# SURVEY ON SPIDER FAUNAL DIVERSITY OF DARJEELING TEA PLANTATIONS

**Sumana Saha*, Tapan Kumar Roy** and Dinendra Raychaudhuri****

* Department of Zoology, Darjeeling Government College, Govt. of West Bengal, Darjeeling-734101; INDIA. E-mail: sahasumana2010@gmail.com
** Department of Agricultural Biotechnology, IRDM Faculty Centre, Ramakrishna Mission Vivekananda University, Narendrapur, Kolkata – 700103, INDIA. E-mails: tapanroycal1@gmail.com; dinendrarccu@gmail.com

**[Saha, S., Roy, T. K. & Raychaudhuri, D.** 2016. Survey on spider faunal diversity of Darjeeling Tea Plantations. Munis Entomology & Zoology, 11 (2): 622-635**]**

ABSTRACT: Effect of pesticides in the crop fields is now well known. Tea is no exception to this. Idea behind the present study is to appreciate the biological potential of spiders against tea pests. The study area included 6 tea estates viz. Badamtam T.E., Ging T.E., Salim Hill T.E. (organic), Castleton T.E., Namring T.E., and Thurbo T.E. (conventional). Altogether 85 species under 52 genera distributed over 18 families could be recorded. These can broadly be categorized into 7 trophic groups. The decreasing order of the groups are Orb weavers (48.24%) > Ambushers (22.35%) > Ground dwellers (11.76%) ≥ Stalkers (11.76%) > Foliage hunters (9.41%) > Sheet web weavers (2.35%) > Space web builders (1.18%). Out of the total species encountered 1 species is considered new to world, 4 species from the country, 1 from the state and 36 species from the study area. Based on the species richness, the decreasing order of the tea estates are BTE (61.18%) > NTE (54.12%) > GTE (51.76%) > STE (12.35%) > CTE (28.24%) > TTE (25.88%). This leads to infer 'organic tea system' exhibits higher spider heterogeneity. Araneids and salticids are the dominant groups. Other than the Oriental representatives, Australian and Palaearctic are the next major groups. Nearly 32.94% of the species are found to be endemic.

KEY WORDS: Spider fauna, diversity, tea plantations, Darjeeling, West Bengal, India

Spiders constitute an important component of the fauna distributed in tropical and subtropical areas of the world. Being nature's master spinners of silken webs, they are the highly potential predators, certainly putting a check to the insect pests. Of late Entomologists/Plant Protection Specialists are laying emphasis on this tiny group as a proficient candidate of biological control. In depth knowledge on the biodiversity of spider communities of crop fields is important both in terms of enhancing pest control and understanding the driving forces influencing conservation strategies (Mansour et al., 1983; Maloney et al., 2003; Jayakumar & Sankari, 2010; Sharma, 2014).

Tea, unlike other perennials, is unique because only of its vegetative parts 'two leaves and bud' that are commercially exploited. Cultivation practice of tea has made the monoculture ecosystem distinctive, accommodating 1031 species of arthropods and 82 species of nematodes globally (Chen & Chen, 1989; Hazarika et al., 2009); it is 230 in Asia (Muraleedharan, 1992) while 173 arthropods and 16 nematodes are known to be pests in North-East India (Hazarika et al., 1994). Their attack is supposed to cause yield loss to about 10-15%. India is the world's 4$^{th}$ largest exporter of tea. Over the last few decades, India's share in world tea export declined consistently for several reasons. One of the most important reasons is residual effect of pesticides in made tea. On the contrary, recent agricultural practices like organic farming towards reduced pesticide use and ecological sustainability have lead to increased interests in spiders as potential tools (Hazarika et al., 1994).

The spider fauna of several crop ecosystem have been well documented in some parts of the world (Sengupta et al., 2014). In India the araneofauna of tea ecosystem are well documented by Raychaudhuri & Saha (2012), Roy (2014) and Saha & Raychaudhuri (2015). Nestling in the foothills of snow-covered Himalayan range, Darjeeling, 'the Queen of Hills' grows one of the world's most exclusive teas at altitudes ranging from 300 to 2000 meters. Currently there are 87 operational tea gardens in Darjeeling district (Coordinates: 27°3'N 88°16'E) covering an aggregated area of about 19,000 hectares. In recent times growing appreciation and demand for the organic products has driven some tea gardens of Darjeeling to produce 'organic tea'. But unfortunately attempt to document diversity of the spider fauna of Darjeeling tea gardens is still wanting under the changed scenario.

Above prompted to study the spider species assemblage in tea ecosystem of Darjeeling, West Bengal.

The study area included six tea estates namely Castleton T.E., Salim Hill T.E., Thurbo T.E. (in Kurseong Subdivision) Namring T.E. (in Kalimpong Subdivision) and Badamtam T.E. and Ging T.E. (in Darjeeling Sadar Subdivision). Among them Badamtam T.E., Ging T. E. and Salim Hill T. E. are organic gardens while Castleton T.E., Namring T.E. and Thurbo T.E. are conventional.

## MATERIAL AND METHODS

Survey was conducted during the period August, 2011 to March, 2013 in different sections of the referred tea estates in almost every month of any calendar year. Sampling was done by visual search, hand picking, inverted umbrella, bush beating, foliage, trunk and branch scanning, pitfall and leaf litter extraction. Collected samples were preserved following Tikader (1987) and Barrion & Litsinger (1995). The collected samples were studied under Stereo Zoom Binocular Microscopes model Zeiss SV-6 & 11 and Olympus SZX7. Status of the taxa were determined with the help of Tikader (1970, 1980, 1982 & 1987), Tikader & Malhotra (1980), Majumder & Tikader (1991), Barrion & Litsinger (1995), Sebastian & Peter (2009), Keswani et al. (2012), Metzner (2015) and WSN (2015). Later they were confirmed by comparing with the type specimens deposited in Zoological Survey of India.

All materials are in the deposition of Department of Agricultural Biotechnology, Ramakrishna Mission Vivekananda University.

## RESULTS AND DISCUSSION

The present study unfolds the spider diversity of six tea estates of Darjeeling. A total of 2072 individuals belonging to 85 morphospecies under 52 genera and 18 families are recognized (Tables 1 & 2; Fig. 1). Araneids and salticids are the dominant groups (Fig. 3). Out of 85 species one species is recognized as new to world while four are recoded first time from the country, one from the state and 36 species from the district Darjeeling (Table 1; Fig. 2). Twenty seven species are reported as native to India (Fig. 3) exhibiting high endemicity (32.94%). Of these, most of the species are recorded from the family Araneidae (9). The generated data represents 5.04%, 11.87% and 30.0% of the Indian species, genera and family respectively. Even though species richness is little higher during premonsoon, always there remains a state of equilibrium throughout seasons. Six species viz. *Araneus mitificus* (Simon), *Agriope pulchella* Thorell, *Neoscona bengalensis* Tikader & Bal, *Dendrolycosa gitae* (Tikader), *Thiana bhamoensis* Thorell and *Leucauge decorata* (Blackwall) are the dominant members and encountered in

most of the months of the year. Analysis of the zoogeographical distribution reveals that the fauna apart from Oriental, includes Australian (12.94%), Palaearctic (12.94%), Ethiopian (7.05%), Nearctic (2.35%) and Neotropical (1.18%) elements. Number of recorded spider taxa from the study areas shows that species diversity is maximum in Badamtam T.E. (possesses 52 morphospecies) and minimum in Thurbo T.E. (no. of species 22). Based on species diversity, the decreasing order of the tea estates are BTE (61.18%) > NTE (54.12%) > GTE (51.76%) > STE (42.35%) > CTE (28.24%) > TTE (25.88%). This leads to infer 'organic tea system' exhibits higher spider heterogeneity (exception in NTE). There may be two way explanation to such a fact. One may be that Namring T.E. being close to Teesta Valley experiences a tropical situation promoting heterogeneity or the in house species are tolerant to insecticides or both. Spiders such as wolf spider *Pardosa* are highly tolerant to botanicals such as neem-based chemicals (Theiling & Croft, 1988; Markandeya & Divakar, 1999). They are also generally more tolerant of organophosphates and carbamates than of pyrethroids, organochlorines and various acaricides. Tolerance may due to genetic resistance bred over a period of continuous exposure (Theiling & Croft, 1988; Wisniewska & Prokopy, 1997; Yardim & Edwards, 1998; Marc et al., 1999; Tanaka et al., 2000). For example, *Pardosa*, *Tetragnatha* are highly sensitive to the inorganic chemicals, but not to botanical pesticides (Tanaka et al., 2000). Species homogeneity is more common in conventional gardens. Both diversity and density of spiders are more in organic gardens as compared to conventional ones. At any point of time diversity and density of predators are more in organic gardens. Succession of species is more in organic gardens while conventional gardens are with dominant species in more numbers. All these gardens are dominated by the members of the family Araneidae. The dominant guild is constituted by the Orb weavers (48.24%) followed by Ambushers (22.35%), Ground dwellers (11.76%) and Stalkers (11.76%), Foliage hunters (9.41%), Sheet web weavers (2.35%) and Space web builders (1.18%) (Table 3). The common explanation for the observed pattern of spider guilds are structural diversity, microenvironment or the level of disturbance of the habitat (Jiang and Li, 2006). Guild composition can provide insight into the effect of habitat alteration and disturbances on arthropod diversity (Stork, 1987). So, the most promising option for utilizing the predatory characteristics of spiders for the biological control of pests is to increase their density and diversity within crops as physically close to pests as possible (Sunderland & Samu, 2000).

## ACKNOWLEDGEMENTS

Authors are indebted to Tea Board, for sponsoring the project (Sanction no. RL-33 (167)/2010/Part-VI dt.11.8.2011). All logistic support extended by the officials of the respective Tea estates, the Head, Department of Zoology, University of Calcutta and the Hon'ble Vice-Chancellor, Ramakrishna Mission Vivekananda University for carrying out the research work is thankfully acknowledged. Sincere thanks are also due to Dr. Anirban Basu Majumder, Research Officer, Tea Board for his manifold assistance. Thanks are also due to Dr. Dhruba Chandra Dhali and Dr. Sutirtha Sarkar for their cooperation during field visit.

## LITERATURE CITED

**Barrion, A. T. & Litsinger, J. A.** 1995. Riceland Spiders of South and South East Asia. CAB International, UK & IRRI, Philippines, 716 pp.

**Chen, Z. & Chen, X.** 1989. An analysis of the world tea pest fauna. J. Tea Sci., 9 (1): 13-22.
**Hazarika, L. K., Borthakur, M., Singh, K. & Sannigrahi, S.** 1994. Present status and future prospects of biological control of tea pests in North East India. Proc. 32nd Tocklai, Conf. TRA, Tocklai Exp. Stn. Jorhat: 169-177.
**Hazarika, L. K., Bhuyan, M. & Hazarika, B. N.** 2009. Insect pests of tea and their management. Ann. Rev. Entomol., 54: 267-284.
**Jayakumar, S. & Sankari, A.** 2010. Spider population and their predatory efficiency in different rice establishment techniques in Aduthurai, Tamil Nadu. J. Biopesticides, 3 (1 Special Issue): 20-27.
**Jiang, S. L. & Li, B. P.** 2006. Composition and distribution of soil spider assemblages in three natural secondary forests in Ziwuling, Gansu. Zool. Research., 27 (6): 569-574.
**Keswani, S., Hadole, P. & Rajoria, A.** 2012. Checklist of Spiders (Arachnida: Araneae) from India-2012. Ind. J. Arachnol., 1 (1): 129 pp.
**Majumder, S. C. & Tikader, B. K.** 1991. Studies on some spiders of the family Clubionidae from India. Rec. Zool. Surv. India, Occ. Pap., 102: 175 pp.
**Maloney, D., Drummond, F. A. & Alford, R.** 2003. Spider predation in Agroecosystems: Can spiders effectively control pest populations? MAFES Technical Bulletin, 190: 1-32.
**Mansour, F., Richman, D. B. & Whitcomb, W. H.** 1983. Spider management in agroecosystems: Habitat manipulation. Environ. Management, 7 (1): 43-49.
**Marc, P., Canard, A. & Ysnel, F.** 1999. Spiders (Araneae) useful for pest limitation and bioindication. Agric. Ecosyst. Environ., 74: 229-273.
**Markandeya, V. & Divakar, B. J.** 1999. Effect of a neem formulation on four bioagents. Plant Prot. Bull., 51: 28-29.
**Metzner, H.** 2015. Jumping spiders (Arachnida: Araneae: Salticidae) of the world. Online at: www.jumping-spiders.com (accessed on 25.11.2015)
**Muraleedharan, N.** 1992. Pest control in Asia. Tea cultivation to consumption. Chapman and Hall, London: 375-411.
**Raychaudhuri, D. & Saha, S.** 2012. Spiders–A potential component in tea pest management. Publ. A National Tea Research Foundation, Tea Board, Kolkata, 93 pp.
**Roy, T. K.** 2014. Spiders (Araneae: Arachnida) of Tea Ecosystem of Dooars, West Bengal. Ph. D. Thesis, University of Calcutta: 488 pp.
**Saha, S. & Raychaudhuri, D.** 2015. Spiders (Araneae: Arachnida) of Tea ecosystem of Assam. Publ.: LAP Lambert Academic Publishing, Germany, 174 pp.
**Sharma, S.** 2014. A study on spiders as predators in the agro ecosystems. Mun. Ent. Zool., 9 (1): 80-83.
**Sebastian, P. A. & Peter, K. V.** 2009. Spiders of India. Universities Press (India) Pvt. Ltd., 614 pp.
**Sengupta, A., Saha, S. & Raychaudhuri, D.** 2014. Diversity of spiders in different low lying crop fields of south 24-parganas, West Bengal. Ind. J. Arachnol., 3 (2): 17-27.
**Stork, N. E.** 1987. Guild structure of arthropods from Bomean rain forests trees. Ecol. Entomol., 12: 69-80.
**Sunderland, K. & Samu, F.** 2000. Effects of agricultural diversification on the abundance, distribution, and pest control potential of spiders: a review. Ent. Exp. et Appl., 95: 1-13.
**Tanaka, K., Endo, S. & Kazano, H.** 2000. Toxicity of insecticides to predators of rice planthoppers, spiders, the mired bug and the dryinid wasp. Appl. Entomol. Zool., 35: 177-187.
**Theiling, K. M. & Croft, B. A.** 1988. Pesticide side-effects on arthropod natural enemies: a database summary. Agric. Ecosyst. Environ., 21: 191-218.
**Tikader, B. K.** 1970, The spider fauna of Sikkim Himalaya India. Rec. Zool. Surv. India, 64 (14): 1-84.
**Tikader, B. K.** 1980. The Fauna of India, Araneae : Thomisidae (crab spiders). Zool. Surv. India, Calcutta, I (1): 1-247.
**Tikader, B. K.** 1982. The Fauna of India, Spider: Araneae (Araneidae & Gnaphosidae). Zool. Surv. India, Calcutta, II (1): 533 pp.
**Tikader, B. K.** 1987. Hand book of Indian spiders. Ed. Director Zool. Surv. India, Calcutta: 251 pp.
**Tikader, B. K. & Malhotra, M. S.** 1980. Fauna of India, spiders (Lycosidae). Zool. Surv. India, Calcutta, I (2): 248-447.
**Wisniewska, J. & Prokopy, R. J.** 1997. Pesticide effect on faunal composition, abundance, and body length of spiders (Araneae) in apple orchards. Environ. Entomol., 26: 763-776.
**World Spider Catalog.** 2015. World Spider Catalog. Natural History Museum Bern, online at http://wsc.nmbe.ch, version 16.5 (accessed on 25.11.2015)
**Yardim, E. N. & Edwards, C. A.** 1998. The influence of chemical management of pests, diseases and weeds on pest and predatory arthropods associated with tomatoes. Agric. Ecosyst. Environ., 70: 31-48.

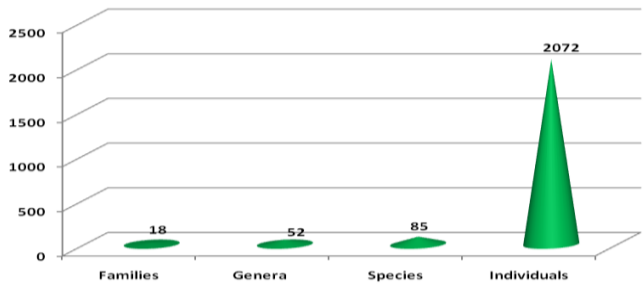


Figure 1. Summary of the recorded spider taxa trapped from tea estates of Darjeeling.

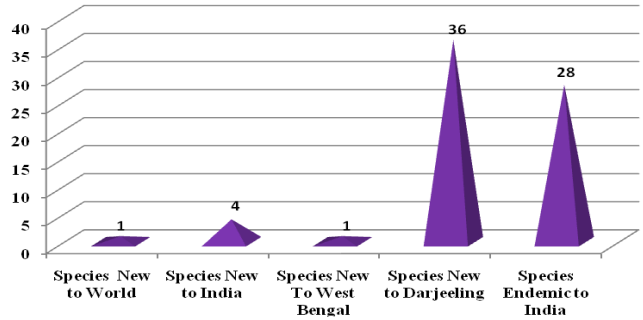


Figure 2. Spider fauna of Darjeeling – highlights.

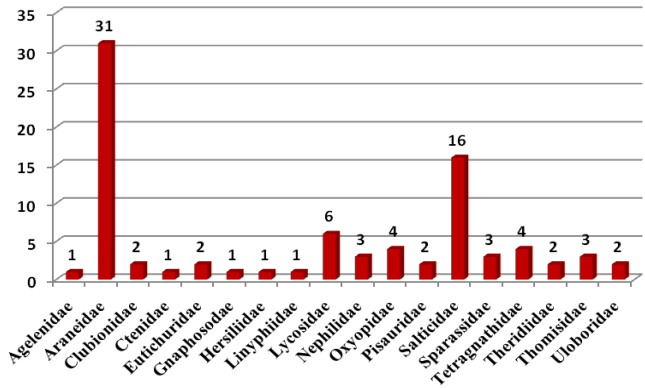


Figure 3. Spider species trapped under different families from the Tea Estates of Darjeeling.

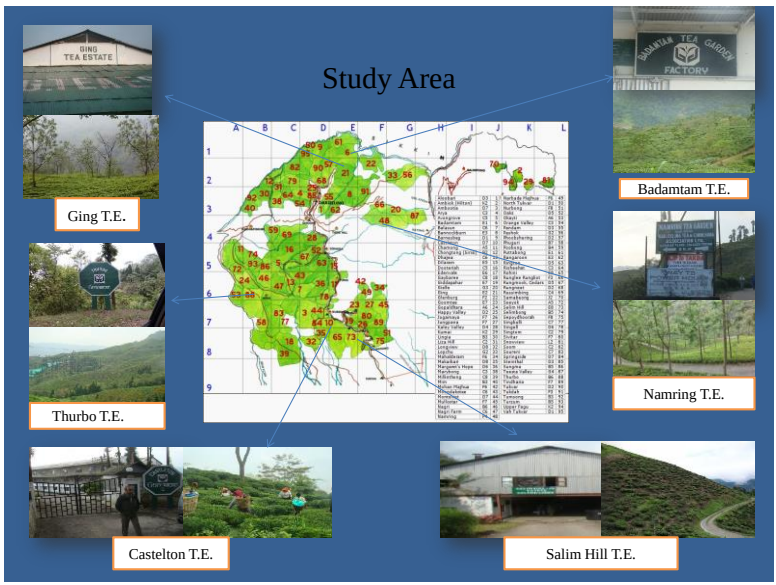

Table 1. Spider taxa recorded from tea estates of Darjeeling.

| Family | Taxa | Distribution | | |
|---|---|---|---|---|
| | | **Tea Estates** | **India** | **Elsewhere in World** |
| **Agelenidae** (Funnel web spiders) | ●♦1. *Agelena barunae* Tikader | BTE,GTE,NTE | Sikkim, West Bengal | - |
| **Araneidae** (Typical orb weavers) | ●♦2. *Arachnura angura* Tikader | NTE | Kerala, Sikkim, West Bengal | - |
| | 3. *Araneus mitificus* (Simon) | BTE,CTE,GTE, NTE,STE,TTE | Assam, Andhra Pradesh, Chhattisgarh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, West Bengal | Bangladesh, Hongkong, Japan, Malaysia, Myanmar, Pakistan, Philippines, New Guinea, Singapore, Thailand, Vietnam |
| | ♣4. *Araneus* n. sp. | CTE | West Bengal | - |
| | 5. *Argiope aemula* (Walckenaer) | NTE,STE | Assam, Andaman & Nicobar Island, Andhra Pradesh, Chhattisgarh, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal | China, Indonesia, Malaysia, Myanmar, New Hebrides, Philippines, Sri Lanka, Taiwan, Thailand, Vanuatu |
| | 6. *Ariope pulchella* Thorell | BTE,CTE,GTE, NTE,STE | Andaman Island, Arunachal Pradesh, Assam, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Tamil Nadu, West Bengal | China, Indonesia; Malaysia, Myanmar |
| | ♦7. *Chorizopes bengalensis* Tikader | TTE | West Bengal | - |
| | 8. *Cyclosa bifida* (Doleschall) | NTE,STE | Assam, Arunachal Pradesh, Kerala, Meghalaya, Sikkim, West Bengal | Malaysia, New Guinea, Philippines, Sri Lanka |
| | ♦9. *Cyclosa bilobata* Sen et al. | NTE,TTE | West Bengal | - |
| | 10. *Cyclosa insulana* (Costa) | BTE,STE | Meghalaya, Sikkim, West Bengal | Australia, Mediterranean to Philippines |

| | | | | |
|---|---|---|---|---|
| | ●11. *Cyclosa mulmeinensis* (Thorell) | BTE | Assam, Maharashtra, West Bengal | Africa, Japan, Malaysia, Myanmar, Philippines, Singapore, Taiwan |
| | ♦12. *Cyclosa neilensis* Tikader | BTE | Andaman Island, West Bengal | - |
| | ●13. *Cyclosa quinqueguttata* (Thorell) | BTE, GTE,NTE | Assam, Sikkim, West Bengal | Bhutan, China, Myanmar, Taiwan |
| | ♦14. *Cyclosa simoni* Tikader | BTE,CTE,GTE, NTE,STE,TTE | Assam, Sikkim, West Bengal | - |
| | 15. *Cyclosa spirifera* Simon | BTE,CTE,GTE, NTE,STE,TTE | Assam, Arunachal Pradesh, Chhattisgarh, Madhya Pradesh, West Bengal | Pakistan |
| | ●¤16.*Cyclosa krusa* Barrion & Litsinger | BTE | West Bengal | Pakistan, Philippines |
| | ●17. *Cyrtarachne raniceps* Pocock | GTE | Karnataka, Orissa, West Bengal | Sri Lanka |
| | 18. *Cyrtophora moluccensis* (Doleschall) | GTE,STE | Andaman & Nicobar Islands, Karnataka, Kerala, Madhya Pradesh, Sikkim, West Bengal | Australia, Fiji, Indonesia, Japan, Malaysia, Myanmar, Nepal, Papua New Guinea, Sri Lanka, Tonga |
| | | | | |
| | ●19. *Cyrtophora exanthematica* (Doleschall) | GTE,STE | West Bengal | Australia, Indonesia, Japan, Myanmar, New South Wales, Papua New Guinea, Philippines, Singapore |
| | 20. *Eriovixia excelsa* (Simon | NTE | Assam, Arunachal Pradesh, Chhattisgarh, Madhya Pradesh, West Bengal | Pakistan |
| | 21. *Gasteracantha diadesmia* Thorell | STE | Assam, Andaman & Nicobar Islands, Sikkim, West Bengal | Myanmar, Philippines, Thailand |
| | 22. *Gasteracantha kuhlii* C.L. Koch | BTE, GTE, NTE, STE | Andaman & Nicobar Island, Assam, Bihar, Kerala, Sikkim, | Bhutan, Hongkong, Indonesia, Japan, Malaysia, Myanmar, |

| | | | | |
|---|---|---|---|---|
| | | | West Bengal | Philippines |
| | ●23. *Gasteracantha unguifera* Simon | BTE,NTE,STE, TTE | Sikkim, West Bengal | China |
| | ●24. *Gea zaragosa* Barrion & Litsinger | GTE | West Bengal | Philippines |
| | ●25. *Larinia chloris* (Audouin) | NTE | Maharashtra , Madhya Pradesh, West Bengal | Bangladesh, Egypt, Israel, Libya, Mozambique , Syria, Turkey, Uganda |
| | ♦26. *Neoscona bengalensis* Tikader & Bal | BTE,CTE,GTE, NTE,STE,TTE | Assam, Andhra Pradesh, Kerala, Manipur, West Bengal | - |
| | ♦27. *Neoscona mukerjei* Tikader | BTE,CTE,GTE, NTE,STE, TTE | Assam, Andhra Pradesh, Arunachal Pradesh, Kerala, Madhya Pradesh, Maharashtra, Manipur, West Bengal | - |
| | 28. *Neoscona nautica* (L. Koch) | BTE,CTE,GTE, NTE,STE | Assam, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Manipur, West Bengal | Cosmo tropical |
| | ●29. *Neoscona theisi* (Walckenaer) | CTE,STE,TTE | Gujarat, Madhya Pradesh, Maharashtra, Orissa, West Bengal | China to Pacific Island, New Guinea |
| | ●30. *Neoscona vigilans* (Blackwall) | BTE | Assam, West Bengal | Africa to Philippines, New Guinea |
| | 31. *Neoscona yptinica* Barrion & Litsinger | BTE, CTE, GTE, NTE, STE, TTE | Assam, West Bengal | Philippines |
| | 32. *Parawixia dehaani* (Doleschall) | BTE | Assam, Karnataka, Kerala, Sikkim, West Bengal | Indonesia, Japan, Malaysia, Myanmar, New Guinea, Philippines, Polynesia |
| **Clubionidae** (Sac spiders) | ●33. *Clubiona drassodes* O. P. Cambridge | BTE, CTE | Andaman, Bihar, Maharashtra, Karnataka, Uttarakhand, West Bengal | Bangladesh, China |

| | | | | |
|---|---|---|---|---|
| | ◘34. *Clubiona rama* Dankittipakul and Singtripop | BTE | West Bengal | Thailand |
| **Ctenidae**<br><br>(Wandering spiders) | ♦35. *Ctenus sikkimensis* Gravely | BTE, GTE | Sikkim, West Bengal | - |
| **Eutichuridae**<br><br>(Dark sac spiders) | ♦36. *Cheiracanthium himalayense* Gravely | BTE, CTE, GTE, NTE, STE, TTE | Gujarat, Maharashtra, Meghalaya, Uttarakhand, West Bengal | - |
| | 37. *Cheiracanthium triviale* Thorell | BTE, CTE, GTE | Andhra Pradesh, Goa, Madhya Pradesh, Maharashtra, Manipur, Tamil Nadu, Uttar Pradesh, West Bengal | Myanmar |
| **Gnaphosidae**<br><br>(Mouse spiders) | ●♦38. *Zelotes pseudopusillus* Caporiacco | TTE | Jammu & Kashmir, West Bengal | - |
| **Hersiliidae**<br><br>(Two tailed spiders) | ●39. *Hersilia savignyi* Lucas | BTE, GTE | Assam, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal | Myanmar, Philippines,Sri Lanka |
| **Linyphiidae**<br><br>(Sheet web spiders) | ●♦40. *Lepthyphantes rudrai* Tikader | BTE, CTE, GTE, NTE, TTE | Sikkim, West Bengal | - |
| **Lycosidae**<br><br>(Wolf spiders) | 41. *Hippasa agelenoides* (Simon) | GTE, NTE | Arunachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal | Myanmar, Taiwan |
| | ●42. *Hippasa greenalliae* (Blackwall) | GTE | Andhra Pradesh, Karnataka, Kerala, Maharashtra, Orissa, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal | Bangladesh, China, Sri Lanka |
| | ♦43. *Hippasa himalayensis* Gravely | BTE, GTE, STE | Assam, Himachal Pradesh; Karnataka West Bengal | - |

| | | | | |
|---|---|---|---|---|
| | ●44. *Lycosa phipsoni* Tikader | TTE, NTE, STE | Assam, Maharashtra, West Bengal | China, Myanmar, Taiwan |
| | ●45. *Pardosa heteropthalma* (Simon) | BTE | Tamil Nadu, West Bengal | Indonesia |
| | 46. *Pardosa songosa* Tikader & Malhotra | NTE, TTE, GTE | Assam, Uttar Pradesh, West Bengal | Bangladesh, China |
| **Nephilidae** (Long legged orb weavers) | ●47. *Herennia multipuncta* (Doleschall) | BTE, GTE, NTE, STE | Assam, Arunachal Pradesh, Kerala, Maharashtra, Meghalaya, Tamil Nadu, West Bengal | China, Indonesia, Malaysia, Myanmar, Nepal, New Guinea; Philippines, Taiwan, Thailand |
| | 48. *Nephila clavata* L. Koch | BTE, CTE, GTE, NTE, STE | Andaman & Nicobar Islands, Lakshadweep Island, Meghalaya, Sikkim, West Bengal | Bhutan, China, Indonesia, Japan, Korea, Myanmar, Pakistan, Taiwan, Thailand |
| | 49. *Nephila pilipes* (Fabricius) | BTE, CTE, GTE, NTE | Andaman & Nicobar Islands, Arunachal Pradesh, Assam, Gujarat, Kerala, Maharashtra, Madhya Pradesh, Sikkim, Uttar Pradesh, West Bengal | China, Philippines to Australia |
| **Oxyopidae** (Lynx spiders) | ●♦50. *Oxyopes kamalae* Gajbe | BTE, GTE | Madhya Pradesh, West Bengal | - |
| | ♦51. *Oxyopes naliniae* Gajbe | BTE, GTE, NTE, STE | Assam, Madhya Pradesh, West Bengal | - |
| | 52. *Oxyopes shweta* Tikader | BTE, CTE, NTE, TTE | Assam, Arunachal Pradesh, Kerala, Manipur, Meghalaya, Sikkim, Tripura, West Bengal | China |
| | ♦53. *Oxyopes sitae* Tikader | BTE, GTE | Andaman Islands, Gujarat, Meghalaya, Sikkim, WestBengal | - |
| **Pisauridae** (Nursery web spiders) | ◘54. *Dendrolycosa robusta* (Thorell) | BTE | West Bengal | China, Laos, Myanmar, Vietnam |
| | ♦55. *Dendrolycosa gitae* (Tikader) | BTE, CTE, GTE, NTE, STE, TTE | Assam, Andaman Islands, Kerala, Sikkim, West Bengal | - |

| | | | | |
|---|---|---|---|---|
| **Salticidae**<br><br>(Jumping spiders) | ♠56. *Carrhotus viduus* (C. L. Koch) | BTE | Assam | Bintan Island, China, Indonesia, Malacca, Malaysia, Myanmar, Nepal, Penang Island, Singapore, Sri Lanka, Sumbawa |
| | 57. *Epocilla aurantiaca* (Simon) | CTE, STE | Assam, Kerala, West Bengal | Malacca, Malaysia, Myanmar, Sri Lanka, Vietnam |
| | 58. *Hyllus semicupreus* (Simon) | BTE, GTE, NTE, STE | Assam, West Bengal | Sri Lanka |
| | 59. *Menemerus brevibulbis* (Thorell) | BTE | Assam, West Bengal | Africa, South America |
| | | | | |
| | ●♦60. *Myrmarachne bengalensis* Tikader | BTE, GTE, NTE | West Bengal | - |
| | ●61. *Myrmarachne caliraya* Barrion & Litsinger | GTE | West Bengal | Philippines |
| | ●62. *Phintella vittata* (C.L. Koch) | NTE | Assam, West Bengal | China, Indonesia, Malaysia, Myanmar, Philippines, Thailand, Vietnam |
| | 63. *Plexippus paykullii* (Audouin) | BTE, CTE, GTE, NTE, STE, TTE | Assam, Arunachal Pradesh, Kerala, Manipur, West Bengal | Africa, Europe, Myanmar, Philippines, Sri Lanka, and all warmer regions of the World |
| | ●♦64. *Plexippus pseudopaykullii* Sen, Dhali, Saha & Raychaudhuri | NTE, STE | West Bengal | - |
| | ●65. *Portia fimbriata* (Doleschall) | BTE | Kerala, West Bengal | Amboina, Australia, Indonesia, Japan, Krakatau, Malaysia, Nepal, Papua New Guinea, South Africa, Sri Lanka, Taiwan |
| | ●♦66. *Rhene danieli* Tikader | CTE, GTE, NTE, STE | Maharashtra, West Bengal | - |

| | | | | |
|---|---|---|---|---|
| | ●67. *Rhene indica* Tikader | STE | West Bengal | Andaman Islands, China |
| | ●68. *Rhene rubrigera* (Thorell) | BTE, NTE | West Bengal | China, Hawaii, Indonesia, Karakatau, Malaysia, Mexico, Myanmar, Vietnam |
| | ●69. *Siler semiglaucus* Simon | BTE, GTE, NTE | Kerala, West Bengal | China, Indonesia, Krakatau, Nepal, Philippines, Singapore, Sri Lanka, Vietnam |
| | 70. *Telamonia dimidiata* (Simon) | BTE, GTE, NTE, STE | Assam, Gujarat, Kerala, Maharashtra, West Bengal | Bhutan, Indonesia, Singapore |
| | 71. *Thiania bhamoensis* Thorell | BTE, CTE, GTE, TTE | Assam, Andaman Island, Kerala, West Bengal | China, Indonesia, Myanmar, Singapore |
| **Sparassidae** (Giant crab spiders) | 72. *Bhutaniella sikkimensis* (Gravely) | GTE | Manipur, Meghalaya, Sikkim, West Bengal | Bhutan, Nepal |
| | ●♦73. *Heteropoda andamanensis* Tikader | NTE | Andaman Islands, Kerala, West Bengal | - |
| | ●♦74. *Olios obesulus* (Pocock) | BTE, CTE, NTE, STE | Bihar, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh, West Bengal | - |
| **Tetragnathidae** (Long jawed orb weavers) | 75. *Leucauge decorata* (Blackwall) | BTE, CTE, GTE, NTE, STE, TTE | Assam, Bihar, Gujarat, Karnataka, Kerala, Maharashtra, Meghalaya, Orissa, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal | Africa, America, Bangladesh, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand |
| | 76. *Leucauge tessellata* (Thorell) | GTE, NTE | Assam, Arunachal Pradesh, Gujarat, Karnataka, Kerala, Maharashtra, Manipur, Sikkim, West Bengal | Bhutan, China, Laos, Moluccas, Myanmar, Taiwan |
| | 77. *Opadometa fastigata* (Simon) | BTE, GTE | Kerala, Orissa, Uttar Pradesh, West Bengal | Indonesia, Myanmar, Philippines, Singapore, Sri Lanka, Thailand |

| | | | | |
|---|---|---|---|---|
| | ◘78. *Tetragnatha caudicula* (Karsch) | BTE,NTE, TTE | West Bengal | China, Japan, Korea, Russia, Taiwan |
| **Theridiidae** (Cobweb spiders) | ♦79. *Chrysso urbasae* Tikader | GTE, NTE, TTE | Kerala, Sikkim, West Bengal | - |
| | | | | |
| | ●♦80. *Theridion indicum* Tikader | BTE, GTE, NTE, TTE | Assam, Andaman & Nicobar Island, West Bengal | - |
| **Thomisidae** (Crab spiders) | 81. *Camaricus formosus* Thorell | BTE | Andaman Island, Arunachal Pradesh, Karnataka, Kerala, Maharashtra, Manipur, West Bengal | Bangladesh, China, Indonesia, Myanmar, Philippines |
| | ●♦82. *Thomisus andamanensis* Tikader | NTE | Andaman Island, West Bengal | - |
| | ●♦83. *Ozyptila khasi* Tikader | GTE, STE | Meghalaya, West Bengal | - |
| **Uloboridae** (Hackled web spiders) | ♦84. *Uloborus khasiensis* Tikader | BTE, STE | Assam, Meghalaya, West Bengal | - |
| | ●♦85. *Miagrammopes* nr. *kirkeensis* Tikader | STE | Maharashtra, West Bengal | - |

Legends:

♦ Endemic to India

♠ New record from West Bengal

◘ New record from India

● New record from Darjeeling

♣ New to science

BTE – Badamtam Tea Estate

CTE – Castleton Tea Estate

GTE – Ging Tea Estate

NTE – Namring Tea Estate

STE – Salim Hill Tea Estate

TTE – Thurbo Tea Estate

Table 2. Summary of the recorded spider taxa of the tea estates of Darjeeling.

| | **Badamtan Tea Estate** | **Ging Tea Estate** | **Salim Hill Tea Estate** | **Namring Tea Estate** | **Castleton Tea Estate** | **Thurbo Tea Estate** | **Total** |
|---|---|---|---|---|---|---|---|
| **No. of family** | 17 | 16 | 12 | 14 | 10 | 10 | 18 |
| **No. of genera** | 35 | 34 | 24 | 34 | 16 | 18 | 52 |
| **No. of species** | 52 | 44 | 36 | 46 | 24 | 22 | 85 |
| **No. of individuals** | 504 | 299 | 351 | 428 | 299 | 191 | 2072 |

Table 3. Spider guilds.

| **Spider Guilds** | **Family** |
|---|---|
| Orb weavers | Agelenidae, Araneidae, Nephilidae, Tetragnathidae, Uloboridae |
| Ground dwellers | Clubionidae, Ctenidae, Gnaphosidae, Lycosidae |
| Foliage hunters | Eutichuridae, Hersiliidae, Pisauridae, Sparassidae |
| Stalkers | Lycosidae, Oxyopidae |
| Ambushers | Salticidae, Thomisidae |
| Sheet web builders | Linyphiidae |
| Space web builders | Theridiidae |