A Quantitative Method for Assessing the Nuisance Caused by Non-biting Aquatic Insects[1]

By Philip S. Corbet
Entomology Research Institute, Canada Department of Agriculture, Ottawa, Ontario

Abstract

Can. Ent. 98: 683–687 (1966)

A quantitative method is described for measuring the nuisance caused by non-biting aquatic insects (Chironomidae, Trichoptera, Ephemeroptera) in the absence of a human observer. Threshold nuisance densities referring to different human occupations are given; and application of the method is discussed.

Introduction

An insect nuisance, caused by adult Trichoptera, exists in summer along the banks of the St. Lawrence River, Montreal, Quebec. Basically, the nuisance results from unwelcome physical contact with the insects near lights during the first part of the night. They cause inconvenience by alighting on the skin, hair and clothes, or by contaminating food and drink. Sometimes they may also spoil freshly painted surfaces, obstruct the vision of motorists, or cause a refuse-disposal problem beneath powerful lights. Thus the nuisance resembles that occasioned by other non-biting aquatic insects, notably Ephemeroptera and Chironomidae.

Work is in progress to mitigate this problem on St. Helen's Island, Montreal, in anticipation of the World Exhibition to be held there in 1967. During this work it became necessary to develop a standard method for assessing nuisance, and one that could be used in the absence of a human observer. The method described here proved useful for comparing densities at different places and times, and for indicating when a nuisance level was reached.

Whether or not a certain density of insects constitutes a nuisance depends partly on the individual tolerance of the persons exposed to it. Nevertheless we found that independent observers can make consistent assessments from one day to the next and, furthermore, that different observers usually agree with one another closely. Thus, for a given set of observers, it can be meaningful to speak of a threshold nuisance density of insects. The need discussed here is to relate these nuisance judgments to a quantitative method of assay that can be used in the observers' absence.

Methods

As aquatic insects cause nuisance mainly by alighting, a "landing-rate" method of assessment was used. The number settling on a standard (adhesive) surface in a given time was recorded while observers made a nuisance judgment on a similar but non-adhesive surface nearby. To obtain consistent results the properties of such surfaces must be standardized with respect to: illumination; colour and reflectivity; surface area; stickiness and odour of adhesive; horizontality; height above ground; distance from a specified light source; orientation with respect to wind; and duration of exposure.

The site used for standardization of the test surface was the uncovered balcony of a large building on St. Helen's Island; this balcony was open only to the south-east across a low balustrade. The arrangement of a light source and test surfaces in the centre of the balcony is shown in Fig. 1.

The central light, comprising an unshaded, clear, 150-watt, tungsten bulb, stood 7 ft. high and 4 ft. from the balcony balustrade. On either side of the light,

[1]Publication No. 1 resulting from the World Exhibition Shadfly Project: Canada Department of Agriculture, Research Branch; Provincial Department of Agriculture, Quebec; and the Canadian Corporation for the 1967 World Exhibition.

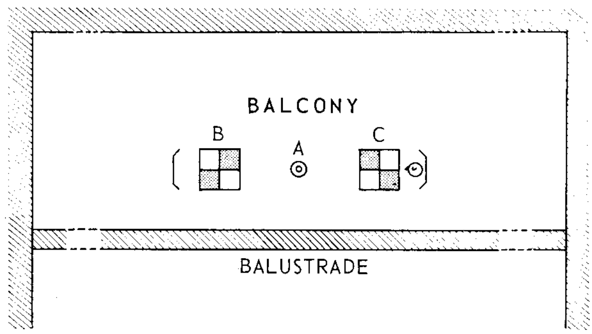

Fig. 1. Arrangement of light source (A), the test table (B) and the observer table (C) on the balcony during standardization tests. A building encloses the balcony on three sides.

4 ft. away, were two identical tables (top 2 × 2 ft.; height 2 ft. 4 in.) to each of which were clipped four mat cards (1 × 1 ft.), two white and two black (Hughes Owens Company (Ltd.), Montreal; Nos. 121 11780/46/1900 and 121 11780/55/1909) arranged as illustrated (Fig. 1). The cards on one table had been coated on the upper side, not more than six hours previously, with Tanglefoot (Tanglefoot Company, 314 Straight Ave., S.W., Grand Rapids 4, Michigan). The cards on the other table, watched by the observer, were not coated. A chair stood by each table on the side away from the light. The central light provided the only significant illumination, which was the same at each table. (Reflected light measured 1 meter above the centre of the tables was 180–185 and 175 ft-c. at the beginning and end of the exposure period, respectively.) The test (adhesive) and observer (non-adhesive) tables were reversed for alternate assessments. Nuisance assessment was made only in the evening, for a 30-minute period beginning 10 minutes after Civil Twilight. Definitive observations were made only during calm weather (wind-speed less than 1 km.p.h. at the balcony edge) because even a light wind was liable to upset the symmetrical arrival of insects at the two tables, greater numbers alighting on the downwind side. Standardization was based on results from 21 such evenings, between 25 June and 27 July 1965.

There were three observers, one being the writer; and at least two were present on each of the first 10 evenings. No other people came within 8 ft. of the tables while a test was in progress. The first observer would sit at the observer table during the 30-minute period, occasionally rising to walk a few steps. At the end of the test period this observer would make a nuisance judgment ("yes", "doubtful" or "no") in each of three categories referring to the observer's imagined occupation: feeding, sitting or walking. Within the first category, eating and drinking were actually assessed separately throughout the study, but these two occupations can obviously be treated as one: judgments for eating and drinking differed on only 2 of 21 occasions and then by very little ("yes" vs. "doubtful"). Meanwhile, the second observer remained nearby, also watching the observer table, and made an independent nuisance judgment. The two judgments were then compared. As they seldom differed, and then only slightly, a few of the later tests were conducted with one observer alone. After each test the adhesive cards were placed in insect-proof boxes, and the insects on the cards were later classified and counted, a squared transparent overlay facilitating this process. To guard against avoidable bias in their judgments, observers were not apprised of any threshold values detected until all tests had been completed.

TABLE I
Group composition of aquatic insects alighting during the 21 standardization tests

Group	White (2 cards)		Black (2 cards)		White and black (4 cards)	
	M*	M_w	M	M_w	M	M_w
Chironomidae	86.5	85.2	83.8	81.6	85.4	85.4
Trichoptera	12.5	13.5	13.9	16.4	13.0	13.3
Ephemeroptera	1.0	1.2	2.3	2.0	1.5	1.3
Totals (all aquatic insects)	2738		1704		4442	

*Arithmetic (M) and Williams' (M_w) means are expressed as percentages for each set of cards.

Results

Nuisance judgments were based on all the aquatic insects considered together. (Terrestrial insects alighted in negligible numbers.) The group-composition of the aquatic insects is probably best expressed as Williams' means (Haddow 1960), although in our work there was little difference between these and the arithmetic means (Table I). To provide a valid threshold for nuisance density, the site chosen had to be a place where on many nights densities were below nuisance level. (For feeding, the frequencies for "yes", "doubtful" and "no" during 21 evenings were 10:2:9.)

The group-composition of the alighting insects is affected by the choice of location. At the place selected, small insects predominated. Chironomidae comprised about 85%. Of the Trichoptera, about 78% were small (length of body plus wings when wings folded 5 mm. or less) and mostly Hydroptilidae; the rest were mainly Hydropsychidae (*Cheumatopsyche* and *Hydropsyche*) which are substantially larger. When making judgments, observers made no conscious distinction between insects of different size or behaviour. But it is clear that if the threshold has to be based on total numbers then account should be taken of the relative contributions made by large vs. small insects, and by active vs. inactive ones. For example Hydroptilidae, which run actively, are likely to be more troublesome per insect than many Chironomidae, which move very little after alighting. Thus the thresholds we obtained would possibly be too high in situations where larger Trichoptera or Ephemeroptera predominated. Some investigators might therefore wish to undertake their own standardization tests where the group-composition differed widely from the one recorded here.

The statistic required for each occupational category is the lowest density at which a nuisance was ever recorded (Table II). That this gives a meaningful threshold is evident from Fig. 2 in which both "yes" and "no" judgments have been plotted. ("Doubtful" judgments, which occurred on 13% of occasions,

TABLE II
Values for threshold nuisance density referring to different occupations

Occupation of observer	White (2 sq. ft.)		Black (2 sq. ft.)		White and black (4 sq. ft.)	
	n	100 log *n*	*n*	100 log *n*	*n*	100 log *n*
Feeding	24	138	18	126	42	162
Sitting	60	178	33	152	93	197
Walking	132	212	106	203	238	255

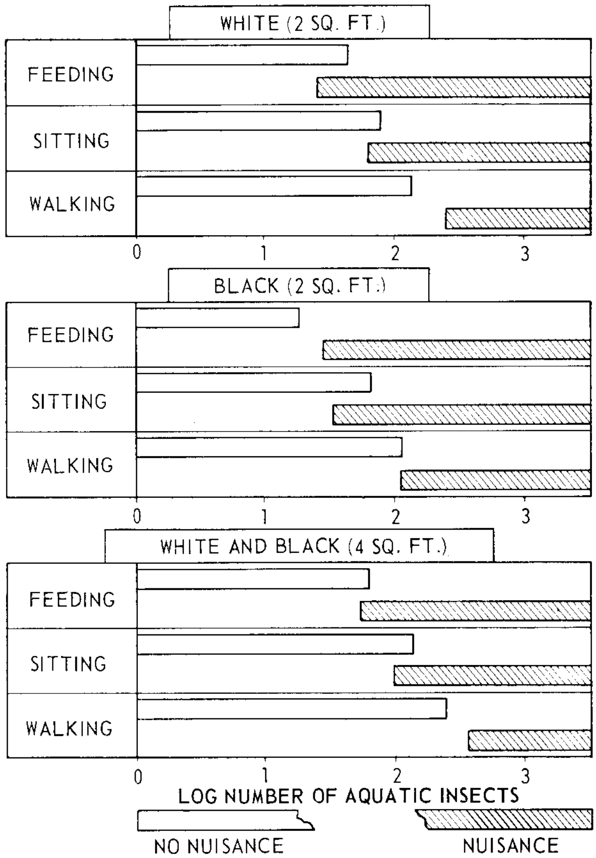

Fig. 2. Ranges of density recorded for different occupations and on different sets of cards during standardization tests.

fell near the thresholds, but have been omitted from the figure and the estimates of threshold.) Here the threshold nuisance density (TND) is defined as that value above which a nuisance is liable to be experienced. Thus where "yes" and "no" ranges overlap (Fig. 2) the TND is obtained by subtracting one from the least density which occasioned a nuisance. Where these ranges do not overlap (e.g. the "walking" category for white cards) the TND is the greatest value at which no nuisance was experienced. Figure 2 is based on the raw data. In Table II the TND for white and black taken together for "feeding" has been adjusted (from 53 to 42) so that it becomes the sum of the TND values for white and black considered separately—a more conservative estimate. No other such changes have been made.

The TND, as expected, depends on the human occupation being considered: tolerance is least while feeding and greatest while walking. The TND can appropriately be expressed as 100 log n (to two places of decimals) for the group spectrum of insects encountered. It should always be given as the totals landing on two white, on two black or on four cards (white and black). It is clearly not permissible to divide respective totals by 2 or 4 to obtain a TND applicable to 1 sq. ft. of surface, because the white and black cards are patronized differently (Table III) and because each card, white or black, must be seen as part of the

TABLE III
Proportions of different insect groups alighting on white and black surfaces

Group	White (2 cards)		Black (2 cards)		Totals
	M*	M_w	M	M_w	
Chironomidae	62.4	64.5	37.6	35.6	3795
Trichoptera	59.1	58.9	40.9	41.1	579
Ephemeroptera	41.2	51.6	58.8	48.5	68
All aquatic insects	61.6	65.2	38.4	34.7	4442

*Conventions as in Table I.

whole chequered complex. If, to save time, assessments are based on the two white cards only, it follows that these cards must have been exposed in the standard way, adjacent to black cards also coated with Tanglefoot. (If the black cards are not coated, insects alighting on them may move and ultimately adhere to a white card.) Thus it would be appropriate to express one of our findings as follows. "For people sitting, but not feeding, the TND (100 log *n*) for aquatic insects (Chironomidae 85.4%; Trichoptera 13.3%; Ephemeroptera 1.3%) on four cards is 197."

Application

The value of this method will be proportional to the care exercised in its application. Essential precautions are that no definitive observations be carried out when the wind-speed exceeds 1 km.p.h.; and that the test surfaces be exposed only for 30 minutes at the specified time of day. It should be remembered also that nuisance levels may vary greatly at sites only a few feet from one another. Thus an assessment made at one site only should not provide the basis for generalizing about conditions at others nearby. With these reservations in mind, a coated test surface of standard dimensions can be exposed to measure the nuisance at a given site. It can of course be exposed at any light intensity; the light was standardized in our tests only to equalize conditions at both tables.

This method can provide a means for assessing the effectiveness of decoy light-traps in reducing insect nuisance at specific sites. It is well suited for this purpose. Test surfaces can be used to compare nuisance at sites with and without decoys, and they can be deployed in lines to reveal the distance and direction over which a decoy may be effective.

Acknowledgments

It is a pleasure to thank Miss Reine Bourret and Mr. Jon Percy for their critical and competent help as observers; Mr. J. B. Maltais, who kindly loaned equipment; and Mr. A. Labrie, of the City of Montreal Parks Department, who allowed us unrestricted use of the testing site.

Reference

Haddow, A. J. 1960. Studies on the biting habits and medical importance of East African mosquitos in the genus *Aedes*. I. Subgenera *Aedimorphus, Banksinella* and *Dunnius*. *Bull. ent. Res.* 50: 759–779.

(Received 22 December 1965)