OVIPOSITION OF *TOXORHYNCHITES THEOBALDI* IN DIFFERENT TYPES OF ARTIFICIAL CONTAINERS IN MEXICO

FILIBERTO REYES-VILLANUEVA[1], M. H. BADII[1], M. L. RODRIGUEZ-TOVAR[2] AND MARIBEL VILLARREAL-LEAL[2]

Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Depto. Zoología de Invertebrados, Laboratorio de Entomología, Apdo. Postal 2790, Monterrey, N. L., México

Toxorhynchites theobaldi (Dyar and Knab) is a neotropical mosquito which, as other members of the genus, is carnivorous in its larval stages and is not haematophagous in the adult stage (Steffan and Evenhuis 1981). It is a widely distributed species in tropical America (Clark-Gil and Darsie 1983, Darsie and Mitchell 1985), which offers some potential as a natural enemy of *Aedes aegypti* (Linn.) because both insects prefer to oviposit in temporary breeding sites. However, little is known of its ecology and relatively few observations on larval habitats and oviposition site preferences have been made under natural conditions. The larvae have been found in cut and bored insect damaged bamboo cane (Davis 1944), bromeliads and leaf axils (Forattini 1965) and rock holes (Heinemann and Belkin 1978). With regard to the oviposition site preferences, *Tx. theobaldi* [as *Tx. hypoptes* (Knab)] oviposits near ground level as well as in the canopy (Galindo et al. 1951). It also uses artificial containers, where eggs have been collected in graveyard flowerpots in Venezuela where it preferred shaded places as oviposition sites (Rubio et al. 1980, Rubio and Ayesta 1984). In order to determine if this predator can exert natural control upon *Ae. aegypti* populations, more observations need to be made upon manufactured containers used as habitats. This paper describes the variation in *Tx. theobaldi* egg numbers in different habitat types including artificial containers.

Sampling of *Tx. theobaldi* eggs was carried out in the graveyards of Mante City, Tamaulipas as well as Valles City, San Luis Potosí in Mexico. Both localities are included in the "Huasteca Region" located in northeastern Mexico. The region has a tropical climate with summer rains. Forest vegetation is minimum and in transition to high grassland savannah towards the south (CIU-UANL 1976).

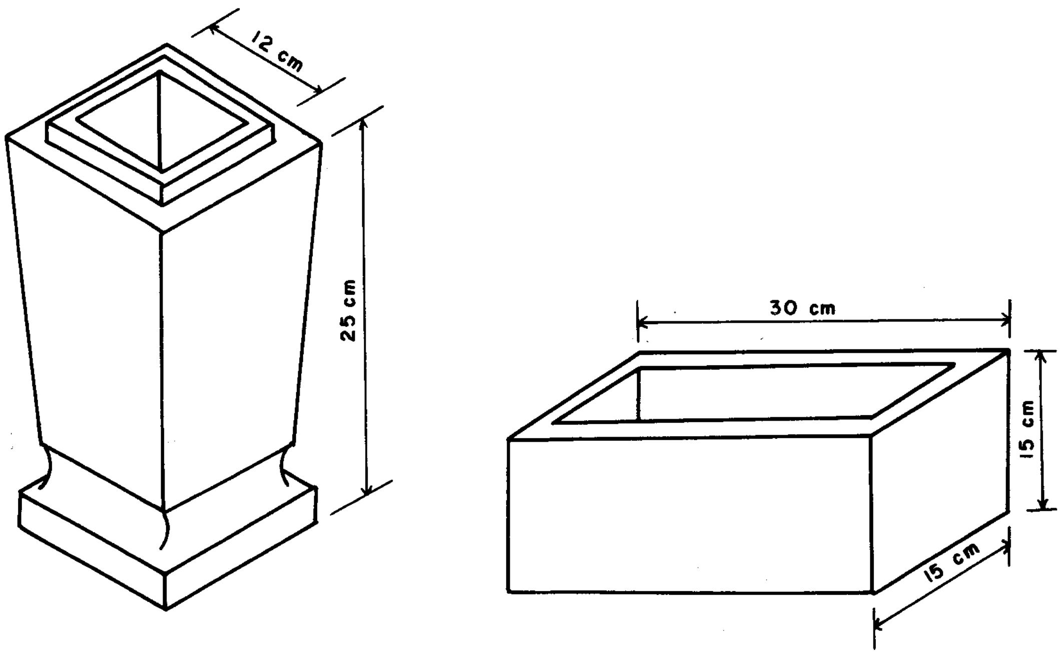
One week before sampling, all containers were filled to the top with potable water (drinking water from the city pipeline) and 3 types of containers were used: small cement flowerpot (Fig. 1A), large cement flowerpot (Fig. 1B) and discarded containers made of metal or glass. Eggs were counted in all containers. Presence or absence of flowers in the container, and shady or sunny conditions were marked for each one. The containers were categorized as follows: shady, small flowerpot with flowers; shady, small flowerpot without flowers; sunny, small flowerpot with flowers; sunny, small flowerpot without flowers; shady, large flowerpot with flowers; shady, large flowerpot without flowers; sunny, large flowerpot with flowers; and sunny, large flowerpot without flowers. For discarded manufactured containers, we counted eggs in shady, metal/glass containers with flowers; shady, metal/glass containers without flowers; sunny, metal/glass containers with flowers; and sunny, metal/glass containers without flowers.

To identify the species of *Toxorhynchites*, 70 random samples of eggs were collected from the containers, and hatched in the laboratory. Eggs were placed individually in separate vials and the hatched larvae were fed daily using 10 *Aedes aegypti* larvae per individual predator. Emergence to adults was 100% and all were identified as *Tx. theobaldi* according to the taxonomic keys of Costa Lima et al. (1962) and Vargas (1953).

A chi-square analysis ($\chi^2_c = 1.02 < \chi^2_{.05}$, 6 df) showed that there were no differences between observed egg means in comparison to the expected values, and therefore the egg frequencies were the same under the 4 ecological conditions (Table 1). However, according to the trend observed here and independently of ecological conditions, the mean egg count for the large flowerpot (2.24) was 1.3 and 4 times greater than those for the small flowerpot (1.67) and discarded container (0.55), respectively. Similar results were obtained in relation to the mean egg count of shady and sunny containers with flowers and with no flowers (Table 2). The proportion of eggs in containers with flowers and without flowers was the same under both light con-

[1] Current address: Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Escuela de Graduados, Apdo. Postal 391, San Nicolás de los Garza, N. L., México.

[2] Current address: Universidad Autónoma de Nuevo León, Facultad de Ciencias Biológicas, Depto. Zoología de Invertebrados, Lab. de Entomología, Apdo. Postal 2790, Monterrey, N. L., México.



I A I B

Fig. 1. Containers sampled for oviposition of *Toxorhynchites theobaldi*. A. Small cement flowerpot. B. Large cement flowerpot.

Table 1. Mean number of eggs of *Toxorhynchites theobaldi* per container, for 3 types of containers in 4 different ecological conditions. Underlined numbers are averages, numbers in parentheses are expected frequencies according to the test, and the upper numbers are N values.

	Ecological conditions				
Container type	Sunny with flowers	Sunny without flowers	Shady with flowers	Shady without flowers	Total mean
Large flowerpot	61 0.72 (0.79)	49 0.33 (0.54)	34 3.05 (2.35)	63 4.78 (5.19)	2.24
Small flowerpot	77 0.56 (0.54)	76 0.67 (0.37)	49 0.88 (1.62)	87 4.00 (3.57)	1.67
Discarded container	21 0.24 (0.19)	24 0.04 (0.13)	15 0.60 (0.55)	28 1.21 (1.22)	0.55
Total mean	0.58	0.46	1.59	3.84	1.71

ditions ($\chi^2_c = 0.19 < \chi^2_{.05}$, 6 df), but the mean number of eggs per shady container (3.07) was 6 times greater than the sunny container (0.51). It is interesting that the average number of eggs per container without flowers (2.26) was 2.2 times greater than the container with flowers (1.03). In general, oviposition of *Tx. theobaldi* in the 3 breeding sites was as follows: 50%, 37% and 13% for large flowerpot, small flowerpot and discarded containers, respectively; while oviposition through different ecological conditions of containers was: 84% and 16% for shady and sunny containers, and 65% and 35% for containers with flowers and no flowers, respec-

Table 2. Mean number of eggs of *Toxorhynchites theobaldi* per container, in shady and sunny containers with flowers and no flowers. Underlined numbers are averages, numbers in parentheses are expected frequencies according to a χ^2 test, and the upper numbers are N values.

	Flower factor		
Light factor	With flowers	Without flowers	Total mean
Shady containers	98	178	3.07
	1.80	3.78	
	(2.00)	(3.57)	
Sunny containers	159	149	0.51
	0.57	0.46	
	(0.37)	(0.66)	
Total mean	1.03	2.26	1.71

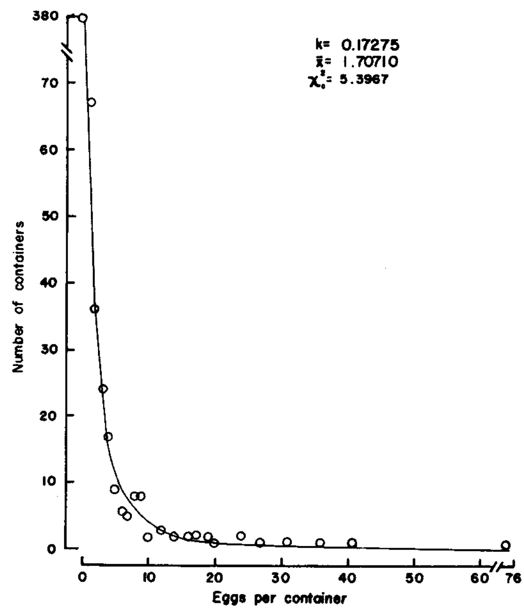


Fig. 2. Frequency distribution of number of artificial containers with different number of *Toxorhynchites theobaldi* eggs from two graveyards in northeastern Mexico.

tively. Higher oviposition was in the larger containers without flowers. It is suspected that the rate of evaporation is increased from the water surface of containers which lack flowers. This may enhance the ability of the insect to detect the oviposition site as suggested by Furumizo and Rudnick, (1978). In addition, *Tx. amboinensis* (Doleschall) preferentially oviposits in larger containers (Focks et al. 1983).

In addition to the above, the frequency distribution of containers with different number of eggs was obtained (Fig. 2) to understand better the oviposition of *Tx. theobaldi*. The appropriate function to describe this relationship was the negative binomial distribution, which is useful when the population is clumped or aggregated. This distribution is described by 2 parameters: the mean and the exponent k, which is a measure of the amount of clumping and is often referred to as the dispersion parameter (Southwood 1966). Both parameters were estimated from the frequency distribution of the sample by the statistics $\bar{x}$ and $\hat{k}$, and the latter was computed by the method of maximal likelihood (Bliss and Fisher 1953). In this study they were: $\bar{x} = 1.7071$ and $k = 0.17275$. Expected frequencies of containers with x eggs were calculated by the equation of Px which is:

$$Px = (Po)\left(\frac{\bar{x}/k}{\bar{x}/k + 1}\right)\left(\frac{x + k - 1}{x}\right),$$

in which

$$Po = \frac{N}{(\bar{x}/k + 1)^k}$$

is the probability of containers with zero eggs, and $N = 584$, the total number of containers. Lastly, the goodness of fit of the negative binomial to the set of observed frequencies here, was determined by means of a chi-square test. There was a good fit ($\chi^2_c = 5.3967 < \chi^2_{.05}$ with 7 df). In relation to observed data, there were 380 containers with zero eggs and 204 with at least one egg. This means that predator was present in 35% of the potential breeding sites for *Aedes aegypti*. Containers with 1–3 eggs were represented by 22%, while 13% was the proportion for containers with more than 3 eggs. In spite of the high number of possible containers in a relatively small habitat (160,000 m^2 each cemetery), there were many empty containers. Females of *Tx. theobaldi* probably search for oviposition sites in a restricted area and perhaps very near to their oviposition or breeding sites, since there was one container observed with 76 eggs under shaded conditions.

The authors are indebted to Dr. José Cavazos

López, Director of Secretaria de Salud del Estado de Nuevo León, México, for financial support of this project.

REFERENCES CITED

Bliss, C. I. and R. A. Fisher. 1953. Fitting the negative binomial distribution to biological data. Biometrics 9:177–199.

CIU-UANL. 1976. Análisis y Expectativas de la Estructura Urbanística del Noreste de México. F. 2: Análisis Geográfico Físico del Noreste de México. Centro de Investigaciones Urbanísticas. Universidad Autónoma de Nuevo León. 97 pp.

Clark-Gil, S. and R. F. Darsie, Jr. 1983. The mosquitoes of Guatemala, their identification, distribution and bionomics, with keys to adult females and larvae in English and Spanish. Mosq. Syst. 15:151–284.

Costa Lima, A. da, N. Guitton and O. Ferriera. 1962. Comentarios relativos os espécies da Tribo Toxorhynchitini (Megarhinini) com a descricas de una espécie nova da *Lynchiella* (Diptera, Culicidae). Mem. Inst. Osw. Cruz 60:225–252.

Darsie, R. F., Jr. and C. J. Mitchell. 1985. The mosquitoes of Argentina. Parts I and II. Mosq. Syst. 17:153–362.

Davis, D. E. 1944. Larval habits of some Brazilian mosquitoes. Rev. Bras. Entomol. 15:221–234.

Focks, D. A., S. R. Sackett, D. A. Dame and D. L. Bailey. 1983. Ability of *Toxorhynchites amboinensis* (Doleschall) (Diptera: Culicidae) to locate and oviposit in artificial containers in an urban environment. Environ. Entomol. 12:1073–1077.

Forattini, O. P. 1965. Entomologia médica. Vol. 3. Culicini: *Haemagogus, Mansonia, Culiseta.* Sabethini. Toxorhynchitini. Arboviroses. Filariase bancroftiana. Genética. São Paulo Univ. Sao Paulo. 416 pp.

Furumizo, R. T. and A. Rudnick. 1978. Laboratory studies of *Toxorhynchites splendens*: Biological observations. Ann. Entomol. Soc. Am. 71:670–673.

Galindo, P., S. J. Carpenter and H. Trapido. 1951. Ecological observations on forest mosquitoes of an endemic yellow fever area in Panama. Am. J. Trop. Med. 31:98–237.

Heinemann, S. J. and J. N. Belkin. 1978. Collection records of the project "Mosquitoes of Middle America" 10. Panama, including Canal Zone (PA, GG). Mosq. Syst. 10:119–196.

Rubio, Y., D. Rodriguez, Ç. E. Machado-Allison and J. A. Leon. 1980. Algunos aspectos del comportamiento de *Toxorhynchites theobaldi* (Diptera: Culicidae). Acta Cient. Venezolana 31:345–351.

Rubio, Y. and C. Ayesta. 1984. Laboratory observations on the biology of *Toxorhynchites theobaldi.* Mosq. News 44:86–90.

Southwood, T. R. E. 1966. Ecological methods with particular reference to the study of insect populations. Methuen and Co. Ltd., London, 391 pp.

Steffan, W. A. and N. L. Evenhuis. 1981. Biology of *Toxorhynchites.* Annu. Rev. Entomol. 26:159–181.

Vargas, L. 1953. *Megarhinus* de Norteamerica (Diptera: Culicidae). Rev. Inst. Salubr. Enferm. Trop. 13:27–32.