SOME ASPECTS OF THE REPRODUCTIVE BIOLOGY OF *ONTHOPHAGUS GAZELLA* (F.) AND *ONTHOPHAGUS RECTECORNUTUS* LANSB. (COLEOPTERA: SCARABAEIDAE)[1]

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(With a plate)

Key words: *Onthophagus gazella, Onthophagus rectecornutus,* biology, nesting

Reproductive biology of *O.gazella* was studied in the laboratory. The duration and size of different developmental stages were recorded. On the average the development from egg to adult took 41.3 days. Hatching of an egg of *O. gazella* and larval emergence were observed under a stereo microscope. Mites belonging to *Caloglyphus karnatakensis* were found feeding on the eggs of *O.gazella* and the fungi *Beauveria* sp. and *Metarhizium* sp. infected their pupal stage. *O.rectecornutus* took 31.8 days to complete its life cycle.

INTRODUCTION

Various species of *Onthophagus* have been extensively studied (Fabre 1897, Main 1922, Sim 1930, Lindquist 1933, Ritcher 1945, Halffter and Mathews 1966, Tyndale-Biscoe *et al.* 1981, Fincher and Hunter 1987, to cite a few). Halffter and Edmonds (1982) have defined seven nesting patterns of dung beetles. Onthophagini fall under pattern I. Pattern I is characterized by the following characters: a) very high fecundity, b) larval food in the form of a brood mass, c) construction of pupal chamber by the larva within the brood mass. Rougon and Rougon (1980) reported that *O.gazella* took 41 days to complete its life cycle. Lee and Peng (1982) worked on the nesting density and progeny size of *O.gazella. O.gazella* has been introduced to Australia (Lee 1979) and to Solomon islands (Stapley 1979) for the biological control of bush flies. As *Onthophagus* is the largest genus in the entire animal kingdom (Matthews 1976) many of the species have been poorly studied. In this connection an attempt was made to study the reproductive biology of the two commonly occurring South Indian species — *O.gazella* and *O. rectecornutus.*

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MATERIAL AND METHODS

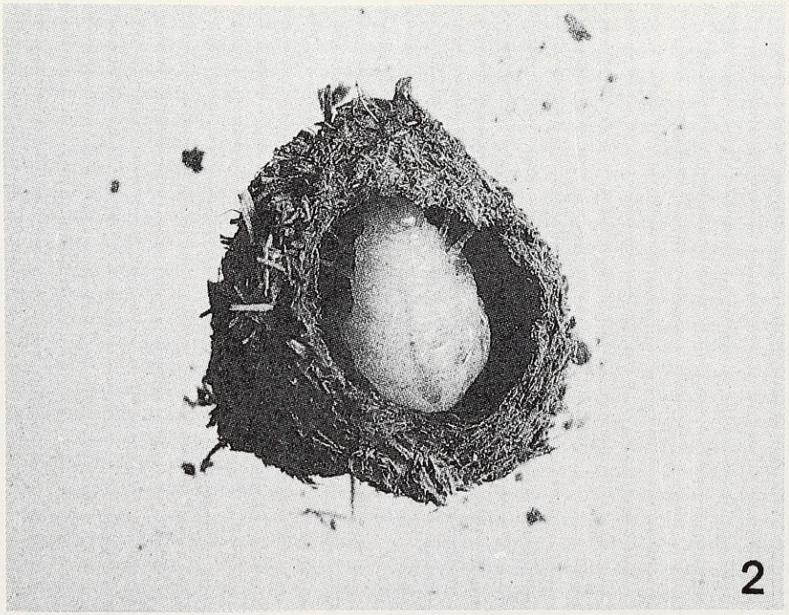
This study was conducted in Hebbal, which is on the outskirts of Bangalore, Karnataka. The mean minimum temperature, mean maximum temperature and total annual rainfall were 18.2°C, 29.8°C and 548.3 mm, respectively.

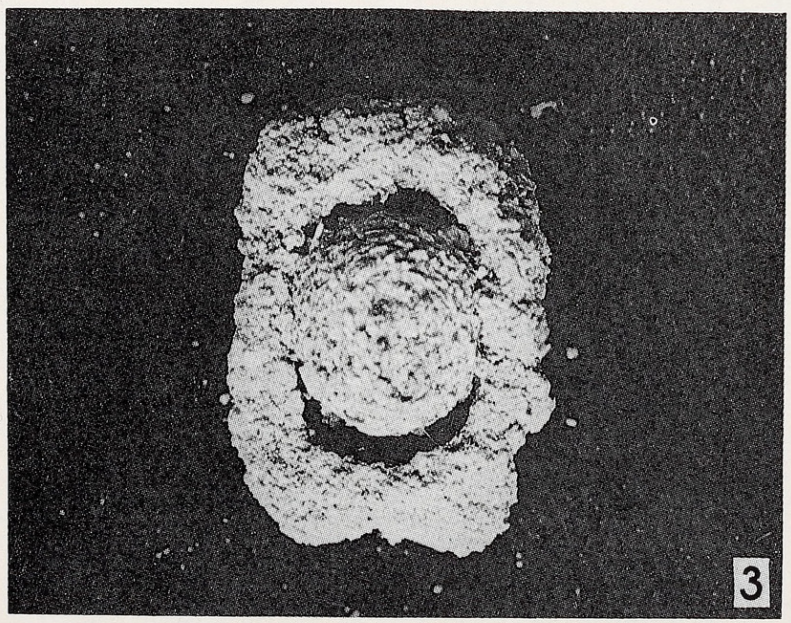
Adults of *O.gazella* and *O.rectecornutus* were collected from cow dung pats and also from the soil beneath dung pats in pastures. *O.rectecornutus* were found in large numbers in shaded dung pats.

Glass jars (33.5 cm x 10.5 cm) were filled with moist soil and freshly deposited cow dung was dropped on the soil. Five pairs of beetles of either sex of the same species were released in the jars. The top of the jar was covered with a wire gauze and the jars were kept in the dark. After about 5-8 days the soil from the jar was removed carefully and the brood of each species was maintained in plastic boxes with moistened soil. Duration and size of different developmental stages were recorded. Observations were also made on nest construction and mating of *O. rectecornutus* in the glass jars. Observations were made on the nature of emergence of the larva of *O.gazella* from the egg using a stereo microscope.

RESULTS

Adults of *O.gazella* emerged after the first showers in May. They were found from May to





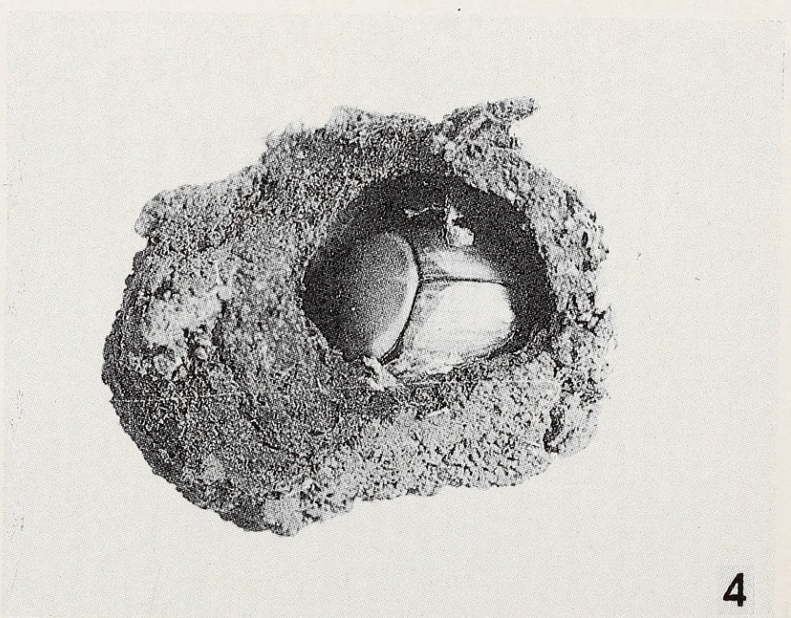


Fig. 1. Cylindrical brood masses of *Onthophagus gazella* (F.); Fig. 2. Intial stages of cocoon construction by *O.gazella* (F.); Fig. 3. Cocoon of *O. gazella* (F.) in brood mass; Fig. 4. Newly formed adult of *O. gazella* (F.) in the cell.

February with peak population in May.

Feeding: Adult beetles were found feeding either in dung or in shallow vertical tunnels beneath the dung. They dug tunnels underneath the dung and filled the tunnels by bringing dung little by little from the surface. These food burrows were made 5-6 cm deep. In this fashion the males and the females fed separately in their individual food burrows for 8-10 days.

Brood burrows: After the completion of the feeding period males and females were found together in much deeper burrows (16.5 ± 3.0 cm, n = 8). A broad ended burrow was constructed and the female provisioned it with dung. Sometimes the male helped her. After filling 3/4 of the broad ended tunnel she laid an egg in it and closed the egg chamber with a layer of dung. Following the construction of one brood mass she excavated a neighbouring cavity in which she fashioned a second brood mass. The brood masses were cylindrical in shape. The average length, width and weight of brood masses are 40.6 ± 0.03 mm, 16.0 ± 0.08 mm, 8.4 ± 0.9 g (n = 15), respectively (Plate 1, Fig. 1).

Egg: The egg was laid in the egg chamber which stood in a vertical position. The inner side of the egg chamber was smeared with the excreta of the female. The eggs were elongate, cylindrical and creamy white. Later on the egg increased in size and became spheroidal in shape. Those eggs which were lying on their sides became black and never hatched. On an average a female laid 6 eggs in one nest in the laboratory. The measurements of the eggs are given in Table 1.

Hatching: Close to hatching, the egg shell became transparent and the 'V' shaped larva was clearly visible through the chorion. The larva emerged with its abdominal end first. It contracted and expanded its body several times. After some time the head also emerged. The larva withdrew its abdominal end many times and stretched its body and touched the distal end of the abdomen with the head and shrank back. This was repeated many times till it completely freed itself from the shell.

The newly emerged larva was transparent, with only the tips of the mandibles being dark brown.

TABLE 1
DIMENSIONS OF DIFFERENT LIFE STAGES OF *O. gazella* AND *O. rectecornutus* IN mm

		N	Min.	Max.	Average	S.D.
O. gazella						
Egg stage I	L	8	2.5	3.5	3.1	0.2
	B	18	1.0	1.5	1.4	0.1
Egg stage II	L	7	3.0	4.0	3.3	0.3
	B	7	2.5	2.0	2.07	0.1
Larva I instar		25	9.0	15.0	11.4	1.7
Larva II instar		25	15.0	20.5	18.5	1.3
Larva III instar		18	17.0	24.0	20.1	1.5
Pupa	L	22	9.4	13.0	11.2	0.8
	B	22	6.0	8.5	7.4	0.7
Cocoon	L	29	13.0	18.0	16.1	1.2
	B	29	10.0	12.5	11.2	0.7
O. rectecornutus						
Egg stage I	L	15	2.7	2.8	2.75	0.1
	B	15	0.9	1.2	1.1	0.09
Egg stage II	L	16	2.8	3.3	3.0	0.12
	B	16	1.6	1.9	1.7	0.09
Larva I instar		25	9.0	12.0	10.9	0.9
Larva II instar		25	14.5	17.5	16.1	0.8
Larva III instar		25	17.5	25.0	20.4	1.9
Pupa	L	26	9.0	11.5	10.2	0.6
	B	26	5.5	7.0	6.3	0.3
Cocoon	L	11	11.0	14.0	11.6	0.9
	B	11	9.5	11.0	9.70	0.6

L= Length; B = Breadth

All the legs on each side appeared to be attached to each other distally.

Larva: The larva had its characteristic hump which it used as a pivot when it fed on the dung in the brood mass. For the first few days the hump remained transparent.

These larvae once taken out of their brood masses were seen moving on the lateral sides of their abdomen and never used their legs. They excreted a greyish brown semi-solid paste. Using this material they repaired any damage to the brood mass. From the second instar onwards the larva started biting with its mandible once disturbed. The measurements of different larval instars are given in Table 1.

Whenever a larva was placed in an artificially fashioned dung ball with a cavity bigger than what

the larva required, the volume of the cavity was reduced so that it fitted against the larval body. It did this by pulling and remaking the inner wall of the brood mass with its mandibles.

Cocoon construction: Towards the end of the third instar the larva started constructing a cocoon or pupal cell. A greyish brown paste was excreted from the abdominal end and held on the truncated end of the abdomen till it dried partially (Plate 1, Fig. 2). The larva constructed the cocoon till 3/4th of it is finished and then used its mouth parts to extend the paste and spread it across the opening.

TABLE 2

NUMBER OF DAYS TAKEN TO COMPLETE EACH LIFE STAGE OF *O. gazella* AND *O. rectecornutus*

O.gazella

	N	Min.	Max.	Average	S.D.
Egg	5	5	6	5.4	0.54
Larva	5	25	28	26.2	1.22
Pupa	6	10	12	11.16	0.98
Total life cycle	5	40	44	41.4	2.60
O. rectecornutus					
Egg	10	3.0	5.0	4.0	0.47
Larva	5	17.0	21.0	19.0	2.00
Pupa	9	9.0	12.0	10.88	1.05
Total life cycle	10	30.0	35.0	31.8	1.93

During this process the construction collapsed many times. Inspite of this, the larva worked continuously till the whole cocoon was completed. The inner surface of the cocoon was very smooth and the outer surface coarse. These cocoons could be easily separated from the brood mass. The upper 1/3 of the cocoon easily came off as a cap when a little pressure was applied on that region (Plate 1, Fig. 3).

By the time the larva finished constructing the cocoon, it had become creamy white, and its alimentary canal was entirely empty.

The larva then attained the prepupal stage and did not feed further. The larva had considerably shrunk in size and showed very little movement even when disturbed. The cocoon length and breadth are given in Table 1.

Pupa: The newly formed pupae were creamy white, shiny, with five pairs of finger-like processes on the dorso-lateral region of the abdomen. Later on, the pupae turned golden brown in colour with the tips of fore tibiae and clypeus being dark brown. Sexual dimorphism was evident in pupae. The male pupae had two horns on the head along with a median projection, whereas the female had only the median projection. The average length and breadth of the pupae are shown in Table 1.

Adults: Once the adults emerged they stayed in the cocoon for about 3-4 days (Plate 1, Fig. 4). They made their way out by boring a hole in the brood mass and entered the soil. Adults took 3-4 days to develop pigmentation. The last three abdominal segments were left exposed in a newly formed adult. The durations of different developmental stages are presented in Table 2.

Natural enemies of *O. gazella*: 75 pupae were affected by the white muscardine disease (*Beauveria* sp.). Some of the newly formed adults also had the fungus appearing white and fluffy all over their bodies. Twelve pupae were affected by green muscardine disease (*Metarhizium* sp.). In both the cases the pupae were immobile. In addition mites belonging to *Caloglyphus karnatakensis* (Acari: Acaridida: Acaraidae) were found feeding on the eggs.

Biology of *O.rectecornutus*: Biology of *O.rectecornutus* resembled *O.gazella* in many respects. However there were some differences like the number of days taken for development of each life stage, the number of eggs laid by the female, etc.

Adults of *O.rectecornutus* were found throughout the year with a peak population during the month of December.

Feeding: Adult beetles fed in shallow food burrows which measured 4-5 cm. These food burrows were inhabited by both sexes separately. They fed in these food burrows for a week and then started making brood burrows.

Brood burrows: The brood burrows were long (12 ± 2 cm, n=7) with a broad brood chamber at the

base. The females constructed the brood chamber either alone or in cooperation with a male. A detailed description of a pair constructing a nest and mating is given below.

A vertical tunnel was constructed below the dung pat and both the male and female were seen moving in the tunnel. The male carried dung from the top and deposited it midway. The interaction between the male and the female was observed only once when the male met the female who was coming up the tunnel. Initially, he appeared to behave aggressively by butting her with his clypeus. Then he pushed the female and stood above her and copulated with her, supporting himself by leaning on the walls of the tunnel (soil and glass wall) with his front legs. During mating the female exhibited some backward jerking movements. They mated for 2 minutes and 30 seconds.

The male collected the dung with his forelegs and moved down the tunnel and deposited it midway down the tunnel. The female went upwards and collected the dung with her forelegs and moved down the tunnel with her rear end first. She brought it to the broad end of the chamber and packed it against the wall of the chamber. When the male did not bring a sufficient quantity of dung the female virtually scraped the place and collected whatever dung was sticking against the walls of the burrow and brought it down the chamber. Sometimes she was also seen dropping dung down the tunnel without carrying it. When the male did not return she herself went and brought the dung. Now and then the male and female met each other but they behaved calmly without exhibiting any hostility towards each other.

The brood masses are cylindrical in shape. The number of brood masses varied between 10 and 15, the average being 12 brood masses per nest (12 ± 2.5, n = 5). The average length and breadth of the brood masses was 34.7 ± 0.33 mm, and 11.3 ± 0.11 mm (n=15), respecively.

Egg: The egg was cylindrical and creamy white in colour and resembled that of *O. gazella* but for the size. The measurements are given in Table 1.

Larva: The larva resembled that of *O.gazella* in all instars but for the measurement (Table 1). Behaviours such as movement, cocoon construction, repairing the damage of brood mass was similar to that of *O.gazella.* The pupae were also similar to that of *O.gazella.* The measurements of different larval instars and pupae are given in Table 1.

The number of days taken to complete the developmental stages are presented in Table 2.

Discussion

There are two types of nests in Onthophagini. They are simple nests and compound nests (Halffter and Edmonds 1982). Both *O.gazella* and *O.rectecornutus* belong to the latter nesting type as they produce several brood masses in a single nest. *O. gazella* produced 6 brood masses per nest whereas *O. rectecornutus* produced 12 brood masses per nest. Halffter and Edmonds (1982) have reported that *O. gazella* is a prolific breeder and produces about 180-200 brood masses per female. Here the reduction in number of brood masses may be due to the restricted place that was provided for the breeding pair. As the brood masses of *O.rectecornutus* were smaller than those of *O. gazella,* more brood masses were produced. Even though there is no true cooperation between the male and the female as in *Copris* spp. (Halffter and Edmonds 1982), there was some assistance from the male to the female in bringing the dung to make the brood masses.

Rougon and Rougon (1980) studied the biology of *O.gazella* and reported that it needs 41 days to complete its life cycle. In the present study it was found that while *O.gazella* took 41.3 days to complete its life cycle *O. rectecornutus* took a shorter time of about 31.8 days. This is because of the short larval stage of *O.rectecornutus.*

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