



Research Article

Natural enemies associated with aphids and coccids from Sikkim, India

SUNIL JOSHI* and RUMKI H. Ch. SANGMA¹

National Bureau of Agricultural Insect Resources, Post Bag No. 2491, H./A. Farm Post, Bellary Road, Bangalore 560024, Karnataka, India

¹National Research Centre for Orchids, Pakyong 737106, Sikkim, India

*Corresponding author E-mail: sunjoshi.pdbc@gmail.com

ABSTRACT: A survey was conducted to collect aphids, coccids and their natural enemies from Sikkim, India. Forty one species of aphids, five species of mealybugs, four species of soft scales, three species of armoured scales and a species of orthozid were recorded. Out of these, seventeen species of aphids, a species of soft scale and mealybug each, were reported for the first time from Sikkim. Two species of aphids were recorded for the first time from India. Among natural enemies of aphids and coccids, twelve species of coccinellids and two species of braconids, one species each of Aphelinidae and Pteromalidae were recorded during the survey. Although there were no new distribution records for natural enemies, four new host associations of coccinellid predators are reported through this study. The present study resulted in addition of 17 new species of aphids and a new species of mealybug to the existing collection of Aphididae and Pseudococcidae at NBAIR, Bangalore.

KEY WORDS: Aphididae, Coccidae, Diaspididae, Pseudococcidae, natural enemies, Sikkim

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INTRODUCTION

India is recognized as one of the twelve mega diversity centres of the world. Out of the eighteen biodiversity hot-spots in the world, India owns two, namely the Western Ghats and the Eastern Himalayas. Sikkim, covering just 0.2 per cent of the geographical area of the country, has tremendous biodiversity and has been identified as one of the hot spots in the eastern Himalayas (Mittermeier *et al.*, 2000).

Reports on the aphid fauna of Sikkim have been published through series of papers earlier (Ghosh and Raychaudhuri, 1968; Ghosh *et al.*, 1971a; Ghosh *et al.*, 1971b and Ghosh *et al.*, 1971c) and a total of 112 species of aphids have been reported from there so far. Recently a survey was conducted for collection of aphids, coccids and their natural enemies from Sikkim. The purpose of this study was to record diversity of Sternorrhynchan pests belonging to Aphididae, Coccidae, Diaspididae and Pseudococcidae families and their natural enemies.

MATERIALS AND METHODS

Survey was conducted during October and November 2014, in Sikkim mainly in areas *viz.*, Tadong (27.3167°

N, 88.6000° E), Pakyong (27.1400° N, 88.6500° E) and Rumtek (27.3319° N, 88.6019° E). Infested plant parts with colonies of aphids, coccids and pseudococcids were collected in the field as such and placed in the plastic ventilated containers (6 inches height and 3 inches diameter). Later part of insect colony was preserved in 75% ethanol for slide preparation and identification, and part of the colony was retained in the plastic containers for parasitoids emergence. Slides were prepared by following standard procedures as given by Blackman and Eastop (2000) for aphids and Williams and Granara de Willink (1992) for coccids. For identification of aphids, keys developed by Blackman and Eastop (2000) and Blackman and Eastop (2006) were used, while for identification of mealybug and armoured scales, keys developed by Williams (2004) and Miller and Davidson (2005) were referred, respectively. Prey records of aphidophagous coccinellids were checked from the review and bibliography published by Agarwala and Ghosh (1988). All coccinellid predators were identified by Dr. J. Poorani, Principal Scientist, NBAIR, Bangalore, and aphid parasitoids were identified by Dr. Ankita Gupta, Scientist, NBAIR, Bangalore. All specimens, unless otherwise mentioned, were collected by the first author and all aphids and coccids were identified by the first author.

RESULTS AND DISCUSSION

A total of 41 species of aphids were collected under 28 genera (Table 1). All these species belonged to the family Aphididae, of which majority, that is 27 species (65 per cent), belonged to the subfamily Aphidinae followed by Hormaphidinae subfamily, under which seven species of aphids (17 per cent) were recorded. Three species of aphids belonged to Greenideinae and two belonged each to Calaphidinae and Lachninae. Of the 27 species of Aphidinae subfamily, 17 species (63 per cent) belonged to tribe Macrosiphini and remaining 37 per cent (10 species) belonged to the tribe Aphidini. All the aphid species of the subfamily Hormaphidinae belonged to the tribe Cerataphidini. The genus *Aphis* Linnaeus was the most predominant under which seven species were recorded. This was followed by the genus *Ceratovacuna* Zehentner under which three species were noted. There were six genera in which more than one species (i.e. two) were recorded; these genera were *Greenidea* Schouteden, *Impatientinum* Mordvilko, *Macrosiphoniella* del Guercio, *Macrosiphum* Oestlund, *Melanaphis* Walsh and *Pseudoregma* Doncaster. These aphids were collected from 26 species of determinate and four species of indeterminate host plants. Poaceae was the most common host family from which ten aphid species were recorded which was closely followed by Asteraceae which harboured seven species of aphids. Three species of aphids were recorded from Rosaceae and two from Fabaceae. Remaining plant families were found to be infested by only one species of aphid. The present study reports 15 aphid species for the first time from Sikkim. Of which, two species viz., *Macrosiphoniella artemisiae* (Boyer de Fonscolombe) and *Uroleucon sonchellum* (Monell) are first records from India. Majority of aphids i.e. nineteen species were collected from Tadong and nine species were recorded from Pakyong, which was obviously because these areas were visited more frequently and more intensive surveys were carried out here. Earlier to this study, 112 species of aphids have been recorded from Sikkim (Ghosh and Raychaudhuri, 1968; Ghosh *et al.*, 1971a; Ghosh *et al.*, 1971b and Ghosh *et al.*, 1971c). This study adds fifteen more species to this list and the total number of aphid species so far recorded from this state stands at 127. Many species of aphids which were not listed in earlier studies but were encountered in the present studies have not been included as new records as many of them were cosmopolitan in nature. Through this survey, 17 species of aphids were added as new to the existing collection of Aphididae at NBAIR, Bangalore.

A total of 13 species of scale insects were recorded in the present study, of which, five species belonged to Pseudococcidae, four to Coccidae, three to Diaspididae and one to Orthezidae (Table 2). These scale insects were recorded from eight determinate plant species and four indeterminate plant species. *Insigniorthesia insignis* (Browne) was recorded from several ornamentals, weeds and tree species. Maximum numbers of scale insects were recorded from plant family Orchidaceae (four out of thirteen species of scale insects). Of the scale insects recorded through this study, *Trionymus palauensis* Beardsley and *Milviscutulus mangiferae* (Green) were recorded for the first time from Sikkim. *Trionymus palauensis* has been recorded earlier from Andhra Pradesh (Williams, 2004) and *M. mangiferae* is common in Bihar, Tamil Nadu and West Bengal (Ali, 1971). *Trionymus palauensis* is also a new addition to our existing collection of mealybugs at NBAIR, Bangalore. Relatively less number of mealybugs could be recorded in the present survey which was perhaps because of low temperature that prevailed during the course of visit and mealybugs are known to prefer warmer weather conditions.

Among natural enemies of aphids and coccids, twelve species of coccinellids and two species of braconids, one species each of Aphelinidae and Pteromalidae were recorded during the survey (Table 1). Although there were no new distribution records for natural enemies, four new host associations of coccinellid predators were reported through this study. Records of *Oenopia mimica* (Weise) on *Taoia indica* (Ghosh and Raychaudhuri), *Calvia explanata* Poorani and *Calvia sykesii* Crotch on *Taoia indica* (Ghosh and Raychaudhuri), and *Alloneda dodecaspilota* (Hope) on *Macrosiphoniella artemisiae* (Boyer de Fonscolombe) are new records of host associations. Coccinellid predators viz., *Macraspis pussilus* Poorani and *Jauravia quadrinotata* Kapur were collected on *Bambusa* sp. which was not infested by any insect pests, similarly, *Coccinella septempunctata* Linnaeus was found on many host plants which were free from any pests and hence these records have not been included in Table 1.

Although intensive surveys have been carried out by the Department of Zoology, University of Kolkata, Kolkata during late sixties and early seventies, the present study resulted into many new distribution records and host associations, which indicates that more frequent and rigorous surveys should be carried out in this area at regular intervals to get exact picture of the existing fauna of aphids and coccids and their natural enemies at this biodiversity hot spot.

Table 1. Aphids and their natural enemies collected from Sikkim

Species	Family/Subfamily/Tribe	Host plant	Natural enemy collected	Place
<i>Aphis craccivora</i> Koch	Aphidinae: Aphidini	<i>Parkia biglandulosa</i> (Fabaceae)	<i>Harmonia sedecimnotata</i> (F.) (Coleoptera: Coccinellidae)	Tadong
<i>Aphis fabae</i> Scopoli	Aphidinae: Aphidini	<i>Maesa chisia</i> (Myrsinaceae)	<i>Scymnus posticalis</i> Sicard (Coleoptera: Coccinellidae)	Pakyong
<i>Aphis gossypii</i> Glover	Aphidinae: Aphidini	<i>Bidens pilosa</i> (Asteraceae) <i>Gazania</i> sp. (Asteraceae)		Tadong Pakyong
<i>Aphis spiraeicola</i> Patch	Aphidinae: Aphidini	<i>Chromolaena odorata</i> (Asteraceae)		Tadong, Pakyong
<i>Aphis (Toxoptera) aurantii</i> (Boyer de Fonscolombe)	Aphidinae: Aphidini	<i>Camellia</i> sp. (Theaceae) <i>Schima wallichii</i> (Theaceae)		Pakyong Pakyong
<i>Aphis (Toxoptera) citricidus</i> (Kirkaldy)	Aphidinae: Aphidini	<i>Citrus</i> sp. (Rutaceae)	<i>Cryptogonus quadrigut-</i> <i>tatus</i> (Weise) (Coleoptera: Coccinellidae); <i>Aphelinus</i> sp. (Hymenoptera: Aphelinidae)	Tadong
<i>Aphis (Toxoptera) odinae</i> (van der Goot)	Aphidinae: Aphidini	<i>Rhus copallinum</i> (Anacardiaceae)		Pakyong
<i>Melanaphis bambusae</i> (Fullaway)	Aphidinae: Aphidini	<i>Bambusa</i> sp. (Poaceae)		Chi-che
<i>Melanaphis sacchari</i> (Zehntner)	Aphidinae: Aphidini	<i>Saccharum officinarum</i> (Poaceae)		Tadong
<i>Rhopalosiphum maidis</i> (Fitch)	Aphidinae: Aphidini	Indeterminate grass (Poaceae)		Bulbay
<i>Acutisiphon obliquoris</i> Basu, Ghosh and Raychaudhuri	Aphidinae: Macrosiphini	<i>Carex</i> sp. (Cyperaceae)		Tadong
<i>Acyrtosiphon pisum</i> (Harris)	Aphidinae: Macrosiphini	Indeterminate tree (Fabaceae)		Rumtek
<i>Aulacorthum solani</i> (Kaltenbach)*	Aphidinae: Macrosiphini	<i>Dendrobium</i> sp. (Orchidaceae)		Pakyong
<i>Brachycaudus helichrysi</i> (Kaltenbach)	Aphidinae: Macrosiphini	<i>Chromolaena odorata</i> (Asteraceae)	<i>Propylea luteopustulata</i> (Mulsant) (Coleoptera: Coc- cinellidae)	Rumtek
<i>Brevicoryne brassicae</i> (Linnaeus)	Aphidinae: Macrosiphini	<i>Brassica oleracea</i> (Brassicaceae)	<i>Aphidius</i> sp. (Hymenoptera: Braconidae); <i>Diaeretiella</i> <i>rapae</i> (M'Intosh) (Hymenop- tera: Braconidae); <i>Pachy-</i> <i>neuron</i> sp. (Hymenoptera: Pteromalidae)	Banjakri
<i>Impatientinum asiaticum</i> Nevsky *	Aphidinae: Macrosiphini	<i>Impatiens</i> sp. (Balsaminaceae)		Pakyong
<i>Impatientinum impatiens</i> (Shinji)	Aphidinae: Macrosiphini	<i>Impatiens</i> sp. (Balsaminaceae)		Pakyong
<i>Lipaphis erysimi</i> (Kaltenbach)	Aphidinae: Macrosiphini	<i>Brassica oleracea</i> (Brassicaceae)		Banjakari
<i>Macrosiphoniella artemisiae</i> (Boyer de Fonscolombe) **	Aphidinae: Macrosiphini	<i>Artemisia</i> sp. (Asteraceae)	<i>Alloneda dodecaspilota</i> (Hope) *** (Coleoptera: Coccinellidae)	Bulbulay
<i>Macrosiphoniella sanborni</i> (Gillette)	Aphidinae: Macrosiphini	<i>Dendranthema grandiflora</i> (Asteraceae)		Tadong

<i>Macrosiphum euphorbiae</i> (Thomas) *	Aphidinae: Macrosiphini	<i>Rosa</i> sp. (Rosaceae)		Tadong
<i>Macrosiphum rosae</i> (Linnaeus)	Aphidinae: Macrosiphini	<i>Rosa</i> sp. (Rosaceae)		Tadong
<i>Myzackaia verbasci</i> (Chowdhuri, Basu, Chakrabarti and Raychaudhuri)*	Aphidinae: Macrosiphini	Indeterminate shrub		Tadong
<i>Myzaphis rosarum</i> (Kaltenbach) *	Aphidinae: Macrosiphini	<i>Rosa</i> sp. (Rosaceae)		Bulbulay
<i>Myzus persicae</i> (Sulzer)	Aphidinae: Macrosiphini	<i>Pelargonium</i> sp. (Geraniaceae)		Pakyong
<i>Pentalonia nigronervosa</i> Coquerel	Aphidinae: Macrosiphini	<i>Musa paradisiaca</i> (Musaceae)		Tadong
<i>Uroleucon sonchellum</i> (Monell)**	Aphidinae: Macrosiphini	<i>Sonchus</i> sp. (Asteraceae)		Tadong
<i>Taovia indica</i> (Ghosh and Raychaudhuri)	Calaphidinae: Calaphidini	<i>Alnus nepalensis</i> (Betulaceae) <i>Alnus nepalensis</i> (Betulaceae)	<i>Oenopia mimica</i> (Weise) *** (Coleoptera: Coccinellidae); <i>Calvia explanata</i> Poorani *** (Coleoptera: Coccinellidae); <i>Calvia sykesii</i> Crotch *** (Coleoptera: Coccinellidae)	Tadong Pakyong
<i>Tinocallis himalayensis</i> Ghosh, Ghosh and Raychaudhuri	Calaphidinae: Panaphidini	<i>Duabanga grandiflora</i> (Lythraceae)		Tadong
<i>Eutrichosiphum raychaudhurii</i> (Ghosh)*	Greenideinae: Greenideini	<i>Alnus</i> sp. (Betulaceae)	<i>Oenopia sexareata</i> (Mulsant) (Coleoptera: Coccinellidae)	Tadong
<i>Greenidea bucktonis</i> Ghosh, Basu and Raychaudhuri*	Greenideinae: Greenideini	<i>Duabanga grandiflora</i> (Lythraceae)		Tadong
<i>Greenidea ficicola</i> Takahashi	Greenideinae: Greenideini	<i>Ficus hookeri</i> (Moraceae) <i>Psidium guajava</i> (Myrtaceae)		Tadong Rumtek
<i>Astegopteryx bambusae</i> (Buckton)	Hormaphidinae: Cerataphidini	<i>Bambusa</i> sp. (Poaceae)		Baluakhani
<i>Ceratovacuna lanigera</i> Zehntner	Hormaphidinae: Cerataphidini	<i>Saccharum officinarum</i> (Poaceae)		Bulbulay
<i>Ceratovacuna silvestrii</i> (Takahashi) *	Hormaphidinae: Cerataphidini	<i>Lophantherum gracile</i> (Poaceae)		Chi-Che
<i>Ceratovacuna spinulosa</i> Ghosh and Raychaudhuri *	Hormaphidinae: Cerataphidini	Indeterminate grass (Poaceae)		Chi-Che
<i>Glyphinaphis bambusae</i> van der Goot *	Hormaphidinae: Cerataphidini	<i>Bambusa</i> sp. (Poaceae)		Bulbulay
<i>Pseudoregma bambusicola</i> (Takahashi) *	Hormaphidinae: Cerataphidini	<i>Bambusa</i> sp. (Poaceae)		Chi-che
<i>Pseudoregma montana</i> (van der Goot) *	Hormaphidinae: Cerataphidini	<i>Bambusa</i> sp. (Poaceae)		Chi-che
<i>Nippolachnus piri</i> Matsumura **	Lachninae: Lachnini	Indeterminate tree		Tadong
<i>Stomaphis</i> sp. **	Lachninae: Lachnini	Collected in yellow pan trap		Tadong

* New records from Sikkim

** New records from India

*** New host associations

Table 2. Coccids collected from Sikkim

Species	Family	Host plant	Place
<i>Milviscultulus mangiferae</i> (Green) *	Coccidae	Indeterminate tree	Tadong
<i>Coccus hesperidum</i> Linnaeus		<i>Dendrobium</i> sp. (Orchidaceae)	Pakyong
<i>Coccus viridis</i> (Green)		<i>Citrus</i> sp. (Rutaceae)	Tadong
<i>Saissetia oleae</i> (Olivier)		<i>Ficus bengalensis</i> (Moraceae)	Rumtek
<i>Aspidiotus destructor</i> Signoret	Diaspididae	<i>Dendrobium</i> sp. (Orchidaceae)	Pakyong
<i>Aulacaspis tubercularis</i> Newstead		<i>Mangifera indica</i> (Anacardiaceae)	Chi-che
<i>Diaspis boisduvalii</i> Signoret		<i>Dendrobium</i> sp. (Orchidaceae)	Pakyong
<i>Pseudococcus longispinus</i> (Targioni Tozzetti)	Pseudococcidae	<i>Dendrobium</i> sp. (Orchidaceae), <i>Beaucarnea recurvata</i> (Ruscaceae)	Pakyong Tadong
<i>Rastrococcus invadens</i> Williams		Indeterminate tree	Tadong
<i>Trionymus palauensis</i> Beardsley *		Indeterminate grass (Poaceae)	Tadong
<i>Paracoccus marginatus</i> Williams and Granara de Willink		<i>Hibiscus</i> sp. (Malvaceae)	Rumtek
<i>Phenacoccus solenopsis</i> Tinsley		Indeterminate weed	Rumtek
<i>Insignorthezia insignis</i> (Browne)	Orthezidae	Many host plants	Rumtek, Tadong, Pakyong

*New records from Sikkim

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