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Monitoring of three *Hoplocampa* sawfly species in plum orchards

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RESEARCH ARTICLE

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ABSTRACT

Three sawfly species (*Hoplocampa minuta, Hoplocampa flava, Hoplocampa fulviicornis*) have been monitored in plum orchards during the flowering period in three consecutive years at three different locations in Hungary using chromotropic white sticky traps. Black and yellow sawflies (*H. minuta* and *H. flava*) are one of the most important pests in plum orchards, however plum-fruit sawfly (*Hoplocampa fulvicornis*) has not yet been documented from plum orchards in Hungary. In almost all locations and years, *H. minuta* was the most dominant species, except in Cegléd, 2014, where *H. flava* was the most abundant one. In terms of sex ratio, in all three species, more males than females were caught in the traps except in 2016 at Érd, where more *H. flava* females flew into the traps.

KEYWORDS

Hoplocampa minuta, *Hoplocampa flava*, *Hoplocampa fulvicornis*, chromotropic white sticky trap, monitoring

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INTRODUCTION

Black and yellow sawflies (*Hoplocampa minuta* Christ, 1791 and *Hoplocampa flava* Linnaeus, 1761), (Hymenoptera: Tenthredinidae) are one of the most dominant pests of plum (*Prunus domestica* L.) (Rosaceae) in Europe, causing significant damage and yield losses in plum orchards (Caruso and Cera, 2004; Liston et al., 2019; Nagy, 1960). According to our knowledge, *Hoplocampa fulvicornis* (Panzer, 1801) has not yet been documented as a pest species in plum orchards in Hungary. In other European countries, the primary host plant of this species is the blackthorn (*Prunus spinosa* L.) (Rosaceae) (Pschorn-Walcher and Altenhofer, 2000); however, this sawfly has also been recorded from cultivated *Prunus* species (Malenovský, 2012; Roberti, 1948).

H. minuta and *H. flava* are univoltine, monophagous species, often co-occur in plum orchards and feed exclusively on plum fruits. After emerging and mating, during the plum flowering period, the fertilized females insert their eggs into the calix of the flower using their saw-like ovipositor. Parallelly with the fruit development, the larvae hatch and enter into the fruit. One sawfly larva can damage up to 6 fruits, which increases the damage level of these pests. Unripe fruits fall to the ground due to the damage. In organic and non-treated orchards, the yield loss can vary between 36 and 96% (Caruso and Cera, 2004; Rozpara et al., 2010). So far only chemical treatment is available to control this species. The insecticide application has to coincide with the petal fall of the flowers. However, at this time several bees and other beneficial insects are present in the orchard feeding on the residual flowers, which can be harmed by the insecticides. The most important aim of integrated pest management (IPM) is to spatiotemporally predict the existence of pests to determine efficient insecticide delivery timing (Lefebvre et al., 2015). So far only the chromotropic white sticky trap is available to monitor the flight activity of these two sawfly species in plum orchards (Blaisinger, 1975; Tamošiūnas et al., 2014). Although *H. minuta* and *H. flava* are present in Hungarian plum orchards, little is known about their populations' size, flight dynamics and distribution of the different species.

This study aimed to monitor the flight activity, species and sex ratio of *Hoplocampa* species during 3 years in three different locations in Hungary using chromotropic white sticky traps.

MATERIAL AND METHODS

The field trapping experiment was carried out at three different locations in Pest county, Hungary:

1. At Cegléd in the plum GenBank orchard located at the Research Institute for Fruitgrowing and Ornamentals (47°09′51.2″N 19°50′08.2″E) in 2014 between March 27 and April 26. This orchard contains more than 200 different plum varieties with different flowering times. *P. spinosa* was not found near the orchard. During the experiment, the plum trees were not treated with any insecticide.
2. At Érd in a non-cultivated plum orchard (47°20′47.7″N 18°51′34.2″E) in 2015 between March 31 and May 04, and 2016 between March 29 and April 22. *P. spinosa* may have occurred nearby this orchard, however, we did not conduct any survey on it. This orchard had no insecticide treatment.

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3. At Pomáz in a cultivated plum orchard (47°65′52″N 18°98′77″E) in 2015 between April 07–23. As far as we know *P. spinosa* did not exist near the orchard. During the experiment, this orchard was not treated with any pesticide.

In all three orchards, the stock of the plum trees was myrobalan plum (*Prunus cerasifera*). At Érd and Pomáz, besides the cultivated plant varieties, the wild type myrobalan plum was also found. This plum tree starts the flowering period a couple of days earlier compared to the cultivated varieties.

The white sticky traps (CSALOMON® PALf) were provided by Plant Protection Institute, CAR, ELRN (Budapest, Hungary) and placed out in plum orchards at the three different locations. At all locations, 4 traps were placed out. The traps were hung on the plum tree branches at 1.5 m above the ground. The traps were 10 m apart from each other. New traps were placed out at every inspection time. Traps were brought to the laboratory where the specimens were identified, sexed and counted by using a stereomicroscope. To separate *H. minuta* and *H. fulvicornis*, we used the morphological identification key published by Nagy (1960). *H. minuta* has 4–5 mm, while *H. fulvicornis* has a 3 mm body length. The whole body of *H. minuta* is black, however, the color of the clypeus, tegula and the distal part of the abdomen are brownish or yellowish of *H. fulvicornis*. *H. minuta* has a brow stigma, however, *H. fulvicornis* has a yellowish one. *H. minuta* males have yellowish-brown antennae, while *H. fulvicornis* males have a yellow one.

RESULTS

The average trap catches of the three different species varied between the experimental years and locations. In 2014, at Cegléd first adults appeared in the traps on March 27 (Fig. 1A and B) and *H. flava* was the dominant species (Fig. 1C). At this location, traps did not catch any *H. fulvicornis*. The highest trap capture of *H. flava* was on April 04, on this date the males were dominant (Fig. 1B). Interestingly, more females than males of *H. minuta* flew into the traps (Fig. 1A).

In the year 2015 at Pomáz, the trap caught the first adults on April 10 (Fig. 2A, B and C), in the same year at Érd the first adults were caught ten days earlier, on March 31 (Fig. 3C). In both locations, *H. minuta* was the dominant species. At Pomáz the highest trap capture of this species was recorded on April 13 (Fig. 2A); however, in the same year at Érd, the traps caught the highest number of *H. minuta* four days later on April 17 (Fig. 3A). It is important to note that both locations traps caught a third species, *H. fulvicornis* (Fig. 2C and 3C). Also, at both locations this year, traps captured more males than females of all three species (Fig. 2D and 3D).

In 2016 at Érd, the traps caught the first *H. flava* adults on March 29 (Fig. 4B). *H. minuta* was the most dominant species and the highest trap capture of this species' males was recorded on April 08 (Fig. 4A). On April 15, traps captured slightly more *H. flava* females than males (Fig. 4B). In this year, traps also caught both males and females of *H. fulvicornis* (Fig. 4C).

DISCUSSION

In this study, we monitored three different *Hoplocampa* species in three different locations of plum orchards in three consecutive years using white, sticky chromotropic traps. Because *H.*

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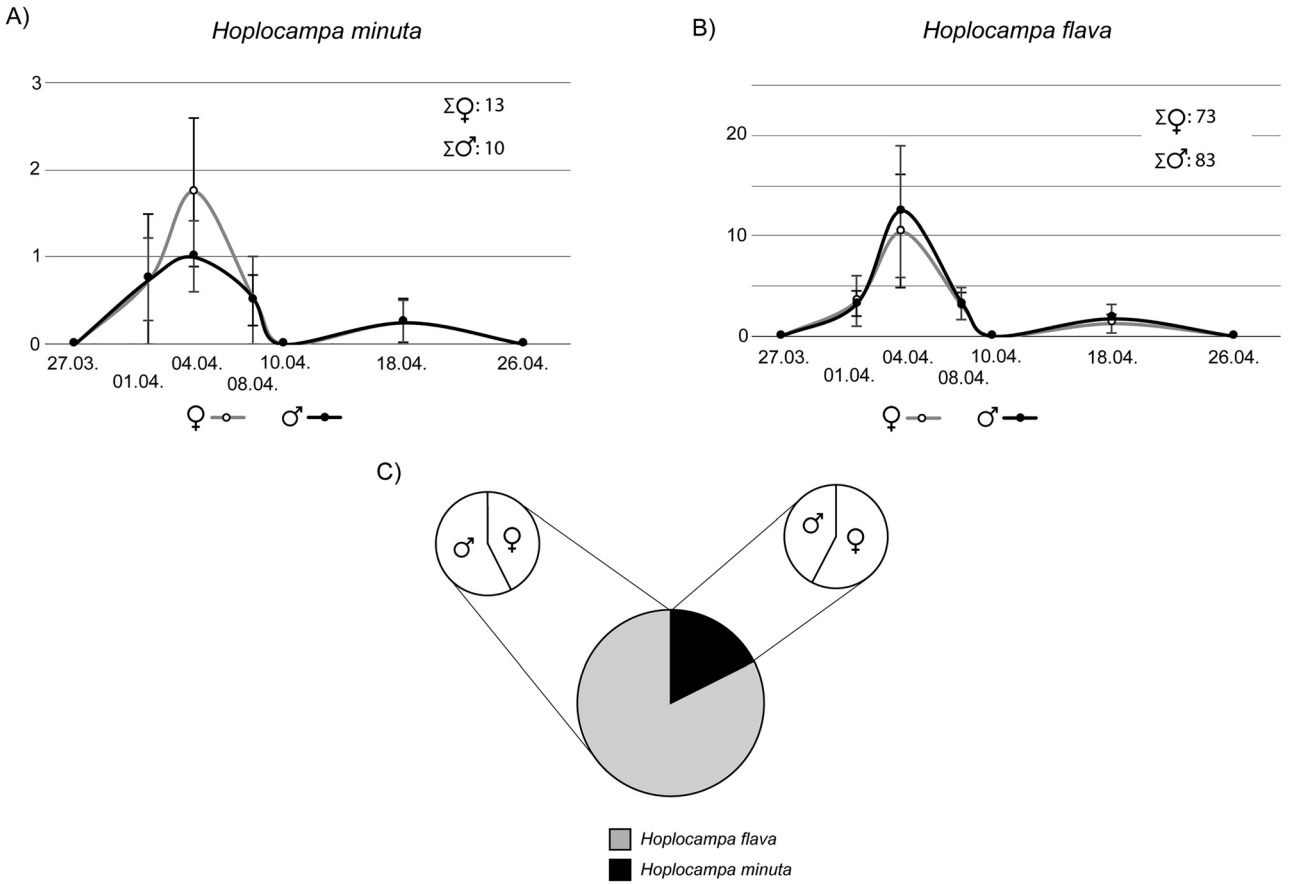


Fig. 1. Mean trap captures of *H. minuta* (A) and *H. flava* (B) at the inspection dates during the experiment in 2014 at Cegléd. Error bars represent the standard error of the mean. The pie chart shows the ratio of caught species and the sex ratio of each species (C)

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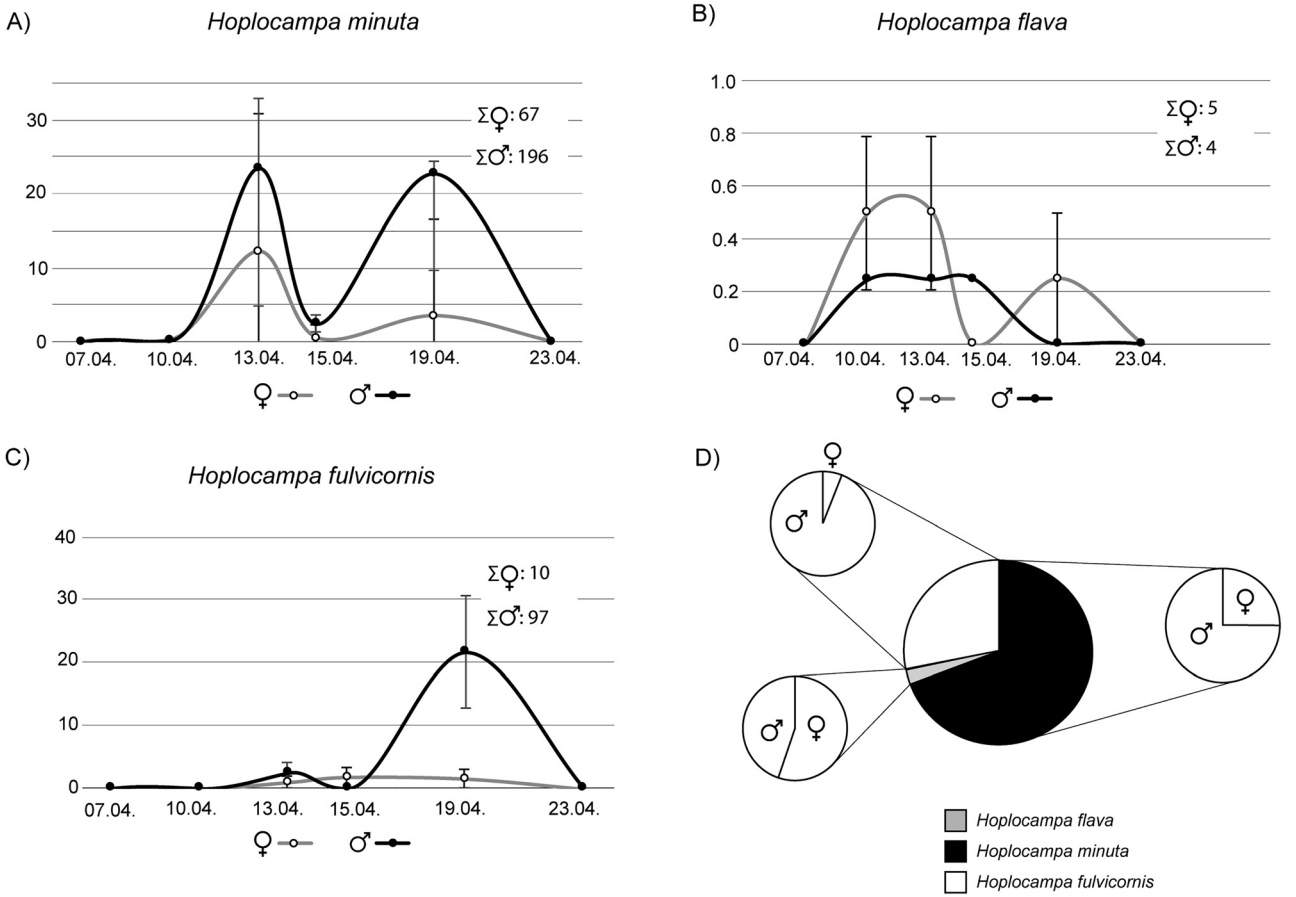


Fig. 2. Mean trap captures of *H. minuta* (A), *H. flava* (B) and *H. fulvicornis* (C) at the inspection dates during the experiment in 2015 at Pomáz. Error bars represent the standard error of the mean. The pie chart shows the ratio of caught species and the sex ratio of each species (D)

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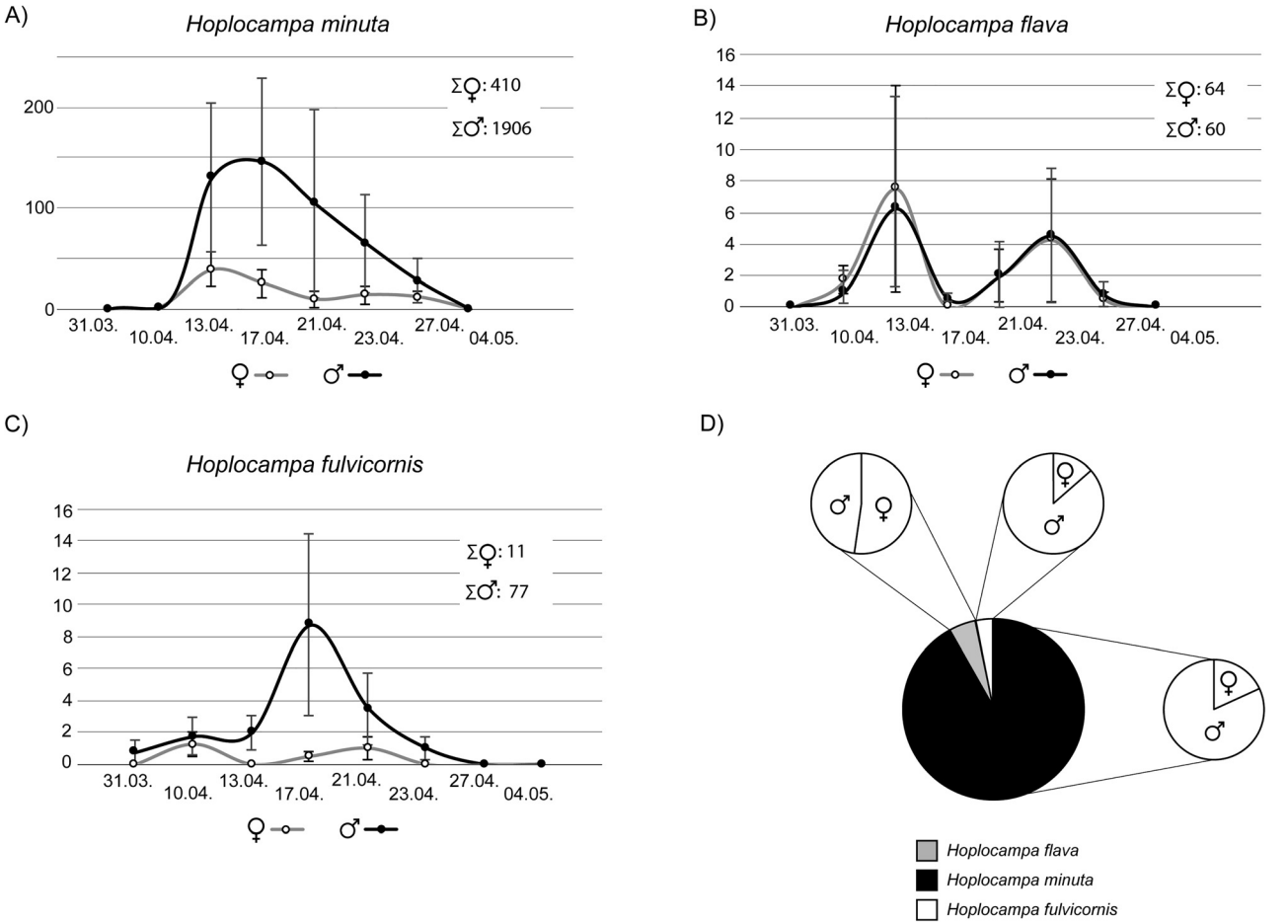


Fig. 3. Mean trap captures of *H. minuta* (A), *H. flava* (B) and *H. fulvicornis* (C) at the inspection dates during the experiment in 2015 at Érd. Error bars represent the standard error of the mean. The pie chart shows the ratio of caught species and the sex ratio of each species (D)

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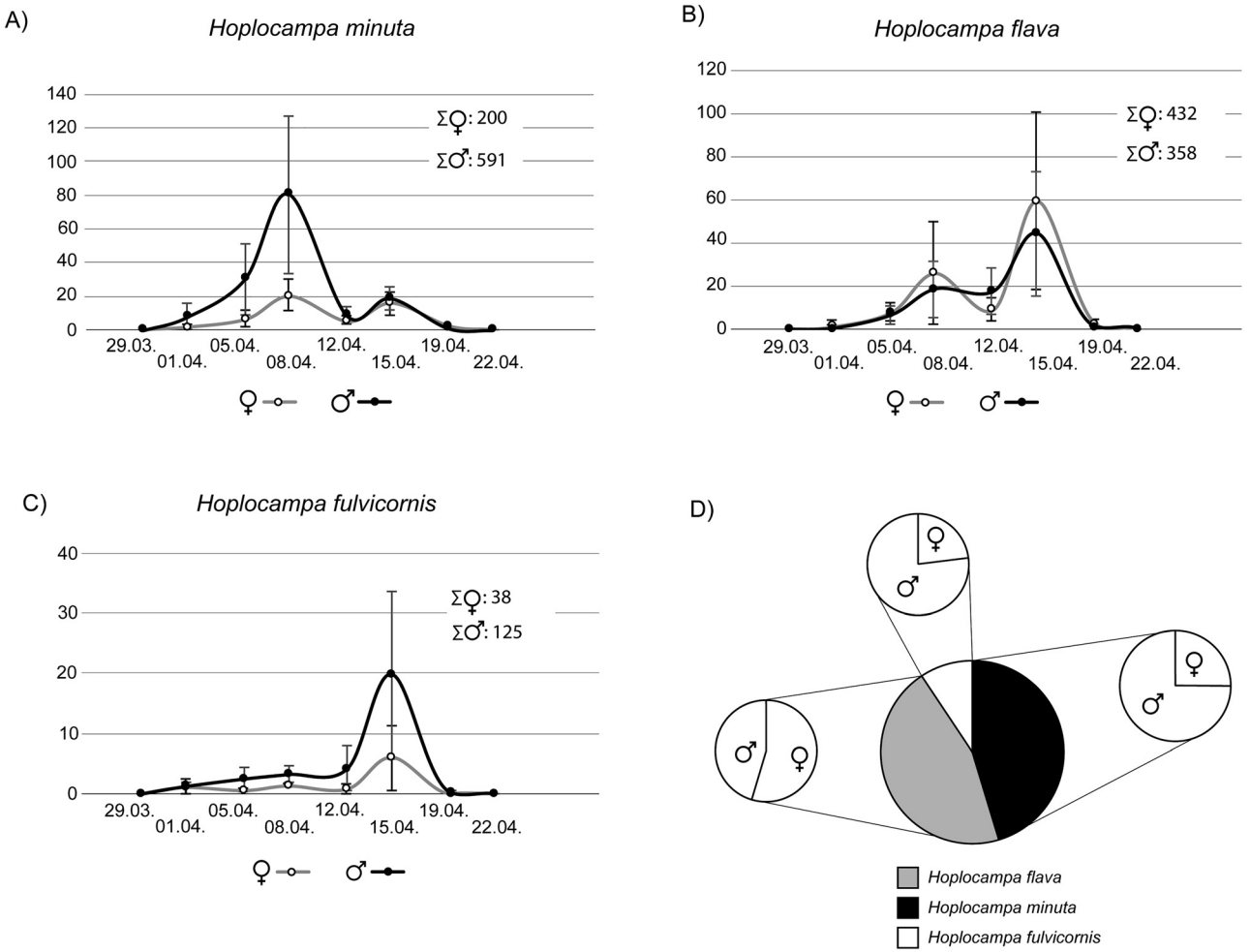


Fig. 4. Mean trap captures of *H. minuta* (A), *H. flava* (B) and *H. fulvicornis* (C) at the inspection dates during the experiment in 2016 at Érd. Error bars represent the standard error of the mean. The pie chart shows the ratio of caught species and the sex ratio of each species (D)

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minuta and *H. flava* are one of the most important pest species in the plum orchards in Europe (Caruso and Cera, 2004), monitoring the population of these species is important in terms of the timing of pesticide treatments. Up to date, only the white sticky trap exists to estimate sawflies' population density in plum orchards. Neither pheromones nor feeding attractants have been identified to attract any sawfly species, which could help to monitor them.

The number of caught *H. minuta*, *H. flava* and *H. fulvicornis* adults in traps considerably varied between years and locations. For instance, at Érd location comparing two consecutive years the highest average trap catches varied between 146 and 80 in the case of *H. minuta* males. This could be due to the previous years' insecticide treatment, seasonal differences between years, prolonged diapause of the larvae, or larval survival rate. Tamošiūnas et al. (2014) also reported different population densities of *H. minuta* between consecutive years in the same location.

Surprisingly, the traps caught *H. fulvicornis* for the first time in plum orchards in Hungary. Although the average number of adults caught was low, however, the existence of this species in plum orchards is remarkable. *H. minuta* and *H. fulvicornis* are closely related species (Liston et al., 2019), the identification of these species is difficult, therefore, it might be that in earlier studies attention did not focus on the separation of these two species. The catches of *H. fulvicornis* in the traps do not automatically mean that this species can cause damage to plum fruits. The larvae of this species could develop in other *Prunus* species' fruits and the adults could fly into the plum orchards, attracted by the white color. Pschorn-Walcher and Altenhofer (2000) show that *P. spinosa* is the main larval host of this species; although, this assumption was based on the adult occurrence not the larvae in the fruits. In Italy, Roberti (1948) convincingly showed that this species attacks cultivated plum varieties (*P. domestica* and *Prunus salicina*). Our study did not focus on the different species' larval development in plum fruits; however, there is a high probability that this species could also damage plum fruits.

Comparing three consecutive years, the first adults were caught in 2014 on the first day of April, in 2015 at Pomáz, in the second week of April (April 10), at Érd on the last week of March and 2016 also in the last week of March. Pajač Živković et al. (2020) reported that the first *H. minuta* and *H. flava* adults flew at end of March in Croatia, Zagreb in 2019. However, in Lithuania, the white sticky traps caught the first *H. minuta* and *H. flava* adults one month later presumably due to the lower annual temperatures between 2010–2012 (Tamošiūnas et al., 2014). In terms of the first adult catch in the same year (Pomáz 2015, Fig. 2; Érd 2015, Fig. 3), we found 10 days differences between the locations. This could be due to the below-ground temperature differences before the first adult emergence between the locations. In the case of *Hoplocampa testudinea*, Zijp and Blommers (1997) found a correlation between the soil temperature and first adult emergence.

The average trap catches varied between different locations in the same year. For instance, in 2015 at Érd, on average, traps caught 6 times more *H. minuta* males as compared to Pomáz at the date of the highest trap catch. Most probably, this variability is caused by biological or environmental factors. Prolonged diapause could also be the reason for this phenomenon, which has been observed in *H. minuta* and *H. testudinea* populations (Tauber and Tauber, 1976; Hadzistevic, 1959; Leski, 1960). Presumably, the overwintering larval survival rate was higher at Érd compared to Pomáz, due to some biotic (parasitoids or fungal diseases) or abiotic factors (climate). For example, entomophagous fungi could cause larval mortality, which has already been reported on *H. testudinea* (Niezborala, 1978; Jaworska, 1992).

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In our study, males were dominant in all locations and years. Conversely, in Lithuania, Tamošiūnas et al. (2014) reported that more females than males of *H. minuta* flew into the traps. Also, in the same study, they show that the ratio of males and females of *H. flava* was equal.

In terms of species abundance, we found that in almost all locations and years *H. minuta* was the dominant species, except in 2014 at Cegléd, where more *H. flava* than other species flew into the traps. However Pajač Živković et al. (2020) showed that in Croatia *H. flava* was more abundant than *H. minuta*.

The data of trap catch could be used to predict the damage level caused by these species and could help in the timing of the applied insecticides. Further studies should focus on investigating the development of *H. fulvicornis* larvae in plum fruits and the correlation of blooming time and trap catches of all species in Hungary. Also, future studies could focus on pheromone and feeding attractant identification of these three *Hoplocampa* species.

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