SOME STUDIES ON THE SWARMING BEHAVIOUR OF IMAGO CASTE OF *MICROCEROTERMES CHAMPIONI* (SNYDER) (ISOPTERA: TERMITIDAE)

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ABSTRACT: Swarming behaviour of *M. championi* was observed during the swarming season of 1997 and 1998. Swarming took place on 16 nights out of the 92 nights for which observations were made. Swarming started after second rainfall of the season, which created suitable combination of relative humidity and temperature required for swarming. Peak emergence of alate was observed after heavy rainfall (44.0 mm) of short duration at 22.1±°C to 36.5±°C with 80% to 84% relative humidity. Frequency of swarming was maximum between 8.00 pm to 8.30 pm. Overall sex ratio of *M. championi* indicates that females predominate over males 3:1 (F:M).

Key words: Humidity, Imagoes, Temperature, *M. championi,* Swarming

INTRODUCTION

The swarming period provides the only occasion when observations can be made undisturbed on many species of termites (Nutting, 1966). Mitchell (2008) studied swarming in *Macrotermes natalensis* (Haviland) and described that dispersal flights of termites are the result of sum of a number of complex and highly orchestrated behavioural responses by different castes to a variety of cues. Few studies are available on swarming of termites in Pakistan. Particularly, the information regarding flight period in relation to temperature, humidity condition and rainfall is lacking. Afzal (1981) described swarming pattern of *Bifiditermes beesoni* in field and under laboratory condition. Akhtar (1978) observed swarming of termites in Pakistan from June to mid September. Akhtar and Amanullah (1989) studied swarming of termites on specified plot in New Campus area, Lahore, Pakistan and recorded 25 swarms of four species of termites, *Coptotermes heimi*, *Microtermes unicolor*, *Microtermes obesi* and *Eremotermes paradoxalis*. Akhtar and Shahid (1990) reported the swarming of termites in Lahore, Pakistan, and noted that swarming started after second heavy rainfall of summer season in different parts of the world however, lot of work is available on swarming pattern of termites (Sands, 1965; Nutting, 1966; Josens, 1972; Leong *et al*., 1983). Nutting (1966) reported colonized flights of damp wood termite *Paraneotermes simplicicorns* in South Arizona, and reported that flight begins at 23°C weekly mean temperature and 60.8% relative humidity. According to Leong *et al*. (1983) the key microenvironmental factor regulating the flight was wind velocity. In *Coptotermes formosanus* flight was initiated if wind velocity was below 3.7 km/h. If the wind velocity increased to over 3.7 km/h after flight was started, the flights were terminated.

In the present study, effect of various environmental factors regulating the swarming pattern of *M. championi* in a specified plot in Lahore is reported.

MATERIALS AND METHODS

Two plots 100 x 100 meter were selected in the New Campus area adjoining Botanical Garden and Wagha Border. For collection of swarming termites, a light trap of 200 watt was installed in specified plots and was posted 3.5 feet high from the ground. Each day from June 1, 1997/98 to August 31, 1997/98, observations for the collection of swarming alates, irrespective of rainfall were made from sunset till 11:00 PM at night. Number of alates collected at light trap during every 30 minute were kept separate to know the time of peak emergence of alates of *M. championi.* Besides, daily account of environmental factors i.e., rainfall, atmospheric temperature, relative humidity etc., was also kept to see their effect on swarming. The data pertaining to environmental factors was obtained from the regional Meteorological Centre, Lahore.

Imagoes, collected both manually and with the container, from the light trap were preserved in 80% alcohol for further studies in the laboratory. Imagoes were sexed on the basis of width of seventh sternum, which is broader in females. than in males. Besides sexual dimorphism present, in which females are slightly elongated than males. Data regarding production of alates in relation to environmental conditions were analyzed for correlation coefficient

RESULTS AND DISCUSSION

During 1997, flights of *M. championi* around the specified plot were recorded on only sixteen out of ninety-two nights for which observations were made. A total of 16 swarms of *M. championi* were observed. Basic data regarding the number of alates collected on different dates and times along with environmental factors is indicated in Table 1. During 1997, the first swarming took place on June 7, 1997 at 38.0°C atmospheric temperature and 70% relative humidity. Before the initiation of swarming, two sporadic rains of light intensity occurred in the area and resulted in increase in atmospheric humidity. Maximum number of alates (110) and (115) were collected on two occasions on July 5, 1997 and July 20, 1997 at 34.8±°C and 34.4±°C atmospheric temperatures and 84% relative humidity. A total of 1002 alates were collected during the swarming season of 1997. The swarming dates in relation to maximum atmospheric temperatures during 1997 (data from Meteorological Department) are indicated in (Table 1)

The swarming behaviour of *M. championi* was also studied for 1998. The first swarming was observed on June 3, 1998 at 42.9±°C atmospheric temperature and 50% relative humidity after second rainfall. The swarming period lasted from June 3, 1998 to August 26, 1998. During the period 2211 alates were collected (Table II).contrary to 1997, the number of swarming individual during August 1998 was higher than that of 1997. This was most probably because of more rains during 1998 as compared to 1997. The data regarding the number of alates collected at different times and dates along with environmental factors is given in Table 1 &II. During the study period of 1997, a total of 1002 alates of *M. championi* were collected, and atmospheric temperature ranged from 32.0±°C to 38.8±°C, soil temperature from 30.4±°C to 46.6±°C. Whereas during 1998, atmospheric temperature ranged from 23.4±°C to 42.9±°C and soil temperature from 29.6±°C to 43.8±°C. Maximum swarming of the species took place on July 20, 1997 at 84% relative humidity when there was a heavy rainfall (58.2 mm) and atmospheric temperature 34.4±°C. During 1998 maximum swarming of *M. championi* was witnessed on July 19, at 80.0% relative humidity, 44.0 mm rainfall and 36.5±°C atmospheric temperature Record of different environmental factors (atmospheric temperature, soil temperature, relative humidity and rainfall) that would be interacting with the swarming of *M. championi* was also kept. The swarming behaviour of *M. championi* in relation to these factors was discussed.

During the study period of 1997, a total of 1002 alates of *M. championi* were collected. During the swarming period atmospheric temperature ranged from 32.0±°C to 38.8±°C but soil temperature ranged from 30.4±°C to 46.6±°C. Coefficient of correlation between number of alates collected at different atmospheric temperatures was positive but non-significant ($r = 0.419$; d.f. 14; $P>0.05$). The correlation value of number of alates at different soil temperature was also positive and significant ($r = 0.385$; d.f. 14; $P<0.05$). The correlation between number of alates and relative humidity was positive but non-significant ($r = 0.491$; d.f. 14; $P>0.05$). The data show that higher relative humidity favours swarming of *M. championi*. (Table 1)

When the emergence of alates per week was considered, it was maximum during the first, second and third week of July 1997 and later on, in the last week of August 1997 very poor swarming was recorded. This was because of the fact that the area did not receive any rainfall after July 20, 1997 and consequently a critical combination of temperature and relative humidity necessary for swarming could not develop and swarming almost ceased during the last week of August. The other explanation can be that by that time most of the swarming had already taken place.

During the swarming season of 1998, swarming of *M. championi* started on June 3, 1998 at relatively very high atmospheric temperature (42.9±°C) just on the day of first rainfall (20.0 mm) at 50%. relative humidity. There were traces of rainfall during the next week and the second swarming initiated on June 10, 1998 at 40.3±°C atmospheric temperature, 35.6±°C soil temperature and 52% relative humidity. After this there were frequent rainfalls during 1998 and maximum swarming was observed in the third week of July 1998 at 36.5±°C atmospheric temperature and 80% relative humidity. The minimum number of alate was collected on August, 11 1998 at 36.5±°C atmospheric temperature and 70% relative humidity.

The coefficient of correlation between number of alates and atmospheric temperature was positive but non-significant ($r = 0.204$; d.f. 14; $P>0.05$). Similarly, the relationship between soil temperature and number of alates was slightly higher but non-significant ($r = 0.415$; d.f. 14; $P>0.05$). The relationship between relative humidity and number of alate was positive but non-significant ($r = 0.0512$; d.f. 14; $P>0.05$) and very weak, though maximum swarming was observed on the day when there was a maximum relative humidity (80%) during the swarming season. (Table II)

Frequency of swarms at different times during the swarming season of 1997-1998 is shown in Table III and illustrated in Fig.1. This species swarms between 8:00-9:00 P.M. Maximum frequency (27) of swarms was observed between 8:00-8:30 P.M. and a total of 2,658 alates of *M. championi* were collected during this time. Two swarms of *M. championi* were observed from 8:30-9:00 P.M. and a total of 275 alates were collected. (Table IV). Relationship of number of alates and time of flight

of *M. championi* in Lahore (Pakistan) is shown in Fig.II. Number of individuals of *M. championi* were collected swarming before sunset, however, majority of the swarms of *M. championi* were observed after sunset. Swarming of *M. championi* continued up to 9:00 P.M. and no swarming of this species was witnessed after 9:00 P.M. till 11:00 P.M.

Table 1: Relationship of different environmental factors with number of alates in Lahore (Pakistan) during 1997.

Date	Time of start of swarming (P.M.)	Atmos-pheric temp. (°C)	Soil temp. (°C)	Rainfall (mm)	Relative humidity (%)	*Microcerotermes championi* (Snyder)				Total
						Male		Female		
						No.	%	No.	%	
07.6.97	8.10	38.0	32.8	12.0	70	25	27.7	65	72.2	90
09.6.97	8.15	38.8	36.6	0.4	68	12	15.0	68	85.0	80
13.6.97	8.10	32.0	40.0	1.0	71	22	22.0	78	78.0	100
22.6.97	8.15	36.5	40.6	0 (Traces)	70	19	21.5	69	78.4	88
27.6.97	8.00	36.4	46.6	0.0	68	12	15.0	68	85.0	80
05.7.97	8.10	34.8	28.8	0.0	84	29	26.3	81	73.6	110
09.7.97	8.00	34.6	32.4	0.0	80	22	22.0	78	78.0	100
11.7.97	8.15	34.6	33.6	110.0	84	16	16.8	79	83.1	95
15.7.97	8.10	34.8	32.6	0.0	80	24	26.6	66	73.3	90
20.7.97	8.15	34.4	34.6	58.2	84	32	27.8	83	72.1	115
03.8.97	8.10	33.1	32.1	0.0	89	4	40.0	6	60.0	10
06.8.97	8.15	33.5	30.4	0.0	80	2	22.2	7	77.7	9
12.8.97	8.10	33.7	31.9	0.0	86	3	30.0	7	70.0	10
18.8.97	8.15	33.2	32.1	0.0	88	3	27.2	8	72.7	11
26.8.97	8.10	33.9	30.4	0.0	85	3	37.5	5	62.5	8
28.8.97	8.15	33.6	30.8	0.0	83	2	33.3	4	66.6	6
Total:						230		772		1002

Correlation coefficient: Atmospheric temperature vs total number of alates = 0.419; Soil temperature vs total number of alates = 0.385; Rainfall vs total number of alates = 0.353; Relative humidity vs total number of alates = 0.491.

Table 2. Relationship of different environmental factors with number of alates in Lahore (Pakistan) during 1998 at Wagha Border.

Correlation coefficient: Atmospheric temperature vs total number of alates = 0.2040; Soil temperature vs total number of alates =

Date	Time of start of swarming (P.M.)	Atmos-pheric temp. (°C)	Soil temp. (°C)	Rainfall (mm)	Relative humidity (%)	*Microcerotermes championi* (Snyder)				Total
						Male		Female		
						No.	%	No.	%	
03.6.98	8.00	42.9	33.6	20.0	50.0	24	24.0	76	76.0	100
10.6.98	8.30	40.3	35.6	Traces	52.0	40	26.6	110	73.3	150
12.6.98	8.15	23.4	41.2	12.6	55.0	46	23.0	154	77.0	200
13.6.98	8.30	31.5	40.6	13.6	59.0	30	27.0	81	72.9	111
28.6.98	8.30	41.9	43.8	28.6	68.0	26	26.0	74	74.0	100
02.7.98	8.40	34.1	32.1	20.0	70.0	27	25.7	78	74.2	105
07.7.98	8.20	35.5	29.6	12.0	68.0	34	30.9	76	69.0	110
11.7.98	8.40	31.7	34.1	14.6	75.0	44	25.8	126	74.1	170
13.7.98	8.10	35.7	33.2	41.0	76.7	45	25.7	130	74.2	175
19.7.98	8.30	36.5	34.2	44.0	80.0	48	18.4	212	81.5	260
01.8.98	8.30	36.5	30.4	1.8	65.0	5	35.7	9	64.2	140
03.8.98	8.30	39.5	31.5	59.0	70.0	5	33.3	10	66.6	150
04.8.98	8.25	32.4	30.6	40.0	65.0	6	42.8	8	57.1	140
11.8.98	8.25	36.5	32.7	Traces	70.0	2	40.0	3	60.0	50
12.8.98	8.30	34.0	31.9	48.0	71.0	5	38.4	8	61.5	130
26.8.98	8.25	34.4	32.7	0.2	70.0	4	33.3	8	66.6	120
Total:						391		1163		2211

Swarming in termites is essentially a seasonal phenomenon. In regions with cold winters and evenly distributed rainfall, alates production and their flights are restricted to the warmer summer months (Grasse, 1949). Weesner (1965) has noticed the flights of *Reticulitermes tibialis* from late winter to spring and again in fall. Kumar and Sen-Sarma (1987) reported swarming of *Odontotermes distans* from last week of February to last week of March in India. In Pakistan, flights of termites are associated with summer rains. Akhtar and Amanullah (1989) reported that swarming of *Coptotermes heimi, Microtermes obesi, Microtermes unicolor* and *Eremotermes paradoxalis* started after second rainfall of the season, which created suitable combination of relative humidity and atmospheric temperature. Akhtar and Shahid (1990) have observed 79 flights of seven species of termites. They reported that during 1988, the locality received abnormally high rainfall and swarming was initiated after fourth rain of the season. Ahmad *et al.* (1979) reported that whenever, it rained moderately the swarming of *Bifiditermes beesoni* occurred on several consecutive days.

Table 3:- Frequency of swarming of *M. championi* at different times during study period of 1997-1998 (based on data of two years)

Time of Swarming (P.M)	Swarming frequency of *M.championi* (snyder)
6.30-7.00	-
7.00-7.30	-
7.30-8.00	3
8.00-8.30	27
8.30-9.00	2
9.00-9.30	-
9.30-10.00	-
10.00-10.30	-
10.30-11.00	-

Table 4: Number of alates of *M. championi* during different times throughout the study period of 1997-1998(based on data of two years)

Time of Swarming (P.M)	No of alates of *M. championi* (Snyder)	Total No of alates
6.30-7.00	-	-
7.00-7.30	-	-
7.30-8.00	280	280
8.00-8.30	2,658	2,658
8.30-9.00	275	275
9.00-9.30	-	-
9.30-10.00	-	-
10.00-10.30	-	-
10.30-11.00	-	-
Total	3,213	3,213

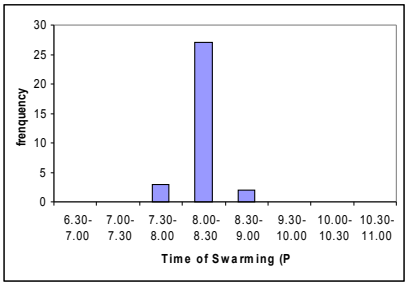

Fig 1: Frequency of swarming of *M. championi* at different times during study period of 1997-1998 (based on data of two years)

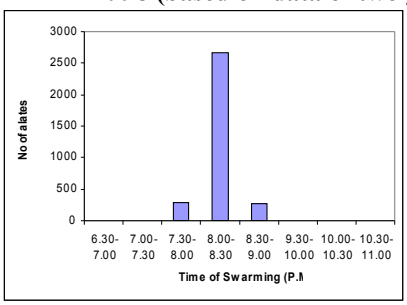

Fig 2: Number of alates of *M. championi* at different times during study period of 1997-1998 (based on data of two years)

Present studies on swarming behaviour of *M. championi* revealed that swarming was confined to summer months (June – August). It was recorded that swarming took place after first rainfall of the season in 1997 and after second rainfall during 1998. During 1997/1998, a total of 3213 alates of *M. championi* were collected from eight swarms. Information on the number of alates related to colony is difficult to obtain particularly, where the largest population occurred in subterranean nest (Nutting, 1969). However, Roonwal (1960) reported 18-43.3% of alates in colony of *O. obesus.*

Swarming activity is restricted by light during the day. Studies on *M. championi* revealed that emergence of alate of *M.championi* start at 8:00 P.M. after sunset and continued up to 8:40 P.M. under suitable environmental conditions. No swarming of *M. championi* witnessed after 9:00 P.M. till 11:00 P.M. Afzal (1981) stated that time of emergence of *B. beesoni* in field colonies was different from that of laboratory colonies.

He stated that in field colonies emergence always initiated after sunset, whereas in laboratory colonies emergence began several minutes before sunset. Many observers have recorded the temperature, or range of temperature during flight of a particular species. Wider range of temperature is from 12±°C to 30±°C for *Anacanthotermes ochraces* (Clement, 1956). No one seems to have determined threshold temperature above which the flight is physiologically possible, although even these would undoubtedly vary with wide range of species (Johnson, 1966). However, Shi *et al*. (1987) recorded swarming of *O. hainanensis* from mid May to early June when daily mean temperature was 24.0±°C to 26.8±°C and relative humidity between 90.0 – 97.0%. Swarming of *M. championi* was recorded from 32.0±°C to 38.8±°C atmospheric temperature but the swarming was maximum between 34.4±°C – 34.8±°C. Akhtar and Shahid (1990) recorded swarming of different species between 25.5±°C to 38.0±°C atmospheric temperature, but the maximum swarming was observed from 25.5±°C to 30.0±°C. They have recorded that *O. lokanandi* swarms at atmospheric temperature of 25.5±°C, which was lowest recorded temperature during the swarming season. The temperature factor thus may play an important role in promoting reproductive isolation in different closely related species of termites.

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