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A Study on diversity and abundance of coleopterans in Gujarat, India

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Abstract

The present survey gives the current information on Coleoptera diversity of Gujarat. This is the first comprehensive account on Coleoptera species diversity. Different locations were selected for the collection of coleopteran insects in whole of Gujarat, covering all the districts. Altogether, 177 species belonging to 117 genera under 32 families in the order Coleoptera are reported from the state of Gujarat. This study indicated that the diversity index, species richness and evenness of Coleoptera fauna in Gujarat were 1.44, 47.1 and 0.63 respectively. This study is part of mission which was initiated under the research project sanctioned by Gujarat Biodiversity Board, Gandhinagar.

Keywords: Coleoptera, Shannon-Weiner species diversity index, Margalef's richness index, Pielou's evenness index, Gujarat

Introduction

Studying the immense variety of life on the planet and the complex relations among living things- what we now call biodiversity- has been a fundamental activity of conservationists and has become an important concern due to rapid species loss and increasing habitat degradation around the world. Time has come to record and try to conserve what is present today.

Gujarat is situated on the west coast of India, between 20°01' to 24°07' North latitudes and 68°04' to 74°04' East longitude and boasts of a 1,600 km long coastline. It has the geographical area of 195, 984 sq.km. This has rich diversity of species, habitats and ecosystems. Many of these ecosystems are unique and shelter some of the world's only remaining populations of threatened species of plants and animals.

The order Coleoptera includes more species than any other order, constituting almost 25% of all known life-forms [1]. About 40% of all described insect species are beetles (about 400,000 species) and new species are discovered frequently. Some estimates put the total number of species, described and undescribed, at as high as 100 million, but a figure of 1 million is more widely accepted [2]. The diversity of beetles is very wide. They are found in all major habitats, except marine and the Polar Regions. There are particular species that are adapted to practically every kind of diet. Furthermore, beetle is indicator of soil properties [3], temperature and humidity variation of the environments [4], forest disruptions [5] and environmental disturbances in the landscape structure [6]. The order Coleoptera includes 3,50,000 species, amongst which about 1, 5088 species of coleopteran insects are known from Indian region [7]. Beetles are exceedingly variable both ecologically and biologically. The majorities of beetle are terrestrial herbivores; many are predatory, frequently with highly specialized host ranges or life cycles [5, 8].

As far as sporadic work has been reported, few to be mentioned are work done by Pilo *et al.*, (1996) for Shoolpaneshwar Wilde Sanctuary; Parikh *et al.*, (2001) for Gir PA and Naidu and Kumar (2011) have studied the diversity of Coleopterans in Vadodara district [9-11]. The present study focuses on the diversity of beetles in Gujarat. The aim of the present study was to generate base line data of insect order Coleoptera in Gujarat. The survey of beetle assemblage, the most diverse group of insects, not only will help to assess the diversity of the state but also will help to carry out further studies to conserve the biodiversity of Gujarat state.

Materials and methods

The entire stretch of Gujarat was thoroughly surveyed so as to select the suitable sampling sites. Such as forest type, proximity of water body and/or road, relative distance from human settlement. At broad levels the State is divided into 32 districts, all the districts with different

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habitat were visited from April, 2014 to April, 2015. In addition to visual sighting and photo documentation, insects were collected manually, by pitfall trap where small Plastic cups filled with mixture of 70% Ethyl alcohol and Glycerine was buried up to the rim in the ground so that passing insects may fall. The nocturnal beetles were collected by light trap method, where halogen bulb was kept at the study site and the insect thus attracted were collected in the plastic container. Bark of the trees was scraped as to expose underneath coleopterans. Sweep nets were employed for catching flying beetles and beating umbrella method was used for collecting

beetles from the trees. All the insects thus collected were then processed for further identification; the specimens were narcotised by exposure to Cyanide vapour, for maintaining its original colour. Following the standard protocols of pinning each specimen was pinned for further identification. Identification was done by using standard reference books and published articles. The identified collections were stored in insect cabinets, containing naphthalene balls wrapped in paper, pinned at one corner of cabinet. The specimens identified were confirmed by comparing with the authentic specimens of Bombay Natural History Society, Mumbai.

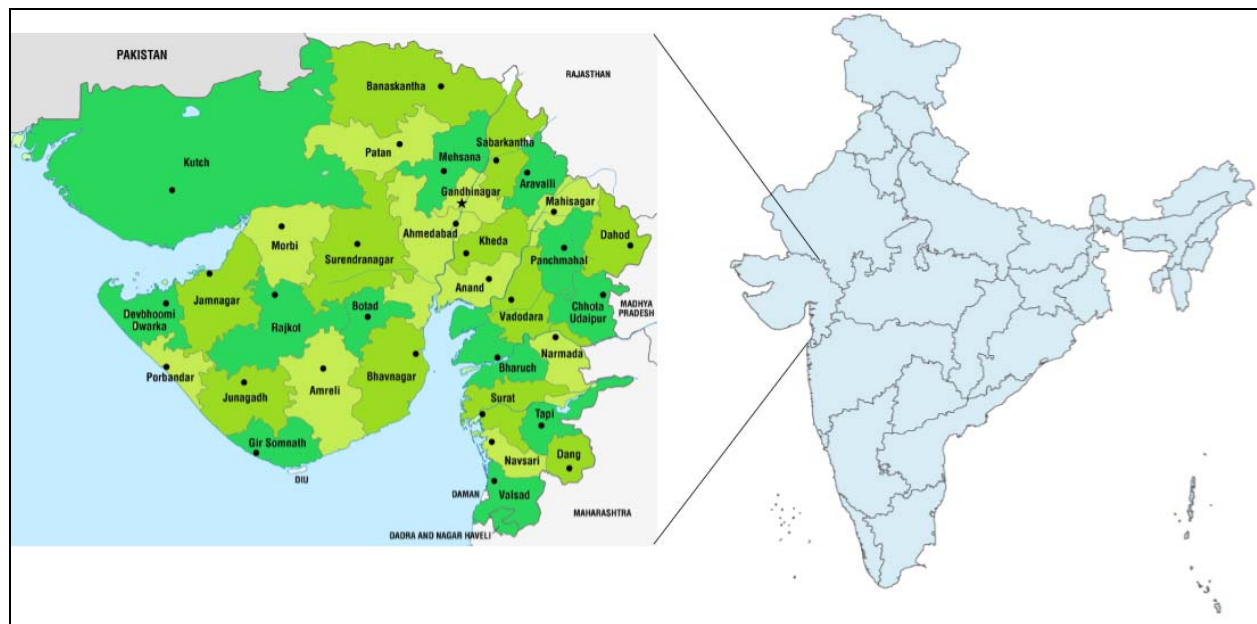


Fig 1: Map of Gujarat

Data analysis

As beetles are reported to be the diverse group of insects, main focus of the present study was to estimate the diversity of beetles in Gujarat State. Diversity indices used were:

1. Shannon-Weiner species Diversity Index

The diversity index was calculated by using the Shannon-Wiener diversity index^[12]

$$\text{Diversity index} = H = - \sum H P_i \ln P_i$$

Where, $P_i = S / N$

S = number of individuals of one species

N = total number of all individuals in the sample

In = logarithm to base e

2. Margalef's index for Richness

Margalef's index was used as a simple measure of species richness^[13]

$$\text{Margalef's index} = (S-1) / \ln N$$

Where,

S = total number of species

N = total number of individuals in the sample

In = natural logarithm

3. Pielou's Evenness Index

For calculating the evenness of species, the Pielou's Evenness Index (e) was used^[14]

$$e = H / \ln S$$

Where,

H = Shannon-Wiener diversity index

S = total number of species in the sample

Result

During the present survey a total of 5195 individuals belonging to order Coleoptera were collected. A total of 32 families belonging to Coleoptera were recorded. Of the collected individuals a total of 160 species were identified and 17 individuals were not identified. An annotated checklist of Coleoptera collected is presented in Table I. Of the total families identified 8 families (Dermestidae, Cleridae, Attelabidae, Nitidulidae, Languridae, Aphodiidae, Silvanidae and Anobiidae) are the ones which are first time reported in Gujarat. Of the 32 families, Scarabaeidae was the most dominant (21.6%) family with 38 representatives of Coleoptera, followed by Carabidae (13.6%) with 24 representatives, next in order was Tenebrionidae (7.9%) with 14 representatives. Chrysomelidae, Coccinellidae and Cerambycidae and Curculionidae (6.8%) had 12 representatives each. Buprestidae and Meloidae had 5 representatives (2.84%). Staphylinidae was represented by 4 species (2.27%). Cicindelidae and Dysticidae had 3 representatives each (1.7%). Hydrophilidae, Anthicidae and Bostrichidae were represented by 2 species (1.13%). Rest of the families: Gyrinidae, Lycidae, Cucujidae, Brentidae, Cantharidae, Apodiidae, Trogostidae, Lampyridae, Cleridae, Anobiidae, Languridae, Nitidulidae, Attelabidae, Silvanidae, Laemophloeidae and Dermestidae (0.5%) were having 1 representative each (Fig:3). This study indicated that the diversity index, species richness and evenness of Coleoptera fauna in Gujarat was 1.44, 47.1 and 0.63 respectively.

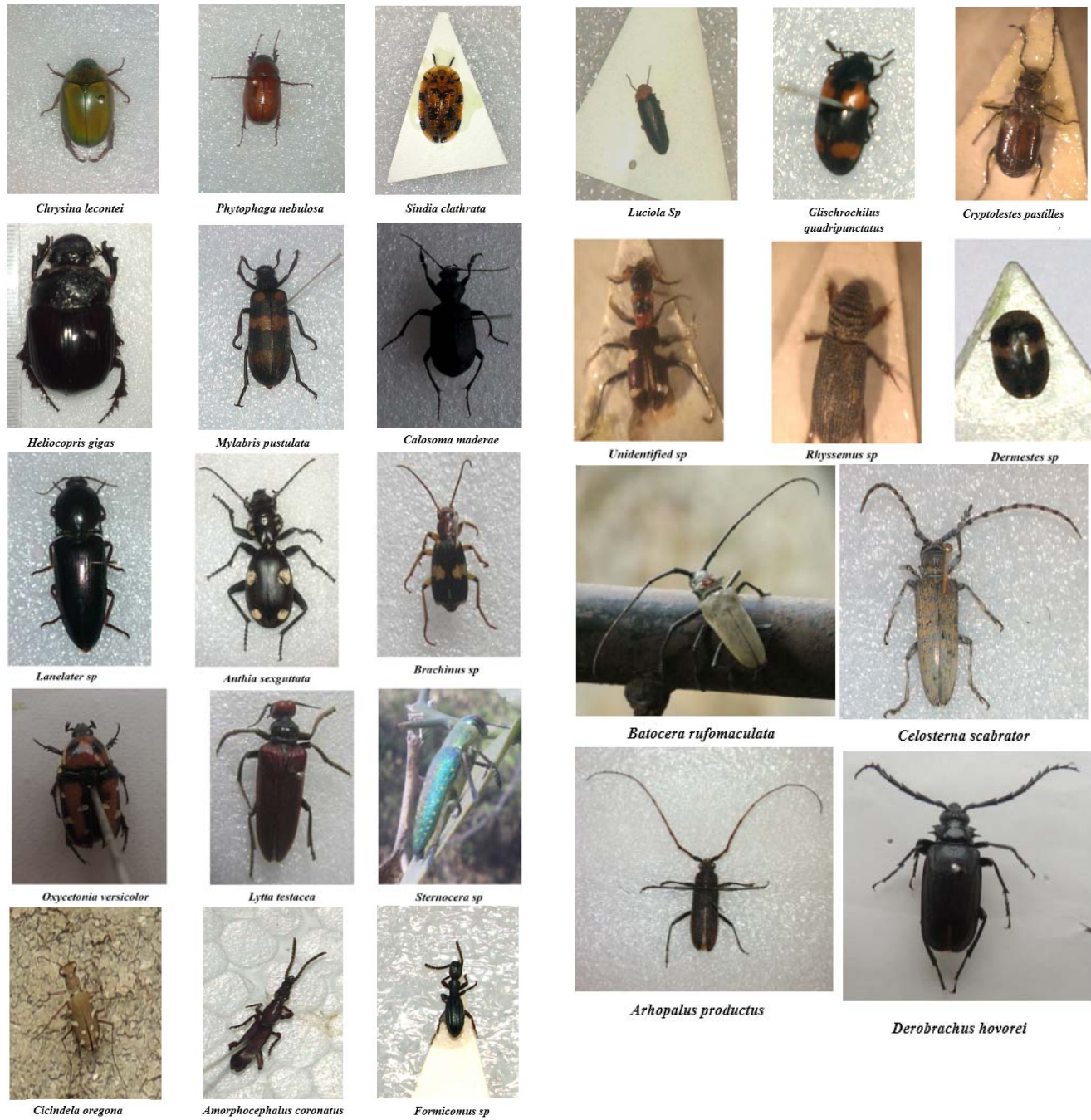


Table 1: An annotated checklist of Coleoptera Species collected from Gujarat

Family	Species name	No. of Individual
Carabidae	<i>Anthia sexguttata</i> (Fabricius,1775)	172
	<i>Archicolluris</i> sp. (Liebke, 1938)	78
	<i>Bembidion conforme</i> (Dejean, 1831)	89
	<i>Bembidion</i> sp.	36
	<i>Bembidion tetracolum</i> (Say, 1823)	47
	<i>Brachinus crepitans</i> (Linnaeus, 1758)	23
	<i>Brachinus exhalans</i> (P. Rossi, 1792)	52
	<i>Calosoma maderae</i> (Fabricius,1775)	124
	<i>Chlaenius bimaculatus</i> (Dejean, 1826)	39
	<i>Chlaenius</i> sp.	42
	<i>Craspedophorus saundersi</i> (Chaudoir, 1869)	19
	<i>Drypta lineola</i> (W.S. Macleay, 1825)	31
	<i>Laemostenus</i> sp.	22
	<i>Microcosmodes symei</i> (Murray, 1857)	26
	<i>Neocollyris andrewesiregia</i>	12
	<i>Paranchus albipes</i> (Fabricius, 1796)	37

	<i>Pheropsophus catoirei</i> (Dejean, 1825)	27
	<i>Pheropsophus verticolis</i> (Dejean, 1825)	18
	<i>Pheropsophus</i> sp. 1	53
	<i>Pheropsophus</i> sp. 2	28
	<i>Pterostichus oblangopuctata</i>	14
	<i>Pterostichus aethiops</i> (Panzer, 1797)	31
	<i>Scarites terricola</i> (Bonelli, 1813)	103
	<i>Tachyta nana</i> (Gyllenhal, 1810)	120
	<i>Cicindela oregona</i> (LeConte, 1857)	166
Cicindelidae	<i>Cicindela ocellata</i> (Klug, 1834)	78
	<i>Cicindela</i> sp.	43
	<i>Cybister tripunctatus</i> (Olivier 1795)	37
Dysticidae	<i>Desmopachria</i> sp.	83
	<i>Eretes sticticus</i> (Linnaeus 1767)	29
Gyrinidae	Unidentified sp.	25
	<i>Adoretus</i> sp. 1	49
	<i>Adoretus</i> sp. 2	52
	<i>Anomala bengalensis</i> (Blanchard, 1851)	93
	<i>Aphodius fossor</i> (Linnaeus, 1758)	24
	<i>Aphodius</i> sp.	34
	<i>Ateuchus</i> sp.	21
	<i>Caccobius</i> sp.	17
	<i>Cetonia</i> sp.	34
	<i>Chrysina lecontei</i> (Horn, 1882)	23
	<i>Copris incertus</i> (Say, 1835)	32
	<i>Copris numa</i> (Lansberge, 1886)	54
	<i>Copris</i> sp. 1	78
	<i>Copris</i> sp. 2	27
	<i>Cyclocephala pasadenae</i> (Casey, 1915)	23
	<i>Gymnopleurus cyaneus</i> (Fabricius, 1787)	46
	<i>Gymnopleurus miliaris</i> (Fabricius, 1775)	76
	<i>Heliocopris bucephalus</i> (Fabricius, 1775)	7
	<i>Heliocopris gigas</i> (Linnaeus, 1758)	9
	<i>Holotrichia reynaudi</i> (Blanchard, 1851)	29
	<i>Melinopterus</i> sp.	12
	<i>Melolonthinae</i> sp.	42
	<i>Onthophagus alropolitus</i>	131
	<i>Onthophagus lemur</i> (Fabricius 1781)	53
	<i>Onthophagus tweedensis</i> (Blackburn, 1903)	46
	<i>Onthophagus gazelle</i> (Fabricius, 1787)	178
	<i>Onthophagus</i> sp. 1	39
	<i>Onthophagus</i> sp. 2	49
	<i>Onthophagus taurus</i> (Schreber, 1759)	156
	<i>Oxycetonia jucunda</i> (Falderman, 1835)	32
	<i>Oxycetonia versicolor</i> (Fabricius, 1775)	28
	<i>Oxythyrea</i> sp. 1	15
	<i>Phyllophaga nebulosa</i> (Polihronakis, 2007)	47
	<i>Phyllophaga obsoleta</i> (Blanchard, 1851)	39
	<i>Phyllophaga</i> sp. 1	63
	<i>Scarabaeus erichson</i> (Harold, 1867)	8
	<i>Xylotrupes ulysses</i> (Guérin-Méneville, 1830)	6
	Unidentified sp. 1	3
	Unidentified sp. 2	2
	<i>Adonia variegata</i> (Goeze, 1777)	36
	<i>Anegelis cardoni</i> (Weise, 1892)	23
	<i>Brumoides suturalis</i> (Fabricius, 1798)	44
	<i>Cheilomenes sexmaculata</i> (Fabricius, 1781)	29
	<i>Chilocerus nigrinus</i>	18
	<i>Chilocerus circumdatus</i>	21
	<i>Coccinella repanda</i> (Thunberg, 1781)	29
	<i>Coccinella transversalis</i> (Fabricius, 1781)	26
	<i>Coccinella undecimpunctata</i> (Linnaeus, 1758)	13
	<i>Harmonia expallida</i> (Weise 1907)	8
	<i>Menochilus sexmaculatus</i> (Fabricius, 1781)	16
	Unidentified sp.	2
	<i>Alcidodes</i> sp.	13
Curculionidae	<i>Bagous alismatis</i> (Seidlitz, 1875)	28
	<i>Cosmopolites sordidus</i> (Germar, 1824)	58
	<i>Myllocerus</i> sp.	39

	<i>Notaris scirpi</i> (Fabricius, 1793)	19
	<i>Notaris</i> sp.	11
	<i>Odoiporus longicollis</i> (Olivier, 1807)	6
	<i>Oxystoma</i> sp.	10
	<i>Phyllobius</i> sp.	5
	<i>Polydrusus formosus</i> (Mayer, 1779)	26
	<i>Unidentified</i> sp. 1	2
	<i>Unidentified</i> sp. 2	1
Tenebrionidae	<i>Alphitobius</i> sp.	24
	<i>Ceropria induta</i> (Wiedemann, 1819)	16
	<i>Eleodes</i> sp. 1	53
	<i>Eleodes</i> sp. 2	72
	<i>Eusattus</i> sp.	19
	<i>Gonocephalum</i> sp.	102
	<i>Hopatrum</i> sp.	11
	<i>Mesostena</i> sp.	8
	<i>Opatrum</i> sp.	15
	<i>Pimelia canariensis</i>	1
	<i>Platydema</i> sp.	13
	<i>Uloma</i> sp.	5
	<i>Unidentified</i> sp.	1
	<i>Zophosis punctuate</i>	3
Elateridae	<i>Abelater</i> sp.	13
	<i>Agriotes ustulatus</i> (Schaller, 1783)	13
	<i>Hemicrepidius</i> sp.	9
	<i>Lanelater fuscipes</i> (Fabricius, 1775)	42
	<i>Lanelater</i> sp.	13
	<i>Mulsanteus</i> sp.	18
	<i>Prosternon</i> sp.	7
	<i>Unidentified</i> sp. 1	2
	<i>Unidentified</i> sp. 2	1
Staphylinidae	<i>Ocypus brunnipes</i> (Fabricius 1781)	36
	<i>Paederus riparius</i> (Linnaeus 1758)	28
	<i>Quedius</i> sp.	39
	<i>Siagonium</i> sp.	43
Hydrophilidae	<i>Enochrus</i> sp.	27
	<i>Hydrophilus</i> sp.	137
Buprestidae	<i>Acmaeodera</i> sp.	9
	<i>Psiloptera coerulea</i> (Olivier, 1790)	17
	<i>Sternocera</i> sp. 1	6
	<i>Sternocera</i> sp. 2	5
	<i>Sternocera aequisignata</i> (Saunders, 1866)	8
Lycidae	<i>Unidentified</i> sp.	2
Cucujidae	<i>Unidentified</i> sp.	1
Meloidae	<i>Eletica testacea</i>	17
	<i>Epicauta</i> sp.	11
	<i>Lytta caraganae</i> (Pallas, 1781)	20
	<i>Mylabris pustulata</i> (Thunberg, 1821)	34
	<i>Unidentified</i> sp.	2
Cerambycidae	<i>Acanthophorus serraticornis</i> (Olivier, 1795)	2
	<i>Neocerambyx</i> sp.	8
	<i>Arhopalus productus</i> (LeConte, 1850)	4
	<i>Batocera rufomaculata</i> (Degeer, 1775)	7
	<i>Celosterna scabrator</i> (Fabricius, 1781)	9
	<i>Chlorophorus</i> sp.	3
	<i>Derobrachus hovorei</i> (Santos-Silva, 2007)	1
	<i>Niphona fuscatrix</i> (Fabricius, 1793)	13
	<i>Niphona</i> sp.	10
	<i>Prionus californicus</i> (Motschulsky, 1845)	2
	<i>Xylotrechus stebbingi</i> (Castelnau & Gory, 1841)	3
	<i>Unidentified</i> sp.	1
Chrysomelidae	<i>Asp. idomorpha militaris</i> (Fabricius, 1775)	12
	<i>Cassida</i> sp.	17
	<i>Chrysolina</i> sp.	24
	<i>Chrysolina coerulans</i> (Scriba, 1791)	11
	<i>Chrysolina fastuosa</i> (Scopoli, 1763)	20
	<i>Clytra</i> sp.	9
	<i>Crioceris</i> sp.	13
	<i>Podagrica fuscicornis</i> (Linnaeus, 1766)	16

	<i>Sindia clathrata</i> (Olivier,1808)	8
	<i>Unidentified sp. 1</i>	4
	<i>Unidentified sp. 2</i>	3
	<i>Unidentified sp. 3</i>	6
Brentiidae	<i>Amorphocephalus coronatus</i> (Schoenherr, 1840)	5
Anthicidae	<i>Anthelephila sp.</i>	16
	<i>Formicomus sp.</i>	31
Cantharidae	<i>Rhagonycha fulva</i> (Scopoli, 1763)	4
Aphodiidae	<i>Rhyssemus sp.</i> (Mulsant, 1892)	3
Trogostidae	<i>Unidentified sp. 1</i>	1
Bostrichidae	<i>Unidentified sp. 1</i>	1
	<i>Unidentified sp. 2</i>	3
Lampyridae	<i>Luciola anceyi</i> (Olivier, 1883)	46
	<i>Luciola sp.</i>	24
	<i>Unidentified sp. 1</i>	4
Cleridae	<i>Unidentified sp. 1</i>	7
Anobiidae	<i>Lasioderma serricorne</i> (Fabricius, 1792)	19
Languridae	<i>Unidentified sp. 1</i>	1
Nitidulidae	<i>Glischrochilus quadripunctatus</i> (Linnaeus,1758)	7
Attelabidae	<i>Paratrachelophorus sp.</i>	17
Silvanidae	<i>Oryzaephilus surinamensis</i> (Linnaeus, 1758)	28
Laemophloeidae	<i>Cryptolestes pusillus</i> (Schoenherr, 1817)	4
Dermestidae	<i>Dermestes sp.</i> (Linnaeus,1758)	1

Table 2: Diversity of Coleopterans at various study sites of Gujarat during April 2014-April 2015.

Shannon-Weiner species Diversity	1.44
Margalef's Richness,	47.1
Pielou's Evenness	0.63

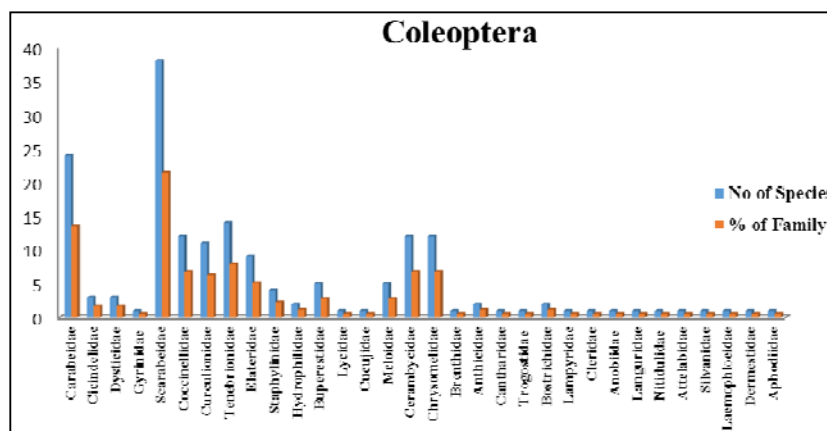


Fig 3: Distribution of Coleopterans families in Gujarat

Discussion

The appreciable numbers of coleopterans reported in the present study suggest that Gujarat has a good assemblage of this group of insects. Scarabaeidae was reported to be the most dominant (21.5%) of all the families, probably due to the adults of these beetles are more noticeable and sighted due to their relatively large size, bright colors, often with elaborate ornamentation [15]. Moreover, the dung beetles, through their dung consumption and relocation activities, might be helping in performing a series of ecological functions such as nutrient cycling, soil aeration, parasite suppression, secondary seed dispersal, nutrient cycling and bioturbation [16]. The members belonging to Scarabaeidae were the major contributors diversity-wise as well as density-wise. Of all the species *Onthophagus* was found to be present in all the districts and throughout the study period. Our results are in agreement with many researchers who have reported Scarabaeidae to be the most dominant group during their studies on diversity of Insects in Maharashtra [26]; in Jalgaon district [17]; in Kolhapur [18]; in Bikaner [19].

Carabidae was the second dominant (13.6%) coleopteran reported in the present study. Carabids are usually predators and primary importance of Carabids lies in the variety of the location and are considered to be opportunistic feeders that consume a variety of foods, where some species are omnivorous, some phytophagous and most of them are carnivorous [20, 21]. Family Carabidae commonly known as ground beetles are important biological control agents in agro ecosystems, and play a significant role in ecologically-based integrated pest management programs that focus on avoidance or reduction of pest pressure through cultural practices and biological controls. An appreciable number of ground beetles in Gujarat thus suggest a positive ecological role of these insects. [22, 23]

Tenebrionids generally feed on material of plant origin including decaying matter, wood, leaf litter, pollen, as well as fungal and algal matter. Some are also scavengers while very few species are predatory especially of wood boring beetles. A small number of species are myrmecophilous. Some tenebrionids have become associated with stored grain

products and are now considered as cosmopolitan pests of such commodities [24]. The good assemblage of Tenebrionidae (7.9%) in Gujarat is in agreement with the earlier reported work in India by many scientists [17, 25, 26].

Coccinellidae, Cerambycidae, Chrysomelidae and Curculionidae families were represented by 6.8% in Gujarat. However, as these groups of coleopterans are usually considered to be the harmful one and at no time or place they were reported to be in aggregation that can lead to the serious problem. Hence, the reported harmful group of coleopterans is comparatively less. A review of literature has shown the presence of Cerambycidae [27], Coccinellidae [28] and of Chrysomelidae [29] in Maharashtra state.

Elateridae commonly known as click beetles were commonly sighted at the nurseries and under the bark. They are generalists, feeding on a large variety of crops, resulting in damage to seeds, roots, stems, and harvestable plant parts, which can facilitate secondary crop damage by pathogens [30]. As this was the preliminary survey it is difficult to conclude the less diversity of Elateridae reported, however, further detailed study focusing on family wise diversity may throw more light on it.

Buprestidae, Meloidae and Staphylinidae family too had a very less diversity (<3%) and similarly, Cicindelidae, Dysticidae, Hydrophilidae, Bostrichidae and Anthicidae (<2%) were also seen to be represented by very less number. Thus, due to the poor representation of these groups it is very early to comment on the diversity of this group of Coleoptera. Rest of all the families which constitutes almost 50% of the total Coleoptera families found in the present studies had <1% representation. However, 8 families are the one as stated earlier which are reported for the first time in Gujarat. From the present survey it can be concluded that Gujarat has a rich Coleopteran diversity. Short time survey has resulted into generation of almost 21% of the families present in India. This study indicated that the diversity index, species richness and evenness of Coleoptera fauna in Gujarat were 1.44, 47.1 and 0.63 respectively. Overall, during the present survey it was in general observed that Gujarat harbors an appreciable number of Coleoptera which can be attributed to the congenial agro-climatic conditions and availability of preferred host plants. A long term study is needed to observe the species occurrence in all seasons and their interaction with the environmental changes for better results. Hence, the present inventory survey will provide baseline data for upcoming researchers and furnishes wide scope for further long term studies.

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