been frequently used to differentiate this from other species. The writer has found that a rather large percentage of the specimens of this species collected in the southwest exhibit a varying number of branches in the head hairs. This frequently makes it difficult or impossible for the investigator unfamiliar with the genus to make an accurate and positive identification. The other species of the genus that are apt to be confused with *P. signipennis* in the larval state are discussed along with suggestions for distinguishing between them.

**Literature Cited**


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### ECOLOGICAL CONDITIONS WHICH INFLUENCE CONTROL OF MOSQUITO-LIKE NUISANCE PESTS (TENDIPEDIDAE)

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Prior to the advent of chlorinated hydrocarbon insecticides the few efforts made to control midge infestations in open bodies of water met with questionable success. This was due in part to the lack of detailed information relative to the habits and the development of even the more common species of the group—and in part to the attempted adoption of the early mosquito control oiling method for midge control. Since the midge immature stages possess gill-like respiratory appendages and procure their oxygen directly from the water in which they live, periodic surfaceing is unnecessary. Under these conditions the possibility of larval contact with surface oil is so remote that its potentialities as an effective larvicide are practically nil. Likewise, in adult emergence, where the pupa rises directly from the bottom mud to the water surface and the adult escape is nearly instantaneous, surface oil does not appear to be an effective adulticide. In more recent years a variety of methods have been utilized in midge control. The type of treatment selected to combat any particular species is dependent upon the habits of the specific pest and the existing chemical and physical characteristics of its environment.

While misting and fogging have pro-
duced excellent temporary control, the most economical and most effective treatments have resulted when the toxic materials have been applied as laricides. Dispersal of small quantities of emulsified chlorinated hydrocarbon insecticides throughout the water habitat have been successful: (1) where existing physical conditions favor retention of the insecticide over the period of time necessary to provide a residual effect; and (2) where the chemical qualities of the water provide a pH which is compatible with the insecticide. To date, no standard method has been formulated which may be successfully applied to all midge breeding areas. To illustrate the variation in control measures necessitated by the divergence: (1) in the habits among species; and (2) in the chemical and physical factors encountered in the various breeding media—three outstanding midge control problems and their solutions have been selected for discussion.

Mosquaitia Pond—This 74-acre brackish pond with an average depth of 2.5 ft. is separated from the open ocean only by a 150-ft. wide shingle beach. The chloride content of the water varies from 2700 to 4500 parts per million, the pH of 7.82 is probably due to the presence of Chara which is a lime secreting plant, and the strong hydrogen sulphide odor of the bottom mud is due to the presence of sulphur reducing bacteria. An outlet on the inland side of the pond discharges into a short improved brook which flows westerly into the main creek of an inland salt marsh. Only extreme high tides reach the pond through this natural outlet. Losses from the pond, through the natural drainage outlet or by evaporation, are replaced by surface drainage from the watershed with an area of 0.9 square mile. Aquatic growth other than Chara includes species of Potamogeton and Enteromorpha which are rooted to the bottom; and Cladophora, a filamentous green algae, which forms a heavy scum on the water surface. The small midge, Aedesia elachitus Townes, develops in the aquatic vegetation and although three peaks of emergence are evident i.e., second week of May, first week of July, and third week of August—a rather dense population persists throughout the intervening periods to produce a continuous nuisance from May to late October. Because of its diminutive size this pest passes readily through most window screening into the interior of homes where it creates an obnoxious condition. In 1953, as the result of increase real estate development in the area, control treatments were restricted to the pond proper. On May 7 the pond was treated with 14 lbs. of Rhothane* (technical grade) dissolved in 60 gals. of orthodichlorobenzene to provide a dosage of 0.1 part Rhothane to 30 million parts of water. The application was made with manually propelled flat bottomed ski equipped with a 30-gallon pressure tank and a 10 ft. boom rigged over the stern. The tank and boom were connected by flexible copper tubing with a shut-off valve inserted in the line. When the equipment went into operation the boom was adjusted to place the .062 nozzles, carried by 6-inch off sets at either end, from 2 to three inches below the water surface. This provided an injection effect in contrast to the regular surface spraying method. The insecticide solution was divided to make three equal loads of about 20 gals. each. This allowed about one third of the tank capacity for an air load. At the beginning of each application the air pressure in the tank was built up to 100 lbs. per sq. in. and remained above 8 lbs. per sq. in. throughout each injection period. No residual effect was anticipated because of the high alkalinity (pH 7.85) which tends to destroy the toxic qualities of chlorinated hydrocarbon insecticides. The solvent, orthodichlorobenzene, with specific gravity of 1.415 was selected to facilitate rapid settling of the solution and subsequent contact with the submerged vegetation in which the pest breeds. As a result of this treatment the Aedesia elachitus larvae and pupae were destroyed. However, the eggs existing at the

* Rhothane contributed by Rohm & Haas C
Top: Musquashit Pond—showing green algae masses which harbor Aedes taeniorhynchus.

Middle: Merrimack River—showing sludge flats or breeding medium for Gygaptentipes lobiferus.

time of treatment survived to produce a second generation of adults which began to appear during the first week of the month of July following the control operation.

**Merrimack River**—During the summer of 1950 a major midge nuisance occurred along the heavily polluted Merrimack River, particularly in the ponded section at Merrimacport where this active stream is nearly 2,000 ft. in width. A preliminary study of the environmental conditions showed that the chloride content of the water varied from 14 to 113 ppm, that the pH averaged 6.9, and that the BOD was sufficient to exclude all fish life. Both green and blue-green algae formed small scattered masses on the water surface—masses of *Oscillatoria* being the most prevalent. Water weeds were absent with the exception of *Salvinia* which formed a dense vegetative mat along the river banks at the high tide line. Although the ledge bottom of the stream bed was comparatively free of sediment, as the result of constant scouring by the strong current, extensive sludge flats were present in the quiet water adjacent to the river banks.

Due to the fluctuation of the water level, which is a reflection from the tidal action at the mouth of the stream, these flats were almost completely exposed each day during the ebb tide periods. Immature stages of the midge *Glyptotendipes lobiferus* were found concentrated in the river flats composed primarily of partially digested organic sludge, although a few larvae were dredged up from small masses of sludge located in the channel at a 22-ft. depth. In the winter and early spring of 1951, larvae were not found above the low water line until after May first, when they again became numerous in the upper portion of the sludge flats. Information gained during the preliminary study indicated the probable success of a control program organized to take advantage of two outstanding environmental conditions as follows: (1) the restricted distribution of the larvae and pupae to the sludge flats located along the river banks; and (2) the exposure of these flats at each ebb tide period. Under the existing conditions, it appeared obvious that any control treatment should be limited to the sludge flats. On June 12 and 13 when pupa began to appear in quantity, New Jersey larvicide diluted with river water (1:5) was applied at the rate of 25 gals. of finished spray per acre. The river spraying equipment, borrowed from the East Middlesex Mosquito Control Project, consisted of a small flat bottomed skiff in which a Pacific-Marine fire pump has been mounted at rail level, and an open topped insecticide tank carried in the skiff; also two sizes of extension hose, the larger leading from the pump, the smaller from the insecticide tank, with both terminating at a common mixer nozzle. In operation, the major portion of the river water delivered by the pump was diverted to a water jet at the stern, an arrangement provided propulsion for the spray rig. The remaining water from the pump passed through the larger extension hose to the affixed nozzle, where it was mixed with New Jersey larvicide drawn by suction through the smaller hose leading from the insecticide reservoir. When the pyrethrum emulsion came in contact with the water-saturated flats, it was diffused readily throughout the surface sludge with the following results: (1) emergence of larvae from the harboric medium in from 1 to 3 minutes; and (2) total paralysis of the larvae within minutes. Observations made on the 18th and 22nd of June indicated that the mortality had approximated 90 per cent. However, re-examination of the flats or month after spraying produced evidence of re-infestation. As a consequence, a second application was scheduled for the 24th and 25th of July. Periodic collections taken from the flats during the following August and September indicated a definite scarcity of *Glyptotendipes* larvae in the sludge. As an addition check on the control method, the adult population density was measured weekly by light trap collections taken from May through October. During the following summer (1952) no complaints were r
erved relative to the presence of this pest. However, in late August of 1953 this midge again became moderately numerous and residents of the Merrimacport area petitioned for a repetition of the 1951 treatment for the spring and early summer of 1954.

Weston Swimming Pool.—This municipal pool actually represents a natural spring-fed pond which has been converted to a sanitary bathing pool with a refill inlet from the domestic water supply. After constructing the pool, the bottom mud was removed and replaced with a layer of gravel which in turn was covered with a finished layer of beach sand. More than the half of the pool area, with a depth varying from 1½ to 3 ft., was restricted as a wading area for small children—while the basin-like northern end, with a depth of 10 ft. and flanked by a concrete retaining wall equipped with spring boards and similar appurtenances, was designed to accommodate the teen-age group. The completed pool has a capacity of 700,000 gals., a width of approximately 100 ft., length of 325 ft., and a total area of 1/4 an acre. During the third season of operation (1953) the midge Tendipes viridicollis became sufficiently numerous to institute a minor nuisance, particularly in regard to pupal skins which accumulated on the water surface and presented an unsightly appearance. After the pool had been closed, a brief study was conducted to determine whether a simple treatment might be devised to eliminate its pest. Observations made in late September disclosed that small patches of organic matter were scattered about the sandy bottom and that these were harboring midge larvae. On the 10th of October, larviciding had apparently ceased, it was noted that the majority of the larvicides had deserted the organic material to burrow into the sandy bottom. On the 11th of October, the pool was treated with 5 per cent Rhothane emulsion at the rate of 1 part Rhothane to 30 million parts of water. The insecticide was applied by spilling small amounts from a bucket into the pool at several points along the periphery. Although the embedded larvae exhibited no discernible reaction to the toxic material on the day of treatment, by the early part of the following day (12th of October) or after 24 hrs. contact, the majority had emerged from the sand and a high percentage had succumbed to the treatment while a few still displayed slight convulsive movements. This treatment demonstrated the lethal effect of Rhothane on midge larvae embedded in the sandy bottoms of pools or similar bodies of water.

In conclusion, recent midge control investigations have demonstrated: (1) that a Rhothane-orthodichlorobenzene solution injected below the water surface at the rate of 1 part Rhothane to 30 million parts of water will destroy the immature stages of the water weed inhabiting midge Aedes clavipes; (2) that Rhothane emulsion applied at the rate of 1 part Rhothane to 20 million parts of water will destroy the larvae of Tendipes viridicollis embedded in the sandy bottom of a pool where the water is nearly neutral; (3) that New Jersey larvicides will destroy immature stages of Glyptotendipes lobiferus, embedded in intermittently exposed sludge flats, when diluted with 5 parts of water and applied to the bare flats at the rate of 25 gals. of finished spray per acre.