

COLONY FOUNDING AND LIFE-CYCLE IN THE ANT *CAMPONOTUS SERICEUS* FABRICIUS (HYMENOPTERA : FORMICIDAE)

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After the nuptial flight, in the months of September and October only dealate females were observed, searching for suitable nesting sites and to excavate their nests. Alate males did not participate in such activities. Each dealate female made a vertical burrow and the brood-chamber was formed at the blind end of the nest. In 80% of the cases a single female was involved in colony founding under laboratory conditions, but only in 20% of the cases more than one individuals were involved. Duration of the life-cycle under natural conditions in the field and under laboratory conditions, with near natural conditions was more or less similar *i. e.* 24 to 26 and 21 to 30 days respectively. Whereas duration of the life-cycle under laboratory condition with and without media was 40 and 55 days respectively. Developmental period of different life stages of the ant *C. sericeus* was dependent on temperature and media.

INTRODUCTION

In most species of ants, the queen ant first builds a separate closed chamber in soft ground for her living, protection and for the future colony (Goetsch, 1957). Markin *et al* (1972) reported that the queen places the developing eggs, larvae and pupae separately in different regions of the same brood chamber or in different brood chambers. Reports reveal that the period of life-cycle varied in different species of ants and the duration of the developing stages were dependent on temperature (Markin *et al.*, 1972; Creighton & Snelling, 1974; Neal *et al*, 1975; Stringer *et al*, 1976).

Since there are no reports regarding the colony founding and life-cycle of ants from the Indian sub-continent, the authors attempted to study the colony founding and life cycle of *Camponotus sericeus* in the field at Karnatak

University Campus and its vicinity at Dharwad and in laboratory conditions as well.

MATERIAL AND METHODS

Field observations on colony founding were made only after their nuptial flight. In order to study the number of different developmental stages such as eggs, larvae, pupae and adults in natural field conditions about 100 newly formed nests were marked in the field. Two to three nests were dug open on every alternate day, examined for the presence of different developmental stages and recorded their number (Table I).

Dealate mated queen ants searching for suitable ground for nesting were collected from the field and used for present investigation. Experiments were conducted to study the duration of different developmental stages in the laboratory on the following aspects.

Duration on developmental stages

Structure of the nest in the presence of nest building material : Ten glass jars measuring $30 \times 18 \times 9$ cm were filled with moist soil up to 10 cm height. In each jar one dealate queen ant was introduced. The temperature and relative humidity in the jars, and the average number of eggs, pupae and adults were recorded (Table II).

Construction of nest without media (Lab-conditions) : In each of the ten glass jars measuring $9 \times 6 \times 4$ cm, a dealate queen was introduced and about 10 sugar crystals were also placed. Glass jars were covered with glass plates. Temperature, humidity and duration of different developing stages were noted (Table III).

Studies under captivity with near normal field conditions : For this purpose the dealate queens were kept individually in the wide mouthed, flat bottomed tubes measuring 2.5×7 cm and the mouth of the tubes were closed with cork stoppers. Ten such tubes were buried in the moist soil kept in big troughs. These tubes were removed and examined every 5 days to determine the rate of brood development. Results of the observations were as given in Table IV.

Effect of temperature under captivity : Petri-dishes (9×2 cm) containing moist soil were used as artificial brood chambers. One dealate queen was introduced in each of ten petri-dishes. All such petri-dishes were closed with equal sized petri-dishes and were kept in an incubator maintained at 30°C and 60% R. H. The rate of development of the brood from the above petri-dishes was recorded (Table V).

Studies on participation of number of queens in colony founding

Number of ants involved in excavation of nest : The experiment was meant to determine whether a single or more than one individual dealate queens participate in excavating the nest and raising the brood. For this purpose 10 dealate queens were released into a glass trough (30 × 15 cm) containing the moist soil. Ten such troughs were maintained under observation.

RESULTS

Field observations

Nuptial flights of *C. sericeus*, in nature, occurred during the months of

Table I. Developmental stages and their number in establishing colonies of the ant *C. sericeus* under the field conditions.

Days of observation after the settlement of the queen	Number of eggs present	Number and duration of developmental stages of		
		Larvae	Pupae	Adults
2	5-8 (6)	—	—	—
4	12-16 (13)	—	—	—
6	20-26 (24)	—	—	—
8	21-30 (25)	2-6 (4)	—	—
10	13-17 (14)	18-22 (15)	—	—
12	6-15 (10)	20-26 (22)	—	—
14	3-5 (3 5)	20-30 (25)	—	—
16	8-17 (12)	20-33 (26)	0-7 (1)	—
18	19-24 (21)	14-25 (19)	5-10 (8)	—
20	10-21 (14)	16-24 (18)	8-16 (10)	—
22	7-15 (10)	12-20 (14)	10-18 (13)	—
24	2-10 (5)	14-20 (16)	11-23 (17)	0-2 (1)
26	11-18 (14)	9-17 (12)	9-20 (16)	2-8 (5)
(i) Atmospheric temperature & Relative humidity		15-33°C 60-100%	(ii) Ground temperature & Relative humidity	17-39°C 30-80%

September and October when the temperature and humidity varied from 21–31°C and 60–100% respectively. The soil during this period was moist and loose which enabled ants to excavate the soil. The females of *C. sericeus* after descending to the ground and shedding the wings found moving in search of suitable nesting site to establish their nests. The males simply made aimless movements here and there and finally disappeared. The dealate female (queen) after her nuptial flight, took approximately 30 min to 6 hrs to search a suitable place for nesting. After finding a suitable site, the dealate queen excavated the nest at an average depth of 7 ± 0.6 cm (5.0 to 10.0 cm) from the surface of the ground. Initially the queen excavated a small vertical tunnel measuring 0.6 to 0.8 cm in diameter and 5 to 10 cm in depth. After burrowing the tunnel, the dealate queen enlarged the blind end to form a brood chamber. The queen ant, on completion of the excavation and formation of the brood chamber sealed the entrance of the tunnel. About 90% of nests possessed only one brood chamber in each nest and only 10% of the nests possessed two brood chambers. The brood chambers on an average measured 2 to 3 cm in depth and 1.5 to 2.0 cm in height.

Data pertaining to the number of eggs laid by the queen, time taken for

Table II. Details regarding the number of eggs, larvae, pupae and adults of the ant, *C. sericeus* present on different days after the establishment of the dealate queen in the laboratory condition.

Number of days after the release of dealate queens into glass jars	Number of eggs	Number of larvae	Number of pupae	Number of adults
5	10	—	—	—
10	24	—	—	—
15	30	2	—	—
20	11	10	—	—
25	2	15	2	—
30	5	10	7	—
35	12	6	11	—
40	21	10	14	2
45	26	8	8	8

Room temperature	22–30°C	Relative humidity	52–83%
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the eggs to hatch into larvae and the emergence of adults from pupae were recorded from field nests. Number of eggs laid by the queen during the first eight days after excavating the nest varied from 21 to 30. It was not possible to keep track of the exact number of eggs laid by the queen after 8th day, because of the fact that some of the eggs were found hatched into larvae and the larvae possibly fed on some of the eggs. However, number of eggs present in the nest from 8th day until the formation of first progeny is shown in Table I. Following is the summary of the life-cycle of *C. sericeus* in field conditions :

1. Eggs to larvae 8 days,
2. Larvae to pupae 10 days,
3. Pupae to adults 6 to 8 days,
4. Eggs to adults 24 to 26 days.

Structure of the nest in the presence of the nest building material (Lab-conditions)

The dealate queen was found moving in the jar for 1 to 3 hrs possibly in

Table III. Details regarding the number of eggs, larvae, pupae and adults of the ant, *C. sericeus* present on different days after the establishment of the dealate queen in the laboratory condition (without media for construction of the nest).

Number of days after the release of dealate queens into the glass jars	Number of eggs	Number of larvae	Number of pupae	Number of adults
5	1	—	—	—
10	14	—	—	—
15	26	—	—	—
20	32	2	—	—
25	20	5	—	—
30	16	8	—	—
35	8	12	2	—
40	6	6	6	—
45	13	10	8	—
50	22	13	10	—
55	20	14	13	1
60	14	16	10	5

Room temperature 22–30°C,

Relative humidity 40–80%

search of suitable nesting site. Afterwards, she excavated a tunnel of 3 to 6 cm deep, enlarged its blind end to form a brood chamber and closed the exit of the tunnel. Construction and sealing of the nest was completed within 20 to 30 hrs after the introduction of female alate into the jar.

Each queen on an average laid 2 eggs/day for the first 15 days and on 15th day there were two larvae in addition to 30 eggs. After 15th day it was not possible to keep track of the number of eggs laid per day. Table II reveals the number of eggs, larvae, pupae and adults recorded on different days. Following is a summary of the life-cycle as observed in this experiment :

1. Eggs to larvae 20 days,
2. Larvae to pupae 15 days,
3. Pupae to adults 20 days,
4. Eggs to adults 55 days.

Construction of nest without media (Lab-conditions)

Queen ants did not feed on the sugar crystals provided to them. About 20% of the queens died within 2 to 3 days after the commencement of the experiment. The dead queens were subsequently infested by an unidentified fungus. Egg-laying (1/day) in the surviving queens commenced after 5th day. Number of eggs, larvae, pupae and adults found on different days were as shown in Table III. Following is the duration of various stages in the life-cycle :

Table IV. Data on the number of eggs, larvae, pupae and adults of the ant, *C. sericeus* present after the settlement of dealate queens in the laboratory provided with near normal conditions of the field.

Number of days after the release of dealate queens into the petri-dishes	Number of eggs	Number of larvae	Number of pupae	Number of adults
5	21	—	—	—
10	24	6	—	—
15	13	13	1	—
20	6	17	8	1
25	11	10	12	5

Room temperature 25–33°C,

Relative humidity 45–85%

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|-----------------------------|-----------------------------|
| 1. Eggs to larvae 20 days, | 3. Pupae to adults 20 days, |
| 2. Larvae to pupae 15 days, | 4. Eggs to adults 55 days. |

Studies under captivity with near normal conditions

Queen ant started laying eggs a day after the commencement of the experiment. Average rate of egg-laying was 3 to 4 per day during the first 10 days and thereafter it was not possible to keep track of the number of eggs laid per day. The number of eggs, larvae, pupae and adults observed on different days in the initial colonies were as shown in Table IV. Period of different stages in the life-cycle was :

- | | |
|----------------------------|-----------------------------|
| 1. Eggs to larvae 5 days, | 3. Pupae to adults 10 days, |
| 2. Larvae to pupae 5 days, | 4. Eggs to adults 20 days. |

Number of ants involved in the construction of nest

About 80% of the individuals were involved in the construction of the nests and raising the brood individually.

DISCUSSION

Nuptial flight in ants depend on weather condition. Bhattacharya (1943)

Table V. Effect of temperature on the duration of developmental stages of the ant *C. sericeus* in the laboratory conditions.

Number of days after the release of dealate queens into the petri-dishes	Number of eggs	Number of larvae	Number of pupae	Number of adults
5	10	6	—	—
10	22	10	2	—
15	7	18	4	11
20	3	10	10	2
25	11	13	6	6

Temperature $30 \pm 1.5^{\circ}\text{C}$,

Relative humidity in the incubator 60%

reported that the onset of rains and congenial humidity influenced the undertaking of the nuptial flight in *Oecophylla smaragdina*. A correlation in rainfall, humidity and the nuptial flight has also been reported for *O. longinoda* (Way, 1954) and *Solenopsis invicta* (Markin *et al.*, 1972). Goetsch (1957) stated that a warm day with sufficient dampness and perhaps a hint of a storm in the air caused the sexuals to initiate their nuptial flight. The nuptial flight in *C. sericeus* occurred after the monsoon rains with high humidity and low temperature thus showing the importance of environmental conditions as has been reported in other ants.

It is reported that after nuptial flight, the ants select suitable place(s) for building their nests (Sudd, 1967; Nickerson *et al.*, 1975). According to Wheeler (1917) the females of *Pogonomyrmex barbatus* preferred to dig their first nests in soft ground puddles. Pontin (1966) stated that nests in shaded locations were less likely to succeed than nests in full sun. According to Poldi (1963) females of *Tetramorium caespitum* preferred sunny spots and avoided shade. Markin *et al.* (1972) have observed the queens of *S. invicta* selecting their nest sites under some solid objects such as wood or clods of dirt and occasionally in the open soil. In the present study, the dealate queens of *C. sericeus* selected nest sites in open fields and sometimes on road sides where the soil was loose and moist.

After the selection of a suitable nesting site, the dealate queens excavate their nests in the soil. Vertical burrowing and enlargement of the blind end of the nest into a brood-chamber(s) is reported in some species of ants (Markin *et al.*, 1972). In addition to the vertical burrowing of the nest, Green (1967) in

Table VI. Duration of life-cycle of *C. sericeus* under field and laboratory conditions (in days).

Developmental stages	Field conditions	Laboratory conditions	Lab without media	Lab near normal conditions	Lab conditions at 30°C
Eggs to larvae	8	15	20	8-10	5
Larvae to pupae	10	10	15	8-10	5
Pupae to adults	6-8	15	20	5-10	10
Eggs to adults	24-26	40	55	21-30	20

imported fire ant, described horizontal burrowing of the nest and the blind end terminating in a brood-chamber. Once the construction of the nest and the formation of the brood-chamber is complete, the queens seal the entrance of the nest (Goetsch, 1957; Markin *et al.*, 1972).

Generally, a single queen participates in colony founding (known as pleometrosis), while more than one queen in the higher ants is reported to participate in colony founding as reported by Wheeler (1933), Wilson (1963) and Markin *et al.* (1972). Present study shows the single ant queen participating in the colony founding. Under laboratory conditions, 80% of queens individually participate in colony founding. This observation suggested that under laboratory conditions pleometrosis can be induced in lower ants by crowding.

The queen ant of *C. sericeus* is observed in the field and laboratory nests, placing the developing eggs, larvae and pupae in different regions of the brood-chamber. This observation is in accordance with those of Lubbock (1894) and Wheeler (1910) in the ants of the genera, *Myrmica*, *Aphaenogaster*, *Formica*, *Camponotus*, and in *S. invicta* (Markin *et al.*, 1972). However, in the present study the first instar larvae were observed remaining with egg clusters for a number of days and it was believed that these larvae fed on the nearby eggs. Similar observations are on record for the ant, *Tetramorium caespitum* (Sudd, 1967) and *S. invicta* (Markin *et al.*, 1972). As suggested by Markin *et al.*, first instar larvae feeding on the eggs seems to be a common feature in many species of ants.

Developmental period are reported to vary in different species of ants and the duration of life-cycle is shown to be temperature dependent (Markin *et al.*, 1972; Creighton & Snelling, 1974; Neal *et al.*, 1975; Stringer *et al.*, 1976). Duration of the developmental period in *C. sericeus* from egg to larva, larva to pupa and pupa to adult in the field was 8, 10 and 6 to 8 days respectively. Total time taken to complete the life-cycle was 24 to 26 days. During this period the temperature of soil varied from 17 to 39°C. In laboratory-reared colonies, duration of the developmental stages was prolonged. The duration of development, under laboratory conditions, from egg to larva, larva to pupa and pupa to adult was 15, 10 and 15 days respectively. Thus, the total period to complete the life-cycle under laboratory conditions was 40 days. Temperature in the laboratory varied from 22 to 30°C. The longer period taken to complete the life-cycle under laboratory conditions may be due to lower temperature.

Construction of nest without media (Lab-conditions)

Where the queens were reared in glass jars without soil the total period of the life-cycles was the longest (55 days). This may be due to the exposing of

eggs, larvae and pupae to the atmosphere.

Studies under captivity with near normal field conditions

When near normal field condition were provided, the total period of the life-cycle was more or less similar to that observed in field nests (Table VI).

Effect of temperature under captivity

When queens were reared at a constant temperature of $30^{\circ} \pm 1.5^{\circ}\text{C}$ the life-cycle was completed in 20 days. Higher temperature seems to have accelerated the development of eggs, larvae and pupae to the next stage(s). The duration of life-cycle in *C. sericeus* is also dependent on weather conditions especially temperature and media.

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