THE DISTRIBUTION, NESTING HABITS, AND ACTIVITY PATTERN OF CAMPONOTUS ACVAPIMENSIS MAYR (HYMENOPTERA : FORMICIDAE) IN SAVANNA AREAS OF SOUTHERN GHANA.

By

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A thesis submitted for the Master of Science degree at the University of Ghana, 1978.

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LEGON

This is to certify that this thesis has not been submitted for a degree to any other University. It is entirely my own work, and all help has been duly acknowledged.

KOFI OSAE OFEI

This work is dedicated to my late father who through his needy days sacrificed and made me what I am today. His memories will always remain.

ACKNOWLEDGEMENT

This work is a report of 12 months of field and laboratory studies. My gratitude goes to Professor R. Kumar, my immediate supervisor, who suggested this project and without whose encouragement, directions and criticisms this work would not have been possible.

My thanks go to the members of my supervisory committee especially Dr. Lock of Botany Department University of Ghana whose suggestions and directions highlighted the problems of the study plots and suggested alternative methods to study them.

I wish to thank also, the Headmaster of Presbyterian College Legon, Rev. E.S. Mate-Kodjo for permitting me to do the course at a very short notice, and allowing me to use the laboratory facilities and portions of the school plots as my study plots without disturbances.

I am also indebted to him for his help which enabled me to enjoy study leave and stay on the school compound during the course.

I wish to thank Mr. D. Decker, Chief Technician, Department of Zoology for his help in providing me with various materials at odd hours. I thank Mr Afreh Nuamah, a National Service worker of the Zoology Department who helped me with the operation of the scientific equipments used for field work.

I thank Mr. R. Pobi formerly of Presbyterian College for typing various portions of this work for me. I wish to thank Mr. E. Attua-Afari, the Assiatant Headmaster, who permitted me to use the school typewriter for the initial typing work. I thank Miss Gloria Aye of Cocoa Marketing Board, Produce Buying Section Koforidua for spending her precious hours to type the final work. My thanks are also extended to Mrs. Jackson a Horticulturist, now at Kumasi University for helping me with the identification of the various plant species that were on the study plots. Lastly, my thanks go to the Department of Zoology and Ghana Education Service who supported this work.

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The distribution, nesting habits and activity as well as seasonal population pattern of Camponotus acvapimensis Mayr were studied in a savanna area of Ghana. The ants were distibuted in the poor shaded areas of the savanna grassland. Type of soil, light and food availability were found to influence the nesting and ant's distribution. Analysis for preference of nesting sites indicated that the ants nest in the soil or grass roots but where wood is available, the bark formed a very good nest.

Two types of nests were identified. The first type is the primary nest with many cells. Such nests contained the highest populations and had larvae, pupae, workers, soldiers and alates in them. The second type is the secondary nest that largely seved as nests for tending other insects and such nests had few larvae and pupae and rarely alates with the soldiers and workers tending the sap feeders.

The ant is active both day and night but peaks of activity were comparatively high during the nights and low during the day. The workers were numerous and formed a maximum of 70% or more of the ants (excluding larvae and pupae). The workers and soldiers were found to forage all day but the number of soldiers foraging at night was comparatively few.

The ants feed on sugary materials such as nectar and honey dew from other insects. They also collect flower parts and vegetable tissue. The ant tends aphids, coccids, other homoptera and hemiptera.

C H A P T E R O N E

GENERAL INTRODUCTION

CHAPTER 1

GENERAL INTRODUCTION

West Africa possesses a rich fauna of ants that are found in different ecosystems. The distribution of these ants tends to be influenced by factors which are mainly environmental. Vegetation cover plays an important role in habitat selection of ants as plants provide the source of food and nesting sites for most of them. Two types of vegetational zones are recognizable in Ghana. These are the forests which are made up of rain forest or 'cocoa forest' (Leston and Hughes 1968) and the savanna grassland. In Ghana many genera and numerous species of ants are found. Room(1971) found 48 genera and 128 species of ants on mistletoe which made him conclude that about 50% of the insect species found on cocoa mistletoe Tapinauthus bangwensis (Engle and K. Krause) were ants.

The occurrence and activities of ants have thus been studied by several workers (e.g. Leston, 1968, 1971; Aryeetey, 1971; Majer, 1972, 1973, 1974, 1976a-c; Ackonor, 1977; Adabie, 1977). These works concerned ants in the cocoa ecosystem only. No work appears to have been done on savanna grassland ants which have become economically important due to the introduction of large scale farming in the grassland areas of Ghana. The distribution of the savanna species has only been mentioned in the work of Majer(1972) where he placed

Camponotus acvapimensis Mayr under the sub-dominant group 'which under certain field conditions may numerically predominate and exclude all forms and species!. Room (1971) mentions the nesting sites and materials used for nesting by Camp. acvapimensis. Goetsch (1929) records the seed collecting habits of some ants and this is an indication that Camp. acvapimensis may have preference for the new food source which may be grown as a monoculture.

The present work is an attempt to study Camp. acvapimensis in the savanna ecosystem. Although the species Camp. acvapi-memsis has Ghana as its type locality, no work has been done on the species. The only findings that have been made on the species are the incidental observations during investigations on pests of cocoa or other ants, or collecting ants and insect species in the cocoa farm ecosystem. These include the work of Gorenz (1969) who reported that Camp. acvapimensis was the possible cause of the pod-rot disease carrying the inoculum from the base of the tree to the pods in the canopy. Evans (1971, 1973) confirmed the findings of Gorenz and accepted the role of the ants in the transmission of the spores of the fungus from the soil to the pods in the canopy. Evans (1971, 1973) felt that the spores might have been carried on the bodies of the ants. Apart from these reports on the involvements of the ants in fungus transmission, some reports have also been made on the foraging and nesting habits. Bigger (1972) collected the ants on cocoa trees; Room(1971) recorded the presence of the ants, nesting and foraging areas in the cocoa farm as well as collecting the ant from Tapinanthus bangwensis. Firempong (1975) reported on this ant's association with the aphid Toxoptera aurantii(Boy.) and other scale insects, and Majer (1972) mentioned the ant as preferring broken canopy in the cocoa ecosystem.

Mayr(1863) described the characters of the workers of Camp. acvapimensis but no account is available of the castes of this species. Wheeler (1922) however, mentions that the species of Camponotus often form populous colonies and exhibit great diversity of nesting habits. He also states that they may live in the ground either under stones or in crater nests and others under bark in dead wood and hollow twigs. On Camp. acvapimensis, Room(1971) recorded the ant's nesting habits and indicated that the nests are found within the soil or in dead wood in the soil. In all these, no details of the worker castes are available. Wheeler(1922) mentioned that the species from Bolenzi in the Republic of Congo were found nesting in the trunks of Oil Palm trees. Very little is known about the behaviour of the species but Majer(1972) mentioned that it may exclude all forms from areas in the cocoa farm ecosystem without shade. This could imply numerical abundance and pugnacious habits. Very little is known about the food habits of the ants but several workers such as Firempong(1975), Evans(1971, 1973) and others have found that the ant tends aphids, scale insects and mealybugs in the cocoa ecosystem. Wheeler(1922) also reported capturing some workers of Camp. acvapimensis at Faradje in the Republic of Congo while tending plant lice on the young leaves of orange trees. Evans(1971, 1973) mentioned that these ants used gnawed materials for building tents over the mealybugs which they tend.

Predatory activity of the ants has not been reported by any worker but Wheeler(1922) found the workers of Camp. acvapimensis in the stomachs of the toads Bufo regularis Reuss and B. fenereus Bocage. One major worker was found in the stomach of a frog, Rana occipitalis Gunther, showing toads and frogs prey on these ants.

The aim of this is to provide information on the ecology of Camponotus acvapimensis. Distribution of the ant in relation to farming habits as well as the effects of external factors such as vegetation are studied. The type of nests constructed by the ants, their colony size as well as the phenology of the caste and brood over the period of study are examined. Activity pattern, foraging range and distance and the flight activity are considered. The ant!s association with other insects is investigated. Attempts are also made to furnish information on interaction with other ants occuring in the area.

CHAPTER TWO

GENUS *CAMPONOTUS* MAYR

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The genus *Camponotus* was erected by Mayr(1862) and the number of species in the genus has increased with time. Smith (1866) noted the numerous additions and remarked " the number had increased from 18 in 1861 to 32 in 1865". He suggested that new species were likely to be discovered. The discovery of new species did indeed take place and numerous new species were described by Emery(1883); De Geer(1884); Oertzen(1887) and Forel(1890).

The sub-divisions of the genus towards the end of the last century was caused by the large number of known species. Emery(1896) sub-divided *Camponotus* into more or less natural groups of 26 subgenera but Forel(1912) sub-divided the genus into 20 subgenera and in 1914 published a list of all known species at that time. Emery(1920) also published a revised classification of the genus taking into account geographical distribution of the species. The former status of *Camponotus* as belonging to the subgenus *Myrmoturba* by Forel(1912) was followed by Emery(1920).

Wheeler(1922) described the genus *Camponotus* as a "huge cosmopolitan genus, comprising more than 1,000 described forms". He noted the frequent occurrence of the species of the genus *Camponotus* in all countries excepting United Kingdom and New Zealand. Wheeler(1922) further attributed the extraordinary variability of many of the species of *Camponotus* to their response to slight differences in their environment. He recognised two different forms of *Camponotus* grouped by their appearance and habits. The first group was described as smaller forms that are stolid, apathetic or timid(*Camponotus acvapimensis* belongs to this group as it is very reluctant to bite, although possessing quite formidable mandibles). The second group comprises maxima workers of the large species belonging to the subgenera *Dinomyrmex*, *Myrmoturba*, *Myrmothrix* and *Myopiromis* which are pugnacious and are capable of inflicting wounds with their powerful mandibles.

The subgenera of *Camponotus* described by Wheeler(1922) are distributed within certain areas of Africa and Asia as follows:

REGION	SUBGENERA
Ethiopian	*Myrmoturba*, *Dinomyrmex*, *Myrmosericus*, *Myrmothrix*, *Orthonotomyrmex*, *Myrmotrema* *Myrmopyromis*, *Myrmorhachis*, *Myrmopsamma*, *Myrmamblys* and *Colobosis*.
Malagassy	*Camponotus*, *Myrmosaulus*, *Mayria*, *Myrmonesites* and *Myrmopytia* .

REGION	SUBGENERA
African	Myrmopsamma, Myrmopiromis.
Madagascar	Myrmosaga, Mayria, Myrmonesites and Myrmopytia.
West African	Myrmoturba, Myrmosericus, and Orthonotomyrmex.
Southern China across India to South Africa and Gulf of Guinea	Myrmosericus, and Myrmoturba.

Table 1. Distribution of subgenera of Camponotus (after Wheeler 1922)

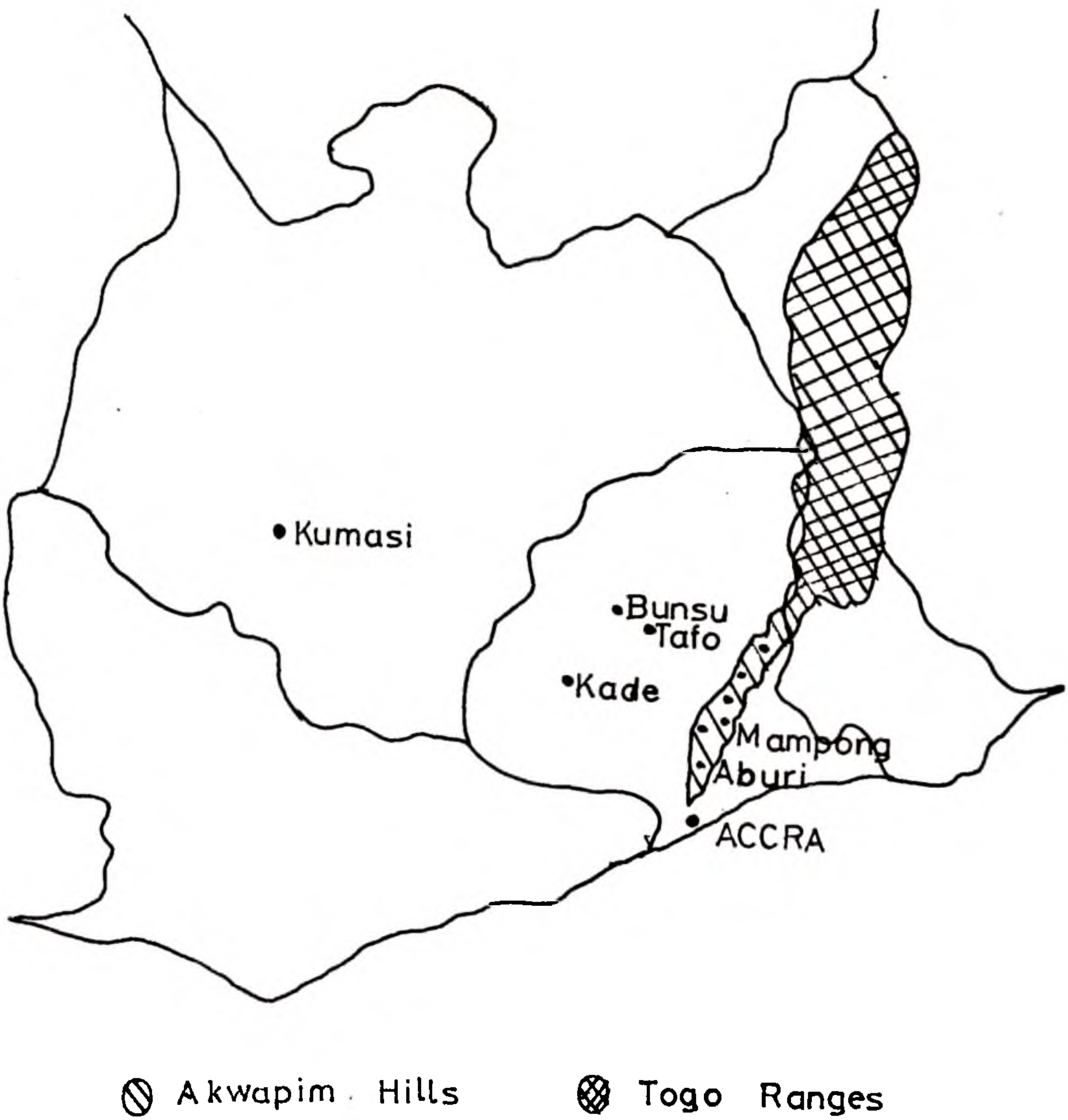
Out of these species(Table 1), Wheeler(1922) named a few species that have a greater coverage with respect to distribution. These are Camponotus (Myrmopytia) species that occur in the Malagassy region. He names Camponotus(Myrmoturba) maculatus (Fabricius) as the typical form which is West African and two other species Camponotus(Myrmosericus)rufoglacus Jerdon and Camponotus(Orthonotomyrmex)sericeus (Fabricius) as having singular distribution with forms of Camp. maculatus occuring in all the continents. Camp. rufoglaucus has many varieties that are found in Southern China across India and Equatorial areas to South Africa and Gulf of Guinea.

Wheeler(1922) mentions Camp. sericeus as occupying similar ranges but showing little tendency to produce sub-species and varieties.

Later works on the species included changes in spellings, for example, Camp. acwapimensis: Camp. acqwapimensis: Camp. akvapimensis and Camp. akwapimensis Emery(1877; 1899), Reh (1905). The type locality of the species is from the Akwapim Mountains of Ghana and this might have caused confusion in the spellings of the type species. In Ghana, the species occurs in several places and these include Aburi, Tafo-Akim, Bunsu, Kade, Mampong Akwapim, Kumasi and other places (Evans, 1971; Room, 1971; Firempong, 1975; Majer 1972, 1973, 1976a - c). These places and the type locality of the species are shown on the map (fig 1).

In Ghana, three species of the ground nesting ants of the genus Camponotus are common in grassy patches in the savanna areas or clearings in the forest zones but as many as 10 species of Camponotus were recorded by Room(1971) during a sampling programme in a cocoa farm. The three grassland species found in Ghana and nesting in the soil are Camp. acvapimensis Mayr, Camp. chrysurus Gerstaecker and Camp. vestitus (F.Smith). In terms of numbers, Camp. acvapimensis is by far the dominant species in the grassy patches followed by Camp. chrysurus and Camp. vestitus, the last preferring more or less a bare ground.

FIG: 1: Map of Ghana showing distribution of C. acvapimensis



CHAPTER THREE

THE STUDY AREA

3.1 LOCALITY

The study area was situated around Presbyterian College and Madina (fig 2). The different plots (A and B) were selected for the study. The plots measured about 2 hectares and were continuous. They were boardered (fig. 2) on the far North by the Madina new road, on the far East by the Institute of Professional Studies buildings (I.P.S.), on the immediate South by the road to I.P.S. and on the immediate West by the bungalows of Presbyterian College (fig. 2).

Within the plots the vegetation covers consisted of :

(i) Plot A - an area frequently disturbed by fires when the grassland is dry during certain periods of the year. It was largely devoid of green vegetation during the period when conditions were not favourable and with green vegetation when conditions were favourable.

(ii) Plot B - an area not frequently disturbed and had cultivated plants such as corn, cassava, and cocoyam, and was not subject to fires.

3.2 Plot A (savanna grassland)

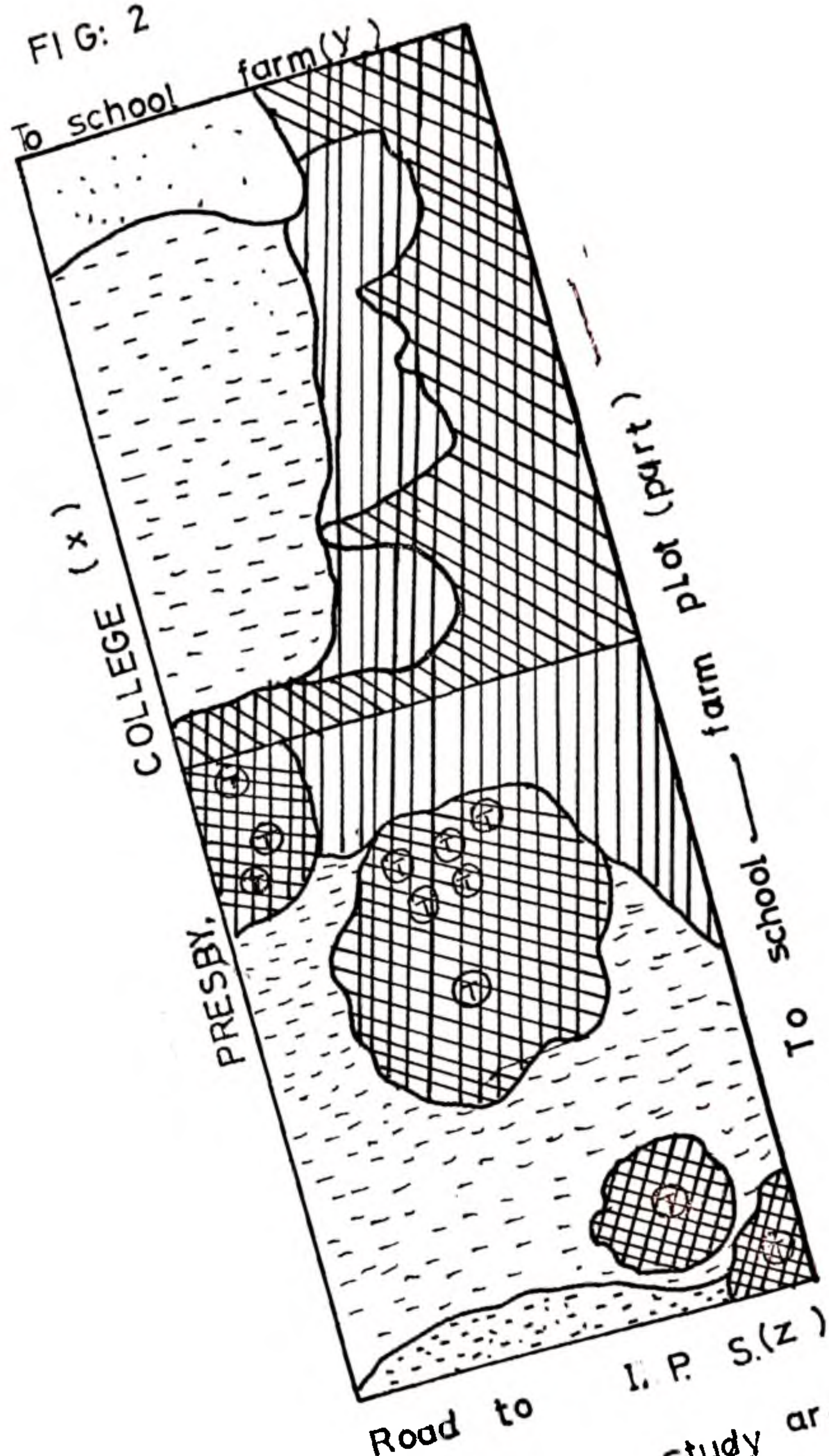
This was a fire frequent plot because during the dry seasons (late December to March or April and late July to early September), the grasses dry-up and the bush fires start sweeping through the field, consuming the entire vegetation. The fires are set by the farmers as frequently as the grasses dry-up and once started, they

KEY TO FIGS: 2, 4 & 5

	CONTINUOUS SHADE
	BROKEN SHADE
	POOR SHADE
	NO SHADE
	TREE
	NEST OF C. SERICEUS
	NEST OF C.
	NEST OF C. ACVAPIMENSIS IN SOIL
	" " " " STUMPS
	" " " " TREE
	" " DRIVER ANTS
	PLATYTHYREUS

1cm. = metres

FIG: 2



Map showing study area with shade regimes are controlled by the driving force of the wind and its direction. The fires cause destruction over a large area. The land is usually left bare and the grasses are reduced to mere stumps in some areas whilst the vegetation excepting the burnt remains of the woody shrubs at other places is totally destroyed.

3.3 Effects of wet season on Plot A.

During the rainy seasons, the vegetation encountered is different. The rains fall between late and early April and last till July and then begin again in early or late September and last till November or early December. The vegetation flourishes with guinea grasses predominating in this area. Two types of grasses sometimes dominate the area and these are the tall guinea grasses and the soft weak-stem grasses that trail the ground. The total area of Plot A measures about one hectare. During the rainy seasons, herbs also occur within the area and these are mostly *Tridax* and *Talinum* species and a few climbers mostly *Clitoria teratea* L., that spreads easily forming cover over the area. Species of *Passiflora foetida* L. provide shade over the grasses in some areas. Distribution of trees follows a scattered fashion. The trees in the area were mostly *Mangifera indica* L. (Mango), and *Azadirachta indica* Allioni (Neem) with the latter dominating the site (table 1).

With the abundance of rain the stumps of dominating grasses increase in size due to new growth. The total foliage is increased and seeds of grasses germinate and increase the vegetation which

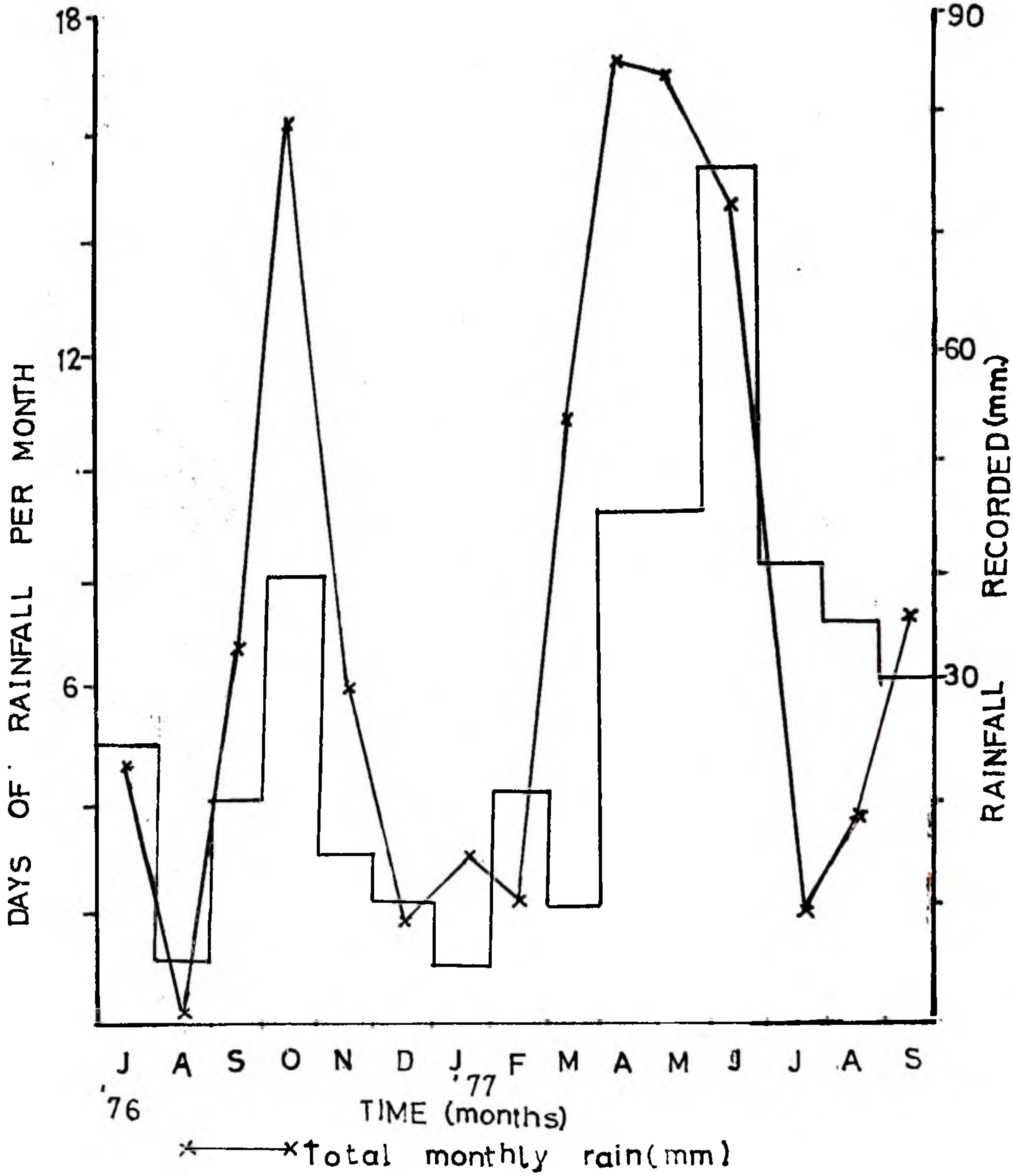


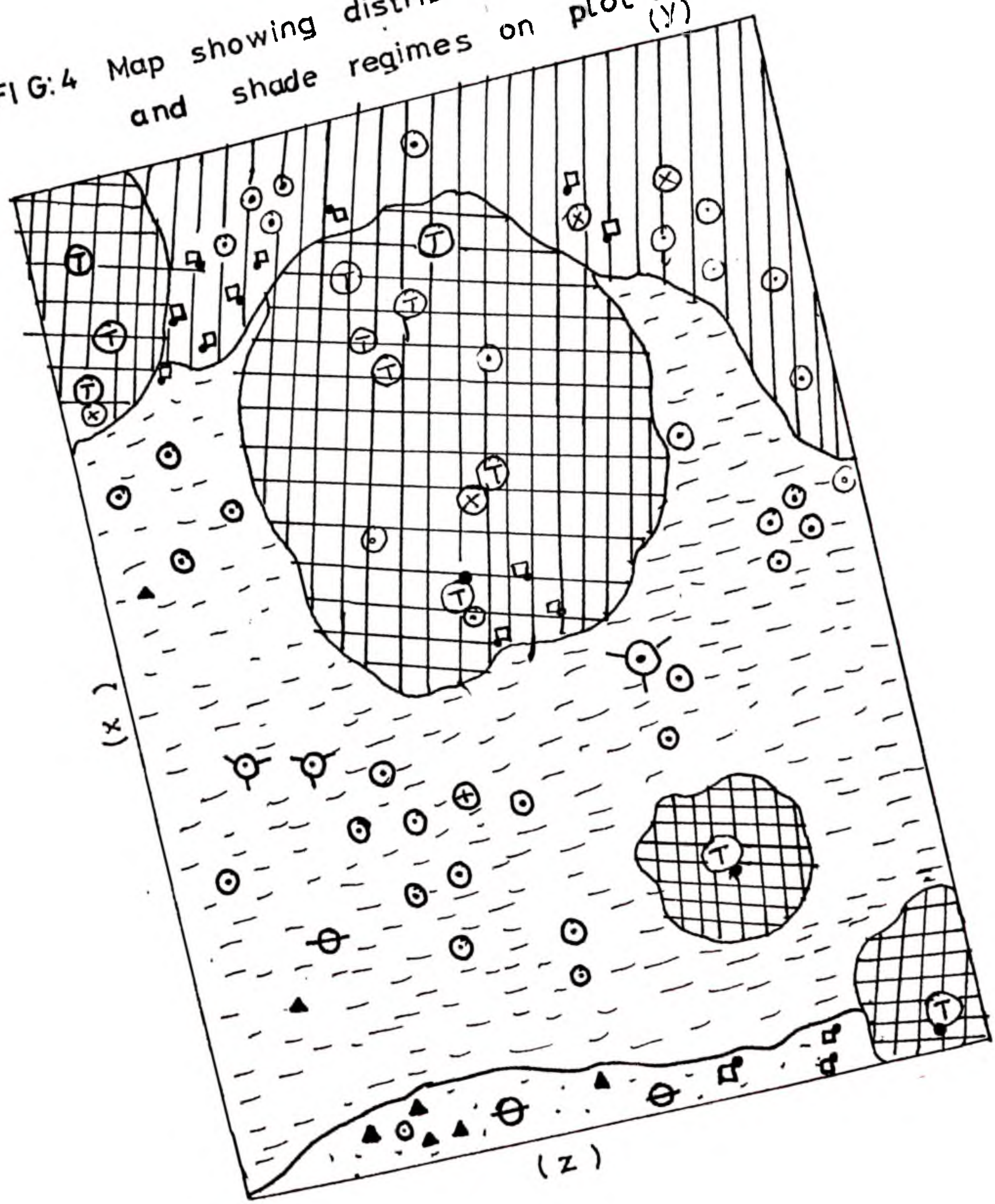
FIG. 3: Meteorological information at the study area

covers the whole area. A closer study of the vegetation however, provides different information. The grasses are not very close but numerous stalks are developed and these form a sort of canopy above the soil level giving the appearance of total cover of the area by grasses. During this period, the tall grasses may stand as high as 2.4 metres or more from the base to the inflorescence but elsewhere the grasses measure up to 1.7 metres. Rainfall figures are given in Fig 3. The effects of such climatic factors as temperature and humidity are not marked and infomation on them is given in chapter 6.

3.4 Effects of dry season on Plot A

The period of dry season varies and most cases begins in late December and ends in late March or early April (depending on the time of the first rains). There is also a period of short dry spell which is experienced during late July to early September. This dry spell is caused by scattered rains (if there is rainfall at all) and periods of no rain. During this period the vegetation withers and falls to the ground. The only visible grasses are few stalks still maintaining their stands due to their thickness as compared to those easily blown off by the wind. Herbs are absent and the whole field which is totally covered with green leaves (vegetation) during the wet season appears brownish and is covered with dry leaves. This is the cause of the quick sweeping fires since the dry grasses burn easily.

FIG: 4 Map showing distribution of ants and shade regimes on plot A



The shrubs are reduced to mere stems and bear very few (if any) leaves. Only trees and few shrubs have green leaves (table 1).

3.5 Plot B (farm-land)

The meteorological factors affecting this plot were the same as those affecting Plot A. However, there were major differences caused by the different shade regimes provided by the plants such as *Zea mays* L. (maize), *Manihot esculenta* Crantz (cassava). *Musa paradisiaca* L. (plantain), with the last forming the dominant plants of the area. The seasons influencing Plot B were the same as those influencing Plot A. The main differences were caused by the shade provided by the shade plants in the area as well as the ability of the cultivated plants to survive periods of drought. The grasses are absent or when present they are found in patches in few places whilst in their places are different plants. Humidity ranges from an average minimum of about 56% R.H. for the periods of day to about 98% - 99% R.H. during the rainy periods. Sunshine varies with the seasons but the effects of light intensity on the soil depend to a greater extent on the type of plants growing in the area as dominant species and those growing as an undercover. The shade depends on the type of plants found in the area and in particular where plantains and cassava are grown, the shade is quite dense. Trees are absent which is the result of removal of such plants during the clearing

FIG: 5 Map showing distribution of ants and shade regimes on plot B

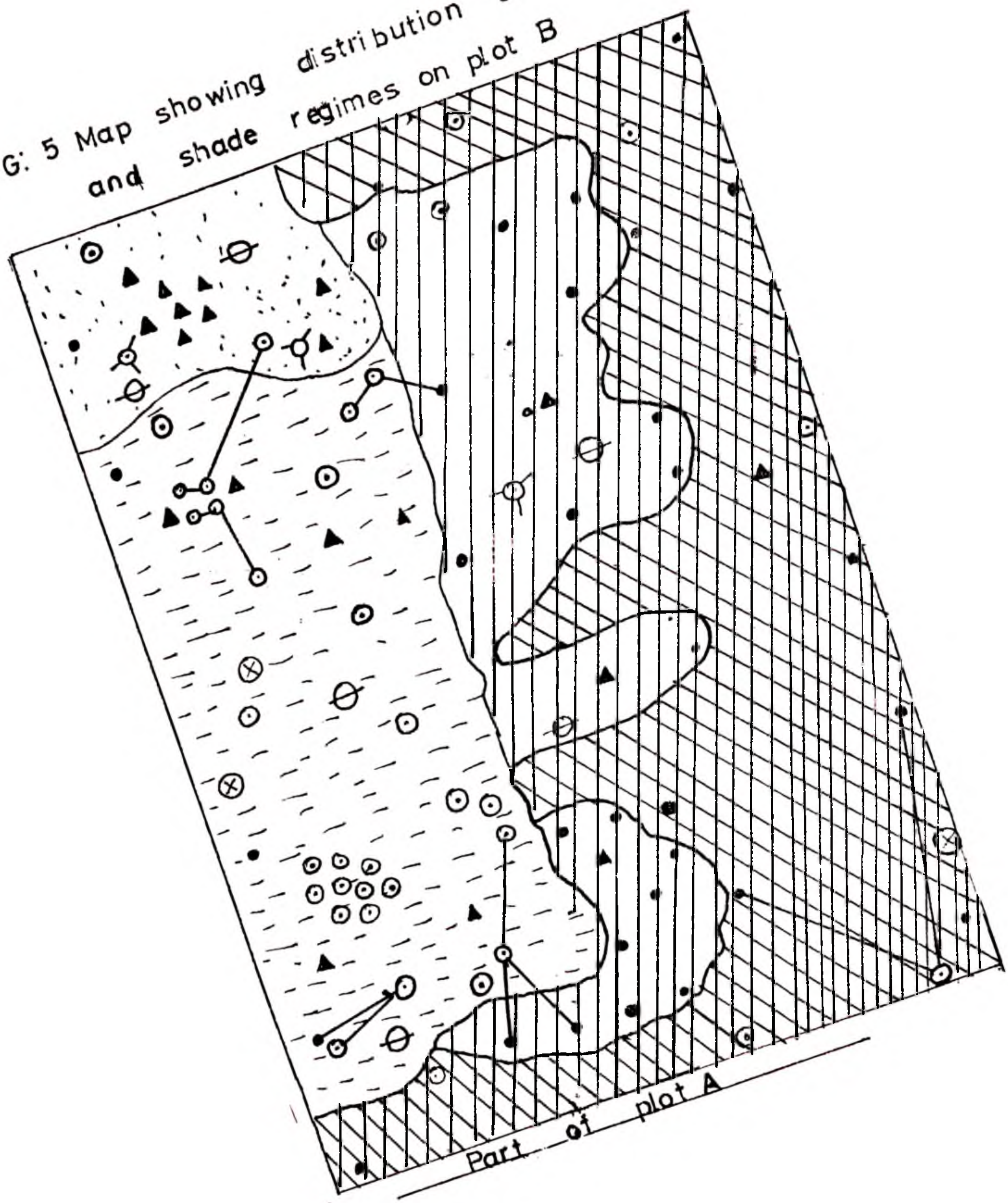


Table 1. Distribution of plants on Plot A.

PLANT TYPE	WET SEASON	DRY SEASON
	Plant Species	Plant species
DOMINANT GRASSES	Guinea grasses	-
DOMINANT UNDERCOVER	<u>Talinum</u> <u>triangulare</u> L. <u>Tridax</u> <u>procumbens</u> L.	- -
CLIMBERS	<u>Clitoria</u> <u>teratea</u> L. <u>Passiflora</u> <u>foetida</u> L.	- -
DOMINANT SHRUBS	<u>Abutilon</u> spp	-
TREES	<u>Mangifera</u> <u>indica</u> L. <u>Azadiacta</u> <u>indica</u> Allioni	<u>Mangifera</u> <u>indica</u> <u>Azadiacta</u> <u>indica</u>

of the area for farming. The under shrub found in these areas are low growing herbs such as *Tridax* and *Talinum* species with very few grasses which grow initially but after one or two clerings are lost from the farming areas. They are then replaced by succulents which are herbaceous (table 2).

3.6. Effects of wet season on vegetation of Plot B

The wet season usually lasts from March to early July and then begins again in late or early September and ends by late November or early December. During this period, more foliage is found due to the rains and part of this gets removed due to weeding and maintenance of the farm in healthy condition. However, herb species during this period are more thqn those occuring during the dry season (table 2). These are the cultivated plants as well as those growing with the onset of rains. Mangoes and Neem trees that were left during clearing are also present.

3.7. Effects of dry season on the vegetation on Plot B

During the dry season, the vegetation consists mostly of crop plants that have been established e.g. plantain, cassava and corn stalks. Grasses, if present, are in patches. Most of them remain dry but not dead and may die when unfavourable conditiond prevail over a long period. Maize, *Tridax* and the *Euphorbia* plants do not flourish. Trees are very few(table 2).

Table 2 : Distribution of plant species on Plot B

	WET SEASON	DRY SEASON
PLANT TYPE	PLANT SPECIES	PLANT SPECIES
DOMINANT PLANTS	Musa paradisiaca L.	Musa paradisiaca
	Zea mays L.	-
	Manihot esculenta Crantz	Manihot esculenta
UNDERCOVER	Talinum triangulare L.	Talinum triangulare
	Tridax procumbens L.	-
	Commelina spp	Commelina spp
	Euphorbia spp	-
	Boerhaavia diffusa L.	Boerhaavia diffusa
CLIMBERS	Absent	Absent
TREES	Azadiacta indica Allicni	Azadiacta indica

3.8 Other disturbances affecting the two plots

These plots of land are constantly weeded during the rainy seasons as a check on the plants that grow within these areas. Weeding is done once or twice during each rainy season. Apart from these disturbances, somm indigenous hunters use truncheons to disturb the vegetation in search of grass-cutters. Such invaders tend to cause some changes in the vegetation that grows within these areas due to their habit of reducing the tall grasses in height so as to walk through the bush easily. The vegetation as a result suffers constant destruction.

CHAPTER FOUR

RELATIVE DISTRIBUTION OF ANTS IN SPACE

CHAPTER 4

RELATIVE DISTRIBUTION OF ANTS IN SPACE

4.1 INTRODUCTION

Various workers have studied the ecological distribution of ants in different habitats in several ant species (for example, Gosswald, 1932; Tabolt, 1934; Dennis, 1958; Leston, 1971; Majer, 1972, 1973, 1974, 1976a-c). In all these cases, selection of habitats was discussed as being influenced by climatic factors and conditions such as the availability of food and vegetation cover.

Camponotus species have been reported from several ecosystems. Brown(1959) reports *Camponotus* species associated with other ants on coconut plantations on Solomon Island. He mentions four different species of ants but specifically he stated of *Camponotus* species as foraging on palm stems but not on their spadices.

Wheeler(1922) records *Camp. acvapimensis* from the following places where the ants have been found:

GHANA : Akwapim Mountains,

GUINEA: Kindia; Camayenne; Mamou; Los Island.

SIERRA LEONE: Most places.

LIBERIA: Grand Bassa ; Junk River (H. Brauns).

SOUTHERN NIGERIA : Moor plantation near Ibadan; Old Calabar.

CAMEROON : Victoria.

CONGO KINSHASA : Banza Masola; Ganda Sundi; Mondombe; Congo da Lemba; Yambui; Zambi; Faradje; Garamba; Bolengi; near coquilhatville; Stanleyville; Vankerckhonville;

Akenge; Niangara; Thysville and Eala.

RHODESIA : Bulawayo.

KENYA AND TANZANIA : Kigerama; Mombasa; Tangan; Mto-ya-Kifaru; Kilimanjaro and Patta Manda.

UGANDA : Chacansengula.

SOMALIA: Lower Gunaya; Giar Bule; between Obbia and Berbera.

ETHIOPIA : Arussi Galla; Ganale Gudda; Dime to Bass Narok; Bela; Coromma; Western Ethiopia; Keren and Asmara.

In Ghana the species have been collected from several areas and these include places such as Tafo, Bunso, Kumasi, Akwapim Mountains (Mampong) and Kade. Majer(1972) in a series of samples collected Camp. acvapimensis on cocoa trees at a frequency of 31 out of 144 samples. Their occurrence and presence in different places and localities have also been reported by Room(1974) who collected Camp. acvapimensis on a mistletoe Tapinanthus bangwensis In another work, Room(1971) names Camp. acvapimensis as one of the ants found under cocoa farms and foraging on herbs under the cocoa trees.

Wheeler(1922) described the genus as a large group with more than 1,000 described forms, and one is tempted to investigate the status of the species of this genus within their natural ecosystem, as to whether their relative abundance will make them dominant or not. With respect to numbers, Leston(1971) recognized the ant species of the cocoa farm to belong to 3 distinct groups which he named as : (1) Dominants (2) Co-dominants and (3) Non-dominants. Majer(1972) considered Camp. acvapimensis as a sub-dominant group and further stated that "under certain field conditions they may numerically predominate to exclude all other species from the area of cocoa farm ecosystem which are devoid of shade and having characteristics of savanna grassland". Wheeler(1922) however, refers to the genus as "often forming populous colonies and exhibiting great diversity of nesting habits". This is an indication that any of the species within a favourable ecosystem can reach the status of 'dominant' species. The status accorded to Camp. acvapimensis as a sub-dominant group by Majer(1972) applies to the species only in the cocoa farm ecosystem which is possibly not their natural habitat. Wheeler(1922) emphasizes that the "extraordinary variability of many of the species in response to slight differences of environment makes the genus one of considerable interest to the student of geographical distribution". Several reports on Camp. acvapimensis in the cocoa farm ecosystem indicate the importance of these ants within the ecosystem.

The aim of this section is to map the nests of Camp. acvapimensis in relation to shade regimes as well as in relation to the other ants nesting in the area. Nesting habits of the ants will be presented and the percentages of such nests in the habitat determined. The colony size of the ants will be investigated and the number of nests forming one colony would also be worked out.

4.2 METHODS

4.2.1 Abundance of nests and nest distribution in relation to shade regimes on Plot A. (Savanna)

An area mostly covered with grasses(referred in chapter 3 as study plot A) was demarcated. Trees and other plants in this area were recorded and those bearing nests of *Camp. acvapimemsis* were mapped out. Distribution of nests was studied and consideration given to the place where the nest was found. preference of nesting area was determined by the abundance of nests in a particular area. A comparison table was constructed to determine if there was any significant difference in the distribution of nests on the savanna area as compared to the farming area. The entrances to the nests were mostly found by observing and tracking the ants that were carrying food materials. Another method used was to follow any ant that had its abdomen (gaster) raised and moving very fast due to excitement into its nest and then labelling the nest.

4.2.2 Abundance of nests and nest distribution in relation to shade regimes on Plot B(farm land)

A search for nests of *Camp. acvapimensis* was done in the farming area(plot B) which had plantain, cassava and corn during the wet season and no corn during the dry season. Counting of the nests was done by observation and searching through the plantain field. The plantains with nests were noted and their numbers tabulated. Nests found in the soil were distinguished from those found on the plantain suckers by using different symbols. The effects of the changing seasons on the abundance of nests were tabulated and the percentage distribution of such nests also determined. The percentage distribution of such nests with respect to shade regimes was calculated for the plot during the wet and dry seasons and the results tabulated. Other ants nesting in the area were mapped and the percentages of their nests in different shade regimes was obtained. This was then compared with the nest distribution of Camp. acvapimensis in relation to shade preferences.

Investigation into shade preferences was carried out by three methods.

(1) By counting the number of nests in the different shade regimes and finding out the percentage of such distribution in relation to the other shade regimes;

(2) By artificially shading areas having numerous nests and determining the effects of the shade on the nesting preferences of Camp. acvapimensis;

(3) By clearing the shade provided in some areas and finding out if the nests present will be abandoned or other nests will be established in such areas.

The effects found were recorded and preferences estimated by abandonment or establishment of nests in such areas. Similar calculations were made for the other ants with reference to the number of nests found in the soil and those found on plantain suckers or other places.

4.2.3 Colony size

Colony size was determined by the following methods:

1. Transfer of workers foraging on leaves

Camponotus acvapimensis is timid but easily gets excited and moves away when disturbed. As a result, the ants could not be induced for transferrence to other places by any easy method. The only way to cause an easy transferrence of the ants to other areas was to carry them from where they were found foraging. The transferrence was done gently to avoid excitement. By means of a sharp knife, the branch on which the ants were foraging was cut and carried carefully to an area with other ants of the same species foraging and gently putting the cut branch on the vegetation and observing the interaction of the ants in the new habitat as well as the ants that were found there. The behaviour of the ants was then recorded.

2. Attempted excavation of some nests

A few centimetres of some nests were excavated and the ants disturbed. The ants were observed to find out if they would abandon their nests to establish new nests. The behaviour of the ants such as the carrying of larvae and pupae was then observed and recorded. The new nests where the larvae and pupae were sent were considered as parts of the colony.

3. Providing a bait

Since *Camp. acvapimensis* workers tend aphids and other Homoptera for honey dew and other sugary materials, Sugar baits were used as a source of enticement. The ants in the area were then observed during their feeding habits and their reactions towards each other recorded. In this method it was assumed that these ants being timid may avoid ants of the other colonies and would move off rapidly. It was also assumed that the ants from the same colony may feed with the least disturbance from other ants, from different colonies. Characteristics such as moving towards the nests are characteristics that were used to determine acceptance and rejection of a member of a colony by another member.

4.2.4 Distribution of Camp. acvapimensis in relation to other ants on plot A.

The mapping of the nests followed the same method as the one used on plot B. The only difference was in the mapping of the nests occurring on the plantain suckers. Other nests in the same places as those found on plot B are shown with the same symbols as in plot B in order to bring out the similarities of nesting habits. Ants nesting in the soil and grass roots or shade trees were also mapped out. The occurrence of such ants was subjected to statistical analysis to see if there was any significant relationship between the occurrence of these ants and Camp. acvapimensis. The presence of such nests was plotted on the same map with different symbols in order to differentiate them from those of Camp. acvapimensis. In constructing the maps, the area of the plot was measured and the trees and other features that were found were plotted using the same scale.

4.2.5 Distribution of Camp. acvapimensis inrt relation to other ants on plot B.

The other ants nesting in the area Plot B were mapped out and the distance of their nests to those of Camp. acvapimensis also determined. The number of dominant ants was recorded and their nesting habits discussed in relation to the nesting habits of Camp. acvapimensis. A search for the ants was carried out by methods similar to those used for Camp. acvapimensis. The ants in some cases were provided with crumbs of bread which they carried into their nests. The ants were then identified and numbered together with those of the same species. Their nests were also numbered. By this method, almost all the ants that were dominant species in the area were known and their associationship with Camp. acvapimensis found out by considering their interactions with Camp. acvapimensis. The nesting preferences of all the ants that were found were considered. Those ants that were found on plantain suckers with and those without nests distinguished. The common ants in the field were collected and identified to genera with Bolton!s (1973) key.

4.3 OBSERVATIONS / RESULTS

4.3.1 Abundance of nests on Plot A

The number of shade trees in the area are shown in fig 4.

(i) wet season

During the wet season, the nests were found at 3 different places -

Nests in the soil:- These nests were found as entrances to the main cells underground.

Nests in grass stumps and roots:- These nests were found in the roots of growing grasses and others occurred between the stalks of grasses and others in the middle of foliage leaves (Fig.6).

Nests in dead wood:- These nests were in dead wood or dead portions of living trees. They had one or more entrances.

Out of a total of 54 nests found during the wet season, only 3 (5.6%) were in trees. A total of 15 (27.8%) were found in the roots of grasses and the remainder 36 nests (86%) were in the soil. Of a total of 12 trees found in this area, only 3 had the nests of Camp.acvapimensis. This number represents 25% of the nest bearing trees. From the above observations it seems evident that these ants have preference in nesting in the soil as compared with nesting in wood (table 3).

(ii) Dry season

The results obtained on nest distribution during the dry season on plot A differed slightly from the results obtained in the wet season. Of the 12 trees in the area, only 3 (the same trees that were found during the wet season) had nests of Camp.acvapimensis. This figure represented 25% nest bearing trees. The three types of nests were distributed as follows:

Table 3: Distribution of nests of Camp.acvapimensis during the wet season on plot A

(a) Number of nests on trees and percentage nest trees

	Total No. of trees	Trees without Nests	Trees with Nests	% trees with nests
Nest on trees	12	9	3	25

(b) Percentage distribution of nests in different nesting area

Locality	Total number of nests	% Nest distribution
In soil	36	86.0
In grass	15	27.8
On trees	3	5.6
Total	54	100.00%

(c) Percentage distribution of nests in various habitats

Habitat	Total	in trees		in grasses		in the soil	
(shade regime)	nests	No.	%	No.	%	No.	%
No shade	4	0	0	3	75	1	25
Broken shade	17	0	0	8	47	9	52.9
Poor shade	23	0	0	1	4.4	22	95.7
Continuous shade	10	3	30	3	30	4	40

3 (d) Percentage distribution of soil nests in different shade regimes on plot A in the wet season.

Habitat	No. of nests	% distribution
No shade	1	2.8
Broken shade	9	25.0
Poor shade	22	61.1
Continuous shade	4	11.1
Total	36	100.0

(e) Percentage distribution of nests in grass roots in different shade regimes on plot A in the wet season.

Habitat	No. of nests	% distribution
No shade	3	20.0
Broken shade	8	53.3
Poor shade	1	6.7
Continuous shade	3	20.0
Total	15	100.0

(f) Percentage distribution of nests in trees in the different shade regimes on plot A in the wet season.

Habitat	No. of nests	% distribution
No. shade	0	0
Broken shade	0	0
Poor shade	0	0
Continuous shade	3	100.0
Total	3	100.0

Table 4: Distribution of nests during the wet season on plot B.

(a) Distribution of nests in different nesting areas

Locality	total no of nests	% distribution
In soil	38	53.52
nests on suckers	33	46.5
Total	71	100.0

(b) Distribution of nests in the various habitats in the wet season

Habitat	No.of suckers	No.with nests	No.without nests	% of suckers with nests
No shade	3	1	2	33.3
Broken shade	29	19	10	57.6
Poor shade	6	3	3	9.1
Continuous shade	100	10	90	30.3
Total	138	33	105	100.0

4 (c) Percentage distribution of nests in various habitats and localities

Habitats	Total nests	in plantains No.	in plantains %	in grass roots No.	in grass roots %	in the soil No.	in the soil %
No shade	3	1	33.31	0	0	2	66.7
Broken shade	21	19	90.5	0	0	2	9.5
Poor shade	31	3	9.7	0	0	28	90.3
Continuous shade	16	10	62.5	0	0	6	37.5

(d) Percentage distribution of nests in the different shade regimes on plot B in the wet season

Habitat	No. of nest	% distribution
No. shade	3	4.2
Broken shade	21	29.6
Poor shade	31	43.7
Continuous shade	16	22.5
Total	71	100.0

Table 5a: Comparison of % distribution of nests of <u>Camp.acvapimensis</u> in the soil and other places on plots A and B.

Habitat	Nest in the soil				Nest in other area			
	Plot A	%	PlotB	%	Plot A	%	Plot B	%
No shade	1	2.8	2	5.7	3	16.7	1	3
Broken shade	9	25	2	5.3	8	44.4	19	57.6
Poor shade	22	61.1	28	73.7	1	5.6	3	9.1
Continuous shade	4	11.1	6	16.0	6	33.3	10	30.3

5 b. Comparison of n st distribution during wet and dry seasons on Plot A.

Locality	DRY SEASON		WET SEASON	
	No.	%	No.	%
In trees	3	9.7	3	5.6
In soils	26	83.9	36	86.0
Grass roots	2	6.5	15	27.8
Total	31		54	

Table 6: Percentage distribution of nests on plot A in the dry season:

6 (a) Nest distribution on trees

No. of nests	No. of trees without nests	trees with nests	% nest trees
Nesting on trees 12	9	3	25

6 (b) Percentage distribution of nests in various localities on Plot A

Locality	total no. of nests	% Nest distribution
In soil	26	83.9
In grass root	2	6.5
In trees	3	9.7
Total	31	100.0

6 (c) Percentage distribution of nests in various shade regimes

HABITAT (shade regime)	TOTAL	IN TREES		IN GRASS ROOTS		IN SOIL	
	Nests	No.	%	No.	%	No.	%
No shade	30	0	0	2	6.7	28	93.3
Broken shade	0	0	0	0	0	0	0
Poor shade	0	0	0	0	0	0	0
Continuous shade	4	3	5.0	0	0	1	25.0

Table 7: Percentage distribution of nests in various habitats on plot B during the dry season:

7 (a) Percentage distribution of the nests on plantain suckers

Habitats	No.of suckers	No. with nests	No. without nests	% with nests.
No shade	3	1	2	
Broken shade	29	16	13	
Poor shade	6	3	3	
Cont. shade	100	5	95	
Total	138	25	113	

7 (b) Percentage of nest distribution in various localities

LOCALITY	TOTAL	% NEST DISTRIBUTION
In the soil	22	45.8
on suckers	26	54.2
Total	48	100.0

7 (c) Percentage distribution of nests with respect to shade regimes

HABITAT	Total	on suckers		in grass		in soil	
		No.	%	No.	%	No.	%
No shade	3	1	33.3	0	0	2	66.7
Broken shade	19	16	84.2	0	0	3	15.8
Poor shade	17	3	17.7	0	0	14	82.4
Cont. shade	9	6	66.7	0	0	3	33.3

7 (d) Percentage distribution of nests in the different shade regimes on plot B in the dry season

Habitat	No. of nests	% nest distribution
No. shade	3	62.5
Broken shade	19	39.6
Poor shade	17	39.4
Cont. shade	9	18.8
Total	48	100.0

Table 8: Comparison of the percentage distribution of nests on the two plots A and B.

8 (a) Percentage distribution with respect to shade regimes on plot A

Habitat	Wet season		dry season	
	No.	%	No.	%
No shade	1	2.8	28	96.6
Broken shade	9	25.0	0	0
Poor shade	22	61.1	0	0
Continuous shade	4	11.1	1	3.5
Total	36	100.0	29	100.0

8 (b) Percentage distribution of nests with respect to shade regimes on plot B

Habitat	Wet season		dry season	
	No.	%	No.	%
No shade	2	5.3	2	9.1
Broken shade	2	5.3	3	13.7
Poor shade	28	73.7	14	63.6
Continuous shade	6	16.0	3	13.6
Total	38	100.19	22	100.01

8 (c) Comparison of nests distribution on the two study plots A and B; during the dry season

Study plot	Total	Nests in soil		Nest/trees		Nest/grass	
Plot A	31	26	83.87%	3	9.69%	2	6.45%
Plot B	48	22	45.87%	26	54.17%	0	0%
Total	79	48	60.78%	29	36.71%	2	2.53%

8 (d) Comparison of nests distribution on the two study plots A and B; during the wet season

Study Plot	Total	Nest in soil		Nest/tree		Nest/grass	
Plot A	54	36	86.0%	3	5.6%	15	27.8%
Plot B	71	38	53.52%	33	46.5%	0	0%
Total	125	74	59.2%	36	28.8%	15	12.0%

Table 9: Distribution of nests of C.acvapimensis.

9 (a) Occurrence of nests of C.acvapimensis and other ants in the various habitats (shade regimes) on both plots during the wet season.

Species	Percentage within habitats							
	Cont. shade		Broken shade		Poor shade		No shade	
C.acvapi.	26	35.6%		31.48%		42.59%		7.41%
Driver ants	1	3.35%	0			28.58%		71.42%
C.vestitus	0	0%	0	0%	3	60.0%	0	40.0%
C.sericeus	2	25%	3	37.5%	3	37.5%	0	0%
Platythyreus	0	0%	2	22.22%	3	33.33	4	44.44

9 (b) Occurrence of C.acvapimensis in the various habitats (shade regimes) on the two plots during the dry season.

Ants species	Percentage of nests within the habitat			
	Cont. shade	Broken shade	Poor shade	No shade
C.acvapi.	11.8	0	0	88.2
Driver ants	0	0	0	100%
C.vestitus	0	0	0	100%
C.sericeus	100%	0	0	0
Platythyreus	0	0	0	100%

Table 10 Distances between colonies of *C.acvapimensis*

10 (a) Mean distances within and between colonies of *C.acvapimensis* on plot B.

Distances (m)	within colonies	Between colonies
0 - 5	8	0
5 - 10	3	1
10 - 15	2	1
15 - 20	0	2
20 - 25	0	2

10 (b) Mean distances as found on Plot A

Distances (m)	within colonies	Between colonies
0 - 5	7	5
5 - 10	5	1
10 - 15	3	0
15 - 20	0	2
20 - 25	0	1

Nests in soil:- Out of a total of 31 nests on the study plot, 26 (83.9%) occurred in the soil.

Nests in grass roots:- These nests were those established in the grass roots during the wet season. The nests were affected by the bush fires and drying of the leaves. Out of a total of 31 nests found on the plot during the wet season, only 2 remained during the dry season. This represented 6.5% of the nests found in the area (table 5b).

4.3.2 Abundance of nests on plot B

Wet season

During this season, two different nests were found.

Nests in the soil:- These nests were in the soil only with their entrances showing. Of a total of 71 nests on plot B during the wet season, 38 (53.5%) were in the soil (fig 31).

Nests on suckers:- Secondary nests were found on the plantain suckers, mostly under leaf sheaths with edges sealed off with soil. Out of 71 nests in the area, 33 (46.5%) of nests on plot B were secondary nests occurring on the plantain suckers.

On this plot, the nests occurring in the grasses were absent because the grasses had been removed during clearing of the area for farming. In all cases nests found on this plot were either secondary nests situated on the plantain suckers or primary nests found in the soil. The secondary nests on the plantains were made up of numerous workers and a few soldiers with a few of the nests with about 20 larvae and 12 pupae only. A few of such nests had alates. These ants were tending aphids.

Dry season

The nests found during the dry season were the same as those that were occurring during the wet season. Out of 48 nests counted during this season, 22 (45.8%) were found in the soil. The remaining 26 nests were found on plantain suckers (table 7b).

4.3.3 (b) Distribution in relation to shade regimes

4.3.3.1 (1) On plot A

Demarcation of the shade regimes was done using personal judgement and the following criteria were used for the estimation.

(i) No shade regime: This area had no vegetation excepting during certain periods of the year when a few trailing grasses were found in some places. These grasses measured a few centimetres above ground level. The soil was almost bare for most time of the year.

(ii) Broken shade regime: This area had very tall grasses that stood at most 2.7 metres in height. The whole area appeared covered with grasses only a few areas having shorter grasses. The canopy of the grasses was largely formed by climbers and this provided shade in some parts of the plot.

(iii) Poor shade regime: The vegetation in this area was shorter in height and as a result, the sun rays had almost direct contact with the soil. Consequently, some parts of the soil were dry, causing the vegetation to dry up due to lack of rain. The tallest grasses were at most one metre in height. Occasionally about 48% of the land was bare and the area had a patchy distribution of vegetation mainly grasses and these were usually missing thereby making the land bare most of the time.

(iv) Continuous shade regime: This area was, at some places, characterized by thick shade provided by the few trees. These were the mangoes and Neem trees which are evergreen plants and as such the shade that they provided was almost the same during both seasons.

The number of nests found on plot A were in three different areas or habitats and are thus differently classified:

1. Nests in trees: These nests were in dead wood or dead portions of living trees, mostly the Neem trees. The nests had been abandoned by *Microtermes* spp. Some termites in certain cases were found nearer the living portion of the dead wood and the ants farther away from the living portion.

2. Nests in grass roots: These nests had their entrances in grass stalks or at the bases of the grasses near the roots.

3. Nests in the soil: These nests were found in the soil and only their entrances were seen.

(i) Wet season

The percentage of nests found in the area was estimated and information on plot A is provided in table 3b. It was found that of the total humber of 54 nests that were found on plot A, 36 (86%) were found in the soil and only 3 (5.6%) were in the trees with the remainder of 15 (27.8%) in the roots or the bases of the grasses. Of the 36 nests in the soil, 22 were found in the poor shade regime. This indicated that 61.1% of the total number of nests occurred in the poor shade regime. Only 9 (25%) were in the broken shade regime. The least number of nests were in the continuous shade and no-shade regimes (tables 3a -3f).

Table 9 shows the percentage distribution of nests of both ground and tree nesting ants as compared to those of Camp.acvapimensis in the different shade regimes. From the result it is evident that whereas Camp.acvapimensis had preference for broken shade regimes, the other ants tend to have preference for other extremes with Camp.sericeus prefering both contimuous and poor shade regimes. In terms of nesting, the driver ants had the same preference for poor shade regimes as Camp.acvapimensis.

(ii) Dry season

During the dry season, the vegetation in this area dries up and bush fires are common. As a result the nests of the ants in the grass roots are disturbed by the fires and most were abandoned.

The shade in the area became reduced because most plants providing the shade were burnt off from the plot and only the bases of the grasses were left. In addition, some green stalks that could not be burnt by the fires were also left. The trees were unaffected by the fires. Out of a total of 15 nests found in this area during the wet season, only 2 were still kept by the ants, the remaining 13 had been abandoned. Due to the absence of vegetation and due to the bush fires, the nests occurring during the dry season were mostly in a no-shade regime (table 6).

4.3.3.1 On plot B

The shade regimes on this plot were classified using the same methods as used for the classification on plot A.

NO SHADE REGIME: This area had trailing grasses as the only vegetation at few places. The height of grasses measured 20 cm above ground level. Most parts were bare with only about 47% covered by vegetation.

BROKEN SHADE REGIME: This area had fewer plantains and the shading was not complete hence causing a broken shade regime in that area. The shade was provided by plantain suckers and cassava.

POOR SHADE REGIME: This area had cultivated corn and shade was provided by its leaves. The shade was not intense and in many areas the shade was so poor that it was almost negligible. During the dry season the area was covered by wild grasses which also provided very poor shade.

CONTINUOUS SHADE REGIME: The shade was due to the presence of cassava and plantain suckers. The ground was shaded most of the time during the study period. The effects of the seasons gave very little information with respect to nests distribution in the area.

(i) Wet season

During the wet season the nests were found in two places. These were:

Nest in the soil:- these were the same as those discussed for plot A.

Nest on plantain suckers:- these were secondary nests found under the sheaths of the plantain suckers or corn and had no larvae and pupae except in a few cases. Such nests had mostly workers and soldiers. Within such nests were found aphids and other Homoptera that the ants tend. Out of a total of 71 nests found on this plot 33 (46.6%) were secondary nests occurring under the sheaths of the plantain suckers and corn. 38 nests (53.5%) were in the soil and are classified as primary nests (table 4b). Of a total of 138 plantain suckers on the plot, only 33 (23.9%) had nests of Camp.acvapimensis. The remaining 105 (76.1%) had no nests. It was observed that all the suckers that bore nests had the ants visiting a primary nest in the soil (Fig 3).

Out of the 71 nests found on plot B, 3 (4.2%) were found in the area without shade whilst the broken shade area had 29.6% and the poor shade had 43.7% (table 4d).

(ii) Dry season

During the dry season some nests in the poor shade regime were abandoned because the area had lost most of the corn that provided the shade. Very few grasses were found in the area. The shade was poorer than that occurring in the wet season. This caused the abandonment of some of the nests. The percentage distribution was such that 39.6% of the nests were in the broken shade regime and 35.4% in the poor shade area (table 7d). There was therefore an increase in percentage nest distribution from 29.6% in the wet season to 39.4% in the dry season, whereas the distribution of nests in the poor shade regime declined from 43.7% to 35.4% over the same period.

4.3.4 Colony size

Transfer of nests to other nests and the transfer of workers from one nest into the other nests proved very difficult and did not give good results. The reasons for this are as follows:-

Reasons

(a) The nests of Camp.acvapimensis are underground and as a result, nests or part of nests could not be transferred easily onto other nests considered as different colonies.

(b) The ants could not be made to move onto any object that was provided because they were found to be timid, easily becoming excited and moving away from such objects that were presented to them. The method however, appears suitable for aggressive ants.

1. Transfer of foraging workers

When these ants were transferred slowly whilst still on the leaves where they were foraging, they did not get excited and exhibited two different behavioural patterns:

(a) The ants brushed their mandibles and antennae and each of them moved away. Those found foraging in the area resumed their foraging activities whilst those introduced into the area began to move away slowly with raised gasters. Some such ants moved onto separate leaves and began foraging whilst some left the area to other foliage leaves in the neighbourhood. Such behaviour was considered as acceptance of the other ants that were there before being introduced into the area.

(b) The introduced ants brushed their antennae and the ants were seen making quick bites at the other and dashing off with raised gasters. The ants moved in the opposite directions with raised gasters and left the area. This was considered as rejecting each other.

2. Using Eosin dyes

This method proved useful on the ants found on plantain suckers or had constructed secondary nests. The flourescent eosin indicated the presence of more than one nest and such nests were then considered as belonging to one colony.

The ants that had been dusted in the secondary nests were disturbed and their primary colony was found out. All ants in secondary nests were found to belong to primary nests found in the soil. The mean distances between the nests (table 10) indicated that most of the ants visited their primary nests and were either far from or near their primary nests.

3. <u>Providing bait</u>

It is a common occurrence to find the species of <u>Camp. Acvapimensis</u> belonging to the same colony foraging together on the same plant without aggression. When the bait (a cube of sugar) was provided, ants belonging to the same colony fed from the same sugar source without aggression and excitement.

Ants belonging to different colonies were observed to show different reactions to each other. When ants from a different colony are introduced onto the same sugar source, some workers remained on the source but some moved away and entered their nests. They came out with other workers and moved to the food source. Ants assumed to be from different colonies behaved differently. The workers moved towards the feeding workers but the normal brushing of mouth-parts and antennae was replaced by sudden dashes at each other and the characteristic raising of the gaster took place and the ants moved into their nests. This time, they returned to the food source with soldiers that came to ward off the foraging workers of the other nests and allowing the workers from their nests to collect the food away.

During 25 such observed cases, 23 ants that came out of the nests were the same ants that entered the nest. In the remaining 2 instances, the ants that entered, came out later and joined the others and they all moved towards the food source. The soldiers were found dashing at the workers from the other nests and giving quick bites at them and moving back quickly. After the soldiers had driven off the workers from the other nest they were found guarding the food as the workers collected it home. At times a few soldiers were also seen collecting away some of the food items. Head measurements of such soldiers showed no significant difference between the guarding and food collecting soldiers. In order to determine the correlation between those soldiers that were guarding and those that were carrying food during the determination of the colony size the soldiers guarding and those foraging were collected separately and the head measurements taken. The ants from different primary and secondary nests that form one colony were treated together. As a result two colonies were used and these were labelled as nest one and nest two respectively. The head measurements were then subjected to statistical analysis for comparison in Table 11. The means of these findings indicate that there is no significant difference between the ants from the two nests.

In order to determine the correlation between ants that were guarding and those carrying food during the determination of the colony size, the ants guarding and those foraging were collected separately and the head measurements taken. The ants from different nests were grouped as those from nest one and two. A comparison of the means of the ants from the two nests indicated that there is a significant difference between the guarding and foraging ants in the different nests.

4.4 DISCUSSION

4.4.1 Abundance of nests on Plot A

From the observations, nest distribution seems to be related to shade regime. Most nests were found in the soil but not in dead wood in the soil. This contradicts Room (1971) who reported that the ants nest in dead wood in the soil. Of the total number of 48 nests that were dug during the study period, none were in dead wood in the soil. Nesting in the wood was found to be only a matter of availability. It is therefore not surprising that Room (1971) found the ants nesting in dead wood in the forest areas where there was plenty of wood in which the ants could nest. In this, it is also expected that some nests would be in dead wood in the soil.

With respect to shade regime, it was found that the ants were more in the poor shade regime area. The number of nests occurring in the area constituted 61.1% of the total nests and this tends to agree with the findings of Majer (1972) that Camp.acvapimensis under certain conditions becomes dominant in areas of forests that resemble the savanna ecosystem. The savanna ecosystem that he referred is typically the poor shade regime of this study.

The presence of nests in the continuous shade regimes was only found to be due to the preference that the ants had for nesting in wood as compared to nesting in the soil.

Distribution of nests in grass roots had more of the nests in the broken shade regime. This is likely to be due to the fact that the poor shade area had most of the grasses reduced to mere roots when the light intensity becomes very strong on the roots and causes the ants to abandon such nests. The nests are therefore established in the broken shade regimes to prevent the sun from drying up the eggs.

In general, the ants do not nest in shadeless areas and they do not prefer continuous shade areas either. Preference for shade regimes therefore was for poor shade areas followed by a broken shade area. In the dry season however, there were more nests in the shadeless area. This is because the grasses are often burnt and the nests found at the grass roots as well as in the soil in the grass covered areas become bare and the area is therefore mostly a 'no-shade'area.

4.4.2 Abundance of nests on Plot B

On plot B the findings were different. Distribution of nests in the wet season followed a different pattern in that more nests were found in the poor shade area but the continuous and broken shade areas had almost the same percentage distribution. Camp.acvapimensis thus nests in the poor shade areas but when farming practices permit the area to be changed to continuous or broken shade areas then the ants will be more in the broken shade areas and a few more in the continuous shade regimes. In the dry seasons the ants are found in the same broken shade areas and they are found to move more into the farm lands since the shade in the savanna areas is reduced considerably.

4.4.3 Distribution of the nests

Nests of the species occur mostly in the soil. Camp.acvapimensis is therefore a ground nesting ant with little tendency to nest in dead wood. They also construct secondary nests to tend aphids, scale insects, some Homoptera and Coccids on some vegetable crops such as plantain and melons.

4.4.4 Colony size

The ants were not found to form large colonies and the distances between such colonies increased as the animals constructed nests far away from their primary nests in order to tend other insects.

Colonies may be separated by longer distances or the colonies may be very near the primary nests depending on the distance between the place where the plant on which they want to tend the insects is found. Members of the same colony may feed together without much excitement excepting when they come in contact with members of the other colonies for the first time. When they belong to the same colony, they forage or feed from the same source of food but some of them withdraw to other sides for foraging. Ants of the same colony do not move away from the food source into their nests to recruit more foragers or soldiers when they come in contact with members of the same colony. A difference exists between ants of one colony and those of different colonies. Those ants belonging to different colonies show antagonism which they indicate by quick dashing with open mandibles at ants of the other colonies. Some of the ants move very fast away with raised gasters in undetermined directions and many such ants entering into their nests and later coming out of the nests with other workers or soldiers castes to the source of food. _Camp. acvapimensis_ is likly to produce pheromone for warding off the ants from a different colony. As many as 7 nests, both primary and secondary were found to donstitute one colony. Colony size of the species requires further investigation as the ants are timid and are very difficult to control in experiments that were conducted for the determination of colony sizes. Further work on this ant should consider the primary and secondary nests as well so as to be sure that such nests are part of a primary nest.

4.4.5 Distribution in relation to other ants

The nests of the other ants found in the study areas were very few and this did not make the other ants dominant in terms of presence of nests in the nesting areas. However, in terms of numbers *Camp. sericeus* were found to be more populous than *Camp.acvapimensis*. The numerical consideration of foraging workers for a given period of the ants indicate that *Camp. sericeus* are more active during the day than *Camp.acvapimensis*. The differences could be due to the fact that *Camp. sericeus* forages only during the day whilst *Camp.acvapimensis* forages during the night and day constantly with little breaks when the light intensity becomes high. These two ants were found to have preference for the same nesting areas but were not found to be involved in fights but *Camp.acvapimensis* was found to attack *Camp. sericeus* wherever the two came in contact with the latter retreating from the area. Both ants are timid as compared to other ants described as aggressive. Ackonor (1977) by a series of experiments established that *Cataulaucus guineensis* were very aggressive and involved even members of other colonies in fights resulting in loss of parts of their limbs.

4.4.5.1 Camp.acvapimensis and Camp.sericeus

Nests of these two ants were found in the same areas. Where trees were found on the plot, Camp.acvapimensis was found to nest in the dead portions of such trees but the nests were more confined to the soil in such areas. Camp.acvapimensis is therefore a ground nesting ant and was not competing with Camp.seiceus for nesting sites in the wood. The nests of Camp.acvapimensis were found in the bark of the tree but Camp.sericeus made holes into the wood as nests. With respect to shade regimes, the two ants were found to have preference for areas with broken and poor shade. As the two species have different nesting sites and do not fight but only Camp.acvapimensis shows a tendency of attacking at times, competition for nesting sites was not noticed but the ants were found to compete for food source as they all show preference to sugar diet. Co-existence is therefore more mutualistic than antagonistic. These were the two dominant ants occurring in the savanna region under investigation.

4.4.5.1.1. Numerical abundance

In terms of numbers, the workers of Camp.sericeus were found to be more at any given time as compared with Camp. acvapimensis. The number of ants found during a period of 10 minutes coming out and entering the nests of the two ants (table 12) gives an indication that Camp.sericeus is numerically abundant as compared with foragers of Camp.acvapimensis.

This difference might be due to factors other than just numbers. This is because Camp.sericeus forages only during the day time whilst Camp.acvapimensis forages both day and night and this may account for the reason why the foraging numbers differ. In terms of numbers and activity, these two species are among the dominant species of the savanna areas where the detailed study was carried out.

4.4.5.2 Camp.acvapimensis and Camp.vestitus

Both these ants nest in the soil but the existence between them is a passive association since Camp.vestitus prefers a no-shade area for nesting whilst Camp.acvapimensis was found to nest in areas with poor shade or broken shade or rarely in continuous shade. The former cannot be classified as dominant in terms of number of nests that were found in any area. In terms of foraging they were always very few and non-aggressive. The number of ants found in any given area was very insignificant. The ants Camp.vestitus do not compete with Camp.acvapimensis for space or food since they have different nesting habits and cannot exclude Camp.acvapimensis spatially or numerically.

4.4.5.3 Camp.acvapimensis and Annoma

Driver ants of genus Annoma were found to nest mostly in no-shade areas and were found to be numerically abundant as well as dominant. Together with Camp.acvapimensis and Camp.sericeus they form the dominant species of the savanna ecosystem.

Numerically however, these three species were many but the driver ants were more numerous than the rest and the most aggressive of them all. This is provably because these ants inflict very painful bites and easily bite as compared with the two other species that have been mentioned as timid. The driver ants were found nesting in some areas where Camp.acvapimensis was also found nesting but were never found in antagonism. Both ants had preference in nesting in the soil and their co-existence was probably due to the avoidance reaction of Camp.acvapimensis and secondly due to their preferences for different shade regimes. Driver ants had preference for areas without shade whilst Camp.acvapimensis has preference for areas with varying degree of shade and are not many in shadeless areas.

4.4.5.3.1 Numerical abundance

In terms of numbers, driver ants are numerically dominant as well as aggressive. These ants forage both day and night but unlike Camp.acvapimensis, they move out of their nests in large numbers. In terms of aggression and numerical abundance, this group forms the dominant group of species of the savanna ecosystem followed by Camp.acvapimensis, and then Camp.sericeus in that order.

4.4.5.4 Camp.acvapimensis and Platythyreus tarsartus

Platythyreus species were not very common but were nesting in some areas that Camp.acvapimensis was found nesting.

The aggressive nature of Platythyreus was not observed and this is probably due to the timid nature of Camp.acvapimensis which was found moving away from areas where any ant that is not of the same species was found. On a few rainy days however, a few ants, some of them being workers of Camp. acvapimensis were found being carried away by the ants.

CHAPTER FIVE

NEST AND NESTING HABITS

CHAPTER 5

5.1 INTRODUCTION

Like all social insects, ant communities costruct nest for concealing their brood which is tended by the workers within the nests. Nests of such ants are found in different areas and may occur on leaves, wood or soil. Preference of nesting sites varies with the species. Crematogaster africana Mayr was reported constructing carton nests attached to the trunks of main stems or branch unions (Entwistle 1972), and Room (1971) also reported that the same species nests in the canopy of cocoa trees. This indicates that the same species may have different nesting sites in the same area. Some ants such as Oecophylla longinoda Latreille are reported as founding nests in the cocoa canopies and using leaves for nesting(Leston 1968). Room(1971) also recorded that the same ant nests in the canopy of trees. Ackonor(1977) reported the Catalaucus guineensis F. Smith may nest in dead portions of living trees where termites have already made holes or dead remains of the butress of forest trees where the termites had made the holes. In his work, Ackonor (1977) discussed in detail the nature of the nests constructed by the ants that he had studied.

Very little work exists on the ants that nest in the soil. Out of some 157 species of ants collected by Room(1971) in a cocoa farm, only 3 were reported at a depth of 30 cm below the litter on the soil. These were Solenopsis and Leptanilla species. Not much is known of the species that nest in the soil. Room(1971) reported that Camp. acvapimensis was found nesting in dead wood in the soil but did not investigate further when he reported that the same species were found foraging in the top 10 cm. of the surface litter and soil. Evans(1971) reported that these ants Camp. acvapimensis were found carrying soil to construct tents over mealybugs which they tend. This finding was in connection with his work on the black pod disease. On the same genus Camponotus, Wheeler (1922) reported that the group was mostly found nesting under stones, living in the soil, craters, under bark of trees and in hollow twigs. At Bolenzi, in the Republic of Congo, Wheeler(1922) found Camp. acvapimensis nesting in the trunks of oil palms and at Faradje in the same country, the workers of the same species of ant were found attending plant lice on young leaves of orange trees. The reports of the various workers indicate that 2 types of nests are constructed by the species but in all cases no details of the nature of the nests are available. The castes found within each of such nests were not indicated and the report mainly deals with activity pattern of the species. On site preference, Majer (1972) reported that the ants were found nesting in insolated ground. No information is available on the caste composition in various nests. Wheeler (1922) however, mentions that the ants of the genus Camponotus, form populous colonies and he recognised 2 forms of workers which he referred to as maxima and minima workers. Others which he mentioned were the alates males, females, and the pupae. No information on the phenology of the castes is available.

In the following section, attempts were made to study the changes that occur in the nests during different months of the year and the effects of seasonal changes on the populations density of the ants. Composition of the different castes was also studied and their percentages determined. The nests were examined to ascertain the arrangement of the castes within the nests as well as the storage of food items in the nests. Caste ratio was determined at 3 months intervals by digging a number of nests.

5.2 METHODS

A survey was made and the nests to be excavated were marked by the pegs pushed into the soil near the entrance of the nest. Seventy nests were marked outside the study area for excavation. The reasons for locating the nests outside the study plots was to ensure that changes in the number of nests caused by the different seasons could be recorded on the study plots of changes in the populations of the ants, for a period of 12 months. Architectural specialities found within the nests were also recorded. Arrangement of brood within the nests was noted.

The excavation was timed to start at 12 noon on a predetermined day. This time was selected because of the observations made during the study of activity pattern which indicated that few or no ants came out of the nests just before and some time after noon. The ants were thus found to be less active and very few left the nests for foraging. The nests marked for excavation were the primary nests which were established in the soil. A close study of such nests was done for a period of four days and during this time all the secondary nests used by the workers of the nest in question were marked so as to ensure that during the excavation period almost all the ants that constitute the caste of a particular nest were captured and their numbers recorded. Two nests were excavated each month. In all cases, excavation was done at 2 - week intervals (middle of the month and end of month).

5.2.1 Sampling Proceedure

At the time of sampling a firm nylon thread was gently pushed into the nest as far as possible. Excavation was done using pick-axe, hoe, cutlass and soil chisel. Digging was done slowly in order to enable the worker to follow the thread and the tunnel into the chambers of the nest. To start, a pick-axe was used to loosen the hard surface crust and the soil was then collected from the entrance with the nylon thread acting as a guide into the inner chambers of the nest. When the lower areas were reached, cutlass and other implements were used for slow digging.

This was done to prevent destruction of the ants in concealled chambers. When a chamber was reached, the contents were collected into bottles containing 20% alcohol. These containers were placed very close to the nest so that transfer of the captured ants into them could be done quickly and with ease. All the captured ants were put into the same container. When more than one tunnel was seen leading into different underground chambers, a piece of wood or stick was used to block the entrance to one of them and one tunnel was dug at a time. When digging was complete in one direction and the end of the tunnel was reached, the other blocked tunnel was dug to collect the contents of the chambers that they led into. Workers and soldiers tending aphids and scale insects were captured and added to the castes. No records were made of the number of ants in secondary nests. Any ant of the same species that came searching into the nesting area with the characteristic raising of the gaster was captured and added to the caste.

5.2.2 Sorting

Sorting was done a day or two after excavation of the nest. When the population in any nest was too large, sorting took one or two days to complete but with very small populations, sorting was completed in only a day. The ants that had been sorted were kept in different containers in 50% alcohol and the different stages of the castes being the larvae, pupae, and adults were preserved separately. The ants were also sorted out into workers and soldiers. The sorted ants were kept in a cupboard for counting. Guests of the nests were only recorded as present or absent but their exact numbers were not determined. Food items found in the nests were kept in 20% alcohol and analysed later in order to determine the nature of the food the ants take to their nests.

5.2.3 Counting

Actual counting was done for each of the different castes, of the brood. The ants were picked from one container, their numbers recorded and they were then placed in another container. Counting of the larvae took a long time and in cases where many larvae were found, they were counted with the aid of a hand lens. The ants were recorded as soldiers or workers but it was not easy to distinguish between the pupae that were developing into soldiers or workers. It was however, easier to sort the pupae and larvae of the alates since they were rather large as compared to the larvae and pupae of the worker and soldier castes.

5.2.4 Head measurements

During the sampling period, head measurements were taken for 50 workers and 50 soldiers or more, found in a particular nest. After a time, the measurement of the worker caste was done after two months intervals as they were not found to differ significantly from other workers in other nests. Measurements for the soldier caste continued because the soldiers were observed to be of two types. One type of them was seen to be foragers and collectors of food whilst the second group was found to only guard the workers and other food collectors. The head widths of most of the soldiers were the same so the measurement took into account the length rather than the width. By means of an eye-piece micrometer, the head measurements were taken and the difference between foragers and guarding ants found in the different colonies was determined. The importance attached to finding foragers among the soldiers was because the brood in some of the nests was very large for the workers alone to feed them and it was noted that the soldier caste were also foraging during the period when the brood increased in the nests. Head measurements of the soldiers in other nests were teken to find out if any significant difference existed between the soldier caste of the different nests. No measurements were done for the alates as their numbers were very few during the study period.

5.2.5 The Nest

The tunnels that formed the entire nest were measured with a thread as digging went on. At the end of the digging. the longest thread used for the measurement of the nest tunnels was taken and the results recorded as the actual depth of the nest. Due to the inclinations of most of the nests, two depths were considered. (a) Vertical depth: this depth was measured at the end of digging. The last chamber of the ants that was considered as the deepest of the entire nest was measured with the ground level as the starting point. The greatest distance of the nest from the surface of the soil was then obtained and the results were then recorded; (b) Actual depth: this depth was measured by using a thread. From the entrance of the nest the tunnel was followed and when the contents had been collected, the thread was used to line the centre of the nest until the end of excavation was reached. The digging continued and at the end of collecting the contents, the thread was used to take the measurement of the different tunnels until the total depth of the deepest nest was found. The thread was then measured with a meter - rule.

5.2.6. Type of soil in which nesting took place

Observation during the search for nests revealed that the nests were found in certain areas and this stimulated investigation for the soil type in which the nests were mostly found. For this purpose, a sample of the soil in which the nest was found was taken and put into a measuring cylinder. The volume of the soil was found out and recorded.

Water was poured into the soil and it was then vigorously shaken for all the particles to be loose and dissolve if possible. The cylinder was then put down for the particles to settle down. The sides of the container were washed down and the whole experiment allowed to remain for about four hours. The different soil percentages were then classified as mixture of clay and sand, sand only, silt and clay or silt and sand, or clay and litter. This classification is then related to abundance of nests within the given area and also considered as the basis of preference for nesting areas.

5.2.7 Position of nest entrance in relation to vegetation

Area with nests and thick vegetational cover were cleared to determine the effects of increased temperature and low humidity on the nesting habits of ants. places without nests were provided with artificial shading over a period of time (1 month) to find out if the ants would construct nests in these areas due to the shade that had been provided in the area. Nests in the roots of grasses were carefully studied and the foliage leaves of such grasses removed very close to the roots so that the effects of such environmental factors as rainfall, light intensity, evaporation, low humidity and temperature fluctuations may affect the ants and the behaviour of the ants recorded. Thirty such experiments were performed.

The foliage leaves were never allowed to grow more than 1 centimeter above the height to which it was trimmed at the beggining of the experiment.

5.2.8 Effects of flooding on the nests

Since almost all the primary nests were found in the soil, observations were made on the nests just before a rainfall and immediately after a rainfall. The conditions in which the entrances of such nests were found were recorded and any perculiarities also scrutinized. Just after the rainfall, such nests were observed and the condition under which the nest occurred was recorded. During the dry season, water hose was also used to flood the nests to find out the behaviour of the ants during the flooding period.

5.2.9 Type of nests

Attempts were made to find out the types of nests constructed by the ants and these were then classified as primary or secondary nests. The occurence of such nests has been pointed out earlier (Chapter 4).

5.3 Observations/Results

5.3.1 Contents of the nests

The contents of the nests are made up of larvae, pupae, workers, soldier and few reproductives during some periods of the year.

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(a) Larvae: The larvae were of different sizes and the larvae of each of the castes were found to be of different stages of development. The small ones were very tiny and could be seen only by the use of a hand lens. By the use of even the binocular microscope, no eggs were found in any of the nests. Some of the larvae were very tiny and could easily be taken for eggs. The larvae found show clear segmentation but the segmentation became very marked as the larvae moulted. By comparison, the larvae of the ants that were younger appeared slightly roundish and whitish and became creamy as they became older. Each larva bears distinct hairs on the body and they become more pronounced as the larvae become larger and older. There were no visible head appendages on the larvae. The larvae of the different castes could be distinguished when they became mature and the soldiers appeared larger (fig.9b) then the workers (fig.9c) and the reproductives were the largest (fig.9a) in the overall consideration. As a result, three different larval types could be distinguished by the differences in their sizes. In some cases it was not easy to determine what a larva would develop into as very young stages of soldiers and workers look alike. In such cases, the presence of hairs was used to mark the differences.

(b) Pupae: The pupae of C.acvapimensis are enclosed in cocoons. The pupae were distinguishable when size alone was considered. The worker caste pupae were very small sized

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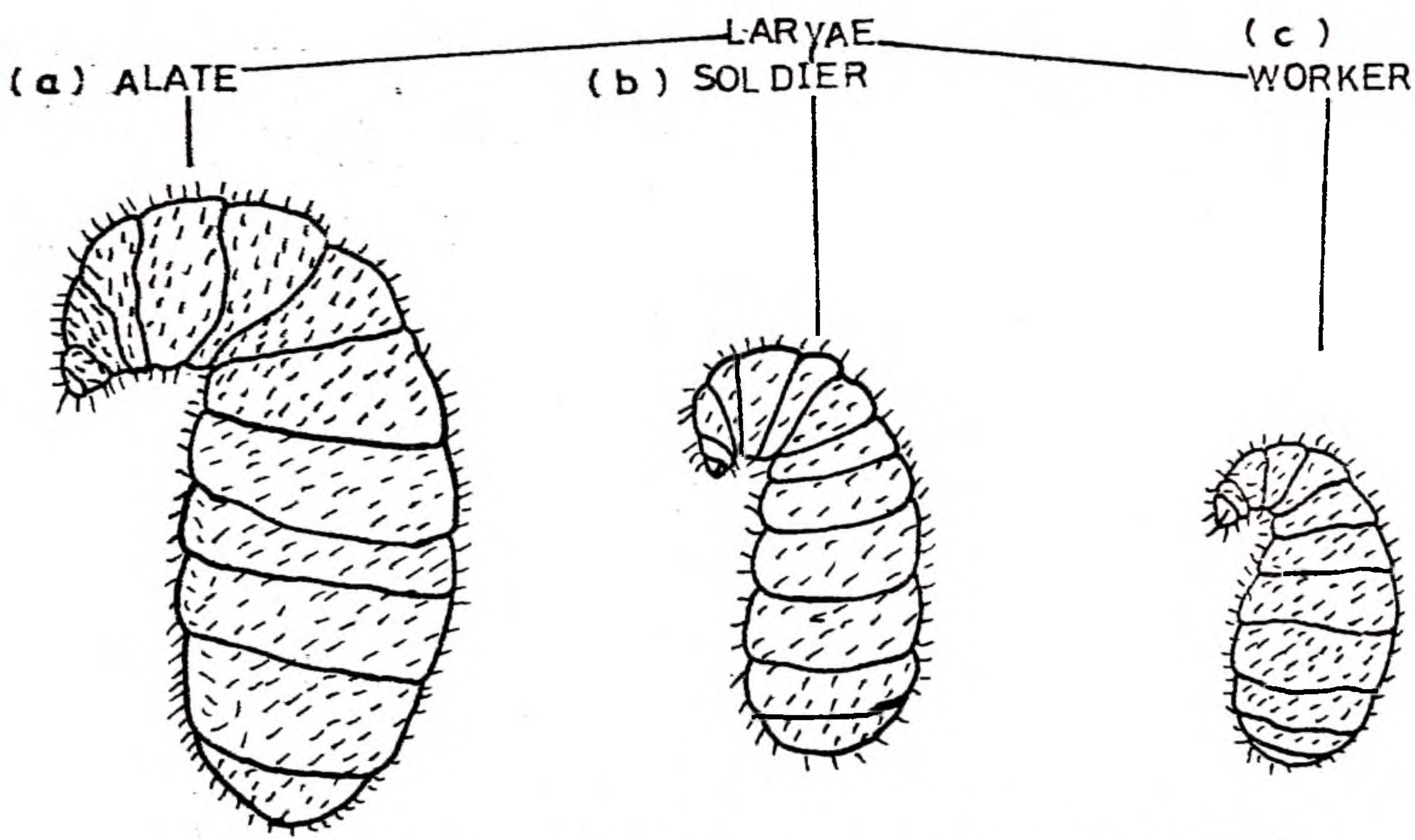
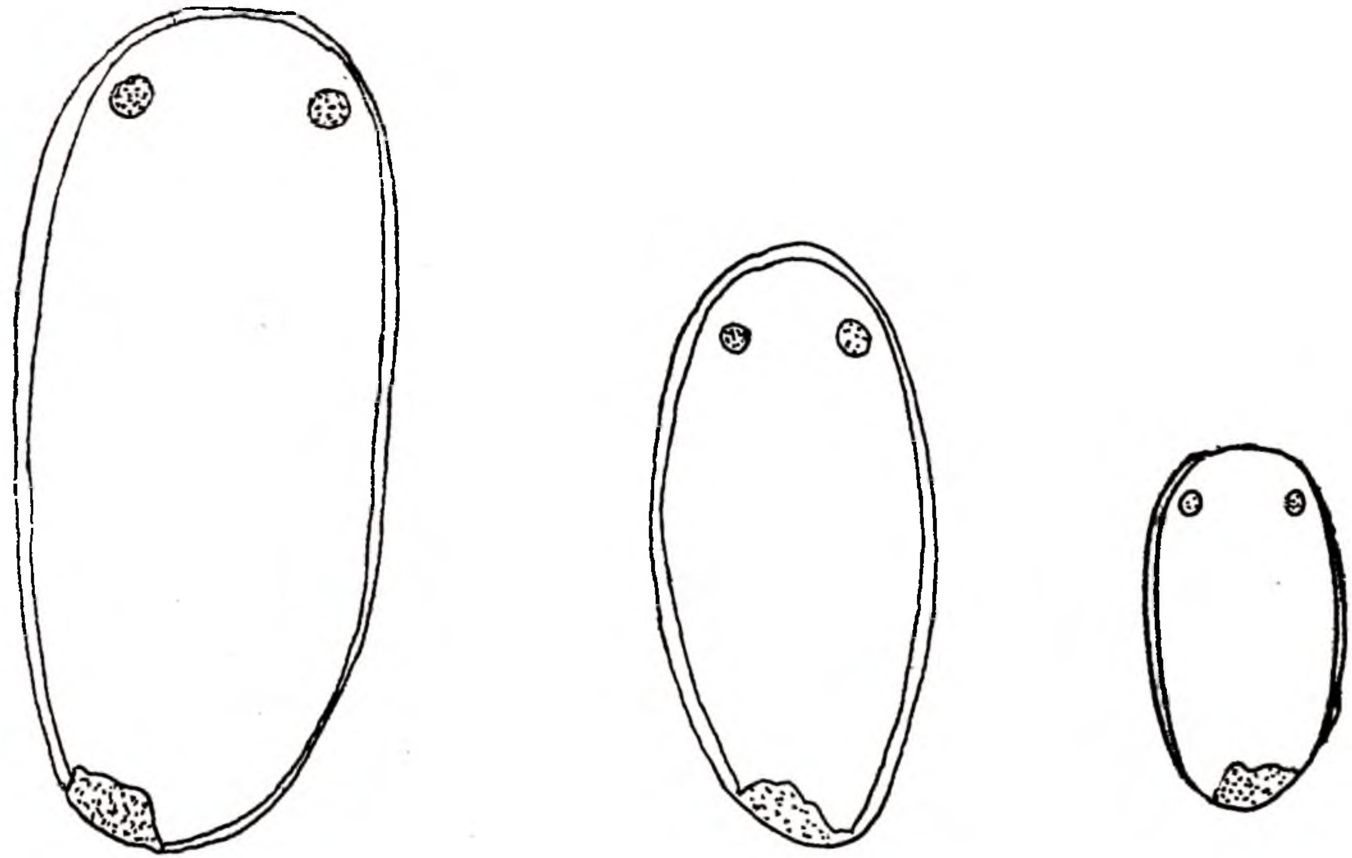


FIG: 9 : Larvae of *C. acvapimensis*

and two types of cocoons were distinguished. The first type of worker caste were smaller forms and the second type were smaller but slightly enlongated in appearance (Fig.10a). The mandibles which could be seen through the cocoon were structurally smaller as compared to those of the soldier caste. The soldier caste had slightly larger and longer cocoons (Fig.10b). The two types of adult soldier castes could not be distinguished during the pupal stage of their development. The alates had very large cocoons but the head and mandibles were very small in size (fig.10c) but could be distinguished from other members of the caste.

In all pupae it was observed that the mandibles were very prominent in the cocoon. The mandibles of the soldier caste were very exceptionally prominent and the size of the mandibles could easily be used to distinguish the soldiers from the larger pupae (workers).

(c) The workers: The workers are small in size as compared with the rest of the castes. The eyes of the ants are very small and are situated behind the middle of the head. The head is narrower in front and broader in the middle. The thorax fits into a grooved depression in the head at the posterior side of the head. The eyes are small and the antennae are 12 - jointed and its scape is situated a little farther from the end of the clypeus.



(a) ALATE (b) SOLDIER (c) WORKER

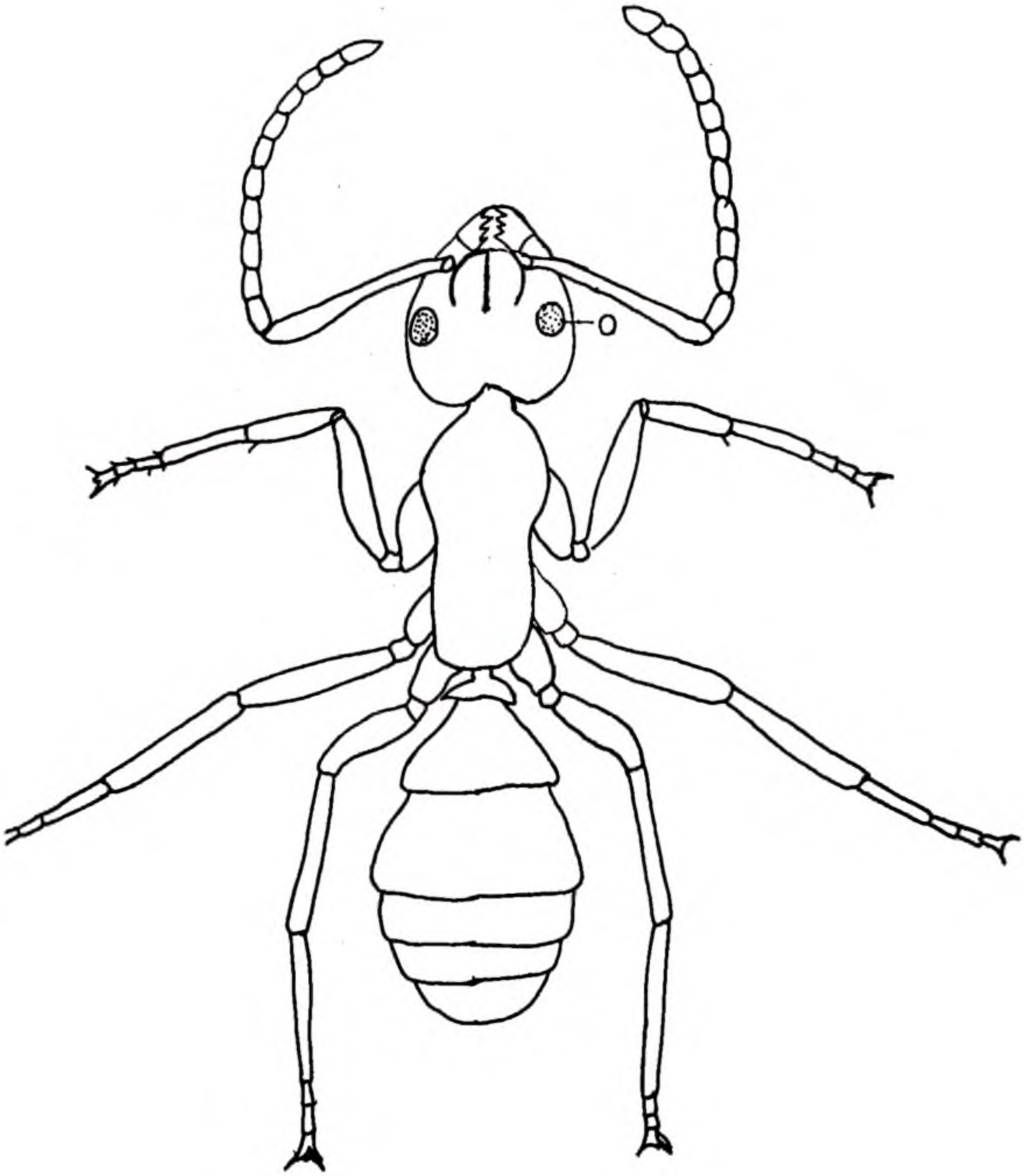
FIG: 10: PUPAE OF C. ACVAPIMENSIS

The mandibles are large and triangular with the teeth found as coarse projections on the broad surface. The thorax is broad in front and is laterally compressed towards the posterior end. The gaster of the ant is slightly larger than the rest of the body and found to be raised in excited ants. The legs are long and well developed. Each tibia possesses a spur just before the tarsus (Fig. 11).

(d) The soldiers: Morphology of the soldiers (Fig.12) is the same as of worker caste but differs in head size which is broader as well as longer than the worker caste.

Two types of soldiers may be distinguished by head size. The first type has broad and short heads and these were earlier referred as the foraging soldiers (Fig. 13a). Their mandibles are less coarse as compared with the mandibles of the other soldiers. The mandibles even though triangular were smaller as compared to the mandibles of the other soldiers. The second type of soldiers (Fig. 13b) were earlier refered to as the guarding soldiers during foraging. These soldiers had broad and long heads and their mandibles were very large and triangular with coarse teeth on the broad surface of the mandibles. By comparison, their heads appeared narrower than those referred to as the foraging soldiers.

(e) The females: The females are the reproductives of the caste. Their head structures appear like the worker caste



O= OCELLUS

FIG. 11: Worker of

C. acvapimensis

X250

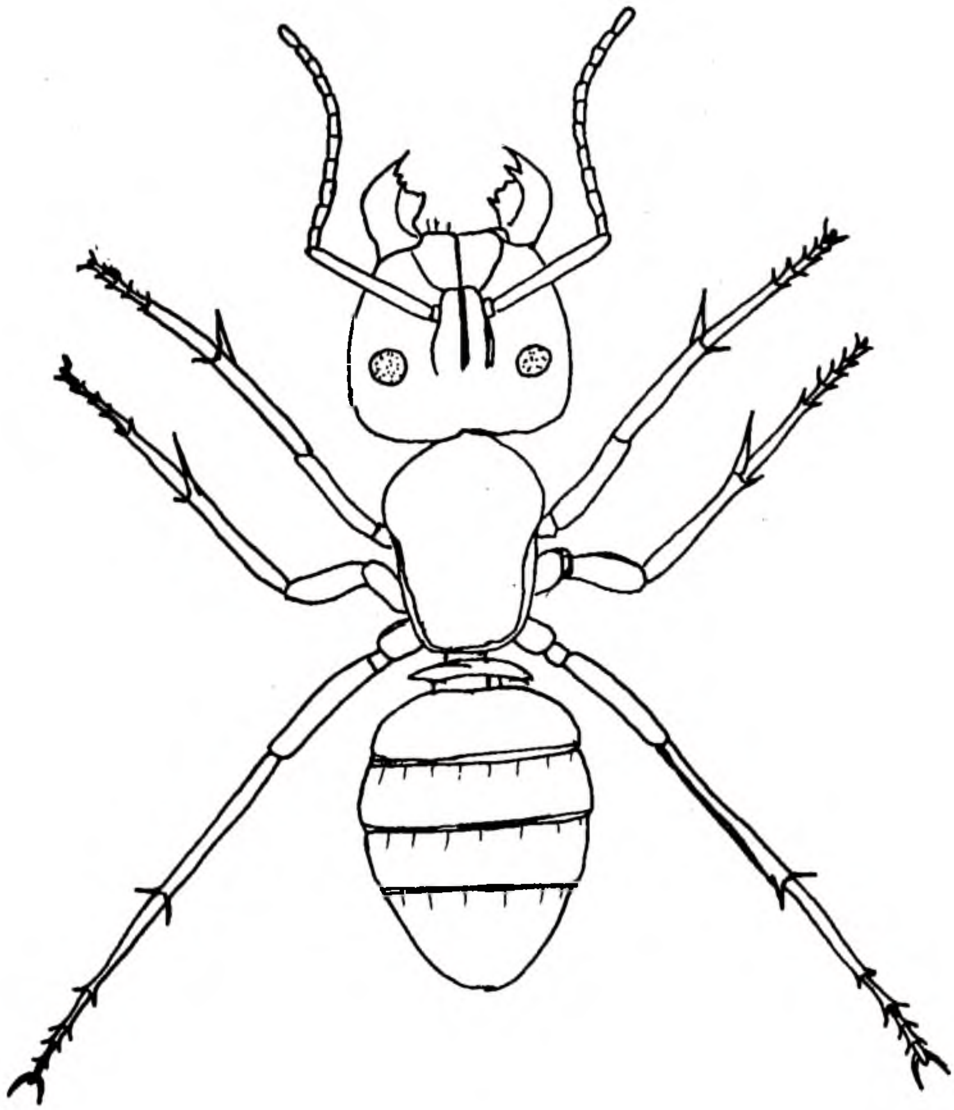


FIG: 12: Soldier of C. acvapimensis

X 120

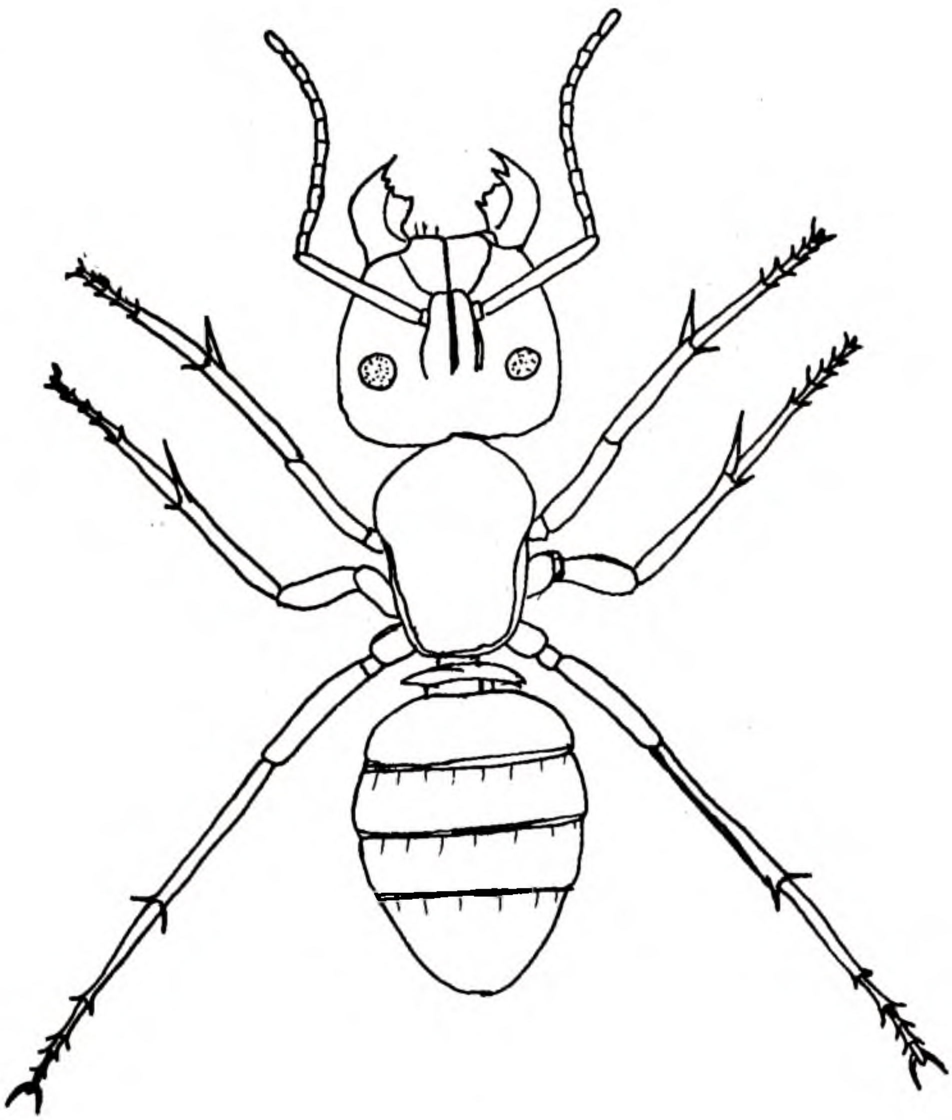
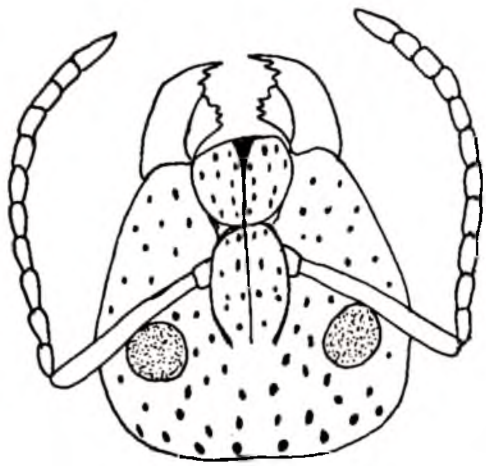


FIG:12: Soldier of *C. acvapimensis*

X 120

(a) forager



(b) guard

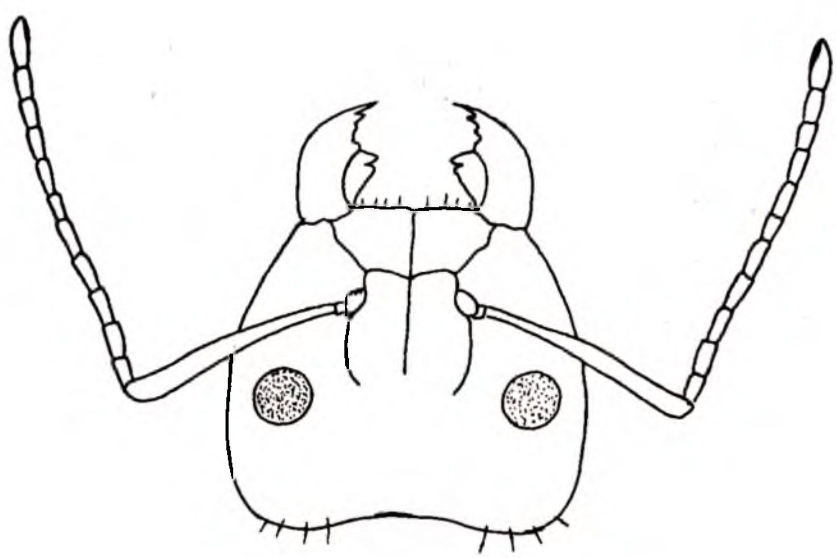


FIG:13. Heads of the two kinds of C. *acvapimensis* soldiers. X2 50 but could be easily distinguished by the presence of wings as well as their very large gasters. They have ocelli and the wings are very long. (Fig. 14).

(f) The males: The males are smaller and slender with short heads. Their eyes appear more prominent and ocelli are also present. Their gasters are comparatively elongate, legs are very slender (Fig. 15).

(g) The queens: The queen of the nest is just like the female of the caste but differs only in the absence of the wings (Fig. 16).

5.3.2 Guests of C.acvapimensis

During excavations, the only foreign insects in the nest of the ants appeared to be termites Microtermes spp. Investigation revealed that the nests of these two insects were separated by thin walls and these walls were broken during excavation when the ants attacked the termites and carried them away. In the nests, any termite present was dead and was among a heep of food items that the ants had collected into the nest and could not be considered as the guests of the ants. Those nests that were found in the wood, the termites were observed to have left the nest before the ants might have occupied the nest at a later stage.

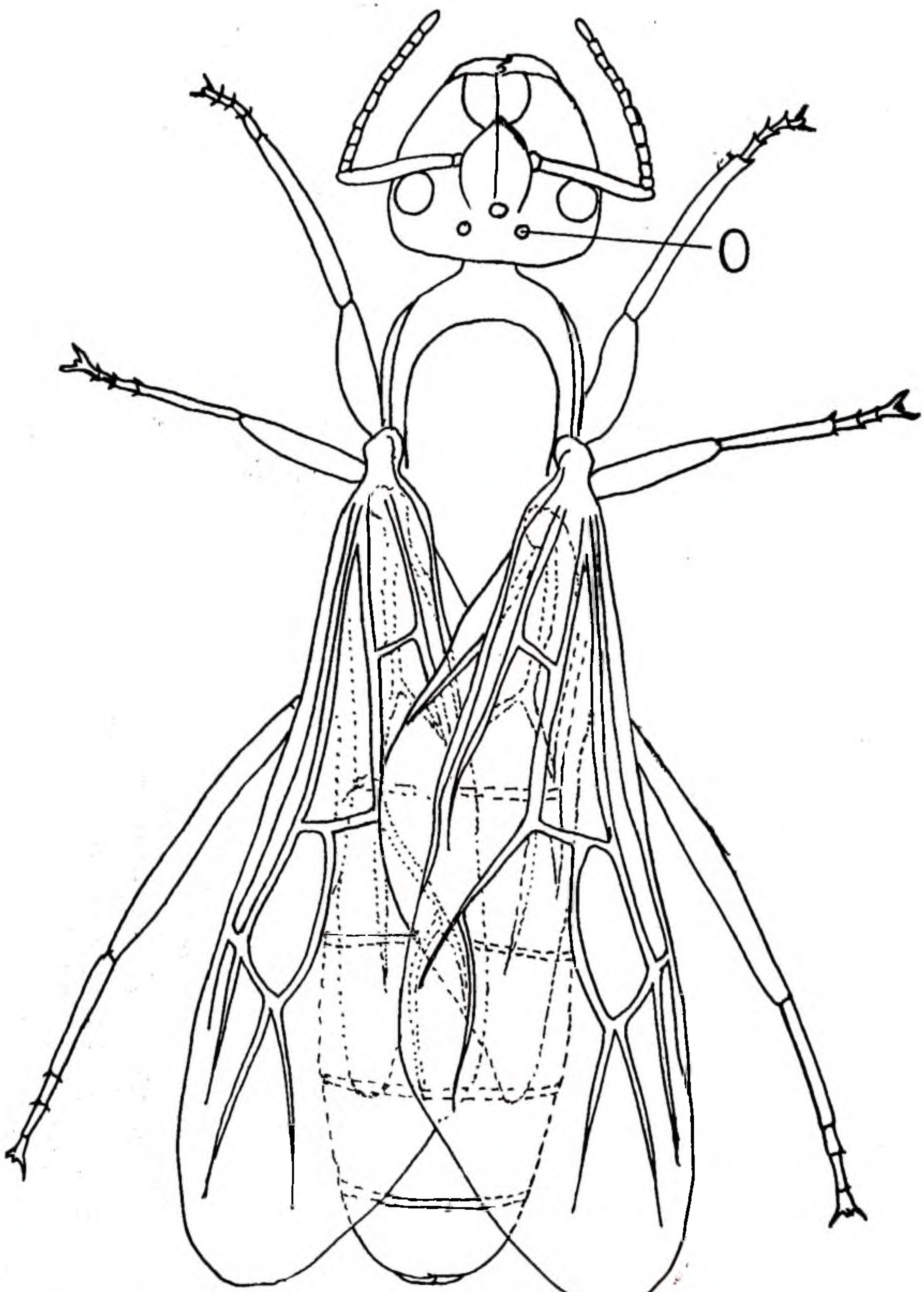
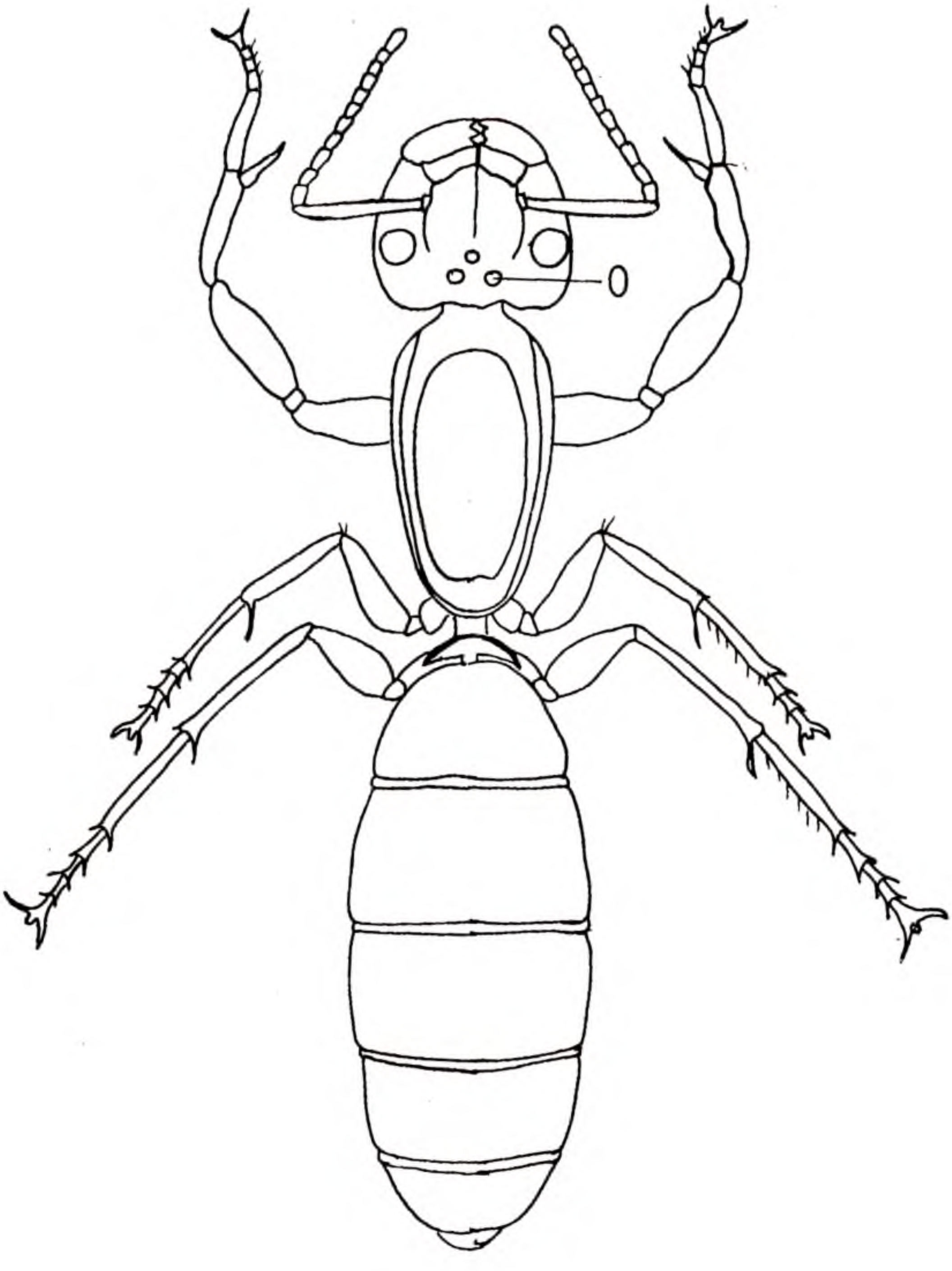


FIG: 14 ALATE QUEEN OF C. ACVAPIMENSIS

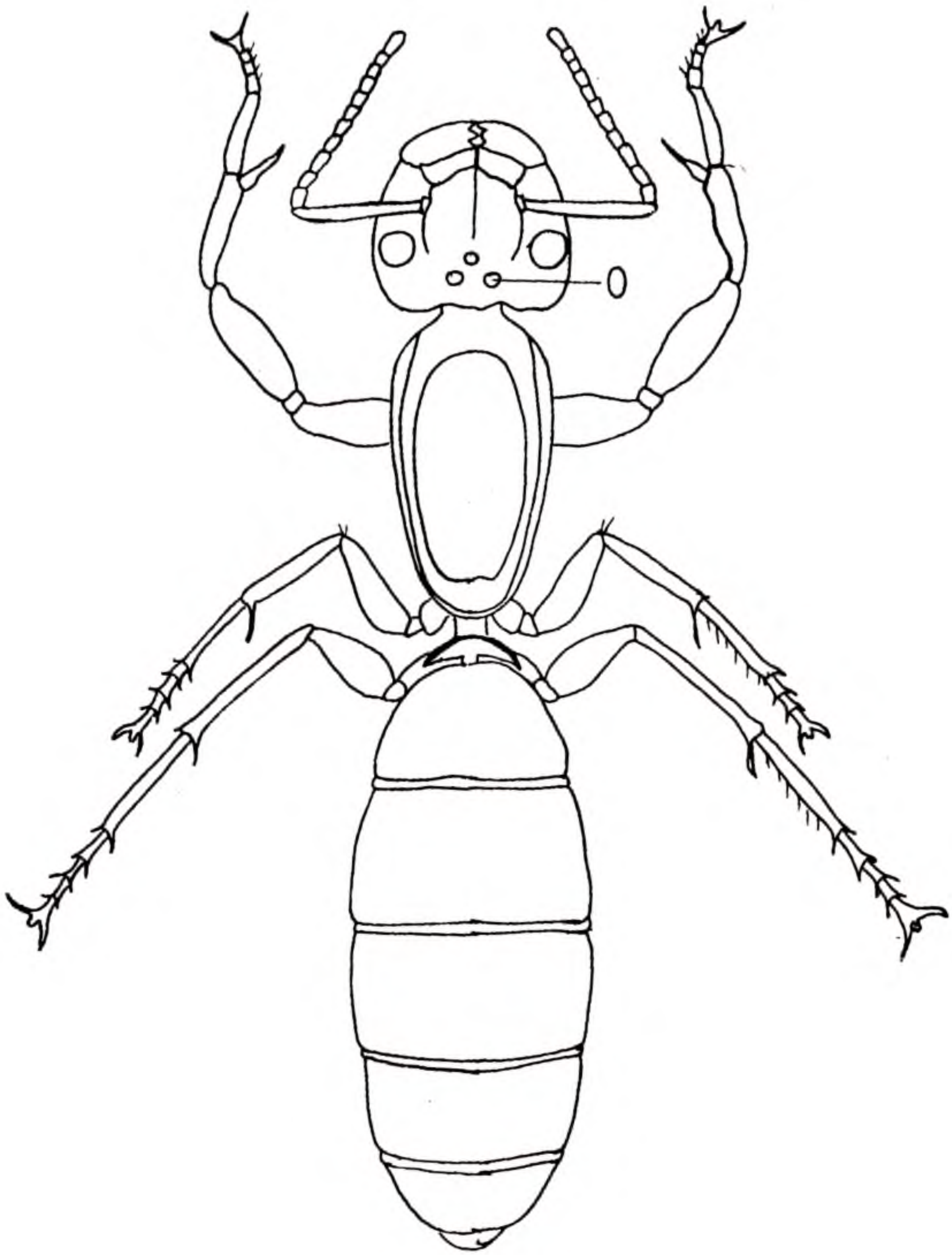
X 120

O=ocellus



O = ocellus

FIG. 16: De-alate queen of *C. acvapimensis* X 120



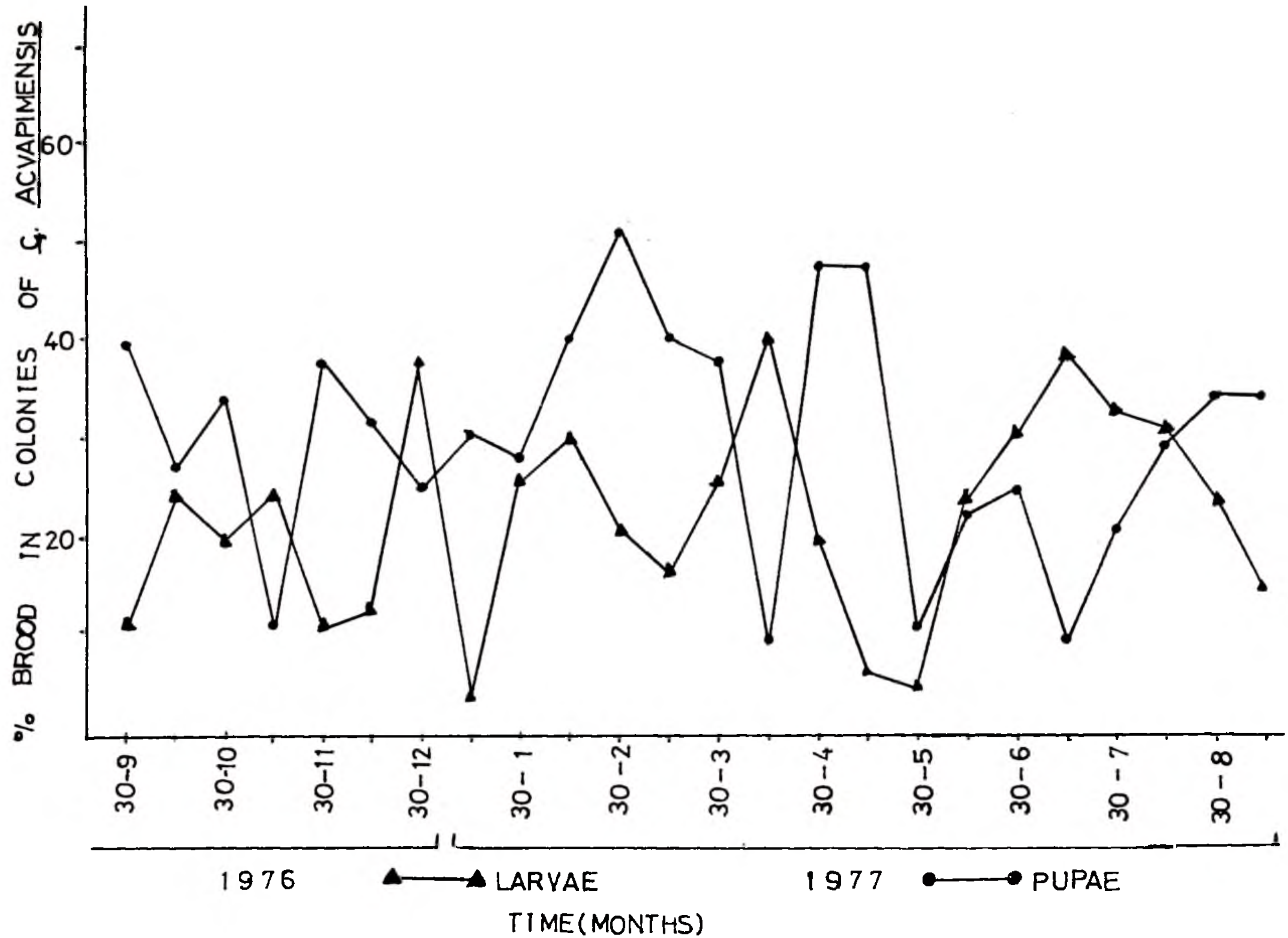
o=ocellus

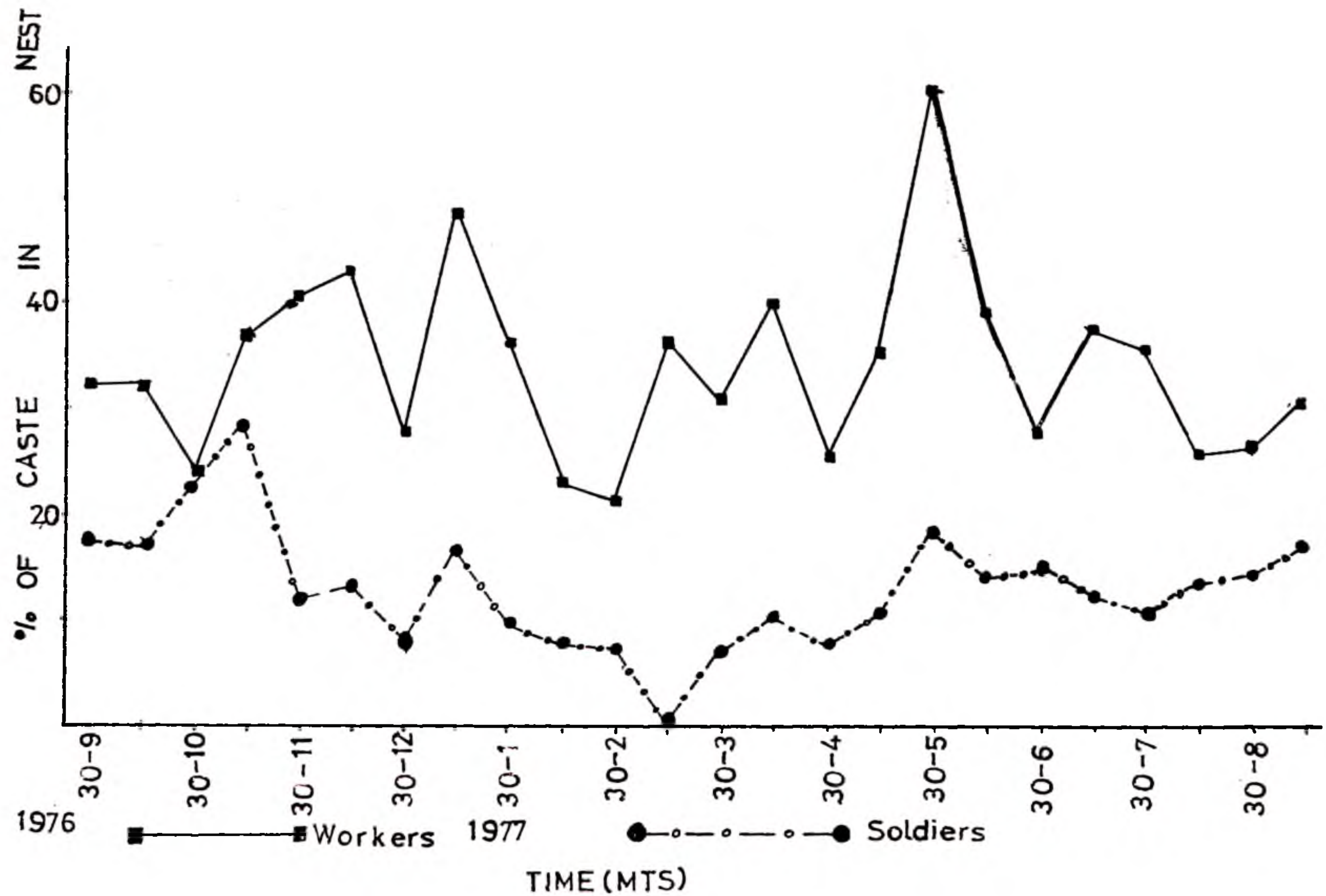
FIG.16: De-alate queen of *C. acvapimensis* X 120

5.3.3 Phenology of brood and castes

During the study period, the brood and adults in the excavated nests were counted and the results are given in table 14. Two population peaks occurred between mid - February and the end of March. The largest population was 1,572 per nest while the smallest was 227 recorded during the middle of January. On the whole, an average of 643 individuals per nest was obtained. Further information on the phenology of the brood and castes is given in Figs. 7 and 8. The larvae were observed to have fluctuating peaks with three of them distinctly marked. The highest peaks occured towards the end of December, middle of April and the middle of July. The lowest peaks occurred at the middle of January and during May. The percentage of pupae per nest followed a pattern opposite to that of the larvae in that during the periods when the larvae were more, the pupae were few and vice versa. Differences occurred in the middle of November, and the middle of December, 1976 and the end of May, 1977 when both larvae and pupae had lower peaks. The highest peaks of the pupae occurred towards the end of September and the minor peaks at the end of February, April - middle of May. The percentage of soldiers present was almost constant except in the middle of November when a high peak occurred and in the middle of March when their numbers declined to a negligible percentage (almost zero).

FIG: 7 Phenology of brood in various nests





% OF CASTE IN NEST
60
40
20
30-9
30-10
30-11
30-12
30-1
30-2
30-3
30-4
30-5
30-6
30-7
30-8
1976
Workers
1977
Soldiers
TIME (MTS)

Table 13: Composition of the castes of the various nests <u>Camp.acvapimensis</u> excavated during the study period.

Date	Larvae	Pupae	Soldiers	Workers	Winged	Total
30/ 9/76	52	197	94	164	0	507
15/10/76	157	179	120	216	0	672
30/10/76	62	108	73	79	0	672
15/11/76	68	29	82	104	0	282
30/11/76	42	152	52	170	0	416
15/12/76	68	170	69	241	0	548
30/12/76	293	192	62	217	18	782
15/ 1/77	9	67	38	111	1	227
30/ 1/77	114	124	43	166	3	451
15/ 2/77	415	558	108	323	0	1405
28/ 2/77	320	789	103	337	22	1572
15/ 3/77	169	416	81	381	0	1048
30/ 3/77	225	334	62	276	0	898
15/ 4/77	220	51	54	221	13	560
30/ 4/77	51	125	20	68	0	265
15/ 5/77	34	241	56	187	5	532
30/ 5/77	18	35	61	204	20	338
15/ 6/77	219	199	131	361	6	916
30/ 6/77	134	109	69	124	9	445
15/ 7/77	320	79	101	316	23	839
30/ 7/77	194	121	62	211	2	590
15/ 8/77	214	201	93	179	6	693
30/8/77	120	172	79	133	0	504
15/ 9/77	94	214	109	192	18	627

recorded. This gave an average of 76 soldiers per nest.

5.3.4 Head measurements

The head measurements for the workers and the soldiers are given in appendix tables 2-13. The maximum of the soldier (from mandibles to where the head is fixed to the thorax) was 2.50mm and the minimum 1.39mm. There were 2 extremes: (a) short heads and (b) long heads.

It was also found out that those of the former category had broader heads and those of the latter group had narrow heads (Figs. 13a and 13b). These differences were found in the soldiers from most of the nests. (Figs 17 - 22 are the results of the head measurements found in the different ranges). From the histograms it is clear that two groups of soldiers are present: (i) those with broad but short heads and (ii) those with narrow and long heads. There were no intermediates between these extremes but in certain colonies (Figs 17 and 18), only one group of short head soldiers were found while in other nest (Figs 19 -22), the range of head length shows 2 groups with Figs 19 and 22 showing a wider range for the head lengths. This indicates that in Figs 17 and 18, there is only one group of soldiers.

In the worker caste, there was no difference in all the colonies. The head range was found to lie between 1.13 and 1.72mm but most workers tended to fall in the middle group (Figs. 23 - 28).

. FIG: 21. - NEST 15

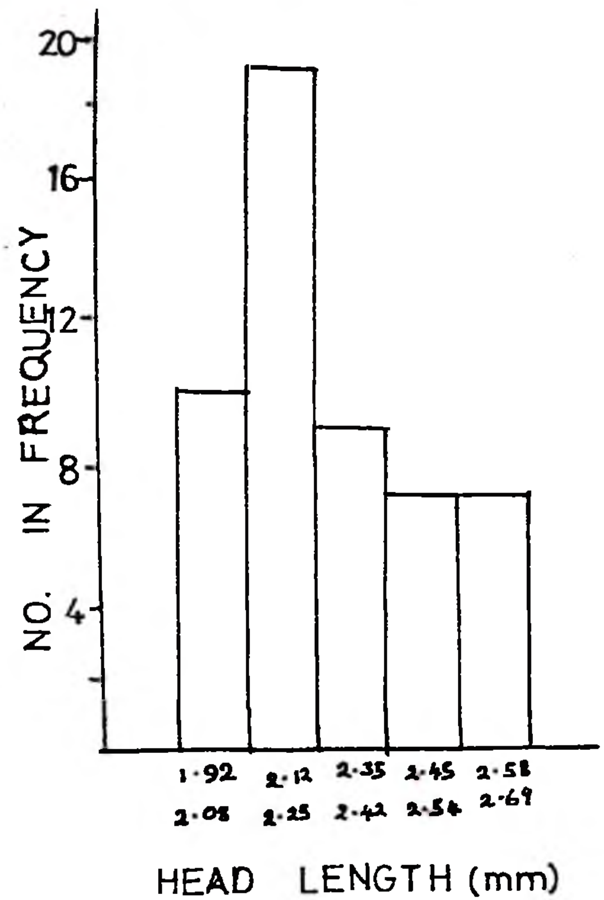
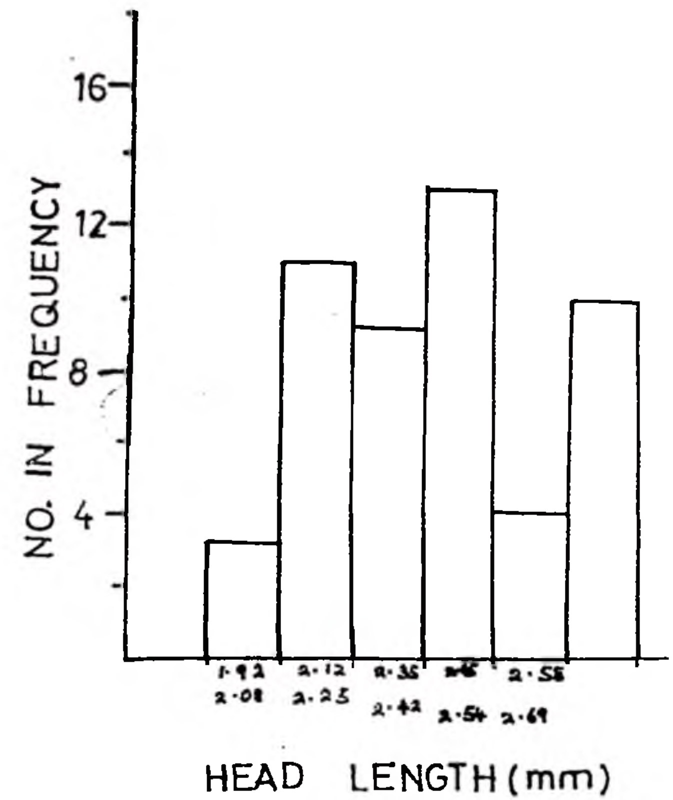


FIG: 22 - NEST 18



KEY TO FIGS 17 - 22

FREQUENCY OF HEAD LENGTH DISTRIBUTION OF SOLDIERS IN DIFFERENT NESTS

FIG: 17 NEST 3

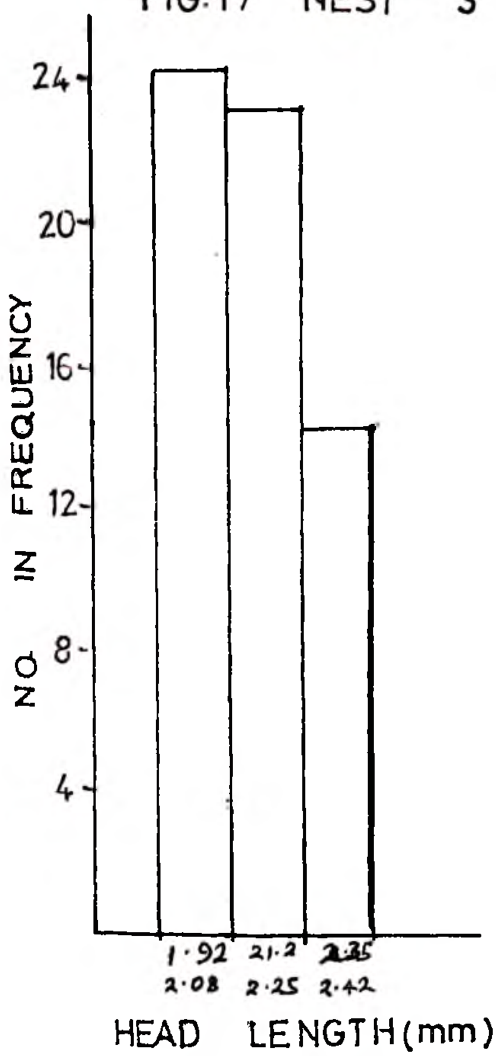


FIG: 18 NEST 5

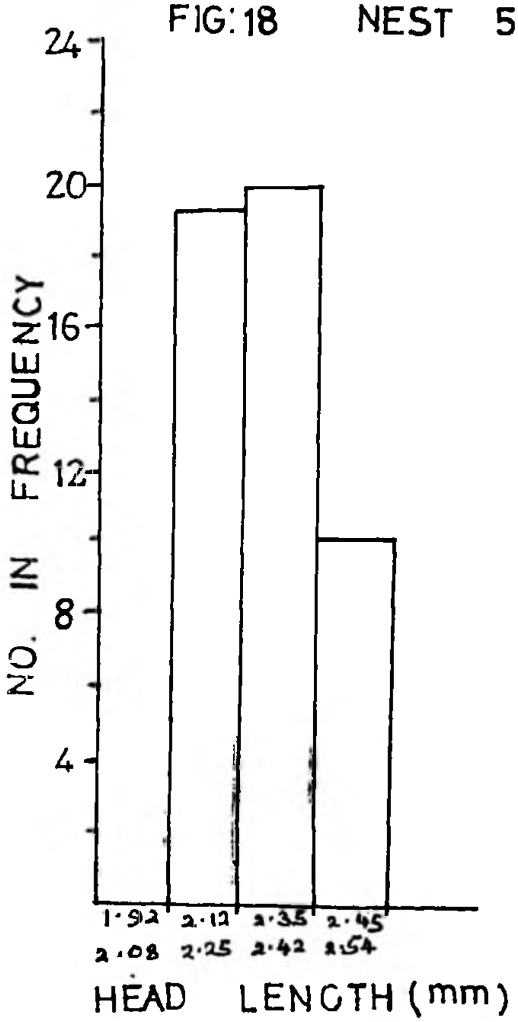


FIG: 19 NEST 8

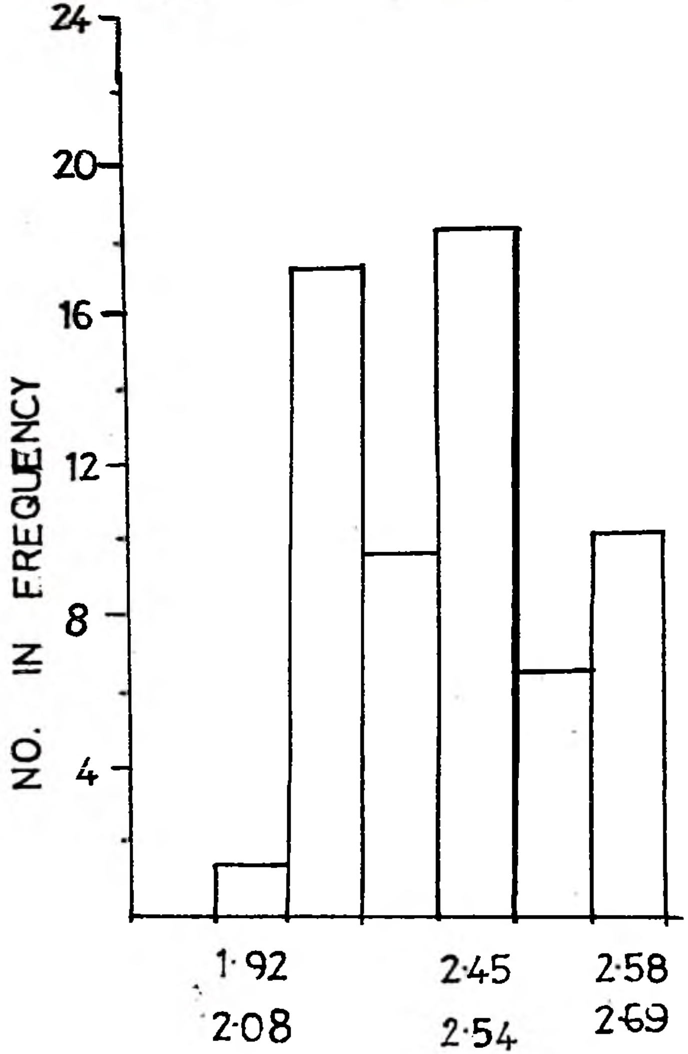


FIG: 20 NEST 12

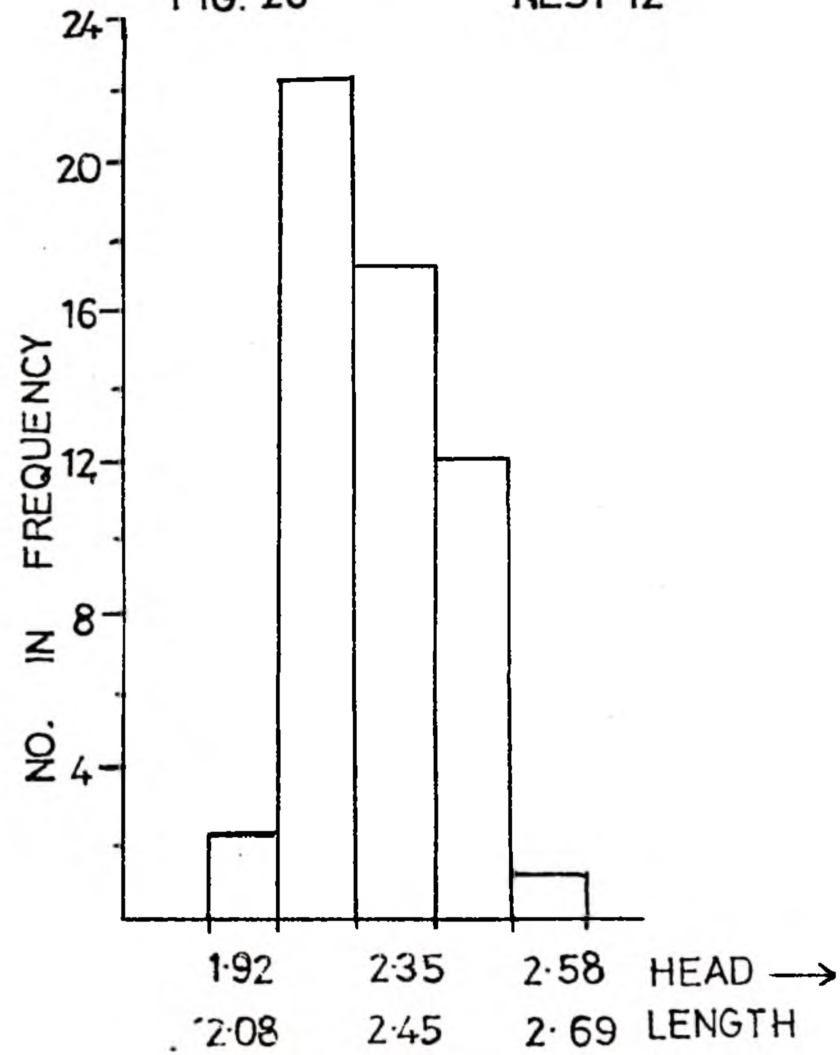


FIG: 19 NEST 8

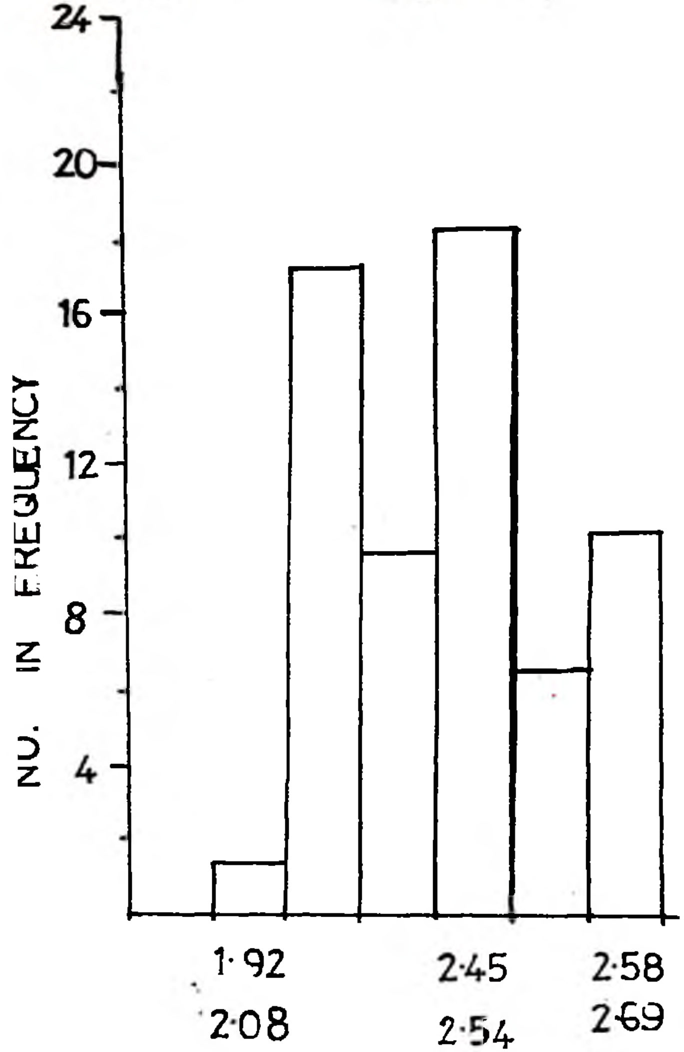


FIG: 20 NEST 12

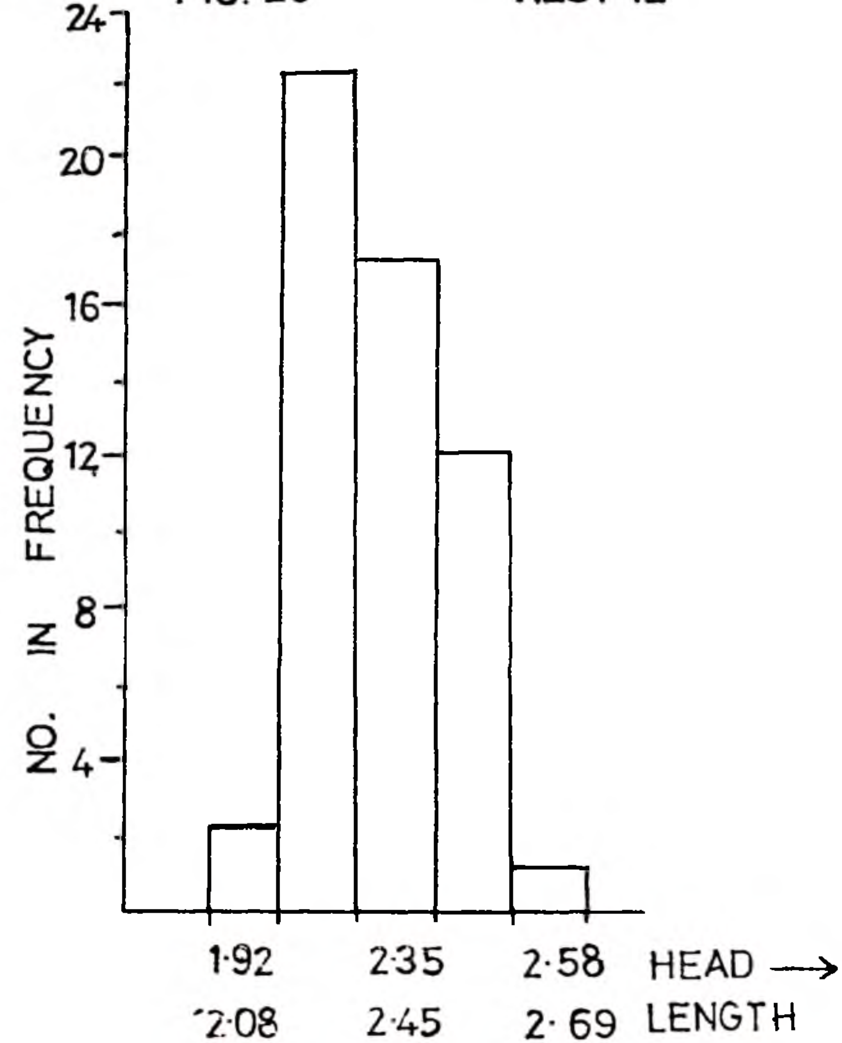


FIG: 21. - NEST 15

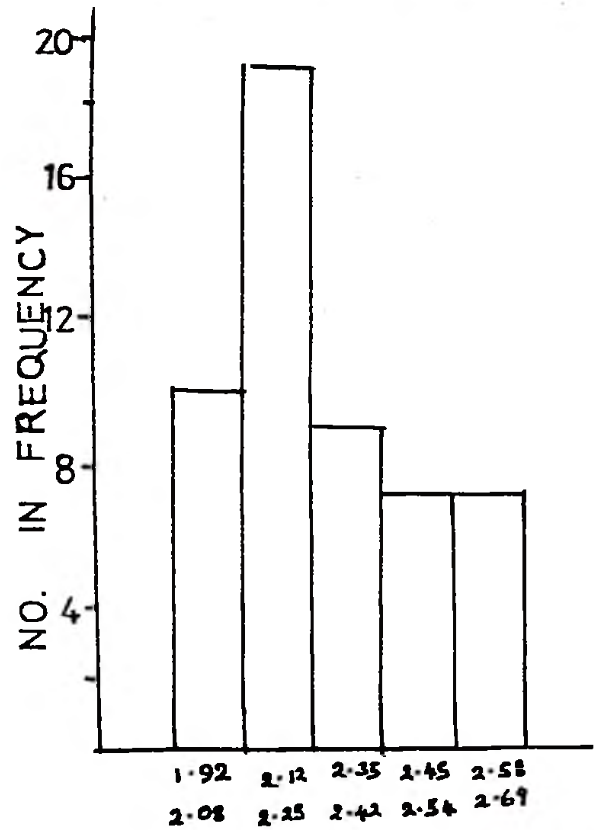
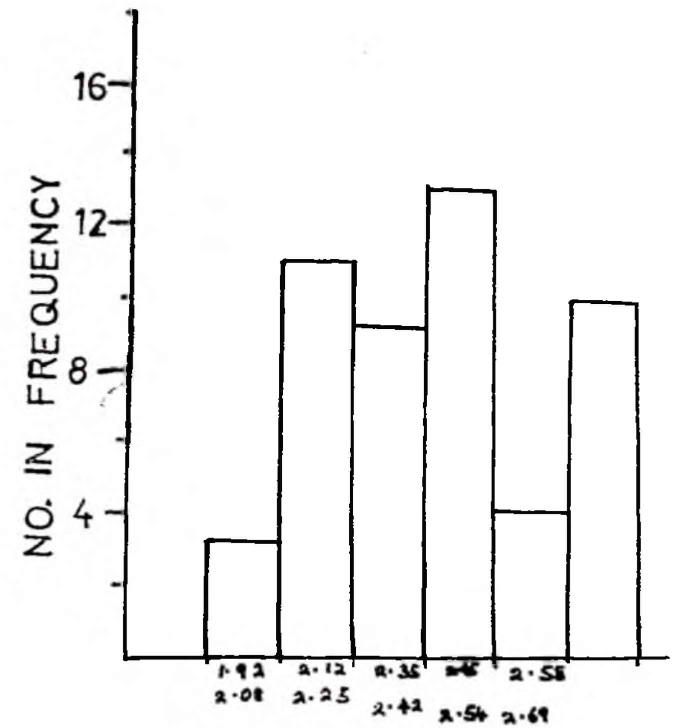


FIG: 22 - NEST 18



KEY TO FIGS 23-28

FREQUENCY OF HEAD LENGTH DISTRIBUTION OF WORKERS IN DIFFERENT NESTS

FIG: 23 - NEST 2

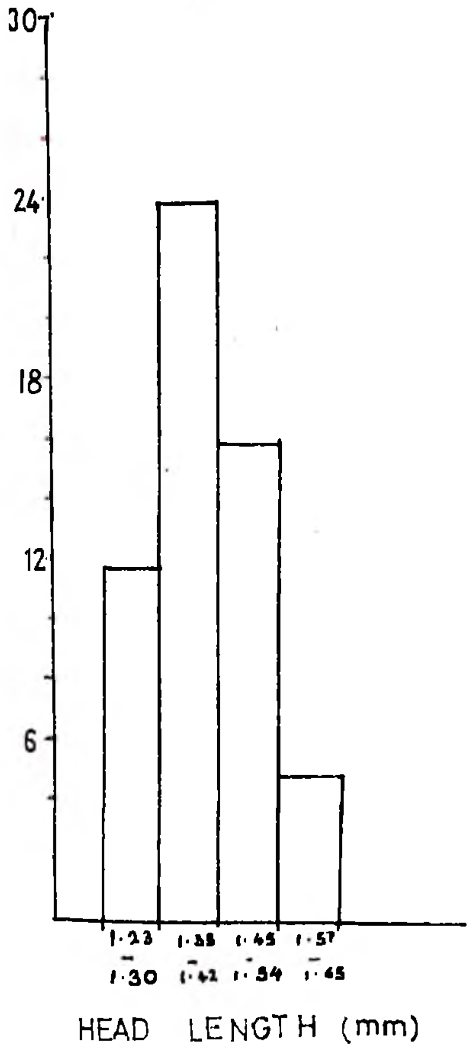


FIG: 24 - NEST 6

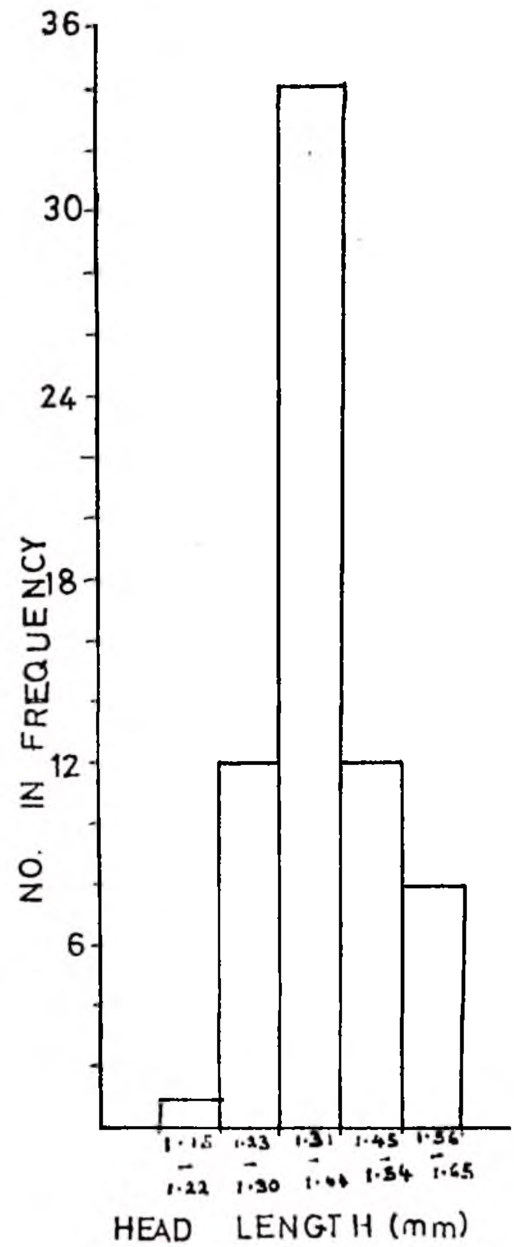


FIG: 25 – NEST 7

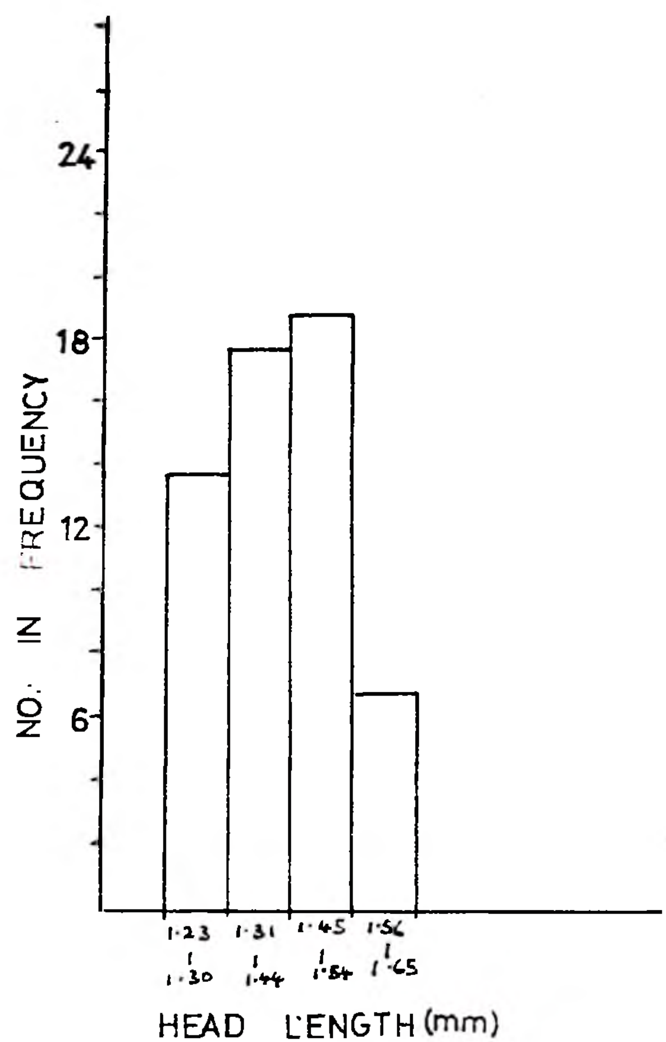


FIG:26 NEST 11

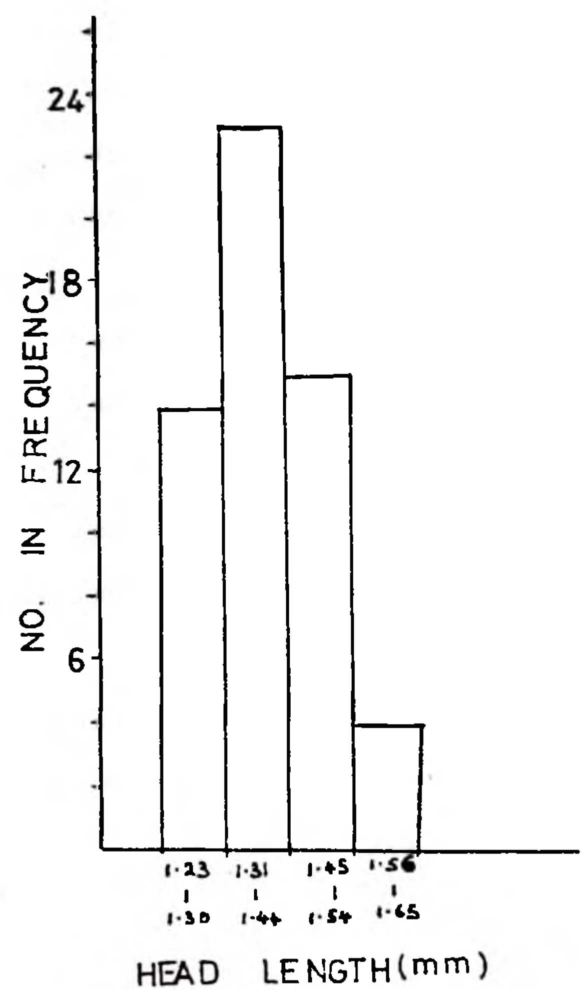


FIG: 27: NEST 16

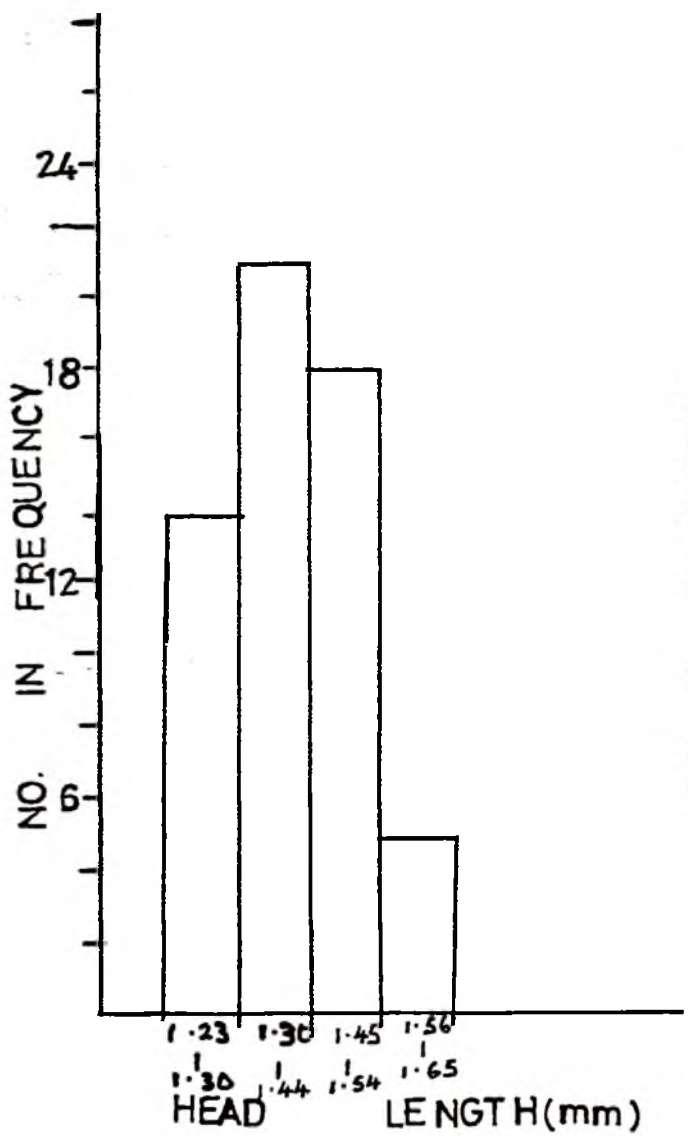
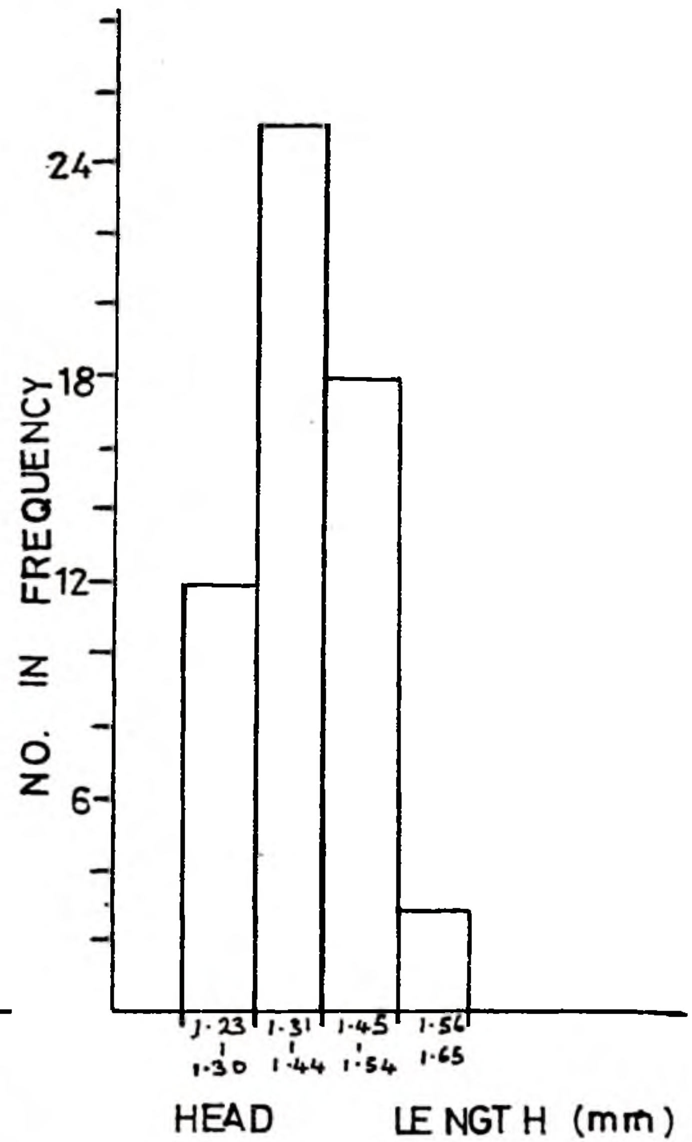


FIG: 28 NEST 17.



5.3.5 The nest

Two types of nests were found (a) primary and (b) secondary nests. The nests excavated were all primary nests and their vertical and actual depths were recorded.

(i) Vertical depth

The deepest nest measured vertically from the surface of the soil to the deepest chamber was 63.1cm deep. The shallowest nest was 12.3cm deep (table 14). In fact most nests were shallow but the compartments found in the nests were numerous and close to the surface of the soil. As a result, the shallow nests had many chambers in some cases. Most chambers were adjacent to each other and just a few centimetres from the surface. One particular nest had a depth of 17.8cm but had as many as 1,572 inhabitants in it while the deepest nest (63.1cm) had only 322 dwellers.

(ii) Actual depth

The actual depth considered took into account only the depth of the deepest chamber from the entrance to the last chamber through the tunnels. The deepest nest was however 98cm. This was the measure of the depth of a single tunnel considered as the deepest one. The shallowest nest was about 27.7cm deep. The deepest chamber when measured through the tunnels, from the surface was not necessarily the deepest, vertically. The most populated nest was only 69.3 cm deep but had many chambers forming the nest.

Table 14: Number of cells vertical and actual depths of nests of Camp.acvapimensis excavated during the study period.

Date	Nest	Vertical depth	Depth last Chamber	No. of Cells
30/ 9/76	1	47cm	69cm	6
15/10/76	2	29.4cm	53cm	3
30/10/76	3	33.4	60.2	5
15/11/76	4	63.1	30.4	4
30/11/76	5	54.3	72.3	7
15/12/76	6	27.5	62.4	6
30/12/76	7	12.3	49.2	7
15/ 1/77	8	15.4	33.4	3
30/ 1/77	9	12.9	27.9	6
15/ 2/77	10	14.5	79.2	8
28/ 2/77	11	17.8	69.3	12
15/ 3/77	12	29.7	72.1	7
30/ 3/77	13	47.3	61.3	5
15/ 4/77	14	51.7	98	7
30/ 4/77	15	30.2	68.1	5
15/ 5/77	16	33.9	72.0	7
30/ 5/77	17	49.0	69.0	6
15/6/77	18	23.4	28.0	5
30/ 6/77	19	29.0	53.4	6
15/ 7/77	20	19.2	49.4	3
30/ 7/77	21	17.4	38.3	5
15/ 8/77	22	32.5	72.7	6
30/ 8/77	23	31.7	89.9	4
15/ 9/77	24	39.3	37.4	5

5.3.6 Type of soil in which nesting took place

The soil analysis carried out using the measuring cylinder and classifying after Dutta (1964) indicated that most of the nests were found in the top-soil that was silt and a lower soil that was clay. In areas where the top soil was found to be sandy, the sand was only about 3-6cm deep from the surface to the mixture of sand and clay in lower layers.

5.3.7 Position of nest entrance in relation to vegetation

The nest entrances were mostly found in or near grass roots, or on the bare soil. When a nest was found on the bare ground, it usually had an entrance with soil clear from the ground and measuring between 0.4 and 1.8cm from the ground level. The ants were found ascending the entrance before entering the nests. When the vegetation at the entrance was cleared, most of the nests were abandoned and no nest was erected in any area where artificial shade was created. When foliage leaves were trimmed, they seemed to have had no effect on the ants during the period but when the rain subsided, the ants left such nests due to a possible increase in the light intensity.

5.3.8 Effects of flooding on nests

During flooding, when there was rainfall or water rushing into the nests, some ants especially the soldiers were seen leaving the nest whilst most of the workers were inside. Some ants got drowned and all those out of the nest had their gasters raised in excitement. After the flooding.

the entrance is re-established and nest cleaning takes place.

5.3.9 Nest cleaning

During the whole study period the ants were observed cleaning the nest about twice a day but during the dry seasons only once. During the rains, nest cleaning was followed almost immediately by nest expansion. Nest expansion brought out volumes of fresh earth, and normally lasted 1-2 days.

5.3.10 Types of nests

There are two types of nests and these may be classified as follows:

(a) Primary nests

Primary nests were those found in the soil and containing most of the castes and all the brood.

(i) Nests in the soil

These nests were found as openings in the soil either in-between the bases of vegetation which consisted mainly of grasses or on the bare ground. The openings of such nests were inclined at an angle of about 60 degrees to the bare ground

(ii) Nests in wood

These nests were few but when found, the caste and brood in them were fewer compared with the proportionate number of the same found in the nests that were excavated from the soil.

(iii) Nests in grass roots

These nests were numerous and had many entrances, most of them opening to the outside through grass stalks and others opening between adjacent stalks.

DISTANCE BETWEEN AND WITHIN COLONIES OF

C. AC VAPIMENSIS

FIG. 29 PLOT B

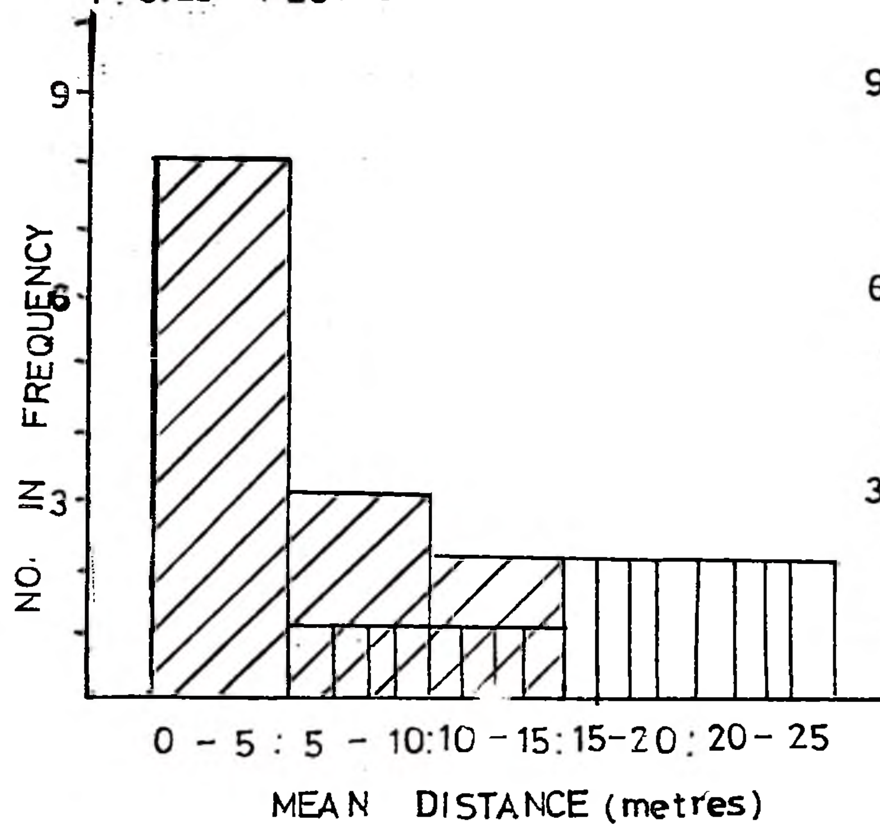


FIG. 30 PLOT A

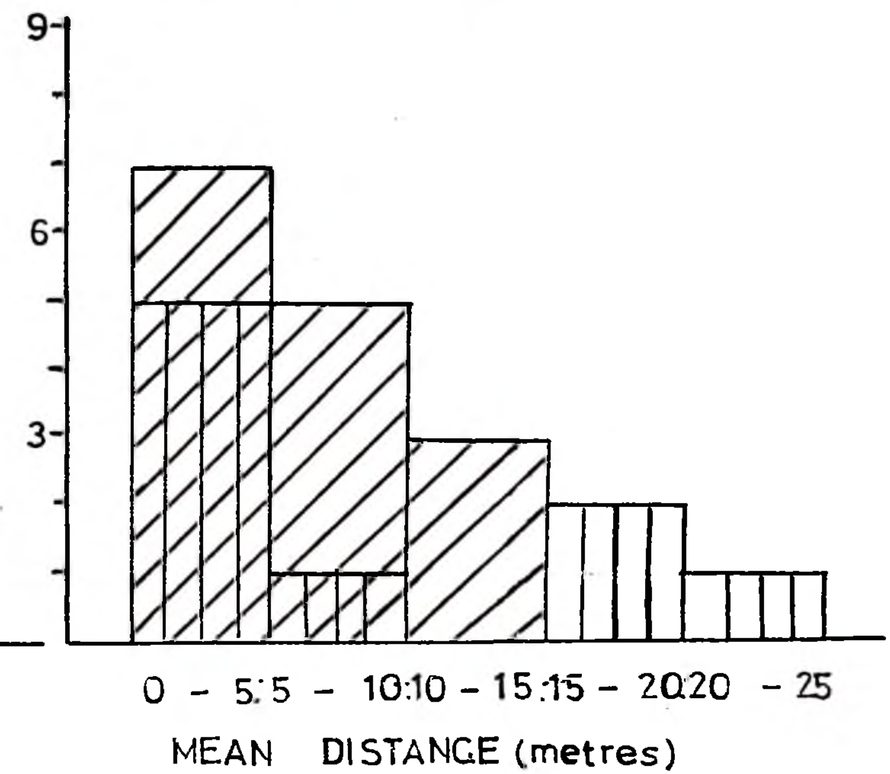
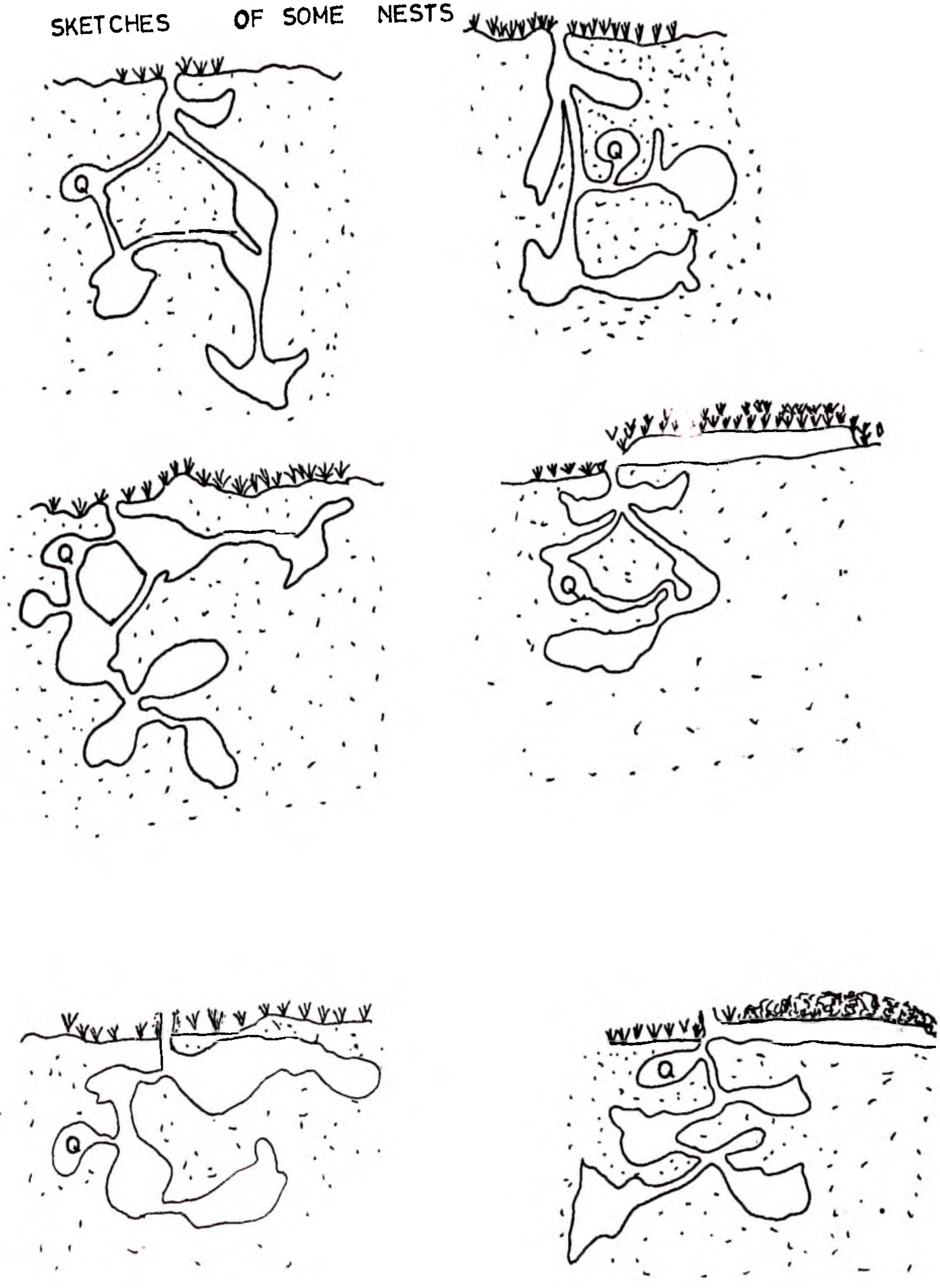


FIG: 31

SKETCHES OF SOME NESTS



These nests were found to be disturbed by the bush fires, about 60% of them being abandoned after such fires.

(b) Secondary nests

These nests were not maintained for longer periods and were found under special conditions. Such as availability of excess brood or tending of other insects.

(i) Tents or (Carton) nests

These nests which contained aphids, some homoptera and beetles in certain enclosed places with the ants found tending them. The number of ants in such nests ranges between 12 in one case to as many as 63 in another case and they were mostly workers and in few cases some soldiers and very few alates were also found.

(ii) Brood nests

These nests were very shallow and were encountered several times, most times being found under growing grasses that trail or heaps of dry leaves. The brood found were mostly pupae and in few cases, very mature larvae. Young stages were never found in such nests.

5.3.11 Arrangement of castes and brood within the nest

In all the nests that were excavated during the study period, the arrangement of the caste and brood followed similar patterns. The pupae were in chambers that were very close to the ground surface whilst the larvae were housed in the deepest chambers. The larval chambers were found to be moist whilst the pupae chambers were always very dry.

The queen was found mostly in one of the deepest chambers usually with a few workers and a couple of soldiers guarding the immediate entrance. In a few cases, however, the queen was found closer to the top surface of the soil.

5.3.12 Nest abandomement

Some of the nests on the study plots were found abandoned and there are 3 main reasons for such an occurrence: (a) fires sweeping through the field (b) nests disturbed by farming practices and (c) when refuse or any waste is dumped at the entrance to the nest. Such nests were found abandoned and the ants never return to them.

5.4 DISCUSSION

5.4.1 Contents of nests

(a) The caste and brood

Larvae and pupae of Camp. acvapimensis are present in the nests all the year round and the pupae are enclosed in cocoons. The size of the smaller larvae initially did not reveal any differences between the would be adult caste but such differences became distinct as they developed. The different individuals could be identified with practical observation. Details of the caste will be discussed under phenology.

(b) Guests of Camp. acvapimensis

It was difficult to determine the specific guests of these ants as nests were crossing at various points with those of termites and driver ants. In cases where the termites and ants were found in the wood, the two insects were separated from each other by a pertition of soil. It was therefore difficult to assume that the two insects coexist. Further investigations would be necessary to throw light in this matter.

5.4.2 Populations in nests and phenology of ants

Wheeler(1922) indicated that the nests of Camponotus were populous and this in fact is apparent in the present work where as many as 1,572 individuals were found in one nest. The changing conditions in the savanna ecosystem may account for the fluctuations in the population of the ant species. Under favourable climatic conditions, it is expected that the population may reach alarming conditions. This idea is supported by the findings of Majer (1974) who found that in the cocoa farm ecosystem these ants may become dominant and exclude all forms from the area. Wheeler (1922) also reported on the effects of slight changes in climate of an area on the population of Camponotus species

The adult worker caste in the populations was always very large and this condition was also noticed by Aryeetey (1971) working on Macromiscoides aculeatus (Mayr) and that of Ackonor (1977) on Cat. guineensis.

Since the foraging is done by the workers and some of the soldiers in the caste, the greater number of brood in some nests was balanced by the sum of the workers and the soldiers found in a nest. The decline in the number of soldiers and workers in a nest and the corresponding high percentage of the larvae and pupae may be explained by the fact that during the periods when such fluctuations were found, the drier conditions and bush fires had killed most of the worker and soldier caste that were foraging during such fires resulting in a decline in the percentage of the worker and soldier caste and the corresponding rise in the percentage of the brood within that nest.
This was observed in February and this was a period when conditions were very dry and bush fires were common. Another possible explanation is increase in the number of immature stages since any increase in the brood caused the relative percentages of the worker and soldier castes to drop. From the results, it is also evident that the period just following this time had marked increase in the worker and soldier caste and this was possibly due to the transformation of the immature stages into adult castes. A marked drop in the immature and adults was evident and this might have been caused by founding of new nests due to fresh growth of vegetation in the nesting areas. This was followed by a sharp rise in the brood which may have been caused by the initial reproductive phase of the new colonies.

The virtual absence of the alates was not expected but this could partly be due to a possibility that these alates had left the nest with some soldier and worker castes. It is not known if these ants carried part of the brood away with them. It was also assumed that the ants left the nest as soon as they had matured because these ants were not caught in light traps and they were not found with the rains. The actual factor influencing their activity are therefore not known.

From the above it is evident that fires, drought and founding of new nests have marked effect on the population of the worker and soldier caste. During the periods when the larvae are few and the pupae many, the corresponding number of the worker and soldiers was very low indicating that some workers left the nest as the pupae needed minimum attention and the few workers that were left could meet the needs of the larvae. It therefore seems that the female alates need the attention of the workers during developmental stages and also during the period when they leave the parent nest to establish a new one.

The absence of alates or dealates from most of the nests in which the workers were found tending aphids and scale insects was an indication that such nests were secondary and the ants had that in addition to other nests. The permanent nest was therefore that nest which had the brood as well.

The average ratio of broad and short heads to broad and long head in the soldiers caste was (2:1). This is an indication that probably the foraging soldiers were more important as compared with the guarding soldiers within a colony.

The Nests

(a) Vertical depth

The excavated nests were deep and this has shown that the ants tend to dig deep in the soil. The presence of nests under decaying organic matter agrees with the finding of Wheeler (1922) that the species are found nesting under stones and other things that were found on the ground.

In this work some nests were found as deep as 63.1cm. In loose soil the ants were found to construct very deep nests but in very hard soils, the nests were rather shallow. Under trailing grasses and in places where the soil was very moist, the depths of the nests were only a few centimetres from the surface while in areas with dry soil the nests were found deep. This is probably because of the use of moisture by the larvae that were found in moist areas. The depth of the nest had thus moisture benefits for the larvae. In dry soils the nests were deeper for the last cell to be in contact with moisture. In the grassland where there is a comparatively high intensity of light causing very high evaporation rate, the surface soil will be drier and this is the cause of the deep nests that were found in this type of environment.

The larvae of the ants were found to have preference for moist soils during their development and this was the cause of the deep nests that were encountered. The relatively deep nests seem to be a feature of dry areas Formica fusca sp is reported as making vertical nests that will be as deep as 70cm in sandy heathland (Brian and Downing, 1958). Sudd (1967) mentioned that deep vertical nests were common in dry regions and he cited the following: (i) Tabolt (1943) as reporting that Prenolepis imparis Say has a nest as deep as 1.2 metres; (ii) Wray (1938) has reported that Pogonomyrmex badius Latr. had nests as deep as 2m and Veromessor species had nests up to 3 m. It is therefore not surprising that Camp.acvapimensis, a savanna ant constructs nests as deep as 63.1 cm.

(b) Actual depth of last cell

This consideration was not found to be benefiting as some ants were found constructing nests with cells a few millimetres within the soil and the cells were not distinct from each other but very shallow. The number of chambers that constituted the nest was therefore considered and it was found.

Soils in which nesting took place

Very few nests were founding in the sandy area and this might be due to the poor nature of the soil as the ants were found to be nesting near food sources.

It is considered that under very favourable consitions the ants might be found nesting in the sandy soils in areas that have good cover of vegetation.

Effects of flooding

Flooding seems to have little or no effect on the ants apart from drowning some of them. On the whole the ants seem to have no nesting preference in relation to flooding.

Nest cleaning

Nest cleaning seemed a constant day-to-day activity but it also took place after the rains. After the rains it became necessary as the materials that had entered the nests were brought out. This activity was extended to include nest expansion, nearly all nest cleanings tend to include nest expansion.

Types of nests and arrangement of brood

The present work has shown that there may be more than one nest and hence there is always one primary nest found in the soil or wood and many secondary nests. This tends to agree with the findings of Wheeler (1922) who found the species nesting in the trunks of oil plam and some of the workers also tending scale insects and aphids on orange trees. It is evident that the nests in which they were found tending the insects remained as nests as long as those insects kept feeding on the plants.

C H A P T E R S I X

ACTIVITY PATTERN OF *CAMPONOTUS ACVAPIMENSIS*

CHAPTER SIX

ACTIVITY PATTERN OF CAMPONOTUS ACVAPIMENSIS

INTRODUCTION

Like all social insects, ant communities contain a number of castes which perform different types of work. The time at which their duties are performed and the duration constitutes activity pattern of the community. The main activities include the building of nests, foraging, mating, feeding of the brood and killing of prey. The time or period during which the ants emerge and begin their activity is influenced by environmental factors. Wheeler (1930) reported that the ant Prenolepis imparis Say begins to emerge as soon as the temperature reaches above freezing point, increasing in number as the temperature rises until the temperature reaches a peak between 45° and 65°F. However, as the temperature rises above 85°F, their numbers decline. Tabolt (1943) also confirmed this report and added that Prenolepis imparis were found to react to temperature but to a lesser degree. Ayre (1958) however, working on Formica subnitens Creighton, concluded in his findings that relative humidity was of a little importance in limiting ant activity. Ayre (1958) attibuted the effects of temperature to the correlation between light, temperature and humidity. Ackonor (1977) working on Cataulaucus guineensis F. Smith reported that air temperature and relative humidity also seem to be important factors influencing ant activity but felt that their effects were indirect whilst light acted directly. He further stated that light intensity was the most important single factor directly or indirectly.

However, environmental factors other than temperature and humidity may also affect the activity pattern of ants. Ayre (1958) further reported on Formica subnitens that on cool days the ants had one foraging activity but on warm days the ants had two foraging activities. This tends to indicate that temperature had effects on the foraging activity of the ants. Rainfall was also another factor that affected the activity pattern of the ants. Ackonor (1977) reported that Cat.guineensis stopped their foraging activity during rainfall which led to a delay in commencement of activity. This he noted also led to a delay in the start of activity on the next day.

Activity pattern can also be affected by the brood present in the nest at any given time. Schneirla (1944) pointed out that the type of brood present in the nest (larvae or pupae) influenced the activity pattern of ants. Vowles (1955) reported that temperature and humidity alone could not account for the differences found in the activity pattern of the ants because the ants seemed to forage despite some unfavourable temperature and humidity effects. He observed that the effect was more the cause of the presence of the brood (eggs, larvae, and pupae) rather than the effects of temperature and humidity. During activity pattern, ants tend to exhibit all sort of behavioural patterns and Vowles (1955) attibuted all these to nervous excitation caused by factors such as hunger and availability of food in the environment. Adabie (1977) attributed the stimulation of foragers in the nest of Crematogaster depressa (Latreille) to forage to the returning of foragers into the nest and the probable scattering of the developing larvae in the lower chambers of the nest. She felt that the returning foragers entered these chambers and stimulated more workers to forage and increase food supply.

In the present study, investigations into the activity pattern of Camp.acvapimensis were carried out. Several factors were considerad. These included the effects of the seasons, the effects of such environmental factors as humidity, temperature and light intensity. Other factors that possibly influenced the activity pattern and foraging of the ants wefe studied. These included the presence of brood and food in the environment.

MATERIALS AND METHODS

6.2.1 Foraging activity

In the study of activity pattern of Camp.acvapimensis two nests were selected for 12 months of observations. This was done to ensure that the effects of any changes in populations could be noticed. One nest was selected in the grassland area of Plot A and the other in the farm land area of Plot B. The two nests were selected for study in order to investigate the effects of seasonal changes on the activity of the ants as well as the effects of farming on the activity of the ants. In all cases the numbers of ants crossing the census points into and out of the nests were tallied on a card and later recorded in a field notebook. It is to be noted that there is only one opening to the nest and the ants use this as the exit and entrance at the same time. It was therefore easy to tally the numbers leaving and entering the nest at the same time. Numbers of ants entering the nest with food were also recorded.

6.2.1.1 (a) Diurnal activity pattern

During the study period the number of ants that entered and left the nest as well as those entering the nest with food were recorded as explained above during the first ten minutes of every hour (i.e. 6.00 - 6.10 a.m. etc). The behaviour of the ants such as moving in trails, or following others in search of food was carefully studied as well as the effects of certain environmental factors such as relative humidity of air, temperature of the air and nest. Other factors like clouds cover and mist were also taken into consideration. The humidity of air was measured with a hygrometer and the temperatures of the air and nest were recorded with a Grant's temperature recording instrument (Grant's miniature recorder). The instrument was set to record the temperature at hourly intervals. The temperature of the nest was measured by pushing the sensitive end of the cable into the nest through the entrance deep down and at the same time ensuring that the nest was not blocked by the cable. To obtain accurate results, the cable was pulled out gently and cleaned about 2 days to the time for study of activity pattern and gently pushed down again. This was done to remove any deposition of soil on the sensitive part of the cable and rendering it ineffective. Two days were considered sufficient to allow the ants to get used to the presence of the cable which had been introduced. The relative humidity of the nests was measured at specific hours (e.g. 6a.m, 7 a.m. etc), but the activity was studied over a period of ten minutes.

6.2.1.2 Nocturnal activity pattern

The ants were observed to be active both day and night and therefore it became necessary to consider the night activity as well. This was carried out using a hurricane lamp near the entrance of the nest. The lamp was covered with a red cellophane and was used throughout the period of study. Other colours tried had certain disadvantages and were discontinued.

5.2.2 Foraging space and distance

In trying to determine how far the ants moved from their nests when they went out to forage, eosin powder was used to dust the ants and then they were later followed as they went out. On specific days, dusting of the ants was done for about 2 hours and the ants were then followed into the field as well as on vegetation. The farthest point that they moved to was recorded. When it became difficult to determine the identity of the marked ants, a drop of water was put on the gaster of such ants. All ants that were dusted showed a characteristic eosin colour on contact with water. Other methods used to study the distances that the ants moved from their nests was to dust ants foraging on leaves and disturbing them. Such ants moved away towards their nests and the distances from their nests to such foraging areas were measured. Such investigations were possible only during the day as the ants could not be tracked easily in the night. It became necessary therefore to use a suitable method for the distance that the ants moved during the night. Since the ants are fond of sugar, sugar baits were used for this purpose. In order to be sure if the ants were from the nests that were being considered, eosin was dusted on the ants that found the baits and then the entrance to their nests was guarded with a hurricane lamp, observing the ants that entered the nest. Any ant that entered the nest was examined with a drop or water as it passed over a blotting paper. Presence of eosin showed up on the blotting paper.

An attempt was made to find out the differences in foraging distances during the dry and wet seasons. This was considered necessary as the green leaves on which the ants were found foraging dried up in the dry season and the ants were found to travel long distances in search of green leaves. To obtain accurate results on foraging behaviour of the smaller and larger workers, these were followed differently onto the vegetation on which they foraged and their activities observed. Observations were also made on the ants that brought food into the nests.

6.2.3 Induced foraging

Since the ants were found to forage day and night and the only interval with least activity was during mid-day when light intensity and temperature were very high, other factors that caused the activity were also investigated.

6.2.4 Ants - phytophagous insects associationship

The activities of the ants in relation to attendance of plant sap-feeders were studied. This took into consideration the type of associationship that existed between the ants and the pests. For this purpose, a search for secondary nests or tents was carried out and the nests found with pests opened and the contents collected into 70% alcohol for classification. The association between the ants and the sap-feeders was then classified as obligate or facultative. In this classification, the presence or absence of tents and other protection afforded by the ants was taken into consideration.

6.2.5 Flight activity

Flight activity of the ants was studied using a light trap for a period of 13 months. Catches were collected and the number of alates found recorded. The number of alates caught over a period of one month was added together.

Food items collected by ants

On days that foraging distance was determined, the plants with foragers were noted and identified. The specific activities of the ants on such plants were recorded. The plants were then grouped under different categories such as: (a) plants on which ants foraged daily, (b) plants from where the ants collected food materials and (c) plants on which ants tended sap-feeders. The food items collected by the ants were seized and analysed. Plants on which the ants were found to be moving on their foraging errands were not recorded but were considered as plants on their way. During such recordings, any damage that the ants caused to the plants was also noted. To investigate further the type of association existing between the sap-feeders and the ants, the ants were sprayed off at the bases of such plants or grease was applied around the bases to prevent the ants from visiting the sap-feeders and observing the effects of this on the pests.

5.3 OBSERVATIONS/RESULTS

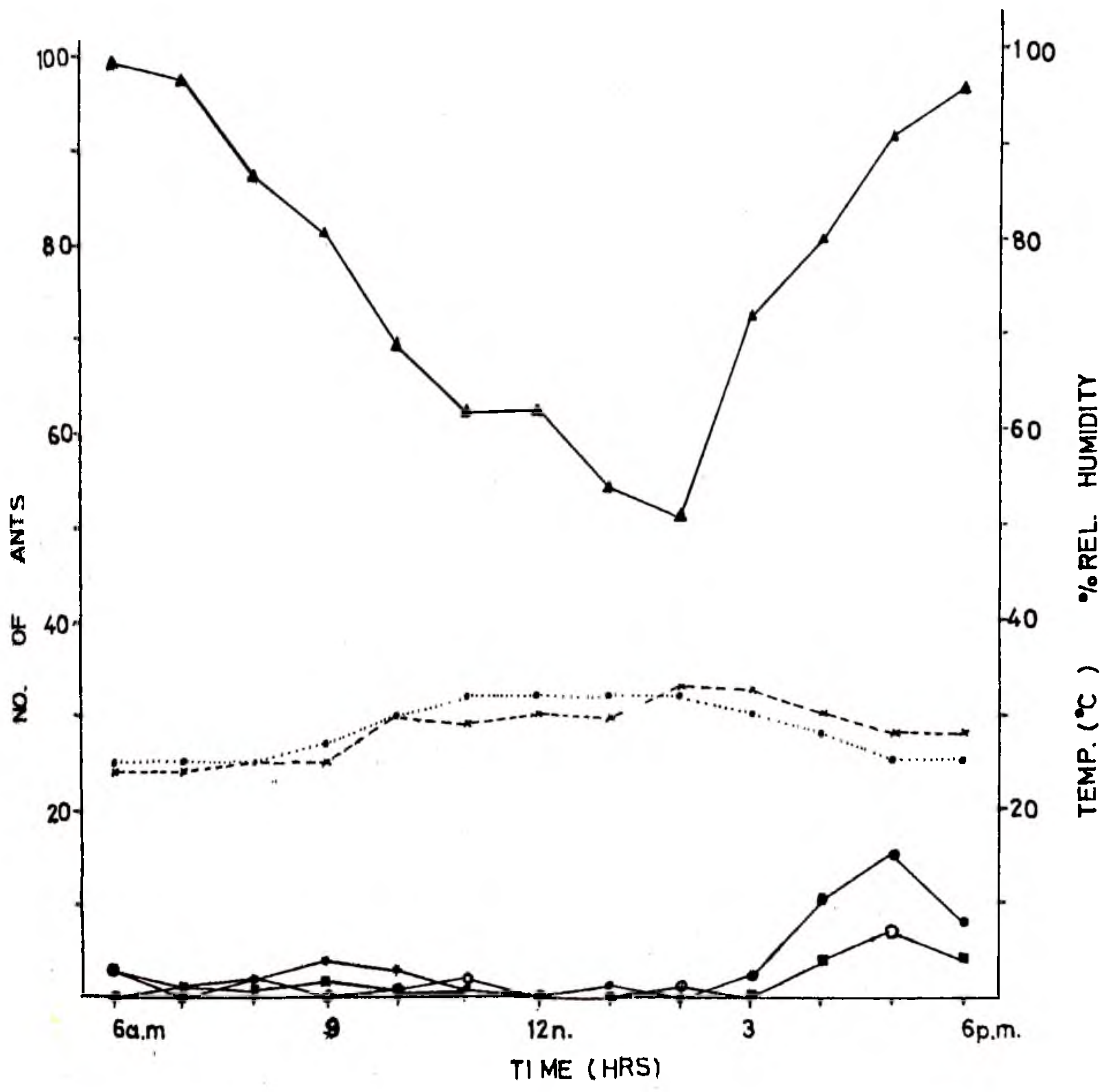
5.3.1 Foraging activity of Camp.acvapimensis

A careful study revealed that the activities of the ants followed the same pattern and rythmn on plot A and B in the wet season but slight differences were found in the dry season. The differences were the results of two major factors, drought which caused the leaves of the plants to dry up and harmattan which increased the evaporation of water from the ants. On the whole, the ants were observed to be active both day and night. The periods varied and could be classified as a period with least activity or a period with maximum activity. Both soldiers and workers were observed to be active all day and night but the workers were observed to be more active than the soldiers probably because of their numbers and secondly because of the functions of the soldiers in the nest. The soldiers came out to forage but they were rarely found coming out alone. They mostly followed the workers. In most cases they returned to nests alone or with the workers. The activity pattern of the ants was then classified as diurnal or nocturnal, depending on the time of activity.

6.3.1. Diurnal activity pattern

The general trend of activity each day was such that some workers left the nests while others entered them but in the mornings, (6 a.m.) fewer ants were found crossing the census point. Most ants that crossed the census point were leaving the nest whilst only a few were entering. On any ordinary day, (i.e. days without rain or any environmental factors causing changes in the climatic and soil conditions), the number of ants found leaving the nest and those entering indicated that two peaks of activity occurred. Between 8 a.m. - 11 a.m, the ants were observed to be active and their activity ceased or became low between 11 a.m - 2 p.m. The same type of activity pattern was observed from 2 p.m - 4 p.m. This resulted in the two peaks of activity found in the ants. One of the activities occurred in the morning and the other in the afternoons (figures 40 and 41). On these days, the activities were found to be influenced by such environmental factors as ligt intensity, temperature and humidity but the light intensity, seemed to affect the other two factors within the environment. On days when the sun rose earlier and the light intensity caused a quick rise in temperature and lowering of humidity, the ants were inactive even though certain factors such as the presence of brood could contribute to an increase in the activity. On such days, very few ants left the nest between 8 a.m and 11 a.m when in fact activity came to a standstill

FIG: 32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NO. OF ANTS
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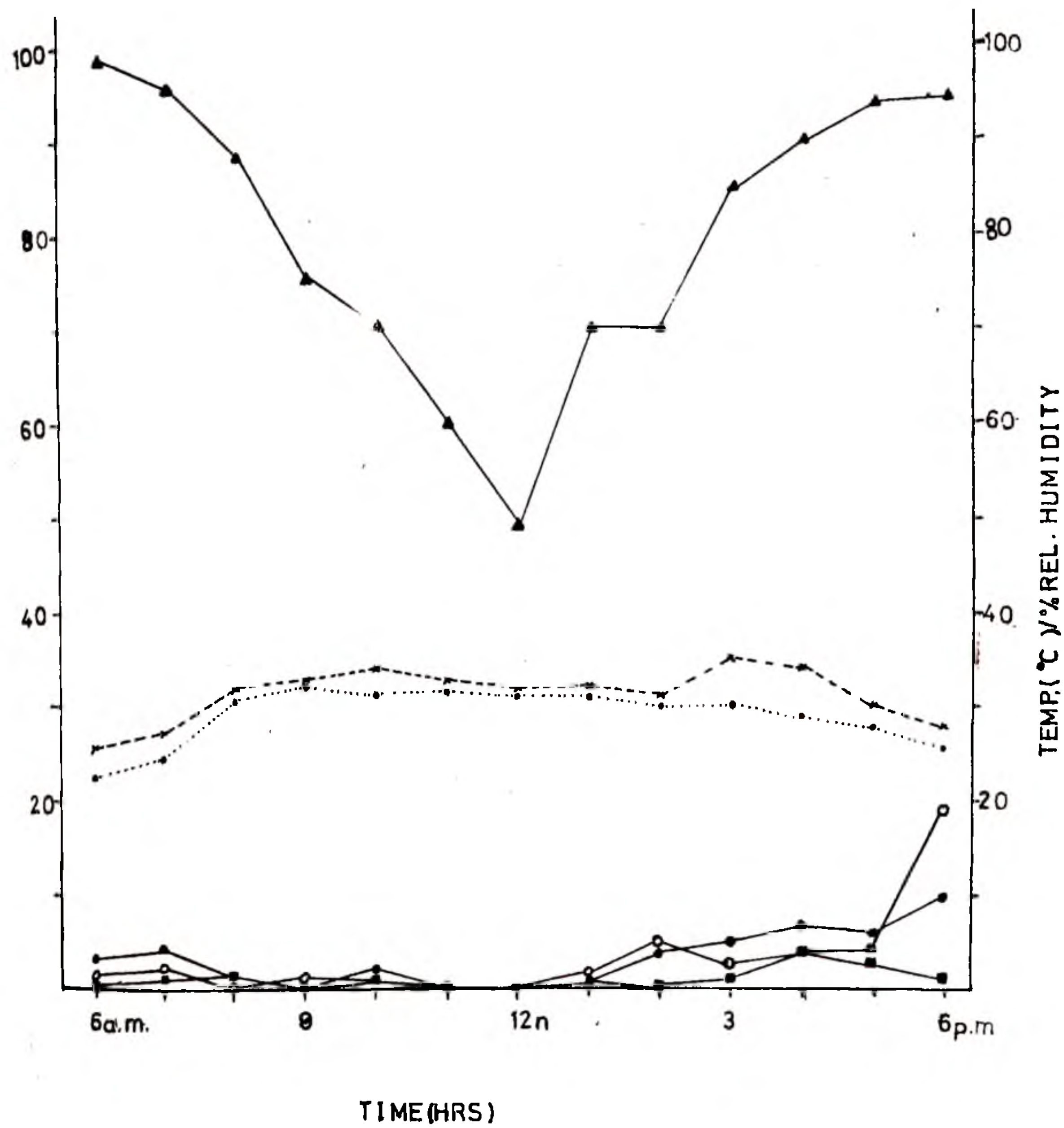
TEMP. (°C) % REL. HUMIDITY
6a.m
9
12n.
3
6p.m.
TIME (HRS)

FIG : 33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6p.m
TEMP.(°C)/% REL. HUMIDITY
TIME (HRS)

FIG : 34

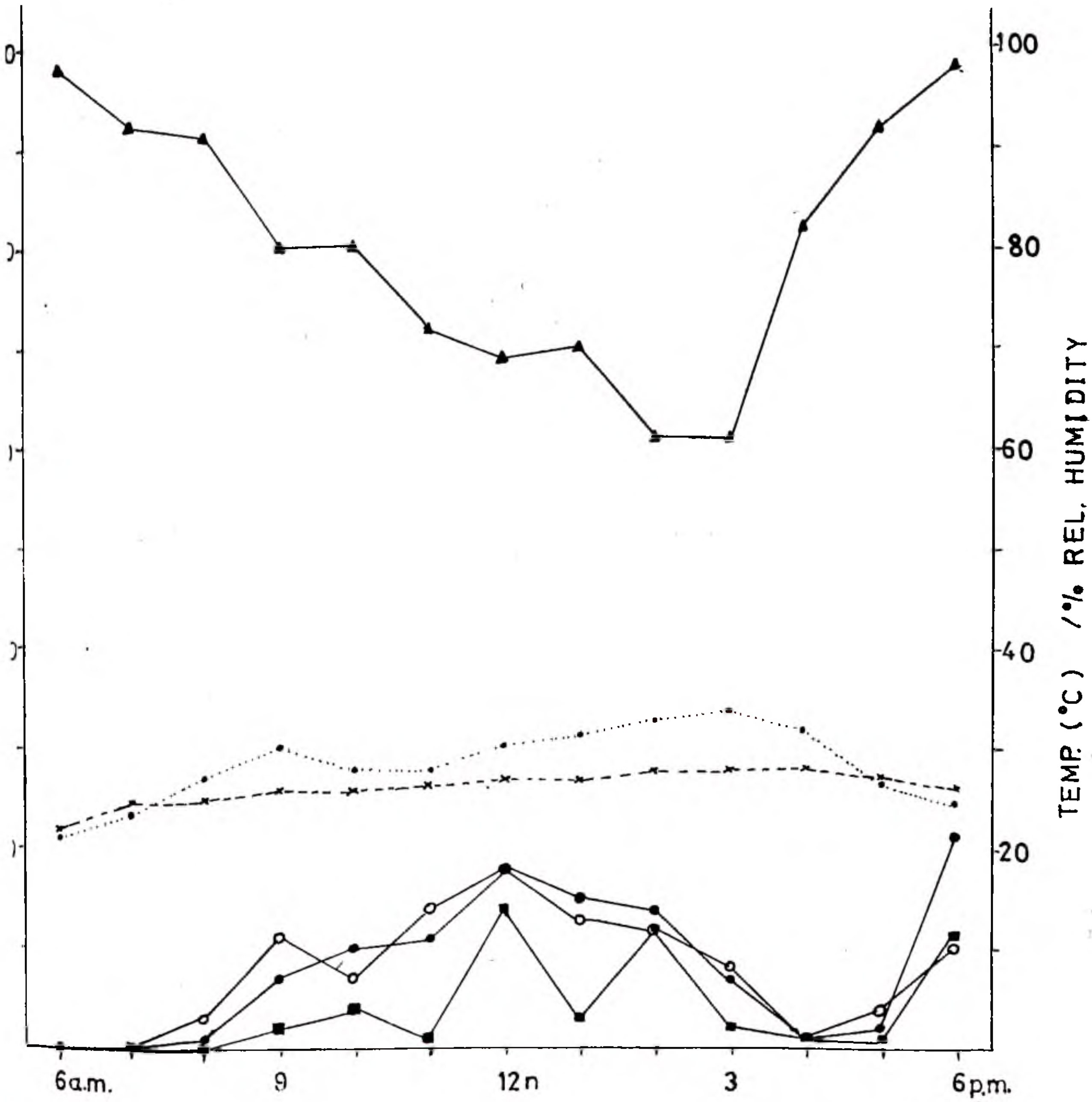


FIG: 35

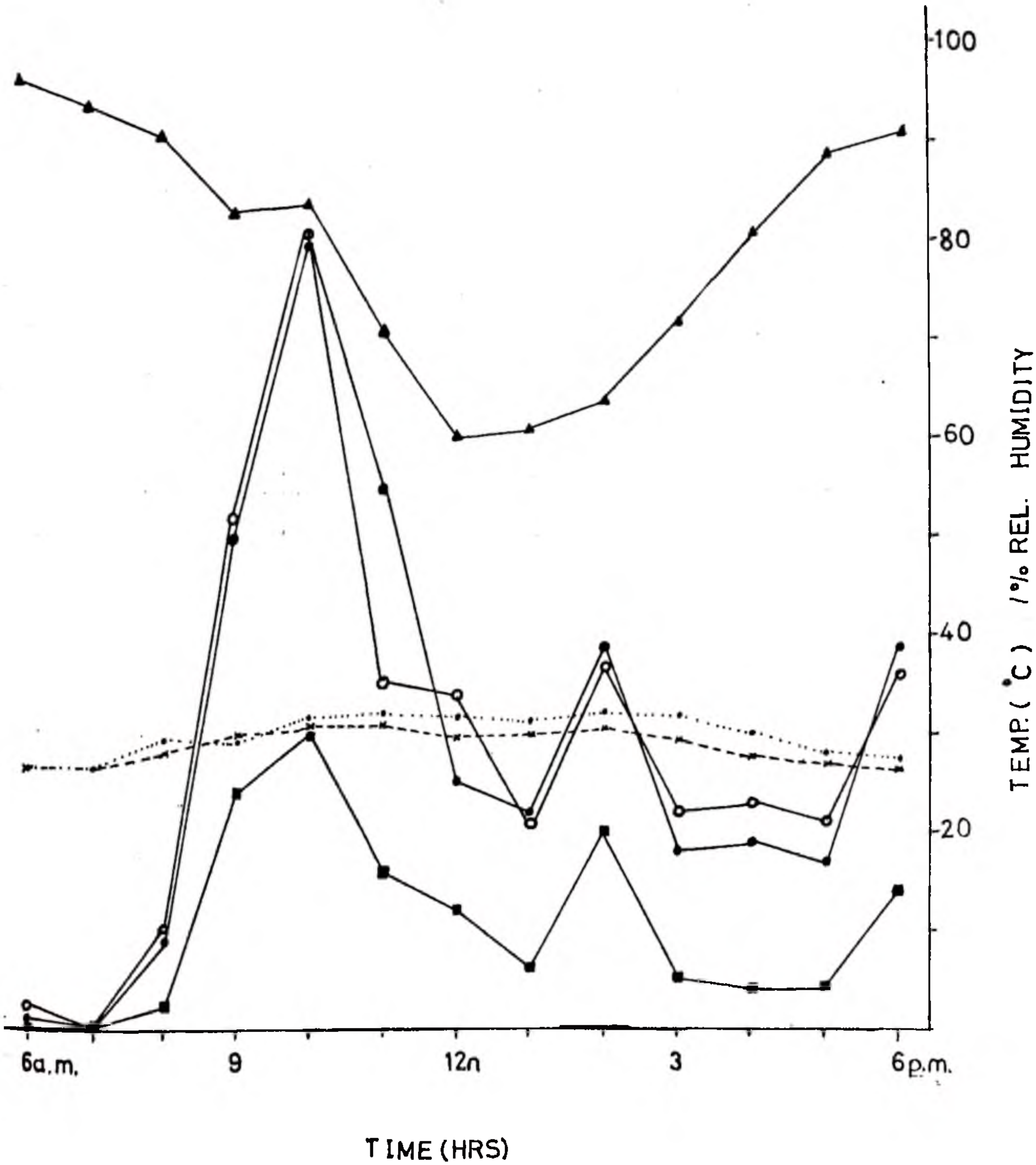


FIG: 36

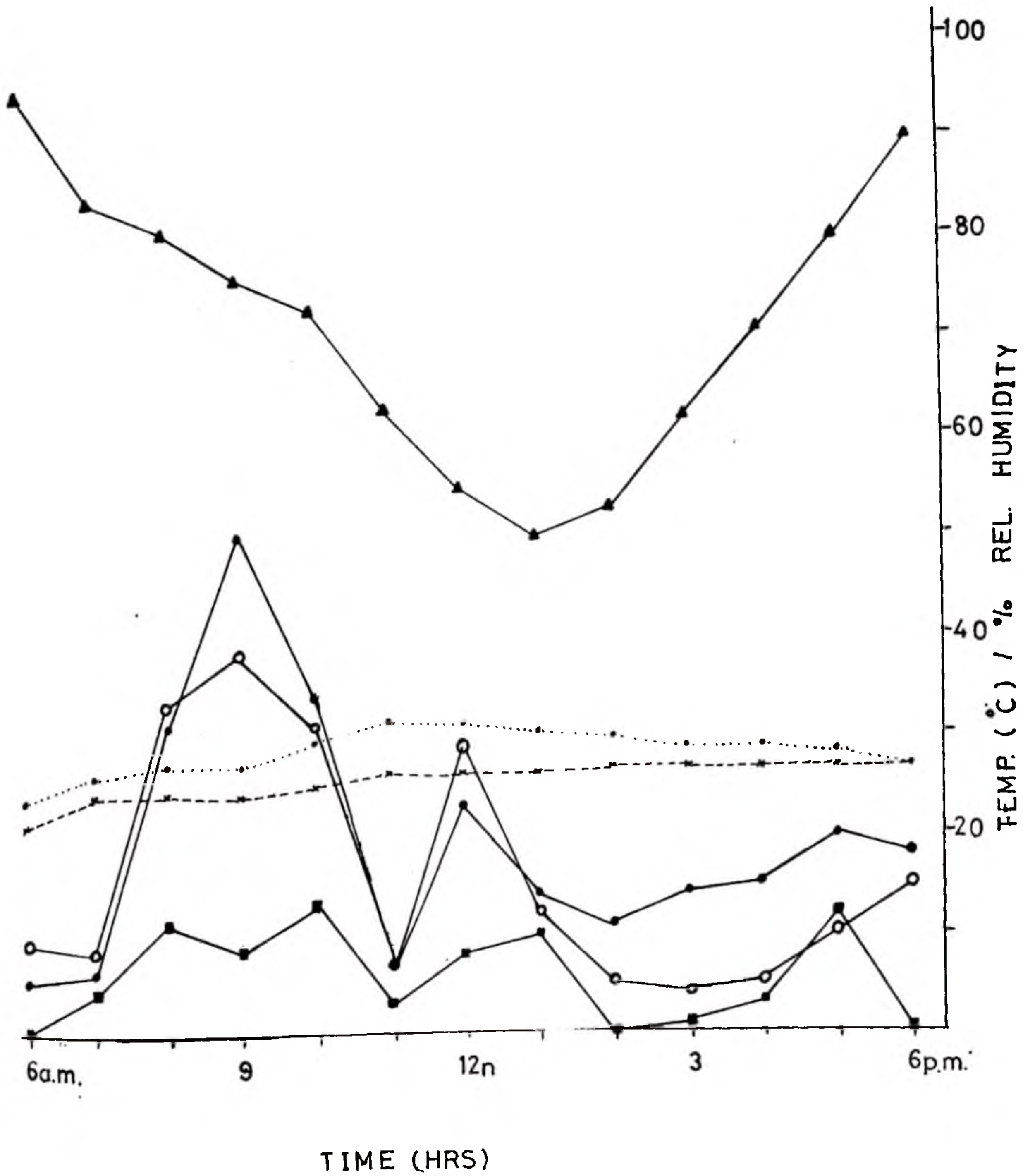
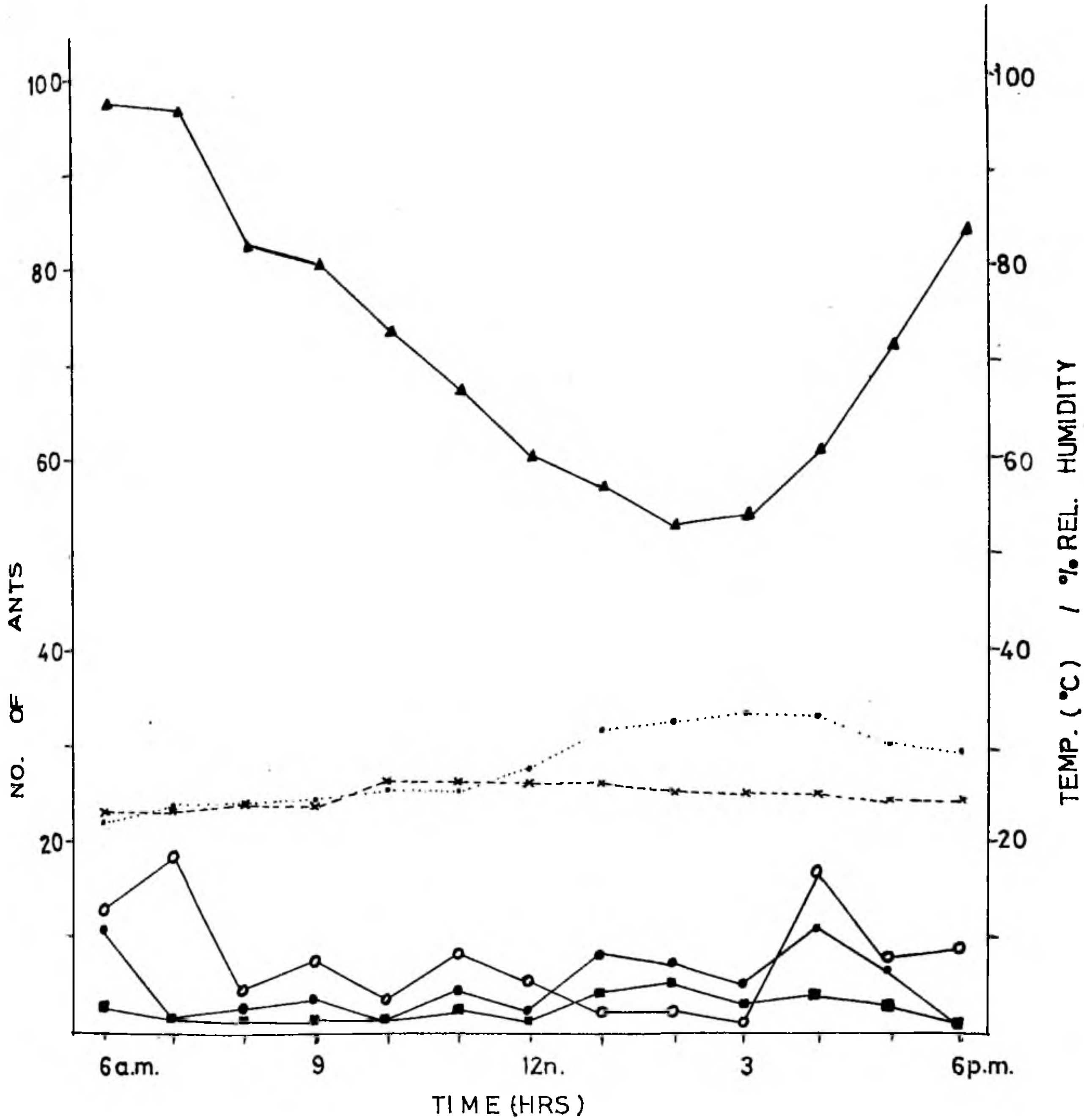


FIG: 37



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NO. OF ANTS
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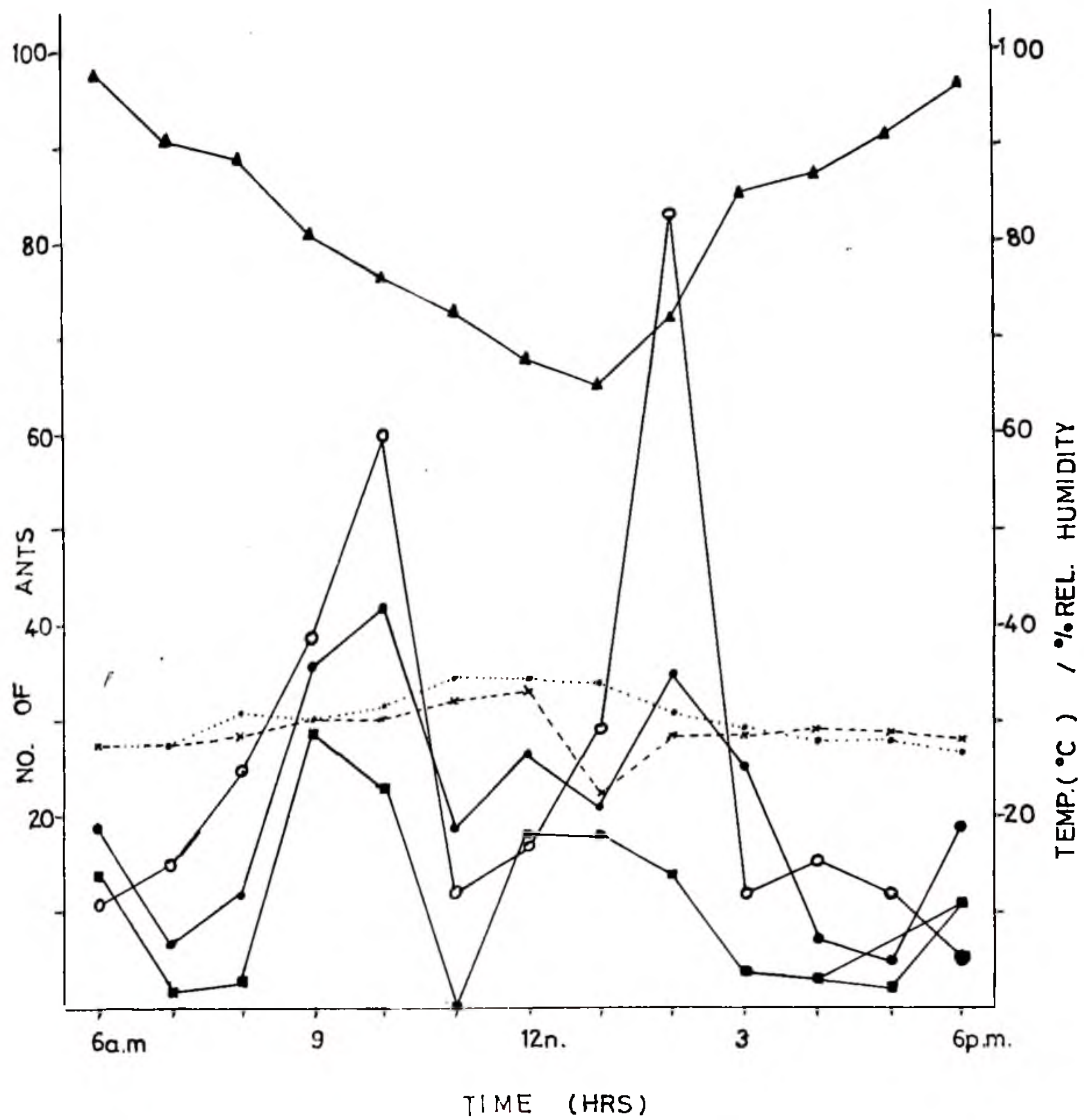
TEMP. (°C) / % REL. HUMIDITY
6a.m.
9
12n.
3
6p.m.
TIME (HRS)

FIG: 38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NO. OF ANTS
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TEMP.(°C) / % REL. HUMIDITY
6a.m
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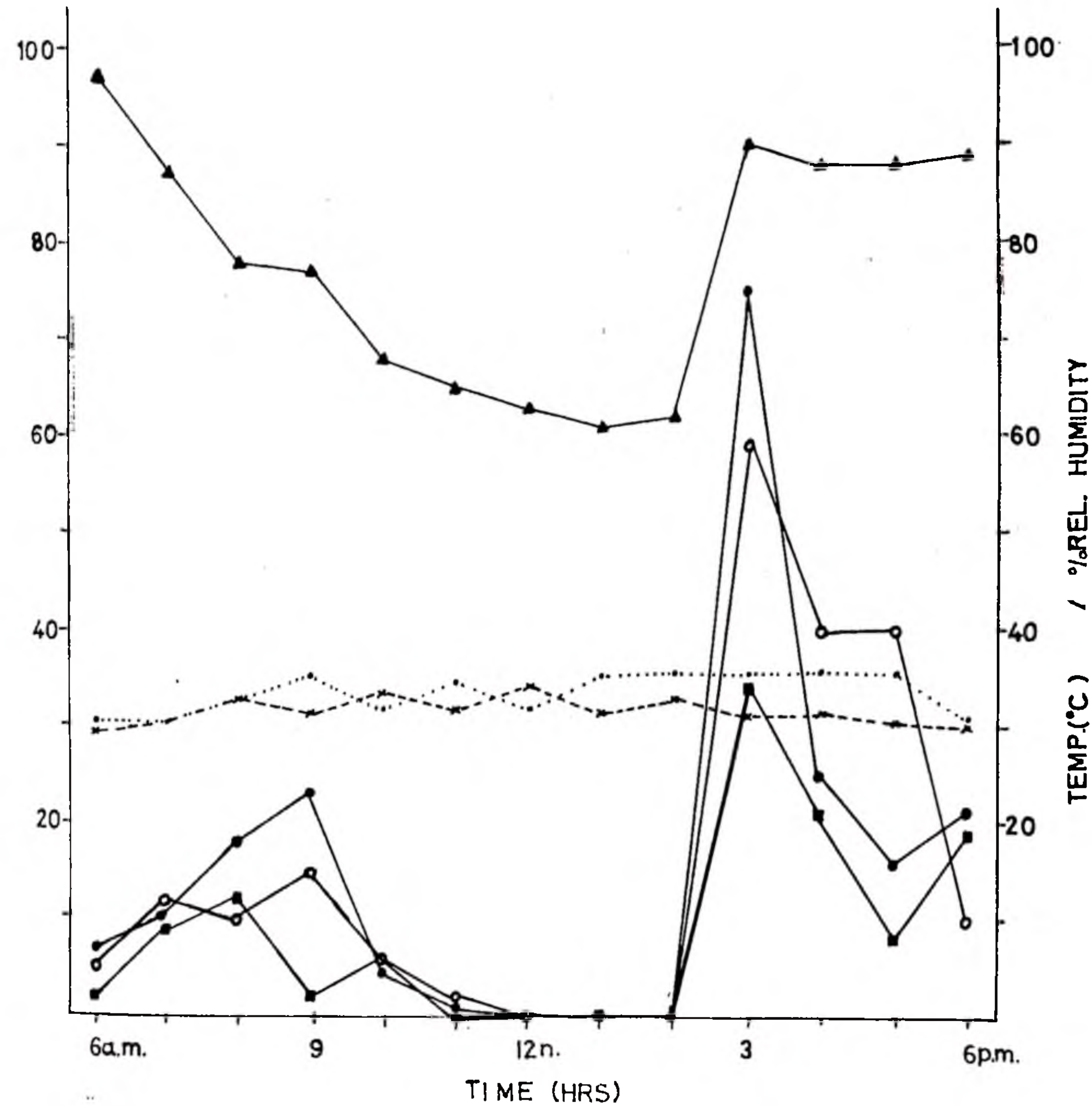
6p.m.
TIME (HRS)

FIG. 39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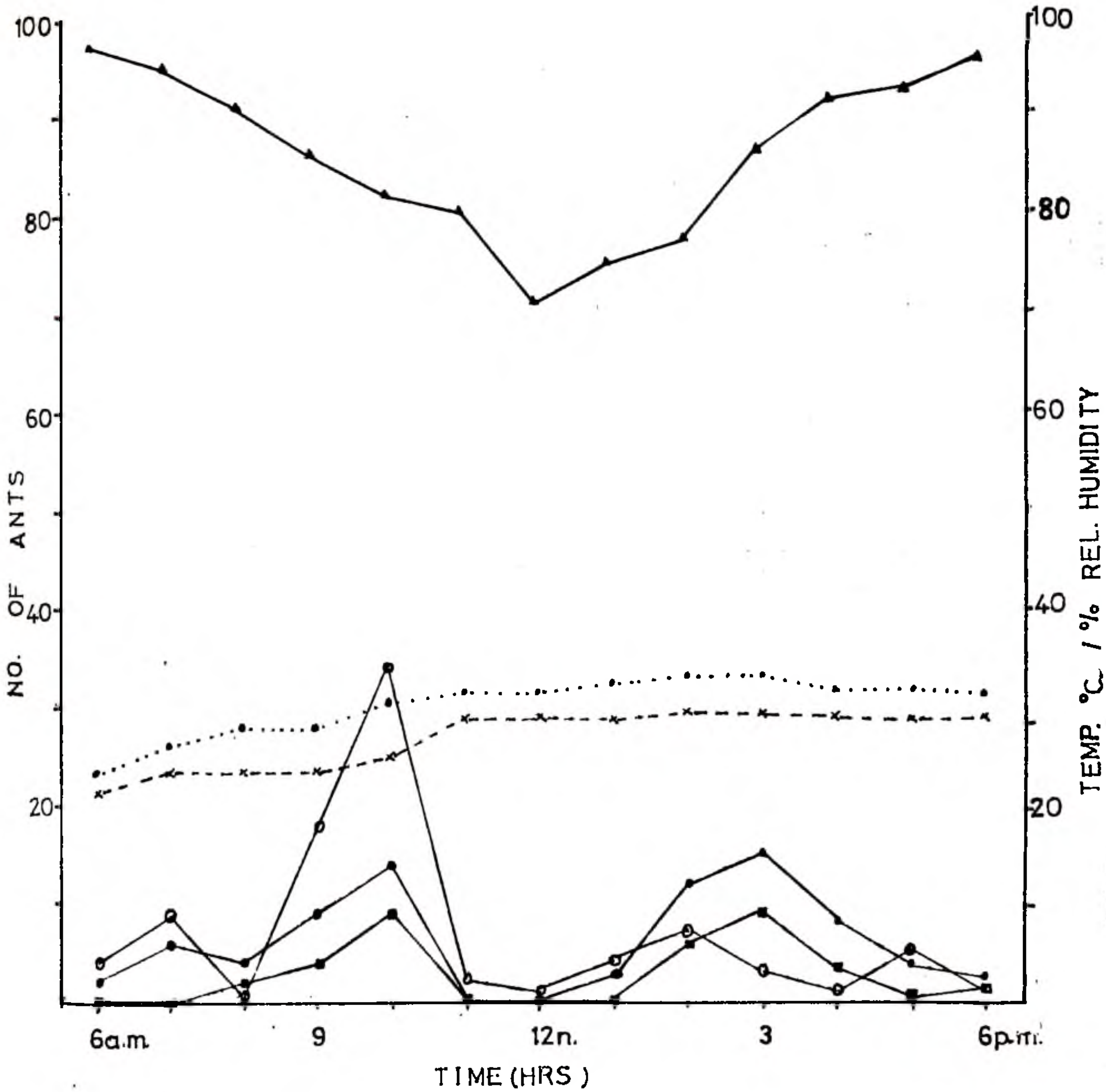
TEMP.(°C) / %REL. HUMIDITY
6a.m.
9
12n.
3
6p.m.
TIME (HRS)

FIG: 40

22-4-77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NO. OF ANTS
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TEMP. °C / % REL. HUMIDITY
6a.m.
9
12n.
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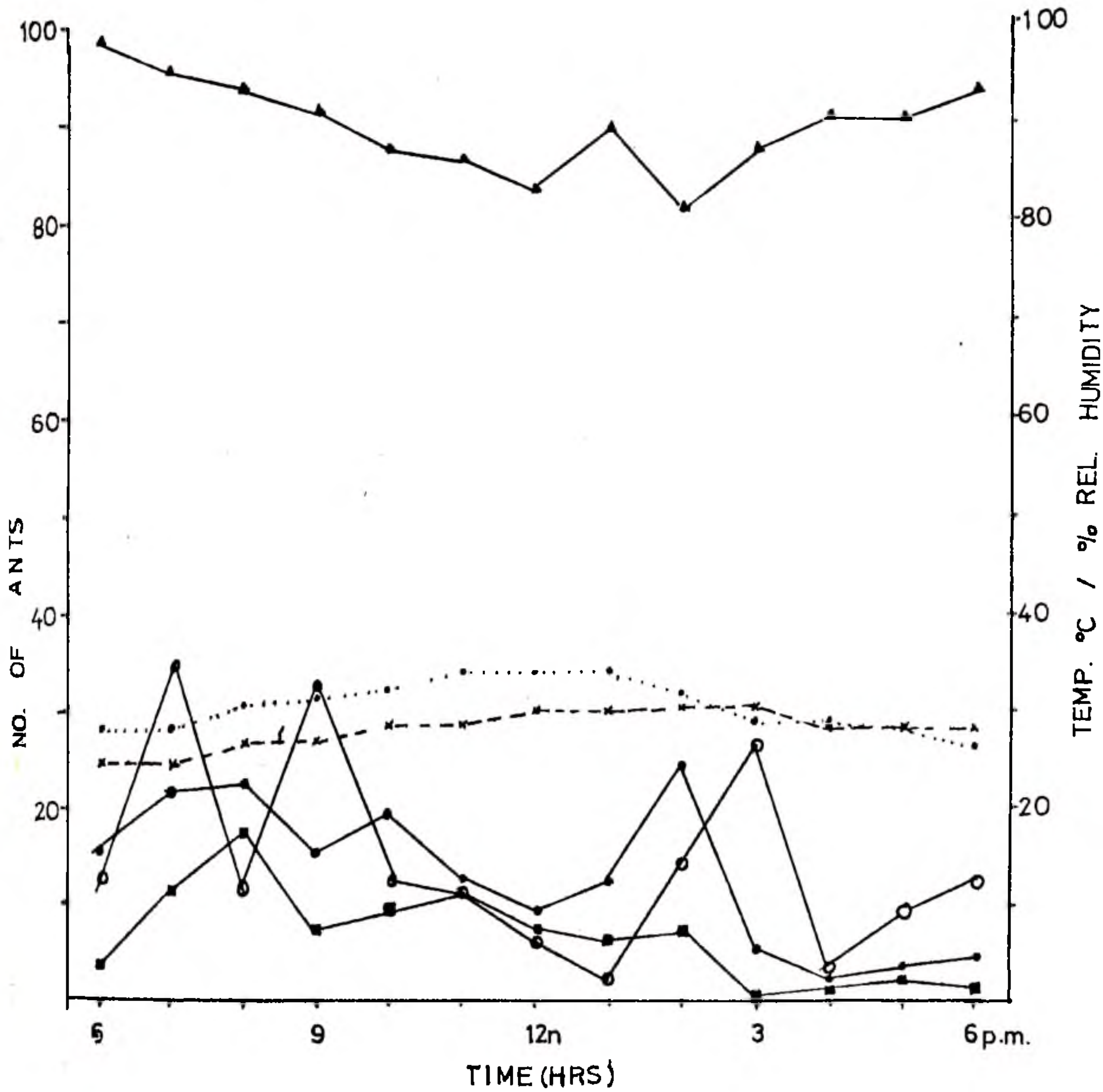
6p.m.
TIME (HRS)

FIG. 41

6-5-77



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NO. OF ANTS
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TEMP. °C / % REL. HUMIDITY
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12n
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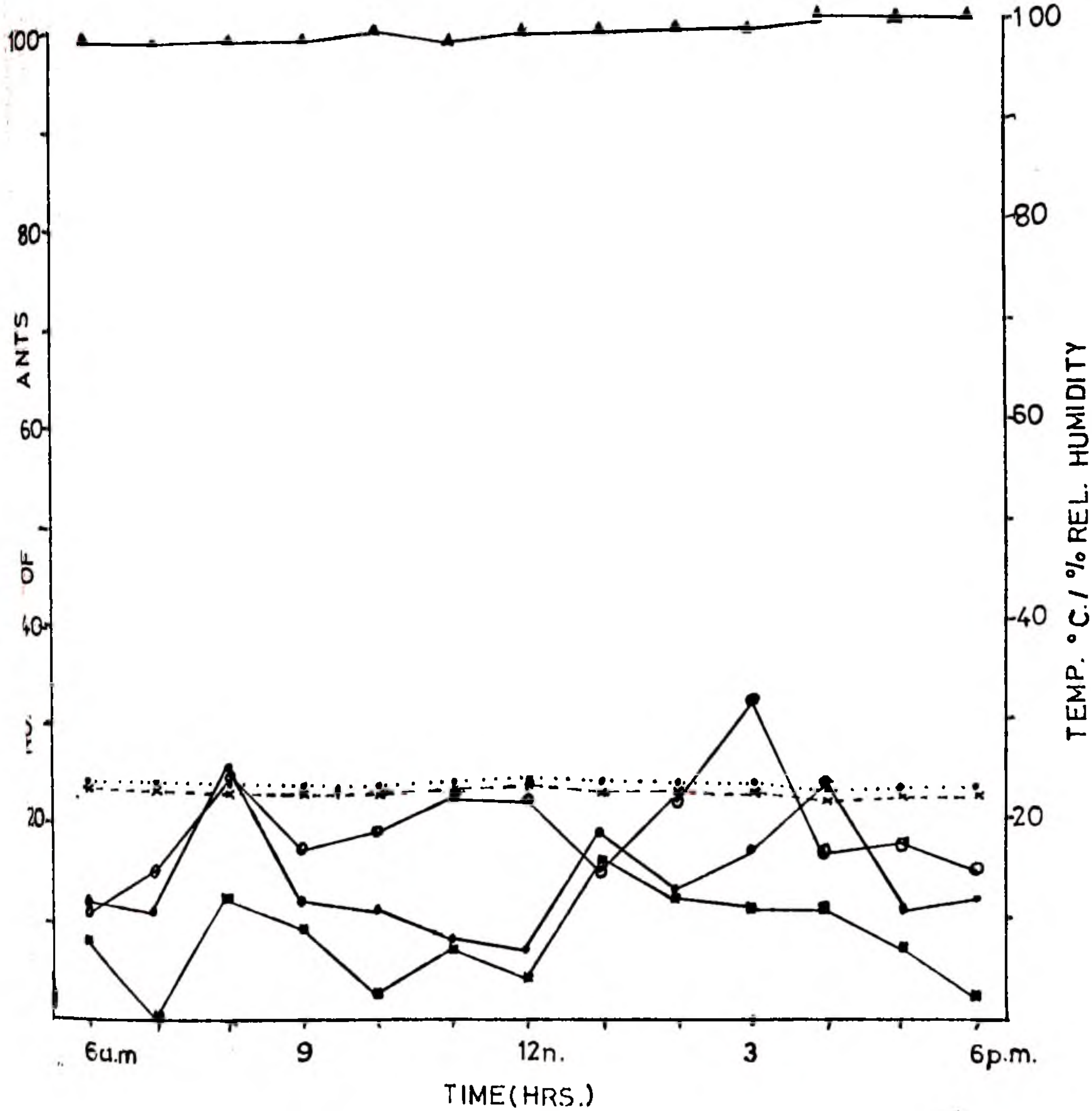
6 p.m.
TIME (HRS)

FIG: 42

17-6-77



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NO. OF ANTS
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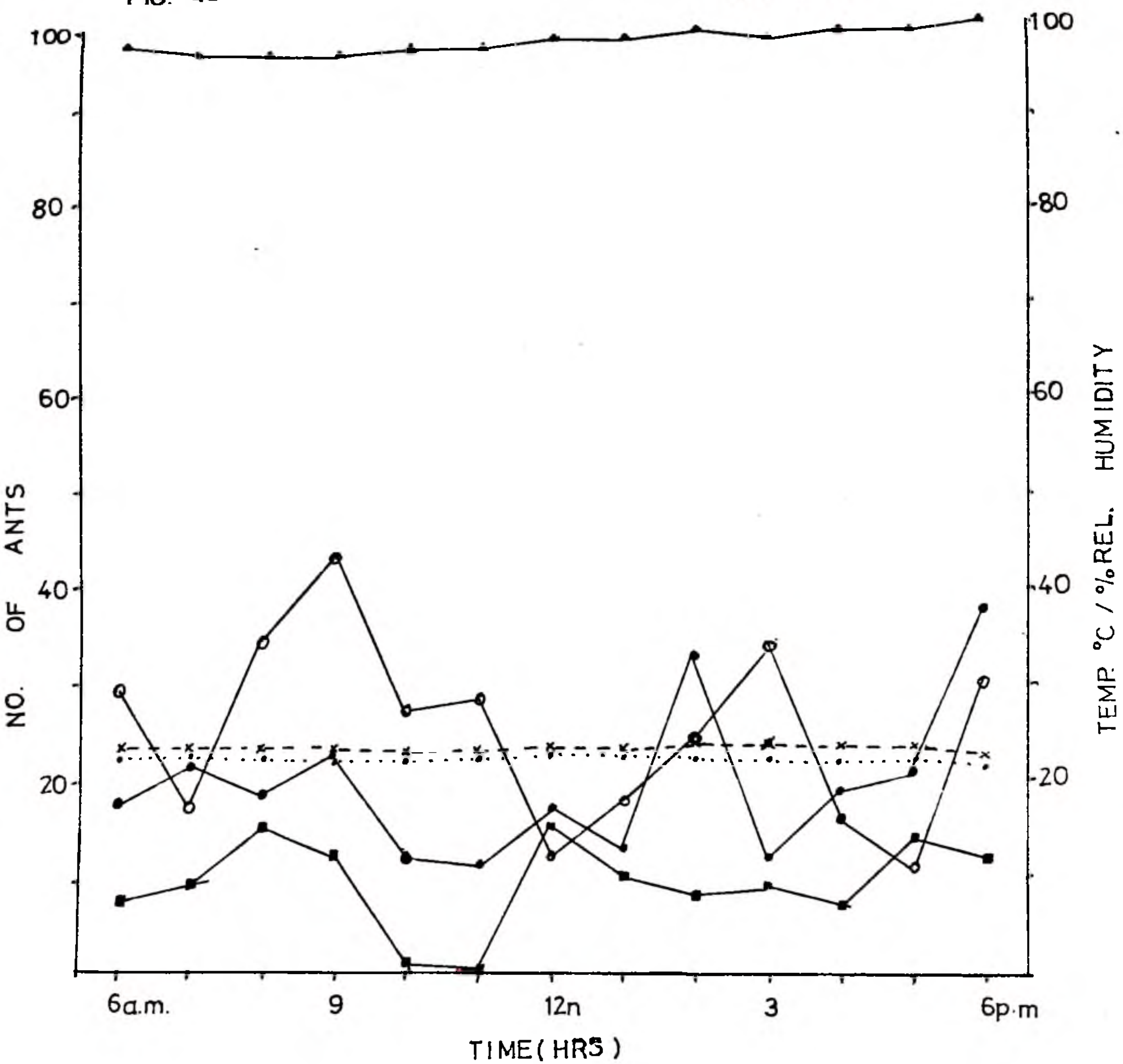
TEMP. °C / % REL. HUMIDITY
6a.m
9
12n.
3
6p.m.
TIME (HRS.)

FIG: 43

26-8-77


100
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NO. OF ANTS
6a.m.
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12n
3
6p.m
TIME (HRS)
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TEMP °C / % REL. HUMIDITY

till about 4 p.m when the activity was resumed. The activities had two peaks but each was so slow and the ants were not seen or were not active with very few just crossing the census point and returning immediately into the nest (figures 32 and 33). On several other days (figures 35,36 and 38), light intensity was high but the ants remained active all day, despite the high temperature and the low humidity (figs 35 and 36) but a careful study of the possible factors indicated that the presence of brood in the nests was high during the same period and this was the probable cause of the increase in activity of the ants. Cloudy days seemed to induce different behaviour patterns as the ants were found to be active all day despite low temperature and high humidity.

(i) Dry season

Activity in the dry season seemed to follow the same rythmn as found on any ordinary days when it was sunny. The activity pattern of the ant did not differ from that found during the ordinary days as shown in figs 32 and 33. These days were characterised by a quick rise in temperature and consequent lowering of humidity (Figs 37 and 38). The number of ants leaving the nests was small in the dry periods. But the ants were active just before 8 a.m and just after 4 p.m. On several occasions, no ants were found leaving or entering the nest at all. This inactivity became very marked during the harmattan when ants were mostly confined to their nests during the mornings and afternoons. There seemed to be no activity at all during the day (Fig 37). This as stated earlier affected the activity of the ants in the night. Temperature, humidity and light intensity also affected the ants but this became marked as the harmattan affected all these factors. On a particular day (25th February, 1977) the ants came out in their numbers despite the harmattan. At 6 a.m as many as 19 ants were found leaving the nest and as many as 14 were carrying food into the nest. Trailing the ants to where they brought the food, the ants were found near a termitarium broken loose by a farmer from which the ants were collecting their food. Food carriers were many which is rather unusual and by 2 p.m, the number of ants that were leaving the nest and those that were entering had doubled. As many as 36 ants entered the nest, 29 (81%) of them carrying food. By 2 p.m, 88 workers and soldiers left the nest and 35 entered, 14 of them carrying food (Fig 38). Similarly, in Fig 43, the ants were active all day but on this day, it was observed that humidity was slightly higher and the activity was also high due to the presence of a food source.

(ii) Wet season

During the wet season, activity pattern was different in that rainfall became another environmental factor that affected the ants. On 11th March, 1977, the day was cloudy at 10.00 a.m. and a heavy rainfall followed around 12 noon.

The ants were not found coming out and none left the leaves into the nest but moved to the lower surface of the leaves. For a period of 2 hours of rain, the ants stayed out, keeping themselves under the leaves on which they were foraging. Just after the rain, the ants began moving towards the nest and others moved to the upper surface of the leaves to forage. The ants became active soon after this (figure 39). Figure 34 shows another day when rainfall in the night was followed by a quick rise in temperature and lowering of humidity due to high intensity of light in the early morning. The rain stopped by 6.30 a.m. in the morning but the ants became active the whole day until 4.00 p.m and their activity rose again after 6.00 p.m.

6.3.1.2 Night activity

The night activity of Camp.acvapimensis followed a different pattern from that of the day time. On most days, the activity pattern of the previous day continued late into the night and sometimes ended by 8.00 p.m (figs 44 - 48). The ants became active again at about 9 or 10 p.m. The period between midnight and 1 a.m was the time for nest cleaning. During this period, the ants were found bringing out pieces of sticks, straw, food particles and soil and depositing such items a few centimetres from the entrance of the nest. On days that the number of larvae and brood were found to be high in the nests, the ants were observed to be active all night. Peaks of such activities did not follow any rythmn

FIG: 44

28-10-76

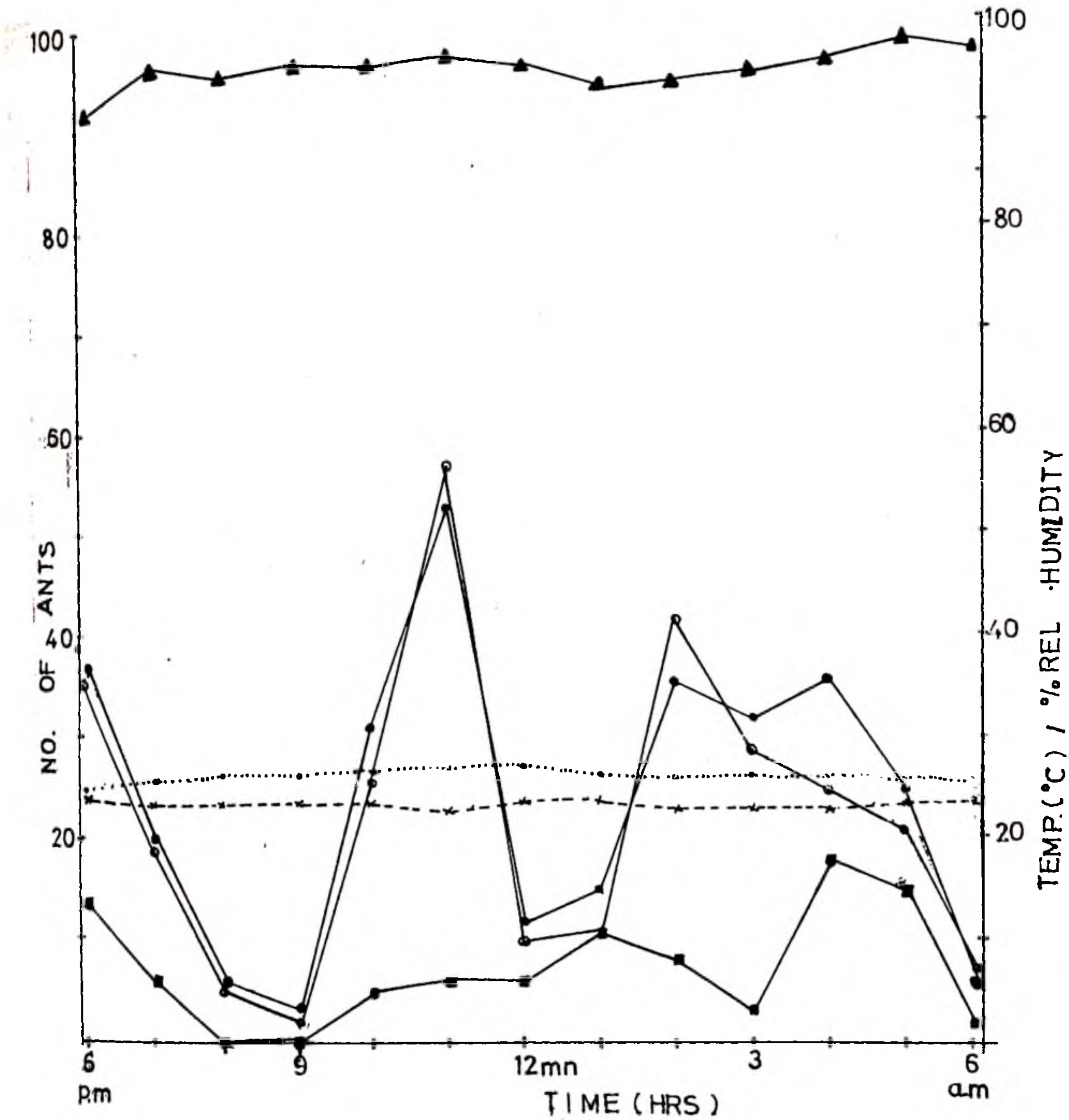


FIG: 45 11-11-76

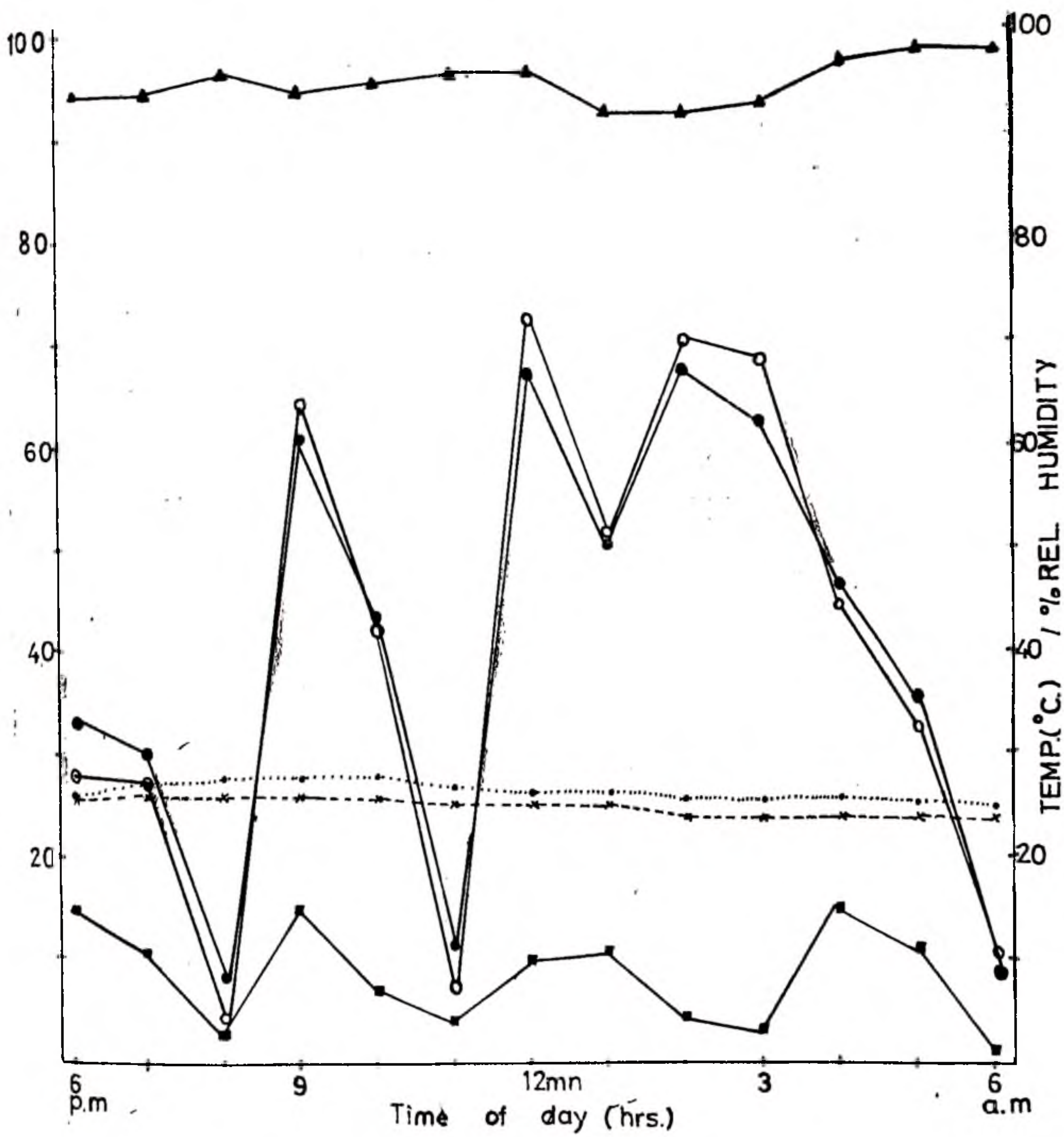


FIG: 46

25-11-76

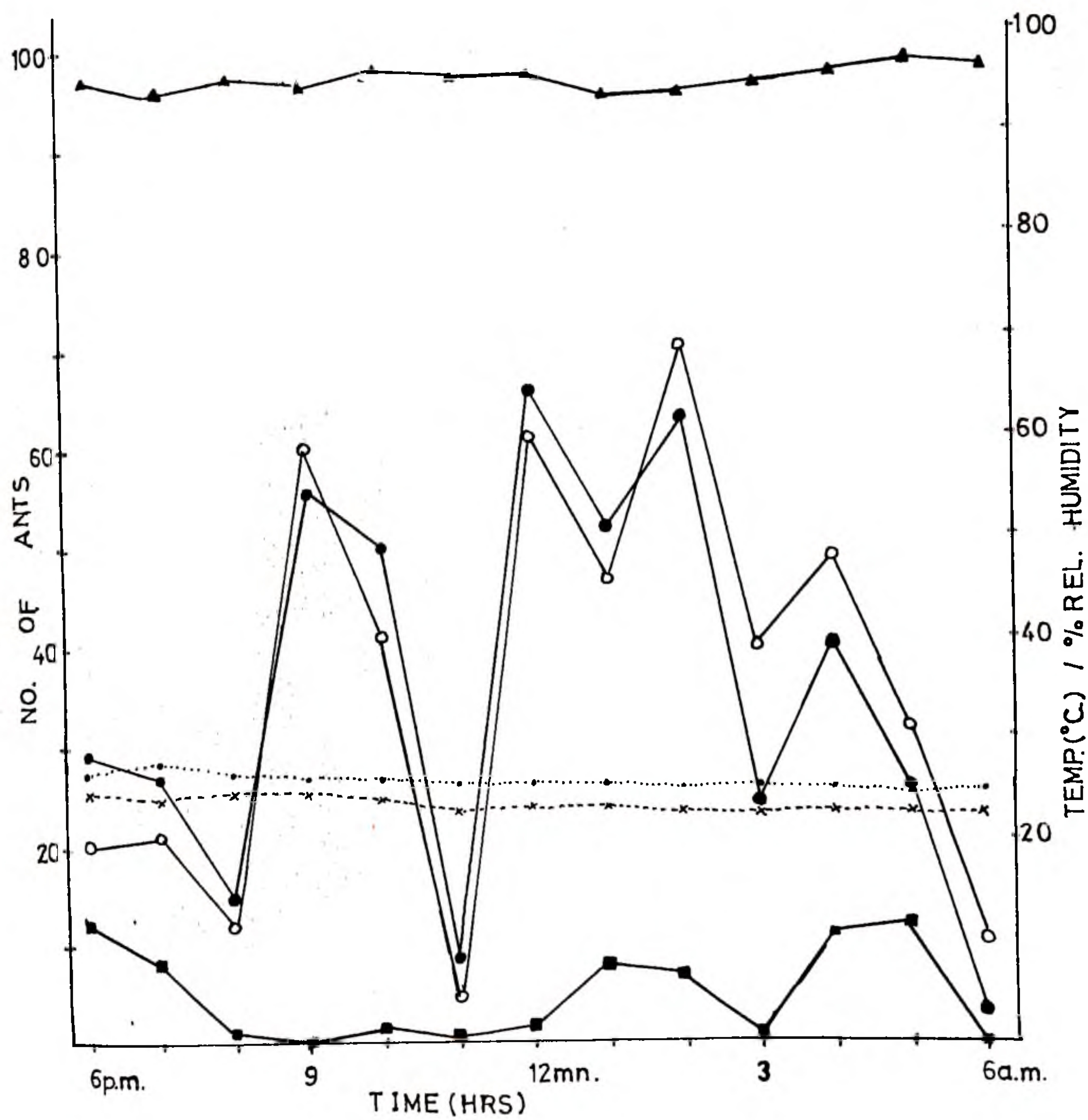


FIG: 47 23-12-76

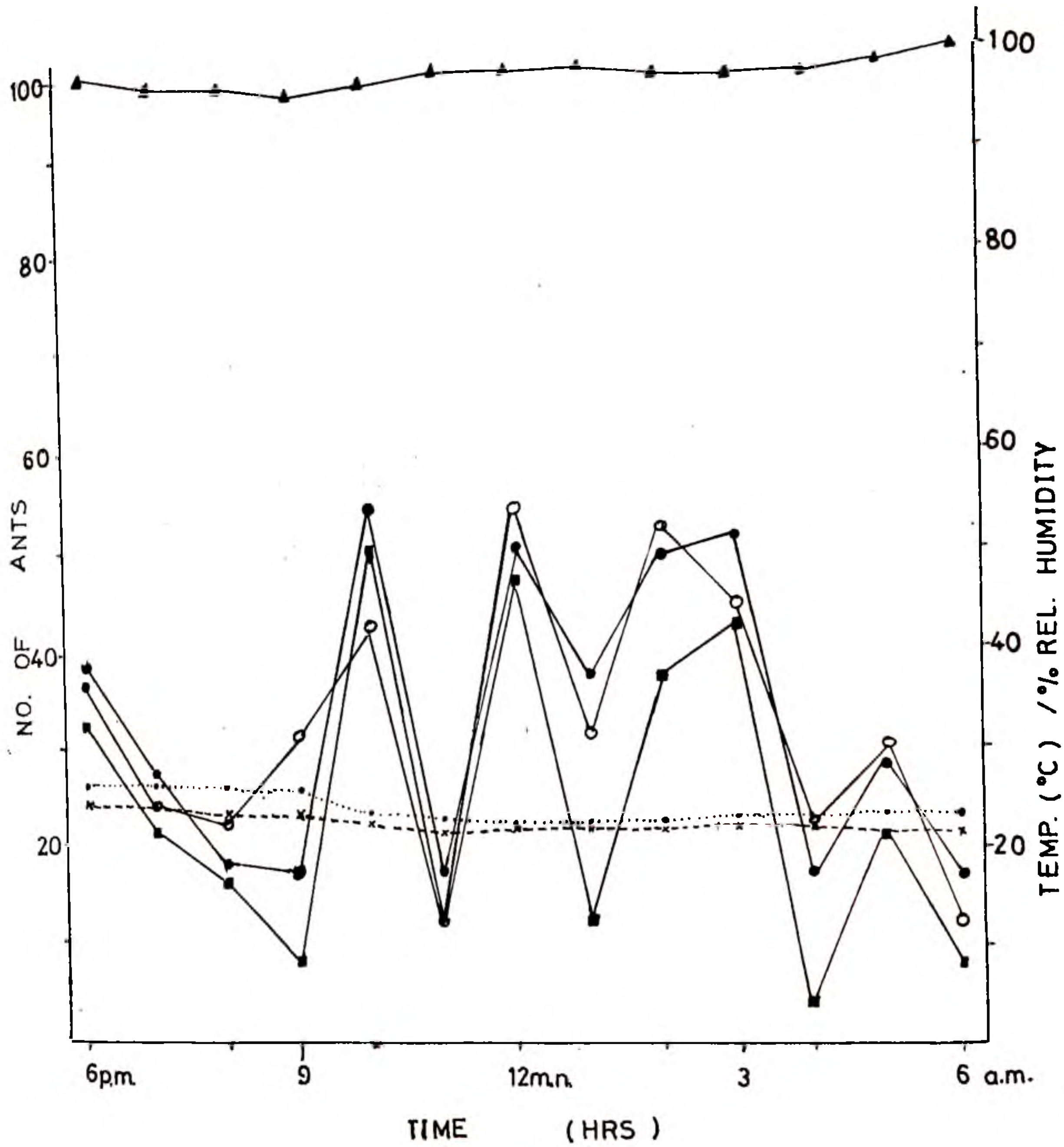
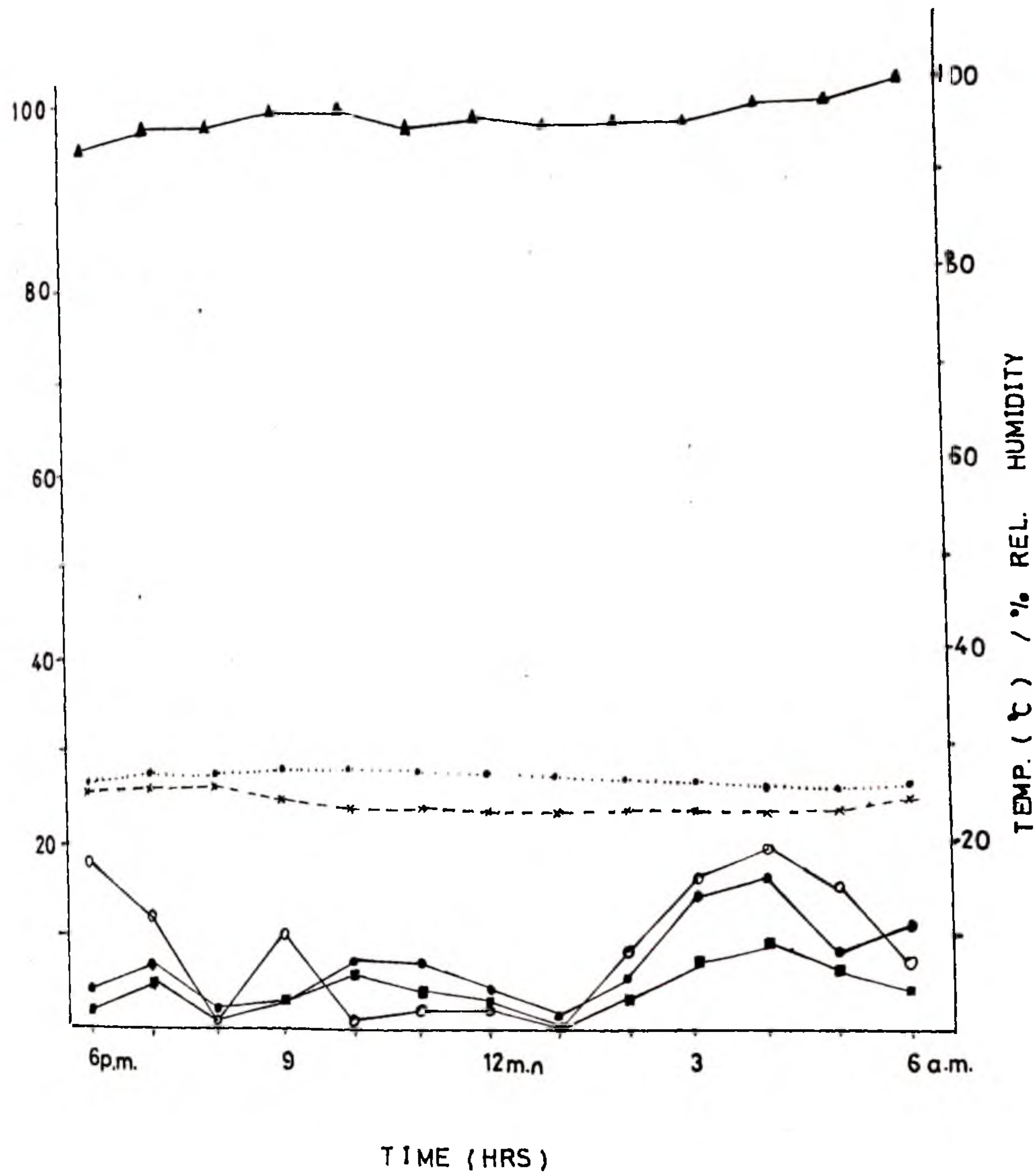


FIG: 48 20-1-77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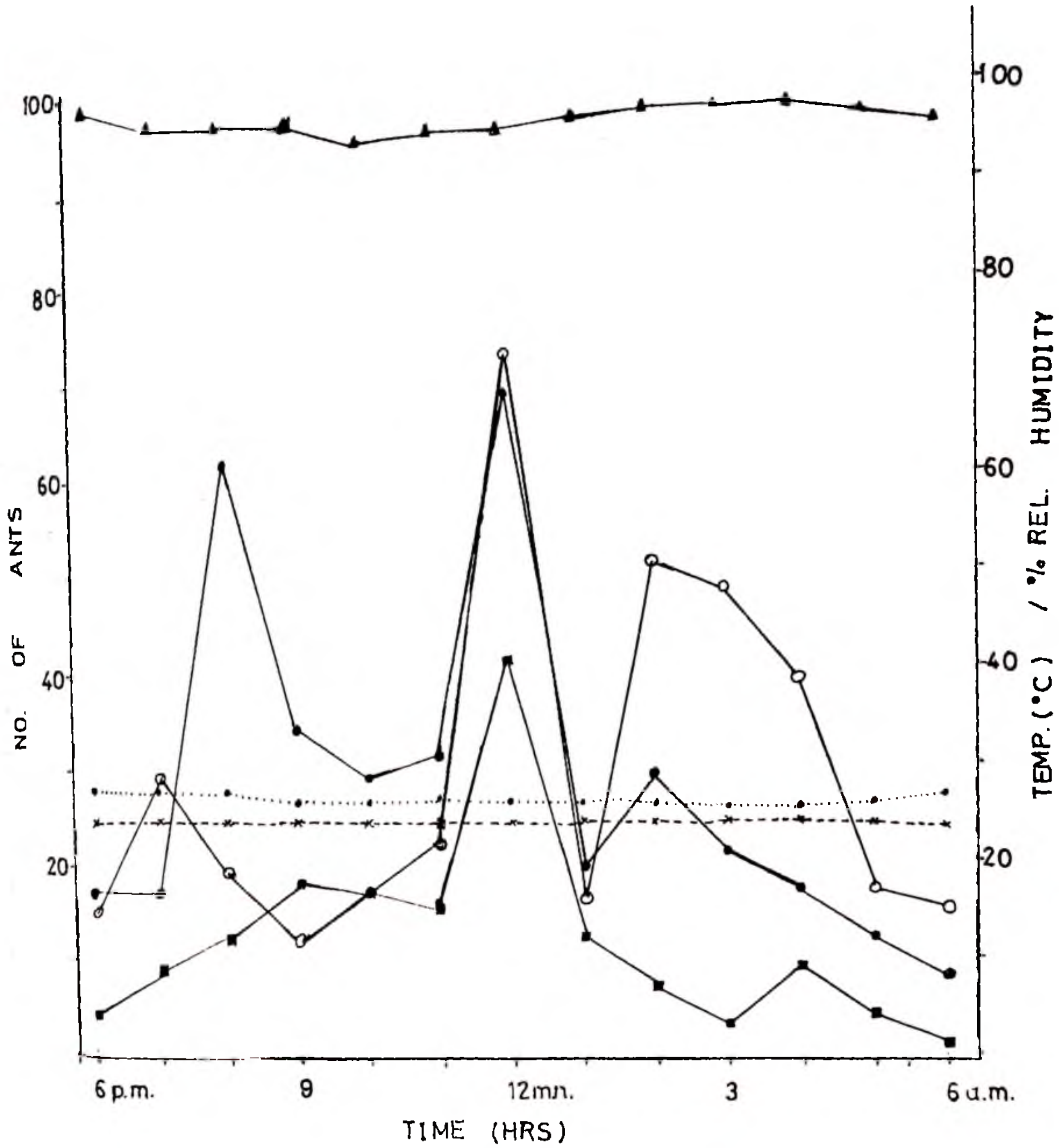
TIME (HRS)

FIG :4 9 4-2-77



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TEMP. (°C) / % REL. HUMIDITY
6 p.m.
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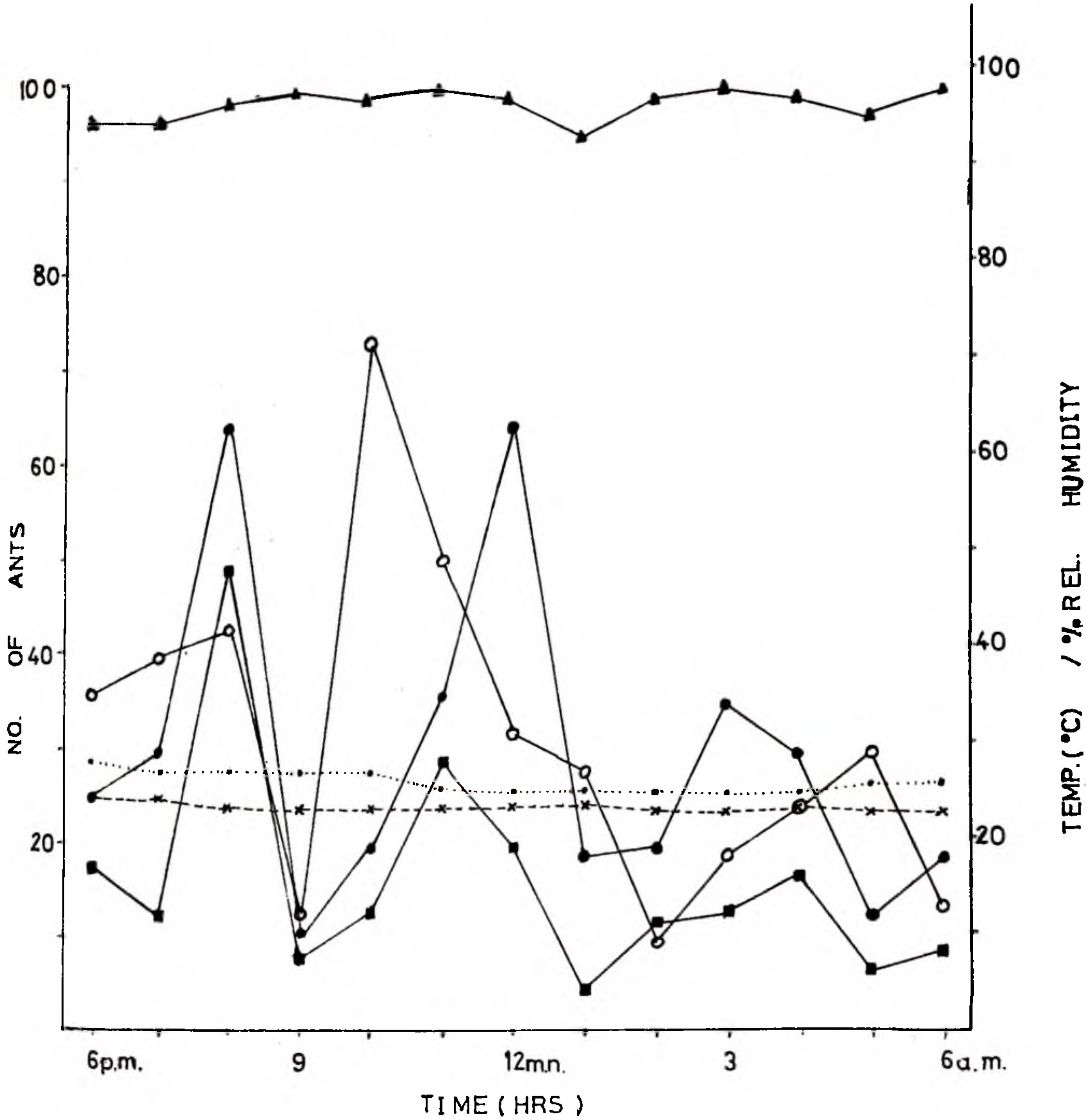
TIME (HRS)

FIG: 50

18-2-77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NO. OF ANTS
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TEMP. (°C) / % REL. HUMIDITY
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12m.n.
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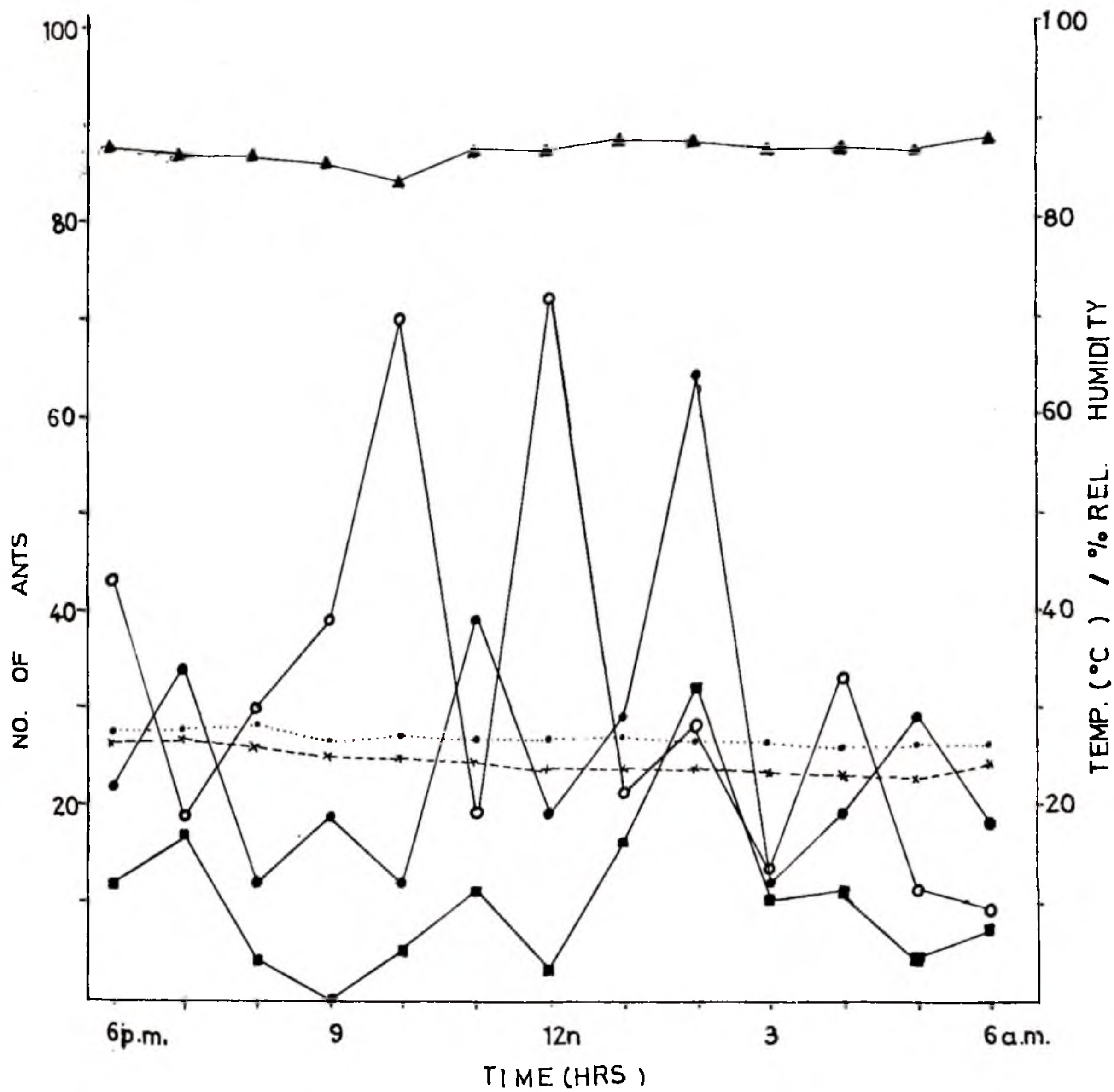
6a.m.
TIME (HRS)

FIG: 51

4-3-77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NO. OF ANTS
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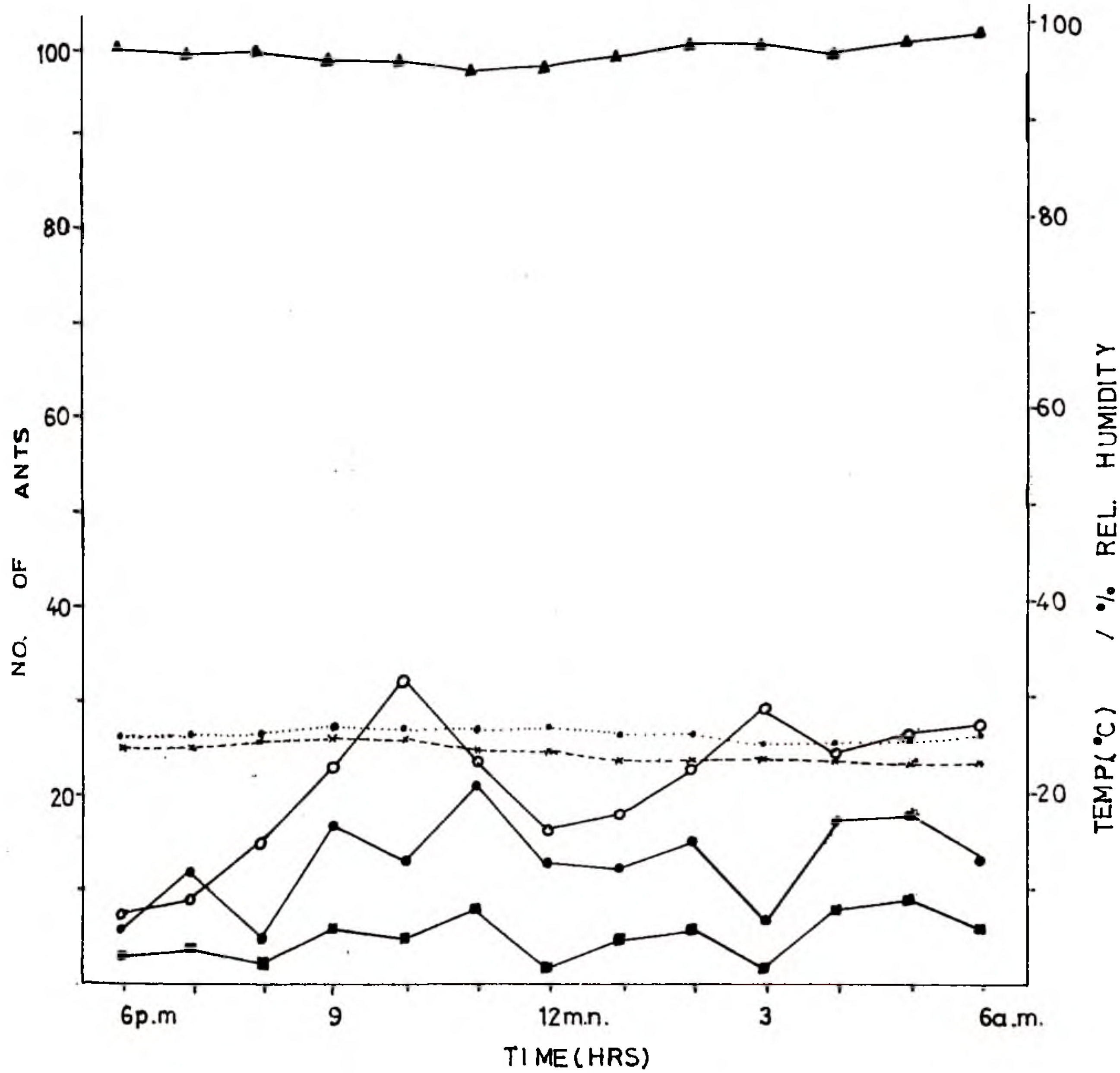
TEMP. (°C) / % REL. HUMIDITY
6p.m.
9
12n
3
6a.m.
TIME (HRS)

FIG: 52 30-4-77



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NO. OF ANTS
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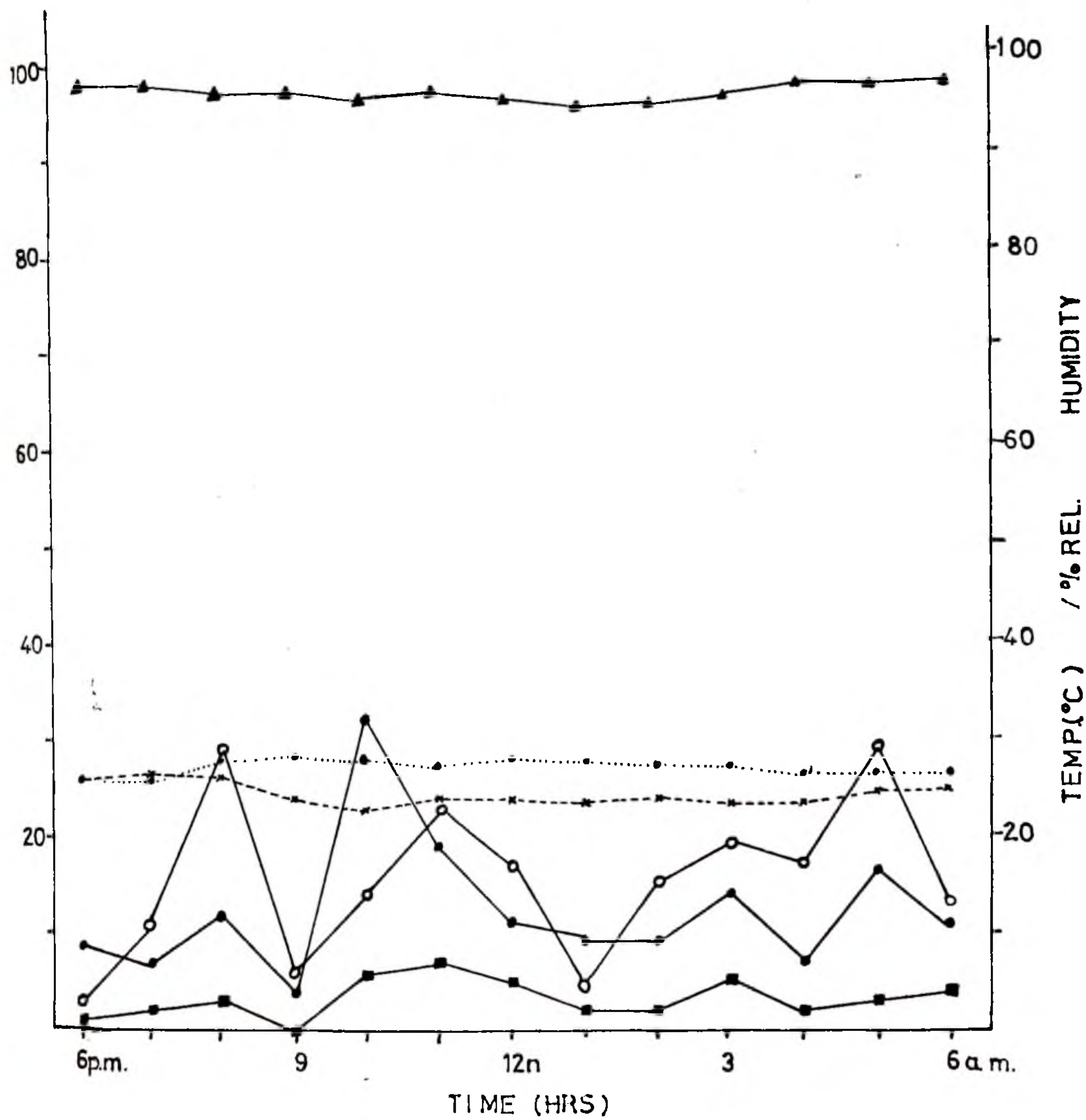
TEMP(°C) / % REL. HUMIDITY
6p.m
9
12m.n.
3
6a.m.
TIME(HRS)

FIG: 53 14-5-77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TEMP(°C) / % REL. HUMIDITY
6p.m.
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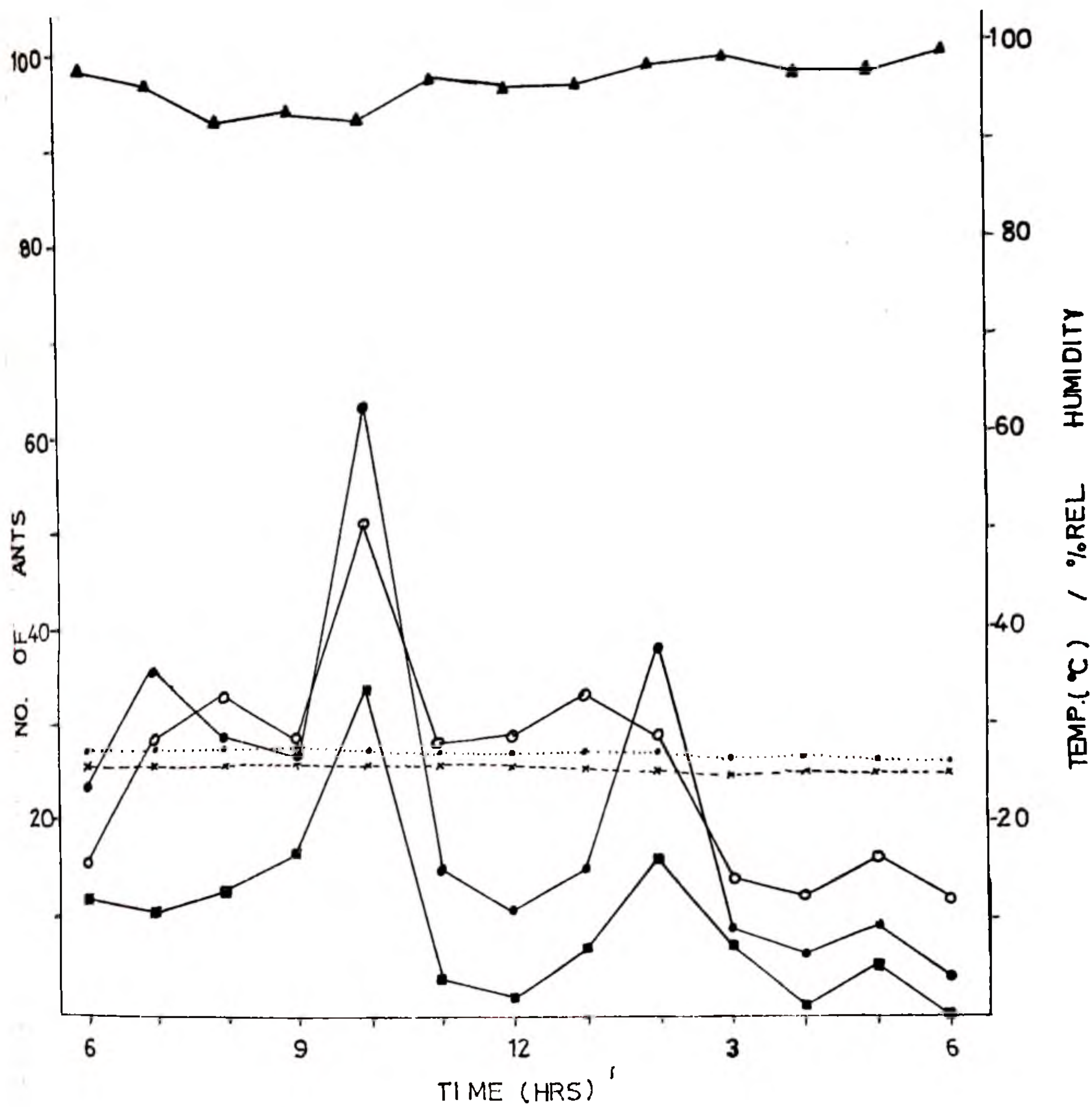
12n
3
6 a.m.
TIME (HRS)

FIG: 54 28-5-77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NO. OF ANTS
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TIME (HRS)
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TEMP.(°C) / %REL HUMIDITY

(figs 47, 49, 50 and 51). On some such days (figs 47 and 51), as many as 4 peaks of activity were observed and they did not follow any rythmn. On certain days only 3 peaks of activity were recorded (figs 49 and 50). Some of the night activities were observed to be influenced by the presence of the brood (Figs 47 and 49 - 51), the activity pattern of the worker caste and to a lesser extent the soldiers. The findings on 25th December, 1976 indicated that as many as 293 larvae and 192 pupae were found (table 13) and the corresponding activity pattern was marked (Fig 47). On 18th February, 1977, as many as 415 larvae and 558 pupae were recorded from a nest (table 13) and this was found to have influenced the corresponding activity pattern in the nest under study (Fig 50). In this figure, many ants left the nest and many ants entered at any particular time which is higher than the normal activities found in the ants. Similar other recordings were made and are presented in figure 51. On certain days the ants were observed to be inactive all night. A close study of table 13 shows that there were only 9 larvae and 67 pupae which is by far very low as compared to the brood found on days that the ants were active. Figure 48 shows that the ants were not as active as compared with nights such as in figure 47. The number of soldiers and workers recorded as foragers was few.

Rainfall in the night seemed to have affected the activity of the ants but the effect was not as marked as that found during the day (Fig 39). On a day when there was drizzling in the night (Fig 52), the ants were active but comparatively less active than the days without rain. On another day (fig 54) however, the rain started at 11 p.m and the activity of the ants dropped and the ants became active again when the rain stopped. On 30th April, 1977, the percentages of larvae and pupae were high but the rains caused inactivity (fig 52).

.3.2 Induced activity

Observations listed above suggest that the activities of the ants were affected by the presence of brood, availability of food source, rainfall and the other factors such as temperature, light intensity and humidity.

.3.3 Foraging space and distance

The ants were found to travel over long distances in search for food and to forage on leaves. Recordings showed that the ants moved or covered different distances in the dry and wet seasons (table 15).

(a) Wet season

During the wet season, the ants were found to travel longer distances to forage. On plot A, some ants went very far from their nests to forage and some even went into the other plot B to forage on the cultivated plants such as cassava and corn. The others foraged within the savanna area

Table 15a: Foraging distance (radius) and space of *Camp.acvapimensis* on plots A and B in the wet season

PLOT A			PLOT B		
Nest	Radius (distance) (metres)	Foraging Space (sq.metres)	Nest	Radius (distance) (metres)	Foraging Space (sq.metres)
25	21.2	1412.5	30	7.3	167.5
26	29.8	2791.0	31	4.9	75.5
27	35.3	3916.3	32	11.5	415.6
28	16.4	845.3	33	15.6	764.9
29	23.4	1720.9	34	22.9	1648.2
TOTAL	126.1	10686.0		62.2	3071.7
MEAN	25.2	2137.2		12.4	614.3

Table 15b: Foraging distance (radius) and space of <u>Camp.acvapimensis</u> on plots A and B in the dry seasons.

PLOT A			PLOT B		
Nest	Radius (distance) (metres)	Foraging Space (sq.metres)	Nest	Radius (distance) (metres)	Foraging Space (sq.metres)
25	26.2	2157.4	30	9.2	266.0
26	39.4	4878.9	31	7.4	72.1
27	31.4	3098.7	32	8.6	232.5
28	19.4	1182.9	33	17.3	940.6
29	21.8	1493.6	34	18.9	1122.7
TOTAL	138.2	12811.5		61.4	2733.9
Mean	27.64	2562.3		12.28	546.8

where a canopy was formed by the climbers in this area. The numbers found foraging on the grasses were very few. Table 15 a & b)indicates that these ants travelled far from their nests as compared with the ants on plot B. The mean distance that the ants travelled from their nest was 25.2 metres and the foraging range or space was 2137.2 sq. metres. Generally, the ants on plot A were found to forage within a larger range. A comparison with the results on plot B indicates that the ants on plot A covered longer distances during foraging. On plot B, the ants were mostly found to move from their nests onto the cultivated plants that were near the entrances to their nests. Very few ants travelled longer distances and most were found in the savanna areas where they were found foraging and collecting seeds. The mean distance covered by the ants was 12.4 metres and the foraging space 614.3 sq. metres. In the wet season, the ants were found to be active but those in the farm lands plot B had most of their activities confined to their immediate surroundings. Those on plot B moved directly onto the plants on which they tended the aphids and Homoptera whilst few left for the grassland to collect seeds of certain grasses. It was observed that the ants covering long distances on the ground had a second nest elsewhere or they moved onto specific plants on which some species of Camp.acvapimensis were already foraging. The ants found on plot A were found visiting plot B for foraging but those on plot B rarely went to plot A. Ants having their nests in areas with a lot of cassava plants were those that covered longer distances from their nests. The ants nesting in areas with corn rarely moved more than 4 metres from their nests since most of the plants on which they foraged were found in the immediate vicinity.

6.3.4 Ants - phytophagous insects relationship

Certain types of sap-feeders were tended by Camp. acvapimensis. These were Homoptera, aphids, larvae of stem boring beetles and coccids. The other association found were unimportant and occurred between the ants and scale insects (table 16). The ants were found to exhibit two types of association:

(a) Facultative associations - This type of association existed between the ants and the aphids, Aphis nerii Fonsc. The ants were found to collect honey dew from these insects. The aphids occurred on the bare surface of the leaves on which they fed. The ants usually spent only a few minutes around one aphid at a time. On several days, the aphids were left unattended by the ants. The ants exhibited similar relations with the scale insects that were found attached to stems of grasses. The time spent with the scale insects was quite short.

With the Coccid, Pulvinaria sp. Boh., found on cassava, the ants visited the coccids once a while and never spent more than 30 seconds with a coccid excepting in rare cases.

With the Pseudococcidae (*Dysmicoccus breuipes* (Ckll.), *Phenacoccus madeirensis* Green and *Ferrisia virgata* (Ckll.) the association was very passive.

(b) Obligate associationship - This was only found on plantain and corn and was so considered because the ants were beneath sheaths serving like tents to protect the sap-feeders that they tended. In some cases, the ants sealed the opening left with soil. Such an association existed between the ants and the larvae of the beetle *Carpophilus fumatus* Boh. which fed on the stems of corn and also the aphid *Pentalonia nigronervosa* Coq. on plantain suckers.

6.3.5 Food items collected by ants

The ants were found to be moving on almost all plants in their foraging space but were found to spend more time on certain species especially *Zea mays* (Corn), *Musa* spp. (Plantain and Banana), *Euphorbia tirucalli*, Cocoyam and *Solanum melongena*. On certain plants they were only found when such plants had sap-feeders on them (table 16). On certain plants such as *Zea mays*, their activities caused markings on the leaves as areas constantly gnawed became pale green and later whitish. On *Euphorbia tirucalli*, the ants were found on the floral parts and spent several minutes on them moving from one flower to the next. Their presence on *Musa* spp. was mostly for tending aphids and Homoptera that were found on these plants.

When the ants were sprayed and prevented from visiting the sap-feeders, a few were affected. Information on this is provided in table 16. On *Solanum melongena*, the ants collected floral parts mainly petals, pollen grains or anthers and sometimes excreta from the Tingid *Urentius hystricellus* (Richter).

6.3.7 *Food items*

These ants were observed to collect insects as food items into their nests. The greater number of insects collected were termites, mostly *Microtermes* spp., when the nests of such termites were destroyed by farmers or other environmental factors. Parts of other insects such as wings of butterflies, seeds of grasses, excreta from aphids and larvae of certain beetles formed the bulk of the food that the ants carried into their nest. On certain plants such as *Euphorbia turicalli*, the ants collected nectar. Examination of the gut contents of ants that spent hours on this plant revealed the presence of a solution which was similar to the secretions that the plant produced. Other food items that the ants were found collecting were the anthers of corn and the floral parts of *Solanum melongena*. Parts of the stem of corn and other plants are usually found gnawed by the ants but it is not known if these were used as food or for building of tents over sap-feeders.

Table 16: Plants on which ants were found foraging (damage and materials collected)

Scientific name	Common name	Part of plant foraged	Damage and materials collected
Panicum maximum L.	Guinea grass	Leaves and seeds	seeds collected
Zea mays L.	Corn	Leaves and under sheaths	leaves discoloured honey dew from insects
Euphorbia turicalli L.	Milk weed	Inflorescence	nectar
Manihot esculenta Crantz	Cassava	Leaves	honey dew
Musa sapientum L.	Banana	suckers	honey dew
Musa paradisiaca L.	Plantain	suckers	honey dew
Azadirachta indica Allioni	Neem	leaves and fruits	juice from fruits
Mangifera indica L.	Mango	leaves and fruits	juice from fruits
Solanum melongena L.	Egg plant	leaves and flowers	petals and anthers
Capsicum frutescens L.	Pepper	stems and fruits	honey dew
Cucumis sativus L.	Cucumber	leaves and fruits	tending aphids (honey dew)
Passiflora foetida L.	Passion flower	leaves and flowers	no damage
Boerrhaavia diffusa L.		leaves	no damage

Table 17: Monthly catches of alates of *Camp.acvapimensis*

MONTH	MALES	FEMALES	TOTAL
September, 1976	14	6	20
October,	15	3	18
November	4	0	4
December	1	0	1
January, 1977	0	0	0
February	3	0	3
March	17	3	20
April	39	5	44
May	47	2	49
June	69	19	88
July	4	0	4
August	3	1	4
September	17	4	21
October	13	7	20

6.3.8 Flight activity

Light trap catches of alates indicated that the number of ants probably flying before 6 p.m were many and as such very few were caught between 6 p.m and 6 a.m (table 17).

6.4 DISCUSSION

6.4.1 Foraging activity of Camp.acvapimensis

The ants were active during the day as well as night. During the day they collect only food and at night the activity mostly dealt with food collection, nest cleaning and nest expansion. Foraging activities generally involved workers, occasionally soldiers were recruited to help in food collection when they were found to act as food carriers or guards during food collection. Similar findings were reported by Dobzansky (1958) in the genus Formica where the foragers recruited other foragers to the food source. In Camp.acvapimensis, all the castes have the characteristic raising of the gaster and this possibly signals the detection of the food source to the other foragers.

The diurnal activities of the ants seemed to be affected by temperature and humidity. From the results, it is evident that these environmental factors influence the activities of the ants. Lower temperature and high humidities tend to influence the activities of the ants in that the ants are more active under such conditions and

are inactive when these factors vary. The only factor that tended to rule out the effects of these two factors was availability of food source in the environment. Availability of food during a very high temperature induced the ants to continue foraging and collect food. The ants were active on such sunny days, collecting food into the nest which was an indication that the presence of a food source in the environment influenced foraging activity of the ants. When food was available in the environment, then humidity and temperature lost their effects on the ants. Another factor that influenced the activity of the ants was presence of brood in the nest. These ants were active when the larvae found in tha nests were many. This agrees with the findings of Vowles (1952) and Schneirla (1944), who reported that the presence of brood and the type of brood in the nests had effect on the activity of the ants. In the present finding, the larvae seemed to influence the activity and this is probably due to the inactivity of the pupae and the active feeding nature of the larvae.
On the whole the ants were found to be active during the periods when there was occurrence of high percentages of brood (larvae). Ackonor (1977) reported of Cat.guineensis as maintaining a high level of foraging activity throughout the year. This he attributed to the occurrence of brood and alates in the nest throughout the year.

In Camp. acvapimensis, the presence of brood does not influence the diurnal activity of the ants but instead the night activities are affected. This is an indication that the percentage of brood in the nests influenced the activity of foragers up to a point.

Another factor influencing the activity was the presence of food source in the environment. Wallis (1963) associated the functions of the worker caste with hunger. In Camp.acvapimensis the presence of food source influenced the ants. On days with high light intensities and very low humidities, the ants were seen foraging continuously because of a broken termite mound. Such foraging activity defied the humidity and temperature as factors influencing the activity of the ants. Ackonor (1977) also noted that the return of foragers which had been successful in obtaining food brings more stimulation to the inmates of the nests to urge them out in search of food. This is probably the cause of the numerous workers leaving the nest of Camp.acvapimensis to forage for food and also probably the raising of the gaster also serves as a signal for the presence of a food source. Adabie (1977) attributed the stimulation of foragers in the nest of Crematogaster depressa (Latreille) to the returning of foragers and the probable scattering of the developing larvae in the lower chambers of the nest. She felt that all returning foragers entered the lower chambers and stimulated more workers to forage and increase food supply. It is therefore not surprising for the first individuals of Camp.acvapimensis to return into the nest to raise their gasters as a signal causing more workers to leave the nest to the food source.

On days that rainfall seemed to be an influencing environmental factor, Camp.acvapimensis remained active during the rain on leaves. Other ants retreated into their nests such as was found in Camp. sericeus (personal observation) and Cat.guineensis in which Ackonor (1977) observed retreat during the rains. This is an indication that the effects of rain on the activity of Camp.acvapimensis is negligible.

Temperature and humidity were found to be influenced by changing seasons such as the harmattan. The ants were very inactive all day and those ants that came out of their nests did not move far from the nest but immediately went back into their nests. This was rather unusual as the ants forage far from the nest as a habit even in the dry season. Harmattan was therefore a factor that affected the general activity of the ants.

6.4.1.2 Nocturnal activity

Effects of environmental factors on the night activities were not marked. Even when the humidities remained high and temperatures low but the ants were found to be active.

There is the possibility that the ants have preference for high humidities and low temperatures. This is very likely because on days when clouds caused low temperatures, the ants were seen active. The fact that these ants were avoiding sunlight and went into their nests when light intensity became high is an indication that low temperatures favoured their activity. This possibly accounts for their increased activity on all nights.

6.4.2 Foraging space and distance

Foraging space and distance of *Camp. acvapimensis* was influenced by the seasons. During the wet seasons, the ants were found near the entrance of their nests. In the dry season, the ants travelled over long distances in search of green vegetation on which they foraged. Such movements might have been influenced by the type of food the ants were searching for. This is because the ants were always searching for green vegetation. The subsequent scrappings of the stems of the green plants caused a concern other than a mere utilization of such materials for building tents over sap-feeders as these were not found during the dry season, and the ants were not building numerous tents over sap-feeders in the savanna areas as they do in other places. It is possible that the ants use such materials for food, Wyniger (1962) reported on *Solenopsis geminata* (F) as gnawing on plants and licking the sap of those plants.

It is probable that this same behaviour is exhibited by Camp. acvapimensis which was reported by Evans(1973) as using such materials for the construction of tents over the Mealybugs which they tended. Sucking of plant sap seems to be a common behavóour of certain ants for Ackonor (1977) also reported that Cat. guineensis possibly was sucking sap from apical tissues of shoots and also collected materials from plants. It is therefore not surprising that Camp. acvapimensis also collects floral parts from certain plants and sap from others as source of their liquid food. Tending of other insects for honey dew is probably to supplement their supply of liquid diet.

It seems that more is involved than a mere nest building habit reported by Evans (1973). In other ants such as Crem. depressa, Adabie (1977) reported that the wood fibres used for nest materials were scrapped from the backs of cocoa pods and other parts of the tree. A further investigation into the use of sap and other plant materials by Camp. acvapimensis will throw light on the damage that the ants cause. In the savanna areas, such plants were not available to stimulate further investigations. This may account for the constant search for green plants by Camp. acvapimensis. The distance travelled by these ants in the dry season therefore was in search of green plants to obtain sources for their food rather than wandering aimlessly.

Since these plants were farther away, the ants were found several metres from their nests. Another possibility was that the sap-feeders which they tended were on green plants and such plants were far from their nests and they had to cover all the area in search of these sap-feeders. The occurrence of secondary nests in areas away from the primary nests was also a possible reason for the distances that the ants moved.

6.4.3 Food items collected by Camp.acvapimensis

The main food items collected by these ants were termites and other insects. This collection of insects confirm the report of Wheeler (1922) who stated that the ants of the genus Camponotus collected unicellular insects and the excreta of aphids for food. It is therefore not surprising for Camp.acvapimensis, a member of this family, to collect termites for food and tend aphids and other insects in the savanna areas. The food of this ant included honey dew collected from the aphids and coccids that it tended. Their continued visits to the aphids is an indication that the aphids secreted the honey dew in considerable quantities and the ants made use of them. Plant juice seemed an important component of the diet of these ants. This can be inferred from the constant sucking of the juice of the seeds of Neem trees and mangoes. The other juice source was nectar from Euphorbia tirucalli. Certainly, these ants might look for nectar from other sources when plants that give off such nectar are not available. The gnawing of pods, as has been pointed out earlier by Evans (1971), may be for a different purpose in the cocoa farm as Adabie (1977) pointed out in Crem.depressa that the ants use such materials for nest building and Ackonor (1977) also found that Cat. guineensis were sucking sap from the apical tissues of the shoots as a source of liquid food. In the savanna, this was probably serving in different purpose other than tent building. The report of Evans (1973) only attributed this behaviour to the nest building habit since they were concerned with finding the source of the pod rot disease. This was most likely forming part of the diet of the ants because Gorenz (1969) reported that Camp.acvapimensis gnaw the skin of cocoa pods for nest building. The obvious reason for these ants to use the gnawed materials for food is that in the savanna areas very few tents are constructed over aphids and other insects in the dry season. Secondly, the primary nests of these ants were in the soil and the use of sap and gnawed materials for incorporating in the nests was not found. However, in the dry season the ants constantly visited green plants and removed portions of the stem. Such materials could be used for food rather than nest building. Coupled with the fact that these ants suck juice from fruits and nectar from flowers, it is possible that these ants were looking for such sap as a food requirement. Wyniger (1962) reported on the gnawing behaviour of Solenopsis geminata and how it licked the sap that came out. It is very likely that Camp.acvapimensis was also licking sap from the plants from which they gnawed the materials.

Seeds collected from grassed were transported and stored in one or more cells in the nest. The food items commonly found in excavated nests were seeds, anthers and pieces of stick. No termites or insects were found in the nests. This is probably because the termites and other insects were used immediately they were carried into the nests. The probable reason is that these insects could not be stored for longer periods without decay but the seeds could stand storage for several days. This accounted for the absence of such food items from the nests.

6.4.4 Ants phytophagous insects relationship

The association between these ants and the sap-feeders were facultative. The aphids and coccids were tended without the ants building tents to protect them but when these were tended under the sheaths of corn or plantain, the sheaths protected the sap-feeders. The only associationship which could be called obligate was that between the ants and the larvae of the beetle in which the ants constructed tents to seal off the openings left.

In this, the ants used soil to seal the space between the sheath and the stem of the plant. During pupation of the beetle, the ants left the sheaths. In some cases, some aphids were found in the same sheaths and the ants continues to tend such aphids. The association found between the aphids and the ants depended on where the aphids were found for when they were found on leaves as they occured on cucumbers, the ants tended them and did not afford them any protection. The damage caused to most of the plants on which the ants were found tending the sap-feeders was jointly caused by the ants and the sap-feeders.

6.4.5 Flight activity

The absence of alates from light trap catches after 7 p.m. was a possible indication that the alates were probably flying off at an earlier time. The number of alates in the nests were also very few and this could mean that colony founding might involve colony expansion rather than increase by the number of alates. This is accounted for by the always high percentage of larvae and pupae of the worker and soldier castes as compared with the alates that were found in the various nests that were excavated.

Generally, flight activity was influenced by the onset of the rains as the ants were seen in light trap catches some days after the rains. This is probably due to the size of the alate queens as they were found to be larger and needed time to come out of such nests. The male alates were seen in the light traps early probably because of their small sizes and this probably causes their easy movement out of the nest than the female alates.

C H A P T E R 7

S U M M A R Y

1. The study deal with the distribution, nesting habits, preferences, seasonal population pattern, general activity patterns such as foraging and food collection and economic importance of Camponotus acvapimensis in savanna areas of Accra, Ghana.

2. The factors which contribute to the distribution of Camp. acvapimensis were investigated by observations, surveys and field experiments. The distribution, abundance, activities and nesting habits were studied on 2 plots, one plot was a farm land and the other a grassland each measuring 1 hectare. The two habitats afforded basis for comparison within a typical savanna ecosystem.

3. In savanna grasslands, the ants were found in areas with poor shade provided by climbers and a few shade plants, mostly annuals (grasses). The ants were almost absent in areas with continuous shade. Occasionally, their populations increased in areas without shade when there was drought. Light intensity, availability of food and other climatic factors were also found to influence distribution.

4. Nest distribution assessment made in 4 different areas of no-shade, broken shade, poor shade and continuous shade showed varied statistically significant differences

between such shade regimes. The ants were found to forage in any of such areas even though their nests were numerous in poorly shaded areas. Further investigation revealed that the ants abandoned the poorly shaded areas when the poor shade condition was lost. It was concluded that <u>Camp. acvapimensis</u> loves poorly shaded areas but may live in broken shade and no-shade areas as well depending on changing seasons.

5. The colony of the ants was not extensive and was made of one primary nest (usually in the soil) and a few secondary nests (in which the ants tended sap-feeders). Such nests were near the primary nests but usually depended on the distribution of the vegetation.

6. Most nests were found in the soil, grass roots and trees and those in the trees were few. Distribution with respect to shade regimes was influenced by the seasons and the nests were numerous in no-shade areas after bush fires. Nests were mostly found in soils with excess of clay and silt but were rare in sandy soils.

7. Fights between soldiers of different colonies were short-lived and involved few soldiers dashing at members from other colonies, giving quick bites with their mandibles and retreating quickly. Only about 10% of the soldiers were engaged in guarding and fights. This represented only about 2% of the population. No harm

was done to any of the ants involved.

8. *Camp. acvapimensis* was found to occur together with other ants. They co-existed with *Camp. sericeus* but excluded them from foraging areas. However, the two ants were found at times foraging on the same plant. In some nesting areas, *Camp. acvapimensis* was found nesting in the soil near *Annoma* driver ants. *Camp. acvapimensis* workers appeared disturbed by *Platythyreus tarsatus* which acted as its predator.

9. The ants were found to excavate nests in the soil or grass roots and these had numerous cells. The number of cells ranged from 3 - 12 and their vertical depth ranged from 12.3 cm - 63.1 cm. The tunnels were mostly inclined at 60° to the horizontal surface. The cells were larger nearer the main entrance of the nest but narrowed deeper down. The larvae were in cells deep down and the pupae nearer the surface. The number of cells had a bearing on the contents (brood and caste) of the nest. Secondary nests were without brood though a few had 10 - 30 pupae only and in such nests the ants tended the sap-feeders.
Some secondary nests found under creeping grasses or heaps of decaying leaves had only pupae and in rare cases few larvae. Some secondary nests had male and female alates as well. Primary nests had larvae, pupae, workers, soldiers and winged forms (larger females and smaller males).

10. The population of ants had the highest peak of 1,572 individuals in February and a minor peak of 916 in June. The highest peaks were both recorded in periods without rain and the lowest peaks in periods with rain. The ants abandoned their nests when the nests were partly excavated during digging by farmers or accidental excavation of farm habitats. When refuse collects at the entrance thus blocking the entrance, the ants also abandon such nests.

11. The ant was found to be active both day and night but activity in the night was marked as compared with that of day. Several peaks of activity were observed in the night. Nest cleaning took place during the night. Day activities were influenced by light intensity, temperature and humidity but light intensity and temperature determined the pattern of activity. Morning activity was around 6.20 - 10 a.m and afternoon activities started around 3 - 5 p.m. Days with high light intensities had low activities and days with low intensities had increased activity. Humidity was average. Rainfall had no effect on activity pattern but activity increased considerably after each rainfall. Availability of food sources increased the activity of the ants and was the only factor that made the ants defy the effects of temperature and light intensity. Effects of presence of brood on activity were marked during the night activities but did not influence the day-time activities.

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12. The ants foraged long distances from their nests singly and their foraging space covered an area of about 2137.2 sq. metres. Foraging was done on vegetation and the ants climbed plants purposely for tending coccids and other sap-feeders or collecting juice from the fruits. Food items carried into nests included termites and seeds of grasses. Sugary materials were carried in liquid form. The ants caused injury to the flowers and leaves of Solanum melongena stems of corn and some other cultivated plants.

13. The ants were found tending the aphids Aphis nerii, passively and Pentalonia nigronervosa actively. Other sap-feeders tended are the coccids Pulvinaria sp., the Pseudococcidae Dysmicoccus breuipes, Phenacoccus madeirensis and Ferrisia virgata. Other important partners were the larvae of the beetles Carpophilus fumatus.

14. Flight activity occurred about four or five days after the rains and the ants were mostly found during the early hours of the night but were rarely seen in the late hours of the night and before dawn. The male alates were seen some days before the females appeared. The number of male alates was always more than the female alates.

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APPENDIX TABLES

ONE - SIXTY

A P P E N D I X T A B L E S 1 - 60

Table 1. Meteorological information on the study plots during the study period.

Month	Amount of rain (mm)	No. of rainy days
July	23.4	5
August	0.8	1
September	33.6	4
October	81.3	8
November	30.0	3
December	8.9	2
January	15.2	1
February	11.0	4
March	55.1	2
April	86.4	9
May	85.7	9
June	71.7	15
July	9. 6	8
August	18.2	7
September	36.4	6

Table 2 : Head measurements of soldiers in certain nests of *C. acvapimensis*

HW	HL	HW	HL
1.81	2.23	1.89	2.31
1.77	2.19	2.23	2.50
1.81	2.31	1.89	2.27
1.62	2.27	2.73	2.42
1.81	2.23	1.85	2.27
1.73	2.27	1.89	2.12
1.85	2.31	1.77	2.27
1.96	2.39	1.67	2.19
2.04	2.42	1.87	2.39
1.85	2.42	1.89	2.42
1.92	2.42	1.89	2.42
1.92	2.15	1.81	2.19
1.41	1.85	2.04	2.42
1.74	2.19	1.89	2.42
1.65	2.15	1.85	2.31
1.69	2.23	1.69	2.19
1.69	2.23	1.85	2.23
1.73	2.12	1.65	2.19
1.85	2.31	1.81	2.31
1.89	2.39	1.81	2.31
1.89	2.19	1.85	2.15
1.81	2.31	1.85	2.23
1.92	2.15	1.85	2.27
1.89	2.42	1.92	2.31
1.92	2.35	1.96	2.31
1.69	2.08	1.73	2.19
1.92	2.15	1.77	2.19
2.04	2.31		
		100.09	124.70

Table 3: Head measurements of soldiers from certain nests of *C. acvapimensis* Nest 7 30/12/76

HW	HL	HW	HL
1.69	2.00	1.81	2.42
1.75	2.25	1.89	2.50
1.69	2.13	1.69	2.19
1.69	2.25	1.63	2.25
1.50	1.89	1.89	2.42
1.81	2.50	1.69	2.42
1.63	2.13	1.69	2.42
1.50	1.89	1.65	2.35
1.63	2.19	1.81	2.35
1.69	2.25	1.69	2.23
1.69	2.13	1.75	2.08
1.81	2.25	1.75	2.19
1.81	2.20	1.89	2.19
1.89	2.19	1.75	2.50
1.75	2.06	1.75	2.42
1.75	2.00	1.89	2.50
1.89	2.50	1.81	2.19
1.63	2.00	1.81	2.31
1.50	2.06	1.63	2.15
1.6[illegible]	2.19	1.75	2.31
1.89	2.06	1.75	2.08
1.50	2.13	1.89	2.13
1.69	2.13	1.75	2.23
1.81	2.75	1.69	2.23
1.75	2.25	1.63	2.25
1.89	2.19	1.89	2.50
1.85	2.42	1.96	2.42
1.92	2.42	1.42	2.15
1.92	2.19	1.75	2.19
1.69	2.42	1.65	2.50
1.69	2.19	1.69	2.42
1.85	2.50	1.65	2.19
1.69	2.42	1.73	2.23
		129.79	182.89

Table 4 : Head measurements of soldiers from certain nests of *C. acvapimensis* Nest & 11 28/2/77

HW	HL	HW	HL
1.62	2.07	1.65	2.31
1.53	2.04	1.73	2.15
1.69	2.12	1.50	1.96
1.65	2.27	1.62	2.04
1.73	2.27	1.52	2.15
1.57	2.08	1.54	2.12
1.57	1.92	1.65	2.15
1.57	2.08	1.65	2.12
1.69	2.15	1.77	2.31
1.62	1.96	1.81	2.31
1.65	2.31	1.62	2.15
1.46	2.23	1.62	2.15
1.69	2.15	1.62	2.15
1.65	2.15	1.65	2.08
1.57	2.08	1.65	2.15
1.62	2.15	1.69	2.12
1.57	2.27	1.50	2.23
1.39	1.12	1.73	2.23
1.57	1.96	1.73	2.08
1.53	2.04	1.65	2.20
1.77	2.31	1.57	2.31
1.57	2.04	1.73	2.04
1.53	1.96	1.81	2.04
1.73	1.96	1.65	2.20
1.69	2.31	1.77	2.23
1.77	2.31	1.65	2.08
1.73	2.12	1.53	2.12
1.73	2.08	1.73	2.31
1.65	1.96	1.65	2.27
1.62	2.07	1.65	2.04
1.69	2.23		
		99.36	129.53

Table 5: Head measurements of soldiers from certain nests of *C. acvapimensis*

Nest 16 15/5/77

HW	HL	HW	HL
1.81	2.23	1.85	2.31
1.77	2.19	2.23	2.50
1.81	2.31	1.89	2.27
1.62	2.27	2.73	2.42
1.81	2.23	1.85	2.27
1.73	2.27	1.89	2.12
1.85	2.31	1.77	2.27
1.96	2.39	1.69	2.19
2.04	2.42	1.85	2.39
1.85	2.42	1.89	2.42
1.92	2.42	1.89	2.42
1.92	2.15	1.81	2.19
1.42	1.85	2.04	2.42
1.73	2.19	1.89	2.42
1.65	2.15	1.85	2.31
1.69	2.23	1.69	2.19
1.69	2.23	1.85	2.23
1.73	2.12	1.65	2.19
1.85	2.31	1.81	2.31
1.89	2.39	1.81	2.31
1.89	2.19	1.85	2.15
1.81	2.31	1.85	2.23
1.92	2.15	1.85	2.27
1.89	2.42	1.92	2.31
1.92	2.35	1.96	2.31
1.69	2.08	1.73	2.19
1,92	2.15	1.77	2.19
2.04	2.31	103.29	120.38

Table 6 : Head measurements of soldiers from certain nests of *C. acvapimensis* Nest

HW	HL	HW	HL
1.65	2.31	1.62	2.07
1.53	2.04	1.73	2.07
1.69	2.07	1.62	2.04
1.69	2.15	1.77	2.31
1.73	2.27	1.57	2.15
1.53	2.04	1.73	2.15
1.57	2.08	1.53	2.15
1.57	2.08	1.65	2.15
1.69	2.15	1.62	2.04
1.65	2.23	1.77	2.12
1.39	1.96	1.73	2.23
1.57	2.31	1.57	2.31
1.77	2.04	1.65	2.20
1.69	2.04	1.96	2.20
1.57	1.96	1.73	2.23
1.57	2.08	1.65	2.15
1.73	2.08	1.57	2.27
1.62	2.15	1.69	2.12
1.39	1.12	1.73	2.23
1.53	2.04	1.73	2.04
1.69	2.31	1.57	2.08
1.77	2.31	1.65	2.04
1.73	2.08	1.53	2.31
1.73	2.12	1.53	2.12
1.65	1.96	1.65	2.27
1.62	2.07	1.65	2.08
1.53	2.04	1.65	2.20
1.69	2.04	1.65	2.20
1.53	1.96	1.73	2.23
1.77	2.31	1.77	2.23
1.57	2.08	1.73	2.20
		101.54	121.43

Table 7 : Head measurements of soldiers from certain nests of *C. acvapimensis*

		Nest	
HW	HL	HW	HL
1.81	2.23	1.85	2.31
1.81	2.31	1.89	2.27
1.62	2.27	2.73	2.42
1.77	2.19	2.23	2.19
1.96	2.39	1.69	2.19
1.73	2.12	1.89	2.27
1.86	2.31	1.77	2.27
1.96	2.39	1.69	2.19
1.85	2.42	2.04	2.39
1.92	2.42	1.89	2.42
1.85	2.31	1.89	2.42
1.69	2.23	1.69	2.19
1.73	2.12	1.65	2.19
1.69	2.23	1.69	2.19
1.81	2.31	1.81	2.31
1.92	2.35	1.96	2.31
1.89	2.19	1.85	2.15
1.81	2.31	1.85	2.23
1.89	2.19	1.92	2.31
1.92	2.15	1.81	2.19
1.73	2.15	1.85	2.19
1.73	2.19	2.04	2.19
1.69	1.85	2.04	2.42
1.85	2.15	1.92	2.31
1.89	2.42	1.92	2.31
1.92	2.35	1.96	2.31
1.69	2.08	1.73	2.19
2.04	2.31	1.77	2.19
1.92	2.12	1.65	2.23
1.42	1.85	2.04	2.42
1.73	2.19	1.89	2.19
		113.24	142.47

Table 8. Head measurements of workers in various colonies of *C. acvapimensis* Nest 2 15/10/76

HW	HL	HW	HL
0.96	1.42	1.22	1.39
0.96	1.46	0.96	1.54
1.04	1.42	0.96	1.54
1.04	1.42	0.96	1.39
0.89	1.35	1.00	1.27
0.96	1.62	0.92	1.39
0.92	1.46	0.92	1.42
0.89	1.35	1.23	1.65
0.89	1.23	0.89	1.42
1.00	1.27	1.04	1.39
1.00	1.30	0.92	1.27
1.12	1.50	0.92	1.30
0.96	1.39	0.89	1.42
1.25	1.46	0.96	1.54
0.96	1.58	0.89	1.54
0.96	1.58	0.89	1.46
1.00	1.42	0.96	1.54
0.92	1.42	1.04	1.23
0.85	1.42	0.85	1.46
1.00	1.35	0.85	1.35
0.92	1.39	1.12	1.27
0.81	1.27	1.00	1.54
0.85	1.27	1.00	1.54
0.85	1.30	0.92	1.46
0.92	1.42	1.04	1.39
0.96	1.54	0.96	1.58
0.92	1.54	0.85	1.35
1.00	1.30	0.96	1.35
		52.07	78.77

Table 9. Head measurements of workers in various colonies of *C. acvapimensis* Nest 6 15/12/76

HW	HL	HW	HL
0.96	1.46	1.04	1.44
0.96	1.54	1.00	1.63
1.04	1.27	0.89	1.31
0.96	1.39	1.13	1.31
0.89	1.27	0.89	1.25
1.00	1.35	0.96	1.38
0.92	1.42	0.96	1.38
0.96	1.46	1.00	1.38
1.00	1.39	1.00	1.62
1.04	1.27	1.12	1.62
1.04	1.27	1.04	1.27
0.89	1.27	1.96	1.35
0.96	1.35	0.96	1.54
0.92	1.42	0.96	1.42
1.00	1.54	0.56	1.42
0.89	1.54	0.96	1.46
1.00	1.39	1.04	1.42
0.94	1.13	1.06	1.25
1.00	1.56	1.13	1,56
0.94	1.31	1.04	1.25
0.89	1.44	0.94	1.31
1.06	1.44	0.94	1.31
0.89	1.25	0.96	1.31
0.89	1.25	0.96	1.31
0.96	1.31	1.00	1.63
1.04	1.44	1.00	1.44
1.00	1.63	1.04	1.63
0.89	1.31	1.13	1.31
1.06	1.44	0.89	1.25
0.96	1.38	0.96	1.38
0.96	1.38	1.00	1.38
		61.49	125.32

Table 10. Head measurements of workers in various colonies of *C. acvapimensis* Nest 7 30/12/76

HW	HL	HW	HL
1.19	1.62	6.89	1.27
0.92	1.46	0.92	1.46
0.92	1.42	1.00	1.30
1.04	1.42	1.04	1.39
1.00	1.30	0.92	1.23
1.08	1.54	1.12	1.46
0.92	1.27	0.89	1.46
0.96	1.46	0.92	1.46
0.96	1.54	0.92	1.54
1.04	1.50	1.00	1.54
0.85	1.39	0.92	1.39
1.15	1.58	0.92	1.39
0.96	1.46	0.85	1.30
1.12	1.40	1.00	1.30
1.00	1.30	0.92	1.30
0.96	1.35	0.96	1.39
0.89	1.42	1.00	1.39
1.00	1.50	0.96	1.46
0.92	1.27	0.81	1.23
0.96	1.42	1.00	1.54
0.89	1.46	0.92	1.39
1.00	1.35	1.00	1.58
1.12	1.58	1.08	1.54
1.15	1.58	1.12	1.54
0.92	1.30	0.96	1.42
1.00	1.42	1.60	1.30
1.04	1.39	1.15	1.58
1.12	1.58	1.15	1.54
1.00	1.30	1.12	1.54
		57.54	82.23

Table 11. Head Measurements of workers in various colonies of *C.* acvapimensis Nest 11 28/2/77

HW	HL	HW	HL
0.96	1.42	0.85	1.27
1.12	1.39	1.00	1.54
0.96	1.39	0.85	1.54
1.12	1.42	0.85	1.54
0.96	1.46	0.85	1.30
1.04	1.54	0.92	1.46
0.96	1.54	0.92	1.42
1.04	1.42	1.04	1.39
0.96	1.54	0.98	1.54
0.89	1.25	0.98	1.58
1.00	1.62	0.85	1.35
0.92	1.39	0.92	1.46
0.92	1.35	0.89	1.42
0.92	1.42	0.89	1.35
1.23	1.65	0.89	1.23
0.89	1.42	1.00	1.27
1.04	1.39	1.00	1.30
0.92	1.27	1.00	1.27
0.92	1.30	0.92	1.30
0.92	1.30	0,96	1,39
0.89	1.42	0.96	1.46
0.96	1.58	0.89	1.46
0.89	1.46	1.00	1.42
0.96	1.54	0.92	1.42
1.04	1.23	0.85	1.42
0.85	1.46	0.85	1.27
1.00	1.35	0.85	1.35
0.92	1.39	1.12	1.27
		53.48	79.86

Table 12. Head mesurements of workers in various colonies of *C. acvapimensis* Nest 16 15/5/77

HW	HL	HW	HL
1.04	1.42	1.04	1.39
0.96	1.54	0.98	1.54
0.89	1.35	0.98	1.54
0.89	1.27	0.98	1.58
1.00	1.35	0.92	1.58
0.96	1.62	0.85	1.35
0.96	1.42	0.85	1.27
1.12	1.39	1.00	1.54
0.96	1.39	1.00	1.27
1.12	1.39	0.85	1.54
0.96	1.46	0.85	1.30
0.92	1.30	0.96	1.39
0.89	1.42	0.96	1.46
0.96	1.46	1.00	1.46
1.00	1.46	0.85	1.23
0.85	1.42	0.96	1.46
0.98	1.39	0.92	1.39
1.12	1.27	1.00	1.42
0.81	1.27	0.92	1.27
0.89	1.27	0.98	1.30
0.96	1.46	0.85	1.30
0.89	1.35	0.96	1.54
0.96	1.54	0.92	1.39
0.92	1.46	1.12	1.46
0.96	1.27	0.92	1.54
0.89	1.27	0.92	1.39
0.89	1.46	0.96	1.62
0.92	1.39	0.92	1,39
0.96	1.65	0.92	1.42
		53.84	81.34

Table 13. Head mesurement of workers in various nelonies of C. acvapimensis Nest 17 30/5/77

HW	HL	HW	HL
0.96	1.42	0.96	1.46
1.04	1.35	1.04	1.42
0.89	1.35	0.96	1.62
0.96	1.46	0.89	1.35
0.89	1.23	0.89	1.42
1.00	1.42	1.00	1.35
0.92	1.42	0.92	1.54
0.96	1.54	1.12	1.54
0.89	1.42	0.96	1.42
1.12	1.65	0.81	1.27
1.04	1.46	1.04	1.46
1.04	1.35	0.85	1.27
0.81	1.27	0.89	1.46
0.85	1.54	0.89	1.54
0.96	1.35	0.96	1.62
1.00	1.27	1.00	1.30
1.12	1.50	0.96	1.39
1.25	1.46	0.85	1.42
0.96	1.54	0.96	1.35
0.92	1.54	0.92	1,46
0.96	1.42	0.81	1.27
1.00	1.42	1.00	1.54
1.04	1.35	1.04	1.39
0.96	1.39	1.04	1.23
1.00	1.27	1.04	1.54
1.04	1.27	1.00	1.39
0.92	1.30	0.85	1.42
0.85	1.54	0.89	1.39
0.96	1.39	0.92	1.27
		55.77	82.38

Table 14

Diurnal activity Paltern of C. [illegible]

on 3/9/76

Time of day	Temp. Air ^{0}C	Temp. nest ^{0}C	Hum. %	Leav. nest	Entr. nest	Entr. with Food
6 a.m.	23.0	21.0	99	18	2	0
7 "	29.0	23.0	98	10	7	3
8 "	29.5	28.0	90	7	15	6
9 "	27.5	30.0	70	15	16	11
10 "	27.0	32.0	61	15	18	9
11 "	27.5	35.0	57	1[illegible]	9	0
12 Noon	34.5	40.5	50	18	12	0
1 p.m.	34.0	41.0	50	16	8	4
2 "	31.5	41.0	58	8	4	2
3 "	33.4	38.0	64	12	16	7
4 "	29.0	36.0	73	7	15	9
5 "	25.0	29.0	89	4	12	10
6 "	24.5	25.0	95	1	11	4

Temperature recording was done by a thermometer.

Table 15.

Diurnal activity Pattern of C. acvapimensis
on 17/9/76

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	22.5	21.5	98	12	3	0
7 "	26.0	24.5	94	6	4	1
8 "	28.0	28.0	64	12	[illegible]	2
9 "	[illegible]	27.0	[illegible]	17	[illegible]	[illegible]
10 "	[illegible]	[illegible]	71	[illegible]	7	1
11 "	28.0	36.0	58	13	10	4
12 Noon	31.0	41.0	64	14	11	0
1 p.m.	31.5	37.0	57	18	10	3
2 "	30.5	40.0	60	4	3	0
3 "	30.0	35.0	70	9	13	6
4 "	28.0	32.0	82	8	17	8
5 "	26.0	32.0	90	6	15	6
6 "	23.0	24.0	95	13	14	2

Temperature recording was done by a thermometer.

Table 16.

Diurnal activity pattern of *C.accraimensis* on 1/10/76

Time of day	Temp. Air ^0C	Temp. nest ^0C	Hum. %	Leav. nest	Entr. nest	Entr.with food
6 a.m.	25.0	24.0	99	3	3	0
7 "	25.0	24.0	97	0	1	1
8 "	25.0	25.0	87	2	2	1
9 "	27.0	25.0	81	0	4	2
10 "	30.0	30.0	69	1	3	1
11 "	32.0	29.0	62	2	1	1
12 Noon	32.0	29.5	54	0	0	0
1 p.m.	32.0	29.5	54	0	1	0
2 "	32.0	31.0	51	1	0	0
3 "	29.5	32.5	72	0	2	0
4 "	28.0	30.0	80	4	10	4
5 "	25.0	27.0	91	7	15	7
6 "	24.0	27.0	95	4	8	4

Table 17.

Diurnal activity pattern of *C. cyarimensis*
on 15/10/7[illegible]

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	22.0	25.0	98	1	3	0
7 "	24.0	27.0	95	2	4	1
8 "	30.0	31.5	88	0	1	1
9 "	32.0	33.0	75	1	0	0
10 "	31.0	34.0	70	1	2	1
11 "	31.5	33.0	60	0	0	0
12 Noon	31.0	31.5	49	0	0	0
1 p.m.	31.0	32.0	70	2	1	1
2 "	30.0	31.0	70	5	4	0
3 "	30.0	35.0	85	3	5	1
4 "	29.0	34.0	90	4	7	4
5 "	28.0	30.0	94	4	6	3
6 "	25.5	28.0	95	19	10	1

Table 18.

Diurnal activity pattern of *C. acvapimensis* on 29/10/76

Time of day	Temp. Air °C	Temp. nest °C	Humum %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	23.0	25.5	98	1	4	0
7 "	28.0	29.5	94	2	4	2
8 "	28.5	30.5	84	3	2	1
9 "	29.5	32.0	70	0	1	0
10 "	30.5	34.0	71	5	2	1
11 "	30.0	34.0	58	4	0	0
12 Noon	31.5	35.0	64	2	0	0
1 p.m.	31.0	35.0	56	3	1	0
2 "	31.0	34.0	54	3	0	0
3 "	33.0	33.0	64	4	6	1
4 "	30.0	33.0	81	6	4	3
5 "	26.5	28.5	91	7	5	2
6 "	25.0	25.0	96	18	16	12

Table 19.

Diurnal activity pattern of *C.acvarimensis*
on 12/11/76

Time of day	Temp. Air ^0C	Temp. nest ^0C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	21.5	22.0	98	0	0	0
7 "	23.5	24.5	92	0	0	0
8 "	27.0	25.0	91	3	1	0
9 "	30.0	26.0	80	11	7	2
10 "	28.0	26.0	80	7	10	4
11 "	28.0	26.5	72	14	6	1
12 Noon	30.5	27.0	69	18	18	4
1 p.m.	31.5	27.0	70	13	15	3
2 "	33.0	28.0	61	12	14	12
3 "	34.0	28.0	61	8	7	2
4 "	32.9	28.0	82	1	1	1
5 "	26.5	27.0	92	4	2	1
6 "	24.5	26.0	98	10	21	11

Table 20.

Diurnal activity pattern of *C. acvapimensis* on 26/11/76

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	26.7	26.7	97	2	1	0
7 "	26.7	26.7	94	0	0	0
8 "	29.2	28.3	91	10	9	2
9 "	29.2	29.4	83	52	50	24
10 "	31.7	30.8	84	81	80	30
11 "	32.2	31.4	71	35	55	16
12 Noon	31.7	29.7	60	34	25	12
1 p.m.	31.4	30.3	61	21	22	6
2 "	32.2	30.6	64	37	39	20
3 "	31.7	29.2	72	22	18	5
4 "	30.0	27.8	81	23	19	4
5 "	28.3	27.2	89	21	17	4
6 "	28.0	26.4	91	36	39	14

Temperature was recorded with a recording machine.

Table 21.

Diurnal activity pattern of *C. acvapimensis* on 10/12/76

Time of day	Temp. Air ^0C	Temp. nest ^0C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	23.5	21.0	95	9	5	0
7 "	26.0	24.0	84	8	6	4
8 "	27.0	24.0	81	33	31	11
9 "	27.0	24.0	76	38	50	8
10 "	29.5	25.0	73	31	34	13
11 "	31.5	26.5	63	7	7	3
12 Noon	31.5	26.5	55	29	23	8
1 p.m.	30.5	26.5	50	12	14	10
2 "	30.0	27.0	53	5	6	0
3 "	29.0	27.0	62	4	14	1
4 "	29.0	27.0	71	5	15	3
5 "	28.5	27.5	80	10	20	12
6 "	27.0	27.0	90	15	18	0

All temperature recording during activity pattern were recorded using the recording machine.

Table 22.

Diurnal activity pattern of *C.acvapimensis* on 24/12/76

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	26.0	24.0	91	15	7	4
7 "	26.5	25.0	81	12	8	6
8 "	26.5	25.0	79	17	11	8
9 "	27.5	26.0	71	27	13	7
10 "	28.0	26.0	70	22	18	12
11 "	28.5	26.0	61	20	12	4
12 Noon	31.0	27.5	52	18	24	18
1 p.m.	31.0	27.0	47	27	12	6
2 "	31.5	27.0	52	16	22	16
3 "	31.5	27.5	53	5	7	6
4 "	30.5	27.5	73	6	12	8
5 "	29.5	26.5	79	8	6	4
6 "	29.5	26.5	80	29	21	16

Table 23.

Diurnal activity pattern of C.acvapimensis
on 14/1/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leave nest	Entr. nest	Entr. with food
6 a.m.	24.0	21.5	97	7	9	5
7 "	25.0	23.5	91	15	8	4
8 "	28.0	25.5	87	24	7	6
9 "	29.0	27.5	80	12	15	11
10 "	31.0	30.0	74	19	23	12
11 "	31.0	30.0	73	36	14	12
12 Noon	31.0	30.5	69	20	29	24
1 p.m.	32.4	30.5	65	30	22	18
2 "	32.0	31.0	59	12	17	11
3 "	32.0	31.0	59	17	3	1
4 "	31.5	30.0	62	12	3	2
5 "	31.5	30.0	62	12	3	2
6 "	28.5	28.5	78	25	14	0

Table 24.

Diurnal activity pattern of C.acvapimensis
on 28/1/77

Time of day	Temp. Air ^{0}C	Temp. nest ^{0}C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	22.5	21.0	95	7	9	6
7 "	24.5	21.0	91	11	12	8
8 "	26.5	22.5	87	19	11	7
9 "	26.0	23.0	81	24	20	17
10 "	28.0	23.0	76	29	18	14
11 "	29.5	25.0	71	12	5	3
12 Noon	29.5	26.0	65	17	11	9
1 p.m.	31.5	26.0	61	11	13	7
2 "	30.5	26.5	59	5	8	3
3 "	30.5	26.5	59	12	5	4
4 "	28.0	27.0	63	8	24	13
5 "	28.0	27.0	65	9	15	12
6 "	27.5	28.0	69	41	37	14

Table 25.

Diurnal activity pattern of *C. acvapimensis* on 11/2/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	21.5	22.5	97	12	10	2
7 "	23.4	23.0	96	18	1	
8 "	23.5	23.5	82	4	2	1
9 "	24.0	23.5	80	7	3	1
10 "	25.0	26.0	73	3	1	1
11 "	25.0	26.0	67	8	4	2
12 Noon	27.5	26.0	60	5	2	1
1 p.m.	31.5	26.0	57	2	8	
2 "	32.5	25.0	53	2	7	5
3 "	33.5	25.0	54	1	5	3
4 "	33.0	25.0	61	17		4
5 "	30.1	24.5	72	8	7	3
6 "	29.5	24.5	84	9	1	1

Harmattan period.

Table 26 . Diurnal acitity pattern of *Camp. acvapimensis* on 25/2/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr nest	Entr with food
6 a.m.	27.8	28.3	91	15	7	2
7	27.8	28.3	91	11	19	3
8	31.0	28.5	89	25	12	3
9	30.2	30.0	81	39	36	29
10	31.8	30.6	77	60	42	23
11	34.6	30.0	73	12	19	0
12	34.6	32.2	68	17	27	18
1 p.m.	33.9	33.4	65	29	21	18
2	30.0	32.2	72	88	35	14
3	28.9	28.5	85	12	15	4
4	27.8	28.9	87	15	7	3
5	27.8	28.5	91	12	5	2
6	26.8	27.8	96	5	19	11

Increased activity due to a broken termitarium.

Table 27.

Diurnal activity pattern of C.acvapimensis

on 11/3/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entre with food
6 a.m.	30.6	29.5	97	5	7	2
7 "	30.6	30.0	87	12	11	9
8 "	33.0	33.0	78	10	18	12
9 "	35.5	31.6	77	15	23	15
10 "	32.2	33.4	68	6	5	2
11 "	34.6	32.2	65	2	1	0
12 Noon	32.2	33.9	63	0	0	0
1 p.m.	35.6	31.6	61	0	0	0
2 "	35.0	32.0	62	0	0	0
3 "	35.0	30.6	90	59	75	34
4 "	35.0	30.0	88	40	25	21
5 "	35.6	30.6	88	40	16	8
6 "	31.1	28.0	89	10	21	19

The day was cloudy and there was a heavy downpour at 12 noon which stopped at half past 2.

Table 28.

Diurnal activity pattern of C.acvapimensis

on 25/3/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr.with food
6 a.m.	24.0	22.0	97	4	2	0
7 "	26.0	25.0	92	7	3	0
8 "	26.5	26.0	89	9	1	1
9 "	26.5	26.0	85	10	5	0
10 "	28.0	26.0	81	3	1	1
11 "	30.0	28.0	75	11	3	0
12 Noon	32.0	28.5	68	0	0	0
1 p.m.	33.0	31.0	71	2	4	1
2 "	33.9	31.5	73	2	7	1
3 "	32.6	31.5	79	2	12	3
4 "	31.6	29.5	82	4	8	2
5 "	30.6	29.0	87	3	7	1
6 "	30.6	29.0	91	9	1	0

Table 29.

Diurnal activity pattern of <u>*C. acvapimensis*</u>

on 8/4/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	26.0	26.7	98	12	8	6
7 "	26.0	26.7	92	15	12	2
8 "	28.2	28.3	91	7	15	12
9 "	28.2	29.4	86	9	8	1
10 "	31.4	30.8	85	18	9	6
11 "	31.2	31.4	81	12	3	1
12 Noon	31.7	29.7	79	4	2	1
1 p.m.	31.8	30.3	79	7	7	3
2 "	32.2	31.6	83	3	5	4
3 "	31.7	29.0	87	2	3	2
4 "	30.1	26.8	92	1	9	0
5 "	28.3	26.8	95	5	4	1
6 "	28.0	26.3	97	7	5	2

Table 30.

Diurnal activity pattern of *C.acvapimensis*

on 22/4/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	23.4	21.4	97	4	2	0
7 "	26.4	23.5	95	9	6	0
8 "	28.0	23.5	91	1	4	2
9 "	28.0	23.5	86	18	9	4
10 "	30.6	25.0	82	34	14	9
11 "	31.6	29.0	71	1	0	0
12 Noon	31.6	29.0	71	1	0	0
1 p.m.	32.4	29.0	75	4	3	0
2 "	33.0	29.0	82	7	12	6
3 "	33.0	29.5	86	3	15	9
4 "	31.6	29.0	91	1	8	3
5 "	31.6	28.5	92	5	4	0
6 "	31.0	28.5	95	1	2	1

Light intensity was high but the larvae and pupae were many yet activity was low.

Table 31.

Diurnal activity pattern of C.acvapimensis

on 6/5/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	27.4	24.0	98	12	15	3
7 "	27.4	24.0	95	34	21	11
8 "	30.0	26.4	93	11	22	17
9 "	31.0	26.4	91	32	15	7
10 "	31.8	28.0	87	12	19	9
11 "	33.6	28.0	86	11	12	11
12 Noon	33.6	29.5	83	6	9	7
1 p.m.	33.6	29.5	89	2	12	6
2 "	31.6	30.0	81	14	24	7
3 "	28.6	30.0	87	26	5	0
4 "	28.6	28.0	90	3	2	1
5 "	27.8	28.0	90	9	3	2
6 "	26.0	28.0	93	12	4	1

A very sunny day but ants were very active due to a food source.

Table 32.
Diurnal activity pattern of C.aavapimensis
on 20/5/77

Time of day	Temp. Air ^0C	Temp. nest ^0C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	28.3	26.7	97	12	16	3
7 "	29.2	28.0	95	19	12	5
8 "	27.2	27.2	91	13	18	7
9 "	26.7	27.2	87	29	19	9
10 "	28.0	29.2	83	16	13	2
11 "	28.3	29.2	76	23	19	0
12 Noon	29.2	29.4	78	36	28	3
1 p.m.	28.0	29.5	79	15	34	2
2 "	30.6	27.2	83	22	38	15
3 "	29.2	27.2	89	8	17	7
4 "	31.4	28.3	91	23	12	9
5 "	33.3	30.0	94	12	18	8
6 "	33.9	31.7	94	34	22	7

Table 33.

Diurnal activity pattern of *C. acvapimensis* on 3/6/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	26.1	26.7	98	9	7	3
7 "	26.7	28.0	95	13	14	7
8 "	28.3	28.3	92	19	12	9
9 "	27.2	28.3	89	7	7	2
10 "	29.4	29.2	81	8	12	0
11 "	30.0	29.4	90	14	16	2
12 Noon	27.0	28.0	96	26	36	7
1 p.m.	26.7	28.0	95	36	45	11
2 "	27.2	28.0	95	40	45	19
3 "	29.2	30.0	86	15	15	5
4 "	30.6	32.8	85	5	11	4
5 "	32.2	31.4	92	6	12	6
6 "	27.2	28.3	97	23	29	8

Table 34.

Diurnal activity pattern of C.acvapimensis

on 17/6/77

Time of day	Temp. Air ^0C	Temp. nest ^0C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	24.0	23.9	99	11	12	8
7 "	24.0	23.4	98	15	11	0
8 "	23.8	23.4	98	24	25	12
9 "	23.9	23.3	98	17	12	9
10 "	23.9	23.4	99	19	11	3
11 "	24.0	23.5	98	23	8	7
12 Noon	24.0	23.5	99	23	7	4
1 p.m.	24.0	23.0	99	15	19	16
2 "	24.0	23.0	99	23	13	12
3 "	23.9	23.0	99	32	17	11
4 "	22.9	22.0	100	17	24	11
5 "	23.0	22.5	100	18	11	7
6 "	23.1	22.5	100	15	12	2

Leavae were many, the day was cloudy and misty with drizziling.

Table 35.

Diurnal activity pattern of C.acvapimensis

on 13/7/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	25.4	22.3	100	17	13	11
7 "	25.3	23.4	96	32	21	8
8 "	25.4	23.5	92	12	15	12
9 "	27.3	23.5	89	19	32	21
10 "	28.0	24.0	78	25	17	11
11 "	28.9	26.1	72	13	12	5
12 "	28.9	26.1	74	17	29	17
1 p.m.	29.5	26.5	73	29	38	21
2 "	29.8	26.9	78	43	17	12
3 "	30.1	26.9	83	16	23	11
4 "	29.1	27.0	82	32	39	19
5 "	28.4	27.0	89	17	28	20
6 "	28.0	27.1	90	19	12	1

Table 36.

Diurnal activity pattern of G.acvapimensis

on 15/7/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr.with food
6 a.m.	27.4	26.3	99	15	30	17
7 "	27.9	27.1	97	21	12	4
8 "	27.9	27.2	93	32	16	12
9 "	30.2	28.4	87	17	39	13
10 "	31.4	28.9	83	23	12	1
11 "	31.4	29.0	87	19	11	1
12. "	32.6	29.1	81	45	14	5
1 p.m.	32.4	29.0	78	28	33	12
2 "	31.0	29.3	75	32	17	13
3 "	30.4	28.7	77	12	29	15
4 "	30.0	28.5	82	19	11	1
5 "	29.5	28.8	89	23	12	7
6 "	29.1	28.8	91	32	17	3

Table 37.

Diurnal activity pattern of C.acvapimensis

on 29/7/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	27.4	21.4	99	26	11	7
7 "	27.0	23.5	97	12	29	18
8 "	30.3	25.0	93	17	16	12
9 "	30.5	25.0	89	31	42	23
10 "	30.5	29.5	86	29	11	4
11 "	31.5	29.4	87	16	29	6
12 "	32.0	29.0	83	34	17	8
1 p.m.	32.0	29.0	81	12	28	13
2 "	31.0	28.5	87	18	32	15
3 "	31.0	29.0	89	25	17	11
4 "	29.0	29.5	91	12	11	10
5 "	29.0	29.5	93	17	23	12
6 "	29.0	29.5	95	19	24	14

Table 38. Diurnal activity pattern of <u>C.acvapimensis</u>

on 12/8/77

Time of day	Temp. Air ^{0}C	Temp. nest ^{0}C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	22.8	22.8	98	12	17	4
7 "	22.9	23.0	96	19	11	7
8 "	23.0	23.3	92	29	12	8
9 "	23.5	23.9	91	39	26	12
10 "	23.6	23.9	87	54	33	26
11 "	24.0	24.6	86	41	51	39
12 Noon	24.3	24.8	81	44	53	34
1 p.m.	24.9	24.8	79	37	15	11
2 "	25.0	26.5	78	39	46	29
3 "	25.0	26.5	83	60	51	41
4 "	24.9	26.0	86	32	43	32
5 "	24.6	26.0	91	12	17	7
6 "	24.0	26.1	94	19	25	21

Table 39.

Diurnal activity pattern of C.acvapimensis

on 26/8/77

Time of day	Temp. Air °C	Temp. nest °C	Hum. %	Leav. nest	Entr. nest	Entr. with food
6 a.m.	23.0	22.1	97	29	17	7
7 "	23.1	22.0	96	17	21	9
8 "	23.1	22.0	96	34	18	15
9 "	23.4	22.0	96	43	23	12
10 "	23.3	22.3	97	27	12	1
11 "	23.4	22.3	97	28	11	0
12 "	23.5	22.4	98	12	17	15
1 p.m.	23.1	22.3	98	18	13	10
2 "	23.1	22.1	99	22	33	8
3 "	23.6	22.3	98	34	12	9
4 "	23.0	22.3	99	16	19	7
5 "	23.0	22.4	99	11	21	14
6 "	22.8	22.4	100	30	38	12

Table 40: Noctural activity pattern of <u>C.acvapimensis</u> on 14/10/76

Time of Day	Temp. Air °C	Temp. nest °C	Huni. %	Leav. nest	Entr. nest	Entr. with food
6 a.m	26.4	25.5	96	35	45	20
7 "	27.8	26.1	94	25	32	10
8 "	27.5	26.1	93	3	13	4
9 "	27.8	26.1	95	25	27	8
10 "	27.5	24.7	95	39	48	6
11 "	27.2	23.9	96	65	59	2
12 noon	26.7	23.9	98	18	10	8
1 p.m	26.4	23.6	92	17	13	6
2 "	26.1	23.3	93	30	39	7
3 "	25.8	23.3	94	27	36	1
4 "	25.5	23.1	97	18	33	17
5 "	25.5	22.8	98	16	24	12
6 "	25.3	23.1	97	2	1	0

Table 41: Noctural activity pattern of C.acvapimensis on 28/10/76

Time of day	Temp. Air °C	Temp. nest °C	Humi. %	Leav. nest	Ent. nest	Ent.with food
6 a.m	25.0	24.5	91	36	39	14
7 "	26.0	23.6	96	19	20	6
8 "	26.5	23.6	95	5	6	0
9 "	26.5	23.6	96	26	3	0
10 "	27.0	23.6	96	26	31	5
11 "	27.4	23.0	97	57	53	6
12 noon	27.4	24.0	96	10	12	6
1 p.m	26.5	24.0	94	11	15	11
2 "	26.3	23.0	94	42	36	8
3 "	25.4	23.0	95	29	32	3
4 "	25.3	23.6	96	25	36	18
5 "	25.3	23.6	98	21	25	15
6 "	25.3	23.6	97	7	6	0

Table 42: Noctural activity pattern of C.acvapimensis on 11/11/76

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	leav nest	Ent. nest	Ent. with food
6 a.m	26.0	26.0	94	28	33	15
7 "	27.1	25.5	94	27	30	11
8 "	27.5	25.5	96	4	8	3
9 "	27.5	25.5	94	64	61	15
10 "	27.8	25.0	95	43	42	7
11 "	26.7	24.5	96	7	11	4
12 noon	26.0	24.5	96	72	67	10
1 p.m	26.1	24.5	92	51	50	11
2 "	25.3	23.1	92	75	67	4
3 "	25.4	23.0	93	68	62	3
4 "	25.5	23.0	97	49	46	15
5 "	25.0	23.0	98	32	35	11
6 "	25.0	23.0	98	10	8	1

Table 43 : Nocturnal activity pattern of C.acvapimensis on 25/11/76

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Ent. nest	Ent. with food
6 a.m	27.0	25.0	97	20	29	12
7 "	28.0	24.5	96	21	27	8
8 "	27.0	25.0	97	12	15	1
9 "	26.5	25.0	96	60	56	0
10 "	26.5	24.5	98	41	50	2
11 "	26.0	23.1	97	5	9	1
12 Noon	26.3	23.5	97	61	65	2
1 p.m	26.0	23.5	95	47	52	8
2 "	25.4	23.1	95	70	63	7
3 "	25.8	23.1	96	40	25	1
4 "	25.5	23.0	97	49	40	11
5 "	25.0	23.0	98	32	26	12
6 "	25.0	23.0	97	11	4	0

Table 44: Noctural activity pattern of C.acvapimensis on 9/12/76

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	26.4	24.5	100	29	32	24
7 "	25.4	24.0	98	20	18	14
8 "	25.0	23.0	97	17	24	21
9 "	25.0	23.0	98	48	52	41
10 "	24.5	22.5	96	46	41	19
11 "	24.5	22.5	96	4	6	4
12 Noon	24.5	21.8	98	54	21	12
1 p.m	24.0	21.5	97	40	49	33
2 "	23.5	21.5	95	62	67	41
3 "	23.5	21.5	97	47	41	32
4 "	24.5	22.0	96	45	12	7
5 "	24.0	22.0	98	38	48	42
6 "	24.0	22.0	98	19	22	12

Table 45: Noctural activity pattern of *C.acvapimensis* on 23/12/76

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	26.0	24.0	98	36	38	32
7 "	26.0	24.0	97	24	27	21
8 "	25.5	23.0	97	22	18	16
9 "	25.5	23.0	96	31	17	8
10 "	23.0	22.0	97	42	54	50
11 "	22.5	21.0	98	12	17	12
12 Noon	22.0	21.5	98	59	50	47
1 p.m	22.0	21.5	98	31	37	12
2 "	22.0	21.5	97	52	49	37
3 "	22.5	21.5	97	44	51	42
4 "	22.5	21.5	97	22	17	4
5 "	23.0	21.0	98	30	28	21
6 "	23.0	21.0	99	12	17	8

Table 46: Noctural avtivity pattern of C.acvapimensis on 6/1/77

Time of Day	Temp. air °C	Temp. nest ° C	Humi-dity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	27.0	27.8	99	42	27	21
7 "	26.2	27.8	98	30	31	25
8 "	25.0	27.8	98	29	22	18
9 "	25.0	28.5	97	17	29	27
10 "	25.0	26.8	98	57	49	41
11 "	24.4	27.3	98	18	7	3
12 Noon	23.9	26.8	98	51	53	48
1 p.m	23.9	26.8	98	39	41	30
2 "	23.4	26.8	97	48	40	36
3 "	23.6	26.6	97	36	21	8
4 "	23.4	26.2	97	18	14	12
5 "	23.4	25.6	98	42	26	17
6 "	25.0	26.2	98	4	18	12

Table 47: Noctural activity pattern of *Caacvapimensis* on 20/1/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	26.4	25.5	95	18	4	2
7 "	27.8	26.1	97	12	7	5
8 "	27.5	26.1	97	1	2	1
9 "	27.8	24.7	98	5	3	3
10 "	27.5	23.9	98	1	7	6
11 "	27.2	23.6	96	2	7	4
12 Noon	26.7	23.3	97	2	4	3
1 p.m	26.4	23.3	96	0	1	0
2 "	26.1	23.1	96	8	5	3
3 "	25.8	23.1	96	16	14	7
4 "	25.3	23.1	98	19	16	9
5 "	25.3	23.1	98	15	8	6
6 "	25.8	24.4	100	7	11	4

Table 48: Noctural activity pattern of C.acvapinensis on 4/2/77

Time of Day	Temp. Air °C	Temp. nest °C	Humi-dity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	27.4	24.3	99	15	17	4
7 "	27.4	24.7	97	29	13	9
8 "	27.2	24.6	97	19	62	12
9 /	26.5	24.3	97	12	34	18
10 "	26.4	24.2	95	17	29	17
11 "	26.8	24.0	96	22	31	15
12 Noon	26.4	24.2	96	73	69	41
1 p.m	26.2	24.1	97	16	19	12
2 "	25.7	24.0	98	51	29	7
3 "	25.4	24.0	98	48	21	3
4 "	25.5	24.0	98	39	17	9
5 "	26.0	23.6	97	17	12	4
6 "	25.8	23.3	96	15	8	1

Table 49: Noctural activity pattern of C.aevapimensis on 18/2/77

Time of Day	Temp. Air °C	Temp. nest °C	Humi-dity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	28.3	24.3	95	35	24	17
7 "	27.4	24.1	95	39	29	12
8 "	27.3	23.2	97	42	63	48
9 "	27.0	23.3	98	12	10	7
10 "	27.0	23.1	97	72	19	12
11 "	25.3	23.1	98	49	35	28
12 noon	25.0	23.4	97	31	63	19
1 p.m	25.0	23.4	93	27	18	4
2 "	21.3	22.8	97	9	19	11
3 "	24.7	22.9	98	18	34	12
4 "	25.0	23.0	97	23	29	16
5 "	23.7	23.7	95	29	12	6
6 "	25.7	23.7	98	12	18	8

Table 50: Noctural activity pattern of C.acvapinensis on 4/3/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	27.8	26.8	98	43	22	12
7 "	27.8	27.0	97	19	34	17
8 "	28.5	26.2	97	36	12	4
9 "	26.8	25.0	96	39	19	6
10 "	27.3	25.0	94	70	12	5
11 "	26.8	24.4	97	19	39	11
12 Noon	26.8	23.4	97	72	12	3
1 p.m	26.8	23.9	98	21	29	16
2 "	26.6	23.9	98	28	64	32
3 "	26.2	23.6	97	13	12	10
4 "	25.6	23.4	97	33	19	11
5 "	26.2	23.4	97	11	29	4
6 "	26.4	25.5	98	9	18	7

Table 51: Noctural aotivity pattern of C.acvapimensis on 18/3/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	28.9	27.8	99	73	19	12
7 "	24.4	25.4	98	89	12	10
8 "	26.2	25.6	97	70	21	4
9 "	25.0	25.0	97	17	19	9
10 "	26.2	25.0	97	22	34	18
11 "	25.6	25.3	96	40	62	33
12 Noon	26.2	25.2	96	17	31	12
1 p.m	26.8	25.4	97	19	39	17
2 "	27.3	25.5	96	33	28	13
3 "	26.2	25.3	98	39	17	4
4 "	26.2	25.6	98	12	19	3
5 "	26.2	25.6	98	17	15	9
6 "	25.6	25.4	99	33	20	5

Table 52: Noctural activity pattern of <u>C.acvapimensis</u>
on 2/4/77

Time of Day	Temp. Air °C	Temp. nest °C	Humi-dity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	29.4	27.8	99	17	18	9
7 "	25.3	26.2	99	34	21	12
8 "	25.0	24.3	100	19	16	3
9 "	25.0	24.8	100	38	12	5
10 "	26.3	23.8	100	37	14	6
11 "	26.2	24.8	99	45	52	18
12 Noon	25.6	23.8	97	73	69	42
1 p.m	25.6	24.0	98	12	17	3
2 "	25.4	24.0	98	18	39	12
3 "	25.4	25.0	98	27	25	17
4 "	25.4	25.0	98	5	3	1
5 "	26.2	25.0	98	19	22	13
6 "	25.6	25.0	97	8	4	1

Table 53: Noctural activity pattern of C.acvapimensis
on 16/4/77

Time of Day	Temp. Air °C	Temp. nest °C	Humi-dity %	Leav. nest	Entr. nest	Entr. with
6 a.m	28.7	26.2	98	6	12	2
7 "	28.0	26.0	97	19	12	8
8 "	26.2	25.0	95	12	16	12
9 "	25.6	25.0	93	34	23	11
10 "	25.6	23.6	96	16	19	12
11 "	25.6	23.6	96	39	15	9
12 Noon	26.8	23.6	97	48	13	6
1 p.m	26.8	23.4	96	71	46	23
2 "	27.3	23.4	98	12	33	19
3 "	27.3	25.0	99	11	29	11
4 /	26.0	25.0	98	14	23	13
5 "	26.0	25.6	97	19	12	4
6 "	25.6	25.0	99	28	17	6

Table 54: Nootural activity pattern of C.acvapimensis on 30/4/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	26.0	25.0	99	7	6	3
7 "	26.4	25.0	98	9	12	4
8 "	26.4	26.0	98	15	5	2
9 "	27.0	26.0	97	32	13	5
10 "	27.0	26.0	97	32	12	5
11 "	27.0	24.7	96	24	21	8
12 Noon	27.2	24.7	96	16	13	2
1 p.m	26.4	23.3	97	18	12	5
2 "	26.4	23.3	98	23	15	6
3 "	25.5	23.6	98	29	7	2
4 "	25.5	23.6	97	24	17	8
5 "	25.5	23.1	98	26	18	9
6 "	26.4	23.1	99	27	13	6

Table 55: Noctural activity pattern of *C. capimensis*

on 14/5/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Ent. nest	Entr. with food
6 a.m.	26.0	26.0	98	3	9	1
7 "	26.0	26.1	98	11	7	2
8 "	27.8	26.1	97	29	12	3
9 "	28.3	24.0	97	6	4	0
10 "	28.0	23.3	96	14	32	6
11 "	27.2	23.6	97	23	19	7
12 Noon	27.8	23.6	96	17	11	5
1 p.m	27.5	23.3	95	4	9	2
2 "	27.2	23.6	95	15	9	2
3 "	27.3	23.1	96	19	14	5
4 "	26.4	23.1	97	17	7	2
5 "	26.4	24.4	97	29	16	3
6 "	26.4	24.9	97	13	11	4

Table 56: Noctural activity pattern of *C.acvapimensis* on 28/5/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	27.8	26.1	99	16	24	12
7 "	28.0	26.1	97	28	36	11
8 "	28.0	26.1	93	33	29	13
9 "	27.8	26.4	94	29	27	17
10 "	27.8	26.1	93	51	63	34
11 "	27.5	26.1	97	27	15	4
12 noon	27.3	25.8	96	29	11	2
1 p.m	27.2	25.5	96	33	15	7
2 "	27.2	25.3	98	29	38	16
3 "	26.4	25.0	99	14	9	7
4 "	26.7	25.0	97	12	6	1
5 "	26.7	25.0	97	16	9	5
6 "	26.0	25.0	99	12	4	0

Table 57: Noctural activity pattern of C.acvapimensis

on 11/6/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	22.4	21.9	98	12	4	0
7 "	22.6	29.7	98	7	12	0
8 "	22.5	21.5	96	3	5	1
9 "	22.3	20.9	99	2	14	1
10 "	22.1	20.9	98	15	7	2
11 "	22.0	21.0	97	25	21	4
12 "	21.0	21.0	97	17	12	2
1 p.m	21.7	21.1	98	11	19	4
2 "	21.9	21.0	97	4	7	0
3 "	21.7	20.9	97	9	16	5
4 "	21.5	20.8	97	11	4	1
5 "	21.9	20.9	97	13	9	0
6 "	22.0	21.2	98	5	1	0

Table 58: Noctural activity pattern of C.acvapimensis on 25/6/77

Time of Day	Temp. Air °C	Temp. nest °C	Humi-dity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	21.9	22.5	99	5	2	0
7 "	22.9	23.9	99	7	1	0
8 "	22.5	24.2	99	12	3	0
9 "	22.1	23.8	98	11	9	3
10 "	23.4	23.2	100	9	5	1
11 "	23.5	23.2	100	18	12	4
12 Noon	24.4	22.5	99	3	7	1
1 p.m	24.1	22.5	99	2	5	2
2 "	24.5	22.0	100	5	15	5
3 "	23.9	22.0	99	17	12	4
4 "	23.9	21.9	99	4	7	2
5 "	23.9	21.9	99	2	9	1
6 "	23.9	21.9	100	1	3	0

Table 59: Noctural activity pattern of C.acvapimensis on 9/7/77

Time of Day	Temp. Air °C	Temp. nest °C	Humidity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	22.4	22.5	99	7	5	1
7 "	22.9	23.9	98	9	19	5
8 "	22.5	24.3	97	12	11	3
9 "	22.3	24.2	96	15	12	2
10 "	22.0	24.2	96	3	14	4
11 "	22.0	23.9	97	12	3	1
12 "	22.4	23.9	97	17	2	0
1 p.m	22.5	23.9	98	3	5	2
2 "	22.5	22.6	97	9	16	3
3 "	22.6	22.9	97	8	9	2
4 "	22.4	23.4	97	7	12	4
5 "	22.4	23.4	98	16	4	1
6 "	22.9	23.6	99	2	3	0

Table 60: Noctural activity pattern of C.acvapimensis on 23/7/77

Time of Day	Temp. Air °C	Temp. nest °C	Humi-dity %	Leav. nest	Entr. nest	Entr. with food
6 a.m	24.4	25.0	99	7	4	1
7 "	26.4	25.0	99	3	12	2
8 "	27.0	26.0	99	13	9	1
9 "	28.0	26.0	97	15	3	0
10 "	27.2	24.3	96	6	2	0
11 "	27.8	24.7	96	12	9	0
12 Noon	27.5	24.7	96	17	11	3
1 p.m	27.2	24.0	97	25	4	2
2 "	27.3	23.6	98	19	12	3
3 "	26.4	23.4	99	4	15	4
4 "	26.4	23.4	100	17	12	3
5 "	26.4	23.2	99	5	9	1
6 "	26.4	23.1	99	7	3	0