NOTE

Switch to Single Sex Alate Production in a Colony of the Termite, *Coptotermes formosanus*[1]

M. W. J. Crosland[2], G. X. Li[3], L. W. Huang[3], and Z. R. Dai[3]

J. Entomol. Sci. 29(4): 523-525 (October 1994)

KEY WORDS Isoptera, Rhinotermitidae, sex ratio, nuptial flight.

Though social insects have been major focus of sex ratio studies, most research has been on social Hymenoptera. Parallel detailed studies have been almost completely lacking in Isoptera (Jones et al., Sociobiology, 14: 89-156, 1988).

The Formosan subterranean termite, *Coptotermes formosanus* Shiraki, has spread to become the most damaging termite in an increasing number of parts of the USA. Alates are important in the spread of *C. formosanus* in the immediate area (Tamashiro and Su, Biology and Control of the Formosan Subterranean Termite, 1987, Res. Ext. Ser. 083, Univ. Hawaii). However, the time required for a field colony to start to produce alates is not known. There have been very few long-term studies relating colony age to alate production (Tamashiro and Su 1987). Here we document a rare example of one such study, where the number of alates produced from a single termite colony has been recorded for 19 successive years, beginning with colony initiation. Furthermore, we note the colony making a fascinating switch to producing alates of only a single sex.

A colony of *C. formosanus* was initiated from a single dealate pair in 1974 and fed on *Pinus massoniana* Lamb. (always plentifully supplied). The colony (presently containing over an estimated 100,000 workers) now occupies a 1.5 m^3 concrete tank inside a small room at Guangdong Entomological Institute. The room temperature averaged 22° C and the colony was exposed to the natural Guangzhou light cycle. Over 90% of the alates were collected every year when they flew. During swarming season (May and June) the room was carefully shut and sealed up at night. Alates (which swarm only in the evenings) were collected with light traps set up inside the room. Collected alates were preserved in

[1] Accepted for publication 19 July 1994.

[2] Department of Biology, Chinese University of Hong Kong, Shatin, N. T., Hong Kong.

[3] Guangdong Entomological Institute, 105 Xingang Road West, Guangzhou 510260, China.

alcohol. Their numbers were estimated (in 1993 by counting sub-samples [Su and Scheffrahn, Sociobiology, 13: 209-215, 1987]) or precisely determined (by painstakingly counting every alate individually, in all years before 1993 [except 1985, see Table 1]). In 1993, 100 alates were randomly selected from each day's alcohol sample and sexed using external abdominal characters (Krishna and Weesner, Biology of Termites, 1969, Vol. 1, p. 43, Academic, New York); all alates from 3 and 28 June were sexed (see Table 2). The 1993 sex ratio was compared with samples of 200-400 alates sexed from a single night's flight from the same colony in 1987, 1988, and 1991. In the other years negligible numbers or no alates were sexed before the alcohol samples were discarded.

Table 1. Annual number of alates estimated produced from the laboratory colony 1974-1993.

Year	No. of alates	Year	No. of alates
1974-1981	0	1988	28,663
1982	869	1989	20,337
1983	0	1990	0
1984	0	1991	17,586
1985	several hundred	1992	5,835
1986	0	1993	20,193
1987	27,813		

The results provide a rare example of the sociogenesis of alate production in a colony of *C. formosanus*. During the first seven years after colony foundation no alates were produced (Table 1). In only two of the next five years (1982 and 1985) were alates produced, but only in low numbers (hundreds). However, when the colony was 13-years-old it started to produce approximately 17,000 to 28,000 alates per year (1987-1993, though 1992 had fewer alates). Such a leveling off in alate production is predicted from the social Hymenoptera literature (Brian, Social Insect Populations, 1965, Academic, London; Hölldobler and Wilson, The Ants, 1990 Belknap, Harvard). Interestingly, a mature *C. formosanus* colony may produce no alates some years (e.g., 1990). This is not predicted by current models (Brian 1965, Hölldobler and Wilson 1990).

All 731 alates sexed in 1993 (Table 2) were found to be male. This contrasted with sexed alate samples from 1991 (containing 275 males and 84 females), from 1988 (200 males and 121 females), and from 1987 (150 males and 54 females).

Table 2. Number of alates produced from the laboratory colony on different dates in 1993.

Dates of swarming - (1993)	29 May	3 June	4 June	8 June	10 June	11 June	16 June	28 June	TOTAL
No. of alates - (estimated)	2,495	72	3,889	424	7,325	1,706	4,943	59	20,913

In the most comprehensive review to date (Jones et al. 1988), there are just two other examples of single sex alate production by a termite colony (*Neotermes connexus* Snyder and *Nasutitermes dunensis* Chatterjee and Thakur). This appears to be the first example of this in *C. formosanus*. Furthermore, we found that there had been a switch from the production of both sexes in three previous years (1987, 1988, and 1991) to the production of solely males in 1993.

In many social Hymenoptera, a switch from production of both sexes to the production of only males occurs when the queen dies (e.g., Hölldobler and Wilson 1990). However, in social Hymenoptera the solely male production is a consequence of their haplodiploid sex determining mechanism. Such a consequence of queen death is not predicted in diploid Isoptera. Nonetheless, Lenz and Runko (Proc. 19th Int. Cong. Entomol., Beijing, p. 244, 1992; M. Lenz, personal communication) recently suggested that a switch to solely male alate production in termites might be correlated with the death of the primary queen, although the mechanism is elusive. Unfortunately, we were not granted permission to break open the 19-year-old laboratory colony to investigate this.