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Dynamics of plant hoppers diversity in Kolli Hills, Tamilnadu, India

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Abstract
In India planthoppers population is fluctuating due to mosaic model of agriculture practices. Traditional communities with their small scale farm practice which also involves integrated pest management and traditional resource management techniques generally such pest are not devastating in nature. However, the present study was able to identify 22 planthopper species in 16 genera *Cemus levicula, Euidella horvathi, Harmalia anacharsis, Latistria testacea, Nilaparvata lugens, Opiconsiva balteata, Peregrinus maidis, Perkinsiella saccharicida, Perkinsiella sinensis, Purohita Cervina, Sardia rostrata, Sogatella furcifera, Sogatella vibix, Sogatella kolophon, Stenocranus distinct, Tagosodes pusanus, Terthronal bovittatum, Toya attenuate, Toya bridwelli, Toya propinqua, Tropidocephala flaviceps* and *Tropidocephala serendiba.* The planthopper density was high at 750 meter amsl altitude, among the density of different planthoppers *Nilaparvata lugens* was significantly high in all paddy fields in all the altitude ranges with p value less than 0.001 followed by *Sogatella vibix* with p value less than 0.001.

Keywords: Kolli Hills, Planthoppers, Altitude, Traditional, Agriculture, Morphology, *Nilaparvata lugens*

Introduction
Development of agriculture travelled a long distance from shifting agriculture to intensive mono cropping with genetically modified crops (Gopinath *et al*., 2004) [5]. Ever increasing population creates numerous challenges to agriculture which lead to transformation from mixed farming practices to mixed cropping to crop rotation to mono cropping. Kolli Hills is one of the hilly tracts of southern peninsular India which falls in the Eastern Ghats region with an average altitude of 1300 meter amsl altitude. Slope lands were used to cultivate upland rice, millets, pulses, etc. by the traditional tribal communities but, the people living in the villages near the roads largely cultivate tapioca and people from intermitted villages cultivate mainly pulses in these regions (Archaya *et al.*, 2014) [1]. Even in these regions plant hoppers have become important pest to be manage to maintain their agriculture production and productivity (Kumerasan *et al.*, 2016) [12].

Planthoppers are large group of insects exceeding 12,000 species that feed on green plants referred as phytophagous insects belong to the order Hemiptera, suborders Homoptera, Auchenorrhyncha, Flugoroida, infraorder Fulgoromorpha and super family Fulgoroidea distributed throughout the world (Watson and Dallwitz, 2003) [18]. The Order Hemiptera comprises of 77 families (Martin and Webb, 2010) [13], in which planthoppers belong to the family Delphacidae and dominate with more than 2000 species. Most of the species of planthoppers are plant feeders among which 55 species are considered as pests, for more than 25 plant species and also acts as insect vectors for virus in rice, sugarcane, coconut palms, maize and several other cereals (Wilson and O'Brien, 1987) [19]. Planthoppers feed on plant sap and damage the plant tissue by ovipositing that lead to wilting of plant commonly known as "hopper burn". Apart from feeding on the plant sap hoppers they also transmit virus during their feeding behavior which causes disease such as grassy stunt and ragged stunt in rice plant (Reissig *et al.*, 1986) [16] and cause extensive damage to the crop (Dyck and Thomas, 1979) [3]. However, in Asia two planthoppers were found to be causing extensive damage to the agriculture are brown plant hopper (BPH), *Nilaparvata lugens* and White backed plant hopper (WBPH), *Sogatella furcifera*.

Among these two hoppers White backed planthoppers occur in large numbers and kill the plants by hopper burn (Reissig *et al.*, 1986) [16]. Brown planthoppers were found to be a major threat for a long time in Asia (IRRI, 1979) particularly in rice plant (Dyck and Thomas, 1979) [3]

Which not only directly damage the rice plants but also transmits viral diseases like grassy stunt and ragged stunt (Reissig *et al*., 1986) [16]. However, initially the brown planthoppers were found to be minor pest in many tropical countries of Asia but in today's context these are important insect pest of rice due to their devastating spreading nature and damage caused by them. White backed plant hopper cause hopper burn not a virus transmitter but their rapid multiplication kills the plants (Reissig *et al*., 1986) [16]. Most importantly these two planthoppers were found to increase after insecticidal application (Shepard *et al*., 1995) [17] when insecticides kill their natural enemy which usually suppress these planthoppers (Kenmore *et al*., 1984) [10]. On one hand insecticides promotes resurgence of insect pest (Heinrichs and Mochida, 1984) [7]. and on the other hand the fertilizers like urea increases the fecundity of planthoppers like brown planthoppers and white backed planthoppers (Preap *et al*, 2002) [15].

Materials and Methods

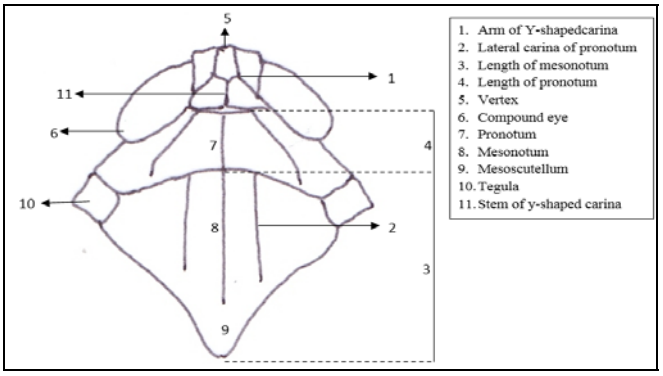
Planthopper collection

Different planthoppers were collected from different sites of Kolli Hills at five different altitude 250meters amsl, 500meters amsl, 750meters amsl and 1000meters amsl using sweeping insect collection net during monsoon. Each time twenty planthoppers are collected in triplicates.

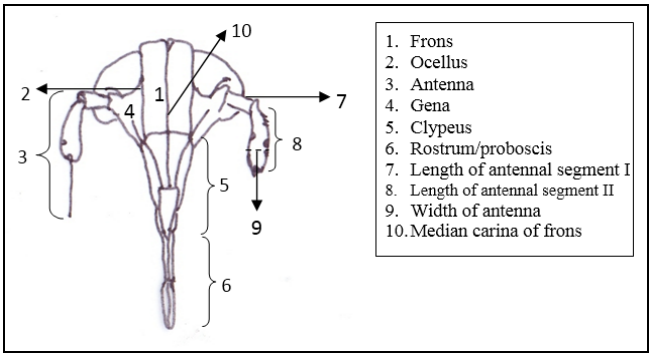
Planthopper identification

Planthoppers collected were aspirated with chloroform and labelled. Before mounting planthoppers are dried in hot air oven at 70 ºC for 24 hours and slides of genitalia are prepared as per Knight (1965) [11]. And adopted terminology as per O'Brein and Wilson (1985) [14]. (Drawing 1 to 5).

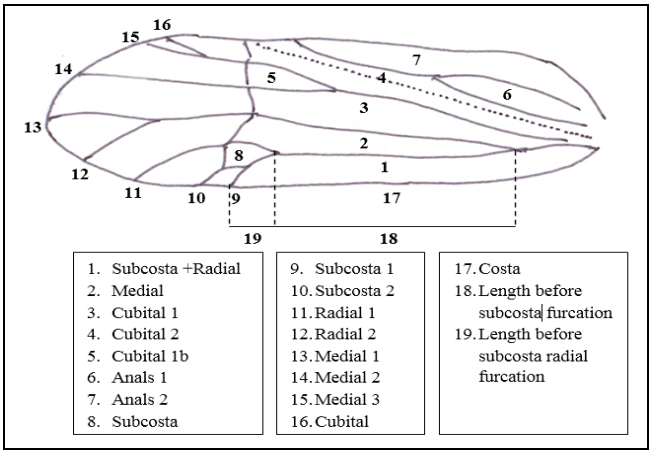
Identification key for Planthoppers



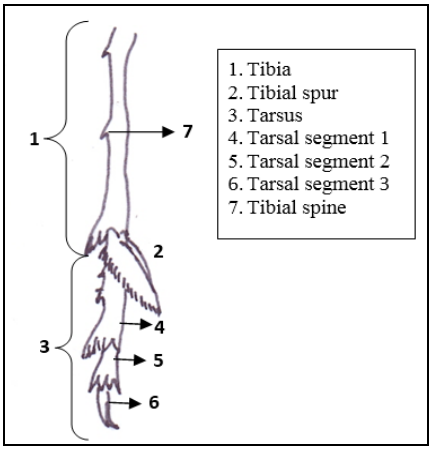
Drawing 1: Morphology of the head, pronotum and mesonotum of planthopper



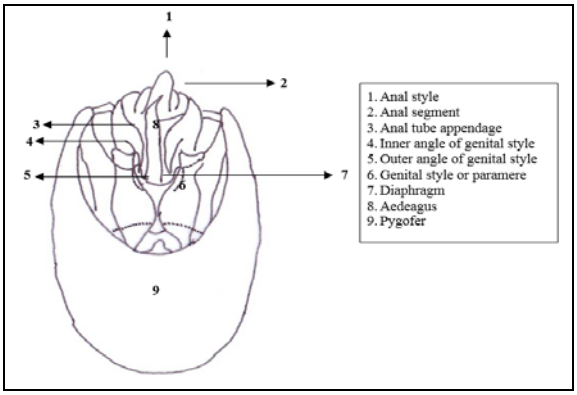
Drawing 2: Morphology of the frons, postclypeus (face) and antenna of planthopper



Drawing 3: Morphology of the fore wing of planthopper



Drawing 4: Morphology of the tibia and tibial spine in leg 3 of planthopper



Drawing 5: Morphology of the male genital segment of planthopper

Results

The present study was able to identify 22 plant hopper species in 16 genera *Cemus levicula, Euidella horvathi, Harmalia anacharsis, Latistria testacea, Nilaparvata lugens, Opiconsiva balteata, Peregrinus maidis, Perkinsiella saccharicida, Perkinsiella sinensis, Purohita Cervina, Sardia rostrata, Sogatella furcifera, Sogatella vibix, Sogatella kolophon, Stenocranus distinct, Tagosodes pusanus, Terthronal bovittatum, Toya attenuate, Toya bridwelli, Toya propinqua, Tropidocephala flaviceps* and *Tropidocephala serendiba* (Table 1).

Among the density of different planthoppers *Nilaparvata lugens* was significantly high in all paddy fields in all the altitude ranges with p value less than 0.001 followed by *Sogatella vibix* with p value less than 0.001 (Figure 1 to 4).

Table 1: Morphological and characteristics of identified planthopper species in Kolli Hills

S. No.	Identification key	Identified Planthopper species
1	Vertex very short and broad between the eyes, pronotum reddish-black with crinae cream colour. Tegmina with characteristic black dots along veing, fuscous streaks apically with a distinct pterostigma. Frons with conspicuous raised pits on either side of the median carina.	*Cemus levicula*
2	Vertex produced in front of eyes. Legs are long and slender. Tegmina with pterostigma	*Euidella horvathi*
3	Body is light brown in colour, Vertex is short. Tegmina is pale brown without pterostigma	*Harmalia anacharsis*
4	Vertex pronotum and scutellum are green colour. Tegmina with pterostigma	*Latistria testacea*
5	Yellowish or dark brown in colour with blue eyes. Tegmina with pterostigma	*Nilaparvata lugens*
6	Head is smaller than pronotum, mesonotum and scutellum are black colour. Pterostigma present	*Opiconsiva balteata*
7	Vertex are small and broad. Vertex, pronotum and mesonotum are orange colour. Pterostigma present	*Peregrinus maidis*
8	Vertex, pronotum and scetellum are yellowish, wings are vrownish, veings granulate and pterostigma present.	*Perkinsiella saccharicida*
9	Vertex, pronotum, and scutellum are yellowish colour, wings are brownish colour. Pterostigma present	*Perkinsiella sinensis*
10	Head narrow than pronotum, Pterostigma present but not differentiated	*Purohita Cervina*
11	Vertex, thorax, tegmina are dark brown colour. Tegmina dark brown with pterostigma.	*Sardia rostrata*
12	Body is black in dorsal view, creamy white in ventral view. Tegmina with a pterostigma	*Sogatella furcifera*
13	Vertex yellowish white. Face with frons, clypeus pale yellowish brown in colour. Genae dark brown in colour Tegmina without a pterostigma	*Sogatella vibix*
14	Vertex and pronotum is light yellowish colour. Face with frons, clypeus and genae entirely pale yellowish brown in colour. Tegmina without a pterostigma	*Sogatella kolophon*
15	Head narrow than pronotum, Vertex elongated. Tegmina stramineous and veins are dark without pterostigma	*Stenocranus distinct*
16	Body is black in dorsal view, creamy white in ventral view. Tegmina with pattern of dark markings Tegmina with a pterostigma	*Tagosodes pusanus*
17	Dark brown with cream colour, Frons, clypeus and genae dark brown colour. Tegmina without pterostigma	*Terthron albovittatum*
18	Plae yellow brown with dark brown colour. Head narrower than pronotum, vertex are wide, frons longer at midline, clypeus are wider.	*Toya attenuata*
19	Aedeagus is broader basally and slightly curved with sub apical teeth like projections.	*Toya bridwelli*
20	Plae yellowish brown with brown frons, abdomen dark brown. Vertex are long, frons are long in mid half and clypeus are wider at base. Tegmina without pterostigma	*Toya propinqua*
21	Vertex, pronotum and mesonotum are prominent. Tegmina longer than abdomen and pterostigma are present.	*Tropidocephala flavicep*
22	Chocolate brown in colour. Vertex, pronotum and scutellum are cream coloured. Tegmina are present with pterostigma	*Tropidocephala serendiba*

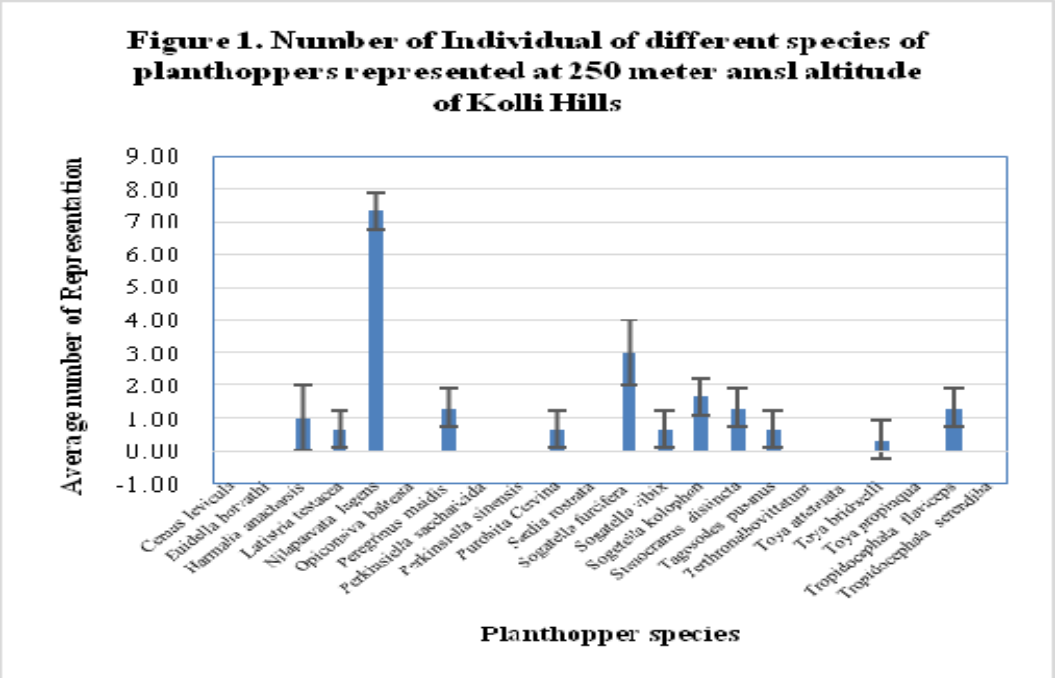


Figure 2. Individual Number of different species of planthoppers represented at 500 meters amsl altitude of Kolli Hills

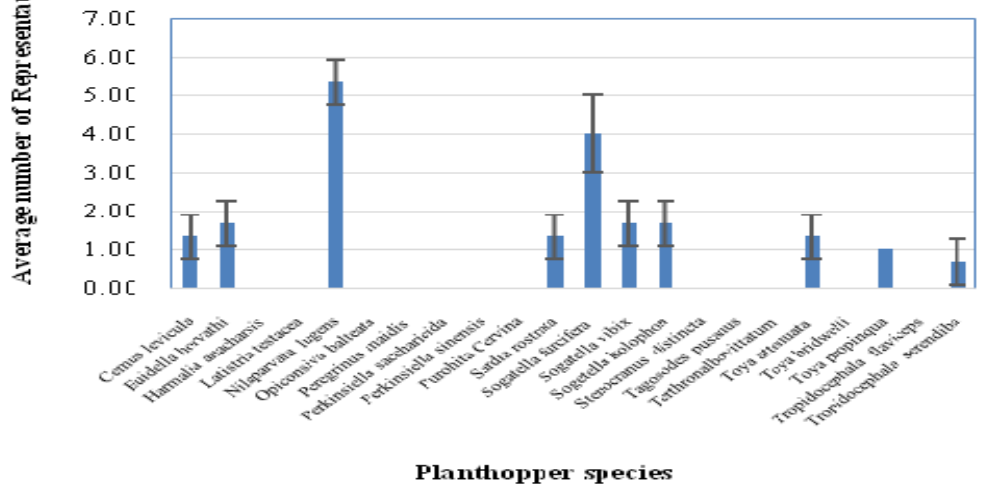


Figure 3. Individual Number of different species of planthoppers represented at 750 meters amsl altitude of Kolli Hills

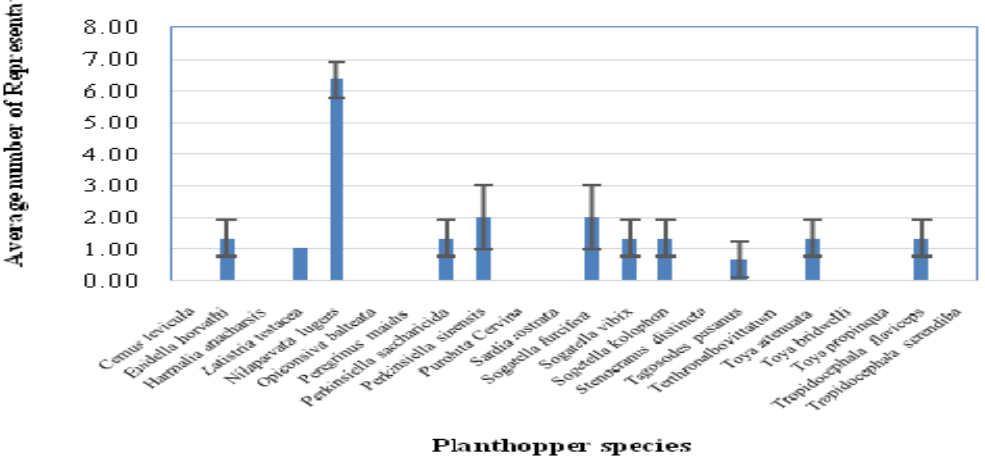
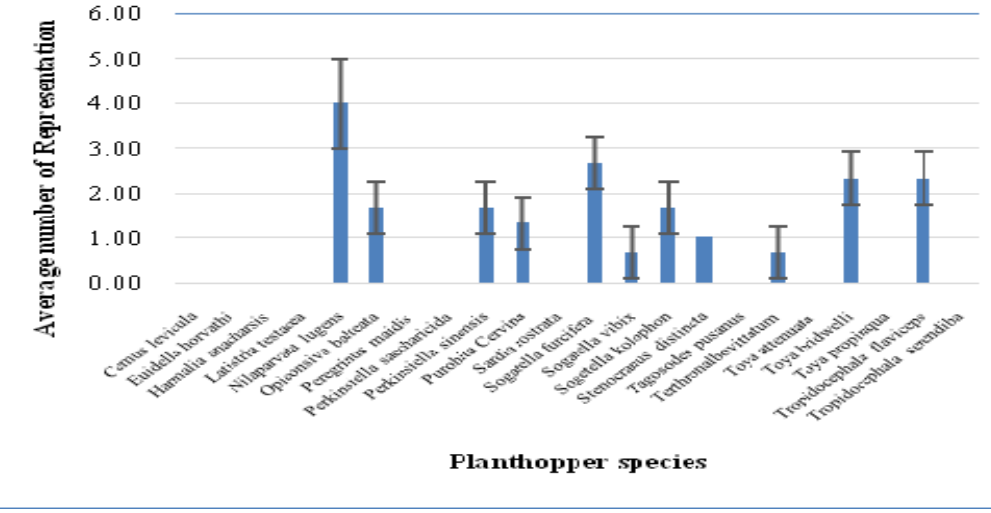


Figure 4. Individual Number of different species of planthoppers represented at 1000 meters amsl altitude of Kolli Hills



Discussion

More than a decade planthoppers population in India was fluctuating due to mosaic model of agriculture practices by small scale farmers which also involved integrated pest management and traditional resource management techniques combined with scientific cultivation methods like spacing seed, processing etc. with optimum fertilizer use and application of insecticides based on need. However brown planthoppers continued to exist even after 1990's where farmers also stated using neonicotinoid insecticides to manage BPH (IRAC 2007) [9]. But in the recent past it was found that resistant variety of BPH to neonicotinoid insecticides due to their indiscriminate and improper use of this pesticide particularly in the southern states of India. Hence in the present study also it was observed the dominance of PBH in all the altitudes. Apart from the pesticide use Indian farmers generally do not adopt new varieties hence, they continue to cultivate susceptible rice varieties and also believe in excessive use of fertilizer would increase the yield without knowing the fact that this enables favorable conditions and microclimate for planthoppers to breed and migrate (Gudem 2006) [6]. Kolli Hills in this context transformed agriculture systems resemble the National average where BPH has become a major threat. Till today now and then reports are made at national level in Haryana, Punjab, Delhi, and Maharastra on devastating damage of planthoppers especially the BPH (Catindig *et al*., 2009) [2]. However such effects are not seen in Kolli Hills since its patchiness with under transitional and traditional agriculture systems.

Planthopper outbreaks were found to be minimal in countries were pesticides are banned for example in Indonesia a decadal reduction was observed in planthopper population and conscious reduction of insecticides is achieved (Huan *et al*., 1999) [8]. This was able to be achieved through conserving the natural enemies of the planthoppers through organic or biological methods (Gallagher *et al.,* 2002).

Conclusion

Density of planthoppers at different altitudes showed steady increase upto 750 meters amsl and reduced at 1000 meters amsl. However, among the density of different planthoppers *Nilaparvata lugens* was significantly higher in all paddy fields in all the altitude ranges with P value less than 0.001 followed by *Sogatella vibix* also P value 0.001.

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