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Proceedings of the 15th Workshop on biodiversity, Jevany

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2025

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Reviewers: Doc. RNDr. Jan Minář, Dr.Sc.
MVDr Andrej Litvinec, Ph.D.

This project was financially supported by

S grant of MSMT (Ministry of Education, Sports and Youth)

The workshop was organized under the auspices of the Czech Academy of Agricultural Sciences, Department of Animal Production

ISBN 978-80-213-3543-1 (PRINT VERSION)
ISBN 978-80-213-3544-8 (ONLINE VERSION)

Prevalence of gastrontestinal parasites in captive animals in the Czech Republic

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Abstract

Routine fecal parasitological monitoring is crucial in zoological gardens to ensure animal health and mitigate the risk of zoonotic transmission. This retrospective study examines the prevalence and diversity of gastrointestinal parasites found in fecal samples collected from various taxa at Tábor Zoo during 2024.From July to November 2024, 256 fecal samples were collected from mammals, birds, and reptiles for analysis. Each 4 g sample underwent flotation and Baermann larvoscopy techniques. Quantitative egg/oocyst counts were performed, and the results were compared with international data. In total, 69.1 % (177/256) of the samples tested positive for parasitic infection. Among mammals, the most commonly detected parasites were Strongylida (51.4 %), *Eimeria* spp. (39.2 %), *Capillaria* spp. (14.3 %), *Nematodirus* spp. (8.5 %), and *Trichuris* spp. (4.2 %). In birds, the prevalent parasites included *Capillaria* spp., *Ascaridia* spp., *Heterakis* spp., along with high *Eimeria* oocyst counts, reaching up to 25,600 oocysts per 4 grams. In birds, mite infestations were recorded in multiple species, with eggs and adult forms commonly found in *Ara* spp., *Amazona* spp., and *Psittacus* spp.

Keywords**:** Zoo, monitoring, coprological, larvoscopy

Introduction

One of the primary goals of zoological gardens is to contribute to the conservation of wild species, with particular attention given to those that are endangered or at risk in their natural habitats. Currently, specific programs are being implemented, such as the European Association of Zoos and Aquaria (EAZA 2025). However, zoological gardens may unintentionally present a risk for pathogen transmission between individuals and species, due to conditions such as close contact between different species and higher animal density. The prevalence of parasites in zoo animals can be influenced by various factors, including environmental conditions, breeding management, disease prevention measures, and treatment protocols (Lim et al. 2008; Da Silva-Barbosa 2020).

Zoonotic parasitic diseases can cause significant health complications not only in captive animals (Cibot et al. 2015) but also in those responsible for their care, such as animal keepers. Exposure to contaminated faeces, soil, and plants can pose an infection risk (Slifko et al. 2000; Panayotova-Pencheva 2013). Parasitic infections in wildlife can also be fatal (Borghare et al. 2009).

Animals release zoonotic parasites into the environment, for example, in the form of oocysts, eggs, or larvae in their faeces (Naz et al. 2021; Cavallero et al. 2020; Shusterman et al. 2021; Vonfeld et al. 2022). This transmission can lead to human infection through the consumption of contaminated food and water (Cai et al. 2021; Fernandes-Santos et al. 2020; Dixon 2021; Santin 2020; Dessi et al. 2020). Furthermore, direct transmission of parasites may occur from animal fur to caretakers (Thomson 2016).

Materials and Methods

Between July and November 2024, a total of 256 fecal samples were collected at regular intervals from a wide range of mammals, birds, and reptiles housed at the Tábor Zoo, Czech Republic. All samples were approximately 4 grams in weight, collected non-invasively from fresh excrement and stored in sterile plastic containers under cooled conditions prior to analysis.

Each sample underwent two parasitological diagnostic methods:

1. Flotation technique (modified Cornell-Wisconsin method): optimized for detection of eggs, oocysts, and cysts of gastrointestinal parasites. Saturated sodium chloride solution (specific gravity 1.2) was used as flotation medium. Results were expressed as eggs per gram (EPG) or oocysts per gram (OPG).

2. Baermann larvoscopy: employed for the detection of nematode larvae. Approximately 4 g of faeces was suspended in gauze and immersed in warm water for 24 hours. Larvae were subsequently recovered and identified under microscopy.

Microscopic evaluation was carried out at 100–400× magnification. Morphological identification was based on egg/oocyst structure, size, and content using standard parasitological keys. Mite infestations were assessed via flotation (visual identification of eggs and adult mites).

Data were compiled into prevalence, intensity (mean EPG/OPG), and co-infection rates. Parasites were grouped taxonomically. Results were processed using descriptive statistics.

Results

Out of 256 examined samples, 177 were positive for the presence of parasites (69.1 %). The most prevalent group was Strongylida, detected in 106 samples (41.4 %). *Eimeria* spp. were identified in 72 samples (28.1 %). Other parasites included *Capillaria* spp. (8. 2 %), *Trichuris* spp. (4.3 %), Ascaridida (3.9 %), and mites (2.7 %). Mixed infections were also observed, particularly in

ruminants and birds. However, larvoscopic examination using the Berman method was negative in all animals.

Mammals:

Ruminants, such as the European bison (*Bison bonasus*) and domestic sheep (*Ovis aries*), showed the highest prevalence of Strongylida and *Eimeria*. The maximum infection intensity was recorded in European bison, with 349.75 oocysts per gram (OPG) of *Eimeria* and 198.75 eggs per gram (EPG) of Strongylida. Bactrian camels (*Camelus bactrianus*) and equids were infected less frequently, but Strongylida and *Eimeria* were also detected in these hosts. Pigs were predominantly infected with *Trichuris* and Ascaridida. Sporadic infections with *Toxocara* spp. and *Capillaria* spp. were found in canids, while felids harbored *Cystoisospora felis*, usually at low infection intensities. More data is shown Tab. 1.

Tab 1. Parasite load in mammals

Host Group	Species Example	Samples (n)	Positive (n)	Strongylida (mean EPG)	*Eimeria* spp. (mean OPG)	Other Parasites
Ruminants	*Bison bonasus*	15	14	3,471.2 (range 550–12994)	1,255.3 (range 11–10230)	*Nematodirus, Trichuris*
Camelids	*Camelus bactrianus*	4	4	670.5	4.0	*Marshallagia, Trichuris*
Equids	*Equus caballus*	12	8	149.6	-	Larvae L2-L3, *Capillaria*
Suids	*Sus scrofa* (wild & domestic)	4	3	10.7	0	*Ascaris suum, Isospora suis*
Felids	*Panthera leo, Puma concolor*	6	5	-	16.2	*Cystoisospora felis, Toxocara* spp.
Canids	*Canis lupus familiaris*	8	2	2.5	-	*Uncinaria* spp., *Cystoisospora canis*

Birds:

Parrots (*Ara ararauna*, *Psittacus erithacus*) and corvids (*Corvus corax*) were primarily infected with *Eimeria*, *Ascaridia*, *Heterakis*, and *Capillaria*, which is shown in Tab. 2. Mites were also identified in the form of both eggs and adults, particularly in parrots. Infection intensities ranged from as few as 4 eggs to over 16,597 eggs.

Tab 2. Parasite load in birds

Bird Group	Species Example	Samples (n)	Positive (n)	Capillaria (mean EPG)	Eimeria (mean OPG)	Other Parasites
Columbids	*Columba* spp.	10	10	1,254.5	9,822.0	*Ascaridia*, *Heterakis*
Psittacines	*Ara* spp., *Psittacus*	12	8	204.3	2,120.4	*Mites* (eggs/adults)
Galliformes	*Phasianus* spp.	5	4	158.0	350.0	*Heterakis*

Reptiles:

In reptiles, only sporadic findings were recorded, mainly nematodes of the genera *Oxyuris* and *Ascaris*. This information is shown in Tab. 3.

Tab 3. Parasite detection in reptiles

Reptile Group	Species Example	Samples (n)	Positive (n)	Parasites Detected
Chelonians	*Testudo* spp.	6	4	*Oxyuris* spp., *Ascaris* spp.
Lizards	*Iguana iguana*	1	0	None

Co-infections:

Mixed infections were frequent in ruminants and birds. For example, European bison commonly harbored Strongylida and *Eimeria* simultaneously, with some individuals also shedding *Capillaria* or *Nematodirus* spp.

Ectoparasites:

Mite infestations were recorded in multiple bird species. Eggs and adult forms of mites were commonly found in *Ara* spp., *Amazona* spp., and *Psittacus* spp. Prevalence in psittacines reached 33%, with infestation intensities up to 75 adult mites per sample.

Discussion

The findings of this study confirm the high prevalence and diversity of gastrointestinal parasites in captive zoo animals, consistent with previous parasitological surveys conducted in zoological institutions across Europe and elsewhere (Lim et al. 2008; Da Silva-Barbosa et al. 2020). The overall infection rate of 69.1 % aligns with earlier reports and underscores the persistent challenge of maintaining parasite-free populations in mixed-species enclosures.

Among mammals, the highest infection intensities were observed in European bison (*Bison bonasus*), where Strongylida egg counts reached up to 12,994 EPG and *Eimeria* oocyst counts exceeded 10,000 OPG. These findings are consistent with previous reports highlighting the susceptibility of ruminants to gastrointestinal strongyles and coccidia under captive conditions (Vonfeld et

al. 2022; Shusterman et al. 2021). Environmental factors such as high humidity and close interspecies contact are likely contributors to the persistence of these infections, as also noted in studies from other zoological gardens (Panayotova-Pencheva 2013).

Co-infections were common in ruminants and birds, suggesting overlapping life cycles and environmental contamination. The frequent co-occurrence of Strongylida and *Eimeria* spp. in bison and small ruminants may indicate insufficient hygiene barriers or inadequate antiparasitic protocols. Such mixed infections can exacerbate clinical signs, even in otherwise healthy individuals (Cibot et al. 2015; Fernandes-Santos et al. 2020).

In psittacine birds and columbids, *Capillaria*, *Ascaridia*, and *Heterakis* spp. were frequently encountered. Oocyst counts above 25,000 OPG were observed in some columbids, supporting findings from other avian studies where confined conditions and high population density contributed to massive parasite loads (Naz et al. 2021; Cavallero et al. 2020). Additionally, the detection of mite eggs and adults in 33 % of parrot samples reflects poor external hygiene and is in line with previous documentation of ectoparasite outbreaks in aviaries (Thomson 2016).

Interestingly, the larvoscopic method yielded no positive findings, reinforcing its limited utility in detecting gastrointestinal larvae in zoo species—likely due to the predominance of parasites with direct life cycles, or the timing of sampling outside larval shedding periods.

The presence of zoonotic parasites such as *Toxocara*, *Uncinaria*, and *Cystoisospora* in carnivores, although at low intensities, supports the argument for stringent hygiene and prophylactic measures to protect both animals and staff (Slifko et al. 2000; Santin 2020). As emphasized by Ayinmode et al. (2016), regular monitoring of carnivores is essential to minimize zoonotic risks, especially in contact zones.

Collectively, the results highlight the importance of routine parasitological surveillance in zoological settings. Preventive strategies should include rotational deworming, environmental management, and species-specific protocols, as advocated by recent literature (Dessi et al. 2020; Cai et al. 2021). Moreover, emphasis should be placed on interdepartmental cooperation to ensure consistent sample collection, diagnosis, and targeted interventions

Conclusion

The study provides significant evidence of a diverse range of gastrointestinal parasites in captive zoo species, with Strongylida and *Eimeria* spp. being particularly widespread among the animals. These findings emphasize the importance of consistent and thorough parasitological monitoring to detect and manage infections early. Additionally, implementing species-specific treatment protocols tailored to the unique needs of each animal is crucial for

ensuring their health and well-being. Such measures not only help maintain optimal conditions for the animals but also play a critical role in reducing the potential risks of zoonotic transmission to humans, ultimately contributing to both animal and public health.

Acknowledgments

We thank RNDr. Evžen Korec, CSc., director of Tábor Zoo, and his staff for their assistance with sample collection. We also acknowledge the Czech University of Life Sciences Prague, especially the Department of Zoology and Fisheries, for providing laboratory facilities. Special thanks to the students and colleagues from the department for their help with parasitological diagnostics.

References

Ayinmode A.B., Obebe O.O., & Olayemi E. 2016. Prevalence of potentially zoonotic gastrointestinal parasites in canine faeces in Ibadan, Nigeria. *Ghana Medical Journal* **50**:201–206. DOI: 10.4314/gmj.v50i4.2.

Borghare A.T., Bagde V.P., Jaulkar A.D., Katre D.D., Jumde P.D., Maske D.K. & Bhangale G.N. 2009. Incidence of gastrointestinal helminthiasis in captive deers at Nagpur. *Veterinary World* **2**:337–338.

Cai W., Ryan U., Xiao L. & Feng Y. 2021. Zoonotic giardiasis: An update. *Parasitology Research* **120**:4199–4218. DOI: 10.1007/s00436-021-07325-2.

Cavallero S., Montalbano Di Filippo M., Rondón S., De Liberato C., D'Amelio S., Friedrich K.G. & Berrilli F. 2020. Nuclear and mitochondrial data on *Trichuris* from *Macaca fuscata* support evidence of host specificity. *Life (Basel)* **11**(1):18. DOI: 10.3390/life11010018.

Cibot M., Guillot J., Lafosse S., Bon C., Seguya A. & Krief S. 2015. Nodular worm infections in wild non-human primates and humans living in the Sebitoli area (Kibale National Park, Uganda): Do high spatial proximity favor zoonotic transmission? *PLoS Neglected Tropical Diseases* **9**(10):e0004133. DOI: 10.1371/journal.pntd.0004133.

Da Silva-Barbosa A., Pinheiro J.L., Dos Santos C.R., de Lima C.S.C.C., Dib L.V., Echarte G.V., Augusto A.M., Bastos A.C.M.P., Antunes-Uchôa C.M., Bastos O.M.P., et al. 2020. Gastrointestinal parasites in captive animals at the Rio de Janeiro Zoo. *Acta Parasitologica* **65**:237–249.

Dessì G., Tamponi C., Varcasia A., Sanna G., Pipia A.P., Carta S., Salis F., Díaz P. & Scala A. 2020. *Cryptosporidium* infections in sheep farms from Italy. *Parasitology Research* **119**:4211–4218. DOI: 10.1007/s00436-020-06947-2.

Dixon B.R. 2021. *Giardia duodenalis* in humans and animals – transmission and disease. *Research in Veterinary Science* **135**:283–289. DOI: 10.1016/j.rvsc.2020.09.034.

European Association of Zoos and Aquaria (EAZA). 2024. EAZA Ex Situ Programmes (EEPs). Available from https://www.eaza.net/conservation/programmes/eep-pages/ (accessed February 2024).

Fernandes-Santos R.C., Medici E.P., Testa-José C. & Micheletti T. 2020. Health assessment of wild lowland tapirs (*Tapirus terrestris*) in the highly threatened Cerrado biome, Brazil. *Journal of Wildlife Diseases* **56**:34–46.

Lim Y.A.L., Ngui R., Shukri J., Rohela M. & Mat-Naim H.R. 2008. Intestinal parasites in various animals at a zoo in Malaysia. *Veterinary Parasitology* **157**:154–159.

Naz S., Arooj S., Ali Z. & Farooq Z. 2021. Potential consequences of captivity and environmental pollution in endoparasitic prevalence in different antelopes kept at wildlife parks. *Environmental Science and Pollution Research* **28**:16308–16313. DOI: 10.1007/s11356-020-11561-x.

Panayotova-Pencheva M.S. 2013. Parasites in captive animals: A review of studies in some European zoos. *Der Zoologische Garten* **82**:60–71.

Santin M. 2020. *Cryptosporidium* and *Giardia* in ruminants. *Veterinary Clinics of North America: Food Animal Practice* **36**:223–238. DOI: 10.1016/j.cvfa.2019.11.005.

Shusterman L., Marsh A.E., Joyner P.H. & Habing G. 2021. Detection of *Trichuris* eggs in feces and soil from giraffe (*Giraffa camelopardalis*) and other hoofstock enclosures under human care in the USA. *International Journal for Parasitology: Parasites and Wildlife* **15**:208–213. DOI: 10.1016/j.ijppaw.2021.05.007.

Slifko T.R., Smith H.V. & Rose J.B. 2000. Emerging parasite zoonoses associated with water and food. *International Journal for Parasitology* **30**:1379–1393. DOI: 10.1016/s0020-7519(00)00128-4.

Thompson R.C.A. 2013. Parasite zoonoses and wildlife: One Health, spillover and human activity. *International Journal for Parasitology* **43**:1079–1088. DOI: 10.1016/j.ijpara.2013.06.007.

Vonfeld I., Prenant T., Polack B., Guillot J. & Quintard B. 2022. Gastrointestinal parasites in non-human primates in zoological institutions in France. *Parasite* **29**:43. DOI: 10.1051/parasite/2022040.

Prevalence of Gastrointestinal Parasites in Zoos Around the World: A Mini Review

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Abstract

While zoological institutions serve an essential function in conserving wildlife and educating the public, the health of animals kept in captivity is frequently threatened by parasitic infections. This review examines how widespread gastrointestinal parasites are in zoo environments worldwide. It considers the range of parasite species identified, explores possible modes of transmission, and outlines key preventive approaches used to reduce their effects. Across the analysed literature, there is consistent evidence of a high occurrence of nematodes, protozoa, and, in some cases, trematodes, affecting various animal species across different regions. These results underscore the need for continuous surveillance and the application of effective management practices to safeguard the health and well-being of zoo animals within conservation programs.

Introduction

Zoos function as pivotal institutions in biodiversity conservation and public education, extending their purpose well beyond recreational value. Nevertheless, the health status of captive animals is frequently compromised by parasitic infections, which pose serious concerns for animal welfare and longevity. Studies have reported that the prevalence of gastrointestinal parasites is notably high in zoo mammals, with variations based on geographical location, species, and management practices (Rahman et al., 2023; Barbosa et al., 2019; Fagiolini et al., 2010). The enclosed nature of zoo environments, often characterized by high animal densities and persistent hygiene challenges, can facilitate the spread of parasitic organisms. As such, an in-depth understanding of the diversity and distribution of these parasites is critical for effective health management in captive wildlife populations.

Materials and Methods

This review synthesized findings from various publications detailing the prevalence of gastrointestinal parasitic infections in zoo mammals worldwide. Data were collected from studies involving coprological examinations across multiple zoos, such as the examination of fecal samples from varied species at zoos in Bangladesh, Brazil, Italy, Turkey, Poland, and other regions. Standard

techniques, such as Mini-FLOTAC and traditional coprological methods, were employed to identify and quantify parasites in fecal samples (Capasso et al., 2019; Silva et al., 2022).

Overview of Reported Cases

Research from around the world consistently shows that gastrointestinal (GI) parasites are common in zoo animals. The prevalence of gastrointestinal parasites such as nematodes (*Ascaris*, *Strongyloides*), cestodes, trematodes (*Fasciola*), and protozoa like *Giardia*, *Eimeria*, and *Cryptosporidium* varies significantly across different zoos all over the world and animal species. For instance, Rahman et al. highlighted that nematodes like *Trichuris* and *Capillaria* were prevalent in captive wild animals in Bangladesh (Rahman et al., 2023). Similarly, Mir et al. (2016) identified coccidian parasites predominating among captive deer in Punjab, emphasizing a direct life cycle that facilitates environmental resistance and transmission.

A meta-analysis of 29 studies (2000–2024) on 8,421 captive wild mammals in China found a high overall GI parasite infection rate of 53.9 %, with nematodes being most common. Infection rates peaked in summer and were highest among primates, while animals in wealthier regions showed lower prevalence (Zhang et al. 2025).

Protozoans, including *Giardia* spp. and *Cryptosporidium* spp., were reported frequently due to their zoonotic potential and ability to cause gastrointestinal disorders, particularly in young or immunocompromised animals (Barbosa et al., 2019). In southern Brazil, a study illustrated a noteworthy prevalence of endoparasites in native and exotic species, underscoring the significance of coproparasitological assessments that are often lacking (Silva et al., 2022).

The studies reflect that helminths and protozoans are widespread in zoo environments—often exacerbated by interconnected factors. Crowded and confined enclosures increase the risk of parasite transmission through contaminated feces. Warm, humid climates common in many zoo locations further support parasite survival, with infection rates typically rising during wetter seasons (Zhang et al. 2025). Inadequate hygiene, including poor sanitation and contaminated food or water, also contributes to the spread. Stress from captivity can weaken animals' immune systems, making them more vulnerable, and some species are naturally more susceptible (Heng & Chua, 2024; Dashe & Berhanu, 2020).

Controlling gastrointestinal parasites in zoo animals requires a comprehensive approach, including developing health monitoring programs, environmental management and improved sanitation protocols, are needed to mitigate the risk of parasitic infections (Maesano et al., 2014). Regular fecal screening using both traditional and molecular methods is essential for early

detection and monitoring. Advances in diagnostic techniques such as FLOTAC have proven beneficial for rapid screening of parasitic infections and could facilitate more comprehensive management practices in zoos (Capasso et al., 2019). Deworming should be tailored to the parasite load and species, with drug rotation to prevent resistance (Heng & Chua, 2024). Managing the environment by improving drainage and, where applicable, rotating pastures limits parasite survival. Supporting animal health through proper nutrition and stress reduction also boosts immunity (Panayotova-Pencheva, 2013). Ongoing research into parasite control, drug resistance, and alternative treatments like biological controls plays a key role in refining management practices.

Preventive measures should also incorporate public education and training for zookeepers on zoonotic risks, especially the potential for transmission of parasites from animals to humans, as highlighted in several studies (Capasso et al., 2019; Maesano et al., 2014). The responsibilities placed upon zoo staff extend beyond animal husbandry to encompass public health considerations.

Conclusion

In conclusion, the prevalence of gastrointestinal parasites in zoo animals is a significant concern that influences animal health and welfare. Given the diverse range of parasites identified across various geographic locations, it is evident that continuous monitoring and effective preventive measures are essential. This should include implementing regular health assessments, improving environmental hygiene, and utilizing advanced diagnostic techniques. Such proactive measures will not only protect the animals but also enhance the educational value of zoos in promoting conservation efforts.

References

Barbosa A., Pinheiro J., Santos C., Lima C., Dib L., Echarte G., … & Amendoeira M. 2019. Gastrointestinal parasites in captive animals at the rio de janeiro zoo. Acta Parasitologica, 65(1), 237-249. https://doi.org/10.2478/s11686-019-00145-6

Capasso M., Maurelli M., Ianniello D., Alves L., Amadesi A., Laricchiuta P. & Rinaldi L. 2019. Use of mini-flotac and fill-flotac for rapidly diagnosing parasitic infections in zoo mammals. Revista Brasileira De Parasitologia Veterinária, 28(1), 168-171. https://doi.org/10.1590/s1984-296120180087

Dashe D. and Berhanu A. 2020. Study on gastrointestinal parasitism of wild animals in captivity at the zoological garden of haramaya university, ethiopia. Open Journal of Veterinary Medicine, 10(09), 173-184. https://doi.org/10.4236/ojvm.2020.109015

Fagiolini M., Lia R., Laricchiuta P., Cavicchio P., Mannella R., Cafarchia C., & Perrucci S. 2010. Gastrointestinal parasites in mammals of two italian zoological gardens. Journal of Zoo and Wildlife Medicine, 41(4), 662-670. https://doi.org/10.1638/2010-0049.1

Maesano G., Capasso M., Ianniello D., Cringoli G., & Rinaldi L. 2014. Parasitic infections detected by flotac in zoo mammals from warsaw, poland. Acta Parasitologica, 59(2). https://doi.org/10.2478/s11686-014-0249-8

Mir A., Dua K., Singla L., Sharma S., & Singh M. 2016. Prevalence of parasitic infection in captive wild animals in bir moti bagh mini zoo (deer park), patiala, punjab. Veterinary World, 9(6), 540-543. https://doi.org/10.14202/vetworld.2016.540-543

Rahman R., Nyema J., Imranuzzaman M. B., Pranto P., Talukder K. & Islam S. 2023. An update on gastrointestinal parasitic infection in captive wild animals in bangladesh. Journal of Parasitology Research, 2023, 1-6. https://doi.org/10.1155/2023/3692471

Silva M., Oliveira D., Santos F., Aguiar C., Prado I., Brandão D. & Fraga R. 2022. Gastrointestinal parasites in wild and exotic animals from a zoo in the state of bahia, brazil - first record. Research Society and Development, 11(13), e19111334959. https://doi.org/10.33448/rsd-v11i13.34959

Zhang X., Zhou H., Ye L., Shi J., Zhang H. & Zhang T. 2025. The Occurrence and Meta-Analysis of Investigations on Intestinal Parasitic Infections Among Captive Wild Mammals in Mainland China. Veterinary Sciences, 12(2), 182. https://doi.org/10.3390/vetsci12020182

Heng Y. & Chua D. H. H. 2024. Risk-Based Gastrointestinal Parasite Control in a Tropical Zoological Institute. Journal of Zoological and Botanical Gardens, 5(2), 200-210. https://doi.org/10.3390/jzbg5020014

Panayotova-Pencheva M. S. 2013. Parasites in Captive Animals: A Review of Studies in Some European Zoos. Der Zoologische Garten, 82(1-2), 60–71. https://doi:10.1016/j.zoolgart.2013.04.005

Health concerns of Irish Cob breed in the Czech Republic

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Abstract

While generally hardy, Irish Cobs are prone to several conditions, including chorioptic mange, chronic progressive lymphedema, polysaccharide storage myopathy (PSSM) and hyperkeratosis (known as Mallenders and Sallenders). Some rare but relevant conditions from abroad include foal immunodeficiency syndrome (FIS) which mostly affects related breeds, and recurrent uveitis, typical of Appaloosas. In the Czech context, the most frequently reported issues are chorioptic mange and hyperkeratosis, particularly due to the dense feathering on the legs. A possible link between hyperkeratosis and biotin supplementation was investigated, but no statistical connection was found. While genetic testing for coat color and PSSM is available and useful for breeders, testing for FIS is currently not accessible. Despite these health challenges, the Irish Cob remains a cherished breed. With proper care, regular health monitoring, and responsible breeding, these horses can live long, healthy lives.

Keywords**:** Horse, Irish Cob, health, genetic testing, illnesses

Introduction

The Irish Cob is still relatively rare in the Czech Republic, but its popularity is growing rapidly (Mieslerová & Stříbrná 2020). While just over 500 individuals were recorded in 2017, by September 30, 2022, the number had increased to 902, including 319 mares and 28 stallions (Krejčí & Nevečeřalová 2022). As interest in the breed rises, it is important to address the specific health issues that affect Irish Cobs, especially those related to their heavy feathering and genetic predispositions.

Common problems include parasitic infestations such as *Chorioptes* mites, skin conditions like hyperkeratosis (also known as “Mallenders” and “Sallenders”), and chronic progressive lymphedema. Additionally, the breed may suffer from a genetic muscle disorder called Polysaccharide Storage Myopathy (PSSM types 1 and 2), for which genetic testing is available. The aim of this paper is to raise awareness among current and future owners about these health risks and provide guidance for proper care of this beautiful and beloved breed.

Materials and Methods

This study focused on breeders and owners of Irish Cobs. Data were collected anonymously through a questionnaire survey. To address the selected topic of *Health Issues of Irish Cobs in the Czech Republic*, a questionnaire method was used, followed by statistical data analysis. A total of 273 respondents completed the questionnaire, the vast majority of whom were owners of Irish Cobs. Considering that there are 902 Irish Cobs in the Czech Republic, it is likely that a significant portion of breeders or owners participated in the survey.

The questionnaire was created using the Czech platform Survio, which allows for the creation and distribution of online surveys. It consisted of eight questions in total. The first question served an informative purpose, determining whether the respondent was a breeder/owner of an Irish Cob or not. The remaining seven questions focused on specific health issues, based on scientific literature. These questions addressed topics such as genetic testing, the most common diseases, nutrition, prevention in horse breeding, and symptoms of selected conditions in Irish Cobs in the Czech Republic. The diseases included: chorioptic mange, hyperkeratosis, chronic progressive lymphedema, and polysaccharide storage myopathy. The questionnaire was distributed via a hyperlink shared on various online platforms or personally shared with respondents in electronic form.

The data were analyzed using the software *Statistica 12*, with the help of contingency tables, and Microsoft Excel, where functions, basic characteristics, as well as graphs and tables were created.

The data were formatted appropriately for statistical evaluation in *Statistica 12*. To calculate dependencies between the observed variables ($P \leq 0.05$), the chi-squared test and contingency tables were used. Microsoft Excel was used for graphical presentation of the results.

Results

Owners' experiences with Irish Cob diseases in the Czech Republic

Out of the 273 respondents, 209 were breeders or owners of Irish Cobs. Figure 1 shows the respondents' opinion on which individual diseases they encountered in Irish Cobs in the Czech Republic. The most numerous disease was chorioptic mange (127 responses), and the least numerous was chronic progressive lymphedema (34 responses). A disease called hyperkeratosis came in second place in the number of cases (94 responses). No breeder in the Czech Republic encountered foal immunodeficiency syndrome (FIS), which is tested for only abroad. The majority of breeders did not encounter any disease in Irish Cobs (79 responses). 38 respondents encountered obvious symptoms of polysaccharide storage myopathy.

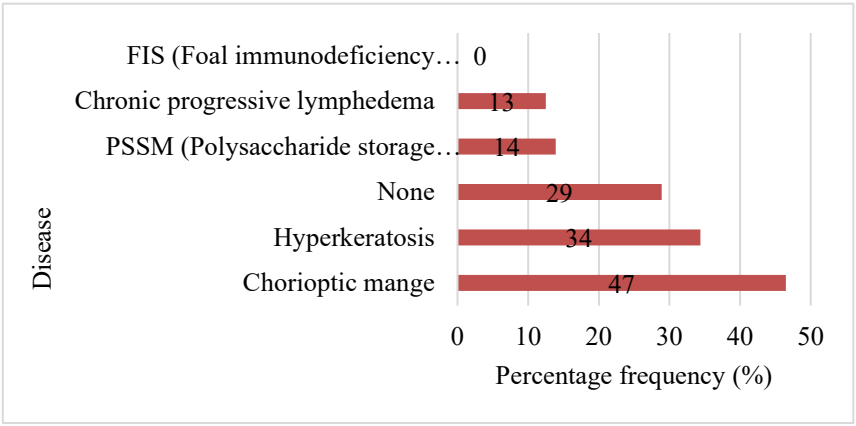

Figure 1: Disease of the Irish Cob's in the Czech Republic

Preventive measures against the occurrence of pathogens in feathering

Figure 2 shows the most common preventive measures to reduce the occurrence of pathogens in lice. The largest number of cases was in the group that used shampoos and other products containing sulphur (172 responses). The second most frequent preventive measure was cleaning lice from mud (120 responses). Almost the same number of cases were in the groups that washed their limbs with clean water (92 responses) and cut their lice (90 responses). 22 respondents chose other preventive measures. These include use of products with fipronil, use of sprays containing silver, mineral oil, combing, massage, shampoos containing chlorhexidine, sprays containing zinc, neostomosan, insecticides, immunostimulants, limiting the feeding of cereals and, last but not least, adding turmeric to the feed. A small part of the respondents does not take

any preventive measures against the occurrence of pathogens in lice (28 responses).

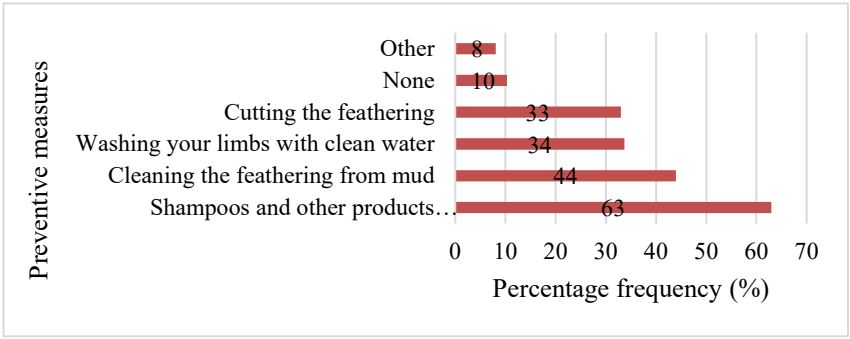

Figure 2: Preventive measures against the occurrence of pathogens in feathering

Clinical signs in Irish Cobs associated with chorioptic mange

Chorioptic mange is the most common disease that occurs in Irish Cobs bred in the Czech Republic. Most owners observed the symptoms listed below, which may be related to the pathogen *Chorioptes equi* or *Chorioptes bovis* in the rouches. Figure 3 shows the most common symptoms that directly refer to the possible cause of infection with this pathogen. The most observed symptoms were scratching the mane or tail (160 responses), stamping with the hind limbs (152 responses), and scratching the limbs on objects (150 responses). Dried scabs and bleeding were observed by 139 respondents. Biting of the limbs was registered by 127 respondents. Almost all symptoms were very frequently observed by the surveyed breeders.

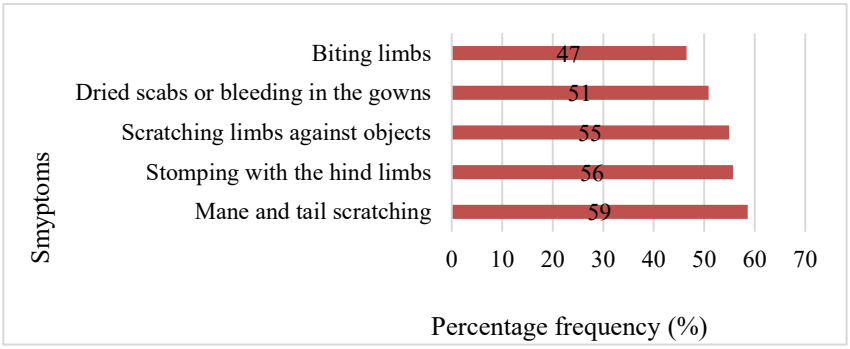

Figure 3: Clinical signs in Irish Cobs associated with chorioptic mange

Occurrence of hyperkeratosis in connection with biotin

Figure 4 shows the dependence of hyperkeratosis on biotin feeding in Irish cobs. The evaluation of the dependence between hyperkeratosis and biotin intake in feed supplements was examined by the chi-square test with a significance level of $P \leq 0.05$. The statistical evaluation did not demonstrate significant dependence between keratinized skin and biotin feeding in feed supplements in Irish cobs and the null hypothesis cannot be rejected. Of the total number of 273 respondents, 211 of them do not feed biotin. Hyperkeratosis occurred in 208 owners.

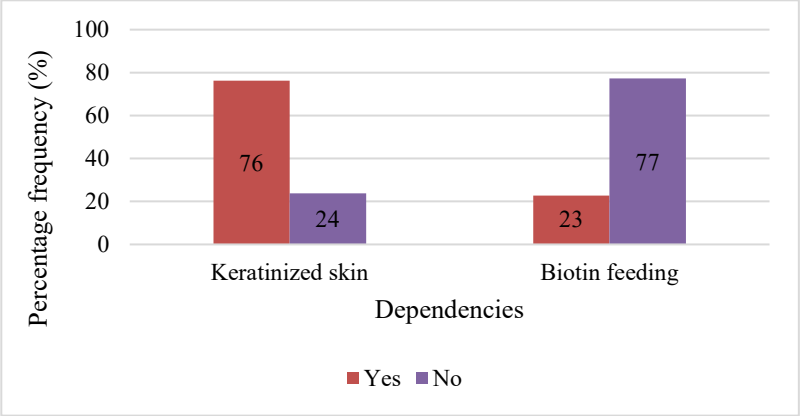

Figure 4: Occurrence of hyperkeratosis in connection with biotin

Positivity of genetic testing for PSSM disease

58 respondents tested positive for polysaccharide storage myopathy and 38 owners breed Irish Cobs with PSSM type 1 or PSSM type 2. The vast majority have never seen or encountered a genetic test for PSSM in this breed (170 responses). 45 owners/breeders have never heard of the disease.

Other diseases of Irish Cobs

Other diseases that were not included in the questionnaire questions occurred in Irish Cobs bred in the Czech Republic. These were dyspnea, photodermatitis, insulin resistance, eye problems (tumors, blindness, conjunctivitis) in most cases associated with blue eye color. The largest number of cases occurred with dyspnea. The second highest frequency was photodermatitis. Almost the same frequency of cases was with insulin resistance and eye problems.

Overt symptoms of PSSM versus a positive genetic test

In this figure number 5 it is evident that more people have encountered a positive individual for polysaccharide storage myopathy, which could only be in the homozygous form without obvious symptoms of the disease. Visible symptoms of both types of disease were in a minority of the surveyed respondents (38 responses), who keep Irish Cobs at home in a homozygous or heterozygous configuration (see Figure 1). A positive genetic test for PSSM was observed by 58 respondents.

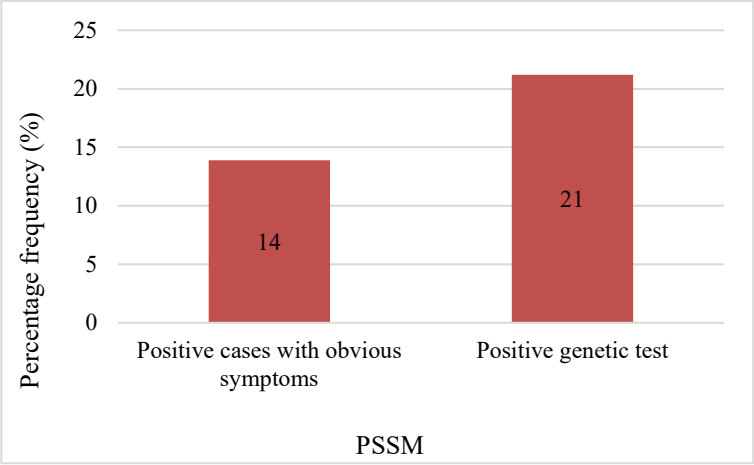

Figure 5: Overt symptoms of PSSM versus a positive genetic test

Discussion

This study found that the most common disease among Irish Cobs in the Czech Republic is chorioptic mange, whose pathogens in horses are *Chorioptes equi* or *Chorioptes bovis*. These mites parasitize in the feathering on the limbs, mane, and tail (Lusat et al. 2011). Based on the responses shown in Figure 3, it is clear that all respondents observed symptoms in their horses that could be directly related to chorioptic mange. These include mane or tail rubbing, stamping with hind limbs, biting at front and hind limbs, rubbing limbs against objects, and dried scabs or bleeding in the feathering. Intense itching is one of the most common symptoms (Osman et al. 2006). Mane and tail rubbing may also be related to other ectoparasitic diseases, such as lice. Tail rubbing may also suggest pinworms.

Most respondents use sulfur-based products (shampoos and sprays) as a preventive or therapeutic measure against mange, as shown in Figure 2. Karasek et. al (2020) a Littlwood (2000) agree that the most effective treatments include fipronil (spray), doramectin, sulfur-based products (e.g., 5% lime sulfur solution), and moxidectin combined with fipronil. Fipronil and doramectin are

not licensed medications for horses, but they have proven effective. It can be safe for horses when used under veterinary guidance and in appropriate doses. Before use in horses, it is necessary to test for allergic reactions.

Rendle et al. (2007) and Brys et al. (2023) report in their studies that these are very effective measures against mange, itching, and they may also have a positive effect on lesions associated with chronic progressive lymphoedema. This disease was reported only rarely in the questionnaire responses. This may be related to a potential genetic factor. However, Irish Cobs are predisposed to this disease, so caution is warranted. It is a very serious condition that can ultimately lead to the death of the horse (Affolter et al. 2020). Almost a quarter of respondents reported no health issues in their Irish Cobs (see Figure1).

Another common disease associated with heavy feathering is hyperkeratosis. It has been speculated that it could be linked to feeding biotin supplements. However, no statistically significant correlation between hyperkeratosis and biotin supplementation was found, as seen in Figure 4. Statistical analysis did not show a significant relationship ($p = 0.5348$) between hyperkeratosis and biotin supplementation in Irish Cobs. Marlin (2020) and Whitehead (1985) agree in their articles that the long-term removal of biotin-containing supplements may actually worsen hyperkeratosis, making it counterproductive. Among breeders and owners, there is a common belief that biotin negatively affects the health of Irish Cobs and worsens hyperkeratosis, but this has not been scientifically proven. Given the number of hyperkeratosis cases, the condition may be related to a lack of biotin in the diet. The majority of owners do not feed biotin supplements (see Figure 4), which could otherwise have a positive effect in treating this condition. This topic needs further research and clarification, especially to communicate to owners that the current belief is not based on scientific evidence.

Another disease is foal immunodeficiency syndrome (FIS), a fatal hereditary condition caused by a recessive gene mutation (Fox-Clipsham et al. 2011). Genetic testing is only available abroad, and not a single case was recorded among Irish Cobs in the Czech Republic (see Figure 1). It is possible that heterozygous individuals exist in the country, but this needs to be verified by testing. This disease is not typical for Irish Cobs, so its absence was expected. Nevertheless, awareness of this disease is important due to its genetic implications. The fact that FIS has not occurred in the Czech Republic may be due to the absence of genetic testing.

Polysaccharide storage myopathy (PSSM) is a disease characterized by the abnormal accumulation of glycogen and glycogen-related polysaccharides in skeletal muscle fibers (Valentine & Cooper 2005). Available literature from abroad and the Czech Republic does not report any PSSM cases of either type in Irish Cobs with clearly visible symptoms (see Figure 1). Only homozygous individuals for PSSM type 1 were observed. Based on the findings of this study,

it is clear that the issue of PSSM is poorly understood in horses in the Czech Republic, even when symptoms are apparent (see Figure 1). A smaller proportion of respondents reported a positive genetic test for this disease. It is possible that some owners who confirmed that their horses have PSSM symptoms have not had it genetically confirmed, and this might therefore be a presumption. In reality, it may have been another neuromuscular disease. The GYS1 gene mutation has also been found in Irish Cobs, making genetic testing important (Valberg et al. 2009).

Other conditions were also observed in Irish Cobs that were not included in the questionnaire and are rather atypical for the breed. The most frequent of these was asthma, or equine asthma. The second most frequent was photodermatitis, also known as photosensitization. This condition may be related to typical Irish Cob phenotypes. The least frequent were insulin resistance and eye disorders, both of which occurred at nearly the same frequency in the survey. A small number of respondents noted that their horses were obese, which could be linked to the insulin resistance observed in a few horses.

The eye disorders observed in Irish Cobs include conjunctivitis (especially in blue-pigmented irises), conjunctival dermoids, and conjunctival cancer in blue eyes. In comparison with foreign literature, which reports positive cases of recurrent uveitis in Irish Cobs, not a single case of recurrent uveitis was reported in the Czech Republic survey responses. This may be due to the lack of available data.

Based on the results, the established hypothesis, that there is no typical disease for the Irish Cob breed in the Czech Republic, aside from issues related to feathering such as chorioptic mange and hyperkeratosis cannot be rejected. The results of this study cannot be compared with foreign data, as such data is not available.

Conclusion

This study provides Irish Cob owners with a comprehensive overview of the most common diseases affecting these horses, describing the symptoms, treatments and preventative measures that can help prevent the occurrence of these diseases in breeding populations.

Based on owners' experiences with diseases, no breed-specific condition has been identified in Irish Cobs in the Czech Republic. The highest prevalence was found for dermatitis caused by the mites *Chorioptes equi* and *Chorioptes bovis*.

No disease has been reported directly related to the Irish Cob breed. The study also examined the effect of biotin supplementation on the presence of hardened skin, known as hyperkeratosis, in these horses. There was no statistically significant correlation between hyperkeratosis and feeding biotin supplements.

The most common diseases are related to the feathering on the legs, the mane, and the tail, where mange or hyperkeratosis can occur.

Acknowledgments

We would like to thank the owners and breeders of the Irish Cob's for their time and patience during a filling out the questionnaire. Special thanks to the family, colleagues, and friends for their help.

References

Affolter V.K., Dalley B., Kass P.H., Brown E.A., Sonder C. & Bannasch D.L. 2020. Chronic progressive lymphoedema in Friesian horses: suggestive phenotype of affected horse and genome-wide association study. Veterinary dermatology **31**:234-251.

Brys M., Claerebout E. & Chiers K. 2023. Alleviating lesions of chronic progressive lymphedema in belgian draft horses by successfully treating *chorioptes bovis* infestation with moxidectin 0,5% pour-on. Veterinary parasitology (e110074) DOI: 10.1016/j.vetpar.2023.110074.

Brys M., Claerebout E. & Chiers K. 2023. Chronic progressive lymphedema in belgian draft horses: understanding and managing a challenging disease. Veterinary sciences **10**:347.

Fox-Clipsham L.Y., Brown E.E., Carter S.D. & Swinburne J.E. 2011. Population screening of endangered horse breed for the foal immunodeficiency syndrome mutation. Veterinary record **169**:655-655.

Karasek I., Butler C., Baynes R. & Werners A. 2020. A review on the treatment and control of ectoparasite infestations in equids. Veterinary pharmacology and therapeutics **43**:421-428.

Krejčí M. & Nevečeřalová K. 2022. Situační a výhledová zpráva: Koně 2022. Ministerstvo zemědělství, Těšnov.

Kunová M. 2024. Health concerns of Irish Cob breed in the Czech Republic [MSc. Thesis]. Czech University of Life Sciences in Prague, Prague.

Littlewood J. 2000. Chorioptic mange: successful treatment of a case with fipronil. Equine veterinary education **12**:144-146.

Lusat J., Bornstein S. & Wall R. 2011. *Chorioptes* mites: re-evaluation of species integrity. Medical and veterinary integrity **25**:370-376.

Marlin D. 2020. Can biotin worsen hyperkeratosis in „sallenders and „mallenders". Dr. David Marlin. Available from https://drdavidmarlin.com/can-biotin-worsen-mallenders-sallenders/ (accessed November 2020).

Mieslerová B. & Stříbrná L. 2020. Koně z naší České republiky. Agriprint, Olomouc.

Osman S.A., Hanafy A. & Amer S.E. 2006. Clinical and therapeutic studies on mange in horses. Veterinary parasitology **141**:191-195.

Paterson S. & Coumbe K. 2009. An open study to evaluate topical treatment of equine chorioptic mange with shampooing and lime sulphur solution. Veterinary dermatology **20**:623-629.

Rendle D.I., Cottle H.J., Love S. & Hughes K.J. 2007. Comparative study of doramectin and fipronil in the treatment of equine chorioptic mange. Veterinary record **161**:335-338.

Valberg S.J., MCue M.E., Lucio M. & Mickelson J.R. 2009. Breeds of horses positive for the GYS1 mutation associated with polysaccharide storage myopathy. Journal of equine veterinary science **29**:312-313.

Valentine B.A. & Cooper B.J. 2005. Incidence of polysaccharide storage myopathy: necropsy study of 225 horses. Veterinary pathology **42**:823-827.

Whitehead C.C. 1985. Assessment of biotin deficiency in animals. Annals of the New York academy of sciences **447**:86-96.

The lance-fly *Silba perplexa* (Diptera, Lonchaeidae) a potential agricultural pest species detected in Europe

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Abstract.
The lance-fly *Silba perplexa* (Walker, 1860) has been detected for the first time in Europe on the island of Sicily. Its previous distribution and known larval host plants are discussed. The taxonomy and differentiation from other European *Silba* Macquart, 1851 species is considered as is its potential impact on agricultural crops.

Key words. Faunistics, Palearctic, Sicily, insect pest.

Introduction

Examination of Lonchaeidae in the collection of the Czech University of Life Sciences, Prague has led to the identification of a specimen of *Silba perplexa* (Walker, 1860) from the island of Sicily. In the World catalogue of Lonchaeidae (MacGowan 2023) *S. perplexa* is noted as one of the relatively few species of Lonchaeidae which occur in more than one biogeographical realm with records from both the Australasian-Oceanian and Indomalayan realms. *S. perplexa* has previously been recorded from Australia (Queensland), Fiji, Malaysia, Philippines, Papua New Guinea, Solomon Islands, Sri Lanka, Thailand, Tonga and Vanuatu (Figure 1). This distribution, which includes several remote Oceanian Island groups, would suggest that the species may be spread by human assistance. There have been no previous records any further east than Sri Lanka and its presence in Europe was unexpected. The most probable explanation is that it has been imported with infested fruit or vegetables and has been able to survive and reproduce in the relatively warm Mediterranean climate.

Material examined: **ITALY**, Sicily, 10km S. of Palermo, 800m, leg. J. Halada,18.vi 2012. 1♂. Specimen in National Museum of Scotland. Specimen number NMS-10030424.

Figure 1. The previously known distribution of *Silba perplexa* (from MacGowan 2022).

Lonchaeidae are small-sized (body length: 3–6 mm), stout-bodied rather hairy acalyptrate flies with broad wings. The body in most genera is shiny blue-black the thorax and abdomen are broad. The wing is usually hyaline, occasionally fumose or with apical darkening, but never patterned, the halter is always black. Genera can be identified by using the key provided by MacGowan & Rotheray (2021). Several species are known to cause damage to agricultural crops including those in the genus *Silba* Macquart, 1851: *Silba capsicarum* McAlpine, 1956 which is considered a potential pest of chilli pepper (*Capsicum frutescens* L. and *C. annuum* L.) on Java (MacGowan & Rauf 2019) and *Silba adipata* McAlpine, 1956, the black fig fly, which is a well-known pest of cultivated figs. Although originating in the Mediterranean area, *S. adipata* has also shown a great ability to disperse with recent records as a pest in South Africa (Giliomee et al. 2007), California (Britt et al. 2022) and Mexico (Bautista-Martínez et al. 2021)

Silba perplexa is a typical *Silba* species with two strong setae on the katepisternum, entirely black body and legs and plumose arista (Fig. 2). Within the European fauna there are currently only four recognised *Silba* species. Of these the very common *S. fumosa* (Egger, 1862) and the rarer *S. retalionis* (McAlpine, 1964) are easily differentiated as both have an almost bare arista. The renaining two species *S. adipata*, and the less common *S. virescens* Macquart, 1851 are externally similar to *S. perplexa* and confirmation of

specimens to species level usually requires dissection of the male genitalia. Fortunately, the male genitalia of *S. perplexa* are very distinctive, in particular the long slender J-shaped phallus (Fig. 2 P) with its slightly angled and expanded apex, is a key diagnostic feature (Fig. 3). It is not uncommon in fresh specimens for the apical part of the phallus, with its characteristic angled apex, to be seen protruding posteriorly from the male genital capsule at the tip of the abdomen. After a little experience this can often allow males to be identified without the need for dissection.

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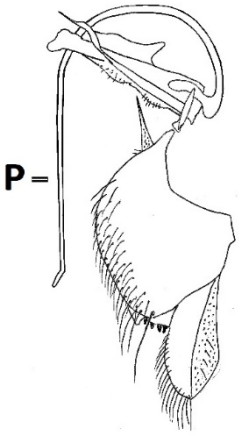

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Figures 2 & 3 *Silba perplexa.* 2. Adult male (museum specimen) 3. Male terminalia, lateral view. P = phallus.

McAlpine (1956: 543) states that a specimen of *S. perplexa* from Malaysia was "ex leaves of African oil Palm" *Elaeis guineensis* Jacq., but this seems unlikely to have been the original larval substrate for a genus whose larvae are primarily associated with fruits. More recent data from Java, Indonesia in 2019 records *S. perplexa* being bred from Egg Plant / Aubergine *Solanum melongena* L., Tomato *Solanum lycopersicum* L. and Bittergourd *Momordica charantia* L. (specimens in National Museum of Scotland collection) although at present there is no data on the impact of this infestation on crop production.

Whether species of the genus *Silba* are primary or secondary invaders of fruits seems to vary between species. Some, such as *S. adipata,* are primary invaders whilst other species will lay their eggs in fruits that have been previously attacked by tephritid species such as the Mediterranean fruit fly

Ceratitis capitata (Wiedemann, 1824). There is no available data on whether *S. perplexa* is a primary or secondary invader of fruits.

The discovery of *S. perplexa* on Sicily may be a cause for concern as two of the crops from which larvae have been recorded are widely grown on the island. Sicily produced an average of 200,000 tonnes per year of greenhouse tomatoes between 2016 and 2020 which represents over 37 % of the total Italian production of greenhouse tomatoes. Sicily is also the fifth largest Italian region in terms of open field tomato production, with in the last five years some 215,000 tonnes per year of being produced (Selvaggi et al. 2021: 6). The eggplant or aubergine is also widely grown throughout Sicily both in greenhouse and open fields. In Italy as a whole aubergine production reached 314.3 thousand tonnes in 2018 (CBI report 2020).

The presence of *S. perplexa* in Sicily is reported here and its presence highlights the need for further surveillance and research to establish whether this species might be a potential threat to the important agricultural crops of Sicily and the wider Mediterranean area.

Acknowledgement

The authors thank Mr. Jiří Halada (Chlum u Třeboně) for donation of the specimen.

References

Bautista-Martínez N., Meraz-Álvarez R., Valdez-Carrasco J.M. & López-Bautista E. (2021) Black fig fly, *Silba adipata* McAlpine, in backyards of the State of Mexico. *Southwestern Entomologist* 46 (3) 793-796 https://doi.org/10.3958/059.046.0323

Britt K.E., Gordon P.E., Faber B.A., Rios S.I. & Wilson H. (2022) First report of black fig fly *Silba adipata* (Diptera: Lonchaeidae), in the United States. *Journal of Integrated Pest Management* 13 (1). https://doi.org/10.1093/jipm/pmac009

CBI report (2020) The European market potential for aubergine The European market potential for aubergine (accessed 16 November 2024)

Giliomee J. H., Venter, E. & Wohlfarter M. (2007) Mediterranean black fig fly, *Silba adipata* McAlpine (Diptera: Lonchaeidae), recorded from South Africa. African Entomology 15: 383–384. https://doi.org/10.4001/1021-3589-15.2.383

MacGowan I. (2022) Lonchaeidae online. Available from: http://lonchaeidae.myspecies.info (accessed 20 November 2024).

MacGowan I. (2023) World Catalogue of the family Lonchaeidae (Diptera, Cyclorrhapha, Acalyptratae). *Zootaxa* 5307 (1), 1-96. https://doi.org/10.11646/zootaxa.5307.1.1

MacGowan I., & Rauf A. (2019). *Silba capsicarum* (Diptera: Lonchaeidae), a newly recognized pest of chilli pepper in Java. *Journal of Asia-Pacific Entomology*. 22: 83–86. https://doi.org/10.1016/j.aspen.2018.12.003

MacGowan I. & Rotheray G.E. (2021) Lonchaeidae (lance flies). *In*: Kirk-Spriggs A.H. & Sinclair B.J. (Eds), Manual of Afrotropical Diptera. Vol. 3. Brachycera: Cyclorrhapha, excluding Calyptratae. *Suricata. Vol.* 6. South African National Biodiversity Institute, Pretoria, pp. 1587–1596

McAlpine J.F. (1956) Old World lonchaeids of the genus Silba Macquart (= *Carpolonchaea* Bezzi), with descriptions of six new species (Diptera: Lonchaeidae). *The Canadian Entomologist*, 88 (9), 521–544. https://doi.org/10.4039/Ent88521-9

Selvaggi R., Valenti F., Pecorino B. & Porto S.M.C. (2021). Assessment of Tomato Peels Suitable for Producing Biomethane within the Context of Circular Economy: A GIS-Based Model Analysis. *Sustainability* 13, no. 10: 5559. https://doi.org/10.3390/su13105559

New records of Lonchaeidae (Diptera) from Czechia and Slovakia with a revised family checklist

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Abstract
An updated checklist of the Lonchaeidae of the Czech and Slovak Republics is provided. Fifteen new species are added to the previous checklist for Czech Republic while four species are removed due to taxonomic changes; six species are added to the previous checklist for the Slovak Republic. but two are removed due to taxonomic changes. Three species on the current checklist are noted as requiring further verification. As a result of these changes the lonchaeid fauna of the Czech Republic is now assessed as containing 72 species in six genera, the greatest number at present recorded for any European country, with 39 species in six genera being recorded from Slovak Republic.

Key words: Insects, faunistics, Palearctic, Europe.

Introduction

The Lonchaeidae fauna of the Czech and Slovak Republics have been relatively well documented culminating in the production of most recent second on-line version of the of the Checklist of Diptera of the Czech Republic and Slovak Republic (Jedlička et al. 2009). The Lonchaeidae chapter listed 61 species from the Czech Republic and 35 from Slovak Republic (Máca 2009). The author also noted that two species recently published from Slovak Republic but not yet checked were not included.

Subsequent to the publication of the 2009 Czech and Slovak checklist Máca et al. (2016) recorded 24 species of Lonchaeidae from that part of the Krkonoše Mountains located in Bohemia, Czech Republic. The list included two species *Lonchaea affinis* Malloch, 1920 and *L. iona* MacGowan, 2001 which were recorded for the first time in the Czech Republic. *Earomyia lonchaeoides* Zetterstedt, 1848 was recorded from Slovakia by Máca (2014) and

Priscoearomyia withersi MacGowan, 2014 has been recorded as new for Czech Republic (Moravia) by Roháček et al. (2022). The record from Slovakia of *L. peregrina* Becker, 1895 by Straka & Majzlan (2008), neglected by Máca (2009), is now included although the specimen has not been examined by us. In the now defunct Fauna Europaea list compiled by Carles-Tolrá (2013) the record of *L. nitens* (Bigot,1885) from Slovakia is unconfirmed while several species, some but not all described recently, are missing; data provided in the Fauna Europaea list are not accepted here. In addition to these literature records our recent examination of the Lonchaeidae in the collection of the Czech University of Life Sciences has added a further 12 species to the previous checklist for the Czech Republic and four to the checklist for Slovak Republic. Four species which were included in previous checklists are re-assessed due to recent taxonomic changes and are removed, three species included in this present checklist are noted as requiring further confirmation of their presence.

Since the latest version of the Czech and Slovak checklist in 2009 there have been several species described as new to the European fauna and with the publication of the World catalogue of Lonchaeidae (MacGowan 2023) there have also been a number of nomenclatural and taxonomic changes which affect species on the checklist. This recent increase in taxonomic knowledge within the Palearctic Lonchaeidae is illustrated by the fact that of the 15 species added to the Czech Republic checklist in this paper ten have been described as new to science since the year 2000. The total number of lonchaeid species now recorded for the Czech Republic is 72 - the greatest number presently recorded for any European country surpassing the previous known largest fauna, that of Sweden, which consists of 66 species (MacGowan 2020).

Materials and methods

The material used in this study originates in the most part from the collections of Miroslav Barták during the years 2011–2016. The specimens newly recorded here were sampled using mass collecting methods (Malaise traps, yellow pan water traps and sweeping vegetation) and voucher specimens were dried from alcohol. All specimens were identified by the senior author. Voucher specimens are deposited in the collection of the Czech University of Life Sciences, Prague, Czech Republic (CULSP). Adults are glued on one side to a stage, which is attached to a standard 38 mm insect pin. Data and determination labels are attached, and any dissected genitalia are stored in glycerol filled plastic micro-vials also attached to the specimen pin. Nomenclature is updated to follow that of the World Catalogue of Lonchaeidae (MacGowan 2023).

Species added to the faunas in this work.

Earomyia Zetterstedt, 1842

Earomyia argenta MacGowan, 2020

Material examined: **Czech Republic**: Třinec-Jahodná, 49.46N 18.43E, mixed forest, 400m, 21.iv.1985, leg. M. Barták. 6♂. Třinec-Sosna, 49.46N 18.44E, damp meadow, 340m, 21.iv.1985, leg.M. Barták. 1♂ 1♀. Bílina-Chloumek, 50.33N 13.50E, damp meadow, 8.v.1994, leg. M. Bartak. 1♀. Vráž nr. Písek, 49.402N 14.118E, Malaise trap alder forest, 430m, 24.3-28.iv.2010, leg. M. Barták. 1♀. Same data, 24.v-24.vi.2010, 8♀. Vráž nr. Písek, 49.398N 14.132E, Malaise trap near brook, 400m, 2.iv-10.v.2011, leg. M. Barták. 3♂. 21♀.

Comments: First described from Sweden in 2020 (MacGowan 2020) with an associated record from Denmark. The larval development site is unknown. This species is little known, and these are the first published records of its occurrence outside Scandinavia.

Earomyia grusia Morge, 1959

Material examined: **Czech Republic**: Vráž nr. Písek, 49.398N 14.132E, Malaise trap near brook, 400m, 10.v- 4. vi..2011, leg. M. Barták. 1♀.

Comments: An uncommon central European species, the larvae feed on the seeds of European Silver Fir (*Abies alba* Mill.).

Earomyia netherlandica MacGowan, 2004

Material examined: **Czech Republic**: Pečky - 1Km N, 15.05N 15.02E, *Salix* shrubs, 16.v.1988, leg. M. Barták. 1♂ 1♀. Bílina, Lom, 50.5833N 13.697E, near pond, 13-29.v.1998, leg. M. Barták. 1♀. Sázava - 5Km N, *Phragmites* growth,17-27.v.2001, leg. M. Barták. 1♀. **Slovak Republic**: Iža, Bokros, 47.751N 18.254E, marsh, 160m, 5-16.v.2017, leg. E. Vidlička & O. Majzlan. 1♂.

Comments: Originally described from the United Kingdom and the Netherlands in 2004 (MacGowan 2004) this species has been found sporadically in European locations. Nilsson-Örtman (2013) provides a record from Sweden. The species seems to be associated with reed beds and fens.

Priscoearomyia **Morge, 1963**

This genus previously known as *Protearomyia* McAlpine was re-assigned by MacGowan (2023). The following two species were only separated from *Priscoearomyia nigra* in 2014 and previous records given for *Priscoearomyia nigra* by Morge & Máca (1986) and the Checklist of Diptera of the Czech Republic and Slovak Republic will probably include these two cryptic species. The status of the genus in the Palearctic is reviewed by MacGowan & Reimann (2021).

Priscoearomyia rameli (MacGowan, 2014)

Material examined: **Czech Republic**: Vráž nr. Písek, 49.399N 14.1327E, near brook, 400m, 4-23.vi.2011, leg. M. Barták. 1♂.

Comments: Previously recorded from Germany, Greece, Spain, Sweden and Turkey (MacGowan & Reimann 2021).

Priscoearomyia withersi (MacGowan, 2014)

Material examined: **Czech Republic**: Jihlava-Pávov, 49.4405N 14.5955E, Malaise trap wetland near pond, 6.vi-5.vii.2009 leg. M. Barták. 1♂. Vráž nr. Písek 49.398N 14.132E, Malaise trap near brook, 400m, 4-23.vi.2011, leg. M. Barták. 2♂. Vráž nr. Písek, 49.403N 14.120E, Malaise trap near pond, 400m, 31.v-7.vi.2019, leg. M. Barták. 1♂.

Comments: Recently recorded from Moravia (Roháček et al. 2022), the above findings are new records from Bohemia. A species which occurs more commonly than *P. rameli*, previously recorded from Andorra, France, Germany, Greece, Poland, Russia (Mordovia), Spain, Sweden, Switzerland and the United Kingdom (MacGowan & Reimann 2021).

Lonchaea Fallén, 1820

Lonchaea angelina MacGowan, 2014

Material examined: **Czech Republic**: Šumava Mts., 1130m, - Zhůřské slatě, t49.06N 13.56E, Malaise trap peat-bog, 18.v-16.vi.1999, leg. M. Barták & Š. Kubík. 1♂. Jizerské hory, Šolcův rybnik, 50.880N 15.114E, Malaise trap, 350m 11-26.v.2011, leg. P. Vonička. 1♂.

Comments: A little-known species previously only recorded from Sweden and the United Kingdom. The larval substrate is unknown.

Lonchaea fraxina MacGowan & Rotheray, 2000

Material examined: **Czech Republic**: Vráž near Písek, 49.399N 14.1327E, near brook, 400m, 2.iv-10.v.2011, leg. M. Barták. 2♂. Jizerské hory, Šolcův rybník, 50.880N 15.114E, Malaise trap, 350m, 11-26.v.2011, leg. P. Vonička. 1♂.

Comments: A scarce species found over much of northern and central Europe. The larvae are associated with ash *Fraxinus excelsior* L.

Lonchaea krivosheinae Kovalev, 1973

Material examined: **Slovak Republic**: Cerová vrchovina, Tachty, 48.151N 19.926E, Malaise trap in meadow, 20.viii-16.ix.2021, leg. J. Roháček. 1♂.

Comments: Previously known from Czech Republic and other central European countries. The larval substrate is unknown.

Lonchaea lateralis MacGowan, 2016

Material examined: **Czech Republic**: Vráž near Písek, 49.4016N 14.11888E, Malaise trap Alnus woodland, 19.vii-10.viii.2010, leg. M. Barták. 1♂. Praha – Troja, 50.1208N 14.3986E, pyramidal trap baited with pig carcass, 24-31.vii.2012, leg. M. Barták. 1♂. Same data, 1-9.ix.2012. 1♂. **Slovak Republic**: Cerová vrchovina PLA, Gemerský Jablonec-Vodokáš, 48.2166N, 19.995E, Malaise trap edge of *Quercetum*, 250m, 15.vi-12.vii.2017, leg. J. Roháček, J. Ševčík & M. Tkoč. 1♂.

Comments: Originally described from Switzerland; this is a species which is most common in central and eastern Europe. The larval substrate is unknown.

Lonchaea ragnari Hackman, 1956

Material examined: **Czech Republic**: Vráž near PÍsek, 49.399N 14.1327E, 31.v-7.vi.2019, leg. M. Barták. 1♂.

Comments: A species most commonly associated with the *Betula* woods of northern and central Europe.

Lonchaea spicata MacGowan, 2008

Material examined: **Czech Republic**: Šumava - Malá Niva, 48.3097N 13.8225E, Malaise trap on peat bog, 750m, 29.iv-16.vi.1999, leg. M. Barták & Š. Kubík. 1♂. Vráž near Pisek, 49'23'59N 14'7'58E, Malaise trap near brook, 400m, 2.iv-10.v.2011, leg. M. Barták. 1♂. Same data, 10.v-1.vi.2011. 2♂. Same data, 30.iv-6.vi.2012. 1♂. Vráž near Písek, 49.4033N 14.1158E, Pyramidal trap over heap of decaying wood, 2.iv-10.v.2011, leg. M. Barták. 2♂. Same data, 10.v-1.vi.2011. 1♂. **Slovak Republic**: Polana B.R., Hrončecký grúň NNR, 48.682N 19.502E, 1050m, 13.v-15.vi.2016, leg. M. Tkoč. 1♂.

Comments: An apparently scarce species found over much of northern and central Europe. The larval substrate is unknown.

Lonchaea stelviana MacGowan, 2016

Material examined: **Czech Republic**: Bílina, Chloumek, 50.5438N 13.8588E, Malaise trap on hilltop steppe, 480m, 13-28.v.1998, leg. M. Barták. 1♂.

Comments: From the available evidence this would seem to be a sub-montane species. Originally known from a specimen taken at 950 m in the Italian Alps in 2005 (MacGowan 2016) with an unpublished record from 900m in Saxony, Germany in 2017.

Lonchaea tenuicornis Kovalev, 1978

Material examined: **Czech Republic**: Podyjí NP, nad Šobesem, 48.8175N, 15.9775E, forest-steppe, 2.vi-2.vii.2003, leg. M. Barták & Š. Kubík. 1♂.

Comments: This species was confused under *L. laticornis* in the CULSP collection. An uncommon species found widely across Europe.

Lonchaea vikhrevi MacGowan, 2010

Material examined: **Czech Republic**: Popovice env., 49.917N 14.658E, car net, 16.v.1992, leg. M. Barták. 1♂.

Comments: Previously only known from the Moscow region of the Russian Federation (MacGowan 2011) and from eastern China (MacGowan & Barták 2022). The larval substrate is unknown.

Further records of *Lonchaea iona* MacGowan, 2001, a species added by Máca et al. (2016)

Material examined: **Czech Republic**: Vráž near Písek, 49.399N 14.1327E, Malaise trap near brook, 400m, 10.v-1.vi.2011, leg. M. Barták.1♂. Vráž near Písek, 49.4033N 14.1158E, Pyramidal trap over heap of decaying wood, 30.4-6.6.2012, leg. M. Barták. 1♂.

Comments: A scarce species found over much of northern and central Europe. The larval substrate is unknown but it is most likely to be decaying wood.

Species included in previous checklists which are now removed due to taxonomic changes.

Earomyia inquilina (Hendel in Seitner, 1929)

Recorded in the 2009 checklist from CZ (M). This species is now considered as *nomen dubium* (MacGowan 2023: 34).

Lonchaea britteni Collin, 1953

Recorded in the 2009 checklist from CZ (B M). This species is now regarded as a junior synonym of *Lonchaea corusca* (MacGowan 2006: 102).

Lonchaea laticornis Meigen, 1826

Recorded in the 2009 checklist from CZ (B M). SK. *L. laticornis* was originally considered as a single species but is now recognised as representing a larger species-group with species within it only distinguishable by examination of the male terminalia. It is not possible to allocate the holotype female of *L. laticornis* to any of these more recently named species and, as a result, the name *Lonchaea laticornis* is, at the present time, applied only to the holotype (MacGowan 2023: 75). Specimens previously determined as *L. laticornis* in the CULSP collections were either females, whose identity could not be confirmed, or mis-identified males.

Lonchaea laxa Collin, 1953

Recorded in the 2009 checklist from CZ (B) SK. This species is now regarded as a junior synonym of *Lonchaea affinis* Malloch, 1920 (MacGowan 2019: 171).

Species recorded in the literature but not included.

Lonchaea stigmatica Czerny,1934
Although not included in any previous checklist this species was recorded from Slovakia by Straka & Majzlan (2007). However, as MacGowan (2023: 76) points out *L. stigmatica*, which was originally considered as one species, is now recognised as being part of a larger species-group with many cryptic species distinguishable only by the male terminalia. At present it is not possible to allocate the holotype female to any of these more recently named species and the name now is applied only to the holotype until further taxonomic evidence is available. It is most likely that the specimen from Slovakia is an individual of *Lonchaea angelina*, *L. fraxina* or *L. iona*.

Revised checklist
*Added since the 2009 checklist.
Lonchaeidae Loew, 1862
Dasiopinae Morge, 1963
Dasiops Rondani, 1856
appendiculatus Morge, 1959. CZ (B), SK
calvus Morge, 1959. CZ (B, M), SK
facialis Collin, 1953. CZ (B, M), SK
hennigi Morge, 1959. CZ (B)
latifrons (Meigen, 1826). CZ (M), SK
mucronatus Morge, 1959. CZ (B, M)
noctuinus Morge, 1959. CZ (B)
perpropinquus Morge, 1959. CZ (B, M), SK
spatiosus (Becker, 1895). CZ (B, M), SK
trichosternalis Morge, 1959. CZ (B)
Lonchaeinae Loew, 1862
Chaetolonchaea Czerny, 1934
brevipilosa Czerny, 1934. CZ (B, M), SK
dasyops (Meigen, 1826). CZ (B, M), SK
pallipennis (Zetterstedt, 1855). CZ (B, M)
Earomyia Zetterstedt, 1842
argenta MacGowan, 2020. CZ (B*, M*)
adriatica (Becker, 1895). SK
albifacies (Czerny, 1934) **Note 1**. CZ (B)
crystallophila (Becker, 1895). CZ (B), SK
grusia Morge, 1959. CZ* (B)
impossibile Morge,1959. CZ (B, M), SK
lonchaeoides Zetterstedt, 1848. CZ (B), SK*
netherlandica MacGowan, 2004. CZ* (B), SK*
schistopyga Collin,1953. CZ (B)

tomskensis Morge, 1959. CZ (B, M)
viridana (Meigen, 1826). CZ (B, M), SK
virilis Collin, 1953. CZ (B, M), SK
Priscoearomyia Morge, 1963
greciana (McAlpine,1962). CZ (B)
nigra (Meigen, 1826). CZ (B, M), SK
rameli (MacGowan, 2014). CZ* (B)
withersi (MacGowan, 2014). CZ* (B, M)
Lonchaea Fallén, 1820
affinis Malloch, 1920. CZ* (B, M)
angelina MacGowan, 2014. CZ* (B)
bruggeri Morge, 1967. CZ (B)
bukowskii Czerny, 1934. CZ (B)
carpathica Kovalev, 1974. CZ (B, M), SK
caucasica Kovalev, 1974. CZ (B)
chorea (Fabricius, 1781). CZ (B, M), SK
collini Hackman, 1956. CZ (B)
contigua Collin, 1953. CZ (B, M), SK
contraria Czerny, 1934. CZ (B, M), SK
corusca Czerny, 1934. CZ (B)
deutschi Zetterstedt, 1838. CZ (M), SK
fraxina MacGowan & Rotheray, 2000. CZ* (B)
fugax Becker, 1895. CZ (B, M), SK
gorodkovi Kovalev, 1974. CZ (B)
hackmani Kovalev, 1981. CZ M, SK
hirticeps Zetterstedt, 1838. CZ (M)
hyalipennis Zetterstedt, 1847. CZ (B, M), SK
iona MacGowan, 2001. CZ* (B)
krivosheinae Kovalev, 1973. CZ (M), SK*
lateralis MacGowan, 2016. CZ* (B), SK*
limatula Collin, 1953. CZ (B, M), SK
nitens (Bigot, 1885). CZ (M)
obscuritarsis Collin, 1953. CZ (B, M)
palposa Zetterstedt, 1847. CZ (B, M), SK
patens Collin, 1953. CZ (B, M), SK
peregrina Becker, 1895. CZ (B, M), SK*
postica Collin, 1953. CZ (B, M), SK
ragnari Hackman, 1956. CZ* (B)
scutellaris Rondani, 1874. CZ (B, M), SK
seitneri Hendel, 1928. CZ (B, M)
sororcula Hackman, 1956 **Note 2**. (CZ (B)
spicata MacGowan, 2008. CZ* (B), SK*

stackelbergi Czerny, 1934. CZ (B, M), SK
stelviana MacGowan, 2016. CZ* (B)
subneatosa Kovalev, 1974. CZ (B, M)
sylvatica Beling, 1873. CZ (B, M), SK
tarsata Fallén, 1820. CZ (B, M), SK
tenuicornis Kovalev, 1978. CZ* (M)
ultima Collin, 1953. CZ (B, M)
vikhrevi MacGowan, 2011. CZ* (B)
zetterstedti Becker, 1902. CZ (B, M), SK

Silba Macquart, 1851
fumosa (Egger, 1862). CZ (B, M), SK **Note 3**
retalionis (McAlpine, 1964) **Note 4**. CZ (delete B, M), SK

Note 1.
We have identified specimens labelled as *Earomyia albifacies* in the CULSP collections as actually being *Earomyia argenta* or *Earomyia netherlandica*. We suggest that a further review of Czech and Slovak material is required to confirm the presence of this species on the checklist.

Note 2.
Introduced to the Czech fauna by Máca (1997) on the basis of a single female from Bohemia with further published records by Máca et. al (2016) based on two females from the Krkonoše Mountains. *Lonchaea sororcula* is a member of the *Lonchaea affinis* species-group which currently contains three Palearctic species with a fourth awaiting description, all of which occur in central Europe. This species remains on the Czech and Slovak checklist but we consider that a male is required to confirm its status.

Note 3.
Máca (2009) introduced this species in the genus *Setisquamalonchaea* Morge, 1963. It was subsequently transferred to *Silba* Macquart, 1851 by MacGowan & Okamoto (2013). Confirmation of its affiliation to the genus *Silba* is being undertaken by the study of DNA data available in the BOLD system.

Note 4.
Specimens labelled as this species (as *Lonchaea retalionis*) which we have examined in the CULSP collections were either females or mis-identified males. *Silba retalionis* is an enigmatic species which is apparently only known with certainty from the male holotype taken at 1000m in the Pyrenees (McAlpine 1964). Unfortunately, the male genitalia, which are usually required to confirm species identity in this genus, have not been illustrated and *S. retalionis* may possibly represent a form of the common *Silba fumosa.* Although his species still

remains on the Czech and Slovak checklist, we consider that a full review its specific status is required. Nevertheless, the record of this species from Osecká in Bohemia (Barták 1995) included by Máca (2009) was erroneous; no specimen determined as *S. retalionis* from Bohemia exists.

References

Barták M. 1995. Diptera communities of "Osecká" dump near Duchcov and its environment. In: Bitušík P; ed. *Dipterologica bohemoslovaca*, Vol. 7. Technical University, Zvolen, pp. 5–16.

Carles-Tolrá M. 2013. Fauna Europaea: Lonchaeidae. In: Pape T, Beuk P, eds. *Fauna Europaea: Diptera, Brachycera. Fauna Europaea version 2.6.2.* http://www.faunaeur.org Recently unavailable.

Jedlička L., Kúdela M. & Stloukalová V. (eds). 2009. *Checklist of Diptera of the Czech Republic and Slovak Republic*. Electronic version 2. http://zoology.fns.uniba.sk/diptera2009 + CD-ROM: ISBN 978-80-969629-4-5. Accessed 28 December 2023.

Máca J. 1997. New and interesting records of Lonchaeidae (Diptera) from the Czech and Slovak Republics. In Vaňhara J. & Rozkošný R. (eds): Dipterologica bohemoslovaca Vol. 8. *Folia Facultatis Scientiarium Naturalium Universitatis Masarykianae Brunensis, Biologia* 95: 107-110.

Máca J. 2009. Lonchaeidae; In Jedlička, L., Kúdela, M. & Stloukalová, V. *Checklist of Diptera of the Czech Republic and Slovak Republic*. Electronic version 2, 2009. DIPTERA CZ & SK

Máca J. 2014. Faunistické zajímavosti z obrazovky počítače. (Faunistic records from the PC monitor). *Živa* 64 (5): CXIX–CXX. (In Czech).

Máca J., Barták M. & Vaněk J. 2016. Kopinatkovití (Diptera, Lonchaeidae) české části Krkonoš. Lance flies (Diptera, Lonchaeidae) in the Czech part of the Krkonoše Mts. *Opera Corcontica* 53: 211–218.

MacGowan I. 2004. New species of Palaearctic Lonchaeidae (Diptera). *Dipterists Digest*, Second Series, 11, 25–32.

MacGowan I. 2006. Further additions and changes to the fauna of British Lonchaeidae (Diptera). *Dipterists Digest*, Second Series, 13 (2), 101–102.

MacGowan I. 2011. A new species of Lonchaeidae (Diptera: Schizophora) from Russia. *Russian Entomological Journal*, 19(4), 325–326. [2010] https://doi.org/10.15298/rusentj.19.4.05

MacGowan I. 2016. Lonchaeidae. *In*: Diptera Stelviana 2. *Studia Dipterologica Supplement*, 21, 109–116.

MacGowan I. 2019. *Earomyia argenta* sp. nov. (Diptera: Lonchaeidae) from Sweden with a revised checklist and province catalogue. *Entomologisk Tidskrift,*140, 167-174.

MacGowan I. 2023. World Catalogue of the family Lonchaeidae (Diptera, Cyclorrhapha, Acalyptratae). *Zootaxa* 5307(1): 1–96. https://doi.org/10.11646/zootaxa.5307.1.1.

MacGowan I. & Okamoto T. 2013. New species of Lonchaeidae (Diptera: Schizophora) from Japan and a re-evaluation of genus *Setisquamalonchaea* Morge. Entomological Science, 16, 196–202. https://doi.org/10.1111/ens.12003

MacGowan I. & Barták M. 2022. An annotated list of Lonchaeidae (Diptera) from China, Cambodia and Vietnam with description of a new species. *Far Eastern Entomologist*, 447, 10–16. https://doi.org/10.25221/fee.447.2

MacGowan I. & Reimann A. 2021. A new species of *Protearomyia* (Diptera, Lonchaeidae) with a review of the genus in the Palearctic. *Zootaxa*, 4966 (4), 487–493. https://doi.org/10.11646/zootaxa.4966.4.8.

MacGowan I. & Rotheray G.E. 2021. Lonchaeidae (lance flies), Chapter 67. pp.1587–1596. In Kirk–Spriggs, A.H. & Sinclair, B.J. (eds), Manual of Afrotropical Diptera. Volume 3. Brachycera: Cyclorrhapha, excluding Calyptratae. *Suricata* 6. South African National Biodiversity Institute, Pretoria.

McAlpine J.F. 1964. Descriptions of New Lonchaeidae (Diptera) II. *The Canadian Entomologist*, 96 (5), 701–757. https://doi.org/10.4039/Ent96701-5.

Morge G. 1962. Monographie der palaearktischen Lonchaeidae. [IV]. *Beiträge zur Entomologie*, 12 (3–4), 381–434. https://doi.org/10.21248/contrib.entomol.12.3-4.381-434.

Morge G. & Máca J. 1986. Lonchaeinae (Diptera: Lonchaeidae) of CzechoSlovak Republic - present state of faunistics. *Beiträge zur Entomologie*, 36, 237 - 244.

Nilsson-Örtman V. 2013. Stjärtflugor (Diptera: Lonchaeidae) i Europa och första fyndet för Norden av den ovanlig arten *Earomyia netherlandica. Entomologisk Tidskrift* 134(4), 197-201.

Roháček J, Černý M, Ebejer M.J, & MacGowan I. 2022. New and interesting records of Diptera on glacial sand deposits in Silesia (NE Czech Republic). Part 3 – Acalyptratae 2. *Acta Musei Silesiae Scientiae Naturales* 70: 195–224.

Straka V. & Majzlan O. 2007. Dvojkrídlovce (Diptera) PR Ostrov Kopáč pri Bratislave. (Diptera of the Nature Preserve, Kopáč Island near Bratislava). In: Majzlan O, ed, Príroda ostrova Kopáč. Fytoterapia OZ, Bratislava, pp. 233–260.

Straka V. & Majzlan O. 2008. Flies (Diptera) of the Martinský les wood near Viničné. *Naturae tutela (Liptovský Mikuláš)* 12: 69–78.

Ants (Hymenoptera: Formicidae) of photovoltaic power plant sites depending on the geographical location of the facility

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Abstract

Field research was carried out focusing on the species composition of myrmecofauna in two photovoltaic power plant sites with different locations within the Czech Republic: Ralsko in the Hercynian mesophytic zone of northern Bohemia (50°35'59"N, 14°53'36"E env., 340 m a. s. l.) and Žabčice near Židlochovice in the Pannonian thermophytic zone of southern Moravia (49°00'11"N, 16°35'59"E env., 190 m a. s. l.). The aim was to compare the species composition and identify differences. A total of 13 species of ants were found, and the fauna of both sites differs significantly, sharing only one species. Three legally protected species were recorded: *Formica cunicularia*, *F. fusca* and *F. rufibarbis*.

Keywords: Solar power station, natural conditions, faunal impact, species diversity, protected species

Introduction

Ants (Hymenoptera: Formicidae) are an ecologically key group of social insects with a global distribution, currently comprising approximately 14,300 described species (AntWeb, 2025). However, including undescribed and cryptic species, their total number may reach up to 20,000 (Schultheiss et al., 2022). The total biomass of ants on Earth has recently been estimated at over 12 megatons of dry matter, representing a substantial proportion of the biomass of terrestrial animals (Schultheiss et al., 2022). Due to their ecological plasticity, high abundance and diverse life strategies, ants play a crucial role in the functioning of terrestrial ecosystems. They are often referred to as "ecosystem engineers" because they shape their environment on a scale that exceeds their body size. Through their nest building and foraging activities, they significantly influence soil structure, contribute to aeration and nutrient redistribution (Del Toro et al., 2012). Their interspecific interactions include mutualism with aphids, predation, and competition, thereby significantly influencing food webs. Due to their sensitivity to environmental changes and ability to rapidly colonize disturbed habitats, many species are also used as bioindicator organisms. Based

on their abundance, species diversity and community structure, it is possible to infer habitat quality and ecological status, including disturbance levels, successional stages or the presence of pollution (Andersen, 1997; Underwood & Fisher, 2006). We believe that it is important to study this group in human-altered habitats, such as photovoltaic power plants.

Solar energy is considered one of the cleanest, most flexibly usable and cheapest renewable energies (Lugo-Laguna et al., 2021). Its use has been growing exponentially worldwide in recent decades, and this trend is expected to continue (Walston et al., 2021). The use of solar technology has basically gone in two directions: photothermal capture and use = concentrating solar power (CSP) and photovoltaic (= PV).

In the case of CSP, mirrors are used that concentrate energy on a small receiver area, where the thermal energy is used either directly or indirectly to drive a turbine (Boretti, 2018). Photothermal power plants can be built where there is high natural radiation (Del Río et al., 2018). This technology is not suitable for use in the Czech Republic and, due to the costs and impacts on the environment and fauna, it appears to be problematic even on a global scale.

PV uses the photovoltaic effect (Eicke et al., 2022). In semiconductor cells, sunlight releases charge carriers (electrons) that create an electric field. There are three main types of PV cells: monocrystalline, polycrystalline (the latter are cheaper to produce) and amorphous (Chaar et al., 2011). PV cells are assembled into PV panels, which are the basic element of each PV plant and can be installed in different locations and at different angles to the predominantly incident light. These installations are the only type used in the Czech Republic.

All potovoltaic power plants have a demonstrable impact on the diversity of the area in which they are built, which consists in changing habitat conditions. This change can be positive or negative, depending on the quality of the environment in which the facility is built and how the internal environment is managed (Fleming, 2025). The density of the PV panels is one of the main factors that determine the predominant impact of photovoltaics on biota. Other important factors are the methods of managing vegetation between and under the panels. The geographical location of such a power plant can also be of great importance for the fauna of the PV area. Below we present an output to highlight the influence of the geographical location of the PV site on the fauna that inhabits it.

Materials and Methods

The research was conducted at two locations with operating PV power plants. For comparison, photovoltaic sites located in different bioregions were selected:

Photovoltaic site A. Ralsko in the Liberec Region at an altitude of 340 m above sea level, in the mesophytic zone of Hercynicum, which is characterized by the humid climate of the given area of northern Bohemia, but not yet downright harsh

(coordinates on middle point 50°35'59"N, 14°53'36"E, faunistic mapping square is 5455).

Photovoltaic site B. Žabčice near Židlochovice in the South Moravian Region (190 m a. s. l.), in the thermophytic Pannonia, whose climate is very dry and relatively warm (coordinates 49°00'11"N, 16°35'59"E, faunistic mapping square 6965).

Both PV power plants have the same arrangement of panels: in rows about 4 m wide and with grassed gaps of at least the same width between the rows. During the year, the grass is repeatedly cut to a low stalk in both PV power plants.

The material was obtained in 2023. A total of nine pitfall traps were placed in each photovoltaic area, among other things, to capture ants. The traps were filled with vinegar, and the traps were regularly collected during the season. The material from them was sorted and identified according to the available literature (Czechowski et al. 2002, Seifert 2018) and compare with our collection funds (V. Vrabec det.). A substantial part of the material was revised by Dr. P. Werner.

Results

A total of 1703 individual ant workers belonging to 13 species were processed, of which three species of the genus *Formica* are protected by law. When we started the research, we did not expect the occurrence of specially protected species. Therefore, the worker ants of the genus *Formica* were captured completely by chance. The taxa in the overview below are sorted alphabetically.

Formicinae
Formica cunicularia Latreille, 1798: B (legally protected species, endangered)
Formica fusca Linnaeus, 1758: A (legally protected species, endangered)
Formica rufibarbis Fabricius, 1793: B (legally protected species, endangered)
Lasius fuliginosus (Latreille, 1798): B
Lasius niger (Linnaeus, 1758): A, B
Polyergus rufescens (Latreille, 1798): B

Myrmicinae
Myrmica rubra (Linnaeus, 1758): A
Myrmica sabuleti Meinert, 1861: B
Myrmica scabrinodis Nylander, 1846: A
Myrmica schencki Viereck, 1903: B
Myrmica specioides Bondroit, 1918: B
Tetramorium caespitum (Linneaues, 1758): B

Dolichoderinae
Tapinoma erraticum (Latreille, 1798): B

The distribution of the number of individuals captured by each species is shown in Figure 1.

4. Discussion

The ant fauna from pitfall traps in differently geographically situated photovoltaic power plants differs significantly in its composition. The PV Žabčice located in Pannonia (B) is richer in species, where we found a total of 10 ant species, in contrast to the PV Ralsko in the north in Hercynicum (A) that showed the presence of a total of 4 species. We attribute these differences to climatic differences related to the geographical location of the investigated areas. Warmer conditions in the south probably determine the presence of a larger number of species in the investigated area.

The most numerous species was *Lasius niger* (1 081 individuals determined), which was present in both localities, with a high dominance. On the other hand, the species *Lasius fuliginosus*, *Tetramorium caespitum* and *Formica cunicularia* were only very rarely recorded. Also interesting is the discovery of the slave-making ant *Polyergus rufescens*, which socially parasitizes other ants and is unable to take care of its colony without the enslaved workers of other species (cf. e.g. Amcha 2015).

Legally protected species were confirmed in both locations (A: *Formica fusca* and B: *Formica cunicularia* and *F. rufibarbis*), so it can be stated that photovoltaic sites represent a suitable environment for protected species.

There are not many sources available for comparison on the fauna of ants in PV power plants. Grodsky et al. (2023) monitored the representation of ants in various microhabitats of a different type of power plant (CSP) in the Mojave Desert in the USA. They found a total of 20 species, i.e. more than the results presented here from the Czech Republic (species composition cannot be compared due to methodology and geographical differences). However, they used a significantly higher number of traps and also installed them in significantly different places, so the captured diversity must have been higher. Taking these facts into account, we could probably conclude that the overall fauna of ants in the Czech Republic PV stations is quite species-rich, but uneven in the numerical representation of species. The question is whether the high numbers of *Lasius niger* individuals can be justified by grass mowing management practices in PV areas (cf. Stukalyuk et al., 2023) or whether it is a natural phenomenon in the given areas. The impact of mowing on ant populations in PV power plants may be a suitable topic for further studies.

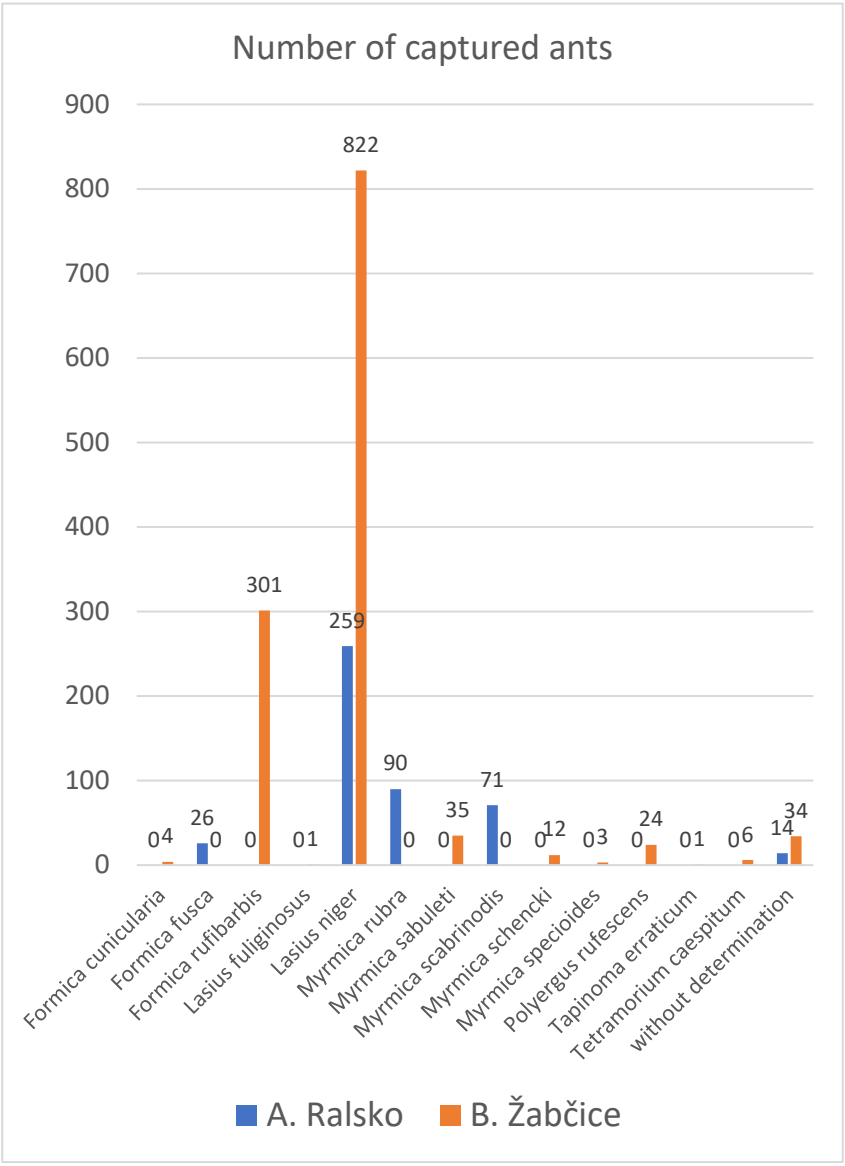

Figure 1: Numbers of captured ants in the studied PV power plants.

Acknowledgements

We would like to thank of company ČEZ, a. s. for their interest in studying photovoltaic power plants and their agreement to publish these results. Personally we thank (without mentioning their titles) A. Laciok and G. Licková. We have special thank P. Werner for his help in accurately identifying the ants. We would also like to thank M. Barták for his valuable comments on the text.

References

Amcha P. 2015. Loupeživé výpravy a rozmnožování u otrokářských mravenců a další případy sociálního parazitismu. *Živa*, 2015(2): 82-84. (In Czech).

Andersen A. N. 1997. Using ants as bioindicators: multiscale issues in ant community ecology. *Conservation Ecology*, 1997, *1*(1): 8.

AntWeb. *AntWeb species list*. 2025 [online]. Available from: https://www.antweb.org

Boretti A. 2018. Cost and production of solar thermal and solar photovoltaics power plants in the United States. *Renewable Energy Focus*. 26, 93–99.

Chaar L., Lamont L. A. & Zein N. 2011. Review of photovoltaic technologies. *Renewable and Sustainable Energy Reviews*, 15(5), 2165-2175.

Czechowski W., Radchenko A. & Czechowska W. 2002: *The ants (Hymenoptera, Formicidae) of Poland*. Museum and Institute of Zoology PAS, Warszawa, 200 pp.

Del Toro I., Ribbons R. & Pelini S. 2012. The little things that run the world revisited: a review of ant-mediated ecosystem services and disservices (Hymenoptera: Formicidae). *Myrmecological News*, 17: 133–146.

Eick L., Eicke A. & Hafner M. 2022. *Solar Power generation*. Pp. 157-169. In: Hafner, M., Luciani, G. (ed.): The Palgrave Handbook of International Energy Economics. Springer Nature Switzerland AG., 770 pp.

Fleming P. A. 2025. All that glitters – Review of solar facility impacts on fauna. *Renewable and Sustainable Energy Reviews*, 224, 115995.

Grodsky S. M., Roeder K., & Campbell J. 2023. Effects of solar energy development on ants in the Mojave Desert. *Ecosphere*, 14(12), e4668.

Lugo–Laguna D., Arcos–Vargas A. & Nuñez–Hernandez F. 2021. A European Assessment of the Solar Energy Cost: Key Factors and Optimal Technology. *Sustainability*, 13(6), 3238.

Río P., Peñasco C. & Mir-Artigues P. 2018. An overview of drivers and barriers to concentrated solar power in the European Union. *Renewable and Sustainable Energy Reviews*, 81(1), 1019-1029.

Schultheiss P., Nooten S. S., Wang R., Wong M. K. L., Brassard F. & Guénard B. 2022.The abundance, biomass, and distribution of ants on Earth. *Proceedings of the National Academy of Sciences*, 119(40).

Seifert B. 2018: *The Ants of Central and North Europe*. Lutra Verlag, Boxberg, 407 pp.

Stukalyuk S. Goncharenko I. & Kozyr M. 2023. Study of Ecological Characteristics of Lasius niger (Hymenoptera, Formicidae) Using Vegetation Data. *Zoodiversity* 57:529-544.

Underwood E. C. & Fisher B. L. 2006. The role of ants in conservation monitoring: if, when, and how. *Biological Conservation*, *132*(2): 166–182.

Walston L. J., Li, Y., Hartmann H. M., Macknick J., Hanson A., Nootenboom C., Lonsdorf E. & Hellmann J. 2021. Modeling the ecosystem services of native vegetation management practices at solar energy facilities in the Midwestern United States. *Ecosystem Services*, 47, 101227.

Gastrointestinal Nematodes in Non-specific Hosts: A Review

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Abstract
Gastrointestinal (GI) nematodes represent a diverse group of parasitic helminths from several families that infect ruminant livestock, wild ruminants, and, in some cases, other mammals. Under certain conditions, these parasites can be transmitted to atypical hosts, which may lead to altered disease manifestations and changes in transmission dynamics within populations. Cross-species infections occur mainly through contact on pastures, at watering points, or via contaminated feed. The course of infection varies according to the host's nutritional status and body condition, immune competence, and environmental factors. In non-specific hosts, GI nematode larvae may undergo atypical migration, cause tissue damage, lead to loss of condition, or reduce reproductive performance. Some species possess zoonotic potential and therefore pose a risk to people in direct contact with animals or when handling meat and organs. Modern molecular-genetic methods allow precise determination of the parasite species and the origin of infection in complex multi-host systems. The health and economic impacts of these infections require the application of the One Health approach, which integrates veterinary, public health, and environmental measures and acknowledges the interconnection between the health of humans, animals, and ecosystems.

Keywords**:** Gastrointestinal tract; *Haemonchus*; Ruminants; Cross-species transmission

Introduction

Gastrointestinal nematodes comprise a taxonomically diverse group of pathogens affecting livestock and wild mammals, particularly ruminants. They include members of the Trichostrongylidae, Strongylidae, Ascarididae and Trichuridae, distributed across all climatic zones and causing considerable economic losses in animal production (Gruner et al. 1994; Königová et al. 2008). While many species are highly adapted to specific hosts, there are numerous situations in which they are transmitted to non-specific hosts. This process, referred to as "spillover" or "spillback," can occur between domestic and wild

ruminants as well as between other animal groups (Stott et al. 2009; Valderas-García et al. 2022).

For clarity, this review focuses on gastrointestinal nematodes of ruminants and their cross-species transmission at the wildlife–livestock interface; classical human soil-transmitted helminths (e.g., *Ascaris lumbricoides*, *Trichuris trichiura*, *Ancylostoma duodenale*, *Necator americanus*) are outside the scope of this article.

Cross-species transmission is facilitated by shared pastures, watering points, supplementary feeding sites, as well as translocation programs and wildlife rescue facilities (Murphy et al. 2011). In a novel host, infection may be subclinical or, conversely, result in severe pathological changes due to a different immune response and parasite behaviour, including aberrant larval migration (Ziam et al. 1999; Peña et al. 2004). In livestock, such infections contribute to reduced weight gain, milk yield, and fertility, while in wild populations they may affect body condition and survival (Douch et al. 1996; Cuquerella & Alunda 2009).

Some species of GI nematodes possess zoonotic potential, posing a risk to farm workers, hunters, and meat processors (White et al. 2007). Studying these interactions and transmission routes is therefore essential for protecting the health of animals, humans, and ecosystems, and requires a coordinated approach within the One Health framework (a collaborative approach uniting human, animal and ecosystem health).

Results

Host range and cross-species transmission

Gastrointestinal nematodes of domestic ruminants are typically closely associated with their natural hosts, yet numerous documented cases demonstrate their ability to infect other animal species. *Haemonchus contortus* (Rudolphi, 1803), primarily a parasite of sheep and goats, has been repeatedly detected in white-tailed deer (*Odocoileus virginianus*) and other wild ruminants sharing pastures with domestic herds (Gruner et al. 1994; Königová et al. 2008). Similarly, *Teladorsagia circumcincta* (Stadelmann, 1894), a common parasite of sheep, can also occur in mouflon and wild sheep, with infections ranging from asymptomatic carriage to mortality in weakened individuals (Stott et al. 2009; Valderas-García et al. 2022).

Experimental studies have shown that some representatives of the family Trichostrongylidae can survive in laboratory models such as gerbils or rabbits (Conder et al. 1990; Conder et al. 1992; Ziam et al. 1999). Infection with *H. contortus* in gerbils resulted in limited development of adult nematodes and shorter survival (Audebert et al. 2004), whereas *Graphidium strigosum* (Dujardin, 1845) in rabbits became fully established and caused damage to the gastric mucosa (Audebert et al. 2003; Cuquerella & Alunda 2009;

Massoni et al. 2011). These models are valuable for studying pathogenesis, host immune responses, and evaluating the efficacy of anthelmintics (Douch et al. 1996).

Factors promoting cross-species transmission include high stocking densities on pastures, mixed grazing systems, shared watering points and feeding sites, as well as climatic conditions favouring the survival of infective stages in the environment. Translocation of animals between regions or to rescue facilities can also facilitate the introduction of parasites into new populations (Gruner et al. 1994; Valderas-García et al. 2022; Murphy et al. 2011).

GI nematode infections in non-specific hosts are often characterised by lower establishment rates and reduced fecundity of adult worms, leading to incomplete or short-lived infections (Audebert et al. 2004; Cuquerella & Alunda 2009). In some cases, however, the parasite undergoes an altered migratory cycle in the new host, which may result in localisation in atypical tissues and severe pathological effects (Peña et al. 2004; Ziam et al. 1999). Aberrant larval migration can cause damage to organs that are not the primary target of infection, such as the lungs, liver, or central nervous system. Clinical manifestations in non-specific hosts therefore vary widely, ranging from subclinical carriage to severe disease with anaemia, cachexia, or neurological signs (Ziam et al. 2000). Differences in the course of infection are often linked to the host's immune response, which may be ineffective against the parasite or, conversely, excessive, thereby increasing the extent of tissue damage (Douch et al. 1996; Ziam et al. 2000; Audebert et al. 2004).

Pathogenesis

The course of infection with GI nematodes varies according to parasite species, host age and condition, and infection intensity. In specific hosts, ingestion of infective stages is followed by a stable migratory cycle leading to the development of sexually mature parasites in the target organ, most often the GI tract (Gruner et al. 1994). Larval stages of *H. contortus* penetrate the abomasal mucosa, where they develop into blood-feeding adults, causing anaemia and hypoproteinaemia (Königová et al. 2008). Similarly, *T. circumcincta* damages the abomasal glands and alters pH, thereby reducing the host's digestive capacity (Audebert et al. 2003; Stott et al. 2009).

The host immune response plays a key role in pathogenesis. In specific hosts, partial immunity develops, limiting the intensity of reinfection, whereas in non-specific hosts the response may be insufficient or, conversely, excessive. An exaggerated inflammatory reaction can cause more extensive tissue damage than the presence of the parasite itself (Douch et al. 1996). Experimental models such as gerbils and rabbits demonstrate that the degree of damage depends on a combination of factors – parasite virulence, host immune competence, and

duration of infection (Douch et al. 1994; Audebert et al. 2004; Cuquerella & Alunda 2009).

Implications for zoonoses

Several GI nematode species are capable of infecting humans, either through direct contact with animals or via contaminated food or water (Honcharov et al. 2022; Shuai et al. 2025). The risk is particularly high for species pathogenic to both livestock and wild mammals, as multi-host cycles increase the likelihood of human exposure (Stott et al. 2009; Murphy et al. 2011). Human infections are frequently associated with handling raw meat during slaughter, skinning, or organ processing, as well as with the consumption of undercooked animal products (Peña et al. 2004; Honcharov et al. 2022; Shuai et al. 2025). The main food-borne risk highlighted in recent literature involves fish-borne taxa such as *Eustrongylides*. In contrast to fish-borne nematodes (e.g., *Eustrongylides*), ruminant GI nematodes of the family Trichostrongylidae are only rarely implicated in human disease (Honcharov et al. 2022; Shuai et al. 2025). In zoonotic species, the course of infection in humans can range from asymptomatic carriage to severe clinical forms involving gastroenteritis, anaemia, or visceral larval migration (Peña et al. 2004).

The occurrence of these diseases has not only health impacts but also socio-economic consequences, especially in developing regions where veterinary control is insufficient and wildlife monitoring is minimal (Stott et al. 2009; Valderas-García et al. 2022). An integrated approach based on the principles of One Health allows better tracking of transmission routes, identification of at-risk populations, and implementation of preventive measures that consider the health of humans, animals, and the environment (White et al. 2007; Honcharov et al. 2022).

Summary

GI nematodes represent an important group of pathogens capable of infecting a wide range of hosts, from livestock and wild ruminants to humans.The review of the literature indicates that cross-species transmission is facilitated by a combination of ecological, husbandry, and climatic factors, and that infections in non-specific hosts may exhibit an altered course and more severe pathological manifestations. Experimental infection models provide valuable insights into mechanisms of pathogenesis and host immune responses, which are relevant for diagnostics and the development of effective preventive measures.

From a public health perspective, zoonotic species are of particular importance, with transmission routes often involving both direct contact with animals and the food chain. An integrated One Health approach is essential for monitoring the occurrence of these parasites, minimising risks to both humans and animals, and ensuring sustainable livestock management and the protection of wild populations.

References

Audebert F., Vuong P.N. & Durette-Desset M.-C. 2003 Intestinal migrations of Trichostrongylus retortaeformis (Trichostrongylina, Trichostrongylidae) in the rabbit. Veterinary Parasitology, 112, 131–146. https://doi.org/10.1016/S0304-4017(02)00386-2

Audebert F., Cassone J., Kerboeuf D. & Durette-Desset M.-C. 2004 Development of Nematodirus spathiger (Nematoda, Molineoidea) in the rabbit and comparison with other Nematodirus spp. parasites of ruminants. Parasitology Research, 94, 112–117. https://doi.org/10.1007/s00436-004-1180-y

Conder G.A., Jen L.-W., Marbury K.S., Johnson S.S., Guimond P.M., Thomas E.M. & Lee B.L. 1990 A novel anthelmintic model utilizing jirds (Meriones unguiculatus) infected with Haemonchus contortus. Journal of Parasitology, 76, 168–170. https://doi.org/10.2307/3283008

Conder G.A., Johnson S.S., Hall A.D., Fleming M.W., Mills M.D. & Guimond P.M. 1992 Growth and development of Haemonchus contortus in jirds, Meriones unguiculatus. Journal of Parasitology, 78(3), 492–497. https://doi.org/10.2307/3283650

Cuquerella M. & Alunda J.M. 2009 Immunobiological characterization of Graphidium strigosum experimental infection in rabbits (Oryctolagus cuniculus). Parasitology Research, 104, 371–376. https://doi.org/10.1007/s00436-008-1206-y

Douch P.G.C., Green R.S. & Morris C.A. 1994 Antibody responses of sheep to challenge with Trichostrongylus colubriformis. International Journal for Parasitology, 24, 921–928. https://doi.org/10.1016/0020-7519(94)90155-4

Douch P.G.C., Green R.S., Huntley J.F. & Risdon P.L. 1996 Serum mast cell proteinase responses of sheep to challenge with Trichostrongylus colubriformis and the effect of dexamethasone treatment. International Journal for Parasitology, 26, 91–95. https://doi.org/10.1016/0020-7519(95)00086-0

Gruner L., Sauvé C., Hoste H., Lefrileux Y., Fleurance G. & Chartier C. 1994 Worm population characteristics and pathological changes in lambs after a single or a trickle infection with Teladorsagia circumcincta. International Journal for Parasitology, 24, 347–356. https://doi.org/10.1016/0020-7519(94)90082-5

Königová A., Hrčková G., Velebný S., Čorba J. & Várady M. 2008 Experimental infection of Haemonchus contortus strains resistant and susceptible to benzimidazoles and the effect on mast cells distribution in the stomach of Mongolian gerbils (Meriones unguiculatus). Parasitology Research, 102, 587–595. https://doi.org/10.1007/s00436-007-0792-4

Massoni J., Cassone J., Durette-Desset M.-C. & Audebert F. 2011 Development of Graphidium strigosum (Nematoda, Haemonchidae) in its natural host, the rabbit (Oryctolagus cuniculus), and comparison with several Haemonchidae

parasites of ruminants. Parasitology Research, 109, 25–36. https://doi.org/10.1007/s00436-010-2217-z

Murphy L., Nalpas N., Stear M. & Cattadori I.M. 2011 Explaining patterns of infection in free-living populations using laboratory immune experiments. Parasite Immunology, 33, 287–302. https://doi.org/10.1111/j.1365-3024.2011.01281.x

Peña M.T., Miller J.E. & Horohov D.W. 2004 Effect of dexamethasone treatment on the immune response of Gulf Coast Native lambs to Haemonchus contortus infection. Veterinary Parasitology, 119, 223–235. https://doi.org/10.1016/j.vetpar.2003.11.002

Stott P., O'Callaghan M., Phillips P. & Verbyla A. 2009 The experimental establishment of ruminant nematodes in European hares (Lepus europaeus). Veterinary Parasitology, 159, 82–85. https://doi.org/10.1016/j.vetpar.2008.10.016

Valderas-García E., Escala N., Álvarez-Bardón M., Castilla-Gómez de Agüero V., Cambra-Pellejà M., González del Palacio L. et al. 2022 Novel compound shows in vivo anthelmintic activity in gerbils and sheep infected by Haemonchus contortus. Scientific Reports, 12, 13004.

White W.H., Gutierrez J.A., Naylor S.A., Cook C.A., Gonzalez I.C., Wisehart M.A. et al. 2007 In vitro and in vivo characterization of p-amino-phenethyl-m-trifluoromethylphenyl piperazine (PAPP), a novel serotonergic agonist with anthelmintic activity against Haemonchus contortus, Teladorsagia circumcincta and Trichostrongylus colubriformis. Veterinary Parasitology, 146, 58–65. https://doi.org/10.1016/j.vetpar.2007.02.014

Ziam H., Pandey V.S., Darwiche J., Losson B. & Kumar V. 1999 Biological parameters of Trichostrongylus colubriformis in Meriones unguiculatus. Veterinary Parasitology, 81, 309–322. https://doi.org/10.1016/S0304-4017(98)00255-6

Ziam H., Pandey V.S. & Cabaret J. 2000 Drug-abbreviated infections of Trichostrongylus colubriformis and development of immunity in jirds Meriones unguiculatus. Veterinary Parasitology, 86, 647–654. https://doi.org/10.1007/PL00008546

Honcharov S.L., Soroka N.M., Halat M.V., Dubovyi A.I., Zhurenko V.V. & Halushko I.A. 2022 Distribution of the nematodes of the genus Eustrongylides (Nematoda, Dioctophymatidae) in the world. Regulatory Mechanisms in Biosystems, 13(1), 73–79. https://doi.org/10.15421/022210

Shuai Y., Zhou Y., Yi P. & Zhao J. 2025 Case Report: The first record of Eustrongylides sp. infection in the Chinese alligator (Alligator sinensis). Frontiers in Veterinary Science, 12, 1579738. https://doi.org/10.3389/fvets.2025.1579738

A new faunistic record of the Bird-cherry Ermine moth, *Yponomeuta evonymella* (L. 1758) (Lepidoptera: Yponomeutidae) in the Czech Republic

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Abstract
Since lepidopterans which caterpillars graze on leaves of woody plants are classified as pests, the monitoring of these arthropods is important to manage these species effectively. Bird-cherry ermine *Yponomeuta evonymella* is native in the Czech Republic but its distribution is predicted to be limited in specific areas. Here, the new faunistic record close to the town of Mělník is presented. The dense silky cocoons with abundant caterpillars of this species were observed in May 2025 to be attached to twigs of bird cherry (*Prunus padus*).

Keywords: insect, *Prunus padus*, cocoon, folivory, pest

Introduction

The genus *Yponomeuta* forms a rather small group of ermine moths (the family Yponomeutidae; Lepidoptera; Ditrysia) and comprised of more than 76 formally described species sometimes appearing as pests (Lewis and Sohn 2015; Menken et al. 1992; Ulenberg 2009). Approximately, about 40 species are indigenous in the Palearctic Region (Lewis and Sohn 2015) One of them, bird-cherry ermine *Yponomeuta evonymella* (L.1758), is a relatively small moth widely distributed in Europe and Asia. Its native range includes Austria, Belgium, Bulgaria, China (Inner Mongolia, Jiangsu, Jilin, Sachalin), Czech Republic, Denmark, England, Estonia, Finland, France, Germany, Greece, Hungary, India, Ireland, Italy (Sicily), Korea, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Turkey, and [former] Yugoslavia (Lewis and Sohn 2015); with records also from Maltese islands (Seguna 2007).

The adult *Y. evonymella* moths are usually active during summer between June and September. Larval growth rate and pupal development were

positively affected by higher temperature (Leather and MacKenzi 1994). Natural enemies, such as bird predators and parasitoids, substantially reduce populations of *Y. evonymella* (Žikić et al. 2018).

The caterpillars of *Y. evonymella* feed on several plant species of the genus *Prunus* L. and on *Sorbus aucuparia* L. (family Rosaceae) and it was reported that *Y. evonymella* abundance and density are consistently higher on woodland trees than on roadside one (Leather and MacKenzi 1994). As a result of grazing activity of gregarious caterpillars of *Y. evonymella*, a complete tree defoliation can be seen.

Key to the understory species composition in European woodlands are trees and shrubs from the family Rosaceae (Pairon et al. 2010) and defoliation is unwanted in this regard. Thus, *Y. evonymella* is commonly classified as a pest because plant protection is difficult (Šefrová and Laštůvka 2023). Interestingly, a host expansion from primary to invasive tree species, namely black cherry (*Prunus serotina*) in Poland, was seen and thus, a biocontrol benefits should be considered (Łukowski et al. 2019).

Either way, monitoring of *Y. evonymella* and its distribution is important. In this study, we present a new record that supports the predicted occurrence based on known distribution in the Czech Republic.

Materials and Methods

The locality was visited personally by both authors on 17 May 2025 (GPS coordinates 50.3473, 14.4713). It is situated on left bank of Vraňansko-Hořínský channel connecting the Elbe river, km 109 and the Vltava river, km 11.4. Riverbank vegetation and also trees nearby were checked visually and photographed. The species was identified with use of iNaturalist.org into which database this record was uploaded.

Results and Discussion

In the locality, dense whitish silky cocoons (also called wooly tents) with numerous caterpillars were found to be attached on twigs of host tree bird cherry (*Prunus padus*; Figure 1a). The species was identified as native Bird-cherry Ermine moth (*Yponomeuta evonymella*, L. 1758). Leaves of the host tree were damaged by grazing caterpillars seriously.

Up today, there are 72 records of *Y. evonymella* in the Czech Republic in total. Based on the records which were mainly collected by users of iNaturalist database via citizen science, areas where the occurrence of this species is expected were visualised. The present record lies within one of these areas and thus, it supports the idea of the mentioned prediction to be valid (Figure 2). The closest record is located approximately 10 km westward (see iNaturalist.org).

Moreover, the seasonal variability of records of *Y. evonymella* in the Czech Republic suggests that the probability of the record is much higher within

spring and summer in comparison with autumn and winter (Figure 3). The presented record is from May when this species became more visible due to the activity of caterpillars.

Figure 1: (a) Caterpillars of Bird-cherry Ermine moth (*Yponomeuta evonymella*) gathered in a whitish silken cocoon spun between leaves of host Bird Cherry (*Prunus padus*) on newly recorded locality; (b) the locality. Author: B. Patoková

Besides general defoliation, in the case of urban green spaces, such as alleys, parks, and public gardens, silky cocoons produced by caterpillars of *Y. evonymella* make the infested trees unattractive visitor (Tomalak et al. 2010). Moreover, the losses in ornamental greenery caused by this moth were observed (Šefrová and Laštůvka 2023).

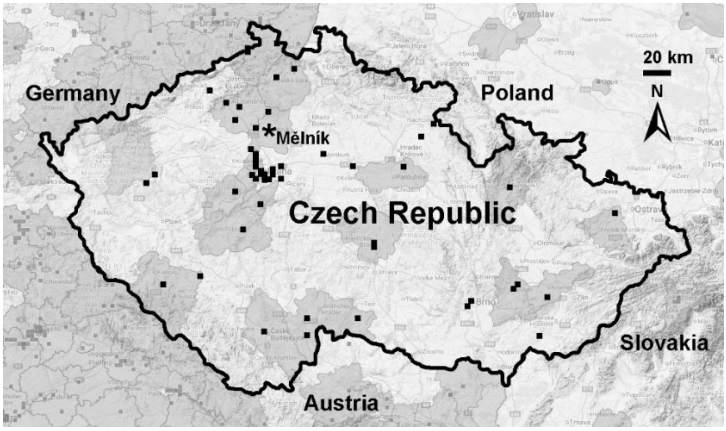

Figure 2: Map of the Czech Republic with all known records of Bird-cherry Ermine moth (*Yponomeuta evonymella*) indicated by black squares. Grey-coloured areas give expected occurrence of the species (adapted from iNaturalist.org). The new record close to the town of Mělník is indicated by black asterisk. Scale bar = 20 km.

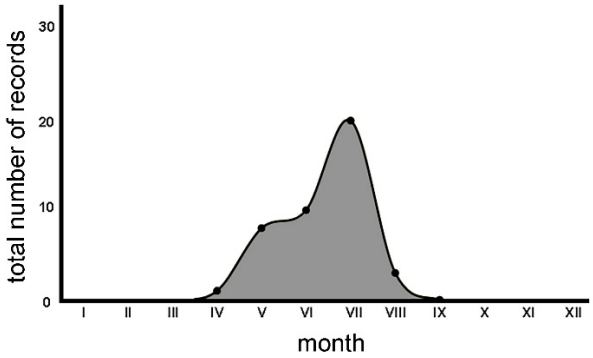

Figure 3: Sum of seasonal records of Bird-cherry Ermine moth (*Yponomeuta evonymella*) in the Czech Republic (adapted from iNaturalist.org).

Since *Y. evonymella* is considered to be locally risky for certain host trees, its monitoring is recommended in the Czech Republic and other European countries as well to predict the areas of its expected occurrence more precisely in ongoing years.

Acknowledgements

BP was supported by the Jan Evangelista Purkyně University Project No. UJEP-SGS-2025-43-004-2. The authors declare that artificial intelligence (AI) tools were not used during manuscript writing and editing.

References

Leather S. R. & MacKenzie G. A. 1994: Factors affecting the population development of the bird cherry ermine moth, *Yponomeuta evonymella* (L.). Entomologist, 113(2): 86-105.

Lewis J. & Sohn J. C. 2015: Lepidoptera: Yponomeutoidea I (Argyresthiidae, Attevidae, Praydidae, Scythropiidae, and Yponomeutidae) (Vol. 12). Brill. Leiden, Boston.

Łukowski A., Janek W., Baraniak E., Walczak U. & Karolewski, P. 2019: Changing host plants causes structural differences in the parasitoid complex of the monophagous moth *Yponomeuta evonymella*, but does not improve survival rate. Insects, 10(7): 197.

Menken S. B., Herrebout W. M. & Wiebes, J. T. 1992: Small ermine Moths (Yponomeuta): Their host relations and evolution. Annual Review of Entomology, 37(1): 41-66.

Pairon M., Petitpierre B., Campbell M., Guisan A., Broennimann O., Baret P. V., ... & Besnard G. 2010: Multiple introductions boosted genetic diversity in the invasive range of black cherry (*Prunus serotina*; Rosaceae). Annals of Botany, 105(6): 881-890.

Šefrová H. & Laštůvka, Z. 2023: Harmful lepidoptera in Czechia–current status, changes and importance. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 71(3): 155-162.

Seguna A. 2007: Yponomeuta evonymella (Linnaeus, 1758). A new record for the Lepidopterofauna of the Maltese Islands (Lepidoptera: Yponomeutidae). SHILAP Revista de Lepidopterología, 35(139): 283-284.

Tomalak M., Rossi E., Ferrini F. & Moro P. A. 2010: Negative aspects and hazardous effects of forest environment on human health. In: Nilsson K., Sangster M., Gallis C., Hartig T., de Vries S., Seeland K., Schipperijn J. (eds.) Forests, trees and human health (pp. 77-124). Dordrecht: Springer Netherlands.

Ulenberg S. A. 2009: Phylogeny of the *Yponomeuta* species (Lepidoptera, Yponomeutidae) and the history of their host plant associations. Tijdschrift voor Entomologie, 152(2): 187-207.

Žikić V., Lotfalizadeh H., Schwarz M., Stanković S. S., Lazarević M., Kos K., .. & Tschorsnig H. P. 2018: Parasitoids of European species of the genus *Yponomeuta* Latreille 1796 (Lepidoptera: Yponomeutidae): new findings with an updated checklist. Phytoparasitica, 46(5): 617-626.

Holier than Caesar's wife: Confusion in Czech terminology related to biological invasions

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Abstract
Biological invasions are a globally highlighted issue with overlapping into huge environmental and socio-economic losses. Management measurements aiming eradication, mitigation and regulation of negative consequences and spreading of invasive species are, in many cases, ineffective, partly due to a misunderstanding of related risks and identification of high-risk taxa. Therefore, to face invasive species effectively, scientists and all stakeholders need to communicate the topic clearly and without undesired confusion. The terminological framework can be misleading not only in English but also in other national and local languages, including the Czech language. Here, we present the use of incorrect translation of the English term "invasive" as "invazní" (correct version) or "invazivní" (incorrect version) [in Czech]. The latter term is related to surgical techniques or penetration of pathogens into the host's body. The total number of records as well as the trend increases over time within the survey period (2008-2025). This can be caused especially by the higher popularity of the topic of biological invasions in comparison with previous years in the Czech Republic. On the other hand, the confusion in the terminological framework used still exists, and this is brought to the attention of all stakeholders dealing with the topic of biological invasions and environmental education.

Keywords: invasive species, definition, Czech language, local language, communication

Introduction

Biological invasions cause both environmental and socio-economic losses worldwide (Haubrock *et al.* 2022; Simberloff *et al.* 2013; Vantarová *et al.* 2023; Zenni *et al.* 2021). Therefore, wildlife managers, conservationists,

scientists, policymakers, and other stakeholders proactively initiate various measures to regulate invasive species in their establishment and spread (Cuthbert *et al.* 2022; Pyšek *et al.* 2020) and predict invasion potential of non-native species in specific target regions (Bohatá *et al.* 2020; Uderbayev *et al.* 2017; Vilizzi *et al.* 2021; Wyman-Grothem *et al.* 2024; Yonvitner *et al.* 2020). Even if not always effective (Patoka *et al.* 2018), to be successful in this effort, the outreach activities and communication with the community must be logically correct, argumentatively accurate and well-explained (Richardson *et al.* 2000). Although the terminology was established (Soto *et al.* 2024), the improvement of public awareness is needed (Haley *et al.* 2023).

Invasive species is a non-native organism that, once introduced by humans to a new natural or semi-natural locality out of its native range, established and spread with negative impact on ecosystem, native biota, and/or human health (Soto *et al.* 2024). Unfortunately, misunderstandings or incorrectly applied definitions can be found in certain cases. These exist not only in English but also in other national or regional languages (Reeb & Heberling 2025; Vilizzi *et al.* 2025), including the Czech language (Černá 2018). In the terminological framework focused on biological invasions, both Czech equivalents of the English term invasive (species) often appear, even at the expert level, i.e., "invazní" and "invazivní". Some authors use both mentioned terms as synonyms. Other authors distinguish between these two terms, while confusing definitions are used; sometimes, some authors suggest that invasive species can be non-native species or also indigenous species (see: www.jarojaromer.cz/slovnik-pojmu/). This is obviously wrong, unacceptable, and the definition of invasive species is lost, with various very negative consequences.

However, "invazní" is the only correct Czech term for invasive species, invasive organism, invasive taxon, etc. Some authors focused on this issue and tried to explain the valid definitions and the meaning of the Czech terminology used (Černá 2018; Pyšek 2018). Especially in sharing the words via outreach, media and social media, campaigns and projects, this is urgently needed to improve the effectiveness of management measurements regarding biodiversity conservation. Without appropriate explanations and education, the general public and certain stakeholders in many countries will not accept focused acts and regulations and will tend to evade and disobey the legal framework; this is also documented in social media, where people upload illegal introduction events of some non-native organisms in the wild (Magalhães *et al.* 2024).

Since the local people commonly harvest information in their native language instead of English, the importance of the correct terminology used is obvious. Especially in terms of the prevention of further introduction events, environmental education is usually referred to. Thus, two recent guidelines for teachers at elementary schools in the Czech Republic were released (Patoková *et al.* 2023, 2024). Indeed, the expected positive effect would be seen after a couple

of years and not early. Hence, the described confusion persists. To ascertain its frequency, we decided to survey focused Czech online articles in this regard.

Materials and Methods

The online sources (including articles, reports and appeals but not bachelor's, master and doctoral theses) in the period between January 2008 and July 2025 were searched. A Google search was conducted using the Czech keywords “invazivní druh” (so-called invasive species), “invazivní živočich/zvíře” (so-called invasive animal), “invazivní rostlina” (so-called invasive plant), and “invazivní organizmus” (so-called invasive organism). Found texts explaining the confusion correctly were not included in the data set. Data were analysed in an EXCEL sheet by computing the trend line and its equation.

Results and Discussion

In total, 145 online sources were found to include the term “invazivní” in the text within the survey period. Moreover, in some of them, both terms (“invazivní” and “invazní”) were used as synonymous or as two different terms. And it is worth mentioning that the term “invazivní” is also used in titles. Details within the time with the trend line are given in Figure 1.

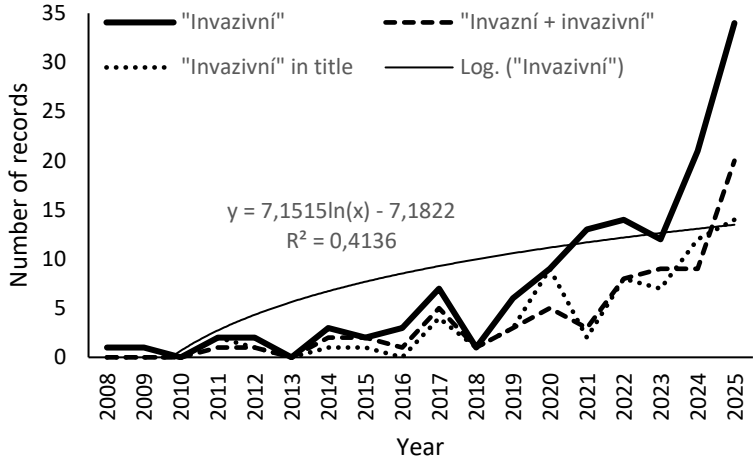

Figure 1: The number of recorded Czech terms “invazivní” (bold solid line), both “invazivní” and “invazní” in the same text (dashed line), “invazivní” in title (dotted line), and logarithmic trendline related to use of the term “invazivní” with its equation (narrow solid line) per year in period from January 2008 to July 2025.

The appropriate communication plays a crucial role in the formation of legislative frameworks and the implementation of policies into robust management approaches. (Baquero et al. 2021; Piria et al. 2017). Once failed, the measurements will be misleading and ineffective, even if the idea is good. The presented results suggest that the environmental education, which is a keystone in this regard, is insufficient in the Czech Republic, and confusion in the terminology related to biological invasions persists. One can conclude that the situation becomes worse over time. On the other hand, the correct interpretation most probably suggests that the topic of biological invasions is more popular in recent years, and its higher importance due to increasing losses caused by invasive species is in line with a higher number of focused articles, reports and other publications. The increase in the outputs related to the topic can also be in line with the implementation of the Regulation (EU) No. 1143/2014 of the European Parliament and the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species.

There is no doubt that the total number of incorrectly used terms "invazivní" exists, and this should be mitigated as soon as possible. This is a challenge for all stakeholders who are responsible for improvement, such as educators, conservationists, wildlife managers, etc. Much was promised in this regard in previous years, but the overlap into practice is still poor in the Czech Republic. The exceptions are two guidelines for teachers at elementary schools and recently released focused board games (Patoková *et al.* 2023, 2024).

Special attention should be paid to titles which matters very much (Buriak 2022). The title usually grabs the attention of the readers, and besides its informative character, it is also used as a mnemonic (Hallock & Bennett 2021). Thus, the correct and clear titles are needed to help readers remember valid terms. In this regard, the found inappropriate terminology used to share the words about invasive species is alarming.

The public plays an important role in citizen science, making an important contribution to biodiversity monitoring, particularly regarding invasive species (Encarnação *et al.* 2021). The well-educated people are able to more accurately distinguish between native and non-native taxa, which is crucial indeed (Lipták *et al*. 2024). The theme of biological invasions is not mandatory included in school plans at Czech elementary schools and absent also in textbooks (Patoková & Patoka 2025a,b,c). This should be improved.

Since consistent terminology is essential for effective global and local communication among scientists, educators, policymakers, and other stakeholders, as well as the general public, particularly in the context of citizen science (Vilizzi *et al.* 2025), similar surveys are recommended to be further investigated also in other languages.

Acknowledgements

This study was supported and covered by the Indonesian Centre for Research on Bioinvasions (ICRB). BP was supported by the Jan Evangelista Purkyně University Project No. UJEP-SGS-2025-43-004-2. The authors declare that artificial intelligence (AI) tools were not used during manuscript writing and editing.

References

Baquero R. A., Ayllón D., Oficialdegui F. J. & Nicola G. G. 2021: Tackling biological invasions in Natura 2000 network in the light of the new EU Biodiversity Strategy for 2030. Management of Biological Invasions, 12(4): 776-791.

Bohatá L. & Patoka J. 2023: Invasion potential of ornamental terrestrial gastropods in Europe based on climate matching. Diversity, 15(2): 272.

Buriak J. M. 2022: First impressions of your science: Title matters. ACS nano, 16(12): 19609-19611.

Černá A. 2018: Jsou organismy invazní, nebo invazivní? Živa, 66(5): 75.

Cuthbert R. N., Diagne C., Hudgins E. J., Turbelin A., et al. 2022: Biological invasion costs reveal insufficient proactive management worldwide. Science of the Total Environment, 819: 153404.

Encarnação J., Teodósio M. A. & Morais P. 2021: Citizen science and biological invasions: a review. Frontiers in Environmental Science, 8: 602980.

Haley A. L., Lemieux T. A., Piczak M. L., Karau S., et al. 2023: On the effectiveness of public awareness campaigns for the management of invasive species. Environmental Conservation, 50(4): 202-211.

Hallock R. M. & Bennett T. N. 2021: I'll read that!: What title elements attract readers to an article? Teaching of Psychology, 48(1): 26-31.

Haubrock P. J., Cuthbert R. N., Hudgins E. J., Crystal-Ornelas R., et al. 2022: Geographic and taxonomic trends of rising biological invasion costs. Science of the Total Environment, 817, 152948.

Lipták B., Kouba A., Patoka J., Paunović M. & Prokop P. 2024: Biological invasions and invasive species in freshwaters: perception of the general public. Human Dimensions of Wildlife, 29(1): 48-63.

Magalhães A. L. B., de Azevedo C. S., Maceda-Veiga A. & Patoka J. 2024: The scientist eyes: monitoring YouTube™ to quantify aquatic pet release in Brazil. Aquatic Ecology 58(1): 73-88.

Patoka J., Magalhães A. L. B., Kouba A., Faulkes Z., Jerikho R. & Vitule J. R. S. 2018: Invasive aquatic pets: failed policies increase risks of harmful invasions. Biodiversity and Conservation, 27(11): 3037-3046.

Patoková B. & Patoka J. 2025a: Biological invasions in teaching at elementary schools. Biologie-Chemie-Zeměpis, in press.
Patoková B. & Patoka J. 2025b: Biological invasions as topic in textbooks of science at primary schools in the Czech Republic. Envigogika, in press.
Patoková B. & Patoka J. 2025c: Biologické invaze a environmentální výchova v ČR. Myslivost, 27(5): 22-23.
Piria M., Copp G. H., Dick J. T., Duplić A., et al. 2017: Tackling invasive alien species in Europe II: threats and opportunities until 2020. Management of Biological Invasions, 8(3): 273-286.
Pyšek P. 2018: Historie, definice, hypotézy a budoucnost biologických invazí. Živa, 66(5): 210-213.
Pyšek P., Hulme P. E., Simberloff D., Bacher S., et al. 2020: Scientists' warning on invasive alien species. Biological Reviews, 95(6): 1511-1534.
Reeb R. A. & Heberling J. M. 2025: Lost in translation: The need for updated messaging strategies in invasion biology communication. Plants, People, Planet, 7(3): 536-545.
Richardson D. M., Pyšek P., Rejmánek M., Barbour M. G., Panetta F. D. & West C. J. 2000: Naturalization and invasion of alien plants: concepts and definitions. Diversity and Distributions, 6(2): 93-107.
Simberloff D., Martin J. L., Genovesi P., Maris V., et al. 2013: Impacts of biological invasions: what's what and the way forward. Trends in Ecology and Evolution, 28(1): 58-66.
Soto I., Balzani P., Carneiro L., Cuthbert R. N., et al. 2024: Taming the terminological tempest in invasion science. Biological Reviews, 99(4): 1357-1390.
Vantarová K. H., Eliáš Jr P., Jiménez-Ruiz J., Tokarska-Guzik B. & Cires E. 2023: Biological invasions in the twenty-first century: a global risk. Biologia, 78(5): 1211-1218.
Vilizzi L., Copp G. H., Hill J. E., Adamovich B., et al. 2021: A global-scale screening of non-native aquatic organisms to identify potentially invasive species under current and future climate conditions. Science of the Total Environment, 788: 147868.
Vilizzi L., Piria M., Pietraszewski D., Yoğurtçuoğlu B., et al. 2025: To be, or not to be, a non-native species in non-English languages: gauging terminological consensus amongst invasion biologists. Management of Biological Invasions, 16(1): 15-31.
Wyman-Grothem K., Castello L., dos Santos Catâneo D. T. B., da Costa Doria C. R., Magalhães A. L. B., Patoka J., Stewart D. & Watson, C. 2024: Invasion risk to the United States from *Arapaima* spp. hinges on climate suitability. Aquaculture Environment Interactions, 16: 175-188.

Yonvitner Y., Patoka J., Yuliana E., Bohatá L., Tricarico E., Karella T., Kouba A. & Reynolds J. D. 2020: Enigmatic hotspot of crayfish diversity at risk: Invasive potential of non-indigenous crayfish if introduced to New Guinea. Aquatic Conservation: Marine and Freshwater Ecosystems, 30(2): 219-224.

Uderbayev T., Patoka J., Beisembayev R., Petrtýl M., Bláha M., Kouba A. 2017: Risk assessment of pet-traded decapod crustaceans in the Republic of Kazakhstan, the leading country in Central Asia. Knowledge and Management of Aquatic Ecosystems, 418: 30.

Zenni R. D., Essl F., García-Berthou E. & McDermott S. M. 2021: The economic costs of biological invasions around the world. NeoBiota, 67: 1-9.

The second observation of interspecific mating of *Phengaris nausithous* and *Phengaris teleius* (Lepidoptera: Lycaenidae)

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Abstract

Interspecific mating of *Phengaris nausithous* and *P. teleius* was recorded and photographed from Central Bohemia in the vicinity of Přelouč town on 11 July 2024. We have previously observed and documented an attempt at a similar interspecific mating in a single case from the vicinity of Hynčice in the Broumov region (Northern Bohemia). This record is published here as a repeated observation of a given phenomenon, which may apparently occur more often than expected in the wild.

Keywords: Dusky Large and Scarce Large Blues, butterflies, sexual behaviour, copulation

Introduction

Interspecific mating attempts or successful completions have been documented in a number of cases in butterflies, including the formation of hybrids (Baidya et al. 2018; Hovanitz 1949; Platt et al. 1978; Sperling 2011; Taylor 1972 etc.). Such observations from nature are available not only for closely related species, but also within different genera (Luckens 1992; Sands and Sawyer 1977). Relatively few observations are available for the family Lycaenidae (Downey 1962; Smetacek and Bhakare 2010).

The genus *Phengaris* Doherty, 1891 (Large Blues) is the subject of very intensive research due to its complex ecological relationship with ants, yet until 2016 we were not aware of any observations of interspecific mating on this genus. We documented this photographically on 19 July 2016 in northern Bohemia in Hynčice near the town of Broumov as first (Pilařová et al. 2024). During an ongoing population study using marked butterflies, a similar observation was made in the wild in central Bohemia near Přelouč. This new observation was also documented photographically. We decided to draw attention to the new record, stating that such attempts at mating between *Phengaris nausithous* (Bergsträsser, 1799) and *P. teleius* (Bergsträsser, 1799) in the wild may probably occur more often than expected.

Materials and Methods

Survey of species of the genus *Phengaris* is important for the conservation of these butterflies protected by the EU Habitat Directive. Our survey of Large Blues of the genus *Phengaris* is going e in the surroundings of Přelouč town (Central Bohemia, Czech Republic) in some habitat patches in the vicinity of the site Slavíkovy ostrovy (GPS on the middle: 50°2'54.201"N, 15°33'28.234"E, 210 m a. s. l.).

We monitored the species to estimate their density using the Mark-Release-Recapture method. The total number of individuals of *Phengaris teleius* for metapopulation in Slavíkovy ostrovy site in 2024 was estimated by the Cormack-Jolly-Seber method (see Schwarz and Arnason 1996; Schwarz and Seber 1999) to be 698 individuals while 467 individuals were estimated for *P. nausithous*.

Monitoring protocols typically record data on the sex, marking, recording time, and behavior of butterflies in the following categories: nectar sucking, flying, basking, resting, searching for the opposite sex, copulation, laying eggs, and others. By retrospectively analyzing data from the recording protocols, we identified details of the observation that we describe below. The author of the observation took a documentary photograph, which is attached.

Results

Copulation between a male *Phengaris teleius* and a female *Phengaris nausithous* was observed on 11 July 2024 at 12:07. According to field records, it took place in the site with the greatest importance for the entire metapopulation in terms of the number and density of butterflies (Vrabec et al. 2017). The area is registered as SO1 – Slavíkovy ostrovy, Přelouč (5959c): 50° 02' 49.58"N, 15° 33' 35.08"E, 208 m a. s. l., area 15,667 m^2. It is a meadow above the former city swimming pool approximately 850 m NW of Masaryk Square in Přelouč. The author of the observation of the copulation (Skrbková observ.) is the co-author of this text, who photographed the unusual pair (see Figure 1) and marked the female that participated on it.

Figure 1: Interspecific mating of *Phengaris teleius* male (X9) and *Phengaris nausithous* female (without mark) at the Slavíkovy ostrovy location near Přelouč, on 11 July 2024. Photo: K. Skrbková.

Discussion and conclusions

As far as the authors of the text know, the observation described here is only the second record of interspecific copulation of *Phengaris nausithous* and *P. teleius* at all, both observations being carried out by our team and made in the wild (see Pilařová et al. 2024). This means that such attempts occur completely spontaneously. Moreover, both observations are clearly documented photographically. Although the observed phenomenon occurs rarely, we must now confirm that it occurs in the wild, and apparently more often than we have been willing to admit until now. However, it is still unknown whether fertilization has occurred, and we lack data regarding any possible hybridization between Large Blue species.

Acknowledgements

Experiments and observations comply with the current laws of the Czech Republic where they were performed. We would like to thank the Regional Office of the Pardubice Region for granting an exemption from the conditions of protection under Act 114/1992 Coll. for research on Large Blues *Phengaris*, file no. 36544/2019/OŽPZ/Si. Special thanks to students of the Czech University of Life Sciences and colleagues: Bitnerová Štěpánka, Bušinová Eva, Domácí Nikola, Gabrhel Vilém, Juračková Tereza, Neugebauerová Iveta, Potočková Hana and Slavíková Daniela for their help in the field in 2024.

References

Baidya S., Basu D.N., Roy S. & Basu Roy A. 2018 Occurrence of interspecific mating between two species of Danaus Kluk, 1780 (Lepidoptera: Nymphalidae) in nature. Psyche: A Journal of Entomology, 2018, e3059017. https://doi.org/10.1155/2018/3059017

Downey J.C. 1962 Inter-specific mating in Lycaenidae. Journal of the Lepidopterists' Society, 16, 235–237.

Hovanitz W. 1949 Interspecific matings between Colias eurytheme and Colias philodice in wild populations. Evolution, 3(2), 170–173. https://doi.org/10.2307/2405551

Luckens C.J. 1992 Inter-specific pairing of two European Satyrias. Entomologist's Record, 104, 188.

Pilařová A., Zachardová S., Frič Faltýnek Z. & Vrabec V. 2024 An attempt of interspecies mating between Phengaris nausithous and P. teleius (Lepidoptera, Lycaenidae). Nota Lepidoptera, 47, 105–111. https://doi.org/10.3897/nl.47.118947

Platt A.P., Rawson G.W. & Balogh G. 1978 Inter-specific hybridization involving Limenitis archippus and its congeneric species (Nymphalidae). Journal of the Lepidopterists' Society, 32, 289–303.

Sands D.P.A. & Sawyer P.F. 1977 An example of natural hybridization between Troides oblongomaculatus papuensis Wallace and Ornithoptera priamus poseidon Doubleday (Lepidoptera: Papilionidae). Australian Journal of Entomology, 16, 81–82. https://doi.org/10.1111/j.1440-6055.1977.tb00066.x

Schwarz C.J. & Arnason A.N. 1996 A general methodology for the analysis of capture–recapture experiments in open populations. Biometrics, 52, 860–873. https://doi.org/10.2307/2533048

Schwarz C.J. & Seber G.A.F. 1999 Estimating animal abundance: Review III. Statistical Science, 14, 427–456. https://doi.org/10.1214/ss/1009212521

Smetacek P. & Bhakare S. 2010 Two instances of inter-generic mating by Lycaenidae (Lepidoptera) in Maharashtra, India. Journal of Research on the Lepidoptera, 43, 23–25. https://doi.org/10.5962/p.266506

Sperling F. 2011 Natural hybrids of Papilio (Insecta: Lepidoptera): poor taxonomy or interesting evolutionary problem? Canadian Journal of Zoology, 68, 1790–1799. https://doi.org/10.1139/z90-260

Taylor O.R. 1972 Random vs. non-random mating in the sulfur butterflies, Colias eurytheme and Colias philodice (Lepidoptera: Pieridae). Evolution, 26(3), 344–356. https://doi.org/10.1111/j.1558-5646.1972.tb01940.x

Vrabec V., Kulma M., Bubová T. & Nowicki P. 2017 Long-term monitoring of Phengaris (Lepidoptera: Lycaenidae) butterflies in the Přelouč surroundings (Czech Republic): is the waterway construction a serious threat? Journal of Insect Conservation, 21, 393–400. https://doi.org/10.1007/s10841-017-9982-2

Effect of tapeworm infection on the urinary zinc excretion of rats overdosed with zinc lactate

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Abstract
Tapeworms can have a considerable impact on their host's metabolism by stimulating the immune response and affecting the digestion of various food components. This study aimed to assess how rat tapeworms *(Hymenolepis diminuta)* influence the urinary excretion of zinc in hosts administered an excessive amount of zinc lactate. Male Wistar rats were categorized into four groups: groups 0T and MT were infected with rat tapeworms, while groups 00 and M0 remained uninfected. The control groups (00; 0T) received a standard rodent compound feed, whereas the experimental groups (M0 and MT) were given the same diet with an additional zinc lactate supplement (20.5 mg of zinc/day). Urine samples were collected weekly, and zinc concentrations were analyzed using inductively coupled plasma optical emission spectrometry (ICP-OES). Throughout the study, the presence of tapeworms led to a notable decrease in urinary zinc levels in the infected rats, a change not observed in the uninfected groups. A statistically significant difference in zinc excretion was identified between the experimental groups (M0; MT) over the six-week period. Our findings indicate that tapeworms substantially lower the excretion of zinc in rats consuming zinc lactate-enriched diets.

Key words: *Hymenolepis diminuta,* urinary metabolism, Wistar rats, zinc excretion, immune response

Introduction

Zinc plays a vital role in the immune system, and when it is deficient in zinc, cellular immunity is considerably compromised. This leads to a reduction in the differentiation of T-lymphocytes and a decrease in their numbers, as well

as to a decrease in the chemotaxis of leukocytes and a limited T-cell response to antigens [7]. Zinc deficiency causes immune dysfunction and increased infection risk, while zinc overload leads to monocyte activation and severe inflammation during sepsis [34, 35]. Zinc homeostasis is maintained by regulating absorption, secretion, faecal and urinary excretion, and tissue redistribution [5].
The presence of a parasite typically poses a disadvantage to the host; however, when the interaction is beneficial for both parties, it is referred to as mutualism or commensalism [19,20,26].

There is a lot of evidence of beneficial impacts of *H. diminuta* infections on the course of autoimmune diseases, especially colitis. This effect is primarily due to the immunomodulatory properties of specific parasite proteins. The accurate identification and characterization of the molecular mechanisms of action of this tapeworm's proteins and the study of the possibility of alleviating inflammatory responses may be crucial for the development of new drugs against autoimmune diseases and allergies [20].

Tapeworms reside in areas vital for nutrient absorption can significantly impact on the nutrients accessible to the host. Several authors [1,2] have shown that due to their high accumulation capacity, helminths, such as the tapeworm *Hymenolepis diminuta*, can influence the accumulation of metals in the host. This can lead to a lower availability of important elements, such as zinc, for the host organism.

Tapeworms often grow to considerable size. The levels of nutrients they take from food consumed by their host are not always negligible. In the case of trace elements such as zinc, these levels can be significant due to their natural content in the host and their presence in food. In addition, tapeworms interfere with nutrient absorption in the final part of the small intestine (jejunum, ileum) [32].

Zinc is absorbed in the small intestine, especially in the jejunum, where changes in the morphology of intestinal villi and crypts in Wistar rats infected with rat tapeworm (*Hymenolepis diminuta*) took place [11]. Zinc resorption in the jejunum occurs through simple diffusion, as well as with the aid of specific ligands, such as histidine, methionine, and cysteine, that allow zinc to enter the cells of the intestinal mucosa. Upon entering the intestinal mucosa cell, Zn is bound to metallothionein, which promotes homeostasis and transports Zn across the intestinal mucosa into the bloodstream. Zn absorption is reduced by phytates, oxalates, tannins, excess Cu, Fe and Cd. A protein-rich diet enhances its absorption, while the presence of carbohydrates reduces the process. The amount of Zn in the body is regulated by both intestinal resorption levels and the excretion of endogenous Zn [12]. Endogenous zinc can be excreted via different ways, including the intestines, kidneys, integument, and semen [31]. The major route of zinc excretion is the intestine. Zinc loss in urine is linked to nitrogen loss due to stress, infection, burns, major surgery, or trauma, possibly caused by

protein catabolism [6, 7]. The main route of zinc excretion is through the gastrointestinal tract. Zinc enters the gastrointestinal tract through pancreatic juices, bile, gastroduodenal secretions, and mucosal cells. Much of the Zn is absorbed from the gut, which maintains homeostasis in the body.

Zinc lactate has long been used as a dietary supplement for humans and animals. In overdose, zinc is excreted in feces and urine, which can among other things lead to environmental contamination. Dietary supplements are used to prevent zinc deficiency. These supplements are especially important for those who consume food sources that reduce zinc absorption (e.g., sources with excessive amounts of phytate). Such supplements also include zinc lactate. In the present study, we focused on how tapeworms affect the levels of zinc excreted in the urine of rats fed diets overdosed with zinc and those fed a standard diet.

Given several previous studies [1,2] that have shown the ability of tapeworms to reduce Zn levels in the organs of a host, we hypothesized that these tapeworms are also able to reduce the amount of zinc excreted in the urine of their host.

Materials and methods

Maintenance of experimental animals

A total of 32 male Wistar rats (150-200 g weight) divided into 4 groups (table 3) were used in the experiment. First, five weeks long acclimatization period took place. During the acclimatization period, the animals were fed a standard mixture for rats (ST-1 by Velaz, Prague, Czech Republic) and given ad libitum access to water.

After the acclimatization period, throughout the experiment, rats were housed individually in metabolic cages, fed a standard rodent mixture (ST-1 from Velaz, Prague, Czech Republic; Table 2) and provided with ad libitum access to water. The room was maintained at a constant temperature (22–24 °C) and a stable humidity value (approx. 70%). A constant day/night cycle (12h light 12h dark) was also sustained.

During the acclimatization period, a total of 32 rats were provided with oral administrations of a glucose solution containing 3 larval stages of tapeworm (cysticercoids). The cysticercoids were extracted from intermediate hosts, namely beetles (*Tribolium confusum*), which had been previously infected with *Hymenolepis diminuta* eggs. The development of the cysticercoids was accelerated by placing the beetles in an incubator for 12 days at 29°C.

This was followed by a 5-week period that was required for the cysticercoids to attach to the intestinal wall of the host and for the tapeworm to develop and grow. At the end of this period, a coprological examination was

performed to verify successful tapeworm infection. At this point, the main phase of the 6-week long experiment commenced.

Experimental design

Initially, a total of 32 Wistar rats were divided into four groups: group 0T consisted of 6 rats, group 00 had 8 rats, group MT included 6 rats, and the fourth group, M0, comprised 12 rats (see Tables 1 and 3). The groups were organized based on the presence or absence of *Hymenolepis diminuta* and the predetermined zinc levels in their feed. Each rat received 25 g of feed daily, except on Sundays, when no food was provided, allowing for accurate tracking of daily zinc intake. Any uneaten feed was deducted from the daily total, ensuring precise data collection. Consequently, each rat could consume a maximum of 150 g of feed each week

Control groups (00; 0T) were fed a standard rodent mixture (ST-1) with 1.75 mg of zinc per 25g of feed (daily dose). This ensured that each control rat could consume a maximum of 10.5 mg of zinc per week. A zinc lactate [Zn (C3H5O3)2·2H2O] supplement was added to the feed mixture given to the experimental groups (M0; MT) to the feed mixture (Table 1). Each rat in the experimental group could consume a maximum of 20.5 mg of zinc/day and 123 mg of zinc/week (6 days).

Sampling

After acclimatization, the rats were kept for six weeks individually in metabolic cages, allowing the separation of feces and urine. Urine samples were collected and recorded every Thursday for the duration of the six-week experiment. Samples were then marked for accurate identification, stored in plastic containers in a refrigerator, and processed several times throughout the experiment.

Analytical procedures

Zinc concentrations in urine samples were determined in the laboratory through inductively coupled plasma optical emission spectrometry (ICP – OES) with axial orientation of the plasma head on an Agilent 720 (Agilent Technologies, Inc., USA) using a two-channel Struman Masters peristaltic pump and a V-groove type pneumatic nebulizer made of inert material.

Statistical analysis

Zinc levels excreted in urine were converted to percentages using data on the amount of food consumed (grams) and the concentration of zinc in the urine in mg/l. The nonparametric Mann-Whitney U test provided a statistical evaluation of the results. Results with a p value of ≤ 0.05 were considered statistically significant (Statistica 10 software; Statsoft, USA).

Results

At the end of the experiment, a total of 144 urine samples were evaluated. Summary results of the individual experimental groups are presented in Table 1. We found that group of rats infected with *Hymenolepis diminuta* (MT group) excreted the lowest levels of zinc as a percentage of their total daily intake. In contrast, rats from control group (00 group) excreted the highest levels of zinc as a percentage of their daily intake. Zinc excretion in urine varied between 0.61% and 4.88% across all observed groups.

In summary comparison of the medians, control group of uninfected rats (00 group) excreted 1.45% more zinc than did group of rats infected with *Hymenolepis diminuta* (0T group). A significantly greater difference was found between the experimental groups (M0 and MT). A comparison of these two groups revealed that tapeworm infection had a more pronounced effect on the levels of excreted zinc as a percentage of their total daily intake. Group of rats that were uninfected but received a zinc lactate supplement (M0 group) excreted 5.3 times as much zinc as did the group of rats infected with *Hymenolepis diminuta*, MT group (Table 1).

Table 1. Zinc dosages and levels of zinc excreted in urine (mg) over a six-week period. Control groups (00; 0T) were fed a standard rodent mixture (ST-1) with 1.75 mg of zinc per 25g of feed (daily dose). A zinc lactate supplement was added to the feed mixture given to the experimental groups (M0; MT).

Group	**Zinc intake (mg/day)**	**Urine Zn excretion (mg/day)**	**Urine Zn excretion (%)**	**Faecal Zn excretion (%) (Sloup et al., 2021)**
0	1.75 ± 0.13	0.082 ± 0.04	**4.88**	*73.67*
0T	1.71 ± 0.16	0.049 ± 0.03	**3.43**	*70.19*
M0	20.25 ± 0.12	0.629 ± 0.35	**3.22**	*87.2*
MT	19.23 ± 1.75	0.111 ± 0.09	**0.61**	*64.84*

Values expressed as the median±standard deviation in the group

When comparing Zn levels excreted in the urine as a measure of weight (mg/day), levels ingested by food intake significantly reflected those excreted in urine (Table 1). The control groups (00; 0T) excreted significantly smaller amounts (mg) of zinc than did the experimental groups. However, rats infected with tapeworms excreted significantly less Zn than did the uninfected rats (Table 1). This difference is more pronounced in the experimental groups, M0

and MT. In those experimental groups, tapeworms decreased levels of excreted zinc more significantly than they did in the control groups.

Table 2. Overview of individual food components within the standard rodent mixture ST-1 (commercially available from Velaz Ltd. CR).

Moisture	%	12.5
Nitrogen compounds	%	24
Fiber	%	4.4
Lipids	%	3.4
Ash	%	6.8
Lysin	mg/kg	14 000
Methionine	mg/kg	4 800
Ca	mg/kg	11 000
P	mg/kg	7 200
Na	mg/kg	1 800
Cu	mg/kg	20
Zn	mg/kg	70
Se	mg/kg	0.38

Table 3. Rats in groups 00 and 0T (control groups) were fed a commercially manufactured feed (ST-1), while rats in groups M0 and MT (experimental groups) were fed the same commercial feed mixture with added zinc lactate; groups as presented in table 1, rats from groups (0T, MT) were infected with rat tapeworms (*Hymenolepis diminuta*).

group	**number of animals**	**Zn/week (mg)**	***H. diminuta***
0T	6	10.5	+
0	8	10.5	-
MT	6	120	+
M0	12	120	-

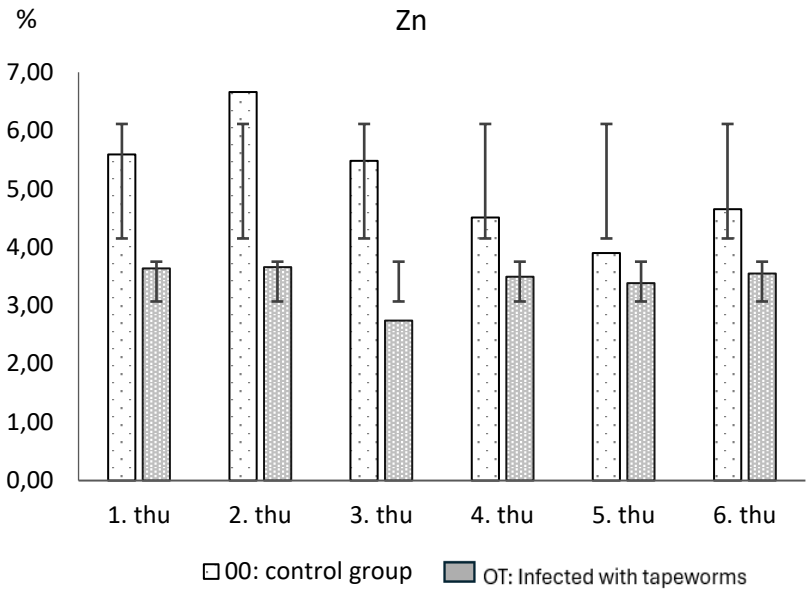

Fig. 1. A comparison of Zn excretion rates (%) in the urine of uninfected control rats (00) and those of control rats infected with tapeworms (0T)

Figures 1 and 2 present median values of Zn excretion expressed as a percentage of total daily intake. It is evident from these graphs that tapeworms have a significant effect on zinc levels excreted in the urine both in the control groups and in the groups that consumed feed with high levels of zinc in the form of zinc lactate.

For the control groups, differences in zinc excretion levels were not considered statistically significant between infected and uninfected rats at any time during the six-week period (Figure 1). For the zinc lactate groups, however, these differences remained statistically significant throughout the entire six-week evaluation.

In the first two weeks, statistically significant differences ($p \leq 0.05$ [*]) were found between the M0 and MT groups. For the remaining four weeks, these differences were even more significant ($p \leq 0.01$ [**]) (Figure 2).

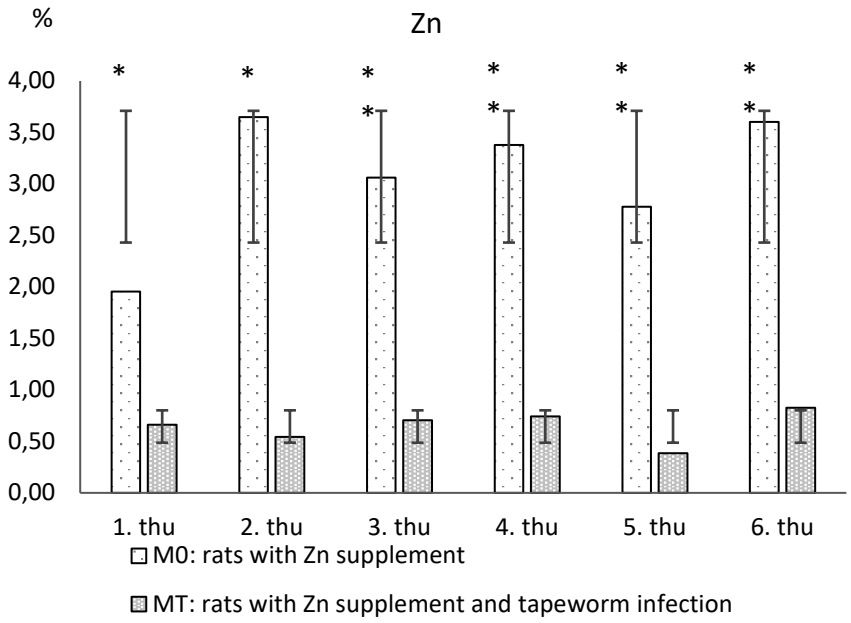

Fig. 2. A comparison between Zn excretion rates (%) in the urine of uninfected Zn overdosed rats (M0) and those of rats from group infected with tapeworms (MT)** statistically significant difference between M0 a MT groups, $p < 0.01$

Discussion

In our previous study we examined fecal excretion of dietary zinc in rats fed overdoses of zinc lactate and infected with tapeworms and we found out that these rats excreted 64.8-87.2 % of Zn in feces depending on tapeworm infection (Table 1); tapeworms significantly reduced the amount of Zn excreted in feces [18]. In this study, rats excreted with urine 0.61-4.88% of ingested zinc; also in this case, tapeworms significantly reduced the amount of Zn excreted with the urine (Table 1).

According to Stehbens [14] humans normally excrete 0.5 mg of zinc in their urine per day. The amount of zinc in the diet affects levels in the urine. Brody [30] determined that when 16 mg of zinc is consumed (daily recommended dose), roughly 0.45 mg (2.8%) is excreted through the urine; however, if zinc levels in the diet are reduced, this decrease is quickly reflected in urinary zinc levels. Similarly, Roohani et al. [15] describes the relationship between the levels of zinc in food and urine. They found that with a dietary intake of 10 to 15 mg zinc per day, 0.5 mg (3-5%) of zinc was excreted in the urine.

When these dietary zinc levels were reduced, these decreases manifested very quickly (within 24 hours) in urinary zinc levels (at times to a minimum of 0.2 mg/day).

In our study, daily zinc intake (less than 2 mg; table 1) in control rats (00; 0T) was approximately one tenth of typical human values. This resulted in a corresponding tenfold decrease in urinary zinc levels. In contrast, zinc levels in the diet of rats in the experimental groups (M0; MT) were proportionately higher than the recommended daily levels of zinc for an adult. This increase in dietary zinc also increased the urinary levels of this metal in rats. However, when calculating excreted zinc as a percentage of dietary zinc intake, there is no longer a significant difference between the control and experimental groups (Table 1; Figure 1 and 2).

Another study using rats demonstrates the ability to maintain relatively constant zinc levels in the body even when dietary zinc intake fluctuates greatly. King et al. [32] administered from 10 to 100 mg of dietary zinc (per kg of feed) to rats, yet zinc levels in these animals remained at approximately 30 mg/kg body weight. Only when the intake fell below 10 mg/ kg or rose above 100 mg/ kg did homeostatic mechanisms no longer maintain a stable level of zinc in the body. For the control groups, we selected daily doses of zinc based on the above-mentioned range (10-100 mg Zn per kg of feed). Groups 00 and 0T specifically received 70 mg of zinc per kilogram of feed. For the groups fed zinc lactate, the amount of zinc in their diet (820 mg/kg of feed) significantly exceeded recommended dosage.

Tapeworms accumulate zinc from their hosts most likely to maintain proper functioning of their own metabolic vital metabolic processes. Like its effect on mammals, zinc may also be essential for tapeworms in terms of development, growth, and overall protein metabolism.

At the gastrointestinal tract, intestinal parasites may be responsible for this inadequate absorption, consequently leading to malnutrition (undernutrition and/or micronutrient deficiencies) and anemia, through processes of inflammation malabsorption, chronic blood loss, anorexia, or hemolysis [36,22].

Results from Lee et al. 2019 [3] describe that helminth infections (or microbial communities favored by them) may induce increased zinc levels directly and that either zinc or iron levels were associated with alterations in helminth infection status (independent of their intake) [3]. Other authors have also suggested the existence of a complex interplay between the host nutritional state, intestinal parasites, and immune responses, which is further complicated by the gut microbiota [3,4].

Horáková et al. [16] report finding the highest zinc concentrations in the immature proglottids located directly behind the scolex. It is possible that these high concentrations are found in the young cells due to the role zinc plays in DNA transcription, RNA translation and cell division. Goodchild and Wells [17]

analyzed samples of the tapeworm *Hymenolepis diminuta* and found a significant presence of histidine and cysteine. Pappas and Durka [18] also found a significant level of histidine and cysteine in tapeworms. Their results show that approximately 32% of the egg casing of *Hymenolepis diminuta* comprises proteins; 22% of this protein volume is made up of histidine. Considering the significant presence of histidine and cysteine in tapeworms, and the relationship these two amino acids have with zinc, it is likely that these cestodes have a considerable need to absorb and subsequently utilize this metal. We can also assume that tapeworms require considerable amounts of zinc owing to their relatively intensive egg production and constant cell renewal.

Jendryzcko et al. [8] reported that children with intestinal parasite (*Giardia*) had lower zinc absorption from the gastrointestinal tract, which led to zinc deficiency; disturbances were found in the zinc metabolism of *Giardia*-infected children. Elimination of zinc via urine, and serum-erythrocyte-zinc concentration were lower in infected children compared to non-infected.

How zinc metabolism is compromised by parasites is not well known. During infection the mucosal epithelium has a high turnover rate and functional immaturity of enzyme and transport systems. Thus, it is hypothesized that the increased intestinal absorption of zinc associated with anti-Giardia treatment may be explained by the restoration of the impaired intestinal mucosa because of the infection [9]. Another hypothesis has suggested that zinc deficiency may result from organ redistribution of zinc, from plasma to the liver, as part of the acute phase response of the host; apparently, the immune response of the host leads to activation of the synthesis of metallothionein in the liver and other tissues, altering the hepatic uptake of zinc [10,13].

The interaction between parasitic infections and zinc metabolism is influenced by multifactorial factors, competition, altered zinc absorption, hormonal regulation, gut microbiota changes and zinc deficiency [28].

The interaction between parasitic infections and zinc metabolism can be influenced by multifactorial factors, competition, altered zinc absorption, hormonal regulation, gut microbiota changes and modulation of the immune response. [20].

Tapeworms are capable of absorbing zinc from the host's intestinal lumen through specialized transport mechanisms. Zinc transporters are divided into two groups - the ZnT group and the ZIP group. ZnT group transporters export zinc from the cytoplasm. The second group of transporters, designated ZIP, transport zinc into the cytoplasm of cells either from the extracellular environment or from vesicles [37]. Tapeworms utilize zinc transport proteins, such as the ZIP (Znt Protein) family, to effectively absorb zinc from the host's diet. By increasing the uptake of zinc, tapeworms reduce its availability for absorption by the host, leading to lower urinary excretion. Another group of intracellular proteins includes metallothioneins which can bind metal cations,

including zinc and cadmium. Metallothionein (MT) is composed of 60-68 amino acids and is expressed in various tissue types – most commonly in the liver, kidney, intestine, pancreas and brain [33, 27]. Its most important function is the transport of essential metal ions and the detoxification of toxic levels of metal ions. It most often binds zinc and, in case of intoxication, also cadmium. It also serves as a reservoir of excess metal ions, which can be used in times of insufficient intake of metal ions [19].

These proteins which can bind and sequester zinc, can be produced/induced by helminths e.g. [24, 29] They not only help in detoxifying excess zinc but also store it for the parasite's metabolic needs, thereby reducing the amount of zinc that would otherwise be excreted by the host.

It is known that the basic zinc homeostasis maintenance mechanism is related to changes in zinc absorption and secretion to and from the alimentary tract. It is associated also with regulation of zinc urinary excretion and its tissue and cell redistribution [5].

The presence of tapeworms can lead to significant changes in the host's metabolism, affecting homeostasis: Impaired Absorption: Tapeworms can interfere with the host's ability to absorb zinc from food. By competing for zinc and other nutrients, they effectively lower the levels of zinc available for absorption, which can lead to reduced excretion through urine.

Tapeworms can also induce hormonal changes [21] that may impact renal function and zinc excretion. Therefore, endocrine modulation may also play a role. Tapeworm infections can alter the host's hormonal balance, particularly hormones involved in kidney function and mineral metabolism [25]. These changes may result in decreased renal excretion of zinc, allowing the host to retain more zinc.

Tapeworms may also have an impact on the gut microbiota composition [23], which can play a role in mineral metabolism. Changes in the gut microbiome due to tapeworm presence can affect the absorption of minerals, including zinc. A modified microbiome may enhance the host's ability to retain zinc or alter the metabolic pathways that influence zinc excretion. Tapeworms can also modulate the host's immune response [21] which may indirectly affect zinc metabolism. The immune response to a tapeworm infection can lead to changes in zinc metabolism. Inflammatory cytokines can influence zinc transport and retention in the body [23] thereby reducing urinary excretion.

Conclusion

Zinc belongs to an intensively investigated element because of worldwide utilization of zinc resulting in potential overdose of the organism and contamination of the environment. Even several times higher doses (than recommended) of zinc lactate did not have a negative effect on experimental rats during six weeks, they all prospered and gained weight. The results of this study

also demonstrate that tapeworms play an important role in decreasing levels of zinc in urine. We observed a significant difference in zinc excretion levels between groups M0 and MT during the entire experiment. Tapeworms, therefore, could decrease urinary zinc concentrations to a significantly greater extent when their host consumes high doses of zinc.

This supports our hypothesis that the tapeworms can (due to accumulating of elements in its body) affect the concentration of these elements in the host's body and thus the subsequent excretion of these elements in urine and feces. The concentration of the elements in animal urine/feces should be monitored to prevent environmental pollution by the animal excreted elements. Especially when they are used as organic fertilizers.

Ethics and animal welfare statement

The authors confirm that the ethical policies of the journal, as noted on the journal's author guidelines page, have been adhered to and the appropriate ethical review committee approval has been received. The authors confirm that they have followed EU standards for the protection of animals used for scientific purposes. All experiments with laboratory animals were conducted in compliance with the current laws of the Czech Republic, Act No. 246/1992 coll. on the protection of animals against cruelty and EC Directive 86/609 EEC. The study was approved by the ethic committee of Czech University of Life Sciences Prague.

List of abbreviations

ICP-OES: Inductively Coupled Plasma Optical Emission Spectrometry, a technique used to analyze zinc concentrations in urine samples.

ST-1: Standard rodent mixture feed used in the study.

MT: One of the experimental groups of rats infected with *Hymenolepis diminuta.*

0T: Another experimental group of rats infected with *Hymenolepis diminuta.*

M0: An experimental group of rats that were uninfected but received a zinc lactate supplement.

00: Control group of uninfected rats receiving standard feed.

MT (Metallothionein): A family of proteins that bind metal ions, including zinc, helping to regulate zinc homeostasis.

ZnT: Zinc Transporter, a group of transport proteins that export zinc from cells.

ZIP: Zrt/Irt-like Protein, a group of transport proteins that import zinc into cells.

p: Probability value used in statistical analysis to determine significance (e.g., $p \leq 0.05$).

EU: European Union, referenced in the context of ethical standards for animal research.

References

Sures B., Grube K. & Taraschewski H. 2002 Experimental studies on the lead accumulation in the cestode Hymenolepis diminuta and its final host, Rattus norvegicus. Ecotoxicology, 11, 365–368. https://doi.org/10.1023/A:1020561406624

Jankovská I., Sloup V., Száková J., Langrová I. & Sloup S. 2016 How the tapeworm Hymenolepis diminuta affects zinc and cadmium accumulation in a host fed a hyperaccumulating plant (Arabidopsis halleri). Environ. Sci. Pollut. Res., 23, 19126–19133. https://doi.org/10.1007/s11356-016-7123-1

Lee S.C., Tang M.S., Easton A.V., Devlin J.C., Chua L.L., Cho I., Moy F.M., Khang T.F., Lim Y.A.L. & Loke P. 2019 Linking the effects of helminth infection, diet and the gut microbiota with human whole-blood signatures. PLoS Pathog., 15, e1008066. https://doi.org/10.1371/journal.ppat.1008066

Popovic A., Bourdon C., Wang P.W., Guttman D.S., Soofi S., Bhutta Z.A., Bandsma R.H.J., Parkinson J. & Pell L.G. 2021 Micronutrient supplements can promote disruptive protozoan and fungal communities in the developing infant gut. Nat. Commun., 12, 6729. https://doi.org/10.1038/s41467-021-27053-4

King J.C., Shames D.M. & Woodhouse L.R. 2000 Zinc homeostasis in humans. J. Nutr., 130, 1360S–1366S. https://doi.org/10.1093/jn/130.5.1360S

Semrad C.E. 1999 Zinc and intestinal function. Curr. Gastroenterol. Rep., 1, 398–403. https://doi.org/10.1007/s11894-999-0021-7

Geiser J., De Lisle R.C. & Andrews G.K. 2013 The zinc transporter Zip5 (Slc39a5) regulates intestinal zinc excretion and protects the pancreas against zinc toxicity. PLoS ONE, 8, e82149. https://doi.org/10.1371/journal.pone.0082149

Jendryczko A., Sodowska H. & Drożdż M. 1993 Zinc deficiency in children infected with Giardia lamblia. Wiad. Lek., 46, 32–35.

Buret A.G., Hardin J., Olson M. & Gall D. 1992 Pathophysiology of small intestinal malabsorption in gerbils infected with Giardia lamblia. Gastroenterology, 103, 506–513. https://doi.org/10.1016/0016-5085(92)90837-X

Cuevas L.E. & Koyanagi A. 2005 Zinc and infection: A review. Ann. Trop. Paediatr., 25, 149–160. https://doi.org/10.1179/146532805X58047

Kosik-Bogacka D.I., Baranowska-Bosiacka I. & Kolasa-Wołosiuk A. 2016 The inflammatory effect of infection with Hymenolepis diminuta via increased expression and activity of COX-1 and COX-2 in the rat jejunum and colon. Exp. Parasitol., 169, 69–76. https://doi.org/10.1016/j.exppara.2016.07.009

Krebs N.F. 2000 Overview of zinc absorption and excretion in the human gastrointestinal tract. J. Nutr., 130, 1374S–1377S. https://doi.org/10.1093/jn/130.5.1374S

Schroeder J.J. & Cousins R.J. 1990 Interleukin-6 regulates metallothionein gene expression and zinc metabolism in hepatocyte monolayer cultures. Proc. Natl. Acad. Sci. USA, 87, 3137–3141. https://doi.org/10.1073/pnas.87.8.3137

Stehbens E.W. 2003 Oxidative stress, toxic hepatitis, and antioxidants with particular emphasis on zinc. Exp. Mol. Pathol., 75, 265–276. https://doi.org/10.1016/S0014-4800(03)00097-2

Roohani N., Hurrell R., Kelishadi R. & Schulin R. 2013 Zinc and its importance for human health: An integrative review. J. Res. Med. Sci., 18, 144–157.

Horáková B., Čadková Z. & Száková J. 2017 Identification of risk and essential elements along the strobila of the rat tapeworm Hymenolepis diminuta. J. Helminthol., 91, 555–560. https://doi.org/10.1017/S0022149X16000535

Goodchild C.G. & Wells O.C. 1957 Amino acids in larval and adult tapeworms (Hymenolepis diminuta) and in the tissues of their rat and beetle hosts. Exp. Parasitol., 6, 575–585. https://doi.org/10.1016/0014-4894(57)90040-1

Pappas P.W. & Durka G.M. 1994 Partial characterization of the protein and carbohydrate constituents of the eggshell of Hymenolepis diminuta. Int. J. Parasitol., 24, 705–712. https://doi.org/10.1016/0020-7519(94)90124-4

Sulima-Celińska A., Kalinowska A. & Młocicki D. 2022 The tapeworm Hymenolepis diminuta as an important model organism in experimental parasitology of the 21st century. Pathogens, 11, 1439. https://doi.org/10.3390/pathogens11121439

Skalny A.V., Aschner M., Lei G.X. et al. 2021 Gut microbiota as a mediator of essential and toxic effects of zinc in the intestines and other tissues. Int. J. Mol. Sci., 22, 13074. https://doi.org/10.3390/ijms222313074

Valdez R.A. Jiménez P. Fernández Presas A.M. Aguilar L., Willms K. & Romano M.C. 2014 Taenia solium tapeworms synthesize corticosteroids and sex steroids in vitro. Gen. Comp. Endocrinol., 205, 162–167. https://doi.org/10.1016/j.ygcen.2014.04.014

Pasricha S.-R., Vijaykumar V., Prashanth N.; et al. 2009 A community-based field research project investigating anaemia amongst young children in rural Karnataka, India: A cross-sectional study. BMC Public Health, 9, 59. https://doi.org/10.1186/1471-2458-9-59

Peachey L.E., Jenkins T.P. & Cantacessi C. 2017 This gut ain't big enough for both of us: Helminth–microbiota interactions in veterinary species. Trends Parasitol., 33, 619–632. https://doi.org/10.1016/j.pt.2017.04.004

Petrlova J., Krizkova S., Zitka O. et al. 2007 Utilizing a chronopotentiometric sensor technique for metallothionein determination in fish tissues and their host parasites. Sens. Actuators B Chem., 127, 112–119. https://doi.org/10.1016/j.snb.2007.04.028

Quintanar-Stephano A., Hernández-Cervantes R., Moreno-Mendoza N. et al. 2015 The endocrine–immune network during taeniosis by Taenia solium: The role of the pituitary gland. Exp. Parasitol., 159, 233–244. https://doi.org/10.1016/j.exppara.2015.09.008

Hammerbauerová I., Richtrová E., Kybicová K., Pajer P. & Votýpka J. 2025 Diversity and multiple infections of Bartonella in red deer and deer keds. Pathogens, 14, 6. https://doi.org/10.3390/pathogens14010006

Miles A.T., Hawksworth G.M., Beattie J.H. & Rodilla V. 2000 Induction, regulation, degradation and biological significance of mammalian metallothioneins. Crit. Rev. Biochem. Mol. Biol., 35, 35–70. https://doi.org/10.1080/10409230091169168

Robinson N.J., Whitehall S.K. & Cavet J.S. 2001 Microbial metallothioneins. Adv. Microb. Physiol., 44, 183–213. https://doi.org/10.1016/S0065-2911(01)44014-8

Koren O. & Tako E. 2020 Chronic dietary zinc deficiency alters gut microbiota composition and function. Proc., 61, 16. https://doi.org/10.3390/IECN2020-06993

Hewitson J.P., Grainger J.R. & Maizels, R.M. 2009 Helminth immunoregulation: The role of parasite-secreted proteins in modulating host immunity. Mol. Biochem. Parasitol., 167, 1–11. https://doi.org/10.1016/j.molbiopara.2009.04.008

Brody T. 1998 Nutritional Biochemistry, 2nd ed.; Academic Press: San Diego, CA, USA.

Lau A.L. & Failla M.L. 1984 Urinary excretion of zinc, copper and iron in the streptozotocin-diabetic rat. J. Nutr., 114, 224–233. https://doi.org/10.1093/jn/114.1.224

Gammoh N.Z. & Rink L.2019 Zinc and the immune system. In Nutrition and Immunity; Springer: Berlin/Heidelberg, Germany, pp. 127–158.

Scott M.E. & Koski K.G. 2000 Zinc deficiency impairs immune responses against parasitic nematode infections at intestinal and systemic sites. J. Nutr., 130, 1412S–1420S. https://doi.org/10.1093/jn/130.5.1412S

Pullan R. & Brooker S. 2008 The health impact of polyparasitism in humans: Are we under-estimating the burden of parasitic diseases? Parasitology, 135, 783–794. https://doi.org/10.1017/S0031182008000346

Popularity of arthropods among preschool and younger school-age children

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Abstrackt

This study explores children's emotional responses to selected arthropod species presented at an environmental exhibition focused on entomology, held during the 16th Environmental Exhibition of the Kolín District. The objective was to identify differences in species perception through a quantitative analysis of preference ratings, expressed using color-coded cards (positive, negative, neutral). The findings revealed that ants received the highest number of neutral ratings, suggesting they are perceived as the most emotionally balanced among the arthropods. In contrast, butterflies and earwigs evoked the strongest emotional reactions—while butterflies were predominantly rated positively, earwigs received the most negative evaluations.

Keywords: Arthropods, children, preferences, biophilia, animal perception

Introduction

The empirical data for this study were collected during the 16th annual Environmental Exhibition in Kolín, an event primarily aimed at children and youth that emphasizes interactive, experience-based environmental education. A central feature of the exhibition was an entomology-themed booth, where participants could engage directly with educational materials related to arthropod biodiversity. Such informal learning environments are increasingly recognized as valuable platforms for enhancing scientific literacy, sparking curiosity, and reshaping children's perceptions of less charismatic fauna, such as arthropods (Ribeiro & Sant'Ana, 2019; Lopes et al., 2018).

Arthropods make up approximately 90% of all known animal species (Santos-Fita et al., 2011), yet they are frequently misunderstood or met with aversion due to deep-rooted cultural biases**.** Lopes et al. (2018) describe these attitudes as part of *entomoprojective ambivalence*—a phenomenon in which people project emotions such as fear or disgust onto arthropods based on symbolic or aesthetic perceptions rather than ecological understanding. However, educational programs that offer direct, structured, and age-appropriate interactions with arthropods have been shown to reduce these negative

perceptions and foster greater appreciation and interest (Lopes et al., 2018; Miller et al., 2025).

Similar approaches are implemented in other parts of the world, such as the *Exposição Entomológica Professora Yoko Terada* at the Museu Dinâmico Interdisciplinar (MUDI) in Maringá, Brazil. This exhibition features didactic collections, interactive games, scientific specimens, and multimedia materials to educate visitors on arthropods biology, ecology, and their roles in health and the economy (Bell Museum, 2007). The Brazilian initiative further exemplifies how taxonomic and scientific collections can be effectively adapted for didactic purposes, making them accessible and engaging to young audiences while preserving their scientific relevance ("Biological Collections," 2021; "Biological collections: ensuring critical research and education for the 21st century," 2020; Hilton et al., 2021)

Both the Kolín and Maringá exhibitions rely on hands-on, inquiry-based learning strategies that encourage observation, classification, and reflective thinking. For instance, the Kolín event's use of a stamp-reward system to motivate participation mirrors gamified pedagogical methods employed in Maringá, such as the arthropods camouflage game and tactile models, which have been shown to facilitate both cognitive gains and affective engagement (Santana et al., 2012; Ribeiro and Sant'Ana, 2019). The open structure of these exhibitions, in which educators adapt content based on the audience's age and knowledge level, supports inclusive, learner-centered science education practices (Ribeiro and Sant'Ana, 2019).

Ultimately, entomological exhibitions like those in Kolín and Maringá serve as exemplary models of how science communication and environmental education can intersect to foster ecological literacy, especially among children. By counteracting negative stereotypes about arthropods and situating them within broader ecological narratives, such initiatives help lay the foundation for more sustainable, biodiversity-conscious worldviews in future generations.

Materials and methods

The stand was systematically divided into four separate sections, each of which focused on a different aspect of environmental education with a specific emphasis on the knowledge and perception of arthropods in children of different age groups (approximately from five years to fifteen years). The stations were designed to convey knowledge in an experiential way, to promote active learning and to enable the collection of relevant data. The first three sites were primarily educational but also served to observe children and their reactions to questions about arthropods.

The key research part took place at the fourth site, which focused on the children's emotional attitudes towards selected arthropods. The research instrument was designed as a simple preference-based selection test but adapted

visually and in colour to the target group. Children were presented with six arthropods species, chosen so that they differed significantly from each other morphologically, but at the same time so that each child was familiar with it. Common arthropods were chosen that they had encountered outdoors while playing in the street or garden, or at school in science lessons - stag beetle, ant, earwig, butterfly, true fly and spider. Each species was shown in a separate picture.

The children came to the stations at random, sometimes in a large group, other times in a small group, for example with their parents. When a larger group was present, two interviewers were present to explain to the children exactly what to do.

Each participant was given three coloured squares of paper - green, red and yellow, with the colours symbolizing the child's emotional attitude towards each type: green = "I like it", red = "I don't like it", yellow = "neutral attitude".

Children were asked to put a coloured square in the appropriate box for each picture according to their personal feeling and evaluation. The children were asked several times if they understood the task. For example, when determining that the spider seemed to them to be the most beautiful, they were asked, "Do you like the spider the most out of these animals?". When communicating with the children, care was taken to communicate with them appropriately. The data obtained in this way form the basis for a quantitative analysis of children's perceptions of various arthropods.

After data collection, all color calls were counted for each of the six morphologically distinct arthropods species. The result was the absolute number of green (positive), red (negative), and yellow (neutral) votes for each species. These data were then used to calculate a so-called preference score, which represents the difference between the number of positive and negative votes for a given species. This index serves as a quantitative indicator of children's overall perception of arthropods species.

Results

The calculation was carried out according to the formula: preference score = number of green squares minus number of red squares. The results were then visualized through bar graphs that displayed both the number of each type of response (green, red, and yellow squares) for each species, as well as a separate graph capturing only the preference score for ease of comparison of popularity between species.

The results thus processed were further used to identify the most and least popular species from the perspective of the child participants. The butterfly was identified as the most popular species by a large margin (305 green squares, preference score +283), while the earwig and the garden spider were perceived most negatively (-111 and -109, respectively), receiving the reddest votes and

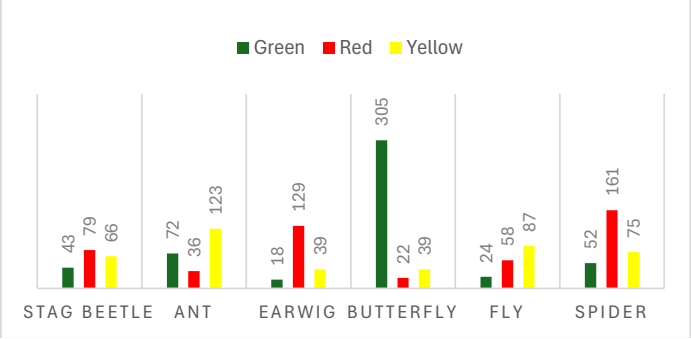

Figure 5. The graph shows the overall emotional evaluation of arthropods by child respondents. *From right to left it shows green (positive attitude), red (negative attitude) and yellow (neutral attitude) bars.*

the lowest scores. These differences also reflect general visual or cultural preferences and stereotypes that children seem to acquire at an early age in relation to arthropods.

The analysis showed that the ant was ranked as the most neutral species, as it received the most yellow markings (n = 123), which represented a neutral

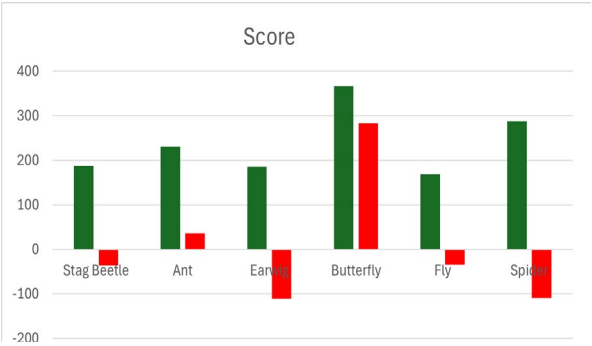

Figure 2. The graph presents the scores of positive and negative emotional reactions of the child respondents towards different types of arthropods.

attitude. Conversely, the butterfly and the earwig received the fewest yellow markings (n = 39), indicating that they elicited stronger emotional reactions in children - the butterfly predominantly positive, the earwig negative. These differences indicate the influence of familiarity and species appearance on children's perceptions of arthropods.

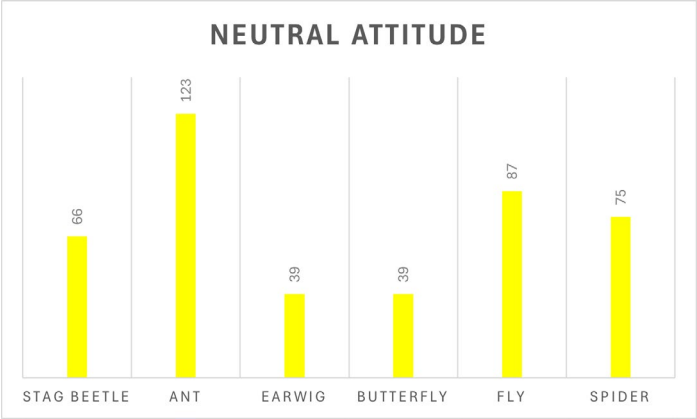

Figure 3. The graph shows the number of neutral ratings (yellow labels) assigned to each arthropods species by child participants.

Discussion

The results of this study confirm that children perceive different arthropods species very differently, with these attitudes influenced by a combination of biological familiarity and visual characteristics. The most interesting finding is the high number of neutrally rated responses for the ant, suggesting that this species is both the most familiar and the least emotionally charged object for children to evaluate. This neutrality may be related to the common occurrence of ants in children's environments and their ubiquity leading to a reduction in fear or disgust, which corresponds with previous studies showing a lower emotional response to commonly familiar arthropods species (Lopes et al., 2018; Ribeiro and Sant'Ana, 2019).

Conversely, the butterfly and the earwig, which children rated with the lowest number of neutral responses, elicited stronger emotional reactions, either positive (butterfly) or negative (earwig). Butterflies are often associated with beauty, colorfulness, and positive metaphors of nature that evoke pleasant feelings and interest in children (Miller et al., 2025). Conversely, the mosquito is perceived negatively by many people, which is manifested in fear or disgust that may be conditioned by its shape, behavior, or even symbolism (Alencar et al., 2012).

However, it should be emphasized that even with positive outcomes, there are differences between species that are primarily shaped by cultural patterns and visual aspects that can influence children's emotional responses. Therefore, future educational programs should take these factors into account and work purposefully to change negative perceptions, for example through targeted activities that demonstrate the ecological value of even the less attractive arthropods species (Lopes et al., 2018).

Although investigating children's emotional attitudes towards arthropods has yielded valuable insights, the study has some limitations. The selection of arthropods was limited to those familiar to the children, which may have influenced the resulting level of emotional reactions. Also, the methodology of using colored cards to express attitudes, while practical and simple, may be limited in revealing the nuances of emotional appraisal. Future research could broaden species selection and combine quantitative methods with in-depth interviews or observations to better understand the basis of children's attitudes towards arthropods.

In conclusion, the results of this work show the attitudes of children from the selected region of Kolín towards different groups of arthropods. It has been shown that the degree of popularity of different species varies considerably, with some groups being perceived positively, while others evoke negative emotional reactions. These results reflect the current state of preferences and aversions among children in the region and provide insight into their relationship with this animal group.

References

Alencar L.R.V., Galdino C.A.B. & Nascimento L.B. 2012 Life history aspects of *Oxyrhopus trigeminus* (Serpentes: Dipsadidae) from two sites in southeastern Brazil. Journal of Herpetology 46:9–13.

Biological Collections 2021 Biological collections. Washington, DC: National Academies Press. https://doi.org/10.17226/25592

National Academies of Sciences, Engineering, and Medicine 2020 Biological collections: Ensuring critical research and education for the 21st century. Washington, DC: The National Academies Press.

Bell Museum 2007 Bugs: Outside the box – media release. Dostupné na: https://www.bellmuseum.umn.edu/bugs-mediarelease/

Hilton E.J., Watkins-Colwell G.J. & Huber S.K. 2021 The expanding role of natural history collections. Ichthyology and Herpetology 109(2):379–391. https://doi.org/10.1643/t2020018

Santana O., Trindade N., Cordeiro J., Júnior S., Marcelo P. & Teixeira M. 2012 Um estudo das representações sociais de estudantes do ensino médio sobre os insetos. Revista de Ciências Exatas e Naturais.

Lopes L.A., Valduga M. & Dal-Farra R.A. 2018 Insetos e o ser humano: o olhar de estudantes do ensino fundamental em produções textuais. Educere et Educare 13(28). https://doi.org/10.17648/educare.v13i28.14098

Miller K.M., Beegle D.K., Blevins Wycoff S. & Frank D.L. 2025 Transforming children's attitudes toward arthropods through in-school encounters. Arthropods 16(1):93. https://doi.org/10.3390/arthropods16010093

Attachments (arthropod pictures for testing)

Attachment 1. Earwig

Attachment 2. Stag beetle

Attachment 3. Ture fly

Attachment 4. Spider

Attachment 5. Ant

Attachment 6. Butterfly

Název: PROCEEDINGS OF THE 15TH WORKSHOP ON BIODIVERSITY, JEVANY
Vydavatel: Česká zemědělská univerzita v Praze
Adresa vydavatele: Česká zemědělská univerzita v Praze, Kamýcká 129, Praha –Suchdol, 165 00
Povoleno: děkanátem FAPPZ
Tiskárna: Power Print, Praha- Suchdol
Náklad: 20 výtisků
Počet stran: 95
Vydání: první
Rok vydání: 2025
ISBN 978-80-213-3543-1 (print version)
ISBN 978-80-213-3544-8 (online version)

Vydala Česká zemědělská univerzita ve svém nakladatelství