THE DISTRIBUTION, NESTING HABITS AND ACTIVITY PATTERN OF *CATAULACUS GUINEENSIS* F. SMITH (HYMENOPTERA: FORMICIDAE) IN A GHANAIAN COCOA FARM

By

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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.

JOSEPH BEKAE ACKONOR.

This work is dedicated to my father who sacrificed his personal interests for my education.

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ABSTRACT

The study deals with the distribution, seasonal population pattern, nesting habits and activity of *Cataulacus guineensis* F. Smith in a Ghanaian cocoa farm. The ant was found to prefer nesting under canopy with continuous shade and showed significant association with *Oecophylla longinoda* Latr. and *Camponotus olivieri* (Forel). However it had no significant association with *Macromischoides aculeatus* Mayr, *Crematogaster depressa* (Latr.) and *Polyrhachis decemdentata* E. Andre. The colony size of *Cat. guineensis* was also investigated and it was found that 1 - 3 nests constituted a colony.

The contents of the nests of *Cat. guineensis* were examined and the importance of the inquilines in the nests is discussed. It was found that an inquiline, *Neotermes* sp., actually initiates the nests of *Cat. guineensis*.

Heads of the adults of the various castes were measured for comparison of head sizes of each caste, and it was found that except in a few cases, no significant differences were shown in the various comparisons. The structure of the nest and the distribution of the brood inside it were also investigated and the brood were found to be distributed almost throughout the nest next.

The effect of meteorological factors, on the activity pattern of the ant was studied. Rainfall seemed to be the most important factor indluencing the activity of *Cat. guineensis*.

CHAPTER 1: GENERAL INTRODUCTION

CHAPTER ONE

GENERAL INTRODUCTION

The cocoa-farm forms a complex, heterogenous ecosystem - with large variations in the degree of canopy density, the number of species of shade trees, present, the depth of litter, amount of dead wood and in the nature of the neighbouring vegetation - both from farm to farm and within the same farm throughout the yearly cycle. The existence of the above features in a cocoa farm makes the cocoa ecosystem habitable to a diverse vertebrate and invertebrate fauna. Since this faunal diversity resembles that of primary forest, it has been suggested by Leston and Hughes (1968) and Room (1971, 1972) that, ecologically the cocoa farm should be regarded as a type of forest - the 'cocoa forest'.

The insect fauna of the 'cocoa forest' has been studied in different parts of the world (Alibert, 1951); and the findings in all the regions, including W. Africa, have always shown it to be very rich and diverse. In W. Africa a large proportion of this rich insect fauna appears to be constituted by ants as the following examples in Ghana will tend to suggest. In an area of 250 m^2 cocoa farm at Tafo, Room (1971) found 48 genera and 128 species of ants and in 1972 he stated that ants form 50% of the insect species found in cocoa mistletoe, *Tapinanthus bangwensis* (Engle & Krause). According to Majer (1974), over 71 species of ants were found in one 2.25 hecter block of cocoa although only 11 ~~of~~ of these ever reached a numerically dominant status.

The ant fauna on plantations has been reported to be distributed in an unexplained patchy pattern by several workers in different geographical regions (Brown, 1959, in the Solomon Islands; Greenslade, 1971, also in the Solomon Islands; Room 1971, in Ghana; Vanderplank,1960, in E. Africa; Way, 1953, also in E. Africa; and Wilson, 1959, in New Guinea). This patchy distribution of the territories of the ant species prompted Leston (1970) to term it the "three dimensional mosaic", which is defined in terms of what has been described by several workers (e.g. Leston, 1971; Majer, 1972, 1973; and Room, 1971) as dominant ant species. Thus the mosaic consists of a patch work of colonies of the "species which numerically predominate in a given area and which generally exclude other ants known to predominate numerically in some areas" : the dominant species. In addition to the dominant species, Leston (1971) recognised two other groups of ants - the co-dominants, numerically predominating groups which can co-exist in a given area by adopting varied forms of behavioural and ecological patterns; and the non-dominants,'numerically insignificant' groups. The non-dominants, according to Leston (1971) are not likely to reach a dominant status under any field conditions. Mayer(1972) recognised a 4th group of ants - the sub-dominants - which "under certain field conditions may numerically predominate and exclude all other species". For instance, Camponotus acvapimensis Mayer is said to predominate numerically and to exclude other ant species from areas of cocoa ecosystem which are devoid of shade and having characteristics of savanna grassland. The individual colony patches may be borded by a "no-man's land" - a peripheral line of trees unoccupied by any dominant species - or the territories of the dominant species may interdigitate more closely (Majer, 1973), with the characteristic "distinct insect spectrum associated with each numerically dominant ant" (Room, 1971).

Generally, little is known about the ecology of cocoa ants in Ghana. Nevertheless some attention has been directed towards the study of several dominant species. For instance, Aryeetey (1971) worked on Macromischoides aculeatus Mayer, Collingwood (1971), reporting on ant predators, emphasized the dominants only, and Leston (1968) investigated the diurnal activity of Oecophylla longinoda Latreille at Tafo, Ghana.

Almost nothing is known about the ecology of the non-dominant species. The mention of them in any of the above works has been due merely to their co-existence with the particular dominant species which is being studied. The present work is an attempt to provide information on some ecological aspects of a non-dominant species - Cataulacus guineensis F. Smith. It is hoped that this work will generate interest in the studies of the ecology and behaviour of the non-dominant ants, since their manipulation in the cocoa ecosystem, together with the proper manipulation of the dominants is likely to enhance the chances of obtaining a more successful biological control in the cocoa farms than the use of the dominant species alone.

CHAPTER 2: THE GENUS *CATAULACUS* F. SMITH

CHAPTER TWO

THE GENUS CATAULACUS F. SMITH

The classification of *Cataulacus* has been a matter of controversy among workers. Smith (1876) treated it as a member of the family Cryptoceridae, in which he included *Meranoplus* F. Smith, and the constituents of the present tribe Cephalotini. Emery (1893) on the other hand suggested the dissolution of this patently artificial and very mixed group, and went so far as to note that *Cataulacus* formed a distinct group on its own. During his attempt to overhaul the higher classification of the Formicidae Forel (1917) created a section Rhagiomyrmicinae to include myrmicine ants characterized by what Bolton (1974) described as 'the flattening of the head and often the entire body, and also by the numerous lateral appendages of the latter'. These criteria, according to Bolton (1974), resulted in the aggregation of five tribes (by modern standards) under one section which, incidentally, came very close to F. Smith's concept of the family Cryptoceridae. The included tribes were the Basicerotini, Cataulacini, Cephalotini (Cryptocerini), Dacetini and Stegomyrmecini, and they are only linked by trivial and inconsistent characters given by Forel, which are certainly the results of convergence rather than an expression of actual relationship. Bolton (1974) states that Emery (1921) "rightly criticized this grouping as unnatural and referred Rhagiomyrmicinae to the synonymy of the various tribes involved".

Although over a century old, the genus as such has not been revised previously as the majority of earlier authors passed it over without comment or criticism and no check whatever was placed upon the amazing and completely uncalled for proliferation of specific and infra-specific names, especially among the African forms (Bolton, 1974). The haphazard and often irrelevant descriptions by Smith during the third quarter of the last century led to the re-discription as new of many of his species by later authors, who could not correlate Smith's descriptions with the specimens available to them (Bolton, 1974). Bolton (1974) reduced the earlier number of names in the genus to about half, mostly by the synonymy of infra-specific forms, described eight new species, and stated further that "it seems apparent that numerous new species await discovery...."

The ant genus _Cataulacus_ F. Smith - according to Bolton's (1974) classification-is now the sole member of the tribe Cataulacini, and it in fact stands in isolation as its affinities are not understood. But it is certainly not closely related to any of the tribes with which it was traditionally grouped (Bolton, 1974).

In the zoogeographical regions occupied by members of the genus the species are known to be distributed as follows:

1) Ethiopian region : 27 species (26 endemic)
2) Malagasy region : 8 species (7 endemic)
3) Oriental region : 6 species (5 endemic)
4) Indo-Australian region: 12 species (11 endemic)

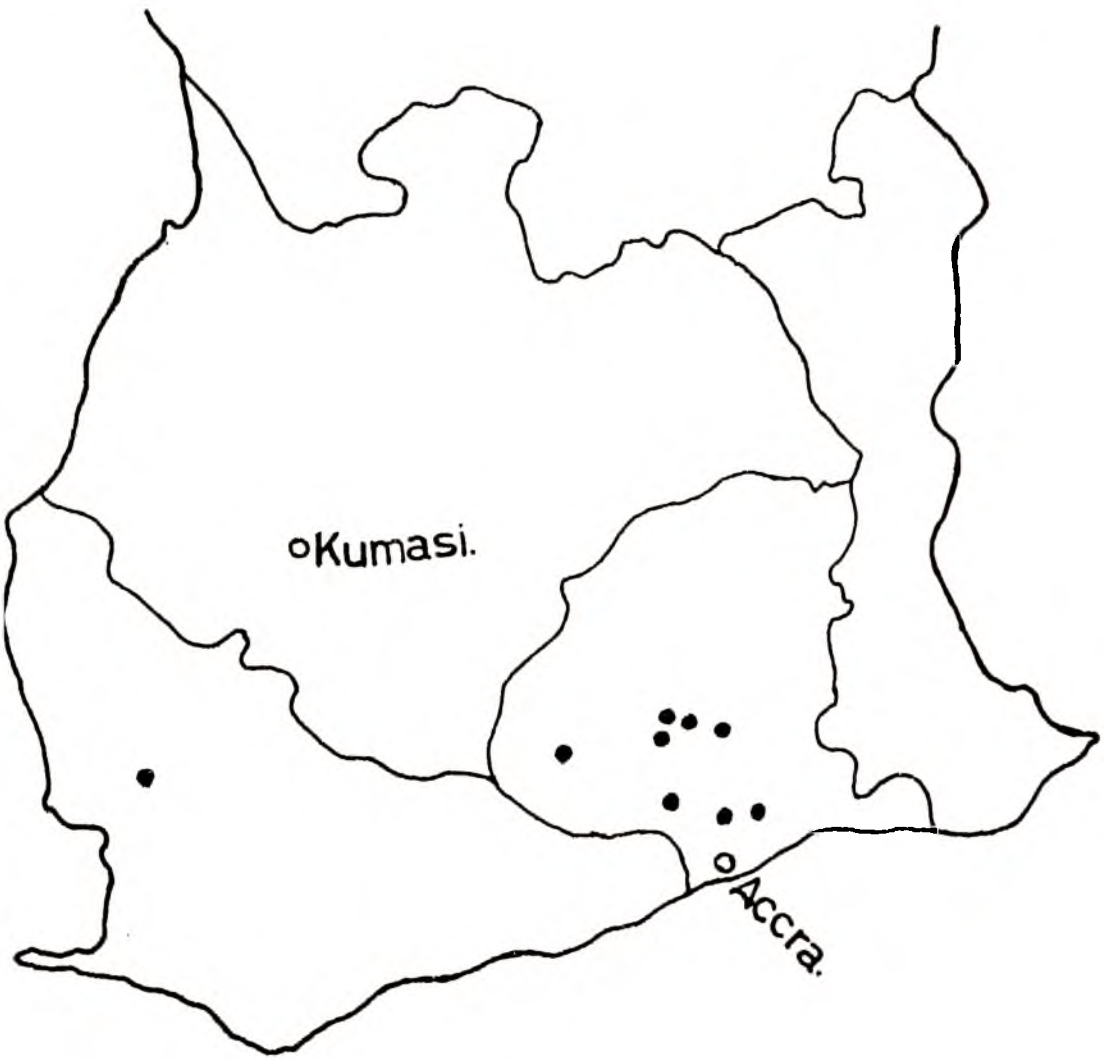
According to Bolton (1974), these species form seven recognizable species - groups of which four occur in the Ethiopian and the Malagasy regions while the remaining three occur in the Indo-Australian and the Oriental regions.

The study of the species of these regions has been by necessity, based on the worker caste since the sexual forms remain unknown in majority of cases (Bolton, 1974). The majority of the species of the Ethiopian and the Malagasy regions are forest dwelling forms, with relatively few adapted to savannah or veld conditions.

Cat. guineensis is a member of the *guineensis* group, the smallest of the four species groups in the Ethiopian and the Malagasy regions. The other two species in this group are *Cat. erinaceus* Stits, and *Cat. greggi* Bolton. These species inhabit the rain forest of West and Central Africa and *guineensis* is believed to be the most common species of the genus in such areas. According to Bolton (1974), in Ghana, *Cat. guineensis* has been found at the following places: Tafo, Bunso, Kibi, Larteh, Enchi, Adeiso, Sajimasi, Kade, Pimpimso, Ankase Forest Reserve, and Mampong. All these areas are within the tropical rain forest region of Ghana (Fig.1).

Bolton (1974) stated that the mature nests are usually populous, containing hundreds of workers, and that the nests are formed in rotten branches of otherwise healthy trees, often at a considerable distance above the group. The species is believed to be unable to bore holes in wood and therefore tends to move into any pre-formed holes made by other insects such as wood-boring beetles and termites.

Fig. 1; A map showing places where *Cat. guineensis* has been reported in Ghana.



Concise descriptive accounts of the castes of this species have been given by Bolton (1974). Like the other species of the _guineensis_ group, _Cat_. _guineensis_ presents a wide range of size, and except in some individuals of _Cat. guineensis_, members of this group are characterized by numerous, simple stout hairs on the dorsal surfaces of the head, body and appendages. In _Cat_. _guineensis_ the remarkable range of size has been found even in one and the same nest. In fact this wide range of size seems to have compounded with the variable sculpturation of the workers caste to create problems with the toxonomic studies of the species.

The species has been reported by Bolton (1974) (and the writer also found it) to forage in areas constantly foraged by _O. longinoda_ and the former appears to tolerate the incessant predatory attempts of the latter, perhaps relying mostly on its armour (seemingly thick cuticle) for protection. Bolton (1974) has further described the defensive behaviour of this ant, and claims that the behaviour varies with the size of the attacker. If the attacker is large and/or persistent the _guineensis_ workers have ~~has~~ been found to roll up, release its grip on the bark of the tree and escape by falling onto the ground.

Very little is known about the food habits of _Cat. guineensis_, though some workers including Bolton (1974) have found it tending aphids and small coccids.

None of the available information on this ant gives any indication of predatory activity on its part, though the species itself has been found in the stomachs of *Bufo tuberosus* Gunther and *B. polycerus* Wernet by Wheeler (1922).

Most of the available information on the species *Cat. guineensis* is rather sketchy and it is the aim of the present study to provide information on some aspects of its ecology and behaviour in detail so as to provide the basis for work on other ants in cocoa ecosystem. In this direction attempts are made to investigate the distribution of this ant in relation to shade regimes and in relation to the distribution of other ant species occurring under such regimes in a Ghanaian cocoa farm. Also included is an investigation into the colony size of the species. Activity pattern, including foraging, and food and nesting habits; as well as the phenological changes in the nests contents are also studied in this work.

CHAPTER 3: THE STUDY AREA

CHAPTER THREE

THE STUDY AREA

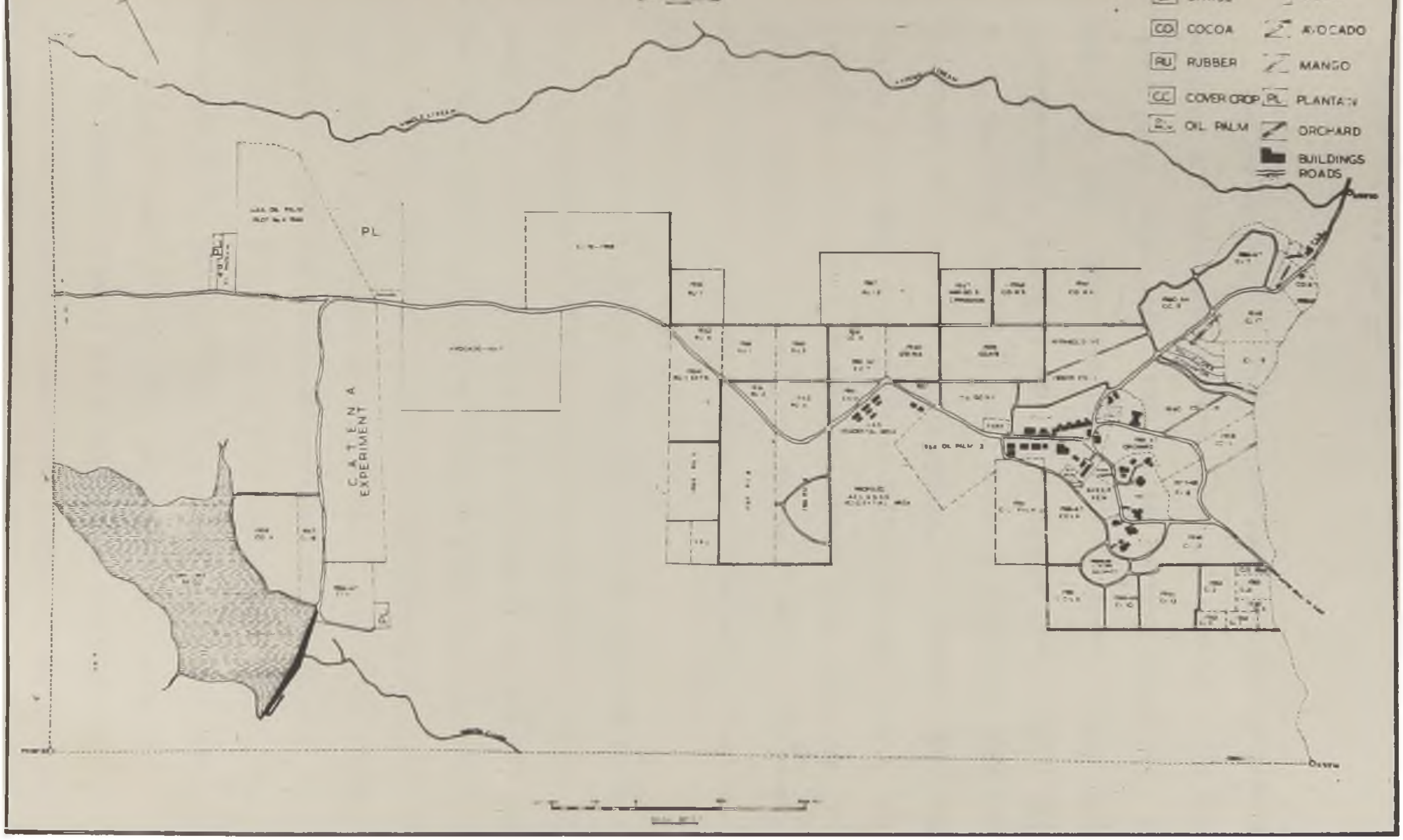
3.1 GENERAL DESCRIPTION

The work was done at the University of Ghana's Agricultural Research Station near Okumanning, a village approximately 8 km north-west of Kade. Kade itself is in the Eastern Region of Ghana and it is about 112 km north-west of Accra (Fig.1). It is located at longitude 0^{o} 55′ W and latitude 06^{o} 09' N and according to Taylor (1952) lies in the *Celtis-Triplochiton* association of moist semi-deciduous forest. The forest here is believed to be over 100 years old. The soil in the area is derived from the precambrian phyllitic rocks and it is of the Nzima-Bekwai-Kokofu soil association. The western, northern and southern ends of the station (Fig.2) are still bordered by dense primary forest which continues to be exploited by the timber industry. However the eastern end has been cleared for the cultivation of oil palm by the State Farms Corporation.

The Station covers an area of about 2,700 acres of which over 1,000 acres have been developed, and was established in 1957-58. According to Majer (1973) "the area then consisted of relics of primary forest, considerable expanses of secondary forest, swamp forest, farm bush, mixed farm land and some cocoa."

Fig. 2 AGRICULTURAL RESEARCH STATION - KADE

LAND USE



The Station aims at studying and improving the performance of perennial and semi-perennial crops, and soils found in the Ghanaian forest belt; crops under study include various Citrus spp., Cola nitida Schott and Endl., Hevea brasilienis Mill. (rubber), Persea americana Mill. (avocado pear), Mangifera spp., Piper nigrum Linn., Elaeis guineensis Jacq., now being studied by Crops Research Institute, Musa spp (plantains and banannas), Carica papaya Linn. (pawpaw), Xanthosoma mafaffa Schott., (cocoyams), orchard (fruit collection) and cocoa. Soil management including systems of land clearing, use of cover crops and fertilizers are also studied. A new project started in 1973 is the sheep project which is aimed at studying problems of integrating sheep rearing with tree crops (e.g. oil palm and citrus.)

Cocoa on the station covers 139 acres of which 25 acres are being used to study the effects of fertilizer and shade on cocoa. The rest is for commercial activity producing about 35 tons of cocoa beans annually. The 'area of detailed studies' (a mapped area where most of the investigations in this project were conducted) was demarcated on one of the cocoa farms used for commercial production (i.e. plot VIII). This plot was planted in 1960 with Amelonado cocoa spaced 2.7 m apart. It lies adjacent to Plot I (planted in 1958) which was originally of farmers' Amelonado cocoa, but was later intermixed with Amazon hybrid trees at 1.6 x 1.6 m square spacing when the University took over.

As shown in Figs. 4 and 5 the area of detailed studies is very close to the residential area of the workers of the station and also to the power-generating house of the station. This means that this area is within an easy reach of the inhabitants of the station. They, together with their domestic animals (fowls, in particular) are very likely to affect the composition and distribution of the fauna of the area. One of the major ways in which they are likely to disturb the distribution of the fauna is the collection of firewood in the plots. This will definitely affect the abundance and distribution of ants such as _Cat. guineensis_ which nests in the very dead wood collected as firewood. The domestic fowls which wander about for food in the plot are likely to consume ants which may happen to forage on the ground. Apart from the direct influences by the people and their domestic animals on the ~~the~~ fauna, there may be some indirect influences as well. For instance smoke from the fire places (some women make large fires along the border of the plot and their houses for preparation of palm oil) and also smoke from the power generating house may have influence on the occurrence and distribution of the fauna of the area.

3.2 _Maintenance of cocoa farms at the Station_: According to Majer (1973) "the station's cocoa farms had been treated at the rate of 4 times annually with 5% gamma-BHC (Gammalin) until 1964 when Snow (1964) reported resistance of the capsid, _Distantiella theobroma_. (Dist.) to this insecticide". DDT was then substituted and applied 4 times a year until 1969 and subsequently three times a year. For the past 2-3 years the rate of spraying has been 2-3 times annually, from August to January (Nartey, farm manager, personal communication). The chemicals which have been used in recent years are Gammalin mixed with Bagon, and Unden 20. According to the farm manager the rate of insecticide application and the type of insecticide used depends on the type of chemical available on the Ghanaian market. The difficulty of obtaining the right insecticide and in good quantities has made it rather impossible for the station to rely on any one particular insecticide.

Clearing of undergrowths is done as and when necessary, solely by cutlassing since the station has found the use of various chemicals to control weeds under the plantation crops too expensive.

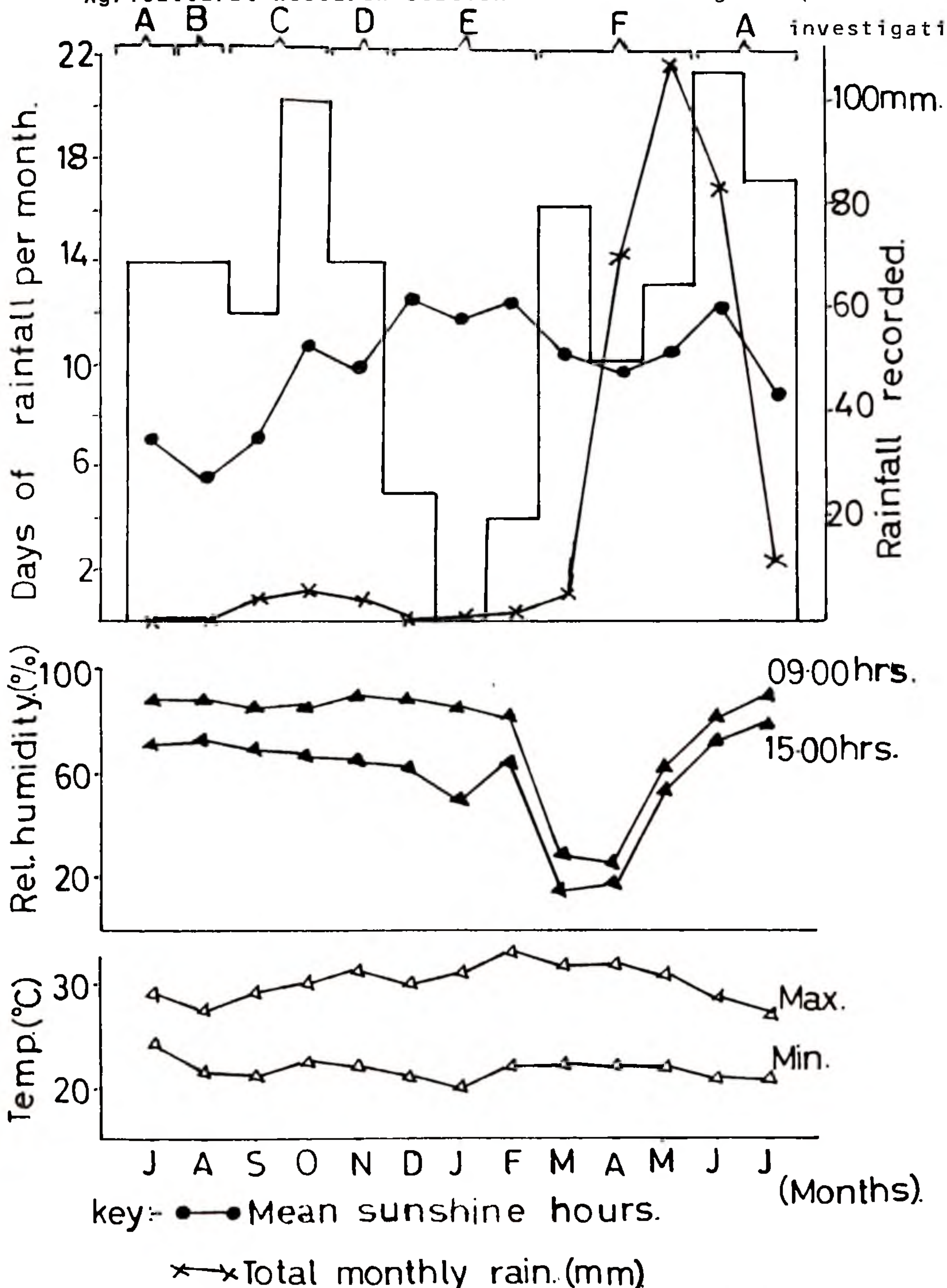
The cocoa mistletoe, Tapinanthus bangwensis (Engle and Krause) is cut annually since this plant kills the apices of the branches of the cocoa trees. According to Room (1971), this practice results in canopy thinning and causes capsid attack. This practice might also affect the spatial distribution of ants, particularly the foliage-nesting species such as O. longinoda and M. aculeatus. Any change in the distribution of these dominant species would definitely affect the distribution of many other ants, particularly the so-called non-dominant species to which Cat. guineensis belongs since "there is a distinct insect spectrum associated with each numerically dominant species" (Room, 1971). The prunning of excess branches and chupons is equally important in the distribution of the ants in the same way as the removal of the mistletoes.

One method of farm cleaning which appears particularly important in the distribution of Cat. guineensis is the annual removal of the dead branches. This in addition to the collection of firewood (mentioned above) will not only disturb the distribution of the species but will also cause reduction in numbers, since many developmental stages and even adults are very likely to perish due to these practices.

3.3. The Climate at Kade: Majer (1973) has given a detailed account of the weather conditions at the station since 1958. In the present work I have restricted myself to providing meteorological information as it occurred during the period of investigation only. The Station's meteorological centre is located at about 300 m away from the area of detailed studies. The relevant information is provided in Fig.3 (appendix table 1).

Gibbs and Leston (1970) devised a sequence of seasons at Tafo, based on "the most variable factors - sunshine and rainfall", and they pointed out that these seasons "fitted the observed biological events better than seasons based on other climatic criteria used by other authors" such as Boateng, 1959 and Kendrew, 1961, who based their seasons mainly on rainfall alone and on rainfall and temperature respectively. Though Kade and Tafo are about 60 km apart, Majer (1973) has shown that the climatic conditions in the two forest localities are similar and in fact he goes on to suggest "the applicability of Gibbs and Leston's scheme to other areas of this type of forest".

Fig.3: Meteorological information at the University of Ghana's Agricultural Research Station at Kade during the period of investigation



A = Dry-sunny season, B = Wet-sunny season, C = First wet-dull season
D = Dry-dull season, E = 2nd Wet-dull season
F = 2nd Wet-sunny season.

CHAPTER 4: DISTRIBUTION IN SPACE

CHAPTER FOUR

DISTRIBUTION IN SPACE

4.1 INTRODUCTION

Bolton (1974) divided the genus, *Cataulacus* into various groups of which one is the guineensis - group. This group comprises 3 species, namely *Cat. erinaceus* Stitz, *Cat. greggi* Bolton, and *Cat. guineensis* F. Smith. The 3 species included in this small group inhabit the rain forests of West and Central Africa and *guineensis* is probably the most common species of the genus in such areas (Bolton 1974).

Perhaps it is because of its relatively commoner occurrence in these regions of Africa that Bolton (1974) was able to obtain specimens of *Cat. guineensis* from different countries in the two regions. For instance in Central Africa he obtained specimens of the species in Leopoldville, Stanleyville, Bolobo and Yambata. Forel (1916) recorded the species at Motombe on the Okiavo, Zaire. In West Africa Bolton (1974) examined materials from the following countries:

1) Liberia (at Bendija, Gibi, Belleyella, Reputa, Cape Mount and Monrovia);
2) Ivory Coast (at Divo and Orstom Research Station, near Abidjan);
3) Nigeria (at Ibadan, Evin-Odo, Old Calabar, Gambari and Olokomeji);

4) Cameroun (at Mbale Mayo to Ekingli) and

5) in Ghana (at Tafo, Bunso, Kibi, Adeiso, Kade, Sajimasi, Mampong, Larteh and Enchi).

One is tempted to raise a number of questions on the above information: (1) How common is the species in these areas where it was found; in other words how common are the nests of the species in these areas? (2) How is the distribution of their nests (or colonies) related to the distribution of shade in its particular ecosystem? (3) What is the colony size, that is, how many nests of the species constitute a colony? (4) What is the distribution of the species in relation to those of other ant species which also occur in its ecosystem? Some information on these questions is available on several ant species. For instance, basing his classification on the relative abundance of various species of ants in Ghanaian cocoa farms, Leston (1971) distinguished 3 groups of ants which he described as (1) dominant, (2) co-dominant and (3) non-dominant. He defined the dominant groups as being numerically predominating in a given area, and these normally exclude other potentially dominant species. The co-dominants, though are also numerically strong, are able to co-exist by adopting a variety of behavioural patterns. The non-dominants appear to be numerically unimportant.

As an example of answers to the second question, Aryeetey (1971) reported that Macromischoides aculeatus (Mayr) is a shade-loving ant. Majer (1976 a,b) agrees with Aryeetey on his finding and goes on to state that some species are found most often under dense canopy, others where the canopy is broken or absent.

With respect to the third question, again Aryeetey (1971) applying the acceptance - rejection method (to be described later) recorded a colony-size range of 2-47 nests for *M. aculeatus*, and with a more sophisticated method using radioactive sugar, he recorded a minimum of 38 and a maximum of 140 nests per colony for the same species.

Lastly, with respect to the fourth question Leston (1970, 1971) reported that the 3 groups of ants he distinguished (above) are distributed in what he called a 3-dimensional mosaic, with different non-dominants co-existing with different dominants by adopting varied forms of behavioural pattern. Hence among the non-dominants, Room (1971) mentioned *Cat. guineensis* as being positively associated with *O. longinoda* but negatively associated with *Crematogaster africana*.

Most of the information on the 4 questions raised above on the various species of ant is lacking in *Cat. guineensis*. Where attempts have been made to supply such information, maps were not provided, data were inadequate and not treated statistically.

It is the aim of this portion of the project to attempt to provide the necessary information on the species, thereby generating interest in its ecology especially the aspects which have been omitted in this work.

4.2 METHODS

4.2.1 Abundance of nests and nest distribution in relation to shade regimes

A preliminary search for nests of *Cat. guineensis* was conducted in five cocoa plots at the station. The plots which were cultivated in different years were plots I (1958), II (1958-59), III (1958-67), VII (1961) and VIII (1960). Plot VIII was found to have the largest number of nests of the species and was accordingly chosen for most of the detailed investigations. No nest was found in Plot III while only a few were found in the other three. These were later harvested in order to examine their contents.

By means of a measuring tape a study area of 12,000 sq.m (i.e. 100 m x 120 m) was demarcated on a portion of Plot VIII where mosts of the nests in the plot were found. This area has been referred to as "the area of detailed studies," (chapter 3). This area was subdivided into thirty 20 metre quadrats. The position of every tree, including the forest trees, stumps and fallen rotting pieces of wood was mapped and each such tree was carefully examined for nests of Cat. guineensis. Incipient nests, usually with one female de-alate plus a few juvenile stages with or without workers, were ignored. The total number of cocoa trees in each quadrat was recorded. Then the percentage of cocoa trees bearing nests of the ant was calculated giving the nest density of the species within the area. Similar calculations were made on the dead rotting forest trees. Nests of other species of the genus were not mapped as these were very few in the area of detailed studies.

For investigations into the shade preferences of the species the method used by Majer (1972) to assess the cocoa canopy was adopted. Hence canopy density was assessed, subjectively, by eye. The various shade regimes, thus determined, were mapped. Nest trees of the species in each shade regime were then recorded and their percentages worked out for comparison. Also to compare the preponderance of nests of the species in the mapped area with those of other ants, similar calculations were done on O. longinoda, M. aculeatus, Camponotus olivieri (Forel), Polyrhachis decemdentata E. Andre and Crematogaster depressa (Latr.). In this project each shade regime is regarded as separate habitat; thus the number of shade regimes demarcated represents the number of habitats in the area of detailed studies.

4.2.2 Colony size

Three methods were applied to investigate the colony size of the species. The first two methods were used to recheck the reliability of each other, thus when method I was used first, method 2 was further used to either confirm or prove contrary the results of method 1 and vice versa. Whenever the two methods gave contradictory results the experiment was repeated several times till a more convincing result was obtained. Method 3 was used on two occasions only, because as will be seen later, this method was convenient only when the nests to be tested were reasonably close together. The 3 methods were:-

1. Transfer of workers method: This method has been used by other workers. For instance Anipare (1971) and Aryeetey (1971) applied it to investigate the colony size of O. longinoda and M. aculeatus respectively. In this method a few workers of C. guineensis were transferred from one nest onto another. A twig, about 40 cm long, was ringed with glue at about 1/4 along its length. The end nearer the glue band was held by the writer and the other end placed onto the nest, hence called the 'donor' nest. When a good number of workers had climbed onto the twig,

the latter was removed from the nest. In this way the ants were trapped on the twig, the glue preventing them from getting to the writer. They were then transferred to the other nest, hence referred to as 'the receiving' nest, by placing the free end of the twig onto it. The reactions of the ants from the two nests were carefully noted.

2. Transfer of nest: This method has earlier been used by Anipare (1971) on *O. longinoda*. It involved the transfer of a piece of one nest onto or very close to another nest so that the wandering ants from the two nests came in contact with each other. This method, therefore, involved not only the worker caste but also the alates and brood as well as such common inquilines as termites.

In both methods 1 and 2 a fight between the ants from the two nests was considered as a rejection of each other and, therefore, each nest constituted a separate colony of *Cat. guineensis*. When no such "animosity" was exhibited the ants were considered as having accepted each other and therefore belonging to one and the same colony.

It should be mentioned that in making these observations care was taken to distinguish the ordinary occasional sudden dashes which workers of this ant often made at their nest mates returning to the nest from their foraging 'grounds' and the fights which will be described later.

3. <u>The bridge method:</u> A third method was the construction of a 'bridge' to connect two nearby nests. This was done by tying enough sticks end to end to obtain the required length and placing it across the two nests, with the two ends touching either of the nests. When necessary an additional stick was placed between the nests to offer support to the bridge. When the distance between the nests was long, a rope instead of sticks, was used for the bridge. The rope was tied at each end around one of the nests. Whether a rope or sticks were used for the bridge, workers from the two nests were enticed to move from their respective nests onto the bridge and gradually advanced towards the other nest till eventually ants from the two nests met. The enticement was done by using method 1 described earlier, to introduce ants from one nest in the neighbourhood of the other and vice-versa.

In one such bridge experiment a piece of white cloth was spread beneath the bridge so that fighters which fell on it could be collected, examined for injuries and counted. As some workers engaged in fighting on the bridge others carried out normal foraging activities. This led to the capture of some fighters from both nests and their cephalic indices were compared with those of the normal foragers from the same nest. To distinguish ants from the different nests some workers from one of the nests (B) were marked with red paint on the gaster. Although this often disorganised the ants they soon resumed normal activities.

By means of these 3 methods the number(s) of nests which formed the various colonies of the species in the area of detailed studies were determined. Nests constituting a colony were joined by a straight line in the map constructed of the area of detailed studies.

4.2.3 Distribution in relation to other ants

A search for nests of other ant species was conducted in the same way as that for nests of *Cat. guineensis*. In this case, however, dead branches of cocoa trees, twigs, stumps and dry pods including cherelles were collected, broken into pieces and carefully examined for nests of the ant species. It was necessary to break these plant materials into bits because some ant species are noctural and therefore unless their nests were broken or at least disturbed those ants would have been by-passed. In most cases these possible nesting sites were collected at hand height by the writer and a field assistant. In some cases, however, where many dry pods or cherelles and/or rotting twigs were present (as was frequently found in capsid infested areas), these possible nesting sites were collected at greater heights by the use of secateurs.

Nests with less than 20 adult workers and with less than 5 of any or a combination of the juvenile stages were ignored. Since the production of the reproductives of several species has been shown to be seasonal, the presence or absence of these castes was not considered in determining what constituted a nest. By choosing 20 adult workers and 5 juveniles as the minimum numbers to constitute a nest, it was possible to ignore incipient nests and also to ignore other ant species with very small numbers. Furthermore even if nests of a species satisfied the minimum requirements, but were found in less than 20 samples over the area mapped the species was not considered in the analysis of the data. In this way it was possible to limit the investigations to only a few species of ants.

Nests formed from or on leaves in the cocoa canopy were recorded without prior examination of their contents. Thus nests of *O. longinoda* and *M. aculeatus* were recorded merely on sight. Trees with nests of the various other species were distinguished from those with nests of *Cat. guineensis* by means of different symbols in various maps (Figs. 5a, b, c, d).

Some common ants were identified in the field by the author and an assistant while others were killed in 35% alcohol, taken to the laboratory and keyed out. Some were sent elsewhere for confirmation or identification. In this respect Dr. Campbel of the British Entomological Team at the Ghana Cocoa Research Institute, Tafo proved very helpful.

The data thus collected were compiled in the form of general 2 x 2 contigency table and subjected to statistical analysis using the chi-square method. To safeguard the reliability of the analyses, Yate's correction factor was applied. By applying Yate's correction factor the results of the various anslyses would be valid even if some of the expected values were very small (less than 5).

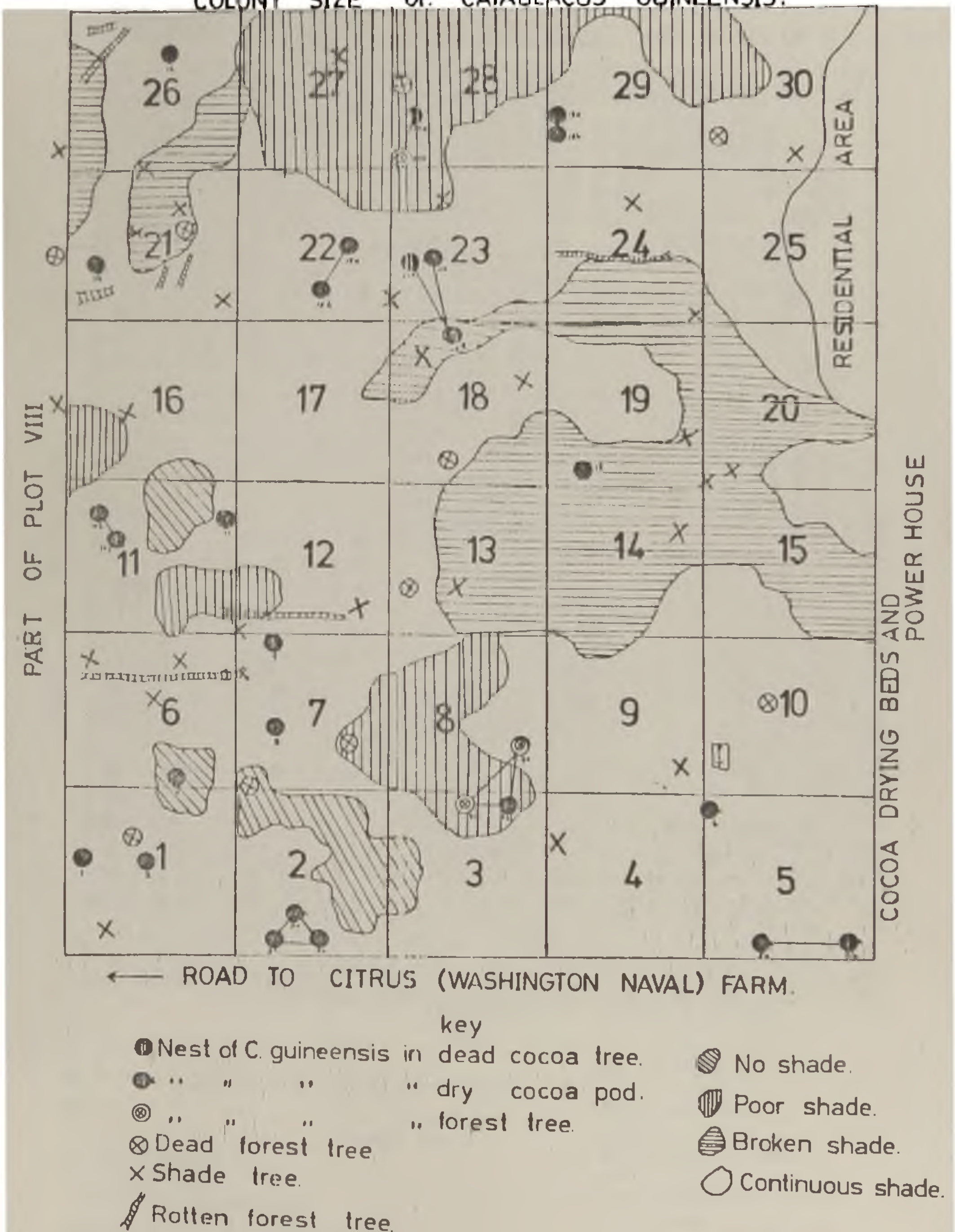
4.3 RESULTS/OBSERVATIONS

4.3.1 Abundance of nests and nest distribution in relation to shade regimes

(a) Abundance of nests

Figures 4, 5a, b, c and d show maps of the area of detailed studies and also the spatial distribution of nests of *Cat. guineensis* in the area.

FIG. 4 MAP SHOWING COLONY SIZE OF CATAULACUS GUINEENSIS.



Scale: 1cm. = 8·0m.

FIG.5a: MAP SHOWING THE DISTRIBUTION OF NESTS OF C. GUINEENSIS AND NESTS OF O. LONGINODA

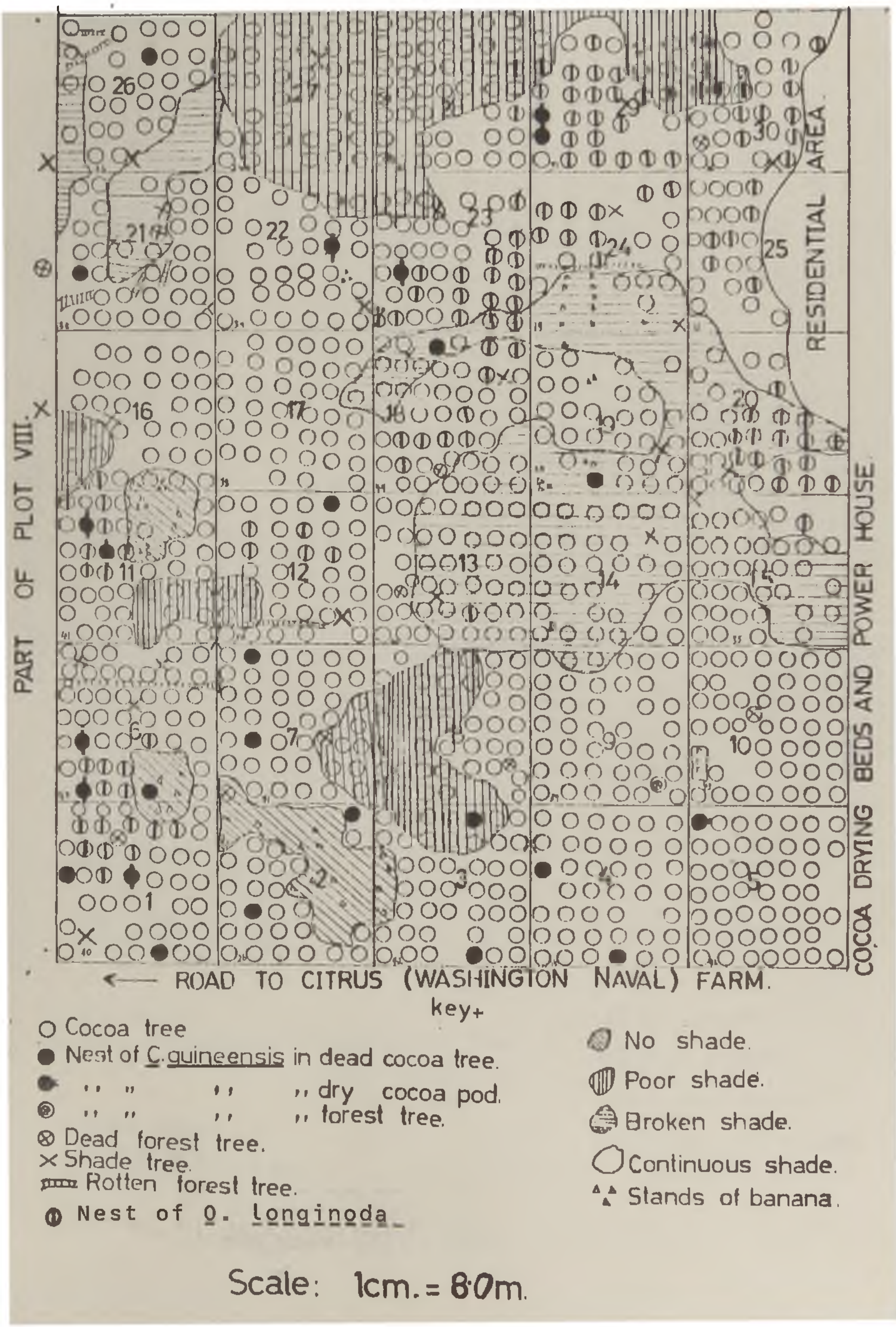


FIG. 5b: MAP SHOWING THE DISTRIBUTION OF NESTS OF C. GUINEENSIS AND NESTS OF M. ACULEATUS

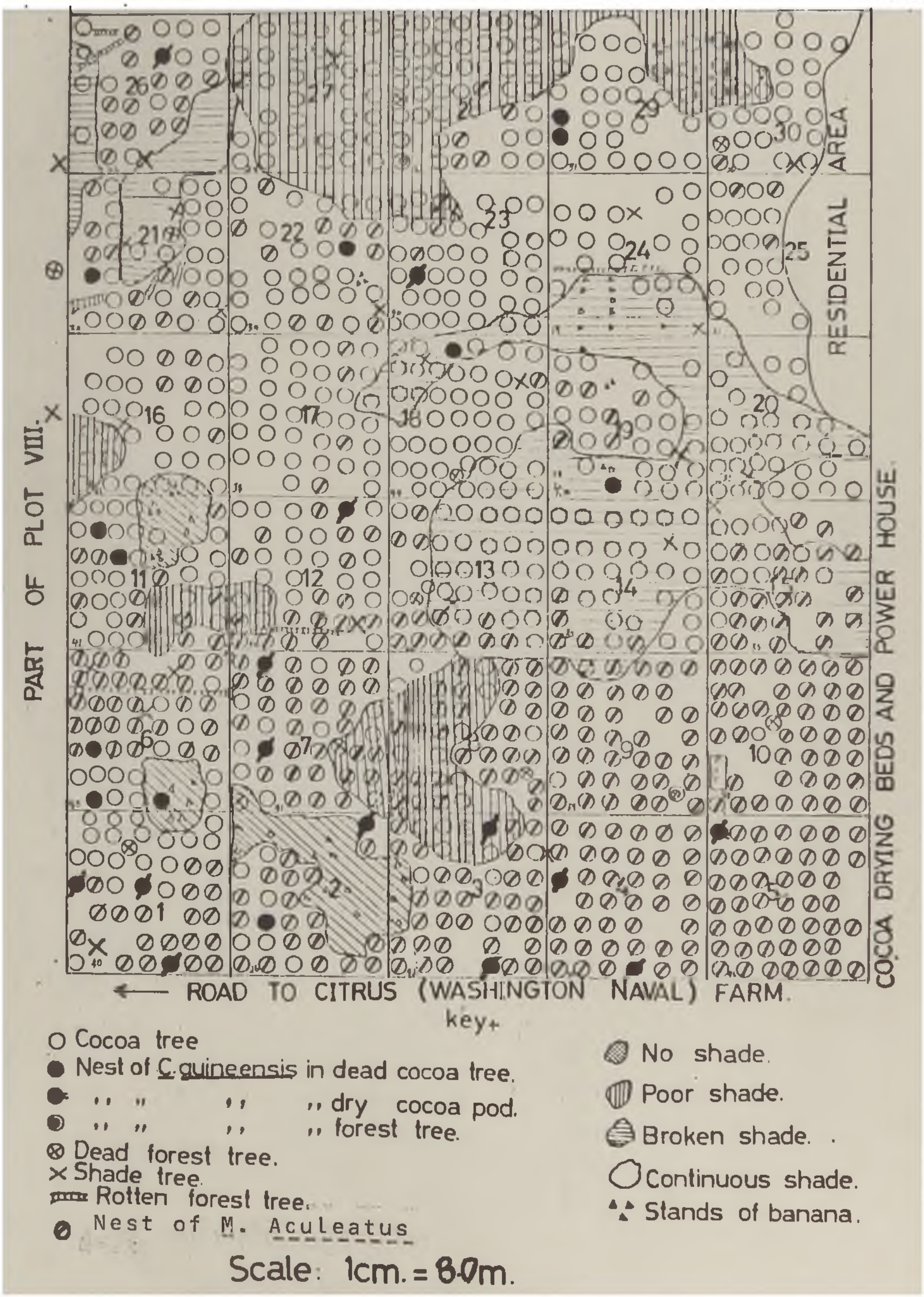


FIG.5c: MAP SHOWING THE DISTRIBUTION OF NESTS OF C. GUINEENSIS AND NESTS OF CAM. OLIVIERI.

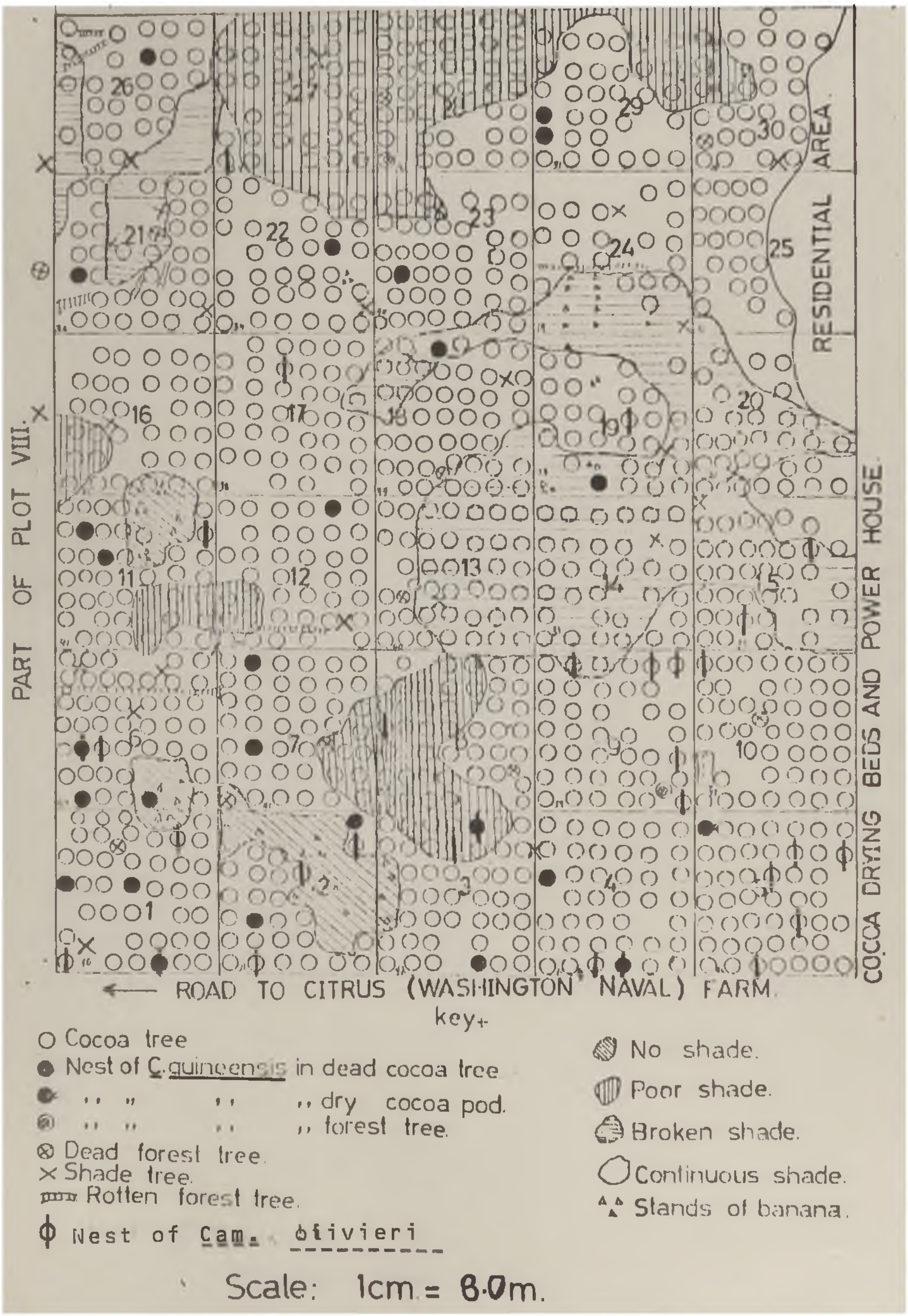
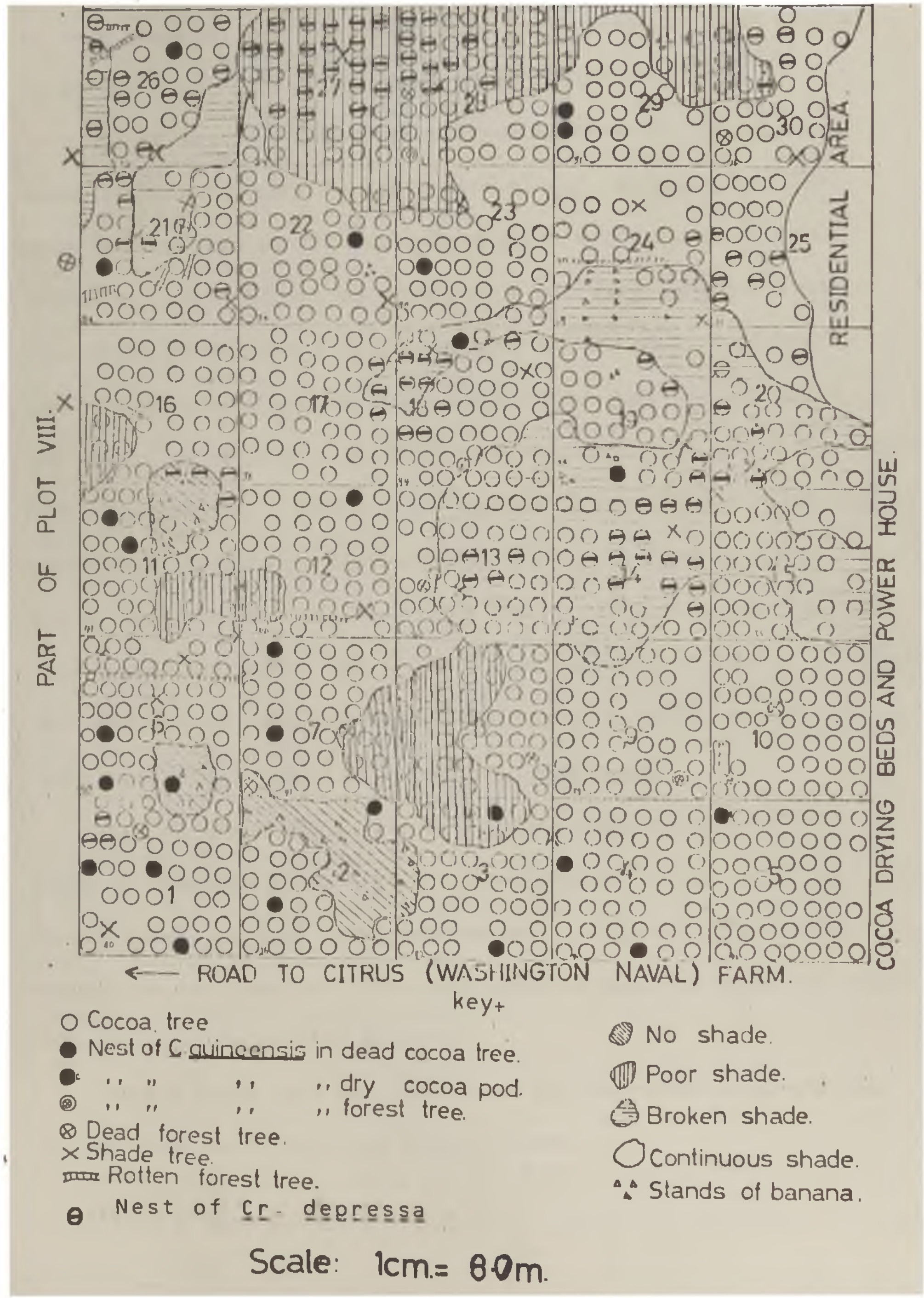


FIG.5d: MAP SHOWING THE DISTRIBUTION OF NESTS OF C. GUINEENSIS AND NESTS OF CR. DEPRESSA.



Serial numbers of the various quadrats are written in the centre of each quadrat, while the number of cocoa trees in each quadrat is at the lower left hand corner of the quadrats.

Out of the 1071 cocoa trees examined only 26, including one cocoa stump were found to bear nests of Cat. guineensis. The positions of some of the nests in figures 4 and 5, are slightly different. This situation arises from the fact that the 2 maps were drawn on different dates and some of the nests in figure 4 had been abandoned and new ones established when figures 5a, b, c and d were being drawn. Nevertheless the number of cocoa trees with nests remained 26. This number represents 2.4% of the total number of cocoa trees examined. This information is provided in table 1. Of the 12 dead forest trees examined, 3 bore nest of the species and this number represents 25% of the total number. If the cocoa trees and the dead forest trees are considered together (1083 trees), then 2.7% of the trees actually bore nests of Cat. guineensis.

Four of the nests on cocoa trees were pod nests and these were found in quadrats 2 and 5 only. A maximum of 3 nest trees were recorded in any single quadrat and a maximum of 2 nests was found on only 2 cocoa trees. In one case both the nests were in pods, while in the other case they were all in rotting branches.

Though there were many pieces of fallen rotten wood and pods in the area, nests were not found in them.

(b) Distribution in relation to shade regimes

The various shade regimes (habitats) observed in the area are demarcated in the figures mentioned above. These are described as:

(1) NO SHADE REGIME: largely an area of rehabilitation with young cocoa, 3½ years old, and intermixed with stands of banana. Trees were absent.

(2) BROKEN SHADE REGIME: canopy is broken at several places or is completely absent, though some shade is provided by forest trees.

(3) POOR SHADE REGIME: poor canopy with little or no shade from forest trees.

(4) CONTINUOUS SHADE REGIME: canopy, though thin is continuous and therefore provides good shade.

The number of cocoa trees in each of the above habitats is indicated in table 1. Also the percentage distribution of the nest-trees in the various habitats is shown in table 1a. It is clear that 84.6% of the nests in the continuous shade regime occurred on only 2.8% of the total number of samples (cocoa trees) in that habitat. Similarly the 3.8% of the nest trees in the poor shade regime occurred on only 0.7% of the samples in that habitat, and so on.

Table 2 displays the percentage distributions of the nest-trees (trees with nests) of *Cat. guineensis* as compared to those of the other ant species mentioned earlier. The information is graphically presented in figure 6. Except *Cr. depressa*, all other species considered exhibited a distribution similar to that of *Cat. guineensis*, that is, they all appear to prefer nesting in the continous shade regime. In *Cr. depressa*

Table 1: Shade regimes and nest distribution.

(a) Percentage distribution of nests in the various habitats.

Habitat (Shade regime)	Total No of samples	No of samples with nests	% of nest trees
No shade	4	1	3.7
Broken shade	142	2	7.7
Poor shade	135	1	3.8
Continuous Shade	790	22	84.6
Total	1,071	26	100.0

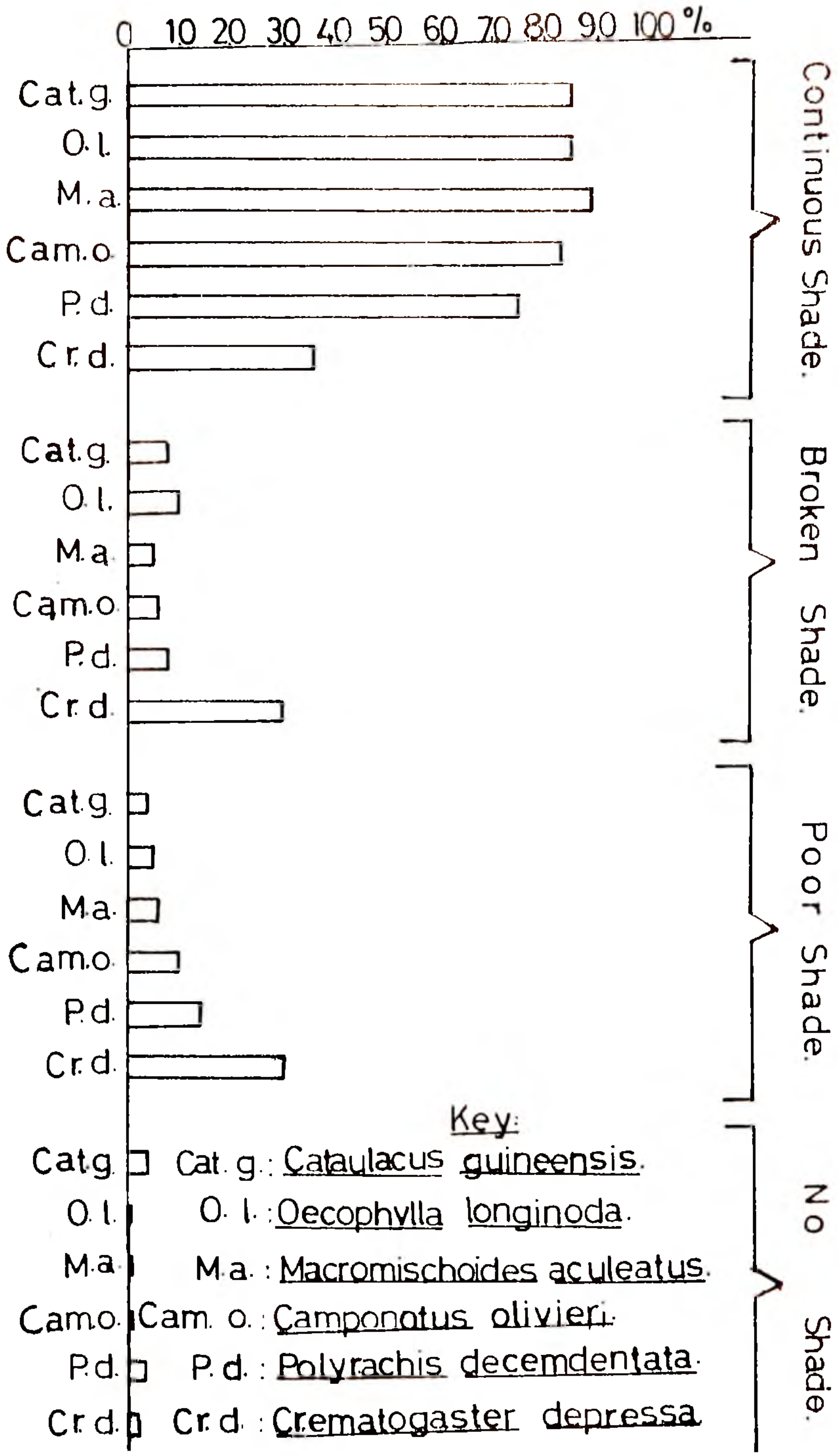
(b) Percentage of samples (trees) with nest(s) in each habitat.

Habitat (Shade regime)	Total No of samples	No of samples without nests	Samples W/nest	% of nest tree trees
No shade	4	3	1	25.0
Broken shade	142	140	2	1.4
Poor Shade	135	134	1	0.7
Continuous shade	790	768	22	2.8
Total	1,.71	1,045 (97.6%)	26 (2.4%)	

Table 2: Occurrence of nests of the various ants in the various habitats (shade regimes).

Species	Habitat			
	Continuous Shade	Broken Shade	Poor Shade	No Shade
Cat. guineensis	84.6%	7.7%	3.8%	3.8%
O. longinoda	84.6%	10.0%	5.4%	0.0%
M. aculeatus	89.3%	5.1%	5.5%	0.0%
Cam. olivieri	82.8%	6.9%	10.3%	0.0%
P. decemdentata	75.0%	8.0%	14.0%	3.0%
Cr. depressa	37.1%	30.5%	30.5%	1.90%

Fig. 6: Percentage distribution of the nest-trees of Cat. guineensis and other ants in the various shade regimes.



the nests were distributed almost equally in 3 of the habitats, quite unlike that of *Cat. guineensis*.

4.3.2 Colony size

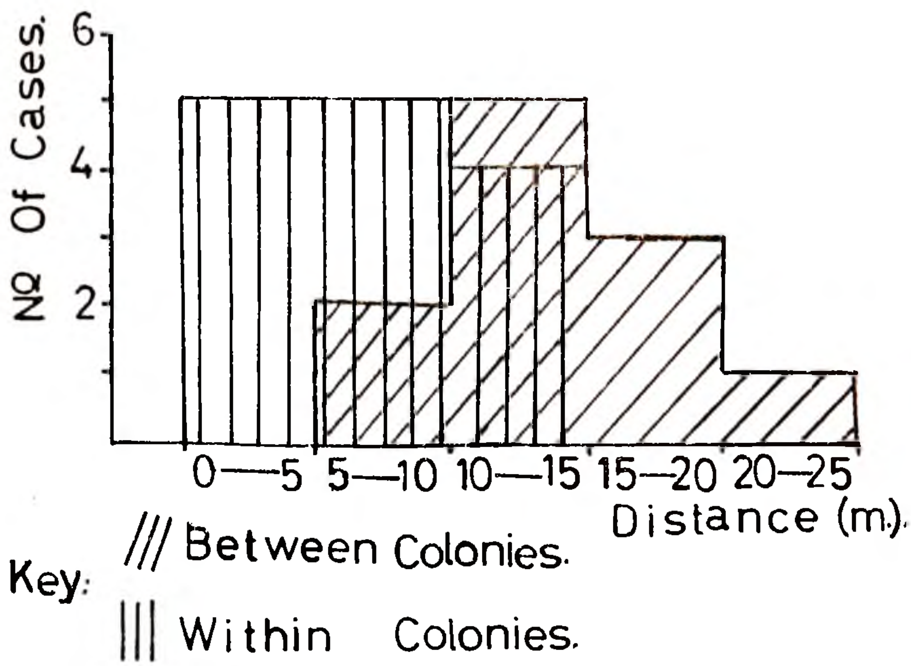
The 29 nests observed constituted 18 colonies as indicated in figure 4. The subscripts a, b, c indicate the number of nests forming any one colony, and nests of one colony are joined by a straight line. The largest number of nests recorded as constituting a colony was 3, and 3 colonies with such a size were found (in quadrats 2, 3 and 8,and 18 and 23). Five other colonies comprised two nests. Each of the remaining 10 nests constituted a separate colony. A colony was formed between nests in pods and in a branch of cocoa tree as found in quadrat 2 or between nests in pods only (quadrat 5) or between nests in a cocoa branch and in forest tree (quadrat 3 and 8, and 28) or between nests in cocoa branches only (quadrats 11, 22 and 29).

A maximum distance of 12.80 metres was recorded between 2 nests constituting a colony (4a and 4c). A minimum distance of 8.50 m was recorded between 2 nests of separate colonies (12a and 15a). The distances measured (table 3), were treated in the form of frequency distribution which is presented graphically in figure 7. As indicated in the table and its corresponding figure, the distance within a colony ranged from 0-15 metres, while that between colonies ranged from 5 to over 25 metres. There is an overlapping between the maximum distance within a colony and the minimum between colonies.

Table 3: Distances between colonies and within colonies

Distance (m)	Within colonies	Between colonies
0 - 5	5	0
5 - 10	5	2
10 - 15	4	5
15 - 20	0	3
20 - 25	0	1
	14	11

Fig. 7: Frequency distribution of distances between colonies and distances within colonies.



Several observations were made on the behaviour of the ants when individuals from different colonies met: (1) Fights between individuals of unequal sizes looked invariably fiercer than otherwise. When it involved individuals of equal or almost equal sizes, the intruder was very often led away by the tip of its antenna or by a pull at any of the legs. In some cases a method which may be described as PULL-PUSH (P-P) was adopted to get rid of the intruder. In this method, as one or more members pulled the antennae or legs of the intruder, others appeared to push it from the end of the gaster. (2) As would be expected, fights were initiated by any 2 enemy-workers, but the number of fighters increased gradually as more and more workers from the opposing nests came across the initiators. When a fight was prolonged and involved many workers, female alates might participate. This was observed on 3 occasions when female alates from an invaded nest were seen actively attacking the 'invading' workers introduced from the enemy nest.

It is perhaps necessary to mention that female alates were also often seen outside their nests when the latter were disturbed, such as when a nest was vigorously shaken. The male caste was never seen in a fight and rarely showed any response to disturbing its nest. (3) Individuals involved in a fight attacked any part of the enemy's body but it was more common to see enemies fighting jaw-to-jaw; particularly when the fight involved only 2 enemies. When more than 2 ants were involved, any part of the body, including the gaster, pedicel, alitrunk and even the spines on it, was attacked almost readily. (4) When 2 enemies were fighting, any 3rd workers which came across them often joined the fight after very little or no hesitation; sometimes, however, the "3rd worker" would just walk by or return almost immediately in the direction of its nest. (5) Injuries caused to individuals involved in a fight included loss of part or whole of antenna(e), loss of all legs (with only coxae remaining) or loss of at least tips of some legs and tips of spines on the alitrunk. (6) A fighter with some or all of the above-mentioned injuries and sometimes even a virtually dead ant was often seen still holding on to its conqueror's leg, spine or antenna. Such victims were seen on several occasions being carried about by the conquerors. Sometimes the victims were even carried into the nest of the conqueror.

The following obsevations were made on a bridge experiment which was started at approximately 4.00 p.m. on the 11th of February, 1976. The bridge (11.6 metres) was between 2 nests, A and B. Thirty minutes after introducing workers from nest B to a point near nest A, workers from A had conquered them and fighting had ceased around that area. However, workers from A continued to advance towards B. The farthest they advanced was only 2.4 metres away from their own nest (A), that is, they were 9.2 m away from the enemy nest, B. Signs of hostilities within the range of 2.4 m from A stopped around 5.00 p.m.

Meanwhile fighting was still going on at a point 0.5 m away from nest B. By 5.09 p.m. workers introduced from A to B had been completely defeated and workers from B advanced towards A. One such fighter from B was seen at a distance of about 1.85 m from its nest, B, at approximately 5.22 p.m.

No fighter from B advanced towards A beyond the 1.85 m point, probably due to the fact that no enemies from A were encountered and/or probably due to the fact that it was getting late. Thus no-man's land of 7.35 m was established between the 2 fighting groups. Even though no new fights were initiated, those started earlier around nest B were still going on around 6.00 p.m. when work was abandoned.

Observation was resumed at 7.30 a.m. on the following day (12th February, 1976). Though several workers from B were seen moving to and from their nest along the bridge, no fights were seen. Workers from nest A had abandoned the bridge completely. When workers from both nests were made to meet again, fights started almost immediately around the 2 nests as it did on the previous day.

Intermittently a worker from either nest would attempt to advance towards the enemy's territory by walking pass a fighting group. Any such 'adventurer' was almost immediately seized by the enemies guarding the rear of their mates which were already fighting. By this defensive behaviour of the guards, advancement to the enemy's territory was very slow; and as fighters continually fell to the ground so also were the establishments of fights between new individuals in their place. At the time of abandoming work (6.15 p.m.) there were only 26 ants still fighting, some in pairs, others involving more individuals. Apart from the fighters a few other ants were still moving along the bridge. Six fighters were seen returning to nest A with their victims still holding on to their bodies.

To investigate the injuries sustained by the fighters, 431 fighters were collected from the piece of cloth spread beneath the bridge from 8.00 a.m. to 6.15 p.m. on 12th February, 1976. Out of this number as many as 409 (94.9%) were found to have parts of their appendages, particularly the antennae broken off. The remaining 22 (5.1%) had no visible injuries.

On the 13th February, observation was resumed around 7.00 a.m. and workers were seen moving up and down the bridge and to and from the 2 nests. The first fight was observed around 8.00 a.m. in the neighborhood of nest B (4.3 m). Up to 2.00 p.m. when work was discontinued, fights involving only a few workers were still going on around nest B; no fights went on around nest A. Four days after the start of the experiment (14th FEbruary), no more ants were seen on the bridge and the experiment was consequently stopped.

Plate 1 shows nest A and part of the bridge. Unfortunately nest B did not appear in the picture and no ants are seen on the bridge. Plate 2 shows 2 ants fighting on the bridge and a 3rd has just joined them. Yet a 4th ant is about to join the fight as shown in plate 3.

It is, perhaps, important to mention here that before after this experiment foragers from A were occasionally seen returning to their nest with injured workers of the species (probably from nest B) attached to their appendanges as described above. Foragers from B were never seen carrying any victims into their nest.

Analysis of data on head measurements of fighters and normal foragers

Plate 1: A portion of the 'bridge' constructed between nest A (arrowed) and nest B (not in the picture).

The base of the nest is still alive and is occupied by Neotermes sp.

Plate 2: A portion of the 'bridge' showing two workers engaged in a fight. A third worker has just joined the fight.

Plate 3: A fourth worker is about to join in the fight.

from the 2 nests (A and B) is provided for comparison in table 4. The t value read from statistical tables is 2.048 at the 5% probability level with 28 degrees of freedom and this far exceeds the calculated t-values (that is 0.55 and 0.52 for nest A and B respectively). The results therefore indicate no significant difference between fighters and ordinary foragers from both nests at the 5% probability level.

Other attempts at investigating division of labour among the workers will be dealt with later.

4.3.3 Distribution of *Cat. guineensis* in relation to other ants

Figures 5a, b, c and d show the spatial distribution of nests of *Cat. guineensis* in relation to 4 of the other 5 ant species mentioned earlier. Table 5 presents the relative number of samples (cocoa trees) in which the various species were found and the number in which each was absent. A further information provided in this table is the number of samples in which each of the species occurred together with *Cat. guineensis* and the number in which each did not occur with *Cat. guineensis*. This preparation of the table made it possible for the use of the chi-square test (with Yate's correction factor) and the results are also provided in the table.

For the purposes of comparison, these informations were provided for the entire area of detailed studies as well as the continuous shade regime. The other 3 shade regimes were omitted, since only a few nests of *Cat. guineensis* (4 nests) occurred in them.

Table 4: Head Measurements of fighting ants and normal foragers from Nests A and B.

	NEST A						NEST B					
	FIGHTERS			FORAGERS			FIGHTERS			FORAGERS		
	H.W	H.L	$\frac{HW}{HL}$x100 (C.1)	H.W	H.L	$\frac{HW}{HL}$x100 (C.1)	H.W	H.L	$\frac{HW}{HL}$x100 (C.1)	H.W	H.L	$\frac{HW}{HL}$x100 (C.1)
	2.35	1.95	120.51	1.90	1.60	118.75	1.75	1.40	125.00	2.25	1.85	121.62
	2.35	1.90	123.68	2.35	1.90	123.68	1.60	1.30	123.08	1.80	1.45	124.14
	1.95	1.65	118.18	2.45	2.05	119.52	1.75	1.40	125.00	1.55	1.20	129.17
	2.40	2.00	120.00	1.85	1.55	119.36	1.70	1.40	121.43	1.60	1.30	123.08
	1.60	1.35	118.52	2.20	1.80	122.22	2.15	1.80	119.44	1.60	1.30	123.08
	1.80	1.50	120.00	2.30	1.90	121.05	1.90	1.60	118.75	1.95	1.65	118.18
	2.30	1.90	121.05	1.90	1.60	118.75	2.25	1.90	118.42	2.15	1.85	116.22
	2.35	1.95	120.51	1.90	1.60	118.75	2.20	1.80	122.22	1.75	1.45	120.69
	2.15	1.80	119.44	1.90	1.65	115.15	1.75	1.40	125.00	1.65	1.35	122.22
	2.50	2.00	125.00	2.00	1.70	117.65	1.60	1.30	123.08	1.70	1.40	121.43
	1.90	1.60	118.75	1.75	1.45	120.69	1.65	1.35	122.22	2.00	1.65	121.21
	1.90	1.60	118.75	1.95	1.65	118.18	2.00	1.70	117.65	2.15	1.80	119.44
	2.00	1.70	117.65	2.25	1.85	121.62	1.60	1.30	123.08	1.75	1.40	125.00
	1.85	1.55	119.36	1.70	1.40	121.43	1.60	1.35	118.52	1.75	1.40	125.00
	2.30	1.90	121.05	1.85	1.55	119.36	2.00	1.70	117.65	1.90	1.60	118.75
Σx	31.70	26.35	1,802.45	30.25	25.25	1,796.16	27.50	22.70	1,820.54	27.55	22.65	1,829.23
$\bar{x}$	2.11	1.77	120.16	2.02	1.68	119.74	1.83	1.51	121.37	1.84	1.51	121.94
Σx^2			216,644.14			215,141.21			221,062.57			223,216.42
$(\Sigma x)^2$			3,248,826.00			3,226,190.75			3,314,365.89			3,346,082.39
	t = 0.55						t = - 0.52					

Table 5: Distributional relationships between Cat. guineensis and other ants

	WHOLE AREA			CONTINUOUS SHADE REGIME			
	O. longinoda		Total		*O. longinoda*		Total
	Present	Absent			Present	Absent	
Cat. guineensis				*Cat. guineensis*			
Present	8	18	26	Present	8	14	22
Absent	122	923	1,045	Absent	102	666	768
Total	130	941	1,071	Total	110	680	790
	$X^2=6.97$				$X^2=7.68$		
	M. aculeatus		Total		*M. aculeatus*		Total
	Present	Absent			Present	Absent	
Cat. guineensis				*Cat. guineensis*			
Present	14	12	26	Present	13	9	22
Absent	445	490	1045	Absent	396	372	768
Total	469	602	1071	Total	419	381	790
	$X^2=0.72$				$X^2=0.23$		
	Cam. olivieri		Total		*Cam. olivieri*		Total
	Present	Absent			Present	Absent	
Cat. guineensis				*Cat. guineensis*			
Present	4	22	26	Present	3	19	22
Absent	25	1020	1045	Absent	21	747	768
Total	29	1042	1071	Total	24	766	790
	$X^2=11.69$				$X^2=5.33$		

Table 5: (cont'd)

	WHOLE AREA			CONTINUOUS SHADE REGIME		
	Cr. depressa			*Cr. depressa*		
Cat. guineensis	Present	Absent	Total	Present	Absent	Total
Present	0	26	26	0	22	22
Absent	105	940	1045	39	729	768
Total	105	966	1071	39	751	790
	X^2=1.87			X^2=0.34		
	P. decemdentata			*P. decemdentata*		
Cat. guineensis	Present	Absent	Total	Present	Absent	Total
Present	0	26	26	0	22	22
Absent	36	1009	1045	27	741	768
Total	36	1035	1071	27	763	790
	X^2=0.17			X^2=0.09		

Tabular X^2 = 3.84 at 5% probability level with 1 degree of freedom.

The chi-square value read from statistical tables at the 5% probability level with 1 degree of freedom is 3.84. A comparison of this value with the various computed chi-square values in table 5 indicates that out of the 5 ant species, O. longinoda and Cam.olivieri were the only ones which showed any appreciable deviation from ordinary chance association with Cat. guineensis at the 5% probability level. This, they did, both in the whole area and in the continuous shade regime. The other 3 species did not show any significant deviation from a chance association with Cat. guineensis.

It was found that O. longinoda exhibited constant and persistent attacks on foragers of Cat. guineensis in the latter's trail as will be shown later; but the latter usually adopted defensive tactics which may be described as "head-lowering defensive tactics". By this method Cat. guineensis folds its antenna in the antennal scrobe on the side of the head attacked and then places this side in very close contact to the tree on which it might be trailing.

In November 1974, when the writer attempted to establish nests of Cat. guineensis around the zoology and botany departments of the University, workers of O . longinoda were constantly seen invading the nests of Cat. guineensis brought from the field and carrying workers of the latter away. It was also very common to find large numbers of workers of the former constantly pulling legs and antennae of the latter here and there until the latter was almost dismembered; and then it was carried away.

It was also found that in the areas where the population of *O. longinoda* was particularly very large, *Cat. guineensis* refused to come out of their nest, and it was then that the former invaded the nest, emerging with both adult and brood of *Cat. guineensis*.

4.4 DISCUSSION

4.4.1 Abundance of nests and nest distribution in relation to shade regimes

(a) Abundance of nests: The scarcity of *Cat. guineensis* in cocoa farms at University of Ghana Agricultural Research Station at Kade tends to be in agreement with Bolton's (1974) generalized statement on the genus *Cataulacus* where among other things he stated that "at no point in its range can any species of *Cataulacus* be considered dominant over other arboreal ant genera". Room (1971) also listed *Cat. guineensis* among what he considered non-dominant species associated with certain dominants. It appears all the species of the genus are very scarce indeed, at least in West Africa, because as shown by the results of this work, even *Cat. guineensis* which is believed to be probably the most common species in West Africa (Bolton 1974) is really quite scare. Probably this is one of the reasons why relatively very little work has been done on this species as compared to work on such species as *O. longinoda* which also lives in cocoa farms in Ghana.

(b) Nest distribution in relation to shade regime: It has been shown earlier (4.3.1b) that the species shows preference for an area with continuous shade. In making this statement it is assumed that the nesting sites (rotting wood and dry pods) were evenly distributed throughout the area of detailed studies. The assumption is important because the number of nests of a species in a given habitat is very likely to be affected by the availability of its nesting sites within that habitat (Dice, 1952).

Leston (1968) reported that storms caused death to both *O. longinoda* and *M. aculeatus*, two species which nest in the cocoa canopy, using fresh leaves. The storms therefore can cause damage to their nests by pulling the leaves apart, thus throwing the ants onto the ground and making them available to predators. This situation will be particularly disastrous to the juvenile stages. Though *Cat. guineensis* nests mostly in wood some of these wood-nests were found to be so weak that they could easily be blown down by strong winds. One such case was actually observed by Bolton (1974) in 1969 at the Cocoa Research Institute of Nigeria stationed at Gambari. He reported that a rotten branch of a cocoa tree containing a large colony broke away during a rainstorm, and the ants were seen later moving their brood up an adjacent cocoa tree where they took up residence in another rotten branch. The writer also observed two such cases in March, 1976, when storms were common at the station.

By nesting mostly in the area with continuous shade, therefore, the species is less likely to be subjected to the full effects of the occasional storms.

The preference for continuous shade regime by *Cat. guineensis* may also be linked closely with the preference of such dominant and effective predatory species as *O. longinoda* as well as *M·aculeatus* for the same habitat as shown by the results of this project (Fig. 6). The dominant ant species are known to exclude other dominants from their habitats.

Therefore by occurring in habitats preferred by these species, *Cat. guineensis* is protected from other possible predators which might be more effective as predators than the two species mentioned above. Aş will be discussed later, though *Cat. guineensis* is persistently attacked by *O. longinoda*, the latter seldom succeeds in its attempts to kill the former.

4.4.2 Colony size

The very small colony sizes (1 - 3 nests per colony) recorded for *Cat. guineensis* appear incompatible with the polygynous nature of the species as will be shown later. Again, inconsistent with the small colony sizes is another finding (to be seen later) in which the female de-alates of the species were frequently found in rotten twigs, larger branches and dry pods of cocoa with a few brood members. These de-alates were believed to be forming new nests. It is, therefore, rather surprising that the colony sizes are very small.

One possible explanation is that most of the female de-alates do not actually succeed in their bid to establish new nests, due, perhaps to unfavourable physical as well as biological conditions. The explanation appears particularly tenable since (as will be seen later) only relatively very few adult workers seem to accompany the queen to establish their nests. Majer (1976c) stated that the chances of winged queens successfully starting colonies is clearly much reduced in mature cocoa by the existence of densely packed ant mosaic; the present work tends to support the above suggestion.

Another explanation is that perhaps in any new successfully established nest the inhabitants loose characteristic scent of the original nest and therefore cannot identify members of their original home as belonging to them. This explanation appears particularly reasonable, again considering the fact that only very few adult workers might accompany the new queen to found a new colony. Therefore, with the emergence of new adult workers, accompanied, perhaps, by the death of the few which accompanied the queen from the mother nest, communication link between the new and old nest might break completely, thus each nest becoming a separate colony.

It is not possible to state which of the two reasons is more tenable as both appear equally good. More detailed work is therefore needed on this aspect of the ecology of the species.

In any case it is important to note that the acceptance-rejection method used does not appear to be very reliable and perhaps a more refined method such as the application of radioactive tracer might have revealed a different colony size. The unreliability of the method used here was actually revealed in Aryeetey's (1971) work when he recorded different colony sizes using the acceptance-rejection method and also the radioactive tracer. It is unfortunte that the radioactive tracer material was not available for use in this project.

The overlapping of the maximum distance between nests of one colony and the minimum distance between nests of separate colonies (figure 7) shows that it is not safe to consider two nests as belonging to a single colony or not just by considering the distance between them.

A few comments are necessary on the territorial defence of the species as exhibited through the various fights observed. The participation of the female in fights suggests that the functions of this caste are not wholly restricted to reproduction (and perhaps colony founding only) but they extend to territorial defence as well. This latter function is, however, performed only in very extreme cases and involves only very few of them. This is unlike the male which does not take part in fights. Perhaps the difference in behaviour of the two reproductives is a reflection on the hardness of the body cuticle of the two. The alate female, (figure 8) apart from being larger than its male counterpart (figure 9) also appears more strongly built and is therefore likely to possess stronger mandibles for fighting. The behaviour of female is perhaps in line with the usual innate maternal care exhibited by many other animals.

Injuries sustained by fighters were found to be invariably fatal and such fights can therefore be a very important cause of great reduction in the population size of the species. Though significant tests were not applied to find out the difference between the number of fighters and normal foragers which showed or did not show injuries, it was assumed that as much as possible the ants which came out to fight had not earlier on sustained all the injuries found on them after the fight. In fact any injuries on the workers before involving themselves in a fight should be minimal considering the fact that in the area where these two particular nests (A and B) were situated, no O. longinoda, the persistent attacker of the species, was ever found throughout the period of investigation. It can therefore be concluded that most of the injuries were

FIG. 8: ALATE FEMALE.

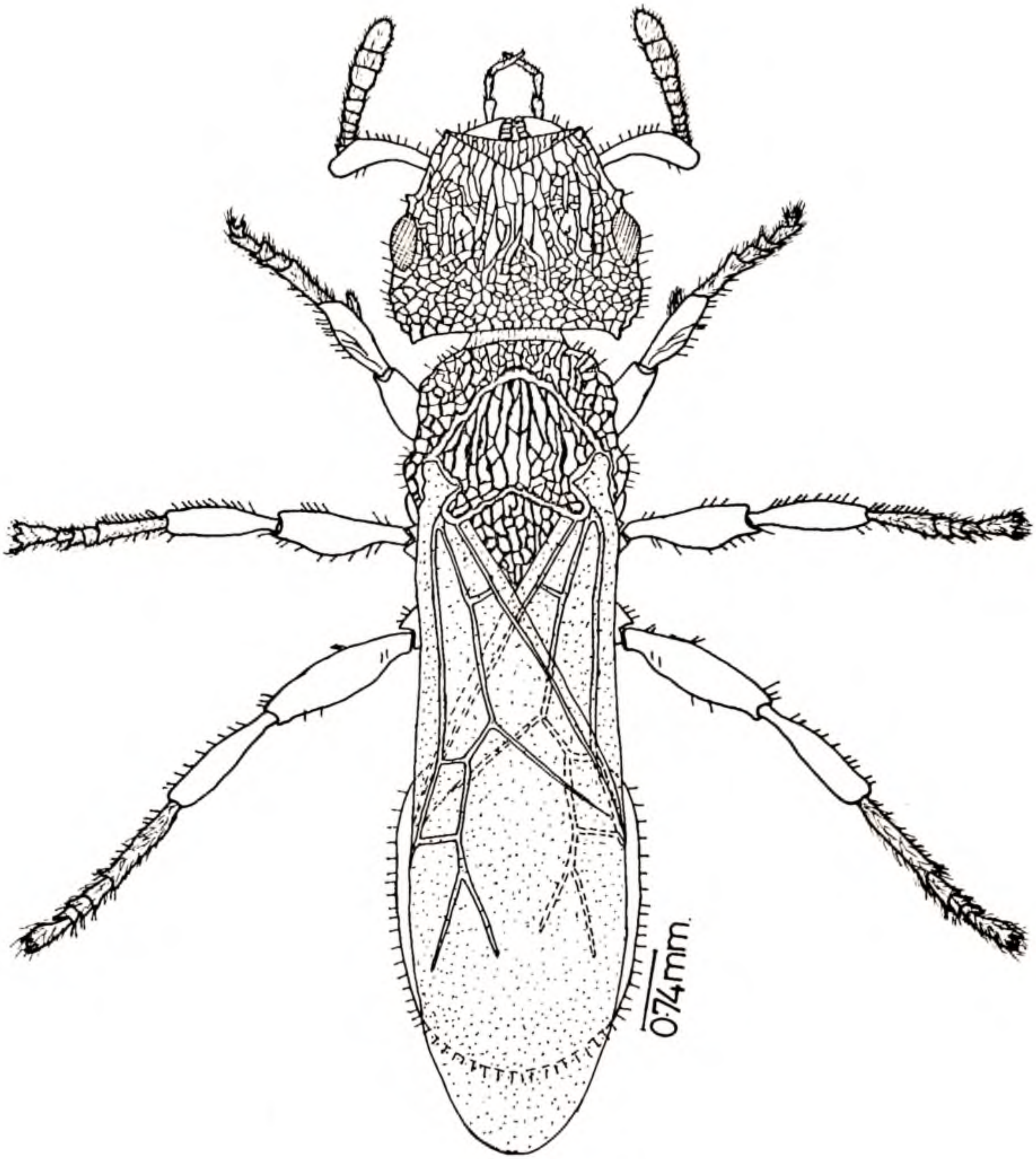
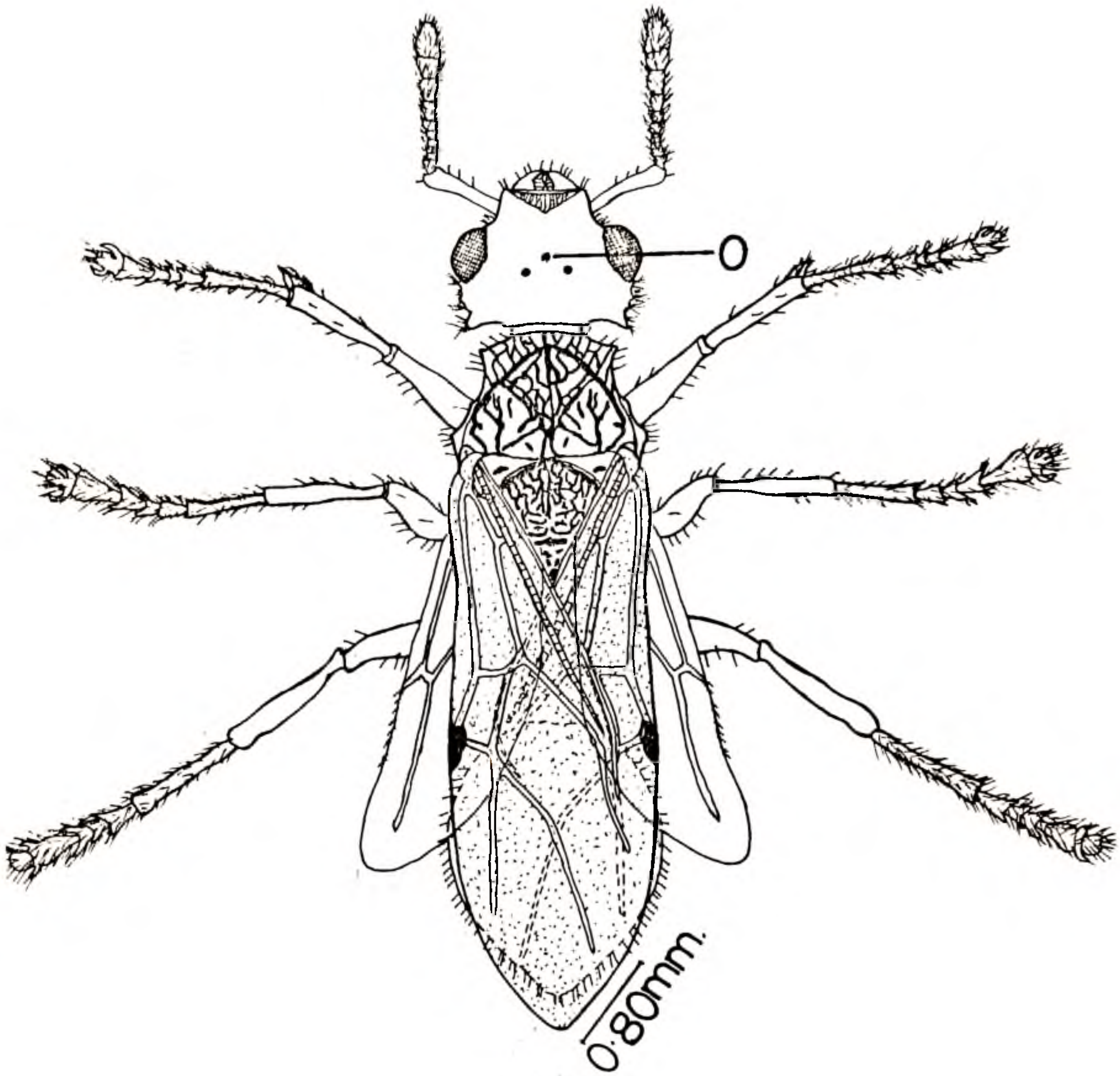


FIG.9: ALATE MALE.



key:-
O: ocellus.

sustained as a result of the fights.

Very fortunately, in Cat. guineensis, fights were not common among members under natural conditions except on a few occasions when a few foragers from nest A returned to their nest with injured workers of the species holding on to their appendages.

Though some of the victims were carried into the nest of the conquerors it is very unlikely that these victims would be devoured, since among the food materials collected from returning foragers (to be seen later) only an insignificant proportion was actually made up of insect bodies, of which only 2 were dry ants belonging to genera different from Cataulacus. It appears to me that the reason for carrying the 'war' victims into their nest was that the conquerors found it impossible to rid themselves of their victims grips since the latter invariably were virtually dead and could not as a matter of course open their mandibles to fall off. The only means left to the conquerors to free themselves from the grips of the victims appears to be the loss of their own appendages on which the victims were hanging; and since these appendages did not break so easily the victims would have to be carried about wherever the conqueror went.

That the analysis of the data on the cephalic indices of the fighters and the normal foragers from both nests A and B showed no significant difference between the two groups in both nests suggests that no further division of labour exists among the workers of Cat. guineensis; and that any worker can be a forager and a potential defender (soldier?) of its nest and territory. More work will be done on this aspect of the project in a section to be treated later.

4.4.3 Distribution in relation to other ants

It is known that in any given series of samples the two species whose association is being measured would be expected to occur together by chance in a certain number of samples. Such chance occurrence would, of course, not indicate any ecological relation between the species concerned (Dice 1952), and it is, therefore, necessary to measure the amount to which the occurrence together of any two given species deviates from that of chance association. This is what the chi-square test seeks to measure. Dice (1952), Hayashida (1960) and Aryeetey (1971) applied a modified form of the chi-square method to find what they called the co-efficient of association in their attempts to study the association between different pairs of ant species. The results of the calculations in this aspect of the project using the ordinary 2 x 2 contigency table, with Yate's corrected factor, will be discussed one after the other; as the various ants concerned are likely to differ in several behavioural aspects, which will in turn determine which of them *Cat. guineensis* will be or will not be able to co-exist with.

1. *Cat. guineensis* and *O. longinoda*

The positive association revealed in this project between these two ant species confirms the findings of Room (1971) who, working on the relative distribution of ant species in Ghana's cocoa farms, included *Cat. guineensis* in the list of the species he considered as sub-dominant and positively associated with *O. longinoda*, a dominant species.

Bolton (1974) also reported that, on plants, ants of the genus *Cataulacus* often occur together with *Oecophylla* or species of *Crematogaster*, and appear to be mostly tolerated by the majority of these forms. What the findings of this work has added to the above informations by the 2 earlier workers is that the two species actually can nest on the same tree.

Several reasons could be cited for the successful co-existence of the two species in the cocoa ecosystem in Kade:

(a) *Cat. guineensis* appears to have developed a high degree of tolererance for the incessant predatory activities directed against it by *O. longinoda*. Its tolerance might be due to its seemingly hard cuticle and the well developed spines on the alitrunk. Bolton (1974) stated that their defence against attacks of *Oecophylla* and *Crematogaster* species lies primarily in their armoured exterior, but their ultimate escape reaction is to curl up and release their grip on the plant, falling to the ground thus making their escape. Though the ultimate escape reaction mentioned by Bolton (1974) was observed, it was only when attempts were made by the writer to catch some of the workers. Therefore, it does not appear to be a very important means of escape from predatory ants. Instead the 'head-lowering defensive tactics', the effectiveness of which is likely to depend on hardness of the cuticle of the ant, appears to be the best means by which *Cat. guineensis* is able to withstand the attacks of *O. longinoda*.

Despite this apparent ability of *Cat. guineensis* to withstand *O. longinoda* it is evident that under experimental conditions, when the latter is very numerous in an area, it can completely wipe out the former. Thus *O. longinoda* may be considered as a potentially efficient predator of *Cat. guneensis* especially if the population of *O. longinoda* is very large in the area where the 2 species exist.

(b) Another possible reason for their very high degree of co-existence is the difference in their nesting habits. Whereas *O. longinoda* uses fresh canopy leaves for its nests, *Cat. guineensis* nests in rotten wood and therefore avoids competition for nesting sites with the former.

(c) Room (1971) suggested that competition for honey dew and prey is a factor which also determines which non-dominants will co-exist with a particular dominant species. This suggestion appears to be true for the successful association of the two species under consideration. *O. longinoda*, though tends several homopteran species, appears to prefer tending the coccid *Stictococcus sjostedti* Ckll. (Room 1971), while *Cat. guineensis*, on the very few occasions when it was seen tending homoptera, tended aphids only. It must be mentioned, though, that Bolton (1974) reported that the species, in addition to the aphids, also tended small coccids. In any case he did not mention the area of his observations. Apart from the difference in their sources of honey dew, the 2 species differ considerably in their general food habits. Whereas *O. longinoda* is generally known to be an active predator, most of the food materials collected from *Cat. guineensis* (as will be seen later) indicate that this species is more of a harvester of plant materials than a predator.

It is not certain what benefits the 2 species gain by living together on the same tree or in same area but as was mentioned earlier, the fact that *O. longinoda*, by its belligerent behaviour, excludes other possible predators, it'protects' *Cat. guineensis* from these possible enemies which may be more effective as predators on *Cat. guineensis*.

2. *Cat. guineensis* and *Cam. olivieri*

Cam. olivieri was found to nest in dry, black pods, cherelles and in rotten twigs of the cocoa trees. Since *Cat. guineensis* was also found, to some extent, to nest in these parts of the trees one would expect some competition between the two species, at least for nesting sites. Inspite of this possibility the 2 species, as shown in table 5 co-exist to a very large extent.

One possible reason for their successful co-existence is the relatively low population level of *Cam. olivieri*. Though no census was taken of the population of this species, its low level was made obvious when nests of the species were collected and broken into pieces when maping the area for detailed studies.

Another reason appears to be the different timings of the activity of the 2 species. As will be seen later, *Cat. guineensis* is a diurnal species but *Cam. olivieri* appears to be nocturnal. Workers of this species were very scarcely seen foraging during the various field work by the writer and his field assistant. Their presence was known only when their nests were broken, and even then they invariably quickly hid themselves in the cavities in the husk of the pod or in the holes in the seeds. The two species thus space themselves out in time.

3. *Cat. guineensis* and *M. aculeatus*

Even though the 2 species tend to prefer the same habitat (figure 6) they do not exhibit any significant co-existence. Perhaps the most tangible reason for this state of affairs is as follows. In the first place *M. aculeatus* is principally a nocturnal species (Aryeetey 1971). Secondly, Majer (1976a) stated that *M. aculeatus* depends more on predation than *O. longinoda*. Thus, even though *Cat. guineensis* is chiefly a diurnal species, the few hours in the early mornings when its activity has just started and the few hours in the evening when activity is getting to a close will expose it to the attacks of the predatory *M. aculeatus*. *Cat. guineensis* was sometimes seen being attacked by *M. aculeatus* during those few hours when their activities coincided. Though it could not be assessed, it is possible that the greater success which *M. aculeatus* might have as a predator against *Cat. guineensis* compared with *O. longinoda* is probably the cause of no significant co-existence between the 2 species, while at the same time such a close association exists between *Cat. guineensis* and *O. longinoda*. From the above explanation it appears that the main cause of a difference in association between *Cat. guineensis* and the two dominant species is that *O. longinoda* 'protects' *Cat. guineensis* from other predators and yet it cannot successfully predate on it itself; on the other hand *M. aculeatus* will exclude other predators from the prey while it can use the prey (*Cat. guineensis*) to supplement its food requirement, hence the latter will tend to avoid the former as much as possible.

(4) Cat. guineensis and Cr. depressa (Latr.)

Bolton (1974) reported that *Cat. guineensis* is able to occupy trees in areas dominated by both *Cr. striatula* Emery and *Cr. clariventris* Mayr, however it seems to be excluded from trees infested with the rather belligerent *Cr. depressa* (Latr.) along with many other arboreal forms.

It has been stated earlier that there is possibility of *O. longinoda* becoming an effective predator of *Cat. guineensis* especially in areas where the population of the former is very high. It is therefore probable that *Cat. guineensis* is unable to co-exist with *Cr. depressa* due to the latter's large population as was estimated in the field. Miss Adabie, working concurrently with me on *Cr. depressa*, recorded an estimated population of this ant as high as 1,907,909 out of which 1,880, 459 were adult workers. She also did not find *Cat. guineensis* in areas dominated by *Cr. depressa*.

In addition to the above suggestions it is possible that the non-significant association between these 2 species results from the differential preferences they appear to exhibit for different habitats (shade regimes) as shown in figure 6 and in fact Majer (1976, a, b, c) reported on *M. aculeatus* that both the canopy density and the distribution of other ant species (dominants) govern its distribution.

5. *Cat. guineensis* and *P. decemdentata*

In the case of *P. decemdentata*, its non-association with *Cat. guineensis* may best be explained in terms of their probable competition for nesting sites, since, in the first place, they all showed preferences for the same habitat and secondly both were found to nest in dry pods. It cannot be explained in terms of inter-generic fights since *P. decemdentata* appeared to be principally nocturnal.

CHAPTER 5: THE NEST AND NESTING HABITS

CHAPTER FIVE

THE NEST AND NESTING HABITS

5.1 INTRODUCTION

Nests are usually the most noticeable feature of the life of almost all social insects. The nature of the nest, the materials it is constructed with, whether in the ground, in wood or in the canopy of trees, tends to depend on the species of the insect concerned. Thus the honey-bee builds elaborate wax combs in cavities in stems and branches of trees. Among the ants, *Cr. depressa* builds carton nests hanging on stems and/or branches of trees, some species of *Pheidole* live in holes in the soil while *O. longinoda* and *M. aculeatus* build their nests in the canopies of trees. The larger carpenter-ants, *Camponotus ligniperda* Latr., *Cam. herculeanus* L. and *Cam. vagus* L. in Europe and *Cam. pennsylvanicus* F. in America nest in wood (Sudd 1967).

Most of the wood-living ants are known to be incapable of boring holes in wood but merely move into the galleries previously formed by activities of other insects such as wood boring beetles and termites. Bolton (1974) reported that *Cat. guineensis* lives in cavities in rotting wood which had been excavated by beetles or termites. However, he did not name the beetles or termites associated with the nest building of this ant.

Ants are known to live together in the same nest with other insects. For instance the mite *Antennophorus foreli* lives as a guest of the ant *Lasius niger* Forel, and the beetle *Claviger testaceus* and some Staphylinidae, according to Sudd (1967) are guests of various ants. Some of these so-called ant guests are in fact harmless to their hosts and are tolerated by the hosts, but the presence of others are rather detrimental to the host. These are either parasitic, predatory or drain the food supply of the host as they often cause a break in the food traffic of the ant host. There is a third group of guests which live as commensals with the ants. In the present work it is intended to examine in some detail the interrelationship between termites, beetles and other inquilines with *Cat. guineensis*.

Phenological changes in the percentages of the juvenile stages as well as in the adult castes of some temperate ant species have been reported by several workers. For instance the periodicity of brood and adult caste productions have been reported by Headley (1943) in *Leptothorax* sp. and Brian (1957) in *Myrmica* sp. In the tropics studies on populations of ants have also been reported. Thus Sudd (1967) quoted Ledoux (1950) as reporting that though *O. longinoda* produces sexuals throughout the year in West Africa, these are more commonly seen just at the end of the rains in November. Gibbs and Leston (1970) also reported periodicity in the production of female *O. longinoda* at Tafo, Ghana, but in this case they found the peak production between March and May.

Again they demonstrated periodicity in alate female production of Odontomachus haematodus (Linn), and Aryeetey (1971) reported periodicity in the sexual caste production in M. aculaetus. In the present work, attempt is made to determine how Cat. guineensis responds to seasonal changes (as described by Gibbs and Leston, 1970) with respect to their reproduction.

It was noticed that a wide range of head sizes occurred among workers of even one and the same nest. A similar observation has also been made by Clark (1951) who reported that in the sub-family Myrmicinae (to which Cat. guineensis belongs) "members of any one nest frequently show considerable difference in head size, and this is particularly noticeable during the early summer". Accordingly, investigations were conducted to find out the groups of workers that occur in this species. It was also found that the mean head widths and the mean head lengths of the workers of some of the nests differed markedly from those of other nests, and it was, therefore, also considered necessary to investigate whether any significant difference exists between the head size of individuals in one (colony) and that in the other colonies.

5.2 METHODS

Sampling was by harvesting the nest and it was not restricted to any particular plot, since, as stated in Chapter 4, nests of this species are not many in any one particular plot. Most of the harvesting was done outside the area of detailed studies so as to avoid too much disturbance in that area. Two or three nests were harvested every month. In most cases, the harvesting was done at approximately 2-week intervals, but in some cases, particularly when three nests were harvested in a month this was done at shorter intervals. A nest was harvested either after 6.15 p.m. or before 6.00 a.m. These periods were chosen because preliminary studies had shown that after 6.15 p.m. and before 6.00 a.m. there was little or no foraging activity and therefore most of the workers were within the nest.

In order to ensure that the nests harvested constituted separate colonies, the 'acceptance-rejection' method, described in Chapter 4, was used prior to harvesting a nest or a group of nests. It is important to mention that the test was conducted only when the distance between two nests was shorter than 15 metres, a distance which was chosen on the assumptions that: (1) any two nests separated by a distance of 15 metres or more constituted separate colonies, and (2) any two nests which were less than 15 metres apart belonged to the same colony. The flaws in these assumptions (detected later) were discussed in 4.4.2 (Chapter 4).

5.2.1 Sampling Methods

Weaker nests (colonies) were simply broken and removed by hand. Stronger ones, such as those in which the bases were still fresh or those which were not rotten much, were cut by means of a cutlass. A deep cut was made, at least one hour prior to the sampling time, at the base of the nest leaving only a very small portion uncut. This offered the necessary support needed by the nest to hold on to the stump of the tree. A nest, thus treated, was easily broken by hand when the ants had calmed down and had gone into the nest.

The broken nest was quickly placed in a polythene bag measuring approximately 50 cm x 100 cm. Some ethyl acetate was then poured over the nest in the bag and the mouth of the latter quickly rubber-banded or tied tightly. The bag, with the nest, was then taken to the laboratory for content analyses.

After about 30 minutes within which the ethyl acetate was expected to have permeated into the chambers of the nest, the bag was untied and the ants which had died outside the nest chambers were transferred onto a glass slab of about 30 cm x 30 cm (12" x 12") for sorting. Though many of the adult workers came out of the nest and died outside it, many others remained within and died there together with the brood and most of the alates and in order to sort these the nest was carefully broken into smaller bits and the contents of the various chambers and their connecting channels taken out. A preliminary sorting of this second batch was almost always necessary for separation of the nest contents into one group of predominantly juvenile stages and another of predominantly adult castes. The juvenile group was then kept in 50% - 70% alcohol until it was sorted out into the various developmental stages. When doing this a piece of coloured paper was placed beneath the glass slab in order to render the eggs and the first stage larvae more visible and distinguishable. The predominantly adult group, like those which died outside the nest, was not put in alcohol and was usually sorted before the predominantly juvenile group. However, when the population was very large the predominantly adult group was dried in an oven and kept there. From the oven the ants were taken out and sorted in smaller numbers until they were also sorted. The sorting sometimes lasted a week or more and keeping the ants in alcohol or drying them in an oven was meant to prevent them from getting mouldy. The ant contents of each nest were sorted into eggs, larvae of all stages, worker pupae, male pupae, female pupae, adult workers, male and female adults. Inquilines were recorded merely as present or absent. They were not counted.

5.2.2 Counting

When the nest population was large, usually running into thousands, counting was done in calibrated glass tubes. The members of a particular caste were counted into a glass tube with a flat bottom and the level marked. The tube was repeatedly filled to the marked point and then emptied as many times as necessary. The few which did not fill the tube to the marked point were actually counted and the number added to the figure obtained by the tube method. All the different castes were counted by the tube method except the eggs which were actually counted. It was necessary to do absolute counts of the eggs because, being very small and also sticking onto the glass slab, the eggs were difficult to transfer from the slab into the tube. Using the results of the various counts, an attempt was made at finding the seasonal population and ratios of the brood and adult castes of the species.

5.2.3 Head measurements

Before any sorting was done, the head width and the head length of 100 adult workers, picked randomly by scooping, were measured under a microscope, using an eye-piece micrometer. The measurements were, however, not made for the following nests: 1-10, 15, 18 and 21 because of pressure of work when these nests were harvested. Furthermore until nest 11 was harvested not much variation in the head sizes had been noticed.

Correlation indices were computed between the head width and the head length of workers of each nest (colony) considered. This was done with the help of the computer science programme in the Physics Department of the University of Ghana. Also with the help of the above department, the mean head widths of the workers of the various nests were compared with one another. Thus the mean head width of workers in nest 11 was compared with the mean head widths of workers in nests 12, 13, 14, 16 etc., that of workers in nest 12 was in turn compared with those of workers from nests 13, 14, 16 and so on until each nest had been matched against every other nest. The essence of this was to find out whether there existed any significant size differences between heads of the workers of different nests (colonies).

Both male and female alates were also treated as above but with these two castes, the number of individuals whose heads were measured varied from nest to nest, depending on the total number of the particular alate present in the particular nest. The data compiled on the head width were used for construction of histograms to show the distribution of head sizes. It must be pointed out at this stage that in drawing the histograms the square roots of the numbers in each head width range were used instead of the absolute numbers. This was to reduce the amount of fluctuations in the various figures. Head lengths were not considered in the frequency distribution of the head sizes because earlier work had revealed a very strong correlation between the two measurements on the head of the species(table 6). No histograms were drawn for the data on the alates because an inspection of the available data on these castes does not reveal any significant variation in the head size of individual of any one nest.

5.2.4. The Nest

a. Nest structure

Notes were made whether a harvested nest was in pod (pod-nest) or in branch or main stem of the tree (wood-nest). The type of tree, whether a forest tree or a cocoa tree, and its physical condition were also noted. Also the architecture of the nests, as well as the distribution of the brood and some of the inquilines were noted carefully when the contents of the nest chambers were being removed for sorting.

b. Nest size

Prior to breaking a nest into ~~a~~ pieces, the diameters of the extremities were measured by means of a measuring tape. The wood was then broken into two at the mid-portion and the diameter measured. The mean of these three measurements was recorded as the diameter of the nest. Prior to measuring the diameter, the length of the nest had been measured. From the data thus collected, the area of each harvested nest was calculated using the formula for finding the area of a "right".cylinder (that is $2\pi rl$).

c. Nest height

The height of each harvested nest was measured from its base and recorded.

5.3 RESULTS/OBSERVATION

5.3.1 Contents of the nests

a. The ant content

These include eggs which are oval in shape (fig. 10a) and different larval stages, some of which are shown in figs. 10b, 10c and 11. The eggs and the very early larval stages (fig. 10) have smooth body surfaces and are almost equal in size. They may, however, be distinguished from each other by the latter's curved body and also its segmentation. Apart from increase in size, older larvae (figs. 10c and 11) show further segmentation and possess bifid and trifid hair-like structures. Apparently, these hair-like appendages increase in number, and also shorter ones are developed as the larva moults and passes from one stage to another (fig. 11). The appendages do not occur on the apparent head of the larva.

In addition to the eggs and larvae are pupae of the different castes which may be distinguished as follows: the worker pupa (fig. 12) has no wings and possesses a pair of long spines arising from the alitrunk. It also lacks ocelli. The male pupa (fig. 13) is about the same size as the smaller worker pupa. However, its spines are shorter and in addition to wing pads possesses ocelli as well. The female pupa (fig. 14) is the largest of all the pupae, and like its male partner has wing pads, though it lacks ocelli. The tip of the gaster is more rounded in the female pupa than in the male pupa.

The adult reproductives (figs. 8 and 9) have already been mentioned in section 4.4.2. The adult workers (figs. 15 and 16) appear to retain basically the characteristics of their pupal stage mentioned above in addition to the development of a high degree of sculpturation on the body. The occurence of apparent two size-groups of workers will be considered later.

Apart from the ant contents of the nests,there were also several invertebrates which were found in the various nests harvested. These other invertebrates are considered as 'guests' (inquilines) of _Cat. guineensis_.

b. _Guests of Cat. guineensis_

A list of the thirty-two nests harvested and the various inquilines found in each of them is presented in appendix table 2. The most frequently found inquiline was a thysanuran species; it was recorded in 20 nests. It was followed by the termite, _Microtermes_ sp. (14 nests), a predatory spider, belonging to the family Clubionidae (11 nests) and the termite, _Neotermes_ sp. and Myriapods (both in 8 nests). It is important to note that the two termite species were never present together in the same nest, though either species was recorded together with any of the other inquilines mentioned above. _Microtermes_ sp. was recorded only in completely rotten, and therefore weak nests. In some such nests certain walls of the chambers within the nest were made of soil while others were made of either dry pulp or thin, flat remains of the wood itself. _Neotermes_ sp. was recorded in stronger nests.

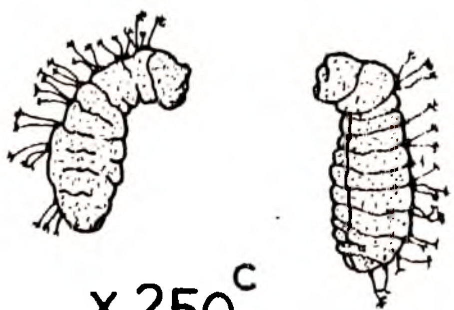
FIG. 10:
SOME DEVELOPMENTAL STAGES OF *C. GUINEENSIS*.

a

Eggs

b

Very early stage lavva

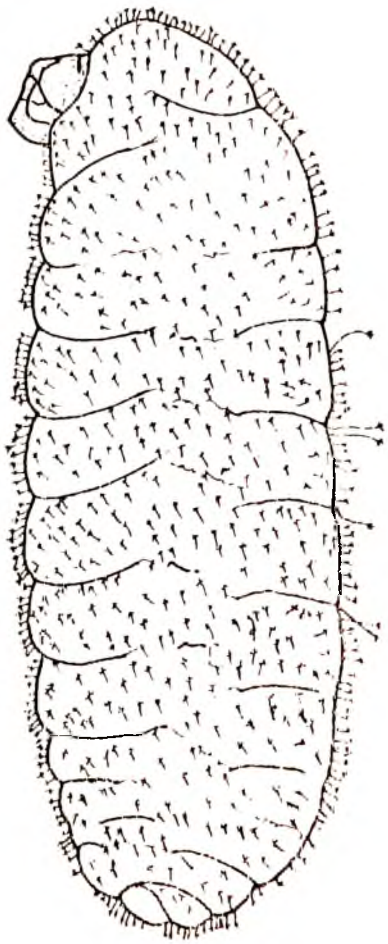


x 250 c

Early stage larva

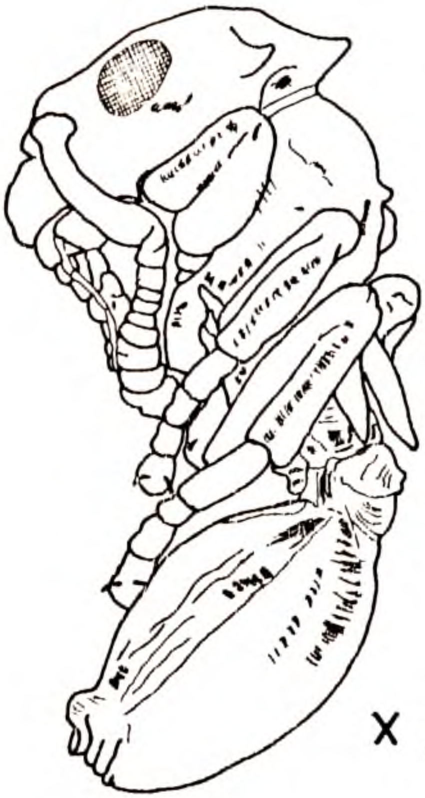
FIG.11:

LATERAL VIEW OF LARVA



x 250

FIG. 12
PUPA OF SMALL WORKER



x 250

FIG13: MALE PUPA

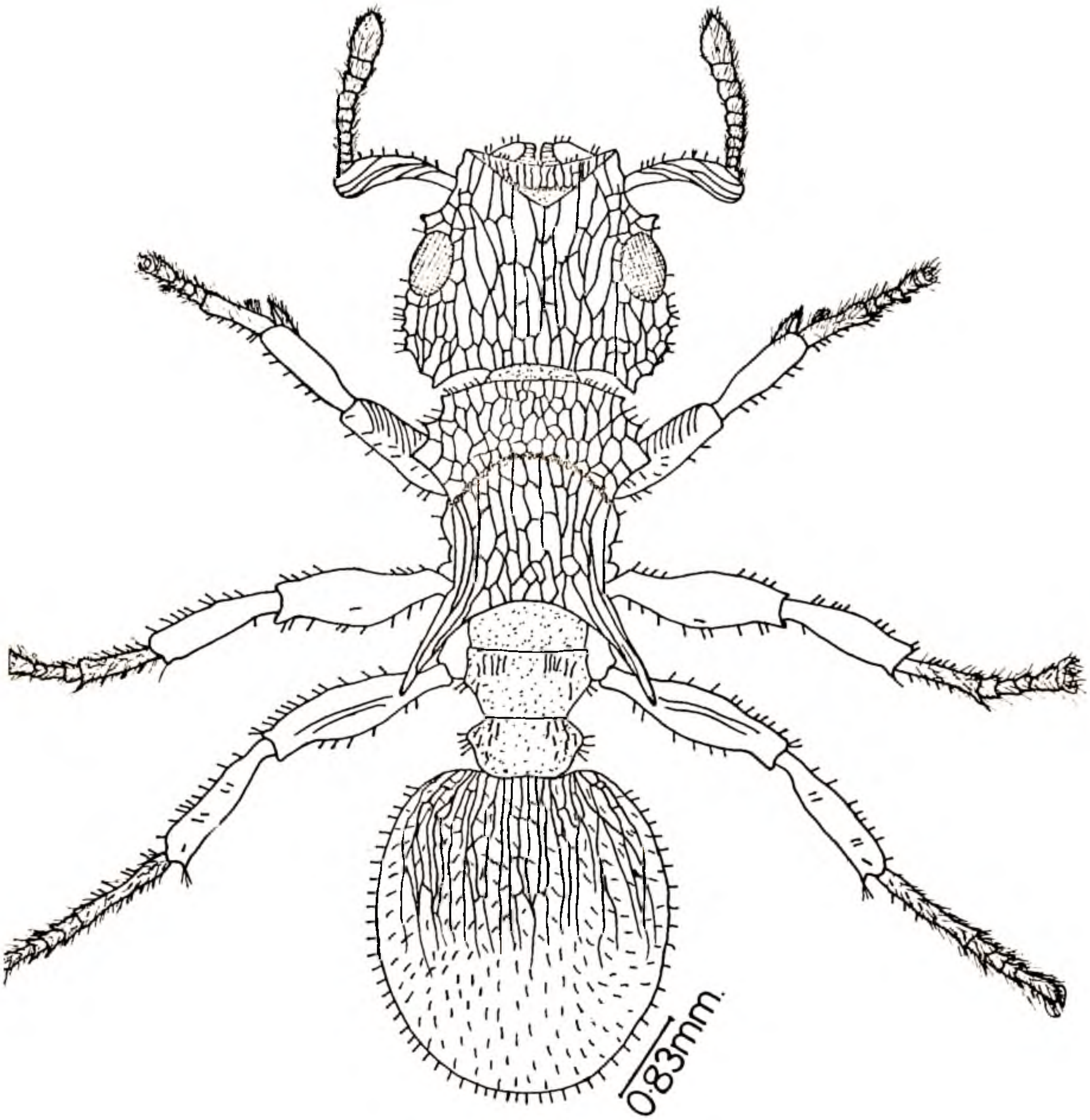
x 250

key:-
O: ocellus.

FIG.14: FEMALE PUPA.

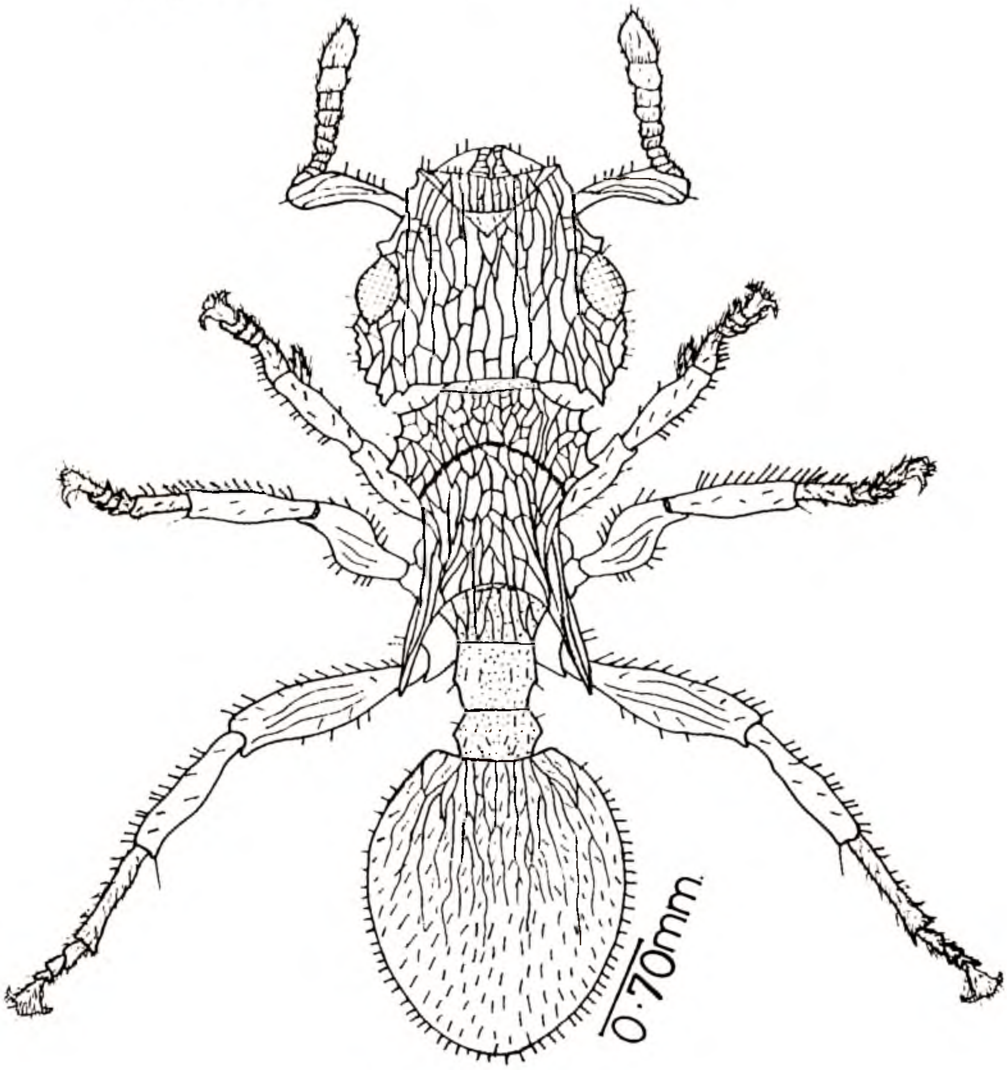
x 250

FIG.15: LARGE WORKER.



Hw= 2·50mm
Hl = 2·00mm

FIG.16: SMALL WORKER.



Hw= 1·90mm
Hl = 1·60mm

The base of such a nest was always alive, and soil was never seen in such nests. The thysanurans were often seen going in and out of the nests. On some occasions they were seen in the trail of the ant, but they never went far from the base of the nest. When a thysanuran met a forager in the trail, both insects stopped for a few seconds only, and each continued in its original direction of movement.

The spiders were sometimes seen attacking foragers of the ant on nest 32, and in fact on one occasion one spider was seen grabbing a forager and carrying it towards the base of the nest.

Though no counting was made of the inquilines, it was obvious that *Microtermes* sp. occurred in the greatest numbers. At times all its different castes, including the winged forms, and eggs were found. *Neotermes* sp. followed *Microtermes* sp. in numbers. No winged *Neotermes* were ever found in the nests. All the other inquilines were present in very small numbers, sometimes only one or two of some of them were found. No inquilines were found in 3 nests, two of which were pod-nests.

5.3.2 Populations in nests and phenology of the ant

Results of the counts of the brood and adult inhabitants of the various nests (colonies) are presented in appendix table 3. The largest total population recorded was 34,391 per nest while the smallest was 1,003. The average number of individuals was 10,607 per nest.

While the largest population was recorded in a wood-nest, the smallest population was recorded in a pod-nest. Of all the 32 nests (colonies) harvested only two were pod-nests.

Information on the phenology of the ant is given in figures 17 and 18. Seasons in the cocoa farm ecosystem in W. Africa have been classified by Gibbs and Leston (1970) and the limits of the various seasons are as follows:- (1) Dry-sunny season: late November - mid-February. (2) First wet-sunny season: late February - late May. (3) First wet-dull season: June and July. (4) Dry-dull season: August. (5) Second wet-dull season: late August - mid - October. (6) Second wet-sunny season: late October - mid - November. These limits vary between years because there is wide scatter in the distribution of both rainfall and sunshine (Gibbs and Leston, 1970).

It is evident from the two figures (17 & 18) that throughout the period of investigations the adult worker caste constituted the largest proportion of the various monthly mean populations, though this proportion, as was expected, fluctuated from one season to another. From a fairly high level in the first wet-dull and the dry-dull seasons, the proportion of adult workers per nest per month dropped drastically to a minimum level in the early half of the second wet-dull season. Towards the later half of wet-dull season however, the proportion of adult worker caste gradually rose reaching

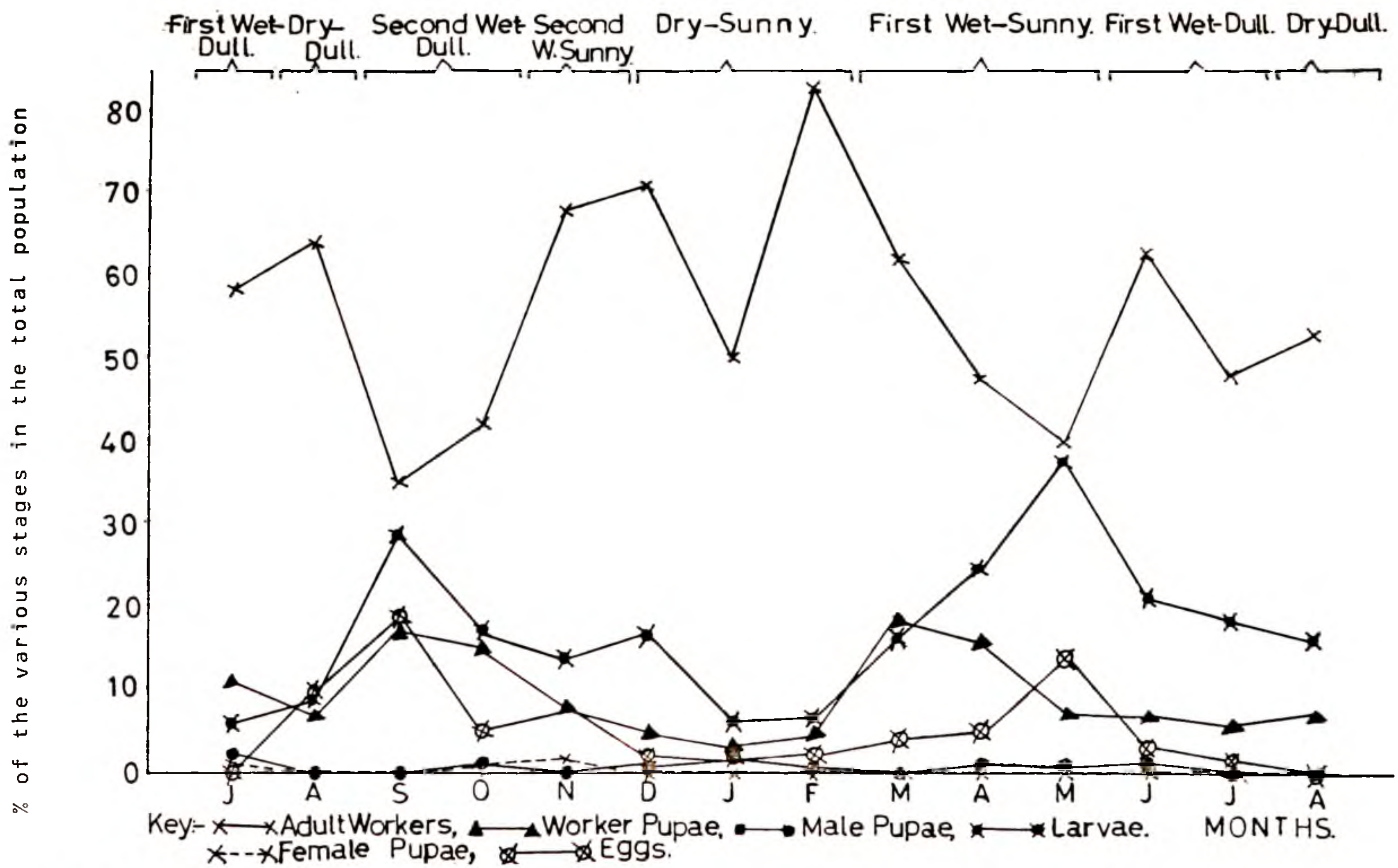


Fig.17: Phenology of the adult workers and the various developmental stages of Cat. guineensis

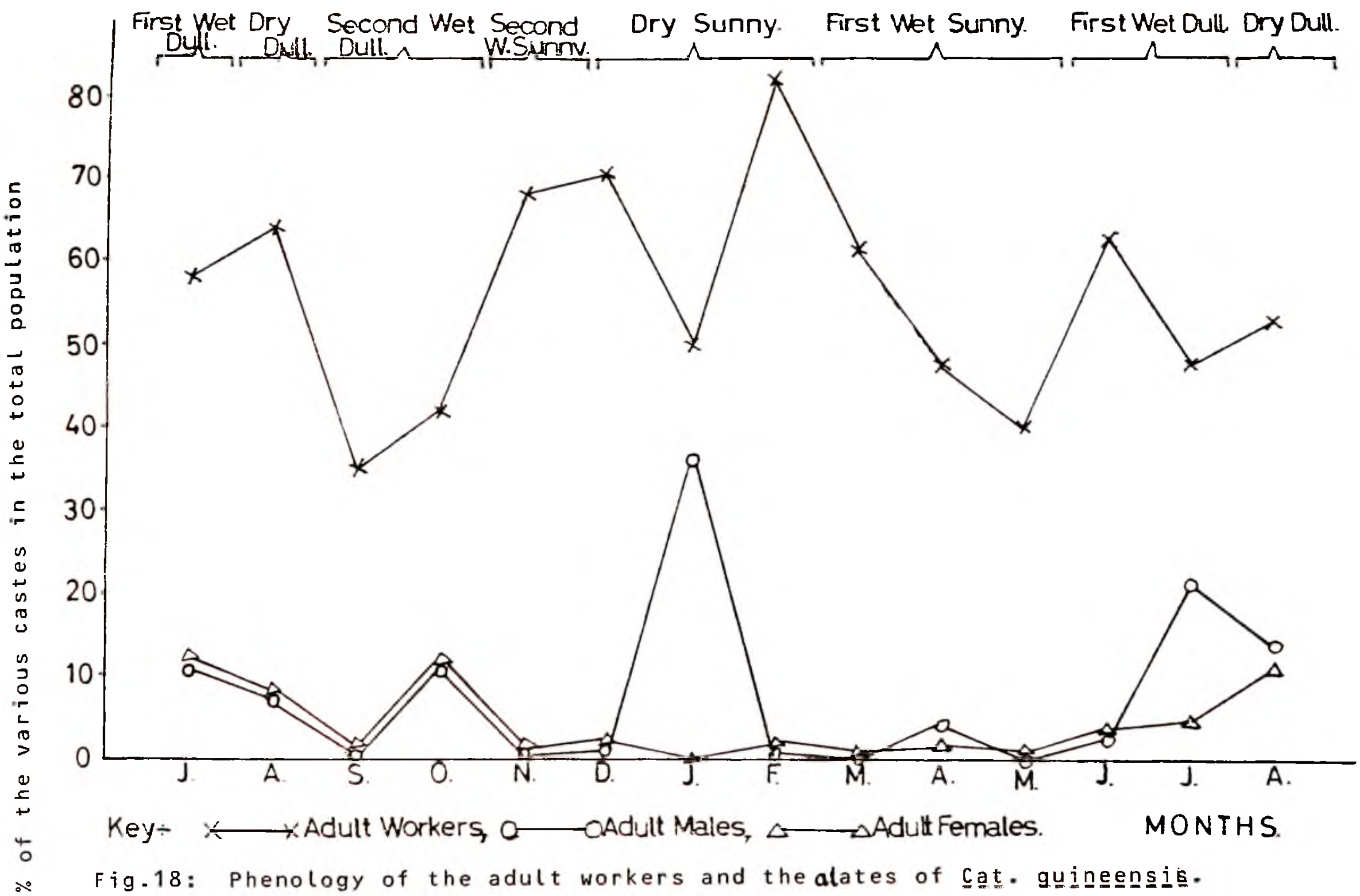


Fig.18: Phenology of the adult workers and the alates of Cat. guineensis.

a high level between the second wet-sunny season and the first half of the dry-sunny season. Towards the middle of the dry-sunny season, the level fell again only to rise suddenly to the highest peak in the later part of the same season. Then in between the dry-sunny season and the first wet-sunny season, the proportion of the adult workers started to fall, reaching a fairly low level in the later half of the wet-sunny season from where it rose again to a fairly high level in the first wet-dull season as in the previous year.

The percent distribution of the larvae fluctuated in a pattern completely opposite to that of the adult workers, rising when the proportion of the adult workers fell and vice versa (fig. 17). Except for only a few discrepancies, the worker pupae presented a pattern similar to that of the larvae. Eggs also exhibited a similar pattern. In fact the two highest percentages for eggs coincided with the two lowest proportions of the adult worker caste in September, 1975 and May, 1976.

The proportions of both the male and the female papae in the total nest populations remained at a very low level over the year, and in fact no female pupae were recorded in the first half of the second wet-dull (September) and also from the middle of the dry-sunny season to the start of the first wet-sunny season (January to March).

In the adult males, the per cent occurrence generally followed a pattern similar to that of the adult worker caste except for a few discrepancies during the dry-sumny season. In fact the highest proportion of the males occurred in January and this coincided with a drop in the proportion of the adult workers in the populations. Though the proportion of the adult males remained very low, their presence was recorded throughout the year (fig. 18).

The adult females presented a pattern similar to males excepting the discrepancy in January, 1976. From the later half of the first wet-dull season through to the later half of the second wet-dull season (July to October),fairly high percentages of adult females in the total populations were recorded. From then up to the first half of the first wet-dull season (November, 1975 to June, 1976), their percentages in the populations were very low and in fact zero per cent was recorded in some months (March and May). The highest percentage recorded for the adult female within this period (November to June) was only 2.14 (in February).

The de-alates were not included in the graphs because of their generally very low numbers. Only two male de-alates were found throughout the sampling period. The female de-alates were recorded in almost all the seasons except in the later half of the second wet-dull season. Generally an average of one female de-alates was recorded in each season. But in the dry-dull season and average of 4 was recorded. In the second wet-sunny and the first half of the dry-sunny seasons, a mean of 9 and 12 was recorded respectively.

It is interesting to note that the periods within which the mentioned relatively larger averages for the female de-alates were recorded (August and November-December), preceded the periods within which the percentage of the adult worker caste fell suddenly and drastically (September and January). Even more interesting is the observation that during these periods when the mean number of female de-alates increased, they (the female de-alates) were very often seen moving about on the branches of the cocoa trees accompanied by a few workers and also some were seen in the canopy where the workers normally foraged. Again during these months it was common to find female de-alate in rotting twigs, branches and also dry pods, including cherelles together with a few (3 - 4) developmental stages, particularly young larvae. In some instances a few adult workers were also found with the de-alate females in their apparent incipient nests. These observations were mainly made when investigations were being conducted into the distributional relationship of *Cat. guineensis* and other ants (chapter 4), during which period rotting twigs, branches and pods were collected and their contents examined for other ants.

The small proportions of de-alates in the nests is obvious (appendix table 4). Also clear is the occurrence of brood, as a group, throughout the year. The presence or absence of eggs was found to be independent of the presence or absence of alate or de-alate females. In other words, there were nests in which no alates or de-alate were found but where eggs were present, and conversely there were other nests in which either alates or de-alate females or both were present and yet there were no eggs, though older brood members were present.

5.3.3 Head measurements

The result of the head measurements of the ants in the various nests are given in appendix tables 5 - 14, 15 - 19, and 20 - 23) on the workers, males and females respectively. Figures 19-37 show the frequency distribution of the head widths of the workers in the various nests. Results of the correlation computations are presented in tables 6, 7 & 8 on workers, males and females respectively. All the computations showed a strong correlation between the head width and the head length of the ants.

Nine of the diagrams on head widths showed two groups of workers without any intermediates. The limits of the head widths for these two groups, however, varied from one nest to another. Thus a range which falls in a group of smaller workers in one colony (nest) may fall in a group of larger workers in another colony. However, on the whole, the head widths of the smaller workers-group ranged from 1.59 mm (fig.21) to 2.24 mm (fig.28) while those of the larger workers ranged from 2.00 mm (fig.19) to 2.55 mm (fig.28). Similarly the head lengths ranged from 1.30 mm (appendix table 6a) to 1.75 mm

Table 6: Table of correlation between headwidth and headlength of worker castes in various colonies

Nest (colony)	Mean		Standard deviation		Correlation (XvrsY)	Regression coefficient	Standard error of reg. coef.
	HW (mm)	HL (mm)	HW (mm)	HL (mm)			
11	1.73	1.43	0.18	0.15	0.98	0.84	0.01
12	2.07	1.76	0.19	0.15	0.96	0.72	0.02
13	1.92	1.62	0.26	0.19	0.99	0.73	0.01
14	2.03	1.71	0.17	0.13	0.96	0.74	0.02
16	2.00	1.69	0.24	0.17	0.98	0.71	0.02
17	1.83	1.55	0.19	0.15	0.98	0.77	0.02
19	2.00	1.67	0.19	0.14	0.97	0.74	0.02
20	1.98	1.65	0.20	0.15	0.98	0.72	0.02
22	2.05	1.70	0.19	0.14	0.98	0.70	0.01
23	1.91	1.58	0.23	0.17	0.98	0.75	0.01
24	1.94	1.64	0.18	0.16	0.99	0.87	0.01
25	2.00	1.68	0.17	0.13	0.98	0.75	0.02
26	1.89	1.57	0.22	0.19	0.99	0.82	0.01
27	1.88	1.57	0.19	0.15	0.98	0.77	0.01
28	1.98	1.66	0.20	0.15	0.99	0.77	0.01
29	1.94	1.61	0.27	0.23	0.99	0.82	0.01
30	1.83	1.52	0.22	0.18	0.99	0.79	0.01
31	2.01	1.69	0.16	0.12	0.98	0.77	0.01
32	2.05	1.72	0.18	0.14	0.98	0.73	0.01
Total	37.04	31.02	3.83	2.99	18.63	14.51	0.26
Mean	1.95	1.63	0.20	0.16	0.98	0.76	0.01

Table 7: Table of correlation between headwith and headlength of alate males in various colonies

Nest (colony)	Mean HW (mm)	Mean HL (mm)	Standard deviation HW	Standard deviation HL	Correlation (X vrs. Y)	Regression coefficient	St. error of Reg. coefficient
12	1.46	1.29	0.06	0.03	0.73	0.42	0.06
13	1.26	1.15	0.07	0.06	0.92	0.73	0.04
14	1.42	1.25	0.06	0.04	0.78	0.57	0.08
20	1.39	1.20	0.05	0.04	0.89	0.81	0.05
27	1.45	1.27	0.04	0.03	0.73	0.57	0.06
28	1.47	1.23	0.06	0.04	0.71	0.45	0.05
29	1.49	1.28	0.05	0.03	0.84	0.57	0.04
30	1.41	1.23	0.05	0.03	0.73	0.45	0.04
31	1.49	1.30	0.05	0.04	0.83	0.65	0.04
32	1.40	1.23	0.05	0.04	0.85	0.64	0.04
Total	14.23	12.43	0.54	0.38	8.Lo	5.86	0.50
Mean	1.42	1.24	0.05	0.04	0.80	0.59	0.05

Table 8: Table of correlation between headwidth and headlength of alate females in various colonies

Nest (colony)	Mean		Standard deviation		Correlation	Regression Coefficient	Standard error of Reg. Coefficient
	HW (mm)	HL (mm)	HW	HL	(X vrs. Y)		
20	2.37	2.07	0.04	0.04	0.84	0.82	0.07
22	2.10	1.88	0.09	0.07	0.94	0.77	0.04
28	2.36	2.07	0.04	0.03	0.75	0.57	0.06
29	2.38	2.08	0.05	0.04	0.76	0.55	0.04
30	2.30	2.03	0.04	0.03	0.75	0.60	0.05
31	2.33	2.04	0.05	0.04	0.86	0.70	0.04
32	2.33	2.03	0.04	0.04	0.86	0.70	0.04
Total	16.17	14.20	0.35	0.29	5.76	4.71	0.34
Mean	2.31	2.03	0.05	0.04	0.82	0.67	0.05

Figs. 19 - 37. Frequency distribution of head widths of workers of *Cat. guineensis* in various colonies (nests)

Fig. 19: Nest 11.

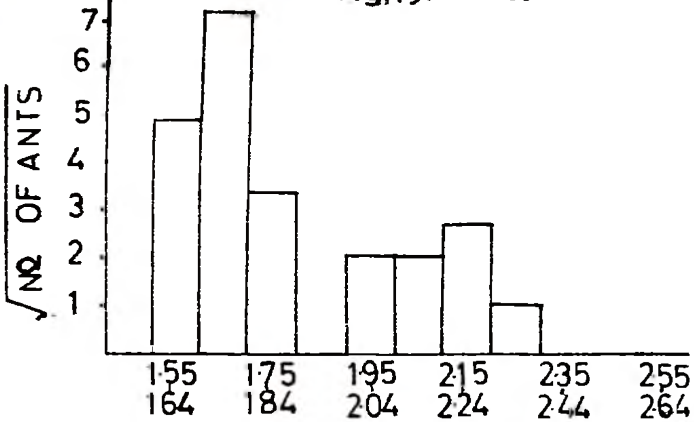


Fig. 20: Nest 12.

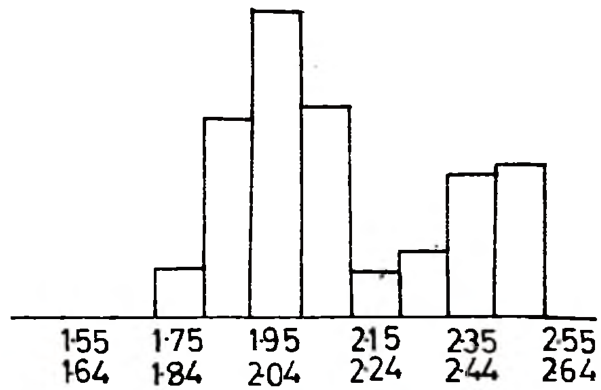


Fig. 21: Nest 13.

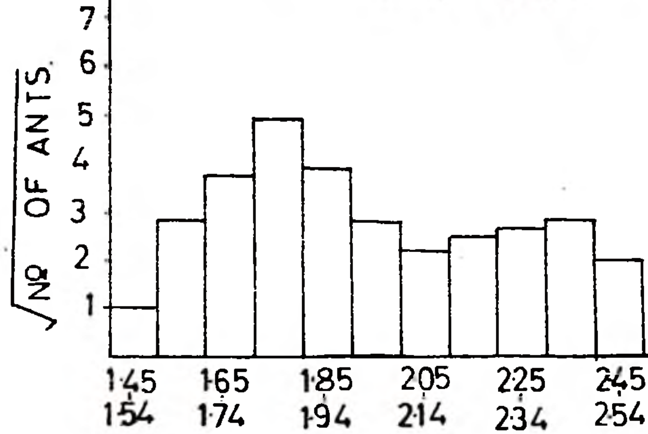
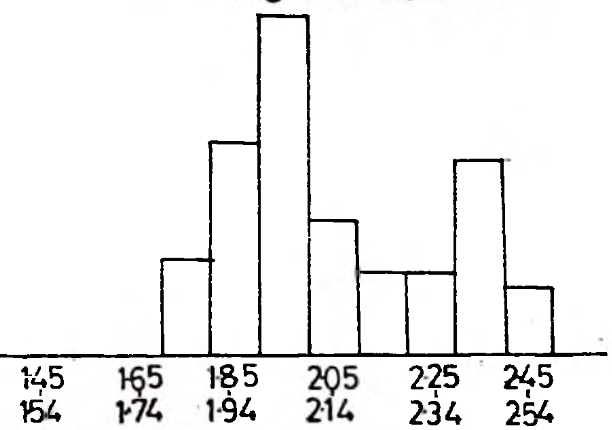


Fig. 22: Nest 14.



Head Width (mm).

Fig. 23: Nest 16.

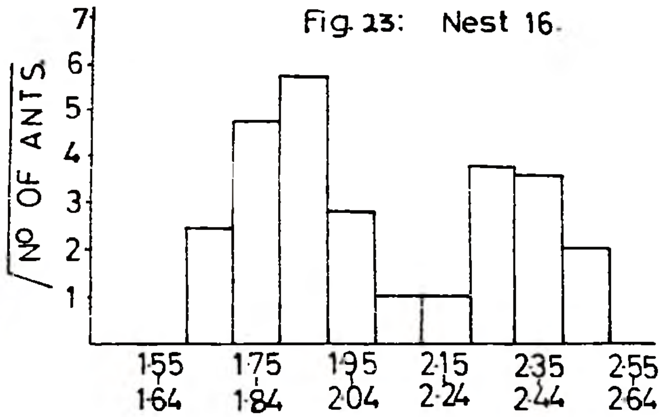


Fig. 24: Nest 17.

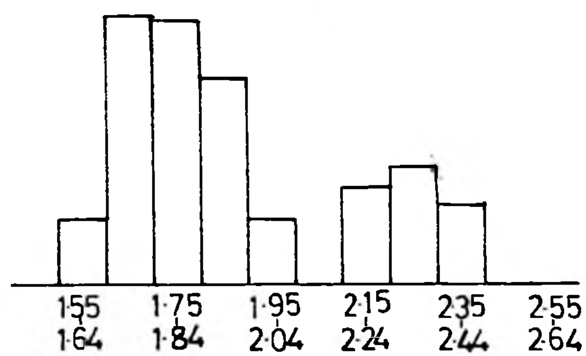


Fig. 25: Nest 19.

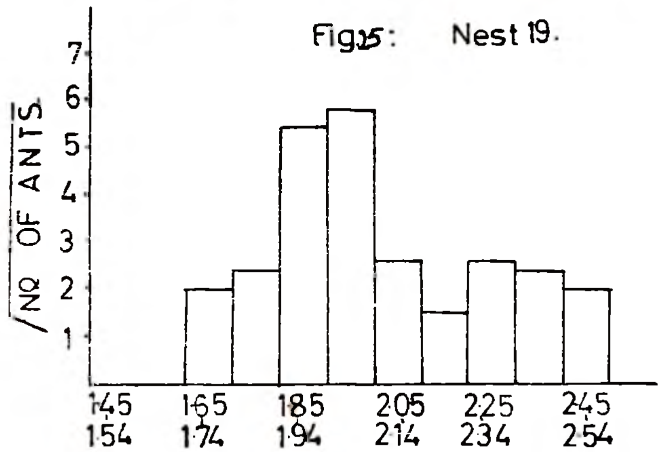
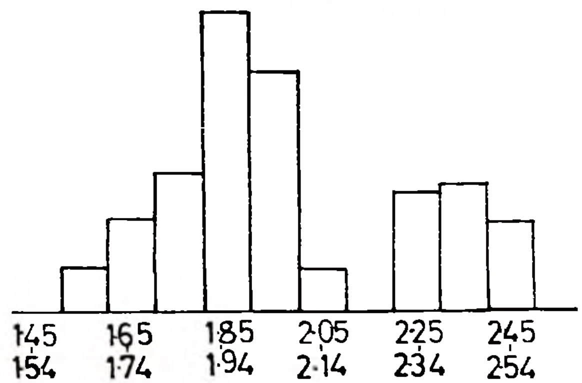


Fig. 26: Nest 20.



Head Width (mm.)

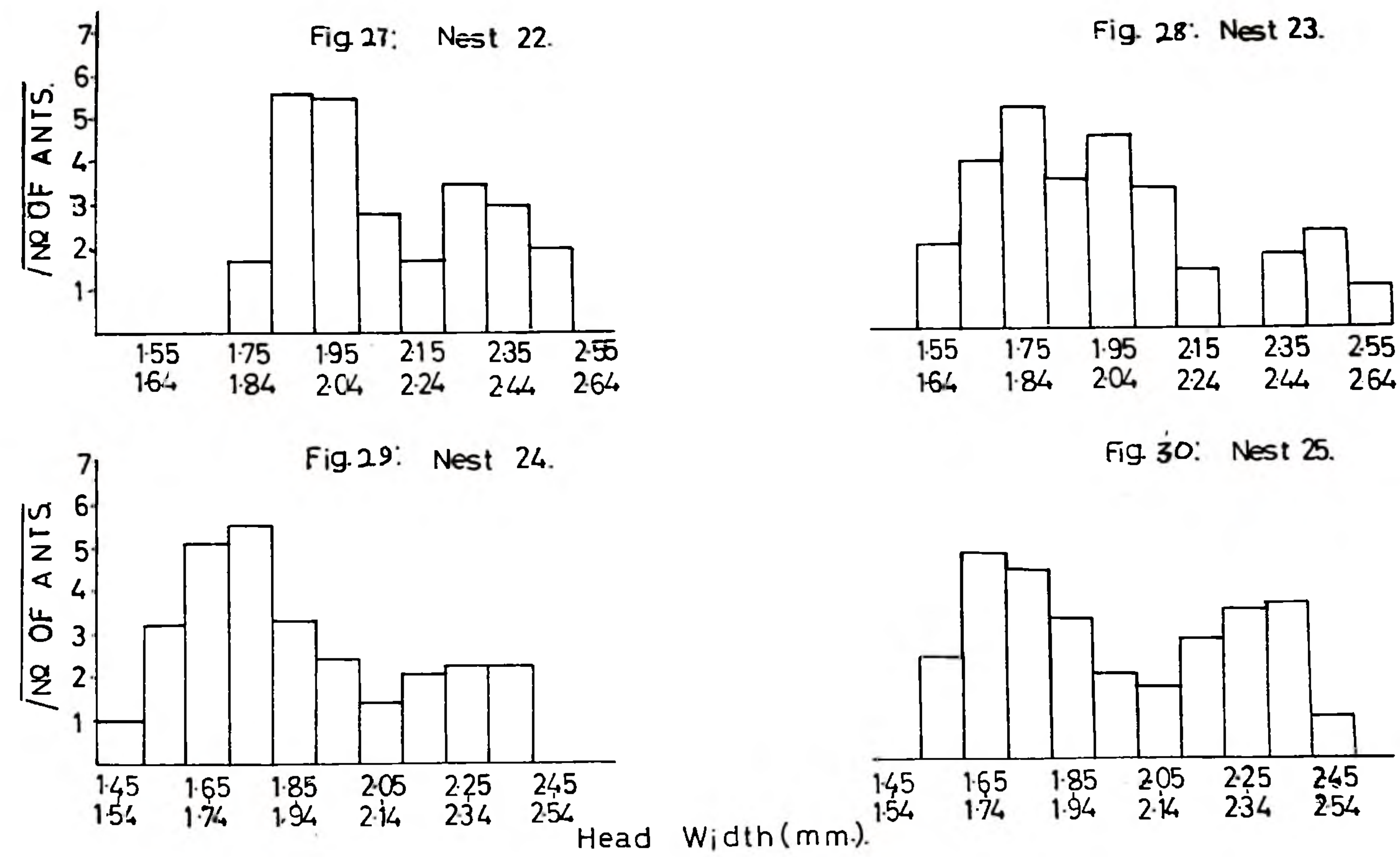


Fig. 27: Nest 22.
Fig. 28: Nest 23.
Fig. 29: Nest 24.
Fig. 30: Nest 25.
NO OF ANTS.
NO OF ANTS
1
2
3
4
5
6
7
1·55 1·64
1·75 1·84
1·95 2·04
2·15 2·24
2·35 2·44
2·55 2·64
1·45 1·54
1·65 1·74
1·85 1·94
2·05 2·14
2·25 2·34
2·45 2·54
Head Width (mm).

Fig. 31: Nest 26.

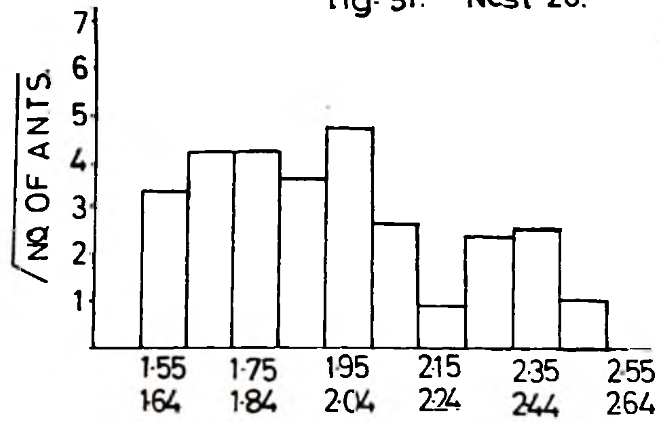


Fig. 32: Nest 27.

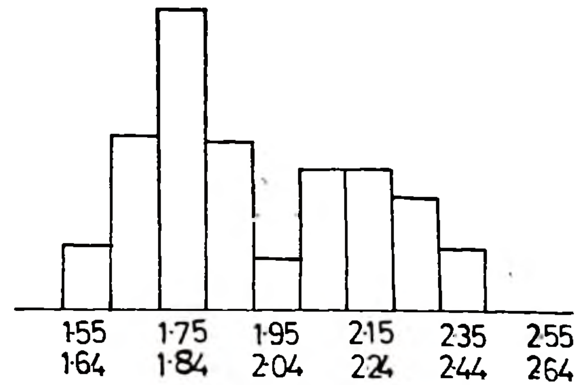


Fig. 33: Nest 28.

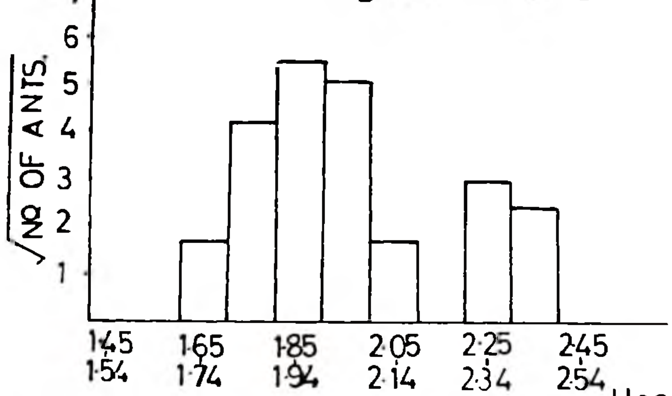
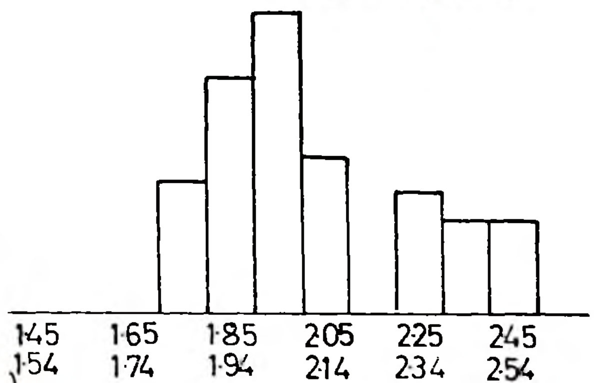


Fig. 34: Nest 29.



Head Width (mm).

Fig. 35: Nest 30.

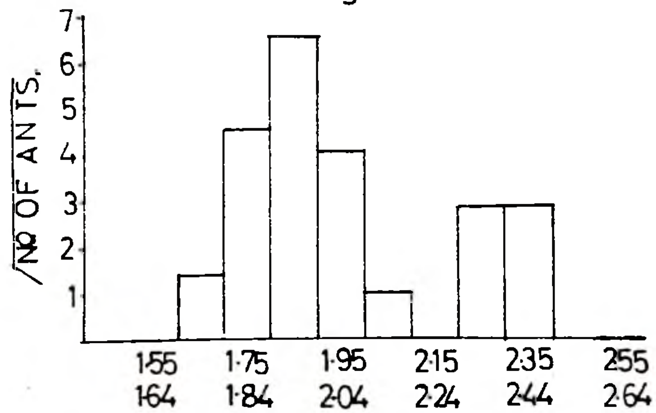


Fig. 36: Nest 31.

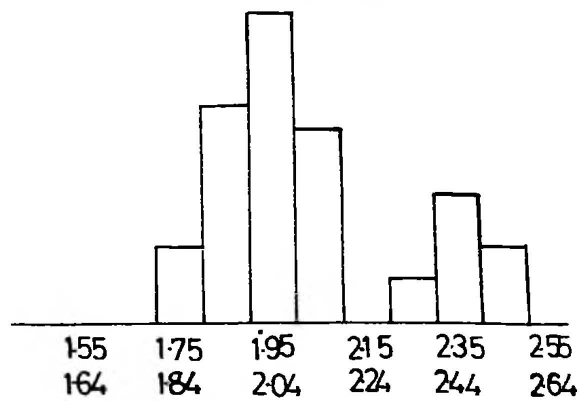
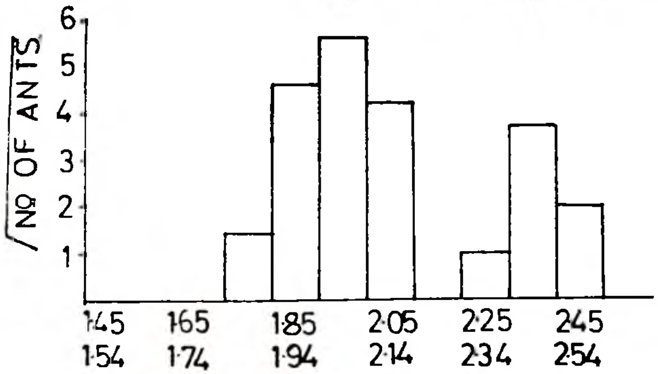


Fig. 37: Nest 32.



Head Width (m.m).

(appendix table 9b) for smaller workers and 1.70 mm (appendix table 5a) to 2.05 mm (appendix table 9b) for larger workers. On an average, the smaller workers and the larger workers occurred in a ratio of 3:1. However, the ratios ranged from 2:1 in 3 cases (figs. 19, 26 and 37) to 5:1 in only one case (fig.28).

In 9 other diagrams (histograms) the existence of two groups of workers is apparent in varied degrees. In all these diagrams there is an indication of the existence of a group intermediate between the two groups. Examples are shown in figures 20, 23 and 30. In one case (fig.21) there appears to be only one group of workers.

No diagrams were made for the alates because it is obvious in the various tables that there is not much variation in the head sizes of males or females from the same nest. It is, therefore, assumed that there is only one group of both males and females as far as the head sizes are concerned.

The head widths of the males ranged from 1.10 mm (appendix table 15b) to 1.60 mm (appendix table 18b) while the head lengths ranged from 1.05 mm (appendix table 15b) to 1.35 mm (appendix table 17a). In the female the range for head widths was 1.85 mm (appendix table 20b) to 2.50 mm (appendix table 21b) and that for head lengths was 1.70 mm (appendix table 20b) to 2.15 mm (e.g. appendix tables 20a, 21a, 21b).

5.3.4 Comparison of means of head widths

The results of these comparisons are given in the appendix tables 24, 25 and 26 for workers, males and females respectively. At the 5% probability level the d value in statistical tables is 1.96. A comparison of this value (1.96) and the computed d values in the above tables shows that significant differences exist between the mean head width of workers in nest 11 and those of workers in all other nests except nests 17 and 30. A few other comparisons also show significant differences. Except for the few cases mentioned above, one can safely state that no significant difference exists between the head size of workers of one nest and those of another. One is tempted to make a similar statement on the male caste in which, as in the case of the workers, significant differences occurred between the head size of individuals of one nest (13) and those of all the other nest. Similarly in the female significant differences occurred between the head width of individuals in only nest 22 and those of all other nest.

It is important to note that an occurrence of significant difference between the head size of one caste did not necessarily mean that a significant difference would arise between the head sizes of all other castes. However, in two or three cases this situation was found, at least in two castes. For instance the difference was statistically significant in both the comparison of workers and the comparison of the females of the following pairs of nests: 20:30, 22:30, and 28:30.

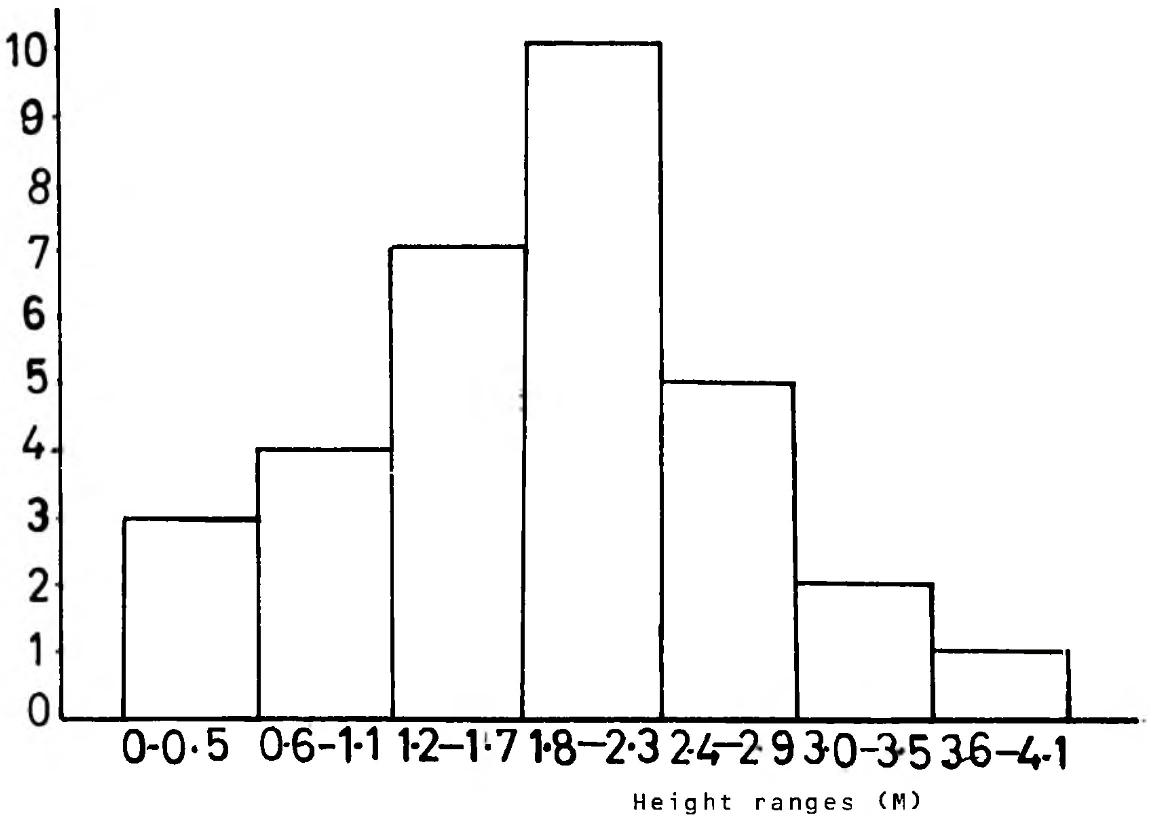
Similarly significant difference occurred between the head size of both males and the workers in nests 12:13 and 30:31 pairs. Significant difference never occurred in all the three castes in any two nests compared.

5.3.5 The Nest

(a) Nest height: Information on this aspect is provided in fig. 38. The figure shows the frequency distribution of the heights of the nests harvested. It is evident that the majority of the harvested nests were located at heights of 1.2 - 2.3 metres. One nest actually started on the ground. This was a stump of a rotten forest tree, and in fact the nest extended several centimetres into some of the roots in the soil. One other stump nest (cocoa stump) was also seen in the area of detailed studies though this was not harvested. The highest nest harvested was at 3.8 metres above the ground, however, one nest in a branch of cocoa tree was seen as high as about 5.4 metres and another, in a rotting forest tree, was at a distance of 4.3 metres, though none of these two were harvested.

The results of the various calculations made to find the area of each nest harvested are presented in appendix table 3. A mean of 2,984.8 sq. cm. was obtained for the wood-nests; the areas of the two pod nests were not calculated.

g.38: Frequency distribution of heights of nests of *Cat. guineensis*



(b) Nest structure: The nest of *Cat. guineensis* is either in a dry pod/cherelle, in a rotting branch of the tree or in a rotting portion of the main stem itself. The term 'pod-nest' used earlier in this chapter refers to nests in pod/cherelle while the term 'wood-nest' refers to nests in the trunk of a tree or its branches. Wood-nests are far more common than pod-nests as was mentioned in chapter 4. In fact only two pod-nests were found and harvested, though a few more were found in the area of detailed studies. Some of the pod-nests in the area of detailed studies were discovered to be colonies by themselves while others were only part of a colony (fig. 4).

Pod-nests are shown in plates 4 - 7. Preferred pod/cherelle for nest is dry and hard, and the surface shows deep; channels which lead to various entrances to the chambers of the nest. When a pod-nest is split up one may find that the developmental stages of the ant are present, not only in the cavity of the pod itself, but also some will be found in chambers within the seeds as well. It is, perhaps necessary to emphasize that no inquilines were found in the two pod-nests harvested.

Plates 8 - 14 are photographs of wood-nests. A wood-nest could be spotted at a distance of 4 - 5 metres away due to the occurrence of powdery materials scattered around the foot of the nest tree, and also trapped in webs (if there is any around the nest) near the nest. The powdery materials are in fact very minute susbstances thrown out of the chambers of the nest by workers when they were cleaning or repairing it. The external appearance of a wood-nest is similar to that of pod-nest, with an increase in the number of the channels which are interconnected with each other. Just as the channels are many so also are the entrances. Plates 12, 13 and 14 show longitudinal and cross sections of a wood-nest. The chambers are elongate and are separated by walls which, in the very old and weak nests consist mainly of very thin remains of the wood. Some of the walls are also made up of dry, hardened pulp. When *Microtermes* sp. occurred in the nest it was usual to find soil in the nest. The channels connecting the chambers are very short due to the closeness of the chambers.

Though the nest is generally dry, some of the chambers, particularly where the developmental stages are predominant, are moist. Apart from the wood-nest and the pod-nest, the ants settled in a hole in the soil for at least 12 days in September 1974 when an attempt was made to make them establish a nest near the Zoölogy and the Botany Departments of the University. Also they were found living in an abandoned carton nest of *Cr. depressa* attached to one of their nests (plate 9).

There does not seem to be any orderly distribution of the brood in the nest. Generally, however, eggs and early instar larvae occurred in the same mass more frequently than eggs and older larvae or eggs and pupae. Similarly, older larvae and

Plate 4: A pod nest. A few workers are seen on the surface.

Plate 5: A pod-nest opened up. At the pedicel end of the pod is shown a seed with a hole (shown by a single arrow); brood can be found in such 'seed chambers'.

The white organisms in the picture are some of the juvenile stages of the ant. A few mature adult workers (black) and one young adult worker (shown by two arrows) are also found in the picture.

Plate 6: The same as plate 5 with one juvenile stage tucking out of the entrance of the'seed chamber' (arrowed).

Plate 7: A pod-nest showing typical characteristics of the external surface.

Plate 8: A rotten branch of an otherwise healthy cocoa tree occupied by Cat. guineensis (wood-nest) The workers normally surge out of the nest in large numbers, dashing here and there when the nest is shaken or even tapped. Under such conditions females, but not males, also might come out of the nest.

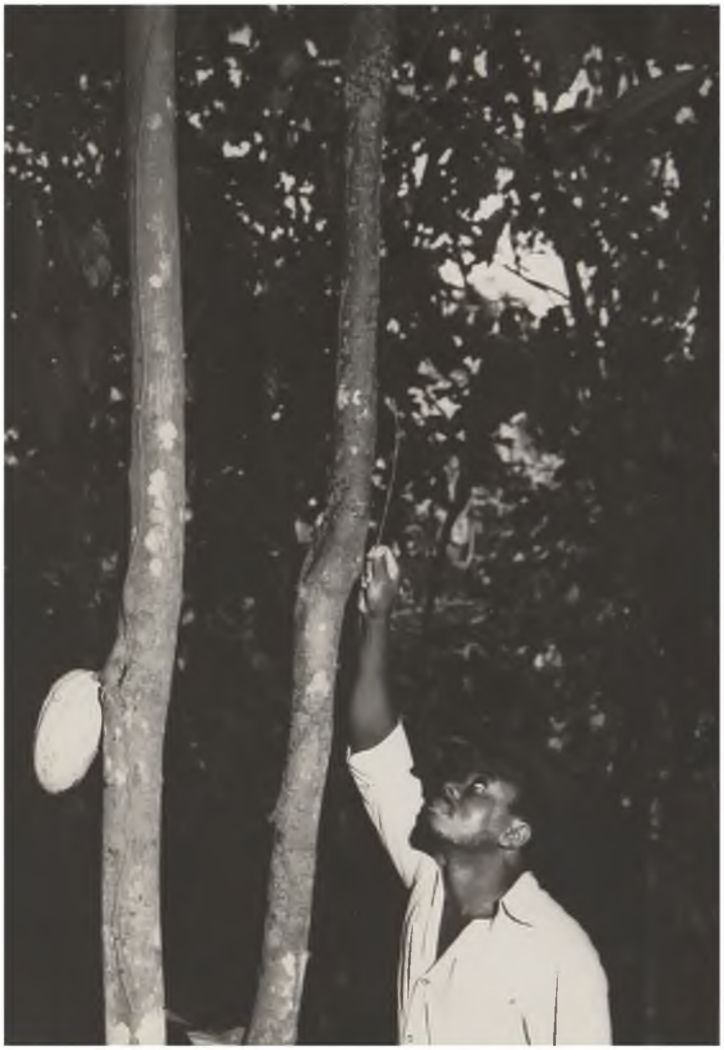


Plate 9: At the distal end of a rotten branch is an old abandoned carton nest of *Cr. depressa* which was occupied by *Cat. guineensis*.

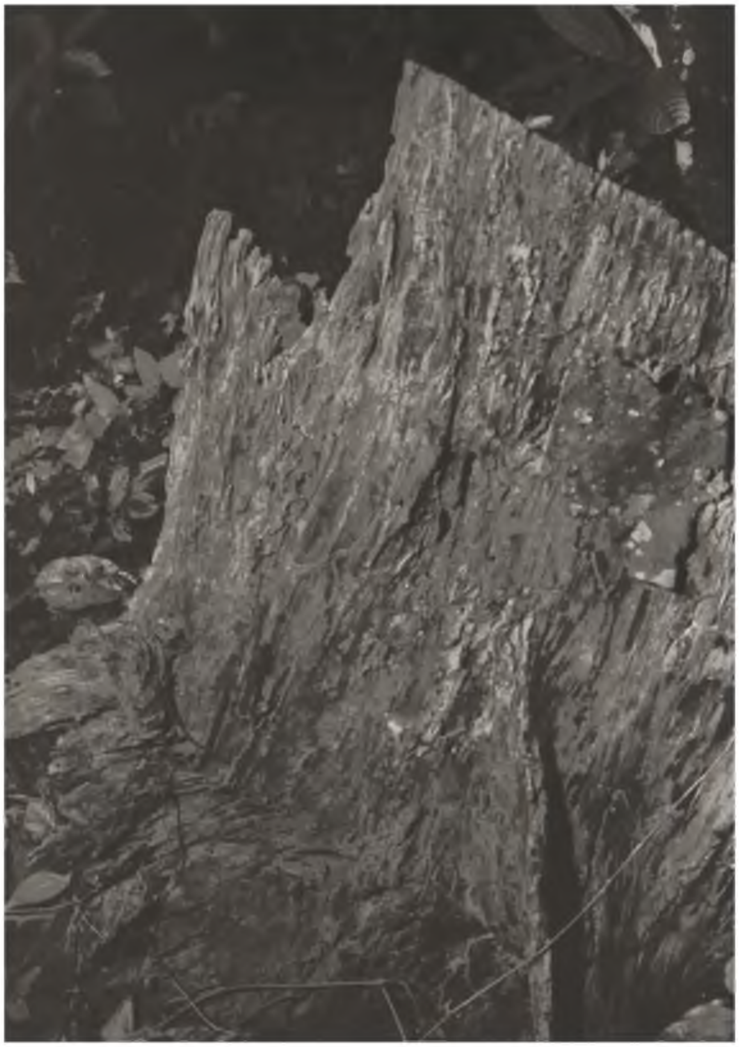


Plate 10: A rotten buttress root of a forest tree used as a wood-nest by Cat. guineensis. This, in fact, is nest B mentioned in the text. Unfortunately no ant is visible in the picture.

Plate 11: The nest in plate 10 pictured at a closer range. A number of adult workers can be seen on the nest.

Plate 12: A longitudinal section of a wood-nest (a branch of cocoa) showing the internal architecture.

Plate 13: A longitudinal section of a wood-nest (a dead branch of a healthy cocoa tree) showing the internal architecture and also groups of termites (*Neotermes* sp.) - arrowed - at the proximal living portion of the nest (nest A, shown in plate 1).

Plate 14: A cross section of a wood-nest (plate 12) showing the internal architecture.

pupae occurred more frequently together in the same group. Within one and the same chamber, however, both the mass which comprises mostly of eggs and early instar larvae and the other comprising mainly of older brood, may occur together. Whereas the eggs and the early instar larvae were always clustered together into one mass, individuals of older stages of development were usually free from each other. As shown in fig. 10c, the younger larvae are provided with long bifid and trifid hairs (as mentioned in 5.3.1). Though the eggs are devoid of these hairs (fig. 10a), it is most likely that the hairs of the larvae plus, perhaps the sticky nature of the surfaces of both the eggs and the larvae are responsible for their being clustered together.

Generally the brood of *Cat. guineensis* are distributed almost evenly throughout the nest, though it appears that the ant showed slight preference for the central portions of the nest for deposition of their brood. It is not possible to say much about the distribution of the adult castes in the nests, because the method for harvesting the nests caused considerable disturbance which would have disrupted any orderly distribution that might have existed before the nest was cut.

The distribution of the ant in relation to that of *Microtermes* sp. is different from that in relation to the *Neotermes* sp. In the first place, as stated above, the two termites species never occurred together in the same nest. When *Neotermes* occurred with the ant, the former was restricted to the basal parts which were invariably the living part of the nest, (plate 13) and it was observed that the termite, *Neotermes* sp., was responsible for, at least, the initial boring of holes within the tree which later became nest of *Cat. guineensis*. Nevertheless, the ant does considerable work to renovate and improve the structure of the chambers and the channels to suit its particular requirements. This inference is made from the regular throwing of materials (including the powdery material mentioned earlier) out of the nest by the ant. In one case (nest 32) a distance of about 8 centimetres was measured between one of the newly constructed chambers of *Neotermes* and one of the most proximal chambers occupied by the brood of *Cat. guineensis*.

Microtermes was not restricted to any particular portion of the ant's nest when the two insects occurred together. They might or might not be distributed throughout the nest. No matter how the *Microtermes* were distributed, they never occurred together in one and the same chamber with the brood of the ant. It was, however, not unusual to find the termite and the brood of the ant in adjacent chambers.

5.4 DISCUSSION

5.4.1 Contents of the nests:-
Guests of Cat. guineensis:

The discussion on Cat. guineensis and inquilines found in its nests is rather difficult since most of the inquilines (guests) rarely come out of the nest. Their day-to-day activities as they affect the ant are therefore not possible to describe fully. Nevertheless attempts will be made to discuss them one after the other:

(1) Thysanura: The species of this order appears to be the most frequently encountered guest of Cat. guineensis. The fact that no "animosity" was observed between the two species both on the nest and in the trail suggests tolerance of each other, though different reactions to each other might be exhibited within the nests.

Sudd (1967) has given account of how several ant guests exploit the behaviour of their hosts to either solicit for or steal food. According to him some guests are capable of exhibiting behaviour patterns which are similar to that of their hosts, and therefore cause the ants to donate food to them instead of donating it to their own kind. As an example, Sudd (1967) quoted Wasmann (1902) as stating that the mite, Antennorphorus forah, sits under the head of its host, Lasius niger and strokes the ant's "cheek" (gena) with its long first legs until the ant produces a drop of food.

Janet (1897) cited by Sudd (1967) found that the thysanuran, *Atelura* sp., though cannot stimulate its host to release food as in the above example, nevertheless, is able to steal part of the drop of liquid food which one ant may be regurgitating to another. It is therefore possible that the thysanuran species found in the nests of *Cat. guineensis* employs a similar means to obtain at least part of its food from the ant. The few seconds halt by the two insects whenever they met in the trail might be the time within which the thysanuran species make their unsuccessful attempts to stimulate the ant forager to donate food.

Within the nest the thysanura may be important to the ant in aspects other than the possible deprivation of them of their food. It must, however, be noted that whatever effect this guest might have on its host is likely to be very little indeed considering the fact that only very few individuals occurred in each nest.

(2) The spider (Clubionidae): Like the Thysanura, the spider occurred in very small numbers in the nests, so their predatory behaviour is unlikely to be significant in reducing the population of the ant. In any case, the spider may prey actively inside the nest since it was rarely seen outside. The spider may be effective (perhaps more effective than *O. longinoda*) as a predator of *Cat. guineensis*, judging from the apparent ease with which one of them was able to

grab and carry a worker of the ant away. The incessant but rarely successful attempts on the ant by O. longinoda have been mentioned earlier (chapter 4).

(3). Myriapods: The millipedes and the centipedes were never seen outside the nest and it is therefore not possible to discuss their activities.

(4). Neotermes: As far as nesting is concerned, this termite species appears to be the most important guest of the ant. Bolton (1974) stated among other things that "the nest of Cat. guineensis are started in rotten braches of otherwise healthy trees when a queen enters a tunnel previously made in the branch by wood-boring beetles or termites".
The present work supports Bolton and further shows that the two insect species can live together in the same nest, the ants moving into the tunnels abandoned by the termite as the latter bores into fresh parts of the tree. Though the basic structure of the nests, as indicated by the tunnels or chambers and their connecting channels, may still be retained, the workers of the ant definitely do a lot of work to renovate the existing galleries to suit their own requirements, judging from their daily active throwing of materials out of the nest.

(5). Microtermes: The absence of *Neotermes* sp. in the nest probably makes it habitable to *Microtermes* sp. which might then move in to join *Cat. guineensis*. In this way *Microtermes* sp., like *Cat. guineensis*, appears to take advantage of the wood-boring activities of *Neotermes*, the only apparent difference between the two ants being that whereas the ant can live together with *Neotermes* sp., *Microtermes* cannot. The role of *Microtermes* sp. in the nest of *Cat. guineensis* is not clear. However one can suggest with some certainty that the soil found in such nests is the result of the activities of this termite. Then the presence of *Microtermes* sp. in the nests may be detrimental to the ant since the soil might block some of the chambers and/or channels within the nests, thus rendering them uninhabitable to the ant, a condition which, if it continues for long, may necessitate nest abandonment by the ant.

5.4.2 Population in nests and phenology of the ant.

Bolton (1974) stated that the populations of ants in the colonies of *Cat. guineensis* ran into several hundreds only. The findings of this work show that Bolton (1974) underestimated the numerical strengths in nests of this species. In any case a comparison of the colony population of *Cat. guineensis* and those of some of the so-called dominant species tends to suggest that *Cat. guineensis* is numerically insignificant. For instance Gotwald (1972) cited Raignier and van Boven (1955) as having recorded as many as 22 million individuals in a colony of the predominantly ground nesting ant genus, Dorylus (Anomma) and Miss Adabie (personal communication) recorded as many as 1,907,909 individuals in a colony of Cr. depressa in a cocoa farm at Kade, Ghana. The relatively insignificant population strength of Cat. guineensis, therefore, tends to support Bolton's (1974) statement that "at no point in its range can any species of Cataulacus be considered dominant over other arboreal genera".

That the proportion of the adult worker caste in the populations was always the highest has also been reported by Aryeetey (1971) in M. aculeatus. Perhaps this observation is understandable since the workers must always be present in good numbers to see to the day-to-day needs of the colonies. This is particularly necessary if one considers the fact that, at least, some of (if not all) the juvenile stages are present in the nests throughout the year.

The decline in the percentage of adult workers in September and January may be explained in terms of the formation of incipient colonies by the relatively larger number of female de-alates which were recorded in the months (August and November-December) preceding those in which the percentage of adult workers declined (September and January).

It is quite possible that the decline resulted from the fact that, the de-alate females, during their departure to found new colonies were accompanied by a number of workers; an observation which, as has been stated earlier, was made on several occasions. Thus in the months (September and January) immediately following those in which relatively larger numbers of de-alates were found in the nests, one would expect a decline in the percentage of the nest population which is made of adult workers. It is, perhaps, necessary to re-emphasize that during those months (September and January) it was common to see de-alate females moving up and down the cocoa trees, and also it was common to find them with a few juvenile stages and sometimes adult workers in previously formed cavities in branches and pods of cocoa. It is true that some of the few workers found with the de-alate females might be the first generation of workers in the new colonies, but it is also true that some of them are the founding members of those apparent incipient colonies.

From what has been stated in the above paragraph and also from the observation that eggs, larvae and worker pupae presented a phenological pattern quite opposite to that of the adult workers, it appears that a good number of the workers would tend to leave with the new queens to establish new colonies rather than remain in their old home to care for the inmates. The findings of this work give a strong indication that the queens of this species do not fly (since fairly large numbers of the female de-alates were found in the nests) and therefore might not disperse far from their original home. This apparent inability to spread far will in turn make it possible for the workers to accompany the new queens in their attempt to establish new homes. The foregoing makes one tempted to speculate that in Cat. guineensis mating may occur within the nest, because, as stated in chapter 4, the male is normally never seen outside the nest. Mating inside the nest has been reported in other ant species, and in fact Sudd (1967) stated that "in some species there seems to be no mating flight though both sexes have wings". He cited Monomorium floricola Jerdon and Mo. pharaonis among other 'crevice-nesters' which mate in their nest.

The alternations in the proportions of the adult workers and the brood mentioned above is reasonable and perhaps must be expected, because the high level of brood production will be needed to replace the number of adult workers which might have left with the new queens. One of the peaks of brood percentages coincided with as little as 35% representing the proportion of the population made of adult workers. It would appear reasonable to suggest that as long as the proportion of the adult worker caste in the total population does not fall below 35%, the basic needs of the colonies might be met, thus allowing for the exodus of these workers with the new queens without too much harm being caused to the old nest.

Of the sexual pupae, the female appears to present a more defined phenological pattern than the male. The fact that no female pupae were found in September (first half of the second wet-dull season) and also generally from January to March (middle of the dry-sunny season to the start of the first wet-sunny season) suggests that the production of this caste, unlike that of the worker caste requires the attention of larger numbers of adult workers. In other words whereas the development of a worker caste might not require much attention from the adult worker (and therefore the latter can leave to found new colonies) such an attention might be of prime importance in the development of a larva into a female (and therefore this caste will not be produced when only relatively very small proportion of the total population is made up of workers). Perhaps the small numbers of the reproductives produced at a time (as evidenced by the very low percentages recorded) makes this suggestion that the development of a larva into a female requires more attention than the development of a larva into a worker more important since the worker brood are more numerous and occurred throughout the year. Though the production of males appeared to go on throughout the year, it was at a very low level.

So far the discussion appears to have established the fact that the female reproductive needs attention of the workers not only at its developmental stages but also during the periods when it leaves the parent colony to found a new one.

The importance of the occurrence of brood throughout the year to the maintenance of a constant high level of trail activity will be discussed in the next chapter. In this chapter it is necessary to discuss why sometimes no female castes (both alate and de-alate) were present and yet eggs were found in the nest together with older juvenile stages. It is important to re-emphasize that though the species is polygynous, and except in the periods prior to the apparent founding of new colonies, there was an average of one de-alate female per colony. The chances of finding this single ant among a huge amount of debris (fragments of the rotten wood) are very slim indeed. Therefore the fact that no de-alate female was found in a nest does not necessarily mean the complete absence of that caste, though this may sometimes happen. Again a de-alate female might have been lost when the nest was being cut, since some ants were actually lost due to the method used for the harvesting. In any case it may not be very surprising even if eggs occurred in a nest in the absence of a de-alate female because it is known in some ants that the workers also lay eggs, though these usually do not develop. For instance Sudd (1967) cited Le Manse (1948) as having reported that "the workers of *Ponera edouardi* do lay eggs, but these do not usually develop".

The absence of eggs in some seasons, and for that matter in some nests, is perhaps a reasonable expectation since oviposition is not likely to be very expedient throughout the year even if the queen were present. The presence of larvae and pupae even in the absence of eggs suggests further that egg production is not continuous process in this ant, perhaps due to its sensitivity to unfavourable weather conditions.

5.4.3 Head Measurments

That the head of all castes of *Cat. guineensis* is broader than long agrees with Bolton's (1974) finding. The apparent occurrence of two groups of workers, based on the head size, appears to occur in other ants and the worker caste of such species has been described as dimorphic. In his 'keys to the sub-families of Formicidae and other taxonomic notes and keys to genera of ants' (based on worker caste), Wheeler (1920, 1922), basing his classification on the characteristic nature of the head size, described the genus *Pheidole* as dimorphic. Gotwald (1972) quoted Weber (1949) as having reported that *O. longinoda* is also dimorphic, with its "maxima" caste performing the foraging tasks. The dimorphism in *Cat. guineensis* does not seem to be very well marked and in fact the evidence provided in this project have shown that the head size of workers of this ant has no relation to the type of function the workers perform.

A finding which needs some discussion is the fact that the limits of the head width and the head length for the two apparent worker groups vary from one colony to another. Since, as mentioned earlier, the production of the worker caste is continuous throughout the years, different generations may be exposed to different environmental conditions, which are likely to affect the generations in different colonies with different degrees depending on the micro-environmental conditions around the nests. In this respect, the size of the area from where the nests were harvested might be very important. As stated earlier, it was necessary to collect nests from several cocoa plots which were far apart. The different times and frequencies at which the plots were cleaned (chapter 3), i.e. weeded, pruned, sprayed and rehabilitated, might have effect on the availability and distribution of food to the various nests at different times. The fact that pod harvesting in the various plots is not possible at one and the same time might also have similar effects as the other factors mentioned above. By their possible effect on the availability and distribution of the ant's food, these factors might indirectly affect the size distribution of the developing workers differently in different nests or colonies. Possibly if all the 32 nests harvested had been present in a smaller area or in only one plot, the factors mentioned above might have been more uniform, and would have affected the developing ants more uniformly, thus eliminating or at least reducing the situation under discussion.

The average ratio of smaller workers to larger ones (3:1) perhaps means that the former are more important than the later in the day-to-day activities of the various colonies. It is likely that the smaller workers are more active and also more efficient and therefore more needed than the larger ones. It is also possible that the adult workers, by their probable unequal sharing of food to the developing individuals, cause the few which get more food to become larger workers.

5.4.4 Comparison of means of head widths.

That almost all the comparisions of the mean head widths showed no significant difference seems a reasonable finding since all the ants whose heads were measured are supposed to belong to the same species. The few discrepancies are rather difficult to explain. The best suggestion which one is tempted to make is the possible existence of subspecies in *guineensis*, but even this suggestion is highly debatable since the occurrence of significant difference in the head width of one caste (e.g. workers) does not necessarily mean the occurrence of a similar situation in all the other castes. The present work has therefore brought to light this problem which requires further research.

5.4.5 The Nest

(a) *The nest heights*: Bolton (1974), writing about the nest of *Cat. guineensis*, merely said, among other things, that "the nests are often at a considerable distance above the ground". The present work, however, indicates that a nest may start right from the ground and may even extend some distance into the roots of the rotten trees in the soil. Such nests may be faced with little problem of getting access to the moisture in the soil, particularly if the termite *Microtermes* sp. is living in it. However, the fact that only three such nests were found throughout the year suggests that getting access to the soil moisture is not an important factor in choosing a nesting site, though the moisture available to such nests may supplement the water requirements of the nests.

Considering the average heights of the nests, and considering the finding that the three nests which started from the ground were very old, with soil in them, one may suggest that the nests of the ant are usually started (by wood-boring insects) at some distance above the ground, and as these wood-boring insects, especially *Neotermes* sp. extend the nest downwards into the fresh parts, the ant takes over the abandoned end of the wood. Thus the ant follows the termite closely until the latter abandons the wood completely when the boring has reached the ground level. After the complete take over by the ant, it might or might not be joined by the other termite species, *Microtermes* sp. It would appear from the above suggestions that how close the wood-nest extends to the ground depends mostly on how long *Neotermes* sp. lives in it and how far it extends its wood-boring activities towards the ground. What is not clear is whether the continuous boring by the termite is the result of its preference to lodge in the living portions of the wood or it is a response to pressure of the increasing population of the ants exerted on the termite.

(b) The nest: Though two types of nests have been mentioned for the ant, also despite the seemingly great importance of *Neotermes* sp. in the nesting habits of the ant, it still seems that the ant is not very fastidious with where to nest and what to nest in. The three instances in which the ant settled in the soil, nested in an abandoned carton nest of *Cr. depressa* and the observations that new queens apparently founded new colonies in previously formed holes and crevices in various parts of the trees support the above statement. It would then appear that in the cocoa farms *Cat. guineensis* will move into any available cavity provided the wood is not lying flat on the ground and is not very wet. A similar finding has been made by Sudd (1967) who listed the genus *Cataulacus* with other genera of ants which "choose their nesting sites anyhow and anywhere". Bolton (1974) made a similar statement about *Cat. guineensis*, while Forel (1916) recorded this species as inhabiting an abandoned wasp nest on the trunk of a tree at Motombe on the Okiavo in Zaire. With the above discussion in mind one would have expected more nests in the dry cocoa pods/ cherelles which were abundant in the plots.

The fact that this did not happen might be due to the fact that dry pods fall to the ground soon and once they fall the ants will abandon them. It could also be due to the possible greater competition to *Cat. guineensis* offered by other pod-nesting species such as *Cam. olivieri* and *P. decemdentata* mentioned earlier in chapter 4.

About the structure of the nest, perhaps what needs to be mentioned is the advantage the numerous entrances to the chambers are likely to offer the inmates. Such numerous outlets will tend to improve ventilation in the chambers. But at the same time it must not be forgotten that the numerous outlets might also increase the amount of heat lost or gained by the core of the nest to and from outside depending on the environmental conditions surrounding the nest.

The importance of the distribution of the juvenile stages throughout the chamber of the nest to the activity pattern of the ant will be discussed in the nest chapter. What needs to be said at present is that this tendency to spread the brood in the nest seems to be a phenomenon in other ants. For instance, Sudd (1967) writing about *Prenolepis longicornis* stated that "in a large undivided artificial nest, the more workers are supplied the larger the area of floor covered by the larval pile becomes". He further stated that in a nest divided into many cells (as in the case of *Cat. guineensis*) the larvae are more dispersed. For instance he found that 200 larvae, which according to him could just be packed into one cell, were spread over two cells by 25 workers. His experiment went further to prove statistically that the greater the number of workers in the nest the greater the area occupied by the larvae.

From these findings it appears that in *Pr. longicornis*, the queen deposits its eggs in certain areas from where they are dispersed by the inmate workers. This is very likely in the case of *Cat. guineensis* since there is normally only one queen (female de-alate) per nest and yet the brood stages are spread almost throughout the entire nest.

CHAPTER 6: ACTIVITY PATTERN OF *CAT. GUINEENSIS*

CHAPTER 6

ACTIVITY PATTERN OF *Cat. GUINEENSIS*

6.1 INTRODUCTION

Many workers have provided information on the activity pattern, including foraging, of various ant species. For instance, Elton (1932), describing foraging and territorial behaviour among the wood ants, *Formica rufa* Linn. at Picket Hill in Hampshire, S. Africa, reported that "each nest had a distinct territory within which lived almost pure cultures of aphids tended by the ants for their secretions, and forming the basis of trackway system from the nests". She reported further that there was no communication between the trackways of neighbouring nests, nor normally any hostility between ants of different ant nests, except for occasional destructive raids. Brian (1955) gave an account of the foraging behaviour of a 4-species Scottish ant community emphasizing the intra-species relations during food collection, while Vowles (1955), in his account of foraging behaviour of several ant species, emphasized the stimuli responsible for eliciting and sustaining foraging. Ayre (1958), investigating the meteorological factors affecting the foraging of *Formica subtenis* Creighton, claimed that light and humidity were the most significant factors, though he could not differentiate their effect from that of temperature and atmospheric pressure, since all these factors are related under field conditions. Pickles (1935, 1936, 1937, 1938, 1940) gave accounts of population densities, their relationship with foraging territory and also interrelations of various ant species at Garforth (Yorkshire) while the foraging behaviour of the ant, *Formica fusca* Linn., has been described by Wallis (1964).

Almost all the examples cited above are on temperate species. Fairly recently some information has been provided on the activity pattern of some tropical species. An example of this is the work on diurnal activity of *O. longinoda* by Leston (1968), and more recently, Aryeetey (1971) worked on *M. aculeatus*, a species common in cocoa farms in Ghana, and reported that this ant is nocturnal. No such information is available on other ants, such as *Cat. guineensis*, which also live in Ghanaian cocoa farms, and this work attempts to fill this gap on *Cat. guineensis*. As a matter of convenience and also to ensure clarity, the work was tackled under two main sub-headings, namely: (a) Trail activity, and (b) Foraging and food habits.

Under trail activity emphasis will be on the time of start of activity, the pattern of activity (as it is indicated by the movement of the foragers in and out of the nest) after the start trailing (foraging), the time of close of trail activity and the weather conditions prevailing during these changes in the behavioural pattern.

Under foraging and food habits attempts will be made, to estimate the size of foraging space (or foraging area or home range, as used by other workers) of the ant, relating the foraging space to certain forms of density, examination of the contents of the crops of the foragers, determination of correlation between head width and food size and finally to try to determine the type of food items transported by the ant into its nest, as well as finding out to what extent this species tends Homoptera.

6.2 METHODS

6.2.1 TRAIL ACTIVITY

The investigations were initially conducted at 2-week intervals, but due to sudden drastic changes in the anvironmental conditions, sometimes it became necessary to work more frequently than twice a month. The purpose was to investigate the effects of weather changes on the trail behaviour of the foragers of this species. Though the work was to be done on a single nest, it became imperative to work on two since the first nest was cut for firewood by an inhabitant of the station despite the warning signs placed on it.

Hourly counts of foragers passing over a census point (0.5 metres away from the base of the nest) and going away from the nest or returning to it were made. Any forager which crossed the census point was considered as either having left the nest or having returned to it, depending on whether its direction was away from or towards the nest. These counts were made simultaneously by tallying and mental counting. Mental counts were made on the more numerous group of foragers, while the other group was tallied. For instance, in the mornings when most of the foragers were leaving the nest it was found more convenient to make mental counts of these and tally the few which returned to the nest at the same time.

Since a preliminary investigation had earlier revealed that foraging in this species started around 6.00 a.m., it was considered appropriate to start work at 6.00 a.m. on each day of the investigation and close when activity ceased. These counts were made within the first 10 minutes of each hour.

Apart from the ant counts, weather conditions such as air temperature, relative humidity and light intensity were recorded by means of a thermometer, a hygrometer and a light meter placed in the same positions on each day of investigation so as to eliminate the influence of positional changes on their recordings.

Though work on the food habits of the species will be tackled in the next section, it was found appropriate to make hourly counts of carriers of solid food materials in this section. Data on the solid food carriers were analysed in an attempt to find what percentage of returning foragers carried food and also to find out in which of the six seasons in a Ghanaian cocoa growing area (as described by Gibbs and Leston, 1970) does the species carry solid food most.

6.2.2 FOOD AND FORAGING HABITS

(a) Foraging space.

The method used by Elton (1932) to study territory among wood ants, *Formica rufa* L. at Picket Hill and later applied by Pickles (1935, 1936, 1937, 1938, 1940) in his investigations into foraging spaces of a number of ant species at Thornhill, Yorkshire, was adopted in this project. In this method the longest distanee the foragers travelled from their nest (in search of food) was considered to be the radius of a circle within which the ants foraged. The area of the circle was then taken as the foraging space of the ants of that particular nest. The short-comings of this method when applied to the present work will be discussed later.

The method was adopted with some modification. Elton (1932) and Pickles (1935, 1936, 1937, 1938, 1940) worked on ground foraging species and it is likely that it was reasonably easy for them to follow the foraging ants.

However, Cat. guineensis, though sometimes foraged on the ground, was found to be mainly a canopy forager. The difficulty in following them in the canopy is, therefore, obvious. It was, therefore, necessary to use a ladder. Climbing the ladder, the writer followed, visually, the trail of the ants as they lined up along it (the trail). A field assistant standing on the ground was then asked to trace the trail on the ground by placing pegs vertically beneath the foragers which the writer spotted in the canopy. The position of the ladder was changed several times as it was necessary. By this method, pegs representing the ants formed a line or lines on the ground. Pegs which did not fall in line with the others represented foragers which had left the trail, but were still within the foraging space. Thus the end of a trail was made known as there was a scatter of pegs beyond that point. The distance between the nest and the farthest peg was then taken to be the radius of the circle within which the ants foraged. In considering the circle as the foraging area it was assumed that the ants would forage throughout the entire circle by changing their trail occasionally in relation to the changes in the source of food within the circle.

These investigations usually started around 6.30 a.m and ended between 12.00 noon and 1.00 p.m. Sometimes it continued till the evening and it was repeated not less than 5 days for any particular nest (colony). The days were not chosen in any regular order. Most of this work was done in May and June, 1976. Work on nests A and B (mentioned in chapter 4) however lasted from the end of April to early August since nest A was the one on which activity pattern was studied. The trail and radius were recorded on each day the activity pattern was studied. By such repeated observation and continual superposition of records, patterns emerged and the foraging spaces were thus estimated for ten colonies (nests) including nest A.

In addition to tracing the foragers of Cat. guineensis, other ants which were often encountered in the foraging area of this species were also traced, though foraging spaces were not determined. Maps were drawn to show the foraging areas of some of the colonies of Cat. guineensis on which these investigations were conducted.

Attempt was also made at finding out the nature of correlation between the populations of the colonies and the size of foraging spaces. In one case the numbers of pupae in the nests were not included in the correlation analysis, since, according to Pickles (1935), these do not influence the foraging activities of the workers because they are not fed. The results of the above analysis in which pupae were ignored were compared with those of another analysis in which pupae were considered. It is necessary to mention that in all these calculations the radii of the circle (distances between the nests and the farthest pegs) were used instead of the actual areas of the various circles, since the radii were the only changing factors in the calculation of the areas of the circles.

For the purposes of calculating the correlation indices, each nest, except colony 2 and nest B, on which the foraging space was determined was also harvested and census taken of its contents.

(b) Population density.

Elton (1932) recognised 3 kinds of density, namely the greatest density (GD), the economic density (ED) and the lowest density (LD). According to Elton (1932) the greatest density is the greatest number of ants in the nest at any time; that is, the total population of each nest represents its greatest density. For *Cat. guineensis* GD will be the population of the nest at the time it was harvested (before 6.00 a.m and after 6.15 p.m) when almost all the foragers were within the nest. The GD was discussed earlier in chapter 5. In the present chapter the determination of the other 2 forms of density is appropriate and will therefore be calculated accordingly. The economic density (ED) is calculated by dividing the total nest population by the total territory (that is, foraging space). In this project however, ED was calculated for each individual colony. The lowest density (LD) is calculated by dividing the total nest population by the total area of the census. Here too the calculations were done separately for each individual nest.

(c) Relationship between head width and food size.

Apart from counting foragers leaving and entering nests at hourly intervals (6.2.1), solid food carriers within the first 10 minutes were also recorded. These food carriers were captured by covering each with a glass tube. They then climbed to the bottom of the inverted tube with their booty. Immediately after trapping them the ants were killed with ethyl acetate. After the day's work all such tubes with ants and the food materials were taken to the laboratory where the head width, the head length, the food width and the food length were measured using a microscope and an eye-piece micrometer. Correlation indices were then calculated between the head width and food width and also between the head width and the food length. Head length was not considered in the analyses since (as shown in chapter 5) a high correlation exists between the head width and the head length of the species. It was therefore assumed that the results of the analyses using head widths will not differ significantly from those using the head lengths.

(d) Food items and examination of the gut of foragers.

Food materials collected from the foragers were taken to the laboratory for identification if this could not be done immediately in the field. Apart from this the ants were carefully watched as they moved about on the trees to find out their relationship with homopteran species, and their other food habits were also noted.

The head of the foragers carrying solid food was carefully broken from the body so as to have the anterior part of the alimentary canal attached to it. The crop was then examined under a pair of binoculars to verify whether or not it was filled with food. Some of the foragers returning into the nest without any food in their mandibles were also subjected to the same treatment.

6.3 RESULTS/OBSERVATIONS.

6.3.1 TRAIL ACTIVITY

Data on the trail activity of the species are provided in appendix tables 27-53. Figures 39-56 were drawn from data given in some of the tables mentioned above. Figures 39-42 describe trail activity on nest 1 while the rest describe that of nest 2. Where the weather conditions deviated sufficiently from normal these have been briefly described in the foot notes in the appropriate tables.

The diurnal nature of *Cat. guineensis* is evident in the various data and figures provided. Trail activity generally started from between 6.00 a.m and a little after 8.00 a.m. There were few instances when trail activity started before 6.00 a.m and these will be described in detail later.

Out of the 7 days on which investigations were conducted on nest 1, trail activity started before 6.10 a.m on 5 occasions, however it was never started earlier than 6.00 a.m on any of the 5 days (e.g. figures 40-42). On the other two occasions trail activity started between 6.10 a.m and 7.00 a.m (e.g. figure 39). All the 5 days on which trailing started before 6.10 a.m followed at least 5 days of no rain fall, whereas all the two days on which it started after 6.10 a.m (but before 7.10 a.m)

Figs 39-56: Activity Pattern of *Cataulacus guineensis* F. Smith.

key to figs. 39 - 56:-

Nº of ants leaving the nest within the first 10 minutes of every hour.

Nº of ants returning to the nest within the first 10 minutes of every hour.

Relative humidity (%)

Temperature (°C).

Light intensity (100...600 lu./ft^2.

% of workers returning to nest with solid food.

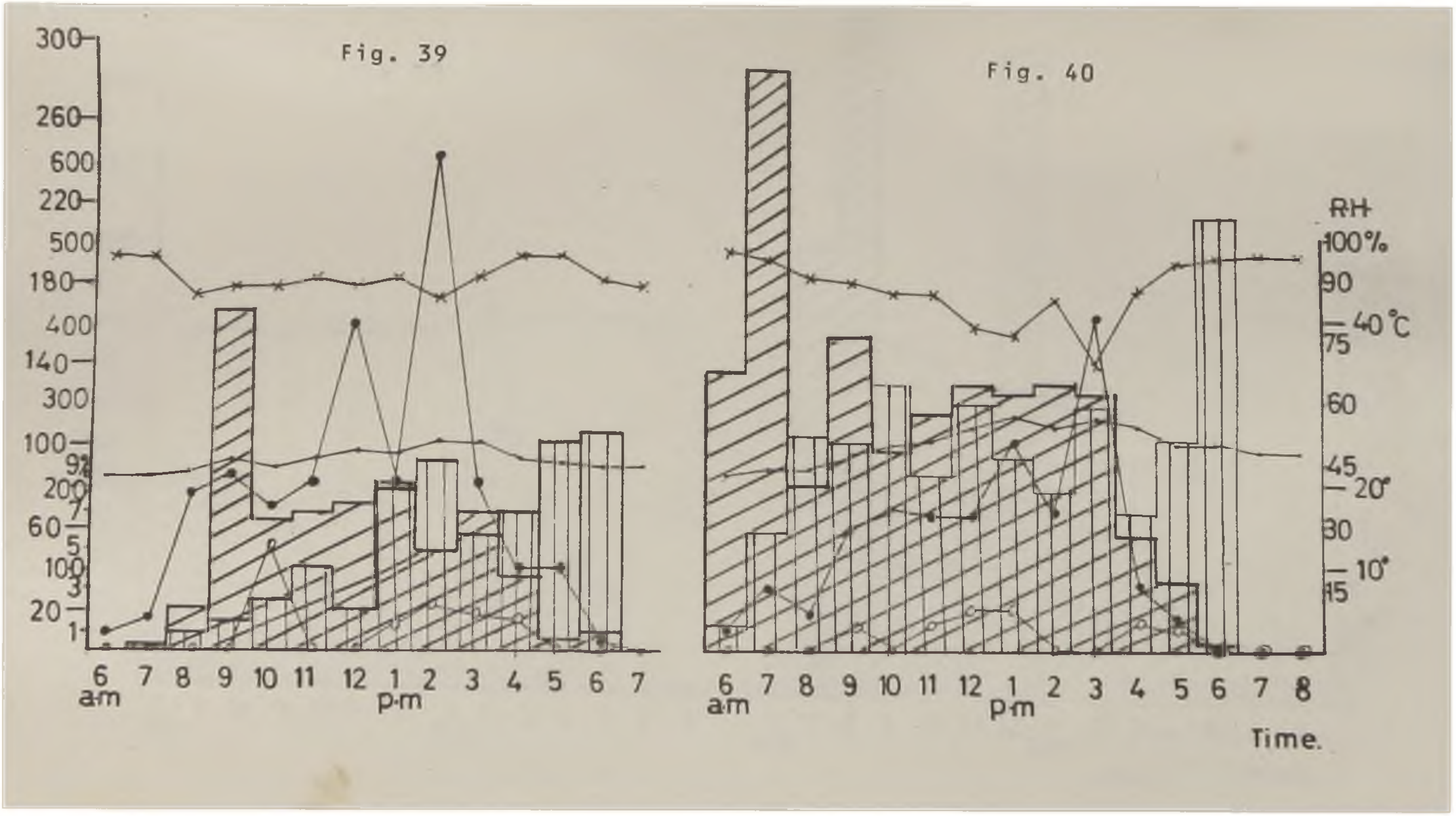


Fig. 39
Fig. 40
RH
100%
90
40 °C
75
60
45
20°
30
10°
15
300
260
600
220
500
180
400
140
300
100
200
60
100
20
6 a.m 7 8 9 10 11 12 1 p.m 2 3 4 5 6 7
6 a.m 7 8 9 10 11 12 1 p.m 2 3 4 5 6 7 8
Time.

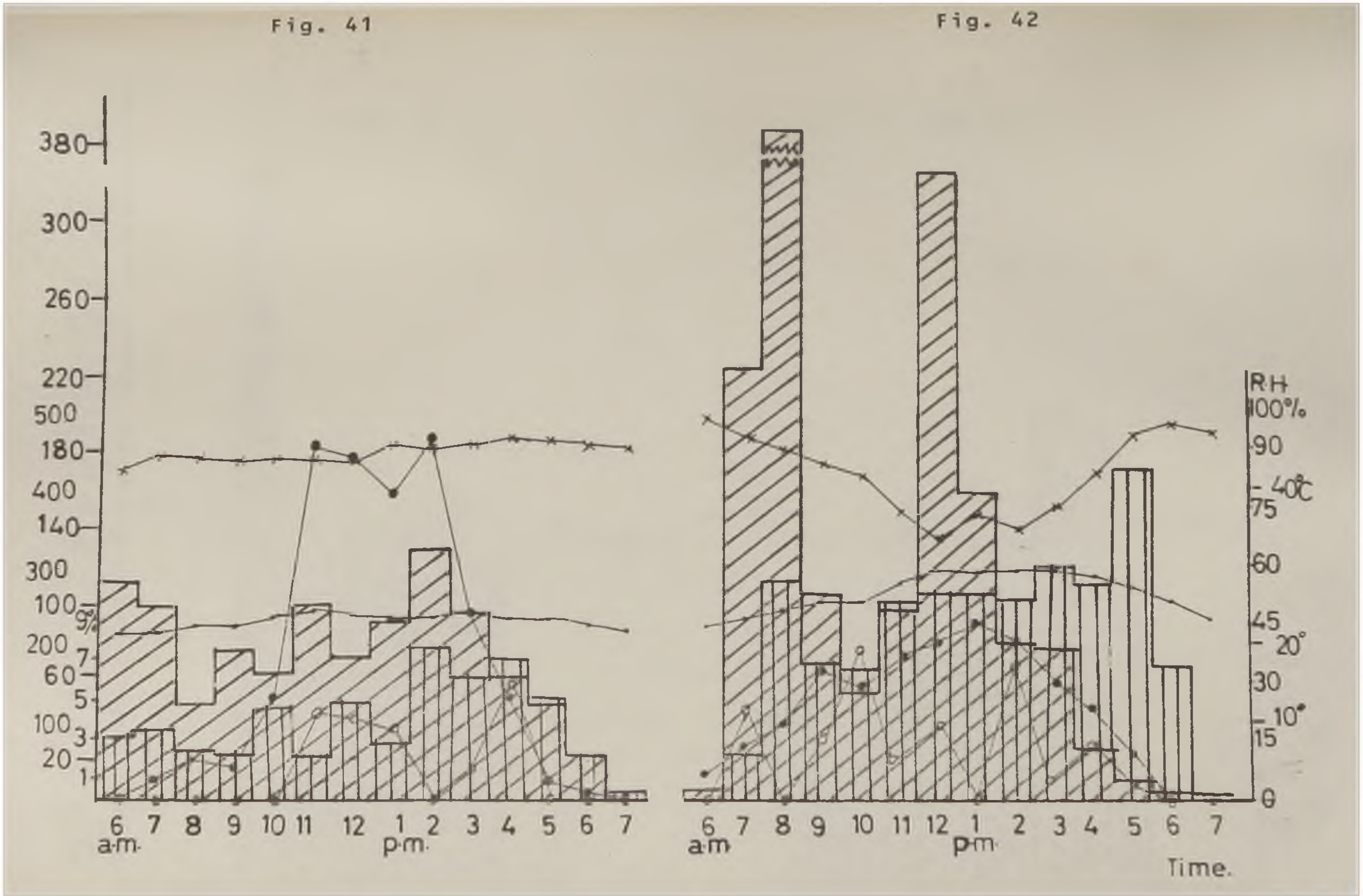


Fig. 41
Fig. 42
380
300
260
220
500
180
400
140
300
100
%
200
7
60
5
100
3
20
1
6 7 8 9 10 11 12 1 2 3 4 5 6 7
a.m.
p.m.
RH
100%
90
40°C
75
60
45
20°
30
10°
15
0
Time.

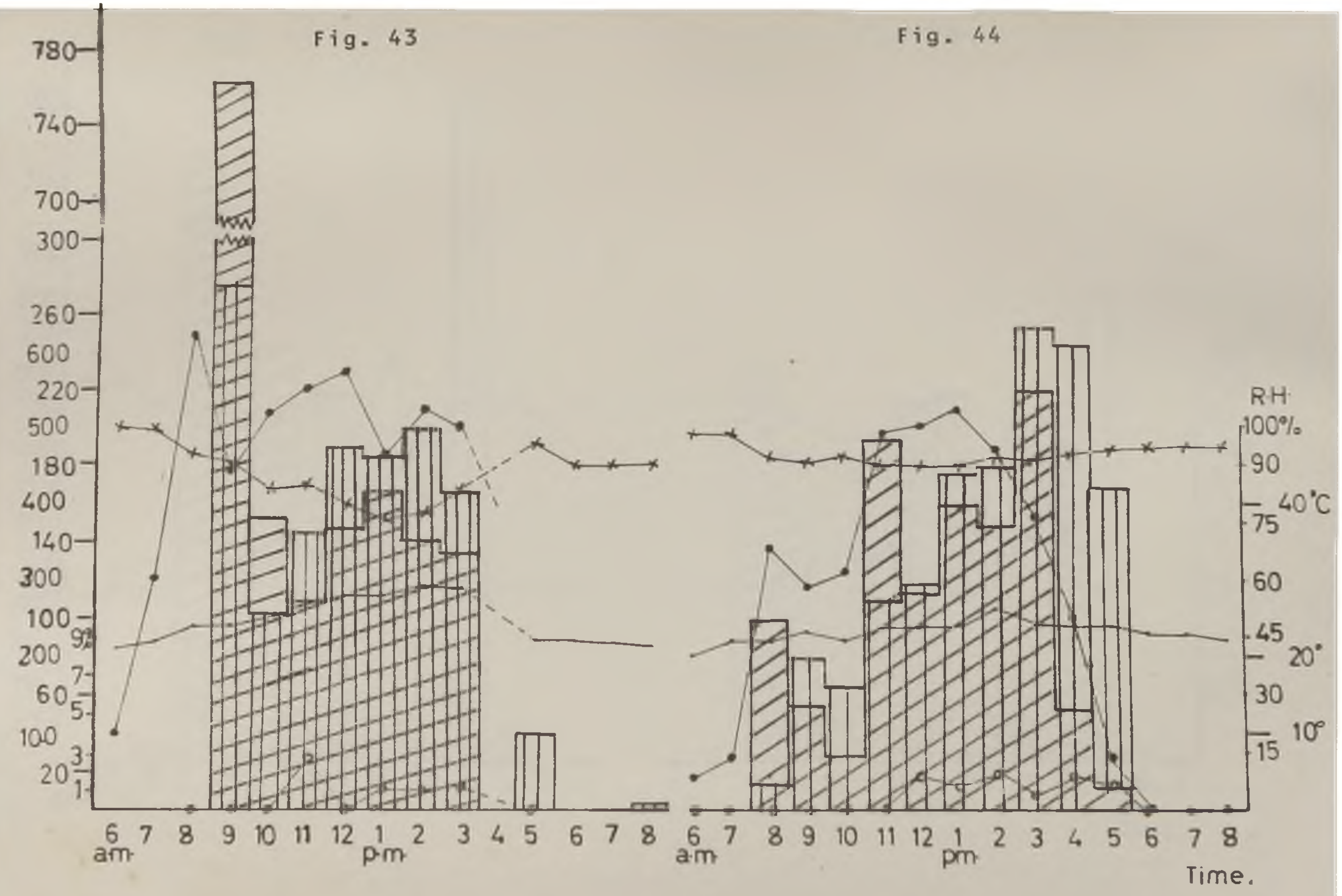


Fig. 43
Fig. 44
780
740
700
300
260
600
220
500
180
400
140
300
100
200
60
100
20
9
7
5
3
1
R·H·
100%
90
75
60
45
30
15
40°C
20°
10°
6 7 8 9 10 11 12 1 2 3 4 5 6 7 8
a·m·
p·m·
6 7 8 9 10 11 12 1 2 3 4 5 6 7 8
a·m·
pm·
Time.

Fig. 45

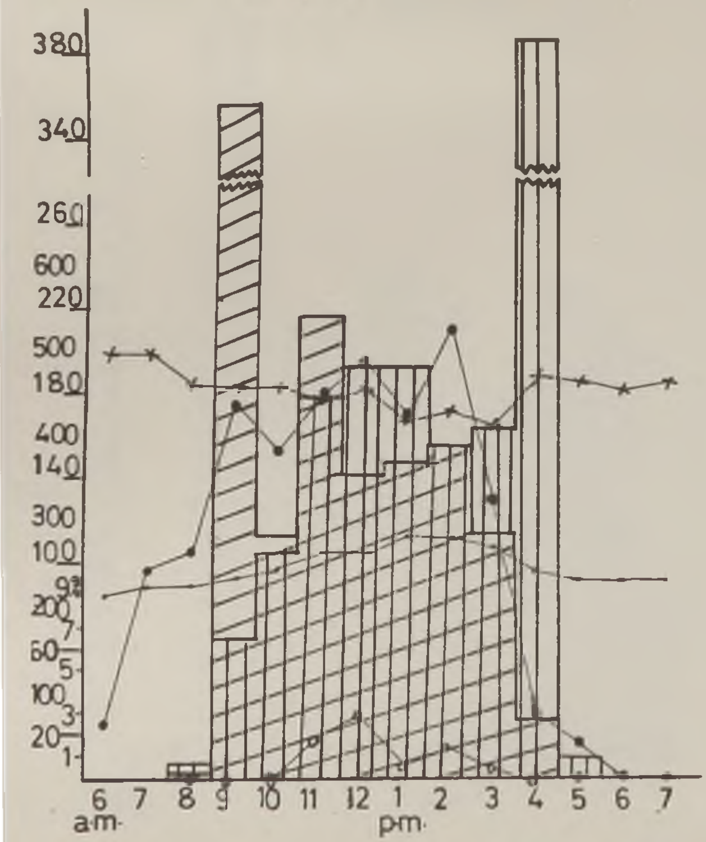

380
340
260
600
220
500
180
400
140
300
100
200
60
100
20
9
7
5
3
1
6 7 8 9 10 11 12 1 2 3 4 5 6 7
a.m.
p.m.

Fig. 46

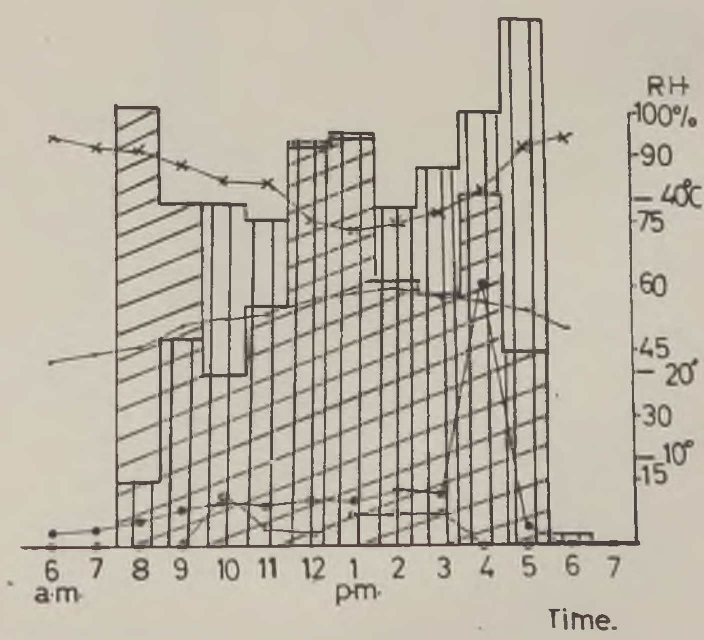

RH
100%
90
40°C
75
60
45
20°
30
10°
15
6 7 8 9 10 11 12 1 2 3 4 5 6 7
a.m.
p.m.
Time.

Fig. 47

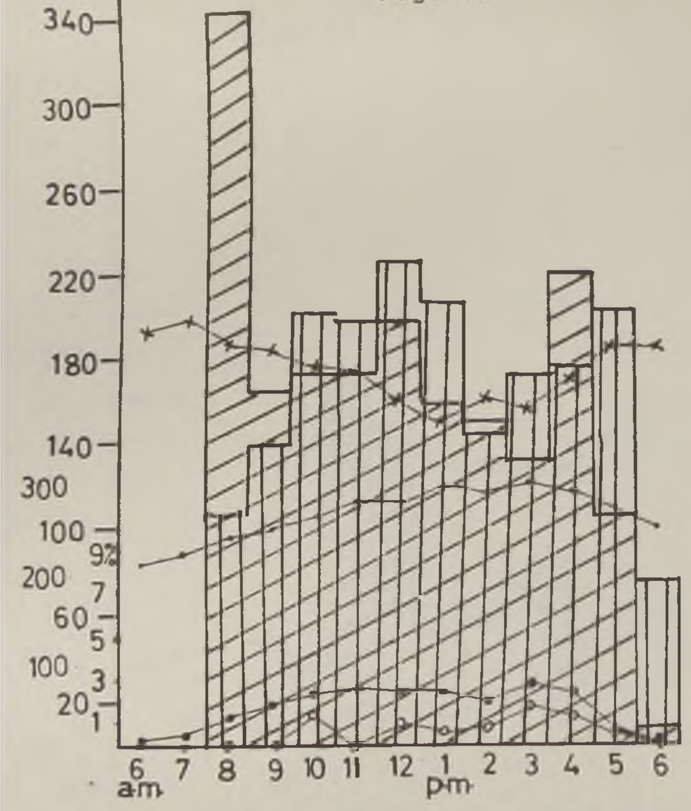

340
300
260
220
180
140
300
100
9%
200
7
60
5
100
3
20
1
6 am
7
8
9
10
11
12
1 pm
2
3
4
5
6

Fig. 48

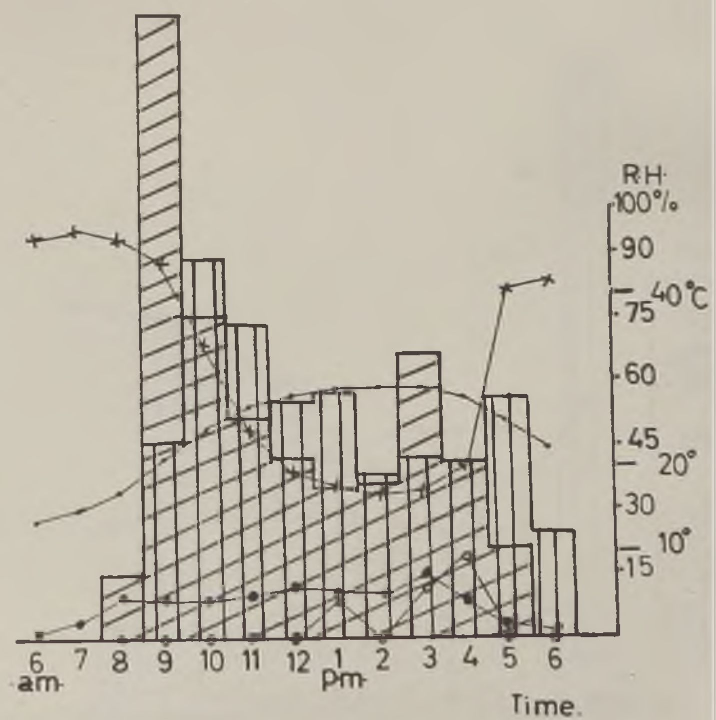

RH 100%
90
75
40°C
60
45
20°
30
15
10°
6 am
7
8
9
10
11
12
1 pm
2
3
4
5
6
Time.

Fig. 49

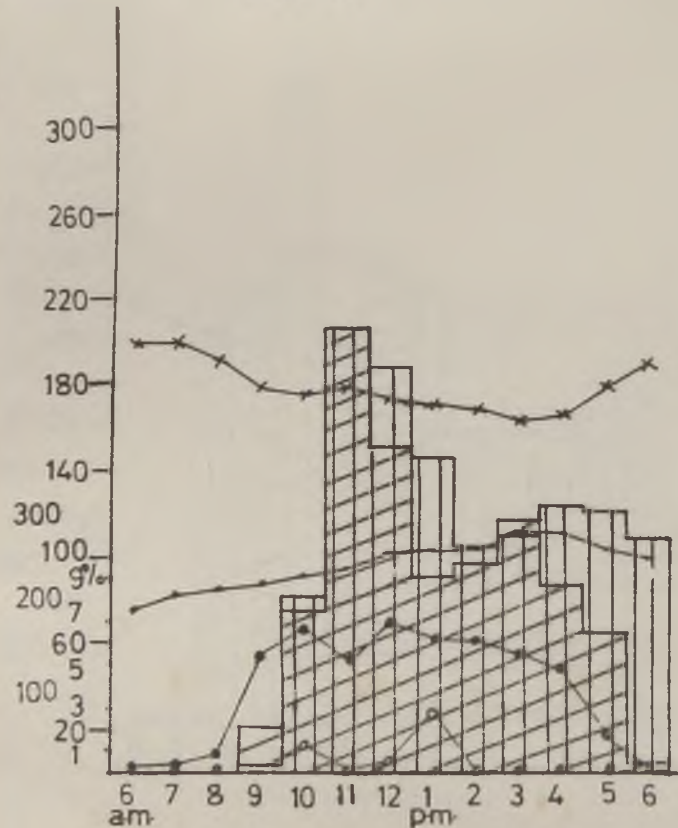

300
260
220
180
140
300
100
g%
200
7
60
5
100
3
20
1
6 am
7
8
9
10
11
12
1 pm
2
3
4
5
6

Fig. 50

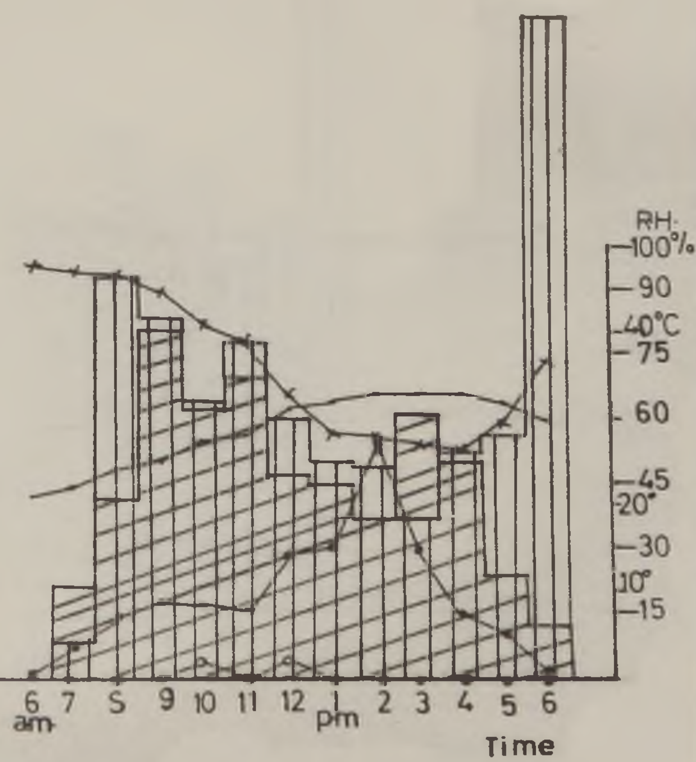

RH
100%
90
40°C
75
60
45
20°
30
10°
15
6 am
7
8
9
10
11
12
1 pm
2
3
4
5
6
Time

Fig. 51

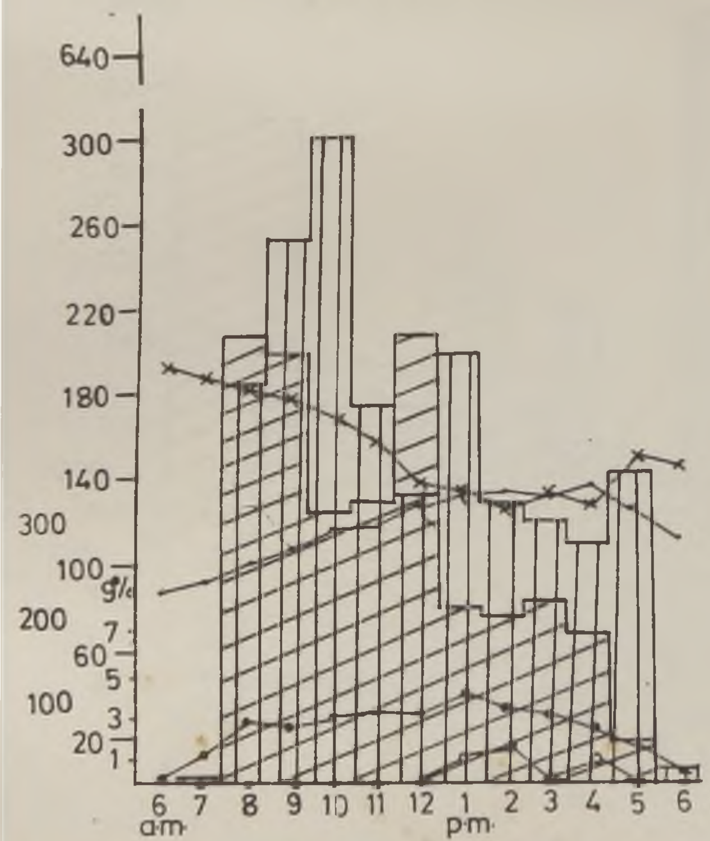

640
300
260
220
180
140
300
100
g/
200
7
60
5
100
3
20
1
6
a.m.
7
8
9
10
11
12
1
p.m.
2
3
4
5
6

Fig. 52

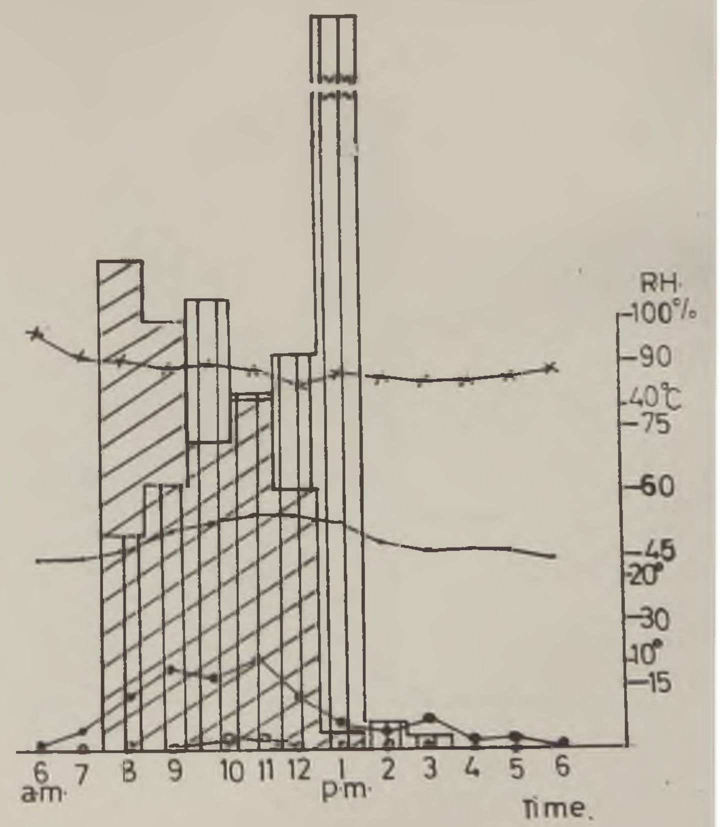
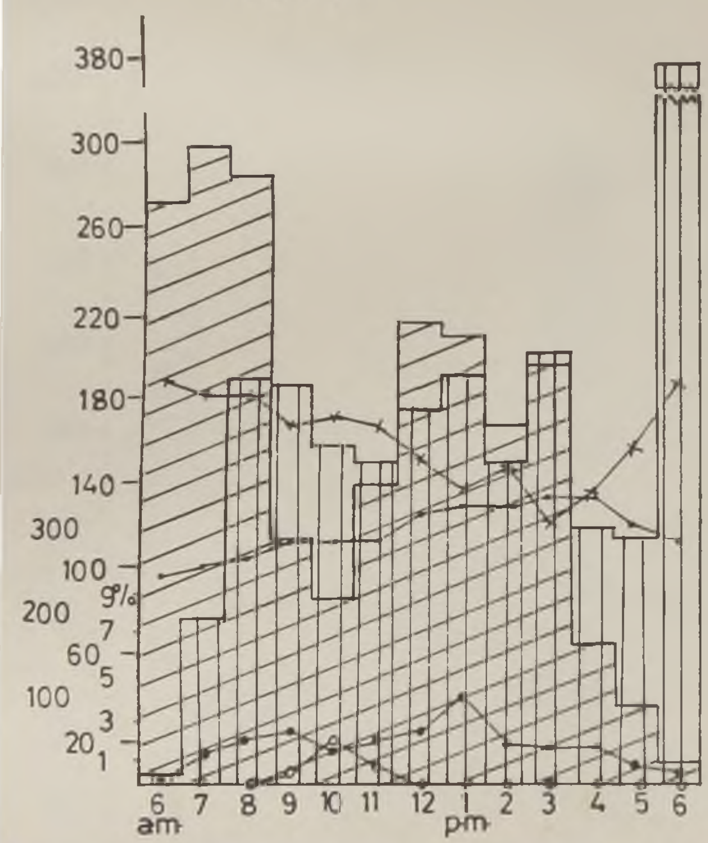

RH
100%
90
40°C
75
60
45
20°
30
10°
15
6
a.m.
7
8
9
10
11
12
1
p.m.
2
3
4
5
6
Time.

Fig. 53


380
300
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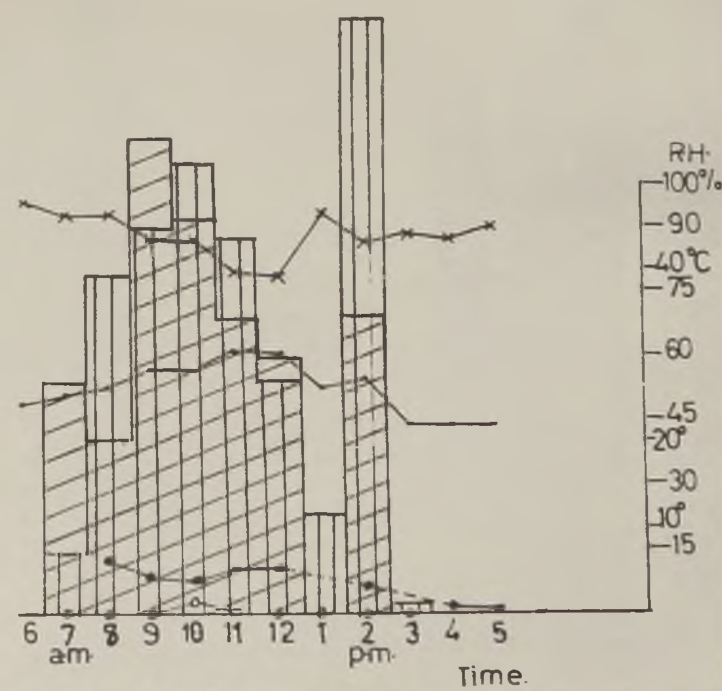
180
140
300
100
g%
200
7
60
5
100
3
20
1
6 7 8 9 10 11 12 1 2 3 4 5 6
am
pm

Fig. 54


RH
100%
90
40°C
75
60
45
20°
30
10°
15
6 7 8 9 10 11 12 1 2 3 4 5
am
pm
Time.

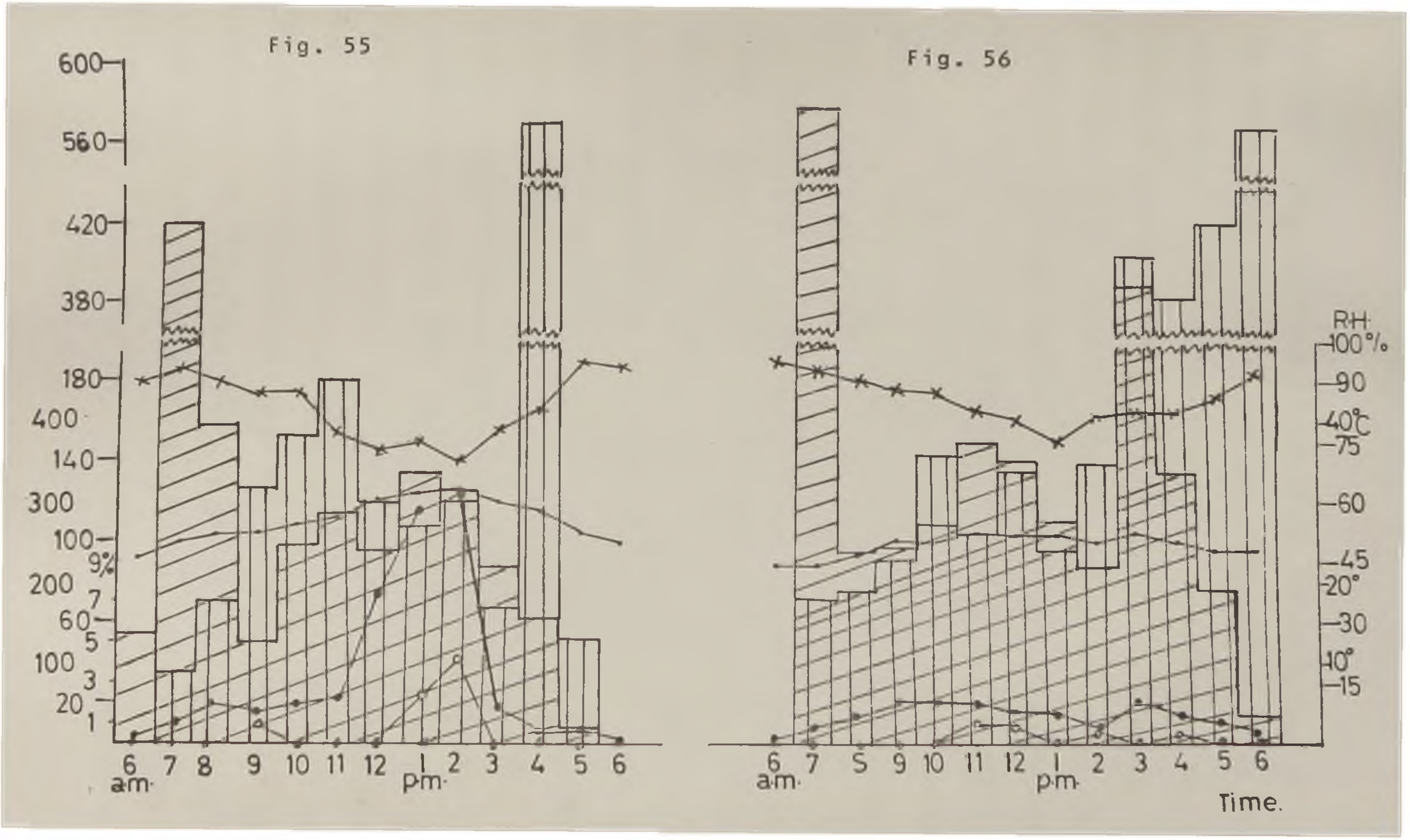


Fig. 55
Fig. 56
600
560
420
380
180
400
140
300
100
9%
200
7
60
5
100
3
20
1
RH
100%
90
40°C
75
60
45
20°
30
10°
15
6 a.m.
7
8
9
10
11
12
1 p.m.
2
3
4
5
6
Time.

followed immediately a night of at least 1 hour of rainfall. On 7th August, 1975, it was actually drizzling in the early hours of the morning and only one forager was recorded for 7.00 a.m (that is, from 7.00 a.m to 7.10 a.m). This ant returned to the nest only a few seconds after it had crossed the census point. On the 9th of October, 1975, only 4 ants were seen cleaning the nest up to 6.35 a.m when trailing started. It can be seen from the appropriate data that the weather conditions on these 2 days did not differ much from those on the 5 other days.

On nest 2 trail activity started before 6.10 a.m on 4 occasions (e.g. figs. 53 and 55). In fact on 11th May, 1976 (figure 53), the ants were for the first time, observed crossing the census point before 6.00 a.m; the exact time was, however, not noted since trailing had started already before the writer started work. There had been no rainfall since 15th April, 1976. Air temperature ranged from 24°C to 33°C and relative humidity and light intensity were normal. Following this observation the ants were watched again on the next day, 12th May, and the foragers started crossing the census point at 5.56 a.m. Similarly, on 13th May, 1976 the first forager crossed it at 5.54 a.m, though mass foraging actually started around 6.02 a.m., the ants leaving in fairly large numbers.

On 7 occasions trail activity started between 6.10 a.m and 7.00 a.m (e.g. figs. 50, 51, 54 and 56). There was no rain on any of the days immediately preceding any of these occasions on which trail activity started between 6.10 a.m and 7.00 a.m.

Some comparison may be made between trail activity on 11th May, 1976, figure 53 (when trailing started before 6.00 a.m) and that on 14th May, 1976, figure 54 (when trailing started around 6.36 a.m). Apart from the delay in the start of trailing on the 14th the level of activity was comparatively lower from the time it started up to around 8.10 a.m. For instance a total of 133 foragers (both leaving and entering the nest) and 372 (also leaving and entering) were recorded on the 14th and 11th May respectively for 7.00 a.m. Again 236 and 471 foragers were recorded on the 14th and 11th respectively for 8.00 a.m. However, within the 9.00 a.m and the 10.00 a.m recording periods, larger numbers were recorded on the 14th than on the 11th May, though the differences between these 2 recordings were not as large as those of the earlier hours cited above. For example 396 and 298 foragers were recorded on the 14th and 11th respectively within the 9.00 a.m, recording time. On the whole trail activity on the 11th May was higher and continued till after 6.10 p.m. but it was comparatively lower on the 14th and ceased completely after 3.00 p.m.

As mentioned in the footnotes of the appropriate tables, data for figure 53 were compiled after about 3 weeks of no rain (since 15th April, 1976) whereas data for figure 54 were compiled after a night of about 45 minutes heavy downpour. Again on the 14th of May, it started raining at approximately 1.09 p.m, lasting about 25 minutes. 45 ants returned to the nest during the first 9 minutes while none went out. The level of trail activity rose again after the rain with a total of 414 foragers (138 leaving and 276 returning) being recorded for 2.00 p.m. The rain resumed around 2.20 p.m and following this only 4 ants were recorded for 3.00 p.m. At the time of abandoning observation (5.10 p.m) it was still drizzling and a few workers were cleaning the nest, throwing pieces of material out of it.

Apart from the rainfall on the 14th, the general meterological conditions on the 2 days were not much different though light intensity was very low on the 11th (fig.53) when trailing started (around 6.00 a.m). No record on light was made at 6.00 a.m and 7.00 a.m on the 14th (fig.54) because the light meter had broken down.

On 8 occasions foraging (trailing) started between 7.10 a.m and 8.00 a.m (e.g. figures 43-48 and 52). Five of these occasions immediately followed a day or a night of rainfall (e.g. figures 43-45 and 52), two followed at least 13 days of no rain (figs 46 and 47) and one was on a day of severe harmattan conditions (fig.48).

Findings on some of the 8 occasions may now be described in detail. From 7.45 a.m to approximately 8.00 a.m on 5th November, 1975 (fig. 43) many workers engaged in nest cleaning and only 4 foragers crossed the census point within the 8.00 a.m recording period. Mass foraging actually started around 8.15 a.m involving a large number of foragers. The 1035 foragers (761 leaving and 274 returning) recorded for 9.00 a.m were moving very fast. Light intensity was generally high, the highest reading being made within the 8.00 a.m recording time. Air temperature and relative humidity were normal.

On 16th December, 1975 (fig. 46),following 13 days of no rain, mass foraging started as late as 7.20 a.m as if it had rained on the previous day. As mentioned above there had been no rainfall on the previous day or night. The level of trail activity was generally high and compared favourably with that on 5th November, 1975 (fig.43). However, on this occasion the light intensity at the start of trailing was comparatively very low though temperature and relative humidity were normal. A similar picture is presented in fig. 47, the data of which were collected on 6th January, 1976, a day following 16 days of no rain. Mass foraging on this day started approximately at 7.30 a.m.

One significant difference between figures 46 and 47 on one hand and 43 and 44 on the other hand was that within the 8.00 a.m recording period (when foraging had started only a few minutes back), trail activity was comparatively very high in figures 46 and 47 but fairly low in figures 43 and 44.

On 14th January, 1976, (fig. 48), a day of severe harmattan conditions, the trail activity was also very low during the 8.00 a.m recording period as in figs. 43 and 44. The severeness of the harmattan, as indicated by the fairly low temperature in the morning and the low relative humidity in the afternoon, is evident in fig. 48. Though trail activity around 8.00 a.m was low, as in figures 43 and 44, the light intensity was not high (as in figures 43 and 44). It was fairly low in the morning and was similar to those recorded during the same hours as in figures 46 and 47 (when trailing was high within these early hours). On this day (14th January, 1976), another important observation different from what was normally seen, was made. That is, normally many foragers stayed in the trail, dashed at other foragers moving in and out of the nest and offering them what has been described by many workers as antennal greetings. This normally occurred from the later hours of the mornings to around 12.00 noon and also from about 3.30 - 4.00 p.m.

to around 5.30 p.m. Activity in the afternoons was characterised by fast running in and out of the nest. But on this day of severe harmattan condtions very few foragers lingered about in the trail during the periods mentioned above.

On only one occasion i.e. 9th February, 1976 (fig.49) trail activity started between 8.10 a.m and 9.00 a.m. On this day the ants were not seen until at about 8.43 a.m when nest cleaning began. The census point was first crossed at approximately 8.56 a.m. Trail activity did not only start very late on this day, but it was, as in figure 48 also generally low, with foragers moving sluggishly in and out of the nest. It is to be noted that after a period of about 50 days without rain (from 21st December, 1975 to 7th February, 1976), the first rainfall, heavy and long lasting (about 5 hours) came in the night of 8th February, 1976. Drizzling continued on the 9th till about 9.45 a.m.

Some general observations made were that trail activity was invariably preceded by nest cleaning, and also towards the evenings when trailing was about to stop many of the workers engaged in nest cleaning. Little nest cleaning was observed from around 10.00 a.m to about 4.00 p.m. As will be seen later these hours

(10.00 a.m to 4.00 p.m) fall roughly within the hours when most of the solid food materials were recorded. When the ants were cleaning the nest they were seen actively throwing minute pieces of materials out of the nest. While some of the workers only extruded their heads out of the numerous entrances of the nest, others emerged completely out of the nest carrying the material to be discarded in the mandibles. Some workers might even walk some distance away from the outlet from which they had emerged, then stand virtually on the hind legs, thrust the anterior part of the body outward before releasing the material from the mouth. On a number of occasions workers were seen cleaning the outer part of nest A (mentioned earlier). Cleaning was mainly done on individual basis by each worker breaking a small bit of the unwanted substance at a time. By this seemingly slow process, workers of the ant were able to clear a group of fungi (basidiomycetes) on nest A.

Another observation worthy of mention is that on the occasions when returning foragers (both with and without food in their mandibles) were being captured for gut examination relatively very few foragers were observed leaving the nest.

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Another observation worthy of mention is that on the occasions when returning foragers (both with and without food in their mandibles) were being captured for gut examination relatively very few foragers were observed leaving the nest.

Yet another observation was that the level of trail activity, as shown in the various figures, was high throughout the year. There were two occasions, however, on which the trail activity was only slightly lower than the rest of the occasions. These two were: (1) the day with severe harmattan conditions (fig. 48 and (2) the day which was preceded by a long period of 'draught' (fig. 49).

The pattern of trail activity after it had been started is difficult to describe. Nevertheless, a brief generalized description is attempted here. As may be expected when foraging started, more foragers were normally recorded leaving the nest than those returning. The differences between those leaving and those returning were usually very high, not only at the start of foraging but such high differences were sometimes recorded for 2 consective recording periods (figs. 40, 42, 46, 52, 53 and 55). Towards the later hours of the mornings, however, the differences diminished gradually till late in the afternoons when increasingly more foragers returned than left the nest. It is interesting to note that the increase in the number of returned foragers was often accompanied by increase in nest cleaning.

On one occasion, 21st August, 1975, however, more foragers were recorded leaving the nest right from the start of activity (before 6.10 a.m) to as late as 3.00 p.m recording period (fig. 41) before a greater number returned than left in the 4.00 p.m recording period. Within the 5.00 p.m recording period, a greater number of foragers returned as usual and equal numbers were recorded for those leaving and returning at 6.00 p.m. On this occasion the light intensity shot up at 11.00 a.m and remained at that high level till around 3.00 p.m when it dropped. The largest number of foragers to leave the nest was recorded for 2.00 p.m and this number coincided with the highest peak of light intensity recorded for the day. Temperature and relative humidity remained almost constant throughout the day.

Also in figure 39 larger numbers were continuously recorded as leaving the nest than returning from the start of foraging to 12.00 noon. The light intensity, again was generally high within this period, with a very high level being recorded around 12.00 noon. There was a drastic drop in the light intensity within the 1.00 p.m recording period and this coincided with a slight increase in the number returning over those leaving the nest.

The highest level of light intensity for the day was recorded for 2.00 p.m and this coincided, contrarly to what was described in figure 41 (above), with a farily large number returning than leaving. As usual the atmospheric temperature and the relative humidity remained about constant.

On one occasion (16th December, 1975) greater numbers were consecutively recorded returning to the nest from 10.00 a.m to close of work around 6.15 p.m (fig. 46). Normally, however, such larger numbers returned continously than those leaving the nest starting from around 4.00 p.m. The above observation therefore deviates somehow from the noraml pattern of trail activity. Though the general weather conditions in figure 46 did not differ much from those of the other days on which continuously larger numbers returned than those leaving with effect from the 4.00 p.m. recording period, the harmattan conditions were still prevailing, as may be inferred from the low level of relative humidity between 12.00 noon and 3.00 p.m.

Foraging in *Cat. guineensis* normally ceased a little after 6.10 p.m. However, there are few cases (mostly on nest 1), in which a few ants were still recorded in the 7.00 p.m and/or 8.00 p.m recording periods, as may be inferred from appendix tables 27, 28, 29, 31, 32 and 34. Three foragers were recorded leaving the nest within the 7.00 p.m recording period on 2 separate days and only one was recorded leaving at 8.00 p.m. A total of 16 foragers returned to the nest within the 7.00 p.m recording period on 4 separate days and only one returned within the 8.00 p.m recording period. These data are summarized in table 9.

Though foraging noramlly ceased after 6.00 p.m as stated above, rainfall appeared to cause earlier cessation of this activity as the following examples will tend to show.

(1) In figure 43 trail activity was reasonably high, with 298 foragers being recorded (133 and 165 leaving and returning respectively) in the recording period immediately preceding the rain. After about 40 minutes of downpour only 39 foragers returned and none left within the 5.00 p.m recording period. No forager was seen again till around 8.00 p.m when only one returned to the nest.

(2) In figure 52 the large number of foragers (639) returning to the nest was recorded for 1.00 p.m. Within the same period only 8 foragers left the nest. At the time of recording these data, there were threats of rain which actually came heavily between 1.10 p.m and 1.50 p.m. During the threats of the rain, almost all the foragers were moving very fast towards the nest, hence the very large number (639) recorded above. After the rain only

Table 9: Record of late foragers.

	ANTS LEAVING		ANTS RETURNING	
	7.00 p.m	8.00 p.m	7.00 p.m	8.00 p.m
	1	1	3	1
	2		2	
			2	
			9	
Total	3	1	16	1

12 and 5 foragers were recorded for 2.00 p.m and 3.00 p.m respectively as returning to the nest. No forager left the nest within these periods, and trail activity stopped a few minutes after 3.10 p.m.

(3) Another example is shown in figure 54. The rain started at approximately 1.09 p.m, lasting about 25 minutes. 45 foragers returned within the 1.00 p.m recording period of 9 minutes, none left the nest. The next recording started at approximately 26 minutes after the rain (2.00 p.m) and activity was high, with a total of 414 foragers being recorded (138 leaving and 276 returning) within the 2.00 p.m recording period. The rain resumed at approximately 2.20 p.m lasting about 20 minutes. At the time of collecting data for 3.00 p.m it was still drizzling and only 4 foragers returned while none left the nest. No forager was recorded for 4.00 p.m and 5.00 p.m and consequently work was stopped immediately after 5.10 p.m. At the time of stopping work it was still drizzling, and a few workers engaged in nest cleaning as described earlier.

(4) Another example was noted on 17th April, 1976. This day was not actually on the schedule for study of the trail activity, but after a heavy rainfall from around 9.45 a.m to about 11.25 a.m, the following observations were made. Quite a large number of foragers

were seen returning to the nest slowly. Occasionally a worker was seen crossing the census point and going away from the nest. However, none went farther than 0.9 metres away from the census point before returning to the nest. Trail activity virtually ceased around 2.00 p.m. At the time of stopping work, 3.15 p.m., it was still drizzling and only a few workers engaged in nest cleaning.

Solid food materials: Tables 10-12 and their corresponding figures 57-59 are the results of work on solid food materials carried into the nest by the foragers. The first solid food to be carried into the nest was usually recorded between 9.00 a.m and 11.10 a.m (fig. 57). However, in one case it was first recorded as early as within the 7.00 a.m recording period after foraging had started at a very low level at 6.10 a.m. The latest recording of a solid food material was within the 5.00 p.m recording period and this occurred in 4 cases only. (appendix tables 28, 31, 35, and 38).

As indicated in the various tables and figures, only a small percentage of the foragers returned to the nest with solid food visible in their mandibles. The highest recorded was 7.6% recorded for 10.00 a.m on 25th September, 1975 (fig. 42.). Any forager which had been

Table 10: Periods of recording first solid food material.

Recording time within which the first solid food was recorded	Number of cases
7 a.m	1
8 a.m	2
9 a.m	6
10 a.m	9
11 a.m	5
12 noon	1
1 p.m	2
	26

Table 11: Number of recording times within which solid food materials were observed.

Range	No. of cases
0 - 2	6
3 - 5	13
6 - 8	7
9 - 11	1
	27

Table 12: Collection of solid food materials within the seasons.

Seasons	Average number of recording periods within which solid food materials were recorded
A) Dry-sunny (late November-mid February	5.0
B) First wet-sunny (Feb-late May)	2.3
C) First wet-dull (June-July)	4.0
D) Dru-dull (August)	5.0
E) Second wet-dull (late Aug-mid October)	7.3
F) Second wet-sunny (late October-mid November)	5.5

g.57: Periods of recording the first solid food.

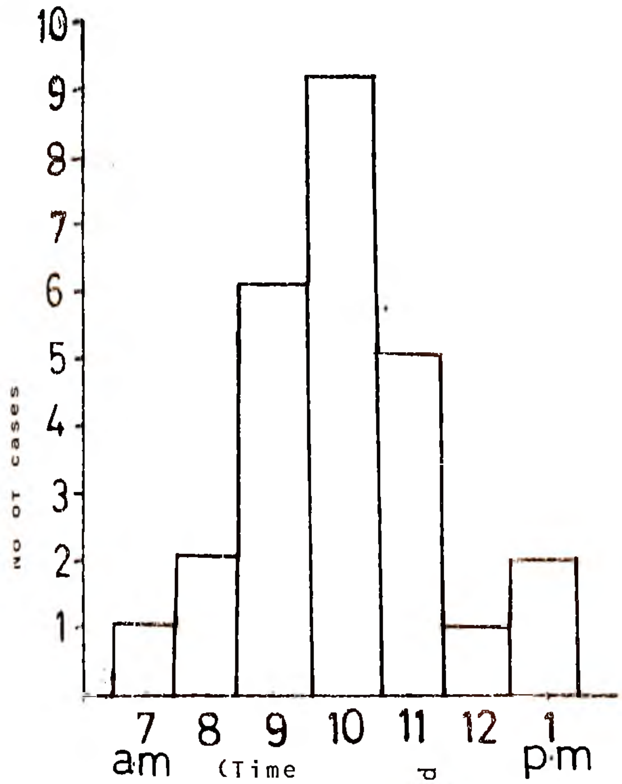
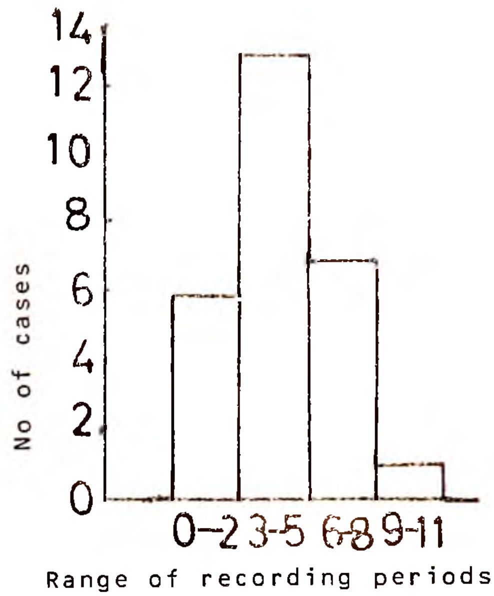


Fig.58: Daily frequency of recording solid food.



(ey to fig. 59:

= Dry-sunny season

Wet-sunny season

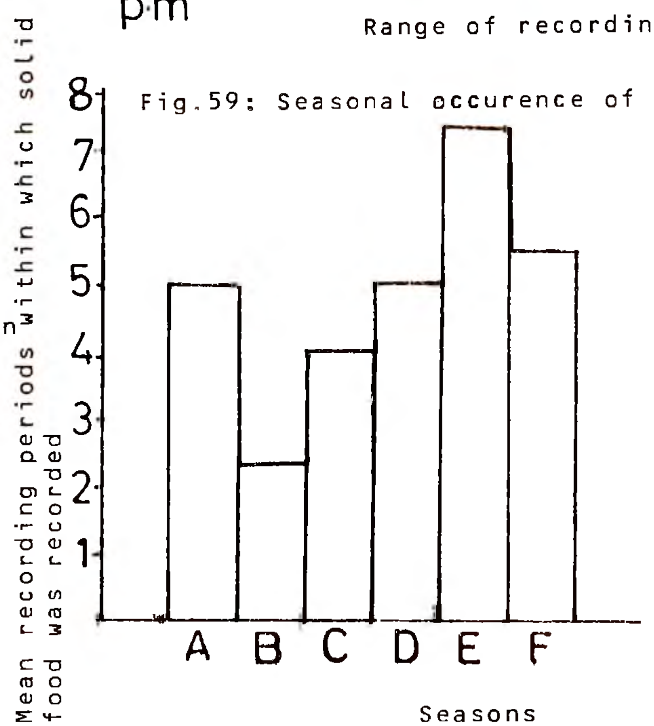
= First wet-dull season

= Dry-dull season

= Second wet-dull season

- Second wet-sunny season

Fig.59: Seasonal occurence of solid food.



able to procure food material carried it into the nest all by itself without passing it on to another forager in a relay pattern. Out of the 13 hours of recording data on each day (6.00 a.m to 6.00 p.m) solid food material was recorded in a maximum of 9 recording periods (fig.42). This formed 81.8% of the total number of recording periods, 11 hours from 7.00 a.m to 5.00 p.m (arbitrary determined), within which solid food was expected to have been located and was therefore expected to be transported into the nest. In one case (appendix table 48) no solid food carrier was recorded throughout the day and in another case (fig.54), only one carrier was recorded. However, in the majority of cases, solid food was recorded in 3 to 5 recording periods (fig.58).

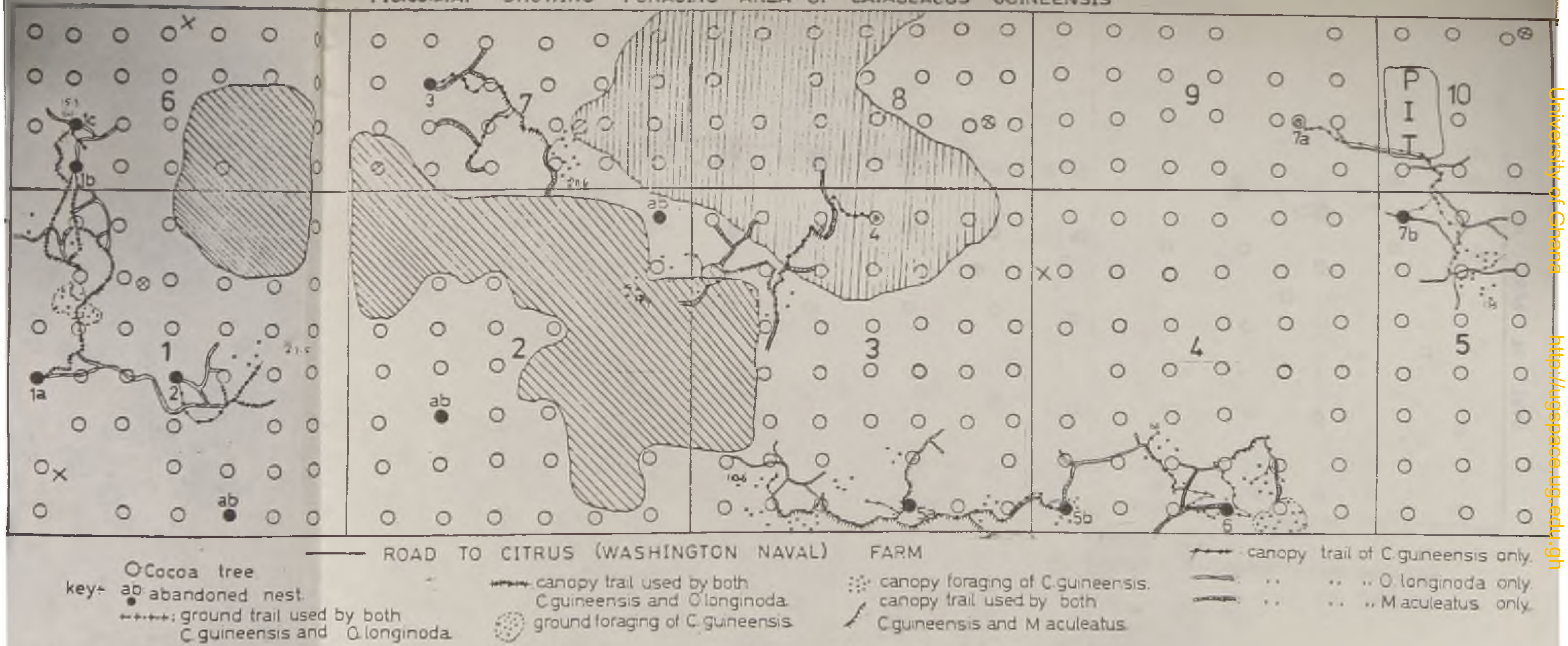
As shown in figure 59 the highest average number of recording periods within which solid food was recorded was about 7 times (precisely 7.3 times) and this occurred in the second wet-dull season (late August to middle of October). This average number dropped gradually through the second wet-sunny and the dry-sunny seasons (November to February), reaching a minimum level in the first wet-sunny season (March to May). Then it rose again through the first wet-dull and dry-dull seasons (June to August) before reaching the peak in the second wet-dull season (September and October).

6.3.2 FOOD AND FORAGING HABITS

(a) Foraging space: Figure 60 is a map of the portion of the area of detailed studies where most of the work on foraging space was done. Fourteen nests had earlier been mapped in this portion but 3 of them were abandoned before their foraging spaces were determined. The remaining 11 formed 7 colonies as designated in the map. It is important to point out that colony 2 was not harvested for its population to be determined. This is because the nest was enclosed within a live cocoa tree and therefore proved unsuitable for harvesting since many of its workers would have been lost. Because of this, colony 2 was left out of the various calculations. Thus 6 colonies were harvested in this portion of the area of detailed studies. The other 4 nests(each of which also constituted a separate colony) were harvested from other plots after recording their foraging spaces. Colony 32 is in fact the same as nest A mentioned earlier. A map on nests A and B and their foraging areas is provided in figure 61.

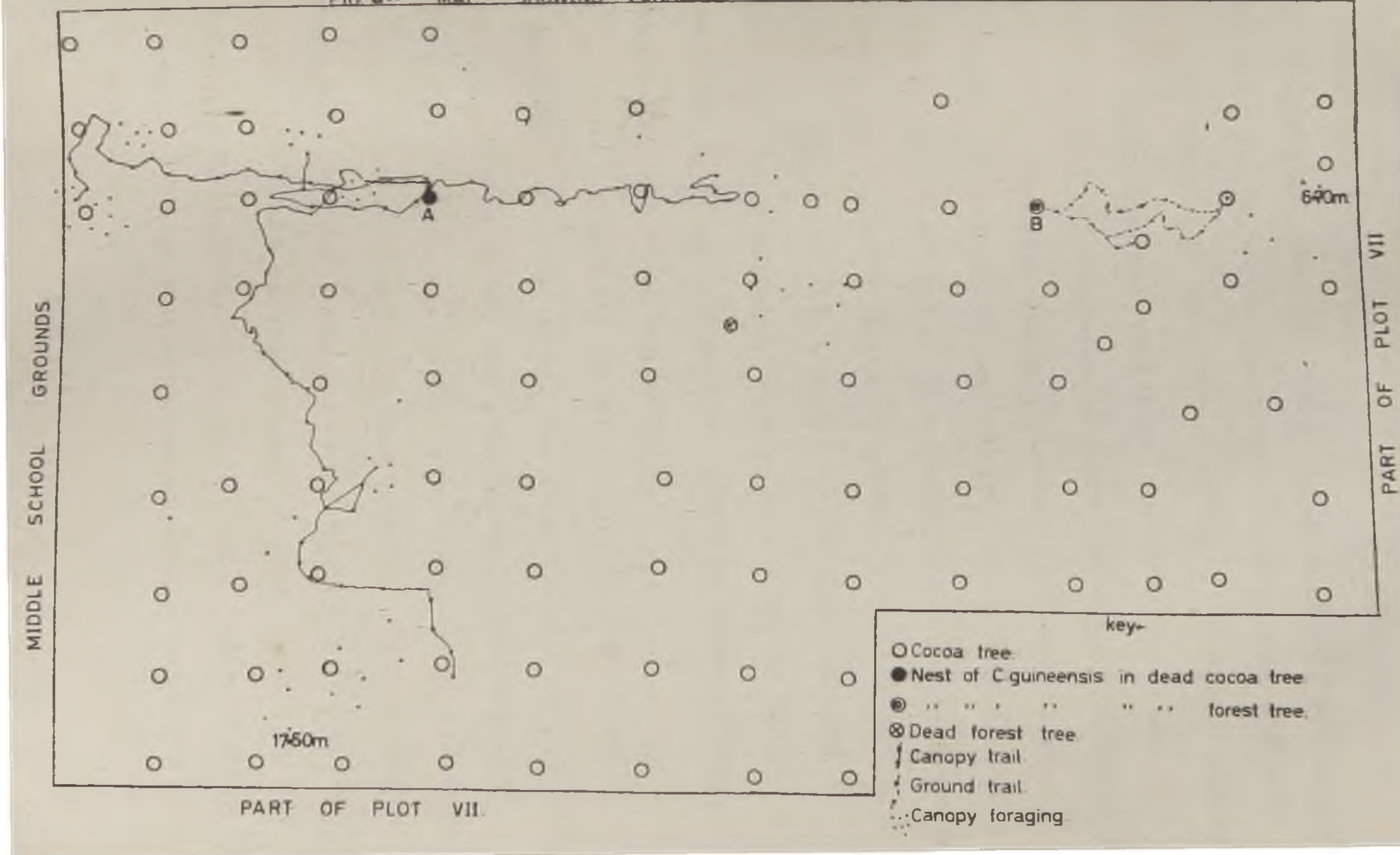
It is evident from figure 60 that, as mentioned earlier, the species forages mainly in the canopy though sometimes it forages on the ground as well. The close interaction of the species and *O. longinoda* is evident from the foraging spaces of colonies 1, 2 and 3, where

FIG.60: MAP SHOWING FORAGING AREA OF CATAULACUS GUINEENSIS



Scale: 1cm. = 3·1m.

FIG 61: MAP SHOWING FORAGING SPACE OF C. GUINEENSIS



the 2 species used the same trails considerably. *M. aculeatus* was also seen in the foraging areas of *Cat. guineensis* but unlike *O. longinoda*. *M. aculeatus* was seen only in the early hours of the mornings and also in the evenings. The interrelationship of these 2 species with *Cat. guineensis* have been discussed in chapter 4.

Analysis of the data on foraging space is shown in table 13. The mean foraging space is 555.0 sq.m. Referring to figure 60 one finds that colony 2, with a foraging space of 176.7 sq.m (radius 7.5 m), is apparently within the foraging space of colony 1 (which has a foraging space of 735.4 sq.m). Similarly colony 6 (nest 27) is apparently within the range of colony 5 (nest 26). These situations indicate apparent over-lapping of the foraging spaces.

Another interesting finding, as indicated in figure 60, was that where the home ranges were likely to overlap, foraging in the 2 colonies concerned was directed in such a way that the foragers in the 2 'enemy' colonies avoided meeting each other. This is shown between colonies 1 and 2, where foraging in colony 1 was mainly directed northwards while that of colony 2 was directed eastwards. Similarly, in all the 2 nests forming colony 5, foraging was directed to the west whereas that of colony 6 was

Table 13: Correlation between foraging space and population size.

Nest (colony)	Radius (metres) (X)	Foraging space (πr^2) sq.m.	Population without pupae (Y)	Population with pupae (Y_1)	(XY)	(XY_1)
23	15.3	735.4	12,643	13,425	193,437.9	205,402.5
24	11.6	419.1	4,190	4,756	48,393.5	54,931.8
25	17.9	1006.6	4,097	4,609	73,336.3	82,501.1
26	10.6	356.3	7,426	8,134	78,344.3	85,813.7
27	6.3	122.7	8,408	9,073	52,550.0	56,706.3
28	13.3	555.7	13,361	15,628	177,701.3	207,852.4
29	7.8	191.1	3,223	3,649	25,139.4	28,462.2
30	12.3	475.3	27,141	28,561	333,834.3	351,300.3
31	15.2	725.8	21,503	24,093	326,845.6	366,213.6
32	17.5	962.1	29,780	34,391	521,150.0	601,842.5
Total	127.8	5,550.1	131,772	146,319	1,830733.6	2,041,026.4
Mean	12.8	555.0	13,177.2	14,631.9	183,073.4	2,04102.6
Sum of squares	1,767.4		2,594,792,238	3,209,068,163		
Squares of the sum	16,332.8		1.736385998^{10}	2.140924976^{10}		

$$r_{(xY)} = 0.434 \ , \quad r_{(XY_1)} = 0.452$$

At 5% probability level with 8 degrees of freedom, the value of r in statistical tables is 0.632. The computed r values of 0.434 and 0.452 are not significant at this level of probability with 8 degrees of freedom.

restricted to a few trees around the colony. Ground foraging was also common around this colony as shown in figure 60.

A similar picture is seen between nests (colonies) A and B (figure 61) where B is apparently within the home range of A. Whereas 3 main foraging directions were found on colony A, only one was found on colony B, and even so, in B most of the foraging was on the ground. The foragers from colony B went up into the canopy only after foraging some distance on the ground.

Results of the calculations of correlation indices are provided in table 13. None of the 2 results showed any significant correlation at 5% probability level with 8 degrees of freedom; the r value in statistical tables at the above probability level with 8 degrees of freedom being 0.632.

(b) Population density: Table 14 gives the results of the various calculations for finding the economic and the lowest densities of the various colonies.

(c) Relationship between headwidth and food size.

Results of this work are provided in the appendix table 54. The results are not significant at 5% probability level with 58 degrees of freedom.

Table 14: Economic and lowest densities of various nests (colonies)

Nest	Foraging space (territory) sq. metres	Economic density (Ed)	Lowest density (LD)
23	735.4	17.19	4.68
24	419.1	10.00	1.55
25	1006.6	4.07	1.52
26	356.3	20.84	2.75
27	122.7	68.52	3.11
28	555.7	24.04	4.95
29	191.1	16.87	1.19
30	475.3	57.10	10.05
31	725.8	29.63	7.96
32	962.1	30.95	11.02
Total	5550.1	279.21	48.78
Mean	555.01	27.92	4.88

Total area of the census = 30 m x 90 m = 2,700 m^2

(d) Food items and examination of the gut of the foragers

The food materials collected from returning foragers included such arthropodan remains as legs of insects, legs of spiders (distintuished from those of insects by their 6 - 7 segments), dead dry cercopid, a dry heteropteran head (?*Bathycoelia*), dead dry remains of other ants, head and thoracic regions of a muscid fly and plant materials such as 'leaves' of mosses broken from the stems of cocoa trees, young cocoa bracts and 2 small seed-like objectss enclosed in a soft pulpy material.

It is important to point out that the materials listed above formed a very small proportion of the food materials found throughout the period of investigations. A greater proportion of the food observed was made up of a white substance. Any small pressure exerted on this substance broke it into a large number of very minute fragments. Another food material (which I think is part of the white substance) was brownish and usually had a bit of the white substance attached to it. As the foragers of this particular nest (A) foraged mainly in the canopy it is assumed that the food materials were obtained up in the canopy. However, it was not possible to ascertain the precise portion of the canopy from which the food was obtained. The white and brown substances gave positive results to a test for starch (turned blue-black with iodine solution).

Tending of homoptera was not a common observation. This was seen on 3 occasions only, and it occurred mainly on the pedicels of cherelles with the ants licking the dorsal surface of the abdomen of the homoptera (aphids). Not more than 4 ants were observed tending aphids at any one time.

One activity which was thought to be a feeding behaviour was that on several occasions (between August and October, 1975) some foragers from the first nest where activity pattern was studied spent time, sometimes running into an hour, on a curcubit plant (which was identified by Mr. Abbiw of Bontany Department, Legon, as *Luffa aegyptiaca* L.) The ants kept their heads between the bases of the leaf petioles and tendrils of this climber, particularly towards the apex of 'the plant, for several minutes. Invariably any time the ants left the *Luffa* plant, they went back straight into their nest. Microscopic examinations of the plant revealed 'bruises' at the bases of the petioles and the tendrils, with slight difference in colouration as compared to the nearby areas which were deep green.

Fifty-one solid food carriers were captured for the examination of the contents of their crops, and out of this 20 (39%) had their crops filled or half-filled, while the remaining 31 (61%) had 'empty' crops. Out of the sixty-five foragers which did not carry any food in their mandibles, 32 (49%) had at least, half-filled their crops. Considering the two groups of returning foragers together, it was found that 44.8% of the returning foragers carried some food in their crops. A filled or half-filled crop appeared dark brown or yellowish when viewed under the binoculars. One such yellowish-looking crop was pierced with a small sharp-pointed pin and the contents which oozed out looked oily. An 'empty' crop was either very light brown or silvery in appearance.

6.4 DISCUSSIONS.

6.4.1 TRAIL ACTIVITY

From the results obtained above it appears that rainfall is a very important factor affecting the start of trail activity in *Cat. guineensis*. The results of the work on the 11th, 12th and 13th May, 1976, in which trail activity started before 6.00 a.m and on the 14th May, 1976, in which it started approximately at 6.36 a.m appear to offer the best support for this suggestion. The results of the work on 9th December, 1976 tend to suggest further that rains coming after a long period of dryness tend to have more delaying effect on the start of trail activity than rains coming after relatively shorter intervals of dryness. However, it is important to remember that it drizzled till about 9.45 a.m on the 9th and this continuous drizzling was, perhaps, an important contributory factor to the delay in the start of trail activity on that day.

Other results, such as those on 16th December, 1975 and 6th January, 1976, give the impression that other factors, apart from rainfall, can also delay the start of trailing activity in this species. Since the species is diurnal, the most probable factor in this respect is likely to be the light intensity in the early hours of the mornings, and the relatively low light intensity within these hours in figures 46 and 47 have already been mentioned. These low light intensities in the early hours, then, are the possible reasons for the delay in the start of trailing activity on these two days.

If this is true then it would mean that there is a minimum light requirement to elicit the start of trailing in this species; and that this minimum light intensity may prevail around 6.00 a.m. particularly when there had been no rainfall on the previous day or night. It is a normal expectation that after a heavy down-pour, the air temperature should be low and the relative humidity high. Such a generalised statement cannot be made on light intensity, since at times the sun becomes very bright almost immediately after a heavy rainfall, while at other times it is virtually blocked by clouds for a long time after a rain. When the sun is thus blocked, low light intensity would be expected but it is very doubtful whether this expected low light intensity will be lower than the minimum required to elicit trailing activity in this ant. Doubt is expressed because some results obtained showed very low light intensities at the times activity started. In fact in one case (appendix table 52) the photometer recorded almost zero for the 6.00 a.m recording period and yet trailing started at a fairly high level (with a total of 67 foragers), before 6.10 a.m. One is therefore tempted to suggest that the minimum light intensity required to elicit activity in Cat. guineensis is too small to be detected by the instrument used.

The atmospheric temperature and the relative humidity may also be important in the start of activity, but their effect is very likely to be an indirect one through rainfall. It would then appear that after a heavy down-pour, though the minimum light intensity required to elicit trailing prevails around 6.00 a.m on the next day, the air temperature may be too low and coupled with an expected high relative humidity, will prevent the ant from foraging until these conditions improve. The time taken for the improvement of these conditions will then, tend to determine how long the start of trail activity will be delayed.

Another factor which appears to be important in delaying the start of trail activity in Cat. guineensis is the harmattan conditions as indicated in figure 48. The very low air temperatures recorded in the early hours of the morning seem to support the suggestion made in the above paragraph, though the relative humidity does not.

From the available results it appears that once trailing activity has started changes in the relative humidity and in air temperature as such did not have much effect on the pattern of this activity. This may be due to the fact that in the tropics these 2 factors do not fluctuate appreciably. However, drastic changes in the light intensity are common in the tropics, (evidenced in the various figures). These changes in the light intensity are likely to cause corresponding fluctuations in the body temperature of the ants even in a cocoa farm, and this will in turn affect the pattern of trail activity. Thus the body temerature of the foragers themselves is likely to affect the pattern of activity. A rise in light intensity, with its concomitant increase in air temperature will in turn cause absorption of more heat during the periods of insolation. In this respect the colour and the shape of the ant may also play a part in altering its body temperature. Thus the black colour and the rough surface of the body of workers of Cat. guineensis (figs. 15 and 16) are likely to cause more heat absorption, thus increasing the body temperature to a point which might make imperative, an adjustment in the behaviour of the ant. The change in behaviour may include a quick return to the nest so as to avoid excessive heat absorption. This then will explain why the foragers were normally seen running very fast in the afternoons, particularly those returning to the nest. In the mornings and towards the evenings however, they could afford to walk more slowly and also remain outside the nest (in their trail) for longer periods and offer antennal greetings and also to solicit for liquid food from returning foragers, since the danger of getting themselves over-heated does not prevail.

The relatively few foragers observed in the trail on the day of severe harmattan also suggests that apart from the possible effect of over-heating, drastic reduction in the relative humidity of the weather also influence the trailing behaviour of the species. It tends to reduce the length of time the forager remains outside its nest. The forager does this, perhaps, to avoid excessive water loss from its body.

So far the discussions have been on the importance of the various meterological factors, including rainfall, on the start of foraging as well as their relative effect on the pattern after the activity had started. It is now appropriate to direct attention to the importance of these factors (or at least some of them) on the cessation of the activity. The ending of foraging after 6.10 p.m, perhsps, emphasizes the importance of light in the behaviour of this ant. Those few foragers which were recorded as leaving the nest around 7.00 p.m and 8.00 p.m were most probably attracted by the light of the lamp during the observation period. The fact that 16 foragers returned around 7.00 p.m on 4 occasions and one around 8.00 p.m suggests that there are times when foraging in *Cat. guineensis* is prolonged a little. Since almost all the 16 foragers were recorded on nest 1, and since (as is evident in the various tables and figures) the light intensities on nest 1 were generally higher than on nest 2, it would appear that the higher intensities are responsible for the late return of some of the foragers. This also tends to emphasize the importance of light in the activity of this ant.

Nevertheless it seems that the importance of rainfall in the cessation of activity over-rides that of light intensity. All the 4 examples cited earlier tend to provide evidence that no matter how high the level of trail activity before a rainfall, it will invariably cease within one or two hours after the rain. Though no records were made of the 3 weather conditions on the day on which activity stopped at approximately 2.00 p.m (17th April, 1976), this time (2.00 p.m) was too early for light intensity to be below the minimum required for foraging to proceed. On the other hand relative humidity is likely to rise, at least a little, and air temperature is also likely to fall. These changes in the two factors, coupled with the continuous drizzling were, perhps, the factors which contributed to the early cessation of foraging.

The discussions, so far, have been on trailing only. Now it is necessary to discuss nest cleaning prior to the start of foraging, prior to normal cessation of foraging and also nest cleaning after foraging has been prematurely stopped due to a down-pour in the day. Wallis (1963) stated that nest cleaning on entering the nest is seen in the foragers of the ant *Formica fusca*, which have failed to find food, and also in some foragers in satiated nests. He described those foragers which failed to find food as unsuccessful. Sudd (1967) found that unsuccessful foragers of *Monomorium pharaonis* L. always stopped to clean inside the nest entrance while successful ones rushed straight back to the nest mates to donate food.

Nest cleaning in *Cat. guineensis* prior to foraging cannot be explained on the basis of their being successful or not, since no foraging had been done by then. It is also difficult to explain it on the basis of the hunger state of the nest. However, it may be explained on the basis of instictive behaviour which is, probably, necessary to warm up the workers in preparation for foraging activity. The fact that workers cleaned the nest towards close of foraging may be explained by

Wallis' (1963) suggestion that satiated ants engage in this activity. During these few hours both satiated and those foragers which have just failed to secure any food may engage in nest cleaning. This probably explains why more nest cleaners were seen in these late hours than prior to start of foraging.

The observation that little nest cleaning was done in the afternoons (12.00 noon to about 3.00 p.m) appear to suggest that most of the foragers are successful in their search for food during this period of the day and would, therefore, rush into the nest to feed their nest mates, and quickly return (perhaps with secondary foragers) to the food source to take more food. This suggestion is supported by the fact that solid food carriers usually ran very fast into the nest with little or no hesitation in the trail or at the entrance of the nest chamber. Those foragers which had no visible food in their mouths and yet returned very fast to the nest are likely to be those that had been successful in procuring liquid food in their crops or those which had filled their infrabuccal pockets with pulp,and must therefore run back home to feed their mates, and possibly to recruit more foragers to the food source.

The return of primary foragers with food elicits recruitment of secondary foragers (Wallis, 1963). Feeding from the returned foragers may then be an important stimulus for recruitment. The observation that when returning foragers were being captured for the crop examination very few foragers left the nest, seems to support the above suggestion. Sudd (1967) also found in his experiment on M. pharaonis L. that when fed ants were not returning to their nest, no recruits left it; but after food was made available to the foragers recruits came out of the nest. A most probable explanation for this situation is that there was no stimulus to elicit foraging in the inmates of the nest since those that returned to it had no food to excite the others to go out for foraging. In the case of Cat. guineensis the reduction in the number of foragers which left the nest during the capture of returning members may be explained in terms of the reduction in the quantity of food reaching the inmates of the nest to excite them.

The above finding by Sudd and to some extent, the observation on Cat. guineensis, seem to suggest that stimulus from returned foragers (with food) is stronger in eliciting foraging in others than stimulus from brood and alates which, as a rule, do not go out of the nest, but whose presence in the nest, according to Schneirla (1944), always causes high activity in a colony. The opposite of this might as well be the case or even both stimuli may be equally important. If the latter suggestions are rather true then the observation whereby fewer or no recruits left the nest when no food was forthcoming may be explained by the fact that when larvae, eggs or alates stimulate workers, they cannot direct the excited workers to any particular food source. However, a returned forager, when it arouses other workers is likely to direct the excited worker to the food source, either by the excited worker following the returned forager, when the latter leaves the nest again or by the worker following an odour trail left by the returned forager. One may argue that in the case of Cat. guineensis not all the returning foragers were captured, but one must not forget that the capture of most of the solid food carriers plus some of those that carried food in their crops greatly diminished the amount of food which would be expected to excite the inmates of the nest.

Another observation which needs comment is the persistently high level of trail activity throughout the year. This may be explained in terms of the occurrence of juveniles, and probably alates, throughout the year. As was seen in the last chapter, brood, at least, larvae and pupae, and also reproductives occurred throughout the year. Larvae and eggs are known to be a source of stimulation for foraging in various ants, and if they are present in the nest, throughout the year then their stimulating effect would be expected to be maintained throughout the year, though this stimulating effect may be diminished by other factors such as severe harmattan and rains coming after a long period of 'draught'. The diminishing effect of these two conditions would then explain why slightly lower levels of trail activity were observed in figures 48 and 49.

According to Vowles (1955), in an *Eciton* species the developing larvae and eggs are spread widely throughout the nest instead of being isolated in a small packet; and he suggested that this type of distribution ensured that they had greater opportunity to stimulate more workers and so increase the supply of food to the nest. As was found out in chapter 5, in *Cat. guineensis*, brood are more or less spread throughout the nest, and therefore as in the case of the *Eciton* sp, have greater opportunity to stimulate more workers to go out for food. The distribution of alates, however, is not likely to be important in eliciting foraging since they are capable of moving from one chamber to another within the nest.

Solid Food. Some comments are also necessary on the results of the work on solid food materials. The small percentage of transporters of these substance tends to suggest that *Cat. guineensis* might rely much more on liquid food (and possibly scraped wood material carried in their infrabuccal pockets) for its survival. The results of the crop analysis cited earlier seem to support this suggestion since comparatively larger percentages of liquid food transporters were recorded both in the solid food carriers and in those which carried no visible food in their mandibles. But it is important to emphasize that even the percentages recorded on liquid food were also small (a total of 44.8%), and are, therefore, not likely to account fully for the food supply of the species. Thereore, *Cat. guineensis* is likely to supplement its food requirement from other source(s). One most probable source may be the stealing of food from the termites which were found as inquilines in most of the nests harvested. It is also likely that some of the foragers carried food in their infrabuccal pockets but these were not visible to the writer.

Even though only a small percentage of foragers returned to the nest with solid food, the availability of the white and brown substances throughout the year is evident in the available data. The possible reasons as to why only a small percentage of foragers took it into the nest are probably a matter of (1) preference and (2) the difficulty in locating its source or (3) the quantities in which the materials occur over the year. Unfortunately, no investigation was conducted along these lines. However, considering the fact that (a) the species forages mainly in their trail(s) for a long distance (figs 60 and 61) before spreading, and (b) because the same trail(s) is used for sometime before it is changed, it appears that the second suggested reason may offer the most probable explanation for the small percentage of solid food carriers recorded.

Not only did small percentages of workers return with solid food but also these percentages were recorded mainly in a few (3,- 5, or 27.3% - 45.5%) of the 11 recording periods within which food was expected to be recorded. The fact that on one occasion solid food was recorded in as many as 9 (81.8%) of the 11 recording periods suggests that if the food source is located early and probably if it is available in large quantities then it would be expected to be recorded in almost all the hours except, perhaps, within the 6.00 a.m and 6.00 p.m recording periods.

Since the solid food was most frequently recorded in the second wet-dull season (late August to October) and least frequently recorded in the first wet-sunny season (March to May), it would appear that the solid food material was most abundant in the former season and least in the latter season. Perhaps the opposite is rather true but since, according to Sudd (1967), the importance of any type of food (honey-dew, prey, sap, seed etc) varies with the time of the year, other sources of food (perhaps liquid food, pulp carried in infrabuccal pockets or food stolen from the termite inquilines) more available and/or more preferable to the species were also present in the first wet-sunny season while they were less available in the second wet-dull season.

The behaviour of the species whereby a successful forager fails to pass its booty on to another forager in a relay pattern is similar to the behaviour of *Formica lugubris* zett, and other wood ants as described by Sudd (1967), but different from the behaviour of *Messor structor* which often transports its food on a relay principle (Goetsch 1929) as cited by Sudd (1967). According to Sudd (1967), this species also deposites seeds on the way to the nest which are carried further by other members of the nest. In this way not all foragers need to reach the food source. Ants with this sort of foraging behaviour are likely to have a further division of labour among its workers, a situation which, as was mentioned in chapter 5, does not exist in *Cat. guineensis*. It is, therefore, not surpring that *Cat. guineensis* does not transport food on relay principle.

6.4.2 FOOD AND FORAGING HABITS

(a) *Foraging space*: The finding that *Cat. guineensis* foraged both on the ground and in the cocoa canopy agrees with the observation made by Room (1971) who listed this species among ants which foraged on herbs under cocoa, cocoa canopy and mistletoe in the canopy. Bolton (1974) also stated that this species and two other species, *intrudens* and *granulatus* forage predominantly on trees and shrubs. Though the evidence provided in the present investigation agrees with the observations of the two previous authors, it gives the impression that the species prefers canopy foraging to ground foraging and will resort to the latter-mainly in an attempt to avoid clashes between foragers of neighbouring colonies. The interrelationship of *Cat. guineensis* with other ant species has already been discussed in chapter 4, therefore the presence of such species as *O. longinoda* and *M. aculeatus* in the foraging areas of this species will not be discussed further.

Though the apparent average foraging space is reasonably large (555.0 sq.m) foraging was for a considerable length of time directed towards a small portion within the area as shown in figure 60. For this reason, taking the areas of the circles corresponding to the various radii as the foraging areas of the corresponding colonies is to overestimate the actual foraging grounds of the colonies. This erroneous impresssion can be corrected by explaining that the areas of the various circles are not in actual fact, the true foraging spaces of the colonies. Instead the areas of the circles are the restricted areas around each colony within which the colony colonizes a portion. Furthermore, since the species forages both on the ground and in the canopy the areas corresponding to the various radii may be regarded as a mere estimation of the actual areas utilized.

One possible reason as to why only a small portion of the circles were actually foraged for a long time (with slight diversion) is a possible continual availability of the food material (the white and brown matter) at one source for a long time. Another possible reason is, perhps, to avoid clashes with foragers from neighbouring colonies, particularly where there is a potential overlapping of the home ranges (fig.60). The observation before and after the bridge experiment on colonies A and B (chapter 4) whereby foragers were often seen returning to A with virtually dead foragers of the species may be cited here, once again, in support of this suggestion. Again to avoid such clashes foragers from one colony (usually the less populous), as stated earlier, tended to forage on the ground for a considerable distance before ascending into the canopy.

Results of the correlation analysis suggest that in *Cat. guineensis* the population size, whether or not pupae are considered, does not have any significant effect on the size of the foraging space. Perhaps this factor (the population size) is, instead, correlated with such foraging aspects as the number of foragers which are stimulated to go out for food, their speed, the amount of food a forager takes into its crop at the food source before returning into the nest or the size of food it carries in its mandibles. However, these could not be investigated in this project. The source of food in relation to the position of a colony is probably the most important factor influencing the distance a worker of *Cat. guineensis* (and in fact all ants) will forage.

If this is a determining factor of the size of a foraging area, then the latter is like to alter in accordance with season(s) of colony founding and also with the seasonal abundance of food.

b. Population density: Only the economic and the lowest densities need comment here; the greatest density was utilized in chapter 5. Economic density will often tend to be a constant density even in fluctuating population, since increases in ED will usually lead to migration into empty spaces until a limiting figure is reached (Elton, 1932). Though the limiting figure is not known for *Cat. guineensis* the average ED of 28 ants per square metre recorded seems to be too small to cause migration of this species from the area studied. This appears particularly true if one considers the fact that this species searches for food from the ground to the canopy. Thus an area of one square metre can conveniently support 28 foragers. In other words the actual space available to the 28 ants as foraging ground is wider than 1 sq.m.

The lowest density, LD, according to Elton (1932) gives some measure of the biological success of the species over a comparatively large area. The average LD (5 ants per sq.m.)is so small that it further suggests that the species is far from reaching any high population level so as to necessitate migration. Though the average ED (28 ants/sq.m) far exceeds the average LD (5 ants/sq.m), it is also possible for the reverse to occur; a situation which would have been due to a great deal of overlapping of the foraging spaces among the various colonies. The fact that this did not occur suggests that the food sources of the species were scattered in the area of investigation, so that there was no need for nearby colonies to use a common home range to any appreciable degree, a situation which would have resulted in constant fighting among foragers of the species. Such regular 'wars' would have caused great losses to the numbers of *Cat. guineensis* since, as mentioned previously, most of the foragers of this species which got involved in fights were injured to such a degree that they could not live any longer.

(c) *Relationship between headwidth and food size*: The finding that the size of the head of a forager does not determine the size of food it will pick tends to support an earlier assertion that no distribution of labour exists among the workers of this species (as it occurs in such genera as *Dorylus*(personal observation).

Since almost all the food materials whose sizes were measured were of the same type (the white and the brown material), the sizes were assumed to correspond to the weights of the various pieces and so the statement made above applies to relationship between the size of the head of the foragers and the weight of the food materials as well.

(d) Food items and examination of gut of foragers: It is clear from the descriptions of the food materials that the species does not exhibit any predatory activities in its territory. However, it appears to be a scavenger to some extent, collecting remains of other arthropods. The extent to which this ant depends on bodies of other arthropods, however, appears to be very minimal. The species may, therefore, depend on plants for a greater proportion of its diet. Even though the exact source of the solid food material was not ascertained it is very likely that it was collected from the mistletoe in the canopy. Room (1971) recorded a good number of foragers of the species in his samples from the mistletoe in the cocoa canopy, and it is very probable that the foragers were there in search of this food material.

Though tending of homoptera was not a common observation it is likely that the ant does more tending in the cocoa canopy. Tending in the canopy, then, will appear to be the source of the liquid food observed in the crops of 44.8% of foragers returning to their nest. The observation made on the climber, Luffa aegyptiaca L. also suggests that Cat. guineensis sucks sap from the soft tissues of the shoot apices and also probably from flower buds and very young cherelles.

The fact that a forager has food in its crop does not appear to prevent it from picking solid food materials, since some of the solid food carriers whose crops were examined had, at least half-filled crops. Judging from the fact that solid food carriers hesitated very little before entering the nest, it is not likely that once a solid food material was procured the forager would abandon it momentarily, suck some liquid before picking it up again. Such an action will tend to demand too much time which a successful forager is not likely to afford. On the other hand it is possible that a forager with food in its crop can stop for a moment to pick up a solid food and then continue to the nest.

CHAPTER 7: SUMMARY

CHAPTER 7

SUMMARY

1. The study deals with the distribution, seasonal population pattern, nesting habits and general activity of *Cat. guineensis* in a Ghanaian cocoa farm.

2. *Cat. guineensis* appears to prefer nesting in areas with continuous shade and the average number of nests per cocoa tree was 1.

3. The maximum number of nests constituting a colony was 3; and 18 colonies were recognised among 29 nests in an area of 100 m x 120 m. A minimum distance of 8.50 m was recorded between 2 nests of separate colonies while a maximum distance of 12.80 m was recorded between 2 nests forming one colony.

4. Under certain conditions, such as prolonged fights involving many workers, the female alates of *Cat. guineensis* came out of their nest to defend it. The males, however, did not exhibit this behaviour.

5. As high as 94.9% of workers which engaged in a fight lost part or whole of some of their appendages. Such fights were, however, rare under natural conditions and therefore may not be important in reducing the population size of the species.

6. *Cat. guineensis* was found to have a close association with *O. longinoda*. Incessant predatory activities of the latter against the former seem to be tolerated apparently by the strong physical build up of *Cat. guineensis*. The two ant species are so often found together in the same area that one is tempted to suggest that when searching for nests of *Cat. guineensis* it would be better to look for areas which are frequently foraged by *O. longinoda*. It has further been suggested that by its predatory activities against many insects, *O. longinoda* protects *Cat. guineensis* against other predators which may be more efficient than itself.

Cat. guineensis was also found to co-exist very well with *Cam. olivieri*, a non-dominant species. No significant associations, however appear to exist between *Cat. guineensis* and *M. aculeatus*, *Cr. depressa* and *P. decemdentata*.

7. *Cat. guineensis* exhibited the following phenological changes.

(a) The minimum percentage of adult workers in the whole population in a nest occurred in the early half of the second wet-dull season (September) and the maximum percentage of adult workers in any nest was in the later part of the dry-sunny season (February).

(b) On the whole eggs, larvae and worker-pupae presented a phenological pattern completely opposite to that of the adult workers, their percentages in the whole population increasing when that of the adult workers decreased and vice versa.

(c) The proportions of the male and the female pupae in the ant populations in the nests remained at a very low level over the year. No female pupae were found in the early half of the second wet-dull season (September) and also from the middle of the dry-sunny season to the start of the first wet-sunny season (January-March).

(d) The adult males and females on the whole followed a pattern of phenological changes similar to that of the adult workers.

(e) Occurrence of an average of one de-alate female per nest per season was the general observation, but in the dry-dull season (August), second wet-sunny season (November) and the early half of the dry-sunny season (December) an average of 4, 9 and 12 de-alate females were respectively recorded. It is suggested that the occurrence of these relatively large numbers of the de-alate females is in preparation for the founding of new colonies. Only two de-alate males were found throughout the year.

(f) Brood as a whole occurs throughout the year, and the presence of eggs does not appear to depend on the presence of female, a finding which suggests oviposition by the workers.

8. A maximum of about 34,391 individuals, including both the juveniles and adults, were estimated to be present in any one nest or a colony.

9. The inquilines found in the nests of the ant were (in order of their frequency of occurrence) a species of Thysanura, *Microtermes* sp.(Isoptera), an undetermined species of the family Clubionidae (Araneida and *Neotermes* sp (Isoptera) and Myriapoda.

10. The head of the ant is always broader than long in all castes and a strong correlation was found between the head width and the head length in all castes.

11. On the basis of the head size there seems to be two groups of workers in this species; these are termed as small workers and large workers. The ranges of the head sizes were found to vary from one nest to another, that is, a head width which falls in a small workers-group in one nest may belong to a large worker-group in

another nest (colony). In some nests the two groups occur without intermediates, but in other nests they occur with intermediate group between them. In any case the occurrence of two groups appears to have no significance with respect to the type of function the worker performs in the nest (colony).

12. Though the nests of Cat. guineensis are generally at some distance above the ground, a few nests actually start from the ground, and may extend into the soil.

13. Most of the nests were found to be 'wood-nests' while a few were 'pod-nests'. The species appears capable of living in the soil and also in abandoned nests of such ants as Cr. depressa.

14. The termite Neotermes sp appears to be the most important insect responsible for, at least, the initiation of the nest of Cat. guineensis in a Ghanaian cocoa-farm.

15. Cat. guineensis was found to be diurnal species. Under normal conditions its foraging activity starts around 6.00 a.m and stops after 6.10 p.m, though a few workers may still linger about between 7.00 p.m and 8.00 p.m. Rainfall in the day may bring foraging activity to a stop as early as at 2.00 p.m in this ant.

16. Apart from causing early stoppage of foraging, rainfall during a day or night often causes a delay in the start of activity on the next day. Air temperature and relative humidity also seem to be important in the start of activity but their effect is more likely to be an indirect one, acting through rainfall. Light may also be important in the start of foraging in this ant but the intensity needed is likely to be very minimal. Another factor which appeared to delay the start of activity is harmattan.

17. On the pattern of trailing activity, after its start, light intensity appear to be the most important factor either directly or indirectly. The slight fluctuations in the air temperature which accompany fluctuations in the light intensity, in turn affect the body temperature of the ant thereby making it adjust its behavioural pattern. With respect to heat absorption by the body of the ant, the black colour and the sculpturation of Cat. guineensis may be important.

18. Nest cleaning in Cat. guineensis was found to be mostly done in the mornings (especially prior to the start of foraging in the morning) in the evening (before the normal end of foraging) and also after foraging has been prematurely stopped by rainfall. Little nest cleaning is done in the afternoons, and it is suggested

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.

19. The foraging activity was found to be maintained at a high level throughout the year; and this may be due to the occurrence of brood and alates throughout the year.

20. The ant appears to depend more on liquid food, carried in the crop of the worker, than on solid food. But even the percentage of returning foragers with liquid food appears too small to account for the food requirements of the species. Though the solid material was transported by only a very small percentage of the returning workers, its availability throughout the year is apparent since it was recorded on almost all the days of investigation.

To some extent *Cat. guineensis* was found to be a scavenger. It also collects materials from plants, tends aphids and appears to suck sap from apical tissues of shoots. Solid food substances were transported mostly in the second wet-dull season (late August to October) and least transported in the first set-sunny season (March-May).

21. Though *Cat. guineensis* forages both in the cocoa canopy and on the ground, the former appears to be preferred to the latter,which seems to be used as a foraging area by one colony in an attempt to avoid clashes with foragers from a neighbouring colony, whose foraging space has the potential to overlap with their own. The species, for a considerable length of time, was found to forage in a small area and this may probably be due to the availability of its food in one area for a long time.

22. It was found that the size of the head of the worker of *Cat. guineensis* does not determine the size or the weight of solid food it will carry into its nest.

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A P P E N D I X

Table 1

Meteorological data at Agricultural Research Station, Kade (Lat. $06^{o}09'$N and Long.$0^{o}49'$W) from July 1975 to July,1976

DATE	RAINFALL (MM)	TEMPERATURE °C		RELATIVE HUMIDITY %		MEAN SUNSHINE HOURS PER DAY
		MAX	MIN	09.00 HRS	15.00 HRS	
July 1975	(14) 0.20	28.4	23.8	89.5	72.9	3.5
Aug	(14) 0.20	26.9	21.2	90.3	76.7	2.7
Sept	(12) 3.90	28.6	20.8	89.1	71.9	3.5
Oct.	(20) 5.60	30.2	21.7	87.9	69.1	5.4
Nov.	(14) 3.90	30.7	21.7	91.8	69.7	4.9
Dec.	(5) 0.20	30.4	21.4	91.3	65.6	6.3
Jan.1976	(0) 0.00	31.1	19.9	87.7	51.7	5.9
Feb.	(4) 1.20	32.5	21.5	86.9	66.5	6.2
Mar.	(16) 4.10	32.3	22.0	31.2	19.2	5.1
Apr.	(10) 69.90	31.5	22.2	29.7	20.9	4.9
May.	(13) 108. 9	31.1	22.2	65.9	60.5	5.1
June.	(21) 84.30	28.9	21.4	84.5	76.4	6.0
Jul.	(17) 11.70	27.3	21.2	90.5	80.5	4.3

Figures in brackets represent the number of rainy days per month.

Table 2: Guests in colonies of Cat. guineensis

Nest (colony)	INQUILINES (guests)				
	Thysanura	Microtermes	Neotermes	Spiders	Chilopoda
1	+	+			
2	+	+			
3	+	+			+
4			+	+	+
5	+	+			+
6					
7	+	+			+
8		+			
9	+				
10	+	+			
11		+			
12	+	+		+	+
13					
14	+				
15	+			+	
16			+	+	+
17	+				
18		+			
19	+		+	+	

Table 2: (cont'd)

Nest (colony)	INQUILINES (guests)				
	Thysanura	Microtermes	Neotermes	Spiders	Chilopoda
20				+	
21	+		+		
22		+		+	+
23		+			+
24					
25	+			+	
26	+			+	
27		+			
28	+		+		
29	+		+		
30	+	+		+	
31	+		+	+	
32	+		+		
TOTALS	20	14	8	11	8

Table 3: Composition of castes and brood in various nests (colonies)

Colony	Date harvested	Nest height (m)	Area Nest (m)	ADULTS Workers	ADULTS ALATES Males	ADULTS ALATES Females	ADULTS DEALATES Males	ADULTS DEALATES Females	PUPAE WORKERS	PUPAE ALATES Males	PUPAE ALATES Females	Larvae	Eggs	Total
A_1 (1	8/7	0.0	3392.9	1,262	512	580	0	1	400	37	78	249	0	3,119
A_1 (2	22/7	2.0	5654.9	6,129	820	961	0	1	976	261	0	476	0	9,614
B_1 (3	1/8	1.7	8356.6	14,486	2,044	1,424	1	3	1,834	79	29	1,352	100	21,352
B_1 (4	15/8	0.6	1866.1	12,511	810	1,402	0	5	1,033	8	0	2,455	2,789	21,013
C (5	8/9	1.5	1382.3	2,082	1	3	0	2	1,075	0	0	1,987	1,356	6,506
C (6	16/9	2.4	-	556	0	0	0	0	240	0	0	196	11	1,003
C (7	1/10	1.8	2148.8	696	259	45	0	0	123	3	0	527	49	1,702
C (8	15/10	2.5	3205.2	1,465	313	507	2	0	561	25	11	372	210	3,466
D (9	2/11	2.0	-	1,496	0	0	0	0	523	0	0	691	317	3,027
D (10	27/11	2.2	5468.6	4,801	5	21	0	17	227	10	141	603	474	6,299
E (11	4/12	1.9	8639.4	11,402	7	39	0	21	1,053	1	377	3,799	509	17,208
E (12	15/2	0.8	7395.8	9,344	265	302	0	3	548	371	0	1,229	0	12,062
E (13	3/1/76	2.1	603.2	1,451	3,796	9	1	4	5	200	0	147	0	5,613
E (14	6/1	0.3	980.2	5,394	40	0	0	0	451	63	0	692	305	6,945
E (15	15/1	2.0	3110.2	536	1,517	2	0	0	2	86	0	58	0	2,201
E (16	4/2	2.6	1649.3	8,699	42	298	0	0	84	0	0	435	0	9,558
E (17	16/2	1.3	659.7	2,782	8	0	0	1	653	49	0	544	301	4,338
F (18	6/3	2.0	188.5	856	0	0	0	0	291	0	0	461	210	1,818
F (19	25/3	2.0	5607.7	2,685	2	0	0	1	739	0	0	500	0	3,927
F (20	10/4	2.1	1869.2	9,584	663	103	0	1	2,397	11	0	659	100	13,518
F (21	19/4	1.2	779.1	1,393	222	154	0	0	1,358	86	0	642	0	3,855
F (22	27/4	3.0	1539.4	1,247	12	126	0	0	213	124	1	5,183	1,054	7,960
F (23	10/5	1.5	1099.6	3,140	0	0	0	1	772	10	0	6,974	2,528	13,425
F (24	14/5	3.0	1209.5	3,130	4	0	0	1	553	13	0	624	431	4,756
F (25	28/5	3.8	2513.3	2,740	17	0	0	0	432	79	1	1,119	221	4,609

Table 3: (cont'd)

(26	12/6	0.5	754.0	5,940	58	569	0	1	658	38	12	558	300	8,134
(27	24/6	1.0	753.9	4,969	222	0	0	1	611	54	0	3,058	158	9,073
A_2 (28	6/7	2.5	1,376.0	6,959	371	137	0	1	1,335	23	9	6,371	422	15,628
(29	13/7	2.5	1,225.2	1,011	698	903	0	1	259	98	69	610	0	3,649
(30	19/7	0.7	7,916.8	14,778	8,830	1,376	0	1	1,377	8	35	2,156	0	28,561
(31	1/8	1.4	4,806.6	14,750	3,470	2,957	0	1	1,529	37	24	1,325	0	24,093
B_2 (32	14/8	1.6	3,392.9	17,710	5,004	3,794	0	1	2,542	69	0	5,271	0	34,391
TOTAL		56.5	89,544.9	175,984	30,012	15,712	4	69	24,854	1,833	787	48,323	1,1845	339,423
MEAN		1.8	2,984.8	5,499.5	937.9	491	0.1	2.2	776.7	573	24.6	510.1	370.2	10,607

A_1 = First wet-dull season (1975), B_1 = Dry-dull season (1975)

C = Second wet-dull season (1975), D = Second wet-sunny season (1975)

E = Dry-sunny season (1975/76), F = First wet-sunny season (1976)

A_2 = First wet-dull season (1976), B_2 = Dry-dull season (1976).

Table 4: Seasonal Occurence of Adults castes and Brood of *Cat. guineensis*

	MONTH	ADULTS					PUPAE			LARVAE	EGGS	TOTALS
			ALATES		DEALATES			ALATES				
		WORKERS	MALES	FEMALES	MALES	FEMALES	WORKERS	MALES	FEMALES			
A	July 1975	58.05 3,696	10.46 666	12.11 771	0.00 0	0.02 1	10.81 688	2.26 144	0.61 39	5.70 363	0.00 0	100.02 6,367
B	Aug.	63.73 13,499	6.74 1,427	6.67 1,413	0.00 1	0.02 4	6.77 1,434	0.21 44	0.07 15	8.99 1,904	8.95 1,895	102.15 21,183
C	Sep.	35.13 1,319	0.03 1	0.05 2	0.00 0	0.03 1	17.52 658	0.00 0	0.00 0	29.01 1,092	18.22 684	99.96 3,755
	Oct.	41.83 1,081	11.07 286	10.68 276	0.04 1	0.00 0	14.98 387	0.54 14	0.23 6	17.41 450	5.03 130	101.81 2,584
D	Nov.	67.75 3,149	0.06 3	0.24 11	0.00 0	0.19 9	8.04 375	0.11 5	1.52 71	13.88 647	8.49 396	100.28 4,663
E	Dec.	70.88 10,373	0.93 136	1.17 171	0.00 0	0.09 12	5.47 801	1.27 186	1.29 189	17.18 2,514	1.74 255	100.02 14,635
	Jan. 1976	50.00 2,460	36.26 1,784	0.08 4	0.00 0	0.02 1	3.11 153	2.36 116	0.00 0	6.08 299	2.07 102	99.98 4,920
	Feb.	82.63 5,741	0.36 25	2.14 149	0.00 0	0.00 1	5.31 369	0.36 25	0.00 0	7.05 490	2.17 151	100.02 6,948
F	Mar.	61.64 1,771	0.03 1	0.00 0	0.00 0	0.03 1	17.93 515	0.00 0	0.00 0	16.74 481	3.65 105	100.02 2,873
	April.	48.26 4,075	3.54 299	1.52 128	0.00 0	0.01 1	15.67 1,323	0.88 74	0.01 1	25.59 2,161	4.56 385	100.54 8,444

Table 4: (cont'd)

	MONTH	ADULTS					PUPAE					
		WORKERS	ALATES		DEALATES		WORKERS	ALATES		LARVAE	EGGS	TOTALS
			MALES	FEMALES	MALES	FEMALES		MALES	FEMALES			
F	May	39.53 3,003	0.09 7	0.00 0	0.00 0	0.03 1	7.71 586	0.44 34	0.03 1	38.25 2,906	13.95 1,060	100.03 7,597
A_2	June	63.40 5,455	1.63 140	3.31 285	0.00 0	0.01 1	7.38 635	0.53 46	0.07 6	21.07 1,813	2.66 229	100.06 8,604
	July	47.55 7,583	20.69 3,300	5.05 805	0.00 0	0.00 1	6.21 990	0.27 43	0.24 38	19.10 3,046	0.88 141	99.99 15,946
B_2	Aug.	52.79 1 6230	13.78 4,237	10.98 3,376	0.00 0	0.00 1	6.62 2,036	0.17 53	0.04 12	15.61 4,798	0.00 0	99.99 30,743

The lower numbers are the monthly means of the various castes and brood members per nest while the upper numbers are the percentages based on the lower numbers.

A_1 = First wet-dull season (1975), B_1 = Dry-dull season (1975)

C = Second wet-dull season (1975), D = Second wet-sunny season (1975)

E = Dry-sunny season (1975/76), F = First-sunny season (1976)

A_2 = First wet-dull season (1976), B_2 = Dry-dull season (1976).

Table 5: DATA ON HEAD MEASUREMENTS OF WORKERS OF <u>CAT. GUINEENSIS</u> IN VARIOUS COLONIES

(A) Colony 11				(B) Colony 12			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.70	1.40	1.60	1.35	1.95	1.65	1.95	1.70
2.20	1.75	1.65	1.35	2.40	2.00	2.00	1.75
1.60	1.30	1.60	1.30	1.95	1.65	2.30	1.95
1.80	1.50	2.10	1.70	2.05	1.75	2.45	2.00
1.80	1.50	1.60	1.30	2.00	1.75	2.50	2.10
1.60	1.30	1.75	1.45	2.00	1.75	2.10	1.80
1.65	1.40	1.65	1.35	2.50	2.00	2.00	1.70
1.55	1.30	1.70	1.45	2.45	2.00	2.40	2.00
2.00	1.70	1.65	1.40	1.95	1.65	2.40	2.00
1.65	1.35	1.65	1.40	2.00	1.75	1.85	1.55
1.70	1.40	1.65	1.40	2.00	1.75	1.95	1.65
1.70	1.40	1.70	1.45	2.00	1.75	2.00	1.75
2.20	1.85	1.65	1.40	2.45	2.00	2.00	1.70
2.05	1.70	1.70	1.45	2.05	1.75	2.05	1.70
1.60	1.35	1.55	1.30	2.05	1.75	2.10	1.80
1.60	1.35	2.00	1.65	2.05	1.75	2.00	1.70
1.60	1.30	1.75	1.45	2.40	1.85	1.95	1.65
1.65	1.35	1.65	1.35	2.00	1.70	2.30	1.95
1.70	1.45	1.65	1.40	1.95	1.65	2.00	1.70
1.60	1.30	1.70	1.40	1.90	1.60	2.50	2.10
1.70	1.35	1.65	1.35	2.10	1.80	2.35	1.95
1.60	1.30	1.70	1.35	2.00	1.75	2.45	2.00
1.60	1.30	2.30	1.90	2.00	1.70	1.95	1.60
2.15	1.80	1.70	1.45	2.50	2.05	1.95	1.60
1.75	1.40	1.70	1.40	1.95	1.60	2.15	1.80
1.75	1.45	2.15	1.75	2.00	1.75	2.00	1.70
1.55	1.30	1.65	1.35	1.95	1.70	2.00	1.70
1.60	1.30	1.65	1.40	1.90	1.65	1.75	1.45
1.65	1.35	1.60	1.35	2.35	1.95	2.00	1.75
1.65	1.35	1.95	1.65	2.40	2.00	1.85	1.55
2.20	1.80	1.65	1.35	1.90	1.65	1.85	1.55
1.70	1.40	1.70	1.40	1.90	1.65	1.90	1.60
1.75	1.45	1.65	1.35	1.95	1.70	2.35	2.00
1.60	1.30	2.20	1.85	2.10	1.75	2.05	1.80
2.15	1.80	1.70	1.45	2.50	2.05	2.00	1.75
1.60	1.30	1.75	1.45	2.00	1.75	2.05	1.75
2.10	1.80	1.65	1.35	2.05	1.85	1.85	1.55
1.75	1.45	1.60	1.30	2.00	1.80	2.05	1.70
1.70	1.40	1.65	1.35	1.85	1.60	2.05	1.75
1.60	1.35	1.65	1.35	2.00	1.75	1.95	1.60
1.65	1.35	1.75	1.45	2.00	1.75	1.85	1.55
1.65	1.40	1.65	1.35	1.95	1.70	1.90	1.65

Table 5: (cont'd)

(a) Colony 11				(b) Colony 12			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.65	1.35	1.70	1.40	2.05	1.80	1.90	1.65
1.70	1.40	1.65	1.35	2.00	1.80	2.00	1.70;
1.65	1.35	1.65	1.35	1.90	1.60	T 207.10	176.05
1.60	1.35	2.10	1.75	1.85	1.60		
1.65	1.40	1.60	1.30	2.45	2.05		
1.70	1.35	1.60	1.35	1.95	1.65	M 2.07	1.76
1.75	1.45	1.65	1.35	2.05	1.80		
1.70	1.40	1.65	1.35	2.05	1.80	ST.D 0.19	0.15
		T 173.00	143.25	2.10	1.80		
				1.95	1.70		
				2.40	2.00		
		M 1.73	1.43	2.10	1.75		
				1.90	1.65		
				1.90	1.60		
		ST.D 0.18	0.15				

B: The standard deviations from the various means are provided in tables 6-8 in the text.

Table 6: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT. GUINEENSIS IN VARIOUS COLONIES

3/1/76 (a) Colony 13				6/1/76 (b) Colony 14			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	1.95	1.95	1.65	2.00	1.75	1.95	1.65
1.80	1.55	1.80	1.55	2.30	1.95	1.95	1.70
1.90	1.60	1.75	1.50	2.15	1.75	1.95	1.65
1.70	1.40	1.90	1.60	2.00	1.70	1.90	1.60
1.95	1.65	1.95	1.65	2.00	1.75	1.85	1.60
1.95	1.65	1.95	1.65	2.00	1.75	2.00	1.70
1.65	1.40	1.85	1.55	1.90	1.60	1.75	1.45
2.15	1.75	1.95	1.60	1.95	1.70	1.95	1.65
1.75	1.45	2.45	2.00	1.90	1.60	1.95	1.70
2.30	1.85	2.10	1.80	1.95	1.65	2.40	2.00
1.75	1.45	2.30	1.95	2.35	1.90	1.95	1.65
1.60	1.40	1.75	1.60	2.00	1.70	1.95	1.65
2.10	1.75	1.80	1.50	1.95	1.70	2.35	2.00
1.80	1.55	1.55	1.40	1.80	1.55	2.05	1.75
1.65	1.45	1.80	1.55	1.95	1.70	2.00	1.75
1.85	1.55	1.90	1.60	1.95	1.70	2.35	2.00
2.20	1.80	2.35	1.90	1.90	1.65	1.95	1.70
2.35	1.90	2.15	1.80	1.85	1.55	2.00	1.70
1.60	1.40	2.15	1.80	2.05	1.75	2.00	1.70
1.90	1.65	2.50	2.05	2.40	2.00	2.15	1.80
1.75	1.50	2.35	1.95	2.35	0.95	1.95	1.65
1.80	1.50	2.40	1.90	1.95	1.65	2.00	1.75
2.25	1.85	1.85	1.55	2.35	1.90	2.00	1.70
1.75	1.50	2.20	1.80	2.05	1.75	2.00	1.70
1.60	1.40	2.05	1.75	1.85	1.55	2.00	1.70
2.40	2.00	2.50	2.05	2.35	1.90	1.80	1.50
2.35	1.95	1.70	1.50	1.95	1.65	1.95	1.70
1.65	1.45	1.70	1.45	2.45	2.00	2.00	1.70
1.85	1.60	1.65	1.40	1.90	1.65	2.00	1.70
1.95	1.70	1.80	1.55	1.90	1.60	1.95	1.60
1.55	1.35	2.15	1.80	2.30	1.95	1.90	1.60
1.80	1.50	1.75	1.55	1.90	1.65	2.10	1.80
1.90	1.60	1.70	1.45	2.00	1.65	1.85	1.60
1.50	1.30	1.70	1.45	1.95	1.65	2.00	1.75
1.70	1.45	1.75	1.50	2.40	2.00	1.95	1.65
1.90	1.60	1.55	1.30	2.00	1.65	2.00	1.70
1.80	1.50	1.80	1.55	1.95	1.65	1.95	1.65
2.30	1.90	1.80	1.50	1.95	1.60	1.95	1.70
2.25	1.90	2.50	2.10	1.95	1.65	1.85	1.60
1.65	1.45	2.05	1.75	1.95	1.60	2.20	1.80
1.75	1.50	1.60	1.40	2.40	1.95	1.90	1.60
1.90	1.60	1.80	1.50	2.30	1.90	1.90	1.60
2.25	1.85	1.85	1.55	2.05	1.75	1.90	1.65

Table 6: (cont'd)

(a) Colony 13				(b) Colony 14			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.80	1.50	2.25	1.80	1.90	1.65	1.90	1.60
1.90	1.65	1.70	1.40	1.90	1.60	2.05	1.70
1.60	1.40	1.85	1.55	2.40	2.05	2.00	1.70
1.70	1.45	2.05	1.70	2.05	1.70	2.45	2.00
1.90	1.60	1.95	1.70	1.80	1.40	1.95	1.65
1.80	1.35	2.35	1.90	1.95	1.65	2.35	1.90
1.70	1.45	1.75	1.50	2.05	1.75	1.95	1.65
	TOTAL	192.30	162.15		TOTAL	202.73	171.45
	MEAN	1.92	1.62		MEAN	2.03	1.71
	ST.D	0.26	0.19		ST.D	0.17	0.13

Table 7: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 16 (6/2/76)				(b) Colony 17 (17/2/76)			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.30	1.85	1.90	1.60	1.80	1.55	1.75	1.50
1.90	1.60	1.90	1.60	1.75	1.45	1.75	1.45
2.40	2.00	2.30	2.00	1.80	1.55	1.65	1.40
1.90	1.65	1.95	1.70	1.85	1.55	1.65	1.40
1.70	1.45	1.85	1.55	1.85	1.60	2.20	1.85
2.35	1.95	1.75	1.50	1.80	1.55	1.70	1.45
1.85	1.55	1.90	1.60	1.80	1.50	2.30	1.90
1.95	1.65	1.80	1.55	1.85	1.55	1.90	1.65
2.35	1.95	1.70	1.45	1.65	1.40	1.75	1.45
1.90	1.60	1.95	1.60	1.65	1.40	1.80	1.55
2.30	1.85	1.85	1.60	1.75	1.45	1.70	1.45
2.35	1.95	1.90	1.65	2.20	1.80	1.70	1.40
1.75	1.50	2.20	1.95	1.75	1.50	1.75	1.50
2.00	1.75	1.90	1.65	1.65	1.40	1.90	1.60
2.25	1.90	2.30	1.90	2.25	1.90	1.85	1.55
1.90	1.65	1.85	1.55	1.70	1.45	1.70	1.45
1.75	1.50	2.00	1.65	2.30	1.90	1.85	1.60
2.50	2.00	2.25	1.85	2.35	1.95	1.80	1.55
2.35	1.95	1.95	1.65	1.70	1.40	1.65	1.40
2.35	2.00	2.30	1.95	1.85	1.60	1.70	1.45
2.35	1.90	1.85	1.60	2.25	1.90	1.75	1.45
1.85	1.55	1.90	1.65	1.65	1.35	1.65	1.40
1.80	1.50	1.75	1.50	1.75	1.50	1.70	1.45
2.00	1.65	1.90	1.60	1.70	1.45	1.75	1.45
1.90	1.60	1.90	1.65	1.65	1.40	1.65	1.40
1.80	1.55	1.90	1.70	1.80	1.55	1.85	1.60
1.90	1.65	2.35	1.95	1.65	1.40	1.70	1.45
1.85	1.60	1.80	1.55	1.70	1.45	1.70	1.45
2.30	1.90	1.75	1.50	1.90	1.65	1.70	1.45
2.45	2.00	1.75	1.50	1.80	1.50	1.60	1.35
1.85	1.60	1.90	1.65	2.40	1.95	1.65	1.40
1.80	1.55	2.30	1.85	2.25	1.85	2.40	1.90
1.80	1.55	2.30	1.85	1.80	1.55	1.85	1.60
1.75	1.50	2.40	1.90	1.80	1.50	1.85	1.60
2.45	1.95	1.90	1.65	1.65	1.35	1.85	1.60
1.80	1.55	1.85	1.60	1.90	1.60	1.75	1.50
1.75	1.50	1.70	1.45	1.90	1.65	1.90	1.65
2.25	1.85	1.70	1.45	1.80	1.50	1.85	1.60
2.40	2.00	1.70	1.45	1.80	1.55	2.20	1.80
2.35	1.90	1.95	1.70	1.60	1.40	2.25	1.85
1.90	1.65	2.05	1.75	1.65	1.40	1.95	1.70
2.45	2.00	1.70	1.40	1.90	1.60	1.65	1.40
1.90	1.60	1.85	1.60	1.70	1.45	1.80	1.55

Table 7: (Cont'd)

(a) Colony 16

HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.85	1.60	1.75	1.50
1.80	1.55	2.25	1.85
1.90	1.65	1.75	1.50
1.80	1.55	1.90	1.65
2.35	1.90	1.80	1.55
2.30	1.85	1.80	1.55
2.30	2.00	1.90	1.65
	TOTAL	199.90	169.30
	MEAN	2.00	1.69
	ST.D	0.24	0.17

(b) Colony 17

HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.70	1.45	1.70	1.45
1.70	1.45	1.75	1.50
1.90	1.60	1.80	1.55
1.80	1.55	1.95	1.70
1.75	1.50	1.80	1.60
1.70	1.45	1.80	1.55
1.75	1.50	2.20	1.85
	TOTAL	182.65	155.21
	MEAN	1.83	1.55
	ST.D	0.19	0.15

Table 8: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT.GUINEENSIS IN VARIOUS COLONIES

1/4/76				12/4/76			
(a) Colony 19				(b) Colony 20			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.30	1.80	2.00	1.60	2.40	2.00	2.10	1.70
1.95	1.60	2.05	1.75	1.75	1.50	2.00	1.60
2.05	1.70	2.30	1.90	2.35	1.90	1.75	1.50
2.00	1.70	2.50	2.00	2.40	1.95	1.95	1.60
2.15	1.75	1.95	1.65	2.35	1.95	1.85	1.50
2.50	2.00	1.95	1.65	2.35	1.95	2.00	1.65
2.35	1.90	1.95	1.60	1.80	1.55	2.30	1.95
2.35	1.90	2.00	1.70	2.35	1.90	1.90	1.60
1.85	1.55	1.95	1.60	1.95	1.60	1.85	1.55
1.90	1.60	1.65	1.40	1.95	1.60	1.70	1.40
1.90	1.60	1.90	1.60	2.45	1.95	1.90	1.65
2.35	1.95	1.90	1.60	1.90	1.60	1.85	1.60
2.10	1.70	1.90	1.60	1.85	1.55	2.50	2.00
2.00	1.65	2.35	1.95	1.85	1.55	1.60	1.35
2.00	1.65	1.95	1.60	1.85	1.55	1.90	1.60
1.85	1.55	2.00	1.65	2.00	1.65	1.80	1.45
2.00	1.65	1.95	1.60	1.95	1.60	1.90	1.65
1.95	1.65	2.35	1.90	1.90	1.60	1.90	1.60
2.05	1.70	1.85	1.55	1.95	1.60	2.25	1.85
1.90	1.60	2.40	2.00	1.85	1.55	1.90	1.60
1.95	1.65	2.30	1.95	2.00	1.65	1.95	1.60
1.95	1.60	1.90	1.60	1.90	1.60	1.85	1.55
1.90	1.60	1.95	1.70	1.95	1.60	1.85	1.60
1.95	1.60	1.90	1.65	1.95	1.60	1.95	1.60
2.25	1.85	2.45	2.00	1.90	1.60	2.25	1.85
2.10	1.70	2.00	1.65	1.90	1.60	2.00	1.65
1.90	1.60	1.90	1.65	1.80	1.50	1.70	1.40
2.30	1.95	1.80	1.55	1.85	1.55	1.90	1.60
1.95	1.60	1.80	1.55	2.00	1.65	1.90	1.60
1.90	1.60	1.90	1.60	1.90	1.60	1.90	1.60
1.85	1.55	1.90	1.60	1.90	1.60	1.75	1.45
1.85	1.60	2.20	1.80	1.90	1.60	2.35	1.95
1.90	1.65	1.95	1.65	1.90	1.65	1.95	1.65
2.00	1.70	1.70	1.40	1.85	1.55	1.90	1.60
1.70	1.40	2.30	1.90	1.85	1.55	1.95	1.65
1.90	1.60	1.85	1.60	1.85	1.60	2.35	1.90
1.95	1.60	1.85	1.60	1.65	1.35	1.85	1.65
1.80	1.50	1.80	1.55	2.00	1.70	2.00	1.65
1.95	1.65	1.95	1.60	2.50	2.00	2.30	1.85
2.45	2.00	1.85	1.60	2.00	1.65	2.30	1.90
2.05	1.70	1.90	1.60	1.95	1.60		
1.85	1.55	1.90	1.65	1.75	1.50	2.00	1.70

Table 8: (cont'd)

(a) Colony 19

HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.85	1.50	2.05	1.70
2.00	1.70	1.95	1.60
1.95	1.60	2.15	1.80
1.95	1.60	1.75	1.45
1.95	1.60	1.90	1.60
2.30	1.95	1.90	1.65
1.80	1.50		
1.70	1.40	T 200.00	166.65
2.00	1.60		
1.95	1.60	M 2.00	1.67
		ST.D 0.19	0.14

(b) Colony 20

HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.45	1.95	1.95	1.65
2.30	1.85	1.90	1.60
2.00	1.65	1.90	1.60
1.80	1.50	1.90	1.65
1.85	1.55	1.90	1.60
1.80	1.55	1.90	1.60
1.95	1.60	1.90	1.65
1.90	1.60		
1.85	1.60		
2.30	1.85	T 197.90	164.85
		M 1.98	1.65
		ST.D 0.20	0.15

Table 9: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT.GUINEENSIS IN VARIOUS COLONIES

28/4/76 (a) Colony 22				12/5/76 (b) Colony 23			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.95	1.60	1.85	1.60	1.85	1.55	2.10	1.70
2.05	1.75	1.80	1.55	1.95	1.65	1.95	1.65
2.30	1.95	1.95	1.65	1.60	1.30	2.05	1.70
1.95	1.60	1.80	1.55	1.75	1.45	2.00	1.70
2.30	1.95	1.95	1.60	1.85	1.55	1.70	1.45
2.10	1.75	2.30	1.90	2.00	1.60	1.75	1.50
2.00	1.65	1.85	1.55	1.65	1.35	2.00	1.65
1.90	1.65	1.85	1.55	2.15	1.75	1.75	1.50
2.45	1.95	1.90	1.60	1.65	1.40	2.00	1.65
1.90	1.60	1.90	1.60	1.75	1.40	1.75	1.45
2.40	1.95	2.05	1.70	2.55	2.05	2.10	1.75
2.30	1.90	1.95	1.65	1.80	1.50	1.80	1.55
2.40	1.95	1.90	1.60	1.85	1.55	1.70	1.40
2.00	1.70	2.00	1.65	1.80	1.50	1.80	1.55
2.45	2.00	2.35	1.90	2.05	1.70	1.65	1.35
2.00	1.65	2.15	1.75	2.45	2.00	2.10	1.70
1.90	1.60	2.00	1.65	1.75	1.40	1.75	1.45
2.30	1.90	1.95	1.65	2.10	1.70	1.65	1.35
2.50	2.00	2.35	1.90	1.95	1.60	2.50	2.05
1.90	1.60	2.30	1.85	2.05	1.70	1.70	1.40
1.95	1.65	2.40	1.95	1.90	1.60	2.00	1.65
2.35	1.90	2.00	1.65	2.05	1.65	2.00	1.65
2.30	1.85	1.90	1.60	2.45	2.00	2.00	1.65
2.35	1.95	2.05	1.75	2.00	1.70	1.95	1.65
2.45	2.00	1.90	1.60	2.00	1.65	1.70	1.40
1.90	1.60	1.85	1.55	1.65	1.40	1.85	1.55
2.00	1.65	2.10	1.75	1.70	1.45	1.55	1.30
2.10	1.75	1.95	1.65	1.65	1.40	1.80	1.55
1.95	1.65	1.95	1.65	1.75	1.50	2.00	1.65
1.90	1.60	2.30	1.85	1.75	1.50	1.75	1.50
1.90	1.65	1.90	1.60	2.00	1.60	2.15	1.75
2.35	1.95	1.85	1.55	2.35	1.90	1.75	1.45
2.05	1.70	1.90	1.60	1.90	1.60	2.50	2.00
1.95	1.60	2.00	1.65	2.00	1.65	2.40	1.95
1.95	1.60	1.90	1.60	1.95	1.60	1.90	1.60
2.30	1.90	1.90	1.60	1.80	1.50	1.85	1.55
1.90	1.60	2.00	1.65	1.75	1.45	1.75	1.50
1.95	1.60	1.90	1.60	1.80	1.50	1.80	1.55
2.15	1.70	1.90	1.60	1.90	1.60	1.75	1.50
1.95	1.65	1.90	1.60	1.75	1.45	2.00	1.60
2.00	1.65	1.95	1.65	2.40	1.95	1.70	1.40
1.95	1.60	1.85	1.60	1.95	1.60	1.85	1.50

Table 9: (cont'd)

(a) Colony 22				(b) Colony 23			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	1.95	2.00	1.70	2.05	1.70	2.00	1.65
2.20	1.70	1.95	1.65	1.75	1.40	1.55	1.30
1.90	1.60	2.05	1.70	1.90	1.60	1.60	1.30
1.80	1.55	2.30	1.85	2.05	1.75	1.85	1.55
1.90	1.60	2.30	1.85	2.50	2.00	1.80	1.55
2.30	1.90	1.90	1.60	2.10	1.70	1.70	1.40
1.95	1.65	1.90	1.60	1.75	1.50	1.75	1.50
1.95	1.60	1.90	1.60	1.70	1.45	1.70	1.40
	TOTAL	204.90	170.35		TOTAL	190.65	158.00
	MEAN	2.05	1.70		MEAN	1.91	1.58
	ST.D	0.19	0.14		ST.D	0.23	0.17

Table 10: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 24 16/5/76				(b) Colony 25 1/6/76			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.75	1.45	2.15	1.75	1.75	1.45	1.85	1.55
1.65	1.35	1.75	1.45	1.75	1.50	2.35	1.95
1.65	1.35	1.70	1.45	2.35	1.95	1.75	1.45
2.25	1.85	1.55	1.30	1.60	1.35	2.15	1.75
1.80	1.50	1.80	1.50	1.65	1.40	1.85	1.55
1.65	1.35	2.25	1.85	2.30	1.90	2.25	1.90
1.95	1.65	1.80	1.50	2.00	1.70	1.70	1.40
1.80	1.50	1.80	1.50	1.75	1.45	1.75	1.45
1.80	1.50	1.80	1.50	1.65	1.40	2.15	1.80
1.90	1.60	1.75	1.45	1.70	1.45	2.35	1.95
1.75	1.45	1.45	1.25	2.35	1.95	1.65	1.35
1.80	1.50	1.55	1.30	1.65	1.40	2.35	1.95
1.70	1.40	2.40	2.00	1.85	1.55	1.70	1.40
1.80	1.50	1.70	1.40	1.60	1.30	1.70	1.40
1.65	1.40	1.75	1.45	2.25	1.90	1.85	1.55
1.60	1.35	1.70	1.40	1.80	1.50	1.80	1.50
1.90	1.60	1.90	1.60	2.40	2.00	2.20	1.85
2.40	1.95	1.95	1.65	2.30	1.90	2.25	1.9i
2.00	1.70	1.75	1.45	2.40	2.00	1.65	1.40
1.65	1.40	1.65	1.35	1.75	1.40	2.45	2.00
2.40	2.00	1.65	1.40	1.75	1.45	1.65	1.40
1.60	1.35	1.75	1.50	2.40	1.95	2.35	1.95
1.60	1.35	1.70	1.40	2.20	1.85	1.80	1.50
1.65	1.40	1.80	1.50	1.65	1.35	2.40	2.00
2.15	1.80	1.85	1.55	1.90	1.60	1.75	1.45
1.70	1.40	1.90	1.60	2.00	1.70	2.25	1.85
1.95	1.65	2.35	1.90	1.95	1.60	1.80	1.50
1.60	1.35	1.55	1.30	1.85	1.55	2.30	1.85
2.20	1.80	1.85	1.55	1.75	1.45	1.60	1.30
1.75	1.45	1.90	1.60	1.70	1.40	1.75	1.45
1.55	1.30	1.80	1.50	1.60	1.30	1.60	1.30
1.85	1.55	1.75	1.45	2.25	1.90	2.30	1.85
1.75	1.45	2.05	1.70	1.65	1.35	2.25	1.85
1.65	1.40	2.30	1.90	1.65	1.35	1.85	1.55
1.70	1.40	1.75	1.50	1.70	1.40	2.30	1.85
1.70	1.45	1.90	1.65	1.65	1.35	1.65	1.35
2.00	1.70	1.70	1.40	1.80	1.50	2.00	1.65
1.70	1.40	1.75	1.45	2.05	1.70	1.80	1.45
1.70	1.40	2.30	1.90	2.35	1.90	2.05	1.70
1.70	1.40	1.65	1.40	2.35	1.95	1.75	1.50
1.95	1.65	1.60	1.35	2.35	1.95	1.85	1.55
1.75	1.45	1.60	1.40	2.15	1.80	2.05	1.75

Table 10: (cont'd)

(a) Colony 24				(b) Colony 25			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.20	1.80	2.30	1.90	1.90	1.60	1.75	1.45
1.70	1.45	2.40	1.95	2.20	1.85	1.85	1.55
1.80	1.50	1.75	1.45	1.70	1.40	1.75	1.45
1.70	1.40	1.80	1.50	2.20	1.80	1.70	1.40
1.80	1.50	1.75	1.50	1.90	1.60	1.70	1.40
1.85	1.55	1.65	1.35	1.70	1.45	2.15	1.80
1.90	1.60	2.10	1.70	1.70	1.40	1.55	1.30
1.70	1.40	1.75	1.45	1.65	1.35	2.25	1.85
	TOTAL	193.80	163.65		TOTAL	200.45	167.75
	MEAN	1.94	1.64		MEAN	2.00	1.68
	ST.D	0.18	0.16		ST.D	0.17	0.13

Table 11: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT.GUINEENSIS IN VARIOUS COLONIES

13/6/76				30/6/76			
(a) Colony 26				(b) Colony 27			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.65	1.40	1.85	1.55	1.95	1.60	1.75	1.45
1.75	1.45	1.80	1.50	1.65	1.35	2.10	1.75
1.70	1.40	2.35	1.95	1.80	1.50	2.15	1.75
1.75	1.40	1.70	1.40	2.20	1.80	1.95	1.65
2.00	1.70	2.00	1.70	1.80	1.55	1.65	1.40
1.60	1.30	2.00	1.70	1.75	1.50	2.15	1.75
1.65	1.40	2.05	1.75	2.15	1.80	1.65	1.40
2.35	1.95	1.85	1.55	1.75	1.40	1.65	1.35
1.65	1.40	1.60	1.30	1.65	1.35	2.05	1.70
1.90	1.60	1.70	1.40	1.80	1.50	2.35	1.90
1.74	1.45	2.30	1.90	1.70	1.45	1.80	1.50
1.95	1.60	1.95	1.60	1.80	1.50	1.65	1.40
1.95	1.65	1.90	1.60	1.75	1.45	1.70	1.40
2.05	1.70	1.75	1.45	1.95	1.65	1.75	1.45
2.00	1.70	1.70	1.40	1.80	1.50	1.80	1.50
1.90	1.60	1.65	1.35	1.70	1.40	2.10	1.80
1.70	1.40	1.70	1.45	1.55	1.30	1.85	1.60
2.40	1.95	1.95	1.65	2.05	1.75	2.30	1.90
1.60	1.30	1.60	1.30	1.70	1.40	1.85	1.55
2.05	1.75	2.05	1.75	1.95	1.65	1.85	1.60
1.85	1.55	1.70	1.40	1.80	1.50	1.80	1.50
1.95	1.65	1.90	1.60	1.75	1.45	2.05	1.70
1.95	1.60	1.95	1.65	1.80	1.50	2.20	1.80
1.85	1.55	1.95	1.65	1.85	1.55	2.15	1.75
1.80	1.50	1.70	1.40	2.05	1.70	2.35	1.90
2.20	1.85	2.00	1.65	1.75	1.45	1.80	1.50
1.65	1.35	1.95	1.60	2.20	1.80	1.75	1.45
2.05	1.70	2.40	1.95	2.25	1.85	1.90	1.60
1.75	1.45	1.55	1.30	2.10	1.70	1.80	1.50
1.95	1.65	1.80	1.50	1.80	1.50	1.90	1.60
1.95	1.60	1.85	1.55	1.80	1.50	2.20	1.85
2.05	1.75	1.70	1.40	1.80	1.50	1.90	1.60
2.40	1.95	2.30	1.85	1.70	1.40	1.80	1.55
2.45	2.00	2.20	1.85	1.75	1.45	1.80	1.50
1.55	1.30	1.60	1.30	2.05	1.75	1.80	1.50
1.60	1.30	1.75	1.50	1.80	1.55	2.25	1.80
1.60	1.35	2.00	1.70	1.85	1.55	1.70	1.45
1.80	1.50	1.95	1.60	1.65	1.35	1.90	1.65
1.65	1.35	2.00	1.70	1.70	1.40	1.75	1.50
1.80	1.50	1.70	1.40	1.80	1.50	1.85	1.55
i.90	1.60	1.85	1.55	1.80	1.55	1.80	1.50

Table 11: (cont'd)

(a) Colony 26				(b) Colony 27			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.05	1.75	1.75	1.45	1.75	1.45	1.75	1.45
1.60	1.30	1.90	1.60	1.80	1.55	1.75	1.45
1.90	1.60	2.25	1.90	1.80	1.50	2.30	1.85
2.30	1.85	1.75	1.50	1.60	1.35	1.75	1.45
1.75	1.45	1.75	1.50	1.85	1.55	1.85	1.55
2.35	1.90	1.80	1.50	2.30	1.85	1.80	1.50
1.55	1.30	1.75	1.50	1.75	1.50	1.85	1.60
1.95	1.65	2.30	1.90	2.05	1.70	2.15	1.75
1.65	1.35	1.95	1.65	2.25	1.85	1.80	1.50
	TOTAL	188.65	157.15		TOTAL	188.20	156.85
	MEAN	1.89	1.57		MEAN	1.88	1.57
	ST.D	0.22	0.19		ST.D	0.19	0.15

Table 12: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT. GUINEENSIS IN VARIOUS COLONIES

8/7/76				16/7/76			
(a) Colony 28				(b) Colony 29			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.40	2.00	2.00	1.70	1.80	1.50	1.85	1.55
2.00	1.65	2.05	1.70	1.90	1.65	2.30	1.85
2.35	1.95	1.95	1.65	1.95	1.65	2.10	1.75
1.80	1.50	1.85	1.55	2.00	1.70	2.35	1.90
1.75	1.45	1.95	1.70	2.10	1.85	2.00	1.65
2.00	1.65	1.90	1.60	1.90	1.60	2.05	1.70
1.95	1.65	2.30	1.90	1.95	1.65	1.85	1.55
2.05	1.70	1.85	1.55	2.05	1.70	2.30	1.90
2.35	1.95	2.05	1.75	1.95	1.65	1.90	1.60
1.85	1.55	1.75	1.45	1.90	1.60	1.90	1.65
2.25	1.85	1.70	1.45	1.95	1.60	2.35	1.90
2.00	1.65	1.75	1.45	1.95	1.65	1.95	1.65
2.35	1.95	1.90	1.60	1.95	1.65	2.30	1.85
1.95	1.60	2.35	1.95	1.95	1.65	1.90	1.60
2.00	1.65	1.85	1.60	1.95	1.65	2.00	1.70
2.00	1.70	1.80	1.50	1.95	1.65	1.95	1.65
1.90	1.60	1.85	1.55	1.95	1.65	1.90	1.60
1.90	1.65	2.00	1.70	2.00	1.70	1.90	1.60
1.95	1.65	1.80	1.50	2.45	2.05	1.90	1.60
2.40	1.95	1.85	1.55	2.00	1.70	1.95	1.60
1.80	1.50	1.85	1.60	1.90	1.60	1.95	1.65
1.80	1.50	1.90	1.60	1.95	1.60	1.85	1.50
1.80	1.55	2.00	1.65	2.05	1.70	2.00	1.70
2.00	1.70	2.30	1.90	2.00	1.65	1.80	1.50
1.95	1.65	1.85	1.55	2.50	2.05	1.90	1.60
1.85	1.55	2.35	1.95	1.95	1.60	1.80	1.50
1.90	1.60	1.80	1.50	2.00	1.70	1.90	1.60
2.00	1.65	2.30	1.90	2.40	2.00	2.00	1.70
1.90	1.65	1.80	1.55	1.95	1.65	1.80	1.50
2.00	1.70	2.40	1.95	2.10	1.75	2.00	1.65
1.95	1.65	1.85	1.55	2.30	1.85	1.85	1.55
1.90	1.60	1.75	1.45	1.95	1.60	1.90	1.65
2.25	1.85	1.80	1.50	1.95	1.65	1.95	1.65
1.85	1.55	2.00	1.65	2.45	2.00	1.80	1.50
2.40	1.95	2.35	1.95	2.10	1.75	1.90	1.60
1.85	1.55	1.90	1.60	2.00	1.70	2.00	1.70
1.80	1.50						
2.30	1.90	1.90	1.60	2.00	1.65	1.95	1.65
1.90	1.60	1.85	1.55	2.05	1.70	1.95	1.65
1.95	1.65	1.85	1.55	2.00	1.70	2.25	1.85
1.95	1.65	1.80	1.55	1.80	1.50	2.30	1.85
1.90	1.65	1.90	1.65	2.00	1.70	2.05	1.75

Table 12: DATA ON HEAD MEASUREMENTS OF WORKERS OF <u>CAT. GUINEENSIS</u> IN VARIOUS COLONIES

8/7/76 (a) Colony 28				16/7/76 (b) Colony 29			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.40	2.00	2.00	1.70	1.80	1.50	1.85	1.55
2.00	1.65	2.05	1.70	1.90	1.65	2.30	1.85
2.35	1.95	1.95	1.65	1.95	1.65	2.10	1.75
1.80	1.50	1.85	1.55	2.00	1.70	2.35	1.90
1.75	1.45	1.95	1.70	2.10	1.85	2.00	1.65
2.00	1.65	1.90	1.60	1.90	1.60	2.05	1.70
1.95	1.65	2.30	1.90	1.95	1.65	1.85	1.55
2.05	1.70	1.85	1.55	2.05	1.70	2.30	1.90
2.35	1.95	2.05	1.75	1.95	1.65	1.90	1.60
1.85	1.55	1.75	1.45	1.90	1.60	1.90	1.65
2.25	1.85	1.70	1.45	1.95	1.60	2.35	1.90
2.00	1.65	1.75	1.45	1.95	1.65	1.95	1.65
2.35	1.95	1.90	1.60	1.95	1.65	2.30	1.85
1.95	1.60	2.35	1.95	1.95	1.65	1.90	1.60
2.00	1.65	1.85	1.60	1.95	1.65	2.00	1.70
2.00	1.70	1.80	1.50	1.95	1.65	1.95	1.65
1.90	1.60	1.85	1.55	1.95	1.65	1.90	1.60
1.90	1.65	2.00	1.70	2.00	1.70	1.90	1.60
1.95	1.65	1.80	1.50	2.45	2.05	1.90	1.60
2.40	1.95	1.85	1.55	2.00	1.70	1.95	1.60
1.80	1.50	1.85	1.60	1.90	1.60	1.95	1.65
1.80	1.50	1.90	1.60	1.95	1.60	1.85	1.50
1.80	1.55	2.00	1.65	2.05	1.70	2.00	1.70
2.00	1.70	2.30	1.90	2.00	1.65	1.80	1.50
1.95	1.65	1.85	1.55	2.50	2.05	1.90	1.60
1.85	1.55	2.35	1.95	1.95	1.60	1.80	1.50
1.90	1.60	1.80	1.50	2.00	1.70	1.90	1.60
2.00	1.65	2.30	1.90	2.40	2.00	2.00	1.70
1.90	1.65	1.80	1.55	1.95	1.65	1.80	1.50
2.00	1.70	2.40	1.95	2.10	1.75	2.00	1.65
1.95	1.65	1.85	1.55	2.30	1.85	1.85	1.55
1.90	1.60	1.75	1.45	1.95	1.60	1.90	1.65
2.25	1.85	1.80	1.50	1.95	1.65	1.95	1.65
1.85	1.55	2.00	1.65	2.45	2.00	1.80	1.50
2.40	1.95	2.35	1.95	2.10	1.75	1.90	1.60
1.85	1.55	1.90	1.60	2.00	1.70	2.00	1.70
1.80	1.50						
2.30	1.90	1.90	1.60	2.00	1.65	1.95	1.65
1.90	1.60	1.85	1.55	2.05	1.70	1.95	1.65
1.95	1.65	1.85	1.55	2.00	1.70	2.25	1.85
1.95	1.65	1.80	1.55	1.80	1.50	2.30	1.85
1.90	1.65	1.90	1.65	2.00	1.70	2.05	1.75

Table 12: (cont'd)

(a) Colony 28				(b) Colony 29			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.30	1.90	1.80	1.50	1.90	1.60	2.24	1.85
1.75	1.45	1.95	1.65	2.10	1.70	1.95	1.65
2.30	1.90	2.00	1.70	2.45	2.00	1.90	1.65
1.70	1.45	1.75	1.45	1.90	1.60	1.75	1.40
1.90	1.60	1.95	1.65	1.90	1.60	2.00	1.70
1.90	1.60	2.40	2.00	1.95	1.65	1.80	1.50
1.95	1.65	1.85	1.55	1.85	1.55	2.05	1.75
1.80	1.50	2.00	1.70	2.40	2.00	2.00	1.70
		2.30	1.90	1.85	1.55	1.85	1.55
	TOTAL	197.75	165.70		TOTAL	194.05	161.10
	MEAN	1.98	1.66		MEAN	1.94	1.61
	ST.D	0.20	0.15		ST.D	0.27	0.23

Table 13: DATA ON HEAD MEASUREMENTS OF WORKERS OF CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 30	22/7/76			(b) Colony 31	29/7/76		
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.95	1.65	2.00	1.70	1.95	1.60	1.90	1.60
1.95	1.65	1.80	1.50	2.05	1.75	1.90	1.60
2.40	2.05	2.35	2.00	1.95	1.65	2.00	1.65
1.90	1.60	1.85	1.55	1.90	1.55	2.10	1.80
1.90	1.60	1.85	1.60	2.00	1.75	2.05	1.70
1.90	1.60	1.85	1.55	1.95	1.65	1.95	1.65
1.85	1.55	2.25	1.85	2.00	1.70	1.95	1.65
1.95	1.65	1.85	1.55	1.90	1.60	2.40	2.00
1.85	1.60	2.25	1.90	1.95	1.65	1.95	1.60
1.95	1.65	2.00	1.70	1.85	1.55	1.95	1.65
1.85	1.60	1.75	1.45	2.00	1.70	2.05	1.70
2.35	2.00	2.30	1.95	2.00	1.70	1.95	1.65
1.90	1.60	1.90	1.65	1.95	1.65	1.95	1.65
1.95	1.65	1.85	1.55	2.40	2.00	2.05	1.75
1.85	1.55	1.90	1.60	1.85	1.55	2.05	1.70
1.80	1.50	2.35	2.00	2.00	1.70	1.90	1.60
2.30	1.95	1.80	1.50	2.45	2.00	2.40	2.00
1.90	1.60	1.90	1.60	1.95	1.65	2.10	1.70
1.95	1.65	1.90	1.60	2.40	2.00	2.35	1.95
1.70	1.45	1.75	1.45	1.95	1.65	2.10	1.75
1.90	1.65	1.90	1.60	2.00	1.75	2.00	1.65
1.90	1.60	1.85	1.55	1.95	1.60	2.00	1.65
1.85	1.55	2.30	2.00	1.90	1.60	1.95	1.65
2.40	2.00	2.30	1.95	1.95	1.65	2.10	1.75
1.95	1.65	1.75	1.45	1.90	1.60	1.95	1.60
1.75	1.45	1.85	1.55	2.10	1.75	2.05	1.70
1.95	1.65	1.90	1.60	1.95	1.65	2.05	1.75
2.30	2.00	1.85	1.55	1.75	1.45	1.95	1.65
1.85	1.55	2.05	1.70	2.00	1.70	2.30	1.90
1.95	1.65	1.90	1.60	1.90	1.60	2.00	1.65
1.90	1.60	1.85	1.55	1.90	1.60	1.90	1.60
1.90	1.60	1.80	1.55	1.90	1.60	1.95	1.65
1.85	1.55	1.80	1.50	2.05	1.75	2.05	1.70
1.95	1.65	1.85	1.55	2.00	1.70	1.95	1.65
1.85	1.60	2.30	1.95	2.45	2.00	2.35	1.90
1.95	1.65	1.85	1.55	2.00	1.65	2.00	1.65
1.80	1.50	1.95	1.65	1.85	1.55	2.05	1.70
2.35	2.00	1.85	1.55	2.00	1.70	1.95	1.60
1.80	1.50	1.80	1.50	1.95	1.65	1.90	1.60
1.75	1.50	1.90	1.60	2.35	1.95	2.50	2.00
1.80	1.50	1.80	1.50	2.00	1.70	1.90	1.60
1.90	1.60	2.40	2.00	1.80	1.50	1.95	1.65
2.35	2.00	1.75	1.50	2.00	1.65	1.85	1.55

Table 13: (cont'd)

(a) Colony 30				(b) Colony 31			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.80	1.50	1.90	1.65	1.85	1.55	2.00	1.70
1.85	1.55	1.80	1.55	1.85	1.55	1.95	1.65
1.90	1.60	1.85	1.55	1.90	1.60	1.85	1.55
1.95	1.65	1.85	1.55	2.35	1.95	2.05	1.70
1.75	1.45	1.75	1.50	2.00	1.65	1.80	1.50
1.95	1.65	1.65	1.40	2.05	1.70	1.85	1.55
1.80	1.50	1.90	1.65	1.95	1.65	2.05	1.85
	TOTAL	182.78	152.45		TOTAL	201.30	168.55
	MEAN	1.83	1.52		MEAN	2.01	1.69
	ST.D.	0.22	0.18		ST.D	0.16	0.12

Table 14: DATA ON HEAD MEASUREMENTS OF WORKERS OF *CAT. GUINEENSIS* IN VARIOUS COLONIES

Colony 32

HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	1.95	2.05	1.75
2.00	1.70	2.35	1.90
2.05	1.70	1.90	1.60
1.90	1.60	2.45	2.00
2.05	1.75	2.00	1.75
2.40	2.00	2.35	1.95
1.85	1.55	1.95	1.65
2.40	2.00	1.85	1.55
1.95	1.65	2.10	1.80
2.10	1.80	1.90	1.65
2.00	1.70	1.95	1.65
1.95	1.65	1.90	1.60
2.05	1.75	2.40	1.95
2.45	2.00	2.00	1.65
2.00	1.70	1.95	1.65
1.90	1.60	2.35	1.90
2.00	1.70	2.40	1.95
2.06	1.75	1.90	1.60
1.95	1.65	1.90	1.60
2.40	1.95	2.00	1.70
1.75	1.45	2.10	1.80
2.35	1.95	1.95	1.65
1.95	1.65	2.00	1.65
1.90	1.60	1.90	1.60
1.95	1.60	1.95	1.65
1.90	1.60	1.95	1.65
1.85	1.55	2.10	1.80
2.35	1.95	2.10	1.80
2.00	1.70	2.10	1.80
2.30	1.90	2.00	1.70
2.05	1.75	2.00	1.65
1.95	1.65	2.00	1.70
1.90	1.65	2.10	1.80
1.90	1.60	2.05	1.75
2.00	1.70	2.00	1.70
2.50	2.00	2.45	2.00
2.40	1.95	2.00	1.70
2.00	1.70	2.00	1.70
1.95	1.65	1.90	1.60
2.05	1.75	2.35	1.95

Table 14: DATA ON HEAD MEASUREMENTS OF WORKERS OF *CAT. GUINEENSIS* IN VARIOUS COLONIES

Colony 32

HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	1.95	2.05	1.75
2.00	1.70	2.35	1.90
2.05	1.70	1.90	1.60
1.90	1.60	2.45	2.00
2.05	1.75	2.00	1.75
2.40	2.00	2.35	1.95
1.85	1.55	1.95	1.65
2.40	2.00	1.85	1.55
1.95	1.65	2.10	1.80
2.10	1.80	1.90	1.65
2.00	1.70	1.95	1.65
1.95	1.65	1.90	1.60
2.05	1.75	2.40	1.95
2.45	2.00	2.00	1.65
2.00	1.70	1.95	1.65
1.90	1.60	2.35	1.90
2.00	1.70	2.40	1.95
2.06	1.75	1.90	1.60
1.95	1.65	1.90	1.60
2.40	1.95	2.00	1.70
1.75	1.45	2.10	1.80
2.35	1.95	1.95	1.65
1.95	1.65	2.00	1.65
1.90	1.60	1.90	1.60
1.95	1.60	1.95	1.65
1.90	1.60	1.95	1.65
1.85	1.55	2.10	1.80
2.35	1.95	2.10	1.80
2.00	1.70	2.10	1.80
2.30	1.90	2.00	1.70
2.05	1.75	2.00	1.65
1.95	1.65	2.00	1.70
1.90	1.65	2.10	1.80
1.90	1.60	2.05	1.75
2.00	1.70	2.00	1.70
2.50	2.00	2.45	2.00
2.40	1.95	2.00	1.70
2.00	1.70	2.00	1.70
1.95	1.65	1.90	1.60
2.05	1.75	2.35	1.95

Table 14: (cont'd)

HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.00	1.70	1.90	1.60
1.95	1.65	1.80	1.50
1.90	1.60	1.95	1.65
1.85	1.55	2.00	1.70
2.05	1.75	2.10	1.80
2.00	1.70	1.95	1.60
1.90	1.60	2.00	1.70
2.05	1.75	2.35	1.95
1.95	1.60	1.95	1.65
1.85	1.55	2.40	1.95
		TOTAL 205.35	172.45
		MEAN 2.05	1.72
		ST.D 0.18	0.14

Table 15: DATA ON HEAD MEASUREMENTS OF MALES OF CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 12		(b) Colony 13			(c) Colony 14	
HW (mm)	HL (mm)	HW (mm)	HL (mm)		HW (mm)	HL (mm)
1.50	1.30	1.25	1.10		1.40	1.25
1.45	1.30	1.25	1.15		1.45	1.25
1.45	1.30	1.30	1.20		1.40	1.20
1.35	1.25	1.35	1.20		1.45	1.30
1.40	1.30	1.20	1.15		1.40	1.25
1.55	1.35	1.25	1.15		1.40	1.20
1.40	1.25	1.30	1.20		1.45	1.30
1.40	1.25	1.30	1.20		1.40	1.25
1.50	1.30	1.25	1.10		1.45	1.30
1.45	1.30	1.25	1.15		1.30	1.20
1.45	1.30	1.15	1.05		1.40	1.25
1.50	1.35	1.10	1.05		1.35	1.25
1.45	1.30	1.35	1.20		1.35	1.25
1.60	1.35	1.10	1.05		1.40	1.25
1.50	1.30	1.30	1.20		1.45	1.25
1.45	1.30	1.35	1.20		1.40	1.20
1.60	1.35	1.25	1.10		1.45	1.30
1.50	1.30	1.25	1.15		1.40	1.20
1.45	1.25	1.30	1.20		1.30	1.20
1.45	1.30	1.30	1.15		1.50	1.30
1.50	1.30	1.20	1.10		1.45	1.30
1.40	1.25	1.25	1.10		1.45	1.30
1.45	1.30	1.30	1.20		1.45	1.30
1.45	1.30	1.25	1.15		1.30	1.20
1.50	1.25	1.35	1.20		1.45	1.30
1.45	1.25	1.35	1.20		1.50	1.30
1.45	1.30	1.30	1.15		1.50	1.30
1.45	1.30	1.30	1.15		1.50	1.30
1.55	1.35	1.30	1.20		1.45	1.30
1.45	1.25	1.15	1.05		1.35	1.20
1.45	1.30	1.30	1.20		1.45	1.25
1.50	1.30	1.15	1.05		1.40	1.20
1.55	1.35	1.25	1.15		1.45	1.25
1.45	1.30	1.35	1.20		1.35	1.20
1.50	1.25	1.25	1.10		1.45	1.25
1.40	1.25	1.25	1.10			
1.45	1.25	1.30	1.20	TOTAL	49.60	43.75
1.40	1.30	1.25	1.15			
1.50	1.30	1.25	1.15	MEAN	1.42	1.25
1.40	1.25	1.15	1.05			
1.40	1.30	1.20	1.10	ST.D	0.06	0.04
1.40	1.25	1.40	1.25			
1.50	1.30	1.15	1.05			

Table 15 (cont'd)

(a) Colony 12		(b) Colony 13	
HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.45 1.35 1.55 1.55 1.40 1.55 1.40	1.30 1.25 1.35 1.35 1.30 1.35 1.30	1.30 1.30 1.20 1.30 1.30 1.40 1.25	1.20 1.20 1.10 1.15 1.20 1.25 1.15
TO-TAL 73.20	64.75	TOT-AL 63.24	57.45
ME-AN 1.46	1.29	ME-AN 1.27	1.15
ST.D 0.06	0.03	ST.D 0.07	0.06

Table 16: DATA ON HEAD MEASUREMENTS OF MALES OF CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 20	12/4/76			(b) Colony 27	30/6/76
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.45	1.25	1.50	1.35	1.45	1.25
1.40	1.20	1.45	1.25	1.50	1.25
1.40	1.25	1.40	1.30	1.45	1.25
1.45	1.25	1.50	1.30	1.45	1.25
1.40	1.20	1.45	1.25	1.50	1.30
1.40	1.20	1.50	1.30	1.45	1.25
1.35	1.20	1.50	1.30	1.50	1.25
1.40	1.20	1.45	1.25	1.45	1.25
1.35	1.15	1.50	1.30	1.45	1.25
1.35	1.15	1.40	1.25	1.45	1.25
1.35	1.15	1.45	1.30	1.45	1.30
1.50	1.25	1.50	1.30	1.45	1.25
1.40	1.20	1.45	1.25	1.45	1.25
1.40	1.20	1.50	1.30	1.45	1.25
1.30	1.15	1.50	1.25	1.45	1.25
1.25	1.10	1.40	1.25	1.45	1.25
1.40	1.20	1.45	1.30	1.45	1.25
1.40	1.20	1.45	1.25	1.45	1.25
1.40	1.20	1.40	1.30	1.50	1.30
1.35	1.15	1.40	1.25	1.35	1.20
1.25	1.10	1.45	1.30	1.50	1.30
1.30	1.15	1.45	1.30	1.50	1.30
1.45	1.30	1.35	1.20	1.40	1.20
1.45	1.25	1.45	1.25	1.50	1.30
1.40	1.20	1.45	1.25	1.35	1.20
1.40	1.25	1.50	1.30	1.40	1.25
1.35	1.15	1.50	1.30	1.40	1.25
1.40	1.20	1.45	1.30	1.35	1.20
1.45	1.25	1.50	1.30	1.50	1.30
1.40	1.20	1.50	1.30	1.45	1.25
1.45	1.25	1.50	1.30	1.45	1.30
1.45	1.30	1.50	1.35	1.35	1.20
1.30	1.25	1.40	1.20	1.45	1.25
1.40	1.20	1.40	1.25	1.45	1.25
1.35	1.20	1.45	1.25	1.45	1.25
1.40	1.20	1.45	1.30	1.50	1.30
1.45	1.25	1.55	1.30		
1.40	1.20	1.45	1.25		
1.45	1.25	1.50	1.30		

Table 16: (cont'd)

	HW	HL			
	1.40	1.20			
	1.35	1.15			
	1.40	1.20			
	1.40	1.20			
	1.45	1.30			
	1.40	1.20			
	1.40	1.20			
	1.45	1.25			
	1.40	1.20			
	1.45	1.25			
	1.35	1.15			
	1.40	1.20			
	1.40	1.20			
	1.40	1.25			
	1.35	1.15			
	1.35	1.15			
	1.40	1.20			
	1.45	1.25			
	1.40	1.20			
	1.40	1.20			
	1.35	1.15			
Total	139.25	72.25	Total	109.05	95.10
Mean	1.39	1.20	Mean	1.45	1.27
St.D	0.05	0.04	St.D	0.04	0.03

Table 17: DATA ON HEAD MEASUREMENTS OF MALES OF *CAT. GUINEENSIS* IN VARIOUS COLONIES

(a) Colony 28 8/7/76 (b) Colony 29 16/7/76

HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.35	1.20	1.50	1.35	1.50	1.25	1.45	1.25
1.45	1.25	1.50	1.30	1.50	1.30	1.55	1.30
1.35	1.25	1.45	1.25	1.45	1.25	1.60	1.35
1.40	1.25	1.55	1.35	1.45	1.25	1.45	1.25
1.40	1.20	1.55	1.35	1.45	1.25	1.50	1.30
1.45	1.25	1.50	1.30	1.35	1.20	1.45	1.25
1.50	1.30	1.50	1.30	1.45	1.25	1.50	1.30
1.50	1.30	1.60	1.35	1.45	1.25	1.40	1.20
1.40	1.25	1.50	1.30	1.55	1.30	1.40	1.25
1.50	1.25	1.55	1.35	1.40	1.25	1.60	1.30
1.50	1.25	1.50	1.30	1.35	1.20	1.55	1.30
1.50	1.30	1.55	1.30	1.45	1.25	1.50	1.30
1.40	1.30	1.45	1.25	1.55	1.30	1.55	1.30
1.40	1.25	1.45	1.30	1.45	1.25	1.50	1.30
1.50	1.30	1.55	1.30	1.55	1.30	1.50	1.30
1.50	1.30	1.45	1.30	1.50	1.30	1.50	1.30
1.45	1.30	1.40	1.25	1.50	1.25	1.55	1.30
1.45	1.25	1.45	1.30	1.45	1.25	1.40	1.25
1.45	1.25	1.40	1.25	1.55	1.35	1.50	1.30
1.45	1.25	1.50	1.30	1.50	1.30	1.50	1.30
1.40	1.25	1.50	1.30	1.45	1.25	1.50	1.30
1.45	1.30	1.55	1.35	1.45	1.30	1.50	1.30
1.45	1.30	1.45	1.25	1.55	1.30	1.40	1.20
1.50	1.30	1.50	1.30	1.45	1.25	1.45	1.25
1.50	1.30	1.50	1.30	1.40	1.25	1.45	1.25
1.35	1.20	1.50	1.30	1.50	1.25	1.50	1.30
1.45	1.25	1.40	1.25	1.50	1.30	1.50	1.30
1.45	1.30	1.55	1.30	1.45	1.25	1.50	1.30
1.50	1.30	1.45	1.30	1.55	1.30	1.50	1.30
1.40	1.25	1.50	1.30	1.45	1.25	1.55	1.35
1.40	1.25	1.45	1.30	1.50	1.30	1.50	1.30
1.50	1.25	1.50	1.30	1.50	1.30	1.50	1.30

Table 17 (contd')

HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.45	1.30	1.45	1.30	1.55	1.30	1.40	1.20
1.50	1.30	1.45	1.30	1.50	1.30	1.45	1.25
1.55	1.30	1.50	1.30	1.45	1.25	1.55	1.30
1.40	1.25	1.50	1.35	1.55	1.30	1.50	1.30
1.45	1.30	1.50	1.30	1.55	1.30	1.50	1.30
1.35	1.20	1.45	1.25	1.55	1.30	1.50	1.35
1.35	1.25	1.50	1.30	1.50	1.30	1.35	1.20
1.45	1.25	1.45	1.30	1.45	1.25	1.50	1.30
1.45	1.25	1.55	1.30	1.55	1.35	1.50	1.30
1.50	1.30	1.50	1.30	1.50	1.30	1.50	1.30
1.45	1.20	1.50	1.25	1.50	1.30	1.40	1.20
1.50	1.25	1.50	1.35	1.50	1.25	1.45	1.25
1.40	1.25	1.55	1.35	1.50	1.30	1.50	1.30
1.50	1.20	1.50	1.30	1.45	1.30		
1.45	1.25	1.50	1.30	1.50	1.30		
1.50	1.30	1.45	1.30	1.45	1.25	T 148.65	128.20
1.45	1.30	1.50	1.30	1.50	1.30		
1.50	1.30	1.50	1.30	1.50	1.30	M 1.49	1.28
				1.50	1.30		
	TOTAL	146.85	128.40	1.50	1.30		
				1.50	1.30		
				1.55	1.30	St. De 0.05	0.03
	MEAN	1.47	1.28	1.50	1.30		
	STANDARD DEVIATION	0.06	0.04				

Table 18: DATA ON HEAD MEASUREMENTS OF MALES OF CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 30	23/7/76			(b) Colony 31	29/7/76		
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.45	1.25	1.45	1.25	1.45	1.30	1.45	1.30
1.40	1.25	1.40	1.20	1.45	1.25	1.55	1.35
1.35	1.20	1.40	1.25	1.55	1.30	1.40	1.25
1.35	1.20	1.45	1.25	1.40	1.25	1.50	1.30
1.45	1.25	1.40	1.25	1.40	1.25	1.50	1.30
1.40	1.25	1.40	1.25	1.50	1.35	1.55	1.35
1.45	1.25	1.45	1.25	1.50	1.35	1.55	1.35
1.40	1.25	1.40	1.25	1.45	1.30	1.50	1.30
1.40	1.25	1.40	1.25			1.45	1.30
1.35	1.20	1.40	1.20	1.50	1.35	1.50	1.30
1.35	1.20	1.40	1.25	1.55	1.30	1.50	1.30
1.45	1.25	1.35	1.20	1.55	1.30	1.50	1.30
1.30	1.20	1.40	1.25	1.45	1.30	1.55	1.35
		1.45	1.25				
1.40	1.25	1.50	1.25	1.50	1.35	1.50	1.30
1.35	1.20	1.45	1.25	1.55	1.35	1.45	1.25
1.35	1.20	1.40	1.20	1.55	1.35	1.50	1.30
1.40	1.25	1.50	1.25	1.55	1.35	1.45	1.30
1.35	1.20	1.30	1.20	1.50	1.30	1.45	1.25
1.40	1.25	1.40	1.20	1.45	1.30	1.50	1.30
1.45	1.30	1.40	1.25	1.55	1.30	1.55	1.35
1.45	1.25	1.50	1.25	1.50	1.30	1.40	1.20
1.40	1.25	1.40	1.20	1.55	1.30	1.55	1.35
1.40	1.20	1.40	1.25	1.60	1.35	1.55	1.35
1.40	1.25	1.50	1.25	1.55	1.30	1.35	1.20
1.35	1.20	1.45	1.25	1.40	1.20	1.50	1.30
1.50	1.30	1.40	1.25	1.50	1.30	1.55	1.35
1.40	1.25	1.50	1.25	1.55	1.35	1.50	1.30
1.40	1.25	1.40	1.20	1.45	1.30	1.50	1.35
1.45	1.25	1.35	1.20	1.50	1.30	1.50	1.30
1.30	1.15	1.45	1.25	1.50	1.30	1.40	1.25
1.40	1.25	1.35	1.20	1.45	1.30	1.45	1.30
1.40	1.25	1.40	1.25	1.55	1.30	1.45	1.25
1.50	1.25	1.40	1.20	1.50	1.30	1.55	1.35
1.40	1.25	1.40	1.25	1.50	1.30	1.50	1.30
1.40	1.25	1.40	1.25	1.40	1.25	1.50	1.30
1.50	1.25	1.45	1.25	1.50	1.30	1.55	1.35
1.40	1.25	1.35	1.20	1.55	1.35	1.50	1.30
1.40	1.25	1.40	1.25	1.50	1.30	1.50	1.25
1.40	1.25	1.45	1.25	1.55	1.35	1.40	1.20
		1.40	1.20	1.35	1.20	1.50	1.30

Table 18: (cont'd)

HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.45	1.25	1.35	1.20	1.45	1.25	1.45	1.25
1.40	1.25	1.45	1.25	1.40	1.25	1.55	1.30
1.40	1.20	1.40	1.25	1.45	1.25	1.60	1.35
1.35	1.20	1.40	1.20	1.50	1.30	1.50	1.35
1.45	1.25	1.40	1.25	1.50	1.30	1.55	1.35
1.35	1.20	1.40	1.25	1.55	1.35	1.50	1.30
1.25	1.10	1.45	1.25	1.50	1.30	1.45	1.25
1.40	1.25	1.35	1.20	1.55	1.35	1.40	1.20
1.45	1.25	1.40	1.25	1.50	1.30	1.55	1.35
1.40	1.25			1.50	1.30	1.50	1.30
				1.50	1.30		
	TOTAL	140.60	123.40		TOTAL	149.40	130.05
	MEAN	1.40	1.23		MEAN	1.49	1.30
	STANDARD DEVIATION	0.05	0.03		STANDARD DEVIATION	0.05	0.04

Table 19: DATA ON HEAD MEASUREMENTS OF MALES OF CAT. GUINEENSIS IN VARIOUS COLONIES

Colony 32 21/8/76

HW (mm)	HL (mm)	HW (mm)	HL (mm)
1.35	1.25	1.40	1.20
1.45	1.30	1.50	1.30
1.45	1.25	1.40	1.25
1.45	1.20	1.35	1.20
1.25	1.15	1.40	1.25
1.35	1.20	1.40	1.25
1.45	1.25	1.35	1.20
1.40	1.25	1.40	1.25
1.40	1.25	1.40	1.25
		1.45	1.30
1.45	1.25	1.40	1.25
1.45	1.25	1.30	1.15
1.40	1.25	1.35	1.20
1.45	1.25	1.40	1.25
1.50	1.25	1.40	1.25
1.35	1.20	1.45	1.25
1.40	1.25	1.40	1.25
1.45	1.25	1.50	1.30
1.35	1.20	1.30	1.15
1.40	1.25	1.40	1.25
1.30	1.15	1.40	1.25
1.35	1.15	1.45	1.25
1.30	1.15	1.40	1.25
1.50	1.30	1.40	1.25
1.35	1.20	1.35	1.20
1.40	1.25	1.35	1.20
1.35	1.20	1.40	1.25
1.40	1.25	1.35	1.20
1.45	1.25	1.35	1.20
1.35	1.20	1.35	1.20
1.40	1.25	1.45	1.30
1.35	1.25	1.45	1.25
1.35	1.20	1.35	1.20
1.35	1.20	1.40	1.25
1.45	1.30	1.45	1.25
1.50	1.30	1.35	1.20
1.40	1.25	1.40	1.25
1.45	1.25	1.40	1.25
1.45	1.25	1.40	1.25
1.40	1.25	1.40	1.20
1.40	1.25	1.40	1.25
1.40	1.25	1.45	1.25

Table 19: (cont'd)

HW (mm)	HL (mm)		HW (mm)	HL (mm)
1.35	1.20		1.35	1.20
1.30	1.15		1.40	1.25
1.40	1.25		1.35	1.20
1.45	1.30		1.30	1.15
1.35	1.20		1.45	1.25
1.45	1.25		1.45	1.25
1.45	1.25		1.45	1.30
1.40	1.25		1.40	1.25
1.40	1.25	TOTAL	139.75	123.45
		MEAN	1.40	1.23
		STANDARD DEVIATION	0.05	0.04

Table 20: DATA ON HEAD MEASUREMENTS OF FEMALE CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 20	12/4/76			(b) Colony 22			28/4/76
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	2.10	2.40	2.05	1.95	1.75	2.20	1.95
2.40	2.10	2.45	2.10	2.10	1.90	2.20	1.90
2.30	2.05	2.40	2.10	2.20	1.95	2.15	1.90
2.30	2.00	2.40	2.10	2.15	1.90	2.10	1.85
2.35	2.05	2.35	2.05	1.95	1.75	2.15	1.90
2.30	2.00	2.40	2.10	2.00	1.80	2.10	1.85
2.25	1.95	2.45	2.15	2.10	1.90		
2.40	2.10	2.35	2.05	1.90	1.70	2.15	1.90
2.40	2.10	2.40	2.10	2.10	1.95	2.05	1.80
2.40	2.10	2.40	2.10	1.85	1.70	2.15	1.95
2.35	2.05	2.35	2.10	2.10	1.85	2.10	1.85
2.40	2.10	2.40	2.10	1.95	1.75	2.25	2.00
2.40	2.10	2.40	2.10	2.05	1.85	2.10	1.85
2.35	2.10	2.40	2.10	2.15	1.95	2.05	1.85
2.40	2.10	2.40	2.10	2.15	1.90	2.05	1.85
2.35	2.05	2.40	2.10	2.20	1.95	2.15	1.90
2.35	2.10	2.40	2.10	2.10	1.90	2.00	1.80
2.40	2.10	2.35	2.05	2.10	1.90	2.15	1.95
2.35	2.05	2.45	2.10	2.00	1.80	2.10	1.90
2.35	2.05	2.40	2.10	2.20	1.90	2.10	1.85
2.30	1.95	2.30	2.00	2.15	1.90	2.30	2.05
2.40	2.10			2.00	1.80	2.20	1.95
2.45	2.10	T130.65	114.00	2.15	1.90	T105.25	94.00
2.40	2.05			2.15	1.90		
2.35	2.05	M. 2.38	2.07	2.10	1.90	M. 2.10	1.88
2.35	2.05			2.30	2.05		
2.35	2.05	St.		2.10	1.90	St.	
2.40	2.05	De.0.04	0.04	2.10	1.90	De.0.09	0.07
2.40	2.10			2.10	1.90		
2.30	2.00						
2.40	2.10						
2.35	2.00						
2.45	2.15						
2.35	2.05						

Table 21: DATA ON HEAD MEASUREMENTS OF FEMALE CAT. GUINEENSIS IN VARIOUS COLONIES

(a) Colony 28 — 9/7/76 | (b) Colony 29 — 16/7/76

HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	2.05	2.40	2.10	2.35	2.10	2.35	2.10
2.40	2.10	2.40	2.10	2.30	2.05	2.45	2.10
2.30	2.05	2.35	2.05	2.45	2.15	2.40	2.10
2.40	2.05	2.35	2.05	2.30	2.05	2.30	2.00
2.40	2.10	2.40	2.10	2.40	2.05	2.35	2.10
2.30	2.05	2.40	2.10	2.40	2.10	2.35	2.05
2.40	2.10	2.35	2.05	2.45	2.15	2.45	2.15
2.35	2.05	2.35	2.05	2.30	2.05	2.40	2.10
2.30	2.05	2.45	2.10	2.40	2.10	2.35	2.10
2.40	2.10	2.35	2.05	2.30	2.05	2.40	2.10
2.40	2.10	2.35	2.05	2.40	2.10	2.50	2.15
2.30	2.05	2.35	2.10	2.40	2.10	2.35	2.10
2.35	2.10	2.40	2.10	2.40	2.10	2.35	2.05
2.40	2.10	2.40	2.10	2.35	2.05	2.40	2.10
2.30	2.05	2.40	2.10	2.40	2.05	2.30	2.05
2.35	2.05	2.40	2.10	2.40	2.10	2.40	2.10
2.25	2.00	2.30	2.05	2.30	2.05	2.30	2.00
2.35	2.05	2.30	2.05	2.40	2.10	2.40	2.10
2.35	2.05	2.40	2.10	2.35	2.05	2.35	2.05
2.40	2.10	2.30	2.05	2.40	2.10	2.35	2.10
2.40	2.10	2.40	2.10	2.35	2.05	2.35	2.10
2.35	2.10	2.35	2.05	2.50	2.10	2.40	2.10
2.35	2.10	2.35	2.00	2.30	2.00	2.35	2.10
2.35	2.05	2.30	2.05	2.40	2.05	2.45	2.10
2.30	2.00	2.40	2.10	2.40	2.10	2.35	2.05
2.35	2.05	2.25	2.05	2.35	2.05	2.35	2.10
2.35	2.05	2.30	2.05	2.35	2.10	2.40	2.10
2.35	2.05	2.35	2.05	2.45	2.10	2.45	2.15
2.45	2.15	2.35	2.00	2.40	2.05	2.40	2.10
2.35	2.05	2.40	2.10	2.30	2.00	2.30	2.00
2.40	2.10	T 177.15	155.30	2.40	2.10	T 178.45	156.15
2.35	2.00	M 2.36	2.07	2.35	2.05	M. 2.38	2.08
2.40	2.10	St. De 0.04	0.03	2.40	2.10	St. 0.05	0.04
2.40	2.10			2.35	2.10		
2.40	2.10			2.35	2.05		
2.40	2.10			2.40	2.10		
2.40	2.10			2.35	2.05		
2.30	2.05			2.40	2.10		
2.35	2.05			2.45	2.10		
2.35	2.05			2.35	2.05		
2.35	2.05			2.40	2.10		
2.35	2.05			2.45	2.10		
2.35	2.10			2.50	2.15		
2.40	2.10			2.40	2.10		
2.40	2.10			2.35	2.05		

Table 21: DATA ON HEAD MEASUREMENTS OF FEMALE CAT.GUINEENSIS IN VARIOUS COLONIES

(a) Colony 28	9/7/76			(b) Colony 29	16/7/76		
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	2.05	2.40	2.10	2.35	2.10	2.35	2.10
2.40	2.10	2.40	2.10	2.30	2.05	2.45	2.10
2.30	2.05	2.35	2.05	2.45	2.15	2.40	2.10
2.40	2.05	2.35	2.05	2.30	2.05	2.30	2.00
2.40	2.10	2.40	2.10	2.40	2.05	2.35	2.10
2.30	2.05	2.40	2.10	2.40	2.10	2.35	2.05
2.40	2.10	2.35	2.05	2.45	2.15	2.45	2.15
2.35	2.05	2.35	2.05	2.30	2.05	2.40	2.10
2.30	2.05	2.45	2.10	2.40	2.10	2.35	2.10
2.40	2.10	2.35	2.05	2.30	2.05	2.40	2.10
2.40	2.10	2.35	2.05	2.40	2.10	2.50	2.15
2.30	2.05	2.35	2.10	2.40	2.10	2.35	2.10
2.35	2.10	2.40	2.10	2.40	2.10	2.35	2.05
2.40	2.10	2.40	2.10	2.35	2.05	2.40	2.10
2.30	2.05	2.40	2.10	2.40	2.05	2.30	2.05
2.35	2.05	2.40	2.10	2.40	2.10	2.40	2.10
2.25	2.00	2.30	2.05	2.30	2.05	2.30	2.00
2.35	2.05	2.30	2.05	2.40	2.10	2.40	2.10
2.35	2.05	2.40	2.10	2.35	2.05	2.35	2.05
2.40	2.10	2.30	2.05	2.40	2.10	2.35	2.10
2.40	2.10	2.40	2.10	2.35	2.05	2.35	2.10
2.35	2.10	2.35	2.05	2.50	2.10	2.40	2.10
2.35	2.10	2.35	2.00	2.30	2.00	2.35	2.10
2.35	2.05	2.30	2.05	2.40	2.05	2.45	2.10
2.30	2.00	2.40	2.10	2.40	2.10	2.35	2.05
2.35	2.05	2.25	2.05	2.35	2.05	2.35	2.10
2.35	2.05	2.30	2.05	2.35	2.10	2.40	2.10
2.35	2.05	2.35	2.05	2.45	2.10	2.45	2.15
2.45	2.15	2.35	2.00	2.40	2.05	2.40	2.10
2.35	2.05	2.40	2.10	2.30	2.00	2.30	2.00
2.40	2.10	T 177.15	155.30	2.40	2.10	T 178.45	156.15
2.35	2.00			2.35	2.05		
2.40	2.10			2.40	2.10		
2.40	2.10	M 2.36	2.07	2.35	2.10	M. 2.38	2.08
2.40	2.10			2.35	2.05		
2.40	2.10			2.40	2.10		
2.40	2.10	St. De 0.04	0.03	2.35	2.05	St. 0.05	0.04
2.30	2.05			2.40	2.10		
2.35	2.05			2.45	2.10		
2.35	2.05			2.35	2.05		
2.35	2.05			2.40	2.10		
2.35	2.05			2.45	2.10		
2.35	2.10			2.50	2.15		
2.40	2.10			2.40	2.10		
2.40	2.10			2.35	2.05		

Table 22: DATA ON HEAD MEASUREMENTS OF FEMALE CAT. GUINEENSIS IN VARIOUS COLONIES

(a) Colony 30 23/7/76				(b) Colony 31 29/7/76			
HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.30	2.05	2.30	2.05	2.35	2.10	2.35	2.10
2.30	2.00	2.30	2.05	2.35	2.10	2.30	2.00
2.20	1.95	2.30	2.05	2.40	2.10	2.35	2.05
2.30	2.05	2.30	2.05	2.40	2.10	2.35	2.05
2.30	2.05	2.25	2.00	2.30	2.05	2.30	2.05
2.30	2.05	2.25	1.95	2.35	2.05	2.30	2.00
2.00	2.05	2.30	2.05	2.35	2.05	2.30	2.00
2.25	2.00	2.25	2.00	2.30	2.00	2.35	2.05
2.35	2.05	2.25	2.00	2.30	2.05	2.30	2.00
2.25	2.00	2.25	2.00	2.35	2.05	2.35	2.05
2.35	2.05	2.30	2.00	2.40	2.05	2.35	2.05
2.35	2.00	2.35	2.05	2.35	2.05	2.40	2.05
2.35	2.05	2.30	2.05	2.35	2.05	2.30	2.00
2.30	2.00	2.30	2.05	2.35	2.05	2.35	2.05
2.30	2.05	2.25	2.00	2.40	2.10	2.20	1.95
2.30	2.05	2.30	2.05	2.30	2.00	2.25	2.00
2.30	2.00	2.35	2.05	2.35	2.05	2.35	2.05
2.30	2.05	2.30	2.05	2.30	2.00	2.35	2.05
2.25	2.00	2.30	2.05	2.35	2.05	2.35	2.05
2.30	2.05	2.30	2.00	2.25	2.00	2.30	2.00
2.35	2.05	2.35	2.05	2.30	2.00	2.35	2.10
2.35	2.05	2.25	2.00	2.35	2.05	2.30	2.05
2.35	2.10	2.35	2.05	2.35	2.05	2.35	2.05
2.35	2.05	2.35	2.05	2.30	2.00	2.25	2.00
2.30	2.05	2.30	2.05	2.30	2.00	2.35	2.05
2.30	2.05	2.35	2.05	2.35	2.05	2.35	2.05
2.35	2.05	2.30	2.05	2.20	1.95	2.40	2.10
2.25	2.00	2.25	2.00	2.35	2.05	2.35	2.05
2.35	2.05	2.25	1.95	2.30	2.00	2.40	2.10
2.25	2.00	2.25	2.00	2.40	2.10	2.30	2.00
2.30	2.05	2.30	2.05	2.30	2.00	2.35	2.05
2.30	2.05	2.30	2.05	2.30	2.00	2.35	2.00
2.35	2.05	2.30	2.05	2.20	1.95	2.35	2.05
2.30	2.00	2.30	2.05	2.30	2.00	2.20	1.95
2.35	2.05	2.30	2.05	2.35	2.00	2.30	2.05
2.30	2.05	2.30	2.05	2.40	2.05	2.35	2.05
2.35	2.05	2.25	2.00	2.40	2.10	2.30	2.00
2.30	2.05	2.30	2.05	2.40	2.10	2.30	2.00
2.30	2.05	2.30	2.05	2.40	2.10	2.35	2.05
2.25	2.00	2.35	2.05	2.25	2.00	2.35	2.05

Table 22 (cont'd)

(a) Colony 30 | (b) Colony 31

HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.30	2.05	2.20	1.95	2.35	2.05	2.40	2.10
2.20	1.95	2.30	2.05	2.35	2.10	2.30	2.00
2.30	2.05	2.30	2.00	2.35	2.05	2.25	2.00
2.35	2.05	2.30	2.05	2.30	2.05	2.35	2.05
2.25	2.00	2.35	2.05	2.35	2.05	2.35	2.05
2.30	2.05	2.30	2.05	2.35	2.05	2.35	2.05
2.30	2.05	2.35	2.05	2.30	2.00	2.30	2.00
2.30	2.05	2.30	2.05	2.40	2.10	2.35	2.05
2.30	2.05	2.25	2.00	2.35	2.05	2.30	2.00
2.30	2.00	2.30	2.05	2.35	2.05	2.30	2.00
	TOTAL	229.90	203.25		TOTAL	233.10	203.85
	MEAN	2.30	2.03		MEAN	2.33	2.04
	STANDARD DEVIATION	0.04	0.03		STANDARD DEVIATION	0.05	0.04

Table 23: DATA ON HEAD MEASUREMENTS OF FEMALE CAT.GUINEENSIS IN VARIOUS COLONIES

21/8/76

Colony 32

HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	2.05	2.35	2.00
2.40	2.10	2.35	2.05
2.40	2.05	2.30	2.00
2.30	2.00	2.30	2.00
2.30	2.00	2.30	2.00
2.30	2.05	2.30	2.00
2.35	2.05	2.35	2.05
2.30	2.00	2.40	2.05
2.40	2.10	2.30	2.00
2.25	2.00	2.35	2.05
2.30	2.00	2.35	2.05
2.30	2.00	2.35	2.05
2.25	1.95	2.35	2.05
2.40	2.05	2.30	2.00
2.35	2.00	2.40	2.05
2.40	2.05	2.35	2.05
2.35	2.00	2.30	2.05
2.30	2.00	2.30	2.00
2.30	2.00	2.40	2.05
2.30	2.00	2.35	2.05
2.40	2.10	2.35	2.05
2.30	2.00	2.35	2.05
2.40	2.05	2.25	2.00
2.30	2.00	2.45	2.10
2.40	2.05	2.35	2.05
2.35	2.05	2.30	2.00
2.35	2.05	2.30	2.00
2.35	2.05	2.35	2.05
2.35	2.05	2.30	2.00
2.35	2.05	2.40	2.10
2.35	2.05	2.30	2.05
2.35	2.05	2.30	2.00
2.45	2.15	2.35	2.05
2.40	2.10	2.35	2.05
2.30	2.00	2.35	2.10
2.20	1.95	2.35	2.05
2.35	2.05	2.35	2.05
2.30	2.00	2.30	2.00
2.30	2.00	2.30	2.00

Table 23 (cont'd)

HW (mm)	HL (mm)	HW (mm)	HL (mm)
2.35	2.05	2.35	2.05
2.30	2.00	2.35	2.05
2.35	2.05	2.35	2.05
2.35	2.05	2.35	2.05
2.35	2.05	2.30	2.00
2.40	2.10	2.30	2.00
2.25	1.95	2.35	2.00
2.25	2.00	2.35	2.05
2.30	2.00	2.30	2.00
2.25	1.95	2.30	2.00
2.35	2.05	2.30	2.00
	TOTAL	233.35	203.10
	MEAN	2.33	2.03
	STANDARD DEVIATION	0.04	0.04

Table 24: Comparison of mean head widths of the workers of *Cat. guineensis*

NESTS	COMPARED	d
11	12	-5.58956*
11	13	-2.86435*
11	14	-5.07092*
11	16	-4.16619*
11	17	-1.64399
11	19	-4.43877*
11	20	-4.05553*
11	22	-5.26076*
11	23	-2.81112*
11	24	-3.50000*
11	25	-4.56383*
11	26	-2.52982*
11	27	-2.46598*
11	28	-4.05553*
11	29	-3.13049*
11	30	-1.58114
11	31	-4.80196*
11	32	-5.33333*
12	13	2.23605*
12	14	0.66666
12	16	1.06748
12	17	3.89331*
12	19	1.13554
12	20	1.44115
12	22	0.32444
12	23	2.46885*
12	24	2.13718*
12	25	1.16666
12	26	2.81112*
12	27	3.08220*
12	28	1.44115

Table 24: (cont'd)

NESTS COMPARED		d
12	29	1.91674
12	30	3.74816*
12	31	1.01418
12	32	0.32879
13	14	-1.67748
13	16	-1.13137
13	17	1.34163
13	19	-1.19257
13	20	-0.88465
13	22	-1.93792
13	23	0.14285
13	24	-0.30151
13	25	-1.21999
13	26	0.43301
13	27	0.59628
13	28	-0.88465
13	29	-0.27472
13	30	1.29903
13	31	-1.38872
13	32	-1.95982
14	16	0.46851
14	17	3.33333*
14	19	0.49999
14	20	0.82199
14	22	-0.33333
14	23	1.89736
14	24	1.52127
14	25	0.51449
14	26	2.24179*
14	27	2.49999*
14	28	0.82199
14	29	1.35680

Table 24: (cont'd)

NESTS COMPARED		d
14	30	3.20256*
14	31	0.34815
14	32	-0.33806
16	17	2.59247*
16	19	0.00000
16	20	0.30151
16	22	-0.76248
16	23	1.31278
16	24	0.92582
16	25	0.00000
16	26	1.62186
16	27	1.82998
16	28	0.30151
16	29	0.84017
16	30	2.50651
16	31	-0.15810
16	32	-0.77151
17	19	-2.75776*
17	20	-2.40192*
17	22	-3.56886*
17	23	-1.23442
17	24	-1.80838
17	25	-2.83333*
17	26	-0.93704
17	27	-0.81110
17	28	-2.40192*
17	29	-1.62186
17	30	0.00000
17	31	-3.04255*
17	32	-3.61677*
19	20	0.32025
19	22	-0.81110
19	23	1.38873

Table 24: (cont'd)

NESTS COMPARED		d
19	24	0.98639
19	25	0.00000
19	26	1.71791
19	27	1.94665
19	28	0.32025
19	29	0.88465
19	30	2.65495*
19	31	-0.16902
19	32	-0.82199
20	22	-1.12089
20	23	1.06748
20	24	0.64888
20	25	-0.32880
20	26	1.38872
20	27	1.60128
20	28	0.00000
20	29	0.58345
20	30	2.31454*
20	31	-0.49999
20	32	-1.13554
22	23	2.16024*
22	24	1.80838
22	25	0.83332
22	26	2.49877*
22	27	2.75776*
22	28	1.12089
22	29	1.62186
22	30	3.43582*
22	31	0.67612
22	32	0.00000
23	24	-0.46852
23	25	-1.42302
23	26	0.29814

Table 24: (cont'd)

NESTS COMPARED		d
23	27	0.46290
23	28	-1.06748
23	29	-0.42426
23	30	1.19256
23	31	-1.60128
23	32	-2.18643
24	25	-1.01418
24	26	0.79056
24	27	0.98639
24	28	-0.64888
24	29	0.00000
24	30	1.73925
24	31	-1.20048
24	32	-1.83333
25	26	1.76141
25	27	2.00000*
25	28	0.32880
25	29	0.90453
25	30	2.72218
25	31	-0.17407
25	32	-0.84514
26	27	0.15617
26	28	-1.38872
26	29	-0.71428
26	30	0.90453
26	31	-1.94665
26	32	-2.52981*
27	28	-1.60128
27	29	-0.88465
27	30	0.78086
27	31	-2.19739*
27	32	-2.79478*
28	29	0.58345

Table 24: (cont'd)

NESTS COMPARED		d
28	30	-2.31454*
28	31	-0.49999
28	32	-1.13554
29	30	1.57142
29	31	-1.06748
29	32	-1.63978
30	31	-2.91998*
30	32	-3.47850*
31	32	-0.68599

The asterics indicate significant difference between nests compared.

Table 25: Comparison of means of head widths of the males of *guineensis*

NESTS COMPARED		d
12	13	5.54699*
12	14	1.15469
12	20	2.11057*
12	27	0.31622
12	28	-0.28867
12	29	-0.90453
12	30	1.50755
12	31	-0.90453
12	32	1.80906
13	14	-4.43759*
13	20	-3.75277*
13	27	-5.72871*
13	28	-5.82434*
13	29	-6.63952*
13	30	-4.33012*
13	31	-6.63952*
13	32	-4.04144*
14	20	0.90453
14	27	-0.94868
14	28	-1.44337
14	29	-2.11057*
14	30	0.30151
14	31	-2.11057*
14	32	0.60302
20	27	-1.99999*
20	28	-2.41208*
20	29	-3.16227*
20	30	-0.63254
20	31	-3.16227*
20	32	-0.31622
27	28	-0.63245

Table 25: (cont'd)

NEST COMPARED		d
27	29	-1.33333
27	30	1.33333
27	31	-1.33333
27	32	1.66666
28	29	-0.60302
28	30	1.80906
28	31	-0.60302
28	32	2.11057*
29	30	2.52981*
29	31	0.00000
29	32	2.84604*
30	31	-2.52981
30	32	0.31622
31	32	2.84604

Table 26: Comparison of means of head widths of the female *Cat. guineensis*

NESTS COMPARED		d
20	22	7.48845*
20	28	0.35356
20	29	-0.33332
20	30	2.47488*
20	31	1.33333
20	32	1.41421
22	28	-7.21109*
22	29	-7.48330*
22	30	-5.54699*
22	31	-6.14700*
22	32	-6.37905*
28	29	-0.66666
28	30	2.12131*
28	31	0.99999
28	32	1.06065
29	30	2.66666*
29	31	1.58113
29	32	1.66665
30	31	-1.00000
30	32	-1.06066
31	32	0.00000

TABLES 27-53: DATA ON ACTIVITY PATTERN

Table 27: 7/8/75

Time	Temp oC	Rel.Hum %	Light Intensity (Lum/sq.ft)	Ants leaving nest	Ants entering nest	Food carriers	% Food carriers
6 am	21.0	96.0	19.0	0	0	0	0.0
7 "	21.0	95.5	39.0	1	1	0	0.0
8 "	21.5	86.0	190.0	19	8	0	0.0
9 "	23.0	87.5	210.0	164	13	0	0.0
10 "	22.0	88.0	170.0	62	24	1	5.0
11 "	23.0	90.0	200.0	66	39	0	0.0
12 noon	24.0	88.0	395.0	70	20	0	0.0
1 pm	23.5	90.0	200.0	78	79	1	1.3
2 "	25.0	85.0	600.0	48	90	2	2.2
3 "	25.0	90.0	200.0	66	55	1	1.3
4 "	23.0	95.0	100.0	35	66	1	1.5
5 "	22.5	94.5	100.0	6	99	0	0.0
6 "	22.5	89.0	11.0	8	103	0	0.0
7 "	22.0	88.0	0.0	1	0	0	0.0
8 "	22.0	89.0	0.0	0	0	0	0.0

It rained for about 1hr. 30mns in the night of 6th August,1975 and it was still drizzling in the morning of the 7th.

Table 28 14/8/75

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft.)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	96.0	21.0	134	12	0	0.0
7 "	21.5	94.0	76.0	279	55	0	0.0
8 "	21.5	90.0	46.0	79	102	0	0.0
9 "	23.0	89.0	140.0	151	99	1	1.0
10 "	24.5	86.0	170.0	95	128	0	0.0
11 "	25.0	86.0	160.0	114	83	1	1.2
12 noon	26.5	78.0	160.0	128	118	4	2.1
1 p.m	28.0	76.0	250.0	124	92	2	2.2
2 "	27.0	85.0	160.0	127	75	0	0.0
3 "	28.0	69.0	400.0	124	117	0	0.0
4 "	27.0	87.0	80.0	56	65	1	1.5
5 "	25.0	94.0	40.0	34	102	1	1.0
6 "	25.0	95.0	1.0	4	210	0	0.0
7 "	24.0	96.0	0.0	0	3	0	0.0
8 "	24.0	96.0	0.0	0	0	0	0.0

There has been no rain for the past five days.

Table 29: 21/8/75

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq. ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	85.0	7.2	109	29	0	0.0
7 "	21.0	89.0	19.0	97	33	0	0.0
8 "	22.0	87.5	47.0	47	24	0	0.0
9 "	22.0	87.0	25.0	73	21	0	0.0
10 "	23.0	88.0	132.0	64	43	0	0.0
11 "	24.0	87.5	452.0	98	22	1	4.5
12 noon	23.5	89.0	434.0	71	48	2	4.2
1 p.m	23.0	91.0	319.0	89	28	2	3.6
2 " *	23.0	90.0	460.0	125	75	0	0.0
3 "	24.0	91.0	233.0	93	61	1	1.6
4 "	23.0	92.5	126.0	61	70	4	5.7
5 "	23.0	91.5	19.0	47	50	0	0.0
6 "	22.0	91.0	5.0	21	21	0	0.0
7 "	21.5	90.0	0.0	0	2	0	0.0
8 "	21.0	87.0	0.0	0	0	0	0.0

* Recorded just after a drizzle which lasted for approximately 20 minutes.

Table 30: 18th September, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq. ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	95.0	40.0	27	0	0	0.0
7 "	22.0	90.0	49.0	229	57	0	0.0
8 "	22.5	86.0	175.0	176	88	2	2.3
9 "	23.8	84.0	210.0	150	83	4	4.8
10 "	23.5	86.0	130.0	118	109	1	0.9
11 "	23.8	86.0	120.0	53	93	1	1.1
12 noon	24.0	78.0	100.0	63	73	1	1.4
1 p.m	24.0	85.5	160.0	97	196	0	0.0
2 "	25.0	84.0	180.0	64	84	1	1.2
3 "	24.0	86.0	108.0	12	126	2	1.6
4 "	24.5	85.5	124.0	31	205	1	0.5
5 "	24.0	91.0	59.0	24	147	0	0.0
6 "	23.5	92.0	4.0	5	77	0	0.0
7 "	21.0	92.0	0.0	0	0	0	0.0
8 "	21.0	93.0	0.0	0	0	0	0.0

Table 31

25th September, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	98.0	32.0	3	1	0	0.0
7 "	23.0	92.5	66.2	220	22	1	4.5
8 "	24.1	90.0	92.0	384	110	0	0.0
9 "	25.0	86.0	160.0	104	69	2	2.9
10 "	25.0	82.5	140.0	54	65	5	7.6
11 "	27.5	74.0	180.0	99	95	2	2.1
12 noon	29.0	66.5	200.0	322	104	4	3.8
1 p.m	29.0	71.5	220.0	156	104	0	0.0
2 "	29.2	69.0	200.0	80	101	7	6.9
3 "	29.4	75.0	150.0	78	117	1	0.9
4 "	28.5	83.0	119.0	26	111	3	2.7
5 "	27.0	92.5	57.0	9	168	1	0.6
6 "	25.5	96.0	1.1	3	68	0	0.0
7 "	23.0	94.0	0.0	0	2	0	0.0
8 "	22.0	95.0	0.0	0	0	0	0.0

Table 32

9th October, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	98.0	45.0	0	0	0	0.0
7 "	22.0	92.5	97.0	102	27	0	0.0
8 "	24.0	88.0	180.0	501	93	0	0.0
9 "	24.5	83.0	200.0	82	88	0	0.0
10 "	26.5	77.0	235.0	135	87	2	2.3
11 "	28.5	68.5	420.0	85	46	2	4.4
12 noon	29.0	78.0	220.0	67	89	0	0.0
1 p.m	30.0	69.0	240.0	115	98	1	1.0
2 "	31.0	69.0	360.0	57	89	1	1.1
3 "	29.5	76.0	182.0	24	74	1	1.4
4 "	28.0	79.0	80.0	34	75	0	0.0
5 "	26.0	92.5	60.0	3	71	0	0.0
6 "	24.5	96.0	1.0	6	71	0	0.0
7 "	24.0	96.0	0.0	2	9	0	0.0
8 "	23.0	97.0	0.0	1	0	0	0.0

Table 33:

24th Octbober, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	97.0	24.0	11	0	0	0.0
7 "	22.0	95.5	61.0	223	53	0	0.0
8 "	23.5	94.0	94.0	300	101	0	0.0
9 "	24.0	90.0	121.0	192	231	3	1.3
10 "	25.0	85.0	170.0	188	200	4	2.0
11 "	25.5	83.5	180.0	251	174	3	1.7
12 noon	28.0	79.5	201.0	266	211	2	0.9
1 p.m	29.0	79.0	224.0	201	215	5	2.3
2 "	27.5	80.0	212.0	156	109	0	0.0
3 "	26.0	84.0	197.0	152	153	3	2.0
4 "	26.0	86.5	91.0	71	100	4	4.0
5 "	25.0	90.0	70.0	54	82	0	0.0
6 "	24.0	94.0	0.9	31	9	0	0.0
7 "	-	-	-	-	-	-	-
8 "	-	-	-	-	-	-	-

N E S T II

Table 34:

5th November, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	100.0	10.0	0	0	0	0.0
7 "	22.0	100.0	30.0	0	0	0	0.0
8 "	24.0	93.0	62.0	3	1	0	0.0
9 "	24.0	91.0	44.0	761	274	0	0.0
10 "	25.0	84.0	52.0	151	101	0	0.0
11 "	27.0	85.0	55.0	107	144	4	2.8
12 noon	28.5	80.0	57.0	145	187	0	0.0
1 p.m	28.0	76.0	46.0	165	184	2	1.1
2 "	29.0	77.0	54.0	139	198	2	1.0
3 "	29.0	83.0	50.0	133	165	2	1.2
4 "	--- R	A I	N E	D-------	O	F F	------
5 "	22.0	96.0	10.0	0	39	0	0.0
6 "	22.0	90.0	0.0	0	0	0	0.0
7 "	22.0	90.0	-	0	0	0	0.0
8 "	21.5	90.0	-	0	1	0	0.0

There was a heavy downpour on the previous night (4th November, 1975). The morning of the 5th was very foggy, making visibility in the cocoa farm rather poor.

Up to 7.35 a.m no ant was seen out of the nest. From then on, however, a number of workers started coming out. These engaged in nest cleaning. No foraging was observed until 8.15a.m The ants recorded at 9.00 a.m. were running very fast.

Table 35:

30th November, 1975

Time	Temp °C	Relative Humidity %	Light Inten. (Lum/ sq.ft)	Ants Leaving Nest	Ants Enter-ing Nest	Food Carr-iers	% Food Carr-iers
6 a.m	20.0	98.0	4.0	0	0	0	0.0
7 "	22.0	98.0	7.0	0	0	0	0.0
8 "	22.0	91.5	34.0	97	12	0	0.0
9 "	23.0	91.0	29.0	53	77	0	0.0
10 "	22.0	91.5	31.0	28	64	0	0.0
11 "	24.0	90.0	49.0	192	108	0	0.0
12 noon	24.0	90.0	50.0	111	115	2	1.7
1 p.m	24.0	90.0	52.0	158	173	2	1.2
2 "	26.0	92.0	47.0	147	178	3	1.7
3 "	24.0	91.0	38.0	218	250	2	0.8
4 "	24.0	92.5	25.0	51	241	4	1.7
5 "	24.0	94.0	7.0	12	168	2	1.2
6 "	23.0	95.0	0	0	0	0	0.0
7 "	23.0	95.0	-	0	0	0	0.0
8 "	22.0	95.0	-	0	0	0	0.0

It rained heavily on the previous evening lasting for about one hour.

Table 36:

3rd December, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	99.0	60	0	0	0	0.0
7 "	22.0	98.0	240	0	0	0	0.0
8 "	22.0	92.0	260	1	5	0	0.0
9 "	23.0	91.0	430	354	63	0	0.0
10 "	24.0	91.0	380	111	104	0	0.0
11 "	26.0	89.0	440	213	176	3	1.7
12 noon	26.0	90.5	480	140	189	6	3.1
1 p.m	28.0	83.0	420	145	190	1	0.5
2 "	28.0	85.0	520	153	153	2	1.3
3 "	27.0	82.0	320	114	162	1	0.6
4 "	24.0	93.0	70	28	383	0	0.0
5 "	23.0	92.0	48	0	10	0	0.0
6 "	23.0	90.0	0	0	0	0	0.0
7 "	23.0	92.0	0	0	0	0	0.0
8 "	22.0	92.0	0	0	0	0	0.0

It rained on the previous day from late in the afternoon to about 9.30 p.m.

Table 37:

16th December, 1975

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/ sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	94.0	8.0	0	0	0	0.0
7 "	22.0	92.0	12.0	0	0	0	0.0
8 "	22.5	90.5	26.0	201	28	0	0.0
9 "	25.0	88.0	39.0	157	93	0	0.0
10 "	26.0	84.0	42.0	77	156	3	1.9
11 "	26.5	83.5	41.0	109	150	1	0.7
12 noon	28.0	75.0	52.0	183	185	1	0.5
1 p.m	29.0	72.5	51.0	187	190	2	1.1
2 "	29.5	74.5	60.0	121	156	2	1.3
3 "	29.0	77.0	58.0	116	173	2	1.3
4 "	28.0	81.5	300.0	162	199	0	0.0
5 "	27.0	93.0	19.0	90	244	0	0.0
6 "	25.0	95.0	0.0	0	3	0	0.0

There has been no rain for the past 13 days. It was misty in the farm between 5.45 a.m and 6.45 a.m A large number of workers crossed the census point around 7.20 a.m.

Table 38:

6th January, 1976

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/ sq.ft)	Ants Leaving Nest	Ants Entering	Food Carriers	% Food Carriers
6 a.m	21.0	96.0	3.0	0	0	0	0.0
7 "	22.0	99.0	8.2	0	0	0	0.0
8 "	24.0	93.0	33.0	342	106	0	0.0
9 "	25.0	92.0	45.0	164	137	0	0.0
10 "	26.0	88.0	58.0	172	199	3	1.5
11 "	28.0	87.0	64.2	171	196	0	0.0
12 noon	28.0	80.0	62.0	195	224	2	0.9
1 p.m	30.0	76.0	60.0	157	203	1	0.5
2 "	29.0	81.0	48.0	149	143	1	0.7
3 "	30.0	78.0	71.0	132	169	3	1.7
4 "	29.0	85.0	60.0	218	173	2	1.2
5 "	27.0	92.0	16.0	105	200	1	0.5
6 "	25.0	92.0	0.2	8	76	0	0.0

Table 39:

14th January, 1976

Time	Temp °C	Relative Humidity %	Light Intens-ity (Lum/sq.ft)	Ants Leav-ing Nest	Ants Enter-ing Nest	Food Carr-iers	% Food Carr-iers
6 a.m	14.0	93.0	0.6	0	0	0	0.0
7 "	15.0	94.5	18.5	0	0	0	0.0
8 "	17.0	92.5	49.0	29	0	0	0.0
9 "	21.0	88.0	43.0	289	92	0	0.0
10 "	24.0	68.0	46.0	151	175	0	0.0
11 "	27.0	47.5	48.0	102	146	0	0.0
12 noon	28.0	39.0	58.0	83	110	0	0.0
1 p.m	29.0	34.5	49.0	69	114	2	1.8
2 "	29.0	34.0	51.5	75	71	0	0.0
3 "	29.0	35.0	74.0	132	83	2	2.4
4 "	28.0	39.5	44.0	81	78	3	3.8
5 "	25.0	81.0	17.0	42	112	0	0.0
6 "	22.0	83.0	0.6	2	50	0	0.0

Severe harmattan conditions, which had started 2 days earlier, still persisted.

Table 40:

9/2/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	19.0	100.0	0.2	0	0	0	0.0
7 "	21.0	100.0	7.0	0	0	0	0.0
8 "	21.0	96.0	19.0	0	0	0	0.0
9 "	22.0	90.0	140.0	21	3	0	0.0
10 "	23.0	88.0	160.0	76	82	1	1.2
11 "	24.0	90.0	130.0	205	205	0	0.0
12 noon	25.0	87.0	170.0	151	188	1	0.5
1 p.m	26.0	86.0	150.0	91	145	4	2.8
2 "	26.0	85.0	150.0	98	106	0	0.0
3 "	28.0	82.0	130.0	117	109	0	0.0
4 "	28.0	83.0	120.0	87	123	0	0.0
5 "	26.0	90.0	41.0	65	122	0	0.0
6 "	25.0	95.0	1.8	5	109	0	0.0

The first rain (heavy and long-lasting, about 5 hrs.) within about 2 months was on the 8th. Drizzling continued on the 9th till about 9.45 a.m.

Table 41:

23/2/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/ sq.ft)	Ants Leaving Nest	Ants Enterning Nest	Food Carriers	% Food Carriers
6 a.m	24.0	98.0	0.5	0	0	0	0.0
7 "	24.0	98.0	23.0	38	24	0	0.0
8 "	25.0	94.0	53.0	144	59	0	0.0
9 "	26.0	91.0	48.0	140	119	1	0.8
10 "	27.0	90.0	68.0	107	104	1	0.9
11 "	29.0	82.0	64.0	137	215	2	0.9
12 noon	30.0	84.0	80.0	113	131	1	0.8
1 p.m	30.0	76.0	56.0	156	123	0	0.0
2 "	32.0	69.0	68.0	110	173	1	0.6
3 "	33.0	70.0	68.0	97	116	0	0.0
4 "	31.0	74.0	44.0	70	98	0	0.0
5 "	30.0	82.0	34.0	150	143	0	0.0
6 "	28.0	93.0	0.6	52	364	0	0.0

Table 42:

9/3/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	21.0	95.0	0.3	0	0	0	0.0
7 "	22.0	94.0	37.0	42	15	0	0.0
8 "	24.0	93.0	65.0	81	183	0	0.0
9 "	25.0	89.0	84.0	159	166	0	0.0
10 "	27.0	82.0	85.0	124	126	1	0.8
11 "	28.0	78.0	78.0	137	154	0	0.0
12 noon	31.0	66.0	140.0	94	120	1	0.8
1 p.m	32.0	57.0	150.0	89	99	0	0.0
2 "	33.0	56.0	275.0	73	97	0	0.0
3 "	33.0	54.0	150.0	121	73	0	0.0
4 "	33.0	53.0	76.0	99	104	0	0.0
5 "	32.0	59.0	57.0	47	111	0	0.0
6 "	30.0	73.0	12.0	23	308	0	0.0

Table 43:

24/3/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/ sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	95.5	0.0	0	0	0	0.0
7 "	23.0	93.5	32.0	0	1	0	0.0
8 "	25.0	91.0	70.0	205	184	0	0.0
9 "	27.0	89.0	65.0	197	251	0	0.0
10 "	29.0	83.5	75.0	124	300	0	0.0
11 "	29.5	79.0	80.0	128	174	0	0.0
12 noon	32.0	69.0	80.0	205	131	0	0.0
1 p.m	33.0	67.0	100.0	80	198	2	1.0
2 "	33.5	64.0	85.0	75	127	2	1.6
3 "	33.0	67.0	80.0	82	120	0	0.0
4 "	34.0	64.0	62.0	68	109	1	0.9
*5 "	31.0	75.0	41.0	18	141	0	0.0
6 "	28.0	73.0	7.5	0	5	0	0.0

* Threats of rain.

Table 44:

7/4/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	25.0	94.0	0.0	0	0	0	0.0
7 "	25.0	92.0	23.0	379	80	0	0.0
8 "	26.0	91.0	45.0	126	152	1	0.7
9 "	27.0	82.0	70.0	160	156	1	0.7
10 "	29.0	82.0	95.0	69	108	0	0.0
11 "	29.0	78.0	70.0	71	83	0	0.0
12 noon	31.0	75.0	110.0	50	97	0	0.0
1 p.m	32.0	72.0	245.0	65	91	0	0.0
2 "	31.0	66.5	80.0	96	50	0	0.0
3 "	33.0	63.5	95.0	65	105	0	0.0
4 "	33.0	67.5	75.0	34	90	0	0.0
5 "	32.0	72.0	60.0	52	101	0	0.0
6 "	29.0	83.0	20.0	0	0	0	0.0

Table 45:

15/4/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	96.0	0.0	0	0	0	0.0
7 "	22.0	91.0	20.0	0	0	0	0.0
8 "	23.0	90.0	60.0	225	97	0	0.0
9 "	25.0	88.0	90.0	198	121	0	0.0
10 "	26.0	89.0	80.0	142	208	1	0.5
11 "	27.0	88.0	99.0	163	161	1	0.6
12 noon	27.0	84.0	60.0	120	182	0	0.0
*1 p.m	26.0	87.0	30.0	8	639	0	0.0
2 "	24.0	85.5	20.0	0	12	0	0.0
3 "	23.0	85.0	36.0	0	5	0	0.0
4 "	23.0	85.0	12.0	0	0	0	0.0
5 "	23.0	86.0	10.0	0	0	0	0.0
6 "	22.0	88.0	0.0	0	0	0	0.0

There was a heavy down pour on the previous evening starting at about 4.30 p.m. and ending around 7.15 p.m.

*Rain was about to start- it actually started almost immediately after the 1.00 p.m. recording. By 2.00 p.m. it was just drizzling.

Table 46:

11/5/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	24.0	94.0	5.0	271	4	0	0.0
7 "	25.0	90.0	30.0	297	75	0	0.0
8 "	26.0	90.0	50.0	283	188	0	0.0
9 "	28.0	83.0	60.0	113	185	1	0.5
10 "	28.0	85.0	40.0	85	156	3	1.9
11 "	28.0	83.0	50.0	138	148	1	0.7
12 noon	31.0	75.0	60.0	213	171	0	0.0
1 p.m.	32.0	68.0	100.0	208	187	0	0.0
2 "	32.0	73.0	45.0	166	147	0	0.0
3 "	33.0	60.0	40.0	194	197	0	0.0
4 "	33.0	67.0	40.0	64	118	0	0.0
5 "	30.0	78.0	20.0	35	113	0	0.0
6 "	28.0	93.0	10.0	9	374	0	0.0

No rain since 15/4/76.

Table 47:

14/5/76

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	24.0	95.0	Out of order	0	0	0	0
7 "	25.0	92.0	" "	106	27	0	0
8 "	26.0	91.5	62.0	80	156	0	0
9 "	28.0	87.0	42.0	219	177	0	0
10 "	28.0	85.5	40.0	181	208	1	0.5
11 "	30.0	79.0	50.0	135	173	0	0
12 noon	30.0	78.0	50.0	117	108	0	0
1 p.m.	26.0	92.5	- R A I N	E D -	45	0	0
2 "	27.0	86.0	30.0	138	276	0	0
3 "	22.0	88.0	-	0	4	0	0
4 "	22.0	87.0	46.1	0	0	0	0
5 "	22.0	90.0	0.2	0	0	0	0
6 "	-	A B A	N D O	N E D -			

The first rain since 15/4/76 was on the 13/3/76, lasting for about 45 minutes.

It started raining at 1.09 p.m. on the 14/5/76, lasting only about 25 minutes.

A second shower started around 2.20 p.m. Activity almost ceased after this second rain.

Table 48:

21st May, 1976

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	23.0	95.0	10.0	0	0	0	0
7 "	24.0	90.0	32.0	0	0	0	0
8 "	25.0	89.0	48.0	203	80	0	0
9 "	26.0	89.0	50.0	134	101	0	0
10 "	27.0	86.0	26.0	133	154	0	0
11 "	30.0	77.0	70.0	84	116	0	0
12 noon	31.0	74.0	60.0	111	162	0	0
1 p.m.	31.0	73.0	66.0	131	196	0	0
2 "	30.0	77.0	50.0	102	107	0	0
3 "	30.0	75.0	65.0	49	109	0	0
4 "	29.0	82.0	30.0	45	298	0	0
5 "	24.0	95.0	20.0	0	243	0	0
6 "	24.0	96.0	0.0	0	68	0	0

Table 49:

1st June, 1976

Time	Temp °C	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	23.0	90.0	6.0	54	0	0	0.0
7 "	25.0	93.0	26.0	419	33	0	0.0
8 "	26.0	90.0	62.0	158	69	0	0.0
9 "	26.0	87.0	40.0	49	126	1	0.8
10 "	27.0	87.0	62.0	97	152	0	0.0
11 "	28.0	77.0	65.0	114	179	0	0.0
12 noon	30.0	73.0	185.0	96	120	0	0.0
1 p.m	31.0	75.0	290.0	133	108	3	1.6
2 "	31.0	70.0	310.0	125	119	5	4.2
3 "	30.0	78.0	45.0	87	67	0	0.0
*4 "	29.0	83.0	13.0	62	568	0	0.0
5 "	26.0	94.0	20.0	7	51	0	0.0
6 "	25.0	93.0	0.5	0	0	0	0.0

The morning of this day was very bright.

* There were threats of rain, the clouds were gathering and a fairly strong wind was blowing.

Table 50:

21st June, 176

Time	Temp ^oC	Relative Humidity %	Light Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	94.0	2.0	409	24	0	0
7 "	23.0	91.0	16.0	469	113	0	0
8 "	24.0	90.0	28.0	131	103	0	0
9 "	25.0	90.0	28.0	100	97	0	0
10 "	25.0	87.0	30.0	94	108	1	0.9
11 "	28.0	84.0	62.0	110	107	2	1.9
12 noon	28.0	81.0	68.0	56	102	1	1.0
1 p.m	29.0	77.0	66.0	169	176	0	0
2 "	28.0	82.0	46.0	101	104	0	0
3 "	28.0	88.0	48.0	129	98	0	0
4 "	29.0	84.0	56.0	108	146	0	0
5 "	28.0	91.0	20.0	87	123	0	0
6 "	----------	RAINED OFF	----------				

Table 51:

5th July, 1976

Time	Temp °C	Relative Humidity %	Light Inten-sity (Lum/sq.ft)	Ants Leav-ing Nest	Ants Enter-ing Nest	Food Carr-iers	% Food Carr-iers
6 a.m	22.0	95.0	0.0	0	0	0	0.0
7 "	22.0	92.0	20.0	572	69	0	0.0
8 "	23.0	90.0	30.0	93	74	0	0.0
9 "	25.0	88.0	50.0	95	89	0	0.0
10 "	25.0	87.0	48.0	107	141	0	0.0
11 "	26.0	83.0	42.0	147	103	1	1.0
12 noon	26.0	80.0	40.0	139	133	1	0.8
1 p.m	26.0	75.0	36.0	111	96	0	0.0
2 "	25.0	81.0	22.0	87	138	1	0.7
3 "	26.0	82.0	52.0	247	261	0	0.0
4 "	25.0	82.0	36.0	134	242	1	0.4
5 "	24.0	86.0	24.0	75	277	0	0.0
6 "	24.0	92.0	18.0	13	446	0	0.0

Table 52:

20th July, 1976

Time	Temp °C	Relative Humidity %	Light Intensity	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	93.0	0.1	61	6	0	0.0
7 "	23.0	95.0	3.0	246	105	0	0.0
8 "	23.0	93.0	5.0	379	167	0	0.0
9 "	24.0	90.0	22.0	358	185	1	0.5
10 "	25.0	88.0	24.0	187	216	1	0.5
11 "	26.0	84.0	20.0	175	202	2	1.0
12 noon	26.0	84.0	5.0	193	184	1	0.5
1 p.m.	26.0	83.0	24.0	218	256	2	0.8
2 "	27.0	85.0	30.0	185	201	0	0.0
3 "	27.0	82.0	28.0	337	280	3	1.1
4 "	27.0	87.0	15.0	244	215	2	0.9
5 "	25.0	93.0	1.0	87	395	0	0.0
6 "	24.0	93.0	0.6	45	387	0	0.0

Table 53:

14th August, 1976

Time	Temp °C	Relative Humidity %	Light* Intensity (Lum/sq.ft)	Ants Leaving Nest	Ants Entering Nest	Food Carriers	% Food Carriers
6 a.m	22.0	95	-	0	0	0	0.0
7 "	23.0	93	-	361	28	0	0.0
8 "	24.0	91	-	202	74	0	0.0
9 "	25.0	91	-	218	63	0	0.0
10 "	27.0	91	-	262	94	0	0.0
11 "	27.0	88	-	158	103	2	1.9
12 noon	28.0	87	-	146	129	0	0.0
1 p.m	28.0	83	-	103	185	1	0.5
2 "	29.0	80	-	118	164	1	0.6
3 "	30.0	80	-	142	196	3	1.5
4 "	30.0	82	-	169	291	0	0.0
5 "	28.0	87	-	105	384	0	0.0
6 "	26.0	92	-	31	122	0	0.0

*The Light meter had broken down

Table 54: Correlation between Headsize and food size

Food Carrier		Food Measurement		XY_1	XY_2
X (HW)	HL	Y_1 Food width	Y_2 Food length		
2.00	1.40	1.00	1.30	2.00	2.60
2.40	1.95	1.10	2.80	2.64	6.72
1.95	1.65	2.00	3.40	3.90	6.63
2.00	1.65	0.60	0.80	1.20	1.60
2.00	1.65	1.95	2.25	3.90	4.50
1.85	1.55	2.65	3.10	4.90	5.74
1.90	1.60	1.15	2.05	2.19	3.90
2.00	1.65	1.05	2.00	2.10	4.00
2.00	1.65	0.85	1.40	1.70	2.80
2.05	1.75	0.80	3.50	1.64	7.18
2.05	1.75	1.00	1.95	2.05	4.00
1.90	1.65	0.90	11.65	1.71	22.14
2.00	1.65	1.90	2.35	3.80	4.70
2.00	1.65	1.25	1.65	2.50	3.30
2.35	1.90	0.55	2.35	1.29	5.52
2.10	1.70	0.66	6.35	1.39	13.34
2.05	1.70	2.50	6.50	5.13	13.22
2.10	1.70	0.70	11.05	1.47	23.21
2.05	1.70	0.35	1.10	0.72	2.26
2.10	1.75	1.05	2.50	2.21	5.25
2.00	1.65	1.35	2.75	2.70	5.50
2.15	1.80	0.85	2.85	1.83	6.13
2.15	1.75	2.05	11.70	4.41	25.16
2.00	1.70	1.10	1.90	2.31	3.99
2.10	1.75	2.00	2.60	4.20	5.46
2.10	1.70	1.25	4.25	2.63	8.93
2.00	1.60	0.95	1.75	1.90	3.50
2.05	1.70	0.30	1.65	0.62	3.38
2.15	1.75	1.10	2.45	2.37	5.27
2.00	1.60	0.26	2.00	0.52	4.00
2.15	1.75	0.40	2.30	0.86	4.95
2.10	1.70	1.40	3.50	2.94	7.35
1.90	1.60	0.30	1.75	0.57	3.33
2.05	1.70	1.00	1.55	2.05	3.18
2.10	1.80	1.25	2.15	2.63	4.52
2.00	1.60	0.40	1.70	0.80	3.40
2.00	1.70	1.85	2.90	3.70	5.80
2.05	1.70	0.60	1.00	1.23	2.05
2.10	1.75	0.95	1.70	2.00	3.57
2.05	1.70	1.10	1.60	2.26	3.28
2.10	1.70	1.50	3.70	3.15	7.77

Table 54: (cont'd)

	Food Carrier		Food Measurement		NY_1	NY_2
	X (HW)	HL	Y_1 Food width	Y_2 Food length		
	2.00	1.65	1.00	2.80	2.00	5.60
	2.10	1.70	1.00	2.50	2.10	5.25
	2.10	1.70	0.90	2.15	1.89	4.52
	2.00	1.65	1.85	3.00	3.70	6.00
	2.10	1.70	0.85	1.25	1.79	2.63
	2.15	1.75	0.80	1.50	1.72	3.26
	2.10	1.70	1.10	3.40	2.31	7.14
	2.10	1.75	1.15	2.00	2.42	4.20
	2.05	1.70	1.00	3.50	2.05	7.18
	2.15	1.80	0.80	2.75	1.72	5.91
	1.85	1.55	0.75	1.05	1.39	1.94
	2.05	1.70	0.75	2.50	1.54	5.13
	2.05	1.75	0.75	1.45	1.54	2.97
	2.05	1.70	1.85	2.50	3.79	5.13
	2.15	1.80	0.70	0.95	1.51	2.04
	2.15	1.80	0.60	1.95	1.29	4.19
	2.20	1.80	1.15	3.75	2.53	8.25
	2.00	1.60	0.85	3.60	1.70	7.20
	2.10	1.75	0.75	2.15	1.58	4.52
Total	123.70	101.90	64.57	172.50	132.69	356.19
Mean	2.06	1.70	1.08	2.88		
Sum of squares	255.25	173.48	86.07	798.41		

$r(XY_1) = -0.23$, $r(XY_2) = +0.07$