Biomonitoring of Ceratopogonidae (Diptera: Nematocera) using car nets

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Car nets were used to collect two samples on a forest road in Podyjí National park, the Braitava forest, Czech Republic. Sampling was done in 2002 between May 31 and June 1, and between July 30 and 31. These consisted of 10 rounds (each 10 km in length) from morning to dusk. Over 3,000 specimens (52 species) of Ceratopogonidae were captured. The results suggest that the car-net method may be efficient in ceratopogonid biomonitoring and e.g. determining their daily flight activity and swarming sites.

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1. Introduction

The car-net method, viz. catching flying insects using a large net attached to the roof of a car, was probably first described by Lohse (Freude *et al.* 1965). Basically it was an improved version of a method described by Strand (1961). Later on, Kronblad & Lundberg (1978) discussed this method in detail, together with results obtained by this method in Sweden. They also included an illustration and a photo of the collecting device. A similar approach was used by Rutanen & Muona (1982) who concluded that car nets were effective and fast in collecting (and detecting the presence of) many beetles, especially ptilids and aleocharines. The authors suggested its use for determining swarming sites and times e.g. for scolytids. The method has since then faced some further improvements. Some researchers have suggested that car nets mounted low (above the ground) and into the front of vehicles can be more efficient (Dr. L. Masner, pers. comm., Peck & Cook 1992).

Recent results of using this method were published by Koehler (1994) and Herrmann (2001). However, mounting a net in this position may be more difficult and even prohibited by legislation of some countries.

2. Material and methods

During 2002, two samples were collected in Podyjí National park, on the forest road in the

Fig. 1. Car nets mounted on the roof of a car.

Braitava forest of the Czech Republic, using car nets (Fig. 1). Both samples (May 31 – June 1 and July 30–31) consisted of ten ca. 10-km long rounds from morning to dusk, and thus totalled about 200 km.

Two car nets of 41 cm × 58 cm were mounted on the roof of a car (Fig. 1). The nets were made of monofil ® attached to a metal frame. A small dose of "knock-down" pyrethroid insecticide was applied to tip of each net before each sampling round to prevent escapes of flies. After each round, nets were emptied into entomological net and the material was immediately stored in 70% ethanol.

The material was then sorted in the laboratory using dissecting microscope with 20 × magnification, and specimens were subsequently identified. Only about 1/5 of the total sample was selected for identification in the case of common morphospecies and progressively higher proportion in the case of rare morphospecies. Simultaneously we performed an assessment of the total number of ceratopogonids applying the 1/10 method (Barták 1997) that indicated that we captured about 3,200 specimens of biting midges.

Specimens were mounted on microscope slides in phenol alcohol or, for some problematic specimens, Canada balm, and identification was done using monographs and keys by Zilahi-Sebess (1940), Remm (1969), Wirth *et al.* (1974), Havelka (1976) and Szadziewski (1983). Species of the genus *Culicoides* were treated by Országh (1980).

For identification of species of the genus *Atrichopogon*, we used papers by Remm (1961a), Havelka (1979), Wirth (1980), Országh & Košel (1995) and Szadziewski *et al.* (1995, 1996). For identification of *Forcipomyia* species, we used papers by Remm (1960, 1961b), Krivosheina (1968), Dow & Wirth (1972), Wirth (1972) and Wirth & Ratanaworabhan (1978). For species of *Ceratopogon*, the key provided by Borkent & Grogan (1995) was used, whereas species of *Dasyhelea*, *Bezzia* and *Palpomyia* were identified using keys of Remm (1962, 1974a, 1974b, 1974c, 1976). All species of the Palaearctic region are listed in Remm (1988). Recent nomenclature was used including the changes by Borkent & Wirth (1997) and Szadziewski & Knoz (2002).

3. Results

Results of species identification are presented in Table 1. Precise counting of selected material is given under "identified specimens" but the true abundance of each species may well be 3–5 times higher. In our samples, altogether 52 species of 10 genera were found, which represents about 26% of the total Czech ceratopogonid fauna. Eleven species are first records from the territory of the Czech Republic (Tóthová *et al.* 2004, in press).

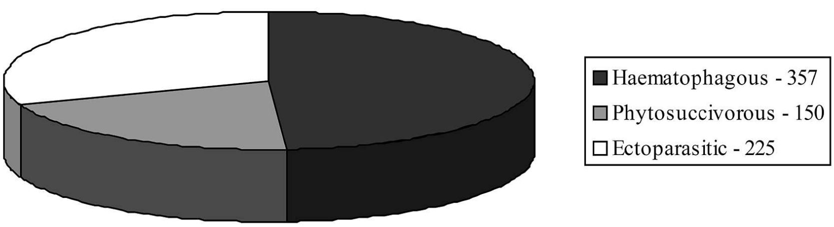

Fig. 2. Number of specimens of trophic groups captured using car net.

Table 1. List of identified species collected using car net. In the present study, the estimated mean abundance of ceratopogonids was ca. 1 specimen per 30 m^3 of air, for the height of ca. 1.5–2 m above ground level.

Species	Males	Females
Culicoides (*Avaritia*) *obsoletus* (Meigen, 1818)	6	55
C. (*Culicoides*) *punctatus* (Meigen, 1804)	–	48
C. (*Oecacta*) *fascipennis* (Staeger, 1839)	2	47
C. (*O.*) *festivipennis* Kieffer, 1914	–	48
C. (*O.*) *kibunensis* Tokunaga, 1937	–	25
C. (*O.*) *pallidicornis* Kieffer, 1919	–	1
C. (*O.*) *pictipennis* (Staeger, 1839)	–	6
C. (*O.*) *reconditus* Campbell & Pelham–Clinton, 1960	–	1
Ceratopogon naccinervis Borkent, in Borkent & Wirth 1997	–	3
Stilobezzia (*Stilobezzia*) *flavirostris* (Winnertz, 1852)	–	2
Stilobezzia (*Acanthohelea*) *ochracea* (Winnertz, 1852)	–	2
Schizohelea leucopeza (Meigen, 1804)	–	17
Serromyia femorata (Meigen, 1804)	2	2
S. morio (Fabricius, 1775)	2	–
S. subinermis Kieffer, 1919	–	5
Bezzia (*Bezzia*) *signata* (Meigen, 1804)	12	0
Bezzia (*B.*) *winnerztiana* Kieffer, 1919	14	0
Bezzia (*Pygobezzia*) *albicornis* (Meigen, 1818)	–	1
Palpomyia melacheira Remm, 1976	–	1
P. nigripes (Meigen, 1830)	–	2
P. serripes (Meigen, 1818)	1	8
P. tibialis (Meigen, 1818)	–	1
Dasyhelea (*Dasyhelea*) *malleola* Remm, 1962	4	4
D. (*D.*) *pallidiventris* (Goetghebuer, 1831)	–	2
D. (*D.*) *paludicola* Kieffer, 1925	1	–
D. (*D.*) *saxicola* (Edwards, 1929)	15	10
D. (*D.*) *septuosa* Borkent [in Borkent & Wirth (1997)]	2	27
D. (*D.*) *versicolor* (Winnertz, 1852)	–	1
D. (*Dicryptoscena*) *modesta* (Winnertz, 1852)	–	1
D. (*Pseudoculicoides*) *flavoscutellata* (Zetterstedt, 1850)	–	13
D. (*Prokempia*) *flaviventris* (Goetghebuer, 1910)	–	25
Atrichopogon (*A.*) *brunnipes* (Meigen, 1804)	1	3
A. (*A.*) *hirtidorsum* Remm, 1961	1	8
A. (*A.*) *minutus* (Meigen, 1830)	3	1
A. (*A.*) *pavidus* (Winnertz, 1852)	–	1
A. (*Meloehelea*) *aff. epicautae* (Wirth, 1956)	–	10
A. (*M.*) *lucorum* (Meigen, 1818)	22	46
A. (*M.*) *oedemerarum* Storå, 1939	–	11
A. (*M.*) *winnertzi* Goetghebuer, 1922	9	36
A. (*Psammopogon*) *flavolineatus* Strobl, 1880	–	8
Forcipomyia (*Euprojoannisia*) *palustris* (Meigen, 1804)	2	8
F. (*E.*) *titillans* (Winnertz, 1852)	–	3
F. (*Forcipomyia*) *bipunctata* (Linnaeus, 1767)	1	–
F. (*F.*) *brevipennis* (Macquart, 1828)	–	2
F. (*F.*) *hygrophila* Kieffer, 1925	–	2
F. (*F.*) *kaltenbachi* (Winnertz, 1852)	–	6
F. (*F.*) *nigra* (Winnertz, 1852)	5	–
F. (*F.*) *tenuis* (Winnertz, 1852)	–	1
F. (*F.*) *tenuisquama* Kieffer, 1924	–	1
F. (*Lasiohelea*) *sibirica* (Bujanova, 1962)	23	86
F. (*L.*) *velox* (Winnertz, 1852)	3	6
F. (*Thyridomyia*) *monilicornis* (Coquillet, 1905)	1	3
Total	132	600

4. Discussion

Biting midges are usually collected using various kinds of light traps, CO_2-baited traps, traps baited with nulliparous females, or using Malaise traps. In collecting biting midges, the car-net method appears to substantially enrich the portfolio of the traditional collecting methods. It also seems to be efficient in collecting biting midges with diurnal and crepuscular activity. Of the 19 genera of biting midges known from the Czech Republic, 10 were captured in our study, suggesting that the car-net method is an effective way to sample entire ceratopogonid faunas in diverse habitats. The qualitative and quantitative richness of our material, collected in Podyjí National Park, reflects the usefulness of this collecting method, and the overall midge abundance in this area. About 1/3 of our material were species of the haematophagous genus *Culicoides* (especially females). This well-studied genus, of veterinary and medical importance, is usually captured using light traps, but its high proportion in our samples shows the utilisation and efficiency of our method. We also collected haematophagous species of the subgenus *Lasiohelea* of *Forcipomyia* that feed on the blood of amphibians (*L. velox*) and mammals, including man (*L. sibirica*). Females of the genera *Atrichopogon*, *Forcipomyia*, *Palpomyia*, *Stilobezzia* and *Serromyia* feed on the haemolymph of other insect groups (Diptera, Coleoptera, Odonata and Lepidoptera). All other genera are phytosuccivorous and pollinovorous.

The car-net method appears to be able to capture not only some of the trophic groups of selected families, but also the entire spectrum of species and their feeding specifications. The diversity of trophic groups in our two samples is another advantage of this method (Fig. 2).

Some species could not be identified because of the poor knowledge of several species groups in the genus *Forcipomyia*. For example, *Atrichopogon* (*Meloehelea*) *epicautae* was identified *sensu* Wirth (1980), but this may actually be a form of *A. lucorum*. The subgenus *Meloehelea* in the Czech Republic is currently being analysed applying 16S rDNA sequences. Moreover, because of the quantitative richness of the examined samples, some specimens may have been overlooked, as some species known from South Moravia were missing in our samples (Knoz 1998). Possible examples are at least *Probezzia* and *Sphaeromias* species.

In general, biting midges have two abundance peaks: late spring and the onset of autumn. The capture of 26% of known Czech species outside their peak abundance period is another indication of the high efficiency of the collecting method used. It also seems to be succesful for quick monitoring of local populations of other dipteran groups.

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