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Take a Beetle to Lunch Today or The Natural History of Dung Beetles

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Take a Beetle to Lunch Today
or
The Natural History of Dung Beetles

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"No race can prosper til it learns that there is as much dignity in tilling a field as in writing a poem"–Booker T. Washington
"A gourmand he's not, but he'll clean up that spot"–Entomologist preferring anonymity

The appellation "dung beetles" refers to those scarab beetles that are usually found with animal feces either feeding on or depositing eggs in it. While this at first may seem like an incredibly unsavory topic, the fact remains that numerous creatures exist that feed on the waste products of other animals. And, as it turns out, it's a good thing they do.

The Scarabaeidae, or scarabs, is one of the larger families of beetles; it has 30,000 plus species worldwide and approximately 15,000 species in North America. (See my *Museum Notes* of March 1970.) The family is divided into subfamilies (based on structural distinctions) such as rhinoceros beetles, leaf chafers, dung beetles, and so on. The subfamily Scarabaeinae is commonly referred to as dung beetles, and it is about these marvelous animals that I would like to give a much needed perspective.

Most dung beetles are coprophagous, that is, they eat feces. Adult dung beetles feed copiously and ingest large amounts of fecal materials which contain undigested food remnants, products of secretion and excretion, bacteria, yeasts, and molds. Steak and potatoes it's not (unless, of course, it actually *once* was), but it is a nutritious mix nevertheless. Most dung beetles are opportunistic and feed on the excrement of many kinds of animals, but some species are specific for the feces of certain animals only. Adult and larval dung beetles possess various modifications in body structure for coprophagy ranging from elongated and bowed legs for handling spherical dung masses to mouthparts adapted for soft foods and teeth on the legs and head that are used for cutting and moving dung masses and burrowing in the soil.

The food used by most dung beetles is the feces of large mammals, particularly cattle and man. Dung beetle behavior and nidification (nest building) are adapted primarily to grassland and savanna conditions which is not too surprising since most excrement is to be found in pasture lands and other grassland areas. Grasslands probably support higher populations of dung beetles because of greater food resources whereas tropical forests enable a higher ecological and morphological diversity because a greater number of niches exist.

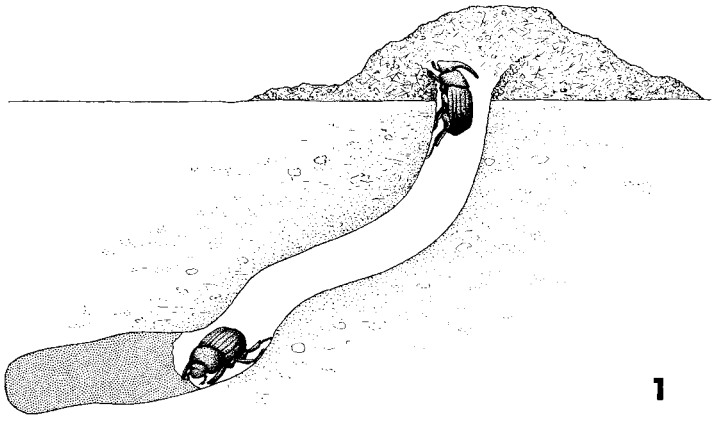


Fig. 1. Pair of Phanaeus *species in a feeding burrow beneath a mass of dung.*

The work of many researchers (Halffter and Matthews are emphasized in this report) suggests that dung beetles live almost exclusively in a world of smell and touch. Olfaction is the primary sense, and the antennae are used for chemoreception over long distances, and certain mouthparts are used at short distances. Vision is so poorly developed that there does not seem to be any visual perception of fecal food ("Praise the Lord," according to a friend of mine).

On the other hand, the sense of touch seems to be highly developed, especially in ball rolling species. Indeed, the ability to manipulate, shape, form, and move dung masses is often remarkable. Although we are not really certain how these beetles find dung masses, they probably engage in random search flights until they encounter odors in air currents. Many tropical forests species perch on leaves and branches with antennae extended to detect currents of odor which may lead to a food source.

Get It While It's Hot

Once food has been found, it may be treated in a variety of ways, depending on the species of beetle involved. Dung beetles handle food in four basic ways:

(1) Many species simply feed at the dung source on the surface of the ground without making a food ball for burial.

(2) Most species in this category excavate an underground chamber beneath or adjacent to the excrement (Fig. 1) using the head and forelegs as a shovel. A mass of dung is then detached from the main source and dragged down into the burrow where it is packed into place at the end of a tunnel to serve as food for the adults or larvae.

(3) The species in this category harvest a portion of dung from the main mass and move it by butting the feces with the head. This overland transportation is accomplished without forming the dung into a ball. *Phanaeus nimrod* has been observed to repeatedly ram and move a portion of dung a distance of 59 feet from the main dung mass . . . and in a straight line!

(4) The forming of a ball of dung is distinctive for most of the species in this group. The techniques for constructing and rolling such a ball are very highly developed. A rough, spheroid mass is first cut away from the principal dung mass, and it is then shaped and smoothed by repeated tamping with the forelegs. "A man-made dung ball will be readily accepted, but trimmed to proper size and shape if too large or not perfectly spherical. New material will be added if it is too small. A flat disc of dung will be made into a ball by pulling up on all the edges. A narrow cylindrical piece will be rolled into ball shape. When presented with scattered small pellets, the beetle will hold on to one with its hind legs and reach out to grasp others, pressing them to the first one to make a larger ball. A forming ball is never left to get more material, but always dragged along. A ball impaled on a vertical or horizontal pointer is freed (after some hesitation) by being cut in two and the halves stuck back together. The beetles also have an awareness of the weight of the ball. An artificial ball of the proper size but containing a lead weight will be torn apart, the weight removed, and the dung pieces put back together again . . . We thus see that the beetles have an acute awareness of the exact shape, size, and weight of the masses they are handling . . ." (Halffter and Matthews, 1966).

The dung ball is used as food for the adults (food ball) or for the larvae (brood ball). In general, a single beetle will construct and consume a food ball whereas a male-female pair will usually construct a brood ball in which to deposit an egg. The ball is formed at the dung mass, rolled away a certain distance (Fig. 2), and then buried beneath the surface where it is either consumed (if a food ball) or an egg

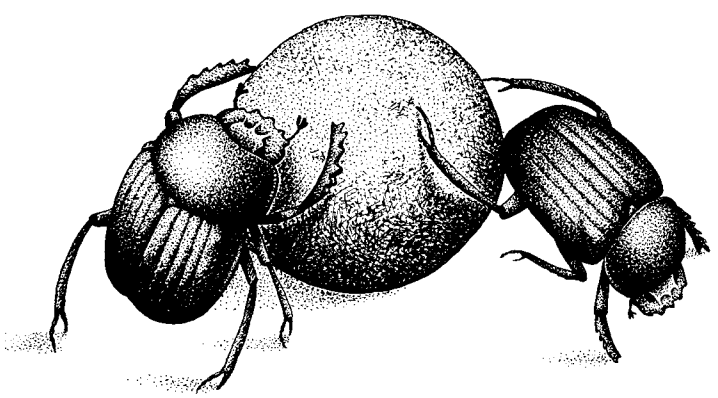


Fig. 2. Male and female Scarabaeus semistriatus *rolling a dung ball.*

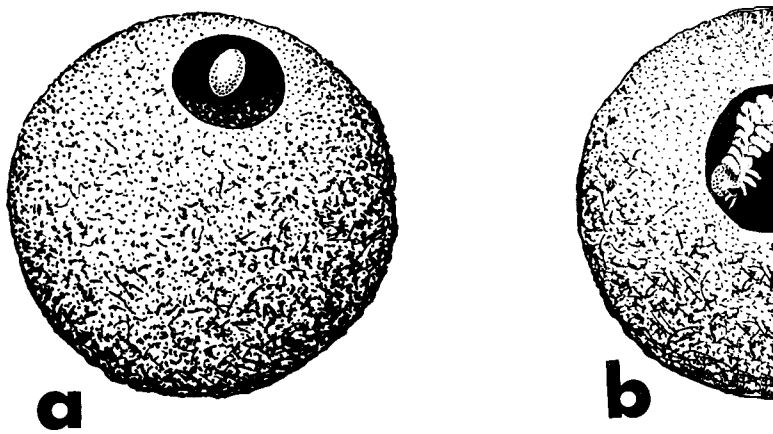


Fig. 3. Sequence showing (a) egg in ball of dung constructed by feeding within ball. Pupation will occur in the space

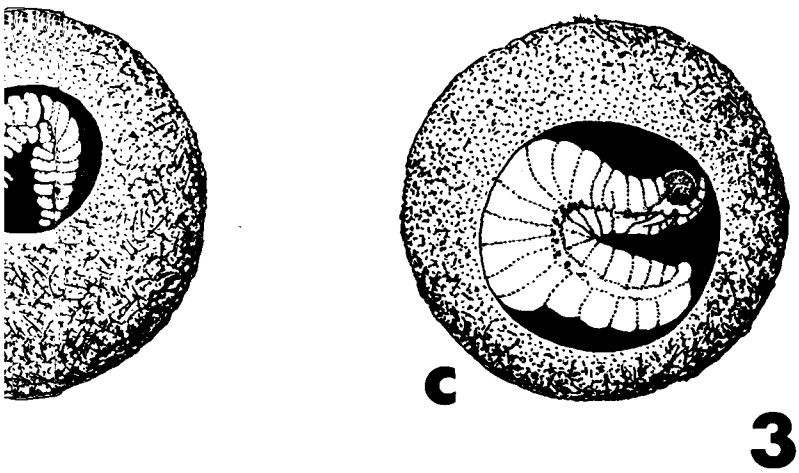
laid in it (if a brood ball). The brood ball serves as a prepackaged food source for the beetle larva when it hatches from the egg (Fig. 3).

There is a distinct advantage to ball rolling behavior in the Scarabaeinae in that intense competition for a limited food resource is lessened if the consumer can carry away and conceal what it needs for its own use. Competition is so keen that theft of another's dung ball is commonly attempted. Also, the problem of limited burial space beneath or adjacent to a dung pile is partially eliminated with dispersal of the dung by ball rolling members of this guild.

Home and a Food Source, Rolled into One

Adult dung beetles (in a temporary pair bond) make from 3-20 brood balls, and the female deposits a single egg in each. For insects, this represents a very low number of eggs which suggests that the survival rate of the young is unusually high. The strategy of providing food encapsulated in a ball for the stationary, largely subterranean larvae accounts for much of this success.

Just as there are several methods for obtaining excrement for food or brood balls, there are also several ways in which various species make nests: (1) The egg is laid directly into the food mass which has been packed into the end of a burrow near or under the food source. (2) The egg is laid in a brood ball or brood pear (Fig. 4) which may or may not be provided with an outer shell of soil. The sphere is constructed underground near or under the food source, and after the female deposits the egg, she leaves the nest without providing further parental care. Alternately, the female and occasionally the male will remain within the nest some or all of the time during larval development caring for the brood ball by removing molds and fungi. (3) A brood ball is formed at the food source and then rolled away where it is then buried and an egg laid within. Some species coat the brood ball with a layer of clay which becomes very hard when it dries. Several species of the genus *Heliocopris* make brood balls the size of tennis balls which have a thick clay shell and may be buried as deep as eight feet. When some of these large, clay-covered brood balls were first discovered in the ground, they were thought to be ancient stone cannon balls! The beetle larvae eat the dung from within the ball



parent, (b) young larva feeding within ball, and (c) mature larva hollowed out from feeding.

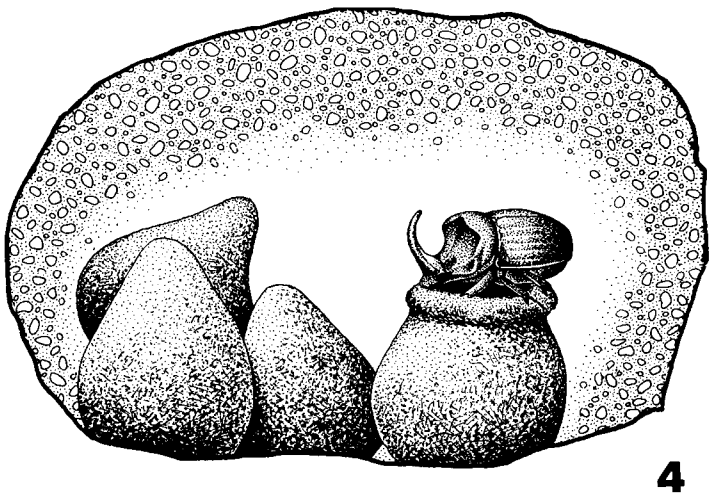


Fig. 4. Copris hispanus *preparing a brood pear made from dung; a single egg will be placed in the narrow end.*

and the remaining clay shell serves as a pupation chamber.

Sanitary Engineers

Dung beetles often serve as intermediate hosts to parasitic worms, especially helminths. However, the burial of feces by dung beetles is also very important in the destruction of the infective forms of parasitic worms when the eggs of these parasites are destroyed by feeding adults and larvae. Dung beetles are extremely important in promoting the rapid disappearance of offensive and contaminated excrement. In addition, the burial of feces by dung beetles greatly reduces the medium in which numerous flies breed, many of which are health hazards to man and livestock. In many parts of the world dung beetles play a major role in the natural control of fly populations. Cows also owe a great debt of gratitude to dung beetles for removing dung from their pasture grasses. If dung was not removed from forage areas and recycled into the ground, many pastures would soon become useless as ever increasing patches of grass became smothered and killed. Australia now has this problem because of introduced livestock and a lack of native dung beetles adapted to large herbivores.

I always marvel at the following passage, and although it is over 50 years old, its impact can only be heightened because of considerable human population increases during those years.

> "Were it not for Nature's scavengers, the East would be the cesspit of the world. Man would surely annihilate himself in the emanations of his own filth . . . The members of the enormous family of Dung beetles, the Scarabaeidae, . . . seek the excrement of men and cattle, gather it into nodules or rounded pellets, and bury it beneath the surface of the soil. Since the greater part of their life is spent hidden in the earth or lodged in the substance of some fecal mass, they are not obvious to every eye. Nevertheless, they exist in prodigous numbers, and the quantity of refuse which they remove is immense, almost beyond belief. So far as I can estimate by rough observation, I believe that in certain active seasons of the year two-thirds of the excrement of this vast country [INDIA] must be carried by scarabs into the substance of the soil. Without their valuable aid the land would be an open sewer. Remember that it supports a teeming population of some 300 million souls. And, save for the few collected in the cities, the whole of this great multitude of people depends on the work of Nature's scavengers to clear its filth away. I will not enter into numerical details, but, taking into account human ordure alone, I believe that in India during May and June as much as forty or fifty thousand TONS of excrement must be carried by scarabs EACH DAY into the soil. And this does not include the dung of animals, which may easily double or treble the amount." (Hingston, 1923). That's a whole lot of ordure!

The Egyptian Connection

Historically, a dung beetle (*Scarabaeus sacer*) played an important and prominent role in the mythology of ancient

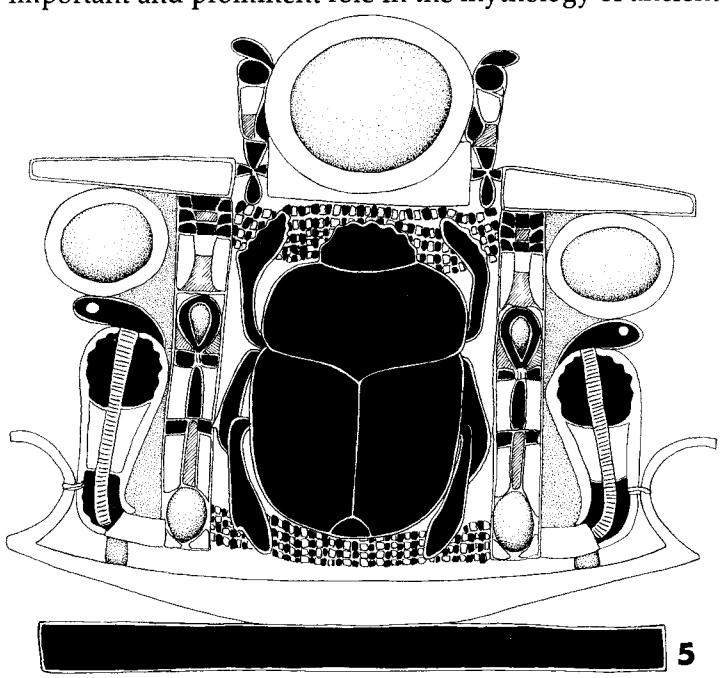


Fig. 5. Portion of a gold inlaid pendant from the tomb of King Tutankhamun showing the sun god depicted as a scarab pushing the sun's disc.

Egypt. Known as the sacred scarab, this insect and its ball-rolling behavior symbolized the movement of the sun across the heavens and the sun god, Ra. After 200 B.C., during the Middle Kingdom, people believed the sacred scarab had supernatural powers which insured rebirth after death. Consequently, its likeness was fashioned into amulets and used extensively in jewelry (Fig. 5), in burial chambers, and in the wrappings of mummies. Heart scarabs carved from greenstone replaced the heart inside the mummy because the heart might incriminate the owner in the next world. These heart scarabs (Fig. 6) frequently had verse from the Egyptian Book of the Dead carved on the bottom side. The use of scarab amulets expanded until they were employed as good luck charms by the Persians and Romans as well as some people today.

All things considered, dung beetles should be regarded as very valuable animals indeed. They remove feces from our environment, destroy parasites, reduce fly populations, aerate and revitalize soil, aid in survival of pasture grasses, serve as food for many birds and mammals, and (despite their preference for food once removed) are aesthetically pleasing to watch and study. And to some, they insure life after death. What more could one ask?

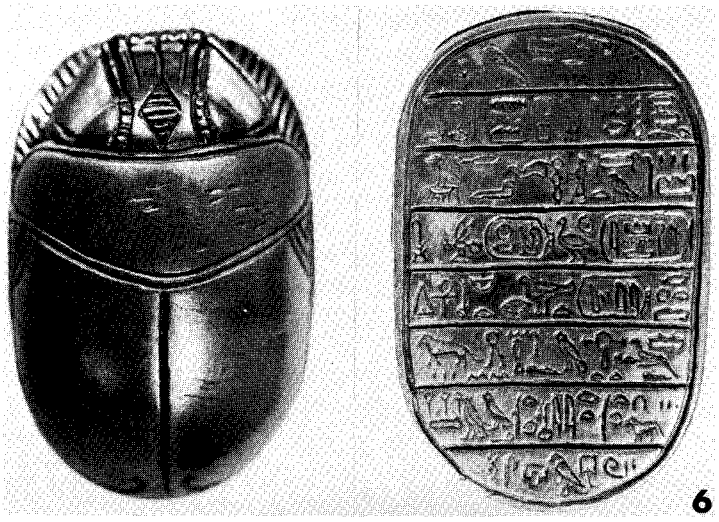


Fig. 6. Egyptian heart scarab showing top and hieroglyphics on bottom.

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The publishers of *UNL News* greatly regret the omission of the name of Thomas P. Myers, author and editor of the previous issue of *Museum Notes*, "American Indian Art: Tradition and Change." Dr. Myers is the curator of anthropology at the University of Nebraska State Museum.

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