

Review Article

A comprehensive review on diversity of predaceous coccinellid beetles (Coleoptera: Coccinellidae)

Abstract

This review delves into the pivotal role of coccinellid beetles, commonly known as ladybird beetles, in biological pest control and their significance in maintaining ecological balance. The successful introduction of the vedalia ladybird in 1888 to control the cottony cushion scale in California stands as a landmark in biological pest control, prompting numerous global attempts to employ predaceous ladybird beetles for aphid control. Predaceous ladybird beetles have gained attention for their ability to feed on a diverse range of prey, emphasizing the need for comprehensive biodiversity information in new areas. Coccinellids, with approximately 6,000 species globally, inhabit various environments contributing significantly to pest management. The Indian subcontinent, with its rich coccinellid diversity explored through catalogues and surveys with highlighting the ecological balance they maintain and the potential for sustainable pest management practices.

Keyword: Coccinellid beetle, Predator, insect pest, beneficial and diversity.

Introduction

The most successful example of classical biological pest control is widely recognized to have been achieved through the successful introduction of the vedalia ladybird *Rodolia cardinalis* Mulsant from Australia into California in 1888. The ladybird was specifically designed to target the cottony cushion scale, or *Icerya purchasi*, which posed a threat to industry [1]. As Joshi et al. (2003) [2] demonstrate, this historic accomplishment led to 155 attempts worldwide to use predaceous ladybird beetles to control aphids. These experiments have shown that predaceous ladybird beetles are an effective pest control tool. The exceptional capacity of predatory ladybird beetles to feed on a diverse array of prey, such as aphids, coccids, phytophagous mites, adelgids, and aleyrodids, has garnered significant attention in recent years as biological control agents [3,4,5,56,57]. Comprehensive data on the biodiversity of these agents in new locations must be produced immediately, given their potential for biocontrol [6, 7].

Coccinellid beetles, commonly known as ladybird beetles, emerge as a crucial group of predatory insects playing a significant role in the biological control of diverse insect pests worldwide [8]. While exhibiting polyphagous behavior, some coccinellids display specificity in their food preferences [9,57]. Inhabiting a variety of environments such as forests, agricultural fields, grasslands, gardens, and human habitats, the Coccinellidae family encompasses

approximately 6,000 described species globally, distributed across 360 genera [10]. Notably, the Indian Prey-Predator catalogue of coccinellid beetles by Omkar and Pervez (2004) record 261 known predaceous coccinellids in India, belonging to 57 genera [11]. Poorani's checklist of Coccinellidae in the Indian sub-region (2002) lists 79 genera and 400 species of ladybeetles, providing insights into their distribution in the subcontinent [12]. Jadhav and Sharma (2012) further contribute to this knowledge by identifying twenty coccinellid beetle species under 15 genera and 6 subfamilies in the fauna of Maharashtra [13,57].

Beyond their role as predators, coccinellids play a vital role in maintaining ecological balance by regulating pest densities, ultimately reducing the dependence on chemical pesticides in agriculture. This review article underscores the significance of research on the diversity of predaceous coccinellid beetles and their potential impact on sustainable pest management practices.

Global Overview

A wide range of Coccinellid beetle species have been identified by several researchers from different parts of the world during their research. The coccinellid community's composition and diversity were investigated by Lovei (1981) in an apple orchard close to Budapest, Hungary, in both insecticide-treated and untreated blocks [14]. In uncultivated areas, Garcia *et al.* (1997) found 13 species of coccinellids [15]. *Hippodamia variegata* has been found in Austria on crops like sorghum, sunflower, lucerne, triticale, and citrus, according to Franzmann's 2002 research [16]. A thorough analysis of the biotic potential, host range, distribution, and ecology of 71 species of predaceous coccinellids in Pakistan was presented by Irshad (2001) [17]. 22 coccinellid species were identified by Zahooret *al.* (2003) after they evaluated the diversity, richness, and evenness of coccinellids and their function as bioindicators in agriculture and woodland regions in Faisalabad, Pakistan [18].

In Sri Lankan regions where vegetables are grown, Mayadunnage *et al.* (2007) identified 15 coccinellid species [19]. From the canopies of olive orchards in southern Spain, Cotes and colleagues (2010) collected thirteen species of ladybird beetles [20]. Twelve coccinellid species from Pakistan's Faisalabad area were reported by Abbas *et al.* in 2013 [21]. In the Mirpur Division of Jammu and Kashmir, Pakistan, Hayat and Khan (2013) collected data on 51 coccinellid species [22]. 11 species of ladybird beetles have been documented from the Mehriz area of Iran [23].

Diversity in India

In India, numerous researchers have delved into various aspects of Coccinellid beetles. Various scientists, such as Kapur (1972), contributed to the understanding of the diversity of coccinellid beetles. Agarwala and Ghosh (1988) reported a total of 36 coccinellid beetle species across India [25]. Kapur's work focused on documenting 17 species of ladybird beetles in Goa [24]. Joshi and

Sharma (2008) conducted a collection and identification effort in the Haridwar district of Uttarakhand, revealing 31 species of coccinellid beetles [26].

In the Srinagar area of Kashmir, a survey carried out by Khan *et al.* (2009) found 15 coccinellid species spread over 12 distinct agricultural ecosystems [27]. In Dehradun, Sharma and Joshi (2010) found 25 species of Coccinellid beetles that are predators [28]. Twenty different species of coccinellid beetles were gathered from tea estates in North Bengal by Roy *et al.* (2010) [29]. Six coccinellid species were found in Hissar, Haryana, according to Kedaret *et al.* (2011) [30]. In the Sub-Himalayan area of North-East India, 12 coccinellid species were studied by Ghosh and Chakraborty (2012) for the occurrence and abundance of predatory beetles, namely *C. septempunctata* [31].

At the Hybrid Rice Evaluation Center, Tamil Nadu Agricultural University, Gudalur, Vinothkumar (2013) identified 13 coccinellid species in the rice agroecosystem [32]. About 24 species belonging to 17 genera were found in a survey conducted by Majumder *et al.* (2013) on the diversity of coccinellid beetles in Tripura, Northeast India's agricultural and forest settings. [33]. Observing 17 and 15 species of predaceous coccinellids in fruit and vegetable ecosystems, respectively, Shah and Khan (2014) undertook a biodiversity assessment of coccinellids in the main belts of Kashmir Valley that cultivate fruits and vegetables [34].

16 species of predaceous coccinellids were gathered by Chaudhary *et al.* (2014) in Jharkhand's mango agroecosystems [35]. 18 species of coccinellid beetles were found in crop fields examined by Megha *et al.* (2015) in the Dharwad district of India [36]. In the citrus orchard of Assam Agricultural University, Jorhat, Ramya and Thangjam (2016) identified 12 species of coccinellid beetles linked to insect pests of Assam lemon [37].

In their 2016 study, Ankalgi and Jadesh [38] found 12 species in 4 distinct subfamilies and 9 genera among the Coccinellid fauna of Ankalg Village, Gulbarga, Karnataka. Four species of coccinellid beetles were observed by Goswami *et al.* (2016) during the Rabi season while conducting field tests to examine the relative prevalence of coccinellid predators in major Rabi oil seeds and pulse crops in Sabour, Bihar [39]. The Western Plain Zone of Uttar Pradesh is home to 21 species of predatory coccinellid beetles, according to Kumar *et al.* (2017) [40].

Ten distinct species of ladybird beetles have been found in the agroclimatic zone of Bhubaneswar, according to Mukherjee and Suman's 2017 research [41]. In the Himachal Pradesh agroclimatic zones, Sharma *et al.* (2017) identified 65 different coccinellid species [42]. Murali *et al.* (2017) noted ten different species of coccinellid beetles over different brinjal crop seasons [43]. From horticultural and agricultural crop areas in Kashmir, Rasheed and Buhroo (2018) gathered thirteen species of ladybird beetles [44]. In vegetable crops from Hyderabad agricultural fields, JesuRajan *et al.* (2018) found nine species of coccinellids [45]. When Shanker *et al.* (2018) conducted study on the biodiversity and predatory capability of coccinellids

in rice habitats in Malan, Himachal Pradesh, they collected coccinellid species from 15 genera, representing 5 tribes of the Coccinellidae family [46].

In Uttarakhand, India's forest habitat, Mishra and Yusuf (2019) identified 15 species of coccinellid beetles [47]. During a survey of the coccinellid fauna in crop areas in North Eastern Karnataka, Kiranet *al.* (2019) discovered 36 species of coccinellid beetles [48]. Six species of predatory lady beetles were found in Sivakasi by Sundareshwariet *al.* (2019) [49].

Table 1. Biodiversity and distribution of different subfamilies within the Coccinellidae family in India [56].

S.No.	Subfamily	Species	Distribution
1.	Chilocorinae	<i>Brumoidessuturalis</i>	North Eastern region of India, Maharastra, West Bengal, Tamilnadu and Gujarat
		<i>Chilochorusnigrita</i>	Southern region of India
		<i>Chilochorussubindicus</i>	Southern region of India
2.	Coccidulinae	<i>Rodoliacardinalis</i>	Southern region of India
		<i>Rodoliafumida</i>	Northern and central region of India
3.	Coccinellinae	<i>Cheilomenessexmaculata</i>	Alloverthecounrty
		<i>Coccinellaseptempunctata</i>	Whole counrty
		<i>Harmonisoctomaculate</i>	Wholecounrty
		<i>Hippodamiavariegata</i>	Northern region of India
		<i>Illiescincta</i>	Whole counrty
4.	Epilachninae	<i>Henosepilachnanarayana</i>	Maharashtra, Karnataka
		<i>Henosepilachnaseptima</i>	Wholecounrty
5.	Scymninae	<i>Cryptogonusorbiculus</i>	North Eastern region of India
		<i>Pseudaspidimerustrinotatus</i>	Southern region of India
		<i>Scymnusnubilus</i>	Southern region of India
		<i>Stethoruspauperculus</i>	Central region of India
		<i>Serangiumparcesetosum</i>	Central region of India
6.	Sticholotidinae	<i>Jauraviaopaca</i>	Karnataka, Maharashtra

		<i>Jauraviasimplex</i>	Southern region of India
		<i>Jauraviapallidula</i>	Maharashtra, Karnataka, Meghalaya, Tamil Nadu, WestBengal

In the apple orchard ecosystems of Kashmir, Himalayas, India, Maqboolet *al.* (2020) found 12 species of coccinellids from 11 taxa [47]. Arunachal Pradesh is home to 44 species of coccinellids, representing 22 genera and 6 tribes, according to Das *et al.* (2020) [50]. In 2020, Pervez and colleagues carried out a field study to investigate the variety of predaceous ladybird beetles in various geographical settings in Uttarakhand, North India. They identified eighteen species of predaceous ladybird beetles belonging to fifteen genera and three subfamilies [51]. In 2020, Thangjamet *al.* found 19 species of coccinellid beetles in 11 taxa that were predaceous on king chilli sucking pests in Assam, India [52].

In the groundnut crop ecosystems of the Rayalaseema Region of Andhra Pradesh, Vasistaet *al.* (2020) recorded nine species of coccinellid beetles [53]. Six species of coccinellids were found in the kharif rice fields of Rajendranagar, Hyderabad, by Anithaet *al.* (2020) [54]. Hiruret *al.* (2020) found three species of coccinellids in their investigation on the biodiversity and quantity of coccinellids in tomato under sprayed and unsprayed circumstances during the rabi season [55].

The coccinellid beetles are found in a variety of environments, such as woods, grasslands, and agro-ecosystems, according to the studies cited in this review article taken together. By gathering specimens for their investigations, these researchers carried out extensive studies on several facets of coccinellid beetles. Throughout the various environments, *Cheilomenessexmaculata* was the most prevalent predatory coccinellid species among the specimens gathered. Variations in environmental circumstances, agricultural crops, and prey species can be observed in the variety and abundance of coccinellid beetle species. The lack of comprehensive research and collecting over the whole geographical area of India impedes a full knowledge of the coccinellid fauna in the region, despite its richness and variety.

Conclusion

This comprehensive review sheds light on the pivotal role of coccinellid beetles, popularly known as ladybird beetles, in the realm of biological pest control. The historical success of introducing the vedalia ladybird beetle (*Rodoliacardinalis*Mulsant) in 1888 to combat the cottony cushion scale in California remains a watershed moment in the field, symbolizing the efficacy of biological control methods. Subsequent global endeavors, totaling 155 attempts to utilize predaceous ladybird beetles for aphid control underscore their significance in pest management. The spotlight on predaceous ladybird beetles intensifies due to their exceptional ability to feed on a diverse array of prey, encompassing aphids, coccids, phytophagous mites,

adelgids and aleyrodids. This recognition elevates their status of predatory coccinellids as potent biological control agents, prompting the urgent need for an extensive understanding of their biodiversity in new territories. The call for more information is particularly pertinent considering their potential for biocontrol and sustainable pest management practices. Zooming into the realm of coccinellid beetles globally, researchers from various corners of the world have contributed valuable insights into their diversity and ecological roles. The documentation of diverse coccinellid species in different habitats, from orchards in Hungary to uncultivated areas and agricultural fields in Spain and Pakistan, illustrates the adaptability and ubiquity of these beneficial insects. The surveys conducted in Sri Lanka, Spain and various regions of India provide a snapshot of the rich tapestry of coccinellid fauna in different geographical contexts. However, the review highlights a persistent gap in understanding of coccinellid diversity in India. Despite substantial efforts by researchers, the sheer vastness of the country and the diversity of ecosystems demand more comprehensive exploration. The dominance of *Cheilomenes sexmaculata* (Fab) among the collected specimens showcases the adaptability of coccinellids across diverse ecosystems.

In essence, this review encapsulates both the global and Indian perspectives on coccinellid beetles, emphasizing their crucial role in biological pest control, maintaining ecological equilibrium and the pressing need for continued research to unlock the full potential of these remarkable insects in sustainable agriculture.

References:

1. Majerus, M. E. N. Ladybirds. Harper Collins, London. 1994: 359 pp.
2. Joshi, S., Mohanraj, P., Rabindra, R. J. and Rao, N. S. Production and use of coccinellid predators. Technical Bulletin. 2003: No. 32, Project Directorate of Biological Control, Bangalore, India.
3. Moreira, L. R., Oliveira, E. E., Hatano, E., Pallini, A., Vilela, E. F. and Lima, F. N. B. Infogumicos de tomateiro mediam o comportamento de herbívoros? Ceresi, 2004; 51: 397-404.
4. Oliveira, E. E., Oliveira, C. L., Sarmiento, R. A., Rezende, L. M. and Fadini, M. A. M. Aspectos biológicos de predador *Cycloneda sanguinea* (Coleoptera: Coccinellidae) alimentado com *Tetranychus evansi* (Acari: Tetranychidae) *Macrosiphum euphorbiae* (Homoptera: Aphididae). *Bioscience Journal*, 2004; 21: 33-39.
5. Khan, A. A. Zaki, F. A. Predation rates of *Coccinella septempunctata* Linnaeus and *Chilocorus infernalis* Mulsant on aphids. *Asian Journal of Bio Science*, 2007; 2: 53-55.
6. Omkar Parvez, A. Ecology and biocontrol potential of a scale predator, *Chilocorus nigritus*. *Biocontrol Science and Technology*, 2003; 13: 379-390.

7. Alia, H. Coccinellid (Coccinellidae: Coleoptera) fauna of District Poonch, Azad and Jammu Kashmir. M. Sc. Thesis submitted to department of Entomology, NWFP Agricultural University, Peshawar. 2002:55pp.
8. Moreton BD. Beneficial Insects and Mites. Vol. 20. Her Majesty, Stationary Office London. Ministry of Agriculture, Fisheries and Food. Bulletin; Ladybirds and spider mites; p. 15-20.
9. Khan I, Din S, Khalil SK, Rafi MA. (2007) Survey of predatory coccinellids (Coleoptera: Coccinellidae) in the Chitral district, Pakistan. *Journal of Insect Science*. Jan 1;7(1):7.
10. Slipinski A. Australian ladybird beetles (Coleoptera: Coccinellidae): their biology and classification. CSIRO publishing; .2013: May 27, 286.
11. Pervez A. Predaceous coccinellids in India: predator-prey catalogue (Coleoptera: Coccinellidae). *Oriental Insects*.2004; May 1;38(1):27-61.
12. Poorani J. An annotated checklist of the Coccinellidae (Coleoptera) (excluding Epilachninae) of the Indian subregion. *Oriental Insects*.2002; Jan 1;36(1):307-83.
13. Jadhav SS, Sharma RM. Insecta: Coleoptera: Coccinellidae. Zool. Surv. India Fauna of Maharashtra, State Fauna. 2012;20:507-9.
14. Lovei GL, Sarospataki M, Radwan ZA. Structure of ladybird (Coleoptera: Coccinellidae) assemblages in apple: changes through developmental stages. *Environmental entomology*.1991;Oct 1;20(5):1301-8.
15. Colunga-Garcia M, Gage SH, Landis DA. Response of an assemblage of Coccinellidae (Coleoptera) to a diverse agricultural landscape. *Environmental Entomology*.1997; Aug 1;26(4):797-804.
16. Franzmann BA. *Hippodamia variegata* (Goeze) (Coleoptera: Coccinellidae), a predacious ladybird new in Australia. *Australian Journal of Entomology*.2002; Oct;41(4):375-7.
17. Irshad M. Distribution, hosts, ecology and biotic potentials of coccinellids of Pakistan. *Pakistan Journal of Biological Sciences*.2001;4(10):1259-63.
18. Zahoor MK, Suhail A, Iqbal J, Zulfaqr Z, Anwar M. Biodiversity of predaceous coccinellids and their role as bioindicators in an agro-ecosystem. *International Journal of Agriculture and Biology*.2003;5(4):555-9.
19. Mayadunnage S, Wijayagunasekara HN, Hemachandra KS, Nugaliyadde L. Predatory Coccinellids (Coleoptera: Coccinellidae) of vegetable insect pests: a survey in mid country of Sri Lanka. *Tropical Agricultural Research*.2007;19:69-77.

20. Cotes B, Campos M, Pascual F, Ruano F. (2010) The ladybeetle community (Coleoptera: Coccinellidae) in Southern olive agroecosystems of Spain. *Environmental entomology*.2010; Feb 1;39(1):79-87.
21. Abbas MN, Kausar S, Rana NA. Diversity and distribution of ladybird beetles (Coccinellidae) in the cropland of Faisalabad District.*International Journal of Advanced Research*.2013 ;1:27-33.
22. Hayat AL, Khan MR. Biodiversity and Species Composition of Lady Bird Beetles (Coccinellidae: Coleoptera) from Mirpur Division of Azad Jammu & Kashmir, Pakistan. *Sarhad J. Agric*.2013;30(3):341-50.
23. Khormizi ZM, Biranvand A, Shakarami J. The faunistic survey of lady beetles (Coleoptera: Coccinellidae) in the Mehriz region (Yazd Province), Iran. *Bulletin of the Iraq Natural History Museum* (P-ISSN: 1017-8678, E-ISSN: 2311-9799), 2013;12(4):43-51.
24. Kapur AP. (1968) TheCoccinellidae (Coleoptera) of Goa. *Records of the Zoological Survey of India*.1968; Dec 1;66(1-4):309-20.
25. Agarwala BK, Ghosh AK. Prey records of aphidophagousCoccinellidae in India. A review and bibliography.*Tropical Pest Management*, 1988;34:1-14.
26. Joshi PC, Sharma PK. First records of coccinellid beetles (Coccinellidae) from the Haridwar, (Uttarakhand), India.*Tropical Natural History*.2008 Oct 1;8(2):157-67.
27. Khan AA, Mir RA, Zaki FA. Relative abundance of predacious ladybird beetle (Coleoptera: Coccinellidae) in Kashmir. *Journal of Aphidology*.2007;21:23-30.
28. Sharma PK, Joshi PC. New records of coccinellid Beetles (Coccinellidae: Coleoptera) from District Dehradun (Uttarakhand), India. *New York Science Journal*.2010;3(6):112-20.
29. Roy S, Rahman A. A study on the comparative predatory efficiency and development of *Micraspis discolor* (F.) and *Menochilussexmaculatus* (F.) on tea aphid *Toxopteraaurantii* (Boyer de Fons.). *Zoology and Ecology*.2014 Jul 3;24(3):285-7.
30. Kedar SC, Saini RK, Ram P. Relative abundance of coccinellid predators associated with *Phenacoccussolenopsis* on Cotton. *Annals of Plant Protection Sciences*. 2011;19(2):475-6.
31. Ghosh SK, Chakraborty K. Incidence and abundance of important predatory beetles with special reference to *Coccinellaseptempunctata* in sub-Himalayan region of north-east India. *International Journal of Plant, Animal and Environmental Sciences*. 2012;2:157-62.
32. Vinothkumar B. Diversity of coccinellid predators in upland rainfed rice ecosystem. *Journal of Biological Control*.2013;Sep 4:184-9.

33. Majumder J, Bhattacharjee PP, Agarwala BK. Diversity, distribution and habitat preference of predacious coccinellids (Coleoptera: Coccinellidae) in agro-and forest habitats of Tripura, northeast India. *International Journal of Current Research*.2013 ;Mar 19;5(5):1060â.
34. Shah MA, Khan AA. Assessment of coccinellid biodiversity under pesticide pressure in Horticulture ecosystems.*Indian Journal of Entomology*.2014 ;76(2):107-16.
35. Choudhary JS, Naaz N, Mukherjee DE, Prabhakar CS, Maurya S, Das B, Biodiversity and seasonality of predaceous coccinellids (Coleoptera: Coccinellidae) in mango agro-ecosystem of Jharkhand.2014
36. Megha RR, Vastrad AS, Kamanna BC, Kulkarni NS. Species complex of coccinellids in different crops at Dharwad region.*Journal of Experimental Zoology (India)*.2015 ;18(2):931-5.
37. Ramya HR, Thangjam R. Predatory coccinellids of insect pests of Assam lemon (Citrus Limon L. Burmf) in Jorhat district of Assam. *Journal of Biological control*.2016 ;30(2):121-3.
38. Ankalgi S, Murali J. Diversity and distribution of Coccinellidae (Coleoptera) in Ankalga village (Gulbarga district) Karnataka, India. *International Journal of Basic and Applied Sciences*.2016 ;5(1):1-5.
39. Goswami TN, Anil CN. Ladybird beetles in major Rabi oil seeds and pulse crops at Sabour, Bihar. *Int J Sci Environ Technol*.2016 ;5(4):2382-6.
40. Kumar A, Singh R, Prasad CS, Tiwari GN, Kumar S. New records of predatory coccinellids beetles (Coccinellidae: Coleoptera) in Western plain zone of Uttar Pradesh. *Journal of Entomology and Zoology Studies*.2017 ;5(3):1140-7.
41. Mukherjee SK, Suman SS. Coccinellid beetles diversity in agro-climatic zones of Bhubaneswar. *Journal of Entomology and Zoological Studies*.2017 ;5(4):12441248.
42. Sharma PL, Verma SC, Chandel RS, Chandel RP, Thakur P. An inventory of the predatory Coccinellidae of Himachal Pradesh, India. *Journal of Entomology and Zoology Studies*.;5:2503-7.
43. Murali S, Jalali SK, Shylesha AN, ShivalingaSwamy TM, Gandhi Gracy R. Relative abundance and species composition of predatory coccinellids fauna in different seasons of Brinjal crop. *Journal of Entomology and Zoology Studies*. 2017;5(5):682-686
44. Rasheed R, Buhroo AA. Diversity of coccinellid beetles (Coccinellidae: Coleoptera) in Kashmir, India. *Entomon*.2018 Jun 8;43:129-34.

45. JesuRajan S, SreeLatha E, K SnehaMadhuri, VijayaRaghavendra R, Rao CS. Predatory coccinellids diversity in organic vegetable farming systems: Conservation and mass production. *Journal of Entomology and Zoology Studies*.2019 ;7(1):1148-1151.
46. Shanker C, Mohan M, Sampathkumar M, Lydia C, Katti G. Functional significance of *Micraspis discolor* (F.) (Coccinellidae: Coleoptera) in rice ecosystem. *Journal of Applied Entomology*.2013 ;137(8):601-9.
47. Mishra AK, Yousuf MO. Notes on coccinellid beetles (Coleoptera: Coccinellidae) from forest ecosystem of Uttarakhand, India. *J Biol. Cont.* 2019 ;33(1):1-6.
48. Kiran S, Prabhuraj A, Hosmani A, Shivaleela, Pampanna Y. Species composition of predatory coccinellids from different ecosystems of north-eastern Karnataka. *Journal of Farm Science*.2019 ;32(4):452-455.
49. Sundareswari C, Sudarmani DNP, Jaya Durkga S. Diversity and abundance of ladybird beetles in selected agricultural fields of Sivakasi in relation to weather factors. *International Journal of Scientific Research in Biological Sciences*.2019 ;6(6):135-137.
50. Das P, Chandra K, Gupta D. The Ladybird Beetles (Coleoptera: Coccinellidae) of Arunachal Pradesh, East Himalaya, India with new combinations and new country records. *Bonn zoological Bulletin*.2020 ;69(1):27-44.
51. Pervez A, Yadav M, Khan M. Diversity of predaceous coccinellid beetles (Coleoptera: Coccinellidae) in Uttarakhand, North India. *Journal of Mountain Research*. 2020;15:7-20.
52. Thangjam R, Kadam V, Ningthoujam K, Borah RK, Saikia DK. Diversity and abundance of predatory coccinellid beetles (Coleoptera: coccinellidae) of king chilli (*Capsicum chinense*Jacq.) in Assam, India. *Journal of Entomology and Zoology Studies*.2020 ;8(5):178-183.
53. Vasista T, Chalam MS, Hariprasad KV, Mohan Naidu G. Bio diversity of coccinellid fauna associated with groundnut crop-ecosystem from Rayalaseema region of Andhra Pradesh. *J EntomolZool Stud*.2020 ;8(4):1313-9.
54. Anitha G, Shanker C, Shashibhushan V, Srinivas C. Diversity analysis of coccinellids in Kharif Rice. *Journal of Entomology and Zoology Studies*.;8(4):18761878.
55. Hirur ME, Anitha G, Kumari AD, Devi UG. Diversity of coccinellids in rabi tomato and effect of dimethoate. *Indian Journal of Entomology*. 82(4):781-783.
56. Prince Paul , Kabilan M , VeeramuthuDurai pandiyan, V. Pushpa Rani , PoothapandiOviya, D. Antony Prabhu , Deon David , Jofy Francis. Biodiversity and Biosystematics of Ladybird Beetles (Coleoptera: Coccinellidae) in India. *The academic*.2023;2(1):366-371-1.

57. Muley, E. D., &Chavan, R. J.. Review on diversity of predaceous coccinellid beetles (Coleoptera: Coccinellidae).*Journal of Entomology and Zoology Studies*.2023 ;1(2): 128-132

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