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## NEW RECORDS OF THE INVASIVE FUNGUS *MELAMPSORIDIUM HIRATSUKANUM* (*PUCCINIALES*) IN UKRAINE

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**Abstract.** In Vyzhnytsia National Nature Park (Chernivtsi Region, Ukraine), an invasive rust fungus *Melampsorium hiratsukanum* was recorded on the new for Ukraine host plants, *Alnus glutinosa* and *Alnus* × *pubescens*, the natural hybrid of *A. incana* and *A. glutinosa*. In Europe *M. hiratsukanum* is currently known from Austria, Czech Republic, Denmark, Estonia, Finland, Hungary, Germany, Italy, Latvia, Lithuania, Norway, Poland, Romania, Russia, Slovakia, Sweden, Switzerland, Turkey, UK, and Ukraine. At present, the distribution of *M. hiratsukanum* in Ukraine is confined to the Ukrainian Carpathians; however, it could not be excluded that in future it may spread into the lowland part of the country. A list of all localities in which *M. hiratsukanum* was recorded in Ukraine is presented. The article is illustrated by micrographs obtained by scanning electron microscopy.

**Key words:** rust fungi, *Alnus glutinosa*, *Alnus* × *pubescens*, Carpathians, distribution, morphology

### Introduction

For the first time in Europe, an East Asian rust fungus *Melampsorium hiratsukanum* S. Ito ex Hirats. f. was noted in 1996 on *Alnus incana* (L.) Moench in Estonia (Põldmaa, 1997) and Latvia (Hantula, Scholler, 2013); the following year it was found in Finland (Kurkela et al., 1998, 1999; Hantula et al., 2009; Lilja et al. 2011) and Lithuania (Markovskaja, 2013). Subsequently, as a typical invasive species, it has been rapidly spreading to the west and south. In Europe, besides the already mentioned countries, this fungus was up to now recorded in Austria (Rigler-Hager et al., 2003; Kruse, 2013), Czech Republic (Dietrich, 2005; Müller, 2003), Denmark (Hantula, Scholler, 2013), Germany (Scholler, 1999; Scholler et al., 2010; Kruse, 2013), Hungary (Szabo, 2002), Italy (Moricca, Maresi, 2010), Norway (Gjaerum et al., 2004), Poland (Wołczańska, 1999; Piątek et al., 2001; Mułenko et al., 2006), Romania (Negrean, Anastasiu, 2006), Russia (Hantula, Scholler, 2013; Bulgakov et al., 2014), Slovakia (Kokeš, 2004), Sweden (Gjaerum et al., 2004; Hantula, Scholler, 2013), Switzerland (Meier et al., 2003), Turkey (Sert, Sumbul, 2005), UK (Stringer, 2010; Hantula et al. 2012), and Ukraine (Tykhonenko, 2011; Tykhonenko, Heluta, 2014).

The aims of this publication are to inform about records of *M. hiratsukanum* on the new for Ukraine host plants and collate the information on currently known localities of this fungus in Ukraine.

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### Materials and methods

Specimens collected in the field were labelled and dried for further treatment. Urediniospores mounted in water and/or lactic acid were investigated by light microscopy under Primo Star microscope and AxioVision 4.7 software, used as well for measurements of microstructures. For scanning electron microscopy samples were coated with an ultrathin coating of gold by ion beam sputtering unit JFC-1100. Images were obtained by scanning electron microscope JEOL JSM-6060 LA.

The specimens are deposited in Mycological Herbarium of M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine (KW).

### Results and discussion

According to literature data, *M. hiratsukanum* was observed in Scotland and Ireland as early as the beginning of the 20<sup>th</sup> century (Wilson, Henderson, 1966), but from later publications (Roll-Hansen, Roll-Hansen, 1981; Henderson, Bennell, 1979) it was shown that the parasite of birch, *M. betulinum* (Pers.) Kleb., can also infect alder and that all previously known European records of the rust on *Alnus* Mill. belong to this species. Studies using molecular phylogenetic methods (Hantula et al., 2009) confirmed that *M. hiratsukanum* appeared in Europe in the mid-1990s, while in the UK (Scotland) on *Alnus glutinosa* (L.) Gaertn. occurs endemic rust indistinguishable from *M. betulinum*. It should be noted

that several records of *M. betulinum* on *A. glutinosa* were also reported for Belgium (Vanderweyen, 2010). The rust of alder is also known from New Zealand, but as it was shown by molecular phylogenetic analysis, the pathogen there is *M. betulinum*, not *M. hiratsukanum* (McKenzie et al., 2013).

Most records of *M. hiratsukanum* in Europe are reported on *A. incana*. On *A. glutinosa* this fungus occurs much less frequently; moreover, in many cases it was recorded on seedlings (Piątek et al., 2001), in forest nursery (Szabo, 2002), or in close proximity to infected plants of *A. incana* (Müller, 2003 Markovskaja, 2013). In Germany it was collected on *Duschekia alnobetula* (Ehrh.) Pouzar (syn. *A. viridis* (Chaix) DC.) (Kruse, 2014), in Turkey – on *A. orientalis* Decne. (Sert, Sumbul, 2005). There are two records of *M. hiratsukanum* on *Betula pubescens* Ehrh. in the UK, confirmed by molecular methods (Lane et al., 2013). In Ukraine, *M. hiratsukanum* was first reported from Gorgany Nature Reserve on *A. incana* in the end of August 2010 (Tykhonenko, 2011). In subsequent years on the same host plant more samples were collected in other parts of the Ukrainian Carpathians (see a list at the end of the article). During mycological surveys in Vyzhnytsia National Nature Park (Chernivtsi Region) on 23–24 August 2015, the development of this fungus was noted on *A. glutinosa* and *Alnus* × *pubescens* Tausch (a natural hybrid of *A. incana* and *A. glutinosa*). On both of these species, the rust was observed in the immediate proximity to heavily infected plants of *A. incana*. The morphological features of the fungus on *A. glutinosa* and *Alnus* × *pubescens* are consistent with the diagnosis of *M. hiratsukanum* and distinct from the close species, *M. betulinum*. In particular, the entire surface of its urediniospores is covered with more or less uniform spines, while in *M. betulinum* the spines gradually decrease in size from the base to the upper part of spore so that its top is a free of spines smooth area (Figure, *b*, *d*, *f*). Furthermore, ostiolar cells of uredinium are much longer (up to 40 µm on *A. glutinosa* and up to 46 µm on *Alnus* × *pubescens*) than those of *M. betulinum* (up to 20 µm) (Figure, *a*, *c*, *e*). Urediniospores size in our specimens of *M. hiratsukanum* (18.2–25.1 × 8.8–10.6 µm on *A. glutinosa* and 19.0–26.4 × 9.2–13.1 µm on *Alnus* × *pubescens*) are slightly smaller than those of *M. betulinum* on *Betula pubescens* Ehrh. (20.6–29.0 × 9.0–12.0 µm) in a specimen collected in the same region of the Ukrainian Carpathians. According to our observations ostiolar cells obviously play an important role in the release of urediniospores: in response to

humidity changes, they bend and unbend to close and open the mouth of uredinium.

At present, the distribution of *M. hiratsukanum* in Ukraine is confined to the Ukrainian Carpathians; however, it could not be excluded that in future the fungus may spread into the lowland part of the country. This rust causing premature defoliation, which certainly affects the physiological state of plants, is of significant environmental importance in riparian habitats.

A list of currently known localities of *Melampsoridium hiratsukanum* S. Ito ex Hirats. f. in Ukraine.

On *Alnus incana* (L.) Moench.

#### Chernivtsi Region

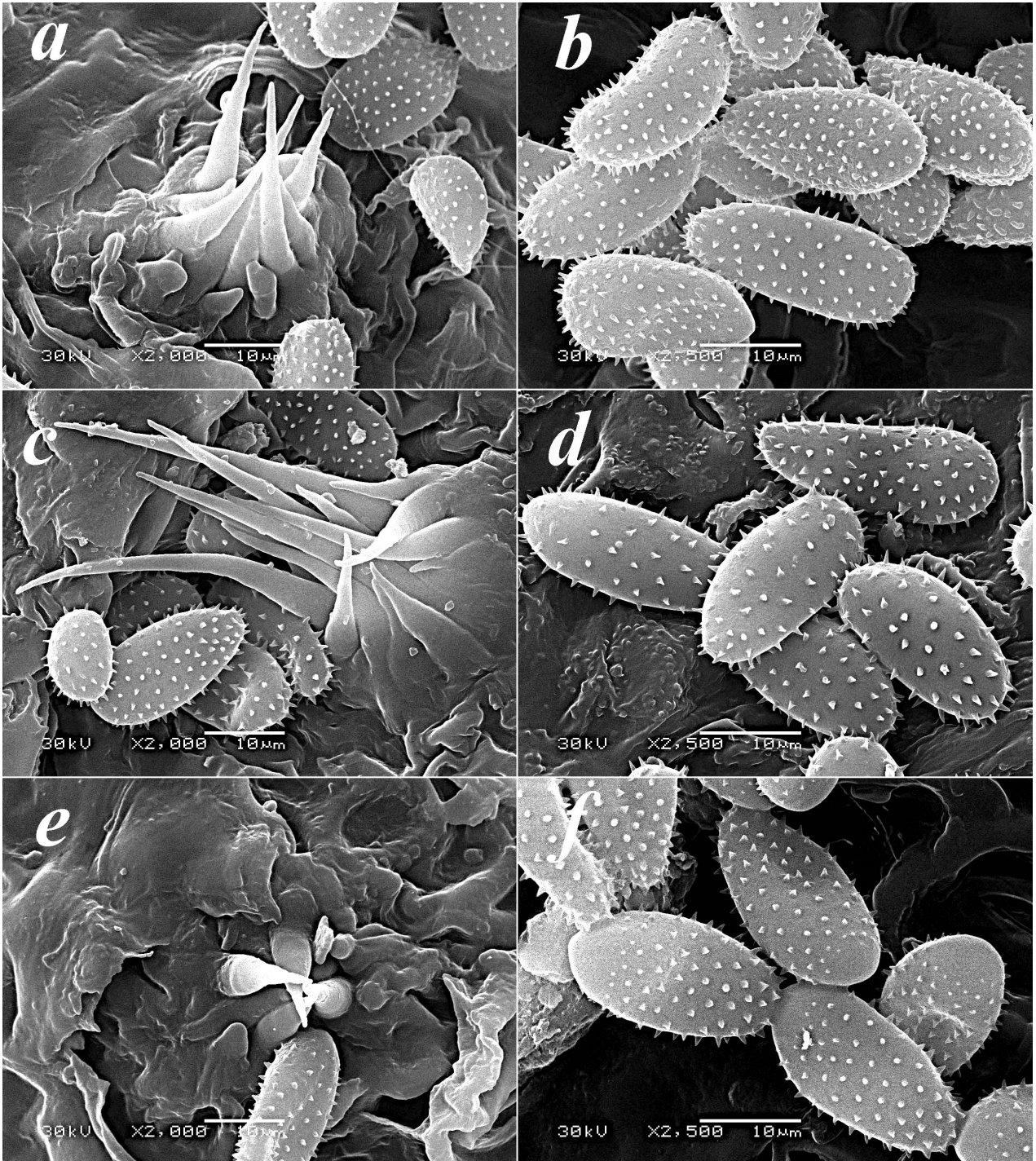
*Putyla District*: Cheremoskyi National Nature Park, Perkalabske environmental parcel, forest on the bank of Sarata river, N 47°48' E 24°57', 27.09.2014, leg. I.O. Dudka, *KW*70526; the same place, 20.08.2015, leg. V.P. Heluta, *KW*70530, *KW*70531; Perkalab, N 47°48' E 24°57', 18,19.08.2015, leg. V.P. Heluta, *KW*70527, *KW*70529; the same place, near buildings, N 47°48' E 24°57', 19.08.2015, leg. V.P. Heluta, *KW*70528.

*Vyzhnytsia District*: Vyzhnytsia National Nature Park, Solonetske environmental parcel, near Chereshenka village, road along brook, N 48°11' E 25°15', 23.08.2015, leg. V.P. Heluta, *KW*70532, *KW*70533; bank of Lekechi river near Lopushna village, N 48°06' E 25°16', 07.09.2013, leg. I.O. Dudka, *KW*70515; bank of Stebnyk river, N 48°08' E 25°15', 06.09.2013, leg. I.O. Dudka, *KW*70514; young mixt forest near foot of the Kichera Mountain, N 48°11' E 25°16', 11.09.2013, leg. I.O. Dudka, *KW*70519; Sukhyi area, road along Malyy Sukhyi brook, N 48°09' E 25°15', 12.09.2013, leg. I.O. Dudka, *KW*70520.

#### Ivano-Frankivsk Region

*Kosiv District*: outskirts of Kosiv, climb on the Kamianysty Ridge, N 48°18' E 25°02', 11.09.2013, leg. V.P. Heluta, *KW*70518; outskirts of Pistyn village, N 48°21' E 25°01', 06.09.2013, leg. V.P. Heluta, *KW*70513; outskirts of Yavoriv village, climb on the Ternoshora mountain, N 48°14' E 28°55', 10.09.2013, leg. V.P. Heluta, *KW*70516, *KW*70517.

*Nadvirna District*: Gorgany Nature Reserve, Chernyivske Department, Novobudova, N 48°24' E 24°22', 09.09.1914, leg. V.P. Heluta, *KW*70521; near office of the Gorganske Department, N 48°29', E 24°16', 26, 27, 28.08.2010, leg. Yu.Ya. Tykhonenko, *KW*70505, *KW*70506, *KW*70509; the same place, 11.09.2014, leg. V.P. Heluta, *KW*70522; right bank of Bystrytsia Nadvirnianska river, near office of the Gorganske Department, 29.08.2010, N 48°29',



*Melampsoridium hiratsukanum* on *Alnus glutinosa*: a – ostiolar cells of uredinium, b – urediniospores. *M. hiratsukanum* on *Alnus × pubescens*: c – ostiolar cells of uredinium, d – urediniospores. *M. betulinum* on *Betula pubescens*: e – ostiolar cells of uredinium, f – urediniospores. Scale bars – 10 μm

E 24°16', leg. Yu.Ya. Tykhonenko, *KW* 70510, *KW* 70511; forest compartment no.14, 26.08.2010, leg. V.P. Heluta, *KW* 70507; forest compartment no. 2, N 48°29', E 24°16', 31.08.2010, leg. Yu.Ya. Tykhonenko, *KW* 70512; in the vicinity of the Reserve, Maksymets village, bank of Bystrytsia Nadvirnianska river, N 48°30', E 24°17', 28.08.2010, leg. V.P. Heluta, *KW* 70508.

*Verkhovyna District*: Verkhovynskiy National Nature Park, Perkalaba environmental parcel, bank of Maskotyn brook, N 47°48' E 24°55', 24.09.2014, leg. I.O. Dudka, *KW* 70525; forest on the left bank of Perkalab river, N 47°47' E 24°56', 21.09.2014, leg. I.O. Dudka, *KW* 70524; bank of Pryluchensky brook, N 47°47' E 24°55', 22.09.2014, leg. I.O. Dudka, *KW* 70523.

*Yaremcha town council*: Carpathian National Nature Park, Vorokhta environmental parcel, *alder and spruce bog forest*, N 48°14' E 24°37', 13.09.2015, leg. I.O. Dudka, *KW* 70534.

On *Alnus glutinosa* (L.) P. Gaertn.

### Chernivtsi Region

*Vyzhnytsia District*: near Chereshenka village, Vyzhnytsia National Nature Park, Solonetske environmental parcel, N 48°11' E 25°15', 23, 24.08.2015, leg. V.P. Heluta, *KW* 70535, *KW* 70536.

On *Alnus* × *pubescens* Tausch

### Chernivtsi Region

*Vyzhnytsia District*: near Chereshenka village, Vyzhnytsia National Nature Park, Solonetske environmental parcel, along brook, N 48°11' E 25°15', 23.08.2015, leg. V.P. Heluta, *KW* 70537.

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Тихоненко Ю.Я., Гелюта В.П., Дудка І.О. **Нові знахідки інвазійного гриба *Melampsorium hiratsukanum* (*Pucciniales*) в Україні.** — Укр. ботан. журн. — 2016. — **73**(4): 385–389.

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Повідомляється про знахідки на території Національного природного парку «Вижницький» (Чернівецька обл., Україна) інвазійного іржастого гриба *Melampsorium hiratsukanum* на нових для України живильних рослинах — *Alnus glutinosa* і *Alnus × pubescens*, природному гібриді *A. incana* і *A. glutinosa*. Нині в Європі *M. hiratsukanum* відомий з Австрії, Великобританії, Данії, Естонії, Італії, Латвії, Литви, Німеччини, Норвегії, Польщі, Росії, Румунії, Словаччини, Туреччини, Угорщини, України, Фінляндії, Чеської республіки, Швейцарії та Швеції. На сьогодні поширення *M. hiratsukanum* в Україні обмежується регіоном Українських Карпат, хоча в майбутньому, з огляду на освоєння цим грибом *A. glutinosa*, не можна виключити його розповсюдження і на рівнинну частину країни. Наведено список усіх локалітетів, у тому числі декілька нових, у яких в Україні був відмічений *M. hiratsukanum*. Робота ілюстрована мікрофотографіями, отриманими за допомогою сканувального електронного мікроскопа.

**Ключові слова:** іржасті гриби, *Alnus glutinosa*, *Alnus × pubescens*, Карпати, поширення, морфологія

Тихоненко Ю.Я., Гелюта В.П., Дудка І.А. **Новые находки в Украине инвазионного гриба *Melampsorium hiratsukanum* (*Pucciniales*).** — Укр. ботан. журн. — 2016. — **73**(4): 385–389.

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Сообщается о нахождении на территории Национального природного парка «Выжницкий» (Черновицкая обл., Украина) инвазионного ржавчинного гриба *Melampsorium hiratsukanum* на новых для Украины питающих растениях — *Alnus glutinosa* и *Alnus × pubescens*, природном гибриде *A. incana* и *A. glutinosa*. На сегодня в Европе *M. hiratsukanum* известен из Австрии, Великобритании, Венгрии, Германии, Дании, Италии, Латвии, Литвы, Норвегии, Польши, России, Румынии, Словакии, Турции, Украины, Финляндии, Чешской республики, Швейцарии, Швеции и Эстонии. В настоящее время распространение *M. hiratsukanum* в Украине ограничивается регионом Украинских Карпат, хотя в будущем, учитывая освоение этим грибом *A. glutinosa*, нельзя исключить возможность его проникновения и на равнинную часть страны. Приведен список всех локалитетов, в том числе несколько новых, в которых в Украине был отмечен *M. hiratsukanum*. Работа иллюстрирована микрофотографиями, полученными с помощью сканирующего электронного микроскопа.

**Ключевые слова:** ржавчинные грибы, *Alnus glutinosa*, *Alnus × pubescens*, Карпаты, распространение, морфология