Is taxonomic accuracy important, or can it be given up? How to identify lacewings?

Fontos-e a taxonómiai pontosság vagy fel is adható? Hogyan határozzuk a fátyolkákat?

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Abstract: The common green lacewing, *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) is the best known, most common, most studied, and most widely used lacewing species. It has long been the focus of attention because it is a suitable candidate for IPM programs: it is found worldwide, its larvae are polyphagous predators that are effective natural enemies of pests of essential crops, it is easy and inexpensive to rear, and populations resistant to pesticides have been found. However, its study and use may be hampered by difficulties in its identification. The reason that it has previously been shown to be a complex of sister species, not a single species. These remarkably similar sister species are complicated to distinguish from each other. In the past, taxonomic difficulties have been compounded by naming problems, and the past still haunts us. According to our current knowledge, the following sibling species occur in Hungary: *Chrysoperla carnea*, *Chrysoperla pallida*, *Chrysoperla lucasina*, and *Chrysoperla agilis*. However, due to the difficulties of identification, errors may still occur in publications, and taxonomic accuracy is often sacrificed in favour of referring exclusively to the complex, even though the ecological requirements of the individual species differ, which may determine their use. The author reviews the practice of species complex separation in Hungary and Europe, and its consequences, with particular regard to the methods and knowledge that can help provide accurate information and guidance on the determination, naming, and occurrence of taxa.

Keywords*: taxonomy, Chrysoperla carnea complex, Europe, Hungary, inconsistency*

Összefoglalás: A közönséges fátyolka *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) a legismertebb, a leggyakoribb, a legjobban tanulmányozott, és a leginkább alkalmazott fátyolkafaj. Régóta áll a figyelem középpontjában, mert alkalmas jelöltje az IPM programoknak: Világszerte megtalálható, lárvái polifág ragadozók, amelyek fontos termesztett növényeink károsítóinak hatékony természetes ellenségei, könnyen és olcsón tenyészthető, növényvédő szereknek ellenálló népességeit találták meg. Tanulmányozását és felhasználást azonban keresztezhetik határozásának nehézségei. Az ok az, hogy korábban kiderült, nem egy fajról van szó, hanem testvérfajok komplexéről. Ezek a rendkívül hasonló testvérfajok nehezen különíthetők el. A múltban a taxonómiai nehézségekhez elnevezési gondok is társultak, s a múlt még kísért. Eddigi ismereteink szerint hazánkban a következő testvérfajok fordulnak elő: a *Chrysoperla carnea*, a *Chrysoperla pallida*, a *Chrysoperla lucasina* és a *Chrysoperla agilis*. A határozás nehézségei miatt azonban még a jelenlegi publikációkban is előfordulhatnak tévedések, illetve a szerzők gyakran feladják a taxonómiai pontosságot és csak a komplexet nevezik meg, noha az egyes fajok ökológiai igényei különböznek, ami megszabja a felhasználhatóságukat. A szerző áttekinti a fajkomplex elkülönítésének magyarországi és európai

gyakorlatát, s ennek bizonyos következményeit különös tekintettel arra, hogy milyen módszerek és ismeretek segíthetik a korrekt tájékozódást és tájékoztatást a taxon határozását, elnevezését és előfordulását illetően.

***Kulcsszavak**: taxonómia, Chrysoperla carnea komplex, Európa, Magyarország, ellentmondás*

1 Introduction

Taxonomic accuracy is fundamental to all work involving living organisms. I assume this also applies to plant protection and requires no further explanation. For the sake of formality, I refer to two relevant publications: Van Driesche and Bellows (1996) and Kaplan (2012). This communication concerns lacewings (Neuroptera: Chrysopidae), more specifically the *Chrysoperla carnea* species complex. Its importance as a biological agent has long been extensively researched and recognised in many cases (Principi and Canard, 1984; Ridgway et al., 1980; Hagen and Tassan, 1980; McEwen et al., 1999; Grafton-Cardwell and Hoy, 1985; Tauber et al., 2000). Nevertheless, the above is not always clear. The reason for this, is the separation and naming of the complex as an entity and the individual species that make it up. Recently, this phenomenon has led to confusion, misunderstandings, and difficulties at the user level and among specialists including neuroropterists (Henry et al., 2001). A detailed report on this has also been published in Hungarian (Bozsik, Canard and Thierry, 2014). The taxonomic situation has theoretically stabilised somewhat with the publication of Price et al. (2015), which proved that the original taxon, *Chrysoperla carnea* (Stephens, 1836), is identical to the most common sister species of the same name, which had been the subject of protracted debate. Thus, many problems arose internationally, but the domestic situation regarding the common lacewing was even more complicated (Bozsik, Canard and Thierry, 2014).

The difficulties currently arise from the identification method and the degree of precision required to define the *Ch. carnea* complex at the sibling species level. To a lesser extent, there are also naming anomalies, but I do not wish to discuss these here. The following brief discussion highlights the domestic contradictions that arise from what is presumably an inaccurate identification.

2 The current situation in Europe

Practical species separation of the *Ch. carnea* complex has been remained difficult. There are three primary methods for determining sister species. 1. Recording and analysing the acoustic mating songs of living individuals (Henry et al., 2002). 2. Examining the genetic patterns of living or dead individuals (Price et al., 2015). 3. Traditional morphological separation of living or dead individuals (Mazel et al., 2006). There is also a fourth possibility that expresses each sibling species' tolerance to cholinesterase inhibitors. Still, it has not been developed in detail (Bozsik and Haubruge, 1998, unpublished). According to the literature mentioned above, the first method is the most reliable, followed by the second, and then the third is a distant third. Each has its contradictions and difficulties. Only live lacewings of different sexes can be used for the first method, as well as Charles Henry's laboratory and equipment. Since copulation usually occurs at night or in the early morning hours, continuous video surveillance is essential. According to the author’s data collection, no one in Europe can apply this method as described. Lacewings of some European researchers are determined by Ch. Henry's laboratory in the USA.

The second method requires a biotechnology laboratory and expertise. According to some neuropterists, this is not really suitable for distinguishing between sibling species (P. Duelli, R.A. Pantaleoni, pers. com., 2025). It is certainly not ideal for everyday mass identification. The third, traditional method, based on morphology and genitalia structure, is the most common. However, many are unfamiliar with the subtle species characteristics, which, according to some researchers (Henry et al., 2002; P. Duelli, pers. com., 2025), can only be applied to taxa widespread in a given area, and identification requires extensive practice (Henry et al., 2002; P. Duelli, pers. com., 2025). What makes the situation even more confusing is that not all specialists are aware of the distinctions between sister species and do not use the already somewhat recognised names correctly. One frequently used excuse is that sibling species are not distinguished, even though their ecological requirements differ, but instead the complex name *Ch. carnea* sensu lato is used (Koczor et al., 2010; Berteloot et al., 2024).

3 The situation in Hungary

Hungary's geographical location, topography, climate, and the effects of global warming influence the occurrence of lacewing species. The appearance of alien species that did not previously live here is becoming increasingly common (Bozsik, 2010, 2011, 2012). It is understandable that a nomadic Mediterranean sister species, *Chrysoperla agilis* (Henry et al., 2003), can also be found in Hungary. This species had a permanent population in central Alaska (Henry et al., 2011) and occurred in Switzerland (Henry et al., 2003).

Apart from scarce species, the following sister species occur more frequently in Hungary (Bozsik, 2024, unpublished):

1. *Chrysoperla carnea* (Stephens, 1836).

2. *Chrysoperla pallida* (Henry et al. 2002).

3. *Chrysoperla lucasina* (Lacroix, 1912).

4. *Chrysoperla agilis* (Henry et al., 2003).

The separation of the species mentioned above is based on the descriptions of Henry et al. (2002, 2003), Mazel et al. (2006), comparative specimens (courtesy of D. Thierry and P. Duelli), and communication with neuropterist colleagues (P. Duelli (2014, 2025), D. Thierry (2000-2024), D. Devetak (2025), R. A. Pantaleoni (2025), A. Letardi (2025), and my own decades of experience. The most essential morphological characteristics are formerly described in Hungarian in the report by Bozsik, Canard and Thierry (2014).

These species are very similar. The author is not aware of any new, clear keys for traditional morphological differentiation. So, most experts make their determinations based on scientific articles, comparative specimens, and extensive practice. Some colleagues, such as P. Duelli and R. A. Pantaleoni (pers. com., 2025), verify the correct taxon based on the double, movement-generated, visually perceptible mating song of live specimens. Obviously, this is only possible with living individuals. Based on the author's own experience, even the most clearly identifiable species, *Ch. lucasina*, has been found to exhibit morphological differentiation (Tóth et al. 2009; Bozsik, Canard and Thierry, 2014). It is worth noting again that morphological traits may vary across geographical areas due to the natural variability of lacewing species (P. Duelli, pers. com., 2025; R.A. Pantaleoni, pers. com., 2025). In any case, knowledge of the lacewing species

living in different geographical areas can facilitate this work. As the recent literature on chrysopids is not very extensive (Table 1), the author consulted European colleagues (A. Letardi, R.A. Pantaleoni, P. Duelli, A. Gruppe, R. Dobosz, D. Devetak, U. Hiermann and L. Dvořák). Unfortunately, several colleagues could not be reached.

Table 1 Occurrence of some species of *Chrysoperla carnea* complex in Europe

Country	*Ch. carnea*		*Ch. pallida*		*Ch. lucasina*		*Ch. agilis*	References
Spain	x		x		x		x	Bozsik, González Ruiz, 2006
France	x		x		x		x	Mazel et al., 2006
Germany	x		x		x		-	Gruppe et al., 2004
Italy	x		x		x		x	Letardi, 2025
Switzerland	x		x		x		x	Duelli, p.c.[1], 2025, Henry et al., 2002
Poland	x		x		x		-	Dobosz, p.c., 2025
Bohemia and Slovakia	x		?		x		?	Jedlička, et al., 2004
Austria	x		x		x		?	Hiermann et al., 2024
Romania	x		x		x		?	Paulian, 2002
Serbia	x		x		x		x	Devetak et al., 2023
Croatia	x		x		x		x	Devetak et al., 2019ab
Slovenia	x		x		x		x	Deverak, 2025b
Albania	x		x		x		x	Devetak, 2025a
Hungary	x		x		x		x	Bozsik, u.,[2] 2024

[1] p.c. : personal communication, [2] u. : unpublished

Presumably due to the extraordinary similarity or the lack of skills and conditions necessary for correct identification, the species *Ch. agilis* has not yet been confirmed in the Hungarian fauna by anyone other than the author. The relevant domestic and international literature is exceptionally scarce, and the species is not mentioned in the most recent publication (Koczor et al., 2025). However, based on other research, *Ch. agilis* was already present in the domestic fauna in 2018. *Ch. agilis* specimens were already found as early as 2005 (Bozsik, unpublished), and they were verified using specimens sent by P. Duelli and D. Thierry. Funnel traps, used in the article of Koczor et al. (2025), caught 250 *Ch. carnea* complex specimens over a period of

about 2.5 months, among which there were only *Ch. carnea*, *Ch lucasina*, and *Ch. pallida* specimens. The authors used the descriptions of Henry et al. (1996, 2002) and Thierry et al. (1998) to define the complex species, but did not mention any comparative specimens, and, to the author's knowledge, no reports on lacewings from other areas have been published. It is striking that the authors identified each individual at the species level, which is interesting because Bozsik has previously identified chrysopids caught in such traps. Still, due to the injuries they sustained (16.8% of all individuals were injured) and the variability in their morphological features, it was not possible to identify all of them. The partial species list of this identification can be found in the article by Tóth et al. (2006). It is possible that among the 197 individuals named as *Ch. carnea* in the article by Koczor et al. (2025), some were *Ch. agilis* individuals, or that several captured individuals were omitted from the publication. It is problematic that, to the author's knowledge, no other identification procedure mentioned above except the morphological method, has yet been implemented in Hungary, as is the case in most European countries. This example, as well as the probable error that occurred in 2009 (Tóth et al., 2009), shows how complex this task is and that much greater care must be taken if you insist on taxonomic accuracy.

4 Recommendations for improving the situation in Hungary

Ch. carnea, *Ch. pallida*, *Ch. lucasina*, and *Ch. agilis* are definitely present in Hungary (Bozsik, 2008, 2024 unpublished), and depending on their natural populations and habitats, they can play a significant role in controlling soft-cuticle pests. However, their usefulness for specific species and their targeted applicability (for use in greenhouses, plantations, or arable crops) requires further study which may need either a new method suitable for mass identification or, traditional identification, highly skilled specialists and a guaranteed comparative series of specimens. The author offers his assistance to the authors of the article by Koczor et al. (2025) or to anyone and is happy to verify their identities.

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