been frequently used to differentiate this from other species. The writer has found hat a rather large percentage of the specimens of this species collected in the southwest exhibit a varying number of branches n the head hairs. This frequently makes t 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 he larval state are discussed along with suggestions for distinguishing between hem.

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

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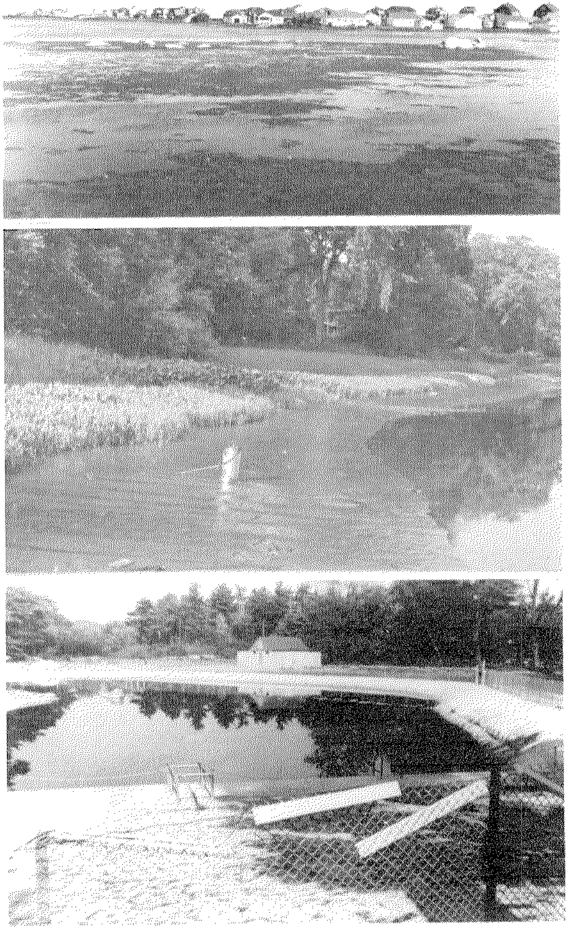
Prior to the advent of chlorinated hydrocarbon insecticides the few efforts made to control midge infestations in open bodies of water met with questionable success. This was due in part to the lack of detailed information relative to the habits and the development of even the more common species of 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 surfacing 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 there 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 produced excellent temporary control, the most economical and most effective treatments have resulted when the toxic materials have been applied as larvicides. 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.

MUSQUASHIAT 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, *Apedilum elachistus* Townes, develops in the aquatic vegetation and although three peaks of emergence are evident i.e., second weel of May, first week of July, and third weel of August—a rather dense population pe sists throughout the intervening periods t produce a continuous nuisance from Ma to late October. Because of its diminutiv size this pest passes readily through mo window screening into the interior c homes where it creates an obnoxious cor dition. In 1953, as the result of increase real estate development in the area, cor trol treatments were restricted to the pon proper. On May 7 the pond was treate with 14 lbs. of Rhothane * (technic grade) dissolved in 60 gals. of orthod chlorobenzene to provide a dosage of or part Rhothane to 30 million parts c water. The application was made with manually propelled flat bottomed ski equipped with a 30-gallon pressure tan and a 10 ft. boom rigged over the stern The tank and boom were connected b flexible copper tubing with a shut-o valve inserted in the line. When th equipment went into operation the boo was adjusted to place the .062 nozzles, ca ried by 6-inch off-sets at either end, fro 2 to three inches below the water surfac This provided an injection effect in co trast to the regular surface sprayin method. The insecticide solution was d vided to make three equal loads of abo 20 gals. each. This allowed about on third of the tank capacity for an air loa At the beginning of each application th air pressure in the tank was built up 100 lbs. per sq. in. and remained above 8 lbs. per sq. in. throughout each injectio period. No residual effect was anticipate because of the high alkalinity (pH 7.8 which tends to destroy the toxic qualiti of chlorinated hydrocarbon insecticide The solvent, orthodichlorobenzene, with specific gravity of 1.415 was selected facilitate rapid settling of the solution an subsequent contact with the submerge vegetation in which the pest breeds. A a result of this treatment the *Apedilu elachistus* larvae and pupae were d stroyed. However, the eggs existing at th

* Rhothane contributed by Rohm & Haas C



Top: Musquashiat Pond—showing green algae masses which harbor *Apedilum elachistus*.
Middle: Merrimack River—showing sludge flats or breeding medium for *Glyptotendipes lobiferus*.
Bottom: Weston Swimming Pool—source of infestation of *Tendipes viridicollis*.

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 *Sagittaria* which formed a dense vegetative mat along the river banks at the high tide line. Although the ledgy 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, appeared obvious that any control treatment should be limited to the sludg flats. On June 12 and 13 when pupa began to appear in quantity, New Jerse larvicide diluted with river water (1–5 was applied at the rate of 25 gals. finished spray per acre. The river spray ing equipment, borrowed from the Ea Middlesex Mosquito Control Project, co sisted of a small flat bottomed skiff i which a Pacific-Marine fire pump ha been mounted at rail level, and an ope topped insecticide tank carried in th skiff; also two sizes of extension hose, th larger leading from the pump, the small from the insecticide tank, with bot terminating at a common mixer nozzl In operations, the major portion of th river water delivered by the pump w diverted to a water jet at the stern, an this contrivance provided propulsion f the spray rig. The remaining water fro the pump passed through the larger e tension hose to the affixed nozzle, whe it was mixed with New Jersey larvici drawn by suction through the small hose leading from the insecticide reservoi When the pyrethrum emulsion came i contact with the water saturated flats diffused readily throughout the surfa sludge with the following results: (1 emergence of larvae from the harborin medium in from 1 to 3 minutes; and (2 total paralysis of the larvae within minutes. Observations made on the 18t and 22nd of June indicated that the mo tality had approximated 99 per cent. How ever, re-examination of the flats o month after spraying produced eviden of re-infestation. As a consequence, second application was scheduled for t 24th and 25th of July. Periodic colle tions taken from the flats during t following August and September in cated a definite scarcity of *Glyptotendip* larvae in the sludge. As an addition check on the control method, the adu population density was measured week by light trap collections taken from M through October. During the followi summer (1952) no complaints were r ived relative to the presence of this pest. lowever, in late August of 1953 this iidge again became moderately numerous id residents of the Merrimacport area etitioned for a repetition of the 1951 eatment for the spring and early summer 1954.

WESTON SWIMMING POOL—This munici- il pool actually represents a natural pring-fed pond which has been converted ito a sanitary bathing pool with a refill itlet from the domestic water supply. i constructing the pool, the bottom mud as removed and replaced with a layer of avel which in turn was covered with a iished layer of beach sand. More than ie-half of the pool area, with a depth irying from 1½ to 3 ft., was restricted as wading area for small children—while ie basin-like northern end, with a depth 10 ft. and flanked by a concrete retain- g wall equipped with spring boards and milar appurtenances, was designed to commodate the teen-age group. The mpleted pool has a capacity of 700,000 ils., a width of approximately 100 ft., length of 325 ft., and a total area of ¾ an acre. During the third season of peration (1953) the midge *Tendipes viri- collis* became sufficiently numerous to nstitute a minor nuisance, particularly regard to pupal skins which accumu- ted on the water surface and presented i unsightly appearance. After the pool id been closed, a brief study was con- icted to determine whether a simple eatment might be devised to eliminate iis pest. Observations made in late Sep- mber disclosed that small patches of ganic matter were scattered about the ndy bottom and that these were harbor- ig midge larvae. On the 10th of October, ter egg laying had apparently ceased, it was noted that the majority of the larvae had deserted the organic material to burrow into the sandy bottom. On the 11th of October, the pool was treated with 6 per cent Rhothane emulsion at the rate of 1 part Rhothane to 20 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 *Apedilum elachistus* despite an existing alkalinity sufficient to eliminate all residual effect; (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 larvicide 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.