a penetrating insecticide can be developed, by the directors of the Florida districts, into a tool that will be of great value to all of us.

MOSQUITOES AND THEIR CONTROL IN PRINCE EDWARD ISLAND [1]

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INTRODUCTION. Prince Edward Island is the smallest of the Canadian provinces, with an area of 2,184 sq. mi. and a population of about 100,000. Situated in the Gulf of St. Lawrence, it is a gently rolling lowland country with no part far from the sea. Its soil is characteristically red sandy loam, with underlying rock formations principally of red sandstone and red clay shale. A large part of the Island is devoted to diversified farming, but numerous farm woodlots and patches of woodland, scattered trees, and tree-lined roads give it a park-like appearance. Its short, deep rivers are subject to the ebb and flow of the tide. Along its coasts are sand dunes and long stretches of fine sand beaches, especially along the north shore. The surrounding sea has a moderating influence on the climate, and mean monthly temperatures range from 15.5° F. in February to 78.8° F. in August. Precipitation is rather uniformly distributed throughout the year and averages about 43 in., of which 11.6 in. is in the form of snow (5).

In June, 1952, I investigated a mosquito nuisance reported in and near Prince Edward Island National Park. This park extends along the north shore of the Province for nearly 25 mi., from Tracadie Bay on the east to New London Bay on the west, but contains an area of only about 7 sq. mi. It is made up of three main sections, each bordering the seashore, and known, from east to west, as the Dalvay-Stanhope section, the Brackley Beach section, and the Cavendish or Green Gables section. The mosquito problem in the area was summarized as follows by the Secretary of the P.E.I. Innkeepers' Association (in litt., March 3, 1952): "Our beaches are outstanding and safe, the temperature of the water ideal, we have some nice playgrounds, but on certain days no one can enjoy any of those facilities on account of the mosquitoes. At times they are not annoying, at others they are simply awful, obliging people either to remain indoors or to leave the district. The worst places are around Brackley, Stanhope and Dalvay. In 1951 there were many mosquitoes in June and July, then they all came back during the end of August and September."

MOSQUITO SPECIES. Up to 1940, only 2 species of mosquitoes had been identified from Prince Edward Island. In May, 1940, I collected larvae in and near the National Park representing an additional 9 species. In June, 1952, 11 species were collected, of which 4 are new records for the Province, bringing the total of species recorded to 15. The associations of the species collected in the larval stage in 1952 are shown in Table 2.

Comments of park officials, residents, and visitors confirmed that mosquitoes are

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TABLE 1.—Mosquitoes collected in Prince Edward Island

Species	Favorite larval habitat	Year Collected		
		1940	1952	Other
Aedes cantator (Coq.)	Salt marshes	X	X	
" *sollicitans* (Wlk.)	" "		X	
" *vexans* (Mgn.)	Rainpools, ditches, etc.		X	X
" *excrucians* (Wlk.)	Transient pools in woods, meadows	X	X	
" *fitchii* (F. & Y.)	" " " " "	X	X	
" *stimulans* (Wlk.)	" " " " "	X		
" *canadensis* (Theo.)	Temporary woodland pools		X	
" *cinereus* (Mgn.)	" " "	X	X	
" *communis* (Deg.)	" " "	X	X	
" *implacabilis* (Wlk.)	" " "	X		
" *intrudens* (Dyar)	" " "		X	
" *punctor* (Kby.)	" " "	X	X	
" *trichurus* (Dyar)	" " "	X		
Culiseta morsitans (Theo.)	Woodland pools		X	
Mansonia perturbans (Wlk.)	Plant-grown areas of ponds, lakes			X

TABLE 2.—Species associations of mosquito larvae collected in Prince Edward Island in June, 1952

Species	*A. canadensis*	*A. cantator*	*A. cinereus*	*A. excrucians*	*A. fitchii*	*A. sollicitans*	*A. vexans*	*C. morsitans*
A. canadensis*	X		X					X
A. cantator		X	X	X	X	X		X
A. cinereus	X	X	X	X				X
A. excrucians		X	X	X	X			X
A. fitchii		X		X	X			X
A. sollicitans		X				X		
A. vexans							X	
*C.** morsitans*	X	X	X	X	X			X

* *Aedes.*
** *Culiseta.*

periodically a nuisance in certain areas from June to September. Of the species found in 1952, only three would be likely to occur in troublesome numbers throughout the season. These are the brown salt-marsh mosquito, *Aedes cantator;* the salt-marsh mosquito, *A. sollicitans;* and the rainpool mosquito, *A. vexans.* During this investigation the brown salt-marsh mosquito was the predominant species.

The brown salt-marsh mosquito and the salt-marsh mosquito are two of the famed salt-marsh mosquitoes of New Jersey. Fortunately, their breeding places and consequently their numbers are much smaller than occur in New Jersey.

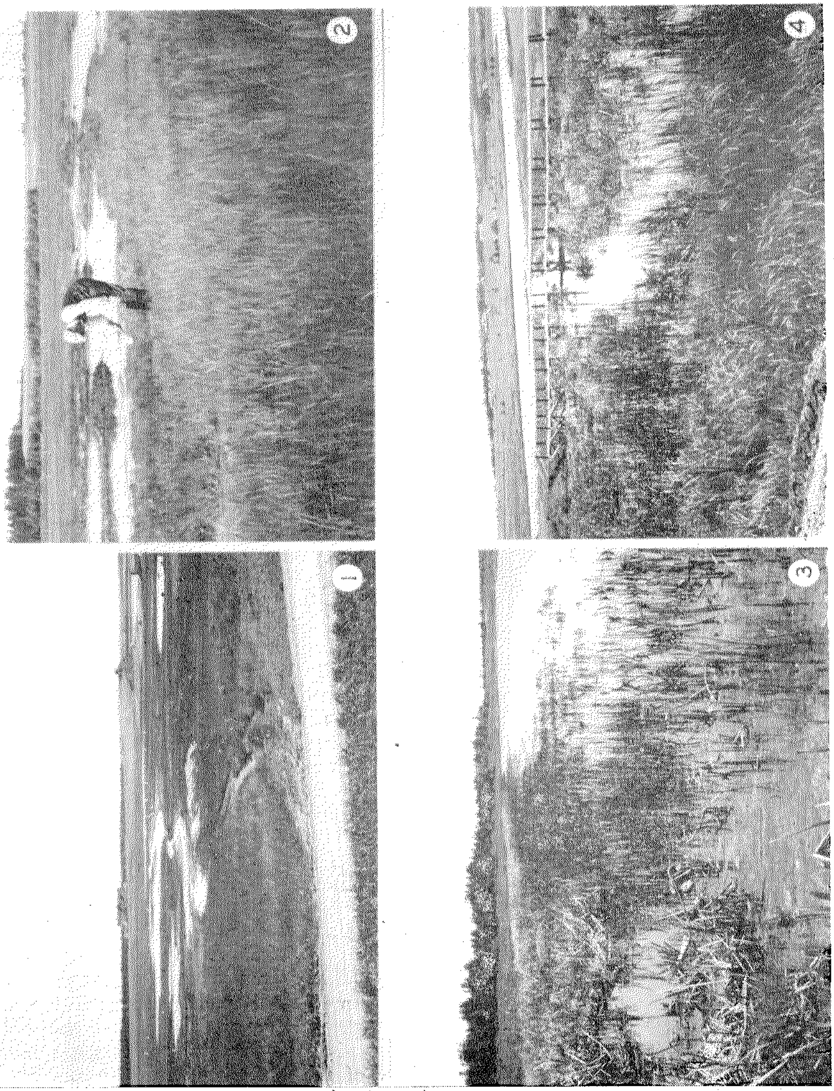
White-banded Salt-marsh Mosquito *(Aedes sollicitans)*: This species had not previously been recorded north of Maine. In 1952 larvae were found in two places: in salt pools on the shore of Tracadie Harbour, and in a marsh on the north bank of the Hillsborough River, near Falconwood Hospital, northeast of Charlottetown. In both places its larvae were greatly outnumbered by those of *A. cantator.* It is probably not an important species in Prince Edward Island.

Brown Salt-marsh Mosquito *(Aedes cantator)*: This species occurs in coastal regions of Prince Edward Island, Nova Scotia, and New Brunswick and along the Atlantic coast southward to Virginia. Between June 9 and 17, larvae in various stages, pupae, and emerging adults were found in salt and brackish marshes and pools in and near P.E.I. National Park, and at several other points in Queens County. These marshes varied in size from a few to many acres. The larvae occurred alone (and in two instances with *A. sollicitans*) in water that was salt or brackish (Figs. 1 and 2). They were also found with other species in water bodies near the seashore that were apparently fresh: in pools in a shrub-grown area on Cape Stanhope, with *A. fitchii;* and in pools along the marshy margin of Long Pond (Fig. 3), near Dalvay, with *A. cinereus, A. excrucians,* and *Culiseta morsitans.* They were most abundant, however, in salt or brackish water.

A valuable source of information on the location of the breeding places of salt-marsh mosquitoes throughout Prince Edward Island is the soil maps that accompany a report of a soil survey of the Province by Whiteside (5), the salt marshes being delineated on the maps. These indicate that most of the salt marshes scattered along the coasts and bays and rivers of the Province range in size from a few to several scores of acres. However, extensive salt marshes totalling many hundreds of acres are shown on the shores of the Hillsborough River, especially near Mount Stewart. Mosquitoes were reported to be very troublesome in this area.

Rainpool Mosquito *(Aedes vexans)*: The rainpool mosquito was found on June 12 in small, shallow, grass- and sedge-grown, fresh-water pools south of the sand dunes at Brackley Point. These pools contained larvae and pupae, and adults were emerging. This species favors transient pools in the open and such places as roadside ditches and marshes. With *A. cantator,* it is an abundant pest in the Tantramar marshes in New Brunswick (4). It is a widespread and troublesome mosquito in many parts of Canada, but to what extent it is a pest in Prince Edward Island is not known. In wet seasons in Ontario several broods may emerge during the summer. Like the salt-marsh mosquitoes it may disperse considerable distances from its breeding places.

Woodland Mosquitoes (*Aedes* spp.): The other species of *Aedes* found in 1952 (Table 1) all breed in or near woods and, in general, do not move far from their breeding places. They have only one generation each year and emerge in the spring. They usually cease to be a pest by midsummer. All readily attack humans. *Culiseta morsitans,* also a woodland species, is not known to attack man. Many of the bodies of water in the National Park, especially in wooded or shrub-grown areas, were free of larvae. These may have been oiled, or the mosquitoes



FIGS. 1 and 2.—Salt marshes at Stanhope and near Brackley Beach, P.E.I., in which *Aedes cantator* (Coq.) breeds. Fig. 3.—Long Pond, near Dalvay, P.E.I.; several species were found in pools along the margins. Fig. 4.—Lake of Shining Waters, Cavendish, P.E.I. Numerous

may already have emerged. Some of the more permanent ponds (Fig. 4) contained numerous small fish and predatory insects that would prevent mosquitoes from developing. None of these species was significantly troublesome in the neighborhood of the National Park in June. The following notes relate to the collection of the various species.

Aedes canadensis.—Pupae were taken on June 9 in pools in scrubby bush at Dalvay, and larvae and pupae were found on June 16 in an alder swamp south of Stanhope.

Aedes cinereus.—Larvae and pupae were collected on June 12 in marsh pools along the margin of Long Pond near Dalvay, and on June 16 in the alder swamp south of Stanhope. Adults emerged June 14–17.

Aedes excrucians.—Larvae were collected at Tracadie on May 20 by Mr. F. M. Cannon, of the Laboratory of Entomology, Charlottetown. On June 13–14, adults emerged from pupae taken on June 12 in pools on the marshy margin of Long Pond.

Aedes fitchii.—Larvae were collected at Tracadie on May 20 by Mr. Cannon. On June 9, larvae and pupae were found in pools near woods east of Stanhope Inn, and in shrub and grass-grown areas at Dalvay, and at Brackley Beach. Adults emerged June 13–14.

Aedes intrudens.—No larvae were found, presumably because emergence was complete. Females of this species were numerous in an alder swamp south of Stanhope, and in swampy woodland near York Station, on June 18–19.

Aedes punctor.—A few females were taken at Stanhope and York Station in mid-June.

Culiseta morsitans.—Larvae were collected between June 9 and 16 in a grassy pool at Dalvay; in mucky pools on the margin of Long Pond in the same area, and in an alder swamp south of Stanhope.

CONTROL. Control of mosquito larvae in the park area appears to have been directed mainly against the woodland species, and to have consisted largely of applying fuel oil to their breeding places. Against the adults an aerosol (5 percent DDT in kerosene) emitted from a TIFA had been employed. In general, the salt marshes apparently had escaped treatment in past seasons. It was recommended that DDT in fuel oil be substituted as a larvicide and applied at about ¼ lb. of DDT per acre by means of portable compressed air sprayers or a power sprayer mounted on a vehicle (2).

One thorough treatment of the breeding places in spring, commenced in April and completed by mid-May, should be sufficient against the woodland mosquitoes, but several treatments during a season might be necessary against the salt-marsh and rainpool mosquitoes. The first application on the salt marshes should be made by early May, and the marshes should be inspected every two or three weeks throughout the season and additional treatments applied as necessary. Temporary rainpools and flooded ditches should be examined shortly after heavy rainfalls during the summer, and sprayed as necessary. If, in spite of these measures, mosquitoes became a nuisance in an area, local relief could be obtained by the proper use of a DDT aerosol (3).

More permanent measures would include draining or filling low places where temporary pools are formed by melting snow or rain, and the cutting of ditches in salt marshes as practiced in New Jersey (1). These ditches should have sufficient laterals to permit the water in the marshes to rise and fall with the tide, so that at high tide the sea water could bring predacious fish into the deeper pools to feed on mosquito larvae, and at low tide the water in the higher, shallower parts of the marshes would be drained away.

SUMMARY. Fifteen species of mosquitoes, including 13 of *Aedes* and 1 each of *Culiseta* and *Mansonia,* are recorded from Prince Edward Island with notes on their breeding places and on the larval associations of some of them. The predominant species in June, 1952, was the brown salt-

marsh mosquito, *A. cantator* (Coq.). Control recommendations are briefly outlined.

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LABORATORY STUDIES ON THE HATCHING OF MARSH-MOSQUITO EGGS

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As a part of a project on the biology of salt-marsh mosquitoes in Florida, extensive laboratory studies were conducted from 1939 to 1941 to develop a method of flooding that would insure a complete hatch of mosquito eggs on soil samples collected from salt marshes for population studies (Bradley and Travis 1942, Travis and Bradley 1943). This paper reports preliminary laboratory tests with various hatching media and the effect of desiccation on the viability of the eggs. Data on the flooding of soil samples collected for egg-population studies are also summarized.

MATERIALS AND METHODS. Eggs used in the tests were laid in the laboratory by the salt-marsh mosquitoes *Aedes taeniorhynchus* (Wied.) and *sollicitans* (Wlkr.), and by one fresh-marsh species, *Psorophora confinnis* (L.-Arr.). The mosquitoes were collected in the field either from a baffle trap baited with a rabbit or from the arms of the laboratory workers.

All the mosquitoes that were engorged were transferred to lantern-globe cages for oviposition. The top of the globe was covered with gauze, on which were placed honey and raisins for food. The bottom was placed in a half petri dish lined with wet paper toweling. Each morning the eggs were washed from the toweling and concentrated by filtration. Consequently each lot of eggs could have been on a wet surface for as long as 24 hours before being used in a test.

Except for one test, in which the eggs were not dried, the eggs were alternately dried and then flooded with various media until there was no further hatching. They were placed in small glass vials or on soil samples in 3-inch evaporating dishes for flooding. At the end of each test the unhatched eggs were dissected to determine whether any were still viable. Unless otherwise stated, the unhatched eggs were found to be nonviable when dissected.

TESTS WITH VARIOUS HATCHING MEDIA. The basic hatching media were distilled, rain, tap, and sea water. To these waters were added solutions of asparagine, and infusions of leaves, coke or charcoal, and soil from salt marshes. The leaf infusions were prepared by triturating 1 to 100 grams of green leaves of saltwort, glasswort, or black or white mangrove in 1 liter of water. The asparagine solutions, 2 parts by weight of asparagine to 1 part of sodium biphosphate, were prepared in

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