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Survey of Reduviid in Southern Districts of Tamil Nadu

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Abstract*: In this study, the diversity of Reduviid predators was studied in the Semi-arid zone, scrub jungle, and tropical forest regions in southern part of Tamil Nadu, India, for 12 months extending from Jan 2023 to Dec 2023, to identify the dominant predator species that exhibit the potential to serve as biocontrol agents of agricultural/forest pests. In this study, we followed the methodology of Christopher, 2009 for the diversity studies. A total of 590 individuals belonging to seven sub-families, 14 genera, and 18 species were recorded from the study region. The number of species recorded in scrub jungles was the highest, followed by semi-arid zones and tropical rain forests. The predator population was high in semi-arid zones and scrub jungles during winter and summer compared to tropical forests. The Shannon-Weiner index and Simson's index for the species recorded in the Scrub jungle were high compared to other regions. Alagarmalai scrub jungle is an important spot for conservation because it is one of the important human interaction zones, from our study area.*

Keywords: *Reduviids, Diversity, Southern District, Scrub Jungle.*

I. INTRODUCTION

Biodiversity research has become a key subject in modern ecology. Forest ecosystems, in tropical as well as in temperate regions are believed to house the major proportion of global biodiversity. Research on animal and plant communities in forest habitats has a long tradition in ecology, nevertheless, Western Ghats remain on the map of global forest diversity. The Western Ghats mountain range comprises a series of hills running almost parallel to the west coast of Indian subcontinent from Tapti River in southeastern Gujarat to Kanyakumari in south Tamil Nadu. Ambrose (1980), Venison (1989), Kumaraswamy (1991), Sahayaraj (1991), Edwin (1997) Murugan (1988) Ravichandrean, (1988) and Sivaramakrishnan (2009) have studied the distribution and diversity of reduviid predators in Tamil Nadu. Being the most species-rich and prevalent insect taxon worldwide, predatory reduviids (Reduviidae) contribute greatly to biodiversity in forest habitats and play various roles in ecosystem dynamics and functioning (Goel 1978; Murugan 1988; Ravichandran, 1988; Kumaraswami and Ambrose, 1994; Edwin And Ambrose, 1996, Rajan and Ambrose, 1996, Edwin, 1997; Daniel at al., 1992) and most of them are effective predators capable of top-down biocontrol (Ambrose, 1999, Sahayaraj, 2007). Previously distribution of Psocids, Isoptera, Blattaria, Dermaptera, Diptera, Hemiptera and Orthoptera (Anu et al., 2009) and nine heteropteran families except Reduviidae (Aland et al., 2010) from south Western Ghats of Kerala and Maharastra respectively were available in the literature. Although, a series of reversionary studies have been subsequently carried out from different parts of of Western Ghats of Tamil Nadu (Ambrose, 1980; Venison, 1989; Kumaraswamy, 1991; Sahayaraj, 1991; Edwin, 1997 and Sivaramakrishnan, 2009), no exhaustive survey has so far been carried out, especially from the various regions of the Western Ghats. Therefore, for the first time an attempt has been made to study the fauna of reduviid bugs in a semi-arid zone, scrub jungle and evergreen forest region of southern Western Ghats Tamil Nadu, also the biodiversity indices include evenness and richness.

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II. MATERIAL AND METHODS

Materials

Reduviid predators and their host insects in the present study were collected in January 2023–December 2023 from different topographic areas like semi-arid zone, Murambu (Latitude N 08°40'54.1" to 41'25.7" and Longitude E077° 51'50.4" to 52'48.3"), scrub jungle, Alagarmalai (Latitude N 08° 5'57.3" to 16' 00.3" and Longitude E 077° 2'16.1" to 32' 53.0") and tropical rain forest, Thaniparai (Latitude N 08° 31' 09.2" - 32' 31.6" and Longitude E 077°18'35.9" to 21' 28.9") of Southern Western Ghat, Tamil Nadu. Six sites were randomly selected from topography with 5 x 5 m area (Christopher, 2009). The sites were designated as site 1 (ST 1), site 2 (ST 2), site 3 (ST 3), site 4 (ST 4), site 5 (ST 5) and site 6 (ST 6). Latitude and Longitude of each locality was recorded using GPS- map76.

Insects were collected from all the six sites of study area regularly once in a month. At each spot, reduviids and inhabiting insects were collected from arboreal, litter, and concealed habitats like underneath the stones and barks (Edwin, 1997 and Sivaramakrishnan, 2009). Both in semi-arid zone and scrub jungle, all the stones were lifted and the reduviids present underneath them were counted as described by Ambrose (1980), Venison (1989), Kumaraswamy (1991) and Sahayaraj (1991). Insect collection was made in the morning or evening hours. Limited opportunistic collection was also made. Insects were narcotized by using killing bottle and brought to the laboratory and preserved by dry preservation method and identified, if they were unknown and collected for the first time. Meteorological readings such as temperature, relative humidity, and wind velocity were recorded using thermometer, anemometer, and hygrometer, respectively.

Data analyses

The Simpson's index is calculated using the equation 1 (Murugan 1988)

$D = \_ \{ni\ (ni\ -1)/N\ (N-1)\}$ … (1)

Where *ni* is the number of individuals in the *i*th species and *N,* the total number of individuals. Simpson's index is usually expressed as 1- *D* or 1/ D, hence as *D* increases diversity of the community decreases.

The Shannon index is calculated by using the formula 2 (Magurran, 1988):

$$\text{Diversity index } H' = -\sum_{i=1}^{s} Pi \ln (Pi) \ldots (2)$$

In this calculation the quantity Pi is the proportion of individuals found in the *i*th species. Where, 'P' is the proportion of the 'i'th species in the community, s total number of species, in is the log with the base 'e' (natural logarithm) (Pielou, 1975).

The overall similarity of different localities with species diversity (Cs) was calculated using the formula 3. A modified version of Jaccard formula as suggested by Sorennson (1948) was used.

Similarity index $Cs = 2j/a+b$…(3)

Where j is the number of species in common to the sites, **a** number of species in site a and **b** number of species in site b.

Simson' diversity index was calculated using the formula 4:

$$= \sum_{i=1}^{s} Pi^2 \ldots\ldots.(4)$$

Species evenness index was calculated by the formula 5:

$E = H''/\ln s$ …… (5)

Where H is Shannon Index, In is the log with the base 'e' (natural logarithm),'s' total number of species.

A one-way ANOVA with a significance level set at $P = 0.05$ was used to compare means between topography. If the ANOVA test was significant a post hoc analysis was performed using the Tukey Honestly significant difference (HSD) test (SPSS, 2001). The Chi-Square test of fit test is a non-parametric test which determines if there are significant differences between two or more sets of frequencies (Dytham, 2002). The underlying assumptions of

this particular test is that individuals are independent, that individuals belong to only one category, and that the test is nonparametric or there is not an assumption about the shape of the underlying distribution. A Chi-Square test was used to determine the significance between the numbers of unique species of the Reduviidae species of the 2012 – 2013 collection between ecotypes.

III. RESULTS

Overall abundance

In total 590 individuals of reduviids belonging to eight sub-families were observed during monitoring. Most of the reduviids dwelt in scrub jungle (70%) (492 individuals of 22 species belong to 14 genera and four sub-families) (Table 1) (df1,9, F= 249.388, P= 0.05) rather than semi-arid zone (20%) (107 individuals of 13 species belong to 10 genera and only one sub-family) (df3,7 F = 0.431, P=0.737) and tropical rain forest (10%) (42 individuals belonging to a sub-family) (df3,7; F= 0.963, P = 0.461). In contrast, Ambrose (1999) reported that most of the reduviids dwelt in tropical rain forest (36%), rather than semi-arid zones (10%) and scrub jungles (8%). He stressed the same point during 2006. Chi-Square Test results showed that different species collected from scrub jungle and semi-arid zone is more significant, than between ever green forest , scrub jungle and semi-arid zone.

Habitats wise distribution

Thaniparai is one of the highly elevated tropical rain forests in Western Ghats. In general, reduviid abundance was lower in Thaniparai (42 individuals belonging to only one sub-family) (Table 2), but reduviids more evenly distributed (E = 0.969). This was due to a marked dominance of *E.plagiatus* and *Sycandus rectiatus*, which represented 41 percent of the total insects collected in this locality. Among the other Harpactorines, no particular species was discrepantly dominant. Alagarmalai is a scrub jungle situated near the Mahendragiri ISRO research station. Rice and floriculture agroecosystems are present 5 km away from the study area. Reduviid population was peak during December 2009 (df2,18; F= 4.274; P=0.030) and May 2010 (df2,18; F= 5.996; P=0.010). Dominant species was *A. pedestris* (18.5%) rather than *E. slateri* (14.8%) and *R. longifrans* (13.6%) (Table 3). Murambuis a semi-arid zone situated near a perennial river Tamiraparani about 5 km vicinity, where farmers have been cultivating cotton, groundnut, caster, cucumber etc. More number of reduviids are recorded (Table 4) during February (33 no.) (df2,18; F= 5.008; P=0.010) and June (27 no.) (df2,18; F= 5.243; P=0.011). The new reduviids belong to the genus, *Sastrapoda* spp (38 no) and *Acanthapsis* spp (21 no) were dominant in this habitat (Table).

Seasonwise abundance

Winter (January and February), summer (March to May), south west monsoon (June to September) and south east monsoon (October to December) are the four prominent seasons in southern part of Tamil Nadu. In the Murambu semi-arid zone (37 individuals belong to five species) (r^2 = 0.252), and Alagarmalai scrub jungle (160 individuals of 16 species) (r^2 = 0.829) reduviid population was maximum during south west monsoon season (Figure 1). A maximum of 25 individuals (6 species) were observed (r^2 = 0.994) in Thaniparai forest during summer season.

Diversity indices

A higher richness and abundance of reduviid predators were observed on scrub jungle zone situated in the southern Western Ghat (Table 5), but population was significantly (P < 0.001, deviation = 30.77) and evenly distributed here (E = 0.408). However, the abundance of predators was significantly lower (P < 0.015, deviation = 10.71) in semi-arid zone. Values resulting from this equation usually fall between 1.5 and 3.5 with higher values representing higher species diversity (Magurran, 1988). This index is more sensitive to rare species within the community than does the Simpson's Index. Values of *E* fall between 0 and 1.0 where zero indicates complete dominance of one species and 1.0 represents a situation where all species are equally abundant. The latter situation was reported in Thaniparai tropical forest of the southern Western Ghat (P < 0.043, deviation = 5.30). Similarity index for shared species for Reduviid per sites assessing Alpha diversity is shown in Table 5. The results

of the Similarity index comparisons show that in Thaniparai and site 3 and 2 share approximately 40% of the total species compliment, while in Aralvaimozhi site 3 and 1 share 67 % of the species similarity and in Murambumaximum share observed was 25.6 % between site 5 and 1. In Thaniparai forest, site 3 did not appear to share with site 1, probably indicating some uniqueness in the species (Graph, 1).

Influence of Prey on Predator population

Correlation between total reduviid predators and their population was invariably negative in Alagarmalai (r^2= -0.1245), Murambu(r^2 = 0.3439) and Thaniparai (r^2 = 0.5163). However, individual reduviid species and particular insect genus showed positive correlation. Fore instance, correlation between *R. kumarii*, *C. gilves, C. crocatus* (r^2= 0.924) and *I. armipes* (r^2= 0.946) with pyrrocorid bugs showed highly positive relation in Thaniparai tropical forest. *Catamiarus brevipennis* population was highly (r^2 = 0.92) correlated with and phytophagous hemipteran insect. High *Sastrapada* sp. in Murambu could be due the weevil population (r^2= 0.962). Whereas *N. therasii* and *I. armipes* polulation were regulated by lepidopteran caterpillar (r^2 = 0.949) and *Dysdercus* spp (r^2 = 1.0) population. In Alagarmalai, *E. cordiger* (r^2 = 0.983) and *E. plagiatus* (r^2 = 0.995) density has been regulated by Dipterans.

IV. Discussion

Documentation of insect's biodiversity is the primary requisite for their conservation. Keeping this requisite in our mind, we made a survey of reduviid predators from three topography in southern Western Ghats of Tamil Nadu, India. Totally we observed 492 individuals belonging to 29 species and 7 sub-families. Among the seven sub-families, Harpactorinae and Reduviinae had maximum number of species as observed by Ambrose (1980), Vennison (1989), Sahayaraj (1991), Edwin (1997) and Sivaramakrishnan (2009) in Tamil Nadu. Louis (1973) reported Harpactorinae species were the most advanced and successful reduviids considering their wide distribution and abundance; our observations lend support to the finding.

Previously, Murugan (1988) and Ravichandran (1988) recorded 317 reduviid species from Indian faunal limits. Later, Ragupathy *et al*. (2001) and Ragupathy and Sahayaraj (2002) recorded 114 reduviids that exclusively dwelled in tropical rain forest (36%), semi-arid zones (10%), shared in three habitats (7.6%) and adjacent agroecosystems (4%). But the present results indicate that reduviid predators are more predominantly present in scrub jungles (70%) than in semi-arid zones (20%) and tropical rain forests (10%), which coincide with high Shannon Weiner Index (2.822), Berger Parker index (d=0.448) and Menhinick's index (Dmn= 2.411) observed for the former category. Hence we presumed that these three indices could be considered for calculating Reduviid diversity indices. Simson's and Mangalef's indices were more in favor of semi-arid zone than tropical rain forest and scrub jungle (Table 3.). Reduviids were more evenly distributed (E=1.315) in tropical rain forests than in the semi-arid zone (E=1.093) and scrub jungle (E=2.136) of Southern Western Ghats of Tamil Nadu. The similarity index in Alagarmalai site 1 has the highest similarity index (0.67), followed by site 2 (0.4) and the remaining 4 sites were dissimilar to one another compared to the former sites. In Murambusite1 and 3 have the highest value 0.256 and 0.25 respectively. The lowest value was 0.0328. In Thaniparai this index was high in site 2 (0.333) and lowest in sites 3 and 6 (0). The species richness and abundance of predators were recorded highest in Alagarmalai. This area is located in the gap of the Western Ghats, where moderate climatic factors are present. Goel (1978) from his lunar periodicity population count mechanism reported a high collection of hemipterans when there was higher humidity and lower rainfall.

Maximum collection of Reduviid in July which had a low rain fall and high humidity. Ambrose (1980) and Vennision and Ambrose (1990) reported that the reduviid population was solely regulated by prey population. But the abiotic factors viz., rainfall optimum humidity, and moderate temperature or minimum temperature appeared to be essential for maintaining a good prey population as well as predatory reduviid population twenty nine species. Vennison and Ambrose **(**1991) pointed out that the predatory reduviid population was dependent on the prey population as well as the climatic factors. But later, it was reported by Sahayaraj and Ambrose (1993) and Thanasingh and Ambrose (2006) that reduviid population was directly influenced by a number of abiotic factors in scrub jungle as well as semi-arid zone. Humidity and temperature seems to have very little influence

on reduviid population dynamics. Since we have not recorded the abiotic factor we are not in a position to support the previous investigations. One of the reasons for this availability of verities of microhabitat in the forest ecosystem which can protect the reduviid species from the direct influence of these major physical parameters (Edwin and Ambrose, 1996).

Ambrose (2006) published the check list of Indian reduviids, where he reported 13 reduviid from Alagarmalai (*N. therasii, Alcmena spinifex, M. nodipes Rhaphidosoma atkinsoni, R. fuscipes, R. kumarii, R. longifrons, R. marginatus, Scipinia horrida, C. Brevipennis, E. tibialis A. pedestris* and *Paralisarda malabarica*), 5 from Murambu(*A. quinquespinosa, E. tibialis, C. Brevipennis, R. fuscipes* and *H. nigroviolaceous*) and nine predators from Thaniparai **(***Ectrychotes annamensis, Labidocoris tuberculatus, Endochus umbrinus, E. plagiatus,L. guerini, Neovillanovanus macrotrichiatus R. kumarii, Sphedanolestes himalayensis, S. pubinotum*). *Acanthaspis predestris*, *E. slateri*, *I. armipes, N. therasi, O. Annulipes, Oncocephalus* spp, *Pygolampis unicolor, Pygolampis unicolor, R. Marginatus* and *Sastrapada* sp*.* are new report to Murambusemi-arid zone of SWG. *A. pedestris, Acanthuspis* sp., *C. brevipennis, Coranus* sp, E. *cordiger, E. plagiatus, E. slateri, E. tibialis, Endochus* sp., *H. melanospilus, Lisarda* sp., *M. picipes, O. annulipes, Oncocephalus* sp, *Peirates* sp., *Physorhincus* sp., were reorited for the first time in Aralvahmozhi Similarly, from Thaniparai we recorded *C.crocatus, C.gilves, Endochus* spp*., Epitus bicolor* , *Irantha* spp*., Rhaphidosoma* sp. , and *Sycandus rectiatus* for the first time.

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Graph I. Distribution of reduviid predators from eighteen sites from three ecotypes of Southern Western Ghats of Tamil Nadu, India from January 2023 to December 2023.

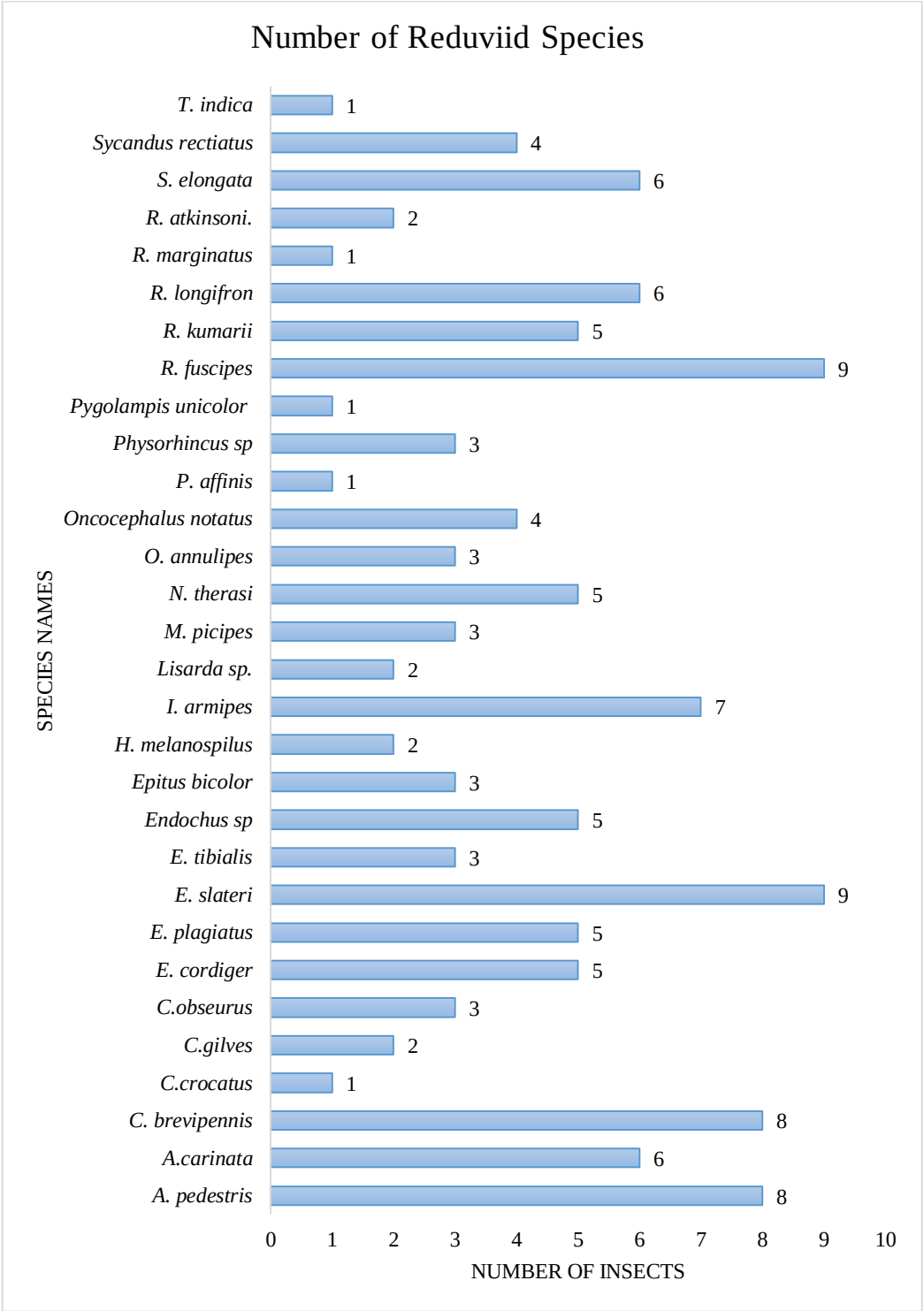

Table: 1. Bivariate Correlation between a biotic factors [Relative Humidity (%), Wind V elocity (minimum, maximum), Temperature] and Predatory populations in all the study areas of Southern Districts of Tamil Nadu

* Correlation is significant at the 0.05 level (2-tailed) 0.

Study areas	Relative Humidity (%)		Wind Velocity (km/h)				Temperature(ºC)	
			Minimum		Maximum			
	r - value	*p* -value	*r* - value	*p* -value	*r* - value	*p* –value	*r* - value	*p* -value
Alagarmalai	0.290	0.361	0.661(*)	0.019	0.143	0.659	0.380	0.223
Murambu	0.112	0.730	-0.074	0.819	-0.204	0.525	0.180	0.575
Thanipari	0.306	0.333	0.769(**)	0.003	0.527	0.078	-0.593(*)	0.042

Table 2. Distribution of phytophagous hemipteran insects recorded

Areas	**Sites of the areas**						**Mean**
	Site 1	**Site 2**	**Site 3**	**Site 4**	**Site 5**	**Site 6**	
Alagarmalai	54	73	36	19	35	04	36.83 ±10.00
Murambu	274	37	14	09	13	04	58.50±43.35
Thanipari	132	93	45	14	04	07	49.16±21.49

Table 3. Diversity Indices

Ecotypes	**Shannon Index of Diversity H**	**Simpson's Index1/D**	**Berger-Parker d**	**Margalef's Dmg**	**Menhinick's Dmn**	**Shannon Evenness E**
Alagarmalai	0.425	0.512	0.22	2.411	1.079	2.136
Murambu	1.615	0.435	0.172	0.316	1.616	1.093
Thaniparai	2.822	0.551	0.448	0.221	3.126	1.315