Cah. O.R.S.T.O.M., sér. Ent. méd. Parasitol., vol. IX, n° 2, 1971.

An increase in the proportion of parous females of *Culex pipiens fatigans* after two years of larval control in Rangoon, Burma

by

L. S. SELF *, M. H. M. ABDULCADER, H. L. MATHIS and A. SEBASTIAN

ABSTRACT.

Adult collections were made during each week of 1968 in an area of Rangoon sprayed (1.33 km²) with fenthion larvicide and in an unsprayed comparison area. Over 60,000 C. p. fatigans *were examined from indoor and outdoor collections. The results clearly showed that a higher percentage of parous mosquitos occurred in the sprayed area, which also had very low densities. It was not possible to conclude from the data obtained that the expectation of life of the vector had increased because of larval control.*

RÉSUMÉ.

Des captures hebdomadaires de femelles de C. p. fatigans *ont été faites durant toute l'année 1968, d'une part dans un quartier de Rangoon (1,33 km²) traité au fenthion en formulation larvicide, et d'autre part dans une zone témoin non traitée. Environ 60.000 femelles, provenant de captures à l'intérieur et à l'extérieur des habitations, furent examinées au cours de ces recherches. Les résultats montrent clairement que le pourcentage de femelles pares est plus élevé dans la zone traitée, où la densité avait été réduite de 100 fois, que dans la zone témoin. Ces données ne sont cependant pas suffisantes pour conclure que l'espérance de vie de ce moustique a été augmentée par suite de la lutte antilarvaire.*

* From the WHO Filariasis Research Unit, Rangoon, Burma.
Present address of the senior author is World Health Organization, C.P.O. Box 540, Séoul, Korea.

INTRODUCTION.

In larvicide and adulticide programmes, precise data on the proportion of parous females may be used to assess the degree of vector control achieved. It also may give an indication whether a control programme, particularly in the case of adulticides, is likely to achieve its epidemiological objective. GARRET-JONES and GRAB (1964) have discussed the interpretation of data on the proportion of parous females and the impact of residual sprays on the vectorial capacity of anopheline mosquitos.

DETINOVA (1962) points out that effective larval control programmes are not expected to cause reductions in the proportion of parous females as in residual adulticide programmes. On the contrary, an increase in the number of nulliparous females indicate that mosquitos are still breeding in the area and that shortcomings in the larvicidal work must be found and corrected.

This paper presents data on the proportion of parous females of *C. p. fatigans* collected in two areas of Rangoon. In Kemmendine (K.E.F.T.), intensive larval control procedures have been carried out for more than two years. Ahlone lies 1.6 km south of K.E.F.T. and is an Unsprayed Comparison Area (U.C.A.). The main purpose of this study was to determine whether any appreciable change has occurred in the parous condition of the females collected in the area under larval control.

AREA OF LARVAL CONTROL.

In March 1968, the W.H.O. Filariasis Research Unit (F.R.U.) began applying fenthion emulsifiable concentrate to breeding sites of *C. p. fatigans*. The original area covered 1.33 km^2 and was designated the Kemmendine Experimental Field Trial. In January 1967, the sprayed area was extended to cover 5.6 km^2, which included K.E.F.T., and outer area designated E.A., and a barrier zone, B.Z. The area was expanded to reduce the possibility of mosquitos infiltrating from unsprayed areas into K.E.F.T.

The present study includes adult mosquitos collected once each week in K.E.F.T. from January through December 1968. This period corresponds to 1.8 to 2.8 years after larval control began. Hence, sufficient time had elapsed to reduce infiltration and also enable control procedures to bring about a marked reduction in adult density. It will be noted later that wide fluctuations in monthly density did not normally occur in K.E.F.T. during this period. Data on 1968 temperature and rainfall are shown in table I.

TABLE I
Monthly temperature and rainfall in Rangoon, 1968

Month	Average temperature °C	Total rainfall mm
January	25	0
February	25	0
March	29	3
April	30	8
May	29	198
June	27	650
July	27	625
August	27	850
September	27	575
October	28	225
November	28	20
December	26	0

METHODS.

The routine collection of adult mosquito for assessment purposes, and standard F.R.U. laboratory procedures have been described (GRAHAM *et al.* 1968). In brief, mosquitos are collected resting indoors at six fixed stations in K.E.F.T. from 20.00 to 21.00 hours. The next three hours are spent outdoors collecting mosquitos that land on the body. Mosquitos are normally collected before appreciable feeding begins, and unfed stages account for 96 - 98 % of the total catch off human bait. Simultaneous tests are carried out in six to nine fixed stations in U.C.A. The next morning all mosquitos are identified, the ovaries of *C. p. fatigans* removed, and the proportion parous recorded after examining the ovarian tracheoles. About equal man hours of collecting are spent in the two areas.

The parous or nulliparous condition is determined in all non-green females in which the ovaries have not developed beyond Christopher's stage 2. All green mosquitos are assumed to be nulliparous and not dissected, as extensive field and laboratory tests at the F.R.U. have showed that the green colour does not persist beyond the third day of adult life of non-gravid specimens. It also should be noted that greens as well as older females are attracted to the human body for the purpose of ingesting blood (SELF and SEBASTIAN, 1969). The proportion parous reported here is therefore based on the ovarian condition of non-greens in which simple age-grading was possible and on the number of nulliparous greens. The greens represented a major portion of the outdoor population in U.C.A., and the exclusion of them from calculations on proportion parous would have resulted in higher parous rates in U.C.A. as well as K.E.F.T.

RESULTS.

Outdoor population.

Results are shown in table II. In U.C.A., wide seasonal fluctuations occurred in biting density (range : 136.1 — 17.1 females per man hour), which was inversely correlated with monthly rainfall. In K.E.F.T., fluctuations were less marked (4,2 — 0,5) although density likewise reached its lowest levels during the wet season.

In U.C.A., the fluctuations in proportion parous (range : 0,54 — 0,14) seemed to be inversely correlated with monthly density per man hour. GARRET-JONES (*personal communication*) points out that these fluctuations may be caused by fluctuations in output from breeding places and may not reliably reflect changes in longevity. Hence, it is unlikely that a true index of daily survival can be derived from the proportion parous in any month when the rate of emergence is exhibiting rapid increase or decline.

In K.E.F.T., fluctuations also occurred in proportion parous, but its levels were clearly higher ; the range being 0,94 — 0,39. Here the inverse correlation with density is less clear. The data from the two areas indicate that the seasonal relationship between adult density and proportion parous is a natural phenomenon.

In both areas, the proportion parous was related to the proportion green. An increase in proportion green indicates the recent emergence of adults from uncontrolled habitats, and this in turn causes a density increase and proportion parous decrease. The mean yearly data on proportion parous in K.E.F.T. and U.C.A., based only on dissected non-greens, was 0,92 and 0,77, respectively.

TABLE II

Density and proportion parous of *C. p. fatigans* biting outdoors in sprayed and unsprayed Areas

Month 1968	Total female mosquitos (proportion green in parenthesis)	Number females per man hour of collection	Proportion parous
	KEFT (Sprayed Area)		
January	226 (0.55)	2.5	0.39
February	306 (0.31)	4.2	0.62
March	87 (0.09)	1.2	0.85
April	92 (0.06)	1.1	0.92
May	86 (0.01)	1.2	0.94
June	47 (0.04)	0.6	0.85
July	198 (0.28)	2.2	0.69
August	35 (0.17)	0.5	0.73
September	72 (0.04)	0.8	0.92
October	129 (0.28)	1.8	0.63
November	118 (0.19)	1.6	0.69
December	101 (0.10)	1.1	0,81
Mean	1497 *a* (0.25)	1.6	0.69 *b*
	UCA (Unsprayed Area)		
January	9428 (0.83)	95.2	0.14
February	9800 (0.78)	136.1	0.19
March	6190 (0.73)	103.1	0.22
April	5047 (0.61)	67.3	0.34
May	3476 (0.63)	64.3	0.30
June	2170 (0.59)	37.1	0.35
July	1422 (0.56)	20.6	0.37
August	1464 (0.66)	20.3	0.30
September	1308 (0.65)	17.5	0.28
October	3382 (0.76)	62.6	0.20
November	4894 (0.79)	62.7	0.15
December	8240 (0.74)	83.2	0.21
Mean	56821 *c* (0.70)	65.8	0.22 *d*

a : Total females captured during 955 man hours.
b : Based on 369 greens, 1080 dissected non-greens ; equivalent to 96.5 % of total catch.
c : Total females captured during 864 man hours.
d : Based on 40041 greens, 16111 dissected non-greens ; equivalent to 98.8 % of total catch

Indoor population.

In U.C.A., marked seasonal fluctuations occurred in indoor density (45,3 — 12,0), which also appeared to be inversely correlated with monthly rainfall (table III). In K.E.F.T., the density was much lower and wide fluctuations (3,8 — 1,1) were not evident. In U.C.A., the density was much higher outdoors than indoors, and this can be attributed to more greens found outdoors. The indoor and outdoor density in K. E.F.T. however, was similar.

In U.C.A., the proportion parous indoors ranged from 0,69 — 0,32 as opposed (except for May) to 0,95 — 0,59 in K.E.F.T. (table III). Data from both areas indicated

TABLE III

Density and proportion parous of *C. p. fatigans* resting indoors in sprayed and unsprayed Areas

Month 1968	Total female mosquitos (proportion green in parenthesis)	Number females per man hour of collection	Proportion parous
	KEFT (Sprayed Area)		
January	122 (0.14)	3.8	0.68
February	51 (0.10)	2.1	0.84
March	38 (0.00)	1.6	0.90
April	31 (0.00)	1.0	0.95
May	51 (0.00)	2.1	1.00
June	25 (0.08)	1.1	0.78
July	99 (0.02)	3.3	0.80
August	32 (0.01)	1.3	0.71
September	69 (0.04)	2.3	0.64
October	88 (0.08)	3.7	0.59
November	62 (0.03)	2.6	0.83
December	40 (0.01)	1.3	0.83
Mean	708 *a* (0.06)	2.2	0.78 *b*
	UCA (Unsprayed Area)		
January	1.086 (0.37)	44.6	0.38
February	1.428 (0.45)	45.3	0.44
March	897 (0.37)	44.9	0.50
April	588 (0.18)	23.5	0.69
May	377 (0.19)	21.0	0.67
June	307 (0.16)	16.1	0.58
July	405 (0.34)	17.0	0.42
August	310 (0.23)	12.9	0.50
September	348 (0.28)	13.9	0.38
October	439 (0.39)	24.4	0.37
November	978 (0.41)	37.6	0.32
December	1.422 (0.27)	43.1	0.49
Mean	8.585 *c* (0.33)	29.9	0.46 *d*

a : Total females captured during 320 man hours.
b : Based on 39 greens, 265 dissected non-greens ; equivalent to 42.9 % of total catch.
c : Total females captured during 287 man hours.
d : Based on 2870 greens, 3430 dissected non-greens, equivalent to 73.4 % of total catch.

an older population existed indoors than outdoors. It should be noted that 57,1 % and 26,6 % of the females captured indoors in K.E.F.T. and U.C.A. respectively, were not separated into simple age-groups because of advanced ovarian condition.

A relationship between proportion green and proportion parous also was evident in the indoor populations. In both areas, the highest levels of proportion parous occurred when the proportion green was at its lowest levels. The mean yearly data on proportion parous in K.E.F.T. and U.C.A., based only on dissected non-greens, was 0,89 and 0,85, respectively.

Discussion.

Before larval control the proportion parous females of combined indoor-outdoor populations in K.E.F.T. ranged from 0,64 — 0,41 with the overage being 0,48 (DE MEILLON *et al.* 1967). These figures are considerably lower than those obtained after control. It is evident that the mosquito population in K.E.F.T. is now older after larval control.

A precise explanation for the higher percentage of older mosquitos in the sprayed area requires further study. Detailed information on possible changes in longevity is not yet available, although recent unpublished studies on flight range indicated significant infiltration was not occurring from outside the barrier zone. It was not considered desirable to calculate the daily survival from data on proportion parous.

Unpublished F.R.U. data for 1969 indicate that the number of breeding sites with larvae are still declining, the adult density and the percentage green have been further reduced, and the proportion parous females has increased slightly. This continuous interference in breeding by spraying polluted water and eliminating newly-discovered sources of container breeding, are also possible explanations for an inability of the parous rate to return to pre-control levels.

CONCLUSIONS.

The data presented herein indicate that intensive larval control procedures in an urban area has caused an increase in the proportion of parous females of *C. p. fatigans*. A precise explanation for the higher percentage of older mosquitos requires further investigation. The absence of marked increases in the proportion of very young mosquitos, coupled with low adult density, indicate that effective larval control is being continuously maintained.

ACKNOWLEDGEMENTS

We thank M. J. W. WRIGHT and Dr N. G. GRATZ of Vector Biology and Control, W.H.O., Geneva, for permission to publish this paper and for supporting the study. We also owe a great debt to M. C. GARRETT-JONES and Dr B. GRAB for reading several revised manuscripts and for offering many valuable suggestions. We also thank M. J. MOUCHET for commenting on the paper.

Manuscrit reçu le 8 février 1971.

RÉFÉRENCES

DETINOVA (T. S.), 1962. — Age-grouping methods in Diptera of medical importance. *World Health Organization Monograph* Ser. No. 47, 216 p.

GARRETT-JONES (C.) & GRAB (B.). — The assessment of insecticidal impact on the malaria mosquito's vectorial capacity, from data on the proportion of parous females. *Bull. Wld Hlth Org.*, **31**, 71 - 86.

GRAHAM (J. E.) *et al.*, 1968. — Studies on the control of *Culex pipiens fatigans* Wiedemann. WHO/VBC/68, 96., 20 p.

MEILLON (B. de), GRAB (B.) & SEBASTIAN (A.), 1967. — Evaluation of *Wuchereria bancrofti* infection in *Culex pipiens fatigans* in Rangoon, Burma. *Bull. Wld Hlth Org.*, **36**, 91 - 100.

SELF (L. S.) & SEBASTIAN (A.), 1969. — A high incidence of green colouration in newly emerged adult populations of *C. p. fatigans* in Rangoon, Burma. WHO/VBC/69. 124. 4 p.