Advances in Biochemistry and Biotechnology

Ali Shah N, et al. Adv Biochem Biotechnol 7: 10110.

www.doi.org/10.29011/2574-7258.010110

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Review Article

Biodiversity of *Scarabaeidaecoleoptera* Scarab Beetles in Different Regions of the World: A Review Article

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Citation: Shah NA, Shah N, Lakha LDS (2022) Biodiversity of *Scarabaeidaecoleoptera* Scarab Beetles in different regions of the World; A Review Article. Adv Biochem Biotechnol 7: 10110. DOI: 10.29011/2574-7258.010110

Received Date: 16 March, 2022; **Accepted Date:** 21 March, 2022; **Published Date:** 24 March, 2022

Abstract

The scarab beetles of the order Coleoptera include both beneficial and harmful insects. The continued increase of small cities in developing nations created a challenge for conservation and an opportunity for implementing new research and land use concepts. Species richness of all taxa be likely to be reduced in highly urbanized areas, while suburban areas showed mixed responses with trends of increasing flora and birds but decreasing invertebrates and non-avian vertebrates. Elements fundamental to human disturbance such as creation of a more heterogeneous environment, level of disturbance and variability may all influence species richness. The objective of this review paper is to describe the biodiversity of scarab beetles *Scarabaeidae* in multiple areas of the world to assist the scientific community for their ecological services by which they act as sanitation agents, suppressing agents of cattle parasites and as bio indicators as well.

Keywords: Biodiversity; Coleoptera; Scarab beetles; *Scarabaeidae*

Introduction

Scarab beetles belong to sub-order polyphaga, family Scarabaeidae, order Coleoptera of class Insecta. For the ancient Egyptians, scarab species from which the family name *Scarabaeidae* has been derived was a holy symbol of resurrection. As per Egyptian spiritual belief, sunrays radiated from head of scarab and its dung ball was the whole world, caught in an eternal cycle of daily renewal foundation that leads to a greatly sustainable system [1]. The scarab beetles of the order Coleoptera include both beneficial and harmful insects. The agro-dung beetles commonly called Laparosticti (dung beetles) perform vital role in cleaning the dung of cattle's and mammals and the phytophagous beetles generally called chafers are serious pests of crops, plants and forest vegetations. Dung beetles are systematically and physio-ecologically very significant components of land ecosystem. They are natural scavengers, adding amounts of dung into the soil thus washing up the earth surface from excretory material of large and medium sized herbivorous mammals [2]. The dung beetle communities are outstanding models to assess and observe that at rate the changes in the vegetation significantly disturb animal communities.

Group pleurosticti (Chafers) are phytophagous scarabs with polyphagous nature, some species do not feed during adult stage. Pleurostict chafers are grouped in nine subfamilies of the family *Scarabaeidae*, which are Sericinae, Melolonthinae, Euchirinae, Rutelinae, Hoplinae, Dynastinae, Valginae, *Cetoniinae* and Trichiinae. Males of Dynastinae are equipped with prominent horns which attack stems and roots of plants where as *Cetoniinae* have a preference for nectar, sapand juice of ripened fruits and vegetables [3]. Rutelinae and Melolonthinae infest fresh leaves while *Cetoniinae* along with few genera of Rutelinae used to visit flowers where they consume nectar and pollen. Larvae of Melolonthinae, Rutelinae and Dynastinae are clear white grubs having soil- dwelling nature and feed on live plant roots and dangerous to agriculture. Few *Cetoniinae* and Dynastinae grubs survive in humus of soil while other *Cetoniinae,* Trichnae and Valginae live in wood and debris gathered in the holes found in trees. Many species of the pleurosticti scarabs are already reported as pests of various agricultural crops [4].

Significance of *Scarabaeidae* Dung beetles

Dung beetles (Coleoptera: *Scarabaeidae*: *Scarabaeinae*) occupy rich communities in most of the terrestrial ecosystems where they donate key ecological services like recycling of nutrients, soil fertilization, pest control and secondary seed dispersal [5,6]. In addition to this, dung beetles are recognized as useful indicators of habitat fluctuations mainly in tropical rain forests.Their community structure is susceptible to many kinds of environmental alterations and allied with mammal communities [7]. The increasing acknowledgment of the influence of humans in the environment has brought about remarkable changes in ecosystem during the last few decades that encouraged conservation biology from a single focus on unmanaged "natural" habitat to one incorporating the role of human-influenced disturbance with agricultural and urban systems becoming new focus of ecological research. Urban areas cover up only three to four percent of the world's area as per UNDP report in 200 cities became the home of more than fifty percent population of the humans and anticipated to continue to grow up to 70 percent of the world population by 2050 as United Nations reported in 2008 [8].

Biodiversity of *Scarabaeidae* Dung beetles

Shahabuddin P, et al. [9] reviewed in their paper focused on the links between ecological functions and biodiversity of *scarabaeinae* dung beetles in order to assess environmental consequences produced by human activities such as deforestation. Both adults and larvae of dung beetles feed upon animal excreta thus trigger various ecological functions including derived seed dispersal, cycling of nutrients , suppression of many pathogens as well as parasites, biological pest controlling agents and source to increase soil fertility to enhance agriculture. Moreover ecosystem services of dung beetles also include pollination enhancers and trophic regulators. Campos RC, et al. [10] worked on taxonomic usage of female copulation organs in Sericini chafers; they worked on morphological variation in female copulatory organs of Scarab beetles (Sericini) with parallel ecology, external morphology as well as copulation mechanisms.

Noriega JA, et al. [11] diversity, faunal composition and conservation assessment of dung beetles in two different reserve forests of Haryana, India in order to understand species richness, abundance, diversity and seasonality. According to their studies, total numbers of collected specimens were round about 6000; these specimens were placed in 33 species, 16 genera and 03 subfamilies. These two reserve forests were named Sonti and Seonsar and 70 kilometers are away from each other and vary in species richness and evenness. Boonrotpong S, et al. [12] worked on the structure of scarab beetle fauna in remnants of forest of Western Puerto Rico, they focused on richness and abundance of scarab beetles. Collection was made by multiple methods and total 2399 specimens were collected belonging to 14 species. This was the 36% of total Scarab fauna of that habitat. This study provided a scheme for ecological assessment of those habitats.

Farias PMD, et al. [13] studied on patterns of abundance and movement of a most common scarab *Canthoncyanelluscyanellus* with reference to the landscape features in Southern Mexico, landscape structure has notable effect on habitat selections and actions of *Canthoncyanelluscyanellus*. The abundance was at peak in big woodland wreckage, tiny woodland fragments and hedgerows but less in pastures. Heydarnejadh MS [14] conducted their studies on bio-diversity and volume of dung beetles fascinated to various dung types in Sulawesi, Indonesia. They made their collection with the help of pit fall traps in six different areas including two sites of natural and selectively lodged rain forests, three sites of agroforestry systems and one site of open area.In each area 10 pit fall traps were installed, 5 baited with anoa and remaining 5 with cattle dung. Total 28 species were collected. Richness, biomass and abundance decreased from natural forest to open areas dramatically whereas selectively logged forests and agroforestry ecosystems maintained high species richness, quite similar to natural forest. The difference of food sources (anoa and cattle dung) has no significant impact on abundance, richness and biomass which indicated that forest habitat played role and yielded much copiousness, volume and richness.

Ganihar SR [15] surveyed assemblages of dung beetles of Sub-family *Scarabaeinae* at Atlantic forest fragments in Southern Brazil, dung beetles of above sub-family are vital organisms that contribute in the decomposition process of nutrients more significantly in tropical ecosystems. Sampling were conducted with the help of 200 pitfall traps, 100 were installed with human feces and remaining 100 with carrion in twenty Atlantic Forest fragments during 2011. A Total 33 species were collected categorized into 6 tribes and 12 genera. The richness of dung beetles (n=33) suggested that diversity in studied area is quite high and enhanced further faunal investigations. In addition, the importance of forest fragments within agricultural lands for maintenance of diversity is proved.

Vieria L, et al. [16] worked on *Digitonthophagusgazellae* in Peru where that species of indo African origin is an invasive. According to their studies that species was reported more spreading over the time and became the most wide spread dung beetle in tropical and sub-tropical pastures of Peru. Boonrotpong S, et al. [12] conducted their comparative study on species composition of dung beetles of sub-family *Scarabaeinae* and coprinae in two types of forests named primary and secondary forests at wild life sanctuary of Ton Nga Chang, Songkhla province, Southern Thailand. Studies were conducted and pig dung baited traps were utilized for collection with visits of two months interval. Results revealed that species diversity is higher in primary forest than secondary forest.Out of total 20 collected species, 07 species were exclusively restricted to primary forest. Variation in forest structure, presence of native animals and environmental factors were the key factors determining diversity in both types of forests. Number of collected specimens in dry season was higher than wet season.

Chandra K, et al. [17] focused on the assemblage of the copro-necrophagous beetle to a variety of soil characters and live stock management in a tropical landscape, according to their results there was a positive relationship between abundance of beetles and physio-chemical features such as moisture, nutrient composition means that higher is recorded when moisture and nutrient composition were higher, such relationship of beetle abundance was also recorded with density of flora. As contrary to this beetle abundance showed negative relationship with management techniques like insecticide usage, anti-parasite treatments and vegetation burning. Miranda B, et al. [18] worked on biomass estimation of dung beetles belonging to super family Scarabaeoidae, he selected 30 species for that object and proposed that body length can be used as an effective tool to estimate biomass.

Gupta D, et al. [19] used length-weight relationship (LWR) as a method of determining biomass of aquatic beetles belonging to family Hydrophilidae and Dytiscidae, he calculated LWR of seven aquatic beetles of Choghakhor Marsh, Iran. Collected specimens were dried for 24 hours at 60celcius degree, cooled in desecrator. Weight was measured into 0.001 g and length into 0.1 mm.LWR parameters (a and b values) were estimated by linear regression. Results suggested that the parameter b varied between 2.315 and 3.117.For all species examined, significant LWR along with high correlation coefficient were observed. Results obtained were helpful in ecological aspects.

Chandra K, et al. [20] estimated biomass of land arthropods based on body length through his work. Specimens of nineteen different land arthropods were sorted from forests of Goa.Couple of models was used including named linear function and power function. Surgut H, et al. [21] surveyed scarab beetles fauna in the different localities of Sindh Agriculture University Tando Jam, Sindh, they collected 337 specimens from June to December which were categorized into two sub families named Coprinae and Dynastinae. Sources of collection were dung, pasture soils and crop fields. Majority of the scarabs were dung feeders with few saprophagous and phytophagous (Chafers)

Medina CA, et al. [22] studied dung beetles of sub family *Scarabaeinae* of FlorestaNacionalContendas do Sincora, Bahia, Brazil. They collected 2143 specimens through pit fall traps, total collection was placed into 21 species, 12 genera and five tribes. *Canthonpilluliformis*, *Canthoncurvipes*, *Canthon sp.* And *Deltochilumverruciferm* were abundant species. [According to a study on taxonomy of dung beetles belonging to families Scarabaeidae, Geotrupidae and Hybosoridae of Chhattisgarh, India. They collected 52 species placed in 22 genera, 12 tribes, 04 subtribes and 05 sub families; taxonomy was conducted through morphological characters. Sub families named *Aphodiinae* and Orphinae and the genera Aphodius, Caccobius, Copris, Phaeochrous, Phalops, Rhyssemus, Sisyphus, Oniticellus, *Onitis* were recorded for first time.

Pathania M, et al. [23] worked on the function of Digitonthophagus gazelle in grazing land cleanliness and production as a result of entombment of bovine dungs. They selected 10 year old pasture of Brachariadecumbens in Beef Cattle Research Station at Brazil. The results suggested that Digitonthophagus gazelle played significant role in pasture production by burying the dung hence cleaning the pasture and favored the efficient recycling of nutrients in the bovine dung.

Kabakov N, et al. [24] worked on the abundance and diversity of scarabaeoid beetles of Pench Tiger Reserve, Madhya Pradesh and developed an updated checklist of 61 species placed in 30 genera, 19 tribes, 7 subfamilies and 3 families named Geotrupidae, *Scarabaeidae* and Hybosoridae. According totheir work, 22 species were ranked as new record from studied area and 2 species named Deloplereuusparvus and Onthophaguscoeruleiocollis are recorded for first time from the entire state of Madhya Pradesh. Davis ALV, et al. [25] In their work presented faunal details of scarabaeoid beetles of Govind Wildlife Sanctuary, Garhwal, and Uttarakhand, India. Collected specimens were categorized into 11 species, same number of genera, 5 subfamilies and 2 families of super family Scarabaeoidae, all were the newly recorded from Sanctuary and three species viz. *Anomalaacntor, Mimelapasserinni* and *Oryctesnasicornis* were first time reported from Uttarakhand. An updated checklist of Scarabaeoid fauna of Uttarakhand comprising 167 species, 52 genera, 21 tribes, 9 sub families and 3 families was also the part of above work.

Chandara K, et al. [26] emphasized the use of pitfall traps as collection apparatus to study abundance of superfamily Scarabaeoidae in Western Turkey. The studies were carried from 2007 to 2012. Total 29 species placed in 21 genera and 5 families were collected at five sampling areas. Most abundant species were Oxythyera *cinctella, Sisyphusschaefferi*, *Tropinotahirta*, *Pentodonidiota* and *Onthophagusfurcatus*. Sabu TK, et al, [27] proposed morphological and terminological aspects of dung beetles male genitalia belonging to sub-family *Scarabaeinae*. They suggested that male genitalia investigations are helpful tools for the identification of species of dung beetles which are one of the ecological benifitors.327 species of subfamily *Scarabaeinae* were examined and their description regarding changes in genital segment, aedeagus, internal sac, and its sclerites and raspules were given.

Tshikae BP, et al. [28] worked on the population dynamics and diversity of chafers Scarabaeidae beetles in eight landscapes of Himachal Pradesh India. Collections were made in 2010 and 2011 for four months each year (May-August) by UV light trap. Total 13569 specimens were collected and grouped into 56 species, 20 genera and 4 subfamilies named Melolonthinae, Rutellinae, Cetoniinae and Dynastinae. Most abundant species were *Brahminacoriacea*, *Adoretuslasiopygus*, *Anomalalineatopennis* and *Holotrichialongipennis*. Genus *Anomala* was most abundant with 11 species while Melonothinae was the most abundant sub-family. Lobo JM, et al. [29] studied faunal distribution and ecology of Scarab beetles belonging to sub-family *Scarabaeinae* in Vietnam and some areas of adjacent countries, they recorded total 256 species. Study also included synonyms, details of collection points with ecological facts as landscapes-biotopes, altitudes etc.

Ghosh J, et al. [30] worked and collected data from Cote d Ivorie and Ghana related with regional manure beetle aggregations of rainy forest, savanna and plantations, their results suggested that a subset of the savanian animal life has unlimited dimension through the Eastern Guinean Forest eco-region, more probably in retort to its alteration from typical incessant rain forest into an island of forest pieces having low sheltered agricultural estate and farm land vegetation that looks like moist savanna. Siddiqi M, et al. [31] studied faunal diversity of families *Scarabaeidae* and Hybosoridae of Baranwapara Wildlife Sanctuary, Chhattisgarh, India. Over all collection was categorized into 43 species, 25 genera, 16 tribes and eight subfamilies.

Becker B, et al. [32] studied dung beetles regarding their diversity, guild makeup and succession connected with dung of Indian elephant at South Western Ghats forests, India. Collection was carried with the help of pitfall traps and from uncovered dung pats in the studied area at the intervals of daily, alternatively up to week, then fortnightly and so on up to 21 days.21 species belonging to three guilds were collected. High abundance of dwellers was reported as than rollers. *Drepanocerussetosus* along with *Onthophagusbronzeus* were most abundant species of dwellers and rollers respectively. 3-5 days old dung pats were suitable for the attraction of dung beetles hence increased abundance. Abundance and species richness of tunnelers was increased as dung become old with decreased moisture; this indicated the tendy of tunnelers with time span of dung.However no such relationship between dung moisture and abundance along with species richness was reported for rollers and dwellers.

Basset Y [33] assessed abundance and species richness of dung beetles in Chobe National Park (a woodland savanna) of Botswanna. Collection was carried with the help of bait types comprising pig dung, cattle dung, sheep dung, elephant dung and chicken livers (carrions). It was observed that species richness was higher and almost similar for traps baited with pig, elephant and cattle dung because all these are larger mammals.Abundance was lower for sheep dung and carrion. High abundance was recorded within traps filled with pig manure.

Sanchez MV, et al. [34] worked on the variation with altitude with reference to the abundance as well as species richness of dung beetles in the Bulgarian Rhodopes Mountains. Collection was made during summer, autumn and spring through pitfall traps and manual methods. Total 6712 specimens of 48 species were collected which comprised 56% species of Aphodinae, 33% of *Scarabaeinae* and 10% 0f Geotrupinae so *Aphodiinae* dominated in degree of species richness and clearly indicated the huge degree of their distribution within studied unit. In terms of abundance *Scarabaeinae* dominated with 67% of total specimens and *Aphodiinae* with 26%. Rate of species richness decreased with altitude around 11 species per km.

Hodar JA [35] surveyed scarab beetles fauna from Salt lake Wetland of Kolkata, India. They reported 14 species belonging to 03 sub families, *Scarabaeinae*, Rutellinae and Dynastinae. Siddiqi M, et al. [31] emphasized on the role of antennal sensilla of various beetles including scarabs as food selection in the fields of sugar cane, they observed four types of antennae into five families of beetles.The number and position of different types of sensilla on the antennal segments were the sources to determine their eco forms, food sources, life styles and tendency towards various smells and tastes. Yang LH, et al. [36] used three linear body dimensions as tools to assess length- dry mass associations of the 54 larvae of *Phylloicus sp*. (Trichoptera: Calamoceratidae) belonging to Brazilian streams. Those dimensions were body length, width of head capsule and interocular distance, these dimensions were statistically analyzed through linrar, exponential and power function models. From the results it was calculated that body length gave best equation to estimate biomass.

White EP, et al. [37] studied abundance and diversity of herbivore insects foraging upon seedlings in a rainforest habitat of Guyana.Total 9056 specimens were collected out of which 244 species fallen into the category of sap-sucking insects and101 species of leaf-chewing insects. Werenkraut V, et al. [38] worked on the concept of the construction of pupation chambers by 3rdInstar larva of *Scarabaeinae* species within brood balls of dung. Information provided through results optimized the character of pupation chamber wall and to incorporate that character in the phylogenic studies of *Scarabaeinae*. Montes E, et al. [39] used regression equations for biomass estimation of arthropods for ecological purpose. A set of regression equations were developed for length-weight parameter of 53 groups of arthropods. The results were significant and suggested remarkable importance of biomass in ecological studies.

Abbas M, et al. [40] suggested that insects are the drivers of the ecosystem processes. In spite of small size and low cumulative biomass, insects have imperative sound effects on carbon and nutrient cycles through modulation of the amount and quality of assets that incorporate into the detritus based food web with effects at the status of ecosystem. Such factors can come up through several pathways like direct invest of hexapod biomass, conversion of detrital volume and the circuitous effects of predatory animals on detritivores as well as herbivores. In all situations the ecosystemic effects of such pathways are related with connections of insects to plants and soil microbes so by discerning hexapod, floral and microbial ecology, it will be easier to assimilate community oriented connections with ecosystem performances.

Sial N, et al. [41] in their reviewed paper emphasized the links between body size and abundance in ecology, they suggested that there is a lack of understanding and need to be analyzed through studying life cycles, trophic associations so one can develop the clear-cut picture regarding body size and abundance link. Ahmeda Z, et al. [42] studied the shape of the species richness-elevation as well as abundance-elevation relationships in soil surface beetles of mountain beetles to analyze how abundance and richness differ within the forests and steppes in association with environmental factors and soil characters.

Conclusion

Population size means the real number of individuals or living organisms within a population. Population density is a tool of amount of population size per unit area that can be obtained by dividing population size with total area. Abundance means relative account of a species in a particular ecosystem. Population density may vary as an outcome of natural disasters like earthquakes, floods or by human induced factors. Calculation of all individuals present at a given period and at a given location is impossible because animals are not easily detectable by so many means so sampling method is applied to determine population size, density and abundance. Abundance estimates can be obtained by sampling a subset of the population of interested individuals. A major postulation is that the sample is envoy of the whole area, including threats, landscape, flora and altitude. Superlatively, assessment and monitoring data allow valuation of the sources and impacts of threats, such as hunting, habitat degradation and fragmentation.

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