# Responses of Tabanidae (Diptera) to canopy traps baited with 4-methylphenol, 3-isopropylphenol, and naphthalene

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ABSTRACT: The attraction of female tabanids to unbaited and single-baited canopy traps using 4-methylphenol, 3-isopropylphenol, and naphthalene was studied in three forest localities in eastern Croatia. Tabanids were collected in a significantly higher number in traps baited with these chemicals compared to unbaited control traps. The number of females of *Tabanus bromius*, *Tabanus sudeticus*, *Tabanus tergestinus, Hybomitra ciureai, Haematopota pluvialis,* and *Tabanus maculicornis* collected from 4-methylphenol baited canopy traps and traps baited with other attractants differed significantly. A total of 89.0% of tabanids collected belonged to these six species. The response of the other species to used chemicals was not analyzed because of small sample sizes. Moreover, the results with 3-isopropylphenol and naphthalene are very similar and not significant for some tabanids. *Tabanus bromius* was the most abundant species with 48.4% in the sample collected by canopy traps. Finally, the 4-methylphenol baited canopy traps collected 16 times more tabanids than unbaited traps, while 3-isopropylphenol and naphthalene baited traps collected 3.5 and 2 times as many tabanids, respectively, than unbaited traps. Also, 4-methylphenol appeared to be a very effective attractant for *Lucilia caesar* (Calliphoridae), *Sarcophaga carnaria* (Sarcophagidae), and *Musca domestica* (Muscidae). ***Journal of Vector Ecology* 32 (2): 188-192. 2007.**

*Keyword Index*: Tabanidae, canopy traps, attractants, Croatia.

## INTRODUCTION

Chemical attractants in traps are used in many parts of the world to attract biting flies (Foil and Hribar 1995). Some phenols are effective attractants for species of Tabanidae in Africa (Gibson and Torr 1999). In West Africa , baiting traps with 3-methylphenol increases the catch of tabanids (Amsler and Filledier 1994, Amsler et al. 1994). In southern Africa, 4-methylphenol is an effective bait for horse flies (Phelps and Holloway 1992). In Louisiana, a mixture of octenol, 3-*n*-propylphenol, and 4-methylphenol in the proportions 4:1:8 is attractive to tabanid flies (Foil and Hribar 1995). Furthermore, the aged urine of African buffalo, rhinoceros, cows, horses, sheep, and pigs contain some phenolic compounds that attract some species of tsetse, as well as most tabanids (Okech and Hassanali 1990, Madubunyi et al. 1996, Mihok et al. 1996, Krčmar et al. 2005, Krčmar et al. 2006). Naphthalene is a commonly used repellent for insects (Den Ouden et al. 1984). Under laboratory conditions during research on the electrophysiological response from the antennae of live tsetse (*Glossina pallidipes* Austen) to naphthalene, many olfactory cells were activated (Voskamp et al. 1999), whereas in the field this compound does not affect trap catches of *G. pallidipes* (Torr et al. 1996). The attractancy of 4-methylphenol, 3-isopropylphenol, and naphthalene for horse flies (Tabanidae) in southeastern Europe is not yet known. This paper reports the results of a study on the responses of tabanids to phenols (4-methylphenol, 3-isopropylphenol) and to naphthalene. The aim of this study was to investigate the efficacy of these rarely-used chemicals in catching tabanids.

## MATERIALS AND METHODS

This study was carried out at three locations in the Croatian part of Baranja which extends from the Drava and Danube Rivers to the border with Hungary. The Croatian Baranja is part of a wider Baranja region, the larger part of which is in Hungary. Collections were made in the Tikveš Forest (UTM CR 36), Monjoroš Forest (UTM CR 37), and Haljevo Forest (UTM CR 16). Tikveš Forest is situated within the Kopački rit Nature Park. The Tikveš Forest area is largely covered with common oak and dyer's green weed, whereas smaller parts are overgrown with common oak and hornbeam. Monjoroš Forest is approximately 2 km NE from the Kopački rit Nature Park. The Monjoroš Forest is on a floodplain along the east bank of the Danube River. The forest is mostly composed of white willow, black poplar, and common oak. Higher terrains are overgrown with white willow forests and black poplar. Haljevo Forest is located at the foot of Bansko brdo Hill, between the town of Beli Manastir and the village of Čeminac. This forest is overgrown with common oak, hornbeam, and beech, whereas the edges of this forest are covered with bush-like vegetation and red hawthorn trees.

Tabanids were collected in 12 black and white linen canopy traps constructed according to the design of Hribar et al. (1991). These twelve canopy traps in the above-mentioned three forest areas were set in groups of four traps in each forest. The canopy traps were baited with 4-methylphenol (99% pure), 3–isopropylphenol (97% pure), and naphthalene (98% pure). Canopy traps were placed along forest transects about 500 m apart and were not visible

from one site to the next, except in the Tikveš Forest. The baits were rotated among the traps daily, so that each bait was used in every trap. There was always one canopy trap without any bait that served as a control. The daily trapping period was between 7 a.m. and 7 p.m. Fresh baits were added at the beginning of each trapping period. Each trap-day, traps were baited with 4 ml of the above-mentioned baits. Chemicals were dispensed from glass vials. All attractants dispensers were placed 30 cm bellow the top of the canopy traps. Collections were made during 14 field trips from mid-June to the middle of August 2006. All trapped flies were preserved in ethanol. Identification and nomenclature followed that of Chvála et al. (1972) and Chvála (1988). Count data were transformed by $X' = (X + 3/8)^{1/2}$ (Anscombe 1948) and analysis of variance (ANOVA) was used to detect differences among numbers of flies attracted to each bait and among trap sites. Tukey's mean separation test was used as an *a posteriori* procedure. Differences in numbers of tabanids attracted to different baits among individual species were investigated via Chi-square analysis. SYSTAT statistical software was used to perform all analyses (SYSTAT 11.0, 2004, SYSTAT Software, Inc., Chicago, IL.).

## RESULTS

The largest number of species and specimens of tabanids were collected in the Monjoroš Forest, followed by the Tikveš and Haljevo Forests, respectively (Tables 1, 2, 3). In these three forest localities, 1,583 specimens were collected and 18 species of tabanids were identified in the following genera: *Chrysops, Atylotus, Hybomitra, Tabanus,* and *Haematopota* (Table 5). The most commonly collected species in the Monjoroš and Tikveš forests was *Tabanus bromius* L. (Tables 1 and 2), whereas in the Haljevo forest it was *Tabanus sudeticus* Zeller (Table 3). The species of tabanid most commonly collected, *T. bromius,* comprised 48.4% of the total. It was followed by *T. sudeticus* with 14.2%, *T. tergestinus* Egger with 8.3%, *Hybomitra ciureai* (Séguy) with 6.5%, *Haematopota pluvialis* (L.) with 6.4%, and *T. maculicornis* Zetterstedt with 5.2%. A total of 89.0% of tabanids collected belonged to these six species; the remaining 12 species made up 11.0% (Table 5). The majority of tabanids (71.4%) was collected from canopy traps baited with 4-methylphenol; 15.2% of the collected tabanids were taken from traps baited with 3-isopropylphenol, whereas 9.0% were obtained from traps baited with naphthalene. Only 4.4% of the total collected was obtained from traps without an attractant (Table 5). The 4-methylphenol-baited canopy traps collected 16 times more tabanids than unbaited traps, whereas traps baited with 3-isopropylphenol and naphthalene collected 3.5 and 2 times as many tabanids, respectively, than unbaited traps. Analysis of variance revealed that there was no significant site effect ($F = 1.469$, $P = 0.231$). Chemical bait influenced the total number of tabanids collected per trap ($F = 64.694$, $P < 0.0001$). There was a slight interaction between bait and trap site ($F = 4.437$, $P < 0.0001$). When the total number of tabanids was analyzed regardless of species, the number of tabanids attracted to 4-methylphenol was significantly different from all other baits tested. There was no significant difference between numbers of flies attracted to 3-isopropylphenol and naphthalene, nor between numbers of flies attracted to naphthalene and control traps (Table 4). Canopy traps baited with 4-methylphenol collected significantly more *T.*

Table 1. Tabanids collected in the Tikveš forest by canopy traps baited with different chemicals and with unbaited control traps.

| Species / attractants | 4-methyl-phenol | 3-isopropylphenol | Naphthalene | Control | Σ |
|---|---|---|---|---|---|
| *Tabanus bromius* L. | 236 | 14 | 23 | 14 | 287 |
| *Tabanus sudeticus* Zeller | 41 | 14 | 17 | 6 | 78 |
| *Tabanus maculicornis* Zetterstedt | 16 | 1 | 2 | - | 19 |
| *Hybomitra ciureai* (Séguy) | 14 | 2 | 2 | - | 18 |
| *Atylotus loewianus* (Villeneuve) | 6 | 4 | 3 | - | 13 |
| *Tabanus tergestinus* Egger | 8 | 1 | - | - | 9 |
| *Haematopota pluvialis* L. | 1 | 4 | 1 | 2 | 8 |
| *Chrysops relictus* Meigen | 6 | - | 1 | - | 7 |
| *Chrysops viduatus* (Fabricius) | 2 | - | 1 | - | 3 |
| *Tabanus autumnalis* L. | 2 | - | - | - | 2 |
| *Hybomitra bimaculata* (Macquart) | 2 | - | - | - | 2 |
| *Hybomitra muehlfeldi* (Brauer) | 1 | - | - | - | 1 |
| *Tabanus bovinus* L. | 1 | - | - | - | 1 |
| *Hybomitra ukrainica* (Olsufjev) | 1 | - | - | - | 1 |
| *Hybomitra acuminata* (Loew) | 1 | - | - | - | 1 |
| Σ 15 | 338 | 40 | 50 | 22 | 450 |

Table 2. Tabanids collected in the Monjoroš forest by canopy traps baited with different chemicals and with unbaited control traps.

| Species / attractants | 4-methyl - phenol | 3-isopropylphenol | Naphthalene | Control | Σ |
|---|---|---|---|---|---|
| *Tabanus bromius* L. | 372 | 40 | 30 | 18 | 460 |
| *Haematopota pluvialis* L. | 70 | 4 | 12 | 6 | 92 |
| *Tabanus sudeticus* Zeller | 40 | 5 | 3 | 2 | 50 |
| *Tabanus tergestinus* Egger | 31 | 4 | 5 | 4 | 44 |
| *Chrysops relictus* Meigen | 28 | 4 | 7 | 2 | 41 |
| *Hybomitra ciureai* (Séguy) | 21 | 5 | 3 | - | 29 |
| *Hybomitra bimaculata* (Macquart) | 21 | 3 | 2 | - | 26 |
| *Tabanus maculicornis* Zetterstedt | 17 | 3 | 3 | - | 23 |
| *Chrysops viduatus* (Fabricius) | 12 | 2 | - | - | 14 |
| *Hybomitra ukrainica* (Olsufjev) | 9 | - | - | - | 9 |
| *Tabanus autumnalis* L. | 2 | - | 3 | - | 5 |
| *Atylotus loewianus* (Villeneuve) | 2 | 2 | - | - | 4 |
| *Haematopota italica* Meigen | 3 | - | 1 | - | 4 |
| *Tabanus bovinus* L. | 3 | - | - | - | 3 |
| *Hybomitra solstitialis* (Meigen) | 1 | - | - | - | 1 |
| *Haematopota subcylindrica* Pandellé | 1 | - | - | - | 1 |
| Σ 16 | 633 | 72 | 69 | 32 | 806 |

Table 3. Tabanids collected in the Haljevo forest by canopy traps baited with different chemicals and with unbaited control traps.

| Species / attractants | 4-methyl -phenol | 3- isopropylphenol | Naphthalene | Control | Σ |
|---|---|---|---|---|---|
| *Tabanus sudeticus* Zeller | 58 | 22 | 14 | 4 | 98 |
| *Tabanus tergestinus* Egger | 37 | 39 | 1 | 2 | 79 |
| *Hybomitra ciureai* (Séguy) | 23 | 29 | 3 | 2 | 57 |
| *Tabanus maculicornis* Zetterstedt | 12 | 20 | 5 | 4 | 41 |
| *Tabanus bromius* L. | 10 | 7 | - | 3 | 20 |
| *Atylotus loewianus* (Villeneuve) | 3 | 5 | - | - | 8 |
| *Hybomitra bimaculata* (Macquart) | 6 | 2 | - | - | 8 |
| *Chrysops viduatus* (Fabricius) | 4 | 2 | - | - | 6 |
| *Hybomitra muehlfeldi* (Brauer) | 3 | 1 | - | - | 4 |
| *Haematopota italica* Meigen | - | 2 | 1 | - | 3 |
| *Haematopota pluvialis* (L.) | 2 | - | - | - | 2 |
| *Hybomitra solstitialis* (Meigen) | 1 | - | - | - | 1 |
| Σ 12 | 159 | 129 | 24 | 15 | 327 |

Table 4. Differences among numbers of tabanids collected in canopy traps provided with chemical attractants.

| Attractant | Mean no. Flies/trap-day[1] |
|---|---|
| 4-methylphenol | 31.39[a] |
| 3-isopropylphenol | 6.69[b] |
| naphthalene | 3.97[bc] |
| Control | 1.92[c] |

[1]Tukey's mean separation procedure. Means followed by the same letter are not significantly different.

Table 5. Total number of tabanids collected by canopy traps baited with 4-methylphenol, 3-isopropylphenol, naphthalene, and unbaited control traps.

| Species | 4-methyl-phenol | 3 –isopropyl -phenol | naphtha-lene | Control | Σ | $\chi^2$ |
|---|---|---|---|---|---|---|
| *Tabanus bromius* L. | 618 | 61 | 53 | 35 | 767 | 860* |
| *Tabanus sudeticus* Zeller | 139 | 41 | 34 | 12 | 226 | 96.7* |
| *Tabanus tergestinus* Egger | 76 | 44 | 6 | 6 | 132 | 58.5* |
| *Hybomitra ciureai* (Séguy) | 58 | 36 | 8 | 2 | 104 | 36.8* |
| *Haematopota pluvialis* (L.) | 73 | 8 | 13 | 8 | 102 | 83.5* |
| *Tabanus maculicornis* Zetterstedt | 45 | 24 | 10 | 4 | 83 | 23.6* |
| *Chrysops relictus* Meigen | 34 | 4 | 8 | 2 | 48 | NA |
| *Hybomitra bimaculata* (Macquart) | 29 | 5 | 2 | - | 36 | NA |
| *Atylotus loewianus* (Villeneuve) | 11 | 11 | 3 | - | 25 | NA |
| *Chrysops viduatus* (F.) | 18 | 4 | 1 | - | 23 | NA |
| *Hybomitra ukrainica* (Olsufjev) | 10 | - | - | - | 10 | NA |
| *Tabanus autumnalis* L. | 4 | - | 3 | - | 7 | NA |
| *Haematopota italica* Meigen | 3 | 2 | 2 | - | 7 | NA |
| *Hybomitra muehlfeldi* (Brauer) | 4 | 1 | - | - | 5 | NA |
| *Tabanus bovinus* L. | 4 | - | - | - | 4 | NA |
| *Hybomitra solstitialis* (Meigen) | 2 | - | - | - | 2 | NA |
| *Hybomitra acuminata* (Loew) | 1 | - | - | - | 1 | NA |
| *Haematopota subcylindrica* Pandellé | 1 | - | - | - | 1 | NA |
| Σ 18 | 1130 | 241 | 143 | 69 | 1583 | |

*Significantly different ($P < 0.05$), NA – not analyzed.

*bromius, T. sudeticus*, *T. tergestinus, Hy. ciureai, H. pluvialis,* and *T. maculicornis* females then did traps baited with other attractants: 3-isopropylphenol and naphthalene (Table 5). However, the number of collected females of *T. bromius, T. sudeticus,* and *H. pluvialis* did not differ significantly when compared to 3-isopropylphenol and naphthalene ($\chi^2 = 0.56$ $P > 0.05$; $\chi^2 = 0.66$ $P > 0.05$; $\chi^2 = 1.18$ $P > 0.05$). The response of the other species to the attractants was not analyzed because of small sample sizes. All collected specimens were females. Furthermore, in this study in traps baited with 4-methylphenol, 67 specimens of *Sarcophaga carnaria* L. and 26 specimens of *Musca domestica* L. were collected during June. During July and August, 258 specimens of *Lucilia caesar* L., 54 specimens of *S. carnaria,* and 48 of *M. domestica* were collected in 4-methylphenol-baited traps.

## DISCUSSION

The data obtained from this study provide insight into the effectiveness of 4-methylphenol, 3-isopropylphenol, and naphthalene as attractants in canopy traps for tabanid collections. These three chemicals are rarely used as attractants in samplings of tabanids. There was no prior evidence for efficacy of 3-isopropylphenol and naphthalene as attractants for tabanid collections. During the review of literature only one datum from southern Africa was found for 4-methylphenol. In southern Africa, 4-methylphenol was an effective attractant in tabanid catches (Phelps and Holloway 1992). Also, in this study in eastern Croatia the 4-methylphenol-baited canopy traps appeared to be the best collection method for tabanids. There was a statistically significant interaction of collection site and attractant. Most tabanids were collected in the Monjoroš Forest, whereas the least were collected in the Haljevo Forest. The variation among the three different forests is not surprising. The Monjoroš Forest is a floodplain situated within the Kopački rit Nature Park, and Tikveš Forest is located in the moist habitats within the Kopački rit Nature Park. This area is characterized by numerous groups of insects that are, at particular stages, tied to water (Krčmar et al. 2006). Unlike these moist forests, the Haljevo Forest is located on dry habitats at the foot of Bansko brdo Hill and is surrounded by farmland on all sides. The present study showed that 4-methylphenol is a very effective attractant for collecting: *T. bromius, T. sudeticus, T. tergestinus, Hy. ciureai, H. pluvialis,* and *T. maculicornis* in the study area. Moreover, the results with 3-isopropylphenol and naphthalene are very similar and not significant for some tabanids. Torr et al. (1996) showed that naphthalene does not affect the trap catches of *Glossina pallidipes;* these data are not comparable with this study's results for Tabanidae. The efficiency and use of baits such as naphthalene and 3-isopropylphenol for other dipteran families is still very poorly known. For this reason, more extensive field studies with these two chemicals may be useful. However, in this study, in addition to tabanids collected in traps baited with 4-methylphenol, specimens of *S. carnaria*, *M. domestica,* and *L. caesar* were collected in 4-methylphenol-baited traps. *S. carnaria, M. domestica,*

and *L. caesar* are very often found in large numbers in excrement, carrion, and decaying material (Zahradnik and Severa 1990). Obviously, phenolic compounds such as 4-methylphenol are very attractive to some dipterans. The present study demonstrated that the use of 4-methylphenol in traps could result in the increased collection of tabanids and also some species of Sarcophagidae, Calliphoridae, and Muscidae in certain geographic regions.

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