Colony Revival, and Notes on Rearing and Life History of the Big-headed Ant[1]

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ABSTRACT

In the laboratory, a queen of the big-headed ant, *Pheidole megacephala* (Fabr.), could successfully revive an experimental nest with only ten newly eclosed minor workers from the non-feeding pupae. However, a nest that had no queen, or had a queen with only major workers, with larvae, or with 10 minor workers failed to revive. Queens and major workers from established colonies could not nurse the newly hatched larvae.

Detailed information is given on ant collecting and rearing of laboratory stock cultures. A generation of minor workers took 34 to 38 days to complete its life cycle at 26° to 27°C.

The big-headed ant (BHA), *Pheidole megacephala* (Fabr.) (Hymenoptera: Formicidae), is common in Hawaiian sugarcane and pineapple fields, particularly in moist areas below the one thousand foot (305 m) elevation. Economically, it serves as a biological control agent by feeding on Isopterous, Dipterous, and Coleopterous insects (Illingworth 1926). However, it is also a direct or indirect pest. Carter (1973) stated that the gray pineapple mealybug *(Dysmicoccus neobrevipes* Beardsley*)* depends on the activity of the BHA for its vigorous growth and reproduction. The mealybug is one of the important vectors transmitting the pathogen of the pineapple mealybug wilt disease (Beardsley et al., 1982). Thus, ant control is essential for control of the disease. The BHA can also act as a vector itself. Evans (1973) reported that the BHA transmits *Phytophthora palmivora* (Butl.), the pathogen of the cocoa black spot disease, by carrying the infected plant materials or soil particles from the tree base to the pots near the crown on which the ants are tending species of Homoptera. The BHA was also reported to attack plastics used for sheathed telephone cables in Australia (Brimblecombe 1958) and for drip irrigation tubes in Hawaiian and Australian sugarcane fields (Chang and Ota 1976, Chapman 1981). At present, the Hawaiian sugar industry has converted approximately 32,000 ha of sugarcane land from furrow irrigation to drip irrigation. The problem of ant damage to drip tubes has become a serious threat to the well-being of the industry (Ota and Chang 1978).

Toxic baits and toxicants injected into the drip irrigation system have been used to control ants in the sugarcane fields (Ota and Chang 1980). However, some of the treated fields were reinfested by ants within 3 to 12 months after a single treatment. One of the possible explanations for such reinfestation is that the toxicant applied did not kill the queen and therefore the colony later revived. However, it was not certain if the surviving queen(s) from an established colony could reproduce and nurse the young to adulthood on her own without the worker ants in the colony. Phillips (1934) with *P. megacephala,* Gregg (1942) with *P. morrisi* Forel, and Stringer et al. (1976) with *Solenopsis invicta* Buren all failed to establish colonies from queens of field colonies if there were no worker ants. Yet, Wilson (1971) observed that queens of young *P. fallax* Mayr and *S. saevissima* (F. Smith) colonies could resume brood care if the colonies suddenly were deprived of worker ants.

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We report here some studies on the role of different castes and the population required to revive a colony of *P. megacephala*. Also, the inability of queens and major workers to nurse immature stages is indicated. Additional notes on the developmental time of the BHA are presented and discussed.

MATERIALS AND METHODS

Collection and maintenance of laboratory stock colonies

BHA colonies can be easily found in moist areas, usually under rocks, plastic pipes, and plant debris. They are also common in leaf litters, old hollow cane stalks, and stumps. The colony used in this study was scooped up together with soil and plant materials and brought back to the laboratory in a plastic tray (54× 41 × 13 cm) the interior walls of which were coated with Fluon AD-1 liquid (Northeast Chemical Company, Woonsocket, RI) to prevent ants from escaping.

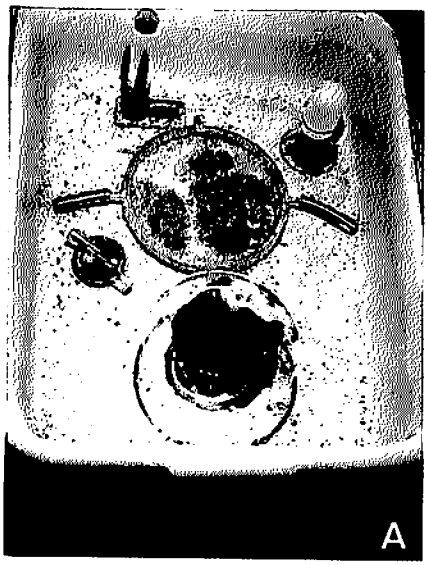
For an artificial ant nest, either the Wilson cell (Wilson 1962) or the Bishop nest (Bishop et al., 1980) was adapted. Both of these nests were filled with 30 g water-saturated dental stone (Sydron/Kerr, Emeryville, CA). Holes (3 mm diameter) for ant passages were drilled on the petri-dish wall, just above the layer of hardened dental stone.

A dry method was used to separate ants from debris. An empty artificial nest covered by several layers of moist paper towels was placed on top of a mound of ant-debris mixture in a plastic tray. When the debris dried up, the BHA moved its colony into the moist paper towels and into the artificial nest that was then taken out and placed in a fresh, clean plastic tray. During the drying process, debris without ants was gradually removed from the tray. The few ants in the remaining debris were separated by putting the ant-debris mixture in an elevated, shallow petri-dish (14.5 cm × 1 cm) (Fig. 1A) inside the tray. The exterior, vertical walls of the petri-dish and the elevating post were painted with Fluon. Ants in the debris could climb over the dish rim and fall into the tray below, but the ants in the tray could not climb up the post to rejoin the ants in the elevated dish, because of the slipperiness of the Fluon material. In a day or two, all live ants left the dish and joined the other ants in the tray.

The BHA colonies required a constant supply of water and a moist environment to thrive. Humidity inside the artificial nest was kept near a saturation point by adding drops of warm water through passage holes, or by connecting a water bottle to the nest through a wick embedded in the dental rock (Fig. 1B). Water was also provided outside the nest with a bird feeder or a self-filling water dish placed in the foraging area (Fig. 1A). Honey-water (50%) and artificial ant diet (Banks et al., 1981) were given about twice a week. For ease of observation, the nest was not covered or darkened. Ants were reared at 26° to 27°C, 50% RH, and 8 hours light from 7 a.m. to 3 p.m.

Procedures for studying colony revival and life history

Test colonies were maintained in plastic storage boxes 31.5 × 17 × 8 cm (Fig. 1B) and furnished with water, food, and honey in a similar manner as the stock colonies. Five types of experimental nest compositions, with six replications each, were organized to study colony revival: nests were stocked with (1) a single queen, (2) a queen and 10 minor workers, (3) a queen and 10 larvae, (4) a queen and 10 major workers, and (5) a queen and 10 pupae. The nest activities and numbers of eggs, larvae, pupae, and adults in each were recorded daily except on weekends for 7 weeks. The developing time recorded for egg, larval, and pupal stages was the average minimum time recorded for each stage. This was done because the queen of



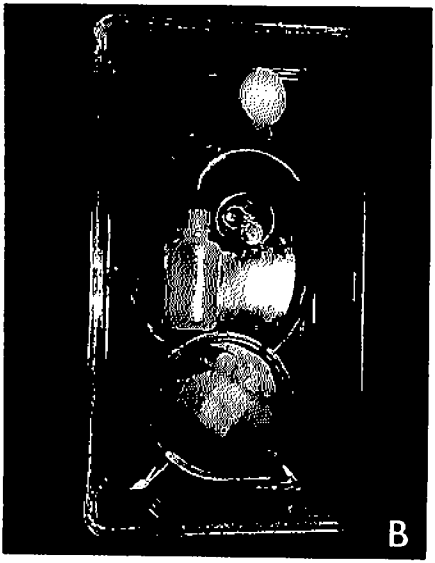


FIGURE 1A. BHA was reared in a Wilson-cell type artificial nest housed in a plastic tray which served as a foraging arena. Two types of water dish were used, one was a bird feeder and another was a self-filling water dish seen at the top left and right corners of the tray, respectively. Honey water and artificial food were placed in a bottle cap near the nest at the center. An elevated petri-dish used to separate ants from debris was located at the lower end of the tray.

FIGURE 1B. A test population housed in a "Bishop nest" and maintained in a plastic storage box.

each nest was not removed after oviposition on the first day. The eggs laid on the first day and on the subsequent days were mixed, thus the developing time of each individual egg could not be followed. Only the minimum days of an egg hatching into a larva were recorded and averaged.

Method of studying nursing ability of the queen and the major workers

The nests containing either mature queens alone or queen and major workers were offered 0.1% calco red dye in soybean oil in the foraging area. If the queen or the major worker nurses the larvae through trophallaxis, the red color of the dye is readily seen through the larval cuticle.

Additional evidence of nursing was collected by observing the development of the first instar larvae in the nest.

RESULTS AND DISCUSSION

Colony revival

Among the five experimental nest compositions, only the nests with a queen and 10 pupae had an increasing worker population 7 weeks after the initiation of the test. The six replications had an average of 30 eggs, 9 larvae, 2 pupae, and 12 minor worker per nest (Table 1). The original 10 pupae in the nest eclosed to minor workers within 1 week. They took care of the queens and nursed the young to maturity. Of the original 10 workers eclosed from pupae, an average of 6 died after 7 weeks. The 4 surviving ones were joined by 8 new workers to share the nest duties. The nests were vigorous and on their way to recovery after 7 weeks.

The nests with a queen and 10 minor workers had an average of 3 minor workers per nest at the end of the test (7 weeks). The original 10 minor workers in each of six replications were dead. The workers found in the nests were new ones reared from eggs. Two of the 6 queens died during the test and their nests subsequently perished. The remaining 4 nests were very weak and their fate was uncertain when the study was terminated after 7 weeks.

The nests with a queen and 10 major workers produced no minor workers during the test period. The nests had eggs and newly emerged larvae, but none of these larvae were nursed by the major workers. The larvae lived for a few days, then disappeared. No larvae were seen carrying the red calco dye internally. However, if a nest had fourth instar larvae, the major workers were seen carrying pieces of insect fragments to the larvae, which matured later to pupae and adults.

In an additional test, we tried to revive two nests with one queen and 200 major workers each. A few eggs hatched but none of the larvae reached the second instar, and eventually all larvae disappeared.

The nests with the queen alone or with a queen and larvae only, died 2 to 3 weeks after the initiation of the test. The queen could forage for food and water for herself, but she did not care for the eggs she laid or the larvae in the nest. A few eggs hatched and the larvae survived for the first couple of days, but eventually they all died of starvation or disease, or disappeared.

The test results confirm that the BHA queen from a mature colony cannot establish a colony on her own without the care of the minor workers. However, this is not to say that if all the workers in the field are killed by an insecticide, the colony will not be revived. In Hawaii, a BHA colony has multiple queens and many young, including pupae, all year round. If one queen survives the chemical treatment, along with the non-feeding pupae, the colony is likely to revive if there are enough pupae in the colony. So it is important in a chemical control program to kill the queens. In searching for an effective chemical or bait toxicant, it is important to screen against the queens instead of only the workers.

Ten young minor workers newly eclosed from pupae are possibly the minimum number of minor workers a colony needs in order to revive. Phillips (1934) kept one BHA colony going for 3 months with one queen, one major worker, and 12 minor workers. He suggested, however, in general, a colony needs at least 50 minor workers to succeed. Gregg (1942) established a *P. morrisi* colony with one queen

TABLE 1. Nest composition 7 weeks after mature queens of *Pheidole megacephala* were isolated with various castes or immatures.[a]

	Average number of individuals per nest 7 weeks after initiation of test					
Type of nest	Queen	Egg	Larva	Pupa	Minor worker	Major worker
Queen + 10 pupae	1	30	9	2	12	0
Queen + 10 minor workers	0.67	14	11	2	3	0
Queen + 10 major workers	1	49	3	0	0	6
Queen + 10 larvae	0	0	0	0	0	0
Queen	0	0	0	0	0	0

[a]6 replications for each type of nest

and 12 minor workers. He failed to start colonies with only 5 minor workers and 2 major workers. Stringer et al. (1976) established colonies of *S. invicta* by using one queen, 25 workers, and 25 immature forms. In our tests, if we used minor workers from field colonies, more than 10 minor workers were needed to start a colony.

The major workers were seen carrying the eggs and first instar larvae around, but we did not have evidence indicating they nursed the first instar larvae with liquid foods. Wilson (1978) also reported that the major workers of *S. geminata* (Fabr.) do not engage in brood care. However, Gregg (1942) reported that the young of *P. morrisi* were brought to maturity in pure major worker colonies. He did not specify the number of eggs or the instars of larvae in the colonies when he started the test, so it is difficult to judge if the new workers obtained were reared from eggs or from the fourth instar larvae.

Life history

While conducting the colony revival tests, data on the life history of minor workers of *P. megacephala* were obtained.

The queen deposited eggs in groups consisting of 2 to 82 eggs per group on random days. The interval between egg-laying could last up to 8 days. In 31 days, a queen laid from 97 to 292 eggs, averaging 6 eggs per queen per day. Not all these eggs hatched, however; some were eaten by newly hatched larvae or workers in the nest. In our test, only 38% of the eggs turned to larvae.

Eggs took 6 to 11 days to hatch with the majority hatching at 7 to 10 days. The larvae required 9 to 21 days to mature with most requiring 16 to 17 days. The pupae took 7 to 11 days to become minor workers. A generation of minor workers took 34 to 38 days to complete its life cycle under experimental conditions.

Phillips (1934), in life cycle studies of the minor workers of the BHA, gave an average cycle of 59 days at 24.5° to 26.7°C. He listed 17 days for the egg stage, 23 days for the larval stage, and 19 days for the pupal stage. This is more than 1.5 times the days needed in the present study for the BHA to complete its life cycle. Fluker (1969) reported a life cycle of 66 to 78 days at 20° to 22°C. He gave 19 to 23 days for the egg stage, 28 to 32 days for the larval stage, and 19 to 23 days for the pupal stage. The low temperature he used to rear the BHA would certainly prolong the days needed for ants to reach maturity.

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