

Bycatch with benefits: CO₂ traps reveal new Hybotidae for Slovakia

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Abstract

Carbon dioxide-baited traps are widely used in mosquito surveillance, yet their bycatch often remains overlooked. In this study, we analysed nontarget Diptera, specifically empidoid flies, collected using BG-Sentinel 2 traps in Slovakia during 2023–2024. Although the target group was rare, empidoids were found in 11 out of 472 samples (2.3%). Their taxonomic significance was striking. We identified one species of Empididae and ten species of Hybotidae. Five of these represent the first records for the Slovak fauna. Our results demonstrate that even minimal bycatch from nontraditional trapping methods can yield noteworthy faunistic discoveries. The rarity of these records underscores their importance: even a handful of specimens can reshape our understanding of national species diversity. This study highlights the value of integrative approaches that embrace incidental data, offering new insights into the hidden diversity of Diptera.

Key words: Central Europe, dance flies, faunistic, new records, unconventional collection method

Introduction

Carbon dioxide-baited traps are widely recognized for their ability to mimic mammalian exhalation, serving as indispensable tools for vector surveillance targeting Diptera such as mosquitoes and sand flies (e.g. Farajollahi et al. 2009; Cilek et al. 2024; Rodríguez-Rojas et al. 2024). However, these traps often capture a broader spectrum of insects beyond the intended target taxa (e.g. Oboňa et al. 2025). Such bycatch from nonculicid Diptera is typically overlooked, dismissed as negligible collateral noise (e.g. Kurina et al. 2025; Grundmann et al. 2025). Yet, this overlooked assemblage can harbor ecologically valuable or scientifically intriguing species worthy of study.

In this work, we explore a seldom-employed, holistic approach: analysing nontarget Diptera captured in CO₂ traps originally deployed for mosquito surveillance programs. By focusing on an unexpected family drawn to CO₂ allure, we challenge the prevailing assumption that bycatch from these traps lacks scientific value. Drawing attention to this incidental catch, we aim to demonstrate

that it can broaden our ecological and taxonomic insight, adding a rich, untapped dataset to entomological research. Although there are numerous studies that have quantified mosquito and sand fly captures using CO₂ traps (Cotteaux-Lautard et al. 2013; Arimoto et al. 2015; Carvalho et al. 2021; González et al. 2024; Ruiz-Arrondo et al. 2023), integrative analyses that incorporate incidental Diptera data from these traps are rare. Here, we present one of the first assessments dedicated to nontarget Diptera assemblages obtained via CO₂ trapping. We advocate for a more inclusive surveillance paradigm that capitalizes on every insect drawn to the collecting nets.

Materials and methods

Sampling

The bycatch presented in this study was collected during mosquito sampling using BG-Sentinel 2 traps (Biogents,



Figure 1. Photographs of BG Sentinel 2 traps (Biogents, Germany), photographs by Tomáš Csank.

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Germany) baited with CO₂ cylinders (Figure 1). These traps were deployed at various locations in 2023 and 2024 (see Table 1). The collection nets were replaced once or twice per week and stored at -20 °C until transported to the laboratory, where they were further stored at -80 °C. The date of trap removal is reported in Results.

After the mosquitoes were sorted, the remaining material was preserved in 75% ethanol. The collected specimens were initially sorted to the family level by the last author and identified to species level by the first author. The material studied is deposited in the insect collection of the first author (RBINS).

Table 1. An overview of sampling sites.

Region	District	City/Municipality	Locality / code	GPS
Bratislava	Senec	Hrubý Šúr	Hrubý Šúr ostrov / SC	48°11'27"N 17°23'24"E
Trnava	Trnava	Slovenská Nová Ves	Ronava / TT	48°18'25"N 17°32'32"E
Trnava	Dunajská streda	Potónske Lúky	Potónske Lúky / DS	48°05'43"N 17°35'22"E
Trenčín	Prievidza	Bojnice	Bojnice / PD	48°46'49"N 18°34'34"E
Nitra	Nitra	Nitra	Sokoliareň SPU / NR	48°18'13.5"N 18°05'51.6"E
Nitra	Komárno	Zlatná na Ostrove	Veľký Lél / KN	47°45'23"N 17°56'30"E
Žilina	Žilina	Žilina	Mojšova lúčka / ZA	49°11'33"N 18°49'15"E
Banská Bystrica	Veľký Krtíš	Lesenice	Lesenice / VK	48°06'18"N 19°14'57"E
Banská Bystrica	Rimavská Sobota	Mojín	Mojín / RS	48°20'17"N 19°58'20"E
Banská Bystrica	Banská Bystrica	Rakyatovce	Rakyatovce / BB	48°40'39"N 19°07'27"E
Prešov	Stará Lubovňa	Nová Lubovňa	Farma Stará Lubovňa / SL	49°15'43"N 20°41'20"E
Prešov	Stropkov	Lomné	Lomné / SP	49°06'17"N 21°38'24"E
Košice	Michalovce	Senné	Senianské rybníky / MI1	48°40'11"N 22°01'54"E
Košice	Košice	Kavečany	ZOO / KE	48°47'01"N 21°12'14"E
Košice	Košice	Kavečany	ZOO, Upper pond / UP	48°47'11.4"N 21°12'11.9"E
Košice	Košice	Kavečany	ZOO, Lower pond / LP	48°47'20.6"N 21°12'22.0"E
Bratislava	Bratislava	Podunajské Biskupice	Podunajské Biskupice / BA	48°07'08.5"N 17°12'40.1"E
Košický	Trebišov	Beša	Beša / MI2	48°32'04.8"N 21°57'20.2"E

Locality

Sampling was performed at 2 sites in 2023 (site codes UP and LP), and other 16 sites in 2024 (See Table 1).

The “Annotated list of recorded species” includes the number and sex of specimens, the date of trap collecting, and the locality name (for more detail see Table 1). For newly recorded species in Slovakia, brief notes on their distribution are provided.

Results

A total of 15 empidoid specimens representing one species of Empididae and ten species of Hybotidae were collected using “BG-Sentinel 2” CO₂ traps during 2023 (58 samples) and 2024 (414 samples), (see Annotated List of Recorded Species). The studied group was detected in 11 out of a total of 472 samples, corresponding to a detection rate of 2.3%.

Annotated list of recorded species

Diptera Empididae

Rhamphomyia (Amydroneura) gibba (Fallén, 1816)

Material examined: ♂, 11.9.2023, Lower pond.

Hybotidae

TACHYDROMIINAE

TACHYDROMIINI

Platypalpus albiseta (Panzer, 1806)

Material examined: ♀, 21.7.2023, Upper pond; ♀, 22.9.2024, Veľký Lél.

Platypalpus longiseta (Zetterstedt, 1842)

Material examined: ♀, 22.8.2023, Upper pond.

Platypalpus palliventris (Meigen, 1822)

Material examined: ♀, 16.6.2024, Ronava.

DRAPETINI

Crossopalpus aeneus (Walker, 1871)

Material examined: ♂, 4.8.2024, Podunajské Biskupice.

Distribution. Austria, Azores Islands, Belgium, Bosnia and Herzegovina, Bulgaria, Canary Islands, Cyprus, mainland France, Germany, mainland Greece (including Crete and Dodecanese), Hungary, mainland Italy (including Sardinia), Madeira, Malta, North Africa, Switzerland, Russia (European part), Ukraine, and West Asia (Grootaert et al. 1991; Shamshev 2016; Grootaert & Beuk 2024). Recorded for the first time in Slovakia.

Crossopalpus chvalai Kovalev, 1976

Material examined: ♂, 6.10.2024, Ronava.

Distribution. Central and South European Russia, Hungary, mainland Greece (Shamshev 2016; Grootaert & Beuk 2024). Recorded for the first time in Slovakia.

Drapetis assimilis (Fallén, 1815)

Material examined: ♀, 9.6.2024, Rakytovce.

Drapetis convergens Collin, 1926

Material examined: 3 ♀♀, 8.9.2024, Veľký Lél.

Distribution. Czech Republic, England, Germany, and Ukraine (Yang et al. 2007). Recorded for the first time in Slovakia.

Drapetis infitialis Collin, 1961

Material examined: ♂, ♀, 25.8.2024, ZOO Kavečany.

Distribution. Belgium, England, mainland France and Corsica, Czech Republic, Finland, Germany, Great Britain, Italy, Norway, and Russia (Shamshev 2016; Grootaert 2023; Grootaert et al. 2023). Recorded for the first time in Slovakia.

Drapetis monsmargila Grootaert, Beuk & Shamshev, 2020

Material examined: ♂, 14.7.2024, Veľký Lél.

Distribution. Bulgaria, Czech Republic, and the Netherlands (Roháček et al. 2021; Grootaert et al. 2024). Recorded for the first time in Slovakia.

Elaphropeza ephippiata (Fallén, 1815)

Material examined: ♂, 7.7.2024, Farma Stará Lubovňa.

Discussion

This study is part of a series examining Diptera bycatch from CO₂ traps (e.g., Oboňa et al. 2025; Grundman et al. 2025; Kurina et al. 2025). Before this study, the Hybotidae family in Slovakia included 170 species (Chvála 2009), a number that was later increased by Weele et al. (2015, 2018), Oboňa et al. (2021), and Beuk et al. (2025) to 178 species. Records of *Crossopalpus aeneus*, *C. chvalai*, *Drapetis convergens*, *D. infitialis*, and *D. monsmargila* in this study increased the total number to 183 species.

The present study moreover highlights the potential of using carbon dioxide-baited BG-Sentinel 2 traps, which

were originally designed for mosquito surveillance, to collect valuable faunistic data on nontarget dipteran taxa, particularly within the Empidoidea family. While these traps are not typically used to survey predatory flies, such as those from Empididae and Hybotidae, our findings demonstrate that even low-yield bycatch can significantly contribute to national biodiversity records. This is particularly relevant for regions where targeted surveys are scarce because even limited incidental material can help fill critical faunistic gaps.

The number of empidoid specimens collected was relatively small (only 15 individuals from 472 trap samples) yet their taxonomic diversity was notable. The recorded material included ten species of Hybotidae and one species of Empididae. Five species reported here as first records for Slovakia. This underlines the importance of not dismissing trap bycatch, even when it represents a minor fraction of total captures (see also Rozkošný & Vaňhara 1995; Sladonja et al. 2023).

The observed diversity, particularly among species of the genera *Drapetis* and *Crossopalpus*, suggests that the microhabitats associated with the trapping sites (such as leaf litter, soil surface, and decaying wood) may harbor previously overlooked dipteran assemblages incidentally attracted to CO₂ plumes. Since many hybotids are ground-dwelling or develop in microhabitats influenced by soil respiration (Drapetini are also known to visit hollows and other partially enclosed spaces), the CO₂ cue could mimic natural conditions and thus act as an attractant. Emphasizing the need for targeted supplementary research to better understand the mechanisms underlying fly attraction would provide a more balanced reflection of the current state of knowledge, while also acknowledging the value of these bycatch data.

Our results support the idea that unconventional or opportunistic sampling methods can play a complementary role in biodiversity assessments and highlight the scientific value of bycatch. We advocate for a more integrative approach to entomological monitoring, where nontarget taxa from surveillance programs are routinely examined. Such incidental collections can provide meaningful insights into species distributions, reveal undocumented taxa, and expand our knowledge of Diptera diversity.

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