

SPECIES DIVERSITY OF WHITEFLIES (ALEYRODIDAE: HOMOPTERA) IN INDIA

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ABSTRACT

Whiteflies comprise a single hemipterous family, Aleyrodidae, and they are economically important as sap-sucking insects infesting a wide range of host plants. The taxonomy of whiteflies is based on nymphal characters, which have great advantage because of the sessile nature of the puparium and it is possible to collect and identify host-plants with the species of whitefly. In India, the family Aleyrodidae is represented by two subfamilies, Aleyrodinae and Aleurodicinae, comprising 290 species under 57 genera. Among them several species are economically important as pests of crops, ornamental plants and forestry plants. In addition, a few Indian whiteflies are reported to exhibit phenotypic plasticity and hence there is a need for the study of large number of specimens associated with different hosts to establish species status of whiteflies.

INTRODUCTION

The family Aleyrodidae (Insecta: Homoptera: Sternorrhyncha) includes insects, which are commonly referred to as whiteflies. They are small inconspicuous phytophagous bugs, often overlooked despite their abundance on the lower surface of leaves. They are not true flies but belong to the order Homoptera, which includes aphids, scale insects and psyllids (David & Subramaniam, 1976). They are

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plant bugs, but the name whitefly is derived from the white appearance of adults of most species due to the deposition of wax on the body and wings, and from their tendency to fly when disturbed. This group of insects is similar to scale insects, except in the adult stage in which they have two pairs of floury wings that are usually white, with a few veins and dusted with wax, and so they are referred to as mealy wings. The female adults lay eggs which are provided with a stalk or pedicel at one end with which they are attached to the leaf. The first nymphal instar is called the crawler, because of its habit of crawling on the leaf surface after its eclosion until it finds a suitable place to settle down and start feeding. The legs and antennae of the second, third and fourth nymphal instars are atrophied and these instars are sessile. The adult develops within the quiescent fourth instar, usually referred to as the "puparium". The classification of aleyrodids is based on the puparium and not on the structure of adults. Martin (2003) commented that 'it seems almost certain that puparia will continue to be dominant in whitefly systematics and there is no particular reason for larval characters to be regarded as second-rate'.

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There are currently around 1,420 known species of whiteflies under two subfamilies, viz., Aleyrodinae and Aleuordicinae (Ko, 2001). Sampson (1943) proposed five tribes under the subfamily Aleyrodinae, viz., Neomaskellini, Aleurochitonini, Siphonini, Dialeurodini and Aleurodini. A 6th tribe namely, Trialeurodini was proposed by Russell (1947). Takahashi (1954) proposed two more tribes Aleurocanthini and Aleurolobini. David (1990) placed the then known 35 genera of Indian Aleyrodidae among 12

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tribes, of which 5, viz., Aleuroplatini, Bemisini, Lipaleyrodini, Tetraleyrodini and Zaphanerini were proposed as new tribes. A perusal of literature indicates that the known Indian fauna of whiteflies comprises 290 species in 57 genera (Table1).

Table 1. Species diversity of whiteflies in India

Tribe		Genus	No. of species
SUB-FAMILY ALEUODINAE Westwood			
I. Aleucanthini Takahashi	1	<i>Aleuorcanthus</i> <i>Quaintance & Baker</i>	31
II. Aleuolonini Takahashi	2	<i>Africaleyrodes</i> Dozier	1
	3	<i>Aleurolobus</i> Quaintance & Baker	49
	4	<i>Aleuopapillatus</i> Regu & David	2
	5	<i>Asterochiton</i> Maskell	1
	6	<i>Crescentaleyrodes</i> David & Jesudasan	1
	7	<i>Orientalleyrodes</i> David	1
	8	<i>Rositalleyrodes</i> Meganthan & David	
	9	<i>Sphericalleyrodes</i> Selvakumaran & David	1
	10	<i>Vasantharajiella</i> David	1
III. Aleuroplatini David	11	<i>Aleuroplatus</i> Quaintance & Baker	5
	12	<i>Viennotalleyrodes</i> Cohic	2
IV. Aleurodini Sampson	13	<i>Aleuromarginatus</i> Corbett	3
	14	<i>Aleurotrachelus</i> Quaintance & Baker	8
	15	<i>Aleurotulus</i> Quaintance & Baker	1

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Tribe		Genus	No. of species
	16	<i>Aleyrodes</i> Latreille	1
	17	<i>Crenidorsum</i> Russell	1
	18	<i>Hindaleyroes</i> Meganthan & David	1
	19	<i>Mohanasundaramiella</i> David	1
	20	<i>Vasdauidus</i> Russell	2
V. Bemisini David	21	<i>Acanthobemisia</i> Takahashi	1
	22	<i>Bemisia</i> Quaintance & Baker	6
	23	<i>Indoaleyrodes</i> David & Subramaniam	1
	24	<i>Neopealius</i> Takahashi	1
	25	<i>Parabemisia</i> Takahashi	2
	26	<i>Pealius</i> Quaintance & Baker	10
	27	<i>Setaleyrodes</i> Takahashi	
VI. Dialeurodini Sampson	28	<i>Aleuroclava</i> Singh	49
	29	<i>Asialeyrodes</i> Sundararaj & David	6
	30	<i>Cockerelliella</i> Sundararaj & David	9
	31	<i>Dialeurodes</i> Cockerell	12
	32	<i>Dialeurolonga</i> Dozier	4
	33	<i>Dialeuropora</i> Quaintance & Baker	3
	34	<i>Dialeuronomada</i> Quaintance & Baker	16
	35	<i>Fippataleyrodes</i> Sundararaj & David	2
	36	<i>Gigaleurodes</i> Quaintance & Baker	1

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Tribe		Genus	No. of species
	37	<i>Kanakarajiella</i> David & Sundararaj	1
	38	<i>Martiniella</i> Jesudasan & David	3
	39	<i>Massilieurodes</i> Goux	1
	40	<i>Minutaleyrodes</i> Jesudasan & David	1
	41	<i>Rabdostigma</i> Quaintance & Baker	2
	42	<i>Rhachisphora</i> Quaintance & Baker	5
	43	<i>Rustostigma</i> Quaintance & Baker	1
	44	<i>Singhiella</i> Sampson	5
	45	<i>Singhius</i> Takahashi	4
	46	<i>Santhiniae</i> David	1
	47	<i>Taiwanaleyrodes</i> Takahashi	2
VII. Lipaleurodini David	48	<i>Lipaleyrodes</i> Takahashi	4
VIII. Neomaskellini Sampson	49	<i>Acaudaleyrodes</i> Takahashi	1
	50	<i>Cohicaleyrodes</i> Bink-Moenen	4
	51	<i>Neomaskellia</i> Quaintance & Baker	1
IX. Siphonini Sampson	52	<i>Siphoninus</i> Silvestri	1
X. Tetraleurodini David	53	<i>Tetraleurodes</i> Cockerell	6
XI. Trialeurodini Russell	54	<i>Trialeurodes</i> Cockerell	2
XII. Zaphanera David	55	<i>Keralaleyrodes</i> Meganathan & David	1
	56	<i>Zaphanera</i> Corbett	2
SUB-FAMILY ALEURODICINAE Westwood			
	57	<i>Aleurodicus</i>	4
Total number of species			290

ECONOMIC IMPORTANCE OF WHITEFLIES

Aleyrodids rank among the most noxious insects attacking field crops, green house crops and plants and trees around the world. Considerable economic loss results from various types of injuries leading to death of plants in nurseries and plantations. In India, a number of species of whiteflies are known to damage the crops, ornamental plants and tree species. The economic loss is due to their activities of sucking the plant sap, acting as vectors of viral diseases, and production of honey dew leading to the development of mould on leaves, thus, adversely affecting photosynthesis. The species that cause such damage are listed in table 2.

Table 2: Economically important whiteflies of India

Common name	Whitefly species	Host plant
Arecanut whitefly	<i>Aleurocanthus arecae</i> David & Manjunatha	Arecanut and Coconut
Babul whitefly	<i>Acaudaleyrodes rachipora</i> (Singh)	Many arid zone forestry tree species
Betelvine whitefly	<i>Aleurocanthus rugosa</i> (Singh)	Betelvine
Betelvine whitefly	<i>Singhiella pallida</i> (Singh)	Betelvine
Cardamom whitefly	<i>Singhiella cardamomi</i> (David & Subramaniam)	Cardamom
Cardamom whitefly	<i>Aleuroclava cardamomi</i> (David & Subramaniam),	Cardamom
Citrus whitefly	<i>Aleurocanthus woglumi</i> Ashby	Citrus
Citrus whitefly	<i>Dialeurodes citri</i> (Ashmead)	Citrus

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Common name	Whitefly species	Host plant
Cotton whitefly	<i>Bemisia tabaci</i> (Gennadius)	Many agricultural and ornamental plants. Also vector of many viral diseases
Greenhouse whitefly	<i>Trialeurodes vaporariorum</i> (Westwood)	Potato
Jasmine whitefly	<i>Dialeurodes kirkaldyi</i> (Kotinsky)	Jasmine. Vector of "chlorotic ring spot disease" in jasmine
Jasmine whitefly	<i>Kanakarajiella vulgaris</i> (Singh)	Jasmine
Mulberry whitefly	<i>Dialeuropora decempuncta</i> (Quaintance & Baker)	Mulberry
Spiralling whitefly	<i>Aleurodicus dispersus</i> Russell	Many agricultural, horticultural and forestry tree species
Sugarcane whitefly	<i>Aleurolobus barodensis</i> (Maskell)	Sugarcane
Sugarcane whitefly	<i>Neomaskellia bergii</i> (Signoret)	Sugarcane

PHENOTYPIC PLASTICITY IN WHITEFLIES

Some whitefly species vary in their puparium depending on the host plant cuticle on which they develop, and this has caused a considerable amount of misidentification (Mound, 1963). Hence, deduction from host plant associations must always be approached with caution (Mound & Halsey, 1978). Takahashi (1933) established a correlation between the structure of the puparium and nature

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of host plant leaves. Phenotypic variations were reported in a few species like *Bemisia tabaci* (Gennadius) (Hussain & Trehan, 1933), (Mound, 1963 and David & Ananthakrishnan, 1976), *Aleyrodes Ionicerae* Walker (Despande, 1933), *Asterobemisia carpini* (Koch) (Trehan, 1940), *Trialeurodes* spp (Russell, 1948), *Acaudaleyrodes rachipora* (Singh) (Mound, 1965 and Bink-Moenen, 1983), *Trialeurodes ricini* (Singh) (David & Ananthakrishnan, 1976) and *Dialeurodes kirkaldyi* (Kotinsky) (Sundararaj & David, 1992). The phenotypic plasticity reported in Indian species of whiteflies is listed in Table 3.

Table 3 : Indian whitefly species, which are reported to show phenotypic plasticity

Whitefly species	Details of morphological plasticity	Characteristics of leaf influencing plasticity
<i>Acaudaleyrodes rachipora</i> (Singh)	Nature of margin	Leaf surface
<i>Aleurolobus niloticus</i> Priesner & Hosney	Size, shape, position of submarginal setae, nature of thoracic comb and size of vasiform orifice and caudal furrow	Leaf surface
<i>Aleurolobus orientalis</i> David & Jesudasan	Size, shape and length of submarginal setae	Leaf surface
<i>Bemisia tabaci</i> (Gennadius)	Number of seta	Leaf hair
<i>Dialeurodes kirkaldyi</i> (Kotinsky)	Number of tubercles in male puparium	Leaf hair
<i>Keralaleyrodes indicus</i> Meganthan & David	Setal length	Leaf thickness
<i>Pealius simplex</i> (Singh)	Puparium size, nature of margin and microsetae on dorsum	Leaf surface
<i>Singhiella bassiae</i> (David & Subrmaniam)	Number of setae	Leaf surface

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<i>Trialeurodes ricini</i> (Misra)	Row of papillae	Leaf hair
<i>Trialeurodes vaporariorum</i> (Westwood)	Number of tubercles	Leaf surface

DISCUSSION AND CONCLUSION

The taxonomy of whiteflies is based on nymphal characters. This has great advantage because of the sessile nature of the puparium and it is possible to collect and identify host-plants with the species of whitefly. Out of about 1,420 species of world Aleyrodidae now known (Ko, 2001) 290 species now occur in India under 57 genera, which constitute 29.66%. However this diversity seems to be a moderate estimation as India, being a tropical country, could be expected to have much more number of whiteflies compared to cooler regions of the world (Bink-Moenen and Mound, 1990). Hence there is a need for further extensive study of aleyrodid fauna of India as related to the ecological and geographical distribution pattern of various genera. Several species of whiteflies are economically important in India. Some whiteflies suddenly emerge in economically damaging populations, infesting new host plants and invading new areas, a phenomenon happening in recent years. The present outbreak of *A. disperses* in areas of south Western Ghats and *Dialeuropora decempuncta* on mulberry in north eastern India are typical examples of concern. Further expression of phenotypic plasticity in a few species of whiteflies suggests that species characteristics are not immutable, but are influenced by the environment and can be highly variable. Often the Aleyrodid literature is replete with cases of mistaken identity of a whitefly species. One of the most spectacular of these relates to the cotton whitefly *Bemisia tabaci*, which has many synonyms because the structure of its puparium is highly variable and dependent upon the form of the host plant leaf. These observations emphasise caution in whitefly taxonomy and the need for the study of large numbers of specimens associated with

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different hosts and establish whether the species is capable of showing plasticity or a stable one.

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