The role of dung beetles in pastures with livestock

A large amount of excrement is produced in cattle pastures. **Dung beetles play a key role in recycling manure**. Dung beetles bury this organic matter to feed and reproduce, and, at the same time, destroy the eggs and larvae of flies and other parasites while removing the soil. These dung beetles are necessary to **close the cycle of incorporation of organic matter** from excrement to the soil.

Dynamics of manure in cattle pastures

In cattle pastures, **forage production is closely dependent on recycling the organic matter produced** and the **amount of nutrients available**. Much of this organic matter comes from animal excrement. To give us an idea, an adult bovine produces 12 dungs a day on average, so each specimen can release 4 to 6 kg of dry matter daily in its droppings. **This is a huge amount**. Fortunately**, manure disappears** quickly naturally for much of the year due to the **action of dung beetles**, which bury this organic matter to feed and reproduce (**Figure 1**). **By burying the manure, the eggs and larvae of flies and other parasites are destroyed and the soil is removed**, thus increasing its permeability and aeration. The amount of manure buried by dung beetles depends on the size and abundance of the individuals of each species (Lumaret and Martínez, 2005). **Large species can bury up to 500 grams of manure** per individual in one night.

Figure 1. Dung beetles feeding on a cow dung. Author: ID 126525345 © Charissa Lotter | Dreamstime.com

However, **when there are no beetles** or their numbers are very low, the dung is not buried and **can remain on the pasture for months**, even years. As explained in detail in the book by Begon et al. (2006), an emblematic example of this phenomenon occurred in Australia. In the past two centuries the cow population had increased from just seven individuals (brought in by the first English settlers in 1788) to about 30 million. All these cows produced around 300 million dungs per day, covering up to 2.5 million ha per year with manure. The native Australian detritivores were unable to degrade these droppings, so the loss of pasture under the manure placed a huge economic burden on Australian agriculture. Ultimately, the decision was made in 1963 to bring dung beetles of African origin, capable of burying bovine manure to Australia to make the country's livestock productive again.

Types of dung beetles

Dung beetles use a wide variety of food resources, with mammalian excrement being the main resource, followed in importance by carrion. Beetles present different behaviour when handling manure for feeding and reproduction (Martínez et al., 2015). This allows them to be classified into **three groups** (**Figure 2**): (i) **burrowing beetles**, which separate portions of manure and bury them under the **dung through tunnels**; (ii) **rolling beetles**, which cut dung balls and then carry them some distance on their hind legs to bury them (they are the typical dung beetles); (iii) **dwelling beetles**, which do not move the food, but remain inside or under the dung. The main characteristics representative of these three groups are shown in **Table 1**.

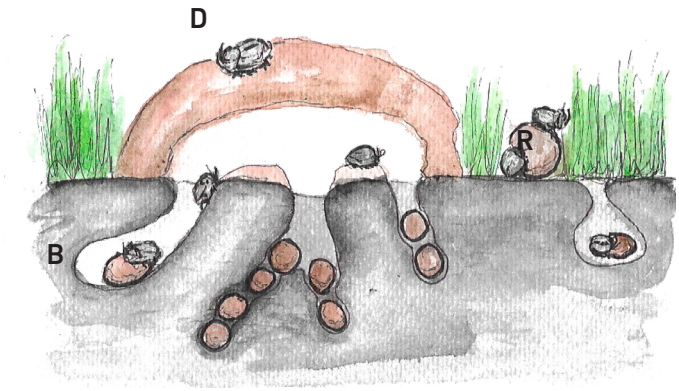

Figure 2. Representation of dung and the way in which the three types of dung beetles take advantage of the manure. B, burrowers; D, dwellers; R, rollers. Watercolor drawing: Victoria Wainer, based on a figure from: Martínez I, et al., (2015) The breeding of dung beetles. Secretary of Education of Veracruz, Mexico.

Types of beetles	Way of making use of manure	Morphological characteristics	Main genera	Image
Burrowers	They bury pieces of manure under the dung where they make the nest	Robust species, with short, wide front legs adapted to dig easily. Great sexual dimorphism	*Geotrupes* *Copris* *Onthophagus*	
Rollers	They transport dung balls away from the dung to make the nest	Less robust but with longer hind legs better adapted for transport	*Scarabeus* *Sisyphus*	
Dwellers	They remain inside or under the dung without nesting	Small and without sexual dimorphism	*Aphodius*	

Table 1. Main characteristics of the three groups of dung beetles.

Life cycle

Manure is a **resource with multiple uses** throughout the life cycle of dung beetles: adults obtain nutrients from the liquid fraction and **larvae feed on the solid part**; but at the same time, manure serves as a meeting place for adults for copulation and egg laying (Martínez et al., 2015). **The female lays an egg in each ball or mass of manure that has been kneaded or buried**. The dung balls harden and dry on the surface, but remain moist and cool inside, so that the larvae can develop and eventually become adults. Young adults come to the surface, feed intensively and, after a time, seek a mate, prepare the nest and start the reproductive cycle again.

The reproductive season of most species of dung beetles **is concentrated during the summer**, although it lasts until the autumn. At that time, young adults or at different stages of development are buried in diapause until the next rainy season in spring, when they emerge and begin to reproduce (Lumaret and Martínez, 2005). **Most species of dung beetles only have one generation of offspring a year** (univoltine species), although some species can have two per year (bivoltine species) and even more than two (multivoltine species).

Environmental and economic benefits of dung beetles

These dung beetles **generate significant environmental and economic benefits for ranchers.** When there are not enough beetles in the pasture, manure accumulates on the pasture for months, sometimes years, and **pests such as flies and parasites that harm livestock and humans increase**. Pastures are sometimes even abandoned because they are not productive. This represents large economic losses for **ranchers who must spend large amounts of money to remove manure from the pastures**. On this basis, it can be said that the **economic value of dung insects is very high**. For example, in the United States it has been estimated that, in the absence of these beetles, 2 million dollars would be spent per year (Fincher, 1981, in Lumaret and Martínez, 2005).

The main risk for dung beetles

The good fit between the western European dung beetle fauna and the use of livestock excrement usually minimises these problems. But the above examples show the **danger of what could happen if the richness and diversity of these insects were destroyed or simply diminished**.

At present, the main risk for dung beetles is the **residues of certain drugs that are found in livestock excrement and which can be toxic to dung insects**. These products, among which **ivermectin** stands out, are used on a wide spectrum of endoparasitic and ectoparasitic species of livestock, since they act in a weak concentration and their persistence in the body protects the animal for several weeks (Lumaret and Martínez, 2005). Precisely due to its persistence, they appear in the dungs of treated animals and, due to its great toxicity, **it eliminates the larvae of dung beetles** (Sánchez-Bayo and Wyckhuys, 2019), it bioaccumulates in insects and is transferred to other animals that feed on them (Verdú et al., 2020). In addition, dung from ivermectin-treated animals may be more attractive than those from untreated animals, increasing risk factors for dung insects. **This mortality is a great risk for livestock farms**, since the disappearance, even temporarily, of dung beetles can dramatically lengthen the time for dung to disappear from the soil surface.