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Tiger Beetles (Coleoptera : Carabidae : Cicindelinae) : The racecars of the insect world recorded from tropical forests of foothills of Eastern Himalaya

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Abstract : *Present study deals with the tiger beetle diversity of the tropical forests at the foothills of Eastern Himalaya (Dooars) under the jurisdiction of West Bengal, India. The data provided is generated through a long term faunistic investigation of the authors. A total of 20 species and 160 individuals belonging to 9 genera speak about the diversity spectrum of the beetles. All 20 recorded species are new from Jalpaiguri district of West Bengal. Setinteridenta rhytidopteroides (Horn) is reported for the first time from West Bengal. Buxa Tiger Reserve appears to be extremely rich in cicindelid fauna. 19 out of 20 species and altogether 117 individuals are trapped from this protected area. Premonsoon is the best season for their occurrence. Analysis of their zoogeographical distribution reveals that the fauna apart from being Oriental also includes some Palaearctic (55%) elements. Ranking sequence of the most abundant three species are [in descending order]: Neocollyris fuscitarsis (20.00%) > Cosmodela duponti (11.25%) > Calochroa assamensis (10.00%).*

Key words *: Cicindelid fauna, tropical forests of Dooars, new record, Jalpaiguri & West Bengal.*

1. INTRODUCTION :

Biodiversity is the outcome of interaction between the phylogenetic history of life on earth and ecological process. The status and trends in biodiversity reflect the health of the ecosystem that support and enrich human life. Every component of life forms on earth play crucial role in ecosystem functioning. So biodiversity conservation of nature and natural resources is an urgent need of the day to safeguard our own survival and that of our planet. Taxonomy is the essential tool that underpins biodiversity conservation by providing a logical classification and framework for describing and studying living organisms. Taxonomy describes the variations present within species and identifying groups of organisms of conservation significance, giving those species and subspecies a formal conservation status. Global estimate on the extant taxa is around 13.5 million with only 1.75 million currently described [1]. More than half of these species are limited to the tropics. The tropics also include mainly developing countries where natural ecosystem are in serious risk from growing populations and rapid 'development'. In a densely populated country like India the maintenance of biological diversity and its conservation in existing habitats is one of most pressing tasks for some obvious factors. Accepting the fast rate of deforestation and degradation, biologists are interested in selecting an efficient, limited set of biological indicators for measuring and monitoring biological diversity [2,3,4,5]. A worldwide study was conducted on species richness pattern of tiger beetles [3] and suggested its use as an indicator taxon for the planning of biodiversity and conservation studies. The other taxa, birds and butterflies, also fit into criteria of good indicators of habitat quality [6]. For the sustained conservation of biodiversity, now restricted to these degraded and patchy habitats it has become mandatory to protect and conserve these areas. But unfortunately, not all can be conserved and it is important to survey potential areas for conservation and prioritize them based on various criteria. Most enumeration efforts often need detailed field surveys requiring manpower, time and funds, which can both be limiting factors [7].

Indicator species are used to monitor environmental changes, assess the efficacy of management and provide warning signals for impending ecological shifts. In recent years use of indicator species is being criticized for several reasons, notably because of the lack of justification behind the choice of any given indicator. Long term monitoring gives variability [8,9] since there is as such no 'normal year' at least for insect abundance. A short time study provides fairly a true picture without having resort to long-term sampling [10]. Tiger beetles have become a significant global

flagship group and used as a good biological indicator group for identifying area/s for biodiversity conservation [11,3,12,13,14,15,5,16]. Tiger beetles are well known; their biology is well understood; they occur over a broad range of biotopes and geographical areas; on a much small geographical scale, tiger beetles are particularly useful as 'fast indicators' of biotope quality relative to disturbance [17] . A study in Peru took only 50 hrs of observation to find 93% of the tiger beetle fauna, while to find out 90% of the butterflies species required nearly 1000 hrs of fieldwork [3].

1.1 The Tiger Beetles

Cicindellids are the racecars of the insect world. Striped patterns, speed and ferocity called for their name. Light coloured species inhabit sandy areas match the environment. Most of the adult beetles are diurnal and highly mobile, their larvae are sedentary and live in burrows constructed in the substrate where the eggs are oviposited [18].

1.2 Global Distribution

Although tiger beetles occur throughout the world with exception of the polar regions and some oceanic islands [19,5]. Mostly the species are subtropical or tropical and enjoy sunny paths or sandy areas. Open habitats such as stream edges, seashores, dirt roads and sand dunes are the most preferred sites. South East Asia accommodates highest number of tiger beetle species. About 23% of the worlds' species are found in this region considering that it constitutes only 2% of the total land area of countries with tiger beetle fauna [20]. Almost 2900 species have been described to date worldwide. Presently India ranks third with 241 described species (Table 1) [21].

Table : 1. Rank of countries in total tiger beetle species count, percentage endemic species and area/species coverage [19,21].

Rank	Top 10 countries (total number of tiger beetle species)	Top 10 countries (percentage of endemic tiger beetle species)	Top 10 countries (area (km2)/number of species)
1	Indonesia (301)	Madagascar (98.7%)	Sri Lanka (1156)
2	Brazil (257)	Australia (89.7%)	Laos (2157)
3	India (241)	Philippines (85.4%)	Nepal (2200)
4	Madagascar (176)	Sri Lanka (62.5%)	Philippines (2294)
5	Philippines (130)	Brazil (60.1%)	Vietnam (2854)
6	Congo (128)	Papua New Guinea (58.2%)	Ecuador (3186)
7	Thailand (123)	Indonesia (52.7%)	Madagascar (3335)
8	Mexico (122)	India (51.9%)	Thailand (4161)
9	USA (120)	Mexico (49.2%)	Malaysia (4574)
10	Australia (116)	USA (41.7%)	Papua New Guinea (5718)

1.3 Morphology

A. Identifying Features of Adults (Fig. 1) : Shape: Elytra straight, parallel-sided or little wider apically; pronotum narrower than elytra, head at eyes wider than pronotum. Colouration brownish, black or green, often brightly patterned, sometimes iridescent. Body slender, about 10 - 24mm long . Clypeus and labrum produced laterally, wider than distance between sockets of antennae. Large, prominent bulging compound eyes. 11-segmented filiform antennae. Large, sickle-shaped mandibles. Legs long and slender.

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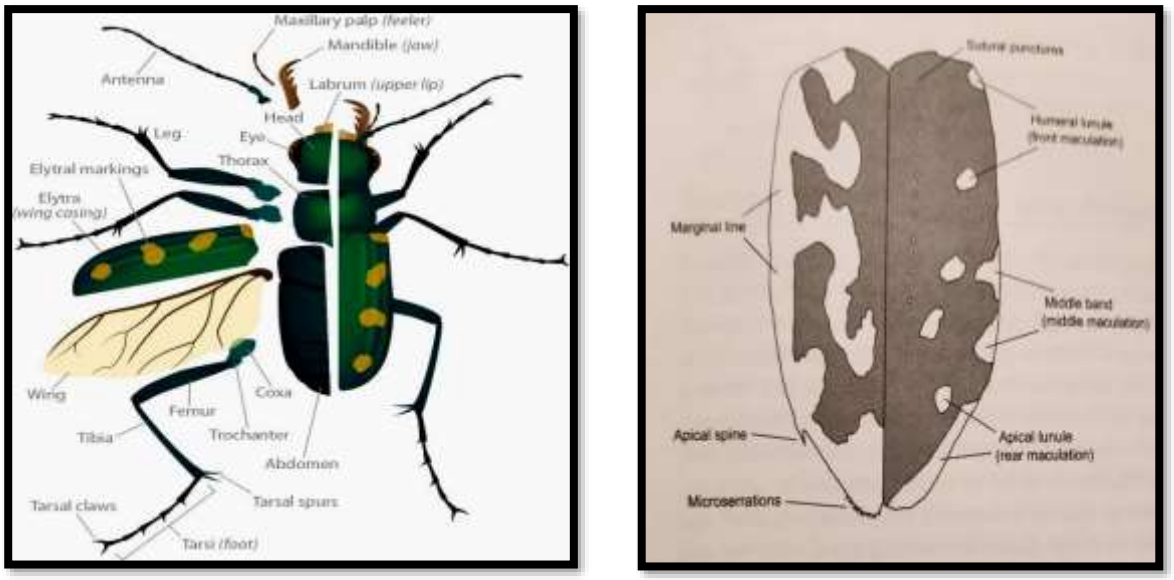

A **B**

C

Fig. 1 Morphology of tiger beetle : A. Dorsal habitus, B. Elytral decoration(Courstey [21]), C. Front view of head showing labrum & mandibles

B. Identifying Features of Larvae (Fig. 2): Elongate, cylindrical, with powerful upward curving mandibles. The larva anchor itself within burrow with hooks located on the fifth abdominal segment.

Fig. 2 Tiger beetle grub showing hooks located on fifth abdominal segment

1.4 Food

Both adults and larvae are predators that prey on small invertebrates, such as other insects and spiders, a characteristic that makes them potentially natural biological controls of pests with an economic value [22].

1.5 Life Cycle (Fig. 4)

After selecting a site, the female digs a hole in the damp soil, 10 mm deep to lay one egg, and then fills up the hole (Fig. 3). Once hatched, the S-shaped larva digs a vertical, cylindrical burrow at the site, goes through 3 instars and

expands the burrow as it grows. Larval stage usually takes 2-3 years to complete depending on the climate and food availability.

Fig. 3 Oviposition sites

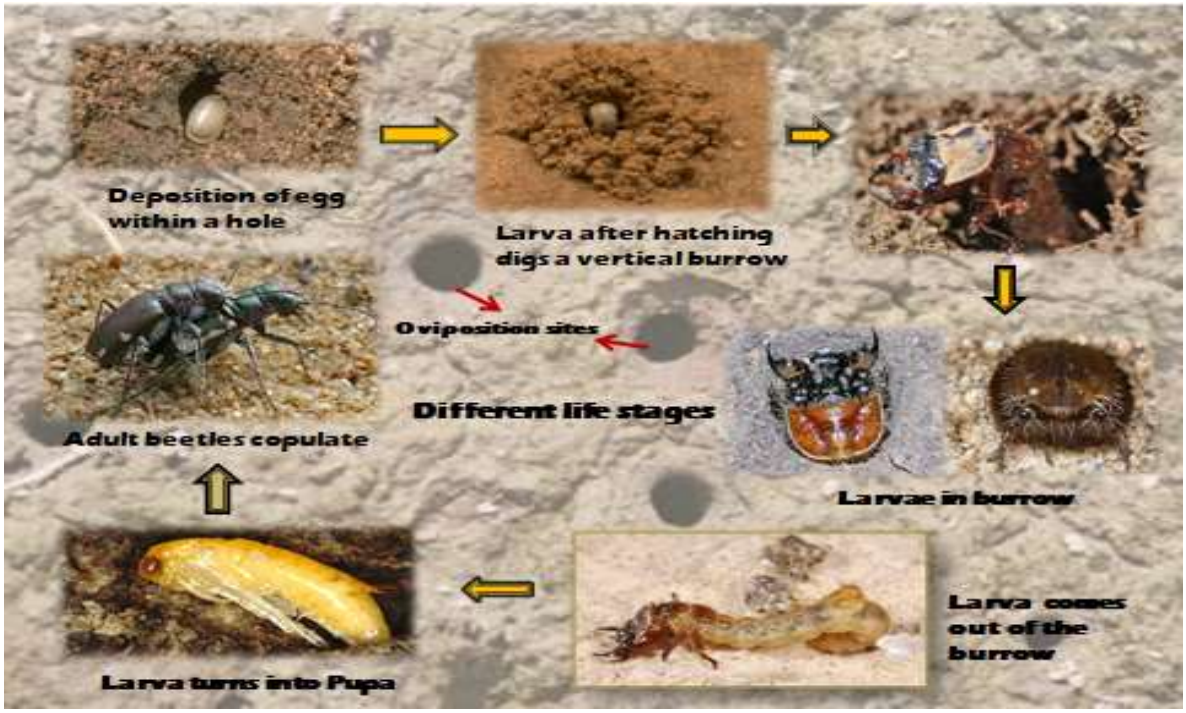

Fig. 4 Life stages of tiger beetles

2. RETROSPECT :

A concise knowledge on the total number of species described or reported from West Bengal is still wanting. However, regional works on Indian tiger beetles were done by several workers [23,24,25,26,27,28,29,30,31,32,33, 34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,21]. Therefore, this work attempts to document patterns of diversity and distribution of tiger beetles in different habitat types in the landscape of Dooars of West Bengal.

3. STUDY AREA (Fig. 5)

The Dooars, a green strip of land lying along the foothills of Himalaya in the district of Jalpaiguri, is predominantly a tea growing area. History reveals that in Dooars for entry from Bhutan to India there were eighteen doors. It is the gateway to the North-Eastern parts of India and stretches from Siliguri in the West to Buxa in the East. This 150 km stretch of dense evergreen moist deciduous Himalayan foothill constitutes one of the 18 biodiversity hotspots of the world [50].

The estimated forest land of West Bengal is 1.54% of the forest land of India. Dooars has a total forest area of 1731.03 sq. km. situated in between latitudes 26º16´ and 27º00´ North and longitudes 88º04´ and 89º58´ East and elevations 90 to 1750m. It also includes 181 tea gardens with a total land area of 1187.06 sq. km. [50].

Dooars in Jalpaiguri district of West Bengal can be divided into 3 regions – (1) Eastern Dooars – region between Torsa and Sankos rivers, (2) Central Dooars – region between Torsa and Jaldhaka rivers and (3) Western Dooars – region between Jaldhaka and Teesta rivers.

Dooars the mostly flat terrain, is lush green with large patches of towering forest and tea gardens. The land is crisscrossed by Teesta, Jaldhaka and Torsa rivers and their innumerable tributaries trolling and rolling down the hills. It represents the biogeographic provinces of Central Himalayas (2C) and lower gangetic plains (7B). Besides a large number of tea gardens Dooars has National Parks, Wild Life Sanctuaries and Tiger Reserve namely, Garumara National Park, Chapramari Wildlife Sanctuary, Jaldapara Wildlife Sanctuary, and Buxa Tiger Reserve [50].

There is a wide diversity of the forests in Dooars, viz., savannah, riverine, drymixed, sal, evergreen, malate forests. Besides, there are plenty of shade trees, *Albizzia* spp., *Acacia* spp., *Dalbergia* spp., *Indigofera* spp. etc., a must for the tea plantations . Major fauna of the Dooars include Elephant, Tiger, Gaur, Rhinoceros, Leopard, Sambhar, Hog deer, Barking Deer, Spotted Deer, Wild Pig, Sloth Beer, various species of cat and a rich varied population of Reptiles, Birds and Fishes [51].

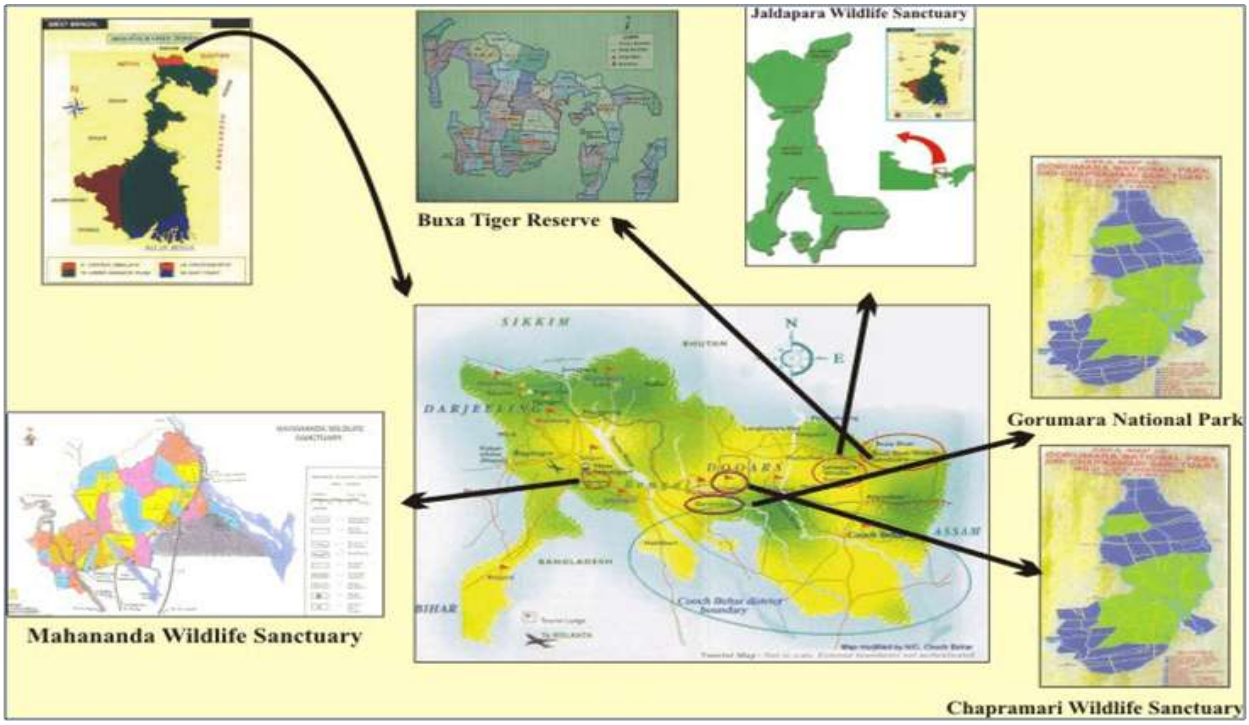

Fig. 5 Study area

4. MATERIALS & METHODS :

Different areas of the reserve forests namely Buxa Tiger Reserve, Jaldapara Wildlife Sanctuary, Gorumara National Park, Chapramari Wildlife Sanctuary & Mahananda Wildlife Sanctuary were surveyed on a regular basis in different seasons for the tiger beetles during 1992 to 2009 every year (Fig. 6 & 7). Such visits involved sampling of the beetles using nets, pitfall traps, UV light traps (Fig. 8) etc. [52,18,53,5] and their preservation in 70% alcohol. Insect samples were then brought to the laboratory for permanent storing following the available recommendations [54]. Taxonomic assessment was done under a Stereoscopic Zoom Binocular Microscope [model Olympus SZX-16], following standard literatures [23,21]. The measurements are in millimeters, made with an eye piece graticule. Materials are in the deposition of Entomology Laboratory, IRDM faculty Centre, Dept. of Agricultural Biotechnology, Ramakrishna Mission Vivekananda Educational and Research Institute, Narendrapur, Kolkata.

4.1. Measuring Diversity Indices [55] :

In order to measure various diversity indices, under mentioned mathematical expressions were adopted :

1) The type of diversity used here is α- diversity which is the diversity of species within a community or habitat. The diversity index was calculated by using the Shannon – Wiener diversity index [56].

Shannon – Weiner Diversity index = H = $-\sum$ Pi ln Pi

[where Pi = S / N, S = number of individuals of one species, N = total number of all individuals in the sample, ln = logarithm to base e].

2) A community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance. As species ichness and evenness increase, so diversity increases. Simpson's Diversity Index [57] is a measure of diversity which takes into account both richness and evenness.

$$\text{Simpson's Index (Dominance Diversity Index)} = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

[where n= total no. of individuals of a particular species , N = total no. of organisms of all species].

3) Margalef's index was used as a simple measure of species richness [58].

Margalef's index = (S – 1) / ln N

[where S = total number of species, N = total number of individuals in the sample, In = natural logarithm]

4) For calculating the evenness of species, Pielou's Evenness Index (e) was used [59].

Pielou's Evenness Index (e) = H / ln S

[where,H = Shannon – Wiener diversity index, S = total number of species in the sample]

5) For calculating species similarity amongst the forests Sørensen's Similarity Index (S_{SD}) was used [60].

Sørensen's Similarity Index (S_{SD}) = 2a/2a+b+c

[where a = no. of species the two communities/habitat have in common, b = total no. of species found in community/habitat 1 & c = total no. of species found in community/habitat 2]

Structural association (% abundance) were also analyzed from pooled data and finally enumerating tiger beetle faunal diversity.

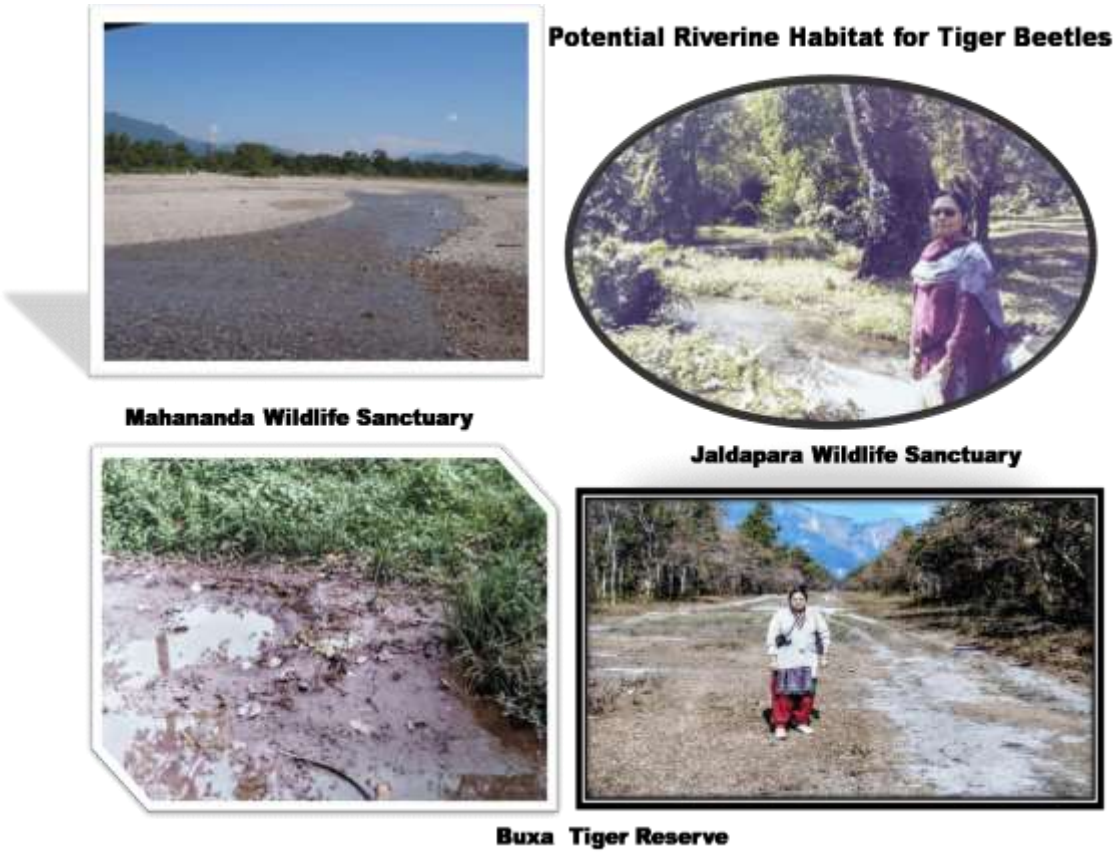

Fig. 6 Study Sites

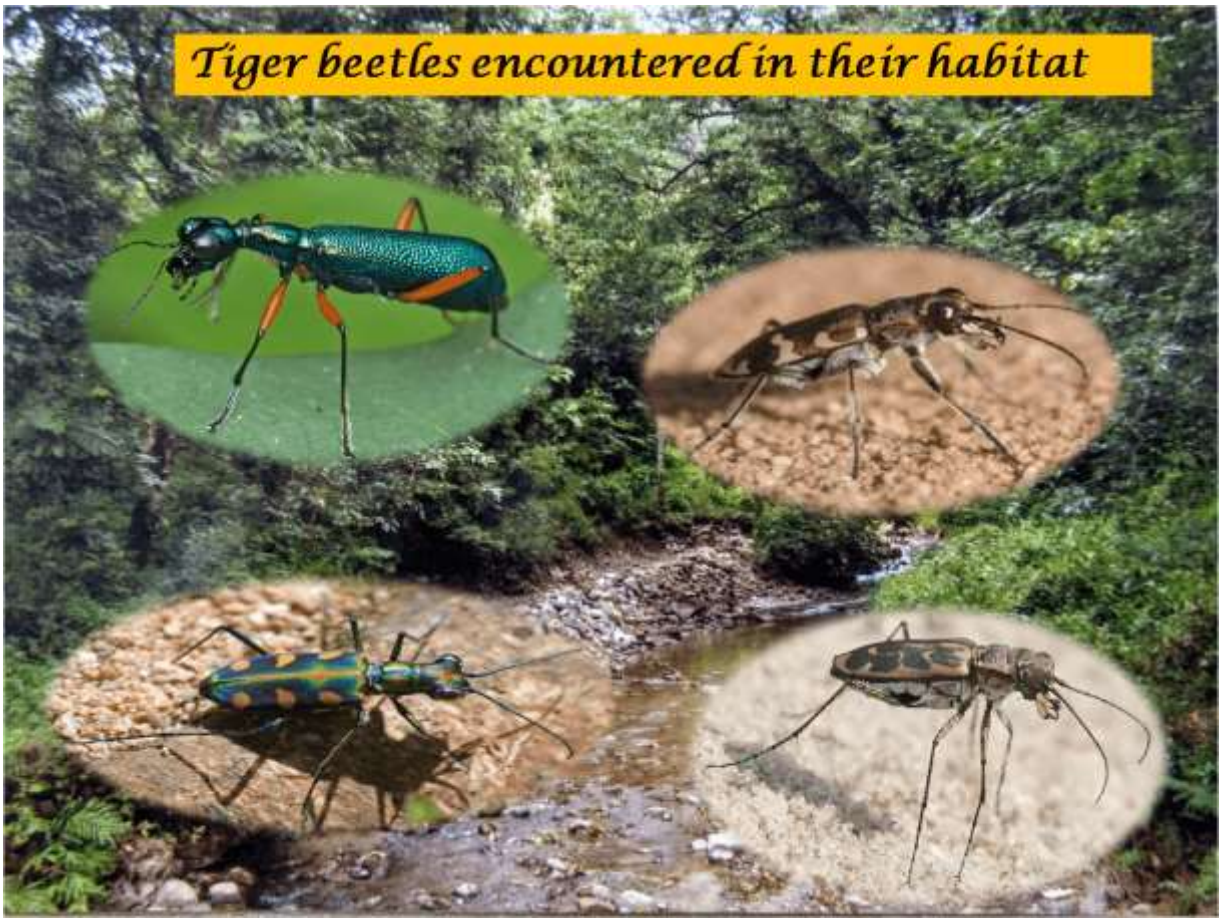

Fig. 7 Different guilds of tiger beetles

Fig. 8 How to trap adult tiger beetle on the ground

Calochroa assamensis
(Parry)

Calochroa bicolor bicolor
(Fabricius)

Calochroa flavomaculata
(Hope)

Calochroa octonotata
(Wiedemann)

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Calomera angulata **(Fabricius)**

Calomera funerea **(Macleay)**

Calomera plumigera macrograptina **(Acciavatti & Pearson)**

Cosmodela duponti **(Dejean)**

Cylindera bigemina **(Klug)**

Cylindera sikkimemsis **(Mandl)**

Cylindera spinolae **(Gestro)**

Hypaetha quadrilineata **(Fabricius)**

Lophyra multiguttata **(Dejean)**

Lophyra parvimaculata **(Fowler)**

Lophyra striolata **(Illiger)**

Setinteridenta rhytidopteroides **(Horn)**

Fig. 9 Tiger beetles collected during field survey

5. RESULTS & DISCUSSION :

A total of 20 species and 160 individuals belonging to 9 genera under the subfamily Cicindelinae of the family Carabidae were collected by the authors during extensive entomological survey (Table 2, Fig. 9). Most of the tiger beetles are sampled in the field using pitfall traps and UV light traps during evening hours. Most preferred site for them are the moist grassy parts of river flood plains and savannas, moist forest floors and sandy river banks (Figs. 6 & 7). All the 20 recorded species are new report from Jalpaiguri district of West Bengal. *Setinteridenta rhytidopteroides* (Horn) is being reported for the first time from West Bengal. Buxa Tiger Reserve is found to be very rich in cicindelid fauna. 19 out of the 20 species and altogether 117 individuals are trapped from this protected area (Fig. 10). Premonsoon is the best season for their occurrence (Fig. 11). Analysis of their zoogeographical distribution reveals that the fauna apart from being Oriental also includes some Palaearctic (55%) element. Ranking sequence of most abundant three species are [in descending order] : *Neocollyris fuscitarsis* (20.00%) > *Cosmodela duponti* (11.25%) > *Calochroa assamensis* (10.00%). Table 3 portrays the site specific biodiversity indices of recorded tiger beetle taxa.

Table : 2 Distribution of Tiger beetles

Sl. No.	Species	Distribution												Habitat
		Within Protected Areas of West Bengal						In India	In World	Zoo geo gra phi cal	Seasonal			
											PM	M	PS M	
		BT R	CW LS	GNP	JW LS	M WL S	Total no. of Indiv idual s							
1.	♣*Calochroa assamensis* (Parry)	+ (10)		+ (1)	+ (3)	+ (2)	16	Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim, West Bengal (Darjeeling, Jalpaiguri)	Bangladesh, Bhutan, India, Myanmar, Nepal	OR	+ (12)	+ (4)	-	Floor of shaded forest with dense undergrow th and along sandy forest streams

2.	♣*Calochroa bicolor bicolor* (Fabricius)	+ (1)					1	Assam, Bihar, Himachal Pradesh, Maharashtra, Meghalaya, Uttarakhand, West Bengal (Birbhum, Burdwan, Jalpaiguri, Kolkata, Maldah, Mursidabad)	Bangladesh, China, India, Myanmar, Nepal, Thailand	OR, PL	+ (1)	-	-	Usually floor of mature to secondary forests but also wooded fields, tall grass
3.	♣*Calochroa flavomaculata* (Hope)	+ (9)			+ (1)		10	Himachal Pradesh, Mizoram, Sikkim, Uttarakhand, West Bengal (Jalpaigur)	Cambodia, China, India, Laos, Myanmar, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam,	OR, PL	+ (6)	+ (3)	+ (1)	Open forest floor, sandy banks of rivers, grassy meadows
4.	♣*Calochroa octonotata* (Wiedemann)	+ (4)			+ (6)	+ (1)	11	Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Uttar Pradesh, West Bengal (Burdwan, Darjeeling, Jalpaiguri, Maldah, Mursidabad)	Bangladesh, Bhutan, China, India, Myanmar, Nepal	OR, PL	+ (3)	+ (7)	+ (1)	Open forest floor, gravel and sand banks of rivers,
5.	♣*Calomera angulata* (Fabricius)	+ (10)					10	Bihar, Himachal Pradesh, Sikkim, Uttarakhand, West Bengal (Jalpaiguri)	Afghanistan, Bangladesh, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam	OR, PL	+ (10)	-	-	Moist sandy river banks
6.	♣*Calomera funerea* (Macleay)	+ (7)					7	Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Maharashtra, Meghalaya, Mizoram, Punjab, Sikkim, Uttarakhand, Uttar Pradesh, West Bengal (Darjeeling, Jalpaiguri)	Bangladesh, Bhutan, China, India, Indonesia, Laos, Pakistan, Myanmar, Nepal, Thailand	OR, PL	+ (6)	+ (1)	-	Sandy banks of forested streams
7.	♣*Calomera plumigera macrograptina* (Acciavatti & Pearson)	+ (1)					1	Arunachal Pradesh, Assam, Bihar, Haryana, Himachal Pradesh,	Bangladesh, India, Myanmar, Nepal, Pakistan	OR	+ (1)	-	-	Along sandy and gravelly banks of large rivers

								Meghalaya, Orissa, Punjab, Uttarakhand, Uttar Pradesh, West Bengal (Jalpaiguri)						
8.	♣*Cosmodela duponti* (Dejean)	+ (14)	+ (2)		+ (2)		18	Assam, Karnataka, Maharashtra, Meghalaya, Tamil Nadu, West Bengal (Jalpaiguri)	Bangladesh, China, India, Laos, Malaysia, Myanmar, Thailand, Vietnam	OR, PL	+ (8)	+ (10)	-	Near small forest streams or in stream beds on large rocks and boulders
9.	♣*Cylindera bigemina* (Klug)	+ (1)					1	Arunachal Pradesh, Bihar, Himachal Pardesh, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Uttarakhand, Uttar Pradesh, West Bengal (Darjeeling, Jalpaiguri, Kolkata, Maldah, Murshidabad)	Afghanistan, Bangladesh, India, Nepal, Pakistan	OR	+ (1)	-	-	Grassy edges of sandy river banks and open forests
10.	♣Cylindera sikkimemsis (Mandl)	+ (5)					5	Arunachal Pradesh, Assam, Manipur, Meghalaya, Sikkim, West Bengal (Jalpaiguri)	India, Myanmar	OR	+ (3)	+ (2)	-	Open areas and along roads
11.	♣*Cylindera spinolae* (Gestro)			+ (2)			2	Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Meghalaya, Orissa, Sikkim, Uttarakhand, West Bengal (Burdwan, Darjeeling, Jalpaiguri)	Bangladesh, Cambodia, China, India, Laos, Myanmar, Nepal, Thailand, Vietnam	OR, PL	+ (2)	-	-	Floor of moist forests
12.	♣*Hypaetha quadrilineata* (Fabricius)	+ (1)					1	Andhra Pradesh, Kerala, Puducherry, Tamil Nadu, West Bengal (Jalpaiguri, South 24 Parganas)	Baluchistan, India, Iran, Malaysia, Myanmar, Pakistan, Sri Lanka, Thailand	OR	+ (1)	-	-	Sandy river banks
13.	♣Lophyra multiguttata (Dejean)	+ (1)					1	Arunachal Pradesh, Assam, Haryana, Himachal Pradesh, Meghalaya, Punjab, Orissa, Uttarakhand, Uttar Pradesh, West Bengal	Bangladesh, Bhutan, India, Myanmar, Nepal	OR	-	+ (1)	-	Moister grassy parts of river flood plains and savannas

								(Burdwan, Darjeeling, Jalpaiguri, South 24 Parganas)						
14.	♣*Lophyra parvimaculata* (Fowler)	+ (3)				+ (2)	5	Arunachal Pradesh, Himachal Pradesh, Sikkim, Uttarakhand, West Bengal (Darjeeling, Jalpaiguri,)	India, Nepal	OR	+ (5)	-	-	Moister grassy parts of river flood plains and savannas
15.	♣*Lophyra striolata* (Illiger)	+ (6)			+ (1)	+ (2)	9	Arunachal Pradesh, Andhra Pradesh, Assam, Bihar, Himachal Pradesh, Karnataka, Kerala, Maharashtra, Madhya Pradesh, Meghalaya, Tamil Nadu, Sikkim, Uttarakhand, Uttar Pradesh, West Bengal (Maldah, Jalpaiguri, Kolkata)	Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Philippines, Taiwan, Thailand, Vietnam	OR, PL	+ (8)	+ (1)	-	Secondary forest floor and shrubby fields
16.	♦*Setinteridenta rhytidopteroides* (Horn)	+ (12)		+ (1)			13	West Bengal (Jalpaiguri)	India, Myanmar, Nepal		+ (13)	-	-	Stream banks
17.	♣*Neocollyris fuscitarsis* (Schmidt-Goebel)	+ (17)		+ (9)	+ (3)	+ (3)	32	Assam, Sikkim, West Bengal (Darjeeling, Jalpaiguri)	Cambodia, China, India, Indonesia, Laos, Malasia, Myanmar, Nepal, Thailand, Vietnam India	OR, PL	+ (26)	+ (6)	-	Broad-leafed undergrowth shrubs in shady forests and on foliage along paths and roadways in forests
18.	♣*Neocollyris insignis* Chaudoir	+ (11)		+ (1)	+ (1)		13	Assam, Meghalaya, Sikkim, West Bengal (Darjeeling, Jalpaiguri)	Bhutan, India, Myanmar, Nepal	OR	+ (12)	+ (1)	-	Forest and forest edge of the foothills of mountain
19.	♣*Neocollyris subclavata subclavata* Chaudoir	+ (3)					3	Tamil Nadu, West Bengal (Jalpaiguri)	China, India	OR, PL	+ (2)	+ (1)	-	Swampy areas of forest
20.	♣*Tricondyla macrodera* Chaudoir	+ (1)					1	Arunachal Pradesh, Assam, Meghalaya, Sikkim, West Bengal (Darjeeling, Jalpaiguri)	Bhutan, Cambodia, China, India, Myanmar, Nepal, Vietnam	OR, PL	+ (1)	-	-	Forest and forest edge in the lowlands
		117	2	14	17	10	160				121	37	2	

Legends : ♣ New record from Jalpaiguri ; ♦ New record from West Bengal; BTR = Buxa Tiger Reserve; CWLS = Chapramari Wildlife Sanctuary; GNP = Gorumara National Park; JWLS = Jaldapara Wildlife Sanctuary; MWLS = Mahananda Wildlife Sanctuary; PrM = Premonsoon (Feb to May); M = Monsoon (June to Sept.) ; PsM = Postmonsoon (Oct to Jan)

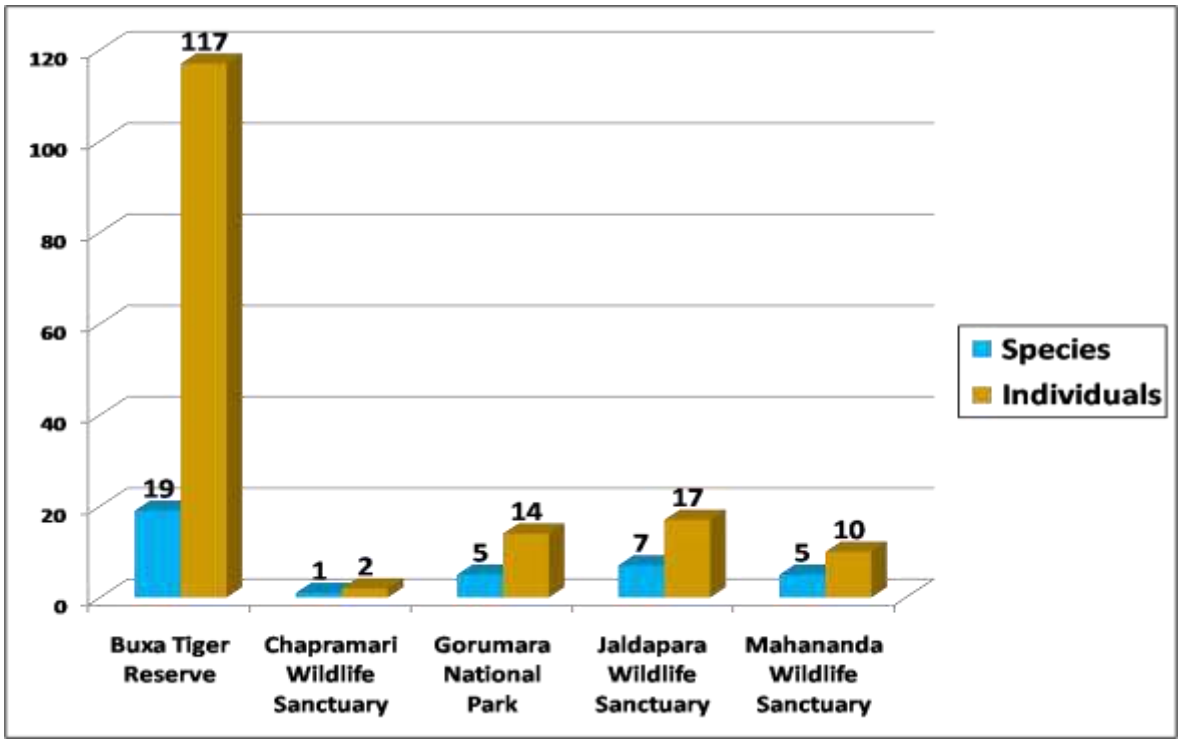

Fig. 10 : Tiger beetles trapped from protected areas of Dooars, West Bengal

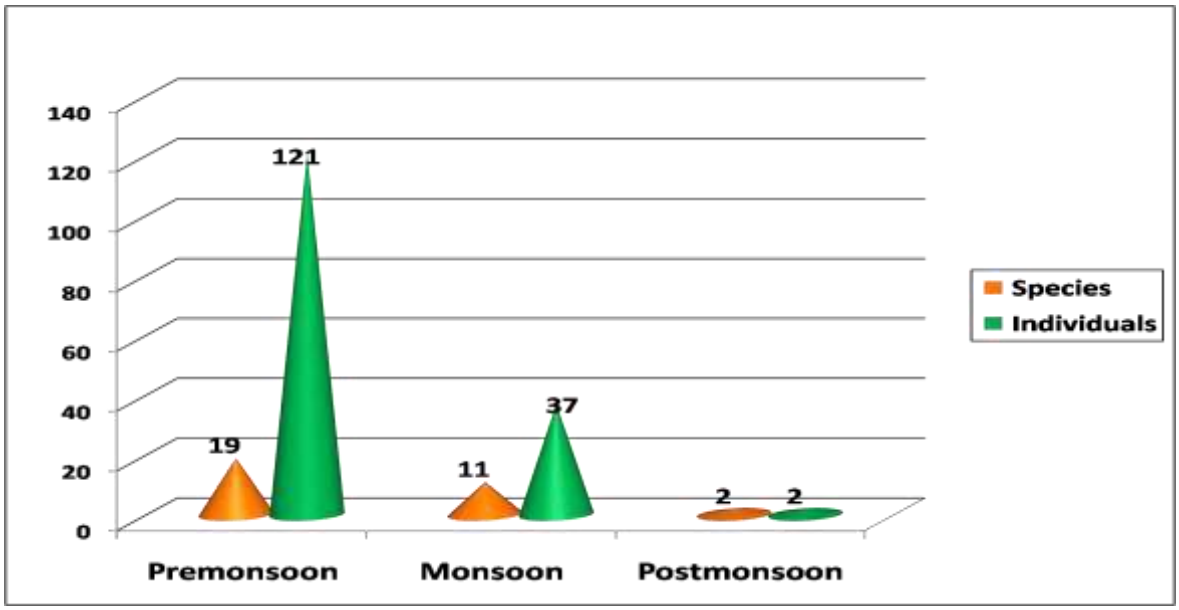

Fig. 11 : Tiger beetles encountered in different seasons

Table 3 : Site specific biodiversity indices of recorded tiger beetle taxa

Diversity Indices	Buxa TR	Chapramari WLS	Gorumara NP	Jaldapara WLS	Mahananda WLS
Shannon-Wiener's Index	0.2531	0.0548	0.0117	0.2381	0.1730
Simpson's Diversity Index	0.9752	1.0000	0.8901	0.8456	0.7778
Pielou's Evenness Index	0.0860	-	0.0072	0.1224	0.1075
Margalef's Index	3.7798	0.0000	1.5157	2.1178	1.7372

Sorensen's Similarity Index					
	Buxa TR	**Chapramari WLS**	**Gorumara NP**	**Jaldapara WLS**	**Mahananda WLS**
Buxa TR	x	0.0909	0.2500	0.3500	0.2941
Chapramari WLS		x	0.00000	0.2000	0.0000
Gorumara NP			x	0.3750	0.2857
Jaldapara WLS				x	0.4000
Mahananda WLS					x

6. CONCLUSION :

Tiger beetles are carnivorous, feed on small insects and other arthropods. Such can be managed and conserved systematically and scientifically in the area of occurrence, could be useful in the control of forest and agricultural pests, causing no harm to health. The tiger beetle species show a high degree of habitat specialization and are found in one or few microhabitats owing to unique climatic and trophic characteristics and resource partitioning. These in turn form the prime character for a bioindicator taxon for which tiger beetles are well known. Thus, monitoring these species in future will give precise idea about changes in microclimatic conditions, if the anthropogenic disturbance increases. Tiger beetles are thus excellent candidates for bioindicators in long term monitoring of forest ecosystems, ecosystem health and its application in a variety of landscapes.

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