Abundance and seasonal activity of animal health risk horse flies (Diptera: Tabanidae) in south Hungary

Horse flies are known to spread pathogens of many serious animal diseases (Foil et al. 1991, Krinsky 1976, Lehane 2005). Tabanid larvae develop in wet soil and their development is positively influenced by soil temperature (Chvála 1972, Krčmar 1999a, 2004, 2005). The rise in average temperature may also cause the soil temperature to increase more rapidly in the spring than in the past, which may alter the seasonal activity of some tabanid species (Krčmar 1999b, 2005). However, livestock keepers would be in dire need of up-to-date information in order to plan for the control of tabanids and to prepare for the accidental appearance of potential pathogens. The aim of present study was to provide new data on the most common species of horse flies and their seasonal activity in south Hungary.

Samples were taken in southern Hungary near the village of Sántos (46°21'17.44" N - 17°52'42.70" E, elevation: 135 m) from May 2018 to end of September 2018. The sampling site was located on a 4-hectare equestrian farm at the edge of a sessile oak-hornbeam forest, 250 m from the Kapos River. Collections were made using a kind of canopy trap, the so-called "H-trap". Ten H-traps were deployed on the area on May 3, 2018, supplemented with another five traps on July 16, 2018. The traps were emptied first on May 7th, last on September 26th, on average every 2-3 days, for a total of 42 times. To analyze seasonal activity, the number of individuals of every species collected by the traps was averaged over decades (ten-day periods). Identification and nomenclature followed that of Chvála (1972) and Krčmar et al. (2011).

A total of 19,366 horse flies belonging to nine genera and 31 species was collected (Table 1). The most frequent species were *Tabanus tergestinus, Haematopota italica, T. bromius* and *T. autumnalis*, representing the 69.93% of the collected material. Statistical analysis (two-way repeated measures ANOVA) showed significant differences even among the most abundant species ($F(3,28)=142.38$ $p=0.00001$). Post hoc Tukey test showed *T. tergestinus* as the most frequent species (23.95%), followed by *H. italica* (19.99%), *T. bromius* (15.15%) and *T. autumnalis* as the least frequent (10.84%). The capture rate for these species was different along the 15 decades ($F(14,392)=18.81$ $p=0.00001$, as the traps captured fewer individuals during the first three and the last five decades than in the middle seven periods. There was a significant interaction in the two factors (species × decades) indicating that the trapping rates followed a species-specific pattern along the study period ($F(42,392)=13.295$ $p=0.00001$).

The six less readily captured horse fly species ranged from 1 to 10%: *T. sudeticus* (7.13%), *H. pluvialis* (5.37%), *A. loewianus* (5.18%), *T. glaucopis* (4,61%), *T. maculicornis* (3.45%) and *H. subcylindrica* (1.6%). For the rarest species, only one

Table 1. The monthly distribution of captured horse flies.

		May	June	July	August	September	Caught
1.	*Atylotus loewianus*	0	29	342	613	20	08.06-19.09
2.	*Chrysops caecutiens*	1	0	0	3	0	05.06-04.08
3.	*Chrysops viduatus*	0	9	11	1	0	28.05-17.08
4.	*Haematopota bigoti*	0	0	0	6	3	20.08-03.09
5.	*Haematopota crassicornis*	2	4	2	1	0	07.05-08.28
6.	***Haematopota italica***	**128**	**1,168**	**1,103**	**1,375**	**97**	23.05-19.09
7.	*Haematopota ocelligera*	2	0	1	0	0	07.05-08.28
8.	*Haematopota pluvialis*	8	167	435	416	14	07.05-04.07
9.	*Haematopota subcyllindrica*	100	135	50	16	8	07.05-26.09
10.	*Heptatoma pellucens*	6	6	10	44	38	07.05-26.09
12.	*Hybomitra bimaculata*	12	24	5	2	0	07.05-13.08
13.	*Hybomitra ciureai*	16	83	12	10	1	11.05-03.09
11.	*Hybomitra distinguenda*	0	1	0	0	1	08.06
14.	*Hybomitra muehlfeldi*	20	44	12	9	0	23.05-04.08
15.	*Hybomitra pilosa*	10	0	0	0	0	07.05-15.05
16.	*Hybomitra ukrainica*	0	1	0	1	0	01.06-04.08
17.	*Philipomyia graeca*	0	2	0	0	0	11.06-18.06
18.	*Silvinus alpinus*	0	2	2	0	0	21.06-16.07
19.	***Tabanus autumnalis***	**708**	**605**	**377**	**329**	**80**	07.05-17.09
20.	*Tabanus bovinus*	8	25	2	0	0	15.05-31.07
21.	***Tabanus bromius***	**71**	**817**	**1247**	**732**	**67**	23.05-17.09
22.	*Tabanus cordiger*	0	0	1	3	0	31.07-17.08
26.	*Tabanus glaucopis*	0	0	94	755	44	13.07-17.09
23.	*Tabanus maculicornis*	101	533	33	1	0	07.05-23.08
27.	*Tabanus paradoxus*	0	0	5	39	0	23.07-28.08
24.	*Tabanus quatornotatus*	1	0	0	0	0	07.05
28.	*Tabanus spectabilis*	0	3	7	4	2	11.06-26.09
29.	*Tabanus spodopterus*	0	4	2		0	11.06-23.07
30.	*Tabanus sudeticus*	10	401	439	508	23	20.05-17.09
25.	***Tabanus tergestinus***	**33**	**2,253**	**1,585**	**757**	**11**	23.05-17.09
31.	*Therioplectes gigas*	0	2	0	0	0	01.06

(*T. quatornotatus*), two (*H. bigoti, Hybomitra distinguenda, Hybomitra ukrainica, Philipomyia graeca, Therioplectes gigas*) or three individuals (*H. ocelligera*) were captured.

Flying periods of species are presented on Fig. 1. For *H. italica, H. pluvialis, H. subcylindrica, He. pellucens, Hy. ciureai, T. autumnalis, T. bromius, T. sudeticus* and *T. tergestinus* the longest flight period of five months, from May to September, was observed. Among them, *H. pluvialis, H. subcyllindrica* and *He. pellucens* appeared already in the first sample on May 7, but they were also collected on the last of September 26. Another nine species were collected at the beginning of the season in May, but the active period of *H. ocelligera, T. bovinus* and *T. spodopterus*, completed in July; for others (*Ch. caecutiens, H. crassicornis, Hy. bimaculata, Hy. muehfeldi, T. maculicornis*) it ended in August. Some species like *Hy. distinguenda, Ph. graeca, S. alpinus,* and *Th. gigas* only appeared in June. Specimens of *Ch. viduatus, Hy. ucrainica, S. alpinus, T. cordiger, T. paradoxus* and *T. spodopterus* were absent from the samples both in May and September, so we could only collect them during the summer.

The 31 species caught from May until September exceeded half the number of Hungarian tabanid fauna (Majer 2001). The flying period started from the beginning of May and after 15 decades ended on 26 September, which corresponds to the Central European data (Chvála 1972).

According to our results, the proportion of *T. autumnalis, T. bromius, T. tergestinus* and *H. italica* exceeded 10% in the whole year sample (see Table 1). All four species occur in several countries in the region, including Bulgaria (Ganeva 2012, 2017), the Czech Republic and Slovakia (Chvála 1972, 2009), Romania (Parvu 2008), Serbia (Krčmar 2011, Krčmar et al. 2002), Bosnia and Herzegovina (Krčmar et al. 2002), Slovenia (Krčmar and Bogdanović 2001) and several parts of Croatia (Krčmar 1999a,b, 2005).

The seasonal activity period of the four most abundant species is long, lasting from May to September, and characterized by bimodality. The first activity peak of *T. autumnalis* was in early June, followed by a smaller peak in the last decade of July. This species is typically one of the spring-early summer horse flies, and its proportion gradually declined during the season. Altunsoy and Kiliç (2012) observed a peak in its abundance in June in Western Anatolia. Krčmar (1999a, 1999b, 2005) found a year-on-year variation, with sometimes unimodal and sometimes bimodal activity of the species on the Pannonian Plain. According to Chvála (1972), the flight period of *T. tergestinus* occurs during the summer. This was confirmed by our results, as the abundance of this species began to rise sharply in the first decade of June and remained high until mid-August. *T. tergestinus*, already apparent in May, had its first maximum in mid-June and peaked again in the last decade of July with a smaller abundance. It is a typically summer-active horse fly species, with 99% of specimens trapped in the summer. According to Croatian data, it mainly flies in July (Krčmar 1999a,b, 2005). The flight period and seasonal activity of *T. bromius* were similar to that of the previous species: they appeared in the second decade of May and were last collected in the middle decade of September. A smaller activity peak was observed in June and a stronger peak in July. In line with our findings, peak of abundance was also recorded in July in Croatia (Krčmar, 1999a, 1999b). The flight period of *H. italica* is long: individuals were collected continuously from the first decade of May until the second decade of September. It was present in low numbers in spring and autumn, while in the summer we caught 94% of all collected individuals. The first and lower peak was in June and the second and higher peak in August. Krčmar (1999a, 1999b) also detected its maximum abundance in August.

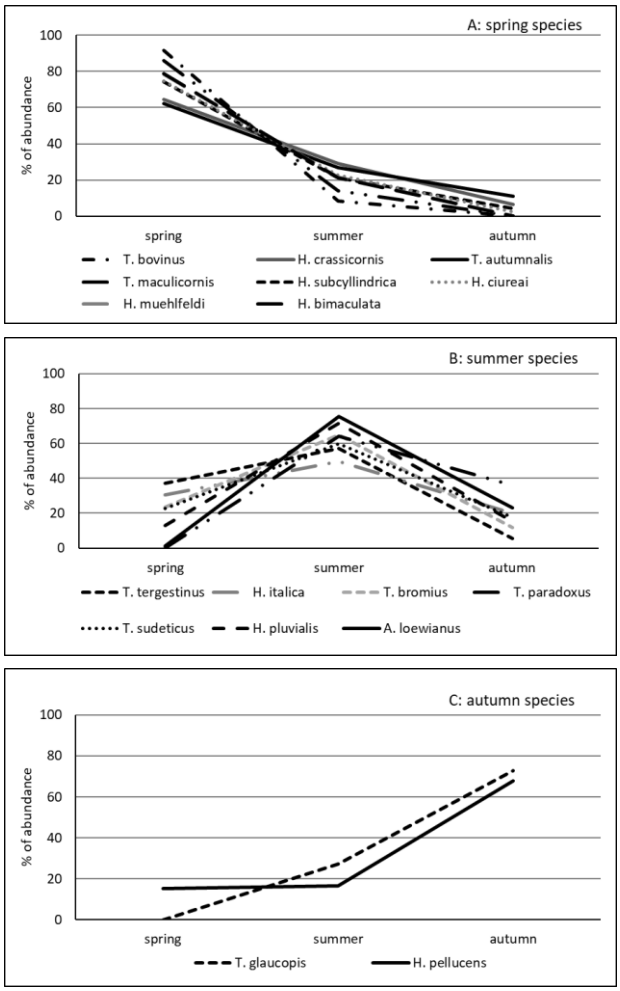

Figure 1. Percentage of the given species grouped by Hayakawa's periods. A: spring interval (1 May-20 June; B: summer interval (21 June-10 August; C: autumn interval (11 August-30 September)

Herczeg et al. (2014) showed that the activity peaks of tabanid species alternate, thereby reducing interspecific competition. Hayakawa (1980) recommends the seasonal classification of tabanid species as follows: spring species (1 May-20 June), summer species (21 June-10 August) and autumn species (11 August -30 September). Based on the intervals suggested by Hayakawa, eight species are included in the spring group of species collected at rates greater than 1%: *T. bovinus, H. crassicornis, T. autumnalis, T. maculicornis, H. subcyllindrica, Hy. ciureai, Hy. muehlfeldi* and *Hy. bimaculata* (Figure 1). The species *T. tergestinus, H. italica, T. bromius, T. paradoxus, T. sudeticus, H. pluvialis* and *A. loewianus* form the summer group. Finally, there are two species in the late summer-autumn group: *He. pellucens* and *T. glaucopis*.

The research on the horse flies is not a neglected area, as evidenced by the number of studies published so far. However, the results of many previous studies are of limited use

due to differences in sampling design and collection methods used. Further, state-of-the-art tools and deliberately planned international cooperation projects could be used to achieve more accurate results in the future.

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