2. INTRODUCTION

Tea, a major monoculture plantation crop, is a permanent but typical ecosystem that provides habitat continuity for 1031 species of arthropods and 82 species of nematodes globally (Chen & Chen, 1989; Hazarika et al., 2009). In Asia, 230 species of insects and mite pests attack tea (Muraleedharan, 1992). However, 173 arthropods and 16 nematodes are reported to be the pests of tea in North-East India (Hazarika et al., 1994).

None of the part of tea bush remains unattacked by the pests that ultimately affect “Two leaf and a bud”. As a result tea crop suffers (10-15%) loss in yield. To control these pests, per hectare consumptions of pesticides is excessively high and equally expensive (Chakravartee & Hazarika, 1995).

Again heavy application of pesticides does no longer produce economic and effective pest control in tea, partly because of the rising cost of pesticides but mainly due to large scale and sometimes indiscriminate use of hard pesticides promote speedier evolution of insect pests; affect non-target species; convert formerly innocuous species into pests and leave undesirable residues in made tea (Hazarika et al., 1994). As a result especially due to importers dissatisfaction with pesticide residues and reluctance to accept such tea, problem of residues has become a major concern to the tea industry.

To address the issue an alternative to chemical based plant protection i.e., an integrated approach based primarily on the use of biocontrol measures, habitat management, need based application of botanicals and safer pesticides, is being adopted. Such an approach is thought to reduce residues and ancillary problems associated with pesticide application (Hazarika et al., 1994).

Recognising natural biological resources to suppress pest population to a level below economic injury is therefore the first step towards their conservation, augmentation and manipulation. These necessarily include predators, parasites and pathogens.

2.1. Arthropoda: Arachnida: Araneae

Spiders, included in the class Arachnida are also arthropods. Order Araneae is exclusively dedicated for the spiders. These spiders are characterized by the possession of cephalothorax which is provided with 4 pairs of jointed legs, abdomen and 4-6 spinnerets. Most of them have eight eyes recognized in four different groups— anterior median eyes (AME), posterior median eyes (PME), anterior lateral eyes (ALE), and posterior lateral eyes (PLE) respectively.
2.2. Spiders: The Focal Group for Taxonomic Evaluation of Tea Ecosystem

Why to carry out the taxonomic evaluation of Spiders? The answers to such a question are many fold.

"Spiders are among the dominant generalist predators of any terrestrial community. When the fauna of the soil and its plant cover is analysed, they came to light in vast number in such convincing abundance that it is evident that they play a significant part in the life of every habitat" (Gertsch, 1979). The abundance of spider is being proved by the current world spider catalogue of Platnick updated to 2013 which includes 42751 species under 3859 genera distributed over 110 families. It is only the one third of the total fauna that could be evaluated (Dondale, 1979). In India, there are 1686 species belonging to 438 genera of 60 families (Keswani et al., 2012). All such spider families are recognized under two suborders – (i) Mesothelae – includes only family – Liphistiidae and Opisthothelae includes two infra orders – (a) Mygalomorphae (typical and atypical tarantula) and (b) Araneomorphae (true modern spider) (Platnick, 1995).

Study of spiders as second level of consumer and their encouragement in tea ecosystem may lead to develop definite management plan that would limit pesticide use and therefore increase economic return. It would not be out of place to mention that the spider fauna of several crop ecosystems have been well documented in some parts of the world, e.g. cotton, soybean, alfalfa, maize, citrus orchards, deciduous orchards and rice (Barrion & Litsinger, 1995; Satpathi, 2004). But unfortunately attempt to document the spider fauna of tea-ecosystem is still wanting.

Following flow chart of tea ecosystem is believed to justify the significance of the study.

![Flow chart of tea ecosystem](chart.png)
2.3. Spiders: Their Biological Role in Tea Ecosystem

Spiders are known to be important agents of insect pest control. Being identified as effective predators of herbivorous insect pests, they can exert considerable top-down control, often catching more insects than they actually consume. A review by Riechert & Lockley in 1984 brought attention to spider as potential agents of biological pest control. Control of insect pests by spider appears to be achieved most efficiently by using a diverse assemblage of spiders rather than specific species in spite of their potential for competition and intraguild predation. Spiders exhibit the ability to both lower and stabilize pest population making them excellent biological pest management candidates (Nyffeler et al., 1994; Sunderland, 1999).

Way back in 1966, after reviewing the pest status of tea in Sri Lanka, Cranham emphasized the necessity of encouraging biocontrol agents in the management of tea ecosystem. Zhang (1993) identified and described several spider species that prey on tea leafhoppers. Huong (1999) experienced small black spider, a potential biocontrol agent of tea pests and accordingly recommended conservation of such spiders. Nam (2001) in his recommendation on tea IPM, also highlighted the necessity of protecting natural enemies by using less insecticide. He recommended mulching between rows to encourage diverse and higher population of spiders that regulate tea pests to a measurable limit. BoGang (2003) conclusively established that encouraging spiders within the IPM programme for the control of insect pests of tea in China reduce pesticide residues and increase significant economic return.

In India, initiation of laying importance to the biocontrol agents in tea ecosystem is done by Das (1974). He is followed by Sarma (1979), Muraleedharan et al. (1988), Borthakur et al. (1992), Hazarika et al. (1994), Somchoudhury et al. (1995). Hazarika et al. (2001) while recording predatory spider species on mites, jassids and aphids of tea, mentioned that more emphasis be given to predatory spiders of tea pests. This probably prompted Hazarika et al. (2001) and Mukhopadhyya & Sarkar (2007) to remark “there is definite necessity of generating baseline data on the predators and parasites mainly the spider”.

2.4. Study Area

A green strip of land lying along the foot of the Himalayas in the district of Jalpaiguri (26°16'-27°00N and 88°04'-89°53'E) is called Dooars. This region has 1,73,103 hec. forest area and 181 Tea Estates spread over 1,18,701.6 hec. [Anonymous 1394 (1987)]. It forms a gateway to the North-Eastern parts of India and Bhutan and stretches from Siliguri in the West to Buxa in the East. The unending stretch of virgin forest is criss-crossed by Teesta, Jaldhaka, Torsa and Rydak rivers and their innumerable tributaries trolling and rolling down from hills. They have divided Dooars into three regions namely Western Dooars between...
Plate- II

STUDY AREA

Kailashpur Meenglas Nepuchapur

Dalgoona
Bhogopore
Kuri
TRA Nagarketa
Nagarketa
Shikarpur
Meenglas
Nepuchapur
Kailashpur
Teesta and Jaldhaka, Central Dooars between Jaldhaka and Torsa and Eastern Dooars between Torsa and Sankos.

Altogether 8 tea estates namely Shikarpur T. E., Kailashpur T. E., Meenglas T. E., Nepuchapur T. E., Nagrakata T. E., Bhogotpore T. E., Kurti T. E., and Dalgaon T. E. are identified for the programme. Of these, the former 4 belong to Western Dooars while the rest are within the jurisdiction of Central Dooars. Of these, Kailashpur and Shikarpur Tea Estates lie close to Baikunthapur forest division, while Meenglas to Neora Valley National Park (Lower Neora) and Nagrakata Tea Estate to Chapramari Wildlife Sanctuary. Rests of the estates are away from the forests.

As per the information gathered none of the estates are identified as organic/ mulch estate. It is learnt that there is rather less pesticide load in Kailashpur and Nepuchapur Tea Estates, highest being in Dalgaon Tea Estate. It is to be noted that Shikarpur Tea Estate has become operational only recently, January 2010.

The following table depicts the encountered tea varieties and shade trees of the referred tea estates of Dooars.

**Table: 1**

<table>
<thead>
<tr>
<th>Tea Estate</th>
<th>Tea Variety</th>
<th>Shade Tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shikarpur</td>
<td>TV1, TV2, TV20, TV22, TV23, Teenali, S3A3</td>
<td><em>Derris robusta, Albizia chinensis, A. procera, Acacia lenticularis, Malea azederach, Indigofera teysmanii</em></td>
</tr>
<tr>
<td>Kailashpur</td>
<td>TV1, TV2, TV9, TV20, TV22, TV23, TV24, TV25, Teenali, S3A3</td>
<td><em>Dalbergia sisso, Derris robusta, Albizia chinensis, A. procera, A. lebbek, A. odoratissima, Acacia lenticularis, Malea azederach, Leucaena leucocephala</em></td>
</tr>
<tr>
<td>Meenglas</td>
<td>TV1, TV9, TV17, TV18, TV19, TV20, TV22, TV29, TV30, S3A3, Teenali</td>
<td><em>Albizia chinensis, A. procera, A. lebbek, A. odoratissima, Acacia lenticularis, Derris robusta, Indigofera teysmanii</em></td>
</tr>
<tr>
<td>Nepuchapur</td>
<td>Assam Hybrid TV9, TV22, TV25, TV30, Teenali</td>
<td><em>Albizia lebbek, A. procera, A. chinensis, A. odoratissima, Acacia lenticularis, Dalbergia sisso, Derris robusta, Malea azederach, Indigofera teysmanii</em></td>
</tr>
<tr>
<td>Nagrakata</td>
<td>TV1, TV9, TV20, TV22, TV25, Teenali</td>
<td><em>Albizia lebbek, A. chinensis, Acacia lenticularis, Malea azederach, Chukrasia tabularia</em></td>
</tr>
<tr>
<td>Bhogotpore</td>
<td>TV1, TV9, TV25, Teenali</td>
<td><em>Albizia lebbek, A. chinensis, A. odoratissima, Acacia lenticularis, Derris robusta, Indigofera teysmanii</em></td>
</tr>
<tr>
<td>Kurti</td>
<td>TV1, TV14, TV17, TV18, TV20, TV23, TV26, Teenali</td>
<td><em>Albizia odoratissima, A. lebbek, A. chinensis</em></td>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Dalgaon</td>
<td>TV9, TV18, TV22, TV23, TV25, TV26, Teenali</td>
<td><em>Albizia chinensis, A. lebbek, A. odoratissima, A. procera, Acacia lenticularis, Dalbergia sisso, Derris robusta</em></td>
</tr>
</tbody>
</table>