

BITING FLIES OF THE EASTERN MARITIME PROVINCES OF CANADA. II. CULICIDAE

DAVID J. LEWIS

Department of Entomology, Macdonald College, Ste. Anne de Bellevue, Quebec,
Canada H9X 1C0

GORDON F. BENNETT

Department of Biology and International Reference Centre for Avian Haematozoa, Memorial
University of Newfoundland, St. John's, Newfoundland, Canada A1B 3X9.

ABSTRACT. Thirty-three species of mosquitoes are now recorded from the Maritime Provinces of Canada. These include 22 species of *Aedes*, 3 of *Anopheles*, 4 of *Culex*, 2 of *Culiseta*, and one species each of *Coquillettidia* and *Wyeomyia*. With the exception of *Ae. triseriatus*

(Say), all have been previously recorded from maritime Canada. The known biology of these mosquitoes is summarized including information on overwintering stages, hatching, larval and pupal habitats, adult emergence and feeding of adults.

INTRODUCTION

There is a great deal of information on the mosquitoes which occur in eastern North America, but very little is known about the biology of the species occurring in the Maritime Provinces (New Brunswick, Nova Scotia and Prince Edward Island) of Canada. Prior to this study much of the knowledge of culicids of maritime Canada has been in the form of distribution records, such as those of Ozburn (1944) and Stone et al. (1965). Twinn (1931) reported on the biology of 25 species of mosquitoes from eastern Canada but did not refer to specific geographic localities. Twinn (1953) recorded 14 species of mosquitoes from Prince Ed-

ward Island and Taylor et al. (1979) observed the host-seeking activity of some mosquitoes in New Brunswick; these apparently are the only studies specifically of mosquitoes of the Maritime Provinces. The present study was an analysis of the species of mosquitoes collected over a 4-year period primarily in New Brunswick, and extended to include Nova Scotia and Prince Edward Island through examination of the culicid material in the Canadian National Collection and literature references.

MATERIALS AND METHODS

Adult mosquitoes were collected from 1 May through 31 August 1973-1976,

during a study of the biting flies of maritime Canada. While collections of mosquitoes were made in Nova Scotia, New Brunswick and Prince Edward Island, most were made in the Tantramar Marshes in the Nova Scotia-New Brunswick border region, and on the Canadian Forces Base (CFB) Gaquetown, Oromocto, New Brunswick (Lewis and Bennett 1977).

Mosquito immatures were collected with dippers, fine gauze nets and rubber syringes. Habitats sampled included pitcher plants (*Sarracenia purpurea* L.), temporary and permanent freshwater and saltwater marshes and pools, as well as naturally and artificially impounded areas used for waterfowl production. About half of each larval and/or pupal sample was placed in 70% ethanol, and the remainder was reared to the adult stage insofar as possible. Immature stages were usually sampled on a weekly basis. The collection of immatures provided data on specific larval and pupal habitats, and adults reared from larvae provided good taxonomic material.

Adults attracted to humans were sampled by regular aerial net sweeps, and at other times while flying about and/or feeding on humans. At regularly sampled sites a standard procedure of 40 figure-eight sweeps were made about the collector. Sweeps were made with a standard entomological aerial sweep net (opening diameter of 30 cm) once during the day and once at dusk or dark at each site. Emergence cages (0.6 × 0.6 × 0.3 m) set in selected localities were also used to collect mosquitoes. Each cage consisted of a spruce frame, covered on the top and 4 sides with fiberglass screen. Mosquitoes from these cages were collected by using an aspirator that was inserted through the side of the cage.

The species of the various stages of mosquitoes were identified using the keys of Carpenter and LaCasse (1955) and Steward and McWade (1961). Generic abbreviations used in this study are those suggested by Reinert (1975). Names of

authors of species are provided in Table 1.

RESULTS AND DISCUSSION

Thirty-three species of mosquitoes are now recorded from the Maritime Provinces of Canada, of which 22 were collected during this study (Table 1). Specimens of only 24 of these species are represented in the Canadian National Collection, Biosystematics Research Institute, Agriculture Canada, Ottawa, *Aedes abserratus*, *Ae. triseriatus* and *Wyeomyia smithii* are recorded from New Brunswick for the first time; *Ae. fitchii* is a new record for Nova Scotia.

Ae. abserratus is univoltine in maritime Canada and overwinters in the egg stage. Larvae were collected from late April until early June in a variety of temporary and semi-permanent pools. Adult emergence commenced during mid-May and continued until early June. This species is mainly crepuscular but also bites during the day in the Tantramar Marshes, where it may be a pest of humans during June. Due to the similarity of 'rubbed' females of *Ae. abserratus* with those of *Ae. punctor*, its actual abundance is uncertain. Larval surveys indicate that *Ae. abserratus* is not as abundant as *Ae. punctor*.

Specimens of *Ae. aurifer* were not collected during this study, but Meyer and Bennett (1976) and Meyer et al. (1974) collected specimens in duck baited traps in New Brunswick. Information on the biology of this species in the Maritime Provinces is lacking.

Ae. canadensis overwinters in the egg stage in the Maritime Provinces, and it is thought to be univoltine even though larvae were collected periodically from early May until mid-August. Immatures were found in temporary, semi-permanent, and permanent pools, roadside ditches, *Sphagnum* bogs and floodwaters of rivers and streams. Females of *Ae. canadensis* feed on humans during the day and in the evening, and were collected for a 3

month period commencing in late May. This species was uncommon in the Tantramar Marshes, accounting for only about 0.1% of the mammalophilic mosquito population, whereas in the Gagetown area, approximately 40% of the mammalophilic population consisted of *Ae. canadensis*. Meyer and Bennett (1976) and Meyer et al. (1974) collected specimens of *Ae. canadensis* in duck baited traps in New Brunswick.

Ae. cantator is multivoltine in maritime Canada and overwinters in the egg stage.

Immatures were found in salt, brackish, and freshwater pools in coastal areas of the Maritime Provinces. Adult emergence commenced in late May and continued throughout the summer. This species is chiefly diurnal in the Tantramar Marshes (Taylor et al. 1979) but also feeds during the evening. While *Ae. cantator* is often a pest in many coastal areas of Nova Scotia, New Brunswick and Prince Edward Island, it was not encountered at all in the Gagetown area. Gibson (1941) and Twinn (1949) reported that immense numbers

Table 1. Culicidae of the Maritime Provinces of Canada.

| Species | Nova Scotia | New Brunswick | Prince Edward Island |
|---|-------------|---------------|----------------------|
| <i>Aedes aberratus</i> (Felt and Young) | 1,2,3 | 3 | 1,2 |
| <i>Aedes aurifer</i> (Coquillett) | | 2 | |
| <i>Aedes canadensis</i> (Theobald) | 1,2,3 | 1,2,3 | 1,2 |
| <i>Aedes cantator</i> (Coquillett) | 1,2,3 | 1,2,3 | 1,2,3 |
| <i>Aedes cinereus</i> Meigen | 1,2,3 | 2,3 | 1,2 |
| <i>Aedes communis</i> (DeGeer) | 2,3 | 2,3 | 1,2 |
| <i>Aedes diantaeus</i> Howard, Dyar, and Knab | 2 | | |
| <i>Aedes dorsalis</i> (Meigen) | | 2 | |
| <i>Aedes euedes</i> Howard, Dyar and Knab | 1 | | |
| <i>Aedes excrucians</i> (Walker) | 2,3 | 2,3 | 1,2 |
| <i>Aedes fitchii</i> (Felt and Young) | 3 | 2 | 2 |
| <i>Aedes implicatus</i> Vockeroth | | | 2 |
| <i>Aedes intrudens</i> Dyar | 2 | 1,2 | 1,2 |
| <i>Aedes provocans</i> (Walker) | 2 | 2 | 2 |
| <i>Aedes punctor</i> (Kirby) | 1,3 | 1,2,3 | 2,3 |
| <i>Aedes riparius</i> Dyar and Knab | 1 | | |
| <i>Aedes sollicitans</i> (Walker) | 1,2,3 | 1,2,3 | 2,3 |
| <i>Aedes sticticus</i> (Meigen) | | 1,2 | |
| <i>Aedes stimulans</i> (Walker) | 1,2,3 | 2 | 1,2 |
| <i>Aedes triseriatus</i> (Say) | | 3 | |
| <i>Aedes trivittatus</i> (Coquillett) | 2 | | |
| <i>Aedes vexans</i> (Meigen) | 1,2,3 | 2,3 | 1,2 |
| <i>Anopheles earlei</i> Vargas | 2,3 | 1,2,3 | |
| <i>Anopheles punctipennis</i> (Say) | 1,2 | 1,2 | |
| <i>Anopheles walkeri</i> Theobald | 2,3 | 2,3 | |
| <i>Coquillettidia perturbans</i> (Walker) | 1,2,3 | 1,2,3 | 1,2 |
| <i>Culex pipiens</i> Linnaeus | 2 | 2 | |
| <i>Culex restuans</i> Theobald | 1,3 | 2,3 | |
| <i>Culex salinarius</i> Coquillett | 1,2 | | |
| <i>Culex territans</i> Walker | 1 | 2,3 | |
| <i>Culiseta impatiens</i> (Walker) | 2,3 | 1,2 | |
| <i>Culiseta morsitans dyari</i> (Theobald) | 1,2,3 | 2,3 | 2 |
| <i>Wyeomyia smithii</i> (Coquillett) | 1,2 | 3 | |

¹ Biosystematics Research Institute (Canadian National Collection), Ottawa.

² In literature.

³ Collected by authors.

of *Ae. cantator* were produced in the Tantramar Marshes and caused considerable annoyance in neighboring communities; during the present study this species accounted for about 8% of the mosquitoes collected in aerial net sweeps. Meyer and Bennett (1976) and Meyer et al. (1974) collected this species in duck baited traps in New Brunswick.

Ae. cinereus is thought to be univoltine in maritime Canada where overwintering occurs in the egg stage. Larvae and pupae were collected from early May until mid-August in temporary and semi-permanent pools, roadside ditches, and in pools of water formed by mats of floating vegetation in permanent marshes. Emergence of adults began in late May and continued through the summer. Females were taken feeding on humans during the day and in the evening in maritime Canada, although they were not usually numerous. *Ae. cinereus* has also been taken in duck baited traps in New Brunswick (Meyer and Bennett 1976, Meyer et al. 1974).

Ae. communis is univoltine in the Maritime Provinces and overwinters in the egg stage. Immatures were collected for about a month commencing late April or early May in almost all types of temporary and semi-permanent pools, and *Sphagnum* bogs. Adult emergence occurs from late May until early June; females of *Ae. communis* are primarily crepuscular in the Maritime Provinces and may be a pest of humans early in the spring. Since 'rubbed' females of this species are morphologically similar to females of *Ae. punctator*, its relative abundance is uncertain.

The authors did not collect *Ae. dian-taeus*, but Gibson (1939) and Twinn (1949) recorded this species from Nova Scotia. Nothing is known of its biology in this area.

Ae. dorsalis was not encountered during this study, but Meyer et al. (1974) collected specimens from duck baited traps in New Brunswick.

Ae. euedes was not collected during this

study, but it has been taken in Nova Scotia (Wood 1977 pers. comm.).

Ae. excrucians is univoltine in the Maritime Provinces where overwintering occurs in the egg stage. Immatures were found from late April until early June in temporary and semi-permanent pools, as well as permanent pools and marshes. Adult emergence began during late May and continued until mid-June. *Ae. excrucians* is primarily crepuscular in the Maritime Provinces; it accounted for only 0.5% of the mosquitoes taken in aerial net sweeps in the Tantramar Marshes, whereas it comprised 21% of the mosquitoes netted in the Gagetown area. Meyer and Bennett (1976) and Meyer et al. (1974) reported taking specimens of *Ae. excrucians* in duck baited traps in New Brunswick.

Ae. fitchii is univoltine and overwinters in the egg stage in the Maritime Provinces, where larvae were collected during early June in permanent pools in wooded areas of Nova Scotia. Adult emergence occurred during mid-June. Twinn (1953) reported that the larval habitat of *Ae. fitchii* in Prince Edward Island consisted of transient pools in woods and meadows. This mosquito is relatively uncommon in the Maritime Provinces, and nothing more is known of the biology of this species in this area except that Meyer and Bennett (1976) and Meyer et al. (1974) collected females in duck baited traps in New Brunswick.

Ae. implicatus was not collected during this study, but Wood (1977 pers. comm.) reports that it has been taken in Prince Edward Island.

Ae. intrudens has not been collected during this study, but it is recorded in the literature as occurring in all 3 Maritime Provinces (Twinn 1949, 1953). Twinn (1953) reported that larvae were found in temporary woodland pools in Prince Edward Island.

Ae. provocans was not collected by the authors, but it has been recorded from the Maritime Provinces by Gibson (1939, 1941) and Twinn (1949, 1953). Larval

habitats consist of temporary woodland pools in Prince Edward Island (Twinn 1953) and open marshy areas of Nova Scotia (Gibson 1939).

Ae. punctor is univoltine in the Maritime Provinces and overwinters in the egg stage. Immatures of this species were found in a variety of temporary and semi-permanent pools from late April through early June. Emergence of adults began during late May and continued for about 3 weeks. *Ae. punctor* is primarily diurnal (Taylor et al. 1979) in the Maritime Provinces where it is usually the most abundant *Aedes* species and often a severe pest of humans early in the spring. Meyer and Bennett (1976) and Meyer et al. (1974) collected specimens of *Ae. punctor* in duck baited traps in New Brunswick.

Ae. riparius was not collected during this study but it is known to occur in Nova Scotia (Wood 1977 pers. comm.).

Ae. sollicitans is multivoltine and is thought to overwinter in the egg stage in the Maritime Provinces, where immatures were found in coastal salt marshes. Females were collected in salt marsh areas of Nova Scotia, New Brunswick and Prince Edward Island where they feed on humans during the day and in the evening throughout the summer. Although chiefly pestiferous in coastal areas (Gibson 1934, Twinn 1949, 1953, authors' data), several feeding adults were taken in the Tintamarre National Wildlife Area (New Brunswick) which is about 8.0 km inland.

Ae. sticticus was not collected by the authors but Twinn (1949) recorded its presence in New Brunswick. Nothing is known of its biology in this area.

Ae. stimulans females were netted about man in Nova Scotia, but little else is known of the biology of this species in the Maritime Provinces. Twinn (1953) reported that transient pools in woods and meadows were the preferred larval habitat in Prince Edward Island. Gibson (1939) reported the presence of *Ae. stimulans* in Nova Scotia and Ozburn (1944) recorded it from New Brunswick.

Adults of *Ae. triseriatus* were reared from larvae found in a discarded metal container in a wooded area of Fredericton, New Brunswick during June 1976. This is thought to be the first record of this species from the Maritime Provinces; nothing more is known of its biology in this area.

Ae. trivittatus was not encountered in this study, but it is recorded from Nova Scotia (Gibson 1939, Twinn 1949).

Ae. vexans is apparently multivoltine in the Maritime Provinces where it overwinters in the egg stage and is relatively uncommon. Immatures were found in a variety of pools, especially those formed by rainfall or flooding. In the Tantramar Marshes *Ae. vexans* feeds on humans during the day and in the evening, but it seldom occurs in sufficient numbers to be a pest. Twinn (1949) reported that large numbers of *Ae. vexans* were produced in the Tantramar Marshes, but this species accounted for only about 1% of the mosquitoes collected during the present investigation.

Anopheles earlei was collected feeding on humans in early May, and it is thought that adults overwinter. This species was also taken flying about and feeding on humans in late July and early August. It is a relatively uncommon species, and further information on its biology in maritime Canada is lacking, although Meyer and Bennett (1976) and Meyer et al. (1974) collected specimens in duck baited traps in New Brunswick.

An. punctipennis was not encountered during this study but Ozburn (1944) and Twinn (1949) recorded its presence in Nova Scotia and New Brunswick.

An. walkeri is bivoltine in the Maritime Provinces and is the most abundant *Anopheles* species in the area. Larval habitats appear to be restricted to permanent natural and man-made freshwater marshes. Adults were taken in emergence cages during late June and again in late July and early August. In the Tantramar Marshes females of *An. walkeri* feed on humans during the day and at dusk and

may be annoying near their larval habitats. Adults have also been collected from duck baited traps in New Brunswick (Meyer and Bennett 1974, Meyer et al. 1974).

Coquillettidia perturbans is univoltine and overwinters in the larval stage in maritime Canada. The time of egg-hatching is unknown, hence the duration of the larval stage is uncertain. Immatures of *Cq. perturbans* are restricted to permanent marshes or lakes with emergent vegetation where they attach to the roots and stems of aquatic plants. Adult emergence commences during late June and continues for about 1 month. *Cq. perturbans* accounted for 76% of the culicid population emerging from permanent marshes and lakes. This species comprised about 70% of the mosquitoes taken in aerial net sweeps in the Nova Scotia-New Brunswick border region, but aerial netting in CFB Gagetown yielded only 3.7% of this species. Taylor et al. (1979) reported *Cq. perturbans* to be the most abundant culicid of the Tintamarre National Wildlife Area, New Brunswick, and demonstrated that it is primarily crepuscular. *Cq. perturbans* is a serious pest of mammals, especially humans, in the Tantramar Marshes, where it was also the most abundant mosquito collected in duck baited traps (Meyer and Bennett 1976, Meyer et al. 1974).

Culex pipiens was not collected in the Tantramar Marshes, and comprised only 0.4% of the mosquito population in the Gagetown area. Ozburn (1944) reported that *Cx. pipiens* accounted for up to 96% of the mosquitoes collected in light traps in Nova Scotia and New Brunswick. Immatures were taken from roadside ditches; little is known of the biology of this species in the Maritime Provinces.

Immatures of *Cx. restuans* were found in temporary pools during August in the Tantramar Marshes. No other information on the biology of this species in the Maritime Provinces is available, except that Meyer and Bennett (1976) and Meyer et al. (1974) collected specimens from duck baited traps in New Brunswick.

Cx. salinarius was not collected during this study but it has been recorded from Nova Scotia by Twinn (1949).

Larvae of *Cx. territans* were collected during late July and August from freshwater marshes, and Meyer and Bennett (1976) and Meyer et al. (1974) collected specimens from duck baited traps. No further information on the biology of this species in this area is available.

Culiseta impatiens females were taken in aerial net sweeps in 1973 in Nova Scotia, but information on the biology of this species in the Maritime Provinces is lacking.

Cs. morsitans dyari overwinters in the egg stage and is bivoltine. Twinn (1953) reported that woodland pools were the preferred larval habitat in Prince Edward Island, but during this study immatures were collected only from permanent freshwater marshes. Larvae were collected during the 1st half of June, and adult emergence began about mid-June and continued until early July. Time of egg hatching and larval development for the 2nd generation are uncertain, but adults emerged near the end of July and early August. Concurrent studies in New Brunswick indicated that *Cs. morsitans dyari* was the 2nd most abundant culicid taken in duck baited traps and that it is a natural vector of *Plasmodium circumflexum* Kikuth (Meyer and Bennett 1976, Meyer et al. 1974). This species was not taken feeding on humans.

Wyeomyia smithii. Little is known of the biology of this mosquito in maritime Canada. Immatures were collected only in the pitcher plant (*S. purpurea*), and are not known to occur elsewhere. Larvae were collected every time pitchers were examined from May through August. On one occasion larvae were collected from a pitcher which had a water temperature of 33°C. It is thought that larvae overwinter.

CONCLUSIONS

From the preceding discussion of mosquitoes on the specific level, it is apparent that the known biology of mosquitoes of the Maritime Provinces agrees very

closely with the biology of these species in other regions of eastern North America. One peculiar difference may be found in *Cs. morsitans dyari*. This mosquito apparently has 2 generations in the Maritime Provinces, but Twinn (1931) reported that it was univoltine in eastern Canada. According to Wood (1975 pers. comm.), *Cs. morsitans dyari* has only one generation throughout its known range in Canada. With the exception of *Ae. triseriatus*, all the species collected during this study have been previously recorded from the eastern Maritime Provinces of Canada.

ACKNOWLEDGMENTS

The authors are indebted to the Department of Biology, Mount Allison University, Sackville, New Brunswick, for facilities provided during the summers of 1973-1975; the Canadian Wildlife Service, Environment Canada, Sackville, New Brunswick, for their logistic support and permission to work in the Tintamarre National Wildlife Area; Mr. Leo Forster, Biosystematics Research Institute, Agriculture Canada, Ottawa, for confirmation of mosquito identifications; Dr. D. M. Wood, also of the Biosystematics Research Institute, for provision of up to date information regarding the taxonomic status of some of the species contained herein; and to Agriculture Canada for financial support.

References Cited

- Carpenter, S. J. and W. J. LaCasse. 1955. Mosquitoes of North America (north of Mexico). Univ. Calif. Press, Berkeley, Calif., 360 pp.
- Gibson, A. 1934. Mosquito suppression work in Canada in 1933. Proc. N.J. Mosquito Exterm. Assoc. 21:102-112.
- Gibson, A. 1939. Mosquito suppression work in Canada in 1938. Proc. N.J. Mosquito Exterm. Assoc. 26:109-116.
- Gibson, A. 1941. Mosquito suppression work in Canada in 1940. Proc. N.J. Mosquito Exterm. Assoc. 28:167-176.
- Lewis, D. J. and G. F. Bennett. 1977. Biting flies of the eastern Maritime Provinces of Canada. I. Tabanidae. Can. J. Zool. 55:1493-1503.
- Meyer, C. L. and G. F. Bennett. 1976. Observations on the sporogony of *Plasmodium circumflexum* Kikuth and *Plasmodium polare* Manwell in New Brunswick. Can. J. Zool. 54:133-141.
- Meyer, C. L., G. F. Bennett and C. M. Herman. 1974. Mosquito transmission of *Plasmodium (Giovannolaia) circumflexum* Kikuth, 1931, to waterfowl in the Tantramar Marshes, New Brunswick. J. Parasitol. 60:905-906.
- Ozburn, R. H. 1944. Preliminary report on anopheline mosquito survey in Canada. Part I-A report on light trap collections. Proc. Entomol. Soc. Ont. 75:37-44.
- Reinert, J. F. 1975. Mosquito generic and sub-generic abbreviations (Diptera: Culicidae). Mosquito Syst. 7:105-110.
- Steward, C. C. and J. W. McWade. 1961. The mosquitoes of Ontario (Diptera: Culicidae) with keys to the species and notes on distribution. Proc. Entomol. Soc. Ont. 91:121-188.
- Stone, A., C. W. Sabrosky, W. W. Wirth, R. H. Foote and J. R. Coulson. 1965. A catalogue of the Diptera of America north of Mexico. U.S. Dept. Agric. Agric. Res. Serv., Agric. Handb. 276:1696 pp.
- Taylor, D. M., G. F. Bennett and D. J. Lewis. 1979. Observations on the host-seeking activity of some Culicidae in the Tantramar Marshes, New Brunswick. J. Med. Entomol. 15:134-137.
- Twinn, C. R. 1931. Notes on the biology of mosquitoes of eastern Canada. Proc. N.J. Mosquito Exterm. Assoc. 18:10-22.
- Twinn, C. R. 1949. Mosquitoes and mosquito control in Canada. Mosquito News 9:35-41.
- Twinn, C. R. 1953. Mosquitoes and their control in Prince Edward Island. Mosquito News 13:185-190.