FORAGING ACTIVITY OF THE SUBTERRANEAN TERMITE, *Anacanthotermes ochraceus* (Burmeister) (ISOPTERA : HODOTERMITIDAE) AT El-FAYOUM GOVERNORATE, EGYPT

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ABSTRACT:

The foraging activity of the subterranean termite, *Anacanthotermes ochraceus* (Burmeister) (Isoptera: Hodotermitidae) was studied at El-Saidia village, Sennoures district, El-Fayoum Governorate, Egypt, throughout the two successive years 1997 and 1998 using perforated Polyvinyl chloride (P.V.C.) traps filled with corrugated cardboard paper then buried into the soil to a depth of 30 cm. Traps were replaced with new ones at monthly intervals. Parameters used for assessing foraging activity are % visited traps, number of workers, food consumption and soil translocation (construction activity).The percentage of visited traps ranged 0-34% in 1997 and 15-57 in 1998. The highest percentages of visited traps were recorded during July – October while relatively less percentages occurred between January and June. The vast majority of the foragers (98%) were workers but their numbers were not regarded as a reliable parameter for measuring foraging activity. Food consumption was relatively low during winter, more or less moderate during both spring and autumn and relatively high throughout summer with two distinct peaks; one in March – May and the other in September. Soil translocation increased progressively between January and September then tended to decline between October and December. Two peaks of soil translocation occurred; the first in May and the second in September. The relative efficiency of the four above-mentioned foraging activity parameters was discussed. Soil translocation seemed to be the most reliable quantitative parameter for the assessment of the foraging activity of the termite species under investigation.

Key words: Termite; *Anacanthotermes ochraceus*; Foraging activity.

INTRODUCTION:

Termites are a group of social insects that belong to the order Isoptera. They are important pests in many countries particularly in the arid tropics and subtropics **(Emerson, 1955 and Harris, 1961 & 1967).** Termites are differentiated into various morphological forms or castes that live in highly organized societies or colonies **(Ahmed, 1997; Rizk and Salman, 1984 and El-Bassyoni, 2001). Snyder (1949), Coaton (1958), Kassab *et al*. (1960) and Hafez (1980)** reported that there are – at least- 11 species of termites in Egypt among which eight species are "ground-nesting" or "subterranean" and three species are "dry-wood" or "non-subterranean".

One of the predominant subterranean termites in Egypt is *Anacanthotermes ochraceus* (Burmeister) from the family Hodotermitidae. According to **Kassab *et al*. (1960), Kaschef and El-Sherif (1971) and Said**

(1979), *A. ochraceus* is the most common termite species in Egypt (Menoufieh, Sharkia, Qalioubieh, Kafr El-Sheikh, Beheira, Ismailia, Giza, Matrurh, El Fayoum and Sinai Governorates in addition to Dakhla and Kharga oases. In seeking for food and/or shelter, termites usually damage not only wood and wood products but also any cellulose-containing materials such as paper, books, cartons and fabrics in addition to a variety of inorganic materials which can neither be digested nor used like buried electric power cables, railroad signal systems and telephone or telegraph communication circuits **(Harris, 1961 and Spears, 1970).**

In Egypt, *A. ochraceus* causes considerable damage to rural buildings constructed with mud bricks as workers tunnel through the walls to reach the straw mixed with the sun-dried mud thus resulting in the collapse of attacked buildings. **Ahmed (1997)** estimated that the value of the total damage caused by *A. ochraceus* at El-Fayoum Governorate exceeded five million Egyptian pounds. In an effort to contribute to the knowledge on the subterranean termite *A. ochraceus* at El-Fayoum Governorate the present investigation was aimed. It concentrated, therefore, on a study of the termite's foraging activity in a badly infested area throughout two successive years and the relative efficacy of different parameters used for the assessment of foraging activity.

MATERIALS AND METHODS:

The study of the foraging activity of the subterranean termite *A. ochraceus* was carried out throughout two successive years extending from the 1st of January 1997 until the 31st of December 1998 at El-Saidia village, Sennoures district, El-Fayoum Governorate, Egypt. This particular village is commonly known to be severely infested with *A. ochraceus* and no termite control measures are practiced in it as well. **Brain (1978)** stated that the most widely used method for studying the feeding habits of subterranean termites is the use of baits which are either presented on soil surface or completely or partially buried. **La Fage *et al.* (1973)** used toilet paper roll baits to estimate the food consumption and foraging intensity of subterranean termites. Several scientists recommended using toilet paper or corrugated cardboard baited traps for the study of the foraging activity of subterranean termites (*e.g.* **El-Sebay, 1991 and 1993; Crawford and Seely, 1994 and Ahmed, 1997).**

An experimental area of 400 square meters (20 meters long x 20 meters wide) was chosen for the study and carefully cleaned up –as far as possible- of any existing weeds or cellulose materials. This area was divided into 100 square-shaped plots (10 rows by 10 columns) each measuring 4 square meters (2 meters long x 2 meters wide). A termite trap was buried in a horizontal position to the depth of 30 cm. into a hole at the center point of every experimental plot on the 1st of January, 1997 then covered with soil to ground level. Trap locations were marked with small red plastic flags (2meters apart from each other from all directions). Buried traps were replaced with new ones on the 1st day of each of the next 23 months until the last replacement was made on the 1st of December, 1998.

Every trap consisted of a perforated P.V.C. cylinder (15cm. in diameter and 20 cm. in height) totally filled up with a clean roll of corrugated cardboard paper and covered from both open ends with polyethylene sheets of suitable size fitted to the outside wall of the cylinder with rubber bands. Before introducing the cardboard rolls into the cylinders the formers were dried at 105°C. for 24 h in an

electric oven and weighed then soaked in water until saturation. Traps were buried into the soil at the formerly designated locations marked with the red flags. As a monthly routine, buried traps were carefully taken off the soil with the aid of a shovel and replaced with new ones. **Su *et al.* (1991) and Ahmed (1997)** reported that corrugated cardboard is quite suitable for the nutritive requirements of termites as it provides them with cellulose, enough moisture and a site similar to the natural tunnels where the different castes live.

Traps removed from the soil were treated as follows: a) every trap was introduced into a separate plastic bag and transferred to the laboratory for thorough examination. There, the cardboard roll (or its remnants) was/were carefully taken off the P.V.C. cylinder and examined for termite damage to determine the percentage of traps visited by the termite species under investigation, b) cardboard rolls showing symptoms of termite visit were gently and patiently unrolled, the termite individuals existing in them were separated with the aid of a fine camel-hair brush, classified into different castes (nymphs, soldiers, workers and alates) and counted to determine caste composition, c) soil particles sticking to cardboard rolls (translocated soil) were gently removed by hand then separately collected in aluminum trays of suitable size, d) after the separation of soil particles cardboard-roll remnants were also separately collected in similar aluminum trays e) trays containing soil or cardboard remnants were dried at 105˚C. for 24 h in an electric oven then weighed. Obtained dry weights represented "soil translocation" **(Collins and Nutting, 1973 and Said, 1979),** and the total weight of consumed food material was used as an index for termite foraging activity **(La Fage *et al.*, 1973).** Food consumption was calculated by applying the following formula:

FC (food consumption) ={CB (cardboard before) –CA (cardboard after) }

where:

FC=Food consumption (in grams).

CB= Dry weight of cardboard roll before burying the trap into the soil (in grams).

CA= Dry weight of cardboard remnants (after removing translocated soil and termite castes) (in grams).

Table (1) shows the physical and chemical characteristics of the soil at the experimental location before the commencement of the investigation. Soil analyses were made at the Institute of Water and Soil Research, ARC, MOA, Giza, Egypt.

Table 1: Type and physiochemical characteristics of the soil at the experimental location.

Tex-ture class	**Mechanical analysis %**			**Chemical analysis**							
				Soluble cations meq./L				**Soluble anions meq./L**			
	sand	**silt**	**clay**	**Ca++**	**Mg++**	**Na+**	**K+**	**CO3-**	**HCO3-**	**Cl –**	**SO4-**
Clay	17.2	34.5	48.3	36.75	9.71	180.8	1.25	0.0	1.94	141.36	85.2

CaCO3% 6.0 **pH** 8.1 **Ec mem/cm** 15.3 **OM%** 1.3

RESULTS:

The monthly and seasonal means of percentage of visited traps, number of captured *A. ochraceus* workers / 100 traps and foraging activity parameters [food

consumption (in g/trap) and soil translocation (in g/trap)] at the study location throughout the two successive years 1997 and 1998 are shown in Table (2) .

1-% Visited traps:

The percentage of visited traps was generally lower in 1997 (0 – 34%) than in 1998 (15- 57%). In 1997, 0 – 11% of the traps were visited in winter, 19-28 % were visited in spring, 31-34 % were visited in summer and 15-31% were visited in autumn.

The corresponding respective percentages of visited traps in 1998 were 15-23%, 17-20%, 42-57% and 28-33%. Based on the seasonal means of the percentage of infested traps, the termite species under investigation foraged almost all the year round but its foraging activity was obviously greater during both summer (seasonal means of 32.67-47.00% visited traps) and autumn (seasonal means of 22.67 – 29.67 % visited traps). Foraging activity tended to decline during winter (seasonal means of 5.00 – 22.33%) and was relatively slightly greater during spring (seasonal means of 22.67-18.67 %). Therefore, for both years of investigation 1997 and 1998, respectively. The highest percentages of visited traps were recorded during July – October, relatively less percentages occurred between January and June and intermediate percentages of visited traps took place during November and December.

2- Caste composition:

In nature**,** the termite colony consists of six different castes. These are larvae, workers, soldiers, nymphs, primary reproductives (winged or unwinged alates) and supplementary reproductives (neotenics). Detailed morphological descriptions of these castes are given by **Harris (1961), El-Sherif and Kaschef (1973) and Abd El-Latif (2003).** Throughout the whole period of the current investigation (January,1997 – December, 1998), the total number of *A. ochraceus* individuals collected from the unrolled corrugated cardboard rolls filling 2400 P.V.C. traps (100 traps/ month x 24 months) was 8763. of these 8551 (97.6%) were workers, 158 (1.8%) were larvae, 38 (0.4%) were nymphs and 17 (0.2%) were soldiers, while no primary or supplementary reproductives could be traced. These numbers and corresponding percentages emphasize the fact that the vast majority of the foragers of the considered termite species consisted of workers only. In coincidence with such finding, **Nutting (1970)** stated that the cast composition of the termite *Heterotermes aureus* includes 4% soldiers and 96% non-soldiers. **Nutting *et al.* (1973)** mentioned that the foragers of the termite *Gnathamitermes preplexus* are mainly workers with only 0.4% soldiers. **Wood (1978)** added that the food supplies of termite colonies are collected by workers which feed themselves as well as the dependent castes. **Fontana *et al*. (1982)** further added that the cast composition of *Reticultitermes lucifugus* in Tuscany, Italy, consisted of 85.76% workers, 8,8% larvae, 1,3% soldiers and 0.23% supplementary reproductives. **Ahmed (1997)** contributed that the average percentages of *A. ochraceus* castes at El-Fayoum Governorate were 66.5-77.1%, 21.7-32.4%, 0.2-0.7% and 0.4–0.9% for workers, nymphs, soldiers and alates, respectively.

Table 2: Monthly and seasonal means of % visited traps, number of captured workers and foraging activity parameters in two successive years.

Year	Season	Month	% visited traps	No. of captured workers /100 traps	Foraging activity	
					Food consumption g/trap	Soil translocation g/trap
1997	Winter	January	4	265	1.85	12.35
		February	0	0	0.0	0.0
		March	11	694	7.54	46.26
		Mean	**5.00**	**319.7**	**3.13**	**19.54**
	Spring	April	21	305	21.98	146.84
		May	28	0	30.71	216.07
		June	19	0	19.65	133.17
		Mean	**22.67**	**101.7**	**24.11**	**165.36**
	Summer	July	31	0	32.60	246.61
		August	34	0	33.84	274.29
		September	33	0	31.91	281.90
		Mean	**32.67**	**0.0**	**32.79**	**267.60**
	Autumn	October	31	0	26.24	194.46
		November	15	695	16.38	106.44
		December	22	982	10.43	47.67
		Mean	**22.67**	**559.0**	**17.68**	**116.19**
	Total		-	2941	233.13	1706.06
1998	Winter	January	15	1148	10.49	67.48
		February	19	1304	11.76	53.44
		March	23	298	15.33	114.34
		Mean	**22.33**	**915.7**	**12.53**	**78.42**
	Spring	April	19	284	12.66	100.22
		May	20	0	13.43	117.72
		June	17	0	11.54	93.38
		Mean	**18.67**	**94.7**	**12.54**	**103.77**
	Summer	July	42	0	29.19	312.78
		August	42	0	29.75	231.99
		September	57	0	37.64	383.93
		Mean	**47.00**	**0.0**	**32.19**	**309.57**
	Autumn	October	28	366	18.58	195.38
		November	28	494	19.53	150.88
		December	33	1716	18.63	117.10
		Mean	**29.67**	**858.7**	**18.91**	**154.45**
	Total		-	5610	228.53	1938.64

3-Number of captured workers:

According to the above-mentioned fact that the vast majority of the trapped individuals of *A. ochraceus* were workers, the discussion of the population changes of this particular species throughout the two years of investigation is founded on the numbers of captured workers shown in Table(2). In 1997, the number of captured workers /100 traps was 265, 694 and 305 during January, March and April, respectively, while no workers were trapped during February as well as from May until October. Workers appeared again during November and December (695 and 982 /100 traps, respectively). In 1998, the

pattern of workers' population was more or less similar to that of the previous year, although it tended to be generally higher (a total catch of 2941 workers in 1997 compared to a total catch of 5610 workers in 1998). In January and February workers population recorded 1148 and 1304/ 100 traps, respectively, then declined to 298/ 100 traps during March. Workers entirely disappeared from the traps from May until September then they were recaptured throughout autumn with counts of 366/100 traps in October, 494/!00 traps in November and 1716/ 100 traps in December.

Table (2) reveals the observation that the workers of *A. ochraceus* quit visiting P.V.C. corrugated cardboard traps between mid- spring and early autumn (May- October in 1997 and May- September in 1998) but successfully invaded and inhabited them from mid-autumn until early spring (January –April,1997, November, 1997 – April, 1998 and October – December 1998). In more or less agreement with this observation, **Ahmed (1997)** stated that the maximum catch of *A. ochraceus* workers in P.V.C. traps in Egypt occurred in March and April while no catch was observed in June. Apparently, cardboard rolls were preferred as suitable living sites that provided enough cellulose, sufficient moisture and an appropriate shelter nearly similar to natural termite tunnels throughout the period of high workers' population (October - April). During the period with no workers catches (May – October), traps were also definitely invaded with workers which totally consumed the filling cardboard rolls (as small fragments) and entirely replaced them with translocated soil. Cardboard fragments were transferred to the storage chambers in workers nest(s). Consequently, the number of workers captured in P.V.C. cardboard traps cannot be regarded as a reliable parameter for measuring the foraging activity of termites.

4-Food consumption:

Food consumption is the actual dry weight of consumed corrugated cardboard paper / trap in grams **(Abd El-Latif, 2003).** Table (2) indicates that in 1997 food consumption was low in winter and increased to a 1st peak of about 31 g /trap in May. This peak was followed by a slight decrease in June then food consumption remained more or less constant at a 2nd peak level of about 32-34 g / trap during summer (July – September). Food consumption decreased gradually thereafter to about 10 g /trap by the end of autumn. In 1998, food consumption was generally low during both winter and spring (about 11-15 g /trap), with a small 1st peak of 15 g/trap in March, then increased progressively during summer until it reached a 2nd high peak of about 38 g / trap in September after which it declined to about 19 g /trap throughout autumn months. These results refer that although the total annual foraging activity of *A. ochraceus* was almost constant (about 233 and 229 g /trap in 1997 and 1998, respectively) it varied markedly from one month to another as well as from one season to the other. Generally speaking, foraging activity, as represented by food consumption, was relatively low during winter, more or less moderate during both spring an autumn and relatively high throughout summer with two distinct peaks; one in March-May and the other in September.

5- Soil translocation (= construction activity):

Soil translocation (construction activity) is the actual dry weight of translocated soil/ trap **(Abd El-Latif, 2003).** For both years of investigation, the

changes in soil translocation were almost similar to those previously described for food consumption. Table (2) shows that soil translocation increased progressively between January and September (from about 12 - 68 g / trap by early winter to about 282 – 384 g / trap by late summer) then tended to decline gradually during autumn between October and December (from about 195 g / trap to about 48 – 117 g / trap). In both 1997 and 1998, the maximum seasonal means of soil translocation took place during summer (about 268–310 g/trap) and the minimum seasonal means of soil translocation occurred during winter (about 20 -78 g /trap). As in the case of food consumption, two peaks of soil translocation were observed; the first in May (about 216 –118 g / trap) and the second in September (about 282 – 384 g /trap). In spite that the rate of soil translocation was relatively higher in 1998 (about 1939 g /trap) than in 1997 (about 1706 g /trap) the changes in soil translocation for both years of investigation were positively correlated to changes in food consumption. **Collins and Nutting (1973)** stated that the workers of *A. ochraceus* exchange a load of soil for a bit of food material. In agreement with the current findings, **Said (1979)** found that in Egypt the foraging activity of *A. ochraceus* is minimal between mid-December and early April and maximal in the summer months of July, August and September.

DISCUSSION:

Different parameters are used for assessing the foraging activity of termites. These parameters depend on using either wood baits or traps baited with toilet paper or corrugated cardboard paper. Wood baits **(Brain, 1978; Wood, 1978; Su and Scheffrahn, 1986; Su *et al*., 1991 and Sajap, 1999)** are usually used for non-subterranean (wood) termites while toilet paper traps **(La Fage *et al*., 1973)** and corrugated cardboard traps **(El-Sebay, 1991; Said,1979; Ahmed,1997 and Abd El-Latif, 2003)** are often used for the subterranean termite species. Paper baited traps are usually buried in the soil to a suitable depth then examined periodically for termite damage symptoms **(Abd El-Latif, 2003).** As a matter of fact, the revision of the available literature failed to trace any previous comparison between the different parameters used for assessing the foraging activity of subterranean termites. This paper tries, therefore, to evaluate the relative efficiency of four different parameters commonly used for assessing the foraging activity of the subterranean termite, *A. ochraceus* (% visited traps, number of workers captured in cardboard traps, food consumption and soil translocation or construction activity) at El-Fayoum Governorate, Egypt.

The simplest, easiest and least tedious parameter to assess the foraging activity of a subterranean termite is to determine the percentage of visited traps which show termite damage. This percentage is positively proportional to foraging activity. In other words, increase of the percentage of visited traps refers to increased foraging. Generally speaking, this parameter may be regarded as a suitable tool for establishing preliminary quantitative ideas about the rate of foraging at a certain time, and the changes in foraging activity from time to time, but it does not reflect accumulated foraging throughout a long period of time.

A second relatively more laborious parameter is the determination of the number of termite workers found in the unrolled cardboard rolls collected from the traps buried into the soil for a certain period of time **(Nutting, 1970; Nutting *et al.*, 1973; King and Spink, 1974 and Fontana *et al*.,1982)** .From the practical

point of view, it is not recommended to rely on the number of workers as an indicator for foraging activity all the year round. As seen in Table (2), workers feed on cardboard fragments and remain encountered inside the rolls during the season of low foraging activity (November to April) only. In such a case, the number of workers reflects – to some extent – foraging activity quantitatively. Throughout the season of high foraging activity (May to October) on the other hand, it is absolutely impractical to assess foraging depending on the number of workers as they totally consume the filling cardboard rolls, entirely replace them with translocated soil, and hide thereafter in their nests away from the buried cardboard rolls.

A considerably more acceptable quantitative third parameter is food consumption, which is defined as "the actual dry weight of consumed corrugated cardboard/trap in grams" **(Abd El-Latif, 2003).** In fact, this parameter is often positively proportional to foraging activity as long as there are remnants of the cardboard rolls in the traps, but after the consumption of the whole cardboard rolls filling the traps the reliability of this parameter renders uncertain. Subterranean termite workers usually exchange a load of soil for a bit of food material **(Collins and Nutting, 1973)** and, thus, when there is no food material soil translocation stops and, consequently, foraging workers move to another locations where a suitable food source is available .In such a particular case, a portion of the foraging activity cannot be traced. Nevertheless, several authors assessed the foraging activity of different species of subterranean termites depending on the food consumption parameter **(Nel and Hewitt, 1969; Nel, 1970; Brain, 1978; Ali *et al*., 1982; Crawford and Seely, 1994; Ahmed, 1997; El-Bassyoni, 2001 and Abd El-Latif, 2003).**

Apparently, the most precise and more quantitatively accurate parameter for the assessment of termite foraging activity is soil translocation (the fourth parameter). This parameter is defined as "the actual dry weight of translocated soil/ trap" **(Abd-El-Latif, 2003).** As in the case of food consumption, there is always a positive correlation between soil translocation and foraging activity. Soil translocation reflects foraging activity as long as there are remnants of the cardboard rolls in the traps. If traps become totally filled up with translocated soil before scheduled exchange timing it is recommended to replace the filling cardboard rolls with new ones to continue following up foraging activity. **Said (1979), Ahmed (1997) and Abd El-Latif (2003)** contributed to the knowledge on the foraging activity of the subterranean termite *A. ochraceus* depending on soil translocation studies.

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نشاط الرعى لنوع النمل الأبيض التحت أرضى *Anacanthotermes ochraceus* (Burmeister) من عائلة Hodotermitidae ورتبة متساوية الأجنحة Order Isoptera

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درس نشاط الرعى لنوع النمل الأبيض (Burmeister) *Anacanthotermes ochraceus* من عائلة Hodotermitidae ورتبة متساوية الأجنحة بقرية السعيدية بمركز سنورس بمحافظة الفيوم خلال العامين المتتاليين ١٩٩٧ و ١٩٩٨ بإستعمال مصائد بلاستيكية مثقبة محشوة بورق الكرتون المضلع ومدفونه فى التربة لعمق ٣٠ سم تم تغييرها بمصائد جديدة دوريا مرة كل شهر. وإستخدمت لتقدير نشاط الرعى أربعة معايير مختلفة هى النسبة المئوية للمصائد التى زارها النمل الأبيض، وعدد الشغالات، والإستهلاك الغذائى، وكمية التربة المنقولة. تراوحت النسبة المئوية للمصائد التى زارها النمل الأبيض بين صفر و٣٤% عام ١٩٩٧ وبين ١٥ و٥٧% عام ١٩٩٨، وسجلت أعلى النسب المئوية للمصائد التى زارها النمل الأبيض فى الفترة من يوليو الى أكتوبر بينما كانت تلك النسب المئوية أقل نسبيا خلال الفترة من يناير حتى يونيو. كانت الغالبية العظمى لأفراد النمل الأبيض التى وجدت فى المصائد (٩٨%) عبارة عن شغالات، إلا أنه لم يؤخذ بأعداد الشغالات كمعيار لتقدير نشاط الرعى لقلة الاعتماد عليه. كان الاستهلاك الغذائي منخفضا نسبيا خلال فصل الشتاء، و متوسطا نسبيا خلال فصلى الربيع والخريف، وعاليا نسبيا خلال فصل الصيف مع ظهور قمتين واضحتين للإستهلاك الغذائى الأولى خلال الفترة من مارس إلى مايو والثانية خلال شهر سبتمبر. أما كمية التربة المنقولة الى المصائد فقد تزايدت بإضطراد خلال الفترة من يناير حتى سبتمبر ثم مالت الى الإنخفاض بعد ذلك بين أكتوبر وديسمبر. وقد سجلت قمتان واضحتان لوزن التربة المنقولة إلى المصائد أولاهما خلال شهر مايو والثانية خلال شهر سبتمبر. وأظهرت المفاضلة بين معايير تقدير نشاط الرعى الأربعة سابقة الذكر أن وزن التربة المنقولة هو أكثر تلك المعايير إعتمادية.