NEW RANGE RECORDS, AND A COMPARISON OF SWEEP NETTING AND MALAISE TRAP CATCHES OF HORSE FLIES AND DEER FLIES (DIPTERA: TABANIDAE) IN NORTHERN ONTARIO

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Abstract *J. ent. Soc. Ont.* 145: 3–14

Horse flies and deer flies (Diptera: Tabanidae) were surveyed in northern Ontario, Canada in 2011, at 11 sites, and 2012, at 12 sites using Malaise traps and daily sweep netting. A total of 2168 tabanids representing 30 species: 10 *Chrysops*, 18 *Hybomitra*, and two *Tabanus* were collected. Malaise traps caught fewer individuals than sweep netting but more species: 850 tabanids of 28 species, eight of which were not caught by sweep netting. Sweep netting caught 1318 tabanids of 22 species, with two not found in Malaise trap samples. The first record of *Hybomitra osburni* (Hine) in Ontario, and range extensions for several other species are given.

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Introduction

When habitats change, insect populations respond rapidly, up or down, depending on the species characteristics (Niemela *et al*. 1993). These changes occur across a range of temporal and spatial scales, and are unique for each species. This quality makes insect diversity an efficient indicator for monitoring both short and long term environmental changes (Danks 1992). The great variety of habitats occupied by insects in Ontario means that studies that require tracking environmental change can benefit from using some insect group for monitoring that change. For such work, up-to-date distributional data are needed for the insect species of interest.

The eastern "Ring of Fire" region in the eastern area of Northern Ontario contains large deposits of chromium and other minerals (Far North Science Advisory Panel 2010), and anticipated large-scale extraction processes will alter insect diversity and distribution.

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To see the effect of such development, as well as possible effects of changing climates, baseline distributional data for these areas are needed. With this purpose, the Ontario Ministry of Natural Resources (OMNR) started a project in 2009 to survey insect diversity and establish species distributions for Northern Ontario.

A widespread and easy to find and collect group are horse flies and deer flies (Tabanidae). Pechuman *et al*. (1961) compiled the first comprehensive report on the Tabanidae of Ontario. Teskey (1990) provided a more complete treatment of Tabanidae in Canada. Since then, two pictorial keys, one on deer flies (Thomas and Marshall 2009) and one on horse flies (Thomas 2011), added new range information to this group. Further reports of sampling, especially from northern Ontario, continue to add distributional data to our knowledge of Tabanidae (e.g., Beresford 2011).

Here we list the different species of Tabanidae caught in northern Ontario using two different collecting methods and report on range extensions of several of them.

Materials and Methods

We sampled horse flies and deer flies in north-west Ontario in 2011 and north-east Ontario in 2012 (Fig. 1, inset map) at 12 locations each year using two sampling methods, sweep netting and Malaise trapping. Ringrose *et al*. (2013) provided detailed site descriptions and locations. Generally, sampling took place within 1 km of remote field camps that were accessed by helicopter. The 2011 sampling was completed in the western half of Ontario boreal forest within a 150 km radius of the First Nations communities of Big Trout Lake and Sandy Lake. The 2012 sampling occurred in the northeastern part of the province within a 150 km radius of the First Nations community of Fort Albany, Ontario. Sampling dates were from 5 June to 17 July in 2011, and from 5 June to 15 July in 2012.

Tabanids were sampled each day by two methods, Malaise traps (6m trap model no. 2877, BioQuip Products 2321 Gladwick Street, Rancho Dominguez, CA 90220, USA), and sweep netting. The collecting heads of the Malaise traps were filled with 80% denatured ethanol to kill and preserve captured tabanids. These were emptied and replaced each day at 9 pm.

Sweep netting was completed at midday as the surveyor (JLR) walked slowly, sweeping for 5 minutes any Tabanidae that assembled around the researcher. The netted samples were killed by placing the end of the bag in large killing bottles charged with acetone. Specimens were then removed from the net and stored in bottles filled with 80% denatured ethanol. The ethanol in each storage bottle was replaced after 24 hours.

All tabanids were pinned and identified by JLR and DVB using the keys found in Teskey (1990), Thomas and Marshall (2009) and Thomas (2011). The main pinned collection is stored in insect cabinets at Trent University, Biology Department, Peterborough, Ontario. A reference collection of voucher specimens is housed at the Canadian National Collection of Insects, Ottawa.

Analysis

A list of the expected species was produced from the distribution records reported in the keys listed above. For those species that did not have records in northern Ontario, we reasoned that any species with records that straddled northern Ontario (either east and west, or north and south of the sampling regions) was likely present in northern Ontario. We compared this expected number of species to the predicted number which we calculated using the lognormal distribution method (Preston's method) as described in Ludwig and Reynolds (1988). This approach allows one to predict the number of species present in an area from sampling data. It is based on a general observation that most species are more or less moderately abundant (the middle region of the lognormal distribution), a few species are very abundant (forming the right tail of the lognormal distribution) and a few are very rare (the left tail of the lognormal distribution). In practice, it enables one to predict the number of rare species that are expected but which might have been missed. Parameters for the lognormal model were fitted using the SOLVER function in MICROSOFT EXCEL 2007.

Catch data were analyzed using the online rarefaction calculator from the University of Alberta (http://www.biology.ualberta.ca/jbrzusto/rarefact.php), to determine the effects of collection size on the number of species collected, as well as to compare trapping methods.

Results

Range records and extensions

From our assessment of published range maps, we expected to find 31 species of Tabanidae: 23 with records from across northern Ontario in the regions where we conducted our study (11 *Hybomitra*, 8 *Chrysops*, 2 *Atylotus*, 2 *Tabanus*), and 8 with ranges that straddle our study regions (5 *Hybomitra*, 2 *Atylotus*, and 1 *Haematopota*).

We collected 2168 tabanids from 30 species over the two years: 839 from 24 species in northwest Ontario (2011 sampling), and 1329 from 25 species in northeast Ontario (2012) (Tables I and II, Fig. 1). We found 18 *Hybomitra*, 10 *Chrysops*, and 2 *Tabanus*, but no *Atylotus*, or *Haematopota*.

The expected number of species was calculated to be 26 (lognormal fitted parameters, $\alpha = 0.28$, $S_o = 4.09$, $\chi2 = 7.93$, $p = 0.34$, d.f.=7) in the western collections (2011) and 28 (fitted parameters, $\alpha = 0.24$, $S_o = 3.73$, $\chi2 = 9.89$, $p = 0.27$, d.f. = 8) in the eastern collections (2012), and 33 species for the combined data set (fitted parameters, $\alpha = 0.23$, $S_o = 4.27$, $\chi2 = 7.72$, $p = 0.56$, d.f. = 9).

The three most abundant species caught in the northwest (2011) were *Chrysops excitans* Walker (35%), *Hybomitra epistates* Osten Sacken (21%) and *H. lurida* (Fallén) (19%). In the northeast (2012) the most abundant were *Hybomitra affinis* (Kirby) (33%), *C. excitans* (22%) and *H. lurida* (19%).

New Ontario record

Our collection of three individuals of *Hybomitra osburni* (Hine) (two in 2011 and one in 2012) are the first records of this species in Ontario. This species has been collected in all western provinces and the Yukon Territory (Teskey 1990) but was previously not known to occur east of Manitoba.

TABLE 1. Tabanidae species and number of specimens collected in 2011 and 2012 using Malaise traps and sweep netting, with abundance records.

Species	2011		2012		Total
	Malaise	netted	Malaise	netted	
Chrysops ater Macquart			1		1
Chrysops cuclux Whitney		1			1
Chrysops dawsoni Philip		2	4	10	16
Chrysops excitans Walker	37	151	245	225	658
Chrysops frigidus Osten Sacken	5		1		6
Chrysops mitis Osten Sacken	11	50	6	5	72
Chrysops niger Macquart			1		1
Chrysops nigripes Zetterstedt	1		1	1	3
Chrysops venus Philip	1				1
Chrysops zinzalus Philip	4		8		12
Hybomitra affinis (Kirby)	7	268	17	62	354
Hybomitra arpadi (Szilady)	8	25	27	25	85
Hybomitra criddlei (Brooks)	1	1			2
Hybomitra epistates Osten Sacken		14	124	153	291
Hybomitra frontalis (Walker)			5	9	14
Hybomitra frosti Pechuman	2				2
Hybomitra hearlei (Philip)			2		2
Hybomitra illota (Osten Sacken)	3	2		1	6
Hybomitra lasiophthalma (Macquart)		21	4	2	27
Hybomitra lurida (Fallén)	59	104	131	121	415
Hybomitra minuscula (Hine)	6	9	3	2	20
Hybomitra nuda (McDunnough)		14			14
Hybomitra osburni (Hine)		2	1		3
Hybomitra pechumani Teskey & Thomas	4	1	8		13
Hybomitra tetrica (Marten)		2	1		3
Hybomitra trepida (McDunnough)		13	19	7	39
Hybomitra typhus (Whitney)		3	8		11
Hybomitra zonalis (Kirby)	2	5	67	6	80
Tabanus marginalis Fabricius			8	1	9
Tabanus vivax Osten Sacken			7		7
Total specimens	151	688	699	630	2168
Total species	15	19	24	15	30

TABLE 2. Tabanidae species listed for each sampling location and date. Only 11 sampling sites are included for 2011 as planned samples were damaged by black bears.

Year	Sampling dates	Longitude (West)	Latitude (North)	Species	C. ater	C. cuclux	C. dawsoni	C. excitans
2011	May 31 – June 7	89° 6' 27"	53° 12' 8"					
	May 31 – June 7	89° 40' 42"	54° 25' 49"					
	June 8 – 15	88° 54' 51"	53° 45' 34"					X
	June 8 – 15	92° 1' 43"	54° 9' 29"					
	June 16 – June 23	90° 21' 37"	54° 27' 1"					X
	June 16 – June 23	88° 33' 33"	54° 28' 18"					X
	June 28 – July 5	93° 2' 32"	53° 27' 39"			X	X	X
	June 28 – July 5	94° 13' 38"	52° 49' 27"					X
	July 6 – July 13	91° 49' 8"	52° 27' 37"					
	July 6 – July 13	93° 32' 9"	53° 36' 8"					X
	July 14 – July 21	92° 46' 3"	53° 44' 12"					X
2012	June 5 – June 11	81° 57' 47"	52° 46' 34"					
	June 5 – June 11	82° 39' 13"	51° 55' 53"				X	X
	June 12 – June 18	80° 23' 10"	51° 26' 40"				X	X
	June 12 – June 18	81° 50' 56"	51° 39' 7"					X
	June 19 – June 25	81° 39' 22"	51° 58' 8"					X
	June 19 – June 25	82° 41' 2"	52° 53' 25"					X
	June 26 – July 2	83° 17' 23"	51° 29' 53"				X	X
	June 26 – July 2	82° 49' 1"	52° 28' 26"					X
	July 3 – July 9	89° 6' 27"	53° 12' 8"					X
	July 3 – July 9	89° 40' 42"	54° 25' 49"					X
	July 10 – June 16	88° 54' 51"	53° 45' 34"					X
	July 10 – July 16	92° 1' 43"	54° 9' 29"		X			

TABLE 2 continued...

Year	2011											2012											
Sampling dates	May 31 – June 7	May 31 – June 7	June 8 – 15	June 8 – 15	June 16 – June 23	June 16 – June 23	June 28 – July 5	June 28 – July 5	July 6 – July 13	July 6 – July 13	July 14 – July 21	June 5 – June 11	June 5 – June 11	June 12 – June 18	June 12 – June 18	June 19 – June 25	June 19 – June 25	June 26 – July 2	June 26 – July 2	July 3 – July 9	July 3 – July 9	July 10 – June 16	July 10 – July 16
Species																							
C. frigidus										X													X
C. mitis					X	X	X			X					X		X	X		X	X		X
C. niger																						X	
C. nigripes											X												X
C. venus										X													
C. zinzalus										X	X											X	X
H. affinis					X	X	X			X	X			X	X		X	X	X	X	X	X	X
H. arpadi			X		X	X	X			X					X		X	X	X	X	X	X	
H. criddlei									X	X													
H. epistates							X			X				X	X	X	X	X	X	X	X	X	X
H. frontalis																	X	X		X			
H. frosti											X												
H. hearlei																	X	X					
H. illota			X			X		X									X						

TABLE 2 continued...

Year	2011											2012											
Sampling dates	May 31 – June 7	May 31 – June 7	June 8 – 15	June 8 – 15	June 16 – June 23	June 16 – June 23	June 28 – July 5	June 28 – July 5	July 6 – July 13	July 6 – July 13	July 14 – July 21	June 5 – June 11	June 5 – June 11	June 12 – June 18	June 12 – June 18	June 19 – June 25	June 19 – June 25	June 26 – July 2	June 26 – July 2	July 3 – July 9	July 3 – July 9	July 10 – June 16	July 10 – July 16
Species																							
H. lasiophthalma			X		X		X	X		X				X			X	X					
H. lurida	X		X		X	X	X	X		X		X	X	X	X	X	X		X				
H. minuscula							X				X						X					X	X
H. nuda			X		X		X																
H. osburni			X														X						
H. pechumani							X				X											X	X
H. tetrica			X							X							X						
H. trepida							X	X		X							X	X			X	X	
H. typhus							X												X			X	
H. zonalis					X	X	X			X				X	X		X	X	X		X		
T. marginalis																				X		X	X
T. marginalis																				X	X	X	X

Range extensions

We report nine new northern range records in Ontario. They are: *Chrysops cuclux* Whitney, *C. niger* Macquart, *C. venus* Philip, *Hybomitra criddeli* (Brooks), *H. epistates*, *H. lasiophthalma* (Macquart), *H. pechumani* Teskey & Thomas, *H. tetrica* (Marten), *H. trepida* (McDunnough), and *Tabanus vivax* Osten Sacken. In addition, we provide three new western records of *Hybomitra* for Ontario: *H. minuscula* (Hine), *H. typhus* (Whitney), and *H. frosti* Pechuman.

Gap infill

Chrysops ater Macquart is described as an abundant species having a general northern distribution in Canada south of the tree line (Teskey 1990). Our collection of a single specimen in 2012 is therefore not a surprise; however, there has been little collection in northern Ontario so our collection has filled a gap between previous collecting locations. It is perhaps surprising that it was so rare in our collections. Our records of *Chrysops dawsoni* Philip and *C. frigidus* Osten Sacken are consistent with known ranges.

Chrysops excitans, and *C. mitis* Osten Sacken, and to a lesser extent *C. nigripes* Zetterstedt and *C. zinzalus* Philip, are found in Canada south of the tree line (Teskey 1990), and have been reported from Polar Bear Provincial Park (Beresford 2011). Our records are consistent with these reports.

We caught eight species of *Hybomitra*, consistent with known ranges: *H. affinis*, the most abundant and widely distributed Canadian species of Tabanidae (Teskey 1990; Thomas 2011), *H. arpadi* (Szilady), *H. frontalis* (Walker), *H. hearlei* (Philip), *H. illota*

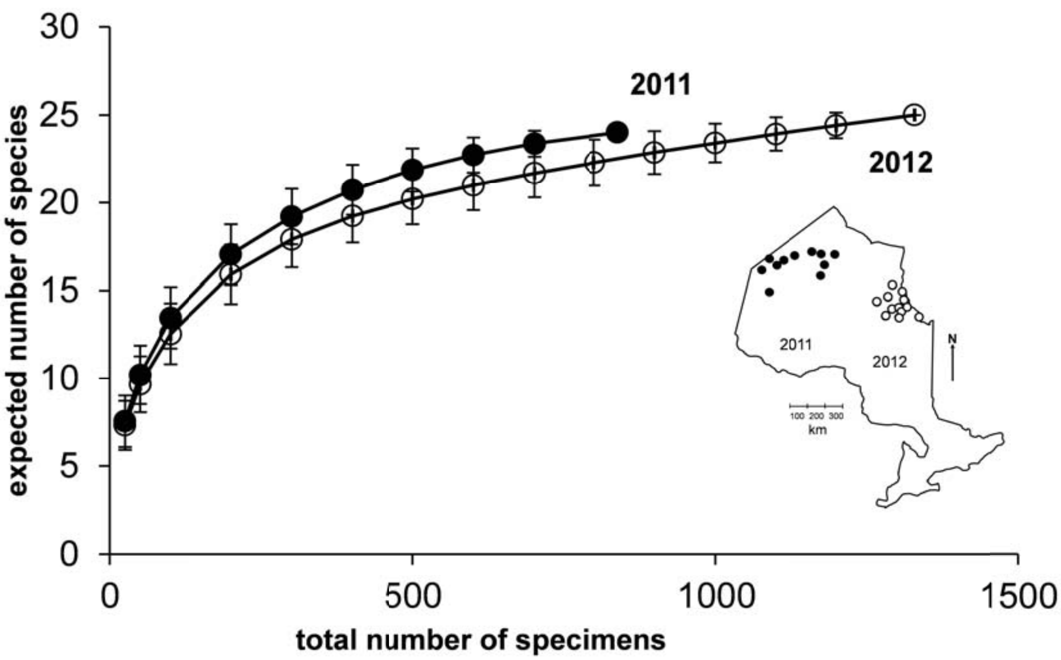

FIGURE 1. Rarefaction analysis showing the expected number of species (y axis) for smaller total catch sizes (x axis), for 2011 (closed circles) and 2012 (open circles). The inset map shows sample locations in both years. Error bars represent standard deviations.

(Osten Sacken), *H. lurida*, *H. nuda* (McDunnough), and *H. zonalis* (Kirby).

Tabanus marginalis Fabricius has been collected from across Canada except on the east coast (Teskey 1990). While the known range encompasses our sampling locations (northern Manitoba and northern Quebec) our records are the northernmost from Ontario.

Trap comparison

The Malaise sampling caught fewer individuals than sweeping yet produced more species. Malaise traps collected 850 specimens of 28 species (151 in 2011 and 699 in 2012); sweep netting collected specimens 1318 of 22 species (688 in 2011 and 630 in 2012) (Fig. 2).

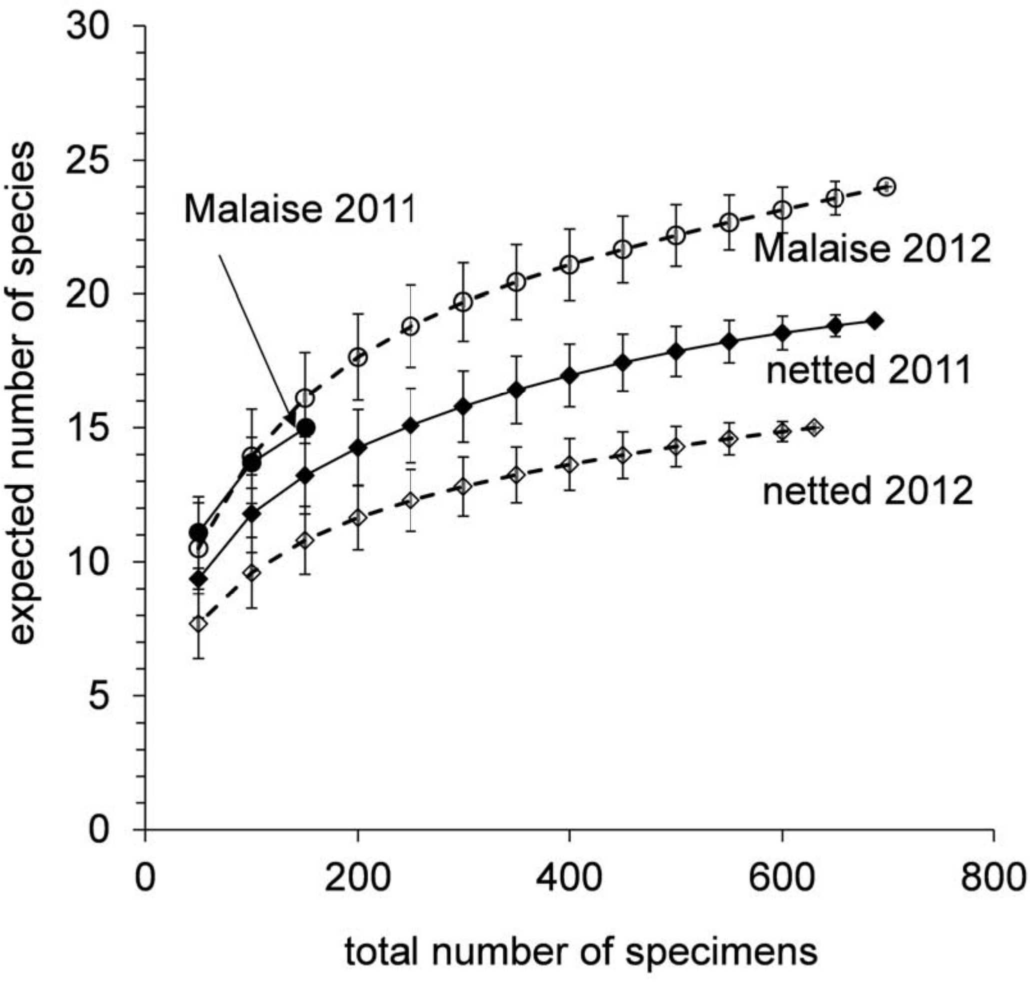

FIGURE 2. Rarefaction analysis of 2011 and 2012 data, separated by trapping method. Malaise traps (circles) and sweep netting (diamonds) in 2011 (closed) and 2012 (open). Error bars represent standard deviations.

Discussion

Comments on range extensions and new distributional locations are based on range maps from Teskey (1990), Thomas and Marshall (2009) and Thomas (2011). Because of the few intensive studies from northern Ontario we expected to add range records for many of the species we collected.

Our range map assessment underestimated by four the number of species we expected to catch, namely, 8 *Chrysops*, 16 *Hybomitra*, and two *Tabanus*; we caught 10 *Chrysops*, 18 *Hybomitra*, and two *Tabanus*. The lognormal prediction of 33 species was three more than what we found. Our survey did not include catches from August, and we expect there are more species in our study region that we did not manage to collect.

The two trapping methods collected different species (Table 1). Some species were abundant in both trapping methods, e.g. *C. excitans*, *H. epistates*, and *H. lurida*. *Hybomitra zonalis* was abundant in the Malaise collections, whereas *H. affinis* and *C. mitis* were abundant in the netted samples. Two species, *C. cuclux* and *H. nuda*, were absent from Malaise traps, and eight species, *C. ater*, *C. frigidus*, *C. niger*, *C. venus*, *C. zinzalus*, *H. frosti*, *H. hearlei*, and *T. vivax* were absent from the sweeps. When differences are examined within each year, the effect of trapping method becomes even more pronounced: nine species caught only by sweep netting and five only in Malaise traps in 2011; one species caught only by sweep netting and 10 only in Malaise traps in 2012 (Table 1, Fig 2). These results highlight the importance of collecting using a variety of methods in insect surveys to overcome catch biases. Other methods used to sample Tabanidae include larval collection (Philip 1928), chemical attractants (i.e., CO_2 or Octenol), baited traps such as the Nzi trap (Mihok *et al*. 2007), traps designed to act as visual cues for host seeking Tabanidae such as the unbaited Nzi traps (Mihok 2002), and Manitoba traps (Thorsteinson *et al*. 1964). Any trap designed to work using visual or olfactory cues for host seeking tabanids would produce high catches, most likely of host seeking females, but it is not known if these higher catches would result in proportionately more or different species. Larval collections do not rely on adult flight or host seeking, but are limited by the habitat that is searched (Philip 1928).

Generally, the most abundant species were caught over the longest period, with some exceptions. In 2011, *H. affinis* was the most abundant species (275 specimens), but was only caught during five sampling sessions (Table 2) whereas *H. arpadi* (33 specimens) and *H. lasiophthalma* (21 specimens), both relatively uncommon, were also captured during five of the sampling sessions. In 2012, *H affinis* (79 specimens) was caught over 9 sessions, but was less abundant than *H. lurida* (252 specimens), which was caught over 7 sessions (Tables I and II).

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