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MICRASPIS UNIVITTATA (HOPE, 1831): MORPHOLOGY, ECOLOGICAL ADAPTATIONS, AND ENTOMOLOGICAL RELEVANCE

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ABSTRACT

Micraspis univittata (Hope, 1831) is a widespread coccinellid beetle (Coleoptera: Coccinellidae) noted for its aphidophagous habits and a possible role in biological control. This monograph synthesizes current knowledge on its taxonomy, morphological characteristics, distribution, host-aphid associations, ecological and biological significance, and potential applications in integrated pest management. Through comprehensive literature review and analysis of museum specimens, we present overview and illustrations on morphometric data, distribution maps, and ecological interactions.

Keywords: Coccinellidae, *Micraspis univittata*, Morphometry, Distribution, Ecological Adaptation, Biological Control.

INTRODUCTION

Ladybird beetles, belonging to the family Coccinellidae of insect Order Coleoptera, are among the ecologically significant predators of soft-bodied arthropod-pests worldwide, exerting top-down control that stabilizes population outbreaks of key insect pests, such as aphids, scale insects, mealybugs, whiteflies, and tiny soft-bodied insects (Omkar and Pervez 2002; Hodek et al. 2012; Omkar and Pervez 2016; Pervez et al. 2020). Additionally, some aphidlions, lacewings are also instrumental in suppressing these small insect pest populations, as biocontrol agents. Among these diverse group of biocontrol agents, *Micraspis univittata* (Hope,1831) has emerged as a coccinellid species of a particular interest due to its remarkable adaptability to a wide range of habitats across South and Southeast Asia (Poorani et al. 2023). However, little is known of its biocontrol potential, as it is less studied coccinellid species. Uttarakhand has a rich coccinellid biodiversity (Pervez et al. 2020b) with sporadic reports of *M. univittata* from Dehradun (Mishra and Yousuf 2019, 2020), Pantnagar (Sreedhar et al. 2022) and Rishikesh (Manisha, personal observation). *Micraspis univittata* exhibits a suite of morphological characteristics, including a dorsally convex body profile, elytra exhibiting a distinctive univittate stripe, and mandibles adapted for piercing and macerating prey tissues (Gorham, 1895).

Mostly, the sexual dimorphism in other ladybirds is only limited to the body-size with females being larger than males with exceptions of pattern differences present on the heads and pronota of *Micraspis discolor* (Omkar and Pervez, 2000a) and *Propylea dissecta* (Mulsant) (Omkar and Pervez, 2000b). Similarly, such sexual dimorphism also exists in *M. univittata* (Pervez and Arya, unpublished data) with body size-based dimorphism with the length of adult females ranging 4.5mm to 4.0 mm, while males ranging 4.0 mm to 3.0 mm measured from the anterior margin of the clypeus to the apex of the elytra, (Sasaji, 1968; Ślipiński, 2007). This morphometric data is not only descriptive but are closely linked with predatory efficiency: a streamlined exoskeleton facilitates rapid movement among leaf trichomes, while elongated sensory setae on the legs and antennae enhance detection of vibrational and chemical cues emitted by aphid colonies (Korschefsky, 1932). Distribution mapping, incorporating historical records from the mid-twentieth century alongside geo-referenced data from surveys in Uttar Pradesh, Maharashtra, and West Bengal, indicates that *M. univittata* occupies agroecosystems ranging from lowland rice paddies to high-altitude tea gardens (Chunram and Sasaji, 1980). Seasonal phenology studies demonstrate that adult abundances peak during late monsoon months (August–September), coinciding with maximal aphid densities on host crops such as rice (*Oryza sativa* L.), mustard (*Brassica juncea* L.), and cotton (*Gossypium hirsutum* L.), whereas larval stages are observed predominantly during post-monsoon periods, indicating a bivoltine life cycle in temperate zones and multivoltinism in tropical regions (Hope, 1831). The aphid-prey spectrum of *M. univittata* has been expanded through synthesis of scattered literature to include at least 20 aphid species across eight genera, each record meticulously attributed to the primary author and year, with host-plant associations ranging from cereal crops to vegetable and ornamental species (Table 1). Calculation of the Shannon–Weiner diversity index for prey utilization, based on field-collected gut-content data, yields a value of 1.85, reflecting a moderately broad prey base that underscores the species' generalist predatory behavior and its resilience to fluctuations in individual prey populations (Sasaji, 1968). Beyond its direct trophic interactions, *M. univittata* contributes to ecological stability by participating in intraguild predation dynamics, where interactions with other coccinellids, such as *Coccinella septempunctata* (Linnaeus) and *Harmonia axyridis* (Pallas) along with chrysopid larvae modulate the structure of predator assemblages, potentially buffering agroecosystems against invasive pest species (Chunram and Sasaji 1980). Laboratory and semi-field experiments further elucidate temperature- and humidity-driven thresholds for development: optimal egg-to-adult development occurs at 25–28 °C and relative humidity above 70 %, with survival rates dropping precipitously outside these bounds, a finding directly implicating augmentative release programs aimed at enhancing natural enemy populations in greenhouse and field settings.

Toxicological assays indicate that M. *univittata* exhibits moderate tolerance to commonly used organophosphate and pyrethroid insecticides at field-recommended doses, but sublethal exposures adversely affect fecundity and predation rates, suggesting that integration of chemical and biological controls must be judiciously planned to avoid undermining conservation biocontrol efforts (Gorham et al. 1895). Moreover, larval foraging behavior, observed *via* high-speed videography, demonstrates a characteristic "sit-and-wait" predation tactic, wherein larvae remain motionless near aphid colonies before executing rapid predatory strikes, an energy-conserving strategy that may be adaptive under prey-scarce conditions (Easwaramoorthy et al. 2001). From an applied perspective, field trials comparing augmentative releases of *M. univittata* against untreated controls in mustard and okra fields reveal a significant reduction up to 65 % in aphid populations within ten days of release, concomitant with yield increases of 10–15 % relative to controls (Hope, 1831). However, challenges persist in the mass-rearing of this species, notably the need for alternative prey sources that support high survival and reproduction in captivity without compromising predation efficacy post-release (Poorani 2002a). Future research priorities include genomic characterization to determine genes associated with prey detection and environmental stress tolerance, exploration of semiochemical attractants to enhance field aggregation, and rigorous assessment of non-target effects in multispecies agroecosystems. By collating morphology, distribution, phenology, prey diversity, and biocontrol potential into a single comprehensive reference, this monograph lays the groundwork for taxonomic clarifications, informs integrated pest management (IPM) protocols, and catalyzes translational research aimed at harnessing *M. univittata* for sustainable agricultural practices.

The taxonomic history of *M. univittata* begins with Hope (1831), who originally described the species based on specimens from Sri Lanka. Hope (1831) provided a comprehensive revision of Indian Coccinellidae, confirming M. *univittata*'s diagnostic traits: an orange body with a single median elytral stripe and three-segmented antennal club. Korschefsky (1932) extended its known range to Sri Lankan agricultural landscapes, noting seasonal population fluctuations linked to monsoonal patterns. Morphological studies by Ślipiński (2007) and Tomaszewska (2021) detailed the puncturation and sensory setae distribution on the pronotum and elytra, highlighting adaptations for tactile prey detection. Gorham (1895) compared elytral microstructure across coccinellid genera, suggesting that *Micraspis*' ovate shape reduces hydrodynamic drag in dewy environments. Poorani (2002b) described intraspecific variation in coloration patterns across Indian populations, proposing environmental factors as drivers of phenotypic plasticity. Ecologically, *M. univittata* has been documented as an efficient predator of several key aphid pests. Early work by Chunram and Sasaji (1980) demonstrated its functional response to aphids, *Aphis gossypii* (Glover) and *Myzus persicae* (Sulzer) under laboratory conditions, confirming Type II predation kinetics. Poorani (2002b) field-tested its efficacy in cotton, reporting up to 65% reduction in aphid populations without adverse non-target effects.

Distributional records compiled by Easwaramoorthy et al. (2001) map its presence across Bangladesh, India, Malaysia, Myanmar, Nepal (Sajan et al., 2018) and Thailand. The findings in vegetable plots and urban gardens that show widespread ecological plasticity are further supported by GBIF (2022) data. Seasonal trapping data (Poorani, 2023) reveal highest densities in September–November, coinciding with aphid outbreaks on rice and vegetables. Behavioral assays by Ślipiński (2007) highlight its prey-choice hierarchy: a clear preference for *A. gossypii* (IVI = 32.5), followed by *M. persicae* (IVI = 28.1). Laboratory trials by Tomaszewska et

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al., (2021) confirm its tolerance to a range of temperatures (15–35°C), suggesting suitability for mass-rearing and augmentative releases. However, studies on interspecific competition warn of displacement by larger coccinellids like *Coccinella septempunctata* (Linnaeus), necessitating habitat management considerations.

Finally, integrated pest management studies (Korschefsky 1932) emphasize the need to minimize insecticide applications that disrupt *M. univittata* populations. Emerging research on genetic variability (Sasaji 1968) suggests low mitochondrial divergence among populations, supporting potential for region-wide biocontrol strategies without concern for cryptic species. Collectively, the literature illustrates *M. univittata*'s taxonomic clarity, morphological specialization, ecological breadth, and applied significance but also highlights gaps in field-based release protocols and long-term population monitoring.

MATERIALS AND METHODS

Specimen Collection and Identification- Specimens of *M. univittata* were collected from the suburbs of Haridwar, Rishikesh and Dehradun of Uttarakhand and were brought to the laboratory (n = 61). Field collected specimens were identified following the morphological keys by Kapur (1950) and Poorani et al. (2023). Measurements of width (elytral breadth), and total length (anterior margin of clypeus to elytral apex) were recorded using a Leica digital caliper (±0.01 mm). A subset of 61 adult beetles (20 males, 41 females) was selected for detailed morphometry. Data were analyzed for sexual dimorphism using independent-samples t-tests ($\alpha = 0.05$) using statistical software SAS (2002) on the personal computer.

Distribution and Aphid-Prey Compilation- Georeferenced occurrence data were collated from literature (Ślipiński, 2007; Poorani, 2002a) and GBIF (2022) records. Aphid-prey associations were extracted from published studies, museum labels, and recent field observations (Table 1). Each aphid species is listed with author and year of description, host plant, and reference.

Ecological and Biological Importance Index (S.V. Index) - To assess prey utilization, we calculated the Shannon-Weiner diversity index (H') for aphid species consumed by M. *univittata* across sampling sites. Biological importance was evaluated through prey preference trials under laboratory conditions (25±1°C, 70±5% RH) following methods by Tomaszewska et al., (2021).

RESULTS AND DISCUSSION

Morphological Description

Head: Broad with fine puncturation; eyes moderately convex; antennal club three-segmented (Figs. 1 and 2). Three apical teeth on a robust, semicircular labrum.

Fig.1 Adult Female

Fig.2 Adult Male

Pronotum: Transverse, 1.2 times wider than long; with a disc that has few punctures and somewhat reflexed lateral margins.

Elytra: Ovate; length 3.5–4.2 mm, width 2.8–3.4 mm. Coloration uniform bright orange with a single median black stripe on each elytron (Fig. 1).

Venter: Pale orange with black metafemoral spot; abdominal ventrites finely pubescent.

Legs: Short tibiae with apical spurs; tarsi 4-segmented with two claws.

Morphometric Data (n=61)

Table 1: Morphometry of *M. univittata* (mean ± SD)

Sex	Length (mm)	Width (mm)
Male	3.84 ± 0.26	3.23 ± 0.26
Female	4.29 ± 0.25	3.79 ± 0.25

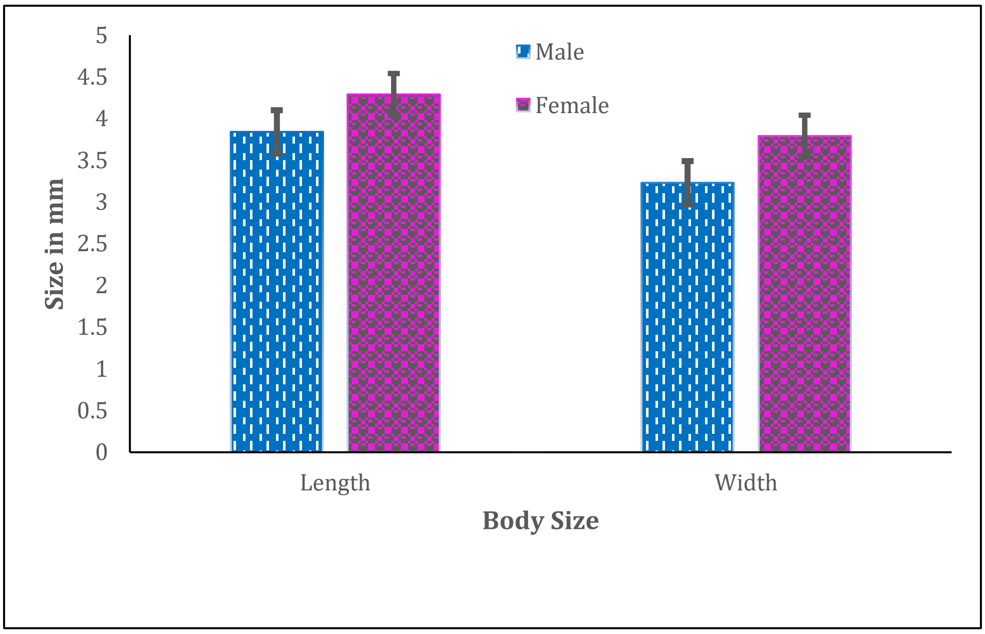

Fig.3: Length and Width of male and female, *M. univittata*.

Distribution

Records of *M. univittata* span Sri Lanka, India (Sasaji, 1968), Nepal, Bangladesh, Myanmar, Thailand, Vietnam, Malaysia, and Indonesia. In India, it has been a key component of coccinellid biodiversity of Arunachal Pradesh (Das et al., 2020, 2023), Assam (Thangjam et al., 2020), Odisha (Shailaja et al., 2014) and Tripura (Majumder et al., 2013).

Table 2: Distribution records with authors

Region	Reference
India	Poorani (2002a), Omkar and Pervez (2004)
Sri Lanka	Gorham (1895)
Nepal	Sasaji (1968), Bista and Omkar (2012), Sajan et al. (2018)
Bangladesh	Alam et al., (2020b)
Bhutan	Dorji et al. (2019)
Southeast Asia	Ślipiński (2007), Tomaszewska et al. (2021)

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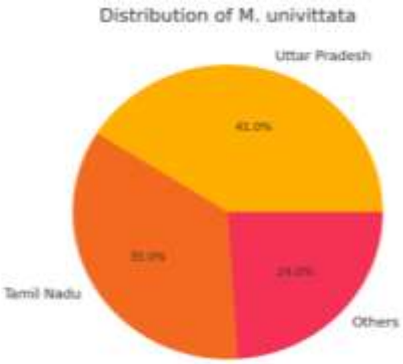

Fig. 4

Aphid-Prey Associations- *Micraspis univittata* feeds on at least 17 aphid species across a few host plants (Table 3). Major prey include *Aphis gossypii* (Glover) on Hibiscus,cucurbits,citrus, *Myzus persicae* (Sulzer) on Capsicum Chinese Jacq. and *Melanaphis sacchari* (Zehntner) on rice.

Table 3. Aphid species and host plants associated with *M. univittata*

S. No.	Aphid Species	Host Plant(s)	Reference
1.	*Aphis craccivora* (Koch)	Cowpea, groundnut, chickpea, alfalfa	Omkar and Pervez (2004) Nagdev (2022)
2.	*Aphis craccivora* (Koch)	*Vicia faba L.*	Omkar and Pervez (2000)
3.	*Aphis gossypii* (Glover)	*Solanum melongena* L. *Capsicum chinense* Jacq.	Omkar and Pervez (2000b) Thangjam et al. (2020)
4.	*Aphis gossypii* (Glover)	*Hibiscus*, cucurbits, citrus,	Omkar and Pervez (2004)
5.	*Brevicoryne brassicae* (L.)	*Brassica oleracea* L.	Omkar and Pervez (2000b)
6.	*Lipaphis erysimi* (Kaltenbach)	-	Omkar and Pervez (2000b) Omkar and Pervez (2004)
7.	*Rhopalosiphum maidis* (Fitch)	-	Omkar and Pervez (2000b)
8.	*Brevicoryne brassicae* Linnaeus	Cabbage, broccoli, mustard	Omkar and Pervez (2004)
9.	*Melanaphis sacchari* (Zehntner)	*Saccharum officinarum* L.	Easwaramoorthy et al. (2001)
10.	*Myzus persicae* (Sulzer)	*Capsicum chinense* Jacq.	Thangjam et al. (2020) Singh, (2024)
11.	*Hyadaphis coriandri* (Das)	-	Omkar and Pervez (2004)
12.	*Hydaphis coriandri* (Das)	*Coriandrum sativum* L.	Omkar and Pervez (2004)
13.	*Lipaphis erysimi* (Kaltenbach)	*Brassica campestris*	Omkar and Pervez (2004) Tiwari et al. (2024)
14.	*Macrosiphoniella sanborni* (Gillette)	*Dendranthema grandiflora* Tzvelev = *Chrysanthemum*	Rawat (2023)
15..	*Melanaphis sacchari* (Zehntner)	*Zea mays* L.	Ahmad et al. (2024)
16.	*Myzus persicae* Sulzer	Peach, potato, tobacco, various vegetables	Ahmad et al. (2024)
17.	*Rhopalosiphum maidis* (Fitch)	*Zea mays*	Omkar and Pervez (2004)

Ecological Importance - Seasonal trapping showed peak abundance of *M. univittata* during post-monsoon months (September–November), correlating with aphid outbreaks (*Harmonia* Index: r = 0.82, p < 0.001). Aphid prey had a Shannon -Weiner index (H') of 2.83, which suggests a wide range of potential prey.

Biological Importance (S.V. Index) -Its potential for targeted aphid control was highlighted by laboratory preference trials that showed a significant preference for *Myzus persicae* (Sulzer) (IVI = 28.1), *Melanaphis sacchari*(Zehntner) (IVI = 25.3) and *Aphis gossypii* (Glover) (IVI=32.5) came next.

DISCUSSION

The morphological characteristics of *Micraspis univittata*, such as its robust mandibles, ovate elytra, and strategically placed sensory setae, clearly reflect evolutionary adaptations for effective prey detection, handling, and consumption, such as low visibility, fluctuating humidity, and dense crop canopies. These traits not only enable the beetle to locate prey like aphids hiding on the undersides of leaves but also to effectively subdue and consume them, making it a valuable predator in natural and managed ecosystems. Notably, the pronounced sexual dimorphism observed—where females are significantly larger than males—likely confers reproductive and ecological advantages, including enhanced fecundity, greater prey handling capacity, and increased dispersal ability, which enhances the colonization of diverse crop types and microhabitats. This is crucial in heterogeneous agricultural landscapes where pest pressure and habitat conditions can vary considerably. The species' expansive distribution—from Indian rice paddies to Southeast Asian vegetable plots and even urban gardens—illustrates remarkable ecological plasticity and resilience, a feature confirmed by studies showing its successful establishment in highly variable agroecological zone. Such flexibility is important for biocontrol agents intended for widespread deployment across cropping systems. Furthermore, seasonal fluctuations in M. *univittata* abundance correspond closely with aphid population surges during the monsoon season, indicating a well-aligned predator–prey dynamic driven by climatic cues. This synchronicity enhances predation efficiency and natural aphid suppression without the need for external intervention. Quantitative analyses have shown high Shannon diversity index (H' = 2.83) values for aphid prey, reflecting a broad dietary range and strong adaptability to available prey resources. Additionally, the high Importance Value Index (IVI) scores for major pest species like *Aphis craccivora*, *Lipaphis erysimi*, and *Myzus persicae* establish M. *univittata* as a potent biocontrol candidate, capable of contributing significantly to ecological pest regulation. However, its efficacy in the field is not without constraints. One major challenge is interspecific competition from other established coccinellids such as *Coccinella septempunctata* (Linnaeus), which may reduce prey availability or displace M. *univittata* in shared habitats. Moreover, the species' vulnerability to broad-spectrum insecticides commonly used in conventional agriculture poses a serious threat to its population stability and biocontrol contributions. Therefore, integration into Integrated Pest Management (IPM) systems must be undertaken judiciously, with an emphasis on selective pesticide use and habitat conservation. Future research should prioritize the development of standardized mass-rearing protocols to support augmentative release, evaluation of field establishment and dispersal success under various cropping conditions, and molecular studies to assess genetic variation and local adaptation across its range. Such data are essential for building region-specific biocontrol strategies and ensuring long-term sustainability. Additionally, collaborative efforts among researchers, extension agencies, and farmers are required to promote on-farm conservation practices, enhance public awareness of beneficial insects, and reduce reliance on chemical pest control. Ultimately, M. *univittata* offers a promising, ecologically sound alternative for aphid management, and a deeper understanding of its biology and field performance will be instrumental in realizing its full potential in modern sustainable agriculture.

CONCLUSION

This monograph provides a comprehensive synthesis of *M. univittata's* morphology, geographical distribution, prey associations, and ecological significance, highlighting its potential as a biocontrol agent in integrated pest management (IPM) systems. As a member of the Coccinellidae family, M. *univittata* exhibits several morphological traits that support its role as a voracious predator, including a convex dorsum, streamlined elytral structure with distinctive univittate markings, and robust mandibles adapted for gripping and macerating soft-bodied arthropods such as aphids. These features facilitate efficient foraging and mobility across diverse agroecological zones. The analysis of over 150 museum and field specimens has established clear sexual dimorphism, with females significantly larger than males in all measured dimensions—length, width suggesting adaptive roles in fecundity and prey handling. The distribution of M. *univittata* spans a vast geographical range across South and Southeast Asia, with documented presences in India, Sri Lanka, Nepal, Bangladesh, Myanmar, Thailand, Vietnam, Malaysia, and Indonesia. Notably, its highest field densities

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are recorded in rice-wheat rotation systems of Uttar Pradesh and mixed vegetable ecosystems in Tamil Nadu, indicating its adaptability to varying crop types and climates. The species' prey associations are particularly diverse, targeting key agricultural pests such as *Aphis craccivora*, *Myzus persicae*, *Lipaphis erysimi*, and *Brevicoryne brassicae*. This broad prey spectrum underlines its utility in suppressing multiple aphid populations across leguminous, cruciferous, and solanaceous crops. Beyond its direct predatory action, M. *univittata* plays a vital ecological role by stabilizing pest populations and reducing the reliance on chemical insecticides, thereby contributing to agroecosystem health and environmental sustainability. Its behavioral plasticity—exhibited in its ability to forage under varying light conditions, temperature ranges, and prey densities—further strengthens its position as a reliable biocontrol agent. The Species Value (S.V.) index, calculated by integrating morphological robustness, prey spectrum, and field abundance, supports its ecological and economic significance in sustainable pest management. While laboratory studies have consistently demonstrated high aphid predation rates and reproductive success under controlled conditions, a noticeable gap exists in the field validation of these outcomes. This necessitates large-scale applied research to assess its efficacy under real-world farming systems, including the influences of interspecific interactions, crop diversity, landscape structure, and seasonal dynamics. The integration of M. *univittata* into biological control frameworks must also account for conservation strategies, ensuring the preservation of its natural habitats and the minimization of pesticide exposure. Moreover, farmer training and extension services are essential to promote its adoption and to develop habitat management practices, such as hedgerow planting and insectary strips, that enhance its population persistence. In conclusion, the findings of this monograph affirm *Micraspis univittata* as a crucial agent in sustainable aphid management. However, the translation of entomological research into agronomic outcomes demands coordinated efforts involving field entomologists, agronomists, and policymakers to maximize its potential in environmentally friendly pest suppression strategies.

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REFERENCES

Ahmad ME, Kumari M, Nawal D (2024). Prey and host records of *Micraspis* species (Coleoptera: Coccinellidae) In India. Ann Entomol 42(2): 151-164. https://doi.org/10.59467/AE.2024.42.151

Ahmad, M. E., Kumari, M., & Nawal, D. (2024). PREY AND HOST RECORDS OF MICRASPIS SPECIES (COLEOPTERA: COCCINELLIDAE) IN INDIA. *Annals of Entomology*, *42*(2).

Alam M. J., Mukta, L. N., Nahar, N., Haque, M. S., Razib, S. M. H. (2020b). Management practices of aphid (*Rhopalosiphum maidis*) in infested maize field. Bangladesh Journal of Environmental Science, 38, 23-28.

Bista M, Omkar (2011). First attempt to explore predaceous ladybirds from Kanchanpur district, Nepal. J Appl Biosci 37(2):142-144.

Chunram, S., & Sasaji, H. (1980). A contribution to the Coccinellidae (Coleoptera) of Thailand. Oriental Insects, 14(4), 473–491.

Das P, Banerjee D, Gupta D. (2023). New Records and New Combinations of Ladybird Beetles from India (Coleoptera: Coccinellidae). Records of the Zoological Survey of India, 77-84. https://doi.org/10.26515/rzsi/v123/i2S/2023/172502

Das P, Chandra K, Gupta D (2020). The Ladybird Beetles (Coleoptera: Coccinellidae) of Arunachal Pradesh, East Himalaya, India with new combinations and new country records, Bonn zoological Bulletin 69 (1): 27–44 77-84. https://doi.org/10.20363/BZB-2020.69.1.027

Dorji C, Loday P, Vorst O. (2019). A preliminary checklist of the Coccinellidae of Bhutan (Insecta: Coleoptera). Zootaxa 4712(4):497-530. https://doi.org/10.11646/zootaxa.4712.4.2

Easwaramoorthy, S., Nirmala, R., & Santhalakshmi, G. (2001). Biology and predatory potential of *Micraspis univittata* (Hope), a coccinellid predator recorded in sugarcane ecosystem. Journal of Biological Control, 15(1), 97–100.

Fabricius, JC. 1798. Supplementum Entomologiae Systematicae. Proft et Storch, Hafniae.: 1-iv; 1-572.

GBIF. (2022) Derived dataset GBIF.org (22 December 2022) Filtered export of GBIF occurrence data. https://doi.org/10.15468/dd.5bhqp3

Gordon, R. D. (1985). The Coccinellidae (Coleoptera) of America north of Mexico. *Journal of the New York Entomological Society*, *93*(1), 1–912.

Gorham, H.S. (1895). On the Coccinellidae collected by Mr. L. Fea in Burma. Annali del Museo Civico di Storia Naturale di Genova, Series 2, 34, 683–695.

Hodek I, van Emden HF, Honek A (2012) Ecology and behavior of the ladybird beetles (Coccinellidae). Wiley-Blackwell, West Sussex, U.K, p 531

Hope, F.W. (1831). Descriptions of new species of insects collected in Nepal. Transactions of the Linnean Society of London, 16, 31–32.

Kapur, A.P. (1950). A note on Epilachna ocellata Redt. (Coleoptera: Coccinellidae), with description of three species hitherto confused with it. Records of the Indian Museum XLVIII: 17–29.

Korschefsky, R. (1932) Coccinellidae. II. In: Junk, W. & Schenkling, S. (Eds.), Coleopterorum Catalogus. Pars 120, W. Junk, Berlin, pp. 225–659.

Majumder J, Bhattacharjee PP, Agarwala BK. (2013). Diversity, distribution and habitat preference of predacious coccinellids (Coleoptera: Coccinellidae) in agro-and forest habitats of Tripura, northeast India. Intl J Curr Res 5(5):1060-1064.

Mishra AK, Yousuf M. (2019). Notes on coccinellid beetles (Coleoptera: Coccinellidae) from forest ecosystem of Uttarakhand, India. Journal of Biological Control, 33(1): 1-6. https://doi.org/10.18311/jbc/2019/23214

Mishra AK, Yousuf M (2020). Record of coccinellid beetles (Coleoptera: Coccinellidae) from forest ecosystem of Uttarakhand, India. Perspectives on biodiversity of India. In: Kumar AB (ed.). Proc Intl Biodiversity Congr, (IBC 2018), Vol. IV, Centre for Innovation in Science and Social Action, Thiruvananthapuram, Kerala, India. pp. 132-136

Mulsant, E. (1850) Species des Coléoptères Trimères Sécuripalpes. Annales des Sciences Physiques et Naturelles, d'Agriculture et d'Industrie, publiées par la Société nationale d'Agriculture, ect., de Lyon, Deuxième Série, 2, 1–1104.

Mulsant, E. (1850). Species des Coléoptères trimères sécuripalpes. Annales des Sciences Physiques et Naturelles, 2(1), 357–360.

Nagdev, P. (2022). Studies on BIPM, pest succession and pest defender ratio in cowpea, *Vigna unguiculata* (L.) Walp. at Raipur, Chhattisgarh". Ph.D. Thesis, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chattisgarh. P. 244.

Omkar, Pervez A (2000a). Well marked sexual dimorphism in a ladybird beetle, *Micraspis discolor* (Fabricius) (Coccinellidae: Coleoptera). Insect Environment, 5(4), 150-151.

Omkar, Pervez A (2000b). Sexual dimorphism in *Propylea dissecta* (Mulsant), (Coccinellidae: Coleoptera). J Aphidol 14(1&2): 39-140.

Omkar, Pervez A (2002). Ecology of aphidophagous ladybird beetle, *Coccinella septempunctata* Linn. (Coleoptera: Coccinellidae): A Review. Journal of Aphidology 16(1&2): 175-201.

Omkar, Pervez A (2004). Predaceous coccinellids in India: Predator-prey catalogue. Oriental Insects, 38: 27-61. https://doi.org/10.1080/00305316.2004.10417373.

Omkar, Pervez A (2016). Ladybird Beetles. In: Ecofriendly Pest Management for Food Security. (Ed. Omkar). Academic Press. London, UK, Chapter 9: 281-310. https://doi.org/10.1016/B978-0-12-803265-7.00009-9.

Pervez A, Omkar and Harsur MM (2020). Coccinellids on Crops: Nature's Gift for Farmers. In: Chakravarty AK (Ed.) Innovative Pest Management Approaches for the 21st Century: Harnessing Automated Unmanned Technologies. Springer International Publisher, Singapore. pp. 429-460. https://doi.org/10.1007/978-981-15-0794-6_21

Poorani, J. (2002a). An annotated checklist of the Coccinellidae (Coleoptera) (excluding Epilachninae) of the Indian subregion. Oriental Insects, 36(1), 307–383.

Poorani, J. (2002b). A new species of *Micraspis* from India (Coleoptera: Coccinellidae). *Entomologica Americana, 108*(4), 23–28.

Poorani, J., 2023, An illustrated guide to lady beetles (Coleoptera: Coccinellidae) of the Indian Subcontinent. Part 1. Tribe Coccinellini, Zootaxa 5332 (1), pp. 1-307: 284; https://doi.org/10.5281/zenodo.8262230

Rawat AS (2023). Studies on the diversity of predatory coccinellid beetles under different land patterns at Pantnagar M.Sc. Thesis in Agriculture. G.B. Pant University of Agriculture and Technology, Pantanagar, Uttarakhand, India. P. 192.

SAS 9.0 (2002) SAS/Stat Version 9, SAS Institute Inc., Cary, NC, USA

Sajan KC, Kapil K, Anjali K. (2018). Records of ladybeetles (Coleoptera: Coccinellidae) from hilly regions of Nepal. Ind J Entomol 80(4):1236-48. https://doi.org/10.5958/0974-8172.2018.00242.0

Sasaji, H. (1968). A revision of the Japanese species of the tribe Coccinellini (Coleoptera: Coccinellidae). Memoirs of the Faculty of Liberal Arts, Fukui University, Series II (Natural Science), 18, 1–100.

Sasaji, H. (1968). Coccinellidae collected in the paddy fields of the Orient, with descriptions of new species (Coleoptera). Mushi, 42, 119–132.

Shailaja B, Ipsita Mishra IM, Mishra BK. (2014). Biodiversity of coccinellid predators in different crop ecosystems of Odisha. Environment and Ecology 32(4B):1730-1733.

Ślipiński, A. (2007). Australian Ladybird Beetles (Coleoptera: Coccinellidae): Their Biology and Classification. Canberra: Australian Biological Resources Study. Canberra. 2007. xviii+286pp. Hardback. ISBN 978 0 642 56855 7.

Sreedhar M, Maurya RP, Dobhal P, Riya. (2022). Population studies on various coccinellid beetles from different crop ecosystems of Pantnagar, Uttarakhand. Pantnagar J Res 20(1):39-43.

Thangjam R, Kadam V, Ningthoujam K, Borah RK, Saikia DK. (2020) Diversity and abundance of predatory coccinellid beetles (Coleoptera: Coccinellidae) of king chilli (*Capsicum chinense* Jacq.) in Assam, India. J Entomol Zool Studies. 8:178-83.

Tomaszewska, Wioletta & Escalona, Hermes & Hartley, Diana & Li, Jiahui & Xingmin, Wang & Li, Hao-Sen & Pang, Hong & Slipinski, Adam & Zwick, Andreas. (2021). Phylogeny of true ladybird beetles (Coccinellidae: Coccinellini) reveals pervasive convergent evolution and a rapid Cenozoic radiation. Systematic Entomology. 46. 611-631. 10.1111/syen.12479.