THE MARSH CRANE FLY, *TIPULA PALUDOSA* Mg., A NEW PEST IN BRITISH COLUMBIA (DIPTERA: TIPULIDAE)

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ABSTRACT

Tipula paludosa Meigen was firmly established in the Vancouver area by 1965, starting in the eastern outskirts of the city. It was taken at Blaine, Wash., in 1966. By 1967 the pest had spread to the Chilliwack area. Populations of 110/ft^2 were measured in 1966 and local observations were recorded of damage, oviposition, feeding, growth, and emergence. A review is included of European literature on populations, life history, weather relations, and biological, chemical and cultural controls, with some speculation on the future.

INTRODUCTION

In the past three years the leatherjacket or larva of the European marsh crane fly, *Tipula paludosa* Mg., has become a serious problem in lawns and pastures in the lower Fraser Valley. Identification was by J. R. Vockeroth, Entomology Research Institute, Ottawa. This is the most common and damaging crane fly in northwestern Europe. The leatherjackets were first found in 1965 causing severe damage to lawns in the eastern outskirts of Vancouver. In 1966 they were considerably more widespread and in pastures on several small farms in this area there was virtually no growth until the middle of May. In the fall adult *T. paludosa* were trapped at Blaine, Washington, 25 miles southeast of Vancouver (U.S.D.A. Cooperative Economic Insect Rpt. 16: 946, 949, 956. 1966). In 1967 heavy infestations of leatherjackets and the resulting damage occurred on large dairy farms near Pitt Meadows, 20 miles east of Vancouver, and in lawns at Yarrow, 30 miles farther east.

The first North American record of this pest was in 1955 on Cape Breton Island (Fox, 1957) where lawns and flowers were attacked. The infestation there was thought to have originated in soil used for ships ballast and dumped ashore. In Newfoundland Morris (1960) reported damage in 1959 to cabbage transplants and turnip seedlings. The origin of the present outbreak is a matter for speculation; a good guess would be the balled roots of ornamentals imported from Europe.

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LOCAL OBSERVATIONS

Most of the damage in British Columbia has been to lawns and pastures but flowers, strawberries and vegetable crops in backyard gardens have also been attacked. These infestations have been easily controlled with DDT or aldrin, but the rapid spread of this pest to pasture has presented a much more serious problem. The lower Fraser Valley is primarily a dairying region, and there is great danger of insecticide residues occurring in meat and milk fats if these and similar persistent insecticides are applied to forage or fodder.

In 1966 preliminary studies were carried out in a heavy infestation on a 10-acre farm. In April and May the larval population was measured in 84 samples, each of ¼ sq ft, on about 4 acres. Gasoline sprayed on the turf brought nearly all the larvae to the surface where they were readily counted. The top 1-inch of sod was examined for the remainder that did not emerge. The population per sq ft averaged 109.6 (range 24-232), or close to 5 million per acre.

Rototilling and disking reduced the population by about two-thirds but the reduction was not enough to allow a new seeding to survive. When oats and grass were planted on April 26 nothing grew, not even volunteer grass or weeds. The larvae matured and stopped feeding about the middle of May. Oats and grass planted on May 20 produced a good crop.

On warm, cloudy days in March and April, the larvae were observed on the surface feeding on the crowns and blades of grass. On bright days they remained in the sod but fed on the surface at night. The larvae were generally found in the top 1-inch of sod, but after about the middle of May they moved downward and many were found as deep as 3 inches below the surface.

Emergence and adult populations were studied by placing six 1-sq-ft cages in a pasture and taking counts twice weekly. The adults started emerging during the first week of August, peaked about September 1, and the last one was collected on September 30. The average number of adults per sq ft was 98 (range 75-112) consisting of 55 males, 43 females.

The egg capacity was observed by Coulson's (1962) method of removing the head from newly-emerged and mated females from the field and floating them on water which induces them to oviposit. The eggs remaining in their abdomens were also counted. The average number of eggs based on 10 females was 281 (range 243-338). This is lower than the average of 360 reported by Coulson (1962) in the north of England but close to Barnes' (1937) figure of 272 in the south.

No parasites have emerged from many hundreds of larvae reared in the laboratory, nor have larvae been observed killed by virus. The only predators seen were spiders and possibly the numerous European starlings, *Sturnus vulgaris,* which appear to feed on larvae and adults. Average survival from the late larval stages to adults was high when 98 adults were obtained from an average of 110 larvae per sq ft. This suggests that there are at present low levels of cannibalism, predation, parasitism and disease in this infestation.

POPULATIONS

It is clear that numbers of the pest were in a runaway phase during 1966. Maercks (1939) in northern Germany, considered that 5 per sq ft would cause serious injury in arable land, and 10 per sq ft serious injury in grass land. Cohen & Steer (1946) considered 20 per sq ft to be a heavy infestation. The population level is likely to decline as existing and imported biological controls assert themselves.

LIFE HISTORY

Several experienced investigators have studied *T. paludosa,* and their accounts are well in agreement with one another. The species appears to be mostly univoltine but some authors state without offering evidence that there may be a partial or complete 2nd generation.

Egg. The eggs are black and shiny, 1.1 x 0.4 mm, are laid at night in August and September, and have very high moisture requirements at first. They will collapse within 2 to 4 minutes in less than 100% relative humidity (Laughlin, 1958). The minimum mortality occurs in upland soil holding twice its dry weight of water (Maercks, 1939). They are laid on or very close to the surface, 68% within 1 cm of it according to Coulson (1962). Rennie (1916) considered that not all the eggs were mature on the emergence of the female, and that some were retained to produce a 2nd batch. Most later workers think that remaining unlaid eggs are simply a residue. The eggs develop without diapause (Sellke, 1936).

Larva. The larvae hatch in 11 to 15 days (Rennie, 1917; Barnes, 1937). They feed from the first day, starting at approximately 2.7 mm long, with 13 segments, growing to 4 or 5 mm in 12 to 13 days (Rennie, 1917). Mortality is high for the first 20 to 30 days (Laughlin, 1958).

The first two instars of three are passed in about 14 days in central England (Barnes, 1937). In six weeks they are about 6 mm long. The winter is spent in the 3rd instar (Fig. 1), which is without diapause and lasts roughly 25 weeks (Sellke, 1937; Coulson, 1962). Growth is rapid in spring when most of the damage occurs (Rennie, 1917). Minimum larval mortality occurs in upland soil holding three times its dry weight of water (Maercks, 1939). Young larvae appear to prefer green leaves to roots and grow most rapidly with least loss on white clover. They also rear easily on lettuce, wheat and rye, but may not complete development on oats (Maercks, 1939). Normally, but not invariably, they surface to feed, during darkness (Sellke, 1937).

Pupa. The larvae stop feeding in mid-May for two or three weeks before pupating (Fig. 2). When the adult is ready to emerge the pupa works its way to the surface where the empty pupal case is left by the emerging adult, characteristically protruding 2.5 cm from the ground. These are easily sexed, and a ratio of 1.72 males to 1 female was established by Coulson (1962). Cannibalism may be a reducing factor in the early stages of pupation.

Adult. The adults emerge soon after sunset in August and September, mate immediately (Fig. 3), lay 75% of their eggs before daylight (Sellke, 1937; Barnes, 1937; Coulson, 1962) and have finished laying within 32 hrs of emerging (Coulson, 1962). They fly very little before laying, but may leave 5 or 6 eggs in one spot, then move a short distance (Rennie, 1917). Males live about 7 days, females from 4 to 5 days (Barnes, 1937). In a 4-year study at Rothamsted, 57% of 3,400 adult crane-flies were of this species (Robertson, 1939).

TABLE 1—Mean monthly temperatures, precipitation, and days with rain, based on 30 years of records, Vancouver International Airport.

Month	Mean mo. temp.,°F	Mean mo. precipitation, inches	Mean days with rain
Jan.	37.2	5.52	19
Feb.	39.4	4.74	16
March	43.2	3.76	16
April	48.3	2.30	13
May	55.0	1.92	10
June	60.4	1.84	9
July	63.8	1.04	6
Aug.	63.6	1.37	8
Sept.	57.8	2.13	9
Oct.	50.3	4.62	15
Nov.	43.1	5.44	18
Dec.	39.6	6.44	20
Total		**41.12**	**159**

WEATHER RELATIONS

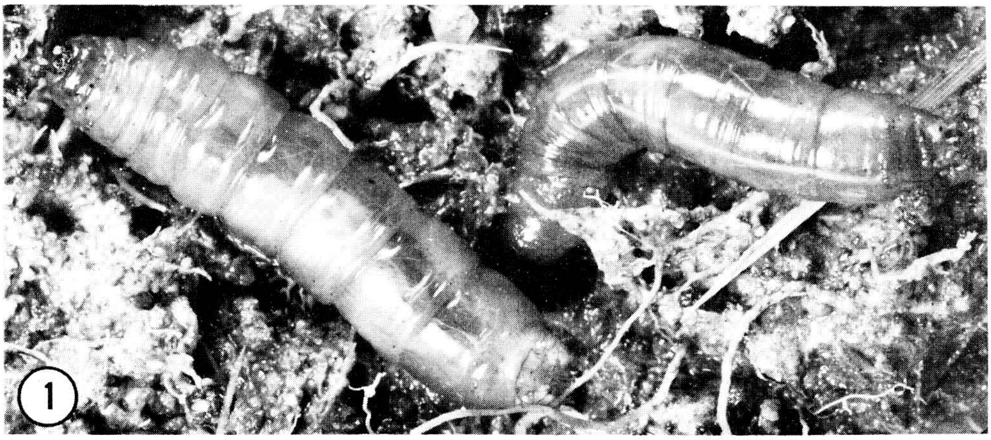
Maercks (1941) concludes that this pest is favored by mild winters, cool summers, and rainfall averaging at least 24 inches per year. Mean monthly values for temperature, precipitation and numbers of days with rainfall are shown by months in Table 1, based on 30-year averages at the Vancouver International Airport. Values for agricultural areas of the lower Fraser Valley differ only slightly. It thus appears that the maritime climate of the wet, coastal belt of British Columbia is practically ideal for this pest.

The present outbreak has been favored by recent weather patterns. In the 5 years, 1962-1966, mean monthly temperatures in winter and summer were above normal as follows:

Nov.	Dec.	Jan.	Feb.	May
4/5	2/5	3/5	5/5	0/5
	June	July	Aug.	
	0/5	0/5	0/5	

The conclusion is that the pest has had five years of ideal conditions in which to become well established.

Damage may be expected following a wet September, especially if the following winter is mild (Maercks, 1941). A cold spring contributes to damage, because the danger period in annual crops is from the time of sowing to the growth of adventitious roots (Rennie, 1917). Robertson (1939) noticed that twice as many adults were taken at light traps on moonless nights as on moonlit ones, and three times as many on cloudy as on clear nights. Most of the trapped adults were males.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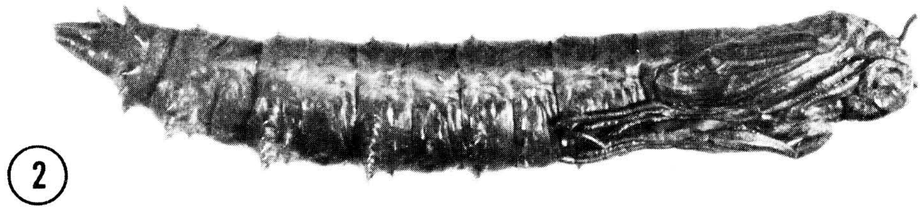
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BIOLOGICAL CONTROLS

T. paludosa is not effectively controlled naturally in northwest Europe. The most effective insect parasite appears to be *Siphona geniculata* De Geer, a small Tachinid that lays up to 9 eggs on the stigmatic crown of the leatherjacket. The larvae enter the main tracheal trunks and bore into the hemocoele but retain a respiratory connection with a chitinous sheath-like structure. There are two generations per year and the parasite overwinters in the host, but the level of parasitism is never high. One record shows 34% to have been affected but the average is much lower, from 6 to 17% (Rennie & Sutherland, 1920). The Vancouver Station is attempting to establish *S. geniculata* supplied by the Institute for Biological Control, Belleville, Ont.

Two virus diseases of leatherjackets have been recorded and plans to use these are under way at Vancouver. However, they do not appear to be highly contagious, although fatal. *Empusa* (= *Entomophthora*) has been recorded as infesting populations in Germany (Müller - Kögler, 1957), and a fungal infection of the tracheae is known (Coulson, 1962). Two species of saprozoic and parasitic nematodes have been recorded in Denmark (Bovien, 1937). Cannibalism is a mortality factor in laboratory rearing, but its effect in the field is difficult to assess and probably small. George (1966) concludes that there is little evidence for effective diseases.

Predation on larvae, especially by European starlings and native moles, *Scapanus* spp., should be studied. Predation on adults is probably not effective, since any adult taken is likely already to have expended most of its quota of eggs.

CHEMICAL CONTROLS

The problem is twofold: how to treat land without creating a residue hazard, and how to live with the pest at the same time keeping down costs. Fortunately the larvae are easily killed and will accept baits readily. They have thin integument, permeable enough for gaseous exchange, lacking an epicuticular layer (Ghilarov & Semenova, 1957). Moreover, 1st and 2nd instar larvae remain close to the surface, and have been killed even by mineral fertilizer (Sellke, 1937).

CULTURAL CONTROLS

Leatherjackets may be reduced by cultivation, since they do not go deep into the soil, but when the numbers are very large the reduction may not be effective. However, *T. paludosa* is adaptable enough to survive and reproduce without the presence of growing plants, by eating decaying rootlets after the manner of wireworms (Rennie, 1917). Maercks (1941) advocates good drainage of land and short grass during egg-laying in August and September. The deleterious effect on the eggs and young larvae of dry weather, may sometimes be offset by the practice of irrigating pastures with sprinklers.

FUTURE PROSPECTS

Review of the extensive European literature indicates that *T. paludosa* is likely to become a constant and possibly a major pest in areas of high rainfall. There are dozens of records of damage by this species in northwestern Europe in research papers and annual reports from Denmark, U.K., Germany, Sweden and Holland. It probably will establish itself in northwestern Washington, but its southern and eastern spread may be restricted by cold winters and by its high moisture requirements. Population crashes in northern England in 1955 and 1959 were shown experimentally by Milne *et al.* (1965) to result from very dry conditions at critical periods.

Fig. 1—Mature 3rd-instar larvae of **T. paludosa.**

Fig. 2—Pupa of **T. paludosa.**

Fig. 3—Marsh crane flies, **Tipula paludosa in copula.**

They predicted that increases may be expected if rainfall in August and September is normal or greater than normal, but when rainfall at this time drops below 50% of normal, sharp declines will certainly occur. Nevertheless there is likely always to be a residue in low-lying land and in ditch-banks.

It appears unlikely that resistance to chemical pesticides will develop within 15 to 20 years.

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