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# **Beetle Significance in Environment and Biomedical Studies**

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**Abstract** : Beetlesplay a significant role in both environmental and biomedical studies. Beetles are valuable indicators of environmental pollutionthey are delicateto ecological parameters and react quickly to changes in the surroundings. In biomedical research, beetleshelpto cure many human diseases. This review explores the potential applications of beetles in biomedical studies, focusing on their role in understanding disease and environmental health. They are ideal for monitoring environmental changes because they are ubiquitous, easily captured, and have large toxin storage capacities.

Keywords: Coleoptera, scrab, bioindicators, and beetles.

### Introduction

Coleoptera, or beetles, are the largest order of animals and play a significant role in plants and fungi. With around 350,000 named species, millions exist worldwide. Adult beetles have hardened forewings and elytra, which protect them from mechanical damage, parasites, and predators. Beetles have a vast range of diversity and occur in every major ecosystem excluding the sea and the polar regions (Banerjee, 2014). The group of organisms with the highest degree of success on Earth is the Phylum Arthropoda. Except for the deep ocean, almost every livable place on Earth is home to insects (Arthropoda, Class - Insecta). They are the main plant eaters and consumers as well as the main predators of plant eaters. They are vital recyclers of decomposing organic matter, the main pollinators of flowering plants, and essential parts of the food webs that support vertebrates and other invertebrates (Imms A.D., 1977). Beetles are responsible for several major agricultural pests. Coleoptera evolutionary success depends on several adaptations, but a complete understanding of them is still lacking. Beetles are not only pestsbut also helpful in controlling the populations of pests. One of known the best, and widely examples is the ladybug or ladybird(Satheesha,2018).

## **Ecological Role:**

**Pollination:** Pollination relies on the Coleoptera order, with some beetle families adapting to serve as flower pollinators. Studies show that some beetle families found in Cretaceous ambers can be pollinators today. During the Earlyand Late-Cretaceous period, gymnosperm and angiosperm plant hosts provide nutrition for short-winged beetles, which also transfer pollen and marking a shift from mutualism to angiosperm and beetle interactions (Peris et al., 2020). Pollinators

play an important part in ecosystem constancybysimplifying plant reproduction and sustaining biodiversity (Fontaine et al., 2005; Ollerton, 2017). Scientists have long focused on bees as pollinators because of their usefulness across wild and farm-grown plants(Willmer et al., 2017). The importance of beetles in pollination has been overshadowed by numerous studies on bees and butterflies(Klein et al., 2007, 2007; Potts et al., 2010). According to fossil evidence, beetles may have served as pollinators as early as the Cretaceous era(Bao et al., 2019). Beetles are the second most significant flower visitors and also the fourth most significant insect pollinators in tropical environments, according to Bawa (1990)(Ollerton, 2017). Prior research has shown that beetles actively pollinate 22% of Australia's dry rainforest(Hansman, 2001). Ecological interactions play an imminent role in the extent and quality of pollination realized through the beetles. The effectiveness of beetles in pollinating plants essentially depends on their species, floral phenology, and timing patterns of flowering reproduction, a major outline dividing into asexual processes or sexual flowers(Gottsberger, 1990; Lamprecht and Seymour, 2010).Beetles visit flowers for mating, oviposition, nectar, pollen, and food rewards. Their distinctive smell, sweet, fruity, musty, or fetid, is a key characteristic of beetle-pollinated flowers(Williams and Adam, 1994). Although beetles are known to visit or pollinate a wide variety of angiosperms, the Oriental Region has not seen much in-depth research on the subject. Many different beetles, potential pollinating mostly from the familiesCurculiondae, Cerambycidae, Sarabaeidae, and Mordellidae were drawn to the floral fragrance chemicals (eugenol, benzyl acetate, methyl benzoate, and linalool) used as bait during a year of trapping in the lowland rainforest of Malaysia(Corlett, 2004). Strong fragrances attract beetles, which enter the floral chamber during the female stage and exit during the male stage. It is reported that in Sumatra, scarabaeids, chrysomelids, and curculionids visited a Polyalthia species(Corlett, 2004)Beetles have developed editions to increase their efficacy as pollinators, vegetation that beetles pollinatehave evolved specific traits that draw beetles and successful pollination. Using nine plant facilitate familiesProteaceae, Magnoliaceae, Myristicaceae, Sterculiaceae, Annonaceae, Arecaceae, Areceae, Cyclanthaceae, and Dipterocarpaceaewe were able to identify various plant usefulcharacters associated with beetle pollination disorders, which affect 28 beetle families (Jacob and Katumo, 2023).

**Decomposition:** Dung beetles, crucial for helminth control, nutrient recycling, and seed dispersal, use dung from herbivorous and omnivorous animals as a food reserve, surviving on various foods like flesh, dung, and specialized foods(Shah NA., andShah N., 2022). With the use of fresh feces as food and fuel for the construction of their nests, dung beetles suppress the parasites and diseases that live in human or animal dung. There should be 75% fewer parasites in calves that graze on pastures where dung beetles are in good numbers(Lastro E., 2006).For at least the last 40 million years, the changing aspects of current dung beetle

communities and the evolution of the Scarabaeinae have been significantly influenced by the ecological relationships between dung beetles and mammals(Cambefort and Hanski, 1991).Because of their extensive fossil record and ability to preserve elytra and other structures, beetles are essential to conservation efforts. Pest species and natural enemies deepen our understanding of conservation issues, while their environmental diversity offers useful information on changes in local assemblages under shifting conditions. In recommendations related to conservation, beetles are often mentioned(New, 2014).Although primarily carrion feeders (necrophagous species), carrion beetles (Coleoptera, Silphidae) can also function as predators by consuming other carrion residents. They are crucial to biological decomposition(Park and Moon, 2020). When organisms (saprophagous species) feed on decomposing organic matter, organic matter breaks down in ecosystems. To partition resources according to the degree of decomposition, various species carry out this process, producing temporal succession(Stokland et al., 2012). The soil holds on to more moisture as resources progress through their degradation stages, and certain soils can serve as temporary, suitable microhabitats. Since they are highly specialized in particular resources or stages of decomposition, many saprophagous insects(Jiménez-García et al., 2023).

**Seed Dispersal:** Seed dispersal plays a central ecological role by facilitating the natural reforestation of habitats(Corlett, 2017).Scarabaedaefamily of Coleoptera, playsa vital role in the process of Pitlochry, acting as secondary seed dispersers(Andresen and Feer, 2005).Through insect-mediated seed dispersal, agricultural expansion puts ecosystem services at risk. The functional and taxonomic features of dung beetles in environments dominated by humans have not received much attention. There are relationships between beetle abundance, seed depth, and functional characteristics in dung beetles, according to a study conducted in the Andes of Colombia(Morales-Alba et al., 2022).

Dung beetles help plants grow by dispersing seeds in animal dung, which lessens competition for resources like water and sunlight and produces stronger, healthier plants(Howe, 1989).Dung beetles eat plant-eating animals' poop, which often contains seeds, which help plants grow in tropical forests. Studying this process is crucial to understanding its impact on plant growth (Terborgh, 1986).Secondary seed dispersal and post-primary dispersion risk factors have a major impact on plant recruitment. Despite competition for dung, dung beetles frequently inadvertently bury seeds. Additionally, they take seeds out of the ground and actively disperse them by leaving excrement on the surface of the soil(Yadav et al., 2023).

**Agricultural Impact:** Research has shown that spiders, earwigs, ants, lacewings, certain types of beetles like carabids and staphylinids, and ladybugs, can all help cut down on the number of pests in an area. They eat a lot of the bugs that harm

plants. So, having these helpful bugs around can make a big difference in keeping pest numbers low(Symondson et al., 2002). In Latin America, research in the field suggests that carabid beetles can control pest populations, but they haven't directly proven that these beetles cause a big drop in pest numbers. For instance, in Mexico, studies found around seven different species of carabid beetles linked to controlling the Colorado potato beetle, a common pest. Although they believe these beetles are essential for controlling the Colorado potato beetle in the future, they haven't fully shown how effective they are in reducing the number of these pests(Cappaert et al., 1991). Beetles are a diverse group of insects found all over the world in places like grasslands and forests. Their larvae, known as wireworms, live in soil, litter, or dead wood, where they eat plants, animals, or decaying organic matter. Some wireworms eat plants, and they're a big problem for farmers because they'll munch on a wide range of crops. This can damage seeds, roots, stems, and other parts of the plant, which can make it easier for diseases to infect the plants(Keiser et al., 2012).Environmental factors such as temperature, moisture, light, soil type, food availability, and crop growth influence the number of carabid beetles in farms, affecting their presence and types, and affecting the overall ecosystem(Lövei and Sunderland, 1996; Thiele, 1977; Thomas et al., 1992). One of the major contributions of predation in its broad sense is population control of other species via reducing the number of individuals or biomass. However, predation is limited to a few species within the genus Phileurus. For this group, there are records of consumption of other insects, such as Heterogomphus chevrolatii(Reig et al., 2022).Sustainable agriculture aims to reduce crop system disease and pest risks, preserving the environment. Understanding ecological processes is crucial before applying agrochemicals.Low-input agroecosystem management is moresustainable and eco-friendly, with Carabidae as a helpful tool (Ivanič Porhajašová and Babošová, 2022). Carabidae family species, such as Harpalus rufipes, Poecilus cupreus, and Pterostichus melanarius, contribute to biodiversity in agroecosystems. However, habitat disturbances can lead to biodiversity decline and unbalanced communities, often due to management disruptions, impacting Carabidae populations (Porhajašová et al., 2018).

**Cultural significance:** Insects have lost their value and contributions to human civilization, but they remain a significant part of human mythology, art, literature, and religious beliefs. They are also studied in ethno-entomological activities and used in various artistic forms, despite their declining appeal in art and culture(Klein and Brosius, 2022). Fireflieswere often connected with ghosts and witches in various African countries. In Benin, a fetishist uses a firefly recipe to free a person from a witch. In Mail, fetishists have light coming from their mouths. In Chad, a magicianshines like a firefly,however, fireflies have nothing to do with the magician themselves. In Kenya, the insect was believed to be given light by God (Van Huis, 2021).The powerful rhinoceros beetles, known as "kabutomushi"

in Japanese, are a representation of people's tolerance for insects. The word comes from combining the terms mushi (insect) and kabuto (a warrior's helmet). In Akihabara culture, the beetle is frequently portrayed as a magnificent, attractive, and grand insect and is frequently understood as a symbol of Japanese tolerance toward insects. Beetles continue to be used in culture, such as in insect gambling, where male Xylotrupes rhinoceros beetles are trained to exploit territorial behavior and mating competition(Hoshina and Takada, 2012).

Beetles as Bioindicator and Conservation: For many different ecological and environmental applications, indicator species have been adopted. Research papers on the effects of environmental changes, including pollution, fragmentation, and land management, usually focus on several well-studied insect groups. These include the following groups: Hymenoptera(Formicidae), Collembola (Springtails), Diplura, and Coleoptera (Carabidae, Curculionidae, and Staphyli-nidae)(Avgin and Luff, 2010; Sklaski et al., 2011; Bendnarska et al., 2013).Beetles are great at telling us about the health of the environment because they're really sensitive to changes in their surroundings. They react fast to any changes and we can easily study them using different methods without spending too much money. So, scientists have been using beetles more and more to figure out how human activities affect different environments(Ghannem et al., 2018). Coleoptera insects are used as biological indicators to assess forest management, elevation, mountain forest segmentation, deforestation, and forest fires. Insecticide use in plantations can impact beetle abundance and diversity, particularly among leaf beetles (Sha'ari and Arumugam2019).Beetles are useful in identifying various types of environmental changes. Due to their widespread distribution throughout most terrestrial environments, interest in their use as biomarkers of environmental pollutants began to grow(Zödl and Wittmann, 2003). Recent studies show that carabid beetles' physiology and susceptibility to stressors are impacted by accumulated toxic metals. As zinc and lead levels increase, the length of the elytra decreases, while the wing length changes slightly(Ghannem et al., 2018). The species of carabid beetles are great at telling us about the environment. They're valuable for studying the effects of forest management in detail, rather than just for big monitoring programs at the regional or national level(Work et al., 2008).Beetles, like detectives, monitor their environment by absorbing harmful substances from plants and dirt. Their easy catch and ability to store toxins make them effective in detecting environmental changes(Ghannem et al., 2018).

#### **Role of Beetles in Biomedical Studies**

In the past ten years, scientists have become more interested in the richest order of the animal kingdom, the Coleoptera order.it is found in most terrestrial environments and comprises around 400,000 species,out of which nearly 25% of all known animal life forms (Stokland et al., 2012). Beetles are important in both

natural and human-influenced ecosystems because they interact with plants, other creatures, and even dead and decaying matter, playing a crucial part in these environments(McKenna et al., 2009). Numerous types of beetles cause significant damage to plants and agricultural products worldwide, resulting in substantial losses in their nutritional value (Tribolium Genome Sequencing Consortium, 2008). Researchers have sequenced the genomes of 11 beetles species, uncovering genetic advancements contributing to their evolutionary success. This insecticide resistance, understanding insecticide effectiveness, includes biological control methods, host-microorganism relationships, and pest management strategies (McKenna, 2018).Red flour beetles, and T.castaneum, a significant pest of crops, had the first sequenced genome(Adamski et al., 2019).Signaling molecules found in insects and mammals share equivalents, revealing remarkable conservation across the animal kingdom. Comparative research between invertebrates and vertebrates could offer insights into neurobiology and function, potentially aiding in treating human diseases like obesity and cardiovascular conditions (Chowanski et al., 2017). Beetle models serve as valuable tools in the initial stages of pharmacological research, evaluating the efficacy of new substances, whether synthetic or derived from plants or animals. Additionally, beetles themselves produce compounds that exhibit potential antimicrobial and antitumor properties, offering promising avenues for applications in cancer therapy and immunology. It seems reasonable, therefore, to use beetle model systems for drug screening and active agent testing(Chowanski et al., 2017; Slocinska et al., 2008)(WalkowiakNowicka et al., 2018). The Chrysomelidae, commonly referred to as leaf beetles, are utilized as medicine for epilepsy, while their caterpillars are employed for treating earaches, strokes, injuries, seborrheic dermatitis, inflammation, and coagulation(Alves and Alves, 2011). Snout beetles (Curculionidae) are utilized to alleviate fever, headaches, and boils(Lauren et al., 2017). Scarabaeidae are a family of coleopterans that comprise approximately 8% of all coleopterans. Their medicinal value has been mentioned frequently in literature. Its antioxidant activity was recently assessed in the large chafer beetle Holotrichia parallela(Scarabaeidae), which has long been used as a medication in China and East Asia to treat gout, tetanus, erysipelas, and superficial infections(Liu et al., 2012).In northeastern India, the dung beetle Catharsius sp. (Scarabaeidae) is prepared into a paste and ingested orally to alleviate diarrhea(Chakravorty et al., 2011). Adolescent girls in Cameroon, Kenya, Rwanda, Uganda, and Zimbabwe collect adult water beetles and induce the growth of breasts by biting their nipples. They also improve swimmer skills, tongue and belly skills, and whistler abilities. In Madagascar, Dytiscidae is cooked and consumed as a cough preventive (Van Huis, 2021). Beetles serve as excellent models for anti-arrhythmic medications like digoxin, with plant glycosides, primarily cardiac glycosides, being used to treat heart failure and various arrhythmias(Evans, 2009). The first insects to colonize vertebrate remains are blow flies and flesh flies.

Help Forensicentomology: The study of in various species of arthropods'developmental stages on decomposed cadavers is known as forensic entomology, and it is most frequently used in death investigations. It is a crucial tool for estimating the amount of time that has scientifically passed since death. Even though entomology has been utilized at crime scenes for centuries, research in the previous several years has directed to a notable advancement in forensic entomology (Monika et al. 2020). Research indicates that certain species, like Thanatophilus Fabricius, can locate corpses in less than a day and have larvae visible shortly after death, providing valuable clues for forensic investigation, similar to blowflies(Park and Moon, 2020). Forensic entomology uses the Silphidae, Staphylinidae, Cleridae, and Dermestidae families to estimate postmortem insect life. Understanding insects' biology, phenology, and preferred habitats is crucial for estimating PMI. Insect succession studies examine colonization patterns in specific areas, aiding forensic studies involving insects in similar settings(Sharma et al., 2018). Forensic entomology uses flies and beetles to supportillegalsurveys. The first insects to colonize invertebrate remains are blow flies and flesh flies. Beetles, on the other hand, become important indicators of time since death in more advanced stages of decomposition. To advance this field, it is essential to comprehend the ecology and behavior of beetles associated with remains (Weidner, L. and Powell, G., 2021).Insects, mainly Coleopterans, attract dead and decomposing bodies sequentially. Histeridae, Dermestidae, and Cleridae beetles, such as Dermestes maculates, feed on animal remains and skin. Beetle specimens were collected from Kanpur city's exposed animal carcasses, and their life history is elaborated. This study may help predict post-mortem interval (PMI) in forensic science (Sonkeret al., 2015).

#### Conclusion

In biomedical research as well as the environment, beetles are indispensable. They greatly enhance the functions of ecosystems in the environment. By dissolving organic materials, beetles improve soil quality and promote the cycling of nutrients. By assisting in the management of pest populations, predatory beetles improve agricultural health and lessen the need for chemical pesticides. Additionally, pollinating beetles aid in the reproduction of various plants, increasing biodiversity. In the field of biomedical research, beetles are useful model organisms. Their varied biochemical processes and physiologies shed light on immunology, developmental biology, and genetics. Research on substances derived from beetles has produced new antimicrobial agents that are useful in the fight against bacteria that are resistant to antibiotics. Certain beetle immune systems' simplicity provides a more accessible framework for researching intricate biological processes, possibly this review paper gives the data or knowledge of beetle significance.

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