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Expansion of *Erythromma lindenii* (Selys, 1840) (Odonata: Coenagrionidae) is still ongoing: settlement of Central Europe by various migratory routes

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Abstract

Expansion of *Erythromma lindenii* (Selys, 1840) (Odonata: Coenagrionidae) is still ongoing: settlement of Central Europe by various migratory routes – The *Erythromma lindenii* population in the Czech Republic was only recently established; the species was not present before 2009. In 2020, *Erythromma lindenii* was identified for the first time in two places in the Moravia territory (eastern country of the Czech Republic) surrounding the town of Znojmo (Znojmo district). In 2021–2022, a stable population was discovered in the area. In 2022, another expansion of the species to the Lanžhot village are was observed at the confluence of the Dyje/Thaya and Kyjovka Rivers (the Břeclav district), at the March/Morava river near Hohenau an der March (the Gänserndorf district) in Austria, and in two places near the Moravský Svätý Ján village in Slovakia (the Senica district, found as a new species in Slovakia). These data confirm the quick north-eastwards expansion of the species range in Central Europe in the area of the Pannonian biogeographical province, i.e., by the Danube-Pannonian current. This expansion contrasts with the expansion to the territory of Bohemia, which was settled by the Lusatian migration flow in 2009.

Abstrakt

Expanze druhu *Erythromma lindenii* (Selys, 1840) (Odonata: Coenagrionidae) stale probíhá: osídlování střední Evropy různými migračními proudy – Výskyt *Erythromma lindenii* byl zjišten poprvé v roce 2009 v severních Čechách. V roce 2020 byl zjišten výskyt *E. lindenii* na dvou místech na území Moravy (východ ČR) v okolí města Znojma (okres Znojmo). V letech 2021–2022 byla v oblasti zjištěna stabilní populace. V roce 2022 bylo pozorováno další rozšíření druhu k obci Lanžhot na soutoku řeky Dyje a Kyjovky (okres Břeclav), na řece March/Morava u Hohenau an der March (okres Gänserndorf) v Rakousku, a na dvou místech u obce Moravský Svätý Ján na Slovensku (okres Senica, jako nový druh zjištěný pro území Slovenska). Tyto údaje potvrzují rychlé severovýchodní rozšíření druhu ve střední Evropě v oblasti panonské biogeografické provincie, tedy dunajsko-panonským migračním proudem. Tato expanze kontrastuje s expanzí na území Čech, které bylo v roce 2009 osídleno lužickým migračním proudem.

Zusammenfassung

Die Ausbreitung von *Erythromma lindenii* (Selys, 1840) (Odonata: Coenagrionidae) ist noch im Gange: Besiedlung Mitteleuropas durch verschiedene Migrationsrouten – Das Vorkommen von *Erythromma lindenii* wurde erstmals für die Tschechische Republik 2009 in Nordböhmen nachgewiesen. Im Jahr 2020 konnte das Vorkommen von *E. lindenii* an zwei Orten in Mähren (östlicher Teil der Tschechischen Republik) in der Nähe der Stadt Znojmo (Bezirk Znojmo) nachgewiesen werden. Im Zeitraum 2021–2022 wurde in der Region eine stabile Population festgestellt. 2022 konnte die weitere Ausbreitung der Art nach Lanžhot am Zusammenfluss der Flüsse Thaya und Kyjovka (Bezirk Břeclav), an die March/Morava bei Hohenau an der March (Bezirk Gänserndorf) in Österreich und an zwei Orte in der Nähe des Dorfes Moravský Svätý Ján in der Slowakei (Bezirk Senica, als neue Art auf für die Slowakei) beobachtet werden. Diese Daten bestätigen die schnelle nordöstliche Ausbreitung der Art in Mitteleuropa im Bereich der pannonischen biogeografischen Provinz, d.h. über die donau-pannonische Migrationsroute. Diese Ausdehnung steht im Kontrast zur Ausbreitung auf das Gebiet Böhmens, das 2009 durch die Lausitzer Migrationsroute besiedelt wurde.

Introduction

Over the last 30 years, the reported composition of the Odonata fauna in Central Europe has changed significantly, partly due to intensive research over the last 25 years (Raab et al. 2006; Dolný et al. 2007; Bernard et al. 2009; Staufer & Holuša 2010) but also due to changes in the fauna composition and the range expansion of certain dragonfly species (David 2000; Holuša 2009; Černý et al. 2014, David & Šácha 2019).

The Czech Republic occupies a very specific position in Central Europe with respect to its biogeographical characteristics, as four biogeographical provinces meet here: the Hercynian, West Carpathian, Polonian, and North Pannonian provinces (Culek 1996). This unique quality contributes to a diverse composition of the dragonfly fauna and diversity in the geomorphological configuration of areas, resulting in different animal migration patterns, especially for insects. The unique characteristics of this played an important role in the postglacial migration of communities into Central Europe (Schmid 1939, 1949), and a number of dragonfly species took advantage of the geomorphological configuration to diversify their settlement in Central Europe (cf. Bernad & Daraż 2015).

Erythromma lindenii is a Western-Mediterranean faunistic element with Westeuropean–Holomediterrean occurrence. The geographical range of the species includes the entire Mediterranean area, including the Maghreb, with a centre of origin in western Europe. The species is common on the Iberian Peninsula and in Italy, France, and western Germany and limited to lowlands and coastal areas in the eastern Mediterranean and throughout the Balkan Peninsula and Turkey. The easternmost range of the insect includes Crimean Peninsula (Khrokalo & Prokopov 2009; Khrokalo et al. 2009)), the Caucasus Mountains, and West and South-west Iran (Heidari & Dumont 2002; Schneider & Ikemeyer 2019). The

northernmost European range includes northern Germany and Poland (Bernard et al. 2009; Brockhaus et al. 2015). Isolated encounters have long been reported in Brandenburg (mid-eastern Germany) and the adjacent portion of western Poland (Beutler 1985; Bernard et al. 2009). From this area, the species likely spread to northern and Central Bohemia (Czech Republic) (Waldhauser 2009). Within the last several years, its range has expanded northwards and eastwards (Dijkstra & Lewington 2006; De Knijf & Anselin 2010; Goffart 2010; Zinkow 2022), and expansion into Belgium, the Netherlands, and northern Germany has been reported (De Knijf et al. 2006; Hunger et al. 2006, Bouwman et al. 2008). With this expansion, the gap between the main range and the "Brandenburg-polish" island is shrinking (Bernard et al. 2009). The gradual colonisation of this area has been described by Günther et al. (2021), who reported that the species has scattered throughout Saxony in Germany. This expansion was confirmed by a recent finding in southeastern Hungary in the region of Kis-Sárrét (Móra & Farkas 2015).

Erythromma lindenii was identified for the first time in the country of Bohemia (western part of the Czech Republic) in July 2009 in the Kunratice u Cvikova locality (Waldhauser 2009). To date, the insect's range has expanded in a southwestern direction, including 37 localities in 25 squares of grid mapping in Bohemia (AOPK ČR 2021).

Moravia is a historic country that forms the eastern half of the Czech Republic (Fig. 4). From a biogeographical perspective, Moravia differs significantly from the region of Bohemia, primarily in the existence of the Pannonian lowlands in the south and the Polish lowlands in the north. The border between Bohemia and Moravia is formed by the forested massif of the Českomoravská vrchovina hills (the highest point of the Devět skal hill is 836 m a.s.l.). Many Submediterranean plants and animals particularly inhabit the area of the North Pannonian region. Despite the presence of suitable habitats and the expansion of *E. lindenii*, the species has not yet been observed in Moravia (Dolný et al. 2007) or in Slovakia (Balázs pers. comm.).

The paper provides documentation of the continued expansion of *E. lindenii* in Central Europe, as revealed by a detailed survey of the dragonfly fauna in the northern part of the Pannonian Plain in 2020–2022. Furthermore, we document the rate of advance and confirm the presence of stable populations, including a discussion of the migratory flows of this species.

Study area and methods

I began intensive surveys of dragonflies in the greater area of the National Park of Podyjí in 2018, which is located in the southwestern part of Moravia and borders Austria, as well as in the area of the Lanžhot village at the confluence of the rivers Dyje (Thaya) and Morava (March) and the adjacent Záhorie region in Slovakia. This is a continuation of previous surveys, the first stage of which took place in Podyjí National Park in 1999–2005 (Holuša 2007), in the Lanžhot region in 1993–1996 (Holuša 1997), and in Slovakia in Zahorie in 1927–1998 (Uvíra et al. 1999) and 1993–1996 (Holuša 1996).

The Podyjí National Park is primarily a canyon of the river Dyje with wooded slopes; however, in the vicinity of the National Park, there are many aquatic habitats, including ditches, streams, ponds, clay pits, dam reservoirs, flooded quarries, and marches. The Vrbovecký rybník pond and clay pit near Přímětice village were evaluated as they are places with the greatest diversity of dragonfly species (Holuša 2007). The surroundings of Lanžhot village represent the alluvial areas of the lower part of the Dyje/Thaya River and the lower part of the Morava/March River, as well as the confluence of the Kyjovka and Dyje Rivers and the border of the confluence of the Dyje/Thaya and Morava/March Rivers. Many water biotopes exist in the area in addition to the course of the Dyje, Morava, and Kyjovka rivers, including many oxbows, drainage channels, flooded gravel pits, and swamps. The alluvium of the March River continues southwards along the border of Slovakia and Austria, and forms a significant part of the Záhorie region in Slovakia.

All localities are situated on the territory of the Pannonian Plain, the Podyjí National Park on the northeastern edge of this plain, the region surrounding Lanžhot village, the region surrounding Hohenau an der March and Moravský Svätý Ján village in the Zahorie region within the plain.

The maps were processed in ESRI 2020 ArcGIS ArcMap 10.8 software.

Results

Erythromma lindenii was identified at five localities in the North Pannonian biogeographical subprovince within the greater "tri-border" Czech Republic/Austria/Slovakia. Its presence was also recorded in two localities in the region of the Znojmo district (in surroundings of the National Park of Podyjí), at one locality in the Lanžhot village region in the Czech Republic, one locality in the region of Hohenau an der March region in Austria, and two localities in the region of Moravský Svätý Ján village in Slovakia.

1. Moravia, Znojmo district, Přímětice village – Natural monument Kaolínka, (48.888105° N, 16.052000° E, 308 m a.s.l., grid mapping code 7162). 16.vii. 2020: 5♂, 2♀, coll. 1♂; 23.vii.2020: 7♂, 3♀ (Fig. 1), coll. 2♂, 2♀; 11.viii.2020: 15♂, 5♀, coll. 2♂, 2♀; 06.vii.2021: 6♂, ♀; 06.viii.2021: 5♂, 3♀; 23.vi.2022: 6♂, 5♀, coll. 3♂, 3♀; 18.vii.2022: 3♂, 1♀. At this location, tandems and egg-laying were observed throughout the day. The habitat in Přímětice–"Kaolínka" includes a clay pit, where Kaolin mining finished in the 1970s. Today, the area persists as a flooded pit measuring 225 × 100 m with a maximum depth of approximately 3.5 m. The lake has slightly turbid water and is mostly shallow, with slightly sloping shores formed by kaolin. On the banks, there is a sparse stand of common reed *Phragmites australis*. On the shore, rushes (*Juncus* sp.) can be found. In the water column, rich stands of rigid hornwort *Ceratophyllum demersum* and Eurasian watermilfoil *Myriophyllum spicatum* are observed (Fig. 2).

Figure 1. An egg-laying pair of *Erythromma lindenii* at Přímětice village, Znojmo district, Moravia, Czech Republic, 11-viii-2021. – **Abbildung 1:** Ein eierlegendes Paar von *Erythromma lindenii* bei Přímětice, Bezirk Znaim, Mähren, Tschechische Republik, 11.08.2021. Photo: OH

Figure 2. Habitat of *Erythromma lindenii* at Přímětice village, Moravia, Czech Republic, 11-viii-2020. – **Abbildung 2:** Habitat von *Erythromma lindenii* bei Přímětice, Mähren, Tschechische Republik, 11.08.2020. Photo: OH

2. Moravia, Znojmo district, Vrbovec village – Natural Monument Vrbovecký rybník pond (48.791402° N, 16.137852° E, 209 m a.s.l., grid mapping code 7262). 23.vii.2020: 1♂. All document specimens in coll. O. Holuša. In 2021, no insects were observed. The Vrbovecký rybník pond represents a smaller shallow pond; the pond did not have water in 2019, and in 2020 there was a maximum water column of 40 cm. Along the banks of the pond there is a wide strip of *P. australis* and occasional "islands" of broadleaf cattail *Typha latifolia*. At the dam, smaller stands of European bur-reed *Sparganium emersum* exist, and sparse stands of three-lobe beggarticks *Bidens tripartite* exist in the water column.
3. Moravia, Břeclav district, Lanžhot village – confluence of Kyjovka River and Dyje River (48.649261° N, 16.921136° E, 154 m a.s.l., grid mapping code 7367). 16.vii.2020: 2♂, 2♀, coll. 1♂ (Fig. 3). The habitat includes a confluence of slow-flowing rivers (width 10–15 m), with a maximum depth of approximately 2 m; the water is slightly turbid. The rivers possess steep clay banks and are sometimes shallow with sandy deposits. Near the shore can some-

Figure 3. Habitat of *Erythromma lindenii* in the March/Morava River near Hohenau an der March, Gänserdorf district, Austria, 09-vii-2022. – **Abbildung 3:** Habitat von *Erythromma lindenii* an der March nahe Hohenau an der March, Bezirk Gänserdorf, Österreich, 09.07.2022. Photo: OH

times be found floating and crisp-leaved pondweed *Potamogeton natans* and *P. crispus*. On the banks, there are dense stands of common nettle *Urtica dioica*, reed canary grass *Phalaris arundinacea*, and European dewberry *Rubus caesius*. Sedges *Carex* sp. can be identified at the foot of the bank, as can a sparse stand of *S. emersum*.

4. Austria, Gänserndorf district, Hohenau a der March village – March/Morava river (48.601636° N, 16.933202° E, 150 m a.s.l.). 09.vii.2022: 1♂. The habitat includes the lower part of the river with slowly flowing water, with a maximum depth of 1.5 m. The banks are clay, with sandy deposits at the base, and the bank is occasionally reinforced with stones. Near the shore, *P. crispus* and sparse stands of *S. emersum* are sometimes present in the water.
5. Slovakia, Senica district, Moravský Svätý Ján village – Morava River (48.608736° N, 16.942591° E, 150 m a.s.l.), 9.VII.2022, 1♂/1♀, coll. 1♂. Same characters as locality No. 4.
6. Slovakia, Senica district, Moravský Svätý Ján village – Malolevárská kanál canal (48.594280° N, 16.971731° E, 150 m a.s.l.). 16.vii.2022, 1♂. The habitat is an artificial canal with slow flowing, but clean water. The banks are steep with a strip of *S. emersum* and sometimes narrow strips of *T. latifoli*a or *P. communis*. Single plants of *S. emersum* are very common on the water surface, as are very often small groups of *P. natans*.

In Přímětice in the Znojmo district, where the insect was first detected, a stable population was identified each year from 2020 to 2022. *Erythromma lindenii* individuals were found in the coastal areas, especially on the bases of *P. australis* stalks, and a larger number (all in tandems) were observed flying above the free water surface, especially in places where *Myriophyllum spicatum* flowers protruded from the water, where females laid eggs (Fig. 1). Tandems were observed laying eggs on *Potamogeton* and *Ceratophyllum* stands. Other species of dragonflies were also observed at the Přímětice site: *E. viridulum*, *Platycnemis pennipes*, *Coenagrion puella*, *C. scitulum*, *Orthetrum cancellatum*, and *Crocothemis erythraea* were the dominant species, but individual *Anax imperator*, *O. albistylum*, *Ischnura elegans*, *I. pumilio*, and *Enallagma cyathigerum* were also observed.

At other localities, the species was found in lower numbers, in tandems or as single specimens. At the confluence of the Dyje/Thaya and Kyjovka rivers, Hohenau an der March, and the Morava river in Moravský Svätý, many species of dragonflies were identified: *Calopteryx splendens*, *E. viridulum*, and *P. pennipes* were the dominant species, and *I. elegans, Gomphus flavipes,* and *O. cancellatum* were identified as individuals. At the Malolevárský kanal canal in Moravský Svätý Ján, groups of *C. splendens*, *E. viridulum*, *I. elegans,* and *P. pennipes* were noted, and individual *Anax imperator*, *A. parthenope*, *Sympetrum sanguineum*, *S. pedemontanum*, *S. meridionale*, *O. coerulescens,* and *O. cancellatum* were also identified.

Discussion and conclusion

Erythromma lindenii populations in the area of the North-Pannonian lowlands on the Czech Republic/Slovakia/Austria border were identified in different habitats (standing water in flooded clay deposits, slow flowing waters of large lowland rivers, and slow flowing channels with rich vegetation), which reflects the ecological variation of the species. The most abundant and stable population is found in standing water with rich submerged vegetation. The species inhabits a wide range of types of water, including flowing water like larger streams, rivers, and canals, as well as stagnant waters, like blind river branches, lakes, ponds, gravel pits, and sand pits. Most commonly, the species prefers water that is open, unshaded, clean, and rich in oxygen. Thus, the species can be found in a large variety of natural and artificial running and standing water, typically characterised by a slow current and with dense aquatic vegetation (Hunger 1998; Dijkstra & Lewington 2006; Koch 2010; Kalkman & Dyatlova 2015). In Poland, the species can be found in numerous locations, where it represents a stenotopic species inhabiting large lakes with rich aquatic submerged vegetation, including *M. spicatum* and *C. demersum* (Bernard et al. 2009). In Germany, the species inhabits stagnant as well as slow-flowing waters, including habitats with rich deposits of submerged vegetation, e.g., *Myriophyllum* sp., *Ceratophyllum* sp., and *Elodea*, and *Potamogeton* sp. on the water's surface. Numerous populations are found where the surface water evaporates in summer and, conversely, the water freezes completely in the winter (Brockhaus et al. 2015). In Austria, the species inhabits artificial lakes and gravel and sand pits with larger bodies of water. However, there must be submerged vegetation at least at the edge (Raab et al. 2006). *Erythromma lindenii* exhibits the ability to quickly colonise artificial water bodies, i.e., gravel pits, or channels (cf. Hunger 1998; Müller 2004; Jović 2009; Jović et al. 2009). This type of habitat, with the aforementioned vegetation, can be found in the National Park of Podyjí and its protective zone in southern Moravia in the Czech Republic. However, because the area has long been a site of odonatological research (Holuša 2007), it is certain that the species *E. lindenii* was not found here previously. All localities have been intensively studied for more than 20 years, and the discovery of *E. lindenii* in 2020 represents confirmation of expansion. The expansion of the species has been widely described in recent years (cf. Dijkstra & Lewington 2006; De Knijf & Anselin 2010; Goffart 2010; Günther et al. 2021). The nearest known localities are in Austria, approximately 190 km from Kendl village and 170 km from Illmitz near Lake Neusiedl (Raab et al. 2006). It is likely that the recent discovery of *E. lindenii* represents an extension of the species' range from these known localities. Spread of the species from known localities in Bohemia is very unlikely, even if the sites are located at the same distance as the Austrian localities (i.e., 190 km).

With respect to altitude, the identified localities are similar to those in Austria (Raab et al. 2006), in Bavaria (Kuhn 1998), and in Bohemia (Waldhauser 2009; AOPK CR 2022).

The range of the species in the Czech Republic, particularly Bohemia, has been growing since 2009, when the species was noted in northern Bohemia (Kunratice village) on the border with Germany. In 2011, the species was reported in the upper reaches of the Ploučnice River, in the Vltava River valley below Prague, and in the village of Dětaň in western Bohemia. In 2013, there were sightings along the Berounka River near Prague, and in 2020 the species was found along the Ohře River, at dozens of sites along the Berounka River, and in the upper Elbe River near Pardubice. In the last year, the species has been found at dozens of sites along the lower Elbe River and the upper Ohře River and has also spread along the Sázava River to the southeast and south into southern Bohemia, the Otava River and its tributary Blanice River to the village of Vodňany. In Bohemia, the south, southwestern and southeastern direction of spread is noticeable, i.e., the gradual occupation of the 'Czech basin' along the major rivers: the Elbe, Ohře, and Vltava and its tributaries, including the Berounka, Sázava, and Otava (the tributary of Blanice River) (Fig. 3).

Expansion of *E. lindenii* into Moravia across the Českomoravská vrchovina Highlands is not an impossibility, but for species of suborder Zygoptera, the massif of these Highlands may be a barrier. Reports of the migration of insect species across the Českomoravská vrchovina Highlands demonstrates that the spread follows the direction of Pannonian-Hercynian migration, i.e., from south to northeast. This migration has been recorded for many butterfly species: *Agriphila tolli* (Lepidoptera: Crambidae; Elsner & Elsner 1985; Laštůvka & Marek 2002; Liška et al. 2015), *Caloptilia honouratella* (Lepidoptera: Gracillariidae; Šumpich et al. 2009; Liška et al. 2018), *Ephestia woodiella* (Lepidoptera: Pyralidae; Laštůvka & Laštůvka 2019; Liška et al. 2018), *Phragmataecia castaneae* (Lepidoptera: Cossidae; Šumpich et al. 2011), and *Mantis religiosa* (Mantodea; Mückstein 2016). The opposite direction of the Hercynian–Pannonian migration is not yet known.

The colonisation of Moravia by *E. lindenii* likely represents a spread from Austrian localities, i.e., by the Moravian-Pannonian stream of expansion. Due to the species ecology, its known area of expansion, and the availability of suitable habitats in the territory of Moravia the species has been able to spread further north, (especially along the Morava River to the foot of the Nízký Jeseník hills in Northern Moravia) through the typical migration corridor for animals, i.e., the Moravian Gate, which has been described for other insect species (Sierka et al. 2008; Banaszak et al. 2017). It is not impossible that in the future the species may be found in the lowland area around the upper course of the Odra River in northern Moravia and Silesia (Fig. 4). However, the wider Pannonian stream of expansion is likely to spread the species into western and southern Slovakia in the near future, particularly the regions of Podunajská nížina lowland, a northern region of the Pannonian plain.

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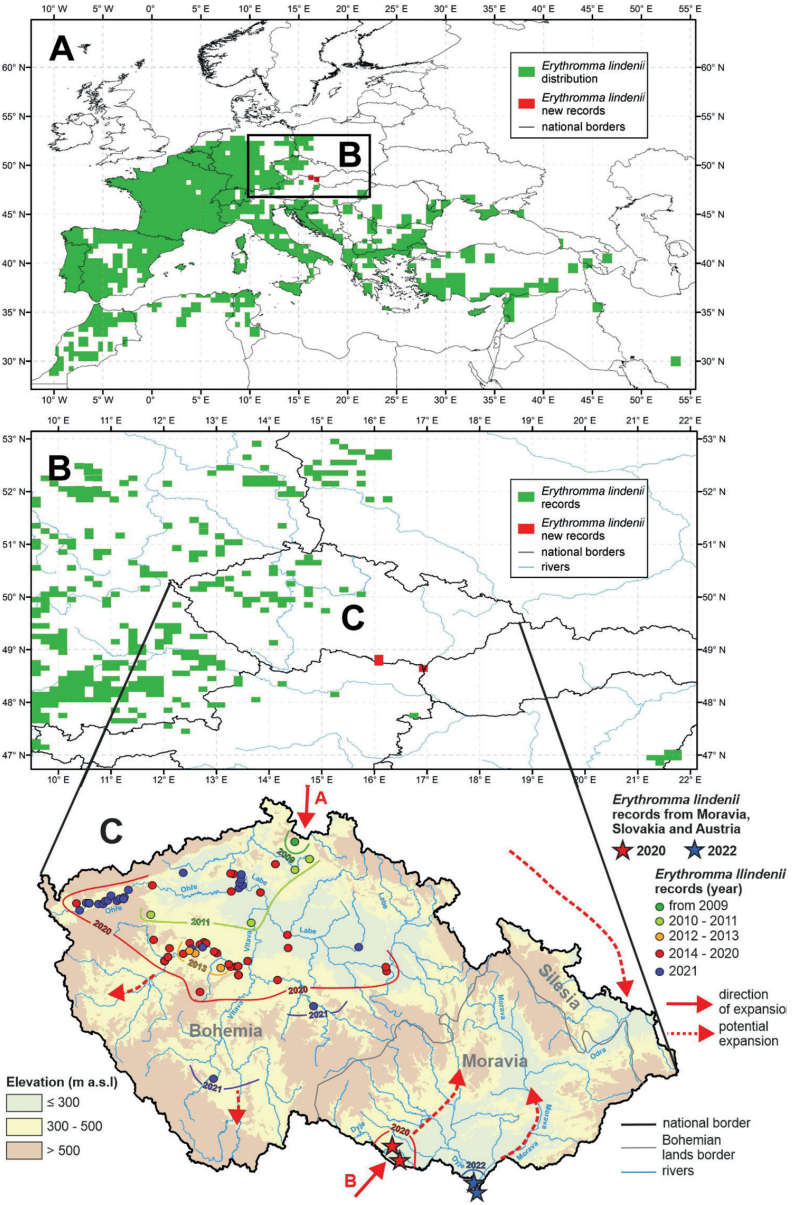

Figure 4. Known locations of *Erythromma lindenii* in the Czech Republic and its subsequent expansion in Central Europe from 2009 to 2022. – **Abbildung 4:** Bekannte Fundorte von *Erythromma lindenii* in der Tschechischen Republik und die Ausbreitung der Art zwischen 2009 und 2022.

References

AOPK ČR [Agentury ochrany přírody a krajiny České republiky] (2022) Nálezová databáze ochrany přírody. https://portal.nature.cz, last access 10.12.2022

Banaszak J., L. Twerd, A. Sobieraj-Betlińska & B. Kilińska (2017) The Moravian Gate as route of migration of thermophilous bee species to Poland: fact or myth? A case study in the "Góra Gipsowa" steppe reserve and other habitats near Kietrz. *Polish journal of Entomology* 86: 141-164

Bernard R., P. Buczyński, G. Tończyk & J. Wendzonka (2009) Atlas rozmieszczenia wazek (Odonata) w Polsce. A distribution atlas of dragonflies (Odonata) in Poland. Bogucki Wydawnictwo Naukowe, Poznań

Bernard R. & B. Daraż (2015) Cordulegaster heros and Somatochlora meridionalis in Ukraine: Solving the zoogeographical puzzle at their northern range limits (Odonata: Cordulegastridae, Corduliiidae). *Odonatologica* 44: 255–278

Beutler H. (1985) Biometrische und variationsstatistische Untersuchungen an der Kleinlibelle Cercion lindeni (Selys, 1840), mit Beschreibung einer neuen Unterart (Odonata, Coenagrionidae). *Entomologischen Abhandlungen Staatliches Museum für Tierkunde in Dresden* 49: 69–82

Bouwman J.H., V.J. Kalkman, G. Abbingh, E.P. de Boer, R.P.G. Geraeds, D. Groenendijk, R. Ketelaar, R. Manger & T. Termaat (2008) Ean actualisatie ven de verspreiding van de Nederlandse libellen. *Brachytron* 11: 103–198

Brockhaus T., H.-J. Roland, T. Benken, K.-J. Conze, A. Günther, K.G. Leipelt, M. Lohr, A. Martens, R. Mauersberger, J. Ott, F. Suhling, F. Weinrauch & C. Willigalla (2015) Atlas der Libellen Deutschlands (Odonata). *Libellula Supplement* 14: 1–394

Culek M. (Ed.) (1996) Biogeografické členění České republiky. Enigma, Praha

Černý M., M. Waldhauser & L. Vintr (2014) First documented record of Gomphus pulchellus in the Czech Republic (Odonata: Gomphidae). *Libellula* 33: 189–194

David S. (2000) Stav a příčiny očekávaných změn biodiversity vážek (Insecta: Odonata) na Slovensku. *Acta environmentalica Universitatis Cominiae* (Bratislava) 10: 163–169

David S. & D. Šácha (2019) Komentovaný seznam vážek (Odonata) Slovenké republiky. *Ochrana Prírody* 3: 49–78

De Knijf G. & A. Anselin (2010) When south goes north: Mediterranean dragonflies (Odonata) conquer Flanders (North-Belgium). *BioRisk* 5: 141–153

De Knijf G., A. Anselin, P. Goffart & M. Tailly (2006) De Libellen (Odonata) van België: verspreiding – evolutie – habitats. Libellenwerkgroep Gomphus, Brussel

Dolný A., M. Waldhauser, O. Holuša, D. Bárta & L. Hanel (2007) Vážky České republiky. Ekologie, ochrana a rozšíření. Český svaz ochránců přírody, Vlašim

Elsner V. & G. Elsner (1985) Nové a významné nálezy mikrolepidopter (Lepidoptera) z ČSSR. *Zborník Slovenského národného Múzea, Prírodné Vedy* 31: 123–143

Goffart P. (2010) Southern dragonflies expanding in Wallonia (south Belgium): a consequence of global warming? *BioRisk* 5: 109–126

Günther A., B. Nicolai, F. Petzold, M. Waldhauser & M. Lange (2021) Aktueller Kenntnisstand zur Verbreitung von Erythromma lindeni in Ostdeutschland und der Tschechischen Republik. *Libellula* 40: 107–135

Heidari H. & H.J. Dumont (2002) An annotated check-list of the Odonata of Iran. *Zoology in the Middle East* 26: 133–150

Holuša O. (1996) Nálezy vzácných druhů vážek (Odonata) na území Slovenska. (Finding some rare species of dragonflies (Odonata) in Slovakia). *Entomofauna Carpathica* 8: 151–15

Holuša O. 1997. Vážky (Odonata) širšího okolí Lednice na Moravě. *Sborník Přírodovědného klubu v Uherském Hradišti* 2: 93–108

Holuša O. (1997) Vážky (Odonata) širšího okolí Lednice na Moravě. *Sborník Přírodovědného klubu v Uherském Hradišti* 2: 93–108

Holuša O. (2007) Výsledky faunistického průzkumu vážek (Odonata) na území národního parku Podyjí a na několika okalitách v okolí. *Thaynesia (Znojmo)* 7: 239–247

Holuša O. (2009) Notes to the first record of Somatochlora meridionalis Nielsen, 1935 in the Czech Republic (Odonata: Corduliidae). *Acta Musei Beskydensis* 1: 89–95

Hunger H. (1998) Biozönologische Untersuchungen zum Habitatschema der Pokal-Azurjungfer (Cercion lindeni Sélys 1840) in der südlichen Oberrheinebene. *Naturschutz am südlichen Oberrhein* 2: 159–166

Hunger H., F.-J. Schiel & B. Kunz (2006) Verbreitung und Phänologie der Libellen Baden-Württembergs (Odonata). *Libellula Supplement* 7: 15–188

Jović M. (2009) Report on Macedonia 2008 project – Odonata. *International Dragonfly Fund Report* 21: 1–23

Jović M., L. Andjus & S. Santovac (2009) New data on some rare and poorly known Odonata species in Serbia. *Bulletin of the Natural History Museum in Belgrade* 2: 95–108

Kalkman V.J. & E. Dyatlova (2015) Erythromma lindenii (Selys, 1840). In: Boudot J.-P. & Kalkman V.J. (eds) Atlas of the European dragonflies and damselflies: 118–120. KNNV Publishing, The Netherlands

Khrokalo L.A. & G. Prokopov (2009) Review of the Odonata of Crimea (Ukraine). *International Dragonfly Fund Report* 20: 1–32

Khrokalo L.A., V.V. Savchuk & E.S. Dyatlova (2009) New records of rare dragonflies (Insecta, Odonata) in Ukraine. *Vestnik Zoologii* 43: 378

Koch L. (2010) Neu entstandene Kleingewässer entwickeln sich zu Libellen-Biotopen. *Beiträge zur Heimatkunde der Stadt Schwelm und ihrer Umgebung* (NF) 59: 19–38

Kuhn K. (1998) Pokal-Azurjungfer. Cercion lindenii (Sélys, 1840). In: Kuhn K. & K. Burbach (Ed.) Libellen in Bayern: 92–93. Bayerischen Landesamt für Umweltschutz und Bund Naturschutz in Bayern e.V., Ulmer, Stuttgart

Laštůvka Z. & A. Laštůvka (2019) Motýli (Lepidoptera) přírodní rezervace Pavlovské mokřady. Mendelova univerzita, Brno

Laštůvka Z. & J. Marek (2002) Motýli (Lepidoptera) Moravského krasu. Korax, Blansko

Liška J., J. Šumpich, G. Elsner, J. Marek, Z. Laštůvka, J. Skyva, M. Žemlička, A. Laštůvka, I. Dvořák, J Sitek., T. Jirgl, M. Knížek, J. Uřičář & T. Kuras (2015) Faunistic records from the Czech Republic – 388. *Klapalekiana* 5: 239–250

Liška J., J. Vávra, A. Laštůvka, J. Jaroš, J. Šumpich, J. Uřičář, L. Bešta, J. Marek, J. Skyva, J. Holomek, E. Kula, M. Bešta, G. Elsner, V. Vysoký, M. Žemlička, J. Černý, I. Richter, A. Gottwald, Z. Laštůvka, T. Jirgl & P. Heřman (2018) Faunistic records from the Czech Republic – 441. *Klapalekiana* 54: 131–148

Móra A. & A. Farkas (2015) First records of Erythromma lindeni (Selys, 1840), from Hungary (Odonata: Coenagrionidae). *Notulae Odonatolgicae* 8(6): 169–175

Mückstein P. (2016) First records of Mantis religiosa (Mantodea: Mantidae) in the

Žďárské vrchy. Protected Landscape Area (Bohemian-Moravian Highlands, Czech Republic). *Klapalekiana* 52: 57–59

Müller R. (2004) Cercion lindeni (Selys, 1840) am Mittellandkanal – Erstnachweis für Sachsen-Anhalt (Insecta: Odonata). *Lauterbornia* 50: 79–83

Raab R., A. Chovanec & J. Pennerstorfer (2006) Atlas der Libellen Österreichs. Umweltbundesamt, Wien, Springer Wien New York

Schmid E. (1939) Die Vegetationskartierung der Schweiz. *Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich* 41: 76–85

Schmid E. (1949) Vegetationsgürtel und Biocoenose. *Berichte der Schweizerischen Botanischen Geselschaft* 51: 461–474

Sierka W., E. Sierka & P.J. Fedor (2008) Introduction to the Probable Movement of Thysanoptera through the Moravian Gate (Štramberk, Czech Republic). *Acta Phytopathologica et Entomologica Hungarica* 43: 367–372

Staufer M. & O. Holuša (2010) First record of Cordulegaster heros in the Czech Republic, with notes on Cordulegaster spp. in southern Moravia (Odonata: Cordulegastridae). *Libellula* 29: 197–204

Šumpich J., J. Liška, O. Jakeš, J. Skyva, J. Sitek, V. Feik, J. Marek, J. Vávra, Z. Laštůvka, P. Vítek, R. Bartas, A. Čelechovský, T. Dobrovský, I. Dvořák, L. Maršík, M. Mikát, J. Šafář, B. Vodrlind, M. Žemlička, M. Dvořák & V. Hula (2009) Faunistic records from the Czech Republic – 287. Lepidoptera. *Klapalekiana* 45: 267–279

Šumpich J., J. Sitek, J. Marek, J. Skyva, J. Uřičář, F. Fiala, O. Jakeš, I. Dvořák, L. Maršík, P. Potocký, A. Laštůvka, V. Elsner, Z. Laštůvka, M. Mikát & A. Kačírek (2011) Faunistic records from the Czech Republic – 326. *Klapalekiana* 47: 281–298

Uvíra V., P. Jeziorski, L. Hanel & O. Holuša (1999) Odonata. In: Opravilová V., J. Vaňhara & I. Sukop (eds) Aquatic Invertebrates of the Pálava Biosphere Reserve of UNESCO: 173–180. *Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis: Biologia* 101

Waldhauser M. (2009) První nález šidélka lindenova, Erythromma lindenii (Sélys, 1840), (Odonata, Coenagrionidae) v České republice. *Buletin Lampetra* 6: 26–29

Zinkow A. (2022) Stanowisko oczobarwnicy jeziornej *Erythromma lindenii* (Sélys, 1840) nad Jeziorem Bnińskim w Błażejewku (Wielkopolska). *Odonatrix* 18: 1–3

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