

SCIENTIFIC NOTE

PEELING DUNG PELLETS: AN UNRECORDED BEHAVIOR IN THE ROLLER DUNG BEETLE *SISYPHUS SCHAEFFERI* LINNAEUS (COLEOPTERA: SCARABAEIDAE: SISYPHINI)

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Sisyphus schaefferi Linnaeus, 1758 is a small (7–11 mm) roller dung beetle distributed in the central-southern Palaearctic, from the Iberian Peninsula and Morocco to China. The species lives in a large variety of open as well as closed habitats. According to the current literature (Halffter and Matthews 1966; Lumaret 1990; Martín-Piera and López-Colón 2000), *S. schaefferi* exploits feces of several mammal species (cow, goat, horse, red deer, and wild boar).

As a rule among the roller dung beetles, individuals of *S. schaefferi* can feed directly on the dung mass, but usually they relocate a portion of dung by making a ball, rolling it away, and burying it for feeding and nesting purposes (Prasse 1957). Several field observations carried out during three years on a natural population of *S. schaefferi* allowed us to record interesting behaviors performed by individuals responding to the constraints related to the hardness of the pellet covers.

The study area is located within La Mandria Regional Park, extending approximately over 3,100 ha, 10 km north of Turin (45°10'N and 4°54'W, Piedmont, northwestern Italy). The area lies at the border of the Padana Plain and extends over a high plain (ranging 254–402 m elevation) derived from old alluvial deposits dating back to the Mindel and Riss glaciations. The soils are acidic and usually rich in clay, so that rain drains away slowly. The area is a mosaic of wooded and open patches, approximately equally extended (51% woods versus 49% meadows). Woods are essentially dominated by a *Quercus-Carpinetum* community, while open habitats are characterized by heather, particularly where woods have been cleared, and grassy vegetation in pastures and

meadows. In 2014, 321 red deer and 73 fallow deer were counted in the Park. The wild boar population is large but its real size has not been correctly estimated because of technical bias (Focardi *et al.* 2001) but can be described by the number of animals selectively killed in 2013 (652) and in 2014 (506).

Field observations were carried out in the following periods: June–August 2012 (mean temperature 22.8°C, maximum temperature 30.1°C, minimum temperature 15.9°C, rainfall 183.6 mm); May–August 2013 (mean temperature 19.8°C, maximum temperature 26.9°C, minimum temperature 13.1°C, rainfall 450.0 mm); and April–August 2014 (mean temperature 18.1°C, maximum temperature 25.0°C, minimum temperature 11.7°C, rainfall 471.4 mm). Two transects of about 3.5 and 3.0 km were set out in wooded patches commonly used by wild mammals as shelter areas. Since *S. schaefferi* displays a diurnal pattern of activity, observations were made between 10:00 am and 6:00 pm once a week along both transects. The activity of each individual beetle was recorded by means of high resolution movies (1,920 × 1,080 pixels) obtained with reflex cameras Canon Eos 60D and Eos 70D, equipped with Canon 100 mm macro lens, without artificial light.

We found 264 single individuals and 42 pairs of *S. schaefferi* on wild boar and red deer droppings, whereas no individuals were detected on fallow deer excrement. A clear preference was recorded for adult male pads of red deer feces, while adult female pads were rarely used (one occurrence) because of their smaller size. Similarly, only adult wild boar excrement was usually exploited (one occurrence for young wild boar).

Our observations showed that *S. schaefferi* adults perform different tactics to manipulate the available excrement. When they exploit a large, more or less compact mass of dung, beetles make the ball by extracting a small portion from the pad. However, dung can be released by mammals as approximately spherical pellets more or less glued together. When pellets are too small but soft enough (dung of female deer or young wild boar in springtime), the beetles can merge together many pellets to obtain a single ball. On the con-

trary, if the pellet is of suitable size, the beetle can roll it away ($n = 11$) without any manipulation, as occurs in many other roller dung beetles. However, some pellets have a hard, smooth superficial crust. In this case, the beetle displays a behavioral variation that we describe here. It consists of removing the crust in order to obtain a ball easy to be utilized ($n = 18$).

When the beetle finds a crevice in the pellet's surface, it introduces its head under the crust and begins to raise an edge by moving the forelegs



Figs. 1-2. *Sisyphus schaefferi*. 1) Beginning to raise an edge of crust by pushing it with its clypeus; 2) With the dung ball and, on the left, the abandoned crust.

and pushing with the clypeus (Fig. 1). The beetle continues penetrating between the crust and the soft surface, thus causing the progressive detaching of the crust from the remaining dung mass. As the beetle carries on, it removes pieces of soft dung from the internal surface of the crust and joins and compacts them to create a new ball. The work ends when the crust is completely detached and abandoned by the beetle (Fig. 2). The entire operation requires 14–38 minutes for deer pellets and 9–23 minutes for wild boar pellets. Then the beetle, or the mating pair, can roll away the new ball. When the pellet's surface partially allows the beetle to grip it but it is exceedingly coriaceous, the beetle does not remove the crust but rather abrades the pellet's surface by scratching it with the forelegs to make it rough ($n = 6$). In this case, the detached dung pieces are usually compacted on the ball surface. However, both peeling and abrading behaviors can be performed on the same pellet when its surface is not homogeneously coriaceous ($n = 4$).

The above described behavior allows the beetles to confront two different problems caused by the hardness of the pellet's crust. The mandibles of dung beetles are both poorly sclerotized and very soft (Hata and Edmonds 1983), and they are not suitable to cut the hard pellet surface. Furthermore, our observations show that this crust makes it difficult to manipulate the pellet, because beetle legs have no grip on its surface. Thus, the beetle is forced to choose pellets with some crevices and reject the intact ones. Therefore, this behavior, hitherto unrecorded in the entire Scarabaeini tribe, allows the adults of *S. schaefferi* to utilize a trophic resource otherwise not exploitable.

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