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FINAL REPORT  
OF  
RESEARCH PROJECT  
No.Ent. (231)  
P1-76/6-ICR-10/0311  
INVESTIGATIONS ON COCKCHAFFER BEETLE  
LEUCOPHOLIS CONEOPHORA BURM.

April, 1976 To December, 1982.

CENTRAL PLANTATION CROPS RESEARCH INSTITUTE  
REGIONAL STATION, KAYANGULAM  
KRISHNAPURAM-690 533  
KERALA, INDIA.  
DECEMBER, 1983.  
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FINAL REPORT

1. Institute Code No.  
Ent. IV (231)
2. ICAR Code No.  
P1-76/6-TCI-HIO/0311
3. Name and address of Research Institute/Centre:  
Central Plantation Crops Research Institute, Regional Station,  
Kayangulam, KRISHNAPURAM-690 533, Kerala, India.
4. Project title:  
Investigations on cockchafer beetle, Leucopholis coneophora Burm.
5. Name and designation of the Project Leader:  
VA Abraham, Scientist S1 (Agri. Entomology)
6. Name(s) and Designation(s) of Project Associates including Project Leader and work done:

Sl. No.	Name	Designation	Time spent	Project Leader Associate
1.	VA Abraham	Scientist S1	1976-1982	Leader
2.	KV Joseph	Scientist S1	1976-1978	Associate

7. Location of Research Project with complete address:

Central Plantation Crops Research Institute,  
Regional Station, Kayangulam, Krishnapuram-690 533  
Kerala.

8. Date of start: 1-4-1976
9. Date of termination: 31-12-1982.

10. a) Objectives:

- 1) To work out the entomological aspects of the insect-biology of the insect on coconut and intercultivated crops-nature and extent of damage on coconut and intercultivated crops-distribution of different life stages of the insect in soil during different periods of the year.
- ii) To find out suitable insecticides with optimum dose for the chemical control.
- iii) To find out the persistence of these insecticides in soil
- iv) Effect of these insecticides on the population of other insects and plant parasitic nematodes.
- v) Movement of insecticides in soil, residues in coconut kernel water and tuber crops.

b) Practical utility including background information:

Adequate information on the biology and bionomics of L. coneophora is not on record and the effective and economic methods of control are not established conclusively. Biology bionomics and control of the pest have been dealt by Nirula et al (1952), Nirula(1958) Mathen et al(1964), Abrcham and Kurlan(1970) and Veevash et al(1982). These publications give only scanty information on the life history, nature and extent of damage, distribution and seasonal occurrence of different life stages. Nirula et al(1952) recorded this insect as a pest of coconut and gave a brief account on the biology of the insect. Nirula(1958) gave some information on the biology. Eggs were laid in soil three inch deep, which hatched in about 20 days. Grubs were seen from June to next year May in soil. Grubs ate away the roots of coconut and intercrops. Adults lived for a month. They did not feed. Sekhar(1958) furnished morphological description of the adult. Pupal duration was observed to range from 26 to 33 days in the laboratory and 28 days in field. The present recommendation for the control of L. coneophora is two applications of heptachlor, BHC, chlordane or aldrin at 6 kg ai/ha once in April and another in August. This recommendation was based on the results of a limited number of field experiments, the results of which were not in full agreement or conclusive. The high degree of heterogeneity in the distribution of grubs population in the field is probably the major factor for the inconsistency of the results obtained in the experiments. The timing of pesticides application will be very vital for the effective control of the pest. Hence a study correlating the distribution of different stages of the insect and precise bioassay and field assay trials using insecticides was necessary to find the most effective and economic insecticide for the control of L. coneophora and to fix the most advantageous period for the application of the pesticide.

ii) Technical programme:

a) List of sub-projects/experiments conducted:

1. Biology and Bionomics

- i. 1) Biology of the insect in laboratory and in potted plants in field
- ii. Effect of different host plants viz. cassava, cacao and wild sunn-hemp, on the development of the insect.
- iii. Nature and extent of damage on the above crops and coconut
- iv. Distribution of the pest with reference to different seasons of the year and at different depths of the soil

II. Chemical control:

- v. Relative efficacy of insecticides to the second and third instar grubs assessed with precise bioassay techniques.
- vi. Evaluation of effective pesticides in the field.
- vii. Fixing on effective and economic schedule of insecticidal application for the control of the pest.

- viii. Assessment of the persistence of BHC and heptachlor in the loamy sand soil of Kerala.
- ix. Vertical movement of the insecticides in soil assessed through bioassay and chemical assay techniques.
- b. Observations taken:
1. Duration, length, width and weight of different life stages of L. coneophora when reared on coconut, casava, cacao and crotalaria.
  - ii. Survival of immature stages, fecundity and percentage of egg hatching of insect reared on different crops.
  - iii. Growth parameters of cassava, cacao and crotalaria when exposed to different levels of grub population and symptoms of attack.
  - iv. Population of different life stages of L. coneophora in  $1m^3$  pits taken at Thazhakkara and Vazhuvadi at fortnightly interval for three years.
  - v. Soil temperature and moisture at different depths in the above pits.
  - vi. Emergence of beetle in relation to atmospheric temperature and rainfall.
  - vii. Mortality of second and third instar grubs at different doses of insecticides tested.
  - viii. Survival of third instar grubs and pupae and establishment of test plants in the insecticide treated soil in cement tubs.
  - ix. Reduction of grub population in the insecticide granule treated field plots.
  - x. Assessment of quantity of insecticide in soil samples taken from different depths at monthly intervals from insecticide treated plots.

## 12. Final report on the project:

### Summary of Result

- 1) The biology of the coconut cockchafer Leucopholis coneophora Burm was studied in full. The techniques for rearing the pest in rooted coconut seedlings planted in pots were standardised. Life cycle of the insect is as follows. Incubation period 23 days, mean larval duration 260 days for males and 270 days for females and pupal durations 25.3 and 25.7 days respectively for males and females and the adult longevity was 42.3 days and 42.6 days for males and females respectively.
- 2) The study on the general morphology of the three instars of grubs did not show remarkable difference facilitating their identification except the head capsule widths which were 3.19, 4.84 and 7.71 mm for the first second and third instars, respectively.
- 3) A key for the identification of the third instar grubs of L. coneophora, L. burmeisteri and L. lepidophora was developed.

4. Differentiation of males and females of L. coneophora based on antennal club character was made possible.
5. Adult behaviour of L. coneophora was studied in the field. Rates of males and females collected from field was 1:0.099, while that of laboratory rearings was 1:0.734. Exit holes left by emerging beetles on the soil surface gave an indication of population density during the season.
6. Adults did not feed on any plant parts. This restricted the possibility of adopting mechanical control of the pest by the collection or spraying the host plants with insecticides and destruction of adults during emergence time.
7. The effect of four different host plants viz. cassava, coconut, cacao and wild sunn-hemp (crotalaria) on the biology and development of L. coneophora was studied in detail. It was observed that the larval nutrition had significant effect on all the aspects studied. Cassava and coconut were found more favourable for the pest than cacao and crotalaria.
8. The extent and nature of damage done by different levels of grub of L. coneophora on the above crops were studied. Cassava was found to be more susceptible at the time of planting and during early stages of growth. Cacao and crotalaria were also highly susceptible (Cassava can be used as a trap crop also)
9. Population of different life stages of the pest in different depths of the soil was studied. The beetles were found more at depths of 30-100 cm during pre-emergence season and between 15 and 30 cm depths during post-emergence period. Eggs were seen predominantly at depths of 30-100 cm first instar grubs at 15-30 cm, second instar at 15-45 cm third instar at 15-30 cm and pupae at 60-100 cm depth.
10. Adults and grubs were seen to have tendency to prefer certain ranges of temperature and humidity.
11. The seasonal occurrence of the life stages of L. coneophora also was studied. Adults were collected from May to August, eggs from May to August, first instar grubs from the second half of May to October, second instar from second half of July to first half of November, third instar from first half of October to the end of July and pupae from April to end of July.
12. The adult emergence appeared to be triggered off by the quantum of rainfall during the pre-monsoon period. When soil temperature reached 37°c the beetles failed to emerge. Beetle emergence was found correlated with intensity of light. Emergence was at peak when light fall down to 70 Lux.
13. Bioassay studies has proved that BHC and heptachlor are cheaper and effective in controlling second instar grubs. It has also shown that controlling the grubs in third instar stage is not economically feasible.

14. Large scale pot culture studies in field revealed that one application of heptachlor at 1.4 kg ai/ha in June or two applications of BHC each at 5 Kg ai/ha in June and September would give complete kill of grubs. Insecticidal application in April was found to be less effective.
15. Persistence of chlorinated hydrocarbon insecticides in Kerala loamy sand soils was comparatively for shorter period only.
16. The downward movement of BHC and heptachlor was too low to cause the death of any of the grub stages. This indicated the desirability of incorporating the insecticides to lower depths in soil.
17. Granular insecticidal trials has revealed that economical control with granules are not possible.
18. Hand picking and destruction of adults during emergence period helps in drastically reducing the pest population.
19. Pathogenic agents did not show encouraging results.

### 13. PROGRESS OF WORK IN RELATION TO THE TIME TARGETED FOR COMPLETION OF WORK AND REASONS FOR NONACHIEVEMENT OF TARGETS, IF ANY

#### I. Biology and Bionomics

##### i. Biology of the pest on coconut

Nirula (1958) had provided some scanty information on the life history and feeding habits of the pest. More detailed information on this aspect was found to be necessary to work out effective control measures against this pest. Insects were reared on rooted coconut seedlings raised in garden pots. Early first instar grubs one in each pot was reared till pupation. Mean duration of different life stages were 40.3, 51.6, 168.1 days for first, second and third instar grubs and 260.0 days total grub period, 25.3 days and 308.3 days respectively, for pupal and egg to adult, respectively for males whereas the same was 40.9, 51.6, 177.5, 270.0, 25.7 and 318.7 days respectively for females (Table 1). Adult longevity was 42.3 days for males and 42.6 days for females.

Sex ratio of male to female collected from field was 1:0.099 and the ratio in the laboratory reared was 1:0.734. The beetle emergence was at dusk around 6.45 pm and they were on their wings for 25.35 minutes. The emergence started when the light fell down to 200 Lux and it was at its peak when the light was at around 70 Lux. Mating lasted for 7-9 minutes. When the beetle came out of soil they left holes of 12-14 mm in diameter. Numerous such holes could be noticed on the ground during the emergence season in the infested area. These emergence holes indicated the severity of pest in the coming season in that area. Adults did not feed on any host plant and hence mechanical or chemical control of adults by collecting beetles from host plants or spraying host plants with insecticides for controlling them as is being done in the case of Holotrichia spp in other parts of the country was not possible in the case of L. coneophora.

Sexes of L. coneophora could be separated by the difference in the length of antennal club. A key based on the larval characters was constructed for the identification of the grubs of L. coneophora, L. burmeisteri and L. lepidophora.

ii. Effect of different host plants on the development and growth of L. coneophora.

In order to ascertain the influence of various inter or mixed crops grown in coconut gardens, the effect of four representative crops viz. cassava, coconut, cacao and crotalaria on the development and biology of L. coneophora was studied.

Duration of development of different life stages was shorter on cassava followed by coconut. There was no significant difference between them. Insects reared on cacao and crotalaria took longer periods to complete the development (Table 1). With reference to the total life period from egg to adult cassava and coconut were found to be quite suitable for the insect, there being no significant difference between the durations of males on these hosts (299.3 and 308.3 days, respectively). But in the case of females cassava was found to be significantly superior to coconut having a shorter duration ( $F_{3,1}$ )

The favourable influence of nutrition was manifested in the second instar stage and persisted through out the remaining stages of development. The size as manifested by length and width of third instar grubs also showed favourable influence of cassava and coconut. Crotalaria was the least favourable and cacao came in between. With reference to the weight gain no influence was observed in the case of male grubs, while cassava and coconut were found to be better host plants for female grubs. In the case of adults also same favourable trend on cassava and coconut was manifested.

The influence of different hosts on survival of immature stages was revealed in Table. 2. Maximum number of insects was obtained on cassava and it was followed by coconut, cacao and crotalaria ( $F_{3,2}$ ). The gradual increase in values from the second instar to the adult stages indicated increasing influence of the hosts in later instars of the insects. Similarly the adults reared using cassava and coconut had significantly longer preoviposition period and higher fecundity as compared to the adults reared on cacao and crotalaria.

In general different hosts seemed to have some influence on the grubs of males as well as females. These results indicated the possibility of some favourable factors in the nutrient content of cassava and coconut which increased the biotic potential and survival rate of L. coneophora. The overall result obtained from these studies indicated the possibility of a higher population build up of L. coneophora in coconut gardens with no intercrops and those cultivated with cassava than in gardens inter/mixed cropped with cacao or crotalaria.

Nature and extent of damage on inter/mixed crops (Table 3)

Cassava

Cassava setts were planted in earthen pots and grubs were liberated at the rate of one per pot. Observation on the establishment of these setts was taken after 45 days. Cassava was found to be highly susceptible to the infestation at the time of planting and early stages of growth. The grubs ate away the roots and rind of the stem just below the ground level which resulted in the failure of absorption and translocation of nutrients and water from the soil. As a result of this aerial portions of plants got stunted and they gradually died out.

Grubs at the rate of one, three and five were liberated in pots having cassava plants of four-month-old growth and the damage was assessed. There was reduction in various growth characters studied. The damage done by the population level of one grub per plant did not vary significantly from the next higher level of three grubs per plant. In most of the characters studied five grubs per plant significantly varied from the lower levels of grub population. However the plants were apparently healthy though there was significant reduction in the yield of healthy tubers. Limited number of tubers in a plant alone were damaged. The unaffected portions of partly damaged tubers and tubers from unaffected plants were assessed for HCN, total starch, amylose and amylopectin. In the infested tubers the HCN content was relatively lower and a lower percentage of starch and amylose and a high percentage of amylopectin was estimated. The reduction of total starch and amylose and increase of amylopectin would reduce the cooking quality also.

The preference of grubs to cassava has indicated the possibility of using cassava as a trap crop. Cassava planted early in February may attract third instar grubs then present in field. These grubs can be destroyed by digging the soil around the plants in March. In a similar experiment with cacao having one, two and three grubs per plant it was seen that even at the population level of one grub per plant at four-month-old stage, the emergence of new leaves and growth of the plant got significantly reduced.

Similarly in the case of crotalaria even one grub per plant in the early stage of growth was fatal to the plant. In middle aged plants one grub per plant lead to significant reduction in growth.

Distribution of different life stage of *L. coneophora* in soil.

Distribution of the different life stages of *L. coneophora* in different depths of soil was studied. 1 m<sup>3</sup> pits were taken in fields one at Thazhakkara and another at Vazhuvadi from 1977 to 1980 at fortnightly intervals. Soil from pits was removed in layers and population was recorded. Soil temperature and moisture in different depths were also recorded. Table 4 shows that adults were predominantly seen at 45-100 cm depth during early emergence period upto June. But since June upto August higher proportion was obtained at 15-30 cm strata (Fig 3). The beetles collected till June might have been pre-emergence individuals whereas the collection obtained from July onwards

included the beetles which had emerged, mated and resettled for egg laying.

In general, a higher proportion of eggs was found in the depth range of 15-60 cm especially during July-September. However the eggs obtained during May-June was largely from the depths of 60-100 cm.

The highest population of first instar grubs was seen at a depth range of 15-30 cm at both the locations. The first instar grubs depend on the roots of weeds and other intercrops as a source of food. This may be the reasons for the higher population of first instar grubs in the upper strata of soil.

Second instar grubs were largely distributed at 15-45 cm depths. Percentage of grubs seen at lower depths was very low. In the different months during the period of observation no definite trend in the depthwise distribution of grubs could be made out.

Third instar grubs were maximum at 15-30 cm depth during 1977-78 and 1978-79 at both locations. But during 1979-80 at both sites the same was at 45-60 cm during which period the total rainfall was just half that of the previous two years. Consequently the moisture in the upper strata would have been lower during the period and temperature higher and that might have resulted in the preference of the grubs for deeper layers of soil. During October they were at 30 cm depth. When the rain was received in November the grubs even migrated to the upper strata of 15-30 cm. The influence of rain over the distribution of third instar grub was also evident from the reverse trend in distribution from January, when grubs were observed in deeper layers of 30-100 cm. This is presumably due to the higher soil temperature and less moisture in the upper layers of soil during the summer months.

Pupae were collected from a depth of 30-100 cm during all the years. Very rarely pupae were collected from 15-30 cm during June-July when rainfall was very high. The high rainfall induced the pupating grubs to remain up by virtue of the higher humidity.

V. Distribution of different life stages of L. coneophora in relation to soil temperature and moisture.

Population of adults and different larval instars were grouped according to the soil moisture and temperature at which they were observed. It was found that adults preferred a soil temperature of 29-31°C and 9-11 per cent moisture. First instar grubs preferred 29-31°C temperature and 8-10 percent moisture. Second instar were predominantly seen in 31-33°C and soil moisture of 8-10 percent. Third instar grubs were seen predominantly in 31-33°C and 7-9 per cent moisture (Fig 4, 5)

## Seasonal distribution of L. coneophora (Table 5)

Period of occurrence of different life stages of L. coneophora was studied from the population counts taken for three years. Adults were seen from second week of May to the end of August. However stray beetles were collected in March-April and September. Population was higher in the months of June and July. Eggs were obtained from second half of May till the end of September.

First instar grubs were obtained from the second half of May/ beginning of June to the beginning of October with a higher level from end of June to September. Second instar grubs were found from the second half of July to the first half of November. Third instar grubs were seen from the first half of October to second half of June at both the locations. However grubs were seen upto the first half of July during 1977-78 at Thazhakkara and up to the end of July during 1978-79 at Vazhuvadi. Thus the grubs were seen in field for about 10 months (Fig-6).

Pupa were seen from beginning of March till the end of August with higher population in April to July.

### VI. Adult emergence:

Beetles emerging in a 50 m<sup>2</sup> plot in Thazhakkara were collected daily throughout the emergence period for three years from 1976-78.

Beetle emergence started by first week of March. Only very few beetles were seen during this month. Low emergence continued till end of May. Period of peak emergence was observed from the first week of June to August. Maximum emergence was in July. Stray beetles were seen in September also. Commencement of emergence appeared to be influenced by rainfall and soil temperature. In the early emergence period when the soil temperature rose to 37°C or more no beetle emergence could be seen. Total rainfall during the premonsoon period of March-April appeared to influence the time of peak emergence. The total quantum of rainfall received in the months of March-April and early May, rather than the commencement of rainy season, initiated beetle emergence.

Peak period of emergence was June-July. About 60 per cent of the total beetle population that emerged from the soil was in July in all the three years.

### Chemical control

Application of BHC 5 percent/heptachlor 3 percent/aldrin 5 percent 120 kg/ha or chlordane 10 percent at 60 kg/ha once in April and another in August is the present recommendation for the control. The results of earlier trials (Nirula and Menon 1957, Nirula 1958; Mathen et al 1954 Johnson and Nair 1966 and Abraham and Kurian 1970) were not in full agreement or conclusive. The high degree of heterogeneity in the distribution of grub population in the field is probably the major factor for the inconsistency of the results obtained in the experiments.

Hence precise bioassay and field assay trials were conducted with a view to finding the most effective and economic insecticide for the control of L. coneophora and to fix the most advantageous period for the application of the pesticide.

#### i. Chlorinated hydrocarbon insecticides

Different doses of five percent dusts of aldrin, BHC, chlordane and heptachlor were applied in 1 meter microplots to a depth of 15 cm and mixed thoroughly. Soil samples were collected from these plots 24 hours after treatment and filled in bottles. One second/third instar grub was liberated in each bottles and each treatment had 10 bottles. There were three replications. Table 6 shows the results of the probit analysis done on the data obtained. Against the second instar grubs aldrin was found to be the best closely followed by heptachlor whereas the third instar was more susceptible to heptachlor than aldrin. Table 6 shows that on cost basis heptachlor had to be preferred to aldrin. BHC was also found to be appreciably effective. Chlordane was less toxic and ineffective. Hence BHC and heptachlor were selected for the field trials. ||

The relative efficacy of BHC and heptachlor during different periods of the year was evaluated under field conditions through a separate experiment. Cement tubs of 1m diameter and 1 m height were used for the experiment. Soil was filled and insecticides were fixed (BHC 5 kg ai/ha and heptachlor 1.4 kg ai/ha) thoroughly with the soil in the tubs upto a depth of 15 cm. Sprouted ground nut seeds were planted in the tubs which served as food for the grubs. First instar grubs collected from field were liberated in all the tubs commencing from June and at fortnightly intervals till the end of occurrence of the first instar grubs in the field. Untreated checks were also maintained. The period of insecticide treatment tried were in (a) April alone (b) June alone (c) April and August and (d) June and September. Each treatment was replicated thrice.

Table 7 shows the results of the experiment. Between the two insecticides heptachlor was found superior to BHC in the corresponding schedules of application. Among the various schedules of treatments application of heptachlor in June followed by a second round in September was found to be the best, since there were no surviving grub or pupa in the above treatments. The absence of surviving grubs in the above treatments was revealed by the absence of the mortality of sprouted ground nut seeds sown in the treated tubs. A single application of heptachlor in June was slightly inferior to two applications, however the difference was negligible. Similarly two applications of BHC in June and September was almost equally effective to single application of heptachlor. The schedule of April and August treatment of the two insecticides was significantly inferior to the June and September application. [A single application of the either insecticides in April alone gave unsatisfactory control.]

It can be concluded that L. coneophora can be best controlled by a single round of treatment with heptachlor at the rate of 1.4 kg ai/ha in the month of June or with BHC applied in June and September each treatment being made at the rate of 5 kg ai/ha of the toxicant. Application of toxicant in April is likely to be less effective since the present studies showed that the third instar grubs present in the field during the period were not amenable to control using the insecticides tested under normal field dosages. Further the grubs inhabit the deeper strata of . . . . .

soil in April and the insecticides applied in the top layer of soil may not reach down to the grubs.

### Granular insecticides

A field trial was conducted at Thazhakkara & Vazhuvadi to find out the effectiveness of granular insecticides in controlling the pest. Field plots of 10 sq. mt. were prepared with bunds all around. Insecticides viz. Thimet 10G (phorate), Sevin 4G (carbaryl), Solvirex 5 G (thiodemeton), Furacil 3 G (carbofuran) and Ekalux 5G (quinalphos) were applied at the rate of 4, 6 and 8 kg ai/ha and untreated check were maintained. Insecticides were applied twice a year.

There were three replications. Observation on grub population in the experimental plots was made just prior to insecticidal application and one month after treatment. The experiment continued for two years. The pest reduction was worked out and the data was subjected to analysis of variance.

The results are presented in table 8. There was significant difference between all treatments and control. Maximum reduction in pest population was obtained with 8 kg ai of carbofuran, phorate and thiodemeton. However the highest reduction was only 78.16. Six kg ai/ha of phorate and carbofuran gave a reduction of around 60%. However there was no significant difference between the lower and middle doses of phorate, carbofuran and thiodemeton. Carbaryl and quinalphos were least effective. It is evident from the table that for control of grubs of L. coneophora high doses of granular insecticides need to be used. Use of such high doses may not be economical.

### VIII. Persistence and downward movement of insecticides

Persistence and downward movement of chlorinated hydrocarbon insecticides viz. BHC and heptachlor was studied. Insecticides were applied in to field plots of nine square meters. Schedule of treatment and dosage are as given in insecticidal control (table 7). Soil samples were drawn from different depths from each plot using soil auger 24 hours after treatment and at monthly intervals. BHC present in soil samples was estimated by colorimetric method and by bioassay and heptachlor was estimated by bioassay alone.

The results showed (Fig 7) that BHC applied in the months of April, June, August and September had half lives of 89.6, 71.8, 66.4 and 35 days, respectively and the residues almost completely disappeared within 7, 5, 4 and 3 months, respectively. The quantity of insecticides found in samples as per chemical assay and bioassay were showing an overall agreement. The half lives of BHC when applied in April as estimated by the two techniques were 89.6 and 97.6 days, respectively. For June, August and September schedules half lives as estimated by chemical assay were 71.8, 66.4 and 35 days respectively while the corresponding values for bioassay were 74.0, 64.3 and 37 days.

The downward movement of BHC applied in April commenced with the onset of monsoon in June when applied in June comparatively

higher proportion of the pesticide had moved to lower depths. In the case of August and September treatments also slightly higher movement of the insecticide to the lower depths of 30-45 was observed.

In the case of heptachlor the persistence was found to be more than that of BHC. The half lives of heptachlor applied in April, June, August and September were 72.2, 76.5, 87.7 and 82.3 days respectively. When applied in April the insecticide moved to 30 cm. But in June application the insecticide moved to 45 cm depth. In general the movements in terms of distance and quantity were less than that of BHC. In the case of BHC and heptachlor the pesticide residues reaching the lower depths of 15 to 45 cm was far below the level of concentration required for causing mortality of grubs of L. coneophora. This indicate the need of application of insecticides to deeper layers of soil.

#### IX. Biological control

Few diseased/dead grubs were collected from field and a nematode Caenorhabditis sp and a bacterium Bacillus sp were isolated and subjected to pathogenicity tests. The organisms were tested singly and in combination on different stages of the grubs. No disease symptoms appeared on the test insects.

#### X. Other methods of control

(Non experimental findings)

1. Beetles were collected from few plots continuously for three years for utilizing them in different experiments. It was found that the population in these plots gradually decreased and by the third year the population was very meagre. Children and aged people were engaged for this mass collection on payment of five paise per beetle. This has indicated that employing children for mass collection of beetles during adult emergence season and thereby reducing the population of grubs is a feasible method of control.

2. Since the adults of L. coneophora are non-feeders the control of adults by hand picking from host trees or, killing by spraying the host trees as done in the case of Holotrichia spp is not possible.

#### 14. Publications

- a) VA Abraham 1983. Biology, bionomics and control of coconut cockchafer Leucophaea conephora Burm.

Ph.D Thesis submitted to Kerala Agricultural University

LITERATURE CITED

Abraham, VA and Kurian, C 1970. Save your coconut palm from the ravages of white grubs. Cocon. Bull. 1: 3-4

Mathen, K, Kurian, C and Mathew, J 1964. Field studies on insecticidal control of coconut white grub Leucopholis coneophora. Indian Cocon. J. 18: 101-108

Nirula, KK, Antony, J and Menon, KPV 1952. A new pest of coconut palm in India. Indian Cocon. J. 5: 137-140

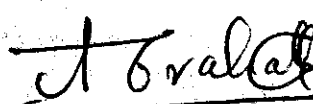
Nirula, KK 1958. Investigations on the pests of the coconut palm Part V. Leucopholis coneophora Burm. Indian Cocon. J. 12: 10-39

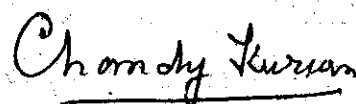
Sekhar, PS 1958. Studies on the cockchafer, Leucopholis coneophora Burm. a pest of coconut palm and other intercultivated crops. Indian Cocon. J. 11(2):67-80

Veeresh, GK, Vijayendra, M, Vijayamohana Reddy, N, Rajamma, C and Rai PS 1982. Biocology and management of areca white grubs (Leucopholis spp). Symp. Silver Jubilee of Arecanut Research, Vittal Dec. 1982.

15. Details(Nos. etc.) of Field/Laboratory Note Books and their final location.

Primary Project File	- One No.	           	Located at the Division of Entomology
Experimental log book	- One No.		
Laboratory note book	- One No.		
Field note books	- Two Nos.		

16.   
Signature of  
Principal  
Investigator

17.   
Signature of  
Head of Division/  
Section/Station

18. Signature of  
Director

Table I. Effect of different host plants on the biology of L. coneophora

Host plants	Mean larval duration (days)				Total	Mean pupal duration	Duration Egg to adult
	First instar	Second instar	Third instar	Total			
<u>Male</u>	Cassava	38.2	48.8	166.0	253.0	23.3	299.3
	Coconut	40.3	51.6	168.1	260.0	25.3	308.3
	Cacao	40.5	55.7	181.9	278.1	26.8	327.9
	Crotalaria	42.0	63.4	179.7	285.1	24.7	332.8
	CD (F = )	NS	9	8.61	10.10	1.4	10.09
<u>Female</u>	Cassava	40.2	48.8	172.8	261.8	22.9	307.7
	Coconut	40.9	51.6	177.5	270.0	25.7	318.7
	Cacao	41.6	55.5	188.7	285.8	26.1	334.9
	Crotalaria	41.4	57.7	185.1	294.2	25.2	342.4
	CD (F = )	NS	5.92	7.45	7.21	1.89	7.83

egg period 23 days

Table 2. Effect of different host plants on the survival of immature stages of *L. conephora* and the longevity and pre-oviposition period

Host plants	Initial population	No. surviving till attaining the stage				Sex	Longevity (days)	Pre-oviposition period (days)
		First instar grub	Second instar	Third instar	Pupa			
Cassava	200	150	128	86	69	M	44.7	34.0
						F	48.7	
Coconut	200	140	126	72	63	M	42.3	34.8
						F	42.6	
Cacao	200	140	124	62	42	M	38.7	30.9
						F	34.5	
Crotalaria	200	150	124	67	40	M	37.8	30.5
						F	33.2	
		2.51	4.91	8.35*	17.13**			
					CD	M	4.42	
					CD	F	2.89	2.15

M = Male  
F = Female

Table 3. Extent of damage done to different host plants by different levels of grubs of I. conopocera

	No. of grubs/plant					CD
	0	1	3	5		
<u>Cassava</u>						
Weight of top growth of top tubers	1388.33	1031.80	924.53	873.93		87.89
Weight of underground growth	5063.67	2423.08	2151.00	1384.98		388.69
Weight of damaged tubers	0.00	605.93	759.47	817.80		254.99
Weight of undamaged tubers	2860.80	2215.40	2033.33	1221.13		343.00
	No. of grubs/plant					
	0	1	2	3		
<u>Cocoa</u>						
Weight of top growth of top tubers	19.88	13.95	9.51	6.53		0.98
Weight of underground growth	9.59	6.33	3.19	1.94		0.84
	No. of grub/plant					
	0	1				
<u>Crabapple</u>						
Weight of top growth of top tubers	67.20	25.39				7.17
Weight of underground growth	5.91	8.73				3.50

Weights are in grams

Table 4. Distribution of the life stages of L. coneophora in different depths of soil at two locations

Year	Thazhakkara depths (cm)					Vazhuvadi depths (cm)				
	0-15	15-30	30-45	45-60	>60	0-15	15-30	30-45	45-60	>60
Adult	1978 0.00	20.83	12.50	25.00	41.66	4.34	0.00	26.08	17.39	52.17
	1979 0.00	12.50	37.50	21.87	28.12	0.00	27.27	33.33	27.27	12.12
	1980 6.75	10.61	29.72	16.21	36.48	2.04	16.32	20.40	26.63	34.69
Egg	1978 8.67	32.54	23.69	0.00	34.68	0.40	0.00	15.16	13.52	70.90
	1979 0.00	24.50	33.99	33.20	8.30	0.00	28.50	45.20	9.38	24.88
	1980 2.15	15.86	41.12	25.26	15.59	1.07	13.17	34.14	22.0	29.56
First instar grub	1978 19.14	50.63	21.27	5.10	3.82	24.00	35.42	27.42	10.28	2.88
	1979 25.00	40.41	18.33	14.58	1.66	23.37	33.76	26.62	13.63	2.59
Second instar grub	1978 11.32	35.84	34.90	12.26	5.66	11.76	29.41	40.00	10.58	8.23
	1979 24.40	40.15	22.83	11.81	0.78	19.29	31.57	29.82	14.03	5.26
Third instar grub	77-78 11.88	35.84	26.13	17.42	8.71	7.63	32.29	27.43	18.40	14.23
	78-79 9.76	27.73	25.39	18.75	17.96	6.50	35.27	24.65	18.44	15.06
	79-80 6.97	18.20	24.80	29.40	20.50	4.76	14.28	31.90	31.90	17.14
Pupa	1978 0.00	0.00	12.90	9.67	77.41	0.00	4.41	11.76	19.11	64.70
	1979 0.00	12.50	20.83	37.50	29.16	0.00	15.51	32.75	31.03	20.68
	1980 0.00	0.00	24.19	24.19	51.61	3.40	4.54	25.00	34.09	32.95

The population at each depth is presented as the percentage of the total population of the concerned

Table 5. Seasonal distribution of *L. coneophora*

Life Stage	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct.	Nov	Dec
Adult	A	0.0	0.0	0.0	2.3	5.6	8.3	6.3	10.0	6.3	3.6	0.3	0.3
	B	0.6	0.6	1.6	5.7	11.6	10.3	8.3	8.0	3.0	3.0	0.7	0.0
Egg	A	9.0	27.6	32.0	64.0	47.4	42.0	32.3	0.0	0.0			
	B	42.0	74.3	49.0	36.0	38.0	38.6	37.6	13.3	18.3			
First instar grub	A	1.5	4.5	32.0	24.5	26.0	27.5	45.5	47.5	24.0	4.5		
	B	6.5	5.5	10.5	27.5	28.0	22.0	29.0	15.5	24.0	6.0		
Secc instar grub	A	1.5	8.5	8.0	12.5	9.5	19.5	8.5	17.5	7.0	3.0		
	B	1.0	5.5	8.0	8.5	8.5	13.5	6.0	11.5	8.5	0.0		
Third instar grub	A	19.0	15.0	15.3	23.0	16.6	27.3	23.0	10.3	7.0	2.0	2.0	22.6
	B	16.0	13.0	12.3	15.0	19.6	25.0	11.0	20.0	5.3	8.0	11.0	4.6
Pupa	A	0.0	0.0	2.0	2.3	5.6	7.0	6.3	10.0	8.0	4.0	1.0	0.6
	B	1.6	2.0	7.3	5.0	5.0	10.0	21.6	10.9	4.3	3.3	0.6	0.0

A = Thezhakkara      a = First fortnight of the month

B = Vezhuvadi      b = Second fortnight of the month

Table 6. Relative toxicity of chlorinated insecticides to grubs of L. coneophora

Stage of grub	Insecticide	LD 50 (kg ai/ha)	Relative toxicity	LD 90 (kg ai/ha)	Cost* (Rs.)
Second instar grub	Aldrin	0.7314	1.0	1.316	174
	BHC	2.3710	3.2	4.837	97
	Chlordane	6.8740	9.4	12.430	1020
	Heptachlor	0.7423	1.0	1.371	115
Third instar grub	Aldrin	4.872	1.8	8.956	1202
	BHC	7.017	2.6	14.980	300
	Chlordane	11.530	4.3	18.740	1509
	Heptachlor	2.677	1.0	5.058	408

\*Cost of commercial formulations of insecticides as 5 per cent dust at LD 90 levels during 1981

Table 7. Survival of first instar grubs of *L. coneophora* in insecticide treated soil when liberated at different intervals after treatment and the establishment of groundnut sown in treated soil, one month after last round of insecticidal application

Treatment	% of first instar grub reaching third instar stage	Pupal stage	Mortality of groundnut seedlings (%)
BHC 5 kg ai/ha in April	70.78 (57.28)	26.64 (31.07)	73.49 59.01
BHC 5 kg ai/ha each applied in April and August	21.30 (27.48)	15.24 (22.98)	45.29 42.62
BHC 5 kg ai/ha applied in June	46.64 (43.07)	7.99 (16.42)	49.34 44.62
BHC 5 kg ai/ha each applied in June and September	11.80 (20.09)	1.79 (7.69)	6.52 14.79
Heptachlor 1.4 kg ai/ha applied in April	30.64 (33.61)	9.25 (17.70)	38.65 38.44
Heptachlor 1.4 kg ai/ha each applied in April & August	6.52 (14.79)	0.0 (0.0)	7.67 16.07
Heptachlor 1.4 kg ai/ha applied in June	10.58 (18.98)	0.0 (6.0)	6.60 14.88
Heptachlor 1.4 kg in/ha each applied in June and September	0.0 (0.0)	0.0 (0.0)	0.0 0.0
Control	90.74 (72.29)	69.09 (56.22)	100.00 (90.00)
S.D.	4.51	4.77	7.86

Figures in parantheses are the transformed mean values

Table 8. Mean per cent reduction in population of grubs of L. coneophora in field plots treated twice a year for two years with different levels of granular insecticides

Insecticide	kg ai/ha	Mean reduction in grub population (%)	
		Original	Transformed
Carbaryl	4	33.87	35.59
	6	59.28	50.35
	8	51.62	45.93
Carbofuran	4	65.15	53.82
	6	78.13	62.12
	8	92.59	74.21
Phorate	4	76.55	61.04
	6	83.32	65.90
	8	95.79	78.16
Quinalphos	4	47.87	43.78
	6	53.88	47.23
	8	94.62	36.60
Thiodemeton	4	79.82	63.31
	6	64.30	53.31
	8	92.88	74.46
Control		7.79	16.21
CD			16.19

FIG. 1 EFFECT OF DIFFERENT HOST PLANTS ON THE BIOLOGY OF  
L. CONEOPHORA

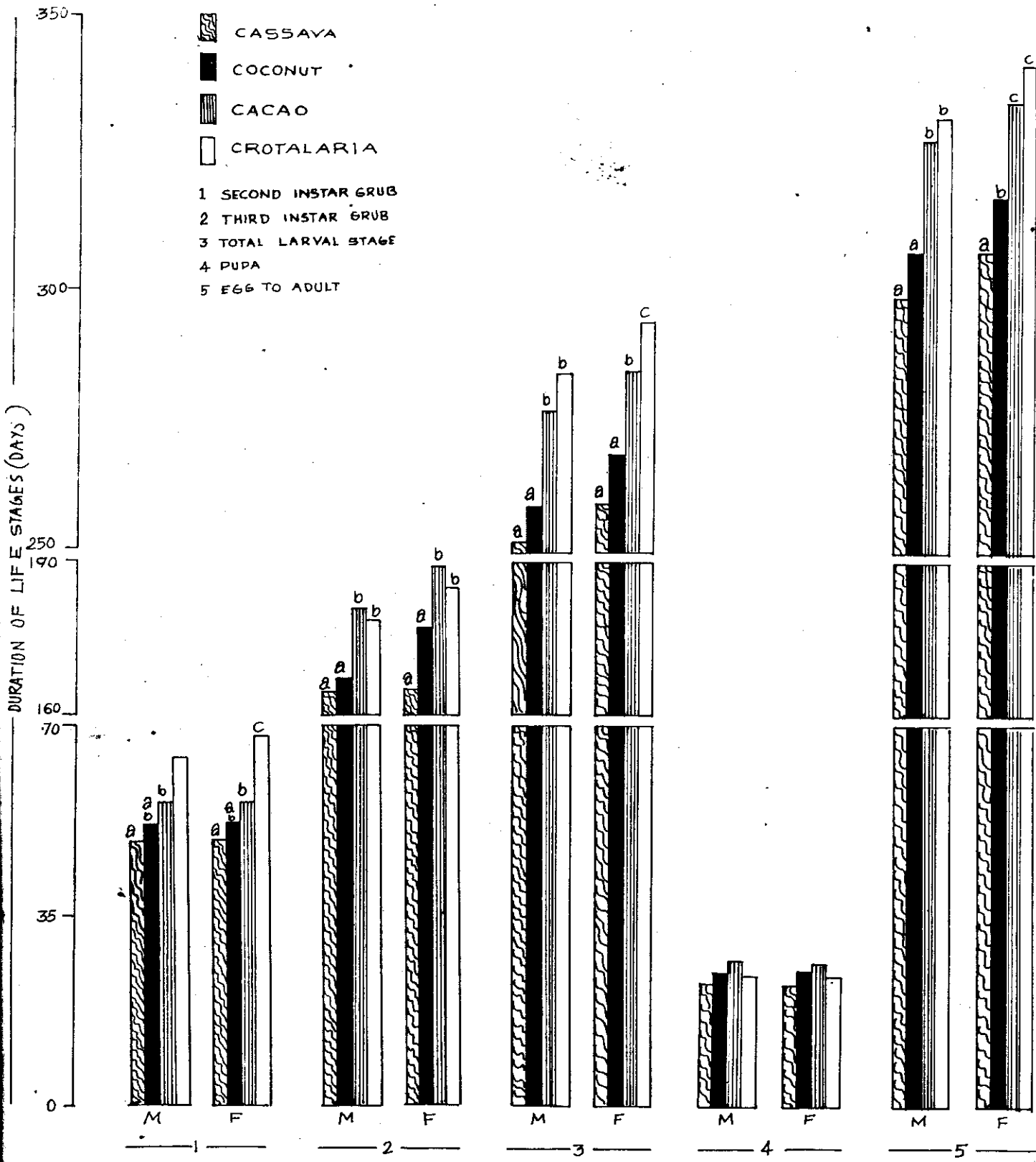
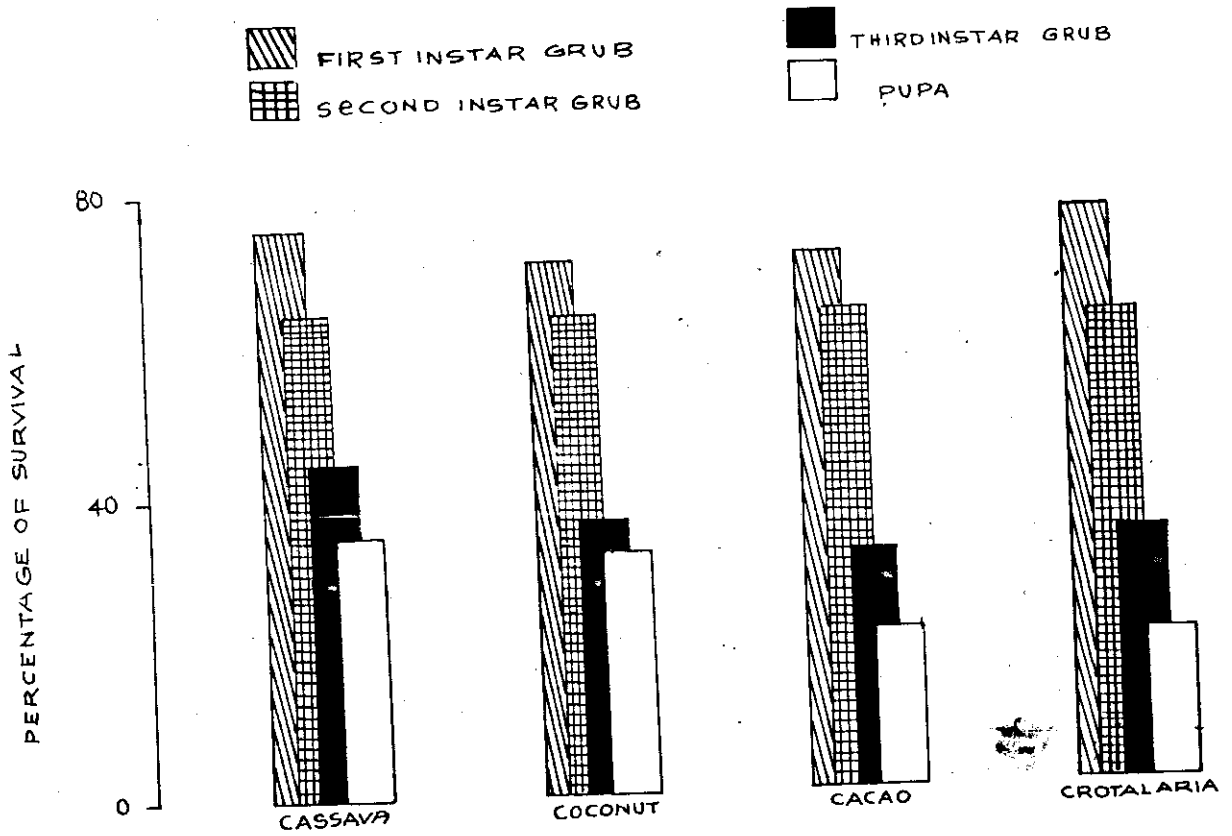


FIG. 2. EFFECT OF DIFFERENT HOST PLANTS ON THE SURVIVAL OF THE IMMATURE STAGES OF L. CONEOPHORA



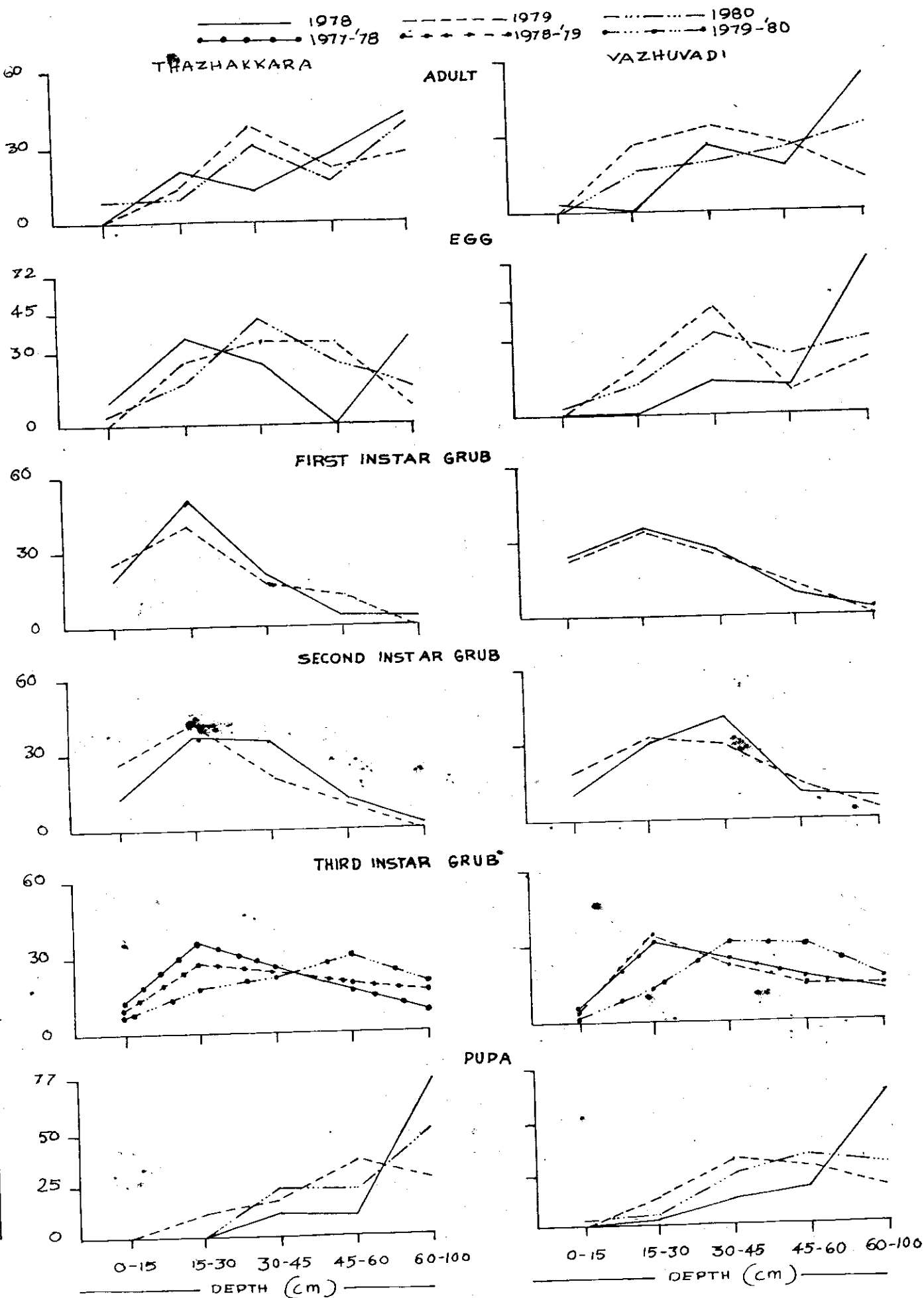
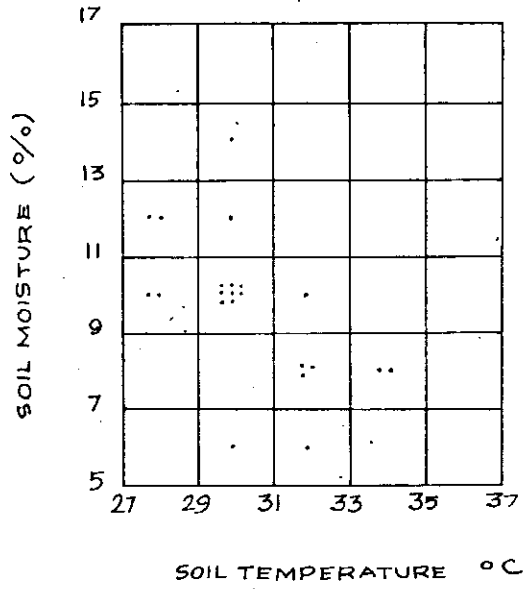
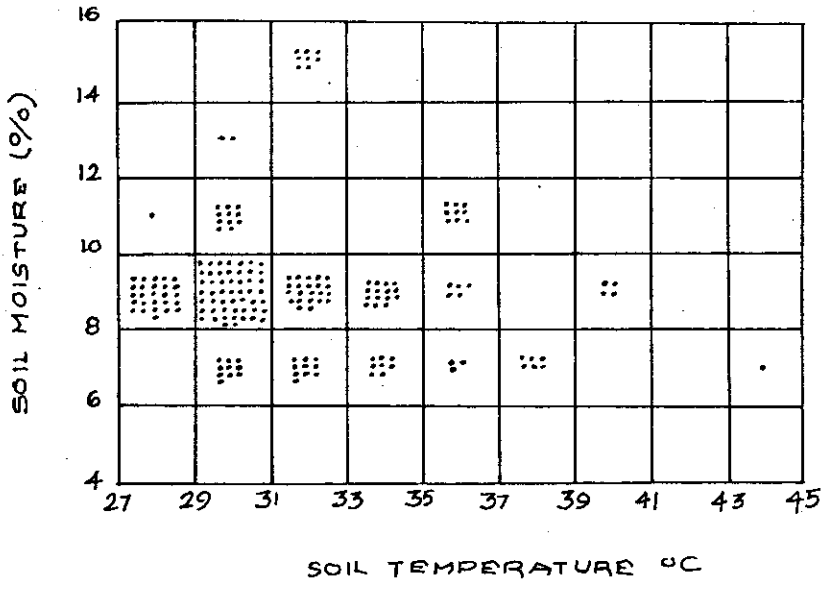


FIG. 3\* DISTRIBUTION OF DIFFERENT LIFE STAGES OF *L. CONEOPHORA* IN DIFFERENT DEPTHS OF SOIL

FIG. 4 MEAN NUMBER OF L. CONEOPHORA IN DIFFERENT RANGES OF SOIL TEMPERATURE AND MOISTURE



ADULT



FIRST INSTAR GRUBS

FIG. 5. MEAN NUMBER OF L. CONEOPHORA IN DIFFERENT RANGES OF SOIL TEMPERATURE AND MOISTURE

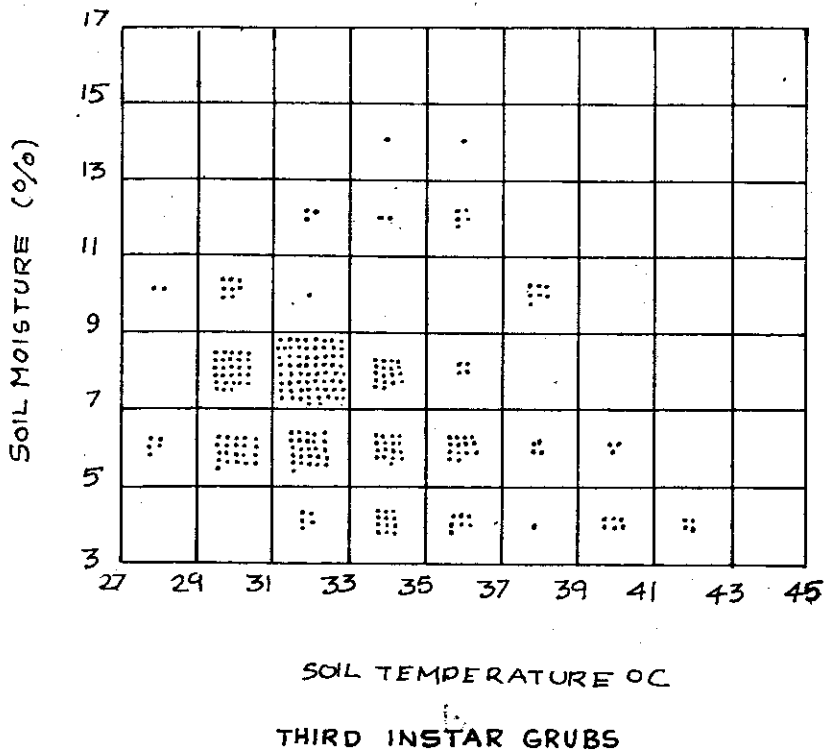
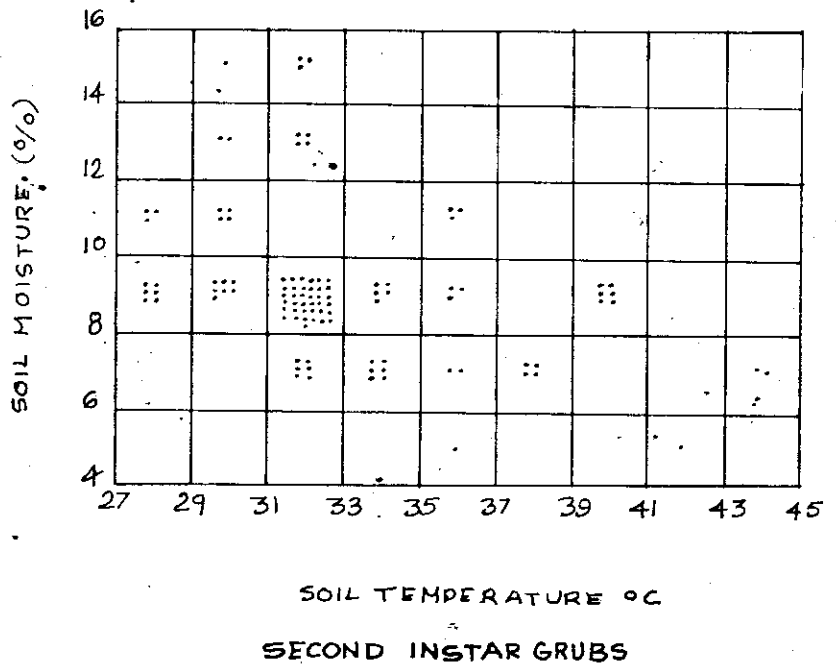


FIG. 6. SEASONAL OCCURRENCE OF DIFFERENT LIFE STAGES OF  
L. CONEDPHORA

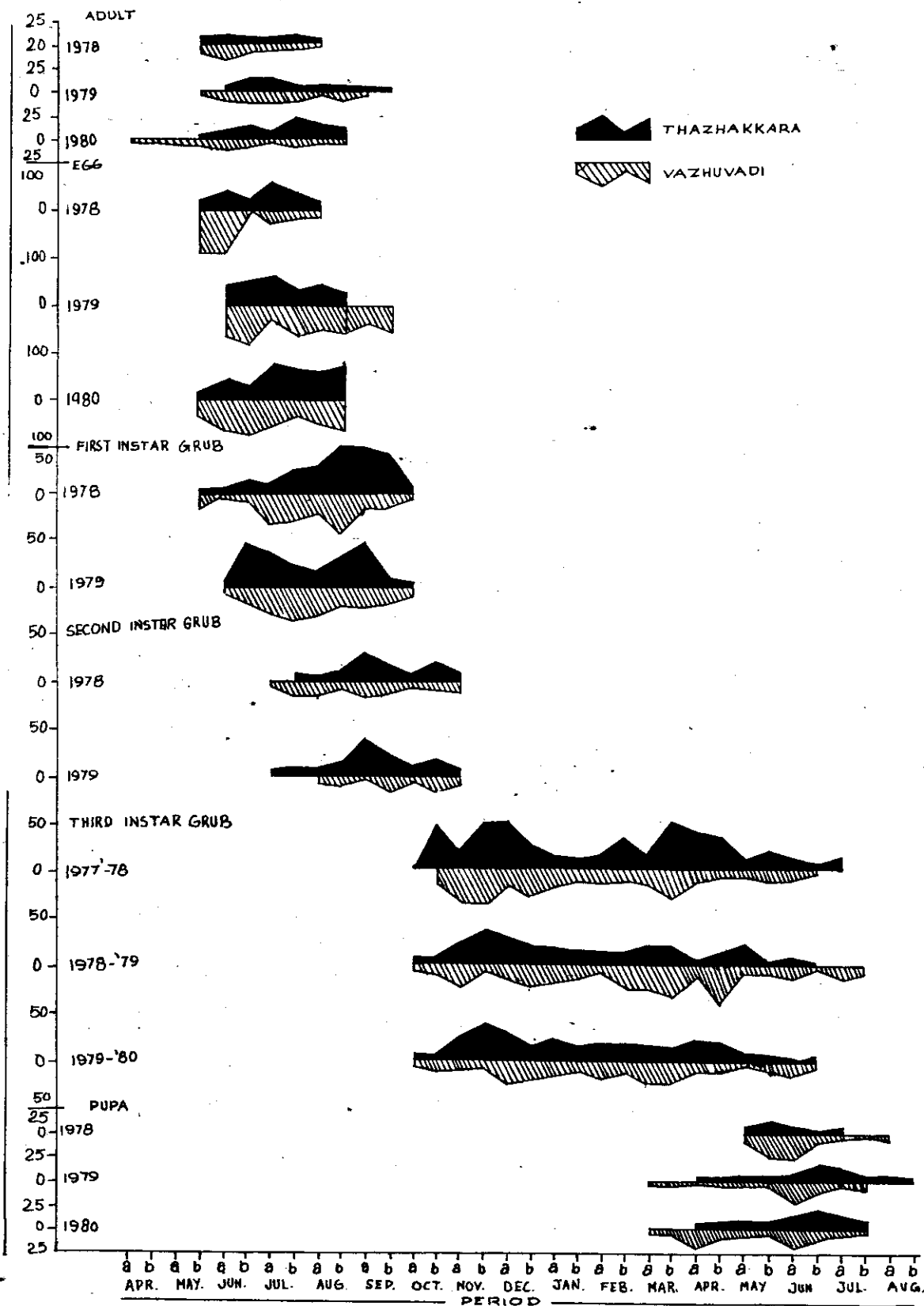
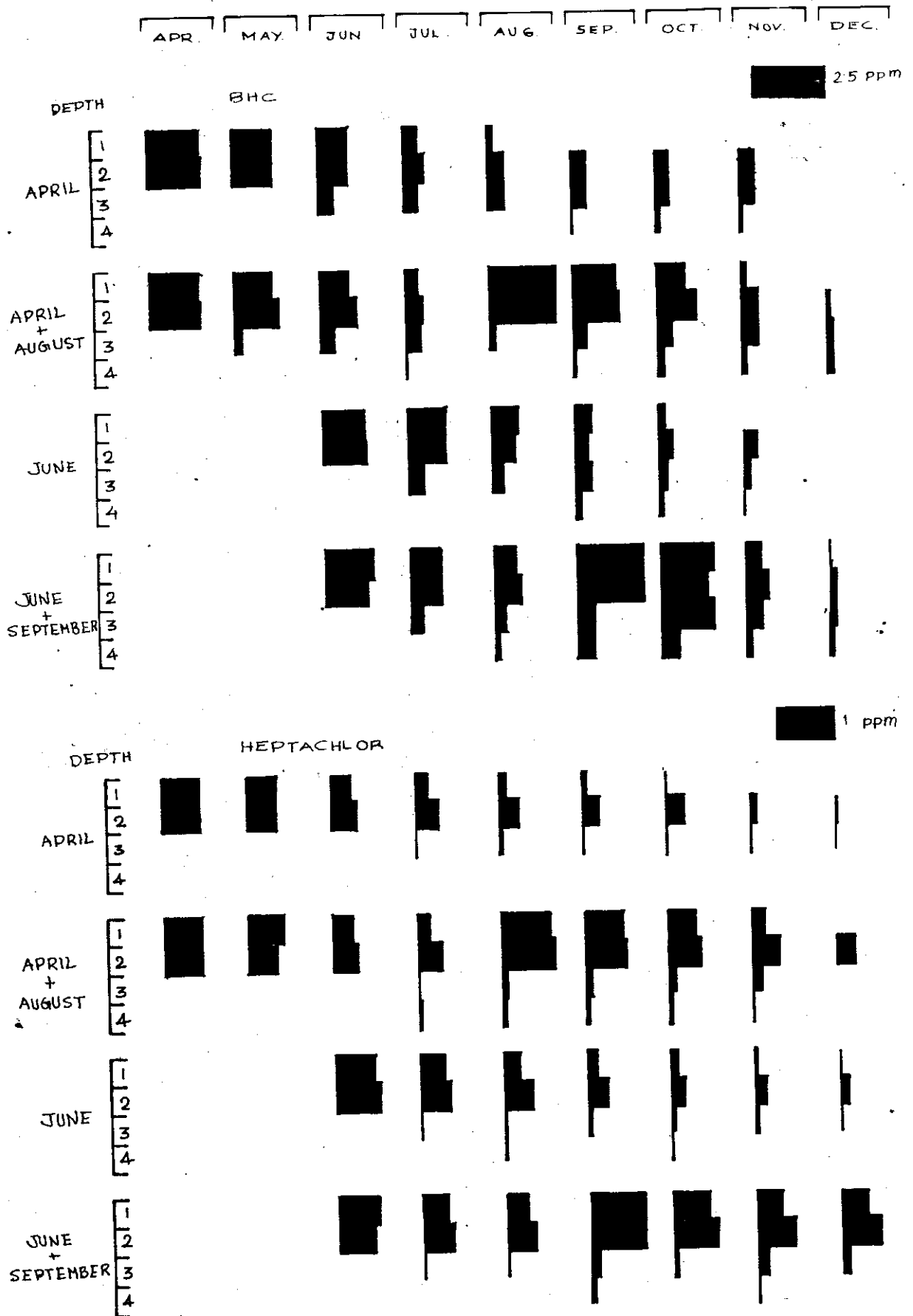


FIG. 7. PERSISTENCE AND DOWNWARD MOVEMENT OF BHC AND HEPTACHLOR APPLIED IN FIELD (LOAMY SAND SOIL) IN ALEPPY DISTRICT, KERALA.



● 1 = 0-7.5 cm. 2 = 7.5 - 15 cm. 3 = 15-30 cm 4 = 30-45 cm.