Catharsius molossus - Molossus Dung Beetle

*Catharsius molossus* (Linnaeus, 1758)

Molossus Dung Beetle

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**Overview**

Ever seen a shiny black thing rolling a ball of soil on the ground? Behold, the janitors of the forest.

Dung beetles get their name from their diet and use of dung as nesting material. This very act makes them important nutrient recyclers in the ecosystem. Small and unassuming little helpers, they deserve a little more recognition for what they do!

Studies have suggested that there are negative impacts of urbanisation on dung beetle abundance. However, it is not known if light pollution from urban areas could be a causing factor. Currently, there is no conclusive studies as to how anthropogenic light pollution may affect the behaviour of these nocturnal dung beetles.

Interestingly, some nocturnal species of dung beetles that belong to the same family as *Catharsius molossus* (Scarabaeidae) use the polarized light of the moon to orientate themselves, helping them to move in a straight line.

While studies have only been on the genus Scarabeus, there is no evidence that other nocturnal beetles do not rely on moonlight for navigation too. In light of such news, it is worth considering what effects rapid urbanisation and light pollution can have on the dung beetles. There should also be more research done on dung beetles in Singapore, especially the nocturnal ones like the Molossus Dung Beetle.
Functional Groups

As you can probably guess, dung beetles get their name from their reliance on animal excrement for food and nesting material. However, different dung beetles have different methods of dealing with dung. As such, dung beetles are usually classified into 3 functional or behavioural groups, depending on how they manipulate dung.

1. Rollers (telocoprids). They construct balls from dung, then roll them away, to prepare and bury them for nesting. Namely:

2. Tunnellers (paracoprids). They create almost vertical tunnels by burrowing down directly under the dung. After which they pack a portion of dung to be used for the formation of a brood ball, in which they lay their eggs.

3. Dwellers (endocorprids) live inside or just slightly below the dung source to feed and breed. Dwellers also tend to be smaller than the other 2 functional groups of beetles.
The Molossus Dung Beetle (*Catharsius molossus*) is a tunneller. Watch this Molossus Dung Beetle tunnel!

This video was filmed in Khao Yai, Phetchaburi, Thailand.

**Common Name**

*Catharsius molossus* is commonly known as the Molossus beetle. In Chinese, it is known as (shén nng qing lng). This directly translates to the "God Farmer's Dung beetle", while there is no direct explanation of this name, it could be linked to it's medicinal usage in Traditional Chinese Medicine and how it's tunnelling behaviour aids in soil aeration for farmers.

**Distribution**

The Molossus Dung Beetle is found across Southeast Asia in India, southern China, Thailand, Vietnam, Indonesia and most recently, again in Singapore.

In Singapore, it was previously thought to be locally extinct after a census done in 2009 at the Bukit Timah Nature Reserve had no specimens. However, a more recent beetle survey done in 2013 using dung-baited traps revealed their presence in both the Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Hurray!

The study had found 48 *Catharsius molossus* specimens in CCNR and 1 in BTNR. Out of those found in CCNR, 20 were found in primary forest sites and 28 in secondary forest site (Figure 3). The sole specimen from BTNR was found in a secondary forest site. This suggests that the Molossus dung beetle is able to persist in both secondary and primary forest sites.
The study also revealed that the Molossus Dung Beetle has a strong preference for using herbivore dung. In Singapore, the most likely source of herbivore dung comes from the Sambar deers and Eurasian wild boars as they are the largest mammals with establish populations in our forests. Hence, the rediscovery and local distribution of the Molossus Dung Beetle could be tied to the distribution and proliferation of these large herbivores.

Singapore’s forest can be differentiated into primary and secondary forests: Primary forests are forested areas that have never been disturbed by human activity like logging and agriculture. On the other hand, secondary forests are forested areas that have been previously cut and regrown. However, some secondary forest sites in Singapore may be less disturbed by humans as compared to primary forest sites that are frequently visited by humans.

Significance

Ecological Role

Dung beetles provide important ecosystem services for maintaining the health of forest ecosystems. Dung beetles play an especially important role in soil aeration, soil fertilisation, enhancing plant growth and secondary seed dispersal. This is attributed to their removal, procession and burial of dung.

Nutrient Cycling

The dung of larger vertebrate animals contain a significant amount of nutrients like nitrogen, which is also often the limiting factor for plant growth and productivity. Thus, by removing, processing and burying the dung of these animals, dung beetles not only help turnover and aerate the soil but also help fertilise the soil. Tunneller dung beetles, like *C. molossus* also help fertilise the soil by packing nutrient-rich dung into the deeper soil layers. They are especially important for soil aeration and maintaining water porosity as they bring deeper layers of soil up to the surface during their nesting behavior. This introduction of dung beneath the soil surface improves soil fertility as it increases the amount of available nitrogen for uptake by plants through mineralization. Thus, indirectly improving plant growth and productivity. Additionally, dung beetles also changes the microorganism community in the soil in a way that increases nitrogen mineralisation rates that improve soil fertility and consequently plant growth.

Secondary seed dispersal

Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR). Seeds are often found undigested in the faeces of primary seed dispersers like the Sambar deer (*Rusa unicolor*) and the Eurasian wild boar (*Sus scrofa*). Both of which have established known populations in Singapore’s Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR).
As the competition for dung can get intense for some of these beetles in the wild, stealing of dung balls and brood balls are a common occurrence. It's a tough life for these dung beetles. Thus, it is always a race to obtain, roll or bury as much dung, as fast as possible. Due to the haste, dung beetles often do not remove the seeds present in dung although they take up space and are not consumed by their larvae. The seeds then get buried in the ground together with the larval brood balls. However, dung beetles may sometimes remove the seeds which end up on the soil surface or somewhere along their tunnels. Dung beetles can move seeds both horizontally and vertically from the original site of deposition due to the combined actions of tunnellers and rollers. This helps seed survival by reducing probability of seed predation and mortality from pathogens. Additionally, it also disperses seeds to locations with better microclimatic conditions for germination. Dispersion of seeds by these dung beetles also reduces chances of overcrowding and resource scarcity.

As the largest known tunneller dung beetle, *Catharsius molossus* plays an important role as secondary seed disperser. As *C. molossus* are larger in size than other dung beetles in Singapore, they are generally able to bury more seeds and larger seeds deeper, than smaller dung beetles can. This is importance to ensure diverse plant propagation. Furthermore, seeds that are buried deeper have lower seed predation risk, thus have higher chance of germination.

**Pest Control**

Interestingly, dung beetles can also help with parasite control through their adult and larval feeding and nesting activity. Dung beetles are able to control the abundance of flies, nematodes and microorganisms that feed on decaying organic materials and blood. Certain studies have show that it could be related to the grinding action of dung beetles during feeding. However, the specific mechanism and reason behind dung beetle's ability for parasite suppression is still poorly understood. This could perhaps be due to the sheer amount of unknowns regarding dung beetle behaviour.

While there have been concerns regarding dung beetles as carriers of certain parasites and pathogens, there has not been concrete evidence proving otherwise. Thankfully, Molossus Dung Beetles are proven to not be carriers of *E. coli*, a bacteria found in animal and human excrement that can cause several diseases like pneumonia and diarrhea. Thus, there is no worry of it having any epidemiological implications for human health.

**Medicinal Use**

The Molossus Dung Beetle is widely used in Traditional Chinese Medicine (TCM). An extract of *C. molossus* is often used in the submerged fermentation of a medicinal fungus called “Ling Zhi” (*Ganoderma lucidum*) also commonly used in TCM to treat various human diseases like gastritis, hepatitis, chronic bronchitis and immunological disorders. The extract of ethyl acetate extracts from *C. molossus* is known to help increase the production of bioactive compounds and polysaccharides (or sugars) in the fungus. Additionally, a polypeptide extract from *C. molossus* can also be used for treatment of Benign prostatic hyperplasia (BPH) or prostate gland enlargement.

![Figure 6: Ling zhi fungus (*Ganoderma lucidum*). Source: Wikimedia (Creative Commons attribution license)](image)

**Diagnostics & Morphology**

Diagnostic characters: Black, broadly oval, very convex and opaque. They have broad heads and clypeus with ocular lobes densely and coarsely granular with a small smooth shining area adjoining inner margin of each eye (See Figure 10 and 11). Pronotum densely granulate with a sharp declivity in front and upper surface of which forms a sharp ridge feebly convex in middle and curved with its extremities. Males having a conical median horn with broad and flattened base and short pointed tip, while female bears a short pointed process.
Confusion:

There is a chance that the Molossus Dung Beetle may be mistaken for a Coconut rhinoceros beetle (Oryctes rhinoceros), a large stag beetle found in Singapore. The Molossus Dung Beetle can be distinguished by its more oval-shaped body as compared to the Coconut rhinoceros beetle which has a longer body.

Figure 7: Lateral view of a male Coconut rhinoceros beetle (Oryctes rhinoceros). Source: Tiffany Lum (permission obtained)

Figure 8: Lateral view of a major male Catharsius molossus. Source: Tiffany Lum (permission obtained)

Larval and Egg

The larval form and eggs of the Molossus Dung Beetle have not yet been documented. This is likely due to the difficulty of rearing them in laboratories. In the wild it could also be difficult to find them as Molossus Dung Beetles are tunnellers, hence the brood balls are usually buried deep in the ground and are tough to sieve out. However, there is a description for Scarabaeinae sub-family larvae. Scarabaeinae larvae are C-shaped, hump-backed, cylindrical and cream-colored with 2-segmented legs. Their maxilla with galea and lacinia are distinctly separate. They have antennae with 4 or 5 apparent segments, the distal segment is greatly reduced in size. Epipharynx with tormae united mesally, anterior phoba present. Their anal opening is surrounded by fleshy lobes. Below is an image of the larvae of Onthophagus babirussa, another dung beetle belonging to the same subfamily (Scarabaeinae) as the Molossus Dung Beetle.

Figure 9: Larva of Onthophagus babirussa in dung. Source: Tiffany Lum (permission obtained)

Adult

Adult dung beetles have modified mouth parts which are adapted to feeding on dung. The clypeus is expanded and covers the mouth parts. The elytra, which cover the wings, expose the pygidium. They also have a space between their middle legs to allow for manipulation of the dung.
Adult Molossus Dung Beetles are usually 25.0 – 45.0 mm in length, with elongate-oval and black bodies. The clypeus (part of head anterior to the frons) is broadly rounded. The pronotum is densely granulate with a sharp declivity in front and upper surface of which forms a sharp ridge feebly convex in middle and curved with its extremities. In both males and females, the frons (part of the head in between the eyes) do not have horns or tubercles, and the pronotum has well-developed tumosity (bump-like) and distinct horizontal ridge. They have a hardened and chitinous wing-cover called the elytra. On the elytra there are indistinct longitudinal lines called striae (iNaturalist, n.d). Only males have horns on their clypeus.

![Figure 10: Dorsal view of a male *Catharsius molossus*. Source: Tiffany Lum (permission obtained). Annotated by Goh Yuen Je Charlotte.](image1)

![Figure 11: Lateral view of a major male *Catharsius molossus*. Source: Tiffany Lum (permission obtained). Annotated by Goh Yuen Je Charlotte.](image2)
Sexual Dimorphism

*Catharsius molossus* exhibits sexual dimorphism where the male and female adult beetles have distinctly different physical traits. Males often have a conical median horn with broad and flattened base and short pointed tip on the clypeal, while females bear short point tips or not at all. The horns on males are important in their mating and courtship behaviour. Interestingly, there are two distinct morphological male types with different horn size. Major males have distinct horns on the clypeal but in minor males, these are reduced or lacking.

Below we see the comparison of the female (Figure 13) and male Molossus Dung Beetle (Figure 14).

Next, we have the side-by-side comparison of the Minor male with smaller and less pronounced horns (Figure 15) and Major male with the larger and more pronounced horns (Figure 14) below. Look at the clear difference in the size and presence of horns!
Biology

Life History & General behaviour

The Molossus Dung Beetle has a four-stage life cycle, comprising of egg, larva, pupa and adult stages. Like other beetle in the tribe Corprini, the Molossus Dung Beetle is nocturnal. This means that it is most active nesting, feeding and mating and engaging in other activities at night.  

Nesting Behaviour

Adult dung beetles usually dung into balls called brood balls, into which females lay their eggs. For *Catharsius* spp., both females and males contribute to the work for the creation of nesting material and digging to establish the nesting site. After hatching, the larvae relies solely on the dung within the brood ball for food, all the way through pupation and until they eventually emerge as adults. Studies on *Onthophagus taurus*, a beetle under the same family as the Molossus Dung Beetle have found that larval diet quality and quantity can affect development time and adult body size and adult male horn size. While no studies of the same nature have been done on the Molossus Dung Beetle, it is very possible their development is dependant on larval diet quality and quantity too. As Molossus Dung Beetles are tunnellers, females tend to create their brood balls at the end of the vertical tunnels. Mating also occurs underground, within the tunnels.

In *Catharsius* spp. the brood balls are divided into several brood ovoids, each with one egg each. Parents also do not tend to broods while they develop.  

Feeding behaviour:

The Molossus Dung Beetle, like other dung beetles are coprophagous. This means they feed on the fecal matter of other large mammals and for *C. molossus*, both adults and larvae feed on dung. Interestingly, recent discovery has shown that the Molossus Dung Beetle appears to be a specialist of herbivores’ dung. This could be because herbivores’ dung may have higher moisture content and large beetles like *Catharsius molossus* tend to prefer dung with high moisture content to avoid desiccation since they dissipate heat slowly. In Singapore’s CCNR and BTNR, populations of larger, herbivorous and omnivorous mammals like the Sambar deer (*Rusa unicolor*) and wild boars (*Sus scrofa*) are likely the main sources of food for these beetles since they are one of the larger beetles and need more dung. Nonetheless, dung from other smaller mammals like the Long-tailed macaque (*Macaca fascicularis*) could also be used by the Molossus Dung beetles.

Taxonomy and Systematics

Classification

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Etymology

Linnaeus first described it as *Scarabaeus molossus* in 1758. The genus epithet, *Scarabaeus*, comes from New Latin, meaning “sacred scarab beetle”. The significance of scarab beetles date all the way back to the ancient Egyptians who revered the scarab beetles. Amulets and gems were even fashioned after these beetles.

The species epithet *molossus* comes from New Latin, which was the name of an ancient breed of Mastiff dog: the Molossian hound or the *molossus*. The Molossian hound is a large, black beastly-looking dog. *C. molossus* could have been named after this due to its size and black colour.

Original species description

*C. molossus* was first described by Linneaeus in 1758 under *Scarabaeus molossus*.

![Image of original species description of *Catharsius molossus* by Linnaeus from Systema Naturae](image)

Type

There were no holotypes designated when Linneaeus first described the species in 1758 as there were no type specimens. Later on, two neotypes used to describe *C. molossus* by Biswas & Chatterjee in Zoological Survey of India, Calcutta in 1986. The neotypes were obtained from Kerala, Silent Valley in 1980. There is no information on where and if these neotypes were preserved.

In Singapore, the reference specimens can be found in the Zoological Reference Collection of the Raffles Museum of Biodiversity Research, National University of Singapore.

Synonomy

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<tr>
<th>Synonyms</th>
<th>Author, Year</th>
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<tr>
<td><em>Catharsius borneensis</em></td>
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<td><em>Catharsius dubius</em></td>
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<td>Copris urus</td>
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<tr>
<td>Scarabaeus molossus</td>
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**Phylogeny**

Early classifications of tribes under Scarabaeinae were based on the assumption that the evolution of dung beetles involved solely on rolling or tunnelling behavior and associated morphological modifications. This suggests that the definition of species could be based on ecological and biological species concept. Such categorisation of dung beetles may have little phylogenetic validity as there were evidence polyphyly and of tunneller groups nested within the rollers.

Figure 17: Bayesian 7-partition analysis was done and the posterior probability values are below branches leading to the node. Posterior probability is a conditional probability that is assigned after the relevant background is taken into account.
In 2007, Monaghan et al. carried out molecular phylogenetic analysis using one nuclear (28S) and two mitochondrial (cox1, rrnL) genes for 214 Scarabaeinae and 11 Aphodiinae species. The use of both nuclear and mitochondrial genes makes the determination of homology more fair since they evolve at different rates with mitochondrial genes evolving faster than nuclear genes. However, to increase reliability of the phylogenetic analysis, more nuclear genes and mitochondrial genes could be used.

After considering the other methods, Bayesian 7-partition analysis was done. The posterior probability value for *Catharsius molassus* displayed is 1.0, indicating that it is a well-supported node. The posterior probability value for *Catharsius*/Metacartharsius is also 1.0, suggesting good support for monophyly. The analysis by Monaghan et al. would thus classify *Catharsius molassus* as a species under the phylogenetic species concept. However, certain problems associated with using Bayesian method include the bias of certain tree topologies. There is also a tendency for overcredibility as too many nodes have the maximum posterior probability value of 1.0 which makes the analysis not very informative. If more data were used in the Bayesian method, the results may be inconclusive.

Additionally, in Figure 18 we see that clade G actually has both rollers (Gymnopleurini) and tunnellers (Coprini), showing evidence of nesting. The Coprini tribe to which *C. molassus* belongs to was found to be polyphyletic as evident in Figure 19. Other tribes like Oniticellini seem to be poorly supported here as well as seen in Figure 19.

Thus, there is need for more studies to be done, perhaps using different genes and including different methods of analysis like maximum parsimony. Until there is consensus, cladograms cannot be used for classification or to tell evolutionary history.
Conservation Message

Insects are often the most unassuming of animals. However, if you stop and take a closer look, you'd often be surprised at what the insect world has to show!

While we may rejoice over the rediscovery of the Molossus dung beetle in our Nature reserves. There is still much more left to be done to ensure that a viable population remains. Considering their ecological significance, there should be more attention given to studying the life histories and ecologies of dung beetles like the Molossus Dung Beetle. Besides more in-depth studies, we should also keep in mind the effects of human development and urbanisation on these insects. Dung beetles, especially nocturnal ones like the Molossus dung beetle can be negatively affected by the resultant light pollution from increasing urbanisation. Most recently, in light of the Mandai Development project that fringes the CCNR, more attention should be directed on assessing the impacts on nocturnal fauna communities.

Figure 20: Female *C. molossus* looking like it's waving good bye! Source: Tiffany Lum (permission obtained)

References
