Host preferences of various strains of *Aedes aegypti* and *A. simpsoni* as determined by an olfactometer*

H. K. GOUCK[1]

Abstract

The author describes and illustrates a new type of olfactometer that can be used to determine the host preference of different strains of Stegomyia *mosquitos. Experiments with human and animal hosts in Tanzania showed that dark strains of* A. aegypti *are much less anthropophilic than light strains.*

The evidence is strong that certain populations of *Stegomyia* mosquitos in Africa are anthropophilic in their biting behaviour and other populations are nonanthropophilic. Mukwaya et al. (East African Virus Research Institute, 1968) have shown that a West African strain (Ilobi) of *Aedes aegypti* preferred a human hand to a local species of rodent, while the *A. aegypti* strain from Bwamba, western Uganda, preferred the rodent to the human hand. They observed similar differences between two different strains of *A. simpsoni* from Uganda. To clarify the evidence further, a portable plastic olfactometer developed in the Gainesville Laboratory of the US Department of Agriculture was used in the WHO East African *Aedes* Research Unit, Dar es Salaam, Tanzania, to test the responses of different strains of *Stegomyia* to various hosts in competition.

Adult females of the following strains of *A. aegypti* were studied: (1) Dhow, of the light *queenslandensis* type, from a coastal dhow in Tanga city harbour; (2) Newala House, a light form approaching *typicus*, caught in houses in Newala, southern Tanzania; (3) Newala Bamboo, dark, captured in bamboo outside houses in Newala, southern Tanzania; (4) Oyster Bay, of the dark *formosus* type, from the Oyster Bay area on the northern outskirts of Dar es Salaam; (5) Rock Hole, dark, found in rock holes on the Msasani peninsula, 8 km north of Dar es Salaam; (6) Dodoma, dark, caught outside houses in Dodoma, east central Tanzania; (7) Keko, a mixture of dark and light types, from the industrial area of Keko, Dar es Salaam. The adult female *A. simpsoni* studied were caught in Mbagala, Dar es Salaam, and in the Ifakara-Mangula-Sanje region about 225 km south-west of Dar es Salaam.

The host subjects used in a series of "round-robin" tests were: man (African), 21 years, 61 kg, of slight build; man (Caucasian), 57 years, 96 kg, of heavy build; guineapig, black, weight 454 g; chicken, weight 681 g; and a wild rat (*Arvicanthis* sp.), weight 72 g. In the preliminary tests, an albino laboratory rat was substituted for the wild rat.

Apparatus and procedure

The olfactometer (Fig. 1) consists basically of a plastic mosquito cage (L); a pair of traps (F), each allowing entry through a cone-shaped screen serving as a funnel (I) and blocked at the other end by a flat mesh screen (E); a plastic test chamber divided into two sections lengthways (B); and a fan (N).

Sugar cubes and water are placed inside the cage (L). The removable rear screen (M) is securely taped on all four sides to prevent the mosquitos from escaping. The night before a test 125–150 adult female mosquitos, 6–9 days old, are introduced by aspirator through a port-hole (K) into the cage.

The two sets of plastic sleeves (C), traps (F), and screens (E and I) are washed in water and dried before each test. Rubber or plastic gloves must be worn whenever the apparatus is handled.

The clean traps (F) are inserted in the trap holders (J) at the front of the mosquito cage, the removable cone-shaped screens (I) being placed next to the port-holes (K) and the removable flat mesh screens (E) away from them. The washed sleeves (C) are slipped over the traps (F), either with a test subject such as a guineapig, chicken, or rat enclosed, or with the front open if the subject is to be the human hand.

The test chamber (B) is open at one end and divided by a sheet of plastic (O) to provide separate compartments for two subjects. At its closed end it has two

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[1] WHO consultant and research entomologist, Entomology Research Division, US Department of Agriculture, Gainesville, Fla., USA.

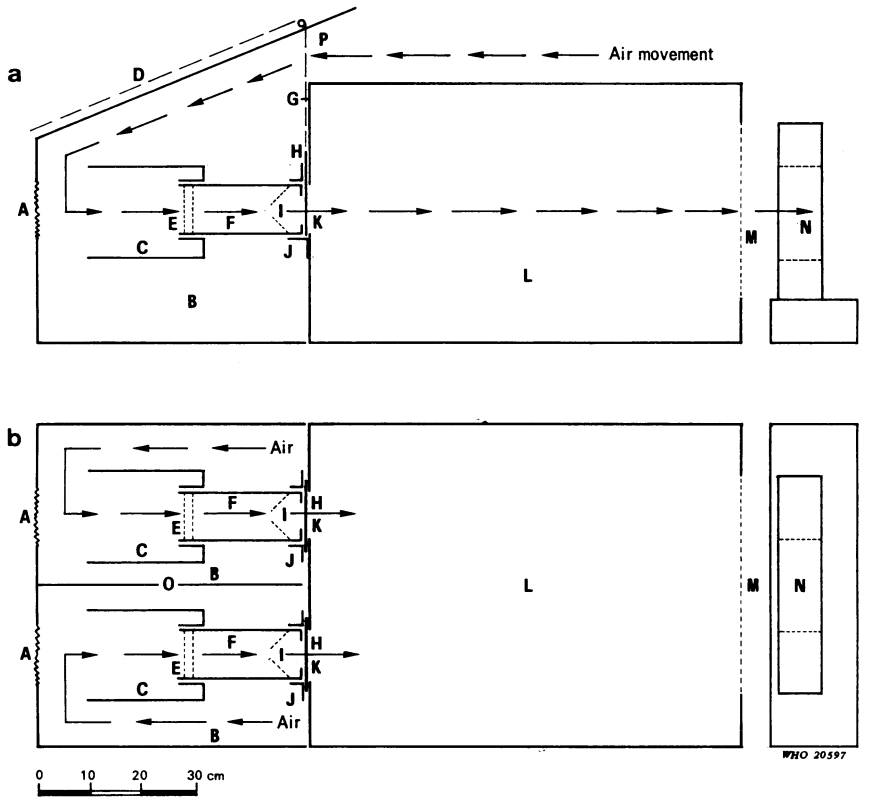

Fig. 1. *a,* Vertical cross-section of the olfactometer. *b,* Simplified plan. For an explanation of the lettering, see text.

diaphragm openings (A) that serve to admit the human hand as subject. To complete assembly, the test chamber is pressed tightly against the mosquito cage and taped to it on both sides and across the bottom.

Another major part of the olfactometer is the fan (N), which draws air through the device at a velocity of 37 m/min.

To carry out a test, the fan is set in motion and the mosquitos in the cage are agitated by tapping on the rear screen. The port-holes (K) are opened from the outside by a length of string (D) attached to the port-hole slides (H), and the slides are lifted until they are halted by the slide stops (G). The air is drawn in by the fan through the opening (P) facing away from the test chamber, through the sleeves (C) containing the subjects, and through the traps and open port-holes into the mosquito cage. The mosquitos are given 5 minutes to respond to the emanations entering the cage.

At the end of the 5-minute test period, the two port-holes are closed and the fan is turned off. The test chamber is separated from the mosquito cage and the sleeves, with any subjects enclosed, are removed from the traps. The mosquitos that have entered the traps are then counted. Large numbers of mosquitos are easier to count during the test, as they enter the traps.

The mosquitos are then replaced in the mosquito cage. First they are blown to the flat mesh screen end of the trap. The cone-shaped screen is then quickly removed and the open end of the trap inserted into a trap holder. The port-hole is opened and the mosquitos are blown back into the cage. After a rest period of 60–90 minutes, the next test can be performed.

The tests

In the preliminary series of tests, approximately equal numbers of the dark form (Oyster Bay strain) and the light form (Dhow strain) of *A. aegypti* were placed in the mosquito cage and were tested with the hand of an African man in one sleeve and with a guineapig (4 tests), an albino rat (3 tests), a chicken (4 tests), or a Caucasian man (4 tests) in the other sleeve. Each of the series of tests was performed on the same day, with intervening rest periods of 60–90 minutes. To ensure that the light and dark forms were properly identified, it was necessary to anaesthetize the trapped mosquitos with chloroform or carbon dioxide, although this tended to affect their responses as the tests proceeded.

In the " round-robin " tests, all 7 strains of *A. aegypti* and the 2 strains of *A. simpsoni* were tested with each subject (African man, Caucasian man, guineapig, chicken, and *Arvicanthis* sp.) in competition with every other subject. Each test was performed 4 times, with each subject situated twice at each port-hole.

Table 1. Average percentage response [a] of Oyster Bay (dark) and Dhow (light) strains of females of *A. aegypti* when man (African) was compared with guineapig, albino rat, chicken and man (Caucasian).

Oyster Bay (dark)	Dhow (light)	Oyster Bay (dark)	Dhow (light)
Experiment 1 : 60 dark ♀, 98 light ♀ [b]			
Guineapig		*Man (African)*	
(7) 12	(1) 1	(7) 12	(50) 51
(9) 15	(0) 0	(1) 1	(12) 12
(1) 2	(1) 1	(2) 4	(19) 19
(2) 4	(1) 1	(0) 0	(5) 5
8.2±3.1	0.8±0.5	4.5±2.6	21.5±9.9
Experiment 2: 58 dark ♀, 95 light ♀			
Rat (albino)		*Man (African)*	
(1) 2	(1) 1	(2) 3	(37) 39
(2) 3	(2) 2	(2) 3	(19) 20
(0) 0	(2) 2	(2) 3	(29) 30
1.7±0.9	1.7±0.3	3.0±0	29.7±5.5
Experiment 3: 58 dark ♀, 95 light ♀			
Chicken		*Man (African)*	
(19) 33	(6) 6	(0) 0	(28) 29
(5) 9	(7) 7	(0) 0	(12) 13
(4) 7	(0) 0	(1) 2	(20) 21
(4) 7	(2) 2	(0) 0	(10) 10
14.0±6.3	3.8±1.7	0.5±0.5	18.2±4.5
Experiment 4: 60 dark ♀, 100 light ♀			
Man (Caucasian)		*Man (African)*	
(4) 7	(14) 14	(6) 10	(47) 47
(0) 0	(11) 11	(0) 0	(9) 9
(2) 3	(15) 15	(4) 7	(10) 10
(0) 0	(5) 5	(1) 2	(12) 12
2.5±1.7	11.2±2.2	4.8±2.3	19.5±9.2

[a] The percentage of the females exposed that were attracted to that particular host in paired tests.

[b] The numbers in parentheses are the actual numbers of females attracted.

Results

In the preliminary tests (Table 1) the light Dhow strain showed a marked preference for man when the human hand was in competition with an animal (experiments 1, 2, and 3), whereas the dark Oyster Bay strain did not. Statistical analysis by means of two-by-two tests showed this difference betweeen the strains to be highly significant. The Oyster Bay strain showed no significant preference for the two mammals tested against man, but its preference for chicken as against man was significant at the 1% probability level.

The light forms showed greater activity than the dark under the confined conditions of the olfactometer. A high proportion responded to the emanations and entered the traps, whereas only a small proportion of the dark forms responded.

In the " round-robin " tests (Table 2), the dark strains of *A. aegypti*—Oyster Bay, Rock Hole, Dodoma, and Newala Bamboo—were found to prefer the chicken, guineapig, and wild rat to man (African or Caucasian). Although all the host subjects attracted some mosquitos, the light strains—Dhow and Newala House—preferred man (African and Caucasian) to chicken, guineapig, and wild rat. These preferences were statistically highly significant, the differences being far in excess of those necessary for significance at the 5% probability level. The Keko strain, which includes both light and dark specimens, showed very little preference between chicken (37%) and man (African) (32%) as compared with guineapig (25%) and wild rat (24%); man (Caucasian) attracted 11%.

The Newala Bamboo (dark) and Newala House (light) are examples of strains originating from the same locality. The House strain showed a greater anthropophilic tendency than the Bamboo strain.

Table 2. The average percentage response (and range of individual results) of *Stegomyia* adult mosquitos to 5 different hosts in paired competitive tests (4 tests)

Strains	% of mosquitos trapped by					LSD [a] (5 % level)
	African	Caucasian	Guineapig	Chicken	Wild rat	
			A. aegypti (average)			
Dhow (light)	46	44	5	8	9	12
Newala House (light)	43	31	15	27	16	13
Newala Bamboo (dark)	2	2	6	10	5	2
Oyster Bay (dark)	10	3	22	28	22	9
Rock Hole (dark)	7	1	19	40	22	8
Dodoma (dark)	4	4	24	43	28	11
Keko (light and dark)	32	11	25	37	24	12
			A. simpsoni (average)			
Mbagala	5	5	28	35	11	14
Ifakara-Mangula-Sanje	4	2	8	12	12	6
			A. aegypti (range)			
Dhow	16–69	30–56	1–9	3–15	7–15	
Newala House	22–50	12–52	4–20	14–39	3–24	
Newala Bamboo	0–4	1–2	0–10	3–20	0–6	
Oyster Bay	3–25	0–6	8–34	17–38	14–32	
Rock Hole	3–13	0–2	9–30	30–54	5–30	
Dodoma	1–6	1–13	16–37	31–63	14–45	
Keko	18–53	5–17	10–49	19–49	8–49	
			A. simpsoni (range)			
Mbagala	2–11	2–11	7–47	22–56	7–20	
Ifakara-Mangula-Sanje	1–9	0–7	1–14	7–19	2–19	

[a] Least significant difference (least difference between hosts necessary to show significance at the 5 % probability level).

Both strains of *A. simpsoni*, and especially the Mbagala strain, showed nonanthropophilic tendencies.

Conclusions

1. The new olfactometer can be used to determine the host preference of *Stegomyia* mosquitos.
2. The different strains of *Stegomyia* can be characterized as to host preference by means of the olfactometer. The experiments described above showed that the dark strains are much less anthropophilic than the light strains.

REFERENCE

East African Virus Research Institute (1968) *Report, 1967*, Entebbe, Uganda, East African Common Services Organization, pp. 55-59