Entomology

Association of aphids with plants belonging to order Nymphaeales, Austrobaileyales, Laurales, Magnoliales and Piperales (Angiosperms) in India

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Abstract

The present article provides an updated checklist of aphids (Homoptera: Aphididae) infesting plants belonging to groups/clades: Basal angiosperms comprising 3 early evolving orders, Amborellales, Nymphaeales and Austrobaileyales; and magnoliids comprising 3 orders, Laurales, Piperales and Magnoliales recorded in India. Aphid association of basal angiosperms is very poor, only 6 species of plants are found associated with 3 species of aphids. Two species, *Rhopalosiphum maidis* (Fitch) and *Rhopalosiphum nymphaeae* (Linnaeus) used plants of the family Nymphaeaceae. Among the clade mangoliids, 14 species of plants of the family Lauraceae, are associated with 38 species of aphids followed by Magnoliaceae (4 species of plants are associated with 13 species of aphids. Six species of *Aiceona* Takahashi are only associated with Lauraceae. *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe uses 13 plant species of the clade mangoliids followed by *Sinomegoura citricola* (van der Goot) (9 plant species) and *Aphis (Aphis) gossypii* Glover (7 plant species). Total 33 species of plants belonging to these orders are colonised by 53 species of aphids belonging to 28 genera.

Keywords: annonaceae, aphids, aristolochiaceae, checklist, lauraceae, magnoliaceae, nymphaeaceae, schisandraceae

Introduction

Angiosperms are plants having flowers and fruits enclosing seeds and are highly diverse group of land plants with about 3,00,000 species. There are eight groups of living angiosperms: 3 basal angiosperms having an early-diverging grade (orders Amborellales, Nymphaeales, Austrobaileyales) and 5 core angiosperms (Chloranthales, Magnoliids, Monocots, Ceratophyllum, Eudicots). Their phylogeny remains unclear but following hierarchy given in APG III [1] is accepted (Figure 1). Number of families, genera and species of these plants are given in Table 1. The present article deals with the aphid association of two orders of basal angiosperms (Nymphaeales, Austrobaileyales) and three orders of the group magnoliids (Laurales, Piperales, Magnoliales) recorded in India.

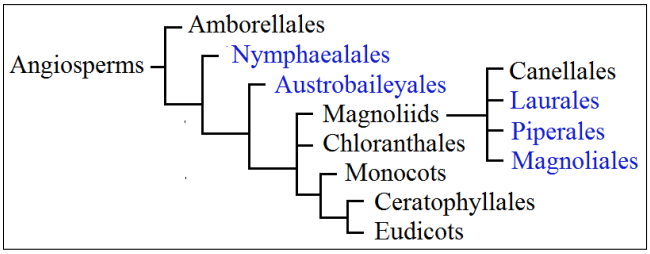

Fig 1: Hierarchy of Nymphaeales, Austrobaileyales, Laurales, Magnoliales and Piperales in angiosperm phylogeny [1]

The aphids (Hemiptera: Aphididae) are small, soft-bodied plant sap-sucking insect pests. Their tiny size, complex life-cycles with alternation of sexual and asexual generations, host plant alternation, polymorphism, short and telescopic generations make them highly prolific in reproduction [2]. They harm the plants by two ways, either by devitalizing them by directly sucking their nutrients or indirectly hampering their normal physiology by secreting high amount of honeydew that blocks stomata and also promotes growth of black sooty moulds [3]. They also transmit hundreds of viral diseases [4]. At present all true aphids belong to a single family Aphididae consisting of 23 subfamilies and 5109 species under 527 genera [5]. In India, 794 species of aphids under 208 genera are known [6]. The information regarding the aphid-food plant association is essential because of the pestiferous status of aphids. Raychaudhuri [7] was the first to catalogue the food plants of Indian aphids which was subsequently updated [8-18].

Materials and Methods

The aphid and host plant records in this checklist are taken from a wide variety of resources such as books, journals, proceedings and a few authentic theses and websites up to November 20, 2022. It may unavoidably include some percentage of misidentifications, both of aphids and their host plants. Some aphid species may also be vagrant individuals on a given host plant [19, 20]. The names of aphids, as well as plants that were misspelt in the original records have been corrected where we logically ascertain the intended species. In the present checklist, attempts have been made to provide the valid scientific names of the aphids following Favret [5], and of the plants, following WFO [21]. In the first inventory of plant names, their synonyms recorded in India are also provided. Only one reference of each record was cited.

Results and Discussion

I. Basal angiosperms

A. Order: Nymphaeales, Family: Nymphaeaceae

The plants belonging to the order Nymphaeales do not have a vascular cambium, which is required to produce both xylem and phloem. It comprises three families of aquatic plants, the Hydatellaceae, the Cabombaceae, and the Nymphaeaceae (water lilies). All these plants have broad leaf base and large, showy flowers. In India, only 5 species of plants of the family Nymphaeaceae is known to act as host plants by 2 species of aphids as given below.

- ***Euryale ferox* Salisb.**
  - *Rhopalosiphum nymphaeae* (Linnaeus, 1761) [22]
- ***Nymphaea alba* L.**
  - *Rhopalosiphum nymphaeae* (Linnaeus, 1761) [23]
- ***Nymphaea candida* J.Presl & C.Presl**
  - *Rhopalosiphum maidis* (Fitch, 1856) [24]
- ***Nymphaea lotus* L.**
  - *Rhopalosiphum nymphaeae* (Linnaeus, 1761) [25]
- ***Nymphaea rubra* Roxb. ex Andrews**
  - *Rhopalosiphum nymphaeae* (Linnaeus, 1761) [26]

B. Order: Austrobaileyales, Family: Schisandraceae

Austrobaileyales includes three families, the Austrobaileyaceae, Schisandraceae and Trimeniaceae, however, in India, only one species, *Schisandra grandiflora* Hook.f. & Thomson belonging to the family Schisandraceae is known as host plant of a single species of aphid, *Rhopalosiphoninus* (*Rhopalosiphoninus*) *ehretis* Bhattacharya & Chakrabarti, 1982 [27].

II. Clade: Magnoliids

The clade magnoliids includes several economically important plants, e.g. magnolias, nutmeg, bay laurel, cinnamon, avocado, black pepper, tulip tree, etc, is the third-largest group of angiosperms after the eudicots and monocots. According to the APG IV system, the clade comprises 4 orders, Canellales, Laurales, Magnoliales and Piperales [28]. In India, only plants belonging to the last three orders are found associated with aphids.

1. Order: Laurales

A. Family: Lauraceae

The order Laurales comprises seven families of trees and shrubs (Table 1), mostly distributed in tropics and subtropics. In India, the aphids are associated only with the family Lauraceae which includes the true laurel and its closest relatives. Few plants of this family are aromatic and their essential oils are valued for fragnances, some are used in cooking, few are valued in medicine, some are cultivated- for camphor and timber production. In India, out of 205 species under 20 genera known, only 14 species of 8 genera are associated with 38 species of aphids belonging to 20 genera as stated below.

- ***Actinodaphne corymbosa* Blume (=*Litsea corymbosa* m.i.)**
  - *Nipponaphis manoji* Ghosh & Raychaudhuri, 1973 [29]
  - *Schizoneuraphis himalayensis* (Ghosh & Raychaudhuri, 1973) [30]
  - *Schizoneuraphis machiliphaga* Takahashi, 1959 [31]
- ***Cinnamomum camphora* (L.) J. Presl**
  - *Sinomegoura citricola* (van der Goot, 1917) [32]
- ***Cinnamomum tamala* T.Nees & Eberm.**
  - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776) [32]
- ***Cinnamomum* sp.**
  - *Eutrichosiphum makii* Raychaudhuri & Chatterjee, 1974 [33]
- ***Lindera* sp.**
  - *Aphis (Aphis) spiraecola* Patch, 1914 [32]
  - *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [34]
  - *Eutrichosiphum* sp. [35]
  - *Metanipponaphis silvestrii* (Takahashi, 1935) [30]
  - *Myzus (Myzus) obtusirostris* David, Narayanan & Rajasingh, 1971 [36]
  - *Schizoneuraphis himalayensis* (Ghosh & Raychaudhuri, 1973) [30]
  - *Sitobion (Sitobion)* sp. [37]
  - *Takecallis arundinariae* (Essig, 1917) [32]
  - *Taoia indica* (Ghosh & Raychaudhuri, 1972) [32]
- ***Litsea cubeba* Pers. (syn. *Litsea citrata* Blume)**
  - *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [38]
  - *Eutrichosiphum sankari* Raychaudhuri, Ghosh, Banerjee & Ghosh, 1973 [39]
  - *Mollitrichosiphum (Mollitrichosiphum) tenuicorpus* (Okajima, 1908) [39]
- ***Litsea glutinosa* (Lour.) C.B. Rob. (syn. *Litsea sebifera* Pers.)**
  - *Eutrichosiphum dubium* (van der Goot, 1917) [40]
  - *Eutrichosiphum litseae* Raychaudhuri, Raha & Raychaudhuri, 1977 [41]
  - *Lachnus tropicalis* (van der Goot, 1916) [42]
  - *Parathoracaphis manipurensis* (Pramanick, Samanta & Raychaudhuri, 1983) [30]
  - *Thoracaphis* sp. [43]
- ***Litsea monopetala* Pers. (syn. *Litsea polyantha* Juss.)**
  - *Aiceona (Aiceona) robustiseta* Ghosh & Raychaudhuri, 1973 [44]
  - *Aiceona (Aiceona) titabarensis* (Raychaudhuri & Ghosh, 1964) [45]
  - *Aphis (Aphis) craccivora* Koch, 1854 [46]
  - *Aphis (Aphis) gossypii* Glover, 1877 [43]
  - *Aphis (Aphis) spiraecola* Patch, 1914 [47]
  - *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [34]
  - *Aphis (Toxoptera) citricidus* (Kirkaldy, 1907) [48]
  - *Greenidea (Greenidea) ficicola* Takahashi, 1921 [49]
  - *Greenidea (Trichosiphum) psidii* van der Goot, 1917 [49]
  - *Greenideoida (Pentatrichosiphum) lutea* (Basu, 1969) [50]
  - *Kurisakia indica* Basu, 1967 [51]
  - *Nipponaphis manoji* Ghosh & Raychaudhuri, 1973 [29]
  - *Nipponaphis* sp. [51]
  - *Schizoneuraphis himalayensis* (Ghosh & Raychaudhuri, 1973) [29]
  - *Schizoneuraphis machiliphaga* Takahashi, 1959 [50]
  - *Sinomegoura citricola* (van der Goot, 1917) [43]
- ***Litsea salicifolia* Hook.f.**
  - *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [52]
  - *Sinomegoura citricola* (van der Goot, 1917) [32]

- ***Litsea* sp.**
- *Aiceona (Aiceona) titabarensis* (Raychaudhuri & Ghosh, 1964) [44]
- *Aphis (Aphis) gossypii* Glover, 1877 [32]
- *Aphis (Aphis) spiraecola* Patch, 1914 [32]
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [48]
- *Chaitophorus indicus* Ghosh, Ghosh & Raychaudhuri, 1970 [53]
- *Eutrichosiphum makii* Raychaudhuri & Chatterjee, 1974 [39]
- *Greenidea (Greenidea) ficicola* Takahashi, 1921 [54]
- *Kurisakia indica* Basu, 1967 [54]
- *Schizoneuraphis machiliphaga* Takahashi, 1959 [30]
- ***Machilus gamblei* King ex Hook.f. (syn. *Persea bombycina* (King ex Hook.f.) Kosterm.)**
- *Aiceona* sp. [55]
- *Aphis (Aphis) craccivora* Koch, 1854 [46]
- ***Machilus odoratissimus* Nees (syn. *Persea odoratissima* (Nees) Kosterm.)**
- *Aiceona (Aiceona) pseudosugii* David, Sekhon & Bindra, 1970 [56]
- *Aiceona (Subaiceona) manipurensis* [57]
- *Machilaphis machili* (Takahashi, 1928) [37]
- *Schizoneuraphis himalayensis* (Ghosh & Raychaudhuri, 1973) [43]
- ***Machilus villosa* Hook.f.**
- *Aiceona (Aiceona) pallida* Ghosh & Raychaudhuri, 1972 [30]
- ***Machilus* sp.**
- *Aiceona (Aiceona) pseudosugii* David, Sekhon & Bindra, 1970 [58]
- *Aiceona (Aiceona) retipennis* David, Narayanan & Rajasingh, 1970 [59]
- *Nipponaphis monzeni* Takahashi, 1958 [30]
- *Schizoneuraphis himalayensis* (Ghosh & Raychaudhuri, 1973) [50]
- ***Neolitsea umbrosa* (Nees) Gamble (syn. *Litsea khasiana* (Meissn.)**
- *Eutrichosiphum flavum* (Takahashi, 1941) [60]
- ***Persea* sp.**
- *Schizoneuraphis himalayensis* (Ghosh & Raychaudhuri, 1973) [29]
- ***Phoebe lanceolata* (Nees) Nees**
- *Aiceona (Aiceona) retipennis* David, Narayanan & Rajasingh, 1970 [32]
- **Indetermined species**
- *Aiceona (Aiceona) retipennis* David, Narayanan & Rajasingh, 1970 [61]
- *Aiceona (Aiceona) titabarensis* (Raychaudhuri & Ghosh, 1964) [62]
- *Greenideoida (Greenideoida) bhalukpongensis* Ghosh, Banerjee & Raychaudhuri, 1971 [37]

2. Order: Magnoliales

The order Magnoliales includes 7 families, however, only 2 families, Annonaceae and Magnoliaceae are associated with aphids in India.

A. Family: Annonaceae

The Annonaceae, commonly known as the custard apple family, consists of trees, shrubs, or rarely lianas and is distributed mostly in the tropics. Several species of the family are used as food (annona: custard apple, sweetsop), medicines, etc. In India, out of 154 species under 25 genera known, only 5 species of 5 genera are associated with 8 species of aphids belonging to 4 genera as stated below.

- ***Annona squamosa* L.**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [34]
- *Taiwanaphis (Taiwanaphis) kalipadi* (Raychaudhuri & Ghosh, 1964) [63]
- ***Annona* sp.**
- *Aphis (Aphis) gossypii* Glover, 1877 [64]
- *Aphis (Aphis) odinae* (vander Goot, 19717) [55]
- ***Artabotrys hexapetalus* (L.f.) Bhandari (syn. *Artabotrys odoratissimus* R. Br.**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [65]
- *Aphis (Toxoptera) citricidus* (Kirkaldy, 1907) [66]
- ***Artabotrys* sp.**
- *Greenidea (Trichosiphum) anonae* (Pergande, 1906) [67]
- ***Monoon longifolium* (Sonn.) B.Xue & R.M.K.Saunders (syn. *Polyalthia longifolia* (Sonn.) Thwaites)**
- *Lachnus tropicalis* (van der Goot, 1916) [68]
- *Aphis (Aphis) gossypii* Glover, 1877 [69]
- *Aphis (Aphis) spiraecola* Patch, 1914 [69]
- ***Polyalthia* sp.**
- *Aphis (Aphis) gossypii* Glover, 1877 [70]
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [71]
- ***Uvaria narum* Wall.**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [65]

B. Family: Magnoliaceae

The Magnoliaceae, commonly known as the magnolia family consists of only two genera, *Magnolia* and *Liriodendron* (tulip trees). Few members of this family are economically important for light weight timber and medicine. In India, out of 33 species known (Table 1), only 4 species are associated with 13 species of aphids belonging to 6 genera as mentioned below.

- ***Magnolia campbellii* Hook.f. & Thoms.**
- *Formosaphis micheliae* Takahashi, 1925 [47]
- ***Magnolia champaka* (L.) Baill. ex Pierre (syn. *Michelia champaka* L.)**
- *Aphis (Aphis) fabae* Scopoli, 1763 [43]
- *Aphis (Aphis) gossypii* Glover, 1877 [43]
- *Aphis (Aphis) nasturtii* Kaltenbach, 1843 [31]
- *Aphis (Aphis) spiraecola* Patch, 1914 [66]
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [54]
- *Formosaphis micheliae* Takahashi, 1925 [72]
- *Prociphilus (Prociphilus) micheliae* Hille Ris Lambers, 1933 [73]
- *Prociphilus (Prociphilus) osmanthae* Essig & Kuwana, 1918 [50]
- *Sinomegoura citricola* (van der Goot, 1917) [43]
- ***Magnolia grandiflora* L.**
- *Sinomegoura citricola* (van der Goot, 1917) [43]
- ***Magnolia stellata* (Siebold & Zucc.) Maxim.**
- *Formosaphis micheliae* Takahashi, 1925 [47]
- ***Magnolia* sp.**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [34]

- *Aphis (Toxoptera) citricidus* (Kirkaldy, 1907) [32]
- *Aphis (Toxoptera) odinae* (van der Goot, 1917) [48]
- *Prociphilus (Prociphilus) micheliae* Hille Ris Lambers, 1933 [67]
- *Pseudomegoura magnoliae* (Essig & Kuwana, 1918) [32]
- *Sinomegoura citricola* (van der Goot, 1917) [32]
- *Tinocallis (Tinocallis) magnoliae* Ghosh & Raychaudhuri, 1972 [63]

3. Order: Piperales

The order Piperales include the black pepper, kava, lizard's tail, birthwort, and wild ginger. It consists of three families, but in India, only 2 families, Aristolochiaceae and Piperaceae are recorded.

A. Family: Aristolochiaceae

The Aristolochiaceae, commonly known as the birthwort family, are mostly perennial, herbaceous plants, shrubs, or lianas. In India, only one unidentified species of *Saruma* Oliv. is associated with a single species of aphid, *Aulacorthum (Aulacorthum) rhamni* Ghosh, Ghosh & Raychaudhuri, 1971 [31].

B. Family: Piperaceae

The Piperaceae, also known as the pepper family, mostly distributed pantropically. The plants are highly economically important as they are used as spices (black pepper, *Piper nigrum* L.), traditional medicines (long pepper, *Piper longum* L.; betel, *Piper betle* L.). In India, out of 84 species known, only 3 species are used as host plant by 3 species of aphids belonging to 2 genera as mentioned below.

- ***Piper betle* L.**
- *Aphis (Aphis) gossypii* Glover, 1877 [74]
- ***Piper longum* L.**
- *Sinomegoura citricola* (van der Goot, 1917) [49]
- ***Piper nigrum* L.**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [34]
- *Sinomegoura citricola* (van der Goot, 1917) [75]
- ***Piper* sp.**
- *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe, 1841 [76]
- *Sinomegoura citricola* (van der Goot, 1917) [49]

Aphid association of basal angiosperms is very poor, only 6 species of plants are found associated with 3 species of aphids. Only two species of aphid, *Rhopalosiphum nymphaeae* (Linnaeus) and *Rhopalosiphum maidis* (Fitch) are associated with 5 species of plants of the order Nymphaeales while only a single species, *Rhopalosiphoninus (Rhopalosiphoninus) ehretis* Bhattacharya & Chakrabarti was recorded on a single species of the plant of the order Austrobaileyales of the basal angiosperms. However, 50 species of aphids are associated with the plants belonging to the five families of the clade Mangoliids in India, among which the plants of the family Lauraceae were found more suffered; 38 species of aphids are associated with 14 species of plants; 6 species of *Aiceona* Takahashi are only associated with the family Lauraceae. Among the Magnoliales, only 4 species of *Magnolia* L., the type genus of the family Magnoliaceae, are associated with 13 species of aphids. *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonscolombe uses 13 plant species of the clade mangoliids followed by *Sinomegoura citricola* (van der Goot) (9 plant species) and *Aphis (Aphis) gossypii* Glover (7 plant species). Total 33 species of plants belonging to these orders are colonised by 53 species of aphids belonging to 28 genera (Table 1).

Table 1: Number of plant species belonging to the different orders/families of the some basal angiosperms and Magnoliids of flowering plants in the world [21] and in India [77, 78] associated with aphids; and number of host plant species of each family infested by aphids; and number of aphid species infesting these plants in India

Group/Clade/ Orders	Families	In World		In India					
		Genera	Species	Genera	Species	Host plants of the aphids		Associated aphid species	
						Genera	Species	Genera	Species
Basal angiosperms									
Nymphaeales	Nymphaeaceae	6	107	4	14	2	5	1	2
Austrobaileyales	Schisandraceae	3	78	3	6	1	1	1	1
Total		9	185	7	20	3	6	2	3
Magnoliids									
Laurales	Lauraceae	45	2850	20	205	8	14	20	38
Magnoliales	Annonaceae	108	2400	25	154	5	5	4	8
Magnoliaceae		2	294	2	33	1	4	6	13
Piperales	Aristolochiaceae	8	695	3	30	1	1	1	1
Piperaceae		5	3850	3	84	1	3	2	3
Total		168	10089	53	506	16	27	26	50

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