



SPECIES COMPOSITION OF GRASSHOPPER FAUNA IN DIFFERENT HABITATS OF JABUGAM IN GUJARAT, INDIA

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ABSTRACT

One of the biggest and most varied groups of insects is the order Orthoptera, which includes grasshoppers. In natural grassland environments, they are the predominant above-ground invertebrates. To acquire information about the biodiversity of the grasshopper fauna, a systematic survey was conducted in the collection sites at various parts of the Jabugam area of Gujarat, India from June 2023 to December 2023. A total of nine species of grasshoppers belonging to three families and eight genera were recorded. Family Acrididae was dominant with (five species), followed by Tettigoniidae (three species) and Pyrgomorphidae (one species). This habitat was studied for the first time and a maximum number of the short-grasshoppers were recorded as compared to the long-horned grasshoppers.

Key words : Orthoptera, Acrididae, Grasshopper, Diversity, Richness, Gujarat.

Introduction

Grasshoppers are abundant and play a significant role in a variety of ecosystems, including marshes, grasslands, woodlands and deserts. Reports of them come from almost every ecosystem, except the Arctic. Grasshoppers are the main herbivores in the grassland ecosystem and are crucial to the control of the food chain and the recycling of nutrients. Although tropical in nature, the majority of the species are also widely distributed in temperate regions. They are from sea level to the Himalayas' highest heights (Bhowmik and Rui, 1982). Grasshoppers are categorized as herbivorous (forbivorous), carnivorous (cambivorous), or mixed feeders (Isely, 1944). The majority of grasshoppers are oligophagous, meaning they have specific host preferences (Mulkern, 1967). They are often the main invertebrates in the grassland ecosystem as consumers (Curry, 1993). Grasshoppers are highly damaging agricultural crop pests. They pare down the crop to nothing. Grasshoppers constitute an abundant food resource for other groups such as lizards and raptors birds (Capinera *et al.*, 1997; Mayya *et al.*,

2005).

Grasshoppers are members of the order Orthoptera, which is the sixth largest insect order after Hemiptera (Alfred, 2003). According to the data available from the Orthoptera species File (Cigliano *et al.*, 2021), 372 Orthopteran species were described from the Indian subcontinent during 1776-1899, followed by 559 species during 1900-1949, 276 species during 1950-1999 and 188 species during 2000-2020. Thus, the total number of Orthopteran species described from this region is 1,395, which includes 709 Ensiferans and 686 Caeliferans. Caelifera (short-horned grasshoppers) and Ensifera (long-horned grasshoppers) are the two suborders that make up the order Orthoptera, which is represented by 29034 species globally (Cigliano *et al.*, 2021). Of which 1166 species/subspecies belonging to 449 genera and 22 families are listed from India (Gupta and Chandra, 2019). Eight superfamilies and seventeen families make up the suborder Ensifera, whereas the sub-order Caelifera has eleven super-families and thirty-six families. Four of these families *i.e.*, Acrididae, Tetrigidae, Pyrgomorphidae and

Tettigoniidae are economically significant because their members severely harm agricultural and forest crops. Some have ensiform antennae, but most have filiform ones. Two to four segments in the tarsi; the hind femora are expanded and altered for jumping. Wings that are completely formed, brachypterous, or absent. The fore wing is leathery tegmina, whereas the hind wing is membranous and fan-like. The female's ovipositor might be externally long or short, tympanal auditory organs normally present on either side at the base of the abdomen, and hind tarsi are always three segmented. Generally, in most species, male grasshoppers make noise but females cannot make noise (Srinivasan and Prabakar, 2012).

Certain significant works by Muralidharan and Patel (2007), Chandra *et al.* (2010), Shishodia *et al.* (2010), Yadav and Singh (2011), Akhtar *et al.* (2012), Waghmare *et al.* (2013), Kumar and Usmani, (2014), Arya *et al.* (2015), More and Nikam (2016), Yadav and Kumar (2017), Gaikwad *et al.* (2018), Newport and Newport (2019), Rana and Kumar (2020), Suganya *et al.* (2020) and Chand *et al.* (2022) added information on grasshopper fauna from different regions of India. From the literature analysis, it is observed that the studies on grasshopper fauna in Gujarat are meager. Hence, the present study was carried out in Jabugam, which is part of middle Gujarat. The data collected will serve as a foundation for further investigations into the potential of grasshopper distribution and biodiversity in connection to their habitat and host plants.

Materials and Methods

Study area

The present investigation on the diversity of the grasshoppers was carried out in different habitats at Jabugam, Bodeli taluka and district Chhotaudepur of Gujarat, India. Geographically, Jabugam is situated at 22°17'37.70" North latitude, 73°46'41.02" East longitude with an elevation/altitude of 92 m above mean sea level (MSL). The climate of the Jabugam region is semi-arid and sub-tropical with hot summer and cold winter. In this region, generally, monsoon commences in the month of June and retreats from the end of September. Most of the rainfall is received from South-West monsoon currents. July and August are the months of heavy showers Taluka. The river Orsang also flows in this area. As a result, the water table of the farm is quite shallow (12 m). The quality of underground water is also good. The soil is sandy loam and fertile. Bananas, cotton and maize are the major crops of the surrounding area. Jabugam has an average precipitation of 0-2 days, while the average high temperatures range from 80 to 90°F

(25-35°C).

Sample collection, preservation and identification

Grasshoppers were collected by hand and by sweeping using an aerial insect net; the net was used for catching insects individually or by sweeping over crops. The insects caught were transferred to a glass jar containing cotton soaked in ethyl acetate, to kill the specimen. Once killed, the specimen was removed from the bottle to prevent color change. Specimens were first relaxed, right wings were stretched by putting a piece of paper on it (if needed) and pinned by inserting a pin on the posterior right thorax on a stretching board and left to dry for 72 hours. The collected specimens were preserved by both dry and wet preservation methods. Pinned specimens were kept in storage boxes and cabinets, with naphthalene balls to prevent decomposition. The specimens of adult grasshoppers were later identified up to species level and then counted based on external morphological characters with the help of a stereoscopic binocular microscope, by referring to the web pages namely, <http://bugguide.net> and <http://www.orthoptera.org>. Moreover, the taxonomic identification keys of Kirby (1914) and Zahid *et al.* (2020) were used.

Results and Discussion

After an intensive survey was made in different habitats and different localities of Jabugam. Overall, nine species of three families *viz.*, Pyrgomorphidae, Acrididae and Tettigoniidae have been recorded (Table 1). Present data revealed that the grasshopper diversity of study regions is rich and they are distributed throughout the area because of the variety of flora and complex ecological conditions, rainfall patterns and temperature. Data presented in Fig. A indicates that the members of the sub-order Caelifera (66.7%) were dominant as compared to the sub-order Ensifera (33.3%). While talking about families it was observed that the Acrididae family was dominant (56% of total individuals recorded) with

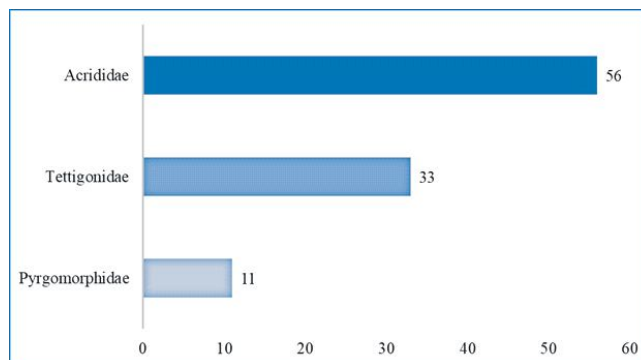


Fig. A: Family wise distribution percentage of grasshopper species.

Table 1 : Checklist of Grasshopper species reported from different habitats of Jabugam, Gujarat, India.

Suborder	Superfamily	Family	Subfamily	Tribe	Genus	Species
Caelifera	Pyrgomorphoidea	Pyrgomorphidae	Pyrgomorphinae	Poecilocerini	<i>Poecilocerus</i>	<i>pictus</i> (Fabricius, 1775)
	Acridoidea	Acrididae	Acridinae	Acridini	<i>Acrida</i>	<i>exaltata</i> (Walker, 1859)
			Acridinae	Acridini	<i>Acrida</i>	<i>turrita</i> (Linnaeus, 1758)
			Cyrtacanthacridinae	Cyrtacanthacridini	<i>Cyrtacanthacris</i>	<i>tatarica</i> (Linnaeus, 1758)
			Catantopinae	Not Assigned	<i>Choroedocus</i>	<i>robustus</i> (Serville, 1838)
Hemiacridinae	Hieroglyphini	Hieroglyphus	<i>banian</i> (Fabricius, 1798)			
Ensifera	Tettigonioidea	Tettigoniidae	Conocephalinae	Copiphorini	<i>Euconocephalus</i>	<i>incertus</i> (Walker, 1869)
			Hexacentrinae	Hexacentrini	<i>Hexacentrus</i>	<i>unicolor</i> (Serville, 1831)
			Pseudophyllinae	Cymatomerini	<i>Sanaa</i>	<i>regalis</i> (Brunner von Wattenwyl, 1895)

four subfamilies, which amounted to four genera and five species. Whereas, the Pyrgomorphidae family had only one subfamily with one genus and one species and accounted for only 11% of the total individuals. Moreover, the species composition of the Tettigoniidae family was followed by Acrididae, which accounted for a 33% share comprising three subfamilies with three genera and three species.

Details of all the species of grasshoppers recorded during the present study are given below:

1) *Poecilocerus pictus* (Fabricius) : It belongs to the family Pyrgomorphidae, subfamily Pyrgomorphinae, and sub-order Caelifera of the order Orthoptera (Fig. 1).

Diagnostic characters : Head in lateral view oval; a row of tubercles absent in the lateral side of the head behind eyes; pronotum texture foveolate; pronotum unarmed without a bilobed tubercle nor spines in prozona; fastigium in dorsal view broadly projecting; the width of prozona in dorsal view narrower than the width of

metazona; length of prozona in dorsal view as long as the length of metazona; large body; green color with patches of yellow or orange on head, thorax, abdomen and legs, tegmina green with yellow markings and ting of pink on back (Zahid *et al.*, 2020).

Morphometry (length in mm) : Male: body 50-50.5, pronotum 11.5-12.5, tegmina 33.5-34, hind femur 23-23.5; Female: body 50.5-52, pronotum 13-13.5, tegmina 34-34.5, hind femur 24-24.5 (Younus *et al.*, 2024).

Distribution : It is recorded from major parts of India *viz.*, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Himachal Pradesh, J&K, Karnataka, Madhya Pradesh, Orissa, Rajasthan, Uttar-Pradesh and West Bengal (Anand *et al.*, 2016) while elsewhere it is found from Bangladesh, Nepal, Pakistan, Maldives, Sri Lanka and Bhutan (Marino-Perez, 2020).

Ecology and habitat : Its preferred host plants are *Calotropis procerca* (Ait.) and *C. gigantia* in semi-arid conditions. Moreover, the readiness to accept



Fig. 1 : *P. pictus*.

alternative host plants like paddy has enabled *Poecilotherpes* to survive in some areas where *Calotropis* is scarce or even absent (Pawar *et al.*, 2021; Mounika *et al.*, 2024). Previously, Yadav and Kumar (2017) collected *P. pictus* from a new host, *Jatropha* sp. from the Eastern Uttar Pradesh region.

2) *Acrida exaltata* Walker : It belongs to the family Acrididae, subfamily Acridinae and sub-order Caelifera of the order Orthoptera (Fig. 2).



Fig. 2 : *A. exaltata*.

Diagnostic characters : Head with acute in profile, green in color, basal part narrow and as long as the pronotum and conically ascending; tegmina without intercalary vein (if present, weak, irregular and serrated vein in a male); hind femur very long and slender; pronotal disc weakly tectiform; fastigium of vertex broad, transverse sulcus of pronotum placed near the middle of disc; wing-cells not centered with fuscous; tegmina without pointed apex, a little produced beyond the hind femora (Rahman and Mazumdar, 2022).

Morphometry (length in mm) : Male: body 29-35, pronotum 4-5, tegmina 21-27, hind femur 17-20; Female: body 45-61, pronotum 8-10, tegmina 40-48, hind femur 27-35 (Younus *et al.*, 2024).

Distribution : It is distributed throughout India while elsewhere it is found in Tibet, Nepal, Sri Lanka, Pakistan, Afghanistan, Bangladesh, Saudi Arabia and Yemen (Mandal *et al.*, 2007; Shishodia *et al.*, 2010).

Ecology and habitat : This species is widely distributed throughout the plains and hilly regions of the Indian subcontinent. Occasionally gregarious and migratory in behavior. This species is a pest of rice, millet, jowar, maize, groundnut, tomato, pinus, sal and sugarcane (Shosha, 2005).

3) *Acrida turrata* (Linnaeus) : It belongs to the family Acrididae, subfamily Acridinae and sub-order Caelifera of the order Orthoptera (Fig. 3).



Fig. 3 : *A. turrata*.

Diagnostic characters : Head slender, conical; the body is uniformly greenish; tegmina long, narrow, pointed, extending until abdomen when closed; light green wings that are never tessellated and pointed at the extremity; very long, narrow hind femur (Baba *et al.*, 2022).

Morphometry (length in mm) : Male: body 30.21, pronotum 5.02, tegmina 25.01, hind femur 18.21; Female: body 45.25, pronotum 7.70, tegmina 43.23, hind femur 28.78 (Baba *et al.*, 2022).

Distribution : It is distributed throughout India, while elsewhere it is found in Africa, Asia, Pakistan and South Europe (Kubhar *et al.*, 2019).

Ecology and habitat : This species almost invariably lives in grassland, thick grasses, and bare land where the shape and coloring give it protection however, rice is identified as the preferred host (Gupta and Chandra, 2016).

4) *Cyrtacantha cristatarica* (Linnaeus) : It belongs to the family Acrididae, subfamily Cyrtacanthacridinae and sub-order Caelifera of the order Orthoptera (Fig. 4).



Fig. 4 : *C. tartarica*.

Diagnostic characters : Large body; filiform antennae; fastigium of vertex angular; frontal ridge narrow, slightly depressed at median ocellus; pronotum with median carina slightly raised; lateral carinae absent; metazona as long as prozona; posterior margin of pronotum angular; prosternal process large, strongly curved backward, touching or nearly touching mesosternum; mesosternal lobes rectangular; tegmina and wings fully developed; hind femur slender; external apical spine of

hind tibia absent (Kumar and Usmani, 2014).

Morphometry (length in mm) : Male: body 49.87, pronotum 10.53, tegmina 40.51, hind femur 24.65, Female: body 64.44, pronotum 14.48, tegmina 60.40, hind femur 33.88 (Kumar and Usmani, 2014).

Distribution : It is distributed throughout India while elsewhere it is found in Nepal, Africa, Hainan, Pakistan, Philippines, Bangladesh, Central America, Indonesia, Sri Lanka, Madagascar, the Mediterranean Region, Sumatra, Myanmar, Red-Sea, Sahara, Saudi Arabia, Seychelles, South West Asia and Thailand (Kumar and Usmani, 2014).

Ecology and habitat : It is found feeding on wild and cultivated plants like tapioca pearl millet, cluster bean, jujube, snowbush and water melon (Paulraj *et al.*, 2007; Samejo and Sultana, 2016).

5) *Choroedocus robustus* (Serville) : It belongs to the family Acrididae, subfamily Catantopinae and sub-order Caelifera of the order Orthoptera (Fig. 5).



Fig. 5 : *C. robustus*.

Diagnostic characters : Head short, slightly obtuse, a broad brown band running down beneath the eyes, bordered in front with yellow stripes; body large robust; antennae filiform; fastigium rounded in front, frontal ridge narrowing between antennae; eyes prominent, laterally elongated; pronotum dark brown; tegmina without spots; supra-anal plate tongue shaped, apex broadly rounded; the hind tibia is slightly shorter than the hind femur, hind tibia, and tarsi are coral red, tibia with extremely base blackish, shining, with black-tipped spines; hind femur longer than the abdomen and is not serrated; wings hyaline with a bluish iridescence toward the base; circus wide, thick, strongly compressed, incurved and down curved; ventral abdomen greenish-yellowish brown, with some yellow spots towards the extremity (Srinivasan and Prabakar, 2013).

Morphometry (length in mm) : Male: body 42.19, tegmina 39.46, pronotum 3.89, hind femur 28.41; Female: body 66.89, tegmina 57.7, pronotum 4.15, hind femur 45.56 (Usmani and Khan, 2010; Yadav *et al.*, 2017).

Distribution : It is recorded from major parts of India *viz.*, Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh, Manipur, Meghalaya, Nagaland,

Sikkim, Tripura, West Bengal, Uttar Pradesh (Shishodia *et al.*, 2010, Srinivasan and Prabakar, 2013; Yadav *et al.*, 2017) and Gujarat while elsewhere, it is found from Bangladesh, Bhutan and Nepal (Pudasaini and Dhital, 2022).

Ecology and habitat : This species is more abundant in natural and uncultivated ecosystems and mostly seen on the river bank on barren grounds with grass. Moreover, it is also recognized as a pest, which prefers mixed vegetation and paddy fields (Srinivasan and Prabakar, 2013).

6) *Hieroglyphus banian* (Fabricius) : It belongs to the family Acrididae, subfamily Hemiacridinae, and sub-order Caelifera of the order Orthoptera (Fig. 6).



Fig. 6 : *H. banian*.

Diagnostic characters : Body medium to large; antennae filiform, longer than head and pronotum together; head shorter than pronotum; fastigium of vertex wider than long, with obtuse angular apex; frons oblique; frontal ridge sulcated; dorsum of pronotum cylindrical, crossed by three or four transverse sulci; median carina weak; lateral carinae absent; metazona shorter than prozona; posterior margin of pronotum obtuse-angular or rounded; prosternal process acutely conical or bifurcate; mesosternal interspace elongate, strongly constricted; tegmina or wings fully developed or shortened; radial area of tegmen with series of regular transverse stridulatory veinlets; hind femur slender; external apical spine of hind tibia present; arolium very large (Kumar and Usmani, 2015).

Morphometry (length in mm) : Male: body 42.01, pronotum 7.59, tegmina 32.84, hind femur, 20.46; Female: body 55.19, pronotum 8.90, tegmina 41.66, hind femur: 25.6 (Kumar and Usmani, 2015).

Distribution : It is distributed in major parts of India *viz.*, West Bengal, Andhra Pradesh, Sikkim, Himachal Pradesh, Bihar, Orissa, Rajasthan, Maharashtra, Tamil Nadu, Uttar Pradesh (Kumar and Usmani, 2015) and Gujarat while elsewhere, it is found in Pakistan, Afghanistan, Bhutan, Nepal, Bangladesh, Burma, Thailand, N. Vietnam, China, Sri Lanka (Sultana and Lecoq, 2019).

Ecology and habitat : The normal habitat of *H. banian* is marshy areas and wet ditches with grassy

banks, typical of most rice-growing regions (Feakin, 1974). Vyas *et al.* (1983) experimented with 11 alternative hosts for *H. banian* in Gwalior, Madhya Pradesh (India) and found that sorghum was the most preferred crop, followed by maize and pearl millet. Das *et al.* (2002) confirmed paddy as a highly acceptable food by *H. banian* in terms of preference and weight gain. Moreover, Jadhao and Khurad (2011) described only one species of grasshopper *i.e.*, *H. banian* out of 23 species of insect pests in the rice ecosystem from Maharashtra.

7) *Euconocephalus incertus* Walker : It belongs to the family Tettigoniidae, subfamily Conocephalinae and sub-order Ensifera of the order Orthoptera (Fig. 7).



Fig. 7 : *E. incertus*.

Diagnostic characters : Body medium to large slender in shape, green or yellowish-brown in color; head cone shaped; pointed fastigium extending beyond the antennal sockets; eyes spherical; fastigium separated from frons by a notch; pronotum with side keels, tegmen and wings fully developed; wings transparent with green veins; stridulatory organ exposed on the left tegmina; hind femora surpassing beyond the end of abdomen; hind femora and fore tibiae with ventral spines; cerci in male thick at the basal half and slightly pointed at apex; cerci in female thick at basal half and thin at the apex; ovipositor long and straight (Panhwar *et al.*, 2014).

Morphometry (length in mm) : Male: body 33.5-34.5, pronotum 9.7-10.3, tegmina 46.6-47.5, hind femur, 25.7-26.3; Female: body 32.5-33.5, pronotum 7.8-8.5, tegmina 47.6-48.5, hind femur: 25.5-27.5 (Panhwar *et al.*, 2014).

Distribution : It is distributed in major parts of India viz., Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh, West Bengal and Gujarat while elsewhere, it is found from Ceylon, Penang, Tokin Calcutta, Burma, Philippines and Java Hebard (Panhwar *et al.*, 2014).

Ecology and habitat : It is found mostly in grasslands with scattered bushy vegetation moreover, it was observed in the gum Acacia tree (Panhwar *et al.*, 2014). Mitra *et al.* (2018) recorded *E. incertus* from

field crops and suggested that it could be a potential pest as it is phytophagous.

8) *Hexacentrus unicolor* Serville : It belongs to the family Tettigoniidae, subfamily Hexacentrinae and sub-order Ensifera of the order Orthoptera (Fig. 8).



Fig. 8 : *H. unicolor*.

Diagnostic characters : Colour brownish-yellow or greenish-yellow; fastigium of vertex narrow, conical, apex acute; a special dark-brown colored band covers the pro, meso, and metanotum; left anterior tibia with 6 external and 5 internal and right anterior tibia with 5 external and 6 internal spines; hind knee lobes with a spine on each side; hind femora with widely spaced big spines and between them lie small spines; hind tibiae with small spines on dorsal and ventral face externally and internally (Gupta and Chandra, 2018; Chen *et al.*, 2021).

Morphometry (length in mm) : Male: body 36.53-41.70, pronotum 6.60-7.15, tegmina 29.80-34.52, hind femur 18.91-21.22; Female: body 34.55-38.01, pronotum 5.10-5.84, tegmina 27.69-30.32, hind femur 20.41-21.58 (Panhwar *et al.*, 2017; Chen *et al.*, 2021; Ghosh *et al.*, 2023).

Distribution : It is distributed in major parts of India viz., Andaman & Nicobar Islands, Chhattisgarh, Himachal Pradesh, Manipur, Mizoram, Nagaland, Sikkim (Srinivasan and Prabakar, 2012; Gupta and Chandra, 2018) and Gujarat while elsewhere, it is found from Borneo, Celebes, China, Japan, Java, Moluccas, Myanmar, Philippines, Sumatra, Singapore, Taiwan and Thailand (Shishodia *et al.*, 2010; Chen *et al.*, 2021).

Ecology and habitat : It is generally found in long grasses, hilly areas and mixed vegetation (Gupta and Chandra, 2016).

9) *Sanaa regalis* (Brunner von Wattenwyl) : This species belongs to the family Tettigoniidae, subfamily Pseudophyllinae and sub-order Ensifera of the order Orthoptera (Fig. 9).



Fig. 9 : *S. regalis*.

Diagnostic characters : Colorful katydid; pronotum greenish-yellow, elytron brown with black spots, hind wing spotted anteriorly; four large greenish-yellow maculae on its brown tegmina; meso and metasternum brown; pleura black; legs brownish, all femora medially and ventrally black; ovipositor black at the base (Beier, 1962; Gupta and Chandra, 2018; Cigliano *et al.*, 2021).

Morphometry (length in mm) : Male: body 55.56-61.70, pronotum 8.50-11.45, tegmina 40.78-47.15, hind femur 18.70-21.80.

Distribution : It is described originally from Sikkim and later reported from East Himalayas (Darjeeling, Assam, Nagaland, West Bengal, Arunachal Pradesh) (Ingrisch, 2002; Barman, 2003; Gogoi *et al.*, 2015) and Central Himalayas (Sajan and Sapkota, 2021), Raipur, Chhattisgarh in Central India (Gupta and Chandra, 2018) and Gujarat.

Ecology and habitat : It can be observed in bushes or mid hills areas (Sajan and Sapkota, 2021).

Conclusion

The diagnostic character and morphometrical description of grasshopper species will be useful for their identification under field conditions. Overall, it will be useful to distinguish each species from other species of grasshoppers. Furthermore, the host preference and habitat of a particular grasshopper species will help decide whether it is a pest of cultivated crop or not and that will lead to the planning of integrated management strategy.

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Author contribution statement

JVI, RCB, KVC and NS conducted a study, collected samples, analyzed data, and wrote the manuscript. MRD planned, designed and supervised the study. All authors read and approved the manuscript.

Conflict of interest

The authors declare that the research work was carried out without any financial or commercial dealings that could be raised as a probable conflict of interest.

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