A VILLAGE–SCALE TRIAL OF BAYTHROID (OMS–2012) FOR CONTROL OF THE MALARIA VECTOR *ANOPHELES ACONITUS* IN CENTRAL JAVA, INDONESIA *

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ABSTRAK

Pengujian racun serangga baythroid 10 % wdp. tingkat pedesaan (stage IV) dosis 100 mg/m^2 telah dilakukan untuk menanggulangi vektor malaria *Anopheles aconitus* yang telah kebal terhadap DDT di daerah pedesaan dekat Semarang, Jawa Tengah.

Hasil percobaan ini menunjukkan bahwa penyemprotan racun serangga baythroid efektip selama 8 minggu untuk menanggulangi populasi *An. aconitus* yang hinggap di kandang malam hari, di dalam rumah dan di luar rumah pada pagi hari. Sedang jumlah *An. aconitus* yang menggigit orang di dalam dan di luar rumah pada 3 minggu sesudah penyemprotan tampak mulai meningkat. Umur residu yang efektip racun serangga ini (kematian *An. aconitus* $>$ 70 %) pada permukaan bambu di dalam rumah adalah selama 5 minggu setelah penyemprotan, sedang pada permukaan kayu kematian tidak mencapai 70 %, kecuali pada penilaian minggu ke 4 setelah penyemprotan. Pengaruh fumigasi racun serangga baythroid adalah sangat lemah, kematian hanya sebesar 3,5 % di dalam rumah dan 4 % di dalam kandang pada 4 hari setelah penyemprotan.
Selama percobaan tidak ditemui adanya kesulitan dalam membuat suspensi, hambatan pada tangki penyemprot, maupun masalah keracunan dalam penggunaan racun serangga ini.

INTRODUCTION

Anopheles aconitus Donitz is the main malaria vector on the Island of Java and was first reported resistant to DDT and dieldrin by Soerono *et al.* (1965) in many areas of Central Java due to agricultural use of these insecticides in rice-field, the principal larval habitat. Secondly O'Connor and Arwati (1974) found wide-spread DDT resistance in Central Java in the early 1970's and by late 1970's DDT resistance occurred throughout most of the provinces of Central and East Java (Santijo, p.c.). Malaria transmission continues to occur in areas sprayed with DDT which indicates that it is no longer an effective insecticide. Therefore, alternative insecticides are being investigated at the village-scale trial level.

During the past seven years (1976 – 1982) three synthetic pyrethroid (chloropoxim, decamethrin and cypermethrin) compound in different formulation and dosages were tested to determine their residual effectiveness in village-scale trial. Another synthetic pyrethroid compound, baythroid, has never before been field tested against *An. aconitus* in Central Java. Here a village-scale trial of baythroid in Central Java against DDT resistant *An. aconitus* is presented.

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MATERIAL AND METHOD

Trial area.

The trial was carried out in an area described in detail by Joshi *et al.* (1977), about 27 km southwest of Semarang city in the northern foothill of Ungaran Mountain, at an altitude of 300 — 350 m surrounded by terraced ricefields. The climate is hot and humid. The average rainfall per year is about 3000 mm. The rainy season is from December to April with rainfall occurring sporadicaly in the other months. The months June to August are considered to be the driest. The temperature ranges between 20°C and 33°C. The area is agricultural with rice being the main crop, grown in terraced irrigated fields. The other important crops are corn, cassava, peanuts, and vegetables. Fruit trees grown around houses and in hilly areas not suitable for rice cultivation. A group of houses forms a hamlet (kampung) and a series of hamlets scattered over an area of about 5 — 10 km^2 make up a village (desa). Houses are with wood frames with wood or woven bamboo walls having mostly tiled roofs and few with thatch. They are relatively large having 250 — 350 km^2 of sprayable surfaces. About 40% of the surfaces are often painted or whitewashed. Water buffaloes, cows or other animals are kept in an enclosed shelter attached to the house or in an opensided shelter near the house.

The treated area measures 10km^2 and consists of 13 hamlets with 886 houses and a population of 3,962. The hamlet Polaman having 141 houses and a population of 710 and 21 cattle shelters with 21 buffaloes and 26 cows in the centre of the treated area was taken for entomological evaluation.

The hamlet Kaligading located 10 km south of the treated area with 148 houses and population of 644 peoples and 14 cattle shelters with 31 buffaloes and 13 cows was the untreated comparison area (check).

Spraying operation.

Spraying operations were carried out in 15 working days, from 22 March to 8 April 1983 and the evaluation hamlet was treated on 24 and 26 March. Two spray-squads, each consisting of five spraymen and one squad chief, were supervised by local malaria service officials assisted by WHO official and their national counterparts. The 10% wdp. baythroid was prepacked into pump charges of 200 g and was applied at a target dosage of 100 mg/m^2 using Hudson X-pert^R compression sprayers fitted with pressure gauges and C-HSS 800 2E nozzle tips calibrated for an initial discharge of 760 ml/min at 40 psi. Sprayable surfaces were walls inside and ceiling of houses to 3 m, underneath beds, furniture, behind cabinets, and outside walls. If the roof projected one meter or more were sprayed. Cattle shelters and all outbuildings were also sprayed inside to 3 m.

Safety precautions and toxicology.

Safety and protective measures for spraymen and inhabitants as described by Joshi *et al.* (1977) were used. Baythroid is not a cholinesterase inhibitor therefore these tests were not carried out on spray personnel.

Entomological evaluation.

Densities of *An. aconitus* were measured weekly in treated and untreated areas in fixed sites which were selected for their productivity during the pretreatment period. The pre-treatment entomological data were collected for 21 weeks and continued after treatment for 12 weeks.

The following types of collection were made :

Night collection (18.00 — 22.00).

a. Indoor landing on main three houses, by three collectors, one in each house and rotating every hour.
b. Outdoor landing on man in three houses, by three collectors, one in each house and rotating every hour.
c. Searching resting mosquitoes in two cattle shelters for 15 minutes per-shelter/hour.

Morning collection (07.00 — 09.00).

a. Searching resting mosquitoes in 16 houses by two collectors, each searches in 8 houses spending 15 minutes per-house.
b. Searching resting mosquitoes in natural outdoor places (2 collectors in vegetation along irrigation cannals and 2 collectors along stream banks.
c. One collector searches resting mosquitoes in four cattle shelters for 15 minutes per-cattle shelter.

Ovary dissections were made in all collections for the determination of parous rates.

Air bioassay tests were carried out using laboratory reared, freshly blood fed *Aedes aegypti*, using 12 cm^3 cages with 20 — 25 mosquitoes per-cage, hung in the corner at a distance of 50 cm from side walls and ceiling in houses and cattle shelters at night for 4 hours. Wild caught blood fed *An. aconitus* were used for contact bioassay tests. These bioassay tests were carried out in accordance with standard WHO methods (Anonymous, 1976). Mortalities for both types of bioassays were recorded after 24 hours exposure.

RESULTS AND DISCUSSION

Spraying operation

The spraying operation was completed within 15 days covering 866 houses out of 885, using a total of 1029 pump charges (200 g) i.e. ± 23.3 active ingredient per-house which was close to 100 mg/m^2 target dosage. One closed house could not be sprayed because the owner has moved to another subdistrict.

Erosion of nozzle tips was very slight after 15 days of spraying operations.

Safety and protective measures for spray personnel, house-holders and domestic animals as used in previous trials were followed and resulted in no toxicological problem.

Entomological evaluation.

Landing densities of *An. aconitus* on man indoor and outdoor were not reduced from pre-treatment levels and actually increased (Fig. 1 and Fig. 2). In the treated area indoor landing rates on man increased from 0.70 per-man/hour during six weeks before spraying to 1.30 per-man/hour during three weeks after spraying and outdoor landing rates on man increased from 2,95 to 4,40 per-

man/hour (Table 1). However parous rate of indoor landing in the treated area reduced from 52% before spraying to 39% for about six weeks after spraying (Table 1 and Fig. 1) and parous rate of outdoor landng reduced from 60% before spraying to 29% for about three weeks after spraying (Table 1 and Fig. 1).

The nocturnal resting densities in cattle shelters and parous rate were slightly reduced for about eight weeks compared to pre-treatment and check area (Fig. 3). Resting densities in cattle shelters at night reduced from 68.00 per-man/hour before spraying to 64.00 per-man/hour during nine weeks after spraying, which in untreated area increased from 181.50 to 374.00 per-man/hour (Table 1). Parous rate were reduced from 49% before spraying to 42% during six weeks after spraying.

The diurnal resting densities in cattle shelters were greatly reduced for about 12 weeks compared to pre-treatment and check area (Fig. 4). The density in treated area reduced from 111.00 per-man/hour before spraying to 90.00 after spraying and in untreated area increased from 136 to 220 per-man/hour (Table 2). Parous rate was also reduced for 12 weeks, from 59% before spraying to 49% after spraying, while in untreated area increased from 60% to 67% per-man/hour.

The densities diurnal resting in houses after spraying ranged from 0.50 to 1.00 remained below the check area ranged from 6.90 to. 7.30 per-man/hour for 12 weeks and the number of mosquitoes collected following treatment was too low to calculate parous rate (Table 2 and Fig. 5).

The diurnal resting densities in natural outdoor sites after spraying were not reduced when compared before spraying, but remained below the check area for twelve weeks (Fig. 6). Densities in natural outdoor sites ranged from 28.00 to 41.00 per-man/hour after spraying were not reduced when compared 32.50 per-man/hour before spraying. Densities in the check area were 43.00 per-man/hour before spraying and ranged from 35.00 to 45.00 per-man/hour during twelve weeks after spraying (Table 2). Parous rates in treated area reduced from 39% before spraying ranging from 18 to 26% during 12 weeks after spraying, whereas the check area remained high before (42%) and after spraying period (ranged from 35 to 45%) (Table 2).

Contact bioassay tests with wild caught blood fed *An. aconitus* on bamboo surface in houses resulted in mortalities above 70% for five weeks. Other results were erratic and not reaching 70% mortality except on the fourth week on wood in cattle shelters (Table 3). The airborne effect of this insecticide was negligible, percent mortalities ranged from 3,5 to 4,0% four days after spraying.

CONCLUSIONS

This village-scale trial of baythroid at a dosage of 100 mg/m^2 showed that it was effective to control the population of DDT resistant malaria vector *An. aconitus* resting in houses, cattle shelters and in natural outdoor resting places for eight to 12 weeks. However, man vector contact was not reduced and actually increased following treat-

Table 1. Night collections. Indoor and outdoor landing and cattle shelter resting densities of *An. aconitus* before and after treatment in treated and untreated area.

Type of collection	Before spraying $\bar{X}$: 1 – 6 weeks		Weeks from spray date							
			3		6		9		12	
	Density *)	% parous	Density *)	% parous	Density *)	% parous	Density *)	% parous	Density *)	% parous
Landing on man										
Indoor :										
Treated	0.70	52	1.30	20	1.00	39	0.90	51	1.00	57
Untreated	0.53	25	0.53	53	1.11	50	1.90	43	0.20	38
Outdoor :										
Treated	2.95	60	4.40	27	5.70	55	7.00	40	5.60	43
Untreated	1.68	34	3.20	32	3.60	40	5.60	35	1.10	45
Cattle shelter resting										
Treated	68.00	49	42.00	30	51.00	42	64.00	53	68.00	42
Untreated	181.50	53	272.00	32	376.00	55	374.00	47	208.00	60

*) Density (mosquitoes/man/hour).

Table 2. Morning collection. House resting, cattle shelters resting and natural outdoor resting densities of *An. aconitus* before and after treatment in treated and untreated area.

Type of collection	Before spraying $\bar{X}$: 1 – 6 weeks		Weeks from spray date							
			3		6		9		12	
	Density *)	% parous	Density *)	% parous	Density *)	% parous	Density *)	% parous	Density *)	% parous
Rest. in house :										
Treated	1.13	36	0.50	4/6	0.90	27	0.50	4/6	1.00	3/5
Untreated	1.53	55	6.90	49	9.60	46	9.30	50	7.30	55
Rest. in catt. shelter:										
Treated	111.0	59	28.00	29	46.00	49	56.00	51	90.00	49
Untreated	136.0	60	219.00	54	204.00	62	108.00	59	220.00	67
Rest.in nat. outdoor:										
Treated	32.50	39	39.00	18	41.00	26	28.00	25	39.00	23
Untreated	43.00	42	74.00	35	89.00	45	71.00	44	33.00	43

*) Density (mosquitoes / man-hour).

Table 3. Percent mortalities of wild caught blood fed *An. aconitus* in contact bioassay tests on surfaces treated with 100 mg/m^2 baythroid

Days from spray	Houses				Cattle shelters			
	No. tested	Wood	No. tested	Bamboo	No. tested	Wood	No. tested	Bamboo
10	29	13.8	29	86.2	15	40.0	15	40.0
17	21	19.0	28	67.8	14	35.7	14	35.7
24	27	51.8	30	86.7	15	66.7	13	46.2
31	26	34.6	30	76.6	11	72.7	12	33.3
38	30	30.0	29	79.3	15	66.6	15	53.3
45	29	13.8	29	55.2	15	26.7	14	14.3
52	30	6.6	30	36.6	14	21.4	15	13.3
59	10	0	10	30.0	13	15.3	10	10.0

ment. Parous rates of mosquitoes landing on man indoor were below that of the check and when compared with pre-treatment for six weeks but in outdoor for only about three weeks. As these two parameters showed little effect following treatment is is possible this compound may have only a limited value for malaria control in Central Java despite the reduction in the overall population.

The duration of residual effectiveness of this insecticide lasted only for five weeks on bamboo surface and was not effective on wood surface, indicating that this compound has a relatively short residual life. There was no significant airborne effect observed with this compound.

The 10% wdp. formulation of baythroid used did not present any operational problems of intoxication or complaints of symptoms.

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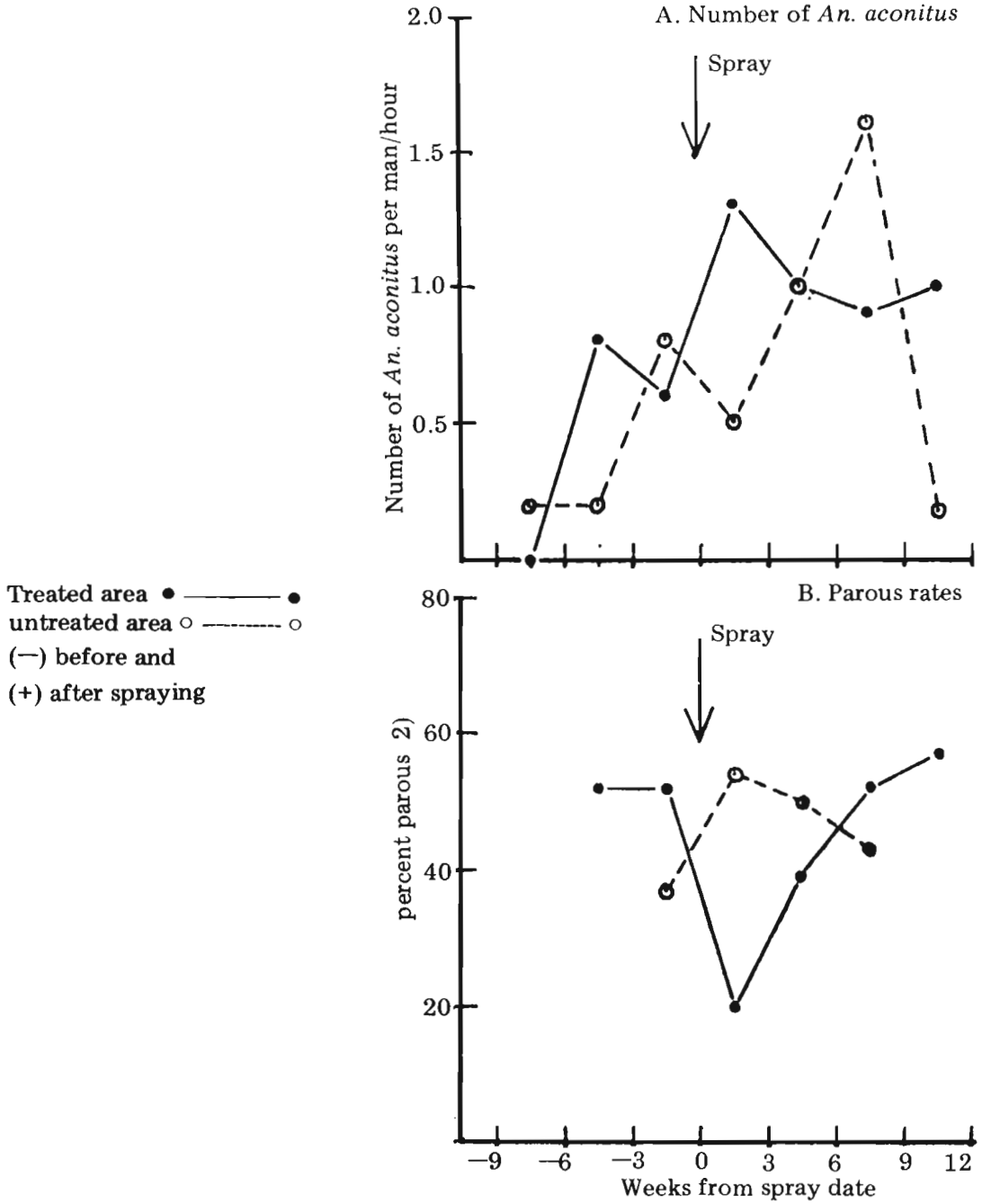
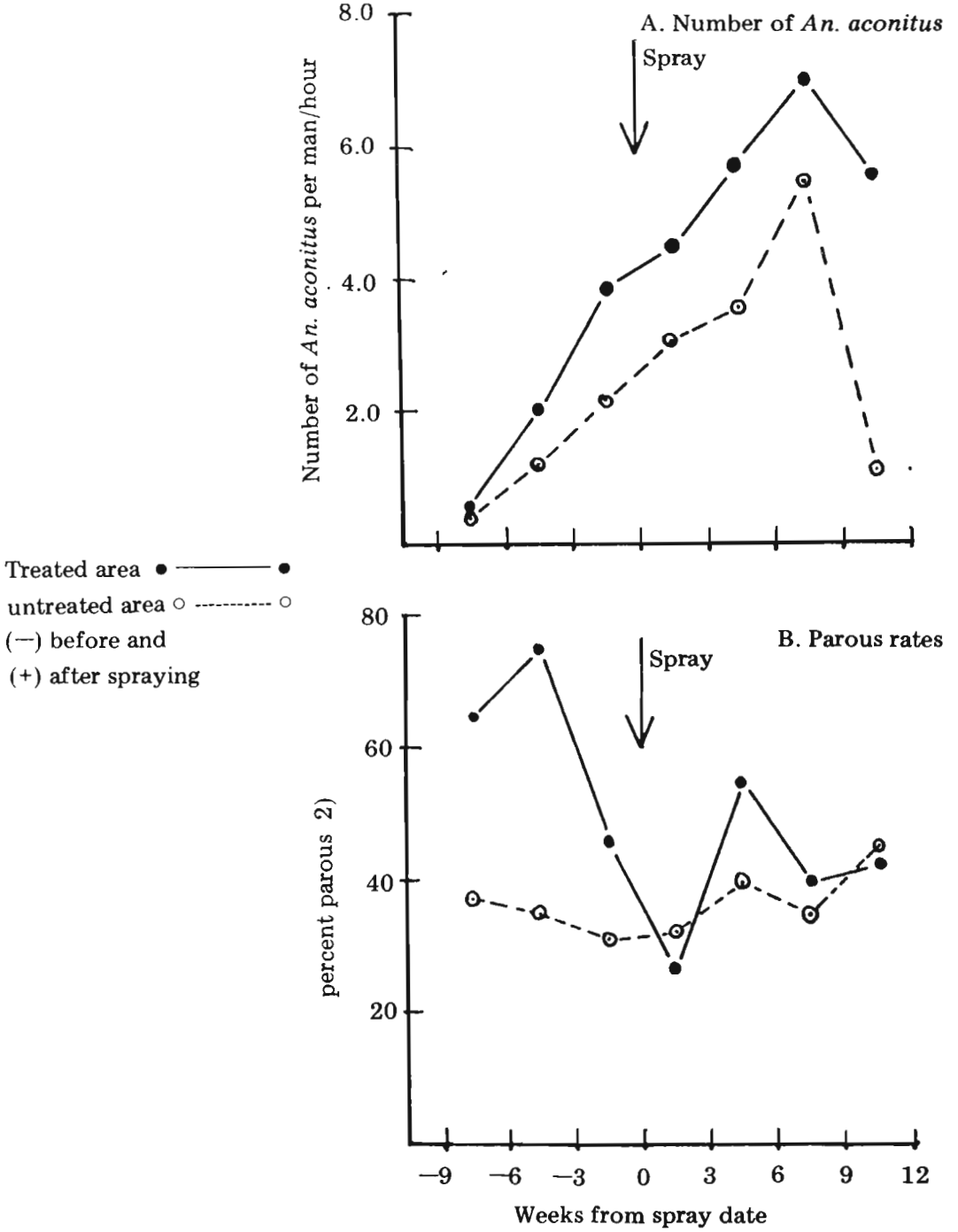
Figure 1. Number of *An. aconitus* per man-hour (A) and parous rates (B) landing on man indoors in baythroid treated and untreated areas 1)



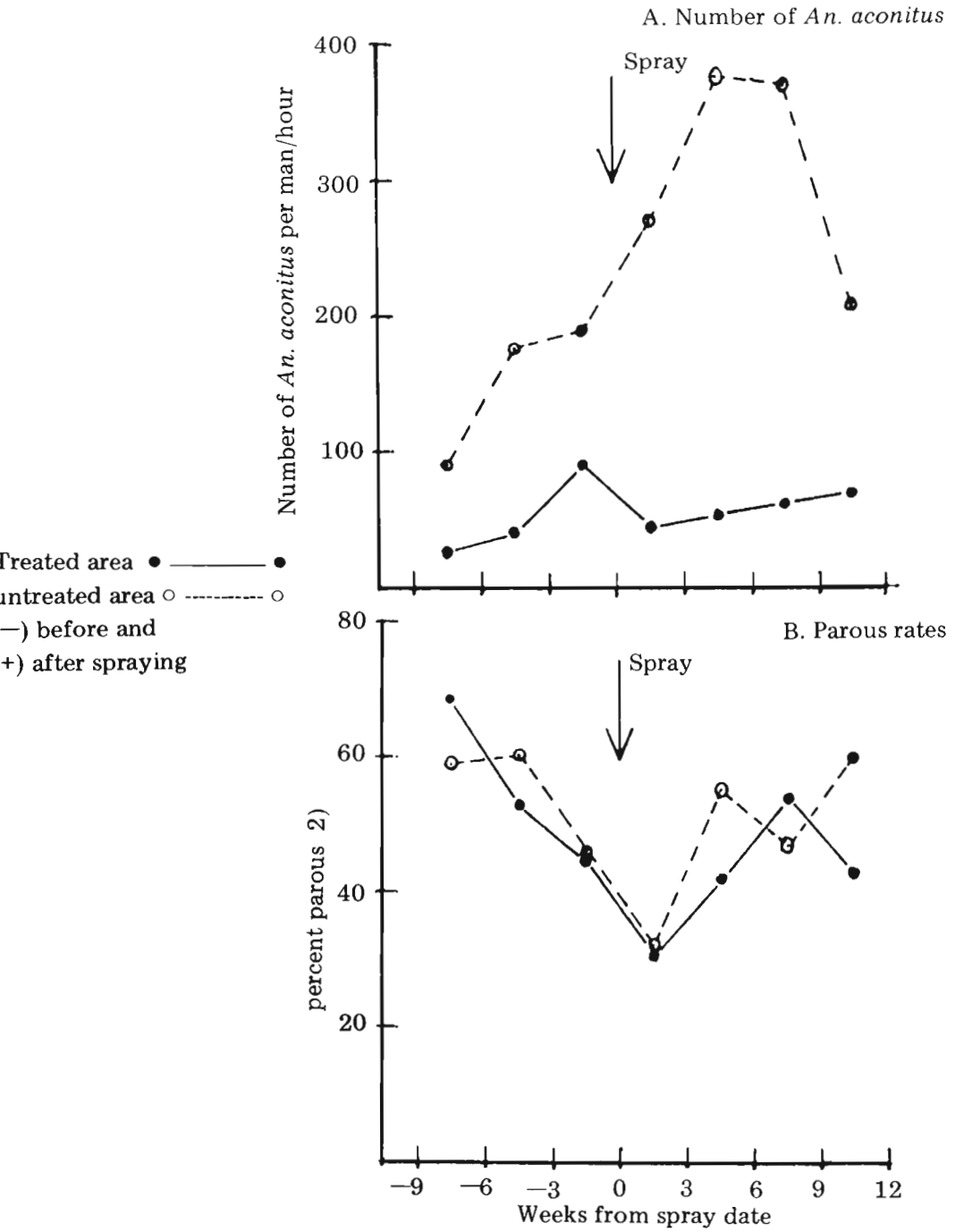
1) Three weekly collections combined
2) Number disected perpoint ranged from 19 to 58

Figure 2. Number of *An. aconitus* per man-hour (A) and parous rates (B) landing on man outdoor in baythroid treated and untreated areas 1)



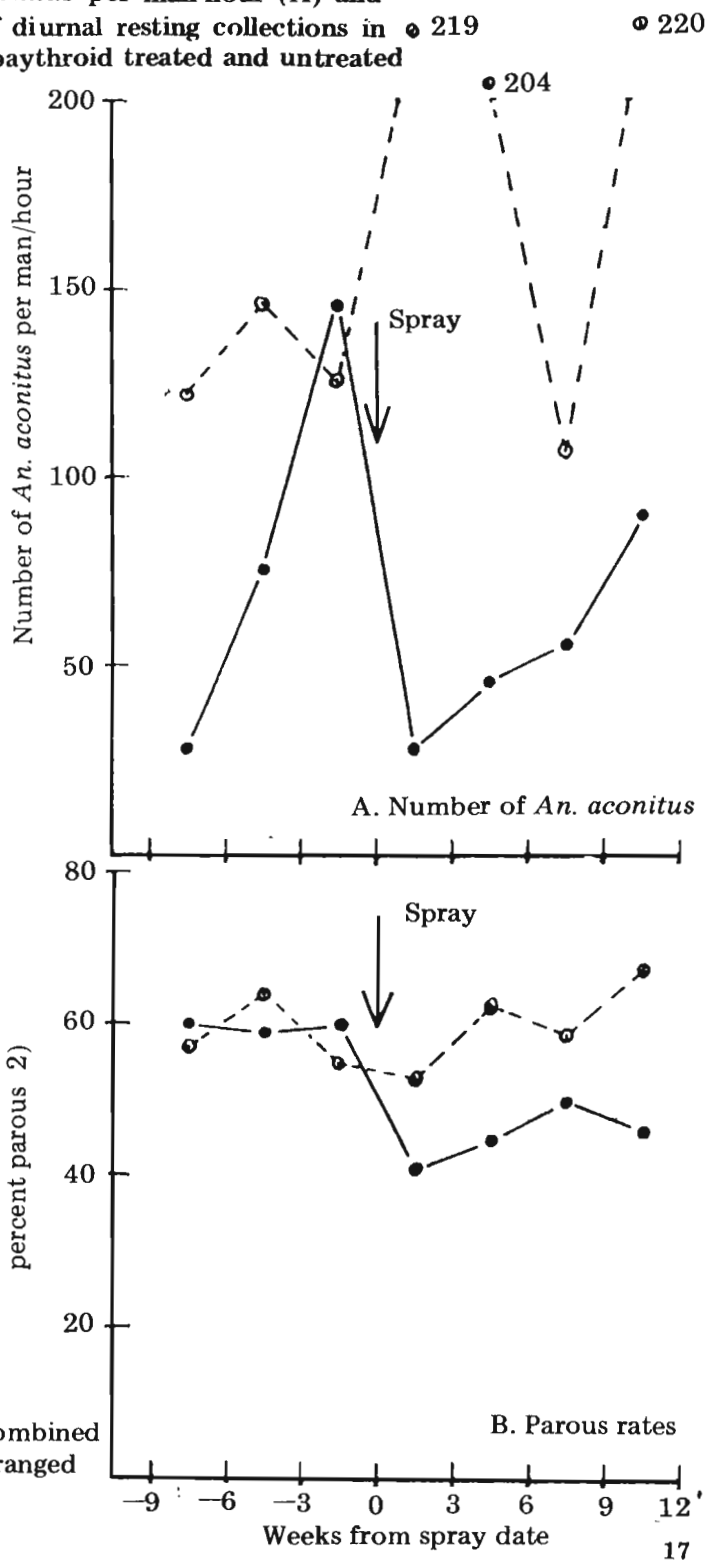
1) Three weekly collections combined
2) Number disected perpoint ranged from 19 to 58

Figure 3. Number of *An. aconitus* per man-hour (A) and parous rates (B) of nocturnal resting collections in cattle shelters in baythroid treated and untreated areas 1)



1) Three weekly collections combined
2) Number disected perpoint ranged from 19 to 58

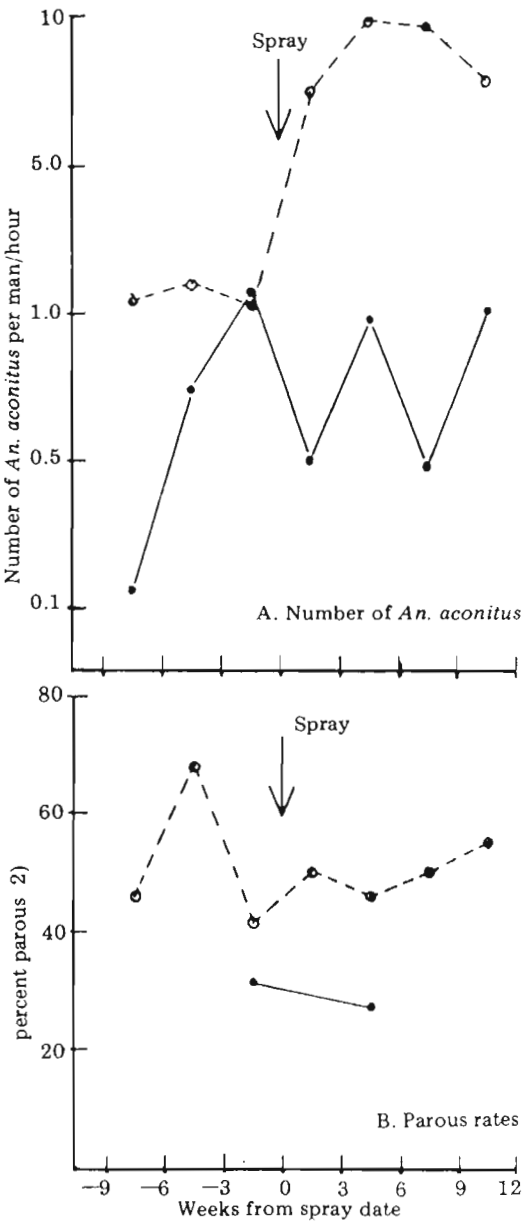
Figure 4. Number of *An. aconitus* per man-hour (A) and parous rates (B) of diurnal resting collections in cattle shelters in baythroid treated and untreated areas 1)



Treated area ● ——— ●
untreated area ○ ---------- ○
(—) before and
(+) after spraying

1) Three weekly collections combined
2) Number disected perpoint ranged from 19 to 58

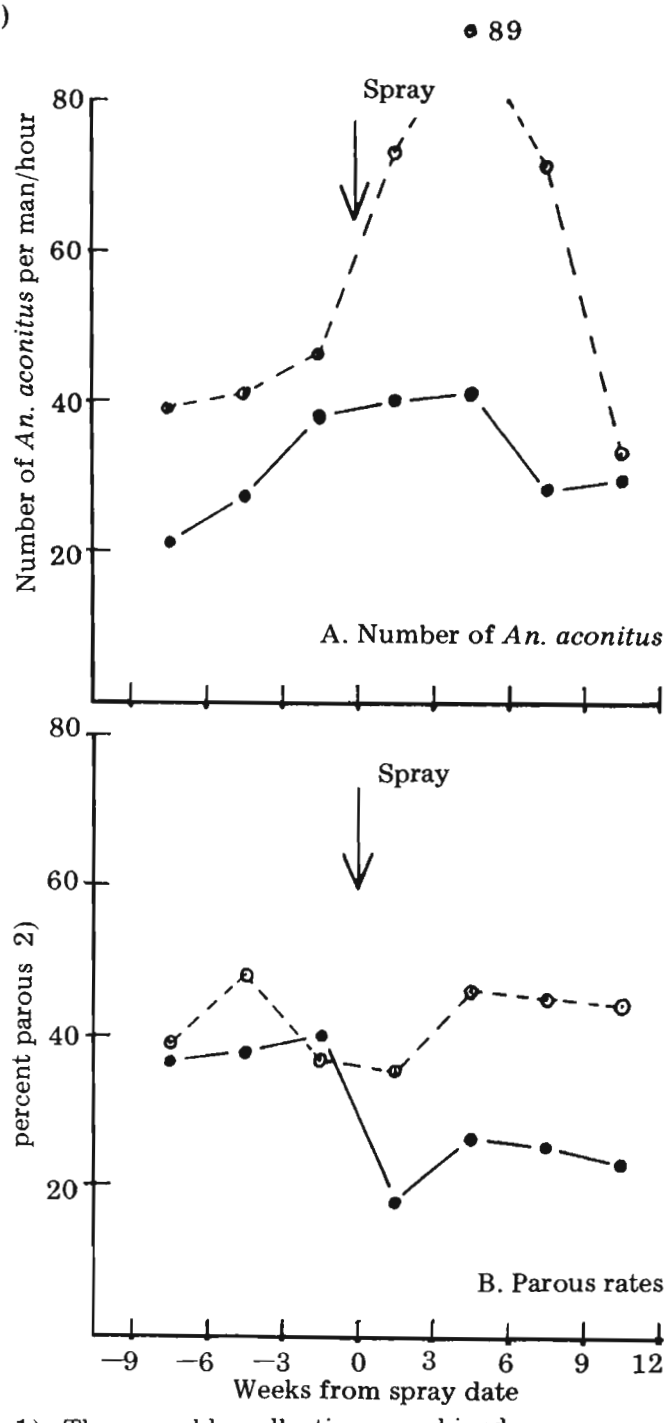
Figure 5. Number of *An. aconitus* per man-hour (A) and parous rates (B) of diurnal resting collections in houses in baythroid treated and untreated areas 1)



Treated area ● ——— ●
untreated area ○ ---------- ○
(—) before and
(+) after spraying

1) Three weekly collections combined
2) Number disected perpoint ranged from 19 to 58

Figure 6. Number of *An. aconitus* per man-hour (A) and parous rates (B) of diurnal resting collections in natural outdoor places in baythroid treated and untreated areas 1)



Treated area ● ——— ●
untreated area ○ ---------- ○
(—) before and
(+) after spraying

1) Three weekly collections combined
2) Number disected perpoint ranged from 19 to 58