea, H. salicis-herbaceae* and *H. substrangulata* var. *rhodophylla*, have a wide distribution in both the subarctic and low arctic zones, while *H. conica* var. *conica* was only recently confirmed from the low arctic zone.

In the low arctic continental part of Greenland only five taxa were recorded from the well studied Loc. 11: *H. citrinopallida*, *H. lilacina*, *H. xanthochroa, H. conica* var. *aurantiolutea* and *H. substrangulata* var. *rhodophylla* (Lange 1955, 1957, present study).

Twenty-three of the taxa recorded from Greenland, are distributed in temperate, as well as (sub-) arctic and/or (sub-) alpine regions of Europe. *H. pratensis*, *H. conica* var. *conica*, *H. conica* var. *chloroides*, *H. conica* var. *aurantiolutea* and *H. laeta* var. *flava* enter the low arctic zone also in Europe. So far *H. substrangulata* var. *rhodophylla* has only been reported from The Alps and Greenland. The remaining taxa from Greenland are confined (almost) to subarctic, boreo-atlantic and/or (sub-) alpine areas in northern Europe and appear to be rare or absent in the Alps, viz. *H. cinerella*, *H. citrinopallida*, *H. lilacina*, *H. xanthochroa* and *H. biminiata*.

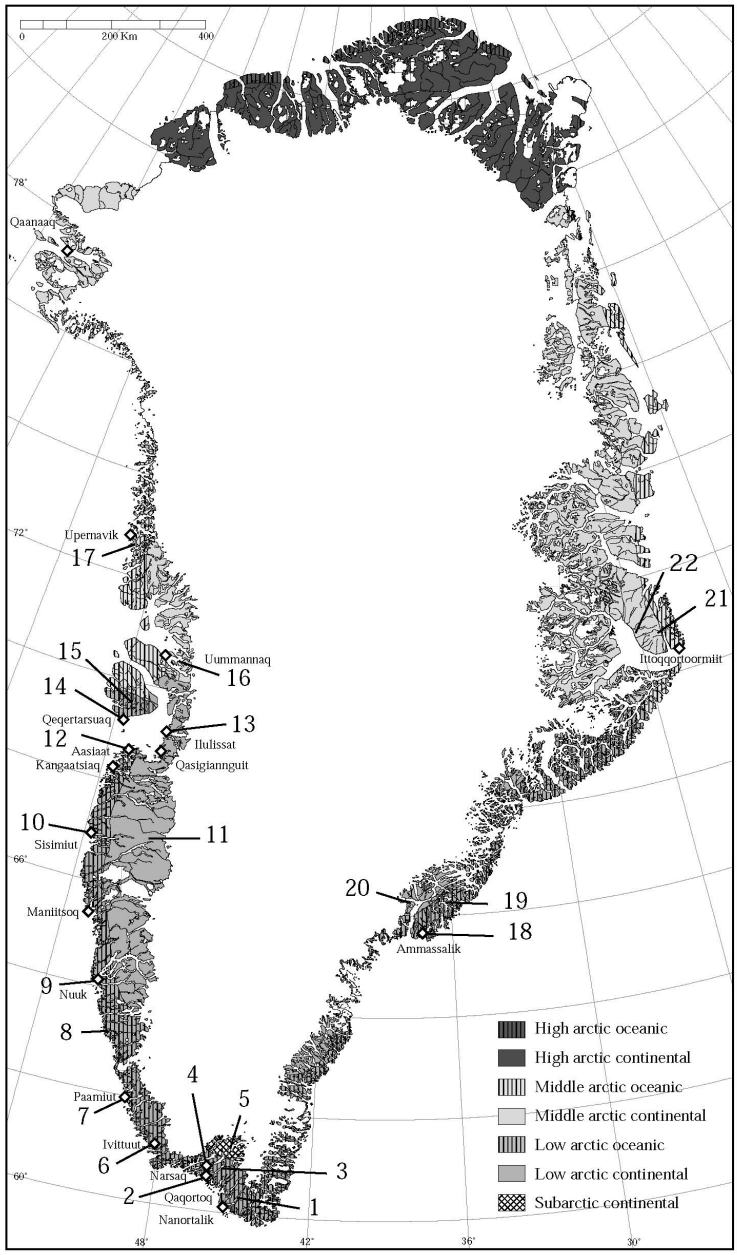

Figure 4. Sampling localities for *Hygrocybe* and *Camarophyllopsis* in Greenland. See also Appendix 1. Climatic zonation according to Bay (1997).

Table 2. Occurrence of *Camarophyllopsis* and *Hygrocybe* taxa in various habitats in Greenland. Group 1: Taxa confined to the subarctic zone of S Greenland. Group 2: Taxa present both in subarctic and low-, exceptionally middle arctic zones. Group 3: Taxa confined to the low/middle arctic zone(s). 1 = Grassland slope, often grazed by sheep/horses; grassland patches in the low arctic area. 2 = Fens/Bogs, with or without *Sphagnum*. 3 = Continental heaths dominated by *B. nana*. 4 = Subarctic copses with *B. pubescens* and *S. glauca*, oceanic to continental. 5 = Low arctic and oceanic copses of *S. glauca*. 6 = Sandy/gravelly sites. 7 = Oceanic herb-slopes, mostly with *Alchemilla*. 8 = Oceanic dwarf-scrub heaths, dominated by *Empetrum*, in the fiords partly replaced by *B. nana* or *B. glandulosa*. 9 = Snow-patches dominated by *S. herbacea*, mosses and lichens. x = Present, r = Rare, o = Occasional, c = Common. A = Occurring in the low (-middle) arctic zones. S = Occurring in the subarctic zone. B = Occurring in the boreal zone outside Greenland. T = Occurring in the temperate zone outside Greenland. S > T: More common in the former, than in the latter zone. Terminology in the distribution column sensu Elborne & Knudsen (1990). ? indicates that the taxa possibly were found in these habitats (Rostrup 1888, Lange 1955), but no specimens are preserved and the identity cannot be confirmed.

		1	2	3	4	5	6	7	8	9	Distribution
Group 1.	*C. foetens*	r									T > S
	H. russocoriacea	x									T > S
	H. virginea	o						x			T > S
	H. colemanniana	r									T > S
	H. lacmus	r									T > S
	H. psittacina	r									TS
	H. ceracea	x									T > S
	H. constrictospora	x									T > S
	H. reidii	x									TS
	H. insipida	x									T > S
	H. acutoconica	x	x								T > S
	H. reai		x								T > S
	H. cantharellus	x									T > S
	H. rubrolamellata	o			o						S
Group 2.	*H. pratensis*	x			x	x		r			T > SA
	H. virginea	o							x	?	T>S
	H. cinerella		o						o		A > S
	H. citrinopallida	r	r	o					c	o	A > SB
	H. conica var. *con.*	o			c		x		r		T > SA
	H. conica var. *chlor.*	x			x			r			T > SA
	H. conica var. *aura.*	c	r	x	x	x	x	o	x	x	SA > B
	H. salicis-herbaceae	c			x	o		o	o		SA
	H. laeta var. *flava*	x							?		TS
	H. substrangulata		x				o				TSA
	H. rhodophylla		c				c		o		SA
	H. turunda	o									SB > T
Group 3.	*H. lilacina*	x	c	r					o	o	A > SB
	H. xanthochroa		x	o					x		SA > B
	H. biminiata		o	x					c	o	A
	H. miniata	x		x					x		T > A

	July	August		September		October
	16-31	1-15	16-31	1-15	16-30	1-15
H. biminiata	8	12	13	7	1	0
H. lilacina	6	2	11	9	2	1
H. rhodophylla	8	11	14	7	1	0
H. citrinopallida	4	3	7	9	6	1
H. salicis-herbaceae	0	0	10	22	3	0
H. conica var. *chloroides*	0	1	0	1	0	0
H. conica var. *conica*	0	0	1	0	0	0
H. conica var. *aura*.	0	0	5	5	1	0
H. cinerella	0	2	8	3	1	0
H. pratensis	0	0	1	1	3	0
H. xanthochroa	1	0	6	7	0	0
Total no. of records	27	31	76	71	18	2
Total no. of taxa	5	6	10	10	8	2

Table 3. Phenology of species of *Hygrocybe* in the Paamiut area, Loc. 7. Number of records of *Hygrocybe*-taxa during all seasons.

At least 17 Greenlandic taxa have been reported from North America by Hesler & Smith (1963), Bird & Grund (1979) and/or Laursen *et al.* (1987). *H. citrinopallida* and *H. lilacina* are taxa in common with (sub-) arctic and (sub-) alpine tundra sites in Alaska (Laursen *et al.* 1987). In addition these authors included *H. conica* var. *aurantiolutea* in *H. conica* and very probably *H. substrangulata* in *H. aff. coccineocrenata*. Consequently, these taxa may occur also in Alaska.

It is striking that species of sect. *Oreocybe* are particularly well represented in Greenland. Of these at least *H. citrinopallida* and *H. lilacina* have a long season (Table 3), and are able to sporulate after frost (Borgen unpubl.). Thus they appear to be well adapted to the Arctic. Subsect. *Squamulosae* is well represented also. It is astonishing that *H. miniata* and *H. turunda* occur in the low arctic zone, as they are not known (definitely) from true arctic/alpine areas in Europe.

Ecology

The most important habitats for the taxa are presented in Table 2. They are classified largely in accordance with Böcher *et al.* (1978). A few exceptions have been made for practical reasons: Bogs and fens have not been separated; various types of oceanic heaths have been lumped together, including fell-fields. The expression "sandy/gravelly habitats" covers riverbeds, eroding coastal slopes and (inland) dunes. Finally grassy roadsides are included in grassland sites.

In Greenland, like in NW Europe, grasslands are the preferred habitats for the taxa. Most of the taxa from the subarctic zone in Greenland (Table 2, group 1) are confined to grassland slopes. The same is true for both the sub- and low arctic zones (group 2), although the taxa here are also known from a variety of different other habitats. It deserves mentioning that Rune & Rald (unpubl.) in 1987 and 1992-1994 made detailed my-

cological studies in subarctic seminatural grasslands at Qassiarsuk and Tasiusaq (Loc. 5 C, D), and recorded *C. foetens*, *H. colemanniana*, *H. lacmus* and *H. laeta* var. *flava* from Greenland for the first time. These records are included in Boertmann (1995, distributional maps), as well as in the present paper.

The number of taxa observed in grassland slopes is somewhat lower than in similar grassland slopes in (sub-) alpine parts of the Alps (Favre 1955, 1960, Kühner 1976, 1977a, b, Kühner & Lamoure 1986) and in Scandinavia (Hansen & Knudsen 1992, Boertmann 1995); Scotland (Watling 1987); the Faeroe Islands (Møller 1945, Petersen *et al.* 1994) and Iceland (Hallgrimsson 1974). The smaller number of taxa in Greenland may be "due to the unfavorable weather-conditions and the isolated position of Greenland", as suggested by Knudsen & Borgen (1987) and/or the short vegetational history of Greenland since the last glaciation (N. Hallenberg, pers. comm.).

Ten taxa were noted in fens and/or bogs. Three of these occur among *Sphagnum*, viz. *H. cinerella*, *H. substrangulata* var. *substrangulata* and var. *rhodophylla*. *H. acutoconica* and *H. reai* were collected in basic fens, partly with *Dryas* nearby. It is remarkable that no species have been recorded from *Dryas* heaths so far, in comparison with the list from this community in the alpine zone of Vanoise, France (Kühner & Lamoure 1986).

In the low arctic, oceanic part of Greenland the best habitats for *Hygrocybe* are fens and mossy, dwarf-shrub heaths dominated by *Empetrum* (Table 2, groups 2, 3).

Phenology

The occurrence of *Hygrocybe* during all seasons in the Paamiut area (Loc. 7) is given in Table 3. In most years the first author has been there from 1 August and onwards. Usually, snow covers the ground from about medio September/medio October until May. The lower number of collections the first half of August is accidental, due to limited collecting efforts in some years in this area. The optimum for *Hygrocybe* is in the second half of August and early September, in fact fructification declines already after the first week of September. Compared to this, the general peak is esteemed to be late August. The earliest record of any *Hygrocybe* in Greenland is a record of *H. substrangulata* var. *rhodophylla* made on 2 July. The latest records are two collections of *H. citrinopallida* and *H. lilacina* made on 2 October, included in Table 3.

Taxonomic part

Classification

Camarophyllopsis Herink subgen. ***Hodophilus*** (R. Heim) Arnolds

C. foetens (W. Phillips) Arnolds

Hygrocybe subgen. ***Cuphophyllus*** Donk

Sect. ***Cuphophyllus***

H. cinerella (Kühner) Arnolds
H. lacmus (Schumach.) P.D. Orton & Watling
H. colemanniana (A. Bloxam) P.D. Orton & Watling
H. pratensis (Pers.: Fr.) Murrill
H. russocoriacea (Berk. & T.K. Mill.) P.D. Orton & Watling
H. virginea (Wulfen: Fr.) P.D. Orton & Watling

Sect. ***Oreocybe*** Boertm.

H. citrinopallida (A.H. Sm. & Hesler) Kobayasi ap. Kobayasi *et al.*
H. lilacina (C. Laest. ex P. Karst.) M.M. Moser
H. xanthochroa (P.D. Orton) M.M. Moser

Hygrocybe subgen. ***Hygrocybe***

Sect. ***Hygrocybe***

Subsect. *Nigrescentes* (Bataille) Arnolds
H. conica (Scop.: Fr.) P. Kumm. var. *conica*
H. conica var. *chloroides* (Malençon) Bon
H. conica var. *aurantiolutea* T. Borgen & Arnolds var. nov.

Subsect. *Macrosporae* R. Haller Aar. ex Bon
H. acutoconica (Clem.) Singer

Hygrocybe subgen. ***Pseudohygrocybe*** Bon

Sect. ***Glutinosae*** Kühner

Subsect. *Psittacinae* (Bataille) Arnolds
H. laeta (Pers.: Fr.) P. Kumm. var. *flava* Boertm.
H. psittacina (Schaeff.: Fr.) P. Kumm.

Subsect. *Insipidae* (Herink) Bon
H. reai (Maire) J.E. Lange
H. insipida (J.E. Lange) M.M. Moser
H. salicis-herbaceae Kühner

Sect. ***Coccineae*** Fayod

Subsect. *Coccineae* (Bataille) Singer
H. ceracea (Fr.: Fr.) P. Kumm.
H. constrictospora Arnolds
H. reidii Kühner

Subsect. *Squamulosae* (Bataille) Singer
H. miniata (Fr.: Fr.) P. Kumm.
H. biminiata Kühner
H. rubrolamellata T. Borgen & Arnolds spec. nov.
H. substrangulata (P.D. Orton) P.D. Orton & Watling var. *substrangulata*
H. substrangulata (P.D. Orton) P.D. Orton & Watling var. *rhodophylla* (Kühner) Boertm.
H. turunda (Fr.: Fr.) P. Karst. sensu F.H. Møller
H. cantharellus (Schwein.: Fr.) Murrill

Key to the Greenlandic wax caps (tribus *Hygrocybeae*)

1a. Pileipellis a hymeniderm consisting of subglobose to broadly clavate elements. Basidiocarps dark brown, with a very strong, foetid smell. Spores in average 5.4-7.0 x 4.3-5.1 µm, Qav = 1.20-1.40 . . . . . .*Camarophyllopsis foetens* p. 22

1b. Pileipellis a cutis, an ixocutis or a trichoderm. *Hygrocybe* 2

2a. Basidiocarps whitish, greyish, brownish, or dull brownish orange. Stipe dry. Pileus dry or slightly viscid. Lamellae decurrent. Hymenophoral trama interwoven. *Hygrocybe* sect. *Cuphophyllus* . . . . . Key A p. 18

2b. Basidiocarps vividly coloured, yellow, orange, red, green, sometimes orange-brown but then pileus viscid. Stipe dry or viscid. Lamellae free to decurrent. Hymenophoral trama regular, subregular or interwoven, in the latter case pileus viscid 3

3a. Lamellae decurrent. Hymenophoral trama interwoven. Basidiocarps yellow, greenish to orange-brown, frequently mixed with violet. Pileus viscid when young, fading to whitish. Stipe glabrous, viscid when young. *Hygrocybe* sect. *Oreocybe* . . . . . Key B p. 19

3b. Lamellae free, adnate or decurrent. Hymenophoral trama (sub-)regular. Basidiocarps predominantly red, orange to yellow. Pileus dry to glutinous, not fading to whitish. Stipe dry or viscid 5

4a. Hymenophoral trama strictly regular, made up of very long (300-2500 µm) tubuliform elements, tapering to the ends. Lamellae free or narrowly adnate. Pileus ± umbonate. Stipe dry, in age fibrillose-striate. Context blackening or not. *Hygrocybe* subgenus *Hygrocybe* . Key C p. 19

4b. Hymenophoral trama subregular to slightly irregular made up of short to medium-sized (130-200(-400) µm), cylindrical or inflated elements. Lamellae narrowly adnate to decurrent. Pileus rarely umbonate. Stipe not fibrillose-striate, smooth. Context not blackening. *Hygrocybe* subgenus *Pseudohygrocybe* . . . . . Key D p. 20

Key A: *Hygrocybe* subgen. ***Cuphophyllus*** sect. ***Cuphophyllus***

1a. Basidiocarps whitish or pale yellowish, pileus lubricous to slightly viscid when moist. 2

1b. Basidiocarps distinctly coloured 3

2a. Pileus pale leather-coloured to yellowish ochre when moist. Smell strong, reminiscent of wood of *Juniperus* . . . . . *H. russocoriacea* p. 25

2b. Pileus whitish or cream-coloured. Smell indistinct . . . . . *H. virginea* p. 26

3a. Pileipellis a dry cutis 4

3b. Pileipellis an ixocutis, in subarctic grassland 5

4a. Basidiocarps dull orange-brown to incarnate. Pileus 30-80 mm wide. In herb-slopes and subarctic grassland . . . . . *H. pratensis* p. 24
4b. Basidiocarps dark brownish purple, occasionally with a lilac tinge. Pileus 10-30 mm wide. Mainly in low arctic fens and moist heaths . . *H. cinerella* p. 22

5a. Pileus dark grey-brown with a lilac tinge, lamellae pale violaceous grey . . . . . *H. lacmus* p. 24
5b. Pileus date-brown, lamellae pale brown . . . . . *H. colemanniana* p. 24

Key B: ***Hygrocybe*** subgen. ***Cuphophyllus*** sect. ***Oreocybe***

1a. Basidiocarps with some shade of violet 2
1b. Basidiocarps only with yellowish colours 3

2a. Stipe partly pale violaceous.Lamellae pale, greyish violet, very pale towards the edge. Pileus in part pale violaceous, frequently with a long striation. Spores in average 5.6-6.6(-7.5) x 3.4-4.1 (-4.6) µm . . . . . .violaceous collections of *H. xanthochroa* p. 31
2b. Stipe ± uniformly reddish violet. Lamellae deep yellow to ochre, frequently with a violaceous shade. Pileus ± sordid yellow-orange, ochraceous to brownish orange, occasionally intermixed with violet, pale violaceous only when old, at most indistinctly striate towards the margin. Spores in average 6.8-8.7 x 4.4-5.4 µm . . . . . *H. lilacina* p. 29

3a. Lamellae (very) pale yellow, pale watery ochre-yellow, paler towards the edge. Pileus dull yellowish ochre to (dull) orange-yellow, frequently with a long striation. Spores in average 5.6-6.6(-7.5) x 3.4-4.1 (-4.6) µm . . . . . yellowish collections of *H. xanthochroa* p. 31
3b. Lamellae (lemon-) yellow, luteous to pale yellowish ochre, edge concolorous. Pileus subconcolorous, indistinctly striate, usually only at the margin. Basidiocarps rarely with a greenish yellow tinge. Spores in average 7.2-9.1 x 4.0-4.9 µm . . . . . *H. citrinopallida* p. 26

Key C: ***Hygrocybe*** subgenus ***Hygrocybe***

1a. Basidiocarps blackening on injuring or age 2
1b. Basidiocarps not blackening . . . . . *H. acutoconica* p. 37

2a. Pileus (orange-yellow), orange-red to red. Stipe in part orange-yellow to orange. Lamellae whitish to yellow, occasionally with a reddish flush . . . . . *H. conica* var. *conica* p. 33
2b. Pileus pale yellow to orange. Stipe (pale-) yellow. Lamellae whitish to pale sulphur-yellow 3

3a. Pileus (pale) yellow often with a slight olivaceous tinge. Context in places bluish grey, then greyish black . . . . . *H. conica* var. *chloroides* p. 34
3b. Pileus deep yellow, orange-yellow, to orange. Context turning violaceous black . . . . . *H. conica* var. *aurantiolutea* p. 35

Key D: Hygrocybe subgenus **Pseudohygrocybe**

1a. Pileus dry to subviscid, often hairy or squamulose. Pileipellis a dry cutis, ixocutis or trichoderm. Stipe dry; stipitipellis a poorly differentiated cutis . . 2
1b. Pileus viscid or glutinous. Pileipellis an ixotrichoderm. Stipe (sub-) viscid to glutinous; stipitipellis an ixocutis or ixotrichoderm 13

2a. Pileus dry to subviscid, glabrous or slightly adpressed hairy; pileipellis a dry cutis or a thin ixocutis 3
2b. Pileus dry, scurfy to squamulose, pileipellis a trichoderm, at least at the centre 5

3a. Smell unpleasant, sweetish, sometimes weak, spores 6.5-7.5(-8.0) x 3.5-5.0 µm, in average 7.3 x 4.2 µm, Qav ± 1.75, predominantly binucleate, < 25% constricted. Pileus red at first, pileipellis a dry cutis (if trichodermal hyphae are present, see 10). Hypoderm-like pileitrama absent. Stipe may appear greasy when moist, but stipitipellis a dry cutis . . . . . *H. reidii* p. 43
3b. Smell none or different. Spores either smaller or larger, uninuclate 4

4a. Spores 6.5-8.0(-8.5) x (3.0-)3.5-4.0(-4.5) µm, in average 7.0-7.6 x 3.4-4.0 µm, Qav = 1.95-2.05. Pileus subviscid due to a thin ixocutis, underneath the pileipellis with a distinct hypoderm of strongly inflated cells. Stipitipellis a dry cutis to a very thin ixocutis. Pileus orange yellow to orange . . . . . *H. ceracea* p. 42
4b. Spores (6.5-)7.0-9.5 x (3.5-)4.0-4.5(-5.5) µm, in average 8.3 x 4.5 µm, Qav = 1.85-1.90. Pileipellis a dry cutis, hypoderm absent. Stipitipellis a dry cutis. Pileus reddish orange fading to orange . . . . *H. constrictospora* p. 43

5a. Stipititrama elements in average (129-)141-275(-296) x 12.5-21 µm. Lamellae ± arcuate-decurrent. Spores binucleate 6
5b. Stipititrama elements in average 51-132(-137.5) x 8-17(-18) µm. Lamellae broadly adnate, rarely decurrent. Spores uni- or binucleate 8

6a. Pileus with minute to distinct, brownish to blackish scales 7
6b. Pileus with minute, ± concolorous scales . . . . . *H. cantharellus* p. 60

7a. Pileus with minute to coarse, predominantly brown to blackish scales on a scarlet to orange-yellow background. Lamellae pale to deep yellow, sometimes orange-yellow. Mostly in mesic to dry grassland slopes . . . . . *H. turunda* p. 56
7b. Pileus with minute, dark brown to blackish scales on a red to orange-red background. Lamellae white, then cream coloured to wax yellow, occasionally pale red near base. Mostly in Sphagnum bogs, never in grassland slopes . . . . . *H. coccineocrenata* p. 56

8a. Spores in frontal view broader towards the apiculus and often constricted, obovoid to obpyriform; in side view ellipsoid, (6.5-)7.5-9.5 (-10.0) x (4.0-)5.0-6.0(-6.5) µm, in average 8.1-8.7 x 5.0-5.5 µm, in frontal view 5.6-5.9 µm broad. Cheilocystidia often present . . . . . *H. miniata* p. 44
8b. Spores not broader in frontal view. Cheilocystidia absent or not distinctive .. 9

9a. Spores 6.5-9.5(-10.5) x 3.5-5.5(-6.5) µm, in average 7.2-8.4 x 4.2-5.1 µm. In subarctic, dry grass- and heathland 10
9b. Spores (7.5-)8.0-14.0(-15.0) x 4.5-8.0 µm, in average 8.6-12.4 x 4.8-6.7 µm. In moist, peaty, occasionally drier heaths, frequently among Sphagnum, moist sand or gravel 11

10a. Spores in average ± 7.3 x 4.2 µm, binucleate. Lamellae pale yellow, occasionally flushed reddish at the base. Pileus apricot to orange. Smell unpleasant sweetish, sometimes weak. Pileipellis predominantly a dry cutis, with some trichodermial hyphae . . . . . *H. reidii* p. 43
10b. Spores in average 7.2-8.4 x 4.2-5.1 µm, uninucleate. Lamellae red, also in between. Pileus red to orange-red. Smell weak. Pileipellis a distinct trichoderm . . . . . *H. rubrolamellata* p. 49

11a. Terminal elements of pileipellis in average 27.5-41 x 6-10 µm, (sub-) concolorous. Hairs in stipe-apex in average 4.0-5.5 µm broad. Not in bogs . . . . . *H. biminiata* p. 45
11b. Terminal elements of pileipellis in average 37.5-81 x 7.5-15.5(-16.5) µm, predominantly grey-brown. Hairs in stipe-apex in average 6.5-11.5 µm broad. Frequently in bogs 12

12a. Lamellae pale yellow, orange (-red) to pastel red. Pileus pale orange to red. Stipe concolorous. Mainly subarctic . . . . . .*H. substrangulata* var. *substrangulata* p. 51
12b. Lamellae usually pastel red to dark pinkish red. Pileus red to blood red. Stipe concolorous. Widely distributed . *H. substrangulata* var. *rhodophylla* p. 53

13a. Pileus, stipe and lamellae with bright green colours when young, gradually discolouring to yellowish, pinkish or lilac . . . . . *H. psittacina* p. 37
13b. Basidiocarps without green colours 14

14a. Edge of lamellae gelatinous and hyaline, sterile by numerous slender cheilocystidia. Stipe very glutinous, covered by a thick ixotrichoderm . . . . . *H. laeta* var. *flava* p. 37
14b. Edge of lamellae not gelatinous, fertile 15

15a. Most spores broadened towards the base in frontal view, obovoid to obpyriform, frequently constricted. Taste bitter . . . . . *H. reai* p. 38
15b. Spores constricted or not, but not broadened towards the base in frontal view. Taste mild or bitter 16

16a. Pileus 10-40(-50) mm wide, mostly obtusely conical. Stipe (15-)40-60 x 3-7(-10) mm. Spores in average (7.2-)7.5-9.1(-10.1) x 4.3-5.6 µm, rarely slightly constricted. Taste bitter or acrid. Lamellae adnate to emarginate with a tooth ..... *H. salicis-herbaceae* p. 39

16b. Pileus 5-20 mm wide, convex to irregular. Stipe 14-25 x 1.5-4 mm. Spores in average 6.4-7.3 x 3.4-4.1 µm, 20-50% constricted. Taste mild. Lamellae adnexed, adnate to subdecurrent 17

17a. Stipitipellis a distinct ixocutis. Lamellae pale orange-red to reddish salmon. Hypoderm-like pileitrama absent ..... *H. insipida* p. 38

17b. Stipitipellis at most a thin ixocutis < 15 µm thick. Lamellae light yellow to yellow. Hypoderm-like pileitrama present ..... *H. ceracea* p. 42

Descriptions

Camarophyllopsis

Camarophyllopsis foetens (W. Phillips) Arnolds in Mycotaxon 25: 643, 1986.

For synonymy, selected icones and descriptions, see Arnolds 1990.

Habitat and distribution: Seven partly caespitose basidiocarps on naked soil with sparse lichens and mosses, on a rocky slope towards a rivulet, 20.08. 1993. The site is subarctic and subcontinental.

Material: Greenland: Loc. 5D, *ER & FR 93.515.

Observations: *C. foetens* is new to Greenland. Although the material has not been seen, the species is included in our paper, due to the collectors' extensive field description and good colour-slide. The colour of the pileus was darker than in most descriptions and illustrations which were compared, but well in accordance with the description by Schmid-Heckel (1985). The microscopic features given in the key are extracted from Arnolds (1990). *C. foetens* has been collected only once in the alpine zone in the Alps, Bavaria (Schmid-Heckel 1985).

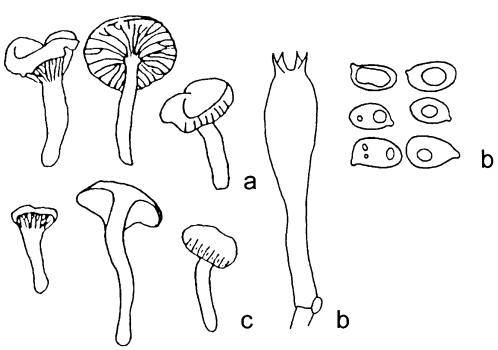

Figure 5. *H. cinerella*. a: TB 82.18, basidiocarps x 0.8 – b: TB 79.91, spores & basidium x 800 – c: TB 86.252, basidiocarps x 1.

Hygrocybe subgen. *Cuphophyllus*

Hygrocybe cinerella (Kühner) Arnolds in Persoonia 13: 386, 1987.

Figure 5.

Synonyms: *Camarophyllus cinerellus* Kühner 1977b.

Misapplications: *Hygrophorus cinereus* sensu Hesler & Smith 1963.

Selected descriptions: Hesler & Smith 1963; Kühner 1977b; Candusso 1997.

Selected icones: Moser & Jülich 1988: Camarophyllus 2; Boertmann 1995.

Pileus 7-26(-29) mm wide, convex with a slightly involute, not or indistinctly striate (up to 2/3 R), frequently crenu-

late margin, then ± expanded, often with a shallowly depressed to subumbilicate centre, occasionally with a low umbo, dry, slightly scabrous or sometimes concentrically adpressed squamulose, especially when dry; at first dark brown (Mu. 7.5YR3/2), with concolorous or slightly paler (7.5YR5/2) margin, then grey-brown to pale greyish brown (e.g. 10YR6/2), sometimes with a shade of brownish violet, mostly with a very pale brownish grey (10YR7/2) margin, entirely fading to pale brownish grey or almost whitish, in exsiccata frequently grey-brown with a shade of lilac. Lamellae (L=18-38, l=1-3) moderately close to subdistant, ± decurrent, arcuate to triangular, up to 3.5 mm broad, often slightly furcate or intervenose, slightly brownish grey (10YR6.5/1), occasionally with flush of purple, then pale grey (10YR7/1), sometimes with a shade of lilac, exceptionally with a pinkish flush. Stipe (5-)6-27 x 1-5(-6) mm, equal or tapering towards the base, solid then fistulose, dry, dull or silky, aeriferously fibrillose to almost glabrous, slightly whitish tomentose at base, light brownish grey, pale brown or almost white (e.g. 10YR6/2-3), paler when dry. Context rather thick in the centre of the pileus, almost concolorous with surface, in the base of the stipe sometimes pale brown, waxy and brittle. Smell not distinctive, taste mild. Spore-print white.

Spores 6.0-9.0(-10.5) x (3.5-)4.0-5.5(-6.0) µm, in average 6.4-7.6 x 4.4-4.9 µm, Q = 1.20-1.80(-2.00), Qav = 1.40-1.65, mostly ovoid or ellipsoid to slightly lacrymiform, some broadly ovoid or elongate, sometimes slightly constricted. Basidia rather slenderly clavate, 35.5-45 x 6.5-8.5 µm, Q ± 4.0-6.0(-8.0). Cystidia not observed. Hymenophoral trama irregular, made up of short elements, ± 51-75 x 8-13.5 µm, exceptionally slightly incrusted (in KOH, imm.). Pileipellis a dry cutis, made up of hyphae, ± 3-7 µm wide, with greyish intracellular pigment. Stipitipellis a dry cutis with groups of slender, cylindrical hairs, up to 37 x 2.5 µm. Clamp connections numerous.

Habitat and distribution: In moist heaths with *Empetrum*, *Vaccinium*, lichens and mosses, in fens on peat among mosses, frequently *Sphagnum*. Not uncommon in low arctic, hyperoceanic to oceanic sites in S and SW Greenland, probably rare in subarctic S Greenland. Early August to medio September.

Material: *Greenland*: Loc. 1B, TB 91.131. – Loc. 7A, TB 80.98, TB 85.252, TB 85.266, TB 86.271, TB 95.071. – Loc. 7C, TB 82.18 (duplicate at WAG), TB 85.253. – Loc. 7D, TB 79.91, TB 86.281. – Loc. 7G, TB 87.188. – Loc. 8, PMP 73.526. – Loc. 9A, ML 8-9.08. 1971, TB 87.151, HFG 87.100, HFG 87.101, HFG 87.102, SAE GR 87.118, SAE GR 87.159. – Loc. 9B, SAE GR 87.176. – Loc. 9D, TB 87.112, SAE GR 87.107.

Observations: Kühner (1977b) collected the type in N Sweden near Abisko, and Hesler & Smith (1963) collected it in USA, Washington, Mt Rainier National Park. Hallgrímsson (1974) described a collection from Iceland (Vatnamyrúm at Arskógströnd) *sub nom. H.* cf. *cinereus*, which, judging from the description, almost certainly belongs here. Furthermore, Arnolds (unpubl.) has collected it in S Norway, Haukeliffjell and Ohenoja (pers. comm.) made an unpublished record from arctic Canada, near Hudson Bay. Also known from arctic Russia (W Siberia): (Knudsen & Mukhin 1998). *H. cinerella* has probably a circumpolar distribution.

Kühner assumed that his species differed from *Hygrophorus cinereus* sensu Hesler & Smith by its larger spores, viz. 7.5-9.5 x 5-6.5 µm versus 7-8(-10) x 4.5-5.5 µm, and the lack of purple to lilac colours. However, several Greenlandic collections show a larger variation in spore-size and colours. It was impossible to segregate taxonomic units within the material, so we are convinced that only a single, variable species exists.

Hygrocybe lacmus (Schumach.) P.D. Orton & Watling in Notes from the Royal botanic Garden Edinburgh 29: 131, 1969.

For synonymy see Arnolds 1990.

Selected icon: Boertmann 1995.

Habitat and distribution: Six fasciculate specimens in sheep grazed vegetation dominated by grasses and mosses, with *Salix glauca* and *Betula pubescens*, at a rivulet, below a cliff, 04.09.1994. The site is subarctic and subcontinental.

Material: *Greenland*: Loc. 5D, FR 94.134, duplicate at TB.

Observations: The collector's field-notes, a good colour-slide (published in Boertmann l.c.), and our study of the dried material leaves no doubt that it is quite typical. The record was erroneously published as *H. flavipes* (Brizelm.) Arnolds in Boertmann (1995 1st ed.: p. 59, map). Most probably *H. lacmus* is rare in Greenland.

Hygrocybe colemanniana (A. Bloxam) P.D. Orton & Watling in Notes from the Royal botanic Garden Edinburgh 29: 121, 1969.

For selected descriptions and icones, see Arnolds 1990.

Habitat: In sheep and horse-grazed, subarctic grassland, 19.08.1993.

Material: *Greenland*: Loc. 5C, *ER & FR 93.490 (slide), ER.

Observations: The material has not been studied by us, but the field-description and slide are in full accordance with *H. colemanniana*. The basidiocarps are smaller than usual (pileus 10-25 mm broad, stipe 10-25 (-30) x 4-5(-7) mm), but inside the variation given by Kühner (1977b) from the Alps. *H. colemanniana* is most probably rare in Greenland.

Hygrocybe pratensis (Pers.: Fr.) Murrill in Mycologia 6(1): 2, 1914.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Habitat and distribution: *H. pratensis* is not common, but widely distributed in S Greenland. The sites are subarctic to low arctic, hyperoceanic to subcontinental. Lange (1955: 15) recorded the species growing with *Alchemilla* (probably herb-slope) and in luxuriant copses of *S. glauca*. During the present investigation it was recorded from a herb-slope dominated by *Alchemilla*, in *S. glauca* copses rich in herbs, and in grassland slopes with *Alchemilla* and *Juniperus*. Late August to late September.

Material: *Greenland*: Loc. 5B, HK, TB & JHP 602. – Loc. 5F, TB 02.156. – Loc. 6A, ML 610. – Loc. 6B, ML 601. – Loc. 7A, TB 97.141. – Loc. 7C, TB 86.335, TB 86.339 (TB), TB 95.154, TB 97.206.

Observations: The collections are rather uniform and in full accordance with the European concept of var. *pratensis*, e.g. Arnolds (1974) and Kühner (1977b). The unexpected occurrence in the hyperoceanic Paamiut indicates a wider distribution in Greenland.

Hygrocybe russocoriacea (Berk. & T.K. Mill.) P.D. Orton & Watling in Notes from the Royal botanic Garden Edinburgh 29: 131, 1969.

Figure 6.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Pileus up to 7 mm wide, plano-convex with incurved, crenulate margin, when moist subviscid, shiny and slightly translucently striate to the centre, orange-white (Mu. 7.5YR8/2), at the centre slightly darker, pale beige, hygrophanous, paler when faded. Lamellae distant (L=20, l=0-1), deep arcuate-decurrent, rather broad at the middle, watery whitish, edge entire. Stipe up to 18 x 2 mm, slightly tapering downwards, dry, white, aeriferous-fibrillose, watery whitish underneath. Smell sweetish-spicy, like wood of *Juniperus*.

Spores (6.0-)6.5-9.5(-10.0) x (3.0-)3.5-5.0(-6.0) µm, in average 8.3 x 4.5 µm, Q = (1.25-)1.45-2.20(-2.65), Qav = 1.85, variable in shape, mostly oblong, many ellipsoid or ovoid, less frequently obovoid, rarely pyriform, in side view 5%, in frontal view 35% constricted. Basidia (1-), 2- or 3-spored, slenderly clavate, 35-50 x 6-7.5 µm, Q = 5.0-8.0. Cystidia not observed. Hymenophoral trama irregular, elements 23-50 x 3-5(-7.5) µm. Pileipellis a thin ixocutis, ± 12-23(-47) µm broad, made up of loosely organized, mostly ascending hyphae with many free, obtuse ends, elements ± 50 x 2-5 µm. Clamp connections rare.

Habitat and distribution: Only recorded once. Three young, fasciculate basidiocarps on a rather dry lichen-heath with scattered *B. pubescens*, 27.07.1983. The site is subarctic and subcontinental.

Material: *Greenland*: Loc. 5A, HK, TB & JHP 6.

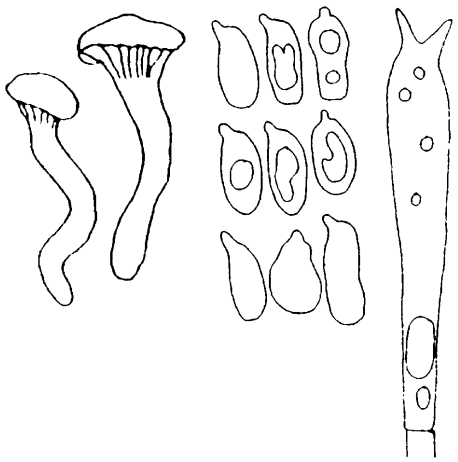

Figure 6. *H. russocoriacea*: HK, TB & JHP 6, basidiocarps (after slide by J.H. Petersen) x 1.65, spores & basidium x 1250.

The Netherlands: EA 3518 (WAG), EA 3550 (WAG).

Observations: *H. russocoriacea* has been recorded earlier from the Faeroe Islands (Møller 1945) and Iceland (Hallgrímsson 1974), but appears to be an uncommon species in subarctic areas. Favre (1960) recorded it from the subalpine zone of Grisons, Switzerland, but it has not been recorded from the alpine zone of Vanoise (Kühner & Lamoure 1986).

Apart from the smaller basidiocarps and the presence of constricted spores, the collection described above is well in accordance with the description by Arnolds (1974), and the two Dutch collections compared. It is well known that many taxa have reduced dimensions when occurring in arctic and alpine areas. Furthermore, the presence/absence of constricted spores does not seem to have much importance in this group (compare the descriptions of *H. virginea* and *H. cinerella*).

Lange (1955) reported a fungus from Loc. 6A, 22.09.1946, (ML 623), having the same external features as *H. russocoriacea*, but deviating by having a subregular hymenophoral trama. A study of the material gave the

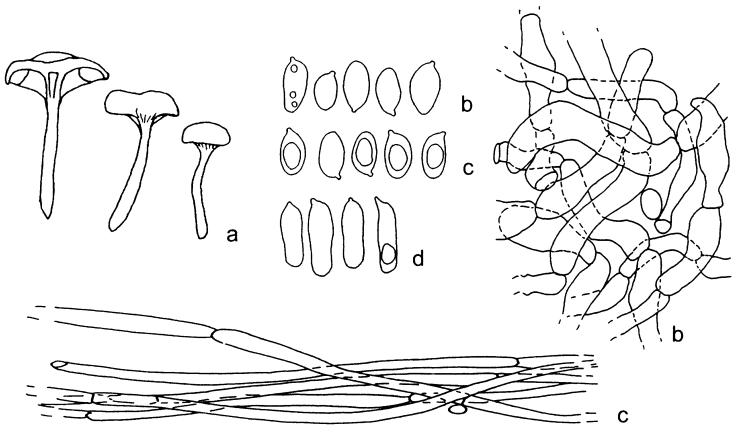

Figure 7. *H. citrinopallida*. a: TB 82.143, basidiocarps x 1 – b: TB 79.127, spores x 700, hymenophoral trama x 280 – c: TB 81.151, spores x 700, pileipellis x 450 – d: TB 86.157, abnormal spores x 700.

following information: Spores (6.0-) 6.5-7.5(-8.0) x 3.0-4.5 µm, in average 7.1 x 3.7 µm, ellipsoid, amyloid. Basidia short ± 27-32 x 5.5-7.5 µm. Cheilocystidia broadly fusiform to (sub-) utriform, protruding part ± 30-37 x 10.5-15 µm. Hymenophoral trama subregular, elements large ± 120-160 x 9-18 µm. Clamp connections present. In view of the amyloid spores and cystidia the collection certainly does not belong into tribus *Hygrocybeae*, but we are unable to identify it.

Hygrocybe virginea (Wulfen: Fr.) P.D. Orton & Watling in Notes from the Royal botanic Garden Edinburgh 29: 132, 1969.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Habitat and distribution: In rather dry, seminatural grassland slopes, grazed by sheep, and on a dry river plain dominated by *Stereocaulon*. Also at Loc. 1B, Tasersuaq, in herb-slope, but no material was kept. Not uncommon in S Greenland in subarctic, suboceanic to subcontinental sites. Late July to late August. Rostrup (1888: 529) recorded it from Ilulissat (Loc. 13) far outside the present area of distribution in Greenland. As no material exists, we hesitate to accept the record.

Material: *Greenland*: Loc. 5A, TB 94.006. – Loc. 5B, HK, TB & JHP 581, HK, TB & JHP 593, HK & TL 642. – Loc. 5C, HK, TB & JHP 43. – Loc. 5F, TB 02.141, TB 02.150.

Observations: The material is quite typical, and belongs to *H. virginea s. str.* Arnolds (1990). In all collections but one only two-spored basidia without clamp connections were observed.

Hygrocybe citrinopallida (A.H. Smith & Hesler) Kobayasi ap. Kobaysi *et al.* in Bulletin of the National Science Museum Tokyo 14(1): 62, 1971.

Figures 7, 8.

Misapplications: *Hygrocybe vitellina* (Fr.) P. Karst. sensu Møller 1945; *Hygrocybe aff. citrinopallida* sensu Laursen *et al.* 1987.

Selected descriptions: Møller 1945; Smith & Hesler 1954; Laursen *et al.* 1987; Miller *et al.* 1982; Boertmann 1995; Candusso 1997.

Selected icones: Møller 1945; Boertmann 1985; 1995; Petersen *et al.* 1994; Candusso 1997.

Pileus 8-25(-30) mm wide, convex with involute margin, then ± applanate at centre sometimes depressed to subumbilicate, margin crenate or undulate, not or indistinctly striate up to 1/2 R, when young and fresh glutinous to viscid then ± dry, practically glabrous; when young (pale) yellow (Mu. 2.5Y8/8, K. & W. 3A6, CIC "Lemon chrome"), then (deep) yellow ("Lemon chrome", "Luteous"), frequently ± watery hyaline in places, when old sometimes entirely so, hygrophanous, drying cream to whitish. Lamellae shortly to rather deeply decurrent, arcuate to triangular, (sub-) distant (L=16-28, l=0-3), rather thin, often intervenose, first pale yellow then very slightly paler to slightly duller than the pileus, (3A4, 3A6, 4A4-5, 2.5Y8/6, CIC 8G, 9H), when old ± whitish. Stipe (5-)10-29(-37) x 1.5-3

(-3.5) mm, fistulose, (sub-)cylindrical, when young and fresh shiny and glutinous to viscid soon dull and dry, glabrous or minutely innate fibrillose (lens), yellowish white to pastel yellow (2A2-4, 3A3, "Straw"), usually already when young in part ± (yellowish-) hyaline, on drying ± whitish, base often slightly whitish tomentose. Context 1-2 mm thick, almost concolorous with surface on drying yellowish white to whitish, brittle. Smell not distinctive. Taste mild to slightly astringent. Spore-print white.

Spores (6.0-)6.5-11.0 x 3.5-6.0(-6.5) µm, in average (7.0-)7.1-9.4 x (4.1-)4.2-5.5 (-5.7) µm, Q = 1.30-2.30(-2.50), Qav = 1.50-2.05, ellipsoid, ellipsoid- to ovoid-oblong, obovoid to amygdaliform, often somewhat pipshaped, rarely (< 10%) slightly constricted under the apex, not or hardly broader in frontal view, hilar appendix large, obtuse or flattened. Basidia slenderly clavate, mostly 4-spored, 31.5-44 x 7-9 µm, Q = 4.0-6.5. Cystidia absent. Hymenophoral trama interwoven, made up of rather short, cylindrical or slightly inflated elements, 15-120 x 5-20 µm. Subhymenium not gelatinized. Vascular hyphae present. Pileipellis in young basidiocarps an ixotrichoderm to an ixocutis, 40-70(-150) µm broad, made up of loosely interwoven to rather compact, 2-6.5 µm wide hyphae, later a dry cutis. Stipitipellis at first an ixocutis up to 55-75 µm broad, with many free ends projecting up to 120 µm, 1.5-6 µm wide, later a thin, about 20 µm broad, hardly gelatinizing cutis, in addition with some hairs, 2.5-6 µm wide. Stipititrama regular, elements (52-)63-221 x 9-13.5(-14) µm, in average e.g. 138 x 11 µm. Pigment intracellular, dispersed, in addition with crystals of yellowish refringent pigment. Clamp connections in all tissues.

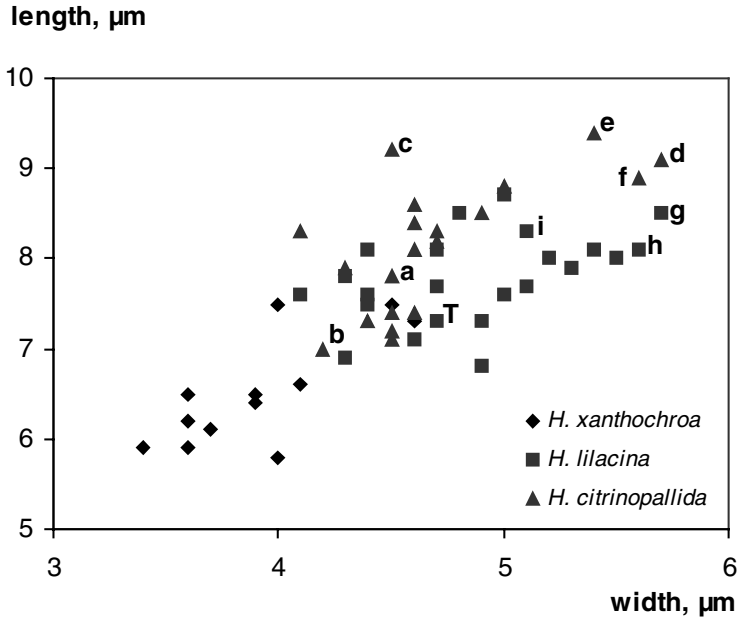

Figure 8. Variation in average spore-size in collections of *Hygrocybe* sect. *Oreocybe*. *H. citrinopallida*: n = 20 from Greenland. *H. lilacina*: n = 19 from Greenland (incl. holotype of *H. violeipes* = T) and 3 from Norway, *H. xanthochroa*: n = 12 from Greenland and 1 from Norway. See text for an explanation of the letter codes.

Habitat and distribution: *H. citrinopallida* is common in S and W Greenland in low (-middle) arctic, hyperoceanic to continental, moist to dry dwarf-shrub heaths dominated by *Empetrum*, in deep moss or snow patches; occasionally in fens, e.g. "on tussocks with *Carex bigelowii*, *Euphrasia frigida*, *Polygonum*, *S. herbacea*, lichens and mosses" (F. Rune & M. Strandberg *in litt.*), once partly amongst *Sphagnum*. It occurs frequently together with *H. lilacina*, although that species prefers wetter microhabitats. Late July to early October.

Material: *Greenland*: Loc. 2, TB 81.53. – Loc. 4, TB 95.010 (TB). – Loc. 6A, ML 584. – Loc. 7A, TB 78.78, TB 79.127 (duplicate at WAG), TB 79.156 (TB), TB 79.162, TB 81.151 (duplicate at WAG), TB 82.106, TB 82.110, TB 82.143 (duplicate at WAG), TB 83.41, TB 83.75, TB 83.85, TB 85.236, TB 85.293, TB 86.242, TB 86.283, TB 86.286, TB 86.287, TB 88.151 (TB), TB 00.178, PMP 73.190. – Loc. 7F, TB 94.17. – Loc. 7G, TB 87.197. – Loc. 7H, TB 02.014. – Loc. 7I, TB 97.172. – Loc. 9A, TB 87.150. – Loc. 9D, TB

87.121. – Loc. 11A, ML 158. – Loc. 11B, TB 00.070. – Loc. 11C, TB 86.157. – Loc. 11D, TB 86.191. – Loc. 14D, PMP 17.07.1974. – Loc. 14F, ML G-67.369. – Loc. 18, MS & FR 301 (photograph in Candusso 1997). – Loc. 21B, HK, SAE & JHP 383.

Observations: The Greenlandic material fits the original description by Smith & Hesler (1954) very well. The collections recorded by Lange (1955: 17) *sub nom. Hygrophorus vitellinus* sensu Møller, were studied and found identical. Kobayasi *et al.* (1971) recorded the species from E Greenland, Kulusuk (close to Loc. 18). The material has not been studied, but the description is convincing.

H. citrinopallida shows some variation in Greenland. Among the microscopical features the average spore measurements fall generally within a rather dense cluster, however, a few collections deviate somewhat (Figures 7, 8). A minor part of the collections has beside "normal" spores (quoted in the description), narrow, very elongate and mostly constricted spores (Boertmann 1990). In TB 86.157 a large proportion of abnormal spores were observed and an attempt to measure the two kinds of spores separately was made. "Abnormal" spores (Figure 7d): (8.0-)9.0-12.5(-18.0) x (3.5-)3.5-4.0 µm, in average 10.8 x 3.8 µm, Q = 2.2-3.0 (-4.8), Qav = 2.79. "Normal" spores: 6.5-9.0(-9.5) x 4.0-5.0 µm, in average 7.8 x 4.5 µm (Figure 8, dot a), Q = (1.55-)1.60-2.00, Qav = 1.71. In TB 86.242 a number of "abnormal" spores are included in the average, which explains the rather high length figure (in average 9.2 x 4.5 µm, Figure 8, dot c). The "abnormal" spores are excluded from the total range of the spores in the description. A few other collections have fairly broad spores: In one of them (TB 86.286) only two-spored basidia were observed (Figure 8, dot d), the collection is macroscopically typical. Two other broad-spored collections with predominantly four-spored basidia deviate also macroscopically (see below).

Macroscopic variation includes mainly colours. The collection TB 00.178 had sordid grey-brown pileus centre (Mu. 10YR4/2 to 5YR5/2.5), partly pale greyish stipe (10YR6.2.5), and fairly large spores: 8.0-10.0(-11.0) x 5.0-6.0(-6.4) µm, in average 8.9 x 5.6 µm (Figure 8, dot f). The collection TB 86.191 differs by having a slight greenish tinge in addition on pileus, lamellae and stipe, as well as much smaller spores, 6.5-7.5(-8.0) x (3.5)4.0-4.5(-5.0) µm, in average 7.0 x 4.2 µm (Figure 8, dot b). Similar material was described by Miller *et al.* (1982) and by Laursen *et al.* (1987). In our opinion the differences are too slight to deserve taxonomic recognition. Finally, the collection TB 95.057 deviated from the remaining material by the presence of orange-yellow colours (K. & W. 4A6-7) in some pilei in the lamellae of one specimen, and slightly broader spores (8.0-10.5(-12.3) x (4.7-)5.0-6.0(-6.5) µm, in average = 9.4 x 5.4 µm, Figure 8, dot e). The latter feature might be due to intermixed two-spored basidia. More material is needed to ensure whether or not it belongs to *H. lilacina*, see that species.

Boertmann (1990) discussed the relations between *H. citrinopallida* and *H. lilacina*. We add a few further comments based on the material studied by us. In our opinion the two species are easily distinguished in the field on the basis of the characters mentioned in the key. In *H. citrinopallida* the pileus and stipe are occasionally more

glutinous due to the broader ixotrichoderm to ixocutis, but this is not reliable because of large overlap. Moser (1967a) also described the stipe in *H. lilacina* as glutinous. The spores in *H. citrinopallida* are frequently narrower on the average than in *H. lilacina* (Figure 8), but also there is a large overlap. *H. citrinopallida* and *H. lilacina* grow often in the same habitats, but *H. citrinopallida* avoids wet fens, although it may grow on the tussocks in fens. Furthermore, unlike *H. lilacina*, it is quite frequent in continental areas. Finally they may have also a slightly different pattern of distribution: At least in Greenland *H. citrinopallida* grows further north than *H. lilacina*. An unexplained difference is that *H. citrinopallida* is rare on the well-investigated Disko Island, while *H. lilacina* is common.

For a discussion on the relationship between *H. citrinopallida* and *H. xanthochroa*, see the latter species.

Hygrocybe lilacina (C. Laest. ex P. Karst.) M.M. Moser in Die Röhrlinge und Blätterpilze, 3 Aufl.: 64, 1967.

Figures 8, 9.

Synonyms: *Hygrophorus violeipes* M. Lange 1955; *Hygrophorus palustris* Wells & Kempton 1975.

Selected descriptions: Lange 1955; Moser 1967a; Wells & Kempton 1975; Boertmann 1995; Candusso 1997.

Selected icones: Petersen *et al.* 1994; Boertmann 1995; Candusso 1997.

Pileus 9-20(-24) mm wide, ± convex with broadly inflexed, crenulate or undulate margin, subumbilicate to depressed, when old applanate to somewhat infundibuliform; not or slightly striate up to 1/2 R, at first viscid and shiny, soon dull and dry, hygrophanous, in primordia yellow (CIC "Luteous", Mu. 10YR8/6), then in the margin more ochraceous or brownish orange (7.5YR5/8, 8.75YR7/8), towards the centre often slightly darker, frequently with a shade of watery reddish violet, when old whitish to lilac, often with yellow spots, when faded cream to violet white (K. & W. 17A2), whitish when old. Lamellae (sub-) distant, (L=19-26, l=1-3), ± arcuate-decurrent, fairly broad, up to 4 mm, rather thin, often slightly furcate or intervenose, edge entire, (pale) yellow ("Straw", "Luteous"), then light yellow, watery ochraceous to orange (7.5YR7/8, 10 YR8/5, 4A5, 5A6, CIC 9H), often with a shade of watery violet, when old occasionally almost without pigment, pale whitish lilac, or occasionally pale watery yellow at base. Stipe 12-35 x 1.5-3 mm, fistulose, cylindrical, when young ± viscid and shiny, soon moist and dull, slightly fibrillose under lens; ± reddish violet, especially at the apex, downwards mostly mixed up with yellowish, when old often pale whitish lilac, yellow colours (when present) only slightly fading, at the base with a slight, whitish to lavender-blue tomentum. Context rather thick (1-2 mm), fairly firm, almost concolorous with surface, the violet colours of the

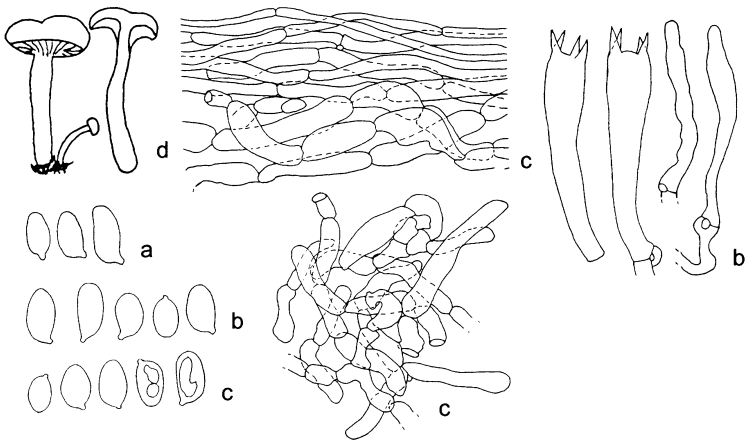

Figure 9. *H. lilacina*. a: ML 571, *H. violeipes*, holotype, spores x 700 – b: TB 79.152, spores, basidia and basidioles x 700 – c: TB 82.124, spores x 700, pileipellis & pileitrama x 490, hymenophoral trama x 280 – d: TB 86.294, basidiocarps x 0.7.

stipe being especially concentrated in the cortex. Smell not distinctive, taste mild. Spore-print white.

Spores (6.0-)6.5-10.0(-11.5) x 3.5-6.5 µm, in average 6.8-8.5(-8.7) x 4.3-5.4 µm, Q = (1.25-)1.30-2.10(-2.55), Qav = (1.40-)1.45-1.85, obovoid, ellipsoid, oblong to pip shaped, often subamygdaliform in frontal view, the longer spores often constricted, sometimes slightly inequilateral, hilar appendix large, obtuse. Basidia slenderly clavate, 34.5-49 x 6.5-8.5 µm, Q = (3.5-)4.0-6.5; basidioles rather frequent, about 31.5-45.5 x 3.5-5 µm, subcylindric, somewhat tortuous. Cystidia absent. Hymenophoral trama interwoven, made up of short, often anastomosing, ± cylindrical elements, (13-)34-86(-103) x (3.5-)4.5-13.5 µm. Subhymenium rather thick, 35-45 µm, not gelatinous. Pileipellis when young a distinct ixotrichoderm, 45-90 µm thick, made up of ± erect to ascending, interwoven, branched hyphae with many free, obtuse ends, 1.5-5 µm wide, later a dry cutis, 20-40 µm broad. Pileitrama irregular, made up of 4-14.5 µm wide hyphae, downwards aerenchymatic. Stipitipellis when young a slightly gelatinized ixocutis 10-30 µm broad, made up of repent to slightly ascending hyphae 1.5-4.5 µm wide, with scattered cylindrical hairs, up to 40 µm long and 1.5-4.5 µm wide. Stipititrama regular, elements (63-)72-268(-330) x (8-)9-13(-13.5) µm, in average *e.g.* 170 x 11 µm. All tissues with vacuolar yellowish pigment, in addition with amorphous dots of refringent yellowish pigment; the outer stipititrama and stipitipellis have in addition very minute, reddish violet, intracellular pigment in granules. Clamp connections present.

Habitat and distribution: *H. lilacina* is common in the low arctic and oceanic sites of S and W Greenland. It was also observed near the ice-cap (Loc. 11D) in the continental Kangerlussuaq (L. Jalink & M. Nauta *pers. comm.*), although sought there in vain by Lange, indicating that it must be rare. *H. lilacina* occurs in wet dwarf-shrub heaths with *B. nana*, *B. glandulosa*, *Carex bigelowii*, *Empetrum*, *Juncus trifidus*, *S. herbacea*, *S. glauca* and *Vaccinium*, occasionally in mesic heaths with *Empetrum* and *Loiseleuria*. It grows also in wet fens with *B. glandulosa*, *C. bigelowii*, *C. rariflora*, *S. arctophila* and mosses, as well as in deep mosses, or on naked peat, but it has not yet been noted amongst *Sphagnum* in Greenland. Furthermore, it occurs in snow patches with e.g. *Diphasium complanatum* and *Empetrum* (Lange 1955), or even with *Anthelia*. Finally it occurs rarely in mossy grass-slopes. Late July to early October.

Material: *Greenland*: Loc. 1D, TB 91.138. – Loc. 2, TB 81.51. – Loc.3, MS 88.135. – Loc. 4, SAE & TL 99. – Loc. 6A, ML 571 (= holotype of *Hygrophorus violeipes*), ML 586, ML 620. – Loc. 6B, TB 91.250. – Loc. 7A, TB 78.79, TB 78.158, TB 79.152 (duplicate in WAG), TB 79.164, TB 81.152, TB 81.197 (TB), TB 81.237, TB 82.88, TB 82.124 (duplicate WAG), TB 84.105, TB 84.115, TB 84.212 (TB), TB 83.87, TB 85.273 (TB), TB 85.275, TB 85.291, TB 86.243, TB 86.294, PMP 73.206. – Loc. 7B, TB 86.273 & 274, TB 86.277 (TB). – Loc. 7C, TB 83.11. – Loc. 7G, TB 92.51. – Loc. 7J, TB 00.196. – Loc. 8, PMP 73.411. – Loc. 9A, HFG 87.98 & 99. – Loc. 11E, TB 00.113. – Loc. 14, PMP 73.157. – Loc. 14B, PMP 70.170, PMP 71.71, ML G-67.105. – Loc. 14C, ML G-67.485 & 487. – Loc. 14E, ML G-67.238, ML G-67.61. – Loc. 18, MS & FR 320. – Loc. 19, MS & FR 408 (photo in Candusso 1997). *Norway*: Hedmark, EA 4174 (WAG).

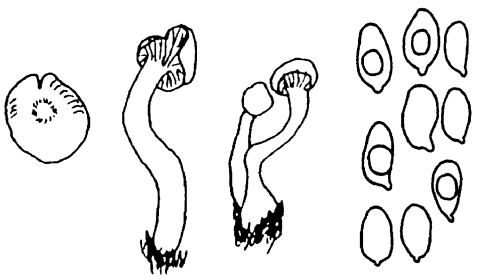

Figure 10. *H. xanthochroa*: TB 86.282, basidiocarps x 1.1, spores x 1020.

Observations: For the differences between *H. lilacina* and *H. citrinopallida*, see that species. When old basidiocarps of *H. lilacina* loose their initial colours completely, and turn very pale whitish violet. In that stage they can be confused with *H. xanthochroa*. The photo in Boertmann (1995) is typical for old specimens.

As stated by Lange (1957), *Hygrophorus violeipes* is identical. We have studied the type and noted that the spores are more variable in shape (viz. 6.0-8.2(-8.6) x (3.7-)4.1-5.2(-5.6) µm, in average 7.3 x 4.7 µm, Q = 1.30-1.80(-1.90), Qav = 1.56 (Figure 8, dot T); predominantly obovoid to ellipsoid, less commonly subamygdaliform, rarely slightly constricted towards the apex), than described and depicted by him (Figure 9a). Other characters were identical with the material described here.

Wells & Kempton (1975) separated their *H. palustris* from *H. lilacina* by the larger spores (9-11 x (5-)5.5-7 µm), more robust stature (pileus 10-35 mm broad, stipe 30-75 x 2-5 mm) and the occurrence in bogs. Like Gulden *et al.* (1985), we believe these two taxa to be identical.

Gulden *et al.* (1985) described and depicted a Norwegian record of *H. lilacina*, consisting of a mixture of pure yellow and ± violaceous basidiocarps (Finnmark, KMJ 95/79). The collector, who took the photograph, informed us that these basidiocarps were growing ± 15 cm apart. The spores in the two colour forms are broad (Figure 8, dots g, h), and the basidia are 1-, 2-, 3- or 4-spored. For several years we have thought that the collection is a mixture of *H. citrinopallida* (yellow basidiocarps), and somewhat faded basidiocarps of *H. lilacina* (violaceous basidiocarps). However, during the International Symposium of Arctic-Alpine Mycology (ISAM) VI in Greenland, a yellowish variant of *H. lilacina* was recorded from Kangerlussuaq (TB 00.113), which probably is identical. In the field it was supposed to differ from *H. xanthochroa* by its coarser habit, non-striate pileus and darker gills. The larger and broader spores: 7.5-9.0(-9.5) x (4.0-)4.5-6.0 µm, average 8.0 x 5.2 µm (Figure 8, dot i), later confirmed this. Unfortunately, most of the material was lost and only few notes were made. For the time being it is treated as a variant of *H. lilacina*, awaiting more field experience.

Hygrocybe xanthochroa (P.D. Orton) M.M. Moser in Die Röhrlinge und Blätterpilze, 3. Aufl.: 64, 1967.

Figures 8, 10.

Synonyms: *Hygrophorus xanthochrous* P.D. Orton 1960.

Selected descriptions: Orton 1960; Hallgrímsson 1974; Bon 1983; Boertmann 1995.

Selected icones: Bon 1990; Boertmann 1995.

Pileus 6-22 mm, plano-convex, at centre depressed to umbilicate, then applanate, margin decurved to straight, equal to slightly undulate, (mostly) translucently striate from $^1/_2$ R (almost) to the centre, glabrous, shiny, glutinous to viscid, then occasionally dry and dull, in primordia pastel yellow (K. & W. 3A4), later yellowish ochre to orange-yellow (CIC 9H, about 4A8-6),

towards the centre frequently slightly duller coloured, sometimes intermixed with pale watery, reddish violet, or with a greyish violet tinge (near Mu. 7.5YR7/2), centre sometimes with a slightly darker, translucent eye, margin sometimes paler (light yellow, ± 4A5), when old ± milk white to hyaline, hygrophanous, when faded whitish to (pale) yellow (2.5A5, 3A4-5, 3A7, 4A4), towards the centre occasionally violaceous white. Lamellae subdistant (L=18-24, l=1-5), (sub-)decurrent, up to 3.5 mm broad, edge entire, glabrous, in primordia pale yellow (2.5-3A3), later pale yellowish to dull watery ochre-yellow (near CIC 8G, 3A3-3.5, 4A4, Mu. 10YR8/2), generally paler towards the edge, occasionally with a pale (greyish) violet tinge (Caill. K91-92). Stipe 13-62 x 2.5-3.5 mm, cylindrical, narrowly fistulose, glabrous or slightly lengthily fibrillose, glutinous, viscid and shiny, occasionally dry and dull, in primordia whitish to yellowish white, later pale, pale yellow (3A2-3), or at apex slightly darker (3.5A3), frequently pale violaceous white. Context thin, not very brittle, almost concolorous, pale when faded. Smell almost none, taste mild.

Spores (4.5-)5.0-8.5(-9.0) x 3.0-5.0(-5.5) µm, in average 5.6-7.6 x 3.4-4.6 µm, Q = (1.20-)1.40-2.00(-2.25), Qav = (1.45-)1.60-1.75(-1.80), obovoid, pip shaped, ellipsoid or subamygdaliform, more rarely constricted towards the apex. Basidia 4- (rarely in part 2-) spored, slenderly clavate, ± 28-45 x (5.5-)6-7 µm, Q ± 5.0-7.0. Hymenial cystidia absent. Hymenophoral trama interwoven, elements ± 45-93 x 7-16.5 µm, made up of slender hyphae, hardly constricted at the septa. Pileipellis typically a distinct ixotrichoderm ± 40-100 µm broad, made up of very loosely entangled, ± erect to ascending hyphae, with many free, obtuse ends ± 2.5-5 µm wide, but in other collections a thin ixocutis (± 15-25 µm broad), to a dry cutis, mainly consisting of ± repent hyphae. Stipitipellis an ixocutis to an ixotrichoderm, ± 15-80 µm broad, made up of repent to ± erect hyphae, ± 2.5-3.5 µm wide, in subpellis, ± 5 µm wide, sometimes a dry cutis. Stipititrama subregular with elements (97-)110-260(-350) x (8-)9-14 µm, in average e.g. 180 x 10.5 µm. Yellowish amorphous dots of intracellular pigment present in all tissues, in some collections with minute reddish violet granules in stipe-cortex. Clamp connections in all tissues.

Habitat and distribution: In fens and dwarf-shrub heaths with *B. glandulosa*, *Deschampsia*, *Empetrum*, *Juniperus*, *Vaccinium*, lichens and mosses. Generally uncommon in low arctic, hyperoceanic to continental sites in S and W Greenland. Late July to medio September.

Material: *Greenland*: Loc. 1C, HK, TB & JHP 547. – Loc. 7A, DB GR 85.23, TB 94.061 (TB). – Loc. 7C, TB 87.221, TB 93.166, TB 93.224 (TB), TB 94.081 (TB), TB 96.126 (TB). – Loc. 7D, TB 86.282. – Loc. 7F, TB 93.204 (photo in Boertmann 1995). – Loc. 7G, TB 94.101 (TB). – Loc. 7I, TB 97.179, TB 97.182. – Loc. 9E, SAE GR 87.28. – Loc. 10, TB 00.114. – Loc. 11E, TB 00.101 (p.p. LJ 8292, leg. L. Jalink). – Loc. 12, MS & FR 702 (MS). – Loc. 14C, ML G-63.486. *Norway*: Nordland, 30.08.1981, RK, (Plate in Bon 1990).

Observations: *H. xanthochroa* is a variable taxon. In most of the collections pale violaceous colours were present, while a few collections had entirely yellowish basidiocarps. The presence/absence of violaceous colours was discussed by Orton (1964) and Gulden & Lange (1971). Orton thought

the ellipsoid-amygdaloid spores of *H. xanthochroa* to be diagnostic, but according to our investigation, both *H. citrinopallida* and *H. lilacina* frequently have spores with a similar shape. Arnolds (1986) thought the distinct viscidity of pileus and stipe to be the best discriminating character, but occasionally collections with a dry or slightly viscid pileus and stipe are met with (Bon 1983).

Since 1993, several fresh collections have been studied. They were recognizable by sharing most of the following features. A: The pileus had long, translucent striations, $^1/_2$ R or more; B: A translucent eye in the pileus centre, C: A gracile stature; D: Pileus (partly-) pale violaceous, dull yellow-ochre to (dull-) orange-yellow. E: Lamellae pale violaceous, (very) pale yellow to pale watery yellow-ochre, ± paler towards the edge, contrasting to the pileus. F: Moreover, the spores are usually distinctly smaller on the average than in *H. citrinopallida* and *H. lilacina*. In four collections (TB 94.061, 96.126, 97.182 and 00.114) the spores are slightly larger (in average 7.3-7.5 x 4.0-4.6 µm). These averages are within the variation observed in the type by Arnolds (unpubl.) and Boertmann (1990), and slightly overlap the average spore-size in the collections studied of *H. citrinopallida* and *H. lilacina* (Figure 8).

The features A, B, C are probably dependent of each other and at least the gracile stature is inconstant, when comparing with the earlier collections, e.g. TB 87.221 and DB GR 85.23 (Boertmann 1995: 67, photo below). For the time being the points D, E and F appear to be the best features to separate *H. xanthochroa* from *H. citrinopallida* and *H. lilacina*.

Hygrocybe* subgen. *Hygrocybe

Hygrocybe conica (Scop.: Fr.) P. Kumm. in Führer für Pilzkunde: 111, 1871.

var. ***conica***

For synonyms, selected descriptions and illustrations, see Arnolds 1990.

Pileus 10-35 mm wide, from acutely to bluntly conical, viscid and shiny when moist, first minutely, then distinctly fibrillose, margin not striate, hardly hygrophanous; scarlet-red, orange-red to orange, blackening. Lamellae subdistant (L±40, l=1-3), free, ventricose, 3-5 mm broad, edge entire or eroded, initially pale yellow, then yellow, occasionally greenish yellow. Stipe 40-52 x 5-10 mm, cylindrical, fistulose, dry, distinctly striate in age lacerate, at apex yellow (CIC "Lemon-chrome") downwards orange-yellow to orange, base pale yellow to whitish. Context brittle, in cortex concolorous with surface, inside whitish to pale yellow, in all parts blackening. Smell indistinct, taste mild.

Spores 8.0-13.0(-13.5) x 4.5-6.4 µm, in average 8.6-11.4 x 4.6-5.6(-6.4) µm, Q = (1.45-)1.60-2.10(-2.20), Qav = (1.60-) 1.75-2.00(-2.10), ellipsoid-oblong to oblong, frequently subphaseoliform, occasionally constricted. Basidia 4-spored. Hymenophoral trama regular, made up of large elements. Clamp connections present.

Habitat and distribution: In seminatural grassland slopes, on gravelly-sandy soil at roadsides and in riverbeds, in open copses of *B. pubescens* and *S. glauca*, on rather dry soil. Common in S Greenland, in subarctic, suboceanic to subcontinental sites, one record in a low arctic, oceanic lichen-heath. It might have a wider distribution, see observations. Late July to late August.

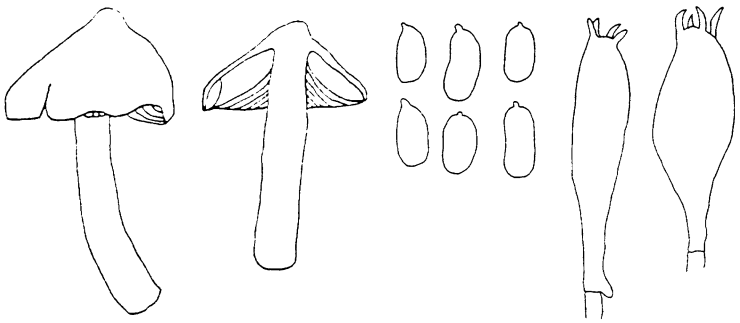

Figure 11. *H. conica* var. *chloroides*: TB 87.208, basidiocarps x 0.85, spores & basidia x 780.

Material: *Greenland*: Loc. 5A, TB 81.40, HK, TB & JHP 5, HK, TB & JHP 15, HK, TB & JHP 564, HK & TL 610, TB 87.161, TB 88.99, TB 94.008. – Loc. 5F, TB 02.148. – Loc. 6B, TB 85.103, TB 91.179. – Loc. 7C, TB 98.185 – also noted from Loc. 1C and 5C.

Observations: Most collections belong to f. *conica* with small basidiocarps. HK, TB & JHP 564, TB 98.185 and TB 02.148 belong to f. *pseudoconica* (J.E. Lange) Arnolds (cf. Arnolds 1985: 476). The collection TB 91.179 deviated from the remaining collections by the orange-yellow pileus, but the large, narrow spores, viz. (9.5-)10.0-12.0(-12.5) x 5.0-6.0 µm, average 11.1 x 5.6 µm, Qav = 1.98, the slender habit, and especially the orange-yellow stipe, fit in with var. *conica* f. *conica*.

Two other deviating collections are briefly described: HK & TL 610, Loc. 5A. On a sandy riverbed between scattered low copses of *S. glauca*, *Cladonia* and *Stereocaulon*. Pileus up to 45 mm wide, broadly conical and ± umbonate, dry, orange-red, rarely orange-yellow, blackening slowly. Lamellae in side view purplish red with yellow margin, in frontal view with a reddish reflex. Stipe 55-70 x 6-10 mm, deep yellow to orange-red, slowly blackening from base. Spores 7.5-9.5 (-10.0) x (4.0-)5.0-6.0 µm, in average 9.0-9.3 x 5.4 µm, Qav = 1.65-1.70. Basidia 4-spored. Clamp connections present. In the field the collection was identified as *H. conicoides* (P.D. Orton) P.D. Orton & Watling on the basis of the reddish lamellae. However the spores are much shorter. Arnolds (1974: 117) mentioned the existence of a few collections of *H. conica* with reddish lamellae. This collection is referred to var. *conica* f. *pseudoconica*.

In C there is an unannotated collection, ML G-67.384, Loc. 14A, with large, compact basidiocarps and narrow spores (in average 9.9 x 4.9, Qav = 2.01) on 4-spored, clamped basidia. The size indicates var. *conica* f. *pseudoconica* or var. *aurantiolutea*, the spores fit the first taxon.

Hygrocybe conica

var. ***chloroides*** (Malençon) Bon in Documents mycologiques 15(59): 52, 1985.

Figure 11.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Pileus 25-35(-53) mm wide, obtusely conical, dry, dull to slightly shiny innately fibrillose, margin straight, not or hardly striate, slightly hygrophanous, pastel to light yellow, in places dull (olive) yellow (K. & W. 3A4, 4A4.5, 3B3, CIC "lemon chrome"), inwards with a slight olive-yellow, or subtle greenish tinge, later dark greyish from the centre. Lamellae subdistant, free to narrowly adnate, 4-8 mm broad, ventricose, (very) pale sulphur- to lemon-yellow (slightly paler than 1A3, "lemon yellow"), in age occasionally greyish green, in places discolouring greyish blue. Stipe 42-55 x 5.5-11 mm, cylindrical, fistulose, fibrillose, dry, sulphur-yellow (1A5), lemon-yellow or with transition to "lemon chrome", whitish at the base. Context concolorous in cortex, central parts whitish, in places turning green-

ish blue to lead grey, soon greyish black, smell none, taste mild.

Spores 8.0-11.0(-11.5) x (4.5-)5.0-7.0(-7.5) µm, in average 9.3-10.5 x 5.2-5.7(-6.8) µm, Q = 1.50-2.15(-2.35), Qav = 1.55-1.95, oblong, ellipsoid-oblong to obovoid-oblong, occasionally slightly constricted or subphaseoliform, sometimes with a suprahilar depression. Basidia 36-49 x 9-11(-14) µm, Q = (2.5-) 4.0-5.5, 4- to (1-, 2-, 3-)spored. Hymenophoral trama regular, made up of large elements. Pileipellis a dry cutis. Clamp connections present or absent.

Habitat and distribution: In *B. pubescens* scrub with *Deschampsia*, lichens and mosses, on a mossy grass slope, and a herb-slope with *S. herbacea*, *Alchemilla* and mosses, probably rare. The sites are sub- to low arctic and hyperoceanic to subcontinental. Early August to early September.

Material: *Greenland*: Loc. 5A, TB 88.100 (TB), TB 94.007 (TB). – Loc. 7A, TB 79.36 (TB), TB 87.208 (TB). *Norway*: Ulvik, TB 89.37 (TB).

Observations: The collections TB 87.208 and TB 94.007 have exclusively 4-spored basidia, while the two other collections have a variable amount of 2-, 3- and 1-spored basidia, and as a consequence, a large variation in spore-size. In accordance with the concepts by Arnolds (1974) and Kühner (1977a), such a variation is accepted within the taxa of subsect. *Nigrescentes*. *H. conica* var. *chloroides* was originally described by Malençon & Bertault (1975: 494-496) with pale sulphur yellow pileus and initially white lamellae. Two out of three Greenlandic collections had a slight olivaceous tinge to the pileus. Other authors described it with purely yellow colours, e.g. Kühner (1977a) from the Alps, *sub nom. H. conica* var. *conica*.

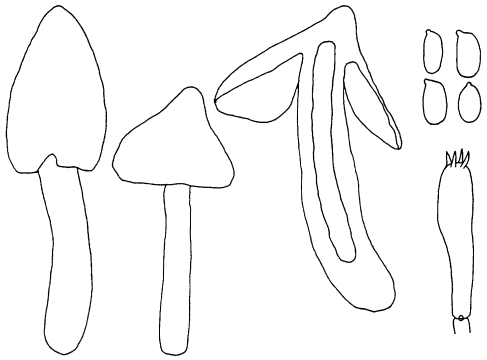

Figure 12. *H. conica* var. *aurantiolutea*. a: TB 85.212, basidiocarps x 0.5 – b: TB 87.201, spores & basidium x 500.

The latter name is not appropriate for nomenclatural reasons (cf. Arnolds 1986b).

Hygrocybe conica

var. ***aurantiolutea*** T. Borgen & Arnolds var. nov.

Figure 12, back cover.

Diagnosis: A varitate typica et varietate chloroides pileo luteo vel aurantio differt.

Holotypus: TB 83.01. Greenland, Paamiut, 20 August 1983, gregarious in herb-slope with *Potentilla tridentata*, *Salix glauca* and grasses, on gravelly soil in a basalt dyke, leg. TB (in C).

Pileus 20-70 mm wide, narrowly parabolic, then acute or bluntly conical, later ± expanded, when moist greasy or subviscid soon dry, margin not striate, glabrous then innate-fibrillose, coarsely so when old, not hygrophanous; initially ± egg- to orange-yellow in part, or at margin pale yellow (K. & W. 2-3A5), later light yellow (4A5) to light orange (6A4-5, 5A5), in age discolouring sordid ochraceous, or with some shade of olive, blackening slowly from the centre, on drying deeper orange towards the margin. Lamellae subdistant (L±40, l=1-3), free or narrowly adnexed, ventricose, 6-16 mm broad, thickish, edge entire later eroded, initially whitish, at least to-

wards the margin, then yellowish white to pale yellow (1A2-3, 2A4), later sulphur-yellow to lemon-yellow, when old ± greyish yellow, gradually violaceous black when injured or in age. Stipe 45-120 x 7-14 mm, stuffed then fistulose, equal, dry and dull, initially minutely fibrillose, then coarser fibrillose, whitish or in central parts pale, to light yellow (1A3.5), then at least in part lemon-yellow to chrome-yellow, occasionally CIC "Yellowish Green". Context brittle, whitish or watery pale, in cortex concolorous with surface, in one collection slightly greenish in part, gradually ± violaceous black, beginning after ± 1/2 min., when injured. Smell none, taste mild. Spore-print white.

Spores 7.5-11.0(-11.5) x (4.0-)4.5-6.5(-6.5) µm, in average (8.6-)8.8-9.9(-10.7) x 4.8-6 µm, Q = (1.45-)1.50-2.15, Qav = 1.65-1.85(-1.90), ellipsoid-oblong, slightly ovoid-oblong, a minor proportion constricted or subphaseoliform, occasionally with a suprahilar depression. Basidia clavate ± 37-45 x 9-10.5 µm, Q = 3.5-5.0, 4-spored. Hymenophoral trama regular, made up of long elements. Pileipellis a thin, dry cutis, made up of repent elements, ± 4.5-10(-14) µm wide.

Habitat and distribution: This taxon is common in S Greenland and it occurs in similar habitats as var. *conica*, except for two collections growing in bogs. It is less common in W and E Greenland, where it occurs in fairly dry, well-drained sites, mostly of grass-vegetation, in herb-slopes dominated by *Alchemilla*, and in dwarf-shrub heaths with *Juniperus* and *Stereocaulon*, but also in *S. glauca* scrubs. Distribution subarctic to middle arctic, hyperoceanic to continental. Late July to medio September.

Material: *Greenland*: Loc. 1B, *ER & FR 93.201. – Loc. 1C, HK, TB & JHP 480. – Loc. 3, HD 81.95. – Loc. 5B, HK, TB & JHP 24. – Loc. 5D, FR 1512. – Loc. 5E, SAE & TL 11. – Loc. 5F, TB 02.151. – Loc. 6B, TB 85.64, TB 91.213, TB 91.249. – Loc. 7A, TB 78.141, TB 81.184, TB 83.01 (holotype), TB 85.212, TB 87.173, all from the same spot, TB 87.206 (TB). – Loc. 7C, TB 86.341. – Loc. 7G, TB 87.192. – Loc.7I, TB 97.075. – Loc. 7J, TB 02.103. – Loc. 11D, EPB 590. – Loc. 15, PMP 71.121. – Loc. 20, MS & FR 377. – Loc. 21A, HK, SAE & JHP 466. *Faeroe Islands*: Suduroy, alt. 100-400 m, ER, JHP & JV F 830. – *Switzerland*: Valais, alt. 1900 m, TB 01.061. – *Russia*: Cape Nyarusalye (68°30′ N, 67°00′ E), TB 96.076, leg. HK.

Observations: Kobayasi *et al*. (1971) provided the first documented report of *H. conica* from Greenland (Loc. 18). According to the short description, it is identical with the present taxon. A recent record demonstrates the presence of var. *aurantiolutea* in that region (Loc. 20). In view of the wide distribution of var. *aurantiolutea* in Greenland, some old, not annoted records of *H. conica* from the middle arctic zone probably belong here, viz. Rostrup (1888) from Ujarassuit, Nuussuaq-peninsula, 70°30′N, 52°W, NW Greenland; Rostrup (1894), "Danmarks Ø", 70°30′N, 27°W, as well as Watling (1983), Mestersvig, 72°14′N, 23°55′W, both E Greenland.

The studied collections have 4-spored, clamped basidia except SAE & TL 11 which has slightly narrower spores (in average 10.1 x 5.2 µm, Qav = 1.90, basidia 2-(4-)spored). Regular observations in one spot over 22 years and experience from other sites demonstrated the constancy in colours and indicate that it does not integrade with var. *conica*, from which it differs in the egg-yellow to orange pileus, pale yellow stipe, and perhaps the vi-

olaceous black discolouring of the context.

Var. *aurantiolutea* differs from var. *chloroides* in pileus colour being deep yellow, orange-yellow to orange versus pale yellow to yellow, often with a slight olivaceous, or subtle greenish tinge, and perhaps the more violaceous discolouring of the context. Moreover, the latter tends to have a more fibrillose pileus.

Hygrocybe acutoconica (Clem.) Singer in Lilloa 22: 153, 1951 "1949".

Synonyms: *Hygrocybe persistens* (Britzelm.) Singer 1940, var. *persistens*. For further synonymy, selected descriptions and icones see Arnolds 1990.

Habitat and distribution: On a footpath in the edge of a fairly dry, probably calcareous fen with e.g. *Amerorchis rotundifoliae*, *Thalictrum* and sedges within a mixed *S. glauca*/ *B. pubescens* copse, and in sheep- and horse-grazed grassland slope. August. The sites are subarctic and subcontinental.

Material: *Greenland*: Loc. 5A, DB GR 85.22. – Loc. 5D, *ER & FR 92358 (slide) ER. – Loc. 5F, TB 02.143.

Observations: The collections are quite typical, hence no description is given.

Hygrocybe* subgen. *Pseudohygrocybe

Hygrocybe laeta (Pers.: Fr.) P. Kumm. var. ***flava*** Boertm. in The genus Hygrocybe: 86, 1995.

Synonyms: *H. laeta*, alpine variant, in Kühner 1977a; *H. flava* (Boertm.) Rune 2000.

Selected descriptions: Kühner 1977a; Boertmann 1995; Candusso 1997; Senn-Irlet *et al.* 1990; Rune 2000.

Selected icones: Boertmann 1995; Candusso 1997; Senn-Irlet *et al.* 1990; Rune 2000.

Habitat and distribution: Gregarious and partly subfasciculate in seminatural and grazed grassland slope with *Juncus trifidus*, *Polygonum* and *Vaccinium*. The site is subarctic and subcontinental. Lange (1955) reported *H. laeta* from the low arctic, hyperoceanic Kangaamiut (65°50'N, 53°20'W), W Greenland. However, the collection was lost (Lange 1955).

Material: *Greenland*: Loc. 5D, FR 1513 (duplicate at TB).

Observations: Rune (2000) described and published an excellent photo of the collection. It might be superficially reminiscent of *H. xanthochroa*, but is easily separated in the field, e.g. on the viscid gill edge and distinct smell. The collection is in full accordance with alpine material of *H. laeta* from France and Switzerland, Kühner, Senn-Irlet *et al.* (1990). It differs somewhat in macroscopic characters from typical lowland collections (Boertmann 1995, Kühner 1977a).

Hygrocybe psittacina (Schaeff.: Fr.) P. Kumm. in Führer für Pilzkunde: 112, 1871.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Habitat and distribution: In subarctic grassland slope, grazed by sheep, gregarious with *B. glandulosa*, *S. glauca* and grasses, 25.07.2002.

Material: *Greenland*: Loc. 3, FR 02.108 (duplicate at TB).

Observations: The record is well documented by a field description and a slide, and the studied material is quite typical in all respects. It was recorded from Greenland by Boertmann (1995), but this was based on an error made by the first author. The present record is thus the first in Greenland.

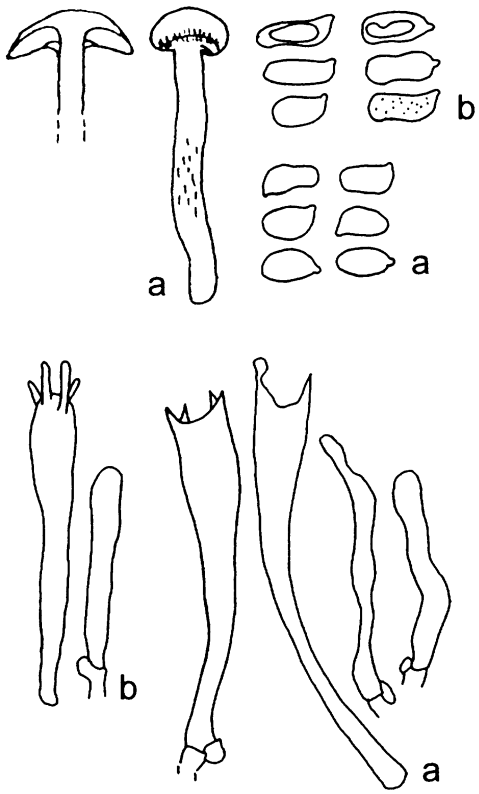

Figure 13. *H. insipida*. a: HK, TB & JHP 22, basidiocarps (after slide by J.H. Petersen) x 2.2, spores, basidia & basidioles x 1000 – b: HK, TB & JHP 582, spores & basidia x 1100.

Hygrocybe reai (Maire) J.E. Lange in Dansk Botanisk Arkiv 4(4): 25, 1923.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Habitat and distribution: A single basidiocarp with mosses in an eutrophic fen, 30.07.1983. The site is subarctic and subcontinental.

Material: *Greenland*: Loc. 5A, HK, TB & JHP 286.

Observations: Only a few notes were obtained. However, the bitter taste, persisting in dried material, and the peculiar spores, reminding of those of *H. miniata*, makes no doubt about the identity.

Hygrocybe insipida (J.E. Lange) M.M. Moser in Die Röhrlinge und Blätterpilze, 3 Aufl.: 65, 1967.

Figure 13.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Pileus 5-22 mm wide, initially plano-convex, remaining so or later broadly convex, sometimes depressed, often irregular, margin ± crenulate, at margin translucently striate up to 1/2 R or not, viscid, hygrophanous, red to orange-red, between striae orange-yellow, on fading paler to yellowish ochre. Lamellae subdistant (L=16-30, l=0-1), adnexed, adnate to (sub-) decurrent and arcuate, not intervenose, pale orange-red to reddish salmon, edge entire, glabrous, yellow to whitish. Stipe 14-20 x 1.5-4 mm, cylindrical and slender, or compact, attenuated towards the base, somewhat irregularly compressed, at apex slightly fibrillose or glabrous, viscid to lubricous, orange-yellow to orange.

Spores 6.0-8.0(-8.5) x 3.0-5.0 µm, in average 6.4-7.3 x 3.4-4.1 µm, Q = (1.60-) 1.65-2.05(-2.10), Qav = 1.80-1.90, ellipsoid-oblong, not broader in frontal view, 20-50% constricted, predominantly uninucleate (3rd coll., TB). Basidia 32.5-47 x 6-7.5 µm, Q = 4.5-7.5, 4-spored, slenderly clavate. Cystidia absent, but basidioles frequent in the first collection, subcylindrical, ± 18.5-29 x 3-3.5 µm. Hymenophoral trama subregular to slightly interwoven, elements (12-)15-84 x 5-12.5 µm, subcylindrical to ± inflated. Pileipellis in the first collection an ixotrichoderm up to 260 µm thick, made up of loosely interwoven, ± erect, branched hyphae with many free ends, ± 1.5-4.5 µm wide; in the last two collections near centre with a rather differentiated, thin ixocutis, ± 20-30 µm broad, made up of repent to ascending hyphae, in places with some erect, free ends, 1.5-3.5 µm wide. Stipitipellis in the first collection an ixocutis, ± 25-45 µm thick, made up of rather loosely interwoven, ascending hyphae, with some free ends, in places more like an

ixotrichoderm with ± erect, free ending hyphae, ± 1.5-3 µm wide; in the last two collections a very thin, poorly differentiated ixocutis, ± 15-25 µm thick, hyphae repent, ± 2-6 µm wide. Stipititrama elements in the second collection (22-)36-147(-217) x (6.5-)11-15.5 µm, in average 101.5 x 13 µm, (sub-)cylindrical, occasionally inflated. Clamp connections numerous, in the first collection with medallion clamps in addition.

Habitat and distribution: Single or fasciculate in rather dry, seminatural grassland slopes. The sites are subarctic and subcontinental. Late July to late August.

Material: *Greenland*: Loc. 5B, HK, TB & JHP 22, HK, TB & JHP 582. – Loc. 5F, TB 02.159. *Denmark*: DB 84.129 (duplicate at TB).

Observations: The first collection resembles *H. subminutula* Murrill in the small, narrow spores (average 6.4 x 3.4 µm) and perhaps the presence of a thick ixotrichoderm (260 µm thick). According to some authors (Orton 1960) that taxon differs also in the red apex of the stipe in contrast with the pale orange colours downwards. In our collection the stipe was uniformly coloured, and in some collections of *H. insipida* a red stipe apex is manifest (Arnolds 1990). According to Bon (1990) a further difference should be the whitish to pale lamellae in *H. subminutula*. The collection fits within the description of *H. insipida* by Arnolds (1990). The last two collections differ from typical *H. insipida* in the short, stout stipe, which is probably a phenotypic aberration due to ecological conditions. The pileipellis and stipitipellis are relatively thin (Arnolds 1990), but in agreement with the description by Kühner (1977a: 67) from the alpine zone in the Alps. They are close to *H. ceracea*, but that species lacks red colours.

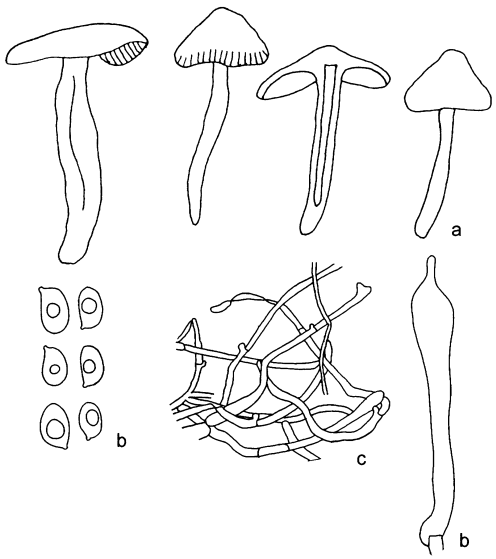

Figure 14. *H. salicis-herbaceae*. a: TB 83.42, basidiocarps x 0.6 – b: TB 81.193, spores & basidium x 600 – c: TB 87.209, pileipellis x 215.

Hygrocybe salicis-herbaceae Kühner in Bulletin Societé mycologique de France 92: 462, 1976.

Figure 14.

Misapplications: *Hygrophorus coccineus* (Schaeff.: Fr.) Fr. sensu M. Lange 1955; *Hygrophorus marchii* Bres. sensu M. Lange 1955.

Excluded: *Hygrocybe salicis-herbaceae* sensu Senn-Irlet 1986.

Selected descriptions: Kühner 1977a; Boertmann 1995; Candusso 1997; Rune 2000.

Selected icones: Boertmann 1995; Candusso 1997; Rune 2000.

Pileus 8-42 mm wide, initially obtusely conical, rarely subcampanulate with narrowly incurved to revolute, occasionally slightly crenulate margin, then convex to ± expanded, not or short translucently striate, initially viscid and somewhat shiny, soon dull and dry, when young blood-red, red, scarlet-red to reddish orange (K. & W. 10B(C)8, 9.5-9A8, 8A8-7, 8B7, 7A8) at the centre, occasionally light orange (5A5), to the margin slightly paler, occasionally pastel yellow (3A4), in the

extreme margin paler orange to yellowish, hygrophanous, soon ± fading to some shade of orange to yellow, typically with darker centre. Lamellae subdistant (L=24-35, l=1-2), rather thick, somewhat ventricose, adnexed, emarginate to adnate, exceptionally subdecurrent, ± 4 mm broad, yellowish white to pale yellow with whitish edge (3A2-2.5), later remaining so, or predominantly pale yellow to pale orange (3A3-4A5, 6A3, 8A4,5, 8-8.5A6), rose to almost coral, edge paler. Stipe 15-50(-60) x 3-8(-10) mm, equal or slightly tapering downwards, often compressed, greasy to subviscid, rarely viscid, soon dry, slightly pruinose at the apex, base whitish tomentose, rarely (scarlet-) red, usually orange (-red) at the apex (10A7.5, 9A8-8.5, 9A7, 8A8-7, 8B8, 6A8, CIC "Apricot"), downwards orange, light orange (5A5) to egg-yellow (CIC "Luteous"), at the base paler (CIC "Lemon chrome") to whitish; sometimes entirely yellow. Context concolorous with surface or paler, on drying egg-yellow. Smell mostly weak, occasionally sweetish iodoform-like, like *Lactarius quietus*, or nasty, reminiscent fox. Taste first mild, after chewing for 1/2-2 min. becoming strongly bitter and acrid, also in exsiccata. Spore print white.

Spores (6.5-)7.0-11.0 x 3.5-6.5(-7.0) µm, in average 7.5-9.1(-10.1) x 4.4-5.3(-5.6) µm, Q = (1.40-)1.45-2.20(-2.30), Qav = 1.55-1.95, ellipsoid-, or slightly ovoid-oblong, not or exceptionally slightly constricted, not broader in frontal view. Basidia mostly 4-spored, sometimes in part (2- or 1-)spored, 38.5-56 x 6-9 µm, Q = 5.5-8.0, slenderly clavate. Cystidia not observed. Hymenophoral trama subregular, consisting of short elements, ± 17.5-79 x 6-18 µm. Pileipellis an ixocutis to ixotrichoderm, 35-150 µm thick, consisting of repent, ascending and erect hyphae, terminal elements 1-5.5 µm wide. Underneath a subpellis is present, terminal elements, 5-12.5 µm wide. Stipitipellis mostly a thin ixocutis, 10-30 µm broad, consisting of slightly gelatinized, repent to somewhat interwoven hyphae, with a few free ends, ± 2-5 µm wide, projecting until 45 µm, rarely a dry cutis. Clamp connections numerous.

Habitat and distribution: *H. salicis-herbaceae* grows on mesic to fairly dry soil in *Empetrum-*, *B. glandulosa/nana*-heaths, in herb-slopes, mostly with *Alchemilla,* and in seminatural grassland, e.g. with *Alchemilla*, *Deschampsia*, *Festuca vivipara*, *Juniperus* and *Potentilla*. Also in copses with *B. pubescens* or *S. glauca*; frequently together with *H. conica* var. *aurantiolutea*. Early August to late September. Common to occasional in the sub- and low arctic, hyperoceanic to subcontinental areas of S and W Greenland.

Material: *Greenland*: Loc. 1A, HK, TB & JHP 433, HK, TB & JHP 445. – Loc. 1B, HK, TB & JHP 473. – Loc. 1C, HK, TB & JHP 478 & 479. – Loc. 5B, SAE & TL 67. – Loc. 5F, TB 02.157. – Loc. 6A, ML 554 & 621. – Loc. 6B, TB 91.251. – Loc. 7A, TB 78.126, TB 78.130, TB 79.136 (duplicate at WAG), TB 81.193 (duplicate at WAG), TB 81.235, TB 83.42, TB 87.203, TB 87.204. – Loc. 7B, TB 81.246, TB 81.285, TB 82.128. – Loc. 7C, TB 82.94, TB 87.210, TB 88.135, TB 90.135 (TB), TB 91.313, TB 91.314 (TB), TB 95.100, TB 95.123A, TB 95.159, TB 95.160, TB 97.201, TB 97.204. – Loc. 7F, TB 98.209. – Loc. 7G, TB 87.195. – Loc. 7I, TB 97.188. – Loc. 7J, TB 00.189, TB 00.190. – Loc. 9A, ML 506. – Loc. 9D, TB 87.59, TB 87.81, TB 87.84. – Loc. 10, ML G-67.575.

Observations: Most of the large Greenland material is in accordance with

Kühner's diagnose and descriptions, although several collections had a viscid stipe (ixocutis) not recorded by Kühner (1977a). The pileus-colour usually varies from orange-red to orange-yellow. Four collections (SAE & TL 67, TB 87.210, TB 91.313 and TB 97.201) had predominantly yellowish pilei, while three collections (HK, TB & JHP 445, TB 87.84, TB 95.123A) were orange or intermediate. The material is variable in other features also: Size, colour of lamellae, (pale) yellow to reddish; smell; spore size and the degree of viscidity in pileus and stipe. The variation is gradual and uncorrelated. *H. salicis-herbaceae* is occasionally reminiscent of *H. reai* in size and colours, but the spores are very different, and the stipe of the latter is usually more viscid. Compared with other taxa, the bitter taste, usually also when dried, is a good field character, although sometimes weak or developing slowly.

Two collections TB 95.160 and TB 97.204 deviated by having red to blood-red pilei, deeper red than described by Kühner (1977a), stipe (scarlet to red), and lamellae (orange-red to almost coral). No transition towards typical *H. salicis-herbaceae* has been seen. However, the microscopic features are identical. They might deserve separation below specific level, but more material is needed.

Lange (1955: 16) reported *Hygrophorus coccineus* from Greenland (Loc. 9A, ML 506) without description. A few notes based on the dried material are given: Pileus 9-18 mm wide, sordid purplish, ± translucently striate, yellowish brown between the striae. Lamellae shortly decurrent (L±20), yellowish to pale reddish. Taste mild. Spores (7.5-)8.0-9.5 x 4.5-5.5(-6.0) µm, in average 8.6 x 5.4 µm, Q = (1.30-) 1.45-1.80(-1.90), Qav = 1.60, ellipsoid to ellipsoid-oblong, not constricted or broader in frontal view. Basidia 4-spored. Hymenophoral trama with short elements. Pileipellis a well-developed ixocutis, up to 80(-100) µm broad, made up of repent and ascending hyphae, in places an ixotrichoderm with erect hyphae with many free ends. The collection differs from *H. coccinea* in small basidiocarps, with slender stipe and a well-developed ixocutis. The microscopic features are in accordance with *H. salicis-herbaceae*. The authors believe it is identical, in spite of the mild taste and the deviating colours of the dried collection.

Lange (1955) identified two collections (ML 554, 621 from Loc. 6A) as *Hygrophorus marchii*, which were "Growing in deep moss, in an open copse of mixed *B. pubescens* and *S. glauca*". He later (Lange 1957) stated the taxon to be: "Fairly common in oceanic *B. glandulosa/Empetrum*-heaths". During the present investigation it was only recorded once, on a mossy grass-slope, late free from snow, by a rivulet at the edge of a dwarf-shrub heath (TB 79.98, Loc. 7C). These three collections differ from the orange-yellow variant mentioned above by having a distinct ixotrichoderm ± 100-180 µm broad on the stipe when young (later a dry cutis), and a mild taste. The other microscopic features are in accordance with *H. salicis-herbaceae*. The site in Eqaluit has since been scrutinized many times, and material with similar colours was frequently seen. However, the stipe was dry or (sub-) viscid due to a thin ixocutis (<30 µm broad), and the taste was always bitter. The habitat is typical for *H. salicis-herbaceae*. Further-

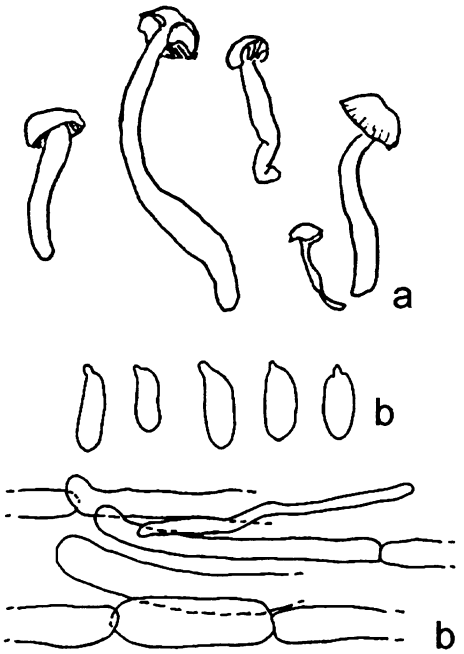

Figure 15. *H. ceracea*. a: DB 93.022, basidiocarps x 1.2 (after slide by D. Boertmann) – b: HK, TB & JHP 629, spores x 1000, pileipellis x 700.

more, the sole recent collection from Ivittuut area belongs to *H. salicis-herbaceae s. str.* The authors might be wrong, but at least for the time being, we prefer to treat it as a variant of *H. salicis-herbaceae*, rather than giving a description of something that might not exist. Lange (1955) suggested a close relationship to *H. insipida*. That taxon is smaller, has a different habit, and smaller, frequently constricted spores.

H. salicis-herbaceae sensu Senn-Irlet has turned out to be a new species, *H. glacialis* belonging to subsect. *Squamulosae* (Borgen & Senn-Irlet 1995).

Hygrocybe ceracea (Fr.: Fr.) P. Kumm. in Führer für Pilzkunde: 112, 1871.

Figure 15.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Pileus 5-12 mm wide, (plano-) convex with flattened centre, margin narrowly incurved when young then straight, not or (indistinct) translucently striate at the margin, glabrous, dull to slightly shiny, greasy to viscid, yellow, in places yellow-orange when fresh, or orange (K. & W. 5A7-8), hygrophanous, fading to slightly duller orange (5B8). Lamellae subdistant (L± 25, l=0-2), broadly adnate with decurrent tooth to subdecurrent, arcuate, pale to light yellow (3A5-7), whitish towards the glabrous edge. Stipe 16-32 x 1-3 mm, glabrous, dull to slightly shiny, dry, greasy to viscid, yellow to orange-yellow, or orange-yellow (4A8-7) above, downwards pale yellow to whitish. Context thin, pale yellow when faded, smell weak, taste mild.

Spores 6.5-8.0(-8.5) x (3.0-)3.5-4.5(-5.0) µm, in average 7.0-7.6 x 3.4-4.0 µm, Q = (1.45-)1.75-2.25, Qav = 1.90-2.05, ellipsoid-oblong to subcylindric, not broader in frontal view, a variable proportion (10-40%) constricted, often subphaseoliform, predominantly uninucleate (two coll., TB). Basidia 34-49 x 6-8 µm, Q = 4.5-7.0, slender, 4-spored. Cystidia not observed. Hymenophoral trama subregular, elements 12-42 x 7.5-14 µm, vascular hyphae present. Pileipellis a distinct, although very thin ixocutis, ± 15-25 µm broad, made up of repent hyphae with some free ends, 1-5(-7) µm wide, clearly differentiated from the hypoderm-like pileitrama underneath, consisting of (7-)16-25 µm broad, inflated elements. Stipitipellis a dry cutis to a very thin, slightly gelatinized cutis, ± 10-15 µm thick, in places a thicker, very compact ixocutis (20 µm) with some erect, free ends. Stipititrama elements 39-132(-167) x (8.5-)10.5-16.5(-18) µm, in average 87.5-90.5 x 12.5-13 µm, subcylindrical. Clamp connections present.

Habitat and distribution: Gregarious

among grasses, lichens and mosses or on path in dwarf-shrub copse with *Thalictrum* and scattered sedges. The sites are subarctic and subcontinental. Medio to late August.

Material: *Greenland*: Loc. 5A, HK, TB & JHP 629, DB 93.022.

Observations: The collections deviate somewhat in structure of stipitipellis from typical *H. ceracea*, by having a thin ixocutis in places. However, in all other characters they are in accordance.

Kobayasi *et al.* (1971) reported *H. citrina* (Rea) J.E. Lange var. *glutinipes* J.E. Lange from Ammassalik (Loc. 18). An identity with *H. glutinipes* (J.E. Lange) R. Haller Aar., or perhaps with *H. ceracea* might be possible, but the description is too short to ensure a safe identification, and the collection has not been seen.

Hygrocybe constrictospora Arnolds in Persoonia 12: 476, 1985.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Habitat and distribution: Six fasciculate basidiocarps on a path with scattered lichens, e.g. *Stereocaulon*, and mosses, within a dwarf-shrub copse with *B. pubescens* and *S. glauca*, 31.08.1993. The site is subarctic and subcontinental.

Material: *Greenland*: Loc. 5A, DB 93.023.

Observations: The collection deviates from the type and other authentic collections (Arnolds 1977, 1990) only by having a smaller percentage of constricted spores (25-35% versus 40-70%). However, it was in all aspects quite similar to a Danish collection, DB 80.023, confirmed by Arnolds. The spores are predominantly uninucleate (TB). It should also be mentioned that the stipititrama consists of short elements viz. 88-164(-173) x 11.0-16.5(-17) µm, in average 115.0 x 13.5 µm, a feature not paid attention to earlier. *H. constrictospora* has not been recorded from Greenland before.

Hygrocybe reidii Kühner in Bulletin Societé mycologique de France 92: 463, 1976.

Figures 2, 3.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Spores 6.5-7.5(-8.0) x 3.5-5.0 µm, in average 7.3 x 4.2 µm, Q = (1.50-)1.55-1.90, Qav = 1.75, ellipsoid or ovoid-oblong, in side view rarely weakly constricted, in frontal view not broader or constricted, predominantly binucleate (Kühner, 1976). Basidia 36.5-43 x 6.5-7.5 µm, Q ± 5.0-6.5, slenderly clavate, 4-spored. Hymenophoral trama subregular, elements ± 30-47 x 6.5-7.5 µm. Pileipellis predominantly a cutis of ± repent, relatively broad hyphae, ± 5-10.5 µm broad, most septa constricted; however, with rather many ascending, free-ending hyphae in places, forming a trichoderm, terminal elements ± 20-58 x 6-9.5 µm, in average ± 38 x 7.5 µm wide, with brownish yellow, vacuolar pigment. Stipitipellis a thin, dry cutis, with groups of short hairs, ± 36-68 x 3.5-5 µm. Stipititrama subregular, elements (45-)49-176(-194) x (9-)12-21 µm, in average 112.5 x 14 µm.

Habitat and distribution: A few basidiocarps closely together in rather dry grassland slope, 29.07.1983. The site is subarctic and subcontinental.

Material: *Greenland*: Loc. 5B, HK, TB & JHP 23.

Observations: Apart from having very small, inodorous basidiocarps, the collection is quite typical.

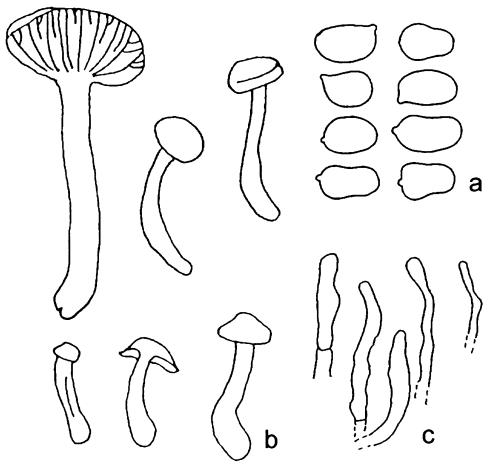

Figure 16. *H. miniata* var. *miniata*. a: TB 87.25, basidiocarps x 0.8, spores x 800 – b: TB 87.42, basidiocarps x 0.8 – c: TB 87.80, cheilocystidia x 800.

Hygrocybe miniata (Fr.: Fr.) P. Kumm. in Führer für Pilzkunde: 112, 1871.

Figures 2, 3, 16, 19.

For synonymy, selected descriptions and icones, see Arnolds 1990.

Excluded: *Hygrocybe miniata* sensu Lamoure *et al.* 1982 (= *H. biminiata*).

Pileus 13-20 mm broad, convex, slightly campanulate or subumbonate then applanate, margin incurved, soon straight, translucently striate up to 1/3 R or not, when moist slightly greasy, glabrous to minutely tomentose, especially on drying, red to orange (-red) (K. & W. 9-8A8, CIC "Apricot"), at the margin frequently with a narrow yellowish zone, hygrophanous, when faded light orange ("Saffron"). Lamellae subdistant (L= 20-30, l=1-3), fairly thin, up to 2.5 mm broad, broadly adnate, emarginate with decurrent tooth to subdecurrent, not intervenose, pastel yellow (3A4), then ± light orange ("Peach", "Saffron", "Orange"), edge whitish. Stipe 16-42 x 3-4 mm, fistulose, cylindrical, sometimes compressed, when moist slightly greasy or not, soon dry, minutely pubescent at apex, ± unicolorous reddish orange to orange-red (7A7-8, 8A8) except for the light yellow base. Context ± concolorous with surface, in central parts watery yellow, more yellow when faded. Smell almost none, taste mild. Spore-print white.

Spores (6.5-)7.5-9.5(-10.0) x (4.0-)4.5-6.0(-6.5) µm, in average 8.1-8.7 x 5.0-5.5 µm, Q = (1.40-)1.45-1.85, Qav = 1.55-1.60, ellipsoid-oblong to ovoid-oblong, rarely (± 10-20%) constricted; in frontal view hardly broader, in average 5.6-5.9 µm, Q = 1.30-1.90, Qav = 1.35-1.60, frequently obovoid to obpyriform and often constricted (35-60%), predominantly (90%) uninucleate (two coll., TB). Basidia 32.5-50.5 x 5-7(-8) µm, Q = (4.5-)5.0-8.0(-8.5), slenderly clavate, 2-,(1-,3-) spored. Edge of lamellae fertile, in two collections in addition with scattered cheilocystidia, ± 12-34.5 x 2-3.5 µm, subcylindric or tortuous. Hymenophoral trama subregular, elements 34.5-93 x 3.5-12.5 µm, subcylindric, occasionally slightly inflated, vascular hyphae present. Pileipellis halfway the centre mainly a dry cutis made up of hyphae with constricted septa ± 5-9 µm wide, towards the centre with trichodermal, erect tufts, with many free ends, 18.5-52(-75) x 6.5-11.5(-13) µm, in average 34.5-39 x 8-9.5 µm, in most sections with some narrow, repent hyphae, ± 2-3.5 µm broad, in addition. Stipitipellis a dry cutis of repent hyphae, 2-6.5 µm broad, apically with many tortuous, irregular, more or less erect hairs, (11.5-)15-58(-61) x (2-)2.5-6, in average 3-4 µm broad. Stipititrama elements (39-)58-145 x 6-15 µm, in average 88 x 11 µm, cylindrical. Clamp connections absent.

Habitat and distribution: Gregarious in acid, seminatural grassland slope, on

mesic to dry, gravelly soil on old riverbanks, either with *Campanula*, *Potentilla* and lichens or in pioneer vegetation with *Carex* sp., *Empetrum*, *S. herbacea* and mosses. 10-13.08.1987. The sites are low arctic and subcontinental.

Material: *Greenland*: Loc. 9D, TB 87.25, TB 87.42, TB 87.48, TB 87.80 (TB). *Denmark*: DB 84.224. *The Netherlands*: EA 3905.

Observations: The Greenlandic collections were in the field referred to subsect. *Coccineae* due to the ± glabrous pilei. However microscopically they matched with *H. miniata* in essential characters, such as the same type of spores, occasional presence of cheilocystidia. In the pileipellis some narrow, repent hyphae were observed in places besides typical trichodermal tufts. Presence of such hyphae has also been reported in the closely related *H. turunda* sensu Arnolds, Moser and in *H. substrangulata* (cf. Kühner 1976). In the present case they do not have diagnostic value. Two-spored collections without clamp connections have not been reported in *H. miniata* var. *miniata* before, but are known in *H. miniata* var. *mollis* (Berk. & Broome) Arnolds (Arnolds 1990). In this case they have no diagnostic value either. For diagnostic microscopic differences between *H. miniata* and *H. biminiata* references should be made to the key. Most probably macroscopic differences exist too: *H. miniata* has frequently fairly (pinkish) red, subdecurrent and, in comparison with *H. biminiata*, rather thin lamellae; moreover, the pileus appears to be more variable in shape, compare Figures 16a, b and 17a, and the stipe appears to be deeper and more uniformly coloured in *H. miniata*.

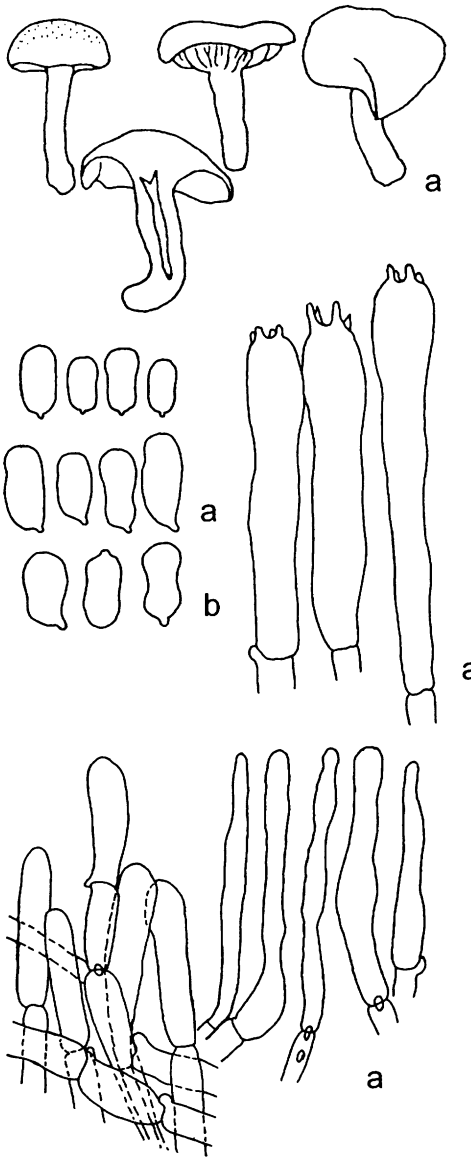

Figure 17. *H. biminiata* (spores uninucleate). a: TB 86.241, basidiocarps x 1, spores, basidia & cheilocystidia x 1000, terminal elements of pileipellis x 700 – b: TB 80.19, spores x 1000.

Hygrocybe biminiata Kühner in Bulletin Societé mycologique de France 92: 462, 1976.

Figures 2, 3, 17, 19.

Misapplications: *Hygrocybe miniata* sensu Lamoure *et al.* 1982.

Selected descriptions: Kühner 1976.

Pileus 13-30(-34) mm wide, convex, rarely slightly umbonate, then ± expanded, with or without depression, margin initially incurved, even to slightly undulate, hardly striate, dry, dull, fibrillose-tomentose to minutely

squamulose, scarlet, orange-red to reddish orange (K. & W. 9A8, 7-8A8, 7A7), sometimes paler, pastel-red (8A5-9A5) to almost light orange, at the extreme margin occasionally yellowish, soon fading to brownish yellow (Mu. 10YR7/4, CIC "Buff"), at centre brownish yellow to brownish orange (10YR6/4, 6C5); squamules concolorous or rarely with very pale grey-brown tips, hardly visible without lens, on drying more distinct, light orange (CIC "Saffron"), paler than the ground colour. Lamellae (sub-) distant (L=15-24(-28), l=1-3(-6)), (broadly) adnate to emarginate, often with decurrent tooth, mostly slightly ventricose, 3.5-5 mm broad, rarely furcate, occasionally intervenose, fairly thick, when young pale, to pastel-yellow (3A3-4), rarely yellowish white (3A2) and almost whitish towards the edge, later pale yellow, pastel yellow, light yellow, reddish yellow, pale- to light orange (3A3, 3A3.5, "Luteous", 4A5-6, 5A3-4) or pastel-red (7A4), the surface between the lamellae yellowish. Stipe 13-30(-40) x 3-6(-7) mm, stuffed then fistulose, dry, ± cylindrical, terete to compressed, in age sometimes slightly fibrillose especially on drying, generally paler than the pileus, when young at apex e.g. reddish yellow (4A6), downwards light orange (5A5), at base pale yellowish to whitish, sometimes unicolorous light yellow (4A5), later at apex red, (orange-) red, pastel-red to light orange (9A7, 8.5A7, 8A8, 7A5, 5.5A5) downwards (deep) orange to deep yellow (5-4A8, 6A4, 4.5A5, "Luteous"), at base light yellow to whitish, (4A5, 3A3, "Straw"), sometimes unicolorous except at the base, at base with a slight whitish tomentum. Context somewhat fleshy, not brittle, concolorous with surface, in central part of the pileus watery orange, in stipe pale yellow, paler on drying. Smell generally weak, occasionally sweetish-sour. Taste predominantly mild, occasionally slightly bitter in the stipe. Spore-print white.

Spores 7.5-12.0(-13.5) x (4.0-)4.5-7.0(-7.5) µm, in average 8.5-10.8 x 4.9-6.2 µm, Q = (1.25-)1.30-2.20(-2.35), Qav = 1.45-1.95(-2.05), ellipsoid, ellipsoid (-oblong), ovoid, obovoid to pyriform, hardly broader in frontal view, constricted or not, in side view 0-67 (-90)%, in frontal view 0-75(-90)%, predominantly uninucleate, some binucleate spores frequently present, < 35% (15 coll., DL, TB), in two collections predominantly binucleate (75%, BSI, DL). Basidia (37.5-)39-55(-64) x (5.5-)6-9(-10.5) µm, Q = (3.5-)4.5-9.5(-10.5), (very) slenderly clavate, mostly 4-spored, but 2-spored basidia are occasionally intermixed. Edge of lamellae fertile, occasionally with scattered, hardly protruding sterile elements (basidioles?), ± 25-45 x 3-5 µm, Q ± 7.5-13. Hymenophoral trama subregular, elements 12-114(-157) x 3-14(-17) µm, (sub-) cylindrical, not constricted at the septa. Pileus a cutis with some trichodermal tufts to a distinct trichoderm, terminal elements (14.5-)17-56 (-65) x (3.5-)4.5-12(-16.5) µm, in average 27.5-39.5(-41) x 6-10 µm, subcylindric, subfusiform, subclavate, ventricose, attenuated to slightly lageniform, at septa constricted or not, with vacuolar, refringent, pale yellowish to pale brown pigment, mostly paler than in *H. substrangulata s.l.* Stipitipellis a thin, dry cutis, elements (1-)1.5-5.5(-6) µm broad, in apex with many more or less erect, subcylindric, usually slightly tortuous hairs, (7.5-)8.5-64 (-83) x 2.5-7(-8) µm, in average 3.5-5.5 µm broad. Stipititrama subregular,

elements (21-)36-149(-182) x 5-19.5(-22) µm, in average (51-)55.5-119.5 x (8-)8.5-17(-18) µm, (sub-) cylindrical. Clamp connections in all tissues.

Habitat and distribution: Common and often gregarious in poor, peaty dwarf-shrub heaths dominated by *Empetrum*, on hummocks in fens and in snow patches with *S. herbacea*, less common in *B. nana/glandulosa* heaths, frequently on raw humus, never amongst Sphagnum. It occurs frequently with *H. cinerella*, *H. lilacina* or *H. citrinopallida*, more rarely *with H. substrangulata* var. *rhodophylla*. In low arctic and hyperoceanic to subcontinental parts of S and W Greenland. Late July to early September.

Material: *Greenland*: Loc. 1D, TB 91.137. – Loc. 7A, PMP 73.191, PMP 73.208, TB 78.75, TB 79.34, TB 80.19, TB 82.64, TB 83.36, TB 83.37, TB 84.104, TB 84.106, TB 84.109, TB 84.121, DB GR 85.46, DB GR 85.54, TB 86.241, TB 86.246, TB 86.250, TB 90.043, TB 93.184, TB 95.053a, b. – Loc. 7B, TB 82.132 (duplicate at WAG), TB 84.165, TB 84.179a, TB 84.191. – Loc. 7C, PMP 73.207, PMP 73.290, TB 86.258, TB 90.004, TB 97.205. – Loc. 7F, TB 98.182, Loc. 7H, TB 02.105. – Loc. 7I, TB 97.189. – Loc. 7K, DB GR 85.2, DB GR 85.3, DB GR 85.14. – Loc. 9A, ML 08.08.1971, HFG 87.37, TB 87.137, leg. HFG, TB 87.148, leg. HFG, SAE GR 87.169. – Loc. 9C, TB 87.15. – Loc. 9D, TB 87.108, leg. MS, – Loc. 13, J. 91.19, leg. ML & PMP. – Loc. 9E, MS 87.12. – Loc. 14A, PMP 72.87. – Loc. 14B, PMP 71.56. – Loc. 14D, ML G-67.317, PMP 77.45. – Loc. 14E, ML G-67.240, DL 77.178, ML G-67.063. – Loc. 22, DB GR 89.59 & 69. *Norway*: Hardanger, Kühner 72-30, Kühner 72-16, Kühner 06.08.1972. – Ulvik, Finse, Kühner 72-24, holotype (all in G), GG 23/74, GG 675/81a, TB 89.91 (TB), TB 89.92 (TB).

Observations: Earlier reported from Greenland by Lamoure *et al.* (1982.), without description.

H. biminiata differs from 4-spored collections of *H. miniata* (sensu Arnolds 1986b) mainly in larger spores, which are not broader towards the apiculus in frontal view. Two-spored collections of *H. miniata* have larger spores than 4-spored collections, slightly overlapping with *H. biminiata*, (Figure 19), but the shape is different.

Also *H. calciphila* has smaller spores than *H. biminiata*. They are, however, broader ellipsoid: in average 6.6-8.6 x 5.0-6.1, Qav = 1.25-1.45 (Arnolds 1985b) and binucleate (Arnolds 1995, Borgen & Senn-Irlet 1995). In addition *H. calciphila* grows on rich, calcareous soils, whereas *H. biminiata* is characteristic of acid raw humus. An additional difference may be that the terminal elements in *H. calciphila* are on the average longer (43-61 x 8.5-9 µm, two collections) than in *H. biminiata* (27.5-39.5(-41) x 6-10 µm).

H. biminiata is similar to *H. miniata* sensu Kühner (1976) in macroscopic characters. Also the spore-size is almost identical: 7.5-12(-13.5) x (4-)4.5-7(-7.5) µm, as opposed to 7.5-11.5 x 4.5-7 µm according to Kühner. A possible difference is the length of the terminal elements of the pileipellis: (14.5-)17-56(-65) µm in our material, against 36-110 µm in *H. miniata* sensu Kühner. Moreover the habitat seems to differ, as the latter was collected on calcareous soil. *H. miniata* sensu Kühner may be identical to *H. biminiata*, but this is not relevant from a nomenclatural point of view.

As the type (Kühner 72-24) was collected in an oligotrophic site (G. Gulden pers. comm.), and the Greenlandic collections are from mainly gneissic areas, there are no obvious differences in bedrock preferences between them.

Compared with the Norwegian material the Greenlandic material has a larger variation in gill colour, and the gill attachment is (mostly) emarginate instead of adnate, but these differences are considered insignificant. We are convinced that *H. biminiata* is a single, although variable, taxon.

Hygrocybe biminiata versus *H. substrangulata*

H. biminiata was described by Kühner (1976) with slightly smaller, binucleate spores of similar shape (8.5-11 x 5-6 µm). It was said to differ mainly from *H. coccineocrenata* f. *ambigua* (= *H. substrangulata*) in the bright yellow lamellae and the golden yellow stipe in young specimens. The small terminal elements of the pileipellis, viz. 25-60 x 7-14(-17) µm, is another difference. Both *H. biminiata* and *H. substrangulata* (including var. *rhodophylla*) are macroscopically and microscopically variable. This made Boertmann (1995) include *H. biminiata* in *H. substrangulata* var. *substrangulata*. However, we found that the hairs in the stipe-apex are distinctly narrower in *H. biminiata* (3.5-5.5 µm) than in *H. substrangulata s. l.* (6.5-11.5 µm), cf. p. 11.

The results of the study of the type and other Norwegian collections of *H. biminiata* will be published elsewhere (Borgen & Arnolds, *in prep*.).

Number of nuclei

Kühner characterized *H. biminiata* mainly by the predominance of binucleate spores. However, there is severe doubt about the taxonomic value of this character: Kühner (1976) described a collection of *H.* cf. *biminiata* with a considerable proportion of uninucleate spores. In our study of the holotype of *H. biminiata*, and the other Norwegian collections quoted, we realized that some collections (GG 23/77, GG 675/81a) have predominantly uninucleate spores, while others (TB 89.91 & 89.92) have only slightly more binucleate than uninucleate spores, but were identical in all other features. The number of nuclei is obviously not a decisive character in the present case. In the Greenlandic material the large majority of the collections tested have uninucleate spores, as indicated in the description.

H. biminiata is also variable in other features. For this reason we have compared the more important characters in 23 well-documented collections, viz. average size and constriction of spores, and colours of pileus and lamellae (Figure 19, Table 4): Four collections have fairly small and broad spores (spore-group 3), which are not or only weakly constricted (in side view 0-25%, in frontal view, 0-30%). Six collections (in spore-group 4) have large and narrow spores, average 9.6-10.1 x 4.9-5.3 µm, with a very variable degree of constriction (in side view 10-90%, in frontal view 30-90%). The size and percentages of constricted spores within the remaining collections are intermediate, and most combinations of colours of pileus and lamellae are present as well. One collection (TB 80.19) had almost all spores constricted (± 90% in both views, Figures 17b, 19 dot 1). In the field it was indistinguishable from other collections. Selected collections from these three groups have predominantly uninucleate spores. It appears that in general the variation of colours is not correlated with spore-size and shape. Only a slight correlation between increasing spore-length and percentage of constriction exists.

Table 4. Variation in colours of the basidiocarps of *Hygrocybe* subsect. *Squamulosae* related to the spore size. Spore size classification: group 1 = < 8.0 x 5.0 µm, group 2 = 8.0-8.5 x 5.0-5.6 µm, group 3: = 8.5-8.9 x 5.6-6.1 µm and group 4 = > 9.1 µm long. *Hygrocybe biminiata* (uninucleate = b, binucleate = **b**), *H. rubrolamellata* (= ru, holotype = RU), and *H. miniata* (= m). Same material as quoted in Figure 19. Order of symbols: 2m2,3 means two collections of *H. miniata* from the spore-groups 2 and 3. The colour names indicated are based on K. & W. and CIC, conf. the descriptions.

Gill colours → Pileus colours ↓	coral	pastel-red	light orange	yellow
red	1ru1	4b4 2m2,3 1ru1	2b4 1m2	1b4
orange-red	1RU1	1b4 1m3 1ru1	3b4 1m2	4b3,4
pastel-red		1b3	1b4	3b4
reddish orange				1**b**4
orange			2b4	1b4

Deviating collections

Two collections (DB GR 89.59 & 69) from Jameson Land (Loc. 22) are quite atypical. According to several excellent slides they differ from *H. biminiata* by having smaller basidiocarps, partly slightly umbonate to pulvinate pilei, partly subdecurrent and (very) pale yellowish lamellae. The spores are partly slightly broader (in average 8.5-9.8 x 5.9-6.6 µm, Qav = 1.45-1.80), and the terminal elements in pileipellis are partly slightly larger (in average: 36.5-42 x 7 µm). Moreover, the locality deviates being situated in the continental zone. More material is needed to decide upon their taxonomic status, but for the time being we consider them to be an aberrant variation of *H. biminiata*.

The collection PMP 73.208, from Paamiut (Loc. 7A), differs from *H. biminiata* by having decurrent, yellowish white lamellae, and larger terminal elements in the pileipellis (in average 49.9 x 9.0 µm). In the latter character it integrades with *H. substrangulata s.l.*, but the remaining characters, including the width of the apical hairs on the stipe, are in accordance with *H. biminiata*.

Hygrocybe rubrolamellata T. Borgen & Arnolds spec. nov.

Figures 2, 3, 18, 19, front cover.

Diagnosis: Pileus 4-22 mm, semiglobatus, dein plano-convexus vel applanatus, hygrophanus, ruber vel aurantiacus, concolore fibrillosus vel subsquamulosus, margine non striatus. Lamellae subdistantes, adnatae vel subemarginatae, crassae, rubrae vel aurantiae. Stipes 21-24 x 3-4.5 mm, subcylindraceus, fistulosus, ruber vel aurantiacus ad luteus, siccus. Caro concoloris, odore saporeque nullis. Sporae (6.5-9.5(-10.5) x (3.5-)4.0-5.5(-6.5) µm, Q = (1.30-)1.40-2.00, ellipsoideae-oblongae vel ovoideae-oblongae, non strangulatae, uninucleatae. Basidia 33-47 x 6-

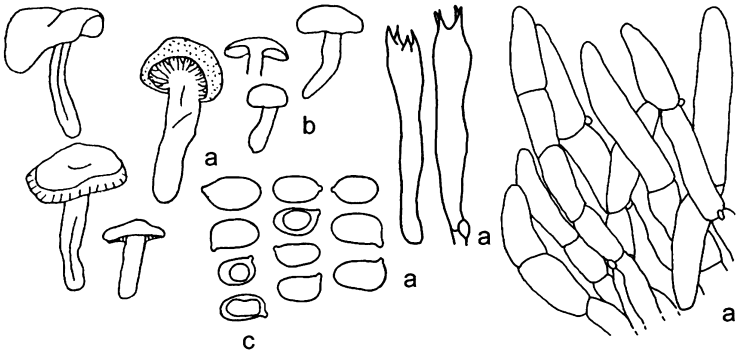

Figure 18. *H. rubrolamellata*. a: DB GR 86.21, holotype, basidiocarps (after slide by D. Boertmann) x 0.8, spores & basidia x 780, pileipellis x 550 – b: TB 84.27, basidiocarps x 1 – c: HK, TB & JHP 18, spores x 780.

7.5(-8) µm, 4- (2-) sporigera, clavatae. Lamellae margine fertiles. Hymenophori trama subregularis, e cellulis 22.5-139 x 5.5-18 µm. Pileipellis trichodermiformis e cellulis terminalis 15.5-61(-75) x 4.5-17.5 µm. Stipitipellis cutis, e hyphis 1.5-5.5(-6.5) µm latis, apice caulocystidiis filiformia (13.5-) 14-88(-94) x 1.5-6 µm. Stipititrama subregularis, e cellulis (42-)48-138(-157) x 5.5-19.5(-25.5) µm. Fibulae frequentes. Holotypus: Greenland, Narsarsuaq, 7 August 1986, gregarious on dry soil on path in copse of *Betula pubescens*, among *Carex* spp., *Thalictrum alpinum*, lichens and mosses, D. Boertmann no. GR 86.21 (in C); isotypi in WAG, DB and TB.

Pileus 4-22 mm wide, first hemispherical, then plano-convex to applanate, frequently slightly depressed at centre, margin incurved, then straight, not or slightly striate, hygrophanous, red, orange (-red) to orange, light orange (CIC "Saffron") in places covered by debris, ± glabrous to the naked eye, under lens minutely radially rimose, slightly scurfy-fibrillose to subsquamulose, especially at the centre, concolorous to slightly brownish, when faded yellowish buff to slightly greyish buff. Lamellae subdistant (L=17-24, l=0-3), adnate to slightly emarginate, slightly ventricose, ± 3 mm broad, rather thick, entirely scarlet-red to orange, edge ± yellow. Stipe 21-24 x 3-4.5 mm, cylindrical to slightly attenuated downwards, sometimes compressed, fistulose, dry, glabrous or slightly fibrillose, occasionally minutely pubescent at apex, at apex scarlet-red, reddish orange, orange or egg-yellow (K. & W. 6A7, "Scarlet", "Luteous"), downwards usually paler, orange, golden-yellow or yellow. Context in cortex concolorous with surface, inside stipe yellow (CIC "Luteous, "Lemon chrome"), smell none, taste weak, slightly earthy or herb-like on mastication.

Spores 6.5-9.5(-10.5) x (3.5-)4.0-5.5(-6.5) µm, in average 7.2-8.4 x 4.2-5.1 µm, Q = (1.30-)1.40-2.00, Qav = 1.55-1.85, not or weakly constricted (0-20%) in both side- and frontal view, ellipsoid-oblong, ovoid-oblong to slightly ob-ovoid-oblong, in side view sometimes subphaseoliform, predominantly or

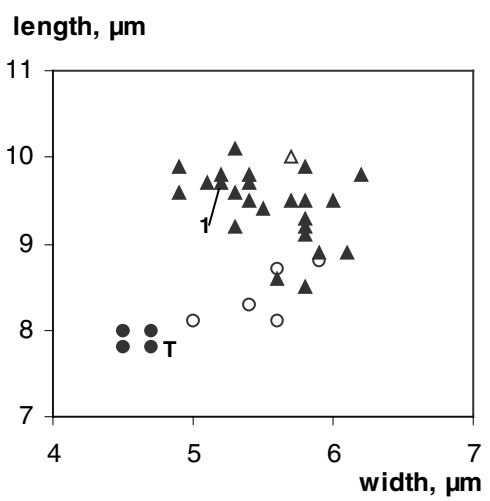

Figure 19. Variation in average spore-size in collections of *Hygrocybe* subsect. *Squamulosae*. For symbols see legend to Figure 2. *Hygrocybe biminiata* with predominantly uninucleate spores: n = 24 from Greenland (incl. TB 80.19 = 1). *Hygrocybe biminiata* with predominantly binucleate spores: n = 1 from Greenland. *H. rubrolamellata*: n = 4 from Greenland incl. holotype (= T). *H. miniata*: n = 3 from Greenland, 1 from Denmark and 1 from the Netherlands.

exclusively uninucleate (two coll., DL, TB). Basidia 4- or sometimes few 2-spored, slenderly clavate, 33-47 x 6-7.5(-8) µm, Q = (4.5-)5.0-8.0. Edge of lamellae fertile. Hymenophoral trama subregular, elements 22.5-139 x 5.5-18 µm, subcylindric, less frequently somewhat inflated, occasionally constricted at the septa, vascular hyphae present. Pileipellis a distinct trichoderm, in places a dry cutis, terminal elements 15.5-61(-75) x 4.5-17.5 µm, in average 39-40 x 6.5-8.5 µm, mostly subcylindric, slightly attenuated, rarely subclavate, hardly constricted at the septa, with pale, partly brownish, vacuolar pigment. Stipitipellis a dry cutis, 30-40 µm broad, elements 1-5.5(-6.5) µm broad, in apex with repent to erect, tortuous to irregular hairs (13.5-)14-88(-94) x 1.5-6 µm, in average 4-5.5 µm broad. Stipititrama subregular, elements (42-)48-138(-157) x 5.5-19.5(-25.5) µm, in average 70.5-101.5 x (9-)10.5-16 µm, cylindrical. Clamp connections in all tissues.

Habitat and distribution: So far only found at Loc. 5A, Narsarsuaq, where it is fairly common on rather dry, sandy-gravelly soil, generally in open vegetation on or near glacial riverbeds, typically with *Festuca* cf. *brachyphylla*, *Thalictrum*, *Thymus*, lichens and mosses, frequently close to *B. pubescens*. The sites are subarctic and subcontinental. Late July to late August.

Material: *Greenland*: Loc. 5A, Narsarsuaq, HK, TB & JHP 18, HK, TB & JHP 487, TB 84.27, DB GR 86.06, DB GR 86.21 (= holotype), TB 87.164, TB 88.97 (TB), TB 94.001, TB 94.002, TB 94.003.

Observations: *H. rubrolamellata* differs from *H. biminiata* in the reddish lamellae and shorter spores (see also key). In addition the habitat is somewhat different: *H. rubrolamellata* seems to prefer drier habitats. It comes very close to *H. calciphila*, but the latter species has binucleate, in average broader, more ellipsoid spores, viz. (4-)4.5-7(-7.5) µm, Qav = 1.25-1.45, and has only been collected on calcareous soils thus far.

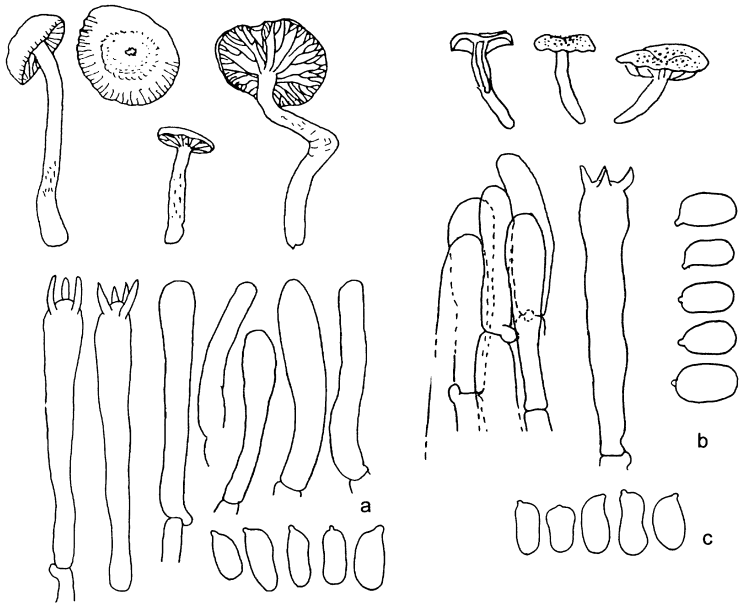

Figure 20. *H. substrangulata* var. *substrangulata*. a: HK, SAE & JHP 467, basidiocarps (after slide by S.A. Elborne) x 0.6, spores & basidia x 620, terminal elements of pileipellis x 440. *H. substrangulata* var. *rhodophylla*. b: TB 82.104, basidiocarps x 0.6, spores & basidium x 620, terminal elements of pileipellis x 440 – c: TB 82.101, spores x 620.

Hygrocybe substrangulata (P.D. Orton) P.D. Orton & Watling in Notes from the Royal botanic Garden Edinburgh 29: 131, 1969.

var. ***substrangulata***

Figures 1, 2, 3, 20, 21.

Synonyms: *Hygrophorus substrangulatus* P.D. Orton 1960; *Hygrocybe coccineocrenata* f. *ambigua* Kühner 1976; *Hygrophorus miniatus* var. *sphagnophilus* Peck 1901; (?) *H. turundus* var. *macrosporus* Hongo 1956.

Excluded: *H. coccineocrenata* var. *sphagnophila* (Peck) Arnolds sensu Arnolds 1985a (= var. of *H. coccineocrenata* s.str., cf. Borgen & Arnolds in prep.).

Selected descriptions: Kühner 1976, 1979; Orton 1960; Høiland 1978; Boertmann 1990, 1995; Borgen & Senn-Irlet 1995; Candusso 1997.

Selected icones: Bon 1990; Boertmann 1990, 1995; Candusso 1997.

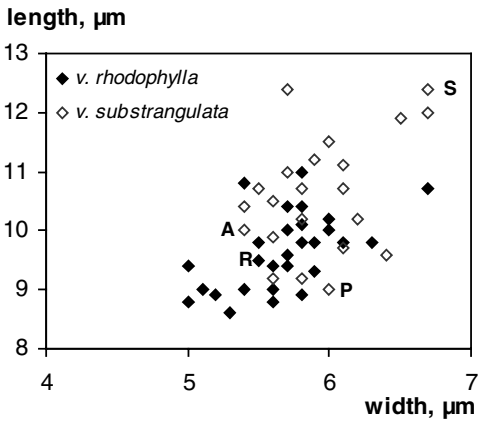

Figure 21. Variation in average spore-size in collections of *Hygrocybe substrangulata*. Var. *substrangulata*, n = 8 from Greenland, 7 from Denmark, 1 from England (isotype = S), 1 from Finland, 1 from France (holotype of *H. coccineocrenata* f. *ambigua* = A), 2 from Norway, 1 from Scotland and 1 from USA (holotype of *Hygrophorus miniatus* var. *sphagnophilus* = P). Var. *rhodophylla*, n = 26 from Greenland and 1 from France (holotype =R).

Pileus 6-26 mm, convex, pulvinate, subcampanulate, parabolic to plano-convex, slightly depressed at centre, margin in- to recurved, not striate or translucently-striate up to $^1/_2$ R, dry; orange-red, reddish orange to orange (K. & W. 8.5-8A8, 7A7-8, 6-6.5A8, 6A6, CIC "Apricot"), then red, orange to pale orange (9B7, "Orange"x"Saffron"), when faded light- to greyish orange (5A5, 5.5B4), minutely to distinctly squamulose, especially at centre, almost concolorous to distinctly grey-brown. Lamellae (sub-) distant (L=13-24, l=1-4), up to at least 3.5 mm broad, adnexed, adnate to (sub-) decurrent, sometimes slightly ventricose, rather thick, pale yellow to light orange, or in places flushed salmon (3.5A5, 4-5A4, 6A5, 6A3.5), then (pale) yellow, orange, reddish orange to pastel red (4A5-6A5, 7A3.5-4, 7A6, 8A4). Stipe 6-40 x 1.5-4 mm, fistulose, cylindrical to slightly attenuated, dry, glabrous to minutely fibrillose or slightly pruinose at apex, orange-red, reddish orange, pale orange, salmon to orange-yellow at apex (8A8, 8A6.5, 6-7.5A7, 6A8, 6A4, 5A5, "Apricot") downwards light orange to light yellow. Context fairly thin, not very brittle, subconcolorous. Smell and taste none. Spore-print white.

Spores (9.0-)9.5-15.0(-16.0) x 5.0-9.0(-9.5) µm, in average (10.1-)10.3-12.9(-13.4) x 5.6-7.0(-7.2) µm, Q = (1.4-)1.5-2.55 (-2.65), Qav = (1.55-)1.65-1.95(-2.15), in side view 5-55%, in frontal view 0-65% constricted, ellipsoid to oblong, occasionally slightly oblong-pyriform, rarely oblong-ovoid, not broader in frontal view, binucleate (four coll., DL, LO, TB). Cystidia none. Basidia 4-spored, 38.5-64.5 x 8-10.5 µm, Q = 4.0-7.5(-8.0). Hymenophoral trama subregular, elements 40-92(-103) x (4-)7-22(-26) µm, cylindrical to slightly inflated. Pileipellis a trichoderm, terminal elements (35-)38-91 x 5.5-14.5(-15.5) µm, in average 53-71(-78) x 8.5-12 µm, slightly clavate, cylindrical to sublageniform, not constricted at the septa, some with greyish, vacuolar pigment, narrow elements not observed. Stipitipellis a dry cutis, elements (1.5-)2.5-10.5 µm broad, in apex with (sub-)fusiform to (sub-) clavate hairs, (13.5-)15-96(-103) x (5-)5.5-12.5 (-13.5) µm, in average 6.5-9 µm broad. Stipititrama regular, elements (30-)36-195(-265) x (8-)11-22(-26) µm, in average 80-125(-137.5) x (12-)13.5-15.5 (-16.5) µm, subcylindric. Clamp connections present in all tissues.

Habitat and distribution: *H. substrangulata* var. *substrangulata* occurs in pioneer vegetation along rivers and brooks, in fens amongst *Sphagnum* or other mosses, sometimes in inland dunes on fairly moist soil with *Polygonum*, *S. glauca* and *Vaccinium*. One collection was growing on black mud at the border of a *Carex rostrata* swamp. Not uncommon in subarctic S Greenland, one record in the middle arctic zone. In August.

Material: *Greenland*: Loc. 1A, HK, TB & JHP 93 (duplicates at TB, WAG), TB 91.082, TB 91.090, TB 91.107, TB 91.129 (TB). – Loc. 5a,

TB 91.062, TB 91.156, TB 91.157. – Loc. 21A, HK, SAE & JHP 467. *Denmark*: TB 89.197, TB 89.198, TB 89.199, TB 89.223, TB 89.224 & TB 89.225 (TB), DB 88.092, DB 84.267, SAE 0629. – *England*, Orton 1561 (isotype of *Hygrophorus substrangulatus*) (E). – *Finland*: Korpilathi, Rimminjärvi, ER. – *France*: Kühner 73-339, G (holotype of *Hygrocybe coccineocrenata* f. *ambigua*). – *Norway*: M. Haukebø 16.09.1969 (O), ML & GG 660.69 (O), Nordland, Dønna, RK (WAG). – *Sweden*: Borgsjø, Halmysina, s.n. ER. – *Scotland*: 24.9.1983, ER & DB. – *USA*: New York, C.H. Peck (NYS) (holotype of *Hygrophorus miniatus* var. *sphagnophilus*).

Hygrocybe substrangulata
var. ***rhodophylla*** (Kühner) Boertm. in The genus Hygrocybe: 108, 1995.
Figures 2, 3, 20, 21.

Synonyms: *Hygrocybe rhodophylla* Kühner 1976.

Misapplications: *H. coccineocrenata* (P.D. Orton) M.M. Moser sensu Borgen 1983; *Hygrophorus turundus* (Fr.: Fr.) P. Karst. sensu M. Lange 1955; (?)*Hygrophorus coccineus* (Schaeff.: Fr.) Fr. sensu Rostrup 1891.

Excluded: *H. rhodophylla* Kühner sensu Gröger 1987 (= *H. phaeococcinea*).

Selected descriptions: Kühner 1976; Borgen 1983; Boertmann 1995.

Selected icones: Bon 1990 (as *H. rhodophylla)*; Boertmann 1995; Candusso 1997.

Pileus 5-28(-30) mm, convex then applanate, slightly depressed at the centre to subumbilicate, margin incurved at first, then straight, crenulate or not, occasionally indistinctly striate; dry, fibrillose-tomentose, especially towards the centre with minute to distinct, adpressed to ± erect squamules, with greyish brown tips; ground colour blood red, red to scarlet red, rarely orange-red in part (K. & W. 11B8, 10-11A8, 10D8-7, 10C8, 10-8A8), at the very margin, especially between striae occasionally in part yellow, when faded reddish- to sordid orange-brown. Lamellae adnate, emarginate to (sub-) decurrent, often with a tooth, (sub-) distant (L=16-24(-30), l=1-3), rather thick, 2.5-5(-7) mm broad, yellowish white, (light) yellow, pale orange, light orange to red (CIC "Straw", 2A5, 3A2, "Luteous", 5A3-5, "Salmon", "Coral"), later reddish, especially on the sides near the edge, (light) orange, orange-red, pastel-red, red, brownish red or pink (8A6, 10A3-7, 9-10A6, 9-10C6, 11A5, "Peach", "Coral", "Rose", "Scarlet"). Stipe (6-)9-29(-38) x (1.5-)2-5(-7) mm, ± cylindrical to slightly compressed, stuffed or fistulose, dry, glabrous, ± concolorous with the pileus, orange-red, pastel-red, red to brownish red (8A8, 9A5, 9A8, 10A8, 10B7, 10D8), lower part paler to yellowish; base whitish or yellowish tomentose. Context rather thin, not very brittle, concolorous with surface when moist, yellow when faded. Smell and taste almost none. Sporeprint white.

Spores (7.5-)8.0-14.5(-15.0) x (4.5-)5.0-8.0(-8.5) µm, in average (8.9-)9.2-11.5(-11.7) x 5.3-6.6 µm, Q = (1.25-)1.40-2.35(-2.50), Qav = 1.50-1.95(-2.05), ellipsoid-oblong, ovoid-oblong, slightly obovoid-oblong, occasionally pyriform, not or hardly broader in frontal view, in side view 0-50(-90)%, in frontal view 0-65(-90)% constricted, binucleate (10 coll., DL, TB). Basidia 4-spored, slenderly clavate (34-)37.5-54(-55) x 6.5-9.5(-10) µm, Q = (4.5-)5.0-7.0. Cystidia none. Hymenophoral trama subregular, elements (24-)27-118(-125) x (4-)4.5-20(-26) µm, subcylindric, less frequently ± inflated. Pileipellis a ± well developed trichoderm, terminal elements (25-)28-97(-101) x 5.5-19.5(-21.5) µm, in average 40-68.5 x 8-14.5(-15.5) µm, (sub-)cylindrical or somewhat inflated, at septa

constricted or not, pigment vacuolar, greyish ochre to distinctly brown, rarely with minute points of greyish pigment in addition. Stipitipellis a dry cutis of repent hyphae, 2.5-7(-8) µm broad, in apex with many (sub-) clavate to subfusiform hairs (20-)21-105(-130) x (3.5-)5.5-13.5(-18.5) µm, in average (7-)7.5-11.5 µm broad. Stipititrama subregular, elements (40-)45-155(-195) x (7-)9-22(-24) µm, in average 62-104 x (8.5-)11.5-15.5 µm, (sub-) cylindrical to slightly inflated. Clamp connections frequent in all tissues.

Habitat and distribution: *H. substrangulata* var. *rhodophylla* is common in fens and moist heaths, growing among *Sphagnum*, other mosses, or on peat, with *Carex bigelowii*, *Empetrum*, *Polygonum*, *S. glauca*, *S. herbacea* and *Vaccinium*, frequently together with *H. cinerella* and *H. lilacina*. It is also common on moist mineral soil along rivers or eroding coastal slopes. It is less common in mesic, mossy heaths. The sites are subarctic to middle arctic and hyperoceanic to continental. Early July to medio September.

Material: *Greenland*: Loc. 1A, HK, TB & JHP 419, HK, TB & JHP 463, HK, TB & JHP 466. – Loc. 1B, HK, TB & JHP 82. – Loc. 1E, PMP 64.11. – Loc. 3, 30.7.1888, leg. Kolderup-Rosenvinge (Rostrup 1891, see observations), BSI 81/479. – Loc. 5A, SAE & TL 138, HK, TB & JHP 19, HK, TB & JHP 58, HK & TL 003, DB GR 86.24, DB GR 86.3, DB GR 86.11, DB GR 86.12, DB GR 86.13, DB GR 86.14, DB GR 86.25, TB 91.063, TB 91.146. – Loc. 6A, TB 91.190 & 191. – Loc. 6B, TB 85.91, TB 91.234 & 235. – Loc. 7A, PMP 73.209, TB 79.144 (duplicate at WAG), TB 82.43, TB 84.111, DB GR 85.29, DB GR 85.34, DB GR 85.32, TB 86.254. – Loc. 7B, TB 82.23, TB 82.34, TB 84.182. – Loc. 7C, TB 79.31 (duplicate at WAG), TB 84.152, TB 84.156. – Loc. 7D, TB 79.92, TB 82.101 (duplicate at WAG), TB 86.279 (duplicate at WAG). – Loc. 7E, TB 80.106. – Loc. 7F, TB 82.31, TB 81.212, TB 93.099, TB 93.100. – Loc. 7G, TB 87.200. – Loc. 7H, TB 97.025 (alt. 250 m). – Loc. 7I, TB 00.017. – Loc. 7J, TB 95.015. – Loc. 7L, PMP 73.260. – Loc. 8, PMP 73.372, PMP 73.483, PMP 73.519. – Loc. 9A, TB 87.149, TB 87.154 (TB), TB 87.155, TB 87.158, HFG 87.99, SAE GR 87.168, SAE GR 87.16. – Loc. 9B, SAE GR 87.177. – Loc. 9C, TB 87.13. – Loc. 9D, TB 87.54, TB 87.67, TB 87.76. – Loc. 11B, ML 198. – Loc. 14D, PMP 70.228, PMP 71.112, PMP 77.46 (duplicate at WAG). – Loc. 17, PMP C 72.394. – Loc. 18, FR & MS 300 (MS & FR) (photograph in Candusso (1997)). *France*, Kühner 74-21 (G) (= holotype of *H. rhodophylla*).

Observations: *H. substrangulata* var. *rhodophylla* was probably reported earlier from Greenland by Rostrup (1891), *sub nom. Hygrophorus coccineus*, from a fen near Igaliko (30.07. 1888). The collection is preserved on alcohol and is in bad condition. We found the spores to measure 8.0-10.5(-11.5) x 5.0-6.0 µm. The few field-notes available indicate that the colours of the basidiocarps were deep red. Lange (1955) filed a record of *Hygrophorus turundus* (ML 198), but the colours and the microscopic features are in accordance with *H. substrangulata* var. *rhodophylla*.

Intraspecific variation: The variation in microscopic characters is considerable, cf. Figure 21, in which 52 well-documented collections of both varieties are compared. The habitats are generally moist, and include peat, Sphagnum bog, sand dunes, but also mesic heaths (var. *rhodophylla*). More specific variability is treated under each variety.

Hygrocybe substrangulata var. *substrangulata* is rather variable: The colours of the lamellae are varying from pastel red to yellow, and the colour of the pileus and the upper part

Table 5. Variation in basidiocarp colours of *Hygrocybe substrangulata* related to spore size. Spore size classification: group 1 = spores < 9.0 x 5.8, or 9.3 x 5.0 µm, group 2 = spores between 9.0 and 11.0 µm long and group 3 = spores > 11.0 µm long. *Hygrocybe substrangulata* var. *substrangulata* (= s, S indicates isotype, A indicates holotype of *H. coccineocrenata* f. *ambigua*, P indicates holotype of *Hygrophorus miniatus* var. *sphagnophilus*). *Hygrocybe substrangulata* var. *rhodophylla* (= r, R indicates holotype). Same material as in Figure 21. Order of symbols: 3r2 means three collections of var. *rhodophylla* within spore-group 2 (see Figure 21). The colour names indicated are based on K. & W. and CIC, conf. the descriptions.

Gill colours → Pileus colours ↓	red	pastel-red	orange-red	orange	light orange	yellow
dark red	3rR2	1r2				
red	12r1,2	8r1,2 4sSP2,3	1r2	2r1,2 1s2	1s2	1r1
orange-red		1r2 3s2		1r1 2s2,3	4sA2,3	
reddish orange			1s2			1s2
pale orange		1s3		1s2		3s2,3

of the stipe ranges from red to orange; moreover, the pileus may be almost smooth to distinctly squamulose, and the scales vary from concolorous to dark grey-brown, and the lamellae are adnate to (sub-) decurrent. Four collections (HK, TB & JHP 93, TB 91.082, TB 91.090, DB 84.267) had distinct, strongly grey-brown scales, but the correlated features (few constricted spores, small basidia) are integrading. Hence we are unable to attribute taxonomic rank to such collections. There is also some integrading towards var. *rhodophylla*.

Hygrocybe substrangulata var. *rhodophylla* is also variable in colours, pileus and stipe blood-red to (orange-) red, lamellae red to pale yellow, but the variation is not correlated with differences in spore-size (Figure 21, Table 5), or habitat. Increasing spore-size seems to be slightly correlated with percentage of constriction (not figured), but since the differences are rather gradual and not correlated with other characters, we regard them as unimportant. One collection (TB 82.101) with binucleate spores, differs from the other collections by having very narrow spores, in average 10.9 x 5.3 µm, which are almost completely constricted in side- and frontal view (80-90%). Macroscopically it is undistinguishable from var. *rhodophylla*.

The macroscopic variation concerning both varieties is shown in Table 5. A small, gracile variant (TB 82.23) was erroneously described before from Greenland as *H. coccineocrenata* (Borgen 1983). Other collections deviate more, the collection PMP 73.372 even by having paler, "yellowish white" lamellae, slightly paler (orange-) red pileus and orange stipe. Not one of these characters appears to be decisive in it self, and the microscopic characters are identical. We do not know the

entire variation of such collections and are unable to separate them convincingly from slender forms of var. *substrangulata* (TB 91.156 & 157). In conclusion: var. *substrangulata* and var. *rhodophylla* are variable in Greenland, and intermediates occur, but we prefer to follow Boertmann (1995), treating them as varieties of one species.

The correct name for this species remained unclear for a long time. We studied type collections of *Hygrophorus substrangulatus* P.D. Orton, *Hygrophorus miniatus* var. *sphagnophilus* Peck, *Hygrocybe coccineocrenata* f. *ambigua* Kühner and *H. rhodophylla* Kühner and concluded that these taxa cannot be separated specifically from each other and are identical with the material from Greenland. The main diagnostic characteristics in common are the large, binucleate spores in combination with the short elements in the stipititrama. The latter character is a good distinctive character with regard to *H. cantharellus*, *H. turunda* and *H. coccineocrenata*. The results of these type-studies will be given and discussed elsewhere (Borgen & Arnolds in prep.).

Hygrocybe coccineocrenata (P.D. Orton) M.M. Moser in Die Röhrlinge und Blätterpilze, 3 Aufl.: 68, 1967.

Figures 1, 2, 23.

For synonymy, selected descriptions and icones see Arnolds 1990.

H. coccineocrenata is not yet recorded from Greenland, but we studied several collections from Europe, including the isotype, for comparison, in particular to establish differences with *H. substrangulata* and *H. turunda*. The results will be given and discussed elsewhere (Borgen & Arnolds, in prep.). The most important microscopic features however, on which the information in the key and Figures 1, 2, 23 is based, are given here.

Spores in average 8.9-11.0 x 5.5-6.2 µm, up to 10% constricted, binucleate (three coll., BSI, Kühner 1976). Pileipellis a trichoderm, terminal elements in average 58-86 x 14-20 µm. Stipititrama regular, elements in average 202-287 x 16.5-21.5 µm.

Material: *Denmark*: 24.08.1985 ER, 13.08.1986 ER, DB 84.059. – *France*: Kühner 62.68 & 69.116 (G). – *Switzerland*: BSI 89/38.

Observations: The most characteristic common features of *H. coccineocrenata* and *H. turunda* are the brown scales on the pileus and the long elements in the stipititrama. The latter character readily distinguishes the two species from *H. substrangulata* in which some pilei may show also greyish to brownish scales. For the differences between *H. coccineocrenata* and *H. turunda*, see under the latter species (p. 59).

Hygrocybe turunda (Fr.: Fr.) P. Karst. in Rysslands, Finlands och den Skandinaviska Halfoens Hattsvampar: 235, 1879, sensu F.H. Møller.

Figures 2, 3, 22, 23.

Excluded: *Hygrophorus turundus*, sensu Arnolds 1974; *Hygrocybe turunda*, sensu Moser 1967a, Arnolds 1990, Galli 1985, Cetto 1984, Lange 1955 (= *H. substrangulata* var. *rhodophylla*), Rald 1986 (= *H. cantharellus*), Candusso 1997 (= *H. coccineocrenata*).

Selected descriptions: Fries 1818 (as *Agaricus turundus*); Fries 1821; Møller 1945; Gulden & Lange 1971; Kristiansen 1981; Boertmann 1995.

Selected icones: Møller 1945; Bon 1987; Boertmann 1990, 1995; Petersen *et al.* 1994.

Pileus 10-25 mm wide, plano-convex, centre flattened, with or without depression, margin involute then ±

straight, not striate, crenulate to undulate, hardly hygrophanous, dry, distinctly to coarsely squamulose, the scales being ± erect at centre, with pointed tips, with tendency to be radially arranged, dark orange-brown to blackish, near margin partly orange, sometimes disappearing in age, leaving a blackish coating; ground colour scarlet-red, reddish to deep orange (K. & W. 9A8, 7B8, 6-7A8), towards the centre concolorous or more orange-brown, at the extreme margin occasionally with a narrow yellowish zone. Lamellae (sub-)distant (L=13-25, l=0-3), distinctly decurrent and arcuate, ± 3 mm broad, fairly thin, not intervenose, (light) yellow (4A4-5, Mu 5Y8/6), edge entire, glabrous. Stipe 20-35(-40) x 3-5.5 mm, fistulose, usually compressed, base occasionally slightly swollen, slightly greasy to dry, glabrous or innately fibrillose, ± unicolorous orange (5A8, 5A6), occasionally reddish orange at apex (7A8), lower third to base paler orange to yellow (CIC "Lemon chrome", 3A5), base with a scanty white to pale yellowish tomentum. Context slightly fleshy, concolorous with surface, inside watery yellow to orange, when faded yellowish white to yellow inside pileus. Smell when kept in a closed box reminiscent of *Cantharellus tubaeformis* or weak, taste mild. Sporeprint white.

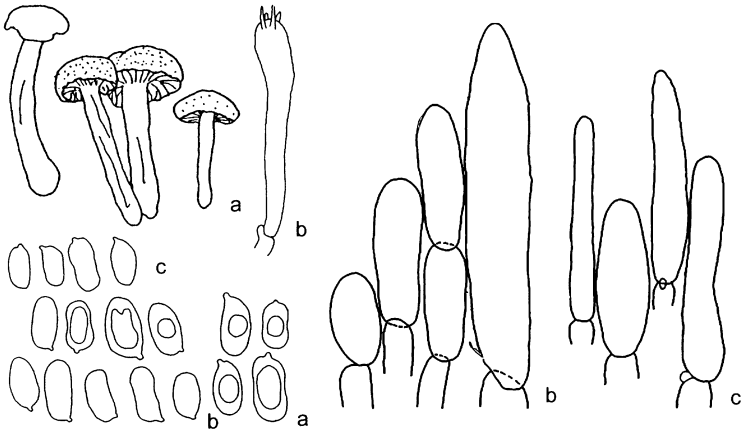

Figure 22. *H. turunda*. a: HK, TB & JHP 27, basidiocarps (after slide by J.H. Petersen), x 0.65 – spores, x 660 – b: TB 87.50, spores & basidium, x 660, terminal elements of pileipellis, x 460 – c: Faeroe Islands, Møller 20.08.1938, spores x 660, terminal elements of pileipellis, x 460.

Spores (7.5-)8.0-11.0(-12.5) x (4.5-)5.0-6.5(-7.0) µm, in average 9.1-9.9 x 5.5-6 µm, Q = (1.40-)1.50-2.00(-2.10), Qav = 1.60-1.70, ellipsoid, ellipsoid-oblong, in side view frequently slightly broader in the apical part, occasionally subphaseoliform, not broader in frontal view, up to 10% constricted, binucleate (one coll., DL), apiculus large, obtuse. Basidia (very-) slenderly clavate, 39-75 x 7-8.5 µm, Q = 5.0-9.0, 4-spored. Edge of lamellae fertile, hymenial cystidia absent or rare (e.g. 37 x 7.5 µm, rostrate). Hymenophoral trama subregular to slightly irregular, elements (23-)27-95 x 5-24.5 µm, subcylindric to inflated, frequently constricted at septa, vascular hyphae present. Pileipellis a trichoderm, terminal elements (29-)

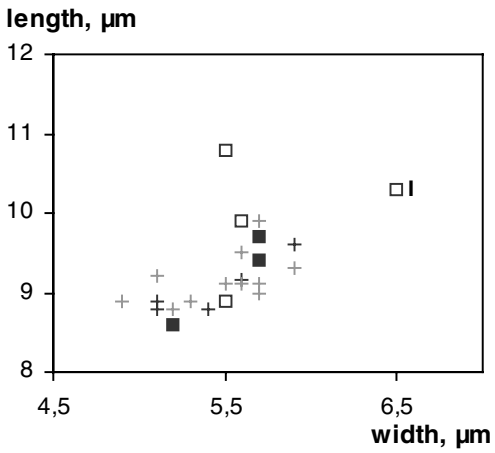

Figure 23. Variation in average spore-size in different taxa of *Hygrocybe* subsect. *Squamulosae*. For symbols see legend to Figure 2. *Hygrocybe cantharellus*, n = 1 from Greenland and 2 from the Netherlands. *H. coccineocrenata*, n = 2 from Denmark, 1 from Switzerland and 1 from England (isotype = I). *H. turunda* with coarse pileus scales (grey symbols), n = 3 from Greenland, 2 from Denmark, 3 from Norway, 2 from Scotland and 1 from Sweden. *H. turunda* with normal pileus scales (dark symbols), n = 2 from the Faeroes and 3 from Norway.

31-112(-118) x 6.5-21 µm, in average 50.5-69.5 x 10.5-15.5 µm, subcylindric, inflated, ellipsoid, obtusely fusiform to slightly lageniform, occasionally constricted at the midportion, mostly constricted at septa, upper layer with distinct brown, vacuolar and granulose pigment. Stipitipellis a thin, dry cutis, elements ± 3-8 µm wide, with infrequent hairs, ± 22.5-60 x 4-6 µm. Stipititrama regular, elements 76-302 (-510) x 8-23 µm, in average 156-255 x 13.5-17 µm, cylindrical or frequently attenuated. Clamp connections frequent in all tissues.

Habitat and distribution: In dry, rather poor grassland slopes, grazed by sheep or reindeers, frequently fasciculate, not common. In Loc. 9D the vegetation consisted of *B. nana*, *Deschampsia*, *Potentilla*, *S. glauca*, lichens and *Polytrichum*. The sites are subarctic to low arctic, and suboceanic to subcontinental. Late July to late August.

Material: *Greenland*: Loc. 5B, HK, TB & JHP 27, HK, TB & JHP 574. – Loc. 5F, TB 02.149. – Loc. 9D, TB 87.50. – *Denmark*: DB 85.221, JV 88.322 (JV). – *Faeroe Islands*: F.H. Møller 20.08.1938, JHP, ER & JV F 24. – *Scotland*: Watling 108C (E), Orton 4163 (E). – *Norway*: GG & ML 314/69, GG & ML 451/69, EA 23.08.1985 (WAG), RK 25.80, RK 26.80, RK 26a.80. – *Sweden*: ER 25.08.1985.

Observations: The above description is based on Greenlandic collections only. The most important or deviating features from several extralimital collections are given for comparison: Pileus 15-35(-40) mm wide, red to orange, sometimes becoming paler, orange-yellow to yellow; occasionally with a greyish tomentum, then with predominantly coarse, erect, later adpressed, blackish brown to dark greyish brown squamules. Lamellae ± decurrent, pale to deep yellow, more rarely orange-yellow. Stipe 25-70 x 2.5-6(-10) mm, red to orange, sometimes later yellow, or yellow at base.

Spores in average 8.8-9.9 x (4.9-)5.1-5.9 µm, up to 25% constricted, rarely (5-10%) slightly subphaseoliform in frontal view, binucleate (three coll., DL, M. Septinus unpubl.). Pileipellis a well developed trichoderm, terminal elements in average 43.5-99 x (10-)12-18 µm. Stipititrama regular, elements in average 151-275(-296) x 13-18.5 µm.

Habitat and distribution: Outside Greenland the species is reported from "moist, mossy soil, not *Sphagnum*, in drier part of a heath bog" (Gulden & Lange 1971); "moist to dry grassland, often with mosses and herbs, occasionally in the vicinity of *Betula*, *Salix* and *Pinus*, or *Juniperus*" (R. Kristiansen *in litt.*); "Dry, grassy soil with *Juniperus*" (D. Boertmann *in litt.*); or "Damp moss or mossy soil, under *Betula* and *Pinus*" (Orton 1960).

H. turunda in the present concept is a rather variable species in respect to development of scales, colours of pileus and lamellae and size of spores (cf. above, Figure 23, Table 6). However, the variation is gradual and not correlated with differences in habitat and distribution.

Agaricus turundus was originally described by Fries (1818: 199, 1821: 106) as a species with a yellow pileus with grey scales ("luteo cinereo-squamulosus"). At present four different interpretations exist (Arnolds 1986b): 1) sensu J.E. Lange (1935-1940), Kühner & Romagnesi (1953), Hesler & Smith (1963) and other European authors with a red pileus supplied with small brown scales, pale lamellae and large, ellipsoid spores (± (8.5-)9.0-12.0 x 5.5-7.5 µm); 2) sensu Møller (1945), Orton (1960), Boertmann (1995) with a yel-

Table 6. Variation in colours of the basidiocarps related to the size of the scales on pileus of *Hygrocybe cantharellus* (= ca), *H. coccineocrenata* (= co, Co indicates isotype) and *H. turunda* (= t). Order of symbols: 2t + (4t) means six collections of *H. turunda* of which four have a coarsely scaly pileus. Same material as in Figure 23. The colour names indicated are based on K. & W. and CIC, conf. the descriptions.

Gill colours → Pileus colours ↓	orange	yellow	pale yellow	white at first
red	(1t)	2t + (4t)	1Co	3ca, 2co
orange	(1t)	3t + (4t)	(1t)	

low or orange-yellow pileus from the beginning with brown scales and slightly smaller, elongate spores (8.5-11.0(-12.0) x 4.5-5.5(-6) µm; 3) sensu Moser (1967), Arnolds (1974a, 1990) with a yellow or orange-yellow pileus from the beginning with brown scales and small spores, broadened to the apiculus in frontal view (7.0-8.5(-10.5) x 4.5-5.5(-6) µm; and 4) sensu Rald (1986) with a red to yellow pileus with concolorous scales, deeply decurrent lamellae and ellipsoid spores (8.0-12.0 x 5.0-7.5 µm).

H. turundus sensu J.E. Lange, Kühner & Romagn. was redescribed by Orton (1960) as *H. coccineocrenata* on the basis of the scarlet pileus, larger spores and occurrence in Sphagnum bogs, whereas *H. turunda* should have a yellow to orange pileus from the beginning, smaller spores and grow in drier habitats. Our studies reveal that pileus colour and spore size are too variable to distinguish between these species. The difference in habitat was confirmed. In addition *H. turunda* seems to have a boreal-montane, low alpine, to (sub-) arctic distribution, whereas *H. coccineocrenata* occurs mainly in the lowlands. In our opinion also morphological differences exist: *H. turunda* is more compact; the lamellae are mostly darker, not white at first, and the scales of the pileus are mostly coarser and darker.

Our concept of *H. turunda* is identical with that of Møller (1945), Orton (1960) in part, Gulden & Lange (1971), Kristiansen (1981) and Boertmann (1995). We studied original material from *H. turunda* sensu Møller (20.8. 1938, C) and provide some microscopic details:

The material left, one specimen, is in very bad condition, badly dried and partly mouldy. Spores ± 7.5-9.5 (-11.0) x (4.0-)4.5-5.0(-6.0) µm, Q ± 1.55-1.80, ellipsoid, a single slightly constricted. Basidia 27-41 x 6.5-8 µm, Q = (3.5-)4.5-6.0, mostly collapsed, number of sterigmata could not be stated. Pileipellis a trichoderm, terminal elements (34-)37-76(-88) x (5-)6.5-12(-15) µm, in average 56.5 x 9 µm, mainly cylindrical, less frequently slightly constricted, with yellowish to brown, vacuolar and granulose pigment. Stipititrama (Elborne *in litt.*) regular, elements (99.5-)121-187 x 13.5-21(-22.5) µm, in average 152 x 17 µm, cylindrical, constricted at septa, sometimes attenuated, fusiform. Clamp connections present, at least at the base of the basidia and in the pileipellis. Møllers (1945) plate deviates somewhat from his description, as noticed before by Gulden & Lange

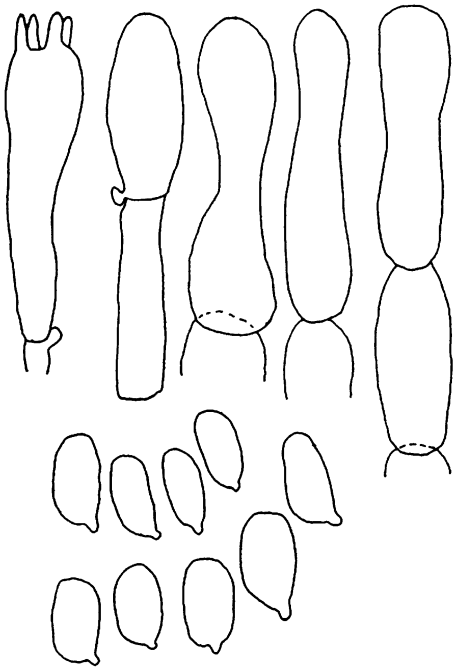

Figure 24. *H. cantharellus*: HK & TL 587, spores & basidium, x 1000, terminal elements of pileipellis, x 700.

(1971). In the original watercolour (kept at C) the pileus is orange to orange-red and the lamellae are pale yellow in the full grown specimen and yellowish white (K. & W. 2A2) in the young specimen, not white like in the printed plate. It is interesting to note that this species was collected again on Faeroe Islands in 1988 and 1989 (Rald *in litt*.). We studied one of these collections (JHP, ER & JV F24), which appeared to be quite similar to Møller's collection.

The interpretation of *H. turunda* by Moser (1967) and Arnolds (1974, 1990) is quite different from the former in much smaller spores, which are broadened and often slightly constricted in frontal view. In fact, the spores are almost identical to those of *H. miniata*.

H. turunda sensu Rald (1986) is conspecific with *H. cantharellus*, see the discussion under that species.

The question remains which of the recent interpretations represents the original *Agaricus turundus* Fr. No authentic material is left and we were not able to trace collections from the surroundings of Femsjø. As stated above, we accept *H. turunda* sensu Møller *et al.* as the most probable concept. A final decision on the identity of *A. turundus* and designation of a neotype has to wait until collections from the surroundings of the type locality have been studied.

Hygrocybe cantharellus (Schwein.: Fr.) Murrill in Mycologia 3: 196, 1911.

Figures 2, 23, 24.

Synonyms: *Hygrocybe lepida* Arnolds 1986b. For other synonyms, selected descriptions and icones, see Arnolds 1990.

Pileus up to 13 mm wide, at first low convex with incurved, crenulate margin then applanate, with or without a depressed centre, concolorous fibrillose-squamulose (when dry in part pale brown); ground colour initially orange-red, later more orange, finally more brownish. Lamellae distant (L=16-18, l=0-1), strongly decurrent and arcuate, rather narrow, occasionally furcate, initially white, then pale to pastel yellow (K. & W. 3A3-4). Stipe up to 20 x 1-1.5 mm, orange, when old with a brownish flush.

Spores 8.5-10.5 x 5.0-6.5 µm, in average 9.6 x 5.8 µm, Q = 1.45-2.00(-2.10), Qav = 1.65-1.70, ellipsoid, oblong, slightly ovoid, rarely obovoid, not broader in frontal view, 5-15% constricted, in frontal view exceptionally subphaseoliform. Basidia 4-spored, ± clavate, 36-48(-52) x (6-)9-10.5(-11) µm, Q = (3.5-)4.0-6.5. Cystidia not observed. Hymenophoral trama subregular, elements (49-)60-194 x (4.5-)6-24(-25.5) µm, ellipsoid, constricted in the middle, cylindrical or undulate, frequently constricted at septa, vascular hy-

phae present. Cystidia not observed. Pileipellis a trichoderm, terminal elements 30-93(-108) x 8.5-18(-19.5) µm, in average 56 x 13 µm, cylindrical, clavate, constricted in the middle, obtusely fusiform, rarely lageniform, septa mostly constricted. Stipitipellis a thin, dry cutis with scattered, short hairs and proliferations ± 4-30 x 2.5-4.5 µm. Stipititrama regular, elements (87-)110-239 x (9.5-)12-19.5(-22.5) µm, in average 141-183 x 13.5-15 µm. Clamp connections in all tissues.

Habitat and distribution: Gregariously among grasses, lichens and mosses (not *Sphagnum*) along a stream, 6-11.08.1984. The site is subarctic and subcontinental.

Material: *Greenland*: Loc. 5A, HK & TL 587. *Denmark*: DB 84.296. *The Netherlands*: Barkman 8871 (WAG), EA 4227 (WAG).

Observations: The collection consists of young basidiocarps, which are only partly ripe, and in a rather bad state (fragmented). It deviates slightly from typical *H. cantharellus* by the squamules becoming pale brown when drying. This feature has been observed before in *H. cantharellus* (Rald 1986), who used the observation to regard *H. turunda* and *H. cantharellus* as conspecific. Later however, he made several collections of *H. turunda* and changed this first opinion (Rald pers. inf.).

Excluded taxa

Hygrocybe coccinea (Schaeff.: Fr.) P. Kumm., Der Führer in die Pilzkunde: 112, 1871.

Observations: This species was recorded from Greenland by Rostrup (1891) and Lange (1955). The collections were studied and the proposed identity had to be rejected, see p. 41 and 54. It was also recorded by Kobayasi *et al.* (1971). However, the small size of the pileus (8-14 mm wide) makes this identification unlikely. From the few notes given, a safe interpretation is impossible. In consequence, *H. coccinea* is not accepted within the Greenlandic basidiomycota.

Acknowledgements

It would not have been possible to complete our studies in a satisfactory way without help from other persons. The late Meinhard Moser (Innsbruck, Austria), David Boertmann (Skive), Christian Bay, the late Tyge Christensen, Peer Corfixen, Henry Dissing, Steen A. Elborne, Henrik F. Gøtzsche, Henning Knudsen, the late Morten Lange, Gert Steen Mogensen, the late Lauritz W. Olson, Peter Milan Petersen and Erik Rald (all Copenhagen), Carsten Brandt (Silkeborg), Ella and Poul-Erik Brandt (Tilst), Flemming Rune (Hillerød, all Denmark), Peter D. Orton (Crewkerne, England), Marcel Bon (Lille), Denise Lamoure (Lyon, France), Andreas Bresinsky (Regensburg, Germany), Helgi Hallgrimsson (Egilsstadir, Iceland), Massimo Candusso (Alassio, Italy), Tsuguo Hongo, Mitsuo Ishigami (both Otsu, Japan), Thomas Kuyper (Wageningen), Machiel E. Noordeloos (Leiden, the Netherlands), Gro Gulden, Klaus Høiland and Kolbjørn Mohn-Jenssen (Oslo), Roy Kristiansen (Sellebakk, Norway), Alexander E. Kovalenko (St. Petersburg, Russia), Roy Watling (Edinburgh, Scotland), Heinz Clemençon (Lausanne), Philippe Clerc (Geneva), Pierre-Arthur Moreau (Zurich), Beatrice Senn-Irlet (Berne, Switzerland), Gary A. Laursen (Anchorage, Alaska) and Rodham E. Tulloss (New York, USA) have greatly contributed to this study by providing valuable information, discussions on ecological, nomenclatural, or taxonomical matters, reprints, technical help and loans or gifts of material. We are indebted to the curators of the following herbaria: BERN, C, E, G, NYS, O, and WAG for loan of material. Furthermore, S.A. Elborne, H.F. Gøtzsche, H. Knudsen, Mikako Sasa (Copenhagen), Beate Nielsen, Morten Strandberg (Silkeborg), Jens H. Petersen (Århus), Viktor Mukhin (Yekaterinburg, Russia), Nils Hallenberg (Gothenburg, Sweden) and the participants in the International Symposium of Arctic-Alpine Mycology (ISAM) VI are thanked for good company in the field and for their efforts to make available well-documented collections.

The first author is especially grateful to G. Gulden for permitting him to stay at the Biological station at Finse, S Norway during field-work in 1989; furthermore to M.P. Christiansen fund, for covering travelling expenses to locations in S Greenland in 1984, 1985 and 2002, to J.E. Lange fund for covering expenses to S Greenland in 1983, 1987 and 2002, to Norway (Finse) in 1989 and making it possible for him to participate in the ISAM foray in Svalbard in 1988. He is also much indebted to the Greenland Homerule, Dept. for Culture and Education, for making it possible to participate in a foray on arctic ecology in Qeqertarsuaq and Kangerlussuaq, 1986, arranged by the University of Copenhagen.

Last but not least the first author is greatly indebted to H. Knudsen and the technical support of Jan Linke Nielsen at the Botanical Museum for much work during the preparation of this manuscript, and to his wife Anne-Mette Larsen for help, encouragement and infinite patience during the entire work.

Appendix 1

Sampling localities in Greenland

Overview of localities where the studied specimens of *Hygrocybe and Camarophyllopsis* were collected. The sampling localities are indicated by numbers in the text. These numbers are listed below together with their location in the phytogeographical zones. The localities 1-7 in S Greenland were classified according to Feilberg (1984). The remaining localities were mainly classified according to Bay (1997) and Fredskild (1996). See also Figure 4.

1. Localities near Tasermiut fiord (60°15-34'N, 44°30-40'W). Sublocalities: 1A: Qinngua Valley. – 1B: At the lake Tasersuaq. – 1C: Tasiusaq. – 1D: Nanortalik. – 1E: At the head of Tasermiut fiord, on the N-side. 1A, 1B and 1E are subarctic and suboceanic, 1C is low arctic and suboceanic, while 1D is low arctic and hyperoceanic.

2. Qaqortoq (Julianehåb) (60°43'N, 46°03'W), low arctic and oceanic.

3. Igaliku (60°59'N, 45°25-26'W), subarctic and subcontinental.

4. Narsaq (61°05'N, 45°25'W), low arctic and suboceanic.

5. Narsarsuaq (61°09-20'N, 45°25-52'W). Sublocalities: 5A: Near the Harbour, in the area around the Airport and The Hospital Valley (Hospitalsdalen), The Flower Valley (Blomsterdalen). – 5B: At the head of Tunulliarfik, around Qanassiassat, "Rosenvinges Plantation."- 5C: Qassiarsuk. – 5D: Tasiusaq at Nordre Sermilik. – 5E: Eqalorutsit Kangillit, at the head of Nordre Sermilik. – 5F: Kiattuut Qaqqaat, N of the main river at Narsarsuaq, subarctic and subcontinental.

6. Ivittuut (Ivigtut) (61°12-14'N, 48°00'W). Sublocalities: 6A: Ivittuut. – 6B: Kangilinnguit (Grønnedal), subarctic to low arctic and suboceanic.

7. Paamiut (Frederikshåb) (61°45'-62°18'N, 48°53'-49°45'W). Sublocalities: 7A: The town area. – 7B: Kangilineq (Kvaneøen). – 7C: Eqaluit, at the head of the fiord. – 7D: Ungilak. – 7E: Tasiusannguaq. – 7F: Taartoq (Mørke fjord). – 7G: Avigaat (Avigait). – 7H: Nigerlikasik. – 7I: At the head of Qassit Kangerluarsua. – 7J: At the head of Nerutusoq Avannarleq. – 7K: Ulussorsuit. – 7L: At the head of Kangerluarsukasik. All localities are low arctic, 7A, 7B and 7G are hyperoceanic, 7C, 7D, 7E, 7F, 7I, 7K, 7L are oceanic, 7J and 7H are are suboceanic.

8. Qeqertarsuatsiaat (Fiskenæsset) (63° 24'N, 50°28'W). Midgård area at the geological field station, low arctic and suboceanic.

9. Nuuk (Godthåb) (64°06-16'N, 50°54'-51°44'W). Sublocalities: 9A: Near the

City, the Airport area. – 9B: At the head of Kangerluarsunnguaq (Kobbefjord). – 9C: Timmiannguit. – 9D: Qooqqut (Qôrqut). – 9E: Ameralik fiord, Uppik. All localities are low arctic, 9A is oceanic, 9B and 9E are oceanic, 9C and 9D are subcontinental.

10. Sisimiut (Holsteinsborg) (66°55′N, 50°53′W), low arctic and oceanic.

11. Kangerlussuaq (Sdr. Strømfjord) (66°50′-67°00′N, 50°30′W). Sublocalities: 11A: Around the Airport. – 11B: Hassels Fjeld. – 11C: Ravneklippen. – 11D: Near the icecap. – 11E: Between Kelly Ville and Ringsødal. The localities are low arctic and continental.

12. Aasiaat (Egedesminde) municipality, in the median part of the island Saqqaliup nunaa (68°38´N, 52°30´W) on the S side, low arctic and suboceanic.

13. Ilulissat (Jakobshavn) (69°14′N, 51° 06′W), low arctic and subcontinental.

14. Qeqertarsuaq (Disko), (69°14-17′N, 53°25-30′W). Sublocalities: 14A: Akuarut (Lyngmarksfjeld). – 14B: Uunnartuarsuk (Lyngmarksbugten & Lyngmarken). – 14C: Uunnartorsuaq (Engelskmandens Havn). – 14D: Granite Area N. of Arctic Station. – 14E: Localities near the Town: (“Mallemukken“, Qaqqaliaq (“Udkiggen“) and Saqqaq). – 14F: Fortune Bay. All localities are low arctic and oceanic.

15. Qeqertarsuaq (Kuannersuit Sulluat, Diskofjord) (69°36′N, 53°27′W), north of the outlet of Kuannersuit Kuussuat, low arctic and oceanic.

16. Nunannguaq on Drygalski´s Peninsula, at the head of Uummannaq fiord (70°27´N, 50°40´W), middle arctic and continental.

17. Tasiusaq on Nutaarmiut (72°35′N, 55°30′W), SE of Upernavik, middle arctic and oceanic.

18. Ammassalik (Angmagssalik) (65° 36′N, 37°28′W), low arctic and oceanic.

19. Kuummiut (Kungmiut) (65°21′N, 36°59′W), low arctic and oceanic.

20. Qinngorsuaq (Cassiopefjeld) (66° 06′N, 37°13′W), low arctic and subcontinental.

21. Jameson Land (70°48′N, 22°42′-22°54′W): Sublocalities: 21A: Valley west of Nathorst Fjeld. – 21B: N. of Gåseelv, middle arctic and continental.

22. Jameson Land, N of the mouth of Draba sibirica Elv (71°02′N, 24°05′W), middle arctic and continental.

References

Arnolds, E. 1974. Taxonomie en Floristiek van Hygrophorus subgenera Hygrotrama, Cuphophyllus en Hygrocybe in Nederland. – Diss. Rijksherbarium. Leiden: 236 pp.

Arnolds, E. 1977. Notes on Hygrophorus 2. – Persoonia 9: 239-256.

Arnolds, E. 1982. Ecology and coenology of macrofungi in grasslands and moist heathlands in Drenthe, the Netherlands, vol. 2. – Bibliotheca Mycologica 90, J. Cramer, Vaduz: 501 pp.

Arnolds, E. 1985a. Notes on Hygrophorus – V. A critical study of Hygrocybe fornicata (Fr.) Sing. sensu lato. – Agarica 6: 178-190.

Arnolds, E. 1985b. Notes on Hygrophorus – IV. New species and new combinations in Hygrophoraceae. – Persoonia 12: 475-478.

Arnolds, E. 1986a. Notes on Hygrophoraceae – VI. Observations on some new taxa of Hygrocybe. – Persoonia 13: 57-68.

Arnolds, E. 1986b. Notes on Hygrophoraceae – VIII. Taxonomical and nomenclatural notes on some taxa of Hygrocybe. – Persoonia 13: 137-160.

Arnolds, E. 1986c. Notes on Hygrophoraceae 9 – Camarophyllopsis Herink, an older name for Hygrotrama Sing. – Mycotaxon 25(2): 639-644.

Arnolds, E. 1987. Three new combinations in Hygrophoraceae. – Persoonia 13: 386.

Arnolds, E. 1990. Tricholomataceae trib. Hygrocybeae. – In: Bas *et al.* (eds.). Flora Agaricina Neerlandica vol. 2, A.A. Balkema, Rotterdam: 137 pp.

Arnolds, E. 1995. Hygrophoraceae (Agaricales) in New York State and adjacent areas. 1. Introduction and Hygrocybe subsect. Squamulosae. – Mycotaxon 33: 1-27.

Bay, C. 1997. Floristic division and vegetation zonation of Greenland in relevance to a circumpolar arctic vegetation map: 27-31. In: Proceedings of The Second Circumpolar Arctic Vegetation Mapping Workshop, Arendal, Norway, 19-24. May 1996 (Walker, S. & A.C. Lillie, eds.). – Occasional Paper No. 52, 1997. Institute of Arctic and Alpine Research. University of Colorado.

Bird, C.J. & Grund, D.W. 1979. Nova Scotian Species of Hygrophorus. – Proc. Nova Scotian Inst. Sci. 29: 1-131.

Boertmann, D. 1985. Vokshatte på overdrev i Vendsyssel. – Svampe 12: 41-49.

Boertmann, D. 1990. The identity of *Hygrocybe vitellina* and related species. – Nord. J. Bot. 10: 311-317.

Boertmann, D. 1995. The genus Hygrocybe. – Fungi of Northern Europe vol. 1. – Svampetryk, Copenhagen: 184 pp.

Boertmann, D. 2002. Index Hygrocybearum – A catalogue to names and potential names in tribus Hygrocybeae Kühner (Tricholomatales, Fungi). – Bibliotheca Mycologica 192: 168 pp.

Bon, M. 1983. Rare and interesting species (Agaricales) found in Norway. – Agarica 4(8): 72-79.

Bon, M. 1987. The Mushrooms and toadstools of Britain and North-Western Europe. – Hodder & Stoughton: 352 pp.

Bon, M. 1990. Flore Mycologique D'

Europe 1. Les Hygrophores. – Doc. Myc. Mem. Hors serie no. 1: 99 pp.

Borgen, T. 1983. Hygrocybe coccineocrenata (P.D. Orton) M. Moser and Omphaliaster borealis (M. Lange & Skifte) Lamoure found in Greenland. – Agarica 8: 265-272.

Borgen, T. & Senn-Irlet, B. 1995. *Hygrocybe glacialis* spec. nov. and notes on subsection Squamulosae based on collections from Switzerland. – Docum. mycol. 25 (98-100): 91-102.

Borgen, T., Elborne, S.A. & Knudsen, H. (*in prep.*). A checklist to the Greenland basidiomycota. – Proceedings from the International Symposium of Arctic-Alpine Mycology (ISAM) VI, 2000 in Greenland. Meddr Grønland, Bioscience.

Brummit, R.K. & Powel, C.E. (eds) 1992. Authors of plant names. – Royal botanic Gardens, Kew: 732 pp.

Böcher, T.W., Fredskild, B., Holmen, K. & Jakobsen, K. 1978. Grønlands flora, 3rd ed. – P. Haase & Søn, Copenhagen: 312 pp.

Cailleux, A. 1981. Code des couleurs des sols. – Boubée, Paris.

Candusso, M. 1997. Hygrophorus s. l. Fungi Europaei vol. 6. – Alassio: 784 pp.

Cetto, B. 1984. Grosse Pilzführer 4 Aufl.-1. BLV, München: 697 pp.

Clemençon, H. 1978. Siderophilous granules in the basidia of Hymenomycetes. – Persoonia 10: 83-96.

Elborne, S.A. & Knudsen, H. 1990. Larger fungi associated with Betula pubescens in Greenland. – Meddr Grønland, Biosci. 33: 77-80.

Favre, J. 1955. Les champignons de la zone alpine du Parc National Suisse. – Ergeb. Wiss. Unters. Schweiz. Nat. Park. 5: 1-212 pp.

Favre, J. 1960. Cataloque descriptif des champignons superieurs de la zone subalpine du Parc National Suisse. – Ergeb. Wiss. Unters. Schweiz. Nat. Park. 6: 323-610.

Feilberg, J. 1984. A Phytogogeographical study of South Greenland, Vascular plants. – Meddr Grønland, Biosci. 15: 72 pp.

Fredskild, B. 1996. A phytogeographical study of the vascular plants of West Greenland (62°20'-74°00'N). Meddr Grønland, Biosci. 45: 157 pp.

Fries, E.M. 1818. Observationes mycologicae 2. – Havniae: 352 pp.

Fries, E.M. 1821. Systema mycologicum 1. – Lundae: 520 pp.

Galli, R. 1985. Gli Igrofori delle nostre Regioni. – La Tipotechnica, Milano: 164 pp.

Gröger, F. 1987. Zwei bemerkenswerte filzhütige Saftlinge (Hygrocybe Subsect. Squamulosae). – Beitrag zur Kenntnis der Pilze Mitteleuropas 111: 95-100.

Gulden, G. & Lange, M. 1971. Studies in the Macromycetes Flora of Jotunheimen, the central Mountain massif of South Norway. – Norw. J. Bot. 18: 1-46.

Gulden, G., Mohn-Jenssen, K., Stordal, J. 1985. Arctic and Alpine Fungi – 1. – Soppkonsulenten, Oslo: 62 pp.

Hallgrímsson, H. 1974. Íslenzkir Hattsveppir IV. Hygrophoraceae. – Act. Bot. Islandica 3: 36-81.

Hansen, L. & Knudsen, H. (eds.) 1992. Nordic Macromycetes vol. 2. – Nordsvamp, Copenhagen: 474 pp.

Henderson, D.M., Orton. P.D. & Watling, R. 1969. British Fungus Flora. Agarics and Boleti. Introduction. Colour Identification Chart. – Edinburgh.

Hesler, L.R. & Smith, A.H. 1963. North American Species of Hygrophorus. – Knoxville: 416 pp.

Hongo, T. 1956. Notes on Japanese larger fungi (8). – J. Jap. bot. 31(5): 16-19.

Høiland, K. 1978. Storsopper i etablert sanddyne-vegetation på Lista, Vest-Agder. 2. Eroderede systemer. – Blyttia 36: 69-86.

Knudsen, H. & Borgen, T. 1987. Agaricaceae, Amanitaceae, Boletaceae. Gomphidiaceae, Paxillaceae and Pluteaceae in Greenland. – In: Laursen, G.A., Ammirati, J.F. & Redhead, S.F. (eds): Arctic and Alpine Mycology 2, Plenum Publishing Corporation, New York: 235-253.

Knudsen, H. & Mukhin, V.A., 1998. The Arctic-Alpine agaric element in the Polar Urals and Yamal, Western Siberia. Pp. 152-162 in Muhkin & Knudsen (eds): Proc. of the Fifth Intern. Symposium on Arcto-Alpine Mycology. – Yekaterinburg: 172 pp.

Kobayasi, Y., Hiratsuka, N., Otani, Y., Tubaki, K., Udagawa, S., Sugiyama, J. & Kazuko, K. 1971. Mycological studies of the Angmagssalik region of Greenland. – Bull. Nat. Sci. Mus. Tokyo. 14(1): 1-96.

Kornerup, A. & Wanscher, J.H. 1978. Methuen Handbook of colour. 3rd ed. – Eyre Methuen, London.

Kristiansen, R. 1981. Foreløbig meddelelse om funn av vokssopper (underslægten Hygrocybe) i nedre Glommaregion 1980, supplert med funn fra Hallingskarvet. – Agarica 3/4: 82-212.

Kühner, R. 1976. Agaricales de la zone alpine. Genre Hygrocybe (Fries) Kummer. – Bull. trimest. Soc. mycol. France 92: 455-515.

Kühner, R. 1977a. Agaricales de la zone alpine. Genre Hygrocybe (Fries) Kummer. – Bull. trimest. Soc. mycol. France 93: 53-115.

Kühner, R. 1977b. Agaricales de la zone alpine. Hygrophoraceae. Généralités. Genre Camarophyllus (Fries) Kummer. – Bull. trimest. Soc. mycol. France. 93: 117-144.

Kühner, R. 1977c. A propos de la delimitation des especes dans les Hygrophores Fries, du Sous-genre Hygrocybe Fries: Deux caracteristiques non ou peu utilisées. – Bibliotheca Mycologica 68: 157-187.

Kühner, R. 1979. Contribution a la connaissance du genre Hygrocybe (Fries) Kummer. Quelques recoltes de la zone silvatique. – Sydowia (Beih.) 8: 233-250.

Kühner, R. & Lamoure, D. 1986. Cataloque des agaricales (Basidiomycetes) de la zone alpine du parc national de la Vanoise et des regions limiotrophes. – Trav. sci. Parc. nat. Vanoise. 15: 103-187.

Kühner, R. & Romagnesi, H., 1953. Flore analytique des champignons supérieurs. – Paris: 557 pp.

Lamoure, D., Lange, M. & Petersen, P.M. 1982. Agaricales found in the Godhavn Area. – Nord. J. Bot. 2: 85-90.

Lange, J.E. 1923. Studies in the Agarics of Denmark – 5. – Dansk Botanisk Arkiv 4: 1-58.

Lange, J.E. 1935-1940. Flora Agaricina Danica vol. 1-5. – Copenhagen.

Lange, M. 1955. Macromycetes. Part 2. Greenland Agaricales (pars). Meddr Grønland 147: 69 pp.

Lange, M. 1957. Macromycetes. Part 3,1. Greenland Agaricales (Pars). Macromycetes Caeteri. 2. Ecological and plant Geographical studies. – Meddr Grønland 147(2): 125 pp.

Laursen, G.A, Ammirati, J.F & Farr, D.F. 1987. Hygrophoraceae from Arctic and Alpine tundra in Alaska. – In: Laursen, G.A., Ammirati, J.F. & Redhead, S.A. (eds.): Arctic and Alpine Mycology 2. The second International Symposium on Arcto-Alpine Mycology 1987: 235-253. Plenum Publishing Corporation, New York.

Malençon, G. & Bertault, R. 1975. Flore

des les champignons superieurs du Maroc 2. – Rabat: 538 pp.

Miller, O.K., Laursen, G.A. & Farr, D.F. 1982. Notes on Agaricales from Arctic tundra in Alaska. – Mycologia 74: 576-591.

Moser, M. 1967. Beitrag zur Kenntniss verschiedener Hygrophoreen. – Z. Pilzk. 33: 1-23.

Moser, M. 1967. Kleine Kryptogamenflora. Band 2 b/2: Die Röhrlinge und Blätterpilze. 4 Aufl. – Stuttgart, New York: 443 pp.

Moser, M. & Jülich, W. 1988. Farbenatlas der Basidiomyceten. – G. Fischer Verlag, Stuttgart, 6 lief.

Munsell, 1975. Soil Color Charts. Munsell Colour Compagny inc., Baltimore.

Møller, F.H. 1945. Fungi of the Færöes – 1. – Copenhagen: 295 pp.

Orton, P.D. 1960. New checklist of British agarics and boleti. Part. 3. Notes on genera and species in the list. – Trans. Br. mycol. Soc. 43: 159-439.

Orton, P.D. 1964. Notes on British Agarics 2. – Not. R. bot. Gdn Edinb. 39: 43-65.

Orton, P.D. 1969. Notes on British Agarics 3. – Not. R. bot. Gdn Edinb. 29: 75-127.

Orton, P.D. & Watling, R. 1969. A reconsideration of the classification of the Hygrophoraceae. – Not. R. bot. Gdn Edinb. 29: 129-137.

Peck, C. 1901. Report of the State Botanist. – N. Y. State Mus. Ann. Rep. 53: 823-864.

Petersen, J.H., Rald, E. & Vesterholt, J. 1994. Føroyskir soppar. – Føroya Skúlabókagrunnur and Føroya Náttúrugripasavn. Tórshavn: 171 pp.

Petersen, P.M. 1977. Investigations on the Ecology and Phenology of the Macromycetes in the Arctic. – Meddr Grønland. 199: 72 pp.

Rald, E. 1986. Vokshattelokaliteter på Sjælland. – Svampe 13: 1-10.

Rostrup, E. 1888. Fungi Groenlandiae. Oversigt over Grønlands Svampe. – Meddr Grønland 3: 517-590.

Rostrup, E. 1891. Tillæg til "Grønlands Svampe" (1888). – Meddr Grønland 3: 591-643.

Rostrup, E. 1894. Øst-Grønlands svampe. – Meddr Grønland 18: 43-81.

Rune, F. 2000. Pupiit – Fungi of Greenland. Naasut. Skævinge: 12 pp.

Schmid-Heckel, H. 1985. Zur Kenntnis der Pilze der Nördlichen Kalkalpen. – Nat. Park Berchtesgaden Forschungsbereich. – Regensburg: 201 pp.

Senn-Irlet, B. 1986. Ökologie, Soziologie und Taxonomie alpiner Makromyzeten (Agaricales, Basidiomyceten) der schweizer Zentralalpen. – Diss. Bern: 252 pp.

Senn-Irlet, B., Mohn-Jenssen, K. & Gulden, G. 1990. Arctic and Alpine Fungi 3. – Soppkonsulenten, Oslo: 58 pp.

Smith, A.H. & Hesler, L.R. 1954. Additional North American species of Hygrophori 2. – Sydowia 8: 304-333.

Watling, R. 1977. Larger Fungi from Greenland. – Astarte 10: 61-71.

Watling, R. 1983. Larger cold-climate fungi. – Sydowia. 36: 308-325.

Watling, R. 1987. Larger Arctic-Alpine Fungi in Scotland. – In: Laursen, G.A., Ammirati, J.F. & Redhead, S.A. Arctic and Alpine Mycology 2. The Second International Symposium on Arcto-Alpine Mycology 1987. Plenum Publishing Corporation, New York: 17-46.

Wells, V.L. & Kempton, P.E. 1975. New and interesting fungi from Alaska. – Beih. Nova Hedw. 51: 347-358.