

# A VILLAGE-SCALE TRIAL OF ALPHAMETHRIN (OMS-3004) AGAINST THE DDT RESISTANT MALARIA VECTOR *ANOPHELES ACONITUS* IN CENTRAL JAVA

Barodji, Sustriayu Nalim and Hadi Suwasono \*)

## ABSTRAK

Suatu uji coba tingkat pedesaan insektisida alphasmethrin (OMS-3004) telah dilakukan untuk menanggulangi vektor malaria *Anopheles aconitus*. Aplikasi dilakukan dengan penyemprotan seluruh dinding rumah (total coverage) dosis 100 mg/m<sup>2</sup> di daerah kecamatan Boja, kabupaten Kendal, Jawa Tengah, pada tahun 1985. *An. aconitus* di daerah tersebut sudah resisten terhadap DDT.

Hasil penilaian dengan parameter nyamuk yang menggigit orang di dalam dan di luar rumah, hinggap di kandang pada malam hari, hinggap di dalam dan di luar rumah pada pagi hari, menunjukkan bahwa insektisida ini efektif selama 6-8 minggu. Umur residu (residual effect) efektif (kematian *An. aconitus* 50%) selama 4 minggu pada permukaan kayu. Pengaruh fumigasi sangat rendah, hanya 8,69% *An. aconitus* mati dua minggu setelah penyemprotan.

## INTRODUCTION

During the past nine years (1976 - 1985) four synthetic pyrethroid compounds (chloropoxim, decamethrin, cypermethrin and baythroid) were tested in different formulation and dosages, to determine their residual effectiveness in village-scale trial. Since these insecticides do not possess any fumigant effect, they were not effective to reduce *Anopheles aconitus* densities in Central Java (Anonymous, 1983; Barodji *et al.*, 1983; Barodji *et al.*, 1984). Another new synthetic pyrethroid compound alphasmethrin (OMS-3004) has been tested in a house-scale trial against the DDT resistant *An. aconitus* in Central Java. The results of indoor residual spraying at a dosage 100 mg/m<sup>2</sup> and 200 mg/m<sup>2</sup> showed that this compound has a long residual life. Contact bioassay test using *An. aconitus* showed that the mortality of *An. aconitus*

is 70% or greater and this phenomena was maintained for about 25 weeks at a dosage of 100 mg/m<sup>2</sup> and 29 weeks at a dosage of 200 mg/m<sup>2</sup> on all surfaces sprayed (Barodji *et al.*, 1985).

Based on its long residual life it was recommended that this compound be investigated at a target dosage of 100 mg/m<sup>2</sup> in a village-scale trial, in which the impact of the treatment of houses, on the vector population is evaluated.

This paper reports the results obtained during the trial using a dosage rate of 100 mg/m<sup>2</sup>.

## MATERIAL AND METHODS

### Trial area

The area Kaligading, Boja Subdistrict was selected for treatment. This area has not been treated with any residual

\*) Stasiun Penelitian Vektor Penyakit, Puslit Ekologi Kesehatan, Badan Penelitian dan Pengembangan Kesehatan, Jl. Hasanuddin 123, Salatiga.

insecticides for five or more years. Kenteng area, in the same subdistrict is about 7 km from the periphery of treated area. It was selected as the control area.

The treated area is located about 27 km, and the control area about 20 km south-west of the city of Semarang. These areas are in the foothills of Mount Ungaran. The climate is warm and humid with temperatur from 20° C minimum to 34° C maximum. The annual rainfall is about 3000 mm with a rainy season from November to April. Rain seems to occur during every month of the year, however June to August are usually the driest months. The area are agricultural, with rice, the main crop being grown in irrigated terraced fields, the principal larval habitat of *An. aconitus*. Other crops are cassava, peanuts, sweet potatoes, fruits such as papaya, bananas, etc. grown near houses. The treated area contained about 20 hamlets, 7071 population, 1254 houses and 153 cattle shelters. The entomological evaluation hamlet, Kaligading, located in the center, has a population of 617 with 154 houses and 16 cattle shelters containing 32 cows and 19 buffaloes. The area was about 12 km<sup>2</sup> and is shown on the map (Fig. 1.). The check area of Kenteng consists of 65 houses with a population of 324, 16 cattle shelters with 52 buffaloes and 3 cows.

### Spraying operation

The Hudson X-pert<sup>R</sup> (8 liters suspension) compression sprayers were used for application of the insecticide. They are fitted with pressure gauges and operated

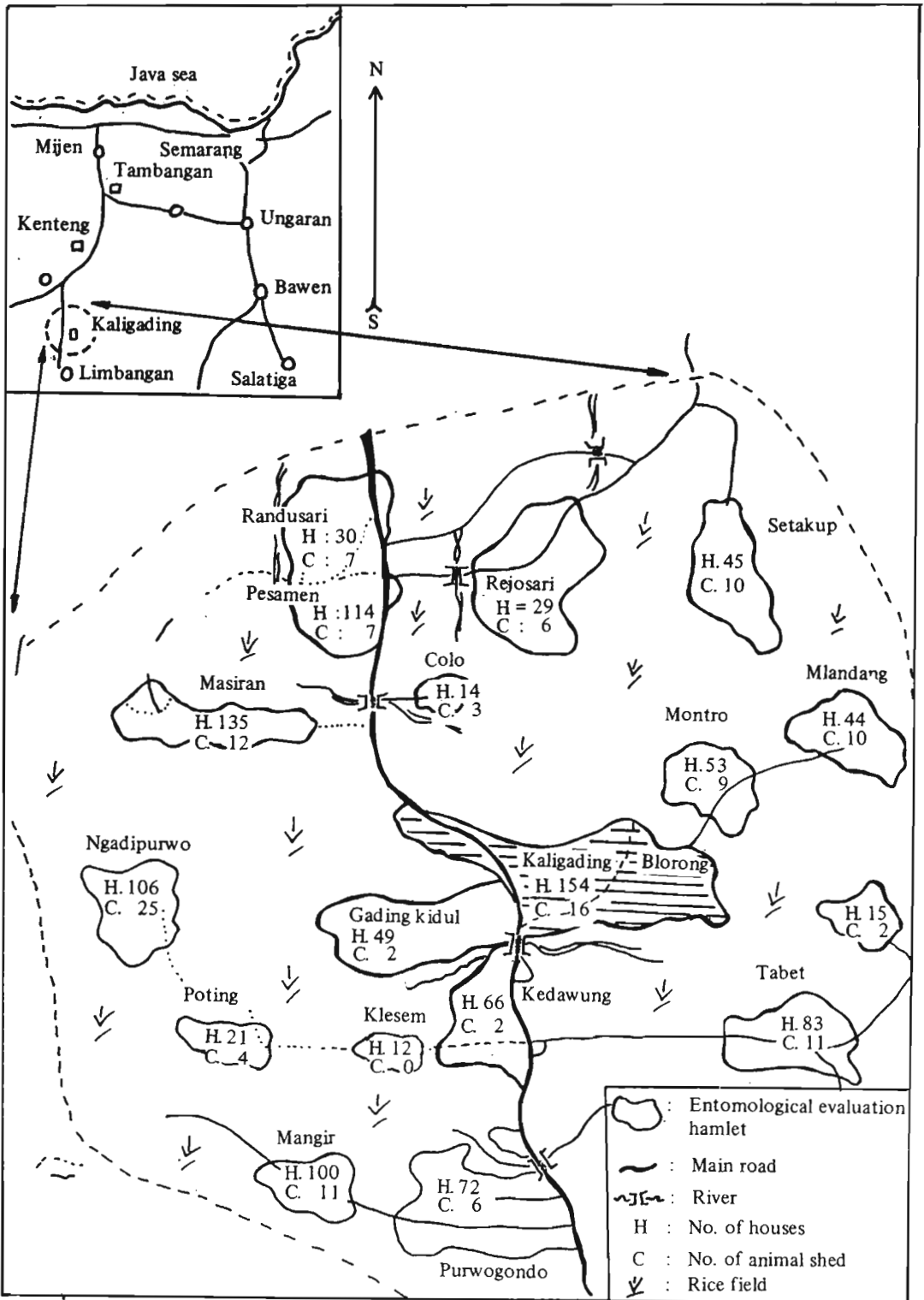
at a pressure 25 to 55 pounds per-square inch (psi.) with spraying system Co. Teejet<sup>R</sup> C-HSS8002E nozzle tips. Discharge rates on all new nozzle tips were determined, and those having rates 750 ml/minutes at 40 psi. were used, which was accordance to the WHO specifications of 757 ml/min.  $\pm$  5%. The tips were recalibrated after each week of spraying to check the amount of erosion at the orifice, that has taken place.

Alphamethrin (OMS-3004) a 5% wdp. was packaged into sprayer charges of 400 g. This gave the desired of 0.25% for 8 liters of suspension, to obtain a dosage of 100 mg/m<sup>2</sup>. The insecticide was packaged in strong plastic bags and sealed with two rubber bands to prevent leakage. The 1254 houses were planned to be sprayed in 17 days, starting with the hamlets located on the periphery and working inward to the entomological evaluation hamlet in the center. The interior walls of the houses as well as undersides of the furniture shelves and other horizontal surfaces, were sprayed if the latter overhang the walls by 1 m or more and all eaves were sprayed from the outside to a height of 3 m. Cattle shelters and all existing buildings were also sprayed.

Spraying was carried out by four squads, each composed of four spraymen and a squad chief.

Precautionary and protective measures for sprayman and inhabitants were as previously described by Joshi *et al.*, 1977.

Fig. 1. Map showing Treated Area of a Village-scale Trial with Alphamethrin (OMS-3004) 5% Wdp. at a dosage of 100 mg/m<sup>2</sup>



## Entomological evaluation

Densities of *An. aconitus* in treated and untreated areas were estimated by fortnightly collections in one hamlet in each area. Mosquitoes were collected three months before spraying. The following types of collections were made; landing on man indoors and outdoors using each two collectors in two different houses and two fixed sites outside houses from 18.00 - 22.00 hours (collectors were rotated every hour); two collections were made in cattle shelters, searching resting mosquitoes for 15 minutes each hour from 18.00 - 22.00 hours; in the morning collections, two collectors searched in 16 houses spending 15 minutes in each houses from 07.00 - 09.00 hours; four collectors, two collectors searched the hollow cavities eroded and under overhanging rocks along stream banks, and two collectors on the vegetation along irrigation canals.

All *Anopheles* mosquitoes from the above types of collections were identified to species and sexed. Ovarian dissections were made on fed and unfed *An. aconitus* for determination of parous rates.

Contact bioassay tests are conducted about two weeks after treatment and afterwards monthly to compare with the house-scale trial. Air bioassay tests were conducted weekly following treatment. These bioassay tests were conducted using the WHO-standard methods (WHO, 1975).

## RESULTS AND DISCUSSION

### Spraying operations and toxicology

Spraying was completed in 17 days, from 4 to 22 February 1985. A total of 1254 houses were sprayed with an average of 4.60 houses/sprayman/day. One householder refused to have his house sprayed. A total of 1521 sprayer charges were used for an average of 1.213 charges/house or 24.258 g of active ingredient per-house. The average house has 240 m<sup>2</sup> of sprayable surface yielding a dosage of 101 mg/m<sup>2</sup>, which is closed to the target dosage of 100 mg/m<sup>2</sup>. There were no probleme in mixing this insecticide as it readily went into suspension.

Fifty percent of nozzle tips Teejet<sup>R</sup> C-HSS8002E, were discharging 800 ml/min. or more by 17 days or after spraying an average of 520 liters of suspension this indicate a rapid rate of nozzle tip erosion with this 5% wdp. formulation (Table 1.)

Inhabitants complained that their faces felt hot for one or two days following spraying. Some complained of itching during the first day after spraying. Sprayman and packagers complained that following the required bath at the end of each work day their faces felt hot which lasted to bed time but by morning it had disappeared. During the first week sprayman complained of itching, however, during the second and third week this was no longer a problem.

**Table 1. Calibration of the nozzle-tip (Co. Teejet<sup>R</sup> C-HSS 8002 E) before and after spraying to check the amount of erosion of the orifice in alphamethrin 5% wdp trial. 1)**

Sprayman	Discharge rates of nozzle-tip		Days after spraying
	Before spraying ml/30 min.	After spraying ml/30 min. <sup>2)</sup>	
1.	375	420	6
2.	375	390	17
3.	375	395	17
4.	375	400	17
5.	375	400	12
6.	375	400	12
7.	375	395	17
8.	375	410	17
9.	375	430	12
10.	375	415	12
12.	375	395	17
13.	375	390	17
14.	375	400	12
15.	375	425	6
16.	375	385	17

1) Nozzle tip calibration were determined at 40 psi.

2) After spraying 9 out from 16 nozzle tip (56%) have eroded (discharge rates  $\geq$  400 ml/30 minutes).

### Entomological evaluation

The result of entomological evaluation are given in Table 2 and Fig. 2 to 4.

Indoor and outdoor landing rates on man (Table 2 and Fig. 1A and 1B) after spraying was reduced for about 6 weeks (i.e. 0,45 per-man/hour average before spraying to 0,37 per-man/hour six weeks after spraying for indoor and 0,37 per-man/hour average before spraying to 0,63 per-man/hour six weeks after spraying). In untreated area indoor and outdoor land-

ing on man was respectively 0,31 and 0,34 per-man/hour average before treatment, while six weeks after treatment it was 0,50 per-man/hour. Due to very low numbers of mosquitoes collected for these parameters before and after spraying, parous rates could not be used to evaluate the insecticidal impact.

Diurnal resting mosquito populations in houses (Table 2 and Fig. 2 C.) was reduced for about 8 weeks from about 2,82 per-man/hour average before spraying to 1,38 per-man/hour to 1,38 per-man/hour

Table 2. Density (per-man/hour) and parous rates of *An. aconitus* in treated (Tr.) and Untreated (Untr.) area before and after spraying

Type of collection (Parameter)	Average before spraying	Weeks after spraying						
		2	4	6	8	10	12	
<i>Landing on man Indoor</i>								
Density	Tr.	0,45	0,31	0,12	0,37	0,69	0,12	0,69
	Untr.	0,31	0,19	0,56	0,50	0,56	0,37	0,50
Parous	Tr.	21/28	2/5	1/2	0/6	5/11	1/1	0/2
	Untr.	11/20	1/3	2/9	2/6	6/9	2/3	2/4
<i>Outdoor</i>								
Density	Tr.	0,37	0,44	0,75	0,63	2,25	0,62	1,00
	Untr.	0,34	0,50	1,00	1,69	2,39	0,37	0,87
Parous	Tr.	3/7	3/12	4/10	12/14	8/36	4/5	3/4
	Untr.	8/20	3/8	7/16	14/27	10/43	2/3	1/7
<i>Resting in houses</i>								
Density	Tr.	2,82	1,50	1,13	1,75	1,38	2,75	0,75
	Untr.	2,93	7,38	5,38	3,25	3,63	1,50	5,25
Parous	Tr.	32/54	2/11	5/9	5/13	8/16	10/10	1/3
	Untr.	20/61	29/50	20/33	8/20	4/10	5/6	11/18
<i>Resting in cattle shelters</i>								
Density	Tr.	185,60	160,75	56,50	77,00	102,25	55,00	114,50
	Untr.	129,10	78,50	169,00	195,25	140,25	62,00	131,50
% Parous	Tr.	50	27	40	31	37	74	66
	Untr.	33	28	48	62	58	89	56
<i>Resting in natural outdoor</i>								
Density	Tr.	57,50	61,49	58,00	34,63	52,63	45,37	42,60
	Untr.	95,70	117,37	141,06	96,00	62,25	63,62	102,50
% Parous	Tr.	51	35	50	39	39	53	52
	Untr.	53	53	60	52	47	63	49

eight weeks after spraying. The mosquito densities in untreated area at the same period increased from about 2,82 per-man/hour average before spraying to 3,63 per-man/hour after spraying.

The densities and parous rates of *An. aconitus* resting in cattle shelters (Table 2 and Fig. 3 A and B.) in treated area was reduced for about 8 weeks after spraying. The mosquito densities declined from about 185,60 per-man/hour average before spraying to 102,25 per-man/hour and parous rates declined from about 50% average before spraying to 37%, it then increased to 74% ten weeks after spraying. The mosquito densities in the untreated area was 129,10 per-man/hour average before spraying and 140,10 per-man/hour eight weeks after spraying, while parous rates showed an increase from about 33% average before spraying to 58% eight weeks after spraying.

The diurnal densities in natural out-

door sites in the treated area after spraying were reduced for about six weeks, from about 57,50 per-man/hour average before spraying to 34,63 per-man/hour six weeks after spraying. Parous rates reduced for about eight weeks, from about 51% average before spraying to 39% eight weeks after spraying. In the untreated area, the mosquito densities and parous rates at the same period remain high, before (95,70 per-man/hour for density and 53% for parous rates) and after spraying (96,00 per-man/hour for density and 47% for parous rates).

The results of the bioassay tests are presented in Table 3. Mortality of 50% was observed in the contact bioassay tests only for four weeks after spraying on wood surfaces in houses, while at the same time on bamboo surfaces it was only 28,60%. The mortality on wood and bamboo surfaces in cattle shelters two weeks after spraying were only 20% and 28.90%

**Table 3. Percent mortality of *An. aconitus* in bioassay tests of houses and cattle shelters treated with 20 mg/m<sup>2</sup> Alphamethrin 5% wdp.**

Days after spraying	Contact bioassay tests 1)				Air bioassay tests 1)	
	Surface treated				Houses	Cattle shelters
	in houses		in cattle shelters			
Wood	Bamboo	Wood	Bamboo			
16	57,30 (89)	17,20 (93)	4,30 (46)	2,30 (44)	5,47 (146)	8,69 (92)
24	52,20 (92)	28,60 (91)	0,00 (45)	28,90 (45)	1,37 (145)	4,00 (100)
30	20,20 (89)	20,00 (95)	2,20 (45)	21,70 (46)	<i>Discontinued</i>	
38	5,20 (96)	8,50 (94)	5,20 (46)	13,60 (44)		

1) No. of mosquitoes tested in parenthesis.

respectively. These contact bioassay test results are quite different as compared to the house-scale trial results. The residual effectiveness (mortality 70% or greater) of this compound in the house-scale trial was maintained for 25 weeks (Barodji *et al.*, 1985), while in this trial 70% was never achieved. The difference in result is not clear, because both trials were conducted in the same area, same method and same dosage. However, both trials were carried out in different seasons (house-scale trial in dry season and village-scale trial in wet season) using different samples of this compound. Possibly, due to complaints from the inhabitants the walls were probably swept and cleaned by the house holder, so that degradation of the residual impact was rapid.

Bioassay of the airborne effects of alphamethrin in this trial was well in accordance to the result of house-scale trial. The mortality of *An. aconitus* only 8,00% occurred one week after spraying.

## CONCLUSION

Evaluation of the mosquito densities (Fig. 2 to 5.) indicates that the maximum effectiveness of alphamethrin in this trial was about eight weeks. All indices measured showed similar results. Parous rates of *An. aconitus* resting in cattle shelters at night and in natural outdoor was also reduced for about eight weeks.

Recalibration of nozzle tips showed that 56% of the nozzle tips were discharging 800 ml/minute or more by 17 days of spraying, this indicated a rapid rate of

nozzle tip erosion with this 5% wdp. formulation.

The formulation of alphamethrin used presented a small problem to the inhabitant and spraymen, however the trial could be terminated successfully.

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## REFERENCES

- World Health Organization (1975), Manual on practical entomology in malaria, Part II, WHO-Geneva.
- Barodji, R.F. Shaw, G.D. Pradhan and Sustriayu Nalim (1985), A village-scale trial of by-throid (OMS-2012) for control of the malaria vector *Anopheles aconitus* in Central Java, Indonesia, *Bull. Pen. Kes. Vol. 13 No. 1*, 1985.
- Barodji, Damar Tri Boewono, Sustriayu Nalim, R.F. Shaw and G.D. Pradhan (1985), House-scale trial of alphamethrin (OMS-3004) against DDT resistant *Anopheles aconitus* in



Central Java, *Bull. Pen. Kes. Vol 13 No. 1*, 1985.

Joshi, G.P., L.S. Self, R.F. Shaw, and Supalin (1977). A village-scale trial of fenitrothion

(OMS-43) for the control of *Anopheles aconitus* in Semarang area of Central Java, Indonesia, Unpublished WHO document WHO/VBC/77.675.

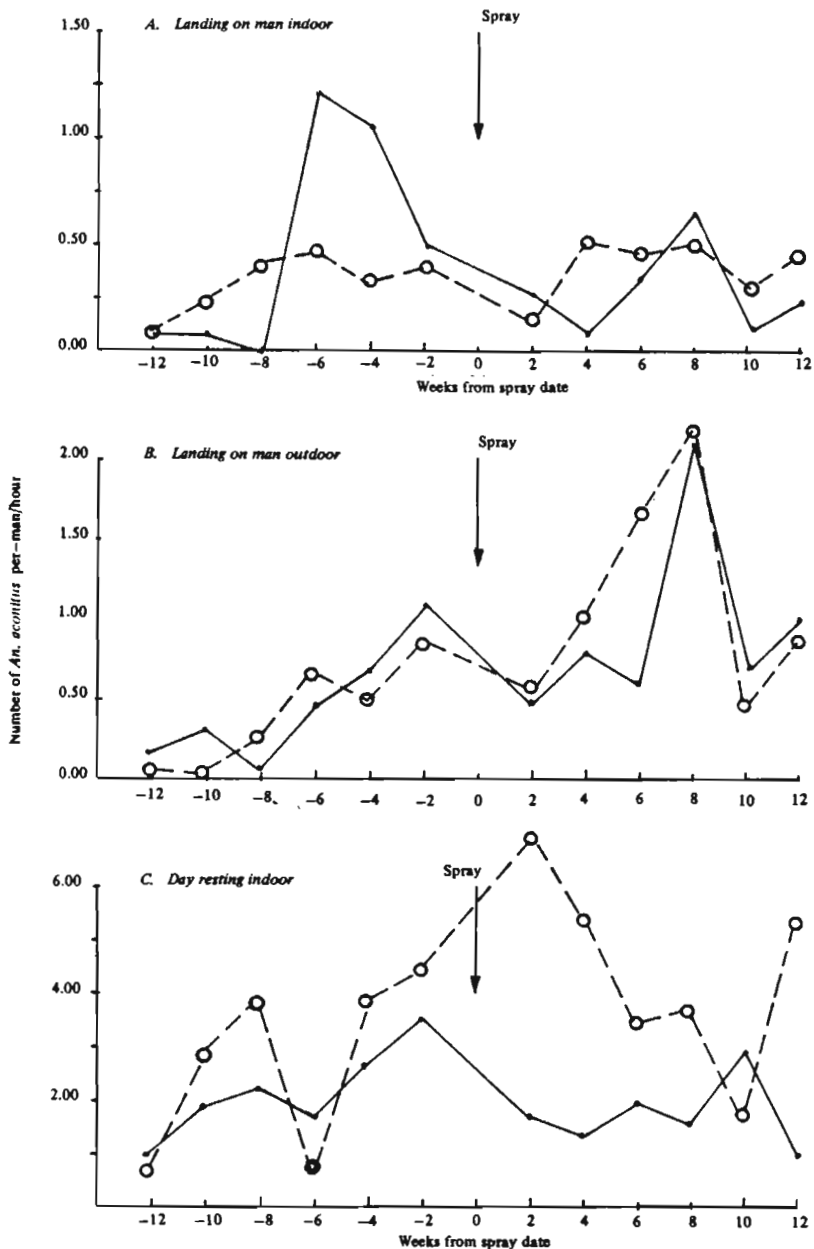


Figure 2. Number of *An. aconitus* per man-hour landing on man indoor (A), outdoor (B) and day resting in door in treated (——) and untreated areas (O---O---O---O).

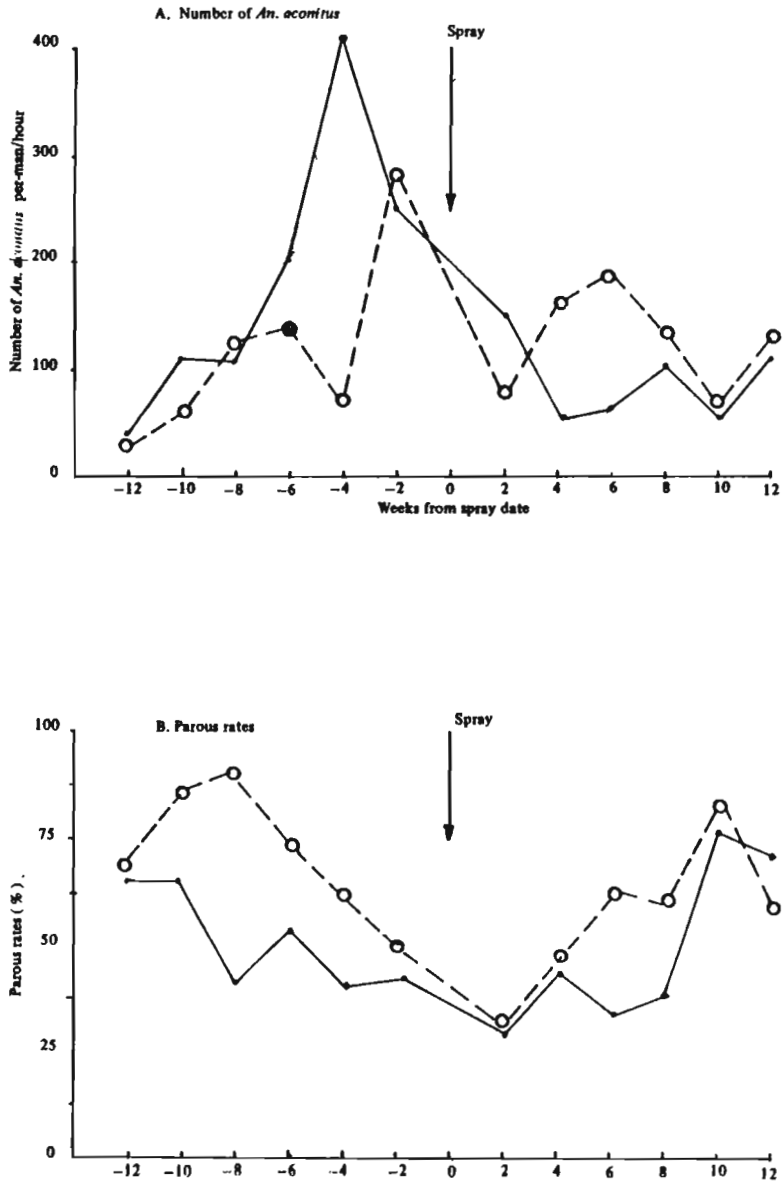


Figure 3. Number of *An. aconitus* per man-hour (A) and parous rates (B) of nocturnal resting collection in cattle shelters in treated (—●—) and untreated areas (O---O---O).

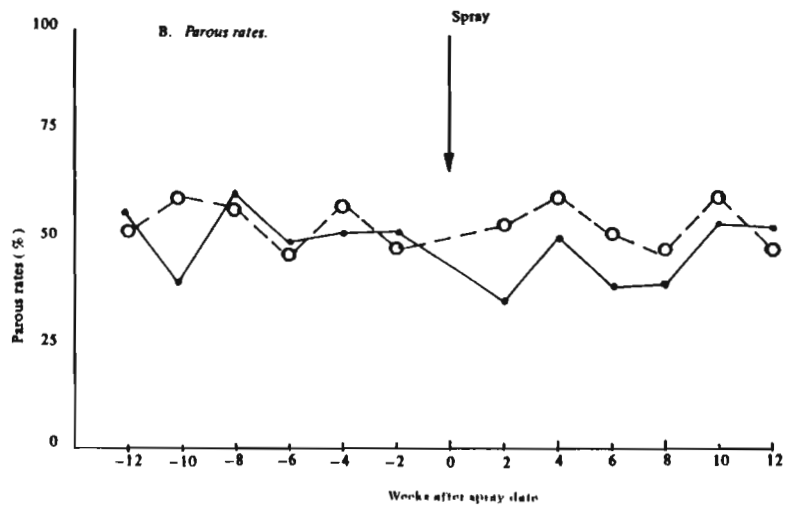
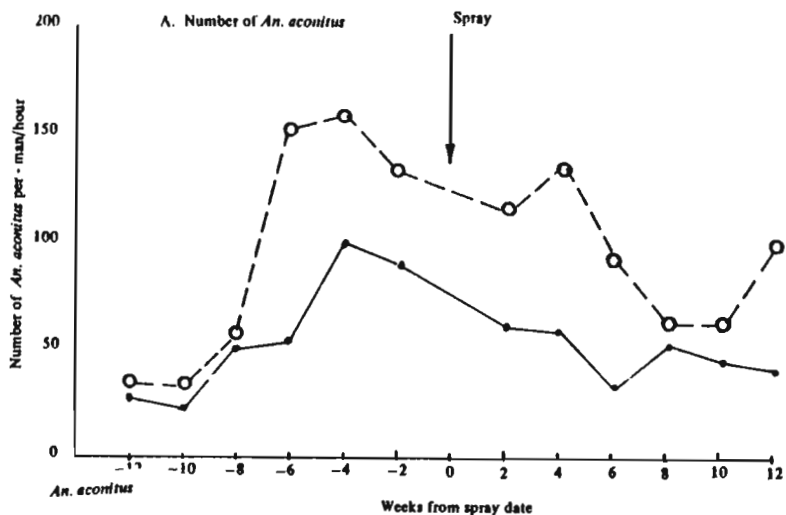


Figure 4. Number of *An. aconitus* per man-hour (A) and parous rates of diurnal resting collection natural outdoor in treated (—●—) and untreated areas (O---O---O)