Article

Catalogue of tri-trophic associations of the common hover fly *Ischiodon scutellaris* (Fabricius, 1805) (Syrphidae: Diptera: Insecta) in India

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Abstract
The present article provides a catalogue of tri-trophic associations of the common hover fly *Ischiodon scutellaris* (Fabricius) across India based on the published authentic literature. It is widely distributed in some parts of Europe, southeast Asia and Australia. It is the most effective natural enemy of aphid pests in economically important crops such as cereals, vegetables, oilseeds, cotton, pulses, etc. It is used in greenhouse aphid pest biocontrol programmes. *Ischiodon scutellaris* (Fabricius) was reported to prey on 50 species of aphids feeding on 88 species of plants excluding unidentified ones with 148 tri-trophic associations distributed in 21 states/union territories across India, mostly in Karnataka (36 triplets) followed by Uttar Pradesh (35 triplets), Uttarakhand (29 triplets), Manipur (28 triplets), Bihar (21 triplets), Maharashtra (20 triplets) and less than 20 triplets in rest of the states and union territories. In fact, there has been no attempt to document the tri-trophic associations of this predator in several regions of India; therefore, a comprehensive survey plan is necessary to document them in those unexplored states/union territories.

Keywords Syrphidae; hover fly; *Ischiodon scutellaris*; aphid; predator; natural control; insect pests.

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1 Introduction

It is crucial to comprehend and preserve the ecosystem services offered by insects, as well as to encourage the increasing necessity to substitute insecticides with natural enemies and parasitoids of agricultural and horticultural crops (Zhang, 2025). Historically, studies have concentrated on species that are particularly good at delivering a specific service, for example, honeybees for pollination or parasitoid wasps for controlling pests. Although this method is beneficial, it might be more effective to explore species that can provide several services at once. Hover flies (Syrphidae: Diptera) are well-recognised as dual service providers (Li et al., 2023).

Adults of most species of hover fly visit flowers, feeding on pollen, nectar, or both. Many of them that visit flowers are acknowledged as vital pollinators in both natural and agricultural ecosystems (Rader et al., 2016; Klecka et al., 2018). On the other hand, their young ones, the larvae, are predatory in their feeding behaviour. They feed on aphids (Aphididae: Homoptera), and other soft-bodied insects. The predatory behaviour of hover fly larvae has prompted research into their potential role in an integrated pest management (IPM) strategy. In addition, they have also been used as bioindicators to assess the loss of biodiversity and the efficiency of restoration and conservation policies (Medeiros et al., 2019).

The aphids have about 5,683 species kept in 629 genera (Favret, 2025) and approximately 794 aphid species are found in India (Singh and Singh, 2019). They are tiny, soft-bodied, apterous or alate, sap-sucking, polyphagic insects with enormous reproductive potential because of their rapid development, viviparity, and parthenogenesis (Singh and Singh, 2022). More than 250 species of aphids are known to damage both agricultural and horticultural crops (Singh and Singh, 2021). Some of them cause overall plant devitalisation by directly harming the plant by sucking out its nutrients (Singh, 2001). They also excrete honeydew, which encourages the formation of black sooty moulds and impairs the plants' ability of photosynthesis and respiration. Furthermore, aphids transmit several plant viruses (Singh and Singh, 2021). There are several natural enemies of aphids worldwide, particularly those belonging to Coccinellidae, Neuroptera and Syrphidae (Singh and Singh, 2016).

Syrphidae constitute one of the largest groups of true flies. The family comprises 6674 species across 284 genera (Dunn et al., 2020), primarily found in the Neotropical, Nearctic, and Palaeotropical regions globally (Thompson and Rotheray, 1998). *Ischiodon* Sack, 1913 is one of the extensively widespread hover fly genus with a taxonomic history full of confusion and synonyms (Vockeroth, 1969). It contains only four species: *Ischiodon aegyptius* (Wiedemann, 1830); *Ischiodon astales* Mengual, 1818; *Ischiodon feae* (Bezzi, 1912), and *Ischiodon scutellaris* (Fabricius, 1805) (Vujić and Petrović, 2024). These species resemble wasps and range in size from small to medium. The genus *Ischiodon* could be identified from all other genera of the tribe Syrphini by the following set of characters: the squamae lack long hairs, the anterior portion of the mesopleuron and hypopleuron are bare, the mesoscutum has well-developed lateral yellow bands, the abdomen is clearly marked, the wings lack microtrichia, and the hind trochanter of males only has digitate or spine-like protuberances (Vockeroth, 1969; Mengual, 2018). Two species, *Ischiodon astales* and *Ischiodon feae* are confined to Madagascar and Cape Verde, respectively, while the other two species are widely distributed (Mengual, 2018). *Ischiodon scutellaris* is widely distributed in Europe in the eastern Mediterranean, Greece, Georgia, Turkey, Ukraine, India, China, Japan, southeast Asia, Australia and some Pacific islands (Huang and Cheng, 2012; Sengupta et al., 2019; Vujić and Petrović, 2024).

The prey records of *Ischiodon scutellaris* compiled by Ghorpadé (1981, 2014), Agarwala et al. (1984), Mitra et al. (2015), Ahmad and Kumari (2024), Sengupta et al. (2024) and others do not provide complete information regarding its tri-trophic associations (predator-prey-host plant, triplet) and their distribution in different states and union territories of India. As predatory efficiency of *Ischiodon scutellaris* varies with aphid species and habitats (Joshi and Ballal, 2013) and host plant species on which its preys feed (Ali et al., 2009; Faheem et al., 2019; Udayakumar et al., 2023a), record of its prey along with their food plants and distribution is essential if it is to be assessed as bioagent against the said prey species for a particular area.

The primary objective of this article is to enlist the tri-trophic associations of *Ischiodon scutellaris* in Indian states and union territories. These data indicate that in most of India, tri-trophic association of this aphidophahous predator has not yet been recorded. This catalogue can be very helpful to taxonomists, researchers, academics, conservation managers, and policymakers to guarantee that *Ischiodon scutellaris* may be used in biological or natural management plans for these aphids.

2 Materials and Methods

This empirical catalogue of aphidophagous *Ischiodon scutellaris* is based on the literature published in books, journals and few authentic theses, and websites, up to April 30, 2025. In most of the literature published earlier, several errors crept in the scientific names of the predators, aphids and host plants even in the recent ones. It happened because such contents become outdated quickly and, due to their perceived comprehensiveness, readers sometimes overlook newer sources of information. Additionally, the researches on the prey-predator relationship are continued with the new records, their modified status, and the publication of other nomenclatural decisions. In the present catalogue, attempts have been made to correct the errors in the scientific names of the aphid prey following the Aphid Species File (Favret, 2025) and food plants following World Flora Online (WFO, 2025) and Global Biodiversity Information Facility (GBIF, 2025).

3 Results and Discussion

Ischiodon scutellaris, usually known as common hover fly or yellow-shouldered hover fly (Fig. 1), is a highly polyphagous predator of aphids. Its taxonomic characteristics and identification keys were given by Mengual (2018). Several authors have evaluated its biology and predatory potential in past in India (Lal and Haque, 1955; Singh and Mishra, 1988; Kumar et al., 1996; Sarma et al., 1996; Joshi et al., 1999a, 2001; Sharanabasappa et al., 2007; Ali et al., 2009; Ali and Rizvi, 2011; Chouhan et al., 2011a; Joshi and Ballal, 2013; Omkar and Mishra, 2016; Varshney and Bisht, 2016). Studies revealed that *Ischiodon scutellaris* is an efficient candidate for biological control of several aphid species as its larvae attack and consume a wide range of aphid species in a considerable number on a variety of crops like cereals (Singh and Ahmad, 2025), brassica crops (Devjani and Singh, 2006; Tiwari et al., 2024a); vegetables such as cucurbits (Singh, 2025a), potato (Tiwari and Singh, 2025a), okra (Singh and Pandey, 2025), tomato (Tiwari and Singh, 2025b), brinjal (Singh, 2025b); citrus (Radhakrishnan and Muraleedharan, 1993) and preying on *Acyrthosiphon pisum* (Harris) (Singh, 2025c), *Aphis craccivora* Koch (Singh, 2024a), *Aphis gossypii* Glover (Singh, 2025d), *Aphis spiraecola* Patch (Singh et al., 2024), *Lipaphis erysimi* (Singh, 2024b), *Myzus* spp. (Singh, 2024c); *Rhopalosipum* spp. (Singh, 2025e), *Sitobion* spp. (Singh, 2025f), wooly aphids (Singh, 2025g), etc. on several crops and wild plants. Joshi et al. (1998) and Udayakumar et al. (2023a) developed an efficient technique for its mass culture as it is the pre-requisite for large-scale production of a bioagent for release purpose in augmentative biological control programmes.

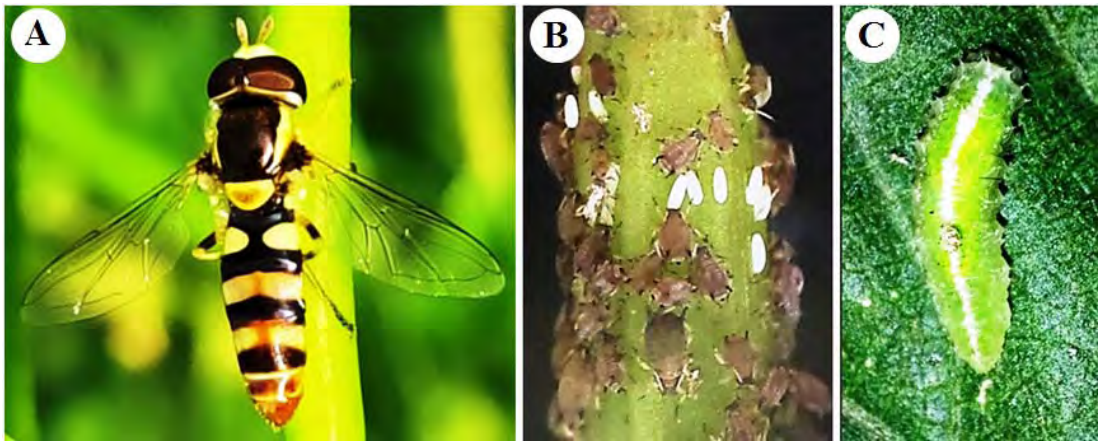

Fig. 1 Photographs of the common hover fly *Ischiodon scutellaris*. A. Adult (pollinator), B. Eggs laid nearby aphid colony and C. Larva (aphidophagous).

The common hover fly *Ischiodon scutellaris*, is the most efficient natural enemy against commercially important aphids in crops like cereals, vegetables, oilseeds, cotton, pulses etc. and is employed in biocontrol programmes against aphid pests in greenhouses and conservation biological control in fields (Joshi and Ballal, 2013). However, because of their speed, small size, and covert action, several behavioural and developmental traits had hardly been seen and recorded. The aphidophagous syrphid *Ischiodon scutellaris* is a good candidate for aphid biological control as its larvae attack and consume a wide range of aphid species and are present on a variety of crops. Bhatia and Shaffi (1933) were the first to observe the aphidophagy of *Ischiodon scutellaris* in India, followed by Cherian (1934), Mani (1939), Lal and Gupta (1953), Lal and Haq (1955), Rao (1969), Ghorpadé (1973) and so on. Recently, Ahmad and Kumari (2024) listed 34 species of aphids feeding on 69 species of plants as prey of *Ischiodon scutellaris* with 114 tri-trophic associations from India without giving their distribution. However, in this catalogue, 50 species of aphids feeding on 89 species of plants excluding unidentified ones with 149 tri-trophic associations are listed distributed in 21 states/union territories of India, mostly in Karnataka (36 triplets) followed by Uttar Pradesh (35 triplets), Uttarakhand (29 triplets), Manipur (28 triplets), Bihar (21 triplets), Maharashtra (20 triplets) and less than 20 triplets in rest of the states and union territories (Fig. 2).

3.1 Synonymy of *Ischiodon scutellaris* along with type locality

Because of phenotypical plasticity and broad genus concepts by the previous authors, *Ischiodon scutellaris* was described even in 6 genera with 15 species (Mengual, 2018).

= *Epistrophe magnicornis* Shiraki, 1963: Micronesia: Chuuk State, Weno Is.
= *Epistrophe platychiroides* Frey, 1946: Philippines: Luzon, Quezon, Atimonan
= *Ischiodon boninensis* Matsumura, 1919: Japan: Bonin Is., Chichijima, Ogasawara-jima
= *Ischiodon penicillatus* Hardy, 1952: nomen nudum
= *Ischiodon trochanterica* Sack, 1913: Taiwan: Kanshizei, Puli as 'Polisha', Suihenkyaku, Tainan and Takao
= *Melithreptus novaeguineae* Kertesz, 1899: Papua New Guinea: Astrolabe Bay, Erima
= *Melithreptus ogasawarensis* Matsumura, 1916: Japan: Bonin Is., Ogasawara-jima
= *Scaeva scutellaris* Fabricius, 1805: India: Tamil Nadu, Tharangambadi. Syntypes, ZMUC (Type species)
= *Sphaerophoria annulipes* Macquart, 1855: Marquesas Is.
= *Sphaerophoria macquarti* Goot, 1964: New name for *annulipes* Macquart
= *Syrphus coromandelensis* Macquart, 1842: India: 'Cote de Coromandel'.
= *Syrphus erythropygus* Bigot, 1884: 'Indes'
= *Syrphus nodalis* Thomson, 1869: French Polynesia: Society Is., Tahiti.
= *Syrphus ruficauda* Bigot, 1884: 96. New Caledonia.
= *Syrphus splendens* Doleschall, 1856: Indonesia: Java.

3.2 Catalogue of tri-trophic associations of *Ischiodon scutellaris* in India

3.2.1 *Acyrthosiphon (Acyrthosiphon) pisum* (Harris, 1776)

- *Pisum sativum* L. - Delhi (Lal and Gupta, 1953); Karnataka (Ghorpadé, 1973); Uttar Pradesh (Chaudhary and Singh, 2012); West Bengal (Agarwala et al., 1979)

3.2.2 *Acyrthosiphon (Acyrthosiphon) rubi* (Narzikulov, 1957)

- *Rubus ellipticus* Sm. - Himachal Pradesh (Das and Raychaudhuri, 1983)

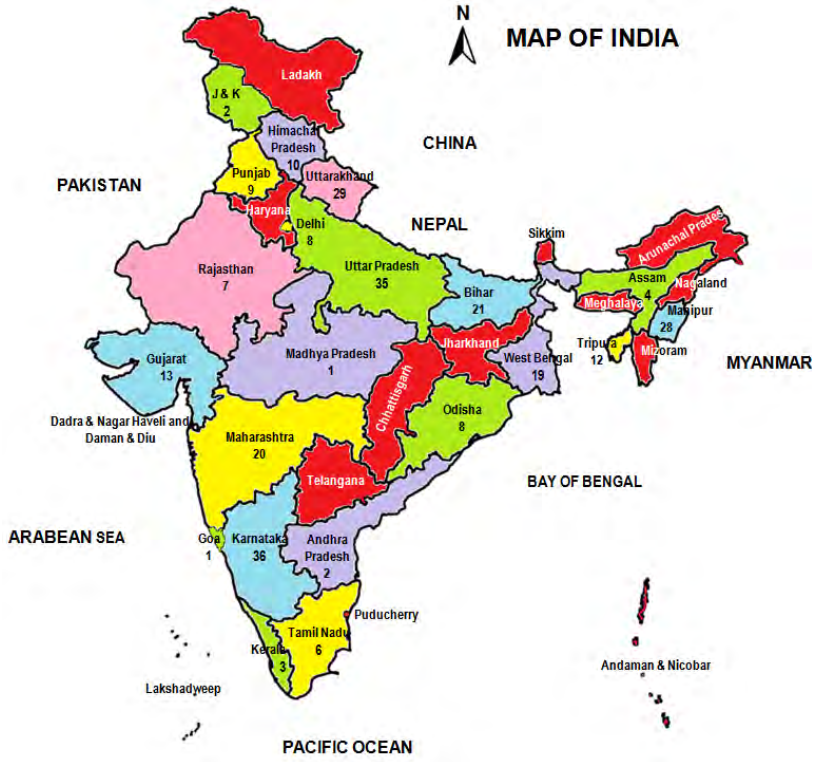

Fig. 2 Map showing the number of tri-trophic associations (triplets) of *Ischiodon scutellaris* in different states/union territories of India. No species of the predators was recorded in the red shaded states/union territories of India.

3.2.3 *Aphis (Aphis) craccivora* Koch, 1854

- *Arachis hypogaea* L. - Gujarat (Patel et al., 1976); Manipur (Singh, 2002); Rajasthan (Priyanka et al., 2022)
- *Cajanus cajan* (L.) Millsp. - Karnataka (Joshi et al., 1997; Chinnu et al., 2023)
- *Gliricidia maculata* (Kunth) Steud. - Kerala (Reji Rani, 1995)
- *Lablab purpureus* (L.) Sweet - Bihar (Ahmad et al., 2020); Karnataka (Joshi et al., 1997); Maharashtra (Kale et al., 2020); Manipur (Singh, 2002); Tamil Nadu (Rangaswami, 1976); Uttar Pradesh (Chaudhary and Singh, 2012; Tiwari et al., 2024b); West Bengal (Ghosh et al., 1981)
- *Lens culinaris* Medik. - West Bengal (Poddar, 1982)
- *Phaseolus mungo* Wall. - Manipur (Singh, 2002)
- *Phaseolus vulgaris* L. - Bihar (Ahmad et al., 2020); Uttar Pradesh (Ali et al., 2009; Ali and Rizvi, 2011)
- *Pisum sativum* L. - West Bengal (Poddar, 1982)
- *Rumex acetosella* L. - Jammu and Kashmir (Bhat and Bhagat, 2017)
- *Senna sophera* (L.) Roxb. - West Bengal (Poddar, 1982)
- *Senna tora* (L.) Roxb. - West Bengal (Poddar, 1982)
- *Solanum melongena* L. - West Bengal (Satpathi and Mandal, 2006)
- *Vicia faba* L. - Delhi (Lal and Gupta, 1953; Saxena et al., 1970); Manipur (Singh, 2002); Uttarakhand (Ghosh et al., 1985); West Bengal (Ghosh et al., 1981)
- *Vigna mungo* (L.) Hepper - Assam (Borah et al., 2012); Bihar (Ahmad et al., 2020); Rajasthan (Jat and Rana, 2018); Uttar Pradesh (Tiwari et al., 2024b); West Bengal (Poddar, 1982)
- *Vigna radiata* (L.) R. Wiczek - Odisha (Dwibedy et al., 2018)

- *Vigna umbellata* (Thunb.) Ohwi and H.Ohashi - Manipur (Singh, 2002)
- *Vigna unguiculata* (L.) Walp. - Gujarat (Chouhan et al., 2011a); Karnataka (Joshi et al., 1999b; Udayakumar et al., 2024); Kerala (Reji Rani, 1995); Manipur (Singh, 2002); Tripura (Agarwala and Bardhanroy, 1997); Uttar Pradesh (Tiwari et al., 2024b); West Bengal (Poddar, 1982)
- Unknown plant - Tripura (Agarwala et al., 1987); West Bengal (Agarwala et al., 1982)

3.2.4 *Aphis (Aphis) fabae* Scopoli, 1763

- *Luffa aegyptiaca* Mill. - Bihar (Ahmad et al., 2020)

3.2.5 *Aphis (Aphis) glycines* Matsumura, 1917

- *Glycine max* L. - Manipur (Singh and Singh, 2000)

3.2.6 *Aphis (Aphis) gossypii* Glover, 1877

- *Abelmoschus esculentus* Moench - Karnataka (Udayakumar et al., 2023a); Maharashtra (Kale et al., 2020); Uttar Pradesh (Tiwari et al., 2024b); Uttarakhand (Rajveer et al., 2016)
- *Brassica oleracea* L. var. *botrytis* - Bihar (Prakash and Rani, 2015); Manipur (Devjani and Singh, 1998; Singh et al., 2002)
- *Cajanus cajan* (L.) Millsp. - Uttar Pradesh (Chaudhary and Singh, 2012)
- *Capsicum annuum* L. - Uttarakhand (Bisht et al., 2006)
- *Chromolaena odorata* (L.) R.M.King and H.Rob. - Karnataka (Chinnu et al., 2023)
- *Chrysanthemum* sp. - Uttarakhand (Bisht et al., 2006)
- *Citrullus lanatus* (Thunb.) - Tamil Nadu (Cherian, 1934)
- *Coccinia grandis* (L.) Voigt - Bihar (Ahmad et al., 2020)
- *Coriandrum sativum* L. - Uttar Pradesh (Tiwari et al., 2024b)
- *Cucumis sativus* L. - Karnataka (Chinnu et al., 2023)
- *Cucumis* sp. - Uttarakhand (Ghosh et al., 1985; Bisht et al., 2006)
- *Fagopyrum esculentum* Moench - Gujarat (Bhat et al., 1986)
- *Fagopyrum kashmirianum* Munshi - Gujarat (Bhat et al., 1986)
- *Fagopyrum tataricum* (L.) Gaertn. - Gujarat (Bhat et al., 1986)
- *Foeniculum vulgare* Mill. - Uttar Pradesh (Tiwari et al., 2024b)
- *Gossypium hirsutum* L. - Gujarat (Chouhan et al., 2011a); Karnataka (Joshi et al., 1999a; Udayakumar et al., 2023a); Maharashtra (Kale et al., 2020); Odisha (Mohapatra, 2004); Tripura (Saha and Mitra, 2016); West Bengal (Agarwala and Saha, 1986)
- *Gossypium* sp. - Bihar (Bhatia and Shaffi, 1933)
- *Hibiscus rosasinensis* L. - Bihar (Ahmad et al., 2020)
- *Lagenaria siceraria* (Molino) Standl. - Bihar (Ahmad et al., 2020); West Bengal (Saha et al., 2016)
- *Luffa aegyptiaca* Mill. - Bihar (Ahmad et al., 2020)
- *Mangifera indica* L. - Uttar Pradesh (Tiwari et al., 2024b)
- *Momordica charantia* L. - Bihar (Ahmad et al., 2020)
- *Phaseolus vulgaris* L. - Uttarakhand (Bisht et al., 2006)
- *Plantago ovata* Forssk. - Gujarat (Prajapati et al., 2020)
- *Psidium guajava* L. - Karnataka (Mani and Krishnamoorthy, 1989); Tamil Nadu (Baskaran et al., 2009); Uttarakhand (Bisht et al., 2006)
- *Solanum melongena* L. - Himachal Pradesh (Vishwajeet, 2020); Manipur (Devi et al., 2002; Shah et al., 2013); Uttar Pradesh (Sreedhar et al., 2020); West Bengal (Agarwala et al., 1982; Satpathi and Mandal, 2006)
- *Solanum tuberosum* L. - Manipur (Nonita et al., 2002); Uttar Pradesh (Raj, 1989)

• Unknown plant - Tripura (Agarwala et al., 1987)

3.2.7 *Aphis (Aphis) nerii* Boyer de Fonsc., 1841

• *Calotropis gigantea* (L.) W.T. Aiton - Karnataka (Joshi et al., 1999b)

• *Calotropis procera* (Aiton) Dryand. - Uttar Pradesh (Chaudhary and Singh, 2012)

• *Calotropis* sp. - Bihar (Bhatia and Shaffi, 1933); Gujarat (Patel and Patel, 1969)

3.2.8 *Aphis (Aphis) odinae* (van der Goot, 1917)

• *Anacardium occidentale* L. - Goa (Maruthadurai and Singh, 2017; Maruthadurai, 2019); Karnataka (Mulimani and Rajanna, 2014; Vanitha et al., 2022)

3.2.9 *Aphis (Aphis) punicae* Passerini, 1863

• *Punica granatum* L. - Karnataka (Sreedevi and Verghese, 2007); Uttar Pradesh (Chaudhary and Singh, 2012)

• Unknown plant - Himachal Pradesh (Das and Raychaudhuri, 1983)

3.2.10 *Aphis (Aphis) rhoicola* Hille Ris Lambers, 1954

• Unknown plant - India (Rao, 1969)

3.2.11 *Aphis* (*Aphis*) *ruborum* (Börner, 1931)

• *Rubus ellipticus* Sm. - Uttarakhand (Ghosh et al., 1985)

3.2.12 *Aphis (Aphis) solanella* Theobald, 1854

• *Capsicum frutescens* L. - Uttar Pradesh (Chaudhary and Singh, 2012)

3.2.13 *Aphis (Aphis) spiraecola* Patch, 1914

• *Artemisia vulgaris* L. - Karnataka (Rao, 1969); Manipur (Raychaudhuri et al., 1978)

• *Cosmos bipinnatus* Cav. - Uttar Pradesh (Dubey and Singh, 2011)

• *Spiraea hypericifolia* L. - Uttar Pradesh (Chaudhary and Singh, 2012)

• Unknown plant - Karnataka (Ghorpadé, 1973); Tripura (Agarwala et al., 1987)

3.2.14 *Aphis (Aphis) umbrella* (Börner, 1950)

• Unknown plant - Karnataka (Ghorpadé, 1973)

3.2.15 *Aphis (Aphis) verbasci* Schrank, 1801

• *Verbascum thapsus* L. - Uttarakhand (Ghosh et al., 1985)

• Unknown plant - Himachal Pradesh (Agarwala et al., 1981)

3.2.16 *Aphis* (*Toxoptera*) *aurantii* Boyer de Fonsc., 1841

• *Camellia sinensis* (L.) Kuntze - Assam (Das, 1974; Das and Kakoty, 1992); Karnataka (Radhakrishnan and Muraleedharan, 1993; Radhakrishnan and Muraleedharan, 1995); Kerala (Radhakrishnan and Muraleedharan, 1991); Manipur (Devi and Varatharajan, 2007; Devi et al., 2010); Tamil Nadu (Muraleedharan et al., 1988); Uttarakhand (Sharma et al., 2006)

• *Citrus* sp. - Karnataka (Singh, 1993)

• Unknown plant - Tripura (Agarwala et al., 1987)

3.2.17 *Aphis (Toxoptera) citricidus* (Kirkaldy, 1907)

• *Citrus* sp. - Karnataka (Chinnu et al., 2023); Maharashtra (Kale et al., 2020)

3.2.18 *Brevicoryne brassicae* (Linnaeus, 1758)

• *Brassica juncea* (L.) Czern. - Himachal Pradesh (Soni et al., 2021); Punjab (Kumar et al., 1988); Uttarakhand (Ghosh et al., 1985)

• *Brassica nigra* L. - India (Agarwala et al., 1984)

• *Brassica oleracea* L. - Karnataka (Udayakumar et al., 2023a); Uttarakhand (Ghosh et al., 1985)

• *Brassica oleracea* L. var. *botrytis* - Bihar (Prakash and Rani, 2015); Himachal Pradesh (Sharma and Bhalla, 1988; Palial et al., 2025); Manipur (Devjani and Singh, 1998; Debaraj et al., 1997);

Rajasthan (Saranya et al., 2022); Tamil Nadu (Debbarma et al., 2017); Uttar Pradesh (Tiwari et al., 2024b); West Bengal (Agarwala et al., 1982)

- *Brassica oleracea* L. var. *capitata* - Gujarat (Chouhan et al., 2011b); Maharashtra (Udtewar et al., 2022); Manipur (Singh et al., 2002; Bijaya et al., 1996); Odisha (Mandal and Patnaik, 2006); Uttar Pradesh (Pal and Singh, 2012)
- *Brassica rapa* L. - Punjab (Kumar et al., 1987); Uttar Pradesh (Chaudhary and Singh, 2012)
- *Raphanus sativus* L. - Uttarakhand (Ghosh et al., 1985)

3.2.19 *Capitophorus formosartemisiae* (Takahashi, 1921)

- *Artemisia vulgaris* L. - Uttarakhand (Ghosh et al., 1985)

3.2.20 *Ceratovacuna lanigera* Zehntner, 1897

- *Saccharum officinarum* L. - Karnataka (Patil et al., 2006); Maharashtra (Rabindra et al., 2002)

3.2.21 *Cervaphis quercus* Takahashi, 1918

- *Quercus serrata* Murray - Manipur (Shantibala et al., 2009)

3.2.22 *Cervaphis rappardi indica* Basu, 1961

- *Cajanus cajan* (L.) Millsp. - Manipur (Shantibala et al., 1997)

3.2.23 *Greenidea (Greenidea) artocarpi* (Westwood, 1890)

- Unknown plant - Karnataka (Ghorpadé, 1973)

3.2.24 *Greenideoida (Greenideoida) ceyloniae* van der Goot, 1917

- Unknown plant - Tripura (Agarwala et al., 1987)

3.2.25 *Hyadaphis coriandri* (Das, 1918)

- *Coriandrum sativum* L. - Punjab (Sagar and Kumar, 1996); Uttar Pradesh (Ali et al., 2009; Ali and Rizvi, 2011); Uttarakhand (Bisht et al., 2006)
- *Foeniculum vulgare* Mill. - Karnataka (Udayakumar et al., 2023b)

3.2.26 *Hyalopterus pruni* (Geoffroy, 1762)

- *Prunus persica* (L.) Batsch - Manipur (Varatharajan et al., 1991)

3.2.27 *Hyperomyzus (Hyperomyzus) carduellinus* (Theobald, 1915)

- *Lactuca virosa* L. - Karnataka (Udayakumar et al., 2023a)
- *Sonchus* sp. - Karnataka (Chinnu et al., 2023)

3.2.28 *Hysteroneura setariae* (Thomas, 1878)

- *Cyperus rotundus* L. - Uttar Pradesh (Chaudhary and Singh, 2012)
- Unknown plant - Karnataka (Ghorpadé, 1973)

3.2.29 *Lipaphis (Lipaphis) erysimi* (Kaltenbach, 1843)

- *Brassica juncea* (L.) Czern. - Assam (Pradhan et al., 2020); Delhi (Lal and Gupta, 1953; Lal and Haque, 1955); Gujarat (Chouhan et al., 2011a; Patel et al., 2019); Himachal Pradesh (Soni et al., 2021); Karnataka (Joshi et al., 1999b); Madhya Pradesh (Mishra and Kanwat, 2017); Manipur (Chitra Devi et al., 2002; Rajeshwari and Singh, 2022); Punjab (Kumar et al., 1988; Sharma et al., 1997); Rajasthan (Yadav et al., 2023; Arvind et al., 2024); Tripura (Agarwala et al., 1989; Datta, 2020); Uttar Pradesh (Ali et al., 2009; Singh, 2013); Uttarakhand (Varshney and Bisht, 2016); West Bengal (Ghosh, 1983)
- *Brassica nigra* L - West Bengal (Ghosh et al., 1981)
- *Brassica oleracea* L. var. *botrytis* - Bihar (Prakash and Rani, 2015); Manipur (Devjani and Singh, 1998; Singh et al., 2002); Rajasthan (Saranya et al., 2022); Tripura (Agarwala et al., 1989); Uttar Pradesh (Tiwari et al., 2024a)
- *Brassica oleracea* L. var. *capitata* - Manipur (Bijaya et al., 1996); Odisha (Mandal and Patnaik,

2006); Tripura (Agarwala et al., 1989)

- *Brassica oleracea* L. var. *gongylodes* - Uttar Pradesh (Tiwari et al., 2024a)
- *Brassica rapa* L. - Bihar (Karthik et al., 2022); Jammu and Kashmir (Bhat and Bhagat, 2017); Maharashtra (Kale et al., 2020); Manipur (Chitra Devi et al., 1996; Devjani and Singh, 2006); Punjab (Kumar et al., 1987); Uttar Pradesh (Singh and Singh, 2013; Tiwari et al., 2024b); Uttarakhand (Karnatak and Thorat, 2006)
- *Brassica* sp. - Delhi (Lal and Gupta, 1953); West Bengal (Roy and Basu, 1977)
- *Raphanus sativus* L. - Tripura (Agarwala et al., 1989)
- *Solanum melongena* L. - Maharashtra (Sathe et al., 2016)
- Unknown plant - Tripura (Agarwala et al., 1987)

3.2.30 *Lipaphis (Lipaphis) pseudobrassicae* (Davis, 1914)

- *Brassica juncea* (L.) Czern. - Delhi (Lal and Gupta, 1953); Punjab (Kumar et al., 1988)

3.2.31 *Macrosiphum (Macrosiphum) rosae* (Linnaeus, 1758)

- *Rosa indica* L. - Uttar Pradesh (Ali et al., 2009; Ali and Rizvi, 2011)

3.2.32 *Melanaphis sacchari* (Zehntner, 1897)

- Unknown plant - Karnataka (Ghorpadé, 1973)
- *Sorghum bicolor* (L.) Moench - Odisha (Patnaik et al., 1977); Uttar Pradesh (Chaudhary and Singh, 2012)
- *Zea mays* L. - Odisha (Patnaik et al., 1977)

3.2.33 *Myzus (Myzus) sorbi* Bhattacharya and Chakrabarti, 1982

- *Sorbaria tomentosa* (Lindl.) Rehder - Uttarakhand (Ghosh et al., 1985)

3.2.34 *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- *Brassica juncea* (L.) Czern. - Delhi (Lal and Gupta, 1953); Himachal Pradesh (Soni et al., 2021); Maharashtra (Bhandare, 2022); Punjab (Kumar et al., 1988)
- *Brassica oleracea* L. var. *botrytis* - Bihar (Prakash and Rani, 2015); Karnataka (Sharanabasappa et al., 2007); Maharashtra (Bhandare, 2022); Manipur (Devjani and Singh, 1998; Singh et al., 2002); Punjab (Kumar et al., 1996); Rajasthan (Saranya et al., 2022)
- *Brassica oleracea* L. var. *capitata* - Maharashtra (Bhandare, 2022); Manipur (Bijaya et al., 2006); Odisha (Mandal and Patnaik, 2008)
- *Brassica oleracea* L. var. *gongylodes* - Manipur (Bijaya, 1998)
- *Brassica rapa* L. - Bihar (Karthik et al., 2022); Maharashtra (Bhandare, 2022); Manipur (Bijaya et al., 2001; Devjani and Singh, 2006); Punjab (Kumar et al., 1987)
- *Brassica rapa* L. var. *pekinensis* - Manipur (Bijaya, 1998)
- *Brassica* sp. - Delhi (Lal and Gupta, 1953)
- *Capsicum chinense* Jacq. - Assam (Thangjam et al., 2021)
- *Hibiscus sabdariffa* L. - Bihar (Parween et al., 2023)
- *Nicotiana tabacum* L. - Maharashtra (Bhandare, 2022)
- *Pisum sativum* L. - Maharashtra (Bhandare, 2022)
- *Prunus persica* (L.) Batsch - Uttarakhand (Bisht et al., 2006)
- *Raphanus sativus* L. - Andhra Pradesh (Krishnamoorthy and Dharmarju, 1960); Maharashtra (Bhandare, 2022)
- *Solanum melongena* L. - Gujarat (Patel and Patel, 1969); Maharashtra (Bhandare, 2022); West Bengal (Agarwala et al., 1982; Satpathi and Mandal, 2006)
- *Solanum nigrum* L. - Maharashtra (Bhandare, 2022)

- *Solanum tuberosum* L. - Maharashtra (Bhandare, 2022); Manipur (Nonita et al., 2002); Uttar Pradesh (Raj, 1989; Tiwari et al., 2024b); Uttarakhand (Ghosh et al., 1985)
- *Zea mays* L. - Gujarat (Chouhan et al., 2011a)

3.2.35 *Myzus (Nectarosiphon) persicae nicotianae* Blackman, 1987

- *Nicotiana tabacum* L. - Andhra Pradesh (Sitaramaiah et al., 2001); India (Agarwala et al., 1984); Karnataka (Venkatesan et al., 2002)

3.2.36 *Phorodon (Diphorodon) cannabis* Passerini, 1860

- *Cannabis sativa* L. - Uttarakhand (Ghosh et al., 1985)

3.2.37 *Prociphilus* sp.

- *Lonicera quinquelocularis* Hardw. - Uttarakhand (Debnath, 1991)

3.2.38 *Rhopalosiphum maidis* (Fitch, 1856)

- *Cenchrus americanus* (L.) Morrone - Uttar Pradesh (Tiwari et al., 2024b)
- *Sorghum bicolor* (L.) Moench - Karnataka (Megha et al., 2015); Maharashtra (Kale et al., 2020); Uttar Pradesh (Singh and Mishra, 1988; Chaudhary and Singh, 2012)
- *Triticum aestivum* L. - Uttar Pradesh (Tiwari et al., 2024b); Uttarakhand (Bisht et al., 2006)
- *Zea mays* L. - Bihar (Kumar and Ahmad, 2017); Karnataka (Joshi et al., 1999b); Rajasthan (Swaminathan et al., 2015); Uttarakhand (Bisht et al., 2006)
- Unknown plant - Delhi (Mani, 1939)

3.2.39 *Rhopalosiphum nymphaeae* (Linnaeus, 1761)

- *Verbena laciniata* (L.) Briq. - Uttar Pradesh (Ali et al., 2009; Ali and Rizvi, 2011)

3.2.40 *Rhopalosiphum padi* (Linnaeus, 1758)

- *Triticum aestivum* L. - Himachal Pradesh (Dixit et al., 2019); Uttarakhand (Bisht et al., 2006)
- *Zea mays* L. - Uttarakhand (Bisht et al., 2006)

3.2.41 *Sarucallis kahawaluokalani* (Kirkaldy, 1907)

- Unknown plant - Karnataka (Ghorpadé, 1973)

3.2.42 *Schoutedenia emblica* (Patel and Kulkarni, 1952)

- *Phyllanthus emblica* L. - Tamil Nadu (Baskaran et al., 2009)

3.2.43 *Sitobion (Sitobion) avenae* (Fabricius, 1775)

- *Triticum aestivum* L. - Himachal Pradesh (Dixit et al., 2019); Uttarakhand (Gaur et al., 2004)

3.2.44 *Sitobion (Sitobion) miscanthi* (Takahashi, 1921)

- *Triticum aestivum* L. - Uttar Pradesh (Srivastava et al., 2009); Uttarakhand (Ghosh et al., 1985; Bisht et al., 2006)
- *Triticum* sp. - India (Agarwala et al., 1984)
- *Zea mays* L. - Uttarakhand (Bisht et al., 2006)

3.2.45 *Sitobion (Sitobion) rosaeiformis* (Das, 1918)

- *Rosa indica* L. - Uttar Pradesh (Chaudhary and Singh, 2012)
- *Rosa* sp. - Karnataka (Ghorpadé, 1973)

3.2.46 *Therioaphis (Pterocallidium) trifolii* (Monell, 1882)

- Unknown plant - Karnataka (Ghorpadé, 1973)

3.2.47 *Tuberculatus (Orientuberculoides) nervatus* Chakrabarti and Raychaudhuri, 1976

- *Quercus serrata* Murray - Manipur (Shantibala et al., 2009)

3.2.48 *Uroleucon (Uroleucon) sonchi* (Linnaeus, 1767)

- *Sonchus arvensis* L. - Karnataka (Ghorpadé, 1973)

3.2.49 *Uroleucon (Uromelan) compositae* (Theobald, 1915)

- *Carthamus tinctorius* L. - Gujarat (Patel and Patel, 1969); Karnataka (Joshi et al., 1999b); Maharashtra (Kale et al., 2020)

3.2.50 Unknown aphid

- *Chrysanthemum* sp. - Bihar (Bhatia and Shaffi, 1933)
- *Dalbergia sissoo* Roxb. ex DC. - Bihar (Bhatia and Shaffi, 1933)

4 Conclusion

Ischiodon scutellaris (Fabricius) is the most effective natural enemy of aphid pests in economically important crops such as cereals, vegetables, oilseeds, cotton, pulses, etc. and may be used in biological control programmes of several aphid pests both in augmentative (release of natural enemies), and conservation (protecting existing natural enemies) biological control. In India, it was reported to prey on 50 species of aphids feeding on 89 species of plants with 149 tri-trophic associations distributed in 21 states/union territories, mostly in Karnataka and Uttar Pradesh followed by Uttarakhand, Manipur, Bihar, Maharashtra and West Bengal. In fact, there has been very little attempt to document the tri-trophic associations of this predeator in several areas of India; therefore, a thorough and comprehensive survey plan is necessary to document them in those unexplored states/union territories.

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