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Negative Impacts of Anthropogenic Disturbances on the Community Structure of Dung Beetles (*Coleoptera*: *Scarabaeidae*: *Scarabaeinae*) in Namibia

***Mukendwa Hosticks Ndozi[1,4], Linnet Gohole[2], & Isaac Mapaure[3]**

[1]Department of Biological Sciences, University of Eldoret, Kenya

[2]School of Agriculture & Biotechnology, University of Eldoret, Kenya

[3]Office of the Vice Chancellor, International University of Management, Windhoek, Namibia

[4]Department of Wildlife Management and Tourism Studies, University of Namibia, Namibia

***Correspondence Author**

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ABSTRACT

Dung beetles (*Coleoptera: Scarabaeidae: Scarabaeinae*) are a distinctive group of insects that are specialized in utilizing mammalian dung. They play a critical role in the ecosystem by decomposing dung, dispersing seeds, suppressing parasites, and cycling nutrients. Anthropogenic activities such as agriculture, land modification, fragmentation, road construction, and desertification have threatened dung beetles despite their roles in the ecosystem. Anthropogenic activities have a negative effect on dung beetle species diversity and composition. Namibia has been experiencing different types of land degradation, such as soil erosion, deforestation, bush encroachment, land conversion through agricultural activities, and sand mining, which have a greater effect on the species diversity and structure of dung beetles. In Namibia, there is a gap in quantitative research on the impact of anthropogenic activities on dung beetles; such a database is crucial for conservation purposes. Researchers have extensively used dung beetles to evaluate the assemblage structure, ecosystem function, and taxonomy of biodiversity.

Keywords: Anthropogenic activities, dung beetles, habitat conversion, *Scarabaeinae*.

INTRODUCTION

Habitat destruction is one example of how human population expansion has affected biodiversity. Human activities such as agriculture, urbanization, and infrastructure development result in the removal of land, which in turn forces numerous species to either adapt or risk extinction due to the loss of their natural habitats (Davis *et al*., 2001; Nichols *et al*., 2007). Furthermore, the increasing population's need for resources has resulted in an excessive use of natural resources, exacerbating the decline of biodiversity. A disturbance in ecology is defined as events caused by either natural or human actions that change the diversity of the environment in terms of space and time. These events impact the physical structure, dynamics, organisation, and populations of different communities (Thornton *et al*., 2009; Alvarado et al., 2018). The impact of anthropogenic settlements on the feeding guilds of dung beetle and composition may have a significant impact on the dynamics of the local ecosystem (Alvarado *et al*., 2020). Predictions indicate that the intensification of land use and future growth of the global economy will cause exceptional levels of global extinctions, resulting in the loss of biodiversity (Estrada *et al*., 2017; Tilman *et al*., 2017). Loss of biodiversity, which is interrelated to natural ecosystem transformations such as habitat fragmentation, deforestation, edge effect, isolation,

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overgrazing, and other impacts, is recognized to be the major concern of land degradation in tropical areas, which can also negatively affect species community structure (Halffter & Arellano, 2002; Filgueiras *et al*., 2015; Alvaradoa *et al*., 2020; Correa *et al*., 2021).

Human-induced factors have significantly transformed ecosystems such as forests, savannah woodlands, and grasslands, leading to the loss of biodiversity in these ecosystems, particularly in tropical savannahs, which has received little research (Fahrig *et al*., 2019; Gallego-Zamorano *et al*., 2020). Anthropogenic land use negatively impacts microclimate conditions, causing changes in normal temperature, relative humidity, and light intensity. It also alters the structure of the habitat, leading to a decrease in tree intensity and canopy openness, and disrupts the ecological interactions among species (Laurance *et al*., 2014; Alonso *et al*., 2020). Anthropogenic-related activities have recently modified substantial areas in the tropics and subtropics for various land purposes; this includes modern agriculture, livestock farming systems, urban settlements, and other areas with native vegetation exposed to these disturbances (Newbold *et al*., 2015).

Anthropogenic landscapes have replaced most native forests, woodland savannahs, and other ecosystems, leading to changes in species turnover and altering the community structure of dung beetle species in various regions and environments (Edwards *et al*., 2015). As a result, changes in the community compositions of species and a decrease in keystone species due to human-induced factors may lead to the extinction of taxa, thereby affecting the functional diversity of species, evolutionary processes, and community structures (Terborgh & Estes, 2013). Favero *et al*. (2011) argue that human-related activities, such as the conversion of landscapes into agriculture and pastureland, are the major factors leading to the fragmentation of natural areas. Converting natural areas into crop fields has seriously reduced the species diversity of dung beetles (Nichols *et al*., 2007). Therefore, large areas of pasture production and agricultural activities influence environmental disturbances by displacing native flora.

According to Nichols *et al*. (2007), dung beetles from the subfamily *Scarabaeinae* (*Coleoptera: Scarabaeidae*) play an ecological role in the utilization of mammalian dung, as well as in the assessment of anthropogenic disturbance and community composition. *Scarabaeinae* have distinguished ecosystem services, including the suppression of parasites that oviposit eggs in the dung; they are also responsible for seed dispersal defecated by frugivorous vertebrates (Andresen 2002, 2003) and recycling of dead materials (Hanski & Cambefort 1991; Andresen & Feer 2005; Nichols *et al*., 2008). The dung beetles also help the nutrients move around in the soil by adding dead organic matter and improving air flow and fertility (Nichols *et al*., 2008; Scholtz *et al*., 2009; Raine & Slade, 2019; Sands *et al*., 2022) and by holding more water and making the soil more stable (Feer & Hingrat, 2005). During the process of nutrient cycling, dung beetles indirectly improve plant nutrient uptake, leading to increased yield (Sands *et al*., 2022). Therefore, researchers have studied dung beetles as biological indicators to assess altered ecosystems.

Namibia is a semi-arid country in sub-Saharan Africa, located in the southern part of Africa. The country is experiencing different forms of land degradation, including deforestation, soil erosion, sand mining and bush encroachment (De Klerk, 2004). Bush encroachment is a serious type of land degradation that affects a variety of land uses and ecosystems. Encroachment affects rangelands' carrying capacity, reducing livestock production and also affecting dung beetle populations. Dung beetles mainly depend on mammalian dung for oviposition and feeding. Land degradation leads to a reduction in mammals (Pryke *et al*., 2022), which in turn alters their community structure. Sand mining is another form of land degradation. The illegal removal of sand for construction is a problem in Namibia, destroying the habitat for many microorganisms and plants. Brick-making and road construction primarily excavate large amounts of sand, negatively affecting various species, particularly insects. Agricultural activities use about 78% of Namibia's land, resulting in the destruction of vegetation.

Reduced natural vegetation exposes topsoil; some insects use topsoil for their ecosystem services. Anthropogenic activities influence land degradation, which in turn affects biodiversity and reduces ecosystem services. We need to evaluate the quantification and characterisation of these anthropogenic activities to make informed decisions and encourage biodiversity growth. Different anthropogenic activities challenge the conservation of dung beetles in Namibia, with the greatest pressure coming from urbanization, resource

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exploitation, or conversion to agro-ecosystems. Different species of dung beetles in Namibia face a serious threat from the modification of habitats in various ecosystems.

Dung beetle communities are currently facing numerous anthropogenic threats in Namibia, and their loss might have a negative impact on their ecosystem functioning and ecological services (Beynon *et al*., 2012), in turn reducing the sustainability of the ecosystem (Nervo *et al*., 2017). Besides, it is not clear how anthropogenic disturbances, such as habitat fragmentation and the use of veterinary medicine, excessive harvesting of dung beetle larvae, and agricultural activities, change the ecosystem functioning of dung beetles in relation to Namibian ecosystems. Addressing these gaps in knowledge is critically imperative given the increased likelihood of climate change. Lack of scientific research in different ecological systems of Namibia remains a major challenge in quantifying the negative impacts of different land-use practices on the communities of dung beetle structures. Given their importance, it is essential to include dung beetles in restoration plans. The review aimed to describe the negative impacts of anthropogenic activities that have been reported in the literature on the community structure of dung beetles and suggest the conservation practices that should be supplementary to works on the subject. This article will further discuss the main findings, new research information, and questions about how different land uses hurt dung beetles. The review will also address the gaps in current research on how human activities affect dung beetles in Namibian ecosystems, possible future developments and conservation issues, and possible challenges for the future.

MATERIALS AND METHODS

Data search

We conducted a bibliographic search using the Google Scholar, Research Gate, Web of Science, Scopus, and Scientific Electronic Library Online (SciELO) databases, focusing on articles from 2000 to 2024. The search included articles mentioning the terms anthropogenic, land use, habitat fragmentation, species diversity, dung beetles, Scarabaeinae, modification, agricultural activities, bush encroachment, and deforestation for the years 2000–2023. The search aimed to identify the most commonly used terms in scientific articles to refer to the dung beetles or Scarabaeinae and anthropogenic disturbances or land-use disturbances of interest. We used these selected terms in order to avoid irrelevant and unnecessary peer-reviewed articles and focus on the articles that are related to the subject matter or area of interest. We quantified the impact of anthropogenic activities on the distribution, abundance, functional behaviours, diversity, and community structure of dung beetles worldwide and compared it to Namibia's situation using peer-reviewed literature. We used the keywords to retrieve more than 200 published papers from internet search engines. Namibian research activities fall short in explaining how anthropogenic activities impact the community structure and composition of dung beetles.

Literature Inclusion and Exclusion Criteria

The study aimed to analyze the relationship between dung beetle communities and anthropogenic activities that might shift their community structure by identifying 200 articles in accessed databases. We removed the grey literature, review articles, and book chapters to ensure accuracy. We excluded 131 papers after evaluating their abstracts as they did not align with the objective of the study. We complimented the negative impact of anthropogenic activities and functional ecology of dung beetles by incorporating articles published in Spanish and Portuguese from the authors' collection. We conducted a survey across the three issues, encompassing all articles that demonstrated potential complementarity. The relevant articles for the negative impacts of anthropogenic activities on dung beetles were selected using the following criteria: i) The study includes species from the *Scarabaeinae* subfamilies; ii) the study is based entirely on anthropogenic activities or land-use disturbances (agricultural activities, use of veterinary medicines, harvesting of dung beetle larvae, road construction, and habitat fragmentation); iii) the study evaluates ecological functions and ecosystem services of dung beetles (e.g., bioturbation, seed germination, fly control, and suppression of parasites). Through the use of these criteria, 53 anthropogenic activities articles, 6 taxonomic diversity articles, and 10 functional diversity articles were retained for data extraction. In total, 69 articles were used in the preparation of this review.

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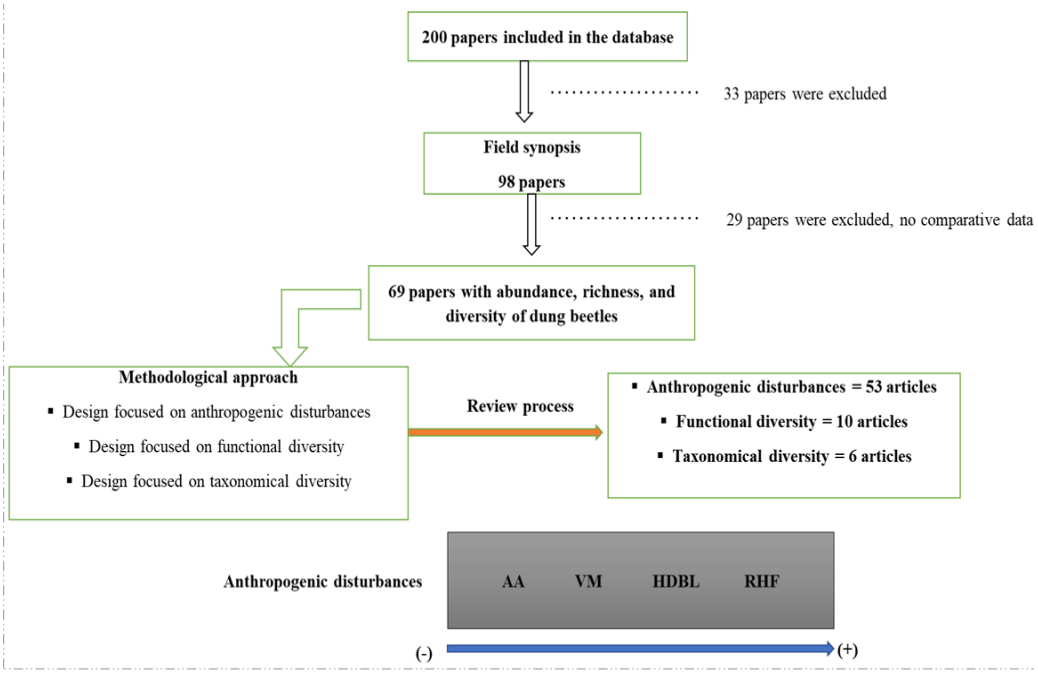

Figure 1. Flowchart showing the process that was used in the collection of information. The 69 studies used in the review are listed in the reference list. The direction of the arrow on the anthropogenic disturbances represents the gradient used in the data analysis. AA = agricultural activities, VM = use of veterinary medicine, HDBL = harvesting of dung beetle larvae, RHF = road construction and habitat fragmentation.

RESULTS AND DISCUSSION

Effect of anthropogenic activities on the assemblage of dung beetles

The human population has been growing for decades, increasing land use in various ecosystems around the world. Agriculture is one of the land use systems that have altered environmental habitats, such as pastureland and crop production. Grazing management in farmlands or pasturelands has a strong influence on the assemblage of dung beetles when compared to protected areas (Scheffler, 2005; Numa *et al.*, 2012). People clear vegetation in farmland in order to increase production, but this negatively affects the composition of dung beetles (Hosaka *et al.*, 2014b; Filgueiras *et al.*, 2016). Grazing systems in different pasturelands have a big effect on the community structure of dung beetles. Overgrazing can occasionally occur, leading to a reduction in diversity, which underscores the importance of examining the impact of various management activities on dung beetle assemblages.

Dung beetles of the family *Scarabaeidae* and subfamily *Scarabaeinae* are the most effective insect groups in assessing the interactions between anthropogenic disturbances and community composition (Nichols *et al.*, 2007). However, anthropogenic activities such as road construction have a serious impact on dung beetle communities (Dangles *et al.*, 2009). The study's findings revealed that there was no significant difference in diversity, abundance, or community composition of dung beetles collected among transects located at various distances from the road. We observed that road construction affected the assemblage and composition of carrion beetles, but this effect was more dependent on road width than road type (Dunn & Danoff-Burg, 2007). Dunn & Danoff-Burg (2007) found that road construction had little effect on the original vegetation composition. We may see a change in land use systems that leads to biotic homogenization, which is the biological simplification and coverage of species from different habitats that lowers beta diversity (Fuzessy *et al.*, 2021). Moreover, beta diversity refers to the existing alteration in species composition among the sites, which appears on a wide range of spatial and temporal scales (Almeida *et al.*, 2011). Research has shown that fragmented areas in most tropical areas reduce the diversity of dung beetles (Nichols *et al.*, 2007). However, in temperate forests, fragmentation does not affect diversity, and changes in species composition are evident (Franka *et al.*, 2017). Nichols *et al.* (2007) reported a decrease in dung beetle diversity in pasturelands and farmlands without the coverage of trees and shrubs.

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Habitat disturbance has an effect on dung beetle community structure in the central Belize corridor, with low species richness and abundance recorded (Latha *et al*., 2016). One of the reasons for the low species richness and abundance was the reduced number of mammals due to habitat loss. Dung beetles make use of mammalian dung as their main source of food. Researchers named unsustainable hunting of mammals and clearing land for farming as the main threats to the large mammal population in the Central Belize Corridor (Gardner *et al*., 2008; Latha *et al*., 2016). These activities could change how dung beetles live together. Clearing land for agricultural purposes and logging can impact physical factors such as temperature, sunlight penetration, and relative humidity, thereby affecting the species richness and abundance of dung beetles (Latha *et al*., 2016). Moreover, various studies showed that human activities changed the dung beetle community structure in the Central Belize Corridor region by negatively impacting the number of mammals, the type of plants that grew there, and the physical features of the habitat. According to several studies (Braga *et al*., 2013; Latha *et al*., 2016), human activities have significantly altered the structure of the dung beetle community in the Central Belize Corridor region. Habitat fragmentation may result from continuous disruption due to large-scale agricultural expansion and clearing of forests for logging in different regions, resulting in more species loss and changing the mammalian composition that affects the normal functioning of the ecosystem (Gardner *et al*., 2008).

Conversion of natural forests for agricultural land use has shown a negative effect on ecosystem functions and services provided by the dung beetles, most especially dung burial activity (Shahabuddin, 2011). Anthropogenic activities such as forest disturbances and changes in land use should not only focus on the direct effect of these activities on the diversity of taxa under investigation but also shed light on the ecological roles played by those taxa. Kremen (2005) suggests further research on the relationships between biodiversity and ecosystem function (BEF), as well as their connection to ecosystem functions. This research should look into (a) the key species that play a key role in ecosystem functions; (b) how ecosystem function and the community's composition interact with each other; (c) the environmental factors that stop the ecosystem from working properly; and (d) the time and space scales that are right for both providers and their normal functions (Kremen, 2005). Shahabuddin (2011) found that dung beetles provide an ecosystem service by removing a total of 53% of dung pats excreted by mammals, and the disturbance of habitats through land conversion into agriculture may negatively affect such services. The experimental evidence **(Figure 1**) from the Wallacea Region in Sulawesi showed the significant contribution of dung beetles in removing excessive dung from different land uses. Although the results suggest that the shift from natural forests to agricultural areas disrupted this ecological function (Shahabuddin, 2011), the percentage of dung pads removed decreased from natural forests to open areas used for agricultural cultivation. Researchers reported a higher species diversity and abundance of individual dung beetles in agricultural environments compared to pasture and forest areas (Rodrigues *et al*., 2012). Food resources for dung beetles were less abundant in agricultural environments; this provided an opportunity for installed traps to attract more dung beetles since they were the only source of food. However, the supply of cow dung was more abundant in pastureland, meaning that the pitfall traps installed in the pasture were not the source of food for dung beetles.

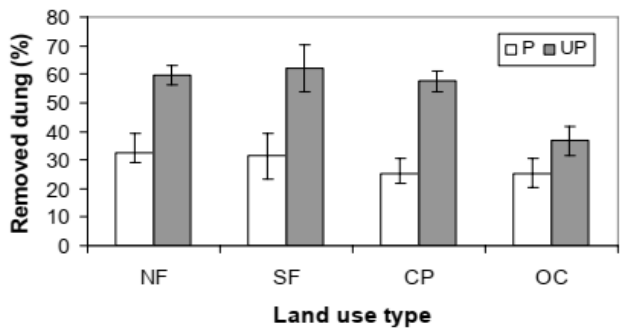

Figure 2. Percentage of removed dung (± SD) from unprotected (UP) and protected (P) bait in relation to land-use type (natural forest (NF), selectively logged forest (SF), cacao plantations (CP) and open cultivated area (OC) (Shahabuddin, 2011).

The community structure of dung beetles increased in the agricultural environment after a number of years of early perturbations. Rodrigues *et al*. (2012) suggest that the migration of mammalian species from neigbouring

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habitats, such as vegetation fragments, may influence the increased numbers of dung beetle species richness and abundance in disturbed areas. Furthermore, food resources (cattle dung) played a crucial role in the species diversity of dung beetles collected between the three areas, including the structure of the environment (Marinoni & Ganho, 2006; Malva *et al*., 2009). Although anthropogenic disturbances in the forest may have contributed to a low diversity index, forest habitats recorded a high number of unique species compared to agricultural environments and pastures (Rodrigues *et al*., 2012). Despite a low diversity index recorded in the forest, this shows the importance of biodiversity conservation because it provides refuge sites for dung beetle species. The diversity and abundance of dung beetles mainly depend on the seasonal supply of food resources.

Ecologists can use dung beetles as a group of insects to assess biodiversity, which can have implications for the type of land use, according to several scholars. Additionally, ecologists regard Scarabaeidae as excellent ecological bio-indicators because of their higher species richness, diversity in different habitats, ease of sampling, and fragility to small alterations (Rocha *et al*., 2010). Dung beetles could also be suitable candidates for monitoring disturbed ecosystems in both kinds of landscapes, including forest and agricultural environments. Because of erosion, dung beetles may have less access to soils with less vegetation cover. The repeated exposure of this group of insects to wind and sunshine will make them vulnerable, and consequently, the dryness and trampling by mammals may hinder their action in the ecosystem. Conservation of small remaining patches of forest is essential because their conservation status and heterogeneity in these environments facilitate the preservation of some species of Scarabaeidae and, subsequently, their environmental services (Rodrigues *et al*., 2012).

Anthropogenic activities on dung beetles' assemblage in Namibia

Different land use systems exist in Namibia, including agriculture, mining, protected areas, and a variety of other uses. All these types of land use might influence the species richness and abundance of dung beetles. Namibia is facing a serious challenge with habitat loss, bush encroachment, and fragmentation as a result of human-related activities. Loss of habits, like many countries in the world, increases serious pressure on species survival, biodiversity conservation, and ecosystem normal functioning (Dangles *et al*., 2009). The biodiversity of insects is crucial to the normal maintenance of ecosystem functioning, and the overall response of insects to human activity remains limited in Namibia.

Agricultural activities

Conversion of landscapes into agriculture is one of the contributing factors to the loss of biodiversity in dung beetles (Jankielsohn *et al*., 2001; Numa *et al*., 2012). Agriculture remains the major source of livelihood in Namibia, even though the majority of the land is not arable for crop production. Land use influenced the abundance of dung beetles, and higher numbers were captured from protected areas than on farms in Northern Namibia, with tunnellers dominating the functional groups (Nependa *et al*., 2021). The high number of mammalian species increases the availability of dung types, which will also increase the number of dung beetles in the area. Therefore, a reduction in the richness of mammalian species on farms or in any ecosystem also reduces the abundance and richness of dung beetles (Braga *et al*., 2013; Raine & Slade, 2019).

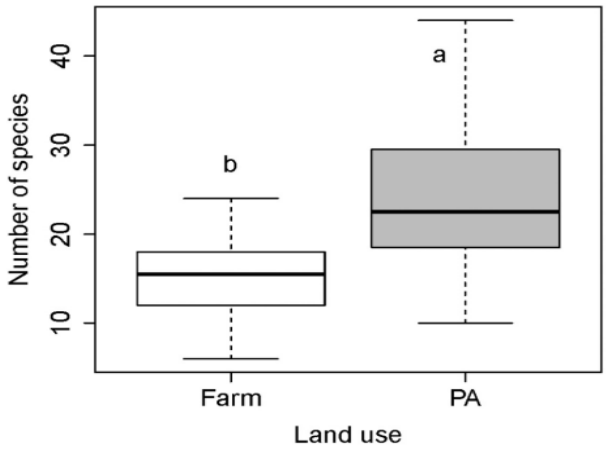

Figure 3. Significant differences were observed in dung beetles collected on protected areas (PA) than on

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farms (Nependa *et al*., 2021).

Most farms in Namibia, especially in communal areas, are experiencing the challenge of overgrazing and bush encroaching, reducing the food availability of mammalian species. A decrease in mammalian species will also reduce dung, which is the primary food source for most of the *Scarabaeinae*. Soil trampling caused by overstocking livestock on farms has deleterious effects on vegetation, reducing the abundance and richness of dung beetles (Vohland *et al*., 2005; Tonelli *et al*., 2017).

Use of veterinary medicine

Because beef production plays a critical role in driving the economy, accounting for approximately 70% of the agricultural GDP, Namibia has been making efforts to broaden its export markets in order to generate more income for its population. Namibia exports the majority of its beef to countries like the United Kingdom (29%), Norway (25%), and South Africa (24%). However, to meet the marketing standards of beef, livestock must undergo comparison vaccinations. Although Namibia has not investigated this, the use of veterinary medicine on both communal and commercial farms may influence the abundance and richness of dung beetles. Numerous studies have demonstrated the negative effects of veterinary drugs like Ivermectin on dung beetles' behaviour, diversity, individual health, community-level effects, and ecosystem functioning. Numerous studies (Wardhaugh *et al*., 2001; Cruz Rosales *et al*., 2012; Pecenka & Lundgren, 2019; Villada-Bedoya *et al*., 2021) have demonstrated the negative effects of veterinary drugs like Ivermectin on dung beetles' behavior, diversity, individual health, community level effects, and ecosystem functioning. Conversely, research regarding the use of veterinary medicines on the community structure of dung beetles is very scarce in Namibia, even in central regions with large cattle herds such as the Khomas, Omaheke, and Otjozondupa regions. Scholtz *et al*. (2009) found that veterinary pharmaceuticals have detrimental effects on dung beetle assemblages, especially under dry conditions such as in Namibia, which is a semi-arid country. Injecting veterinary medicines into livestock to control internal parasites may have some negative effects on dung beetle development, as dung beetles oviposit eggs in dung and provide services such as parasite suppression (Nichols *et al*., 2008). The diversity and number of dung beetles in Namibian ecosystems are among the best in the world. The diversity was highest in protected areas compared to farms (Nependa *et al*., 2021). This shows that turning natural habitats into farms for livestock has negative effects on dung beetle diversity.

Harvesting of dung beetle larvae

The issue of food and nutrition security has become a significant concern, mostly due to the growing global population. However, traditional and familiar options of entomophagy are the only available food choices. Entomophagy is the term used in describing the process whereby human feed on insects. The most consumed type of insects in Namibia includes the butterfly caterpillar, dung beetle larvae, and adult termites. Most of these insects are used food, sold to open markets as a way of generating income, some of them are used as feeds for livestock and poultry production. Dung beetle larvae (*Scarabaeus satyrus*) are primarily consumed by western Kenyan communities, often served as snacks or with carbohydrate foods after toasting, roasting, or frying (Fedha *et al*., 2024). In Namibia, collecting dung larvae from cattle kraals is becoming increasingly popular. People either soak the larvae in warm water or remove the lower portion containing dung before drying and selling them on the open market. Beetle larvae, which are high in protein, fat, and ash, can help meet the recommended daily intake of nutrients and minerals, as well as provide energy (Fedha *et al*., 2024; Kibet *et al*., 2024). The larvae can also be utilised for food fortification, most especially during dry seasons when the food resources are scarce. Despite the nutritional significance of these dung beetle larvae, people do not quantify their harvesting because they generate income through sales, but the ecological implications remain unclear. The collection of dung beetle larvae poses a threat to the species diversity and richness of this insect group. However, further investigation is necessary to understand the extent of consumption and sale of these larvae at both regional and national scales.

Road construction and habitat fragmentation

Anthropogenic activities have greatly altered the Earth's surface, resulting in the breaking up of natural vegetation into smaller areas that are divided by a landscape that has been modified for human use. Due to

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anthropogenic influences, Namibian farmlands are experiencing significant ecological changes, including bush encroachment and an increase in the density and biomass of native woody species. The construction of roads in communal land and commercial setups, including habitat fragmentation through the construction of farmland fences, can be a serious threat to dung beetle diversity and abundance. Roads can have adverse ecological impacts by eradicating and deteriorating nearby habitats, obstructing the movement of organisms, generating edge effects, and heightening the likelihood of road fatalities, wildfires, hunting, and the establishment of exotic species (Laurance *et al*., 2009; Clements *et al*., 2014; Dar *et al*., 2015). The presence of logging dumps, skid trails, and access roads had a detrimental impact on dung beetle communities in Malaysia shortly after logging activities (Hosaka *et al*., 2014a). Similarly, in Central Africa, the composition of small mammal communities varied depending on the type of logging roads, including differences in size, usage, and time since abandonment (Malcolm & Ray, 2000). Both rural and urban areas in Namibia are seeing a rapid increase in road construction, with some of these projects taking place in areas designated as conservancies. Even though road construction may be considered a form of development, it could potentially lead to an increase in insect biodiversity loss.

Road clearings significantly reduced the abundance of functional guilds and dung beetle biomass, while guild composition remained consistent between forest interior and log yards (Hosaka *et al*., 2014a). Most of Namibia's road construction occurred in areas that were previously inaccessible, and most of these constructions are a result of agricultural activities, mining, and other activities related to rural development. However, they also exacerbated land deterioration, causing erosion and soil depletion. Human activities such as road construction have caused changes in the landscape, resulting in alterations to the complexity of vegetation structure and microclimatic conditions (Ezcurra, 2016). Dung beetles are crucial bioindicators for analyzing biodiversity and monitoring human activities' impact on natural ecosystems, including habitat loss and fragmentation, as highlighted by various studies (Spector, 2006; Nichols *et al*., 2007; Villada-Bedoya *et al*., 2017; Salomão *et al*., 2020).

CONCLUSION AND RECOMMENDATION

In Namibia, the conversion of natural forest to different land-use patterns may alter the community structure of dung beetles. Land use types such as national parks and nature reserves may still be the primary areas with the highest dung beetle abundance and species richness. Anthropogenic activities, including agricultural practices, the use of veterinary medicines to control livestock parasites, the harvesting of dung beetle larvae for human consumption, livestock feeds and marketing, road construction, and habitat fragmentation, pose the main threats to the abundance, richness, and species diversity of dung beetles. Due to a lack of scientific research on how some of these anthropogenic activities affect the community structures of dung beetles, there is a need to quantify the extent to which anthropogenic related activities are impacting the dung beetle communities. However, future investigations in Namibian ecosystems are required, with more focus on human-modified environments and disturbances to better understand the interactions between anthropogenic disturbances and dung beetle functioning.

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