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ANTS (HYMENOPTERA: FORMICIDAE) AT HOŠTINÁ (NORTH-WEST SLOVAKIA) WITH NOTES ON SELECTED SPECIES

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Abstract: Species-rich ant assemblages are typically found in open and warm places that are managed extensively and offer various microhabitats. Such places are rare in Javorníky Mts, a mountainous area in the north-west of the Slovak Republic, mainly due to the harmful human activities and abandonment of traditional land management. One of the remaining areas with xerothermophilous grass-herb vegetation was selected, and five years of field research were carried out to discover as much of the myrmecofauna as possible. This site, called Hoštiná, has area of about 1.2 ha and is located on a steep slope at an average altitude of 518 m a.s.l. Valuable data on biology of some rarely found species were recorded – *Bothriomyrmex corsicus* Santschi, 1923; *Plagiolepis xene* Stärcke, 1936; and *Temnothorax albipennis* (Curtis, 1854). As the study area is in the northern part of the country, the country's distributional limits of some of the recorded xerothermophilous species were shifted northwards; in the case of *P. xene*, the overall distributional limit was even extended. The ant species *Lasius sabularum* (Bondroit, 1918) was also found, which is only the second known finding in the Slovak Republic. The survey also provides data on the biology of *B. corsicus*, i.e., for the first time a direct observation of a mixed colony with the specific *Tapinoma* Förster, 1850 species was recorded.

Key words: *Plagiolepis xene*, host species, *Bothriomyrmex*, social parasitism, faunistic, ecology, xerotherm, Javorníky

INTRODUCTION

Since the beginning of this millennium, ant fauna in the Slovak Republic has been intensively researched. The most important contributions were made by Pavel Deván (e.g., DEVÁN 2006, DEVÁN 2008), Milada Holecová (e.g., HOLECOVÁ et al. 2015, HOLECOVÁ et al., 2022), Adrián Purkart (e.g., PURKART 2020, PURKART 2023), Martin Suvák (SUVÁK 2021), Michal Wiezik (e.g., WIEZIK 2008a, b), and their students (e.g., KLESNIAKOVÁ et al. 2016, NOVÁKOVÁ et al. 2018). Despite these efforts, there is still a need for regional studies on ants, especially in areas that

have not yet been explored. Surprisingly, there are still areas for which no records are available, e.g., Prešov region. Recent studies that would cover these areas are more important as they catch up with the latest taxonomic status, which has changed very dynamically in recent years (e.g., SEIFERT & GALKOWSKI 2016, WAGNER et al. 2017, SEIFERT 2023).

The Javorníky Mts are one of the least explored areas. It is a mountain range with the highest peaks at around 1,000 m a.s.l. At higher altitudes, there are primarily coniferous growths, mainly spruce monocultures with occasional occurrence of firs. Of the deciduous stands, beech stands are found the most. Territory with the lower altitude is used chiefly for agricultural purposes; only in some places do alder stands remain. A few faunistic mentions come from the Javorníky Mts, which deal with the study of ants. The last research was conducted by Milan Labuda, which spans the territory of the whole Region of Stredné Považie (LABUDA 1970). This region only partially falls within the Javorníky Mts. Therefore, not all collecting sites from his study belong there. The only collecting sites that can be attributed to the Javorníky Mts are located near Strelenka, today the local part of the village Lysá pod Makytou. The occurrence of 11 ant species was reported from here. These species are *Camponotus ligniperda* Latreille, 1802; *Formica cunicularia* Latreille, 1798; *Formica fusca* Linnaeus, 1758; *Formica nigricans* Emery, 1909; *Formica rufibarbis* Fabricius, 1793; *Lasius fuliginosus* Latreille, 1802; *Lasius niger* Linnaeus, 1758; *Leptothorax nylanderi* Förster, 1850; *Myrmica ruginodis* Nylander, 1846; *Myrmica scabrinodis* Nylander, 1846 and *Tetramorium caespitum* Linnaeus, 1758. The list contains typical species of various grasslands – *F. cunicularia*, *F. nigricans*, *F. rufibarbis* and *L. niger*, but also species typically found in forests – *C. ligniperda*, *F. fusca*, *L. fuliginosus*, *L. nylanderi*, and *M. ruginodis*. Due to the numerous taxonomic revisions and separate species descriptions that have been made since the publication of the study, it is not possible to investigate whether the original specimens also obtained additional species that exist today, e.g., specimens of "*Lasius niger* Linnaeus, 1758" could contain both *Lasius niger* (Linnaeus, 1758) and *Lasius platythorax* Seifert, 1991. Unfortunately, the collection is unavailable for species revision, so the information cannot be found. In addition, other collecting sites near the town of Púchov, which come from the same study, cannot be listed under the Javorníky Mts due to the lack of more precise localization data. For the same reason, it is not possible to consider the finding of the single species, *Polyergus rufescens* (Latreille, 1798), originating from the "Považská Bystrica" (ZÁLESKÝ 1939).

This work extends our knowledge of ants from the Javorníky Mts. It brings not only faunistic data of rarely collected ant species but also interesting or new observations on their biology. It focuses on a single study site, the Hoštiná, which is representative of the preserved xerothermic steppe habitats.

MATERIAL AND METHODS

Study site

Hoštiná study site (named after the nearest settlement – the Púchov town district Hoštiná (Fig. 1), calculated centrum 49°10'13",18°19'37") is located on a hillside. A comprehensive geospatial analysis was performed to describe the geomorphological features. The value of the actual area concerning the slope is 1.266 ha, while the area considering only 2D data is only 1.103 ha. The maximum, average, and minimum altitudes are 540.9 m a.s.l., 518.4 m a.s.l. and 492.8 m a.s.l. respectively. Maximum and average slopes are 46.002° and 28.781° respectively. Approximately 85% of the area has a slope between 25° and 35°. More than 90% of the site is oriented from south to south-east.

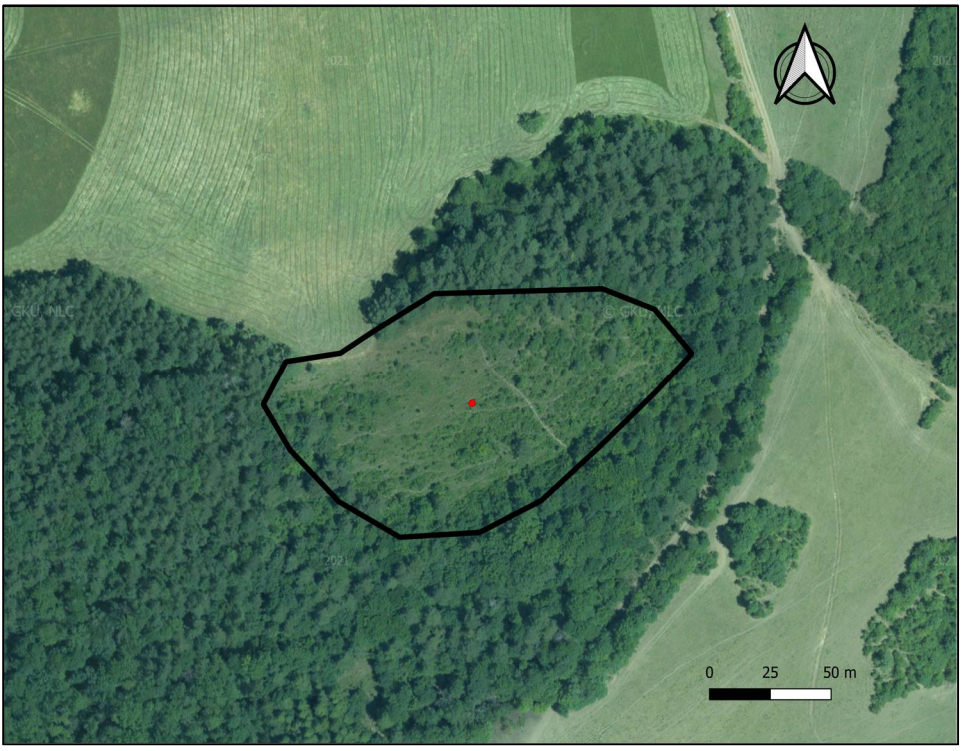

Fig. 1. The defined area of the study site Hoštiná with the marked center. Terrain on July 6, 2021. Picture: Lukáš Jancík, created with QGIS software.

The entire site falls within the map grid sub-square 6875b, which according to the map of the Czech Arachnological Society (https://www.arachnology.cz/pomocnaMapka/) corresponds to the KFME (Kartierung der Flora Mitteleuropas). It has an overall appearance of a forest steppe. Most of the xerothermic areas are located in the central part and covered with sparse and low vegetation (Fig. 2).

Fig. 2. Summer aspect of xerothermic habitat with sparse and low grass-herbal vegetation cover. Photo: Lukáš Jancík, July 2023.

Some places are overgrown with thickets of shrubs – the most important species are *Juniperus communis* and *Rhamnus catharticus*. The study site borders mainly on the forest (*Pinus sylvestris* and mixed forest) and the large thickets of shrubs. The geological substratum consists mainly of Calpionella limestone of Biancone type. In the southern part, the limestone is replaced by flysch (map layer "Geologická mapa SR 1:50 000" in the web GIS https://zbgis.skgeodesy.sk/). The limestone subsoil often protrudes into the surface (Fig. 3) and soils are rich in rock. Climatically, the site is located in an area with a moderately cold mountain climate (KOČICKÝ & IVANIČ 2011a).

The development of habitats and management of the site during the decades before 1970 is not precisely known. However, it can be assumed that at least sporadic grazing by domestic animals could have taken place here. This is concluded since the site was and still is close to the Hoštiná settlement, and it was common to graze the cattle in a larger area of a seat at those times. It can also be supposed that no soil ploughing, and no crop cultivation have been carried out here yet because of its rocky character, poor soils, and significant slope. Based on the relief model map, there are no signs of rock extraction in the past.

Fig. 3. The limestone subsoil protrudes into the surface, surrounded by grass-herbal vegetation and shrubs of *Juniperus communis*. Photo: Lukáš Jancík, July 2023.

Historical orthophotomosaic (https://mapy.tuzvo.sk/HOFM/), which shows the terrain in the year 1950, shows its appearance more steppe-like than another one in the year 2021 (https://zbgis.skgeodesy.sk/). In recent years, when the study was done at the site, areas with bushes obviously enlarged following the succession process. According to the information obtained from local inhabitants, occasional grazing was present directly at the site since establishing an agricultural cooperative (situated approximately 400 meters away from the study site) around 1970. However, this grazing was not directly observed during the visits. Grazing was always observed only on neighbouring plots of land (Fig. 4) separated from the study site by fences, which positions were changing during the visits. Nevertheless, some observations support the grazing. One fact is the presence of numerous trampling paths with exposed soil substrate; another is that the leaves of the bushes were eaten away to a certain extent.

Fig. 4. A view of the Hoštiná study site from down the main road entering the Hoštiná settlement. The site is visible as a forest-free patch on the mountain range stretching in the rear. More or less intensive pastures can be seen down the hill, where grazing sheep occur. Photo: Lukáš Jancík, July 2023.

Description of methods and material processing

The basis for spatial analysis was the map layer of relief model DMR 5.0, which was exported via the Web GIS client (https://zbgis.skgeodesy.sk/). The altitudinal data originate from this map; they refer to Baltic heights after adjustment (1957). The positional coordinates (latitude,longitude) refer to the EPSG:4326 coordinate reference system. Naming, classifying, and boundaries of the geomorphological division follow KOČICKÝ & IVANIČ (2011b). The terms Javorníky Mts and Biele Karpaty Mts should be treated as the Javorníky geomorphological unit and the Biele Karpaty geomorphological unit, respectively. All times refer to solar time.

The field study took place from 2019 to 2023. At the study site, individuals and nests were searched for by routine field inspection, which consisted of browsing vegetation cover, vegetation humus, soil surfaces, tree trunks, stony surfaces, rock crevices, and upper soil layer. To reach some poorly accessible places, such as cavities in the rock, under bark, nest parts in stony ground, or soil under deeply embedded stones, a geological hammer and other equipment were

necessary to deploy. Individuals collected directly in the field were always moved into the transport container using a manual exhaustor, electric vacuum cleaner, tweezer, brush, or simply with hands. Litter sifting and pitfall traps were also used to collect material. The sifted material coming from the forest ecotone was processed to extract the individuals – it was browsed manually under the light, or a Tullgren funnel was used. Pitfall traps (9 pieces) were exposed at the site from July 29, 2023, to September 29, 2023, for which glass containers with an input diameter of 7 cm filled with fixative liquid of 2% formaldehyde were used.

The determinations of specimens primarily followed the keys and descriptions of SEIFERT (2018), CZECHOWSKI et al. (2012), SALATA & BOROWIEC (2013); personal collection of specimens was also used. Nomenclature is based on SEIFERT (2018). Some specimens were integrated into collection of the first author (except for one specimen of *P. xene* gyne – coll. Purkart).

The classification of species (in Tab. 1) into ecological elements is based on ecological preferences shown by the Polish ant population only if available (therefore, classification is taken directly from CZECHOWSKI et al. 2012). Otherwise, the classification is based on the ecological preferences shown by the Slovak ant population and still keeps the specification of classifying into the ecological elements according to CZECHOWSKI et al. (2012) (in bold in Tab. 1).

RESULTS AND DISCUSSION

A total of 48 ant species were detected at the site, and permanent presence (i.e., the presence of colonies) was confirmed for all of them. It represents more than 40% of the total number of 119 free-living ant species recorded so far from the Slovak Republic (KOŽÍŠEK 1984, SEIFERT 1988, WERNER & WIEZIK 2007, DEVÁN 2008, WAGNER et al. 2011, SEIFERT 2012, WIEZIK & WIEZIKOVÁ 2013, BEZDĚČKA & TĚŤÁL 2013, SEIFERT & GALKOWSKI 2016, WAGNER et al. 2017, SUVÁK 2021, PURKART & REPTA 2022). Such diversity is well known for similar xerothermous habitats (e.g., BEZDĚČKOVÁ & BEZDĚČKA 2017). However, there are some factors that prevent the occurrence of the majority of the detected xerothermophilous species recorded here (see list of these species in the text below), especially high altitude and climatic conditions (see study site characteristics).

The ant species composition is remarkably rich and contains many xerothermophilous species, e.g., *B. corsicus*, *C. aethiops*, *C. piceus*, *C. truncata, P. pygmaea,* and *T. corticalis*, but also oligothermous ones e.g., *L. platythorax*, *L. sabularum*, *L. umbratus, M. rubra*, and *M. ruginodis*. The first mentioned species inhabited places with xerothermophilous grass-herbal vegetation (ground-nesting species) or were collected on surfaces of sun-exposed parts of trees (arboricolous species). The oligothermous species were found in shadier places

such as thickets of bushes or inner forest edges. Arboricolous species significantly increased the total species list – *C. fallax*, *C. truncata*, *D. quadripunctatus*, *L. brunneus*, *T. affinis*, and *T. corticalis*. Seven social parasites were detected – *B. corsicus*, *F. sanguinea*, *F. nitidulus*, *L. sabularum*, *L. umbratus*, *P. xene*, and *S. fugax*. This list covers all types of social parasitism known in ants *sensu* BUSCHINGER (2009) – xenobiosis (*F. nitidulus*, and *S. fugax* – facultative), temporary parasitism (*B. corsicus*, *L. sabularum*, and *L. umbratus*), dulosis (*F. sanguinea* – facultative), and inquilinism (*P. xene*).

Although it is supposed that the climatic change facilitates range expansion and density increase of some native European thermophilous ant species (SEIFERT 2018), the presence of suitable habitats, including xerothermophilous grasslands, is crucial for stenotopic ones (CZECHOWSKI et al. 2012). The list of species contains some such species, which can be divided into two groups based on habitat type. One group consists of stenotopes of light and dry deciduous or mixed forests – *C. truncata*, *T. affinis*, *T. corticalis*, and *T. parvulus*. These species were found exclusively in the peripheral parts of the study site, where light growths of coniferous and mixed forests exist. The second group consists of stenotopes of xerothermous grasslands – *B. corsicus*, *C. piceus*, and *P. xene*. The enumerated stenotopes are species that were classified as stenotopes based on ecological preferences shown by their Slovak population, not by their Polish population (the second option is placed in Tab. 1).

Table 1. List of confirmed ant species. In some cases, the maximum altitude at which a particular species was found is provided. A list of field collection methods used to collect certain species is also given.

Species	**Maximum altitude [m a.s.l.]**	**List of field collection methods**	**Ecological element**
Dolichoderinae			
Bothriomyrmex corsicus Santschi, 1923	540	FI, PT	**S**
Dolichoderus quadripunctatus (Linnaeus, 1771)	-	FI	O
Tapinoma erraticum (Latreille, 1798)	535	FI, PT	S
Formicinae			
Formica cunicularia Latreille, 1798	-	PT	P
Formica fusca Linnaeus, 1758	-	FI	E
Formica pratensis Retzius, 1783	-	FI	P
Formica rufibarbis Fabricius, 1793	-	FI, PT	O
Formica sanguinea Latreille, 1798	-	FI, PT	P
Formica truncorum Fabricius, 1804	-	FI	O
Camponotus aethiops (Latreille, 1798)	535	FI	**O**
Camponotus fallax (Nylander, 1856)	-	FI	O
Camponotus ligniperda (Latreille, 1802)	-	FI	O

Camponotus piceus (Leach, 1825)	535	FI, PT	S
Colobopsis truncata (Spinola, 1808)	-	FI	S
Lasius alienus (Förster, 1850)	-	FI	O
Lasius brunneus (Latreille, 1798)	-	LS	O
Lasius emarginatus (Olivier, 1792)	-	LS	O
Lasius flavus (Fabricius, 1782)	-	FI	E
Lasius fuliginosus (Latreille, 1798)	-	FI	O
Lasius niger (Linnaeus, 1758)	-	PT	P
Lasius paralienus Seifert, 1992	-	FI, PT	O
Lasius platythorax Seifert, 1991	-	LS	P
Lasius sabularum (Bondroit, 1918)	-	FI	O
Lasius umbratus (Nylander, 1846)	-	FI	P
Plagiolepis pygmaea (Latreille, 1798)	540	FI, PT	**O**
Plagiolepis taurica Santschi, 1920	-	FI	**O**
Plagiolepis xene Stärcke, 1936	540	FI	**S**
Polyergus rufescens (Latreille, 1798)	-	FI	O
Myrmicinae			
Formicoxenus nitidulus (Nylander, 1846)	-	FI	O
Myrmecina graminicola (Latreille, 1802)	-	LS, FI, PT	O
Myrmica rubra (Linnaeus, 1758)	-	LS	E
Myrmica ruginodis Nylander, 1846	-	LS	P
Myrmica sabuleti Meinert, 1861	-	LS, FI, PT	O
Myrmica scabrinodis Nylander, 1846	-	FI	P
Myrmica schencki Viereck, 1903	-	FI	O
Myrmica specioides Bondroit, 1918	-	FI	O
Solenopsis fugax (Latreille, 1798)	-	FI, PT	O
Stenamma debile (Förster, 1850)	-	LS	O
Temnothorax affinis (Mayr, 1855)	-	FI	S
Temnothorax albipennis (Curtis, 1854)	-	FI	**O**
Temnothorax corticalis (Schenck, 1852)	-	FI	S
Temnothorax crassispinus (Karavaiev, 1926)	-	LS	O
Temnothorax interruptus (Schenck, 1852)	-	FI, PT	S
Temnothorax parvulus (Schenck, 1852)	-	LS	S
Temnothorax unifasciatus (Latreille, 1798)	-	FI	O
Tetramorium sp(p). (*caespitum* species complex)	-	FI, PT	?
Ponerinae			
Ponera coarctata (Latreille, 1802)	-	LS	O
Ponera testacea Emery, 1895	538	FI	S

Abbreviations used: LS – litter sifting and subsequent extraction; FI – routine field inspection (see description in Material and methods section); PT – pitfall traps. Abbreviations for ecological elements with respect to plasticity: E – eurytopes, P – polytopes, O – oligotopes, S – stenotopes.

Ecological elements with respect to plasticity are determined following CZECHOWSKI et al. (2012). The authors classified the species based on the ecological preferences shown by the Polish ant population. Anyway, the presented ecological preferences of some ant species show differences compared to the Slovak ant populations. Furthermore, the ecological preferences of the Slovak population should be used to classify species into the ecological elements, since the Slovak population has been investigated in this study. However, ecological preferences of Polish myrmecofauna were taken to classify the species (in Tab. 1), since there is a need to keep consistent with other studies of Slovak myrmecofauna, which have always used this approach. Anyway, the different ecological preferences of the Slovak population (JANCÍK, PURKART, unpub. data) are proposed for a few xerothermophilous ground-nesting ant species (confirmed for the study site) – *T. erraticum*, *T. interruptus*, and *P. testacea*. All of them are classified as stenotopes, taking into account the Polish population (CZECHOWSKI et al. 2012). However, considering the Slovak population, they are oligotopes. The local population of each mentioned species was revealed to occupy a higher number of habitats (JANCÍK, PURKART, unpub. data). All of them were typically found in steppe-like habitats with xerothermophilous grasslands, but also in various types of woodland – often in light *Pinus sylvestris* forests situated on an approximately southerly exposed slope, where grass-herbal undergrowth and rocky soil substrate were always present. The explanation of broader habitat occupation could be the lower latitude since all species are thermophilous, as well as the existence of suitable woodland habitats.

Some of the listed species are not classified into ecological elements according to CZECHOWSKI et al. (2012) – *C. aethiops*, *P. pygmaea*, *P. taurica*, *P. xene*, and *T. albipennis*, so the classification was performed based on their Slovak population according to ecological preferences recorded in numerous published and unpublished studies. Both *Plagiolepis* Mayr, 1861 spp. occur in open forests, in sun-exposed places with many bare surfaces and low and sparse grass-herbal vegetation. The primary host species of *P. xene* is *P. pygmaea*, an oligotope, so that *P. xene* could also be an oligotope. However, classifying the species is always based on relevant faunistic data, which in this case classifies the species as stenotope. The data covers only habitats of xerothermophilous grasslands, as expected because the host species *P. pygmaea* right here reaches its highest abundance (JANCÍK, unpub. data).

Few species with cryptic subterranean lifestyles which were not detected, could been present according to the habitat type and spatially close sites (distant approximately 7 km, in southwest direction – closer to the Váh River valley) of their confirmed occurrences, namely *Strumigenys argiola* (Emery, 1869); *Proceratium melinum* (Roger, 1860); and *Lasius myops* Forel, 1894 (PURKART et al. 2021, JANCÍK, unpub. data). However, species that can be found easier because

of their above-ground activities or bigger sizes, which may also have been present, were not detected, e.g., *Formica gagates* Latreille, 1798, and *Aphaenogaster subterranea* (Latreille, 1798). The site did not provide suitable conditions for the rich occurrences of species of the *Lasius alienus* group, what was also revealed by the effort to find their nests. Based on random sampling, their nest abundances were low; on the whole site, only a few nests were found. Thus, the possibility of occurrences of thermophilous *Chthonolasius* species or *Austrolasius* species, which are social parasites of that species group, was low.

Notes on selected species

Bothriomyrmex corsicus Santschi, 1923

The nests were often in proximity to stones of various sizes; in a few cases they also consisted of above-ground mounds made up of small vegetation and soil particles. One colony built its nest structures partly inside dead wood (a fallen shrub branch). Large colonies were very aggressive when disturbed by the observer – numerous hurrying workers came out of their nests and used their mandibles to ward off the enemy (Fig. 5).

Fig. 5. The view inside the nest of the colony of *B. corsicus* after it was disturbed during the removal of the nest covering stone. In nest chambers, the remains of body parts of *L. flavus* workers and one visiting worker of facultative xenobiotic species *S. fugax* can be seen. In the centre, two workers of *B. corsicus* can be seen, one is catching larva, and the second is taking an attentive pose. Photo: Lukáš Jancík, June 2023.

The search was conducted to estimate the number of colonies of this species, but also of species of the genus *Tapinoma* Förster, 1850 – these species are potential hosts for *B*. *corsicus* during the colony establishment (*B*. *corsicus* is a temporary social parasite). A total of 21 colonies of *B*. *corsicus* and three colonies of *Tapinoma erraticum* were detected. Interestingly, the colony ratio of 7:1 was high in favour of *B*. *corsicus*, indicating the eradication of *T*. *erraticum* by social parasitism (SEIFERT 2018). No individual of *Tapinoma subboreale* Seifert, 2012 was found at the site; together with the *T*. *erraticum*, these two species are the only free-living species of the genus *Tapinoma* occurring in the Slovak Republic.

Out of the 21 *B. corsicus* colonies, two were mixed with *T*. *erraticum* (Fig. 6). The workers of both species were together moving the brood into deeper chambers when the colonies were disturbed. These additional observations confirm that the *T*. *erraticum* workers were an integral part of the mixed colonies. All these direct observations confirm *T*. *erraticum* as host species during colony founding and represent new data on the biology of the species (SEIFERT

Fig. 6. A unique view into the nest chambers of a mixed colony of *B. corsicus* and *T. erraticum* after it was disturbed during the removal of the nest covering stone. In the upper right and lower left parts, host workers (*T. erraticum* – black) can be seen, one of which is carrying a bunch of *B. corsicus* larvae into the deeper part of the nest. Close to the central part, an accumulation of *B. corsicus* brood can be seen together with freshly hatched *B. corsicus* workers. Photo: Lukáš Jancík, July 2023.

2018). Moreover, the presence of *T. erraticum* in the colony is limited in time after the new colony-establishing *B. corsicus* gyne has invaded it. However, the number of discovered *B. corsicus* colonies was relatively high, so that the number of mixed colonies was not so improbable from this point of view.

Colony demography was recorded in one of the mixed colonies. Nanitic ant workers, typical for the first generation, were present. Based on the presence of wings, gyne and male pupae were detected to be already present among the brood of the colony. Also, the intermediate step in the colony development was observed, representing more prominent workers. These larger individuals were in the minority among the adult workers but were much more numerous as pupae. The nest was populous, and the number of imago workers was estimated at 1,500. This indicates that the first generation of workers of this parasitic species may have been numerically similar to the size of the original colony of the host species, of which only a few tens individuals remained at the time of observation. This observation was made in July 2023. The simultaneous occurrence of the remaining host workers, the nanitic workers and the alates indicates the rapid development of a colony of this parasitic species.

Unfortunately, the queens of all detected *B. corsicus* colonies were not observed at all, what is primarily caused by absence of visits during springtime; there is chance that they would be located closely to the soil surface that time. Observing the queen of the colony, especially in spring, would bring an opportunity to document the extreme physogastrism known to occur in this genus (JANCÍK, pers. obs.). However, alates were observed in huge numbers in the colonies, but no swarming was recorded. Despite the overcrowded nests with them and the numerous colonies, only two gynes were detected in a single pitfall trap.

This species' occurrence in the Slovak Republic was well summarised by SEIFERT (2012) – the study site represented the northernmost distributional point of the species' occurrence in the country. The species' overall northernmost distributional point is at "49.366°N" in the Czech Republic (SEIFERT 2012), which is about two decimal places more than in this study.

Lasius paralienus Seifert, 1992

Nests were found exclusively at the forest ecotone and alongside shrub growths. Two species of the *Lasius paralienus* species complex Seifert & Galkowski, 2016 occur in the Slovak Republic (SEIFERT & GALKOWSKI 2016, SUVÁK 2021, JANCÍK, PURKART, unpub. data) – *L. paralienus* and *L. bombycina* Seifert & Galkowski, 2016.

Lasius sabularum (Bondroit, 1918)

Individuals which belonged to one colony were found after digging in the soil close to the *Pinus sylvestris* tree at the forest ecotone. Although it is not a rare

species (SEIFERT 2018, BRAČKO 2023, JANCÍK, unpub. data), there is only one reported finding from the Slovak Republic so far (SEIFERT 1988). The lack of further records can be explained by the similarity of this species to some other species within the subgenus and the associated difficulties in determination, as well as by its subterranean, cryptic lifestyle. The determinations of species of subgenus *Chthonolasius* Ruzsky, 1913 are the most difficult among the European ants. However, the number of individuals collected in this case was more than 30, what was sufficient for the clear determination result.

Plagiolepis xene Stärcke, 1936

This species was revealed at the site on August 4, 2019, after a small rocky crevice was opened above the soil layer, where a part of the nest of *Plagiolepis* Mayr, 1861 ants was situated. A few tens of host workers, some tens of *P*. *xene* gynes, and several *P*. *xene* males were present among the imago individuals. *P*. *xene* gynes included one which was already utterly wingless, but most of them were just freshly hatched – these had overall light colour and not fully developed wings yet. There was a prevalent number of pupae in the nest part. Therefore, the ratio of *P*. *xene* females and males was not calculated based on the imagines.

Next, this time populous colonies of *Plagiolepis* ants were searched for on July 26, 2020, by randomly disturbing the soil surface. The first such colony was partially extracted together with the nest-surrounding substrate and the grass-herbal vegetation parts (the material was collected to a depth of 15 cm in the soil). The idea was to move this colony into the laboratory conditions for a more detailed investigation of *P. xene* if it was a part. The colony moved from the original nesting structures into the prepared ones within the laboratory. During this transition were observed host colony specimens (workers and queens), but surprisingly also freshly hatched *P*. *xene* imagines of gynes. Husbandry conditions were set as close as possible to the natural ones (Fig. 7), while the most significant exception was the lack of night temperature fluctuations. The *P*. *xene* individuals (both the winged gynes and the wingless males) were observed leaving the artificial nest part into the arena (a transparent container representing the outside world) accompanied by the workers. This was happening over a series of a few days, starting on August 7, 2020, every day at around 15:00 h, and on warm days (higher than 27°C at peaks). In the arena part, the gynes tried to direct their movements towards the light source; those were apparently trying to disperse.

The host species of both the colonies containing the *P. xene* was the *P*. *pygmaea*.

So far, this species is known to be found very rarely in Central Europe – one site in the Czech Republic (WERNER 1989, BEZDĚČKA 1995), two sites in Germany (SEIFERT 1993, SEIFERT 2018), one site in Austria (GLASER et al. 2024), and two sites in the Slovak Republic (P. WERNER, pers. comm.).

Fig. 7. View into the nest part of the artificial nest through the covering glass. Trophallaxis can be seen between a freshly hatched winged gyne of *P. xene* and a worker of the host species. Other *P. xene* individuals and workers of the host species are in their proximity. Photo: Lukáš Jancík, August 2020.

The first data for the Slovak Republic was provided by WERNER (1989), and the species was confirmed in later checklists too (BEZDĚČKA 1996, WERNER & WIEZIK 2007). The two sites are located in the south of the Slovak Republic. The findings are – Plešivecká planina geomorphological subunit, September 1, 1988 (48°33'33",20°25'30"), several imagines of gynes, Petr Werner coll.; Jelšavská Teplica – local part of village Gemerské Teplice, September 2, 1988 (48°36'21",20°16'19"), several imagines of gynes, Petr Werner coll.

The northern distributional limit of this species is located at the site Svatý Kopeček Nature Reserve – 48°48' (the latitude) in south Moravia (the Czech Republic) based on the recorded data. The finding comes from the year 1987 (BEZDĚČKA 2000) and was firstly referred by the WERNER (1989), accordingly by the BEZDĚČKA (1995, 2000). The data of species' occurrence at "sites at 49.1°N in S Moravia" (SEIFERT 2018) were not supported by any records up to now and, therefore, were considered as wrong (SEIFERT, pers. comm.). The northern distributional limit of this species' distributional range was thus shifted (see the study site description).

All collected male specimens of *P. xene* were always completely wingless, with the remnants of wings (Fig. 8). The gynes were very similar to the males (Fig. 9), both in terms of size and colour. However, they can be easily distinguished when new generations appear in the nests since at that time they are winged (Fig. 9). The identification of an ant parasite within *Plagiolepis* colony in the field requires magnification of at least 20x to sufficiently check the more robust thoraxes compared to the workers of the host species. Otherwise, the wingless both gynes and males can be easily confused with the workers which are of the same size and can resemble them in colour. The easiest detection is when a new generation of the *P. xene* occurs within the nest because the small gynes are disclosed by their wings. However, they still can be confused with the similarly appearing males of the host species (although these are usually darker in the colour) when observing with no magnification.

Fig. 8. *Plagiolepis xene* – Dorsolateral view of the wingless gyne (left) and the wingless male (right); the individuals are depicted under equal magnification. The length of both specimens is about 1.3 mm. Photo: Lukáš Jancík, April 2024.

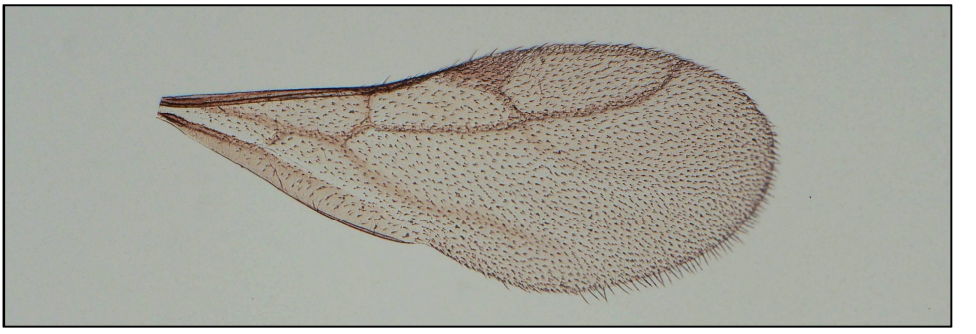

Fig. 9. *Plagiolepis xene* – Detail of the forewing venation of the gyne. The total length of the wing is about 1.5 mm. Photo: Lukáš Jancík, August 2019.

Temnothorax albipennis (Curtis, 1854)

One nest was found at the *Pinus sylvestris* forest ecotone in decaying twig covered and surrounded by grass-herbal vegetation. The colony members located in the nest were extracted entirely on July 22, 2023; the specimens resulted in approximately 40 workers (imagines), approximately 50 pupae of workers, and a single wingless and completely legs-free but antennae-complete gyne. Its condition was exceptional (Fig. 10); it was situated in the center of dense workers' concentration when the nest was uncovered in the field. Before the ants were put to ethanol, the workers surrounded the disabled gyne. One possible explanation for the queen's condition is that it was somehow incorporated into a foreign colony, and during this process, the unfriendly behaviour of workers caused its condition. Another scenario is establishing the colony with multiple gynes where the first workers caused the selection of just one resulting queen in a very violent way; this scenario is supported by the strict monogyny of this species (SEIFERT 2018). At the same time, the determination was conducted separately based on the workers and the gyne, resulting in exact determination. The species was found for the first time in 2004 (WIEZIK 2005), and so far, only several sites of its occurrence were detected: Sitno National Nature Reserve (WIEZIK 2005, WIEZIK 2006), Ladmovce (WIEZIK 2007, SUVÁK 2021), Tisovec (PURKART, unpub. data), Biele Karpaty Mts (JANCÍK, unpub. data), Šúr National Nature Reserve (PURKART 2023), and Javorníky Mts (apart of this study, JANCÍK, unpub. data). The *T. albipennis* was misidentified in the past (e.g., SALATA & BOROWIEC 2013). It can also be challenging to determine this species based on separate specimens since it hybridizes (SALATA & BOROWIEC 2013) and cuticular colour patterns can deviate distinctly toward the typical pattern, even if the individual is not a hybrid.

Fig. 10. The queen of *Temnothorax albipennis*; showing the absence of its legs. The length of the specimen is about 3.2 mm. Photo: Lukáš Jancík, January 2024.

Tetramorium caespitum species complex

According to the study by WAGNER et al. (2017), the determination of species of this complex is one of the most laborious among European ants. Compared to the workers, males are much easier to determine (WAGNER et al. 2017). Unfortunately, catching them in the nests during their typical occurrence was unsuccessful at the study site. Species-level determination based on the workers solely was not conducted entirely, therefore, it was not investigated which one or multiple species occurred here. However, these species were excluded (among all the specimens) – *T. hungaricum* Röszler, 1935 and *T. immigrans* Santschi, 1927.

It is worth mentioning the discovery of one colony of the *T. caespitum* (Linnaeus, 1758), which was found outside the study site – approximately 100 meters from its border on a small clearing on an intensively grazed pasture with low grass vegetation. This nest contained males which were taken along with the workers resulting in exact determination.

The study site in the context of wider area

Regarding how the study site was described, forest-steppe habitats are directly threatened by ongoing succession. Moreover, the site is located on a plot of land, which is declared to be managed as forest or temporary non-forest for forest restoration purposes or after random logging.

There are still present several scattered habitats of long-term forest-steppe with xerothermophilous grass-herbal vegetation cover in the Javorníky Mts – as was investigated here, at least in its southwestern part (alongside valleys: Púchovská dolina, Marikovská dolina, and Papradnianska dolina). These places in the context of the Javorníky Mts are small in area (usually about a thousand square meters) and contain remnant habitats of those that existed at the beginning of the last century. These places are typically situated on hill slopes of mainly southern exposition with altitudes up to some 600 m a.s.l. The reasons for the habitat degradation are mainly afforestation and inappropriate intensity of grazing. The trend of habitat change is given, and there is a clear scenario of the possible loss of these habitats in the area during the upcoming decades. Only one protected area in the Javorníky Mts remains to preserve this kind of habitats – Klapy Nature Reserve, the habitats of European interest (code SKUEV0581). The Klapy (an area of 6.2 ha) is distant from the Hoštiná study site approximately 7 km and was classified as a protected area in 1993. Valuable elements of biodiversity exist here; it is worth mentioning the occurrence of *Parnassius apollo* (Linnaeus, 1758) (KALAFUSOVÁ et al. 2015).

Recommendations to State Nature Conservation Agency of the Slovak Republic

Several activities are recommended to preserve, qualitatively improve, or even extend the area of the habitats. Extensive grazing is an essential activity; concerning the geomorphology of the site and explicitly the steep slope, goat herds are suitable. Potentially available animal resources can be found directly in the adjacent settlement of the Hoštiná. Removal of thickets of bushes should be done during winter when the soil-nesting ant species are more protected. To extend the area, logging of trees would be necessary since there are relatively dense growths in the marginal parts of the study site. It would also cover changes in the declared usage of the plot of land. Keeping the deadwood is also essential, not only for the ants. Old trees and solitary trees should be kept.

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SÚHRN

Táto práca prináša nové poznatky o mravcoch z geomorfologického celku Javorníky po viac ako 50 rokoch. Skúmaná bola maloplošná lokalita, na ktorej sa zachovali zvyšky lesostepi na vápencovom podloží so xerotermnou travinno-bylinnou vegetáciou. Počas piatich rokov terénneho výskumu sa podarilo zistiť hneď viacero faunisticky významných druhov mravcov. Medzi najvýznamnejšie patria sociálne parazitické druhy – *Plagiolepis xene* a *Bothriomyrmex corsicus*. Lokalita sa nachádza na severozápadnom Slovensku a jej vrchol je v nadmorskej výške približne 540 m n. m. Viaceré teplomilné druhy tu dosahujú svoju severnú hranicu rozšírenia v rámci územia Slovenska, *P. xene* dokonca svoju celkovú severnú hranicu rozšírenia. V kombinácii s relatívne vysokou nadmorskou výškou je tento faunistický údaj v európskom kontexte ešte zaujímavejší. Bolo zistených 48 druhov mravcov, čo je viac ako 40% celkovej myrmekofauny Slovenska. Zoznam obsahuje aj typicky lesné či arborikolné druhy – študijná plocha totižto nepredstavuje iba suché a teplé trávnaté habitaty, ale aj okraj lesa či časti zarastené krovinami. Okrem faunistických poznatkov boli učinené aj zaujímavé pozorovania, ktoré priniesli nové údaje o biológii mravca *B. corsicus*. Práca tiež obsahuje hodnotný dokumentačný materiál v podobe fotografií habitatov a jedincov mravcov.