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## ECOLOGICAL FEATURES OF NEW SPECIES OF XYLOTROPHIC PYRENOMYCETES (ASCOMYCOTA) FOR SKOLIVSKI BESKYDY

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The fieldwork was carried out from the end of September to early December 2015, during the main fruiting period. At this time, on the territory of Skolivski Beskydy, we found 26 new species of xylotrophic pyrenomyces. These species represent 20 genera, 14 families, 8 orders, 3 subclasses (Hypocreomycetidae, Sordariomycetidae and Xylariomycetidae), the class Sordariomycetes, the subphylum Pezizomycotina in the Ascomycota phylum. Sordariomycetidae is represented by the largest number of species (17). Six species of xylotrophic pyrenomyces belong to Xylariomycetidae subclass. The smallest number of species (3) of xylotrophic pyrenomyces in the forest ecosystems of Skolivski Beskydy were established in Hypocreomycetidae subclass. Only three species belong to Incertae sedis Sordariomycetes. All new xylotrophic pyrenomyces were found on thirteen species represented by eleven genera of tree plants. The highest number of species (13) of perithecial fungi were found on *Fagus sylvatica* L. Most of the established xylotrophic fungi (19 species) were found on branches and twigs, while only 7 – on stems. The largest number of fungi (17 species) were found on the earliest decay stages of dead wood. Most of the identified xylotrophic pyrenomyces are corticolous destructors of dead wood, and lignicolous saprotrophs constitute much smaller part. For each of the identified species, its wood substrate, accommodation in the ecological niche and specialization of the species to decay stages of dead wood by the Renvall scale are presented.

**Keywords:** xylotrophic pyrenomyces, ecological niches, forest ecosystems, dead wood, Eastern Carpathians.

### INTRODUCTION

Fungi play an important role in forest ecosystems. They are principal decomposers of dead organic matter, such as dead wood and litter. For saprotrophic fungi, dead wood is one of the most important substrates in forests [15]. An important and still insufficiently investigated group of saprotrophic fungi are xylotrophic or wood-inhabiting fungi. These are the fungi that decompose dead wood [28]. Xylotrophic pyrenomyces are one of the most important wood decomposing fungi [3].

One of insufficiently investigated groups of xylotrophic fungi are wood-inhabiting pyrenomycetes. Pyrenomycetes are fungi that occur primarily as perithecial ascomata (flask-shaped fruiting bodies) on a wide range of substrates [12; 29]. Pyrenomycetes occur in all ecosystems and geographical areas throughout the world primarily as saprobes where they play an integral role in the nutrient cycle and decomposition of the organic matter [25].

The fungal diversity of Ukraine is still insufficiently and unevenly investigated. The Skolivski Beskydy demonstrate an exclusive situation. The first study of fungal diversity on the territory of the Skolivski Beskydy was conducted by J. Krupa [13; 14]. Until recently there were no research data on the fungal diversity of this important area [6]. This work is a continuation of a series of publications devoted to the biological diversity and ecological features of sac fungi, including xylotrophic pyrenomycetes in the forest ecosystems of the Skolivski Beskydy. To date, only information on 115 species of xylotrophic pyrenomycetes (Ascomycota) has been reported [5].

With this work we make a further contribution to the fungal diversity investigation in Skolivski Beskydy region. The study continues the research of fungal diversity in the forest ecosystems of Skolivski Beskydy.

## DESCRIPTION OF THE STUDY AREA

Skolivski Beskydy are located in the Subcarpathian upland region of the Ukrainian Carpathian Mountains within the boundaries of Skole, Drohobych, and Turka districts of the Lviv region. They are located in the basins of the Stryi and the Opir rivers [16].

Their absolute heights range from 600 to 1,200 meters. The climate of Skolivski Beskydy is mild, moderately warm and humid. Winter is characterised by frequent thaws and the temperature ranging from 0 °C to +5 °C. The average temperature in January is about -5 °C, in July – +17 °C. The annual precipitation is 800–1,100 mm. The average thickness of snow cover is 39 cm.

On the territory of Skolivski Beskydy one can still find the remains of pure beech forests and spruce fir forest stands, the totality of which occupies the highest position in the area's relief. On some ridges there are rare beech, sycamore and alder forests. The most common on the territory are fir, spruce, beech-fir, and spruce-fir-beech forests with occasional sycamore and grey alder forests [22].

## MATERIALS AND METHODS

The study was conducted in forest ecosystems during the autumn period of 2015 by following the field method. Specimens of xylotrophic pyrenomycetes were collected by the author. They are deposited in the herbarium of the State Museum of Natural History of the NAS of Ukraine (LWS). Attention was paid to xylotrophic pyrenomycetes on wood and bark of decaying tree species. The following indexes were registered: wood substrate, stages of degradation of dead wood and the ecological niche [2].

The found fruit bodies were identified on the site of sampling or in laboratory conditions. Microscopic features were examined in 5% solution of KOH [12]. The micro-morphological investigation of specimens was performed by using MicroMed XS-2610 (LOMO, Russian).

For identification of the specimens a number of monographs and papers on systematics and biodiversity of fungi were used [4; 7; 8; 10; 17; 18; 20; 21; 23; 26; 27].

The nomenclature of the species follows the Index Fungorum database [11]. Their systematic characterization is in accordance with Kirk et al. [12]. The names of the substrata-forming plant species are as in Mosyakin and Fedoronchuk [19], so the authors of these plant names are skipped in the text below. The possibility of the species occurrence on Ukraine's territory was checked by using the "Fungi of Ukraine" database [1] and other recently published papers and monographs devoted to the biodiversity of Ukrainian fungi [9].

Decay stages were defined following a modified Renvall classification [24].

## RESULTS AND DISCUSSION

The study has identified 26 new species of xylotrophic pyrenomycetes for Skolivski Beskydy. The identified fungi belong to the Ascomycota phylum, the Pezizomycotina subphylum, the Sordariomycetes class. Sordariomycetes is represented by 3 subclasses (Hypocreomycetidae, Sordariomycetidae and Xylariomycetidae).

Sordariomycetidae is represented by the largest number of species (17). These xylotrophic pyrenomycetes belong to 4 orders: Boliniales, Chaetosphaerales, Diaporthales and Sordariales. Diaporthales is represented by the largest number of species (8) and Sordariales – by the lowest (4 species). The orders of Boliniales and Chaetosphaerales are represented in one species (*Camarops tubulina* (Alb. & Schwein.) Shear and *Chaetosphaeria* sp. in the anamorphic stage *Gonytrichum macrocladum* (Sacc.) S. Hughes, respectively).

Six species of xylotrophic pyrenomycetes belong to the Xylariomycetidae subclass. These species represent 3 families: Xylariaceae (3 species), Diatrypaceae (2 species) and Amphisphaeriaceae (*Iodosphaeria* sp. in the anamorphic stage *Ceratosporium gracile* Matsush). The smallest number of species (3) of xylotrophic pyrenomycetes in the forest ecosystems of Skolivski Beskydy were established in the Hypocreomycetidae subclass. This class is represented by the Coronophorales and Hypocreales orders. Coronophorales comprises 2 families (Chaetosphaerellaceae is represented by *Chaetosphaerella fusca* (Fuckel) E. Müll. & C. Booth in the anamorphic stage *Oedemium didymum* (J.C. Schmidt) S. Hughes; Nitschkiaceae – by *Nitschkia confertula* (Schwein.) Nannf.), Hypocreales is represented only by one – Nectriaceae (*Nectria nigrescens* Cooke + the anamorphic stage).

Only three species belong to Incertae sedis Sordariomycetes (*Cryptadelphia polyseptata* Réblová & Seifert in the anamorphic stage *Brachysporium polyseptatum* (Preuss.) S. Hughes, *C. sp.* in the anamorphic stage *B. obovatum* (Berk.) Sacc. and *Fluviostroma wrightii* Samuels & E. Müll.) The identified species of xylotrophic pyrenomycetes are listed in the systematic order and among the taxa of the same range – in the alphabetical order.

**Ascomycota** Caval.-Sm.

**Pezizomycotina** O.E. Erikss. & Winka

**Sordariomycetes** O.E. Erikss. & Winka

**Hypocreomycetidae** O.E. Erikss. & Winka

**Coronophorales** Nannf.

**Nitschkiaceae** Nannf.

1. *Nitschkia confertula* (Schwein.) Nannf.  
**Chaetosphaerellaceae** Huhndorf, A.N. Mill. & F.A. Fernández
2. *Chaetosphaerella fusca* (Fuckel) E. Müll. & C. Booth in the anamorphic stage  
*Oedemium didymum* (J.C. Schmidt) S. Hughes  
**Hypocreales** Lindau  
**Nectriaceae** Tul. & C. Tul.
3. *Nectria nigrescens* Cooke + the anamorphic stage  
**Sordariomycetidae** O.E. Erikss. & Winka  
**Boliniales** P.F. Cannon  
**Boliniaceae** Rick
4. *Camarops tubulina* (Alb. & Schwein.) Shear  
**Chaetosphaeriales** Huhndorf, A.N. Mill. & F.A. Fernández  
**Chaetosphaeriaceae** Réblová, M.E. Barr & Samuels
5. *Chaetosphaeria* sp. in the anamorphic stage *Gonytrichum macrocladum* (Sacc.)  
S. Hughes  
**Diaporthales** Nannf.  
**Diaporthaceae** Höhn. ex Wehm.
6. *Diaporthe eres* Nitschke + the anamorphic stage *Phomopsis oblonga* (Desm.)  
Traverso
7. *Diaporthe pustulata* Sacc.
8. *Diaporthe* sp. in the anamorphic stage *Phomopsis juniperivora* G.G. Hahn
9. *Diaporthe syngenesia* (Fr.) Fuckel  
**Melanconidaceae** G. Winter
10. *Melogramma spiniferum* (Wallr.) De Not.
11. *Melanconis alni* Tul. & C. Tul.
12. *Prosthecium pyriforme* Jaklitsch & Voglmayr in the anamorphic stage *Stegon-  
sporium pyriforme* (Hoffm.) Corda
- Valsaceae** Tul. & C. Tul.
13. *Valsa abietis* Fr.  
**Sordariales** Chadeff. ex D. Hawksw. & O.E. Erikss.  
**Helminthosphaeriaceae** Samuels, Cand. & Magni
14. *Endophragmiella ellisii* S. Hughes  
**Lasiosphaeriaceae** Nannf.
15. *Lasiosphaeria phyllophila* Mouton
16. *Lasiosphaeria punctata* Munk (= *Hilberina punctata* (Munk) A.N. Mill. & Huhn-  
dorf) + the anamorphic stage *Endophragmiella biseptata* (Peck) S. Hughes
- Incertae sedis Sordariales**
17. *Brachysporiella setosa* (Berk. & M.A. Curtis) M.B. Ellis  
**Xylariomycetidae** O.E. Erikss. & Winka  
**Xylariales** Nannf.  
**Amphisphaeriaceae** G. Winter
18. *Iodosphaeria* sp. in the anamorphic stage *Ceratospodium gracile* Matsush
- Diatrypaceae** Nitschke
19. *Eutypa sparsa* Romell
20. *Libertella aucupariae* Oudem.

**Xylariaceae** Tul. & C. Tul.21. *Daldinia childiae* J.D. Rogers & Y.M. Ju22. *Daldinia fissa* Lloyd23. *Nemania effusa* (Nitschke) Pouzar**Incertae sedis Sordariomycetes****Trichosphaeriales** M.E. Barr**Trichosphaeriaceae** G. Winter24. *Cryptodelphia polyseptata* Réblová & Seifert in the anamorphic stage *Brachysporium polyseptatum* (Preuss.) S. Hughes25. *Cryptodelphia* sp. in the anamorphic stage *Brachysporium obovatum* (Berk.) Sacc.26. *Fluviostroma wrightii* Samuels & E. Müll.

Three substrate indices were considered: ecological niches, wood decay stages (degree of decomposition) and host tree species.

All new species of xylotrophic pyrenomycetes were found on eleven host genera represented by thirteen species: *Abies alba* Mill., *Acer platanoides* L., *Acer pseudoplatanus* L., *Alnus glutinosa* (L.) Gaerth, *Alnus incana* (L.) Moench., *Corylus avellana* L., *Fagus sylvatica* L., *Frangula alnus* Mill., *Fraxinus excelsior* L., *Juniperus communis* L., *Picea abies* (L.) Karsten, *Populus nigra* L., *Sorbus aucuparia* L.

The highest number of species of xylotrophic pyrenomycetes were found on *Fagus sylvatica* (13), and the lowest (3 species on each) on dead wood of *Alnus incana*, *Acer pseudoplatanus*, *Populus nigra*. Two species were identified on wood of *Abies alba* and *Juniperus communis*. Each of the remaining seven substrates of wood is represented by one species.

According to the ecological niche, the following classification of woody debris was used: 1) branches and twigs of the diameter 3–10 mm; 2) branches of the diameter 10–15 mm; 3) branches of the diameter from 15 to 25 mm; 4) branches of the diameter  $\geq 25$  mm; 5) the upper part of the stem; 6) the middle part of the stem; 7) the lower part of the stem (including stumps).

Decay stages were defined following modified Renvall classification (1995): (I) hard wood, trunks or branches as solid pieces, where a knife penetrates only a few mm into the wood; (II) fairly hard wood, bark usually present but not always firmly attached, where a knife penetrates 1–2 cm into the wood; (III) fairly soft wood, small areas of sapwood already decomposed and without bark where a knife penetrates easily; (IV) soft wood, extensively decayed and usually large sections of the wood completely decomposed, where a knife penetrates through the wood easily; (V) very soft wood, almost completely decomposed which disintegrates easily between fingers. The decay stages were obtained for each fungal species, found in the area of fruitbodies growth.

More information on the ecological features of the new species of xylotrophic pyrenomycetes in the forest ecosystems of Skolivski Beskydy are shown in the Table. The table shows a number of the ecological niches for each xylotrophic pyrenomycetes. As shown in the table, the largest part of the species (8) occurred on branches of the diameter  $\geq 25$  mm, while on branches and twigs of the diameter 3–10 mm were found 6, on branches of the diameter from 15 to 25 mm and on the middle part of the stem – 4 species. A smaller number of species (3) was found on branches of the 10–15 mm diameter and on the upper part of the stem, while on the lower part of the stem – 1 species.

**Ecological features of the xylotrophic pyrenomycetes  
in forest ecosystems of Skolivski Beskydy**

**Екологічні особливості ксилотрофних піреноміцетів  
у лісових екосистемах Сколівських Бескидів**

No	Species	Host	Ecological niche	Decay stage
1	<i>Nitschkia confertula</i>	<i>Fraxinus excelsior</i>	6	III
2	<i>Chaetosphaerella fusca</i> in the anamorphic stage <i>Oedemium didymum</i>	<i>Alnus incana</i>	4	III
3	<i>Nectria nigrescens</i>	<i>Acer platanoides</i>	1, 2, 3	I
4	<i>Camarops tubulina</i>	<i>Abies alba</i> , <i>Picea abies</i>	6	II
5	<i>Chaetosphaeria</i> sp. in the anamorphic stage <i>Gonytrichum macrocladum</i>	<i>Fagus sylvatica</i>	4	III
6	<i>Diaporthe eres</i> + the anamorphic stage <i>Phomopsis oblonga</i>	<i>Fagus sylvatica</i>	2	I
7	<i>Diaporthe pustulata</i>	<i>Fagus sylvatica</i>	2	II
8	<i>Diaporthe</i> sp. in the anamorphic stage <i>Phomopsis juniperivora</i>	<i>Juniperus communis</i>	1	I
9	<i>Diaporthe syngenesia</i>	<i>Frangula alnus</i>	1	I
10	<i>Melogramma spiniferum</i>	<i>Fagus sylvatica</i>	7	I
11	<i>Melanconis alni</i>	<i>Alnus glutinosa</i>	4	II
12	<i>Prosthecium pyriforme</i> in the anamorphic stage <i>Stegonsporium pyriforme</i>	<i>Acer pseudoplatanus</i>	3	I
13	<i>Valsa abietis</i>	<i>Juniperus communis</i>	1	I
14	<i>Endophragmiella ellisii</i>	<i>Acer pseudoplatanus</i>	4	III
15	<i>Lasiosphaeria phyllophila</i>	<i>Populus nigra</i>	4	IV
16	<i>Lasiosphaeria punctata</i> + the anamorphic stage <i>Endophragmiella biseptata</i>	<i>Fagus sylvatica</i> , <i>Abies alba</i>	4	IV
17	<i>Brachysporiella setosa</i>	<i>Fagus sylvatica</i>	4	IV
18	<i>Iodosphaeria</i> sp. in the anamorphic stage <i>Ceratoporus gracile</i>	<i>Alnus incana</i>	5	II
19	<i>Eutypa sparsa</i>	<i>Populus nigra</i>	3	III
20	<i>Libertella aucupariae</i>	<i>Sorbus aucuparia</i>	1	I
21	<i>Daldinia childiae</i>	<i>Fagus sylvatica</i>	3	II
22	<i>Daldinia fissa</i>	<i>Corylus avellana</i>	1	I
23	<i>Nemania effusa</i>	<i>Populus nigra</i>	4	II



The end of the Table

24	<i>Cryptadelphia polyseptata</i> in the anamorphic stage <i>Brachysporium polyseptatum</i>	<i>Fagus sylvatica</i>	6	II
25	<i>Cryptadelphia</i> sp. in the anamorphic stage <i>Brachysporium obovatum</i>	<i>Acer pseudoplatanus</i> , <i>Alnus incana</i>	6, 5	III
26	<i>Fluviostroma wrightii</i>	<i>Fagus sylvatica</i>	5	II

Most of the established xylotrophic fungi were found on branches and twigs (19 species), while on stems – 7. The largest number of fungi (17 species) was found at the earliest decay stages (I and II), whereas in advanced decayed wood, the number of found species was lower, 6 xylotrophic pyrenomycetes at the III decay stage, and 3 species at the IV. At the V decay stage, there were no species of xylotrophic pyrenomycetes found. Most of the identified xylotrophic pyrenomycetes are corticolous destructors of dead wood, a much smaller part constitute the lignicolous saprotrophs.

## CONCLUSION

In this study, 26 new species of xylotrophic pyrenomycetes for the territory of Skolivski Beskydy were identified. These species represent 20 genera, 14 families, 8 orders, 3 subclasses (Hypocreomycetidae, Sordariomycetidae and Xylariomycetidae), the Sordariomycetes class, the Pezizomycotina subphylum in the Ascomycota phylum. Sordariomycetidae is represented by the largest number of species (17). The samples were found on thirteen species of tree substrates. The highest number of species (13) of the perithecial fungi were found on *Fagus sylvatica* L. Most of the established xylotrophic fungi were found on branches and twigs. The largest part of fungi was found at the earliest decay stages of dead wood by the Renvall scale.

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## ЕКОЛОГІЧНІ ОСОБЛИВОСТІ НОВИХ ДЛЯ СКОЛІВСЬКИХ БЕСКИДІВ ВИДІВ КСИЛОТРОФНИХ ПІРЕНОМІЦЕТІВ (ASCOMYCOTA)

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Польові збори були проведені з кінця вересня до початку грудня 2015 р., в основний період формування плодових тіл грибів. У цей час на території Сколівських Бескидів нами виявлені 26 нових видів ксилотрофних піреноміцетів, що представляють 20 родів, 14 родин, 8 порядків, 3 підкласи (Hypocreomycetidae, Sordariomycetidae і Xylariomycetidae), клас Sordariomycetes, підродина Pezizomycotina у відділі Ascomycota. Підклас Sordariomycetidae представлений найчисленнішою кількістю видів (17). Шість видів ксилотрофних піреноміцетів належать до підкласу Xylariomycetidae. Найменшою кількістю видів (3) ксилотрофних піреноміцетів у лісових екосистемах Сколівських Бескидів представлений підклас Hypocreomycetidae. Лише три види належать до Incertae sedis Sordariomycetes. Усі нові ксилотрофні піреноміцети були знайдені на субстраті 13 видів з 11 родів деревних рослин. Найбільшу кількість видів (13) перитеціальних грибів зареєстровано на деревині *Fagus sylvatica* L. Більшість визначених ксилотрофних грибів (19 видів) були знайдені на відмерлих гілках і гілочках, тоді як на стовбурах дерев лише 7. Найбільшу кількість грибів (17 видів) знайдено на мертвій деревині ранніх стадій деструкції. Із виявлених представників ксилотрофних піреноміцетів більшість є кортикофільними деструкторами відмерлої деревини, набагато меншу частину становлять лігнофільні сапротрофи. До кожного визначеного виду наведено його деревний субстрат, розміщення в екологічній ніші, а також спеціалізацію виду до стадії деструкції мертвої деревини за шкалою Ренвалла.

**Ключові слова:** ксилотрофні піреноміцети, екологічні ніші, лісові екосистеми, мертва деревина, Східні Карпати.

## ЭКОЛОГИЧЕСКИЕ ОСОБЕННОСТИ НОВЫХ ДЛЯ СКОЛЕВСКИХ БЕСКИДОВ ВИДОВ КСИЛОТРОФНЫХ ПИРЕНОМИЦЕТОВ (ASCOMYCOTA)

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Полевые сборы были проведены с конца сентября до начала декабря 2015 г., в основной период формирования плодовых тел грибов. В настоящее время на территории Сколевских Бескид нами обнаружены 26 новых видов ксилотрофных пириномицетов, представляющие 20 родов, 14 семейств, 8 порядков, 3 подкласса

(Hypocreomycetidae, Sordariomycetidae и Xylariomycetidae), класс Sordariomycetes, подраздел Pezizomycotina в отделе Ascomycota. Подкласс Sordariomycetidae представлен наибольшим количеством видов (17). Шесть видов ксилотрофных пиреномицетов относятся к подклассу Xylariomycetidae. Наименьшим количеством видов (3) ксилотрофных пиреномицетов в лесных экосистемах Сколевских Бескид представлен подкласс Hypocreomycetidae. Только три вида принадлежат к Incertae sedis Sordariomycetes. Все новые ксилотрофные пиреномицеты были найдены на субстрате 13 видов из 11 родов древесных растений. Наибольшее количество видов (13) перитециальных грибов зарегистрировано на древесине *Fagus sylvatica* L. Большинство идентифицированных ксилотрофных грибов (19 видов) были найдены на отмерших ветвях и веточках, тогда как на стволах деревьев только 7. Наибольшее количество грибов (17 видов) найдено на мертвой древесине ранних стадий деструкции. Из выявленных представителей ксилотрофных пиреномицетов большинство является кортикофильными деструкторами отмершей древесины, гораздо меньшую часть составляют лигнофильные сапротрофы. Для каждого верифицированного вида приводится его древесный субстрат, размещение в экологической нише, а также специализация вида к стадии деструкции мертвой древесины по шкале Ренвалла.

**Ключевые слова:** ксилотрофные пиреномицеты, экологические ниши, лесные экосистемы, мертвая древесина, Восточные Карпаты.

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