AN EVALUATION OF THE EMERGENCE OR BOX TRAP FOR ESTIMATING SAND FLY (*CULICOIDES* SPP.: HELEIDAE) POPULATIONS

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INTRODUCTION. Emergence or box traps have long been used as a handy means of collecting adult insects emerging from nymphs or pupae contained in soil or debris. The Dove *et al.* (1932) type, modified in different ways has been most often used for sand fly work (Breeland 1960, Forattini *et al.,* 1958, for example). Most workers have however, been interested only in evaluating various habitats as breeding grounds during which studies the traps remained in position for relatively short periods. It was hoped that these traps could be used to investigate seasonal fluctuations in sand fly populations, namely *Culicoides furens* Poey and *C. barbosai* Wirth & Blanton in Jamaica, in which case they would be required to stay in position for several months.

The emergence trap offers many advantages over other means of larval sampling such as collecting mud samples of constant volume and extracting and counting the larvae contained, since identification of larvae in mixed populations is not practicable where large numbers are involved. The process of washing and sorting larvae is most tedious, whatever methods are used. By collecting adult sand flies which have just emerged from the ground beneath the trap, the emergence trap provides a handy collection of insects amongst which any particular species can be readily identified. Information regarding autogeny, fat body content, sex and emergence rates can also be sampled which could not be forthcoming from larval sampling.

Experience had shown that after the first week or two the presence of an emergence trap caused a considerable change in the substrate beneath it, especially when placed in mangrove swamps. The pneumatophores of the black *(Avicennia nidita)* and white *(Languncularia racemosa)* mangroves were stimulated to grow taller, and crabs often burrowed beneath the traps, throwing up mounds of mud which raised the level of the substrate considerably. In addition there was evidence to suggest that the traps were in themselves attractive to the larvae in that weekly catches tended to increase the longer a trap remained in position. This was possibly due to the negatively phototropic larvae congregating in the shade beneath the trap.

A trap placed on the surface and not equipped with metal skirts for sinking into the ground will continue to catch *C. furens* for at least 5 months. For example, a single wooden trap covering an area of 4 sq. ft. was placed by the edge of a pond at Greenwood near Montego Bay on 29th March, 1962. Adult *C. furens* were still being recovered from the trap at the rate of 15 per day when observations were discontinued on 17th September, 1962—5½ months later. Obviously, larvae were migrating into the trap from outside since normally the immature stages of the life cycle take 4–8 weeks to develop. The possibility of eggs being laid within the trap by newly emerged autogenous females is remote since on no occasion have fertilized females been taken in these traps.

The following study was undertaken to compare the effect of leaving traps stationary for a long period, with traps which were moved regularly, to see if there was any appreciable difference in catch between them; and to attempt to determine which method would be the most suitable for long term population studies.

METHODS. The traps used in this study were developed from those of Bidlingmayer (1961), consisting of a sheet of heavy tarred roofing felt rolled into a cone, and fastened with paper fasterers or staples, giving a basal opening of 2 sq. ft. in area and with a 2-inch diameter opening at the apex over which a glass jar was inverted. Emerging insects were trapped on the walls of the jar which was greased with castor oil. The jars were collected twice a week, taken to the laboratory where the sand flies were removed from the oil, identified and counted. This type of trap has many advantages over the wooden box type in that it is simple to construct, is cheap, and up to twenty can be stacked within each other for easy transportation.

Two sets of four traps were used, one set in heavy shade and the other in an open space. The area chosen was a mangrove swamp at Bogue adjacent to Montego Bay consisting mainly of young white mangrove saplings bearing a canopy at 15–20 ft., growing in fine black mud with a layer of leaf mould through which protruded a dense growth of fine pneumatophores covered with an algal felt. The area normally supports a large population of *C. barbosai,* moderate numbers of *C. furens* and a few *C. insignis* Lutz. The area is normally flooded twice a day to a depth of 3–6 inches by high tides.

The four traps in each set were placed about 8 ft. apart at the corners of a square and numbered 1–4 consecutively. The diagonally opposed numbers 1 and 3 were fixed in position whilst numbers 2 and 4 were moved slightly at each visit so that they sampled two alternate areas. The traps were visited on Mondays and Thursdays.

After observations had continued for 10 weeks it became obvious that the stationary traps were catching consistently more than the others. In case the stationary traps had been inadvertently placed in more favourable positions the status of the traps was then reversed with the even numbers remaining stationary and the odd numbers being moved.

The second set of four traps was placed in an open space approximately 12 yds. square which had been formed by the previous felling of all mangroves in the area. It was thought that a comparison between shade and open conditions might be of value since one would expect that the shade beneath the traps would be more attractive in the open where the contrast would be greater than in an area already shaded by vegetation. There was no discernable difference in the nature of the mud between the two areas.

RESULTS. Table 1 shows the total numbers of both sexes of sand flies obtained from each pair of traps each week. (*C. insignis* was not present in sufficient numbers for a comparison to be made.) The weekly interval was chosen for computation since it included a summation of the catches from both alternative positions occupied by the movable traps. Comparisons are shown between shaded and open sites, and between moved and stationary traps. The two species are best considered separately.

C. barbosai. This species was present in by far the greatest numbers, and obviously preferred the shaded habitat. In the shade, the moved traps caught the most during the first week only, with numbers almost equal during the second week; thereafter the stationary pair of traps caught in the order of twice the number of the moved traps. This superiority continued even after the status of the traps had been changed. In the open, much smaller numbers were caught, but once again where numbers were large enough to bear comparison the stationary traps caught the most, sometimes over-

TABLE 1.—Total numbers of both sexes of *C. barbosai* and *C. furens* taken in pairs of emergence traps each week. Differences between stationary and moved traps, and between shaded and open sites shown. After the tenth week traps which were originally stationary were moved, and vice versa. The ratio indicates superiority of stationary over moved catches.

	C. barbosai						*C. furens*					
	Shade			Open			Shade			Open		
Weeks	Stat.	Moved	Ratio	Stat.	Moved	Ratio	Stat.	Moved	Ratio	Stat.	Moved	Ratio
1	64	102	0.6	4	1	4.0	5	9	0.6	3	0	..
2	61	68	0.9	4	13	0.3	12	11	1.1	7	12	0.6
3	31	25	1.24	0	0	0	5	1	5.0	1	1	1
4	87	33	2.6	9	0	9	35	7	5.0	27	6	4.5
5	296	161	1.8	50	7	7.1	8	8	1.0	36	16	2.3
6	316	177	1.8	131	27	4.9	49	9	5.4	55	32	1.7
7	166	67	2.5	0	1	..	6	2	3.0	0	0	1.0
8	176	96	1.8	7	6	1.2	22	13	1.7	52	25	2.1
9	201	97	2.1	1	0	1	7	0	..	0	0	1.0
10	648	209	2.2	29	0	29	99	37	2.7	23	4	5.8
						Status Reversed						
11	45	178	3.9	0	1	1	6	31	5.2	0	2	2
12	267	639	2.4	0	2	2	13	20	1.5	0	5	5
13	56	328	5.9	0	19	19	3	1	0.3	0	1	1
14	296	2018	6.8	0	43	43	56	92	1.6	0	6	6
15	58	502	8.7	0	40	40	29	83	2.9	0	29	29
16	57	120	2.1	4	27	4.8	29	20	1.5	0	100	100
	Moved	Stat.	Ratio	Moved	Stat.	Ratio	Moved	Stat.	Ratio	Moved	Stat.	Ratio

whelmingly so as in the fifth, tenth and fourteenth weeks. Once again the change in status made no difference.

C. furens. This species appeared to be present in almost equal numbers in both shaded and open habitats. In the shade the stationary traps caught more sand flies, except for weeks 1, 2, 5 and 13 and this superiority was unaffected by the change in status after the tenth week. In the open, the stationary traps again caught more but the ratio between the two was much the same as in the shade. Unfortunately after the tenth week the moved traps failed to catch any sand flies, suggesting that there was a difference between moved and stationary sites in this case.

DISCUSSION. There is little doubt that the presence of an emergence trap tends to increase the density of the sand fly larval population beneath it, and that this increase appears to last indefinitely. Since it is not possible for gravid female sand flies to enter the trap to lay, one can only conclude that larvae must be entering the trap through the mud from outside. It is well known that both *C. furens* and *C. barbosai* larvae are negatively phototropic so it is most probable that the larvae enter the dark confines of the trap during the course of normal random movement in the mud, and that, on attempting to leave the dark, their tropism comes into action causing them to turn about and re-enter the trap. In this way larvae will enter under normal random feeding activities but will be unlikely to leave, causing a gradual build-up of population within the trap.

For this reason stationary traps give an exaggerated estimate of the larval population, and for population studies a trap which is regularly moved would appear to be more suitable. In addition to avoiding a build-up in population, moved traps would be more likely to sample normal populations since they would be repeatedly placed on sites on which eggs would have been recently laid.

The stationary trap could, however, be employed to sample areas of very low sand fly density, in connection with a control scheme for example, where its attractiveness can be used to determine the presence or absence of larvae with greater accuracy than the direct laboratory detection of larvae in mud samples.

ACKNOWLEDGMENTS. I am grateful to the Ministry of Health, Jamaica for permission to publish this paper.

References

BIDLINGMAYER, W. L. 1961. Field activity studies of adult *Culicoides furens.* Ann. Ent. Soc. Amer. 54(2):149–156.

BREELAND, S. G. 1960. Observations on the breeding habitats of some *Culicoides* and other Heleidae in the Panama Canal Zone (Diptera). Mosquito News 20(2):161–168.

DOVE, W. E., HALL, D. A., and HULL, J. B. 1932. The salt marsh sand fly problem. Ann. Ent. Soc. Amer. 25:505–522.

FORATTINI, O. P., RABELLO, E. X., and POTTOLI, D. 1958. *Culicoides* da Região Neotropical (Diptera: Ceratopogonidae) *II* Observações sôbre biologia em condições naturais. Arq. Fac. Saúde S. Públ. Univ. S. Paulo 12(1).