



ECOLOGICAL STUDIES ON ANOPHELES ACONITUS
IN THE SEMARANG AREA OF CENTRAL JAVA, INDONESIA¹

by

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SUMMARY

The ecology of An. aconitus was studied for a year in an inland area near Semarang, Central Java, in preparation for a Stage V (village scale) trial of alternative insecticides to DDT.

Two An. aconitus peaks were found, the major one in March-April and the other in August-September. Most An. aconitus were attracted to animals, mainly water buffalo and cattle, and readily entered animal sheds to feed on them. While An. aconitus preferred biting man in the first half of the night, a majority were found in animal sheds in the second half of the night. Results from precipitin tests showed An. aconitus to be highly zoophilic with 93.5% feeding on animals and only 6.5% feeding on man.

An. aconitus was also found to be highly exophilic. Total daytime collections yielded only low percentages in houses and animal sheds compared to high numbers resting outdoors along stream banks and irrigation ditches.

Rice fields and their extensive adjacent irrigation ditches are probably the most productive larval breeding places although An. aconitus were also found breeding in streams. The species was highly resistant to DDT but very susceptible to fenitrothion and malathion.

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INTRODUCTION

An. aconitus is the main malaria vector in the inland irrigated areas of Java with extensive rice cultivation and it transmits malaria most of the year (Sundararaman et al., 1957). As a result of insecticide applications during the malaria eradication campaign, An. aconitus developed resistance to DDT in the rice-growing areas of Central Java. In Yogyakarta Province DDT and dieldrin resistance was first reported by Soerono et al. (1965), while widespread resistance to DDT in Central Java was reported in 1973-74 by O'Connor & Arwati.¹ This was reflected in the outbreaks of malaria near Semarang and elsewhere in Central Java in 1973-74; thus the search for alternative insecticides for effective control of the malaria vector has become a paramount necessity. Verdrager & Arwati (1975) carried out parasitological and entomological studies in East and Central Java and found no convincing evidence that DDT appreciably reduced malaria transmission. Consequently, a WHO research unit in collaboration with the Indonesian Ministry of Health was established in Semarang to test alternative insecticides on a village scale (Stage V).

Observations on the ecology of An. aconitus in the central and eastern provinces of Java were made by Sundararaman et al. (1957) and Chow et al. (1960). Recently Self et al. (1976) carried out similar investigations in five localities in West Java. Additional information from other areas on the ecology of this species is needed in order to develop the most suitable control techniques. In view of the proposed village scale trials of alternative insecticides, a one-year study was carried out during 1975-76 in Central Java near Semarang.

THE STUDY AREA

The study area was located in the southern foothills of Mount Ungaran at an elevation of 300-460 m, 20-25 km south of Semarang city. The climate is warm and humid throughout the year. Monthly maximum and minimum temperatures ranged between 28.6-33.9°C and 18.1-22.9°C respectively and the relative humidity was between 65-82% during the study period. Rainfall for one year amounted to about 3000 mm with the maximum recorded from January to March and the minimum from June to August.

A typical village (Desa) consists of about eight hamlets (Kampungs) surrounded by considerable vegetation and trees, and 500 houses mainly dispersed on 5 km² of open rice fields. Except for a few which have brick or concrete walls, virtually all houses are made of wood or matted bamboo walls with clay tiled roofs.

Agriculture is the main occupation of the population, the major crop being rice. The area is surrounded by rice fields most of the year and is crisscrossed by streams and rivulets. A network of irrigation systems regularly feeds water to the rice fields and in areas with a good system, people grow as many as five rice crops in two years. Thus, throughout the year paddy plants can be seen at all stages from seedlings to fully matured plants and An. aconitus breeds continuously.

From nursery to preharvesting stage (about four months), rice grows in well-watered soil. Fields are divided into plots by establishing dikes to maintain water more or less at the same level. The water should either flow or be refreshed regularly. Rice fields are ploughed and allowed to weather for three to four weeks before transplanting. Seedlings are transplanted in rows with about 10 cm between each seedling and 10-15 cm between each row. Weeding is usually done two and six weeks after transplanting. Green fertilizer or manure is applied during preparation of the soil and phosphate is applied just before or right after transplanting. Nitrate is used after each weeding and pesticides, mainly diazinon, are used to control pests.

House spraying in the area for malaria control was carried out with DDT at a target dosage of 2 g/m² annually from 1960 to 1964 and again from 1970-1976.

¹ WHO/VBC/74.505 (WHO/MAL/74.839).

ENTOMOLOGICAL STUDY METHODS

Two villages, Lerep and Bergas Kidul, located 4-5 km apart were visited every 15 days for the following entomological observations:

All-night man-biting collections (1800-0600 h)

Indoor biting collections were made in two houses and outdoor collections usually on two verandahs. One bait collector was posted at each site and each collected mosquitos landing on his legs. Collectors worked in shifts of two hours (one outdoor, one indoor) and one hour of rest and were rotated between the sites to provide periods of rest and minimize bias due to collector efficiency.

All-night collections in animal sheds (1800-0600 h)

Collections of resting mosquitos were made in two animal sheds each having cattle or water buffalo. Collection was limited to the first 15 minutes of each hour, since on some occasions hundreds of mosquitos (other anophelines and also culicines) would be collected in a relatively short time. All mosquito specimens collected were immediately counted and identified in a field laboratory in the village. The An. aconitus females were dissected and the parous condition determined, normally by examining the ovaries for the presence or absence of tracheolar skeins. In instances where the ovaries were already in late Stage II or Stage III, follicular dilatations were checked.

Collection of daytime resting mosquitos (0700-0900 h)

Three mosquito collectors in houses and two in animal sheds searched for resting mosquitos continuously for the two hours but spent only 15 minutes in each house or animal shed. Therefore, in one morning 24 houses and 16 sheds were visited. For outdoor resting mosquitos, three to five collectors spent two hours each during the same period searching numerous sites along stream banks and irrigation ditches and in shady vegetation in and around each study hamlet. These specimens were identified, dissected for parous condition and classified as to abdominal stages.

Larval collections (0700-0900 h)

Larval collections were made in all types of habitats in and around study hamlets by seven collectors using white enamel dippers (capacity 0.47 litres) with about 1-1/2 m wooden extension handles. Only third and fourth instar larvae were counted and identified.

Precipitin test

Blood-fed specimens of An. aconitus collected during daytime resting collections were smeared on filter paper and forwarded for analysis to Dr P. F. L. Boreham, Imperial College Field Station, Ascot, Berks, England.

Susceptibility tests

The WHO method was used in determining the susceptibility of An. aconitus adults to several insecticides. All mosquitos tested were blood fed and had been collected from animal shelters the previous night.

RESULTS

Adult densities and seasonal fluctuations

Man-biting densities of An. aconitus ranged between 1.5 and 16.1 per man night indoors and between 3.5 and 58.8 per man night outdoors. Night-time animal shed densities ranged from 10.0 to 83.5 per collector night. The animal shelters probably would have produced

somewhat more mosquitos if collections continued for the whole hour rather than only 15 minutes per hour. Although An. aconitus was recorded all through the year, two peak periods were observed. The major peak was observed in March-April and the small one in August-September (Table 1). These peaks of prevalence of An. aconitus occurred when the rice plants were at the harvesting stages.

Daytime resting densities were lower in indoor situations in houses and animal sheds than in outdoor sites. Of the three types of resting places searched, houses yielded the smallest number of An. aconitus, the density throughout the year never exceeding one per man hour. Densities ranged from 0.04 to 0.58 per man hour in houses, from 0.50 to 9.67 per man hour in animal sheds and from 0.81 to 16.67 per man hour in natural outdoor shelters. Two prevalence peaks similar to night-time collections were also observed for the daytime resting collections (Table 3).

Biting habits

Man-biting densities of An. aconitus indoors were actually lower than outdoors (Table 1). Outdoor man-biting (17.1 per man night) was about three times higher than indoor (5.4 per man night). Although biting occurs throughout the night, 69.2-75.2% of the mosquitos were collected between 1800-2400 h (Table 2).

Night-time populations of An. aconitus resting in animal sheds occupied by water buffalo and cattle were quite high, the yearly average being 28.0 per collector night (Table 1). More An. aconitus (62.0%) were collected during the latter half of the night with maximum numbers being encountered at dawn (Table 2).

Daytime resting habits

A lower density of An. aconitus (5%) resting inside houses as opposed to other situations was recorded. Whereas 34% of this species were found resting in animal sheds the highest density (60%) was encountered in natural outdoor shelters mainly along stream banks and irrigation ditches (Table 3).

The high percentage of An. aconitus found resting outdoors during daytime indicates exophilic behaviour, only 15.9-22.7% of those caught resting inside houses and animal sheds were observed to be gravid, indicating that the majority of those specimens also passed at least the latter part of their gonotrophic cycle outdoors. The substantial numbers of blood fed An. aconitus (30.1%) encountered outdoors also indicated a refractory nature to indoor resting (Table 4).

During daytime indoor collections, An. aconitus were generally observed to be resting just above the ground levels in crevices and also on hay and grass used as fodder for cattle in animal sheds. Hardly any An. aconitus were found resting higher up on walls, on roofs or ceilings and most were encountered in dark corners of the rooms where disturbances by wind and human activities were minimal.

Parous indices

Parous indices of An. aconitus in man-biting collections in houses ranged from 0.33 to 0.75, the highest being observed in January and the lowest in March and October. For outdoor man-biting populations, the indices varied between 0.31 to 0.68, the highest and lowest rates being recorded in the same months as in man-biting collections indoors. Parous indices of An. aconitus caught in animal sheds during the night were usually higher than biting collections with the indices ranging from 0.54 to 0.73 (Table 5). Although monthly fluctuations in parous rates were observed according to hour, no significant variations were apparent except for the comparatively lower parous rates noted during the first hour between 1800-1900 h (Table 6).

Parous indices of An. aconitus resting indoors by daytime (Table 7) were observed to be higher (yearly averages being 0.71 in houses and 0.68 in animal sheds) than those resting outdoors (0.34). Although the high percentage of collected specimens may have been due to mosquitos recently emerged from nearby breeding sites within the hamlets, larval breeding was mainly found in situations outside the hamlets.

Breeding habits

Collecting An. aconitus larvae proved rather difficult because of its breeding in large water bodies. In a year a total of only 109 larvae of this species was collected by spending 538 man hours. The elusive nature of An. aconitus larvae is further illustrated by the fact that in November 1975, the month when cattleshed densities were lowest, larva were found in four of the habitats, whereas in March 1976 when densities were building up, no larvae were found. Rice fields and irrigation ditches (within the rice fields) were found harbouring An. aconitus larva. Streams, which run through the hamlets and also rice fields, were occasionally positive in both locations. Not a single An. aconitus larvae was recorded from ponds and pools normally situated within the hamlet (Table 8).

About 76% of the total number of larvae collected were found in rice fields and the adjacent irrigation ditches. The main yearly density for all locations sampled was 0.2 larva per man hour. Larva were found every month except March.

Host preference (Table 9)

A marked preference for feeding on bovids (about 90%) irrespective of collecting site was noted. About 7% of the total blood-smears (585) tested were positive for human blood.

Susceptibility to insecticides

Susceptibility tests carried out in August 1974 with An. aconitus using 4.0% DDT test papers for one hour exposure showed an average mortality of 19%. OMS-1476, a DDT analogue, was even less effective. Tests in 1976 with 1.0% fenitrothion showed mortalities ranging from 98.9% to 100%; with 5% malathion mortalities were 100% (Table 10).

Further tests with 4% DDT were made in Bergas Kidul during April 1975 by increasing the exposure time. The results with 237 specimens after exposure for 1, 2 and 4 hours was 13.2%, 32.7% and 84.1% respectively. The control mortality was 7.5%.

DISCUSSION

Although An. aconitus was recorded throughout the year, two density peaks were observed. The major peak was in March-April and a second small one in August-September. Both peaks occurred when the rice plants were at the harvesting stages.

During the wet March-April period, rice crops were extensive in the area due to adequate water supply. The August-September period coincides with the dry season when irrigation is limited due to shortage of water. It would appear that rice fields and nearby irrigation ditches are the major sources of An. aconitus breeding even though larvae were also found in streams. Perhaps because of large surface areas covered by water in such places, it was difficult to detect larvae. Also larval collections during the study period were made on a limited scale just to check the types of breeding places favoured by An. aconitus. More concerted studies, therefore, are warranted since increased larval populations relative to the adult prevalence were not detected in rice fields during the pre-harvest period.

An. aconitus was found, to a greater extent, to be an early biter on man, 75.2% of the indoor and 69.2% of the outdoor biting occurring by midnight, and also to be pronouncedly exophagic. Outdoor biting was three times higher (17.1 per man night) than indoor biting (5.4 per man night). More biting occurred when the human population was still relatively active outdoors.

Large numbers of An. aconitus were found in animal sheds mainly occupied by cattle and water buffalo and were found in most instances already engorged. The more zoophilic tendency of this species was confirmed by the precipitin tests results (93.5% feeding on animals). Most of the An. aconitus in animal sheds were caught between midnight and dawn (62.0%) but this does not necessarily signify that more animal biting took place during this time. Because of resting collections made in animal sheds, probably resting mosquitos increased as the night advanced. The readiness of An. aconitus to enter animal sheds to feed is in marked contrast with the man-biting habits as outdoor man-biting was observed to be more pronounced than indoors. Moreover, the night-time densities in animal sheds peaked in September one month later than in man-biting collection indoors and outdoors. These observations tend to indicate that An. aconitus populations in the area might be composed of biologically different strains or races.

Parous rates of An. aconitus were observed to be higher in night-time animal shed collections than in man-biting collections. This variation also tends to support the contention made above that An. aconitus populations in the area might be composed of biologically different strains or races. Low parous rates observed in March (0.44 and 0.39 in indoor and outdoor man-biting respectively and 0.54 in animal shed collections) coincided with the rise in An. aconitus density. This seems to be natural as more nulliparous mosquitos are being added to the population during such periods of rise. The low parous rates observed in October in man-biting (0.33 indoors and 0.31 outdoors) and in November in night-time animal shed collections (0.58) could not be clearly explained. As An. aconitus densities showed low prevalence during this time, it was most probably the influence of some adverse climatic conditions.

An. aconitus is highly exophilic with more than 75% of the total daytime resting collections being encountered in natural outdoor shelters. Even in animal sheds where night-time densities were quite high, daytime collections yielded low numbers of An. aconitus. The low percentage of gravids (15.9%-22.7%) resting indoors and the presence of blood-feds (30.1%) resting outdoors also reflect the exophilic nature of this species. General observations on spot resting habits in houses and animal sheds showed this species preferring to rest on lower levels of walls and also on hay and grass stacks kept as feed for animals. This suggested that spraying high up on the walls and also the ceilings might have little effect on controlling this species.

An. aconitus was found to be highly resistant to DDT in the study area, but susceptible to fenitrothion and malathion, thus these organophosphorus compounds show promise as substitute insecticides for malaria control in areas of DDT resistance.

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TABLE 1. DENSITIES OF AN. ACONITUS FEMALES IN ALL-NIGHT MAN-BITING AND ANIMAL-SHED COLLECTIONS

Month and year	Man-biting collections						Month and year	Animal-shed collections			
	No. of collections	No. of bait collectors	Indoors		Outdoors			No. of collections	No. of collectors	Total caught	No./ collector night
			Total caught	No./ man night	Total caught	No./ man night					
March 1975	4	9	145	16.1	529	58.8	July 1975	2	4	98	24.5
April 1975	4	8	102	12.8	395	49.4	August 1975	4	8	154	19.3
May 1975	4	8	15	1.9	45	5.6	September 1975	4	8	341	42.6
June 1975	4	8	27	3.4	37	4.6	October 1975	5	10	217	21.7
July 1975	4	8	37	4.6	97	12.1	November 1975	4	10	100	10.0
August 1975	4	8	84	10.5	220	27.5	December 1975	4	12	193	16.1
September 1975	4	8	27	3.4	103	12.9	January 1976	4	8	125	15.6
October 1975	5	10	17	1.7	35	3.5	February 1976	4	8	276	34.5
November 1975	4	8	19	2.4	53	6.6	March 1976	2	4	163	40.8
December 1975	4	8	27	3.4	74	9.3	April 1976	2	4	334	83.5
January 1976	4	8	12	1.5	34	4.3	May 1976	3	6	221	36.8
February 1976	4	8	24	3.0	74	9.3	June 1976	2	4	78	19.8
Total	49	99	536	5.4	1 696	17.1	Total	40	82	2 300	28.0

TABLE 2. NUMBERS AND PERCENTAGE OF AN. ACONITUS FEMALES CAUGHT BY HOUR IN ALL-NIGHT MAN-BITING AND ANIMAL-SHED COLLECTIONS OUT OF THE TOTAL NUMBERS COLLECTED IN ONE YEAR PERIOD DURING 1975-76

Time of collections	Man-biting collections				Animal-shed collections	
	Indoors		Outdoors		No.	%
	No.	%	No.	%		
18.00-19.00	72	13.4	250	14.7	55	2.4
19.00-20.00	89	16.4	176	10.4	124	5.4
20.00-21.00	57	10.6	189	11.1	130	5.7
21.00-22.00	85	15.9	208	12.3	148	6.4
22.00-23.00	48	9.0	188	11.1	198	8.7
23.00-24.00	52	9.7	162	9.6	216	9.4
Total 18.00-24.00	403	75.2	1 173	69.2	871	38.0
24.00-01.00	33	6.2	90	5.3	224	9.7
01.00-02.00	17	3.2	104	6.1	231	10.0
02.00-03.00	20	3.7	82	4.8	221	9.6
03.00-04.00	16	3.0	48	2.8	226	9.8
04.00-05.00	19	3.5	103	6.1	225	9.8
05.00-06.00	28	5.2	96	5.7	302	13.1
Total 24.00-06.00	133	24.8	523	30.8	1 429	62.0
Grand total	536	100	1 696	100	2 300	100

TABLE 3. DENSITIES OF AN. ACONITUS FEMALES IN DAYTIME RESTING COLLECTIONS IN DIFFERENT SITES

Month and year	Houses				Animal-sheds				Natural outdoor shelters			
	No. of collections	Man hours spent	No. collected	No./man hour	No. of collections	Man hours spent	No. collected	No./man hour	No. of collections	Man hours spent	No. collected	No./man hour
March 1975	4	18	10	0.56	4	10	93	9.30	4	16.5	191	11.58
April 1975	4	24	10	0.42	4	9	87	8.67	4	15	250	16.67
May 1975	4	24	3	0.13	4	15.5	16	1.03	4	21	79	3.76
June 1975	4	10	1	0.10	4	10	7	0.70	4	11	26	3.36
July 1975	4	21	10	0.48	4	14	21	1.50	4	19	68	3.58
August 1975	4	24	6	0.25	4	16	8	0.50	4	22	95	4.32
September 1975	5	30	7	0.23	5	20	39	1.95	5	30	194	6.47
October 1975	4	24	1	0.04	4	16	8	0.50	4	22	73	3.32
November 1975	4	26	5	0.19	4	24	12	0.50	4	30	107	3.57
December 1975	4	24	7	0.29	4	24	28	1.17	4	30	101	0.81
January 1976	4	24	3	0.13	4	16	11	0.69	8	124	101	0.81
February 1976	4	24	14	0.58	4	16	27	1.69	8	58	60	1.03
Total	49	273	77	0.28	49	190.5	357	1.87	61	432.5	1 418	3.29

TABLE 4. ABDOMINAL CONDITION OF AN. ACONITUS FEMALES COLLECTED IN DAYTIME RESTING COLLECTIONS

Month and year	Houses				Animal sheds				Natural outdoor shelters			
	Total	Unfed	Fed	Gravid	Total	Unfed	Fed	Gravid	Total	Unfed	Fed	Gravid
March 1975	8	0	7	1	53	1	46	6	89	35	41	13
April 1975	10	1	4	5	83	1	60	22	195	75	53	67
May 1975	3	0	3	0	16	1	13	2	79	35	26	18
June 1975	1	0	1	0	7	0	3	4	26	15	0	11
July 1975	10	0	9	1	21	1	17	3	68	34	15	19
August 1975	6	0	5	1	8	1	7	0	95	55	21	19
September 1975	7	0	7	0	39	0	35	4	194	69	78	47
October 1975	1	0	0	1	8	0	6	2	73	21	13	39
November 1975	5	0	5	0	12	2	9	1	107	67	12	28
December 1975	7	0	4	3	28	0	24	4	101	43	20	38
January 1976	3	1	2	0	11	1	10	0	60	14	31	15
February 1976	14	1	8	5	27	1	24	2	174	55	70	49
Total	75	3	55	17	313	9	254	50	1 261	518	380	363
Percentage	-	4.0	73.3	22.7	-	2.9	81.2	15.9	-	41.1	30.1	28.8

TABLE 5. PROPORTION OF AN. ACONITUS PAROUS IN ALL-NIGHT MAN-BITING AND ANIMAL-SHED COLLECTIONS

Month and year	Man-biting collections						Month and year	Animal-shed collections		
	Indoors			Outdoors				No. dissected	No. parous	Proportion parous
	No. dissected	No. parous	Proportion parous	No. dissected	No. parous	Proportion parous				
March 1975	129	57	0.44	443	172	0.39	July 1975	100	70	0.70
April 1975	93	52	0.56	350	169	0.47	August 1975	151	100	0.66
May 1975	15	8	0.53	45	23	0.51	September 1975	331	225	0.68
June 1975	18	11	0.61	35	21	0.60	October 1975	217	135	0.62
July 1975	41	22	0.54	115	66	0.57	November 1975	97	56	0.58
August 1975	82	50	0.61	223	111	0.50	December 1975	182	117	0.64
September 1975	27	18	0.67	104	67	0.64	January 1976	118	76	0.64
October 1975	18	6	0.33	35	11	0.31	February 1976	273	198	0.73
November 1975	18	9	0.50	53	30	0.57	March 1976	158	85	0.54
December 1975	27	15	0.56	73	36	0.49	April 1976	326	209	0.64
January 1976	12	9	0.75	31	21	0.68	May 1976	216	149	0.69
February 1976	21	12	0.57	74	43	0.57	June 1976	76	51	0.67
Total	504	269	0.53	1 591	770	0.48	Total	2 245	1 471	0.66

TABLE 6. PROPORTION OF AN. ACONITUS PAROUS IN ALL-NIGHT MAN-BITING AND ANIMAL-SHED COLLECTIONS BY HOURS OUT OF THE TOTAL NUMBERS DISSECTED IN A ONE-YEAR PERIOD DURING 1975-76

Time of collections	Man-biting collections						Animal-shed collections		
	Indoors			Outdoors			No. dissected	No. parous	Proportion parous
	No. dissected	No. parous	Proportion parous	No. dissected	No. parous	Proportion parous			
18.00-19.00	67	24	0.36	240	79	0.33	46	21	0.46
19.00-20.00	81	43	0.53	162	72	0.44	116	75	0.85
20.00-21.00	60	36	0.60	196	107	0.55	128	90	0.70
21.00-22.00	77	45	0.58	189	114	0.60	146	108	0.74
22.00-23.00	44	30	0.68	159	86	0.54	195	132	0.68
23.00-24.00	45	26	0.58	132	65	0.49	215	159	0.74
24.00-01.00	29	14	0.48	74	40	0.54	225	163	0.73
01.00-02.00	17	9	0.53	85	41	0.48	224	138	0.62
02.00-03.00	19	9	0.47	76	36	0.47	215	139	0.65
03.00-04.00	16	9	0.56	51	29	0.57	223	144	0.65
04.00-05.00	18	9	0.50	105	48	0.46	221	129	0.58
05.00-06.00	31	15	0.48	122	53	0.43	253	173	0.59
Total	504	269	0.53	1 591	770	0.48	2 245	1 471	0.66

TABLE 7. PROPORTION OF AN. ACONITUS PAROUS IN DAYTIME RESTING COLLECTIONS

Month of year	Houses		Animal sheds		Natural outdoor shelters	
	No.	Parous	No.	Parous	No.	Parous
July 1975	8	4	15	6	27	7
August 1975	5	3	8	4	73	13
September 1975	7	6	33	26	73	23
October 1975	0	0	6	5	32	11
November 1975	5	5	11	7	69	11
December 1975	4	3	24	20	63	25
January 1976	2	1	11	6	47	22
February 1976	10	7	26	17	134	65
Total	41	29	134	91	518	177
Proportion	-	0.71	-	0.68	-	0.34

TABLE 8. DIFFERENT HABITATS POSITIVE FOR AN. ACONITUS LARVAE

Month and year	Rice fields					Stream	Irrigation ditches	Ponds or pools	Man hour spent
	I	II	III	IV	Harvested				
July 1975		+	+				+		45
August 1975		+	+				+		46
September 1975		+					+		47
October 1975		+				+	+		60
November 1975		+		+		+	+		55
December 1975		+	+			+			66
January 1976							+		56
February 1976						+	+		56
March 1976									28
April 1976	+					+	+		26
May 1976			+		+	+	+		24
June 1976			+			+	+		28
No. of III + IV instar larvae	5	14	16	3	1	26	44	0	-

Total man hours spent 537.

Notes: RICE FIELDS

Stage I - with new plants

Stage II - with long plants seed not yet present

Stage III - rice plants with seeds present

Stage IV - rice plants seeds ripe, almost ready for harvesting

TABLE 9. RESULTS OF PRECIPITIN TESTS ON AN. ACONITUS BLOODMEALS
(FEBRUARY 1975 TO FEBRUARY 1976)

Type of shelters	No. tested	Bloodmeals positive for							
		Man		Bovid		Unidentified bovid		Sheep/goat	
		No.	%	No.	%	No.	%	No.	%
Houses	52	4	7.7	47	90.4	1	1.9	0	0
Animal sheds	156	5	3.2	156	93.6	5	3.2	0	0
Natural outdoor shelters	377	29	7.7	330	87.5	15	4.0	3	0.8
Total	585	38	6.5	523	89.4	21	3.6	3	0.5

TABLE 10. INSECTICIDE SUSCEPTIBILITY TESTS USING ONE HOUR EXPOSURE
ON ADULT AN. ACONITUS FEMALES. SPECIMENS TESTED WERE BLOOD FED
AND COLLECTED FROM ANIMAL SHELTERS DURING THE NIGHT

Date	Hamlet and village	Insecticide	% concentration	Total	No. dead in 24 hours	% mortality
31.8.74	Kebon Kliwon Bergas Kidul	DDT	4.0	135	26	19.3
		OMS-1476 ^a	4.0	148	13	8.8
		Control	-	80	2	2.5
13.1.76	Karangbolo Lerep	Fenitrothion (OMS-43)	1.0	20	20	100
			0.1	16	0	0
		Control	-	18	0	0
30.1.76	Karangbolo Lerep	Fenitrothion (OMS-43)	1.0	20	20	100
		Control	-	18	0	0
10.2.76	Karangbolo Lerep	Fenitrothion (OMS-43)	1.0	90	89	98.9
			0.1	26	1	3.8
		Control	-	19	1	5.3
24.2.76	Karangbolo Lerep	Malathion (OMS-1)	5.0	20	20	100
			0.5	20	1	5.3
		Control	-	21	0	0
12.3.76	Kebon Kliwon Bergas Kidul	Malathion (OMS-1)	5.0	125	125	100
		Control	-	25	0	0

^a A DDT analogue.