Nuisance chironomids in waste water stabilization ponds: monitoring and action threshold assessment based on public complaints

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ABSTRACT: Large populations of non-biting midges (Chironomidae) that emerged from waste water stabilization ponds in central Israel created severe nuisance to nearby residents in 1998. A study was begun in summer 1998 to examine the dynamics and phenology of the population as a basis for a successful control strategy. The extensive waste pond area required the development of efficient, reliable and competent sampling methods. The efficiency of four sampling methods was tested: (1) egg-mass counts, (2) larval counts, (3) adult emergence traps, and (4) sampling adults with yellow sticky traps placed on the shoreline. The latter two methods were significantly correlated with and accurately detected midge outbreaks. Yellow sticky traps were safer, easier and more convenient to employ for large scale monitoring. An action threshold was determined based on public complaints that were correlated with the numbers of midges caught by yellow sticky traps. ***Journal of Vector Ecology*** **28(1): 31-36. 2003.**

Keyword Index: Action threshold, Chironomidae, nuisance, wastewater ponds.

INTRODUCTION

Swarms of non-biting midges (Diptera: Chironomidae) became a serious nuisance in central Israel beginning in the spring of 1998. The source of these midges was 200 hectares of ponds in the Dan Region Waste Stabilization Ponds (DRWSP) plant. DRWSP is the central waste treatment and water recycling facility for 1.5 million residents in Israel's largest urban center, Tel-Aviv, and vicinity. Recently, a mechanical-biological treatment plant facility was built to replace the oxidation ponds. In 1998, only 5% of raw sewage was treated in oxidation ponds, changing the water quality to that conducive for midge population outbreaks of a magnitude not previously observed at this site (Broza et al., 2000). Midges became a severe nuisance in the adjacent town, mainly during the spring and midsummer. Adult midges are most active during the evening and they may enter the mouth, eyes and ears, thus limiting evening activities outdoors and indoors. Evening breezes carried large adult swarms, estimated between 40-50 billion individuals/night (Van Poppelen internal report, 1998), toward populated areas. Similar phenomena have been documented in various countries including Italy, Sudan and USA (reviewed by Ali 1996). Recently, Broza and Halpern (2001) showed that chironomid egg masses might serve as the natural reservoir of the cholera bacterium, raising the chironomid problem from a nuisance level to a life-threatening hazard. This gives a new impetus to developing methods of monitoring and control of chironomid numbers.

In this report we focus on the development of an efficient sampling technique suggesting and facilitating the establishment of an action threshold.

MATERIALS AND METHODS

A single, recharged pond was selected for the study (surface area 20 acres, depth up to 150 cm). Five fixed sites located 1 m offshore were marked around the pond. In each site, midge populations were evaluated by three independent sampling methods (methods 1-3). Five additional sites were located on shore 1m from the waterline for method 4. Samples were taken simultaneously on a weekly basis throughout 1999. The four methods tested included:

1. Egg mass sampling. Styrofoam boards (25 x 25 cm) were used artificial oviposition sites for female midges (Broza et al., 2000). They were placed in the pond for 24 h and then transferred to a basin full with water to count the egg masses along the side of the board (Figure 1).

*2. Larval sampling*s. In each site, three mud cores were sampled with a handled scoop sampler of 6 cm diameter and up to (but not consistent) 5 cm deep. The sample was washed and the larvae were counted in a clean pan (Lothrop and Mulla 1998).

3. Adult sampling with emergence traps. See

Mulla (1974) and Ali (2000). A standard fly trap, 17cm diameter at the bottom, was modified by cutting open the bottom of the trap (Shabtieli, LTD Tel-Aviv, Israel). The trap was partially submerged (Figure 2) and hunged for 24 h above the water so the bottom extended 5 cm into the water. Thus, emerging adult midges from the floating pupa would enter the trap.

4. Adult sampling with yellow sticky traps (YST). Yellow sticky traps (Stiky Strips™, Olson Products, OH, USA) (Batzer et al., 1997) were placed 1 m from the water line and 1.2 m high for 24h. The Stiky Strips are flat, 8 x 12 cm, and sticky on both sides.

Sampling methods 2-4 were evaluated immediately in the laboratory. All Chironomini larvae (but almost exclusively *Chironomus* spp.) were counted as the "midge population". Adults were separated into different species (not shown here) and counted with a stereomicroscope in the lab. Representative specimens were preserved for future taxonomic identification.

Sampling midges with all four methods started in September 1998 and continued throughout 1999. Public complaints were used as an indicator for the phenology and severity of nuisance midges (Broza et al., 2000). Computerized logbook data were obtained from the city of Rishon Le-Zion, Division of Environmental Quality.

RESULTS

The 1999 sampling throughout provided a detailed picture of midge population dynamics (Figure 3). Data on egg-mass sampling were significantly correlated with data obtained from adults caught in the emergence traps (Table 1). Larval sampling corresponded with the April peak but not with the others and was not significantly correlated with other sampling methods (Table 1 and Figure 3). Data on adults caught in the emergence traps were significantly correlated with data obtained by YST. Monitoring adults with emergence traps and onshore YST showed a similar trend, with population peaks during summer (June-July) and late in summer (September).

According to the public complaints logbook, the main nuisance problem occurred earlier, starting in late April 1998 and lasted during summer months with a secondary outbreak during autumn (Figure 4). A significant correlation (r= 0.93, df=9, P<0.01) (Figure 5) was found between public complaints and adults in YST for October 1998 – January 1999. Based on the results and correlation from autumn 1998, we suggested that the numbers of complaints could be used to predict the pattern of population build-up during the beginning of the season. In mid April 1998, a minor, though meaningful increase in public complaints preceded the exponential rise that reached over 100 complaints per week (Figure 4**)**. We predicted that this small peak would represent the timing of the management threshold for the following year (see the horizontal line in Figure 4). Four complaints per week were associated with about 40 adults per YST (Figure 5), and were considered as the spring action threshold.

Figure 6 presents the follow-up of 1999 midges population dynamics as sampled by the YST and the subsequent number of complaints. Action threshold was defined in 1999 (Figure 6) as soon as 40 adults/YST were monitored in April. Once the action threshold was reached, a mineral oil was applied (The control method and its effects will not be presented in the current paper).

DISCUSSION

The present study shows that YST is a convenient and reliable method of monitoring chironomid emergence. In addition, we propose that it is highly important to use and monitor public complaints as a key tool for decision-making and assessment of control practices in aquatic environments.

Estimates of midge populations help to predict and develop control programs (Ali 1995). Monitoring insect populations in large and heterogeneous habitats is often limited by sampling resources. The problem is greater when contact with polluted waters is not recommended. Thus, having a reliable and relatively easy sampling method with no need to come in contact with sewage water is highly desirable. The advantages of each monitoring technique tested are listed in Table 2.

Larval sampling was not significantly correlated with all other sampling methods (Table 1). Considering the fact that eggs, adult emergence and sticky traps could reflect adult density, a different developmental phase from larval density, this is not unprecedented.

Sampling egg-masses had some disadvantages, such as being time consuming. Counting egg-masses was inaccurate, especially during the outbreak season as styrofoam plates may exceed over 15-egg masses/cm (Figure 1 and Broza et al., 2000). However, this method can detect major trends in midge population dynamics. It was successfully implemented when monitoring small populations, such as in covered tanks of drinking water supply systems (Broza et al., 1998).

All sampling methods except YST exposed the sampler to polluted water. Yellow sticky traps posted on shoreline enabled easy identification of species and sex, accurate counting, and they may also be helpful in monitoring other important invertebrates in the system. Its value in sampling both pests and their parasitoids was emphasized by Weston and Barney (1998). It was

Table 1. Matrix of correlation coefficients (r) between sampling methods. Pearson analysis was based on a year (1999) of weekly samples, five replicates / method. NS = not significant, * = $P < 0.05$.

	Egg mass	**Larvae**	**Adult-shoreline (sticky)**	**Adult - water (emergence)**
Eggs	-	-0.30 NS	0.31 NS	0.56 *
Larvae		-	-0.6 NS	-0.35 NS
Adult-shoreline (YST)			-	0.56 *
Adult–water (emergence)				-

Table 2. Advantages and disadvantages of each sampling method used in waste stabilization ponds. Signs indicate relative magnitude.

	Egg-Mass	**Larvae**	**Adult (emergence)**	**Adult (sticky)**
Advantages				
Accurate counting	+	++	+++	+++
Sex ratio determination	none	none	+++	+++
Large scale application	++	+	+	+++
Variation between samples	++	++	++	++
Rapid species identification	+	+	+++	++
Disadvantages				
Affected by other ponds	++	none	none	++
Exposure of sampler to polluted water	++	+++	+++	none

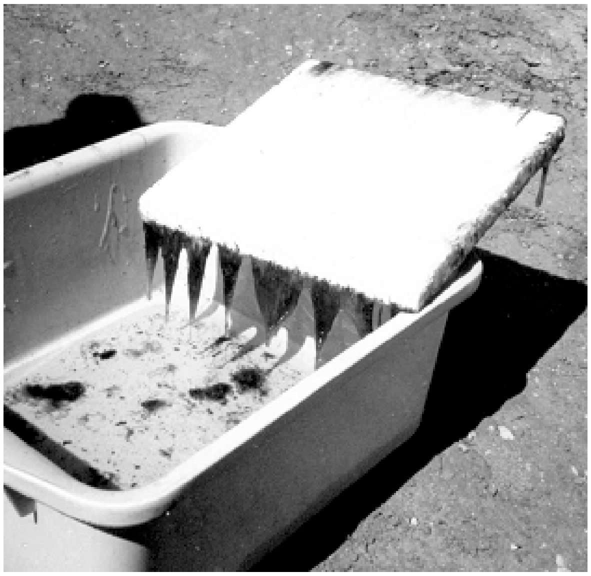

Figure 1. Egg-mass sampling. Styrofoam boards placed for 24h serve as an attractive oviposition site for female chironomids. During high female density, the edges of the plate were covered with thousands of egg-masses glued together forming a typical triangular shape.

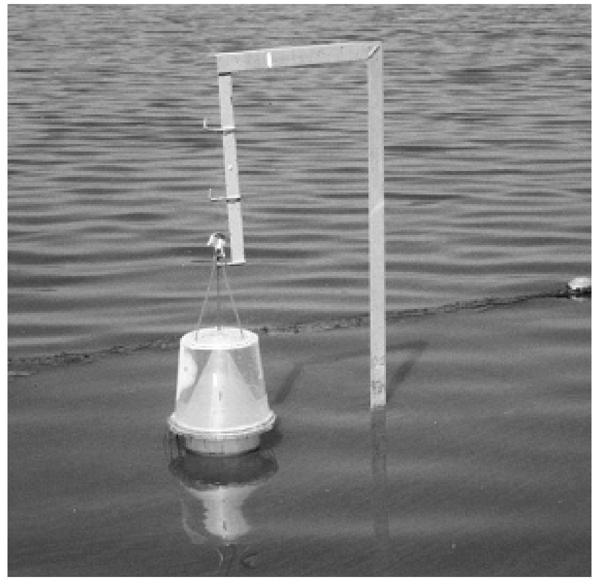

Figure 2. Emergence trap. A standard flytrap was modified by cutting open the bottom of the trap. The trap was hung on a peg in a way that the bottom was 5cm deep in the water.

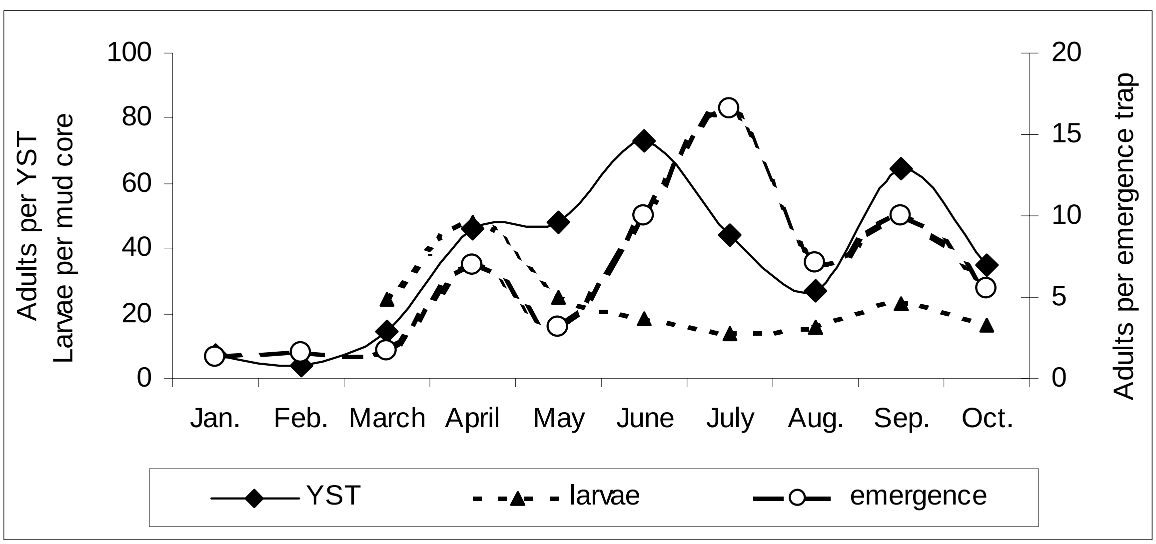

Figure 3. Midge population dynamics as monitored by four methods. Data are the monthly means throughout 1999 (four sampling dates each month, 5 samples each day). See Table 1 for weekly correlation coefficient among methods.

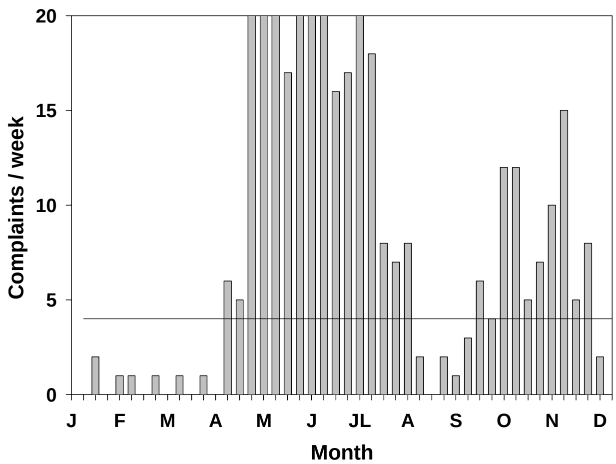

Figure 4. Weekly complaints in the city of Rishon Le-Zion logbook during 1998. A total of 622 complaints on nuisance midges were received. Weeks that exceeded 20 complaints represent between 30-120 complaints. The horizontal line represents the action threshold line as suggested in the present study.

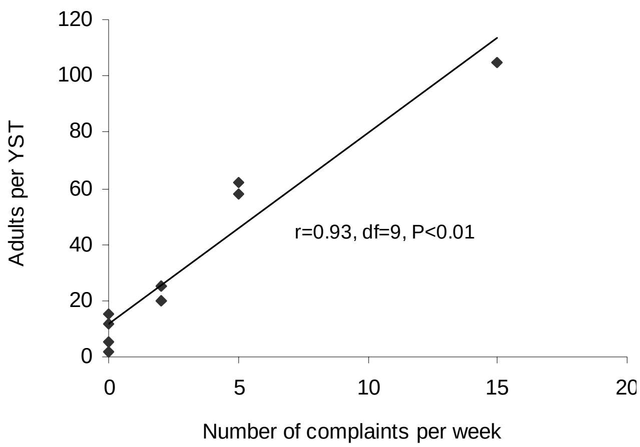

Figure 5. The correlation between adults in yellow sticky traps (YST) and public complaints during October 1998 –January 1999.

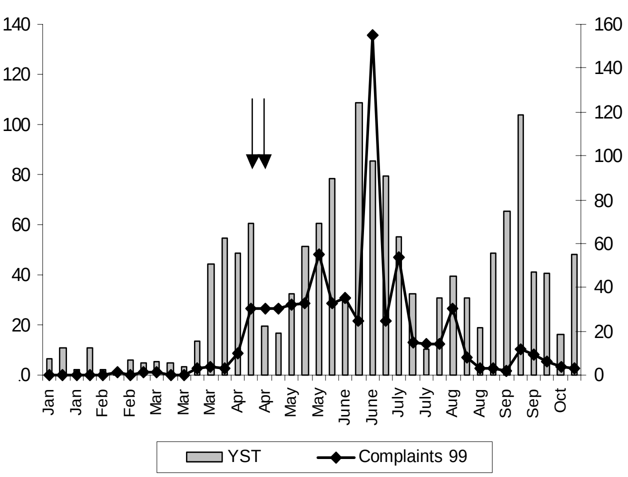

Figure 6. Adult midge populations in columns, as monitored by yellow sticky traps (near the discharge pond only). Data are the weekly means of 5 YST on-shore throughout 1999. The line shows the 1999 complaints as recorded by the nearby municipality. The arrows represent the action threshold and the beginning of treatments with mineral oil. The high level recorded in June is discussed in the text.

the easiest method to operate and maintain and could be applied in large scale monitoring efforts. Sampling with YST may be affected by winds and or adult activity originating in other ponds. Therefore, further studies will examine the relationship between the numbers obtained with emergence traps and those obtained from the YST, and determine if this method is sensitive enough to detect differences among ponds within the same site. Data obtained from YST were highly correlated with public complaints on midge's nuisance (Figure 5). Verification of our prediction regarding the timing for application of control methods (action threshold, Figure 4) was accomplished during the 1999 season.

By comparing 1999 public complaints to adult population monitored (Figure 5), we showed that public response to nuisance insects has a value in characterizing an outbreak. It indicates that the suggested method is sensitive and provides a unique approach to a practical nuisance problem. The high population level recorded in June 1999 was associated with the termination of sewage influx on June 1, which appeared to cause an immediate rise in chironomid adult population levels (unpublished data).

In many cases nuisance insects are noticeable while the outbreak phase already exists and it is too late for establishing an adequate monitoring program. Our approach regarding the determination of action thresholds, using public complaints, provides a way to overcome this obstacle.

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