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Swarming Behavior of the Termite, *Eremotermes neoparadoxalis* Ahmad (Termitidae: Amitermitianae) at Jodhpur (Western India)

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Abstract: Observations on swarming in *Eremotermes neoparadoxalis* were made in the field at Jodhpur (Rajasthan). Swarming takes place usually with the pre-monsoon heavy showers, which generally occur during June and early July but occasionally, in May also. Alates wait in "Swarming Chamber" and emerge from small holes in the ground in early evening. During emergence-flight, no intimate association is seen between males and females but when the alates descend to the ground and shed their wings, they show tandem coupling behavior. Normally, only one pair settles down in each brood chamber, but sometimes, two to three pairs are seen together in a single brood chamber. Based on the observations of last 11 years (1987-1997), influence of pre-monsoon and monsoon showers on the emergence of alates is discussed.

Key words: Dealation, emergence, predator, pre-monsoon showers, termite.

Eremotermes neoparadoxalis Ahmad, a soil dwelling, subterranean termite, has restricted distribution in north-western India and parts of Pakistan. It was described by Ahmad (1955) on the basis of workers and soldiers castes, and their images were recorded from Peshawar (Pakistan) (Akhtar, 1976). However, no biological observations were made by them. The swarming behavior of this endemic termite has been observed, for the first time, by the author during the last eleven years, and the time of emergence of alates has been correlated with climatic parameters, especially the rainfall.

Materials and Methods

Field observations were made at Jodhpur during the last eleven years (1987-1997). *Eremotermes neoparadoxalis* is a soil-dwelling subterranean species found under dung and decaying wood. The colonies of the termite, *E. neoparadoxalis*, that existed naturally and the reproductive alates, emerging out from such colonies in swarms were the materials for the study of some aspects of swarming, e.g., pre-swarming, swarming, and post-swarming behavior. Swarming holes, waiting-chamber and the tunnels connecting the main termite colony, were dug open (Fig. 1). The climatic data were obtained from Central Arid Zone Research Institute, Jodhpur.

Results

Pre-swarming behavior of Alates

Observations on an early swarming behavior were recorded from a previously known spots of swarming.

During the year 1996, due to sudden climatic changes brought about by a western depression and dust storms, good rains (32

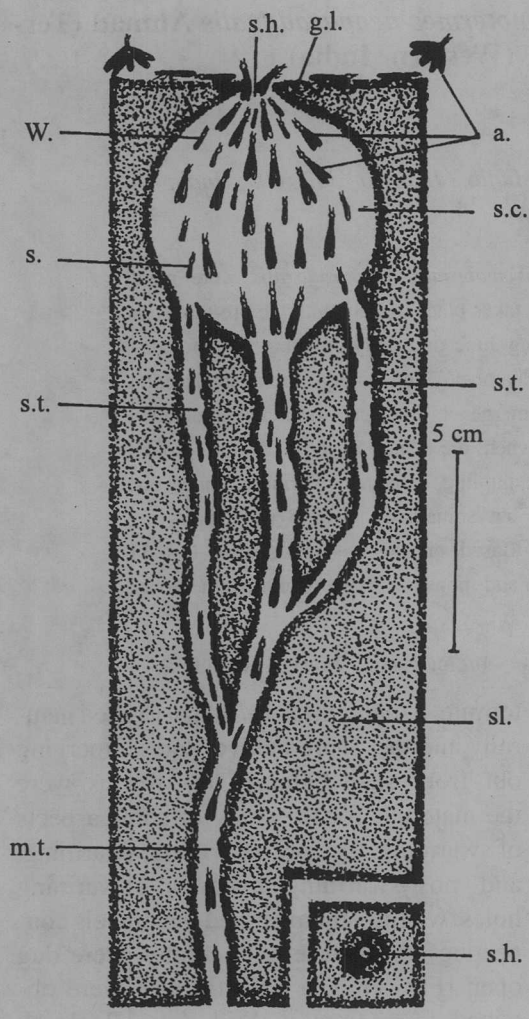

Fig. 1. Swarming chamber and connected gallaries; Jodhpur. (A) In vertical section in soil. (B) A swarming hole in surface view. (a.: alates; g.l.: ground-level; m.t.: main tunnel; s.: soldier; s.c.: swarming chamber; s.h.: swarming (exit) hole on ground surface; sl.: soil; s.t.: side tunnel; w.: worker).

mm) occurred on 14th and 16th May. Due to good rainfall (33 mm), swarming activity was expected, but none was noticed. On the 17th May, few spots where swarming had been recorded earlier were dug to depths of 10-15 cm. Interestingly, these spots showed presence of about 30 alates few soldiers and 1-12 workers. The alates, though pigmented and fully developed, behaved quite differently. They did not show any tendency to fly or run or cast-off their wings. Neither they showed any inclination to form tandem coupling. However, alates were merely waiting for favourable weather conditions to swarm. This was found true when on 23rd night, heavy rains occurred and a very weak swarming was recorded in the evening of 24th May 1996. Alates emerged out of a few swarming holes at long intervals in one or two numbers between 7.05 p.m. and 7.45 p.m. This was the earliest record at Jodhpur since the incidences of swarming were observed in later months (Table 1).

Swarming behavior

Swarming generally takes place just after first heavy pre-monsoon rain, when the weather is very humid, sultry and sometimes, cloudy. Alates emerged out from numerous tiny, rounded "swarming holes" (diameter, ca. 1.5 mm) on the ground surface. They were in clusters of 7 to 10. The individual holes were 10-25 cm apart. Each hole led to underground into a small (5-8 mm long) neck and then into a wide (4.5 x 5 cm) subglobular "swarming chamber" (S.C.), inside walls of which were lined with smooth dark brown material. This chamber led into a 4-5 mm wide vertical main tunnel (m.t.). The narrow, side tunnels (s.t.), having 1.0-1.5 mm di-

ameter, also opened into the swarming chamber. The alates (a), came through the main tunnel, worker (w), and soldiers (s), through the side tunnels and all these assembled in the swarming chamber, from which the alates emerged one by one and fly. The soldiers and workers remained inside the swarming chamber. The soldiers and workers were active during the swarming time as about 25-30 individuals of all castes, mostly alates, were found in the swarming chamber.

Observations on the emergence of swarms were quite interesting. The emergence started at a rate of an alate per 1-2 seconds per hole, then the number gradually increased. After the peak period, the rate declined to an alate per 30 seconds. A large number of winged forms rushed out into the atmosphere. It was noticed that when hardly half portion of the first alate emerges out, the following one or two alates push their way by the former's side, and the emerging alates thus jostle with one another. After coming out of the swarming hole, the alates run on the ground for 5-7 cm distance and try to fly but fail to take off and fall down on ground. This process is repeated 3 to 4 times before the final flight. The swarming alates were observed to fly at a height of about 6 to 7 m. In a closely observed case, 140-145 alates emerged from a hole within a period of 45-50 minutes, after which, the hole was sealed by workers in the presence of soldiers by means of an earthen plug. Before the sealing operation, 4 to 5 workers and 1 to 2 soldiers peeped out of the hole and then went in, after this, the sealing was quickly done by the help of a soil plug.

Relationship with early monsoon showers

An analysis of data on the times of swarming and occurrence of early monsoon showers, spread over 11 years of observations, indicate that alates of *Eremotermes neopardoxalis* emerge out after 24 hours of stoppage of rains. If, however, the spell of rains continues till morning, on eleven occasions out of 35, the swarming took place in the evening, after about 7-8 hours (Table 1). Usually, a single swarming sequence lasted for 45 m and their occurrence over the years varied from 5.15 to 7.00 p.m. and relative humidity from 66 to 94%. No significant correlation between swarming time, the amount of precipitation and maximum and minimum temperatures was observed.

July appeared to be the most active month for swarming of this species (62.7%). Early swarming, associated with premonsoon showers, was seen in May on two occasions (5.6%) and late swarming occurred once in September (2.8%) during the 11 years of study (Table 1).

Post-swarming behavior

After flying for half an hour or so, the alates descend to the ground, and cast their wings off. Immediately after this, they start running around for a few minutes to form a tandem coupling with opposite sex. In tandem, the male actively follows the females, touching the latter's abdominal end with its mouth-parts and antennae. Sometimes, the males similarly touche the

Table 1. Correlation between timing of swarming of E. neoparadoxalis with pre-monsoon showers

Year	Shower (rain on)	R.H. (%)	Amount of precipitation (mm)	Swarming on	Time of Swarming (p.m.)
1987	13/6	74	29.4	14/6	6.00
	15/7	78	17.6	16/7	7.00
1988	11 & 12/7	67	8.0, 4.4	13/7	5.45
	16 & 17/7	78	29.8, 1.8 (morning)	17/7	5.50
	27/7	91	17.0	28/7	6.00
1989	17/7	81	16.0	18/7	6.15
	25 & 26/7	81	11.4, 5.8 (morning)	26/7	5.45
	27/7	87	1.3	28/7	6.30
1990	3, 4, 5, 6, 7/7	95	152.0, 144.3, 59.3, 117.7, 42.7	9/7	6.00
	3, 4, 5/8	94	7.6, 49.6, 13.0 (morning)	5/8	5.30
	6, 7/8	94	60.8, 11.3	8/8	6.00
1991	12, 13/6	72	6.2, 4.0	14/6	5.45
	20/7	92	12.5	21/7	6.00
	22/7	90	41.2	23/7	6.15
1992	24/7	94	10.2 (morning)	24/7	5.25
	25/7	89	18.8	26/7	6.00
	30, 31/7, 1/8	92	38.2, 9.2, 3.4 (morning)	1/8	6.15
	23/9	78	20.4	24/9	6.00
1993	26, 27/6	75	15.6, 35.1 (morning)	27/6	5.30
	29, 30/6	74	16.2, 1.6 (morning)	30/6	5.15
	17, 18, 19, 20/7	92	0.8, 91.6, 7.2, 20.6	21/7	6.30
1994	29, 30/6 & 1, 2, 3/7	89	3.8, 2.8, 9.0, 35.6, 1.8 (morning)	3/7	5.45
	5/7	94	14.0	6/7	6.00
	13, 14/7	86	0.8, 21.2	15/7	6.15
	22, 23, 24, 25/7	97	4.8, 25.0, 31.7, 27.0	26/7	6.15
1995	22/6	85	23.5	23/6	5.15
	19, 20, 21/7	89	5.7, 20.0, 1.3 (morning)	21/7	5.45
	25, 26, 27, 28/7	93	25.6, 90.2, 33.9, 0.6 (morning)	28/7	6.00
1996	23/5	70	24.5	24/5	7.05
	12, 13/6	88	7.8, 29.8 (morning)	13/6	5.45
	1/7	93	35.8	2/7	6.00
	16, 17, 18/7	90	1.4, 15.0, 38.5	19/7	6.15
1997	23/5	66	21.3	24/5	5.30
	1/6	72	17.5	2/6	5.45
	29/7	90	27.6	30/7	6.15

seventh abdominal tergum of the female. Tandem coupling in few cases was observed by alate male and dealated females and vice-versa. In a few cases, a female dealate was followed by two or three males. In the field, this tandem couple goes on crawling for a period extending upto 2 hours, after which, they disappear underground in some hole or crevice.

Only female-male tandem was observed. Reversal of female-male tandem, as observed by Luscher (1951) in *Kalotermes* and *Cryptotermes*, was not noticed in this species.

Calling attitude was taken up by females only after casting off wings. In this attitude, the abdomen of the female was raised up and moved from side to side. In this calling behavior, the female did not move about but remained stationary. The movements of the abdomen continued till contact with a male took place. However, if the male withdrew after contact, or was lost in the subsequent tandem behavior, the female again adopted the calling attitude. It ceases permanently only after the pair start digging in the soil or disappear underground in crevice or some suitable objects.

Discussion

Not much is known about the biology of termites of the genus *Eremotermes silvestri*, which is represented by 6 species - one from Tunis, Kairouan (North Africa) and the other five from Oriental Region. Information about swarming is available only for four species. *E. dehraduni* (Roonwal and Sen-Sarma, 1960), known only from the Doon Valley swarms in the first half of June during bright sunshine from 1000 to 1400 hrs. from small holes in the ground (Thakur, 1991). *E. fletcheri* Holmgren and Holmgren (= *E. maliki* Ahmad), swarms in South India (Tamil Nadu) in May, during early hours of afternoon on clear days (Thakur, 1985). *E. paradoxalis* Holmgren is a widely distributed, soil dwelling species, almost throughout India and humid tropical areas in Pakistan. Swarming records show that it occurs from March to August (Roonwal, 1970), late in the afternoon or late in the evening (1530-1945 hrs.) (Thakur, 1985). In addition to this, swarming data of this species is also available from Punjab, Delhi, Rajasthan, Madhya Pradesh (Roonwal and Rathore, 1974). In Pakistan, the flight schedules of this species have been recorded in the month of July after heavy monsoon showers (Chaudhary and Ahmad, 1972). *E. neoparadoxalis* Ahmad is distributed in north-western India and in some parts of Pakistan. The actual swarming of this species was recorded first time from India by the author in July 1987. The per cent observations, spread over 11 years, have established a positive correlation between swarming and rainfall. It further indicated that time schedules of swarming of this species at any locality are invariably precise and are repeated year after year.

Alates while flying are preyed upon by large number of birds, viz., house crow, *Corvus splendens* Vieillot, white cheeked bulbul, *Pycnonotus leucogenys* (Gray), red vented bulbul, *P. cafer* (Linnaeus), hoopoe, *Upupa epops* Linnaeus, Indian robin, *Saxi-*

coloides fulicata (Linnaeus) and house sparrow, *Passer domesticus* (Linnaeus). When the alates fall on the ground and run here and there, they are actively preyed upon by large black ant (*Camponotus compressus* Fabricius). The Garden lizard or blood-sucker *Calotes versicolor* (Daudin), and the house lizard, *Hemidactylus brooki* Gray, also feed on them.

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