Chorology of the European hypogeous Ascomycetes, I.

Elaphomycetales

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Distribution of hypogeous Ascomycetes in Poland with regard to their areals in Europe is discussed in the paper. The results are illustrated on 63 maps. The paper is the second part of a monographic study of the Elaphomycetales and Tuberales worked out by the author in the Polish Flora – Mycota (vol. 18, 1988).

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1. INTRODUCTION

Knowledge of the geographical distribution for species of hypogeous fungi, and of their local frequency, is important in the understanding of their living requirements. An analysis of herbarium material concerning the area under investigation helps us in the correct interpretation of changes within a species. This is especially valuable when dealing with either extreme forms or deformed specimens resulting from habitat differences and, indirectly, from the geographical situation. This is why the author’s taxonomic studies on hypogeous ascomycetes (Ławrynowicz 1988) refer to the chorological analysis.

The present account takes into consideration both the author’s collections, gathered over 12 years or so, and the available herbarium material from the whole of Europe, with the following aims: (a) to gather all available information on the appearance of those species of hypogeous ascomycetes which may extend into parts of Poland; (b) to represent cartographically the current investigative state of these fungi both within Poland and Europe generally; (c) to interpret their geographical distribution and attempt to determine the hypothetical range of particular species within Europe.

All the material collected by the author, together with a card-index of the analysed specimens, is deposited at the Laboratory of Mycology, Institute of Environmental Biology, University of Łódź.

2. STATE OF INVESTIGATION ON CHOROLOGY OF HYPOGEOUS ASCOMYCETES

In comparison with the knowledge on higher plant geography, for which maps and distribution atlases are available, the chorology of hypogeous fungi, especially Ascomycetes, is poorly understood. The early investigators ignored distribution but concentrated on the taxonomic problems. More recent authors (Knapp, 1950–52; Hawker 1954; M. Lange 1956; Eckblad 1954, 1962; Szemere 1965; De Vries 1971; Kers 1978, 1979a, 1979b, 1980, 1983) include both locality indices and exsiccata citations. Recently, Kers (1983) included in his paper a distribution map of Elaphomyces anthracinus and E. leveillei in Scandinavia, prepared on the basis of a critical revision of both herbarium material and his own collections.

Attempts to establish distribution schemes for some Agaricales have appeared in the literature (Bisby 1933; Vasilkov 1955; Vasileva 1967, 1973; L. Lange 1974; Wasser 1980), indicating some generalizations which could possibly be applied to hypogeous fungi. By analogy to higher plants, these authors attempted to establish range types, concluding that the myco-flora was changing much more in a north-south direction than east-west (Vasilkov 1955). On the other hand the ranges exhibited by fungi are larger
than those shown for higher plants (Vasil'kov 1955; Ainsworth 1971). Vasileva (1967, 1973) proposed a revised classification, specifically for fungi, recognising ten range types. These papers on Agaricales emphasise the ease of air-dispersal of spores over wide areas, and of the possibility of substratum and mycelial disturbance.

Such criteria, however, do not apply to hypogeous fungi. They cannot release spores either from the asci or from the fruitbody, and spores are therefore not wind disseminated. Most species are mycorrhizal, hence the concept of Raitwiir (1964) should be followed with the starting point for mycogeographical analysis and classification based on the individual range of fungus species. In fact, hypogeous species offer excellent material for the determination of individual ranges of fungi.

Many of the important collections from the last century do not include locality details. However, the early monographs (Vittadini 1831, 1842; Berkeley, Broome 1844; Tulasne 1851; Zobel 1854) as well as later ones (Chatin 1892; Hesse 1894; Fischer 1897; Schroeter 1908; Bucholtz 1902; Hollós 1911) attempt to generalise on the distribution by indicating countries and geographical areas for the species described. The published distribution maps cite only a few references, although the economic importance of edible truffles made them an exception. These latter maps were based on truffle localities related to the commercial sale in Mediterranean countries (Nicolas 1975; Delmas 1978).

The exploration of hypogeous fungi prior to World War 1 in central Europe was limited to the discovery of whether or not edible truffles existed and where they could be found. Numerous records were published, including some from northern Poland and from Silesia, which were analysed by Hesse (1894) and Schroeter (1908) who concluded that only a few were valid. Eichler (1904) reported the occurrence of Elaphomyces, Hydnotrya and Tuber. A comprehensive reference list dealing with the state of investigation within Polish territories was provided by the present author (Lawrynowiec 1988) dealing with Elaphomyctales and Tuberales.

The earliest data recorded by map for hypogeous fungi in Poland was published by Bucholtz (1902). In a map of Russia, he indicated a locality on the Vistula river, close to Warsaw. Between the two world wars, Teodorowicz (1928, 1933, 1936) undertook an intensive search for underground fungi in Pomerania, Southern Poland and Great Poland, and his collection of Tuberales proved to be of especial interest.

The first paper of a chorological character was published by Lubelska (1953), presenting the occurrence in Poland of Choiriomycetes meandritiformis and eight taxa of Tuber taken from the available literature. This paper summarised all the available data and represents a starting point for hypogeous fungi investigation in Poland.
Taking into account both the published data and a critical revision of the herbarium material, Skirgiełło & Wosińska (1963) published maps of the distribution of localities for four species of Elaphomycetes in Poland, and Ławrynówicz (1970) provided some additional localities from Central Poland.

From a chorological standpoint, Choiromyces meandriiformis is one of the best known species for Europe. Distribution has been described by Skirgiełło (1976); Gross (1977); Kreisel, Dörfelt & Benkert (1980); and Babos (1981). In the same paper, Babos also provided the distribution of Terfezia terfezioides within Hungary.

Recent monographic accounts have become increasingly orientated towards taxonomic-chorological studies of individual species.

3. MATERIAL AND METHODS

The present account, as far as distribution in Poland and the rest of Europe is concerned, is based upon herbarium studies, and only personally examined exsiccate have been concerned. In a few well documented cases only (e.g. Hawker 1954; Kerr 1983), have literature data been mapped by the present author.

The number of exsiccate extending back to the middle of the last century is apparently quite large. In many cases, however, the collections found in various herbaria represent only a few localities. There was extensive interchange of material between the early collectors, and even small collections were divided into many portions. It is not unusual to find on the sheets in various herbaria only a single specimen or even a small part of one fruitbody coming from the same locality. For parts of Europe where there has been no intensive collecting or investigation the number of known localities remains very small, even for the common species.

The herbarium material studied includes all collections available both within and outside the country under investigation, within Europe. About 1500 collections of the author's own material has been studied, together with about 5000 sheets from 44 herbaria. The list of herbaria and the material examined is given in the taxonomic part, along with keys, descriptions and illustrations to 81 species of Elaphomycetales and Tuberales (Ławrynówicz 1988). When finalising this list, a considerable amount of examined material had to be omitted owing to an unclear taxonomic interpretation, the unlikely occurrence in Poland, the poor state of preservation of the material, or the quality of the material (fruitbodies too young or too old). Quite often a good specimen could not be utilised for the chorological part of the work because the collection details were absent, illegible or unclear in meaning. The
intention has been to use only material accurately identified and accompanied with precise locality details. Collections gathered by the present author form the basis for the distribution maps of hypogeous fungi in Poland, supplemented by other collections coming from Polish and some overseas herbaria.

An initial analysis revealed the majority of records came from areas which had proved geobotanically attractive to naturalists. For this reason, field investigations were directed toward areas and habitats which had been previously ignored, such as Central Poland. Polish exsiccate material came from: Kraków herbaria (KRA — 29 sheets, KRAM — 48 sheets), mainly from Southern Poland, collected by K. Rouppert, B. Gumińska, W. Wojewoda, et al.; the Warsaw herbarium (WA — 23 sheets), from the Tatra Mtns, and the environs of Warsaw, collected by A. Skirgiello, W. Rudnicka-Jezierska, S. Frejlak, et al.; Lublin herbarium (LBL — 20 sheets), from the Lublin Upland and heights of Roztocze, collected by B. Sałata; Poznań herbarium (POZ — 2 sheets), from the Baltic coast, collected by M. Lisiewska; Wrocław herbarium (WRSL — 60 sheets), from the Sudetes and Silesia (in herb. Schröeter, but owing to illegibility of labels only 60⁰/o i.e. 32 sheets could be considered); Łódź herbarium (LOD — ca 1500 sheets).

The majority of overseas collections date comes from the last century. The earliest exsiccate collection is dated 1839, and is deposited in the Bratislava museum. The collections of Saccardo in Padua (PAD), Tulasne & Tulasne in Paris (PC), and Berkeley & Broome in Kew (K), contain exsiccate either exchanged or donated e.g. by Vittadini, may be earlier but are undated. Many of the collections include important mycothecas, which are to be found in several of the older herbaria e.g. Thumen, Mycotheca universalis; Saccardo, Mycotheca italicca; Sydow, Mycotheca germanica, etc. Within Europe, the Munich herbarium (M) houses the richest and well preserved collection, containing the central European collections, including both the older material and well documented contemporary material e.g. E. Soehner and G. Gross. Kew (K) also houses very rich collections, including overseas material, and in recent years has acquired the collections of L. Hawker. The many type collections also make the Paris herbarium (PC) an important source, with many collections from the last century. In central Europe, the important herbaria include Budapest (BP), with the collections of L. Hollós and L. Szemere, and Prague (PRM), which houses both Czechoslovakian material and also old and new material from overseas.

Especially significant are the Scandinavian herbaria: Copenhagen (C), with the Danish collections revised by M. Lange according to contemporary criteria, and Oslo (O) containing Norwegian material collected and examined
by F.-E. Eckblad. In Finland, the collections in Helsinki (H, HFR), Turku (TUR), and Oulu (OULU), include abundant material of Elaphomyces, both the older collection of Hittonen and more recent material by E. Ohe noja and T. Ulvinen. The Swedish herbaria of Stockholm (S) and Uppsala (U) also represent some of the richest collections in Europe, with the Swedish collections of Elaphomyces and, in addition, Tuberales material from several European countries, with both older collections from the last century and more recent specimens e.g. due to L. E. Kers. The collection at Leiden (LD), recently revised by De Vries, must also be taken into account. From eastern Europe, the Leningrad herbarium (LE) has been analysed, but of the material available to the author, only a few collections originated from within Soviet territory, the majority coming from western Europe by exchange. Collections from the Iberian Peninsula have also been analysed: Madrid herbarium (MAF), includes the collections of F. D.-Calonge, and the Lisbon herbarium (LISU) houses the Pinto-Lopez collection. Since the majority of the latter specimens belong to Terfeziaceae, the collections also illustrate, to some extent, the flora of the north coast of Africa and Asia Minor.

The entire material, analysed microscopically, is arranged according to species locality accounts, and provides the documentation for the species distribution maps. The localities in Poland are shown on maps with a 10 × 10 km squares grid. As a result of detailed examination, a square on the map may include several localities so, for reasons of completeness, the list of localities found is appended, with the use of abbreviations explained below. The order of localities corresponds to the physico-geographical partition of Poland according to Kondracki (1977). The background grid used for the maps of Poland was originally used in the “Atlas of Vascular Plant Distribution in Poland”, ATPOL (Zając 1978). The meridian 19°E is the grid axis, the grid being marked on the Poland map 1:1000000. All localities shown on the map were previously identified on detailed topographical maps. The area of Poland is covered by 3437 squares. The cartograms used in this account are in accordance with those adopted by the authors of ATPOL.

Collections from other European countries are used to determine the overall distribution of individual species by the point method, whilst aggregation of the points are indicated by cross-hatching. The species locality accounts form an integral part of that section of the account, and each record corresponds to a herbarium label. For purposes of recording the distribution, data from the literature were utilized where they are important for species chorology, but these localities are not marked on the maps.

The maps presented provide only an introduction to fungal chorology, however, even such a limited account indicates the need and effectiveness in searching for hypogeous fungi in specific sites.
4. COMMENTS ON TEXT AND MAPS

The chorological characteristics of the species are arranged systematically according to the taxonomic part of the investigation (Ławrynowicz 1988). Well known species have separate subsections, whilst the others are treated collectively within the genus and may therefore occasionally diverge from the systematic order. Similarly species with few known localities may appear on the same map.

Localities are defined as a point on the terrain whose distance from the next nearest point (place of appearance of the species) is not less than 1 km in the lowlands, and 0.5 km in the mountains. These localities are arranged according to the macroregions proposed by Kondracki (1977). Within a macroregion, the arrangement is alphabetical and the number of squares on the map is provided.

The locality description includes:

- name of macroregion (acc. Kondracki 1977);
- map coordinates according to the formula ATPOL i.e. first letter and second numeral correspond to column on map, whilst the second letter and first numeral correspond to the strip, e.g. AB 23 indicates strip B2, column A3; the coordinates appear on map-frame;
- name of nearest point, reserve, forest range, forest inspectorate, or two points between which the locality occurs, or the name of the mountain, hill, valley, etc.;
- names of trees, shrubs under/at which the fungus has grown (abbreviations used in forestry, see Trampler, Smykala & Bosiak 1960), finally the plant community abbreviation;
- date (month and year) of collection;
- name or initials of collector;
- herbarium abbreviation (Index Herbariorum 1981) housing collection, together with herbarium specimen number.

The locality descriptions adopt the following punctuation:

- full stop – completes macroregion description,
- semi-colon – separates successive localities in a macroregion,
- comma – separates successive localities,
- dash – precedes locality description for subsequent square.

Localities are cited within the list in such a way as to allow the reader to find them on the map. To find the locality in the country, the reader must refer to the species locality accounts for further details.

List of abbreviations

Abbreviations of names of trees, shrubs and plant communities

Aa – Abies alba
Ag – Alnus glutinosa
Ap – Acer platanoides
Aps – Acer pseudoplatanus
Bpp – Betula pendula and B. pubescens
Ca – Corylus avellana

Cb – Carpinus betulus
Fe – Fraxinus excelsior
FQ – Fago-Quercetum
Fs – Fagus sylvatica
Jc – Juniperus communis
Ldp – Larix decidua and L. polonica
5. CHOROLOGY OF SPECIES OF ELAPHOMYCES

5.1. Elaphomyces granulatus Fr. emend. Holl.

Distribution in Europe (Fig. 1). The species is frequently found in Central Europe and southern Scandinavia in lowlands and low mountain sites. It also occurs in Great Britain (England, Wales, Scotland), southern France, Belgium, The Netherlands, and in European USSR. Northern localities extend to the arctic circle in Finland and Norway; the northernmost site
is at Leirfjord, Nordland prov., at 1000 m alt. It occurs in the Carpathian Mountains, especially frequent in the Tatra and Beskid Mtns, more rarely in Transylvania. In southern Europe, it occurs mostly in the uplands and mountains, along the southern slopes of the Alps (Cavelonte, environs of Turin, Klagenfurt), Vallombrosa, the Central Massif, and the mountains of the Iberian Peninsula). The highest recorded localities are Vaţec (Tatra Mtns) at 850 m alt., Vallombrosa (Appenine Mtns) at ca 1000 m alt., and environs of Klagenfurt (Alps) at ca 800 m alt.

Hypothetical distribution. All Europe, within borders of nemoral and boreal zones (deciduous, mixed and coniferous forests), and analogous mountainous sites. Absent from Steppe and Mediterranean vegetation areas. Most common in region of oceanic climate.
Habitat. A typical forest species, forming ectotrophic mycorrhizal associations probably with several tree species. Found in deciduous and mixed tree stands, more rarely in coniferous stands. According to some authors Fagus sylvatica is the principal mycorrhizal associate, but in its absence will form associations with other deciduous and coniferous trees e.g. Picea abies in Norway. Known in Poland from 121 localities. Often occurring with E. muricatus, more rarely with E. asperulus but (in comparison with the latter) in lower mountain sites. Prefers rather fertile soils, with pH 4-5. Other accompanying species: Genia hispidula, Hydnortya tulasnei, and the sclerotia of Cenococcum geophilum. The fruitbodies are sometimes attacked by Cordyceps capitaia and C. ophioglossoides.

Distribution in Poland (Fig. 2). Occurring throughout the entire country, including coast, lakelands, uplands and mountains. One of the most common species in the mycoflora.

Fig. 2
Elaphomyces granulatus
Hypogeous Ascomycetes


5.2. Elaphomyces asperulus Vitt.

Distribution in Europe (Fig. 3). Occurring commonly and frequently in C, E and N Europe, also known from northern France (vicinity of Paris), E Alps, S and N slopes of Alps, and the entire Carpathian Mtns. In the Tatras, it is the most frequent species of Elaphomyces, similar to the situation found in Scandinavia. The most northern locality is close to Narvik in Norway, whilst the extreme limits, Kuusamo, in Finland are a little to the south. The highest limits are Štrbské Pleso (Tatras) at 1100 m alt., and Pfronten n. Breitenberg in the Bavarian Alps at 1400 m alt. No data exists
for southern Europe, the Hungarian lowland, most of W Europe, or the Steppe regions of E Europe.

Hypothetical distribution. Prefers regions with a temperate, cool or continental climate. Probably occurs throughout the range of Pinus sylvestris and Picea abies. The highest localities occur in montainous regions; in E Europe it represents the most common species of Elaphomyces. Absent from areas with a Mediterranean or Atlantic climate, and in the Steppe zone.

Habitat. Ectotrophic mycorrhizal associations formed primarily with conifers: Pinus sylvestris, Picea abies, and Abies alba, sometimes probably also with deciduous trees, such as Quercus, Betula, Fagus and Carpinus. Often extreme habitats are attained: over 1000 m alt. in mountainous regions, and within poor habitats for pine forests in lowlands where E. granulatus is a rather rare species; pH 4-4.5. It is the species of Elaphomyces
most strongly associated with poor, acid habitats of pine and fir forests, and mixed oak-pine forests. It occurs together with *E. granulatus*, more rarely with *E. muricatus*, *Hydnobolites cerebriformis*, and the sclerotia of *Cenococcum geophilum*. Sometimes, but more rarely than in the case of *E. granulatus* and *E. muricatus*, the fruitbodies are attacked by the stromata of *Cordyceps capitata* and *C. ophioglossoides*.

**Distribution in Poland** (Fig. 4). Currently known from 127 localities distributed throughout Poland. A larger concentration appears in the Bory Tucholskie (Tuchola Coniferous Forests), Puszcza Białowieska (Białowieża Primaeval Forest), regions of older glaciations in the lowlands, as well as in the Beskid and Tatra Mtns. No data are available from regions of the last glaciation and little is known from the Silesian Lowland i.e. regions of mostly loams and loesses.

M. Ławrynowicz


5.3. **Elaphomyces muricatus** Fr.

**Distribution in Europe** (Fig. 5). Common throughout C Europe, southern Scandinavia, and the British Isles. A lowland-upland species, also of low mountain sites. Many localities extend to the southern slopes of the Alps and to the Lombardy heights, but fewer localities are known for the northern slopes of the Alps and no information exists for the E Carpathian Mtns. Remarkably the species occurs on the Hungarian Lowland and nearby Kiev. Differentiated into distinct ecological forms, also differing with their geographical distribution. The full range of forms is limited to C Europe and southern Scandinavia. Further north, it is found only as f. *muricatus* and f. *reticulatus*, with localities around the Gulf of Bothnia, and the northern-most locality at Kittilä, 100 km from the arctic circle (almost 68 N). In the extreme southern localities, only f. *variegatus* and f. *fagicolus* in the *Fagus* range are represented.

**Hypothetical distribution.** A typical deciduous forest species of the nemoral zone of maritime and subarctic climate. Also, in a more continental climate, approaching the forest-steppe border.

**Habitat.** Ectotrophic mycorrhizal associations formed with several tree species; often found in mixed forests, occasionally in coniferous forests. Ecological forms with morphologically differentiated fruitbodies are associated with specific trees, such as *Fagus sylvatica*, *Carpinus betulus*, *Quercus robur*, etc. Occurring in lowlands and low mountain sites, in compact, fertile
soils, with a pH 4.5-5. Frequently found together with *E. granulatus*, more rarely with *E. asperulus*, and the sclerotia of *Cenococcum geophilum*. The fruitbodies are sometimes attacked by *Cordyceps capitata* and *C. ophioglossoides*. In the vicinity, *Hydnorhyna tulasnei*, *Genea hispidula*, and some species of *Tuber* can often be found.

**Distribution in Poland** (Fig. 6). Frequent in lowlands but disappearing in low mountain sites. Until now considered rare in the mycoflora, and known only from individual localities. According to the author’s investigations, it appeared to be the most common species of the hypogeous *Ascomycetes*, and was found in 140 localities.

Localities in Poland. *Pobrzeże Bałtyckie* — AB 23 WoNP FD Międzyzdroje, *F* *Qrp* *FQ*. 10.62: M. Lisiewska, POZ, — Wiselka, *Qrp Cb FQ*. 06.77: ML, LOD 20155; — AB 33
Fig. 6
Elaphomyces muricatus

20055 & 20614-16, – Res. Koniewa n. Spala, Qrp Ps, 05.74 & 08.82: MŁ & RO, LOD 20130, 20373 & 20617-18; – EE 00 Borki n. Spala, Ch Ps, 11.73 & 06.74: MŁ, LOD 20046 & 20115.
5.4. Elaphomyces papillatus Vitt.

Distribution in Europe (Fig. 7). On the basis of herbarium material, only two localities are definitely confirmed: one in Poland and the other in Hungary (Libickozma Komitat Somogy). Further localities have been quoted by Szemere (1965). In the Paris herbarium (PC), there are two samples without indicated localities, but annotated “Ex Musteri Vittadini celebriissimis Tul. dedit”. Probably they originated from N Italy since the region is
quoted in Vittadini (1831), whilst in Tulasne & Tulasne (1851) one read: "Vidiimus siccum e Lombardia benevole ab ill. Vittadinio nobisc. comm." According to this work the species occurs in oak and chestnut forests nearby Milan and Ticino. Hesse (1894) cites it from Kirchditmol (n. Kassel, prov. Hessen-Nassau). The Polish locality is the most northerly in Europe.

**Hypothetical distribution.** Probably quite widely distributed in the mild climatic zone of C and S Europe, but rare everywhere.

**Habitat.** In deciduous forests, under *Quercus robur, Q. cerris, Castanea sativa, Betula pendula, Carpinus betulus*, and *Fagus sylvatica*, in soil with a light litter cover. Until now, found only in localities containing other hypogeous species, possibly implying the need for optimal hypogeous conditions. Fruitbodies few in number when found.

**Distribution in Poland.** (Fig. 8). Appearing in the richest habitat,
with respect to other hypogeous fungi: together with 11 other species of hypogeous *Ascomycetes*.


5.5. *Elaphomyces atropurpureus* Vitt.

**Distribution in Europe.** The species not yet carted because of the lack of data on its localities in the herbarium materials. In the Paris herbarium (PC) there are some specimens from the Tulasne collection but without data. Probably the specimens came from Italy since in Tulasne & Tulasne (1851), p. 102, one read: “In nemoribus prope Roncaro agri Mediolanensis ed Torre d’Isola Ticinensis”, and then: “Vidimus specim. exsiccata”. Ceruti (1960), citing Quélet, reports this species also from the French Jura.

**Habitat.** Oak and chestnut forests; also pine forests on the lime subsoil.

**Distribution in Poland.** Not yet discovered.


**Distribution in Europe** (Fig. 7). Following the accessible herbarium documentation the appearance stated only in environs of Milan (Italy) and in France along the lower Loire river. Hawker (1954) quotes the species from England citing the original collection of Broome (Chudleigh, Devonshire) and her own collection: Westridge & Wotton-under-Edge (Gloucestershire) and Cleeve & Wraxall (Somersetshire); Schwärzel (1958) mentions environs of Basle (Switzerland).

**Hypothetical distribution.** Warmer and wet zone of temperate climate in W Europe and northern Italy.

**Habitat.** Under various species of forest trees: *Castanea sativa*, *Fagus sylvatica*, *Fraxinus excelsior*, and *Quercus*; originally described species collected under *Q. ilex*. Fruitbodies formed in the humus layer.

**Distribution in Poland.** Not yet discovered.

5.7. *Elaphomyces maculatus* Vitt.

**Distribution in Europe** (Fig. 9). Appearing not too often in C Europe, not crossing Alps in the south. Very rare in Scandinavia; the northernmost locality in environs of Uppsala (Sweden). A larger density of localities is known in the Balaton region (Hungary) and in environs of Paris.
The locality in Poland is one of the three easternmost localities. A typical lowland species, no locality exceeds 500 m alt.

**Hypothetical distribution.** The lowland part of C, W & SE Europe and S Scandinavia, in the deciduous forest zone.

**Habitat.** Under *Quercus*, *Fagus sylvatica*, *Carpinus betulus*, *Alnus glutinosa* and *Corylus avellana*, usually quite deep under the soil surface, in humus of the mull-type.


Distribution in Europe (Fig. 11). Often in N Europe, rare and scattered in C & W Europe. Appearing in lowlands and low mountain sites. In the north it considerably exceeds the arctic circle; collected nearby Narvik (Norway) and Gällivare (Sweden). When in continental climate, the range is more restricted to the south. The southernmost localities occur in northern Italy and S slopes of the Alps.

Hypothetical distribution. Entire Europe excluding the S and SE parts, mainly in the boreal zone of deciduous forests.

Habitat. Under *Fagus sylvatica*, *Picea abies*, *Abies alba*, and *Pinus sylvestris*, in acidic, penetrable soils, often in mixed woods including *Quercus*, *Betula*, and *Castanea sativa*. Fruitbodies formed not deep under mossy and lichen-grown soil surfaces. The habitats of the specimens collected by the
The author in Poland and at Gällivare in the far north were quite similar: the undergrowth included the species of Ericaceae: Calluna vulgaris, Vaccinium myrtillus and V. vitis-idaea; in Sweden also Erica sp. and Linea borealis.


5.9. Elaphomyces anthracinus Vitt.

Distribution in Europe (Fig. 12). Not too often in C & W Europe, Scandinavia and S from the Alps and Carpathians. Occurring in lowlands
and low tectonic forelands. A considerable density of localities in southern Sweden; in the north not exceeding the arctic circle: the extreme stand at Konnovesi (Finland).

Hypothetical distribution. Entire Europe except for the Mediterranean & cold zones and high mountains.

Habitat. Mycorrhiza formed with several deciduous tree species: Quercus, Castanea sativa, Corylus avellana, Fagus sylvatica, and coniferous tree species: Abies and Pinus. Fruitbodies formed in the humus layer. In Poland gathered under Carpinus betulus in a site poor in herbaceous plants.

Distribution in Poland (Fig. 8). Nizina Południowowielkopolska DE 34 fr. Wola Wydrzyna n. Szczerców. Cb TC, 08.80: RO, LOD 21116.
5.10. *Elaphomyces septatus* Vitt.

**Distribution in Europe.** Not recorded in available herbarium material. Originally described from Italy in *Vittadini* (1831), p. 68: "In quercetis mediolanensisibus secus flumen Lambro". Also reported from Hungary (*Szeremere* 1965) and Denmark (*Lange* 1956). *Hesse* (1894) states its absence in Germany.

**Habitat.** Gathered under oaks, beeches, and hornbeams.

5.11. *Elaphomyces virgatosporus* Holl.

**Distribution in Europe** (Fig. 7). On the basis of herbarium material, the occurrence ascertained at Szekszard (Komitat Tolna, Hungary), from where the species had been described by *Holló's* (1908). It was there collected also in environs of Basle (Switzerland) by *Knapp* in 1921 (M).

**Hypothetical distribution.** Europe, temperate climate zone of deciduous forests.

**Habitat.** Fruitbodies gathered under *Fagus sylvatica* and *Carpinus betulus*.

**Distribution in Poland.** Not yet discovered.


**Distribution in Europe** (Fig. 7). Only one locality nearby Turin (northern Italy) is recorded in available herbarium material. In the original description of the species by *Vittadini* (1831), p. 71, one read: "In sylva quercina mediolanensi secus flumen Lambro".

**Hypothetical distribution.** Southern Europe.

**Habitat.** Oak and chestnut forests.

**Distribution in Poland.** Not discovered.


**Distribution in Europe** (Fig. 13). Widely distributed. The material from Denmark, FRG, France, Hungary, and Italy has been analysed. Also recorded by *Hawker* (1954) from England. The most northerly finding was in the vicinity of Stockholm by *Kers* (1979), the most southerly ones nearby Milan and in the Adige valley in the Alps. Numerous localities are in the southern part of Hungary.

**Hypothetical distribution.** Not too often, but probably in a wider range than indicated by the currently known localities. Associated with the deciduous forest zone. Throughout Europe, within the temperate climate
range, especially in its warmer zone, as well as within the zones of maritime and submaritime climate.

Habitat. Under Quercus, Fagus, Fraxinus, and Corylus, often in the lime subsoil. Fruitbodies formed ca 10 cm under the soil surface, between branched tree rootlets.

Distribution in Poland. Not yet discovered, but the occurrence quite possible.


Distribution in Europe (Fig. 14). Rare. The examined herbarium material provide some localities in northern Italy and in environs of Paris as
well as single stands in the Iberian Peninsula and south from the Carpathian Mtns.

Hypothetical distribution. Wooded hills of S and W Europe in the warmer zone of temperate and submediterranean climate.

Habitat. Under different species of deciduous trees.

Distribution in Poland. Not yet discovered.

5.15. *Elaphomyces cyanosporus* Tul.

Distribution in Europe (Fig. 15). Small, scattered localities: in the vicinity of Paris, along the lower Loire river, in northern Italy, in environs of Vienna, and in Central Poland.
Hypothetical distribution. Lowlands of C and W Europe; temperate, maritime and submaritime climate zones of deciduous forests.

Habitat. Under Quercus, Castanea, and Carpinus betulus in recent fertile humus, in strongly shaded sites with little plant cover and small moss turfs.

Distribution in Poland (Fig. 8). Nizina Południowowielkopolska – DE 34 f.r. Wola Wydrzyna n. Szczerców, Cb TC, 08.80: RO, LOD 21117.

5.16. Elaphomyces foetidus Vitt.

The herbarium material very scant, without indicating localities. Ceruti (1960) reports the species from oak forests in Italy.
5.17. *Elaphomyces persoonii* Vitt.

Distribution in Europe (Fig. 16). Rare; few localities known south from the Alps, in Appenines, and nearby Paris. In Tulasne & Tulasne (1851) one read that the species had been reported by Fries from Scania, but this is least probable and not confirmed.

![Diagram of Europe showing distribution of *Elaphomyces persoonii* and *E. mutabilis*](image)

Hypothetical distribution. S and W Europe in the warm zone of temperate and submediterranean climate, in lowlands and low mountain sites.

Habitat. Oak forests, in soils rich in humus.

Distribution in Poland. Not occurring.
5.18. Elaphomyces mutabilis Vitt.

Distribution in Europe (Fig. 16). On the basis of herbarium material, some localities ascertained in France, Hungary, and northern Italy. Appearing rarely. The data from Germany (Hesse 1894) require to be confirmed by herbarium material.

Hypothetical distribution. Southern, stenothermal species; probably distributed as E. echinatus.

Habitat. Under oaks, chestnuts, birches, and pines.

Distribution in Poland. Not yet discovered.

5.19. Elaphomyces citrinus Vitt.

Distribution in Europe (Fig. 17). On the basis of herbarium material, some localities ascertained in northern Italy and southern Switzerland.
Hypothetical distribution. Southern and, probably, Western Europe in the submediterranean climate zone and the warmer zone of temperate climate.

Habitat. Oak forests.
Distribution in Poland. Not yet discovered.

5.20. *Elaphomyces striatosporus* Kers

Distribution in Europe. Known from only one locality in Norway: Aker n. Gaustad in the vicinity of Oslo, and one locality in Sweden; originally described by Kers (1980).

Habitat. Under *Corylus avellana*.
Distribution in Poland. Not yet discovered.

6. CHOROLOGY OF *CENOCCCUM GEOPHILUM* FR. (*DEUTEROMYCETES*)

Distribution in Europe. Herbarium material in the form of sclerotia is scant and comes from a few localities. This does not mean that the species is rare or of limited range. According to the author's investigations their sclerotia can often be found within a quite wide changeability range of habitat conditions (Lawrynowicz 1983).

Hypothetical distribution. Probably entire Europe; the range is as large as that of *Elaphomyces muricatus*.

Habitat. Woods, peatbogs, moors: in the fresh humus layer; sometimes also cultivated areas.

Distribution in Poland (Fig. 18). Common throughout the whole country in lowlands, uplands and mountains. Most often in recent coniferous forests.

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