# SARCOLEOTIA GLOBOSA (SOMMERF.: FR.) KORF, TAXONOMY, ECOLOGY AND DISTRIBUTION

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ABSTRACT

*Sarcoleotia globosa* is circumscribed and retained as the only species in the genus *Sarcoleotia* Imai. Its ecology and distribution are discussed. *S. globosa* is arctic and boreo-oroarctic in distribution; a single record from Tierra del Fuego in the Southern hemisphere is within the Cool Temperate zone.

## INTRODUCTION

*Sarcoleotia globosa* is a soil inhabiting, inoperculate discomycete, which was described from Saltdal, Northern Norway, as *Mitrula globosa* by Sommerfelt (1826). For more than 130 years the species appeared to be an endemic to the Scandinavian region, because the only material available were Sommerfelt's original specimens in the University herbaria of Oslo and Uppsala. Mycological exploration of arcto-alpine habitats in Argentina, Eurasia and North America during the past 25 years has changed this picture. *Sarcoleotia globosa* has now been found in many new localities, thus considerably extending the distributional area of the species. Based on the new collections, a more correct distributional pattern can be drawn. It is now possible to better understand the infraspecific variation in the species and to delimit it from closely related taxa.

The purpose of the present study was to examine the taxonomical status, ecology and distribution of *S. globosa*. The taxonomical status of the genus and the other taxa which have been referred to *Sarcoleotia* are also briefly discussed.

## MATERIALS AND METHODS

Microscopical investigations in the present study were made both on fresh and dried specimens. The latter were rehydrated in water. Dried specimens from the following museums and herbaria have been examined (herbarium abbreviations are those of Holmgren, Keuken & Schofield, 1981: AMNH, C, FH, H, L, O, OULU, TRH, TROM, TUR and UPS). Studies of apothecia were made using squash mounts, microtome sections and hand sections. Fresh apothecia were fixed in FAA 70 percent for at least 24 hours then dehydrated in a gradual butyl-alcohol series, embedded in paraffin wax and sectioned at 8 um. Sections were stained and photographed in Safranin - Fast Green using the staining technique outlined by Johansen (1940: 81). Observations were also made in $H_2O$, Melzer's Reagent and in methyl blue in lactic acid (Cotton blue). Photomicrographs were taken with a camera mounted on a Zeiss WL microscope. Drawings were made with the aid of a Wild drawing tube. A biometrical study of the spore morphology was carried out. A scatter diagram was plotted using average lengths and widths of 10 spores from each collection. This means that each dot represents the average spore size of one collection. Twenty-five Nordic collections and four additional taxonomically important ones have been plotted.

SARCOLEOTIA GLOBOSA (Sommerf.: Fr.) Korf, Phytologia 21: 206. 1971.
= *Mitrula globosa* Sommerf., Suppl. Fl. Lapp., p. 287, pl. 3, fig. 3. 1826.
= *Geoglossum globosum* Sommerf.: Fr., Elench. Fung. 1: 234. 1828.
= *Leotia globosa* Sommerf., *In* sched. herb. osloensis.
= *Corynetes globosus* (Sommerf.: Fr.) Durand, Ann. Myc. 6: 417. 1908.
= *Microglossum globosum* (Sommerf.: Fr.) Imai, J. Fac. Agr. Hokkaido Imp. Univ., Sapporo 45: 192. 1941.
= *Cudonia osterwaldi* P. Henn., Verh. Bot. ver. Prov. Brandenburg 46: 118. 1905.
= *Sarcoleotia nigra* S. Ito & Imai, *In* Imai, Trans. Sapporo Nat. Hist. Soc. 13: 182. 1934.
= *Leotia nigra* S. Ito & Imai, Proceed. Jap. Assoc. Adv. Sci. 7: 148. 1932 (*nomen nudum*).
= *Cudonia clandestina* Rahm, Schw. Z. Pilzk. 44: 172. 1966.
= *Sarcoleotia clandestina* (Rahm) Rahm, Schw. Z. Pilzk. 53: 42. 1975 (*nomen nudum*).
= *Sarcoleotia platypoda* (DC.: Fr.) Maas G. (ut *S. platypus* (DC.: Pers.) Maas G. *fide* Maas Geesteranus, 1966), Koninkl. Nederl. Akademie van Wetensch. Amsterdam, Proc., Ser. C, 69: 191. 1966.
= *Helvella platypoda* DC., Fl. franc. 5: 29. 1815.
= *Leotia platypoda* DC.: Fr., Syst. mycol. 2(1): 28. 1822.

Fruitbodies stipitate, at first capitate, then pileate, up to 50 mm high, fleshy, consisting of a fertile head and a stipe. Fertile head obovate to subglobose, remaining so or more commonly becoming flattened and depressed in center; margin at first strongly inrolled and adherent to stipe; hymenium then apparently continuous with the stipe, in fully mature specimens the margin is receded from the stipe so as to reveal an annular cavity between pileus and stipe ('with a sterile roof of the cap') (Fig. 1.A.).

Pileus 2-12 mm broad, 2-8 mm high, dark sepia to chestnut brown (drying black), underneath on receptacle greyish brown in expanded specimens. Stipe 5-35 mm long, 0.5-2 mm broad, terete or slightly flattened, sometimes with a shallow longitudinal groove on one or two sides, occasionally stipe expanded above to 4 mm wide, glabrous or

minutely floccose, distally permanently floccose, greyish brown to dark sepia brown, becoming more whitish towards the base. Medullary excipulum of the fertile portion principally of a loose textura intricata with hyphae 2.5-5 um broad.

Subhymenium of compact agglutinated, slightly interwoven hyphae. Margin of expanded specimens (ectal excipulum) many cells wide of textura porrecta to textura prismatica, innermost cells 2-4 um broad, outermost cells 4-10 x 10-24 um, brown-walled. Ectal excipulum of stipe of textura porrecta, hyphae 3.0-5.8 um wide, coherent, in places the hyphae of the outer layer of ruptured into short segments and with the loose ends curled outwards (Fig. 1B). Medullary excipulum of less coherent textura porrecta, the hyphae running in bundles and interspersed by cavities. Asci clavate, inoperculate, 8-spored, 70-155 x 7.2-11 um, ascospore distinctly J+. Ascospores obliquely biseriate, clavate to subfusiform, straight or slightly curved, smooth, hyaline, at first unicellular and multiguttulate, then principally 1-2 septate or occasionally with 3-5 septae, 22.0-45.5 x 3.0-5.8 um (Fig. 1D). Paraphyses 1.7-2.2 um broad, slightly enlarged to 3.5 um above, septate, apices curved or hooked, occasionally almost straight, cells brown-walled, filled with oleaginous matter (Fig. 1C).

SPECIMENS EXAMINED

*TYPE: Norway*

Nordland. Saltdal. In arena. 9/1819 and 9/1823 Chr. Sommerfelt, in sched. *Leotia globosa* (O-*holotype* of *Mitrula globosa*; UPS ex herb. E. Fries - *isotype*, slide of *holotype* ex. herb. O).

*OTHER SPECIMENS:*

*Norway:*

Hedmark. Stor-Elvdal. Myrstad, Glåma. 7.10.1976 A. Pedersen & T. Schumacher (O).

Oppland. Dovre. Grimsdalen. Kvannbekken. 12.9.1982 T. Schumacher & K. Østmoe (O). Dovre. Grimsdalen. Buåi. 17.9.1983 T. Schumacher & K. Østmoe (O). Dovre. Grimsdalen. Tverråi. 6.8.1984 T. Schumacher, S. Sivertsen & K. Østmoe (O-2 coll.). Dovre. Grimsdalen. Verkenseter 9.8.1984 T. Schumacher, S. Sivertsen & K. Østmoe (O). Vågå. Krokåi in Slådalen 8.8.1984 T. Schumacher, S. Sivertsen & K. Østmoe (O).

Hordaland. Ulvik. Finse. N of Hardangerjøkelen. 10.8.1960 F.-E. Eckblad (O).

Sør-Trøndelag. Midtre Gauldal. SW Amdalvolltjern. 16.9.1972 Å. Erlandsen (TRH). Oppdal. Vinstradalen. Ryphuskollen. 11.1.1984 T. Schumacher, S. Sivertsen & K. Østmoe(O).

Nord-Trøndelag. Røyrvik. Lake Namsvatnet at Vierma. 6.9.1969 S. Sivertsen (TRH).

Nordland. Hattfjelldal. Børgefjell National Park. Storskavlbekken. 30.8.1969 K.I. Flatberg & S. Sivertsen (TRH). Rana. Granlund. Glomåga. 6.9.1975 H. Dissing (TRH). Rana. 1 km S Rausandaksla. 21.9.1974 S. Sivertsen (TRH). Rana. 1 km NW of Reinforshei 3.9.1975 S. Sivertsen (TRH). Rana. Hammerneset. 8.9.1976 A. Pedersen (O). Rana. Dunderlandsdalen. Ørtfjellmoen. 19.9.1974 S. Sivertsen (TRH), 11.9.1976 G. Gulden (O). Rana. Virvassdalen. Virvasselven River. 29.8.1981 S. Sivertsen (TRH). Rana. Virvassdalen. Beveråa. 7.9.1975 T. Schumacher (O). Rana. Virvassdalen. Blerekelva. 7.9.1975 H. Dissing (O, TRH). Fauske. Blåmannsisen W, at Leirelva. 26.8.1967 S. Sivertsen (TRH).

Troms. Målselv. Holt. 30.8.1964 S. Sivertsen (TROM).
Finnmark. Alta. Tomasbakken at Alta River. 13.8.1961 F.-E. Eckblad (O, UPS, TUR). Kautokeino. Øvre Anarjåkka National Park. Elvkrokfjellet. 9.8.1966 S. Sivertsen (TROM). Kautokeino. Mazejåkka. 15.8.1978 H. Dissing (TRH). Porsanger. Lakselv. Lakselv hotel. 16.8.1961 F.-E. Eckblad (O, UPS). Tana. Polmak River. 12.8.1963 E. Kankainen (O, TUR).

*Sweden*:
Jämtland. Åre. Storlien. 20.8.1983 J. Nitare (Herb. J. Nitare, TRH) Åre. Handöl, at Handolsforsen. 15.8.1984 J. Nitare (Herb. J. Nitare, UPS).

*Finland*:
Kuusamo. Posio. Pernu. Korouoma at Kurttajoki River. 19.8.1977. T. Ulvinen & M. Ohenoja (OULU). Juuma, NE-side of the village. 20.9.1975 T. Ulvinen (OULU).
Enontekiön Lappi. Enontekiö. Porojärvi. Porovuoma at Waltijoki River. 20.8.1961 S. Sivertsen (O). Enontekiö. Kuttanen. 13 km SEE of Kaaresuvanto. Palovuoma. 23.9.1968 T. Ulvinen (OULU, UPS, H).

*Iceland*:
S. Thing. 6346 Grafarlönd. 22.8.1974 Hördur Kristinsson (AMNH). S. Thing. 5747 Sandmuladalur. 25.8.1976 H. Hallgrimsson (AMNH).

*Greenland*:
Sydprøven. 30.9.1971 P.M. Petersen -71.162 (C). Frederikshåb. Equluit. 19.8.1973 P.M. Petersen -73.314 (C, as *Sarcoleotia platypus*).

*Canada*:
Northwest Territories. Keewatin. Rankin Inlet. Kudlulik Peninsula. Melvin Bay. 16.8.1971 M. Ohenoja (OULU). Québec. Poste-de-la- Balaine, grid 2126. 8.8.1982 S. Huhtinen (TUR).

*Japan*:
Hokkaido. Kushiro. Mt. Meakan. 25.9.1935 E. Homma (S - ex herb. S. Imai, as *Sarcoleotia nigra*).

*Germany*:
Brandenburg. Marchia. Röntgenthal. Buch. 15.10, 6.11.1904 K. Osterwald (Jaap- Fungi selecti exs. no. 128, Rabenhorst-Pazschke - Fungi europaei et extraeuropaei no. 4466, Rehm-Ascomyceten no. 1576 (S, as *Cudonia osterwaldi*).

*Belgium*:
Neighbourhood of Brussels, no date, Bommer & Rousseau (FH- ex herb. Patouillard, as *Leotia platypoda*).

*Netherlands*:
Asten, Ospeler Peel. 9.10.1965 C. Bas et al. 4600 (L).

LITERATURE RECORDS:

NORWAY (Sommerfelt 1826 - as *Mitrula globosa*; Imai 1940, 1955, Nannfeldt 1942, Eckblad 1963, Kallio & Kankainen 1966 - as *Corynetes globosus*). FINLAND (Ulvinen 1976 - as *Sarcoleotia globosa*). GREENLAND (Korf & Gruff 1981, Korf 1982 - as *Sarcoleotia globosa*; Petersen & Korf 1982 - as *Sarcoleotia globosa* and *S. platypus*). JAPAN (Imai 1934, 1941 - as *Sarcoleotia nigra*). GERMANY (Hennings 1905 - as *Cudonia osterwaldi*). BELGIUM (Patouillard 1886 - as *Leotia platypoda*). NETHERLANDS (Maas Geesteranus 1966 - as *Sarcoleotia platypus*).

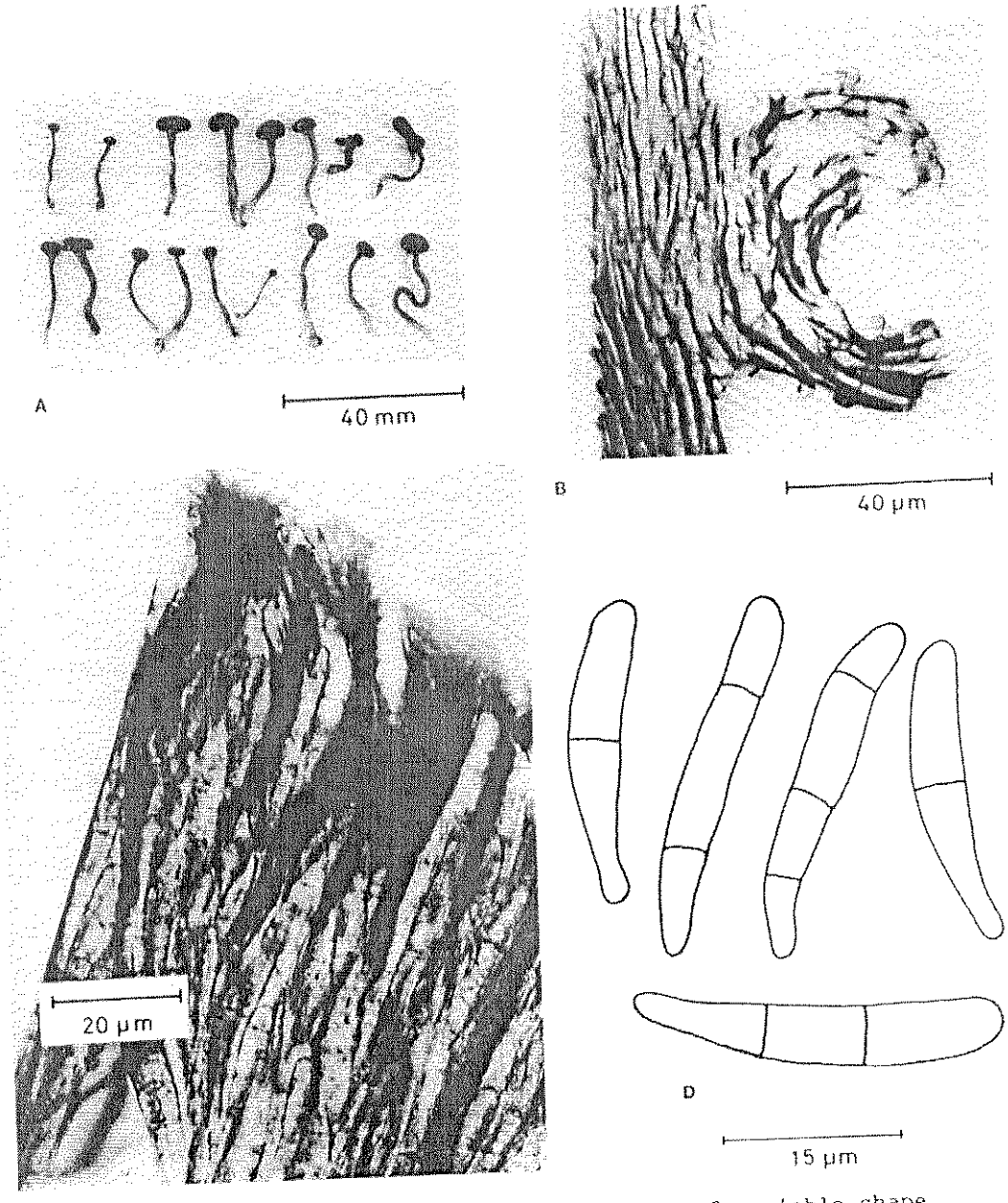


Fig. 1. *Sarcoleotia globosa*. A. Ascocarps of variable shape and size, from coll. 8.8.1984 Schum., Siv. & Østmoe (O); B. detail of stipe with outer portion ruptured and curled outwards; C. detail of hymenium, asci with ascospores and fascicles of paraphyses; D. ascospores, coll. 7.9.1975 Schum. (O).

SWITZERLAND (Rahm 1966 - as *Cudonia osterwaldi* and *C. clandestina*, Rahm 1975 - as *Corynetes globosus* and *Sarcoleotia clandestina*, Müller 1977, Irlet 1984 - as *Sarcoleotia globosa*). ARGENTINA (Gamundi 1979 - as *Sarcoleotia nigra*).

SPECIES DELIMITATION

*Sarcoleotia globosa* is characterized by a pileate, nongelatinous, castanean brown fruitbody with a greyish black, more or less terete

stipe. Under the lense the curved, brownish paraphyses and the hyaline, clavate to subfusiform, non- to few - (3-4) septate ascospores are diagnostic.

Spore septation is a character which has been widely discussed in connection with *S. globosa* and its taxonomic synonyms. The multi-septate ascospores of *S. globosa*, which among others were pointed out my Imai (1940), made Maas Geesteranus (1966) hesitant as to include the species in the synonomy of *S. platypoda* (see discussion below). On the other hand, the multiseptate ascospores of *Cudonia osterwaldi* were according to Maas Geesteranus (1966) rather suggestive of those in *S. globosa*. Rahm (1975) emphasized the larger ascocarps, longer asci and granularly to guttulate, non-septate ascospores of *S. globosus* as distinguishing characters against *C. osterwaldi*. In an earlier paper Rahm (1966) described a new taxon, *Cudonia clandestina*, from the Swiss Alps and found it distinct from *S. globosa* (= *C. osterwaldi* sensu Rahm 1966) on the basis of a larger ascocarp, longer asci and unicellular ascospores of the former. *Cudonia clandestina* also was compared to *S. platypoda* and kept distinct because of the permanently, non-septate ascospores in the former species (Rahm 1975). Maas Geesteranus (1966) studied the type specimen of *Sarcoleotia nigra* and found the ascospores occasionally 3 to 4 - septate, which exceeded the number of septa in the ascospores of *S. platypoda* observed by him. Nevertheless, he included *S. nigra* in the synonymy of *S. platypoda* (Maas Geesteranus 1966).

Table 1. Number of septa in the ascospores of *S. globosa*. (based on counts of 10 ascospores from 26 collections), n = 260.

| *Number of septa* | *% of ascospores* |
|---|---|
| 0 | 18.8 |
| 1 | 43.1 |
| 2 | 28.8 |
| 3 | 8.5 |
| 4 | 0.8 |

As evident from our studies, the septation of the ascospores in *S. globosa* varies considerably (cp. Table 1.). Generally, young specimens tend to have non- to one-septate ascospores, while fully expanded specimens usually have one or more septa per ascospore. Mature specimens with unicellular ascospores also have, however, been observed, and we find the spore septation to be a variable character of little diagnostic value. It should be emphasized that it is difficult to observe the septa of hyaline ascospores in unstained preparations, which may explain some of the discrepancies in the spore statements in the literature. Examination of authentic specimens of *C. osterwaldi* and *S. nigra* also showed variation in the spore septation from specimen to specimen.

Another variable character is the spore size. A scatter diagram showing the distribution of 30 OTUs (operational taxonomic units) with spore length plotted against spore width is given in Fig. 2. The plots include authentic specimens of *C. osterwaldi* and *S. nigra*, and European material interpreted as *S. platypoda* by Maas Geesteranus (1966). A fairly continuous variation is found. It is noted, though, that the collections of *S. nigra* from Japan and *S. platypoda* from The Netherlands are extremes that might call for infraspecific recognitions. However, the number of collections from these areas are limited, which make it impossible to conclude whether or not these slight variations are taxonomically significant. Based on our microscopic examinations and the biometrical study of spore morphology, we recognize only one species.

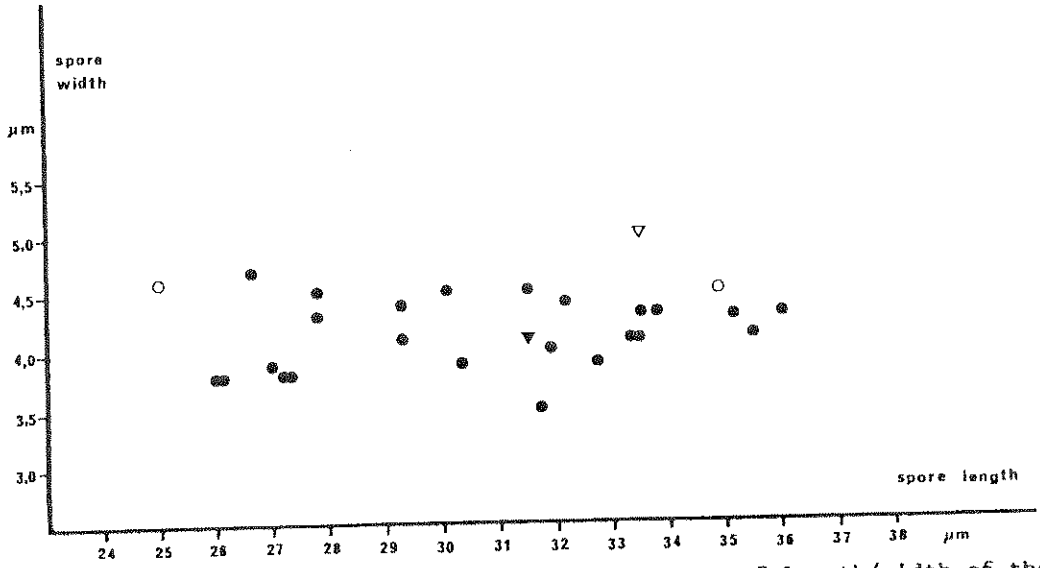


Fig. 2. *Sarcoleotia globosa*, scatter diagram of length/width of the ascospores. Each dot represents an average of 10 measurements per specimen; (solid circle) nordic collections of *S. globosa*, (solid triangle) *C. osterwaldi*, holotype, (empty triangle) *S. nigra*, paratype, (empty circle) *S. platypus*, material in L and FH.

## NOMENCLATURE

Maas Geesteranus (1966) adopted the name *Helvella platypoda* DC. when he recorded the above cited Belgian and Dutch specimens as *Sarcoleotia platypus*. *Helvella platypoda* DC. is an older name than *Mitrula globosa* Sommerf., and it could possibly be used for the present species, as was suggested by Maas Geesteranus (1966). However, we have found several reasons to depart from this solution.

According to De Candolle (1815), *H. platypoda* is gelatinous, somewhat leathery in consistency, with an irregular plicate-undulate brownish head and a compressed, white stipe ('platypoda'). This is indicative of a small *Helvella*, or perhaps a *Leotia* or *Cudonia* species. Fries (1822) adopted De Candolle's species as *Leotia platypoda*. Sommerfelt's specimens, which were seen by Fries, were on the other hand referred to *Geoglossum* (Fries 1828). This indicates that Fries himself never suspected a relationship between the two species. Furthermore, *H. platypoda* was described from the province of Grasse in Southern France, which is far outside the known distributional area of *S. globosa*. Apparently, no authentic specimen of *H. platypoda* exists, while the type specimen of *S. globosa* has been preserved, thus linking the original and Friesian concept of the species. Under these circumstances we have found it unwise to give nomenclatorial preference to *H. platypoda*, even if a neotype could have been selected. Consequently, we have adopted the name *S. globosa* for our species, and *S. platypoda* is here considered a *nomen dubium*.

*Cudonia clandestina* is, on the basis of the description and drawings, put in synonymy with *S. globosa* (Rahm 1966, 1975).

## GENERIC ASSIGNMENT AND CIRCUMSCRIPTION OF THE GENUS SARCOLEOTIA

The generic assignment of *S. globosa* has been disputed since the

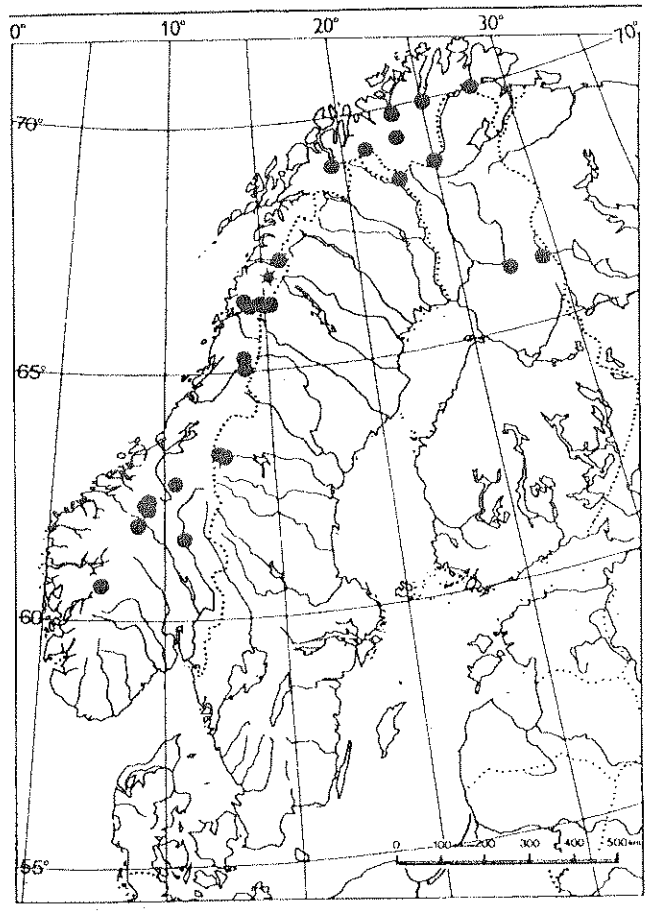


Fig. 3. Distribution of *S. globosa* in Fennoscandia (spoked circle = type locality).

days of its discovery. Sommerfelt was apparently uncertain about its taxonomical position himself; the species was described as *Mitrula globosa*. However, on the herbarium sheet it was referred to as *Leotia* in Sommerfelt's own handwriting (O - ex herb. Sommerfelt). E.M. Fries received some specimens from Sommerfelt and referred the species to *Geoglossum* (Fries 1828). Durand (1908) studied the isotype in Uppsala and transferred it to *Corynetes*, a disposition concurred with by most subsequent authors (Imai 1940, 1955, Nannfeldt 1942, Eckblad 1963). Imai also tentatively referred *M. globosa* to the genus *Microglossum* (Imai 1941), but later on he abandoned this solution and again referred it to *Corynetes* (Imai 1955). Eckblad (1963) pointed out, however, that with regard to shape the species was rather out of place in *Corynetes*. He also drew attention to *Sarcoleotia nigra*, which in shape and colour appeared rather similar to *C. globosus*. Joining the two species in one genus, however, was out of the question due to the dissimilar microscopical features in *S. nigra* as reported by Imai (1934, 1941).

Maas Geesteranus (1964), after having studied Norwegian material of *C. globosus*, concluded that it was 'not a *Corynetes* at all, differing from the species of that genus both in gross morphology and structurally.' He also studied authentic material of *Sarcoleotia nigra* and found it identical to European material interpreted to be *Leotia platypoda* DC. by Patouillard (1886). Based on these findings,

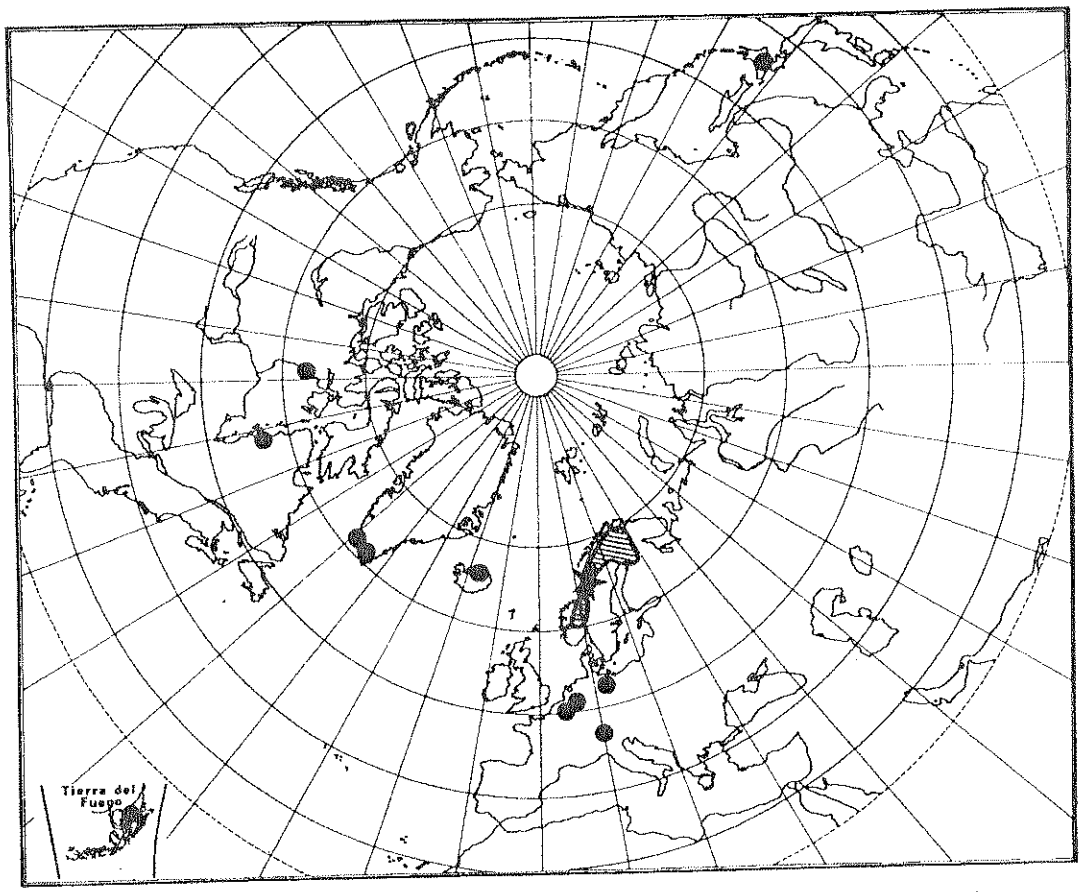


Fig. 4. World distribution of *S. globosa* (star = type locality).

Patouillard's specimens were accommodated in *Sarcoleotia* as *S. platypus* (Maas Geesteranus 1966). The emended description of *S. nigra* provided by Maas Geesteranus (1966), eliminated the main obstacles of bringing *C. globosus* and *S. nigra* (= *S. platypus* sensu Maas G.) together. *Sarcoleotia* was maintained as a "leotiaceous" genus with a pileate fruitbody, having a margin; the stipe being fleshy, non-gelatinous, of textura porrecta throughout; the asci with pore bluing in Melzer's reagent; ascospores hyaline, 1-4-celled and clavate to subfusiform in shape; and the paraphyses being coloured, brownish, straight or somewhat curved above, almost uniform in width throughout (Maas Geesteranus 1966). Maas Geesteranus (1966) concluded: "it is beyond doubt that *C. globosus* belongs to the genus *Sarcoleotia*." Because of the long and slender stipe of *C. globosus*, the dark brown colour of the head and stipe, and the fact that Imai (1940) never suspected the relationship between *S. nigra* and *C. globosa*, Maas Geesteranus (1966) hesitated to include *C. globosus* in his concept of *S. platypus*. A formal transfer of *C. globosus* to *Sarcoleotia* was made by Korf (1971), who apparently accepted the additional species *S. platypoda* in the genus as well (Korf 1973, Petersen & Korf 1982). These taxa are here considered to be identical. *Cudonia clandestina* was also tentatively referred to *Sarcoleotia* (Rahm 1975), however, it was in disaccordance with the Code, and it is therefore not validly published. This taxon is regarded as synonymous to *S. globosa* by us. Another taxon which has been referred to *Sarcoleotia* is *S. turficola* (Boud.) Dennis

(Dennis 1971). It was previously treated among the ombrophiloid, gelatinous members of the genus *Coryne* (= *Ascocoryne* Korf). However, as demonstrated by Dennis (1971), this species lacks the gelatinous layer typical of *Ascocoryne*. For this reason, and because he did not want to erect another new, monotypic genus in the Leotiales, the species was tentatively referred to *Sarcoleotia* Imai (Dennis 1971). We are at present unable to decide where this species belongs. However, the possibility of a common generic assignment with *S. globosa* is excluded. The possibility that *Nothomitra cinnamomea* Maas G. (Maas Geesteranus 1964) represented young specimens of *S. globosa* made us restudy authentic specimens of *N. cinnamomea* (L - 962.271-144, *holotype*). The dried specimens are light-coloured (yellowish brown), concolorous on head and stipe, with hymenium being continuous with the stipe (no sterile roof of the head). Consequently they are not closely related to *S. globosa*, even though there are microscopical features that might indicate some kind of relationship. We agree with Maas Geesteranus (1964) in the erecting of a separate genus to accommodate the above cited specimens.

Accordingly, *Sarcoleotia* Imai is here maintained with *S. globosa* as the only species. The pileate, fleshy, non-gelatinous ascocarp, having a distinct margin, the none- to few-septate hyaline ascospores, and the uniformly, distally curved paraphyses indicate an affinity to the genus *Cudonia* Fr., the latter, however, also is characterized by inamyloid asci and long, acicular ascospores which bud off conidia while still within the ascus.

Originally referred to the family Geoglossaceae (Imai 1934, 1941), *Sarcoleotia* has now been transferred to the Leotiaceae due to the presence of a margin on the ascocarp (Maas Geesteranus 1966). The presence or absence of a margin between the fertile head and the stipe of the ascocarp has been proposed as a main criterion in the demarcation of Leotiaceae and Geoglossaceae, the former family being characterized by having a margin, the latter by the lack of a margin (Maas Geesteranus 1966). Following Maas Geesteranus (1966) and Korf (1973) *Sarcoleotia* and its close relatives in *Cudonia* and *Leotia* are now accommodated in the family Leotiaceae.

## ECOLOGY

Based on our own field observations supplemented by an examination of the herbarium collections and the given notes on the labels of the envelopes of the dried specimens, the site types of the 38 Nordic (Greenland included) collections have been summarized in Table 2.

The sites have been assigned to three main habitat groups, i.e., vegetation influenced by some kind of natural physical or chemical perturbations, vegetation disrupted or created by man, or vegetation on apparently undisturbed ground. Most collections are from disturbed habitats, having been subjected to erosion, inundation by water, burning or cryopedological processes in the many arctic and oroarctic localities. River beds, banks and slopes of intermittent brooks and rivulets turn out as especially favourable sites; all having been influenced by the inundation and erosion of flood water. The river bank localities in the southern parts of Norway are all in boreal and oroarctic river sections, from 240 to 1320 m. Here, as well as along the many recorded arctic river bed localities, *S. globosa* is growing in all subzones of the banks (cp. Schumacher 1978). Common bryophyte and liverwort associates on the banks of rivers, brooks and rivulets are *Blasia pusilla*, *Jungermannia* species, *Philonotis fontana* and *Pohlia gracilis*; on the upper parts of the banks *Polytrichum* species also are characteristic associates. In

Table 2. The occurrence of *S. globosa* in different habitat types

| Site | Number of collections |
|---|---|
| A. *Vegetation influenced by physical/chemical perturbations* | |
| River bed (of these from glacial rivers 6) | 13 |
| Rivulet/brook | 6 |
| Burnt site | 3 |
| B. *Vegetation having been disrupted by man* | |
| Path/road | 4 |
| Gravel pit | 2 |
| C. *Vegetation on undisturbed ground* | |
| Minerotrophic fens | 2 |
| Dwarf shrub heath/forest floor | 4 |
| Gravel and sandy soil (unspecified) | 2 |
| Unknown | 2 |

one collection, from the upper inundation zone of the bank of the Virvasselven River, the moss remnants accompanying the specimens of *S. globosa* were especially rich, including *Blasia pusilla*, *Scapania subalpina*, *Aongstroemia longipes*, *Bryum* sp., *Dichodontium pellucidum*, *Distichium* sp., *Drepanocladus uncinatus*, *Campylium stellatum*, *Hypnum lindbergii*, *Leptobryum pyriforme*, *Meesia uliginosa*, *Blindia acuta*, *Onchophorus virens*, *O. wahlenbergii*, *Pohlia filum*, *P. wahlenbergii*, and *Philonotis tomentella*. On the river bank of Glama in the middle boreal zone of eastern Norway (240 m), *S. globosa* was growing on coarse sand and gravel in a carpet of putrefying sheets of *Nostoc* among shoots of *Pohlia gracilis* and *Jungermannia* sp. These 'algal' environments seem rather appropriate to the type locality of *Cudonia osterwaldi* in Germany, such as described by Hennings (1905). Although not manifest in Table 1, the cryopedological phenomena of frost upheaval and solifluctions are environmental factors, which create and modulate many of the arctic and oroarctic microhabitats of *S. globosa*. The records of *S. globosa* from the Canadian Arctic also seem to fit the characteristic habitat types of the species in Fennoscandia; the specimens were collected on the edge of a ditch-like frost crack amongst *Aulacomnium palustre*, *Distichium capillaceum*, *Riccardia pinguis* and *Eurhynchium pulchellum*, and on sandy soil in between *Equisetum arvense*, *Bryum* sp. and *Polytrichum* sp. on a river bed.

Three of the examined collections are from old, burnt sites amongst pioneer mosses such as *Bryum capillare*, *Pohlia nutans* and *Ceratodon purpureus*. An old fireplace also was recorded as the typical habitat of *Cudonia clandestina* from Austria (Rahm 1966). Six of the Nordic collections are from localities where the soil and vegetation have been disrupted by man, i.e. roadsides, paths and gravel pits with an open, early succesional pioneer vegetation. Only six out of the 38 collections noted in Table 1 are from apparently undisturbed ground. Two collections are from moss carpets in rich, minerotrophic fens with recorded bryophyte associates such as *Sphagnum warnstorfii*, *S. fuscum*, *Calliergon stramineum* and *Paludella squarrosa*, while the remaining are from dwarf

shrub heaths of *Juniperus* and *Empetrum* (3 coll.) and from the ground in a *Pinus* forest (1 coll.). Whether the actual collecting sites have been in closed vegetation, such as interpreted here, or rather within 'scars' in a disrupted vegetation cannot be assumed based on the incomplete information on the herbarium labels of many of the specimens. The many new collections of *S. globosa* in recent years, however, makes it reasonable to conclude that *S. globosa* prefers habitats which have been subjected to some kind of natural or man-made perturbations. Such habitats are known to be favourable sites to the soil-inhabiting operculate discomycetes as well (Petersen 1967, 1982, Schumacher 1978).

The majority of the collections of *S. globosa* are from calcareous areas and from rich soil types. This, together with the affinity of *S. globosa* to burnt sites, known to have an alkaline soil reaction (Petersen 1971), indicates a preference or ability to colonize soils of neutral to alkaline reactions. The Dutch record, however , is maintained as on "poor, peaty soil among mosses" (Maas Geesteranus 1966). It remains to be seen if *S. globosa* is a species which may colonize soils of different nutritional qualities in different climatic subzones of its distributional area.

## DISTRIBUTION

The distribution of *S. globosa* is shown in Figs. 3 and 4. A continuous distribution for *S. globosa* in Central and Northern Fennoscandia is drawn in Fig. 3. Based on the many records in the area, it is concluded that *S. globosa* has an oroarctic and northern boreal distribution in Fennoscandia (cp. Ahti, Hämet-Ahti & Jalas 1968). The majority of finds are from the oroarctic subzones. The other than Fennoscandian records also seem to confirm this phytogeographical picture; the specimens from Iceland, Greenland, the Canadian tundra, the Swiss Alps and the mountains of Hokkaido, Japan, are either from oroarctic areas, low Arctic or from the northern boreal vegetational subzone (cp. Hämet-Ahti 1981). A single record within the Cool Temperate Zone of the Southern Hemisphere from Tierra del Fuego, Argentina, is reported by Gamundi (1979). The Fennoscandian distribution together with the occurrence of *S. globosa* in Eurasia and North America north of 60° latitude may indicate that *S. globosa* has a more or less transcontinental, northern circumpolar boreo-oroarctic and arctic distribution.

At present the temperate lowland localities in Belgium, in the Netherlands and in Germany turn out as somewhat aberrant outposts in the distributional area of *S. globosa* Still more searching for the species in typical lowland-habitats of Middle and Northern Europe is necessary before definite conclusions about its distribution can be drawn.

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