International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Study of Nidification Behavior in Three Dung Beetle Species (Scarabaeidae: Scarabaeinae) From South-Western Maharashtra, India

A. R. Gaikwad[1], G. P. Bhawane[2]

[1]Department of Zoology, Mudhoji College, Phaltan, India

[2]Department of Zoology, Shivaji University. Kolhapur, India

Abstract: ***Nidification behavior in three dung beetle species (Scarabaeinae: Scarabaeidae) were studied. In Onthophagus catta and Onitis philemon the nidification behavior were studied under the laboratory condition while in Liatongus rhadamistus field observations were made. O. catta construct simple nest composed of single unbranched vertical gallery. At bottom end of each gallery, brood balls are lodged. O. philemon construct a simple unbranched numerous and extensive vertical galleries which leads to the enlarged chamber at the bottom , wherein large amount of dung was carried initially for the construction of brood balls. Field observations regarding nidification in L. rhadamistus indicates that just beneath the dung pads up to 9 cm deep, depression of various sizes were constructed for lodging the brood balls. These are the brood chambers. The number of brood balls lodged in each chamber depends on size of the brood chamber. The sizes of brood balls as well as depth of the brood balls constructed by these dung beetles were also studied.***

Keywords: Dung beetles, *Onthophagus catta, Onitis philemon, Liatongus rhadamistus*, nidification, brood balls.

1. Introduction

The insects belonging to subfamilies Coprinae and Scarabaeinae (Scarabaeidae) are considered true dung beetles. They feed on dung; use it to provide housing and food for their larvae. Scarabaeinae beetles are belonging to burrower and roller functional groups. This type of nidification behavior is essentially accompanied with the horizontal and vertical translocation of larval food in borrowers and rollers respectively. The feeding activity of these dung beetles disturbs the dung droppings and creates an unfavorable condition which makes difficulties for survival of dipterous flies. Dung beetles play a small but remarkable role in the pasture ecosystem, improve nutrient cycling, soil structure, and forage growth in the meantime.

Thus, the dung beetles constitute economically important group of beetles, abundant and well distributed in South-western Maharashtra-India; represented by large number of species (Arrow, 1931). However, scant information is exists on the life-cycle pattern, ecology and nidification behavior of Indian dung beetle species. The study on some aspects of behavior of *Catharsius molossus* was done by Veenakumari and Veeresh (1993). Phylogenetic and karyotypic study of Indian scarab beetle was made by Yadav *et.al.* (1990).

An attempt has been made here to study the nidification behavior in three dung beetles species from South-western Maharashtra viz. ***Onitis philemon*** **(Fabricius)**, ***Onthophagus catta,*** **(Fabricius)** and ***Liatongus rhadamistus*** **(Fabricius).**

2. Material and Methods

Collection of dung beetles: These species of dung beetles are most abundant in study area. As these dung beetles are powerfully attracted towards fresh cattle dung, therefore, they are easily collected from the dung pads. One to three days old pads were selected for the collection purpose. The collection was made in the morning hours between 8 to 10 a.m.as and when necessary. The brood balls of *Liatongus rhadamistus* were collected mostly from Phaltan region.

Laboratory Maintenance and Rearing: The adult dung beetles were maintained under laboratory conditions in convenient sized earthen pots. Rearing method proposed by Blume and Aga (1975) and Hunter *et.al.* (1991 and 1996) was followed. Rearing medium was the same sand-soil mixture; the soil used in pots was obtained from collection sites. The mixture of sand and soil was adequately moistened with tap water. The fresh dung of the cattle was regularly provided as food to the beetles. Earthen pots containing beetles were covered with other same sized inverted earthen pots, which simulate the condition of darkness and prevents the escape of the beetles from the pots. These earthen pots were kept in large plastic troughs containing moist sand which maintains required moisture content of sand and soil mixture. By this method the selected dung beetle species can be easily maintained under laboratory conditions with minimum mortality. The beetles in earthen pots maintained at laboratory temperature of 22 to 26 °C.

In *Onitis philemon* and *Onthophagus catta* the nidification were studied in laboratory. The adults were reared in laboratory as mentioned above. In this method a pair of dung beetles was placed in each of five separate earthen pots with cattle dung. After 3-6 days parent beetles and remaining dung were removed from the soil surface. The number and distribution of the burrow were noted and sketched. The content of the earthen pots were poured carefully in a tray. Then soil was immediately examined for brood ball and depth of brood balls were recorded without much disturbing the soil of earthen pots.

Licensed Under Creative Commons Attribution CC BY

The nidification behavior of *Liatongus rhadamistus* was observed in the fields.

3. Result and Discussion

Under laboratory conditions, nidification studies indicates that the *Onthophagus catta* construct simple nest composed of single unbranched vertical or incline galleries. At bottom end of each gallery, brood balls are lodged (fig no.7.B). On the other hand *Onitis philemon* construct a simple unbranched numerous and extensive vertical galleries which leads to the enlarged chamber at the bottom , wherein large amount of dung was carried initially for the construction of brood balls.(fig no.1 and 7.A). Field observations regarding nidification in *Liatongus rhadamistus* indicates that just beneath the dung pads up to 9 cm. deep, depression of various sizes were constructed for lodging the brood balls. These are the brood chambers. The number of brood balls lodged in each chamber depends on size of the brood chamber (fig no.2, 3, 4, 5, 6.and 8).

The length of *Onthophagus catta* brood ball (table no. 1) ranged between 22 to 34 mm with mean length of 27.7 ± 3.79 mm. The diameter of brood ball ranges between 13 to 18 mm and mean diameter value is 15.4± 1.49mm. It is observed that single pair constructed 10 to 35 brood balls in laboratory condition. It was observed that the depth of brood ball constructed ranges between 6 to 22cm.

The length of *Onitis philemon* brood ball (table no. 1) ranges from 80 to 95 mm with value 90.2 ±4.09 mm and diameter ranges from 50 to 70 mm with mean value 62.5± 6.22mm . It is observed that single pair of *Onitis philemon* laid as many as 5 to 8 eggs in dung mass of brood chamber which is then constructed into brood balls . The depth of the brood chamber ranges from 23 to 30 cm in laboratory reared beetles. Not entire mass of dung constructed in to the brood ball , only egg laid part was found constructed in ovoid elongated brood ball, while remaining dung mass of brood chamber remains surrounded with the brood balls.

The brood ball of the *Liatongus rhadamistus* almost spherical. The diameter of brood ball (table no. 1) ranged between 18 to 22mm with mean value 20.5± 1.28mm.

Halffter and Matthews (1966) have given four major nidification categories or groups. Within each of the four major groups, a number of variations usually represent separate evolutionary.

In present investigation the nidification behavior was studied in *Onitis Philemon* and *Onthophagus catta* in laboratory rearing method and to that of *Liatongus rhadamistus* observed in field. The observation indicates that nidification in *Onthophagus catta* may be placed under category I -B which was described by Halffter and Matthews (1966). In this group one egg is laid in relatively small dung mass packed into the end of a burrow. It was observed that this species create an oval mass of dung by first digging out a special cell. The dung is then brought down from the surface. When cell is almost filled; a small cavity is molded by the female in end of dung mass and egg in laid in it. The cavity then being covered over with a filtering plug of dung fibers and soil. The branch or section of the tunnel leading to the cell is then filled with soil and new cell began higher up. This observation is similar to that given by Burmeister (1930) in four European *Onthophagus* spp. The *Onthophagus catta* constructed simple unbranched tunnels with cells lying one above the other. This observation is similar to that in *Onthophagus coenobita* made by (Burmeister, 1930); *Onthophagus tarus* observed by Fabre (1918); *Onthophagus fucatus* by (Main, 1922). Some *Onthophagus* spp. shown branched vertical burrows which ends in to brood cells, e.g. in *Onthophagus nuchicornis* and *Onthophagus fracticornis* (Burmeister, 1930); in *Onthophagus medoresnsis* (Hunter *et.al*.1991).

The depth of brood ball construction in *Onthophagus* spp. was ranged between 6 to 22 cm. The first brood cells constructed by *Onthophagus catta* were always located at the most distal point of the soil surface. Cells subsequently constructed were found further up in the shallower soil. These results are similar to those of Howden and Cartwright, (1963), who reported depth of brood cells ranged from 5 to 12.7 cm. Ritcher (1958) reported depth of brood ball ranged from 5 to 22.9 cm in *Onthophagus hecate*. Similarity range of depth also observed by Halffter and Matthews (1966) in American *Onthophagus* spp. Veenakumari and Veeresh (1996) observed the depth of brood ball at 16.5 ± 3.0 cm in *Onthophagus gazelle* and *Onthophagus reticornustus*. The brood ball of *O. catta* have length ranges between 22-34 mm with mean value 27.7 ± 3.79 mm and width ranges between 13-18 mm with mean value 15.4± 1.49 mm. This result is comparable with results given by Hunter *et.al.* (1991) in *O. medoresnsis* (length ranges from 7.0-13.55mm); in *O. depresssus* (length range is 19-25 mm and width range is 15-17 mm) and by Veenakumari and Veeresh (1996) in *O. gazelle* and average length 40.6 mm and diameter width 16.0 mm. It is observed in present investigation a single pair of *Onthophagus catta* constructed 10 to 35 brood balls on laboratory conditions. These observations are related to Howden and Cartwright (1963) and Lindquist (1935). According to Howden and Cartwright a single female *O. I. texanus* may make 3 to 30 brood balls incapativity and female *O. alluvius* 20-40 brood balls. According to Lindquist 43-67 brood balls produced by a single female of *Onthophagus* spp. In any case the number is far larger than that seen in scarabs with more elaborate nidification behavior, even though *Onthophagus* spp. still has the highly reduced ovary is characteristics of Scarabaeinae (Halffter and Matthews, 1966).

Onitis philemon showed nidification which can be placed under group I-C which was described by Halffter and Matthews (1966). In this type of nidification several eggs are laid in very large dung mass accumulated in a spacious chamber. The observation on nidification of this beetle indicates that these beetles construct simple vertical galleries which leads to the enlarged chamber i.e. brood chamber at the bottom containing 5 to 8 eggs in the dung mass of brood chamber. It was then constructed into brood balls. Not entire mass of dung was constructed in avoid elongated brood ball, the remaining dung mass was found to be surrounded with the brood balls. These observations are not so similar to that given by Oberholzer (1959) in *Onitis euffer* and by Skaife (1953, quoted by Oberholzer,

Licensed Under Creative Commons Attribution CC BY

1958) in *Onitis aygulus*, both in South Africa. Several authors have claimed that the spices of *Onitis* like *Copris*, breaking the dung mass up in to separate ovoid and brooding (Paulian, 1941, Janssens, 1951). In spite of the rather emphatic assertions of these authors, doubt continues to remain primarily because of the absences of supporting details. It is possible that these authors were influenced by Chobaut's (1922) claim that *Onitis belial* nidification like *Copris.* But our field as well as laboratory observations showed clearly that these beetles construct an ovoid elongated brood ball in dung mass of brood chamber.

The length of *Onitis philemon* brood ball ranges from 80 to 95 mm with value of 90.2 ± 4.09 mm and diameter ranges from 50 to 70 mm with mean value 62.5 ± 6.22 mm. The depth of brood chamber ranges from 23 to 30 cm in laboratory reared beetles. There is no data on brood ball and their depth for comparison.

In *Liatongus rhadamistus*, nidification was observed in field. The observation on nidification showed a very different category of nidification. Halffter and Matthews (1966) made an artificial category to all species, which are known to differ radically in behavior and named it as aberrant nidification behavior. The observation on nidification behavior indicates that these beetles construct brood chambers up to 9 cm in depth with irregular shapes just below the dung pads. In these brood chambers, 3 to 5 brood balls were lodged according to size of the brood chamber. Similar type of nidification was found in *Eurysternus magnus* by Howden (1981). He observed that in a large cavity under the edge of dung mass, a pair of beetles had buried a quantity of dung of which they had made three balls. In present investigation, it was observed that a pair first makes brood balls and then constructs a brood chamber just below and along margin of dung pad. The brood balls were lodged in the brood chamber. The brood balls were found arranged properly. There is no literature available on similar type of nidification except *Eurysternus magnus*. But observations on *Liatongus rhadamistus* are quite different and are more similar to that given by Howden (1981) in *Eurysternus magnus*. There is no data available for comparison of brood ball, nidification, etc.

The brood balls of *Liatongus rhadamistus* were almost spherical. The diameter of the brood ball ranged between 18 to 22 mm with mean value 20.5 ± 2.8 mm.

Table 1: The size of brood balls and depth of brood ball formation in three dung beetle species

Species	Brood ball size				Depth of brood ball formation
	Length in mm	Mean +/- SD	Diameter in mm	Mean +/- SD	
Onitis philemon	80-95	90.2 ± 4.01	50-70	62.5 ± 6.22	23-30 cm
Onthophagus catta	22-34	27.7 ± 3.79	13-18	15.4 ± 1.49	6-22 cm
Liatongus rhadamistus	*	*	18-22	22.5 ± 1.28	Up to 9 cm

*Brood balls almost spherical hence diameter only considered.

4. Acknowledgement

Authors are thankful to the Head, Zoology Department, Shivaji University, Kolhapur and Mudhoji College, Phaltan for providing facilities.

References

[1] Arrow, G.J., 1931. The fauna of the British India, including Ceylon and Burma. In: Coleoptera Lamellicornia Part III (Coprinae). Taylor and Francis, London, p. 428
[2] Burmeister, F. 1930. Die Brutfiirsorge und das Bauprinzip der Gattung *Onthophugus* Latr. Zeitschriftfu'r Morphologie und Okologie der Tiere, 16,559-647
[3] Blume, R. R. and Aga, A.1975. *Aphodius* from burrows of a pocket gopher in Brazos County, Texas (Coleoptera: Scarabaeidae). *Coleopterists Bulletin*29:161–162.
[4] Chobaut, A.1922. - Mœurs de l'Onitis Belial. (Bull. Soc. ent. Fr., p. 264-2(6).
[5] Fabre, J.H. 1918 .The Sacred Beetle and Others, Hodder and Stoughton, London.
[6] Halffter, G. & Matthews, E.G.1966 .The natural history of dung beetles of the subfamily Scarabaeinae (Coleoptera, Scarabaeidae). Foliri Entomologica Mexicana. 12-14. 1-3 12.
[7] Howden, H.F. 1981. Random and infrequent dispersals, pp. 188-194. *In*: Vicariance Biogeography (G. Nelson and D.E. Rosen, eds.). Columbia University Press, N.Y.
[8] Howden, H. F. and Cartwright, O. L. 1963. Scarab beetles of the genus Onthophagus Latreille north of Mexico (Coleoptera: Scarabaeidae). Proceedings of the United States National Museum 114: 1–135
[9] Hunter, J.S., III, Fincher, G.T., Bay, D. E. and Beerwinkle, K.R.1991.Seasonal distribution and diel flight activity of Staphylinidae(Coleoptera) in open and wooded pasture in east-central Texas.J. Kans.Entomol.9:212-217.
[10] Hunter, J.S; Fincher, G.T. and Sheppard, D.C. 1996. Observations on the life-history of Onthophagus depressus (Coleoptera: Scarabaeidae).Journal of entomological science, 31:63-71
[11] Janssens, A.1951.Onitini (Coleoptera: Lamellicornia).Inst. Pares Nat. Congo. Belge. Explor.Parc. National Albert.Miss.G.F.de Witte.; 194b.149, 3:1-47.
[12] Lindquist, A.W. 1935. Notes on the habits of certain coprophagous beetles and methods of rearing them. United States Department of Agriculture. Circular 351.
[13] Main, H. 1922. Notes on the metamorphoses of *Onthophagus tarus*. In: Proceedings of the Entomological Society of London. 1922. p. xiv-xviii.

Licensed Under Creative Commons Attribution CC BY

[14] Oberholzer, J.J. 1959. A morphological study of some South African Lamellicorn larvae. I. Description of the third instars larvae. II. Comparative morphology. South African Journal of Agricultural Science 2: 41–88.
[15] Paulian, R.1941 Scarabaeidae. Fauna de France, v. 38.
[16] Ritcher, P.O.1958.Biology of Scarabaeidae. Annual Review of Entomology, 3:311-334
[17] Skaife, S. H. 1953. African Insect Life London Longmans Green and Co. 387.
[18] Veenakumari, K. and Veeresh, G.K. 1993. A Study of Some Aspects of the Behaviour of *Catharsius mollossus* (L.) and C. pithecius (F.) (Coleoptera: Scarabaeidae). Journal of the Bombay Natural History Society (1) 90:65-68.
[19] Veenakumari, K. and Veeresh, G.K. 1996. Some aspects of the reproductive biology of *Onthophagus gazella* (F) and *Onthophagus rectecornutus* (Lansb) (Coleoptera, Scarabaeidae). Journal of Bombay Natural History Society,Vol. 93, 252-256
[20] 20.Yadav, J.S; Pillai, R. K. and Yadav, A. S. 1990. Karyotypic study of some scarab beetles with comments on phylogeny (Coleoptera: Scarabaeidae). Elytron 4: 41-51.

PLATE NO.1

Figure 1: Nidification (marked) in *Onitis philemon*

Figure 2: Single brood ball of *L.rhadamistus*

Figure 3: Three brood balls of *L. rhadamistus*

Figure 4: Four brood balls of *L. rhadamistus*

Figure 5: Brood chambers with brood balls of *Liatongus rhadamistus*

Figure 6: Brood chambers without brood balls of *Liatongus rhadamistus*

PLATE NO.2

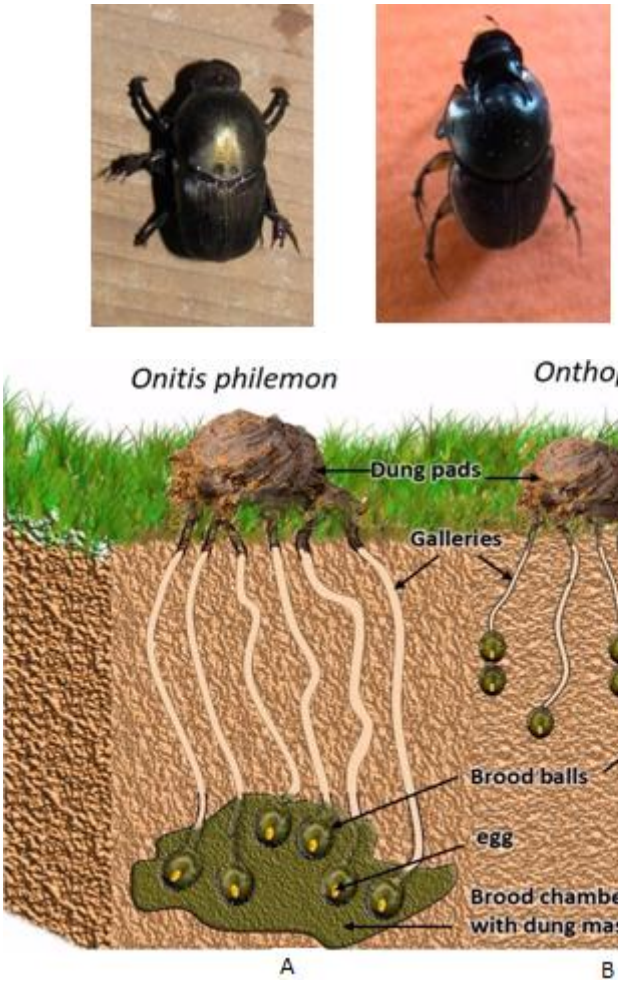

Figure 7: Nidification in *Onitis philemon* (**A**) and *Onthophagus catta* (B)

Figure 8: *Nidification* in *Liatongus rhadamistus*

Licensed Under Creative Commons Attribution CC BY