MALE-DEPENDENT STENOGAMY IN *AEDES TAENIORHYNCHUS*[1]

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ABSTRACT. A male-dependent stenogamous condition was found in a strain of *Aedes taeniorhynchus* that was derived from a field collection taken near Puerto Peñasco, Mexico. Mating occurred readily in this strain, even when the adults were confined in 8-dram glass shell vials. Under such conditions, mating also occurred in interstrain crosses involving Puerto Peñasco males with females from Florida strains of *Ae. taeniorhynchus*, but not in reciprocal crosses. For males of the Puerto Peñasco strain, flight did not appear to be a prerequisite for mating.

INTRODUCTION

Stenogamous mosquitoes mate readily in cages under laboratory conditions, whereas eurygamous mosquitoes do not. Most species of *Aedes (Ochlerotatus)* in North America are eurygamous (Brust 1971). However, stenogamy is common among *Aedes churchillensis* Ellis and Brust, *Aedes diantaeus* Howard, Dyar and Knab, and *Aedes rempeli* Vockeroth and occurs infrequently among *Aedes taeniorhynchus* (Wiedemann) (Ellis and Brust 1973, Smith and Brust 1970). To establish free-mating laboratory colonies of *Ae. taeniorhynchus*, it is usually necessary to select for stenogamous pairs (Haeger 1958). Using a series of crosses involving wild and colonized strains of Florida *Ae. taeniorhynchus*, O'Meara and Evans (1974) found the stenogamous condition to be female-dependent. When confined in gallon-size (3.8 liter) cages, both wild and colony *Ae. taeniorhynchus* males were highly successful in transferring sperm to colony *Ae. taeniorhynchus* females, but most of their attempted matings with wild females ended in failure. Female-dependent stenogamy has been found also in *Culex nigripalpus* Theobald (Haeger and O'Meara 1970) and *Culex tritaeniorhynchus* Giles (Shirasaka et al. 1968).

Recently, we established a laboratory colony of *Ae. taeniorhynchus* from a field collection taken near Puerto Peñasco, Mexico. This population was easily colonized because the mosquitoes were uniformly stenogamous and required little, if any, flight activity for mating. The present study compares the mating behavior of Mexican and Florida strains of *Ae. taeniorhynchus* to characterize further the behavioral basis of stenogamy in this species.

MATERIALS AND METHODS

Three strains of *Ae. taeniorhynchus* were used. The Flamingo strain, which originated from a field collection at Flamingo, Florida (25.1° N 80.9° W), mated readily in 30 cm cages and had been maintained in the laboratory for about 2 years. From Jack Island, Florida (27.5° N, 80.3° W), mated *Ae. taeniorhynchus* females were field collected and their F_1 progeny were used. The third strain, Puerto Peñasco, was derived from a field collection taken near Puerto Peñasco, Sonora, Mexico (31.2° N, 113.3° W). All tests involving the Puerto Peñasco strain used mosquitoes from the first through fifth laboratory generations.

Aquatic stages were reared in enameled pans containing approximately 350 ml of tap water and 80 larvae. Synchronous larval development in 6 days was achieved using a diet composed of 1:1:1 brewer's yeast: lactalbumin: rodent lab chow. This mixture was added to each pan according to the following schedule: days 1 and 2, 50 mg; day 3, 150 mg; days 4 and 5, 200 mg. Adults were allowed to feed *ad libitum* on 10% sucrose solution.

Virgins of known ages were obtained by separating the sexes in the pupal stage and/or by collecting adults at emergence. Newly emerged adults were held for 1 to 2 days before being used in any test. Insemination was assessed by the presence or absence of sperm in the spermathecae of the female.

Mating tests were conducted in a bioclimatic chamber at 27.5 ± 1°C and 85 ± 10% R.H. The day-night cycle was 16.5 hr light and 7.5 hr dark with a 62-min simulated twilight period occurring at each transition. Mosquitoes were caged in either 8-dram glass shell vials or cages that were 30 cm high × 30 cm wide × 30 cm deep (designated the 30 cm cage). The interior dimensions of the glass vial were 21 mm in diameter and 93 mm in height. To provide moisture for the mosquitoes, a wet cotton plug was placed at the bottom of the shell vial. A screened cap prevented mosquitoes from escaping. The 30 cm cage had an acrylic top and side, and a side enclosed with 16 mesh fiber glass screening. The remaining interior sides of this cage were covered with white fiberboard. A pad of wet cheesecloth was placed on the floor of the cage.

The shell vials were used for single pair tests

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(1 ♀ × 1 ♂), whereas experiments with the 30 cm cages involved groups of mosquitoes (25 ♀♀ ×25 ♂♂).

RESULTS AND DISCUSSION

In experiments involving mosquitoes confined in 8-dram shell vials, the extent of effective mating was related to the type of male rather than the type of female used (Table 1). Some females were inseminated in both intra- and interstrain crosses with Puerto Peñasco males, but Jack Island and the Flamingo males were unable to inseminate females of their own strain or the Puerto Peñasco strain. Therefore, we concluded that stenogamy exhibited by Puerto Peñasco *Ae. taeniorhynchus* is primarily male-dependent.

Another test with single-pair crosses used 2 day-old adults of the Puerto Peñasco strain which were confined for 24 hr in 8-dram shell vials where the space available to the mosquitoes was reduced to a height of about 10 mm by filling most of the vial with a large cotton plug. Under these conditions 8 of 18 females were inseminated. Among females of a control group, in vials where space available to the mosquitoes was not reduced, 15 of 22 tested were mated.

The Flamingo strain required a larger cage for intrastrain mating than did the newly colonized Puerto Peñasco strain. Among Florida *Ae. taeniorhynchus,* genital contact is normally initiated while the mosquitoes are in flight (O'Meara and Evans 1974). Clearly, a different type of mating behavior occurs in the Puerto Peñasco strain. Opportunities for flight were limited for mosquitoes retained in the 8-dram shell vials, particularly when the space containing the mosquitoes was reduced to 10 mm in height. Yet, even under these conditions there was mating in the Puerto Peñasco strain, indicating these males do not require flight for mating.

No sperm transfer occurred in intrastrain pairings of Jack Island adults retained in the 30 cm cage (Table 1). However, under these conditions the Jack Island and Flamingo males inseminated Puerto Peñasco females. Similar high rates of insemination were also noted in pairings of the Puerto Peñasco males with either their own or Jack Island females. These results indicate that both sexes influence mating success in the laboratory. The Puerto Peñasco males mated effectively no matter what cage size or strain of female was used. However, the difference in mating success between the crosses, Puerto Peñasco ♀ × Jack Island ♂ and Jack Island ♀ × Jack Island ♂, must be due to the laboratory behavior of the Puerto Peñasco females. Hence, these females are like those of colonized strains of Florida populations of *Ae. taeniorhynchus* in that they display a female-dependent form of stenogamy (O'Meara and Evans 1974).

In addition to being highly stenogamic, the Puerto Peñasco strain differs in other ways from Florida strains. For example, when reared in the laboratory under standardized conditions (O'Meara 1979), the size attained by adult females of the Puerto Peñasco strain was significantly smaller than that of females of the Flamingo population (O'Meara 1985). The wing length (Mean ± SE) was 2.45 ± 0.01 mm (n = 54) in the Puerto Peñasco females and 2.97 ± 0.01 mm (n = 48) in the Flamingo females ($t = 25.5$, $df = 100$, $P < 0.001$). The wet weight (Mean ± SE) was 2.26 ± 0.05 mg (n = 54) in newly emerged, unfed Puerto Peñasco females and 3.49 ± 0.05 mg (n = 48) in similarly treated Flamingo females ($t = 14.9$, $df = 100$, $P < 0.001$). Despite their relatively small size, females of the Puerto Peñasco strain are uniformly autogenous and produce large egg clutches without taking blood (O'Meara 1985). It is not known if these Puerto Peñasco traits are characteristic of other *Ae. taeniorhynchus* populations from the Gulf of California. Elsewhere

Table 1. Incidence of insemination in laboratory crosses involving three strains of *Aedes taeniorhynchus* confined in either shell vials or the 30 cm cages for 3 days.*

Mating combination		Shell vials		30 cm cages	
Female	Male	No. of replicates	% inseminated	No. of females examined	% inseminated
Puerto Peñasco	Puerto Peñasco	52	86.5	22	95.5
Flamingo	Flamingo	39	0.0	—	—
Jack Island	Jack Island	26	0.0	25	0.0
Flamingo	Puerto Peñasco	20	40.0	—	—
Jack Island	Puerto Peñasco	24	75.0	24	79.2
Puerto Peñasco	Flamingo	20	0.0	10	90.0
Puerto Peñasco	Jack Island	24	0.0	23	65.2

* Each vial contained 1 ♀ and 1 ♂, whereas each 30 cm cage contained 25 ♀♀ and 25 ♂♂.

in the distribution of this species, there is considerable variation among populations in adult scaling pattern and in the expression of autogenous egg development (Belkin et al. 1970, O'Meara and Edman 1975).

Our findings with the Puerto Peñasco population corroborate previous associations between colonizing success and high incidence of autogeny in *Ae. taeniorhnychus*. In other mosquito species autogeny is also associated with stenogamy (Ellis and Brust 1973, O'Meara and Craig 1970, O'Meara and Lounibos 1981, O'Meara and Evans 1974, Smith and Brust 1970, Spielman and Weyer 1965). There are some stenogamous mosquito species which are not autogenous (Chapman and Barr 1969), but nearly all autogenous species are also stenogamous. Little is known about the underlying factors responsible for the association of these two traits.

It is very difficult to conduct certain cage studies with eurygamous mosquitoes. For example, our efforts to assess the frequency of male-induced autogeny (O'Meara and Evans 1977) in a number of *Ae. taeniorhynchus* populations have been inhibited because mating does not occur in cages. Induced-copulation techniques (Fukuda and Woodard 1974) are successful with some *Ae. taeniorhynchus* populations, but not with others. Fortunately, the availability of the Puerto Peñasco strain provides a solution to this problem since males of the Puerto Peñasco strain will mate with eurygamous females from other *Ae. taeniorhynchus* populations.

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