GONOTROPHIC STATUS, SPERM PRESENCE AND SUGAR FEEDING PATTERNS IN SOUTHWESTERN QUEBEC TABANID (DIPTERA) POPULATIONS

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ABSTRACT. Parity, stage of follicular development, sperm and fructose presence were determined for 6 tabanid species from southwestern Quebec during 2 consecutive years. Females were collected in canopy traps baited with or without carbon dioxide. Based on the presence or absence of host-seeking nulliparous flies (nullipars), *Hybomitra epistates*, *H. nitidifrons nuda*, *H. sodalis*, *Tabanus lineola* and *T. similis* were classified as being anautogenous. *Hybomitra frontalis* was classified as autogenous for its first ovarian cycle. Sperm was found in 88% and fructose was detected in 84% of the 700 specimens dissected. In anautogenous species, sperm and fructose prevalence was higher in pars than in nullipars.

INTRODUCTION

Tabanids are important pests of livestock. Losses in animal production are related to their blood-feeding behavior (Perich et al. 1986) and their association with several mechanically transmitted pathogens (Foil 1989). Due to their short interaction with livestock during blood engorgement (Clark et al. 1976) and their great dispersal capacity (Cooksey and Wright 1987), tabanids are considered difficult to control. Information on blood-feeding success, mating success, reliance on carbohydrates as a source of energy and follicular development of host-seeking tabanids is needed so that satisfactory control methods can be developed and evaluated. The present study was conducted to determine the gonotrophic status, the stage of terminal follicular development, and incidence of sperm and fructose in southwestern Quebec tabanid populations during two consecutive summers.

MATERIALS AND METHODS

The study was conducted in the Morgan Arboretum, adjacent to the farm of Macdonald College of McGill University, Sainte-Anne-de-Bellevue (45°25′N, 73°56′W), Quebec, Canada, from early June (1980) or late May (1981) to early September. Specimens were collected weekly on sunny days in unbaited and dry-ice baited canopy traps made with ultraviolet resistant polyethylene. Six sampling stations were used in 1980, but only four were selected in 1981 since relatively few specimens were collected at two stations. Half of the randomly selected stations received traps baited with dry ice (10 kg), while traps were unbaited at the remaining sites. The release rate of carbon dioxide was estimated to be 4.0–8.0 liters/min based on sublimation of a block of dry ice maintained under laboratory conditions.

Samples were obtained weekly on sunny days between 0700 and 2100 h EST. Specimens were collected hourly to prevent desiccation, placed in vials, immediately deposited on previously frozen ice packs and later stored at −20°C in the laboratory. Dissection procedures and evaluation of parity, stage of follicular development in terminal follicles, and sperm and fructose presence are described in Leprince and Lewis (1986). Voucher specimens were deposited in the Lyman Entomological Museum of McGill University.

RESULTS AND DISCUSSION

Seasonal distribution: A total of 714 females of 6 species were collected and 700 were dissected. Fewer specimens were collected in 1980 (45%) than in 1981. *Hybomitra epistates* (Osten Sacken), *Hybomitra frontalis* (Walker) and *Tabanus similis* Macquart females were collected from June 5 to August 7, August 18 and September 3, respectively. *Hybomitra nitidifrons nuda* (McDunnough) was collected from May 23 to June 13, *Hybomitra sodalis* (Williston) from July 11 to July 31 and *Tabanus lineola* Fabricius from June 13 to August 21.

Carbon dioxide: On the average, 4.5-fold more tabanids were caught in CO_2 baited than in unbaited canopy traps. The ratio of the number of specimens collected with CO_2 divided by the number collected without CO_2 for both sampling years was 11 for *H. sodalis*, 22 for *T. lineola*, 4.5 for *H. epistates* and *H. nuda*, 2.6 for *H. frontalis* and 2.5 for *T. similis*. Interspecific variations in the response to CO_2 have been reported in tabanids (Roberts 1971). A 2-fold increase in *Chrysops univittatus* females (Leprince and Lewis 1983) and a 9-fold increase in *T. quin-*

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quevittatus females (Leprince and Jolicoeur 1986b) were reported from the same study area. Small sample size prevents further analysis of the data in terms of parity and response to carbon dioxide. The relative response of nullipars and pars to CO_2 did not vary in *T. quinquevittatus* (Leprince and Jolicoeur 1986b), but significantly more parous *C. univittatus* were collected in CO_2 baited traps (Leprince and Lewis 1983).

Follicle development: A single dilatation was found at the bases of each of the ovarioles of 248 (35%) pars (Table 1). Since few females were collected each year for any given species, the parity data were summarized in Table 1. In both years, peaks of abundance for nullipars preceded the one for pars in *H. epistates.* Stage II follicles were present in 35% of the pars and 90% of the nullipars (Table 1). A more advanced stage of follicle development in nullipars has been reported in other anautogenous species (Thomas 1973, Magnarelli 1976, Magnarelli and Anderson 1981, Leprince and Lewis 1986). This difference may reflect the process of follicle maturation prior to and after oviposition. Stage I and N follicles were found in 8.5% of all species (n = 700); 38% of *H. frontalis* had stage I follicles. Stage III follicles were found in a parous *H. epistates* with a partial blood meal. Stage II terminal follicles in host-seeking females are characteristic of ovarian diapause, which is known to be food-mediated in anautogenous insects (Spielman 1971). The presence of host-seeking nullipars throughout the flight periods of both years indicated that populations of *H. epistates, H. nitidifrons nuda, H. sodalis, T. lineola* and *T. similis* were anautogenous in southwestern Quebec. Accordingly, *H. frontalis* appear to be autogenous. Classification of these species as autogenous and anautogenous agreed with previous studies conducted in Alberta (Thomas 1972), New York State (Magnarelli 1976) and in Connecticut (Magnarelli and Anderson 1981). In Ontario, presence of nullipars among *H. epistates, T. lineola* and *T. similis* populations (Troubridge and Davies 1975) also support anautogeny in these species.

Fresh blood or partially digested bloodmeals were found in 7 nulliparous and 5 parous *H. epistates*, 1 parous *H. frontalis*, 1 nulliparous *H. nuda* and 1 parous *T. similis.* The presence of blood in nullipars supports anautogeny in those species. In pars, blood indicates attempts to complete a second ovarian cycle.

In the present study, most pars (65%) had distended follicular tubes indicating that host-seeking behavior was initiated relatively soon after oviposition (Thomas 1972). Similar proportions of pars with sac-stage follicular tubes were reported from tabanid populations in Alberta (72%; Thomas 1973), New York State (67%; Magnarelli 1976), and in Connecticut (76%; Magnarelli and Anderson 1981). Distension of follicular tubes precludes accurate determination of the number of dilatations.

Retained eggs were found in 20% (49) of the parous flies. The total number of eggs retained per female ranged from 1 to 16 and averaged 2.82 ± 3.22 (±SD). Average number and range of eggs retained was 2.82 ± 2.30 (1–8) in 17 *H. epistates*, 2.14 ± 1.17 (1–5) in 14 *H. frontalis*, 4.75 ± 7.50 (1–16) in 4 *H. nuda*, 1.33 ± 0.58 (1–2) in 3 *T. lineola* and 3.60 ± 4.58 (1–16) in 10 *T. similis.* The small proportion of flies retaining eggs and the low number of eggs retained per fly indicates that most eggs are laid under field conditions and that egg retention cannot be used to reliably assess parity.

Sperm and fructose presence: Sperm was present in the spermathecae of 88% of the specimens. Prevalence of sperm was higher in pars than in nullipars in all anautogenous species (Table 1). Uninseminated nullipars and pars exhibited host-seeking behavior, indicating that mating is not a prerequisite to host-seeking. Uninseminated host-seeking females also were found in *T. quinquevittatus* (Leprince and Lewis 1986). The higher prevalence of insemination in

Table 1. Percentage of sperm positive (%Sp) and fructose positive flies (%Fr), percentage of flies with stage of follicular development ≥ than stage II (%FD) and percentage of specimens with sac-stage follicular tubes (%SF) in *Hybomitra* and *Tabanus* females collected in southwestern Quebec.

	Reproductive age												
	Nullipars				Pars					Total			
Species	No.	%Sp	%Fr	%FD	No.	%Sp	%Fr	%FD	%SF	No.	%Sp	%Fr	%FD
H. epistates	238	75	91	92	111	92	92	39	41	349	80	91	75
H. frontalis	—	—	—	—	61	93	74	18	66	61	93	74	18
H. nitidifrons nuda	85	87	85	84	15	100	87	7	67	100	89	85	72
H. sodalis	27	89	78	100	9	100	89	33	78	36	92	81	83
T. lineola	40	90	85	83	29	93	90	72	38	69	91	87	78
T. similis	62	71	65	94	23	96	61	52	70	85	78	64	82
Total	452	81	85	90	248	94	84	35	64	700	88	84	70

pars presumably reflects that they had more time and more occasions to encounter a mate than nullipars (Leprince and Lewis 1986). Since the seasonal pattern of insemination among pars was less variable than that of nullipars in abundant tabanid species (Leprince and Lewis 1986), the proportion of inseminated pars may provide the better indication of the mating success of a species and also may indicate the proportion of unfertilized egg masses laid in the field.

Abundance of *H. epistates* females varied greatly in both sampling years when considering trapping effort (73% of the specimens were collected with 6 canopy traps in 1980, and the remaining with 4 traps in 1981). Furthermore, parity and sperm prevalence in pars was 38% and 96%, respectively, in 1980; and 15% and 64%, respectively, in 1981. A resulting 10-fold decrease in the number of fertilized egg masses laid in the field in 1981 would have been expected. Important variation in population density, mating and blood feeding success as reported in *H. epistates* may affect the annual reproductive output of tabanid species and explain, in part, subsequent annual fluctuations of adult populations. Important variations in the annual abundance of *Hybomitra zonalis* (Kirby) during 3 consecutive years have been reported in the literature (Miller 1951).

Fructose, in its free form or as a component of sucrose, was detected in the diverticulae of 84% of the specimens (Table 1). Prevalence of fructose was a few percent higher in pars than in nullipars in all anautogenous species except *T. lineola*. Carbohydrates are an important dietary component in tabanids (Magnarelli and Anderson 1981, Leprince and Lewis 1983, 1986). In Connecticut, Magnarelli and Anderson (1981) reported a similar prevalence of fructose positivity among tabanid species. Higher prevalence of fructose in pars of anautogenous species suggests that following oviposition, pars rely heavily on carbohydrates to fulfill their energy requirements (Leprince and Lewis, 1986).

Results of parity studies can help describe the blood-feeding success of tabanid populations relative to host availability (Foil et al. 1989) and also provide information on the requirement of a bloodmeal for the completion of the first ovarian cycle. Although the influence of larval conditions is unknown, population density, mating and blood-feeding success along with body size and potential fecundity (Leprince and Jolicoeur 1986a, Leprince and Lewis 1983, 1986; Leprince and Bigras-Poulin 1988) are factors that can influence the production of fertilized eggs by tabanids. Long term studies could help to describe the relative importance of these factors and the different reproductive strategies among tabanid species.

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