

Diversity of Orthopteran insects and their role in Tea Agro-Ecosystem of West Bengal

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Abstract

Documentation on the diversity of the Order Orthoptera and their role in tea agro-ecosystem of West Bengal is meager. The surveys cum collection tours conducted from 2012- 2016 in three districts, Darjeeling, Jalpaiguri and Alipurduar, of West Bengal to explore insect diversity in tea agro-ecosystem of this area. The study reports 39 species under 33 genera belongs to 7 families of Orthoptera. Of which, 5 species under 4 genera are reported for the first time from West Bengal and 3 are endemic. Considering their role in this unique ecosystem orthopteran insects have been found both as herbivorous and carnivorous species.

Keywords: Orthoptera, Tea Agro-Ecosystem, West Bengal

Introduction

Tea is an agro-ecosystem comprising tea plants, shade trees, other ancillary crops and number of insects, mites, soil micro organisms, birds, reptiles, amphibians etc. along with various abiotic elements including soil nutrients, sunshine, light, day length, rainfall pattern (Sana, 1989; Ahmed, 2005). Like other ecosystems, insects are the major components in the Tea garden and play an important role in the provisioning of ecosystem services.

The Orthoptera include terrestrial insects commonly known as grasshoppers, katyids, bush crickets, crickets, and locusts. Orthopterans are successful group of insects in a number of extreme environments which require special adaptations such as cold and hot deserts, polar environments and high altitude (Mani, 1968; Cloudsley-Thompson, 1988; Vickery, 1997; Punzo, 2000). They are mostly herbivorous and their feeding habits assume a great diversity of forms, ranging from extreme generalists to strict specialists (Joern, 1979). However, orthopterans may feed on different plant structures such as leaves, flowers, fruits, pollen, etc. (Gangwere, 1961).

Knowledge on the diversity and the role of orthopteran insects in Tea ecosystem of West Bengal is scanty. Recently,

(Mitra *et al.* 2018) reported six species under six genera belonging to three families of Orthoptera from the tea gardens of West Bengal, of them, *Holochlora indica* (Kirby, 1914), *Mecopoda elongata* (Linnaeus, 1758), *Tarbinskiellus orientalis* (Fabricius, 1775) and *Atractomorpha crenulata* (Fabricius, 1793) are reported as notorious pests of tea.

Present communication reports 39 species under 33 genera of 14 subfamilies belonging to 7 families under 5 super families of order Orthoptera from the tea agro- ecosystems of West Bengal. Of them, 5 species are reported for the first time from West Bengal and 3 species are endemic to India.

Materials and Method

The orthopteran specimens collected, studied and documented during faunistic surveys between 2012- 2016 in three districts- Jalpaiguri, Alipurduar and Darjeeling of West Bengal (Figure 1 and Table 1) and deposited in NZC, ZSI, Kolkata. The collection localities (tea gardens) have been recorded in Dooars and high altitude regions of above three districts at an elevation ranging from as low as 151 ft to as high as 4178 ft. The map of visited tea

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gardens has been reproduced from software Arc GIS (version 10.5) and provided below (Figure 1). The adult specimens have been pinned, photographed and then studied under Stereo Zoom Binocular Microscopes (Leica EZ4 HD). The classification and taxonomic details followed after (Cigliano *et al.* 2020) (*Orthoptera Species File*. Version 5.0/5.0, 2020). All the collections were made by B. Mitra and Party.

Results

Altogether, 39 species under 33 genera belongs to 14 subfamilies of 7 families were recorded (Table 1) from

24 tea gardens of North Bengal. Among them, the family Tettigoniidae shares the maximum number 13 species, followed by Acrididae 12 species and Tetrigidae 4 species. Each of families Pyrgomorphidae, Gryllidae and Trigonidiidae shared 3 species. The family Gryllotalpidae contained only 1 species. Five species are new record for West Bengal (Plate 1) and three species are endemic to India.

Order ORTHOPTERA

Superfamily ACRIDOIDEA

Family ACRIDIDAE

Subfamily CATANTOPINAE

Table 1. Visited tea gardens in North Bengal

Sl. No	Name of the Tea garden	District	Geographical Position	Altitude (ft.)
1.	Batabari	Jalpaiguri	N 26°51.149", E 088°48.045"	570
2.	Hilla	Jalpaiguri	N 26°56.244", E 088°53.807"	1138
3.	Nagrakata Tra	Jalpaiguri	N 26°57.039", E 088°54.370"	1158
4.	Mal Nady	Jalpaiguri	N 26°54.776", E 088°43.785"	873
5.	Mal Bazar	Jalpaiguri	N 26°48.193", E 088°47.790"	470
6.	Nakhati	Jalpaiguri	N 26°55.289", E 088°44.802"	882
7.	Soongachi	Jalpaiguri	N 26°52.952", E 088°45.126"	608
8.	Rangamuttee	Jalpaiguri	N 26°52.497", E 088°42.489"	575
9.	Kurti	Jalpaiguri	N 26°54.975", E 088°56.161"	907
10.	Red Bank	Jalpaiguri	N 26°51.003", E 089°00.432"	644
11.	Anandpur	Jalpaiguri	N 26°45.814", E 088°40.385"	409
12.	Kailashpur	Jalpaiguri	N 26°45.432", E 088°38.545"	442
13.	Sonali	Jalpaiguri	N 26°49.823", E 088°34.511"	465
14.	Bagracote	Jalpaiguri	N 26°52.471", E 088°35.969"	551
15.	Killcott	Jalpaiguri	N 26°54.520", E 088°48.304"	876
16.	Ranichhera	Jalpaiguri	N 26°52.435", E 088°38.888"	565
17.	Diana Tg	Jalpaiguri	N 26°51.308", E 088°40.723"	533
18.	Sonkhini	Jalpaiguri	N 26°51.963", E 088°42.802"	478
19.	Beechtg	Alipurduar	N 26°45.807", E 089°21.563"	502
20.	Mahua	Alipurduar	N 26°48.947", E 089°22.457"	629
21.	Kalchini	Alipurduar	N 26°41.565", E 089°25.320"	420
22.	Majher Dabri	Alipurduar	N 26°32.839", E 089°33.003"	151
23.	Gyabaree	Darjeeling	N 26°49.975", E 088°13.745"	2528
24.	Tingling	Darjeeling	N 26°50.726", E 088°11.623"	4178

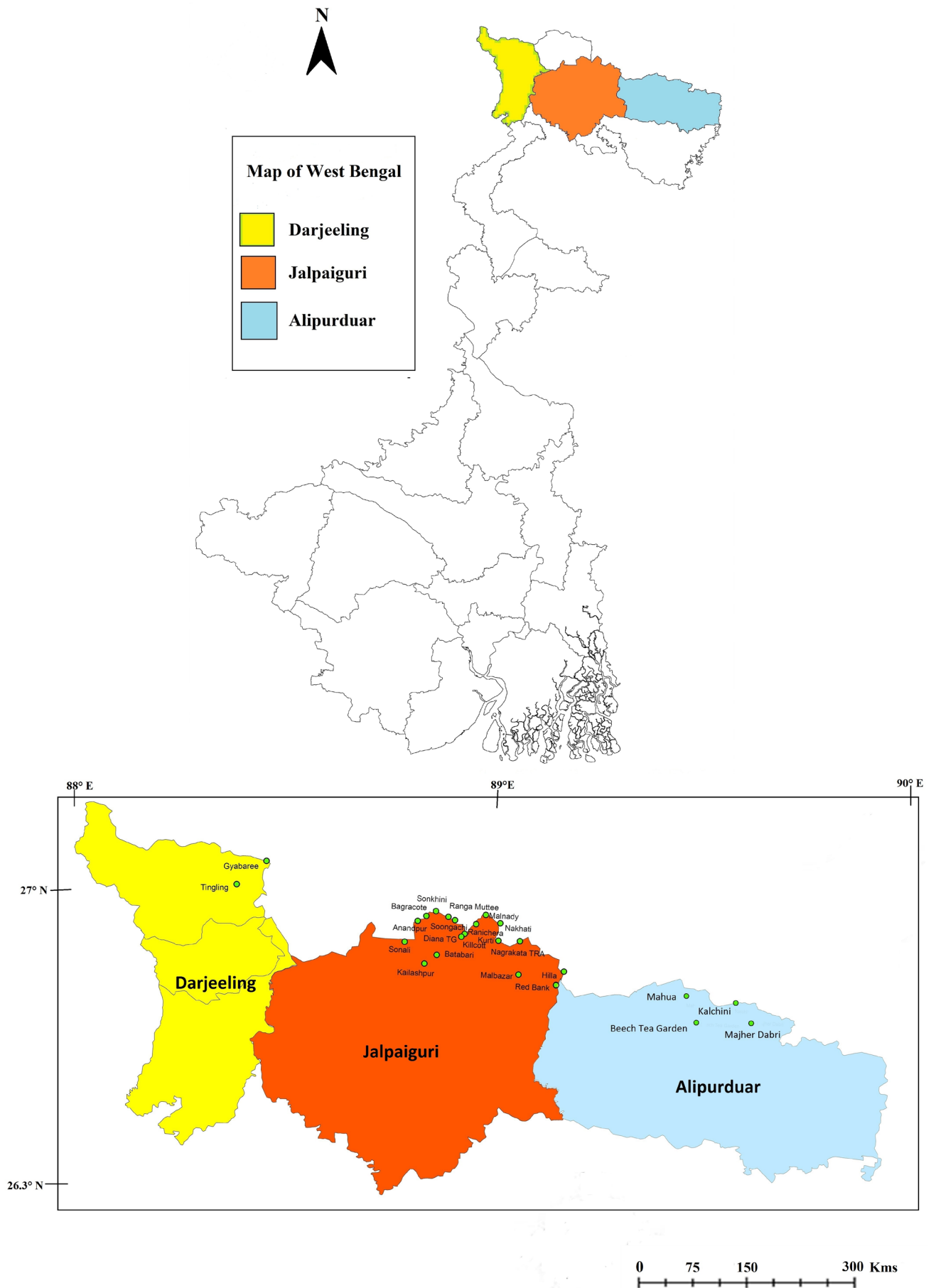


Figure 1. District-wise sampling sites (tea gardens) in West Bengal.

1. *Apalniacris jalpaiguri* Ingrisch, Willemse and Shishodia, 2004

Material examined: 1 ♀, Tingling tea garden, 26.vii.2013.

Distribution: India: West Bengal.

Remark: This is an endemic species is restricted to West Bengal only.

2. *Diabolocatantops innotabilis* Walker, 1870

Material examined: 1 ♀, Diana tea garden, 22.vi.2014.

Distribution: India : Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Lakshadweep Island, Madhya Pradesh, Maharashtra, Meghalaya, Manipur, Nagaland, Orissa, Rajasthan, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal. *Elsewhere:* Afghanistan, Bangladesh, Borneo, Cambodia, China, Hong Kong, Indo China, Japan, Java, Korea, Maldives Island, Malaysia, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Sri Lanka, Sumatra, Tibet and Thailand.

3. *Xenocatantops humilis* Serville, 1839

Material examined: 1 ♂, Tingling tea garden, 26.xii.2013; 2 ♂♂, 1 ♀, Gyabaree tea garden, 13.vi.2014, 19.vi.2014; 1 ♀, Anandpur tea garden, 20.vi.2014; 1 ♀, Hilla tea Garden, 04.ix.2015; 1 ♀, Beech tea garden, 17.viii.2014; 1 ♀, Diana tea garden, 22.vi.2014.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Bangladesh, Borneo, Indo-China, Java, Lombok, Malaysia, Myanmar, Nepal, New Guinea, Philippines, Sumatra, Sri Lanka, Thailand, Tibet, Vietnam and Yunnan.

Subfamily CYRTACANTHACRIDINAE

4. *Cyrtacanthacris tatarica tatarica* Linnaeus, 1758

Material examined: 1 ♀, Diana tea garden, 22.vi.2014.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya

Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Africa, Bangladesh, Central America, Hainan, Indonesia, Madagascar, Mediterranean Region, Myanmar, Nepal, Pakistan, Philippines, Red-Sea, Sahara, Saudi Arabia, Seychelles, Sri Lanka, South West Asia, Sumatra and Thailand.

Subfamily GOMPHOCERINAE

5. *Gelastorhinus* sp.

Material examined: 1 ex., Hilla tea garden, 15.vii.2013.

Distribution: India: Chhattisgarh, Himachal Pradesh, Madhya Pradesh, Maharashtra, Sikkim, Tamil Nadu and West Bengal.

Subfamily CALLIPTAMINAE

6. *Peripolus pedarius* Stål, 1876

Material examined: 2 ♀♀, Gyabaree tea garden, 13.vi.2014.

Distribution: India: Assam, Sikkim, Uttarakhand and West Bengal. *Elsewhere:* Nepal.

Subfamily OXYINAE

7. *Oxya fuscovittata* Marschall, 1836

Material examined: 1 ♂, Malbazar tea garden, 12.vii.2013; 1 ♀, Nagrakata TRA, 28.i.2013.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Afghanistan, Bangladesh, Nepal, Pakistan and USSR (South West).

Subfamily OEDIPODINAE

8. *Aiolopus thalassinus tamulus* Fabricius, 1798

Material examined: 1 ♂, Hilla tea garden, 19.vi.2014.

Distribution: India: Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Bihar, Chhattisgarh, Delhi, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Punjab, Rajasthan, Tamil Nadu, Tripura, Uttarakhand,

Uttar Pradesh and West Bengal. *Elsewhere*: Australia, Bangladesh, Borneo, Brunei, Celebes, China, Hainan, Hong Kong, Indonesia, Japan, Java, Lombok, Malaysia, Myanmar, New Guinea, Pakistan, Papua, Philippines, Singapore, Sri Lanka, Sumatra, Taiwan, Thailand and Timor.

9. *Heteropternis respondens respondens* Walker, 1859

Material examined: 1 ♀, Gyabaree tea garden, 13.vi.2014.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Bihar, Himachal Pradesh, Karnataka, Meghalaya, Nagaland, Orissa, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere*: Bangladesh, China, Indonesia, Japan, Java, Malacca, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Sumatra and Taiwan.

10. *Ceracris nigricornis nigricornis* Walker, 1870

Material examined: 1 ♂, 1 ♀, Tingling tea garden, 26.xii.2013.

Distribution: India: Arunachal Pradesh, Assam, Bihar, Haryana, Himachal Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Orissa, Sikkim, Uttarakhand, Tamil Nadu, Tripura and West Bengal. *Elsewhere*: Afghanistan, Myanmar, South China, Taiwan, Thailand and Vietnam.

11. *Trilophidia annulata* Thunberg, 1815

Material examined: 2 ♀♀, Beech tea garden, 17.viii.2014; 2 ♀♀, 2 ♂♂, Bagracote tea Garden, 03.ix.2015; 2 ♀♀, Nakhati tea Garden, 03.ix.2015; 1 ♂, Batabari tea garden, 14.xii.2013; 1 ♀, 1 ♂, Rangamuttee tea garden, 14.xii.2013; 1 ♂, Killcott tea garden, 16.xii.2013; 1 ♀, Nagrakata TRA, 13.vii.2013; 1 ♂, Kailashpur tea garden, 15.xii.2013; 1 ♀, Kalchini tea garden, 17.xii.2013; 1 ♀, Hilla tea garden, 19.vi.2014; 1 ♀, Ranichhera tea garden, 20.vi.2014.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Orissa, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere*: Afghanistan, Bangladesh, Borneo, China, Hong Kong, Japan, Java, Korea, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Sarawak, Singapore, Sri Lanka, Sumatra, Taiwan, Thailand and Vietnam.

Subfamily SPATHOSTERNINAE

12. *Spathosternum prasiniferum prasiniferum* Walker, 1871

Material examined: 1 ♀, 1 ♂, Diana tea garden, 22.vi.2014.

Distribution: India: Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere*: Bangladesh, Hainan, Myanmar, Nepal, Pakistan, South and East China, Sri Lanka, Thailand, Vietnam and West Malaysia.

Superfamily PYRGOMORPHOIDEA

Family PYRGOMORPHIDAE

Subfamily PYRGOMORPHINAE

13. *Atractomorpha crenulata* Fabricius, 1793

Material examined: 1 ♀, Hilla tea garden, 19.vi.2014; 1 ♀, Red bank tea garden, 13.vii.2016; 1 ♂, Malbazar tea garden, 12.vii.2016; 1 ♂, Anandapur tea garden, 15.xii.2013; 1 ♀, Mal Nady tea garden, 13.xii.2013; 1 ♂, Nagrakata TRA, 28.i.2013.

Distribution: India: Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Jharkhand, Karnataka, Kerala, Lakshadweep Island, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh, West Bengal. *Elsewhere*: Bangladesh, Cambodia, Laos, Maldives Island, Malaya, Myanmar, Nepal, Pakistan, Sri Lanka, Sumatra, South Vietnam and Thailand.

Remark: This species is reported earlier by (Mitra *et al.* 2018).

14. *Tagasta indica indica* Boliver, 1905

Material examined: 1 ♀, Tingling tea garden, 26.vii.2016.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Meghalaya, Nagaland, Sikkim, Tripura and West Bengal. *Elsewhere*: Bhutan and Myanmar.

15. *Chrotogonus* (*Chrotogonus*) *trachypterus* *trachypterus* Blanchard, 1836

Material examined: 1 ♂, Red bank tea garden, 13.vii.2016; 1 ♂, Hilla tea garden, 19.vi.2014.

Distribution: India: Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Afghanistan, Bangladesh, Iran, Nepal and Pakistan.

Superfamily TETRIGOIDEA

Family TETRIGIDAE

Subfamily TETRIGINAE

16. *Hedotettix gracilis* Hann, 1842

Material examined: 1 ♀, Malbazar tea garden, 12.vii.2013; 1 ♀, Mahua tea garden, 09.vii.2013.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Chhattisgarh, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Sikkim, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Bangladesh, Celebes, China, Java, Myanmar, Pakistan, Sri Lanka, Sulawesi, Sumatra, Taiwan, Thailand and Vietnam.

17. *Hedotettix grossus* Hancock, 1915

Material examined: 1 ♂, Mahua tea garden, 09.vii.2013; 1 ♂, Malbazar tea garden, 12.vii.2013; 1 ♂, Hilla tea garden, 15.vii.2013.

Distribution: India: Arunachal Pradesh, Assam, Manipur, Meghalaya, Tripura and West Bengal.

Remark: This is an endemic species.

18. *Paratettix histricus* (Stål, 1861)

Material examined: 1 ♂, Hilla tea garden, 09.xi.2014; 1 ♀, Malbazar tea garden, 12.vii.2013; 1 ♂, Nagrakata TRA, 13.vii.2013; 2 ♀♀, Mahua tea garden, 09.vii.2013.

Distribution: India: Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Himachal Pradesh, Madhya Pradesh,

Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura and West Bengal. *Elsewhere:* Australia, Borneo, Caledonia, Celebes, East Africa, East Afghanistan, Holland, Indonesia, Iran, Java, Malaysia, Myanmar, Nepal, New Ireland, Pakistan, Philippines, Queensland, Saudi Arabia, Solomon Islands, South China, Sumatra, Sri Lanka and Taiwan.

19. *Coptotettix annandalei* Hancock, 1915

Material examined: 1 ♀, Majher Dabri tea garden, 04.xi.2014.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Chhattisgarh, Karnataka, Manipur, Meghalaya, Orissa, Sikkim, Tripura, Uttar Pradesh and West Bengal. *Elsewhere:* Myanmar, Nepal and Sri Lanka.

Superfamily GRYLLOIDEA

Family GRYLLIDAE

Subfamily GRYLLINAE

20. *Modicogryllus* (*Modicogryllus*) *confirmatus* Walker, 1859

Material examined: 4 ♀♀, 1 ♂, Nagrakata TRA, 13.vii.2013; 1 ♀, 1 ♂, 1 ♀, Hilla tea Garden, 09.xi.2014, 03.ix.2015, 04.ix.2015; 1 ♂, Sonkhini Tea Garden, 21.vi.2014.

Distribution: India: Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chandigarh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal. *Elsewhere:* Bangladesh, China, Indo-China, Iran, Israel, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka and Thailand.

21. *Velarifictorus* (*Velarifictorus*) *aspersus* Walker, 1869

Material examined: 1 ♀, Sonkhini Tea Garden, 21.vi.2014.

Distribution: India: Andhra Pradesh, Arunachal Pradesh, Assam, Chandigarh, Delhi, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Meghalaya, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:*

Annam, Borneo, China, Java, Hong Kong, Malaysia, Myanmar, Philippines, Selangor, Singapore, Sri Lanka and Taiwan.

22. *Tarbinskiellus orientalis* Fabricius, 1775

Material examined: 2 nymphs, 1 ♀, Nagrakata TRA, 27.i.2013.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Karnataka, Maharashtra, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Uttarakhand and West Bengal. *Elsewhere:* Malaysia, Myanmar and Sri Lanka.

Remark: This species is reported earlier by (Mitra *et al.* 2018).

Family TRIGONIDIIDAE

Subfamily NEMOBIINAE

23. *Dianemobius fascipes* Walker, 1869

Material examined: 1 ♀, Hilla tea garden, 09.xi.2014.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* China, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Sri Lanka and Taiwan.

24. *Polionemobius taprobanensis* Walker, 1869

Material examined: 1 ♀, Diana tea estate, 22.vi.2014; 1 ♀, Nagrakata TRA, 14.vii.2013.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Chandigarh, Chhattisgarh, Delhi, Himachal Pradesh, Kamataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Bangladesh, China, Indonesia, Malaysia, Malacca, Myanmar, Perak, Sri Lanka, Sumatra and Vietnam.

25. *Pteronemobius (Pteronemobius) heydenii concolor* Walker, 1871

Material examined: 1 ♀, Gyabaree tea Garden, 13.vi.2014.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Afghanistan, Malaysia, Myanmar, Perak, Sri Lanka and Turkistan.

Family GRYLLOTALPIDAE

26. *Grylotalpa africana* Beauvois, 1805

Material examined: 1 ♀, Hilla tea Garden, 03.ix.2015; 1 ♀, Kurti tea garden, 13.vii.2016.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Chandigarh, Chhattisgarh, Delhi, Himachal Pradesh, Jammu and Kashmir, Kamataka, Kerala, Madhya Pradesh, Meghalaya, Orissa, Pondicherry, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere:* Africa, Bhutan, Iran, Madagascar, Malaysia, Myanmar, Nepal, Pakistan, Singapore, Sri Lanka and South Spain.

Superfamily TETTIGONIOIDEA

Family TETTIGONIIDAE

Subfamily CONOCEPHALINAE

27. *Conocephalus (Anisoptera) maculatus* Le Guillou, 1841

Material examined: 1 ♀, Bagracote tea Garden, 03.ix.2015.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Chhattisgarh, Himachal Pradesh, Jammu and Kashmir, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Nagaland, Orissa, Sikkim, Tamil Nadu, Tripura, Uttarakhand and West Bengal. *Elsewhere:* Africa, Australia, Hong Kong, Indonesia, Java, Malaysia, Nepal, New Guinea, Philippines and Sierra Leone.

28. *Euconocephalus pallidus* Redtenbacher, 1891

Material examined: 1 ♀, Hilla tea garden, 19.vi.2014; 1 ♀, 1 ♂, Nagrakata TRA, 27.i.2013; 5 ♀♀, 1 ♂, Malbazar tea garden, 12.vii.2013; 1 ♂, Kurti tea garden, 13.vii.2013; 1 ♀, Anandapur tea garden, 15.xii.2013.

Distribution: India: Andaman and Nicobar Islands, Assam, Chhattisgarh, Himachal Pradesh, Gujarat, Kerala,

Meghalaya, Mizoram, Orissa, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. *Elsewhere*: Bangladesh, Borneo, East Indies, Java, Myanmar, Philippines, Pinang, Singapore, Sri Lanka and Tonkin.

Remark: This species is reported earlier by (Mitra *et al.* 2018).

29. *Euconocephalus indicus* Redtenbacher, 1891

(Plate 1)

Material examined: 1 ♀, Hilla tea garden, 09.xi.2014; 1 ♂, Nagrakata TRA, 27.i.2013.

Distribution: India: Manipur, Meghalaya, Mizoram and Orissa. *Elsewhere*: Australia, Borneo, China, Himalaya, Java, Myanmar, Pinang and Sumatra.

Remark: This species is reported first time from the West Bengal.

Subfamily MECOPODINAE

30. *Mecopoda elongata* Linnaeus, 1758

Material examined: 1 ♂, Nagrakata TRA, 28.i.2013.

Distribution: India: Andaman and Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh and West Bengal. *Elsewhere*: Australia, Aru Islands, Borneo, Celebes, China, Indonesia, Japan, Malacca, Malaysia, Moluccas, New Guinea, Philippines, Singapore, Sunda Islands, Taiwan, Thailand and Tonkin.

Remark: This species is reported earlier by (Mitra *et al.* 2018).

Subfamily PHANEROPTERINAE

31. *Khaoyaiana ambigua* Bolívar, 1900

(Plate 1)

Material examined: 1 ♂, Hilla tea garden, 19.vi.2014.

Distribution: India: Manipur, Meghalaya and Mizoram. *Elsewhere*: Bhutan, Central Thailand and China.

Remark: This species is reported first time from the West Bengal.

32. *Letana linearis* Walker, 1869

(Plate 1)

Material examined: 1 ♂, Tingling tea garden, 26.vii.2013; 1 ♂, Kalchini tea garden, 17.xii.2013.

Distribution: India: Himachal Pradesh, Meghalaya, Mizoram, Manipur, Sikkim and Uttarakhand. *Elsewhere*: Nepal.

Remark: This species is reported first time from the West Bengal.

33. *Letana gracilis* Ingrisch, 1990a

(Plate 1)

Material examined: 1 ♂, Red bank tea garden, 13.xii.2013.

Distribution: India: Assam, Mizoram, and Manipur. *Elsewhere*: China.

Remark: This species is reported first time from the West Bengal.

34. *Letana pyrifera* Bey-Bienko, 1956

Material examined: 1 ♂, Nagrakata TRA, 28.i.2013.

Distribution: India: Madhya Pradesh, North West to South West India, Rajasthan and West Bengal (Das *et al.* 2016).

Remark: This is an endemic species.

35. *Letana atomifera* Brunner von Wattenwyl, 1878

Material examined: 1 ♂, Nagrakata TRA, 13.vii.2013; 1 ♀, Sonali tea garden, 08.xi.2014; 1 ♀, Majher Dabri tea garden, 04.xi.2014.

Distribution: India: Karnataka, Maharashtra, Rajasthan Tamil Nadu, Uttarakhand and West Bengal. *Elsewhere*: Nepal.

36. *Ducetia japonica* Thunberg, 1815

Material examined: 1 ♂, Soongachi tea Garden, 01.ix.2015; 2 ♂♂, Bagracote tea Garden, 03.ix.2015; 2 ♀♀, 1 ♀, 2 ♂♂, Nagrakata TRA, 13.vii.2013, 27.i.2013; 1 ♂, Majher Dabri tea garden, 04.xi.2014.

Distribution: India: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya

Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu and West Bengal. *Elsewhere*: Australia, Bangladesh, Borneo, China, Formosa, Hainan, Indo-China, Japan, Java, Kuala Lumpur, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Selangor, Singapore, Solomon Island, Sri Lanka, South and East Asia, Thailand, Tibet and Tonkin.

Remarks: This species is reported earlier by (Mitra *et al.* 2018).

37. *Holochlora indica* Kirby, 1914

Material examined: As reported from Nagrakata TRA on 27.i.2013.

Distribution: India: Andaman and Nicobar Islands, Himachal Pradesh, Karnataka, Manipur, Meghalaya, Mizoram, Orissa, Sikkim, Tamil Nadu, Tripura and West Bengal. *Elsewhere*: Java and Sri Lanka.

Remark: This species is reported earlier by (Mitra *et al.* 2018).

38. *Elimaea (Elimaea) subcarinata* Stål, 1861

Material examined: 1 ♂, Nagrakata TRA, 27.i.2013.

Distribution: India: Manipur, Mizoram, Nagaland and West Bengal. *Elsewhere*: Bangladesh, China, Hong-Kong and Thailand.

39. *Phaneroptera (Phaneroptera) gracilis* Burmeister, 1838 (Plate 1)

Material examined: 1 ♀, Kailashpur tea garden, 15.vii.2013.

Distribution: India: Arunachal Pradesh, Assam, Bihar, Himachal Pradesh, Kamataka, Madhya Pradesh, Manipur, Orissa, Sikkim, Tamil Nadu and Uttarakhand. *Elsewhere*: Africa, Annam, Australia, Celebes, China, Indo-China, Java, Malaysia, Maldive Islands, Myanmar, Solomon, Sri Lanka, Sumatra and Sumba.

Remark: This species is reported first time from the West Bengal.

Discussion

Tea gardens itself occupy a wide variety of functional niches and microhabitats. Insects, the most diverse component of tea gardens play a major role in the sustainable and healthy functioning of tea ecosystem (Mitra *et al.* 2018). While most orthopterans are herbivorous (Snodgrass, 1930; Parker, 1952; Gangwere, 1961; Uvarov, 1966, 1977; Joern, 1979; Le Gall, 1989), feeding habits assume a great diversity of forms, ranging from extreme generalists to strict specialists (Joern, 1979). However, orthopterans may feed on different plant structures such as leaves, flowers, fruits, pollen, etc. (Gangwere, 1961).

The state of West Bengal harbors 278 species of Orthoptera (Shishodia *et al.* 2010). The results of this research indicate that almost 14 percent of Orthopteran species are associated with tea plants of North Bengal. Of them, majority of the species belong to the family Tettigonidae which shares highest 33% of species composition (Figure 2). According to Bidau (2014), carnivory is common in some tettigoniid subfamilies. The family Acrididae shares 31% (Figure 2) of total orthopteran species. The Grasshoppers (Acridids)

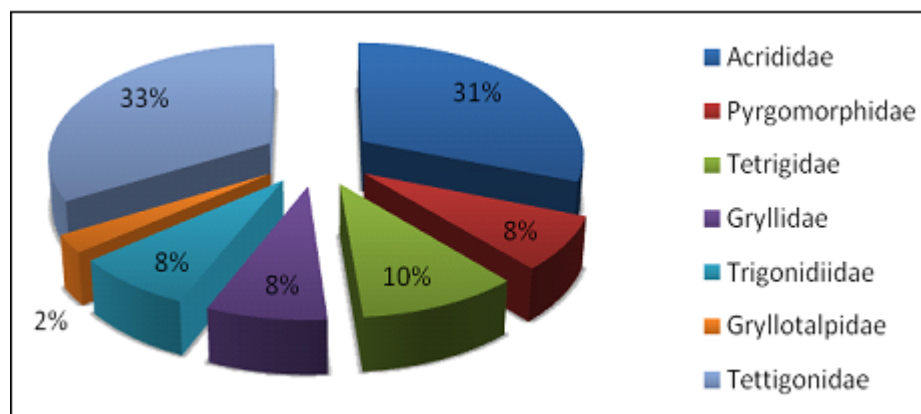


Figure 2. Family-wise species composition (in percentage) of Orthopteran insects in tea agro-ecosystem of West Bengal.

usually feed on various plant parts, like flowers, buds, stems, green bark, leaves and seedlings. Presence of Gryllotalpidae (2%) (Figure 2) in tea ecosystem is not alarming but unhealthy, because mole crickets (Gryllotalpidae) are well-known pests of turfgrass and a number of crops world-wide (Brandenburg *et al.* 2002). Tetrigidae or pygmy grasshopper (10%) (Figure 2) are known to feed variously on algae, lichens, mosses, small plants and detritus although few studies report the diet of individual species (Bidau, 2014). Members of Gryllidae are collectively known as crickets and are often only seen at night, usually remaining concealed during the day on the ground in leaf litter, among vegetation or under logs and stones. Besides this, members of Orthoptera also plays beneficial role in soil ecosystem by creating plant litter for the soil, stimulating plant growth and nutrients and cycling elements (Van Hook, 1971). Both nymphs and adults devour different kinds of vegetation, particularly succulent types. In ecology, these insects provide food

for the predators at all stages of life and some prey upon smaller invertebrates.

The tea gardens being intermixed with other natural ecosystem environs provide a perfect habitat for orthopteran insects to flourish their lives. In conclusion, it can be said that, a long term monitoring study will definitely help to know their specific role in this particular ecosystem and on that basis a better management plan can be prepared for their conservation.

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Plate 1.



Euconocephalus indicus (Redtenbacher, 1891)



Khaoyaiana ambigua (Bolivar, 1900)



Letana gracilis (Ingrisch, 1990b)



Letana linearis (Walker, 1869)



Phaneroptera (Phaneroptera) gracilis (Burmister, 1838)