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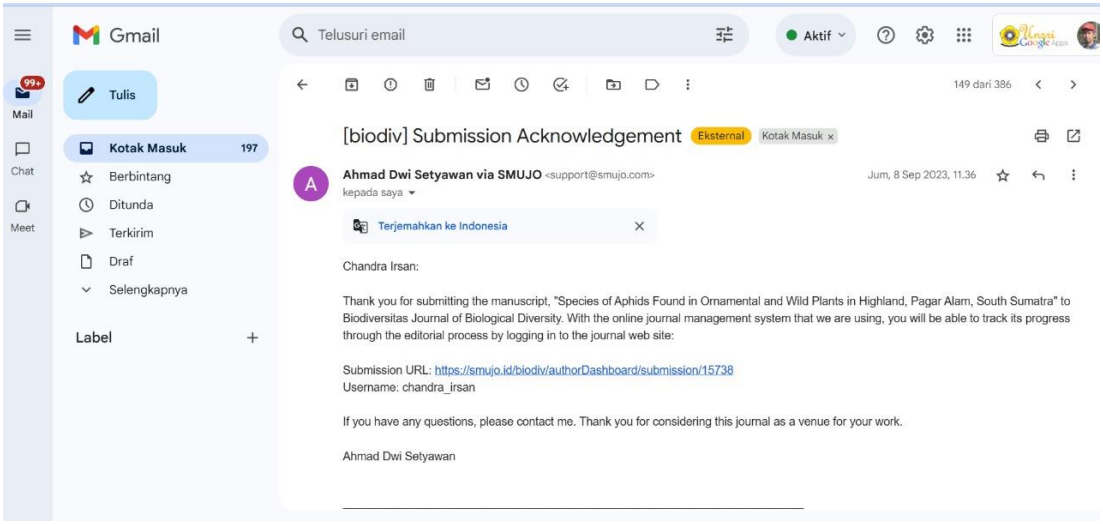

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Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

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Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

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Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Running title: Aphids Found in Ornamental and Wild Plants

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy & Stroyan, 1959). One species of aphids can host more than 400 species from 40 families (Bass et al., 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al., 2020). Aphids can transmit 275 viruses (Ertunc, 2020). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman & Eastop, 2017). Aphids consume young leaves sap, which can deplete essential nutrients for healthy growth (Cao et al., 2018). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones, 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Sarwan Kumar, 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al., 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al., 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al., 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh & Singh, 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Understanding the species diversity of aphids is fundamental to effective aphid control, as it facilitates the development of measures to keep their populations in check. In addition, understanding the diversity of aphid species can provide valuable insights into potential plant diseases, as different aphid species carry distinct viruses. Methods used to control aphids often encompass various techniques, including the use of natural enemies such as predators (like ladybugs, lacewings, and parasitic wasps) (Singh & Singh, 2021; Völkl et al., 2023), parasitoids (Boivin et al., 2012), entomopathogens (Hullé et al., 2020), the use of essential oils as botanical pesticides to control aphids (Ikbal & Pavela, 2019), and crop rotation techniques (Degani et al., 2019). Regular monitoring of aphid populations and diversity can help in detecting when population sizes may be reaching harmful levels, allowing for prompt implementation of the necessary countermeasures.

Many aphid species were found on plants that were not their actual hosts (Peccoud et al., 2010). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al., 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo & Smilanich, 2023), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al., 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto et al., 2020). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al., 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing fruit, vegetable, and ornamental varieties, as well as wild plants or weeds. The collection and identification of host plants, aphids, and their natural enemies involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Aphid identification was conducted using identification keys (Blackman & Eastop, 2008). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010;

Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

RESULT AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii*, *Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae*, *Aphis citricola*, *Aphis craccivora*, *Toxoptera aurantii*, *Pentalonia nigronervosa*, *Hystenura* sp., *Aphis glycine*, *Greenidae* sp., *Rhopalosiphum padi*, *Rhopalosiphum maidis*, *Hyperomyzus* sp. *Lipapis erysimi*. Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland*, h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,* *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

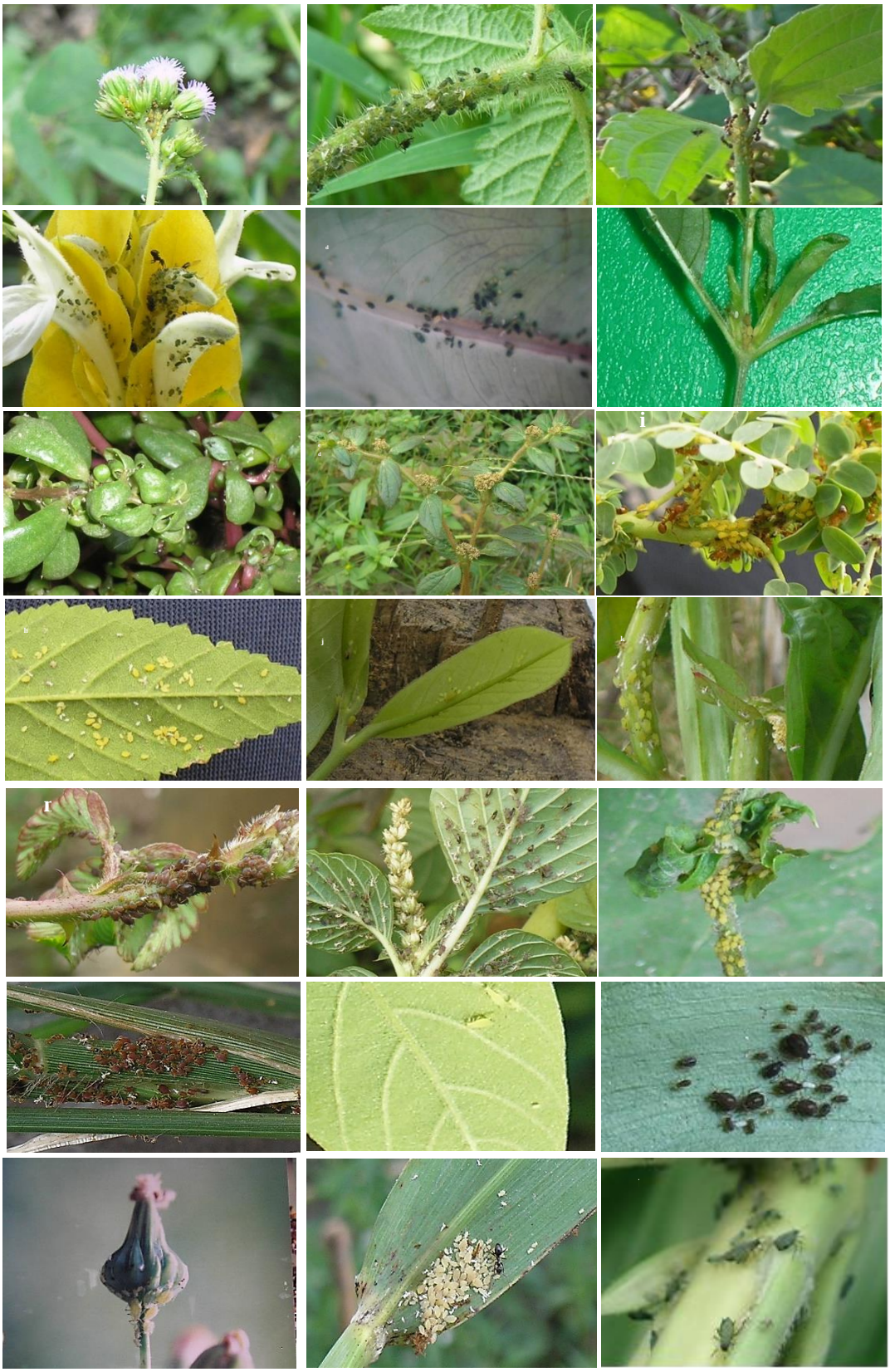

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Peccoud et al., 2010). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring, 2014). *A. gossypii*, and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Margaritopoulos et al., 2006; Alotaibi et al., 2023).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Wäckers & Van Rijn, 2012). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens* (angel's trumpet), *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very

large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii*, and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii*. Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii*, and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii*. These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii*, and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small

to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii*. These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These

aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids. The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai,* was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice*

appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola*. The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora*. The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi*. The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson et al., 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al., 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Peccoud et al., 2010). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al., 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al., 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain nutrient-rich nature (Jakubczyk et al., 2022) and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Chittka, 2007), while others preferred different types of plants and plant parts (Sorensen, 2009). It's worth noting that different aphid species often had distinct preferences for plant ty(Harrington et al., 2007)pes and parts.

Herbs served as an alternative host for aphids in this present study. Aphids consumed sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilized needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al., 2015). Numerous herbs had structural characteristics, such as folds, crevices, and concealed flowering portions (Harrington et al., 2007), that provided aphids with refuge .

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson & Mooney, 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Detrain et al., 2010). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al., 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al., 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann & Vega, 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

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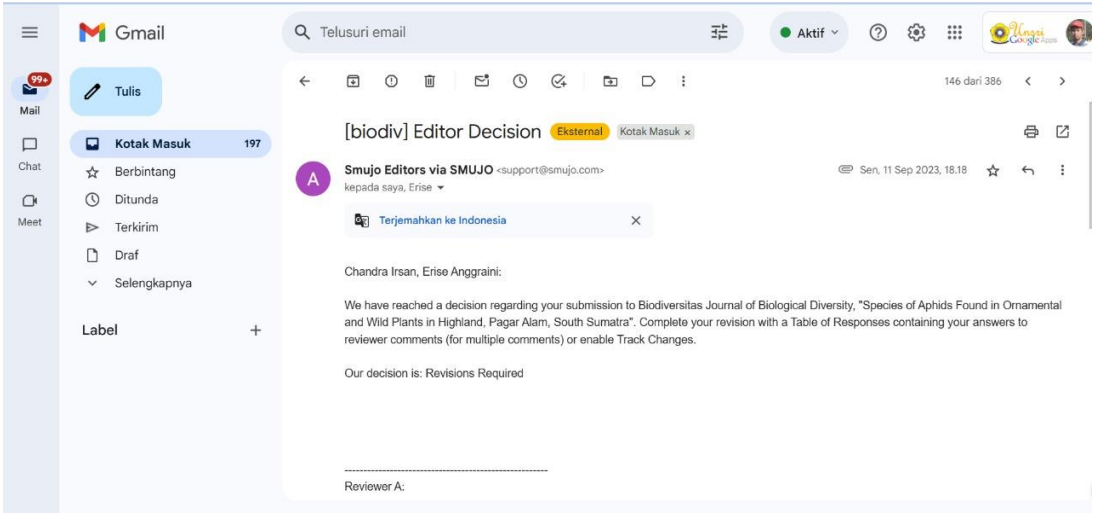
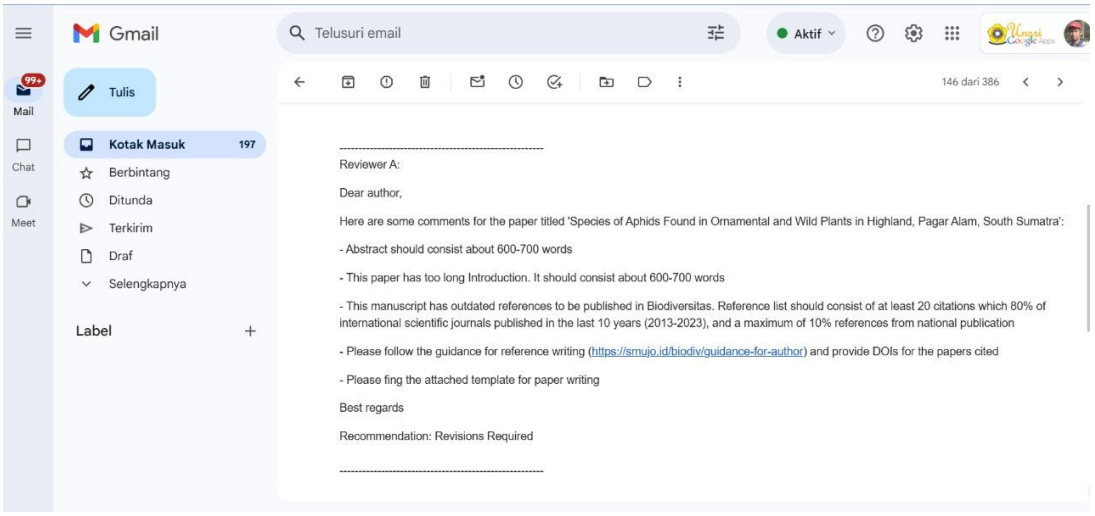
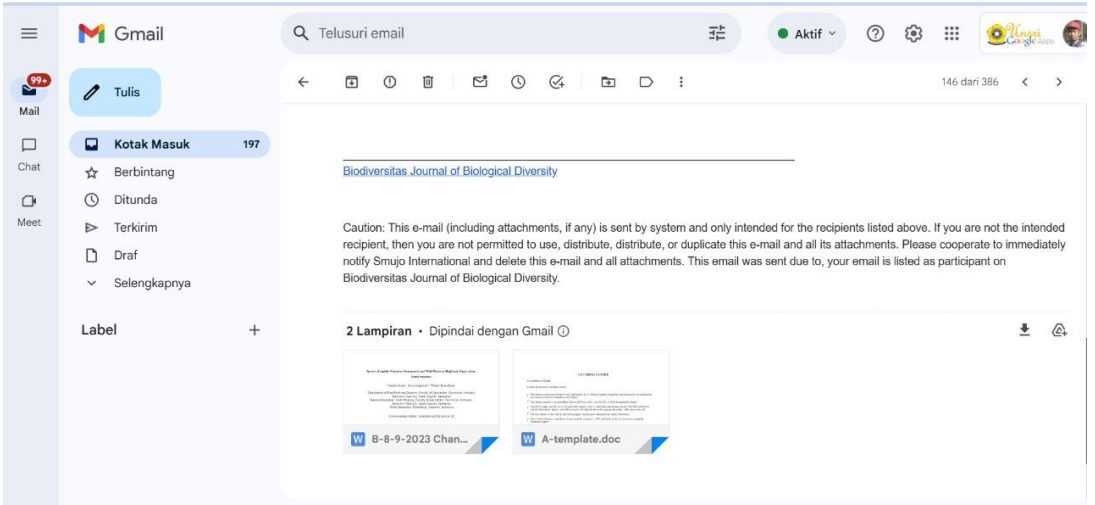
2. Bukti konfirmasi review pertama dan hasil revisi pertama

11 September 2023







Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

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Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Introduction

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy & Stroyan, 1959). One species of aphids can host more than 400 species from 40 families (Blackman & Eastop, 2000). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al., 2020). A single species of aphids can act as a vector for over 150 viruses (Blackman & Eastop, 2000). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman & Eastop, 2017). Aphids consume plant sap, which can deplete essential nutrients for healthy growth (Müller et al., 2001). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones, 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 -

40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Sarwan Kumar, 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al., 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al., 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al., 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh & Singh, 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Understanding the species diversity of aphids is fundamental to effective aphid control, as it facilitates the development of measures to keep their populations in check. In addition, understanding the diversity of aphid species can provide valuable insights into potential plant diseases, as different aphid species carry distinct viruses. Methods used to control aphids often encompass various techniques, including the use of natural enemies such as predators (like ladybugs, lacewings, and parasitic wasps) (Singh & Singh, 2021; Völkl et al., 2023), parasitoids (Boivin et al., 2012), entomopathogens (Hullé et al., 2020), the use of essential oils as botanical pesticides to control aphids (Ikbal & Pavela, 2019), and crop rotation techniques (Degani et al., 2019). Regular monitoring of aphid populations and diversity can help in detecting when population sizes may be reaching harmful levels, allowing for prompt implementation of the necessary countermeasures.

According to Irsan *et al*. (1998), many aphid species were found on plants that were not their actual hosts. Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al., 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Sileshi et al., 2008). These secondary hosts may

offer less adequate nutrition for insects (Capinera, 2005), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al., 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Moran, 1992). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al., 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagaralam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagaralam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

Methods

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing fruit, vegetable, and ornamental varieties, as well as wild plants or weeds. The collection and identification of host plants, aphids, and their natural enemies involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Guidelines for finding host plants were written by Blackman & Eastop 1994, 2000; Irsan 1998; Kranz *et al*. 1978). Aphid identification was conducted using identification keys made by Blackman & Eastop (1994, 2000); Heie (1992, 1994, 1995); Irsan (1998); Kranz *et al*. (1978); Martin (1983). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified based on identification keys made by van Steenis (1988). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

Results

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipapis erysimi.* Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines*	flower

		Hyperomyzus sp.	
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland*, h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is

closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii*	Shoots, young leaves, old leaves
		Aphis glycine	
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,*	Old leaves, young leaves (pupus), leaf axils
		Rhopalosiphum maidis	
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs, petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves

No	Host Plant	Aphid species	Colony location
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

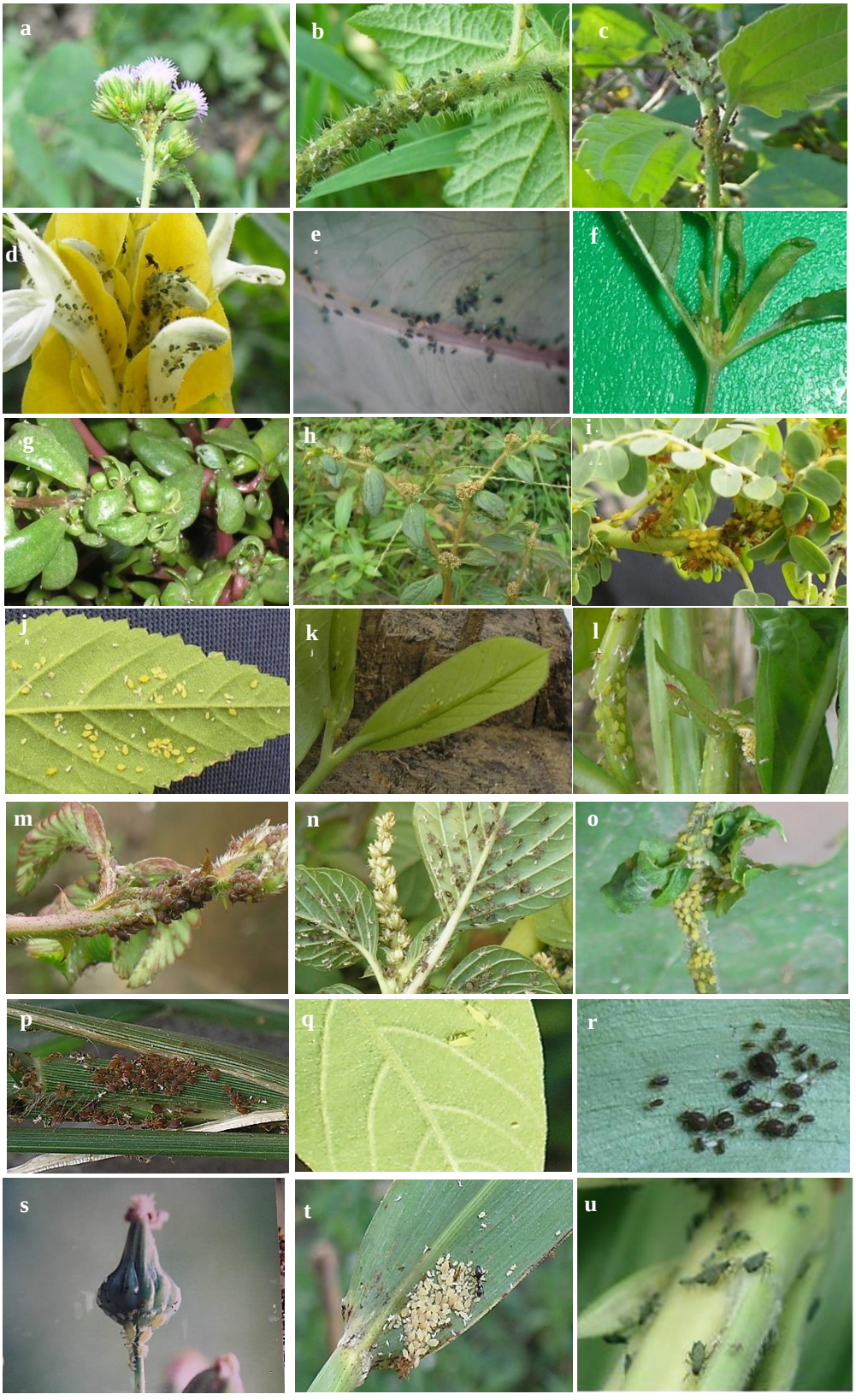

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Peccoud et al., 2010). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring, 2014). *A. gossypii*, and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Margaritopoulos et al., 2006; Piron et al., 2019).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Wäckers & Van Rijn, 2012). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens* (angel's trumpet), *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of

aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii*, and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids

were *A. gossypii*. Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium-sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii*, and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green or

slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were

A. gossypii, and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii*. These aphid colonies were almost always associated with ants. Another species of aphids were founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow-green, with black cauda and siphunculi. Their bodies were very small to small in size. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda

and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light

brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black, and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red-brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids. The aphids were brown to red-brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai,* was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine*. *A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora*. The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson et al., 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al., 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Peccoud et al., 2010). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al., 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and

parasites, and plant defenses developing over time through host switching (Yamamoto et al., 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain nutrient-rich nature (Jakubczyk et al., 2022) and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Chittka, 2007), while others preferred different types of plants and plant parts (Sorensen, 2009). It's worth noting that different aphid species often had distinct preferences for plant ty(Harrington et al., 2007)pes and parts.

Herbs served as an alternative host for aphids in this present study. Aphids consumed sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilized needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al., 2015). Numerous herbs had structural characteristics, such as folds, crevices, and concealed flowering portions (Harrington et al., 2007), that provided aphids with refuge .

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson & Mooney, 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Detrain et al., 2010). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al., 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al., 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann & Vega, 2020).

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This paper described the alternative host of aphids in high land, South Sumatera. The knowledge regarding the alternative of insect pest could be beneficial resource for basic control of aphids.

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Dr. Chandra Irsan

Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

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Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Running title: Aphids Found in Ornamental and Wild Plants

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy & Stroyan, 1959). One species of aphids can host more than 400 species from 40 families (Bass et al., 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al., 2020). Aphids can transmit 275 viruses (Ertunc, 2020). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman & Eastop, 2017). Aphids consume young leaves sap, which can deplete essential nutrients for healthy growth (Cao et al., 2018). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones, 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Sarwan Kumar, 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al., 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al., 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al., 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh & Singh, 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Understanding the species diversity of aphids is fundamental to effective aphid control, as it facilitates the development of measures to keep their populations in check. In addition, understanding the diversity of aphid species can provide valuable insights into potential plant diseases, as different aphid species carry distinct viruses. Methods used to

control aphids often encompass various techniques, including the use of natural enemies such as predators (like ladybugs, lacewings, and parasitic wasps) (Singh & Singh, 2021; Völkl et al., 2023), parasitoids (Boivin et al., 2012), entomopathogens (Hullé et al., 2020), the use of essential oils as botanical pesticides to control aphids (Ikbal & Pavela, 2019), and crop rotation techniques (Degani et al., 2019). Regular monitoring of aphid populations and diversity can help in detecting when population sizes may be reaching harmful levels, allowing for prompt implementation of the necessary countermeasures.

Many aphid species were found on plants that were not their actual hosts (Peccoud et al., 2010). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al., 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo & Smilanich, 2023), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al., 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto et al., 2020). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al., 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing fruit, vegetable, and ornamental varieties, as well as wild plants or weeds. The collection and identification of host plants, aphids, and their natural enemies involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Aphid identification was conducted using identification keys (Blackman & Eastop, 2008). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

RESULT AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii*, *Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae*, *Aphis citricola*, *Aphis craccivora*, *Toxoptera aurantii*, *Pentalonia nigronervosa*, *Hystenura* sp., *Aphis glycine*, *Greenidae* sp., *Rhopalosiphum padi*, *Rhopalosiphum maidis*, *Hyperomyzus* sp. *Lipapis erysimi.* Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland*, h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,* *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

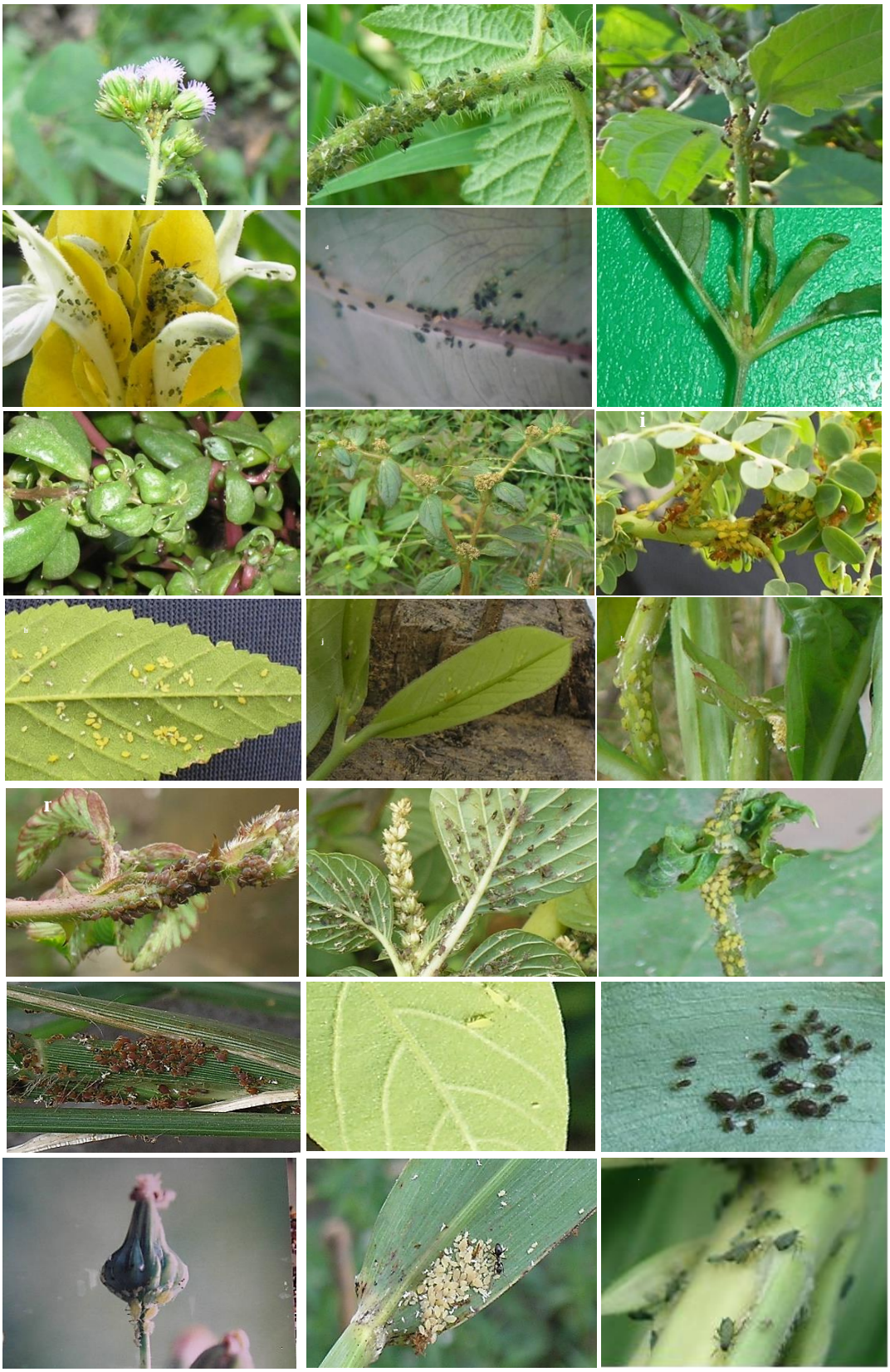

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Peccoud et al., 2010). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring, 2014). *A. gossypii*, and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Margaritopoulos et al., 2006; Alotaibi et al., 2023).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Wäckers & Van Rijn, 2012). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens* (angel's trumpet), *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very

large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii*, and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii*. Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus*. The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii*, and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii*. These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus*. The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa*. First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii*, and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii*. These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small

to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii*. These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These

aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids. The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai,* was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice*

appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola*. The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora*. The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi*. The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson et al., 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al., 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Peccoud et al., 2010). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al., 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al., 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain nutrient-rich nature (Jakubczyk et al., 2022) and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Chittka, 2007), while others preferred different types of plants and plant parts (Sorensen, 2009). It's worth noting that different aphid species often had distinct preferences for plant ty(Harrington et al., 2007)pes and parts.

Herbs served as an alternative host for aphids in this present study. Aphids consumed sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilized needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al., 2015). Numerous herbs had structural characteristics, such as folds, crevices, and concealed flowering portions (Harrington et al., 2007), that provided aphids with refuge .

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson & Mooney, 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Detrain et al., 2010). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al., 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al., 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann & Vega, 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

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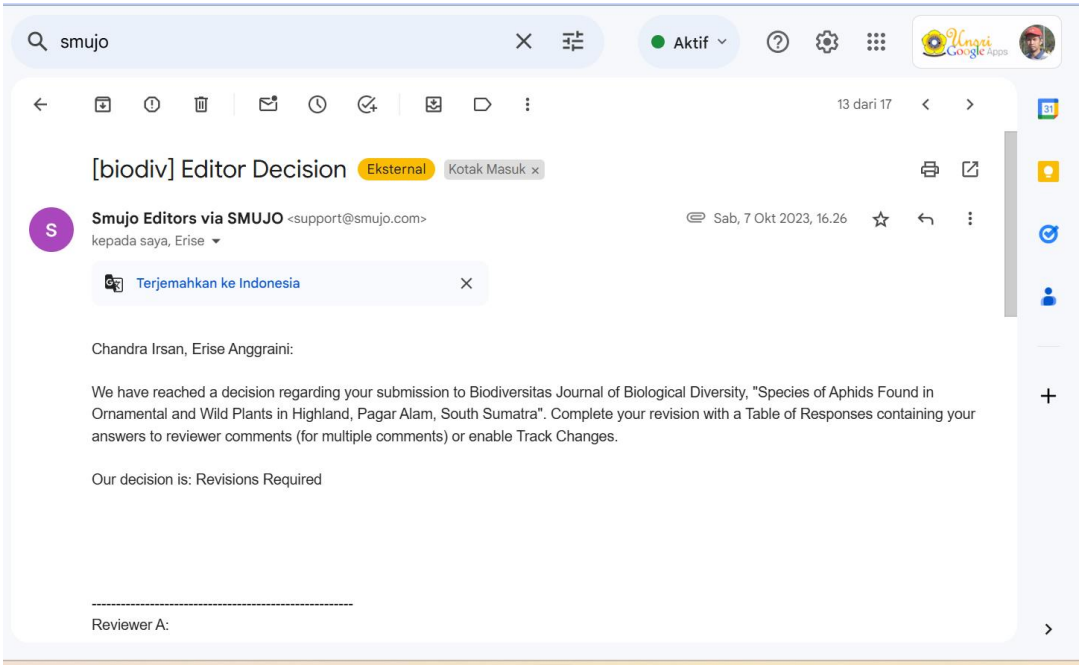
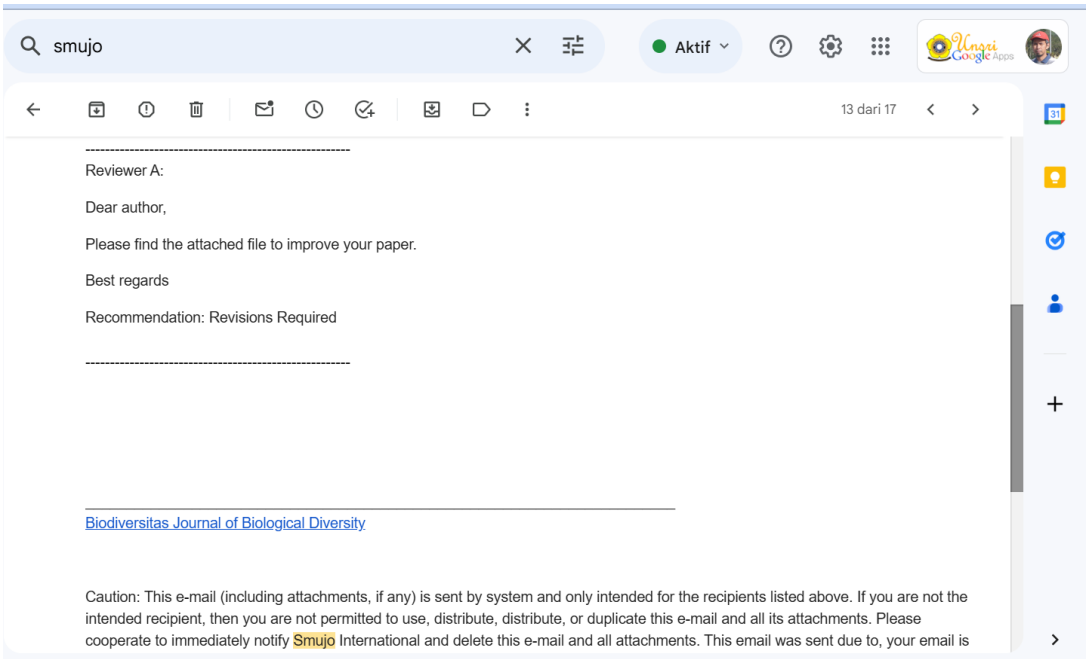
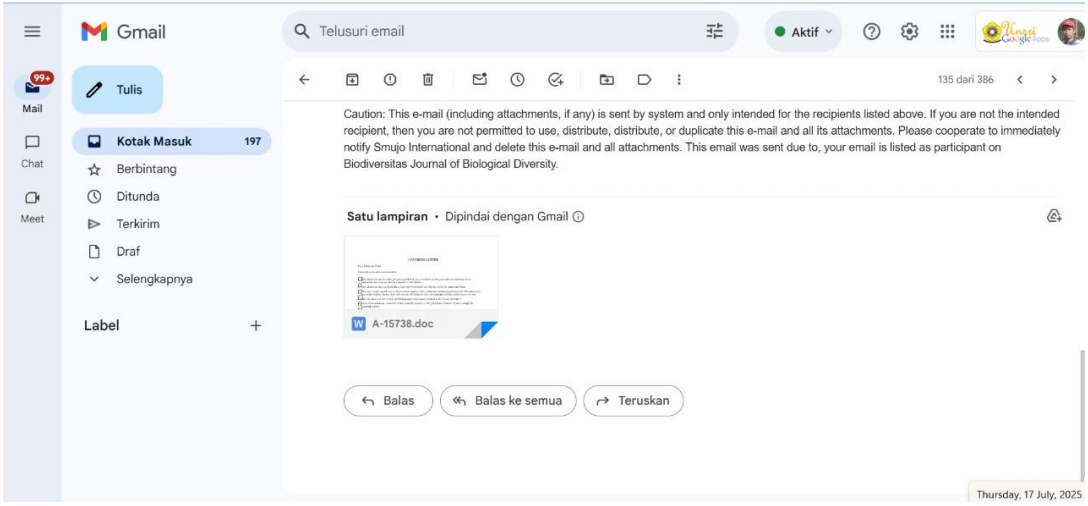
3. Bukti konfirmasi review kedua dan hasil revisi kedua

7 Oktober 2023



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Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

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Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Introduction

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy & Stroyan, 1959). One species of aphids can host more than 400 species from 40 families (Blackman & Eastop, 2000). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al., 2020). A single species of aphids can act as a vector for over 150 viruses (Blackman & Eastop, 2000). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman & Eastop, 2017). Aphids consume plant sap, which can deplete essential nutrients for healthy growth (Müller et al., 2001). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones, 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 -

40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Sarwan Kumar, 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al., 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al., 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al., 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh & Singh, 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Understanding the species diversity of aphids is fundamental to effective aphid control, as it facilitates the development of measures to keep their populations in check. In addition, understanding the diversity of aphid species can provide valuable insights into potential plant diseases, as different aphid species carry distinct viruses. Methods used to control aphids often encompass various techniques, including the use of natural enemies such as predators (like ladybugs, lacewings, and parasitic wasps) (Singh & Singh, 2021; Völkl et al., 2023), parasitoids (Boivin et al., 2012), entomopathogens (Hullé et al., 2020), the use of essential oils as botanical pesticides to control aphids (Ikbal & Pavela, 2019), and crop rotation techniques (Degani et al., 2019). Regular monitoring of aphid populations and diversity can help in detecting when population sizes may be reaching harmful levels, allowing for prompt implementation of the necessary countermeasures.

According to Irsan *et al*. (1998), many aphid species were found on plants that were not their actual hosts. Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al., 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Sileshi et al., 2008). These secondary hosts may

offer less adequate nutrition for insects (Capinera, 2005), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al., 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Moran, 1992). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al., 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagaralam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagaralam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

Methods

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing fruit, vegetable, and ornamental varieties, as well as wild plants or weeds. The collection and identification of host plants, aphids, and their natural enemies involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Guidelines for finding host plants were written by Blackman & Eastop 1994, 2000; Irsan 1998; Kranz *et al*. 1978). Aphid identification was conducted using identification keys made by Blackman & Eastop (1994, 2000); Heie (1992, 1994, 1995); Irsan (1998); Kranz *et al*. (1978); Martin (1983). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified based on identification keys made by van Steenis (1988). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

Results

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipapis erysimi.* Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines*	flower

		Hyperomyzus sp.	
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland*, h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is

closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii*	Shoots, young leaves, old leaves
		Aphis glycine	
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,*	Old leaves, young leaves (pupus), leaf axils
		Rhopalosiphum maidis	
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs, petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves

No	Host Plant	Aphid species	Colony location
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

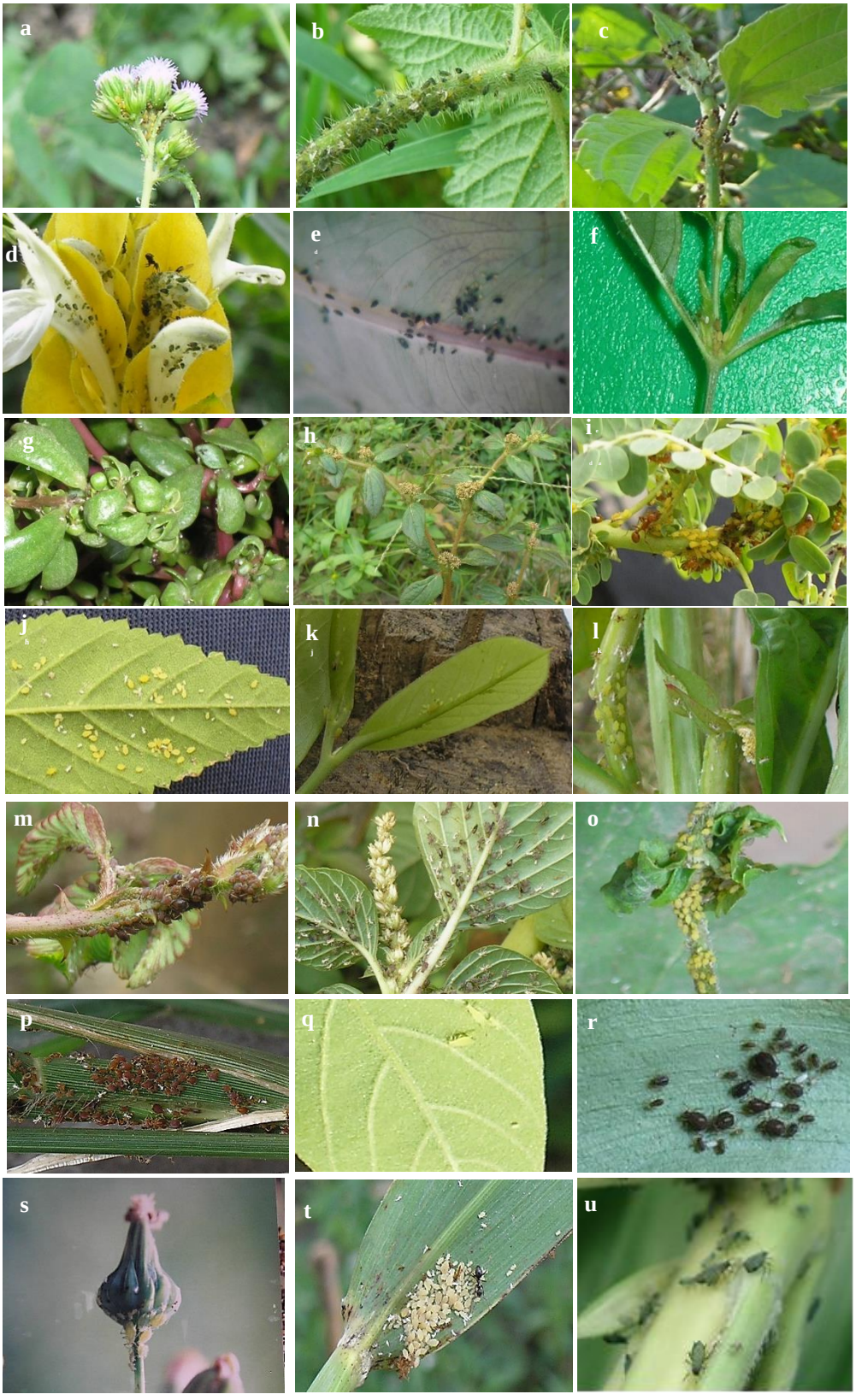

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Peccoud et al., 2010). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring, 2014). *A. gossypii*, and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Margaritopoulos et al., 2006; Piron et al., 2019).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Wäckers & Van Rijn, 2012). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens* (angel's trumpet), *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of

aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii*, and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids

were *A. gossypii*. Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium-sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii*, and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green or

slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were

A. gossypii, and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids were founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow-green, with black cauda and siphunculi. Their bodies were very small to small in size. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda

and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light

brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black, and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red-brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids. The aphids were brown to red-brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae*, which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine*. *A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora*. The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson et al., 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al., 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Peccoud et al., 2010). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al., 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and

parasites, and plant defenses developing over time through host switching (Yamamoto et al., 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain nutrient-rich nature (Jakubczyk et al., 2022) and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Chittka, 2007), while others preferred different types of plants and plant parts (Sorensen, 2009). It's worth noting that different aphid species often had distinct preferences for plant ty(Harrington et al., 2007)pes and parts.

Herbs served as an alternative host for aphids in this present study. Aphids consumed sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilized needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al., 2015). Numerous herbs had structural characteristics, such as folds, crevices, and concealed flowering portions (Harrington et al., 2007), that provided aphids with refuge .

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson & Mooney, 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Detrain et al., 2010). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al., 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al., 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann & Vega, 2020).

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This paper described the alternative host of aphids in high land, South Sumatera. The knowledge regarding the alternative of insect pest could be beneficial resource for basic control of aphids.

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Dr. Chandra Irsan

Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Running title: Aphids Found in Ornamental and Wild Plants

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INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy & Stroyan, 1959). One species of aphids can host more than 400 species from 40 families (Bass et al., 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al., 2020). Aphids can transmit 275 viruses (Ertunc, 2020). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman & Eastop, 2017). Aphids consume young leaves sap, which can deplete essential nutrients for healthy growth (Cao et al., 2018). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones, 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Sarwan Kumar, 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al., 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al., 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al., 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh & Singh, 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Understanding the species diversity of aphids is fundamental to effective aphid control, as it facilitates the development of measures to keep their populations in check. In addition, understanding the diversity of aphid species can provide valuable insights into potential plant diseases, as different aphid species carry distinct viruses. Methods used to control aphids often encompass various techniques, including the use of natural enemies such as predators (like ladybugs, lacewings, and parasitic wasps) (Singh & Singh, 2021; Völkl et al., 2023), parasitoids (Boivin et al., 2012), entomopathogens (Hullé et al., 2020), the use of essential oils as botanical pesticides to control aphids (Ikbal & Pavela, 2019), and crop rotation techniques (Degani et al., 2019). Regular monitoring of aphid populations and diversity can help in detecting when population sizes may be reaching harmful levels, allowing for prompt implementation of the necessary countermeasures.

Many aphid species were found on plants that were not their actual hosts (Peccoud et al., 2010). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al., 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo & Smilanich, 2023), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al., 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto et al., 2020). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al., 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing fruit, vegetable, and ornamental varieties, as well as wild plants or weeds. The collection and identification of host plants, aphids, and their natural enemies involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Aphid identification was conducted using identification keys (Blackman & Eastop, 2008). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010;

Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

RESULT AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipapis erysimi.* Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland,* h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,* *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

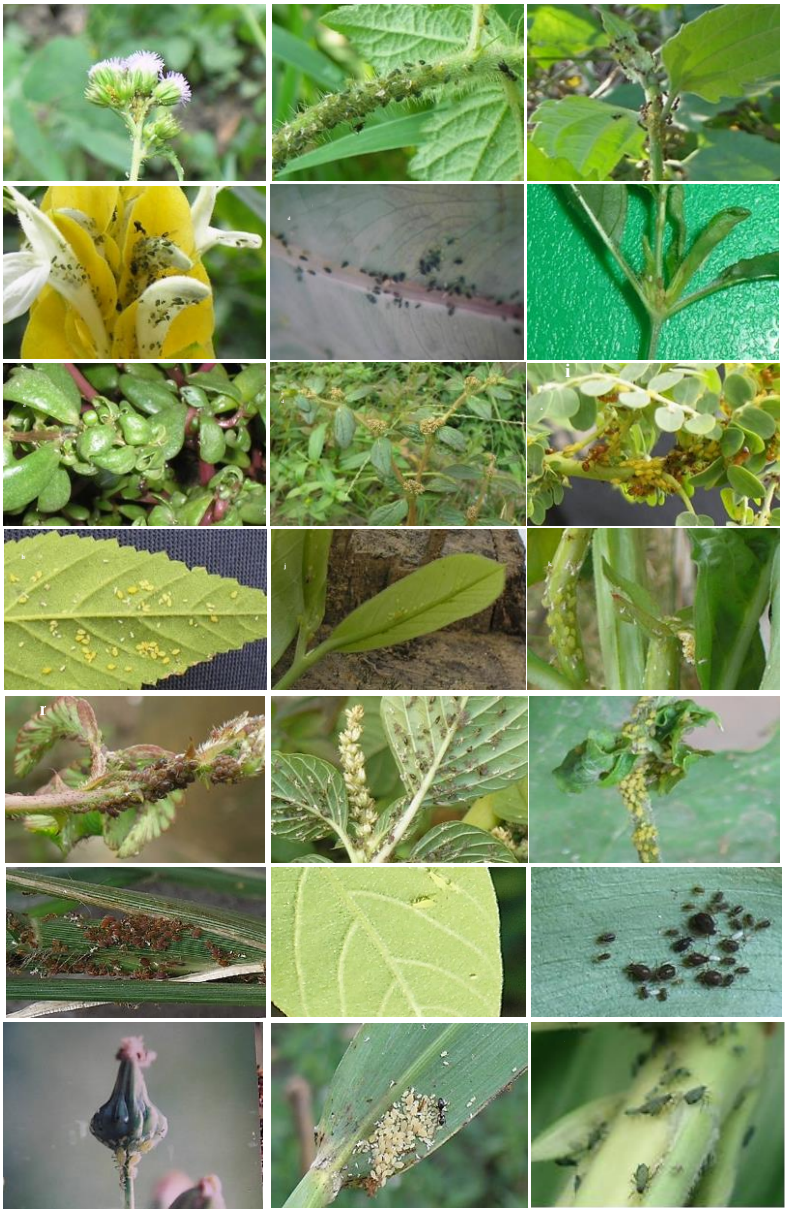

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Peccoud et al., 2010). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring, 2014). *A. gossypii,* and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Margaritopoulos et al., 2006; Alotaibi et al., 2023).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Wäckers & Van Rijn, 2012). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens* (angel's trumpet), *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle)*, A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very

large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii,* and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii,* and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii,* and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small

to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These

aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids*.* The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice*

appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson et al., 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al., 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Peccoud et al., 2010). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al., 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al., 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain nutrient-rich nature (Jakubczyk et al., 2022) and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Chittka, 2007), while others preferred different types of plants and plant parts (Sorensen, 2009). It's worth noting that different aphid species often had distinct preferences for plant ty(Harrington et al., 2007)pes and parts.

Herbs served as an alternative host for aphids in this present study. Aphids consumed sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilized needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al., 2015). Numerous herbs had structural characteristics, such as folds, crevices, and concealed flowering portions (Harrington et al., 2007), that provided aphids with refuge .

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson & Mooney, 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Detrain et al., 2010). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al., 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al., 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann & Vega, 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

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2	This manuscript has outdated references to be published in Biodiversitas. Reference list should consist of at least 20 citations which 80% of international scientific journals published in the last 10 years (2013-2023), and a maximum of 10% references from national publication. - Please follow the guidance for reference writing (https://smujo.id/biodiv/guidance-for-author)	The references have been updated	Line 404

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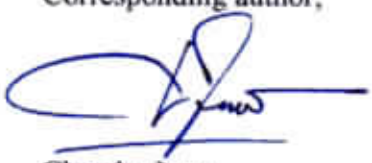

Chandra Irsan

Species of aphids found in ornamental and wild Plants in Highland, Pagar Alam, South Sumatra

Abstract. Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that 21 species of aphids were found in Pagaralam, namely *Aphis gossypii, Aphis citricola, Aphis craccivora, Aphis glycines, Aulacorthum solani, Greenidae* sp., *Hyperomyzus* sp., *Hysteroneura setariae, Lipaphis erysimi, Macrosiphoniella sanborni, Macrosiphum rosae, Myzus persicae, Neomyzus circumflexus, Pentalonia caladii, Rhopalosiphum maidis, Rhopalosiphum nymphaeae, Rhopalosiphum padi, Sinemogoura citricola, Toxoptera aurantii, Toxoptera citricidus,Toxoptera odinae,* and *Schizaphis rotundiventris.*

Keywords: Aphids, ornamental plants, wild plants

Running title: Aphids found in ornamental and wild plants.

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020). Aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck

phloem sap of tender plant parts, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species can further weaken and stunt the growth of infected plants (Jones 2022). Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are found on plants that are not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. Research on the diversity of aphid species in ornamental and wild plants has received little attention. This study reports diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory of cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, and natural enemies where available, involved systematic searches of all existing plant species to find those colonized by aphids. Any plants colonized by aphids aredocumented as aphid hosts. Aphid identification was doneusing identification keys (Blackman and Eastop 2008) in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, including their life color, and photographs of the aphid colonies and their host plants were recorded.

RESULTS AND DISCUSSION

Result

Aphids infesting in ornamental plants

The results showed that 15 aphid species were found in Pagar Alam(Tables 1, 2).. These aphids mostly colonised flowers of various ornamental plants (Table 1, Figure 1).

Table 1. Aphid species recorded in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Macrosiphoniella sanborni*	Leaves, young twig, flower
2	*Brugmansia suaviolens*	*Aulacorthum solani*	Leaves, flower
		Neomyzus circumflexus	Leaves
		Myzus persicae	Leaves, flower
3	*Caladium* sp.	*Pentalonia caladii*	Leaves,
4	*Cananga odoratum*	*Aphis gossypii*	Leaves, flower
5	*Canna indica*	*Rhopalosiphum nymphaeae*	Leaf
6	*Catharanthus roseus*	*Aphis citricola*	Shoot, young leaves, flower
7	*Cestrum* sp.	*Aphis gossypii*	Shoot, flower
		Neomyzus circumflexus	Young leaves
8	*Clitoria ternatea*	*Aphis craccivora*	Flower
9	*Chrysanthemum* sp.	*Macrosiphoniella sanborni*	Shoot, twig

10	*Dahlia* sp.	*Aphis gossypii*	Flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	Flower
12	*Duranta* sp.	*Aphis gossypii*	Shoot, flower
13	*Helianthus giganteus*.	*Aphis glycines*	Flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	Flower
15	*Ixora paludosa*	*Aphis gossypii*,	Flower
		Toxoptera aurantii	Shoot, young leaves
16	*Ixora* sp.	*Aphis citricola*	Flower
		Aphis gossypii	Flower
		Toxoptera aurantii	Shoot, flower
17	*Murraya paniculata*	*Aphis craccivora*	Young Twig
		Toxoptera citricidus	Shoot, flower
18	*Mussaenda frondosa*	*Aphis citricola*	Shoot, flower
		Toxoptera odinae	Shoot, flower
19	*Rosa indica*	*Macrosiphum rosae*	Flower
20	*Spondias dulcis*	*Aphis citricola*	Flower

Fig 1. Photos showing colonies of different aphid species in ornamental plants: a) *Aphis gossypii* in *Dahlia* sp. flower b) *Aphis gossypii* in *Hibiscus rosasinensis* flower c) *Aphis gossypii* in *cestrum* twig and flower, d) *Aphis craccivora* in *Clitoria ternatea* flower, e) *Aphis glycines* in *Helianthusgiganteus* flower, f) *Aphis craccivora* on the *Murayya paniculata* flower, g) *Toxoptera odinae* in the *Mussaenda frondosa*, h) *Macrosiphoniella sanborni*. in *Chrysanthemum* sp. leaves i) *Macrosiphum rosae* in *Rosa indica* flower, j) *Rhopalosiphum nymphaeae* in *Canna indica* leaves. All the photos were captured by Chandra Irsan.

The relationship between aphids and ants was also recorded. Aphids produce a sweet, sticky substance called honeydew. Ants are attracted to this honey because it serves as a food source

for them. When aphids are present, they secrete honeydew, which attracts ants. This research recorded the presence of ants on plant parts colonized by aphids (Table 2).

Table 2. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized

No	Aphid Species	Ornamental plants	Aphids life colour	Plant parts colonized	Ant attendance
1	*Aphis craccivora*	*Clitoria ternatea*	black	flowers	+
		Murraya paniculata	black	flowers	+
2	*Aphis citricola*	*Catharanthus roseus*	greenish yellow	flowers	+
		Ixora sp.	greenish yellow	flowers	+
		Mussaenda frondosa	greenish yellow	shoots, flowers	+
		Spondias dulcis	greenish yellow	flowers	+
3	*Aphis glycines*	*Helianthus giganteus*	greenish yellow	flowers	+
4	*Aphis gossypii*	*Cestrum* sp.	green	shoots, flowers	+
		Cananga odoratum	light green	shoots, flowers	+
		Dahlia sp.	green dark	flowers	+
		Duranta sp.	light green	shoots, flowers	+
		Hibiscus rosasinensis	dark green	flowers	+
		Ixora paludosa	light green	flowers	+
		Ixora sp.	light green	flowers	+
5	*Aulacorthum solani*	*Brugmansia suaviolens*	greenish yellow	leaves, flowers	-
6	*Macrosiphoniella sanborni*	*Aster alpinus*	brown black	leaves, twigs, flowers	+
		Chrysantemum sp.	reddish brown	leaves, twigs	+
7	*Macrosiphum rosae*	*Rosa indica*	green	flowers	-
8	*Myzus persicae*	*Brugmansia suaviolens*	greenish yellow	leaves, flowers	-
9	*Neomyzus circumflexus*	*Cestrum* sp.	light green	young leaves,	-
		Brugmansia suaviolens	light green	flowers	
				flowers	
10	*Pentalonia caladii*	*Caladium* sp.	brown-black	leaves	+
11	*Rhopalosiphum nymphaeae*	*Canna indica*	green black	leaves	+
12	*Sinemegoura citricola*	*Dendrobium* sp.	brown	flowers	-
13	*Toxoptera aurantii*	*Ixora paludosa*	brown black	flowers	+
		Ixora sp.	brown black	flowers	+
14	*Toxoptera citricidus*	*Murraya paniculata*	black	stems	+
15	*Toxoptera odinae*	*Mussaenda frondosa*	reddish-brown	flowers	+

(+): present, (-): absent

Aphids infesting in wild plants (weed or non-weed plants)

In addition, this study documented aphid colonies on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Table 3, Figure 2).

Table 3. Species of aphids found in wild (weed or non-weed) plants and their colony locations.

No	Host Plant	Weeds or non-weed plants	Aphid species	Colony location
1	*Ageratum conyzoides*	weed	*Aphis gossypii*	shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	weed	*Aphis gossypii*	shoots, buds
3	*Alternanthera sessilis*	weed	*Aphis gossypii*	shoots, buds
4	*Amaranthus gracilis*	weed	*Aphis craccivora*	flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	weed	*Lipaphis erysimi*	flowers, shoots, and buds
6	*Croton hirtus*	weed	*Aphis gossypii*	flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	weed	*Schizaphis rotundiventris*	flower, flower stalks
8	*Cyperus rotundus*	weed	*Schizaphis rotundiventris*	flower, flower stalks, leaf axils
9	*Cyperus compressus*	weed	*Schizaphis rotundiventris*	flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	weed	*Hystroneura setariae*	flower, flower stalks
11	*Echinocloa crussgali*	weed	*Hiperomyzus* sp.	young leaves, old leaves
12	*Ecliptica prostrata*	weed	*Aphis gossypii*	shoots, young leaves
13	*Eleusin indica*	weed	*Hysteroneura setariae*	flower, flower stalks, leaf axils
			Rhopalosiphum maidis	flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	weed	*Aphis gossypii*	flower, flower stalks, shoots
15	*Eragrostis tenella*	weed	*Hysteroneura setariae*	flower, flower stalks, seeds
16	*Euphorbia hirta*	weed	*Aphis gossypii*	young leaves, old leaves
17	*Eupotarium odoratum*	weed	*Aphis gossypii*	young leaves, old leaves,
			Aphis glycines	shoot, young twigs
18	*Hymenochera acutigluma*	Weed	*Hysteroneura setariae*	flowers, flower stalks, leaf axils
19	*Bridelia tomentosa*	Non-weed	*Greenidea* sp.	young leaves
20	*Lophatherum gracile*	Weed	*Hysteroneura setariae*	young leaves, old leaves, leaf axils
			Rhopalosiphum maidis	young leaves, old leaves, leaf axils
21	*Melastoma affine*	Non-weed	*Aphis gossypii*	shoots, young leaves
22	*Mikania mikranta*	Weed - liana	*Aphis gossypii*	shoots, young leaves, old leaves
			Aphis glycines	shoot, young twig
23	*Mimosa invisa*	weed	*Aphis craccivora*	shoots, pods
24	*Mimosa pudica*	weed	*Aphis craccivora*	shoots, pods, flowers
25	*Mimosa vigra*	Non-weed	*Aphis craccivora*	shoots, pods
26	*Oryza rufipogon*	weed	*Rhopalosiphum padi,*	old leaves, young leaves (shoot), leaf axils
		weed	*Rhopalosiphum maidis*	old leaves, young leaves (shoot), leaf axils
27	*Oxonopus compressus*	weed	*Hysteroneura setariae*	flowers, flower stalk, leaf axils
28	*Paspalum conjugatum*	weed	*Hysteroneura setariae*	flowers, flower stalk, seeds
29	*Phylanthus neruri*	weed	*Aphis citricola*	shoot, young leaves, old leaves, young twigs, petioles
30	*Portulaca oleraceae*	weed	*Aphis craccivora*	shoots, young leaves, flowers
31	*Physalis angulata*	weed	*Aphis craccivora*	shoots, young leaves, old leaves
		weed	*Aphis gossypii*	shoots, young leaves, old leaves
32	*Rorippa indica*	weed	*Lipapis erysimi*	flowers, fruits, shoots, young leaves
33	*Sida rhombifolia*	weed	*Aphis gossypii*	shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	weed	*Lipapis erysimi*	young leaves, fruit stalks, flowers, fruits

The presence of ants in aphid colonization symbolizes a mutually beneficial relationship where the ants receive food from the aphids while providing protection to the aphids. This study recorded the ant attendance in aphids colonization (Table 4).

Table 4. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized.

No	Aphid Species	Wild plants	Aphids life colour	Plant parts colonized	Ant attendance
1	*Aphis gossypii*	*Ageratum conyzoides*	Light green	shoots, young leaves, old leaves, flowers	+
		Alternanthera	Light green	shoots, buds	+
		philoxeroides	Light green	shoots, buds	-
		Alternanthera sessilis	Dark green	flowers, shoots, young leaves, old leaves,	+
		Croton hirtus	green	young twigs	+
		Ecliptica prostrata	green	shoots, young leaves	+
		Emilia sonchifolia	light green	flower, flower stalks, shoots	+

No	Aphid Species	Wild plants	Aphids life colour	Plant parts colonized	Ant attendance
		Euphorbia hirta	light green	young leaves, old leaves	+
		Eupotarium odoratum	light green	young leaves, old leaves, young twigs	+
		Melastoma affine	light green	shoots, young leaves	+
		Mikania mikranta	yellowish green	shoots, young leaves, old leaves	+
		Physalis angulata	yellowish green	shoots, young leaves, old leaves, fruit/seeds	-
		Sida rhombifolia			
2	*Aphis craccivora*	*Amaranthus gracilis*	black	flowers, shoots, young leaves, old leaves	+
		Mimosa invisa	black	shoots, pods	+
		Mimosa pudica	black	shoots, pods, flowers	+
		Mimosa vigra	black	shoots, pods	+
		Portulaca oleraceae	black	shoots, young leaves, flowers	+
		Physalis angulata	black	shoots, young leaves, old leaves	+
3	*Aphis glycines*	*Eupotarium odoratum*	Greenish	young leaves, old leaves, young twigs	+
		Mikania mikranta	yellow	shoots, young leaves, old leaves	+
			Light green		
4	*Aphis citricola*	*Phylanthus neruri*	Greenish Yellow	shoot, young leaves, young twigs, petioles	+
5	*Greenidea* sp.	*Bridelia Tomentosa*	Greenish Yellow	young leaves	-
6	*Hystroneura setariae*	*Digitaria ciliaris*	reddish-brown	flower, flower stalks	+
		Eleusin indica	reddish-brown	flower, flower stalks, leaf axils	+
		Eragrostis tenella	reddish-brown	flower, flower stalks, seeds	+
		Hymenochera	reddish-brown	flowers, flower stalks, leaf axils	+
		acutigluma	reddish-brown	young leaves, old leaves, leaf axils	+
		Lophatherum gracile	reddish-brown	flower, flower stalk, leaf axils	+
		Oxonopus compressus	reddish-brown	flower, flower stalk, seeds	+
		Paspalum conjugatum			
7	*Hiperomyzus* sp.	*Echinocloa crussgali*	Black	young leaves, old leaves	-
8	*Lipaphis erysimi*	*Blumea lacera*	Whitish green	flowers, shoots, and buds	+
		Rorippa indica	Whitish green	flower, fruit, shoots, young leaves	+
		Sonchus arventris	Whitish green	young leaves, fruit stalks, flower, fruit	+
9	*Rhopalosiphum maidis*	*Eleusin indica*	green	flower, flower stalks, leaf axils	+
		Lophatherum gracile	green	young leaves, old leaves, leaf axils	+
		Oryza rufipogon	green	old leaves, young leaves (shoot), leaf axils	-
10	*Rhopalosiphum padi*	*Oryza rufipogon*	Whitish green	old leaves, young leaves (shoot), leaf axils	+
11	*Schizaphis rotundiventris*	*Cynodon dactylon*	Green	flowers, flower stalks	+
		Cyperus rotundus	green	flowers, flower stalks, leaf axils	+
		Cyperus compressus	green	flowers, flower stalks, leaf axils	+

(+): present, (-): absent

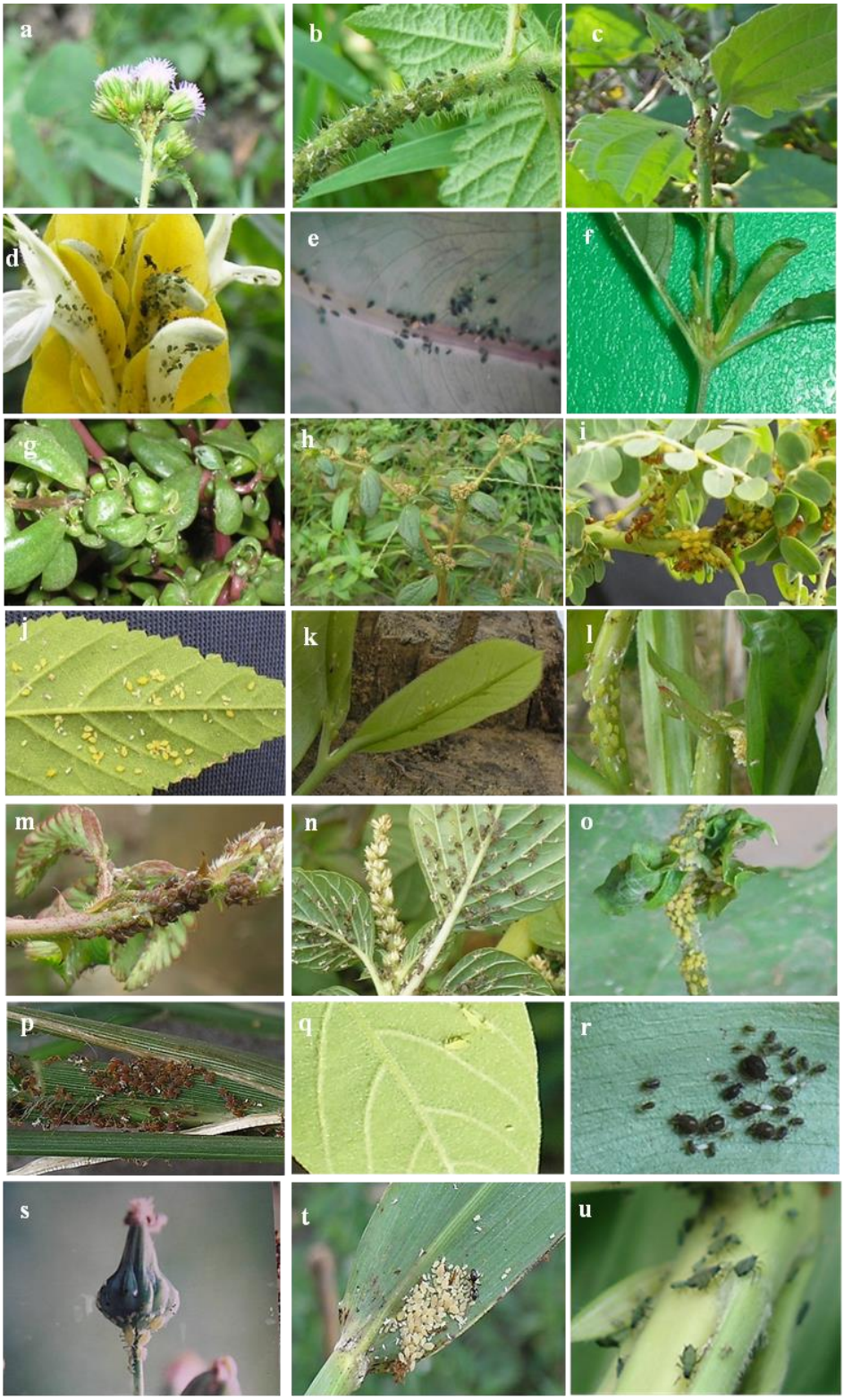

Figure 2. Aphids found infesting wild plants a) *Aphis gossypii* in *Ageratum conyzoides, b) Aphis gossypii* in *Croton hirtus c) A. gossypii* in *Eupatorium odoratum, d) Aphis gossypii* in *Pachystochys* sp., *e) Pentalonia caladii* in *Caladium* sp., *f) Aphis. gossypii* in *Alternanthera sessilis, g) Aphis gossypii* in *Portulaca oleraceae h) Aphis gossypii* in *Euphorbia hirta, i) Aphis citricola* in *Phylantus nerruri, j) Aphis citricola* in *Sida rhombifolia*, k) *Aphis citricola* in *Annona muricata, l) Aphis citricola* in *Ludwigia*

peruviana, m) A. craccivora in *Mimosa pudica*, n) *Aphis craccivora* in *Amaranthus gracilis, o) Aphis glycine* in *Mikania micranta, p) Hysteneura* sp. in *Eleusin, q) Greenidae* sp. in *Bridelia tomentosa* young leaves., *r)Hyperomyzus* sp. in *Echinocloa crusgali, s) Lipaphis erysimi* in *sonchus arventris, t) Rhopalosiphum padi* in *Oryza rufipogon, u)Rhopalosiphum Maidis* in *Oryza rufipogon.* All the photos were captured by Chandra Irsan.

Discussion

In the present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Macrosiphoniella sanborni*, and they were associated with ants. On the *Brugmansia suaviolens*, *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. was found one species of aphids: *P. caladii*. *P. caladii* was known and found in taro plants, the aphids formed colonies under the surface of young and older leaves (Bhadra and Agarwala 2014). According to this present study, the occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants. Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body and the identification results showed that the aphids were *Rhopalosiphum nymphaeae* (Acharya and Singh 2004). The colonies of *R. nymphaeae* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants. Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. The aphids on the *Dahlia* sp. formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* According to this present study, *Sinemegoura citricola* colonies were found on the young leaves

of *Dendrobium* sp., with the color body of the *S. citricola* aphids were yellow, green to dark green, and the colonized plants did not show any disease symptoms, and they were associated with ants. On *Duranta* sp., colonies of aphids were located on the undersides of young leaves and the colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Furthermore, on the *Helianthus annuus*, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found. On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, like sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii,* and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants. Moreover, in *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellowish green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants. Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The identification results showed that the aphids were *Toxoptera odinae.* The aphids were yellow, green, and some with dark green (Blackman et al. 2011). The second type of aphids formed colonies on the stems or

young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*. Many aphid species infest a variety of ornamental plants because these insects are attracted to such plants due to the rich nutrient content in the plant sap (Braham et al. 2023).

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to reddish brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants. *Eleusin indica* was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R.*

maidis colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves. *Eragrostis tenella* was infested by *Hysteroneura setariae* aphids. The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on *E. odoratum* plants were associated with either black or red ants. *Hymenochera acutigluma* or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile* or bamboo grass plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on *L. gracile* to mix. In addition, *Melastoma affine* was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony. *Mimosa invisa (cater*-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms. *Oryza rufipogon* was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis*

appeared green with black siphunculiand cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants. *Paspalum conjugatum* was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black. *Physalis angulata* plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations. The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson, Tjallingii, and Hardie 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a

significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies. According to this present study, ants were present in some aphids colonies from the subfamily aphidini, while the ants were absent in some aphids colonies from the macrocypini subfamily. The absent of ants in aphids colonies could be the colonies have just formed, or the population is still low (Kummel, Brown, and Bruder 2013). Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain a nutrient-rich nature and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *Lipaphis erysimi,* and *Myzus persicae* are the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022). Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson and Mooney 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al. 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann and Vega 2020).

CONCLUSION

21 species of aphids were found in Pagaralam, namely *Aphis gossypii, Aphis citricola, Aphis craccivora, Aphis glycines, Aulacorthum solani, Greenidae* sp., *Hyperomyzus* sp., *Hysteroneura setariae, Lipaphis erysimi, Macrosiphoniella sanborni, Macrosiphum rosae, Myzus persicae, Neomyzus circumflexus, Pentalonia caladii, Rhopalosiphum maidis, Rhopalosiphum nymphaeae, Rhopalosiphum padi, Sinemogoura citricola, Toxoptera aurantii, Toxoptera citricidus,Toxoptera odinae*, and *Schizaphis rotundiventris*.

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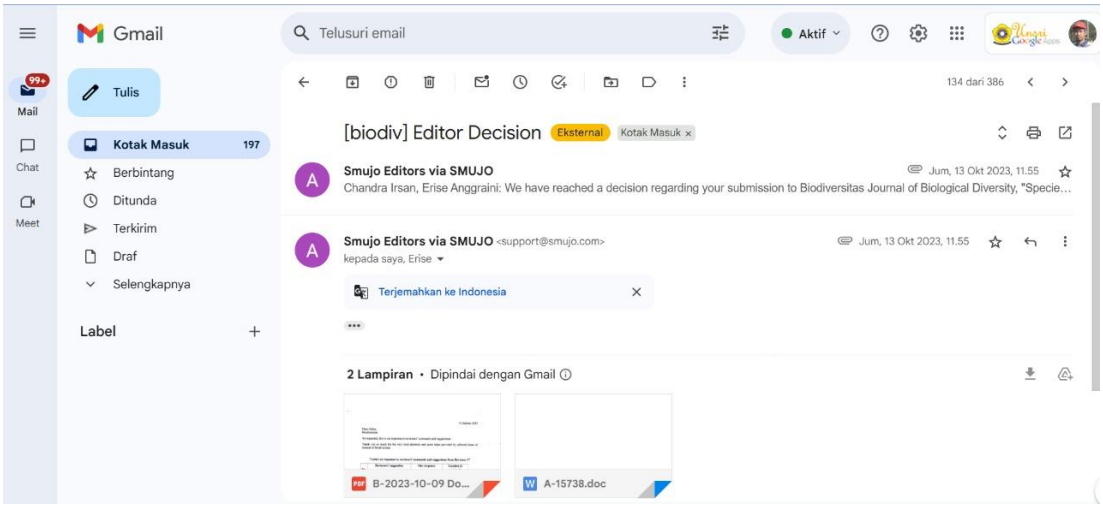
4. Bukti konfirmasi review ketiga dan hasil revisi ketiga

13 Oktober 2023



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Title:

Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

Author(s) name:

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This paper described the alternative host of aphids in high land, South Sumatera. The knowledge regarding the alternative of insect pest could be beneficial resource for basic control of aphids.

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Dr. Chandra Irsan

Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Running title: Aphids Found in Ornamental and Wild Plants

INTRODUCTION

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Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy & Stroyan, 1959). One species of aphids can host more than 400 species from 40 families (Bass et al., 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al., 2020). Aphids can transmit 275 viruses (Ertunc, 2020). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman & Eastop, 2017). Aphids consume young leaves sap, which can deplete essential nutrients for healthy growth (Cao et al., 2018). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones, 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Sarwan Kumar, 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al., 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al., 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al., 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's

leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh & Singh, 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Understanding the species diversity of aphids is fundamental to effective aphid control, as it facilitates the development of measures to keep their populations in check. In addition, understanding the diversity of aphid species can provide valuable insights into potential plant diseases, as different aphid species carry distinct viruses. Methods used to control aphids often encompass various techniques, including the use of natural enemies such as predators (like ladybugs, lacewings, and parasitic wasps) (Singh & Singh, 2021; Völkl et al., 2023), parasitoids (Boivin et al., 2012), entomopathogens (Hullé et al., 2020), the use of essential oils as botanical pesticides to control aphids (Ikbal & Pavela, 2019), and crop rotation techniques (Degani et al., 2019). Regular monitoring of aphid populations and diversity can help in detecting when population sizes may be reaching harmful levels, allowing for prompt implementation of the necessary countermeasures.

Many aphid species were found on plants that were not their actual hosts (Maharani et al., 2018). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al., 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo & Smilanich, 2023), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al., 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto et al., 2020). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al., 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Aphid identification was conducted using identification keys (Blackman & Eastop, 2008). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

RESULT AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipapis erysimi.* Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland,* h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,* *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

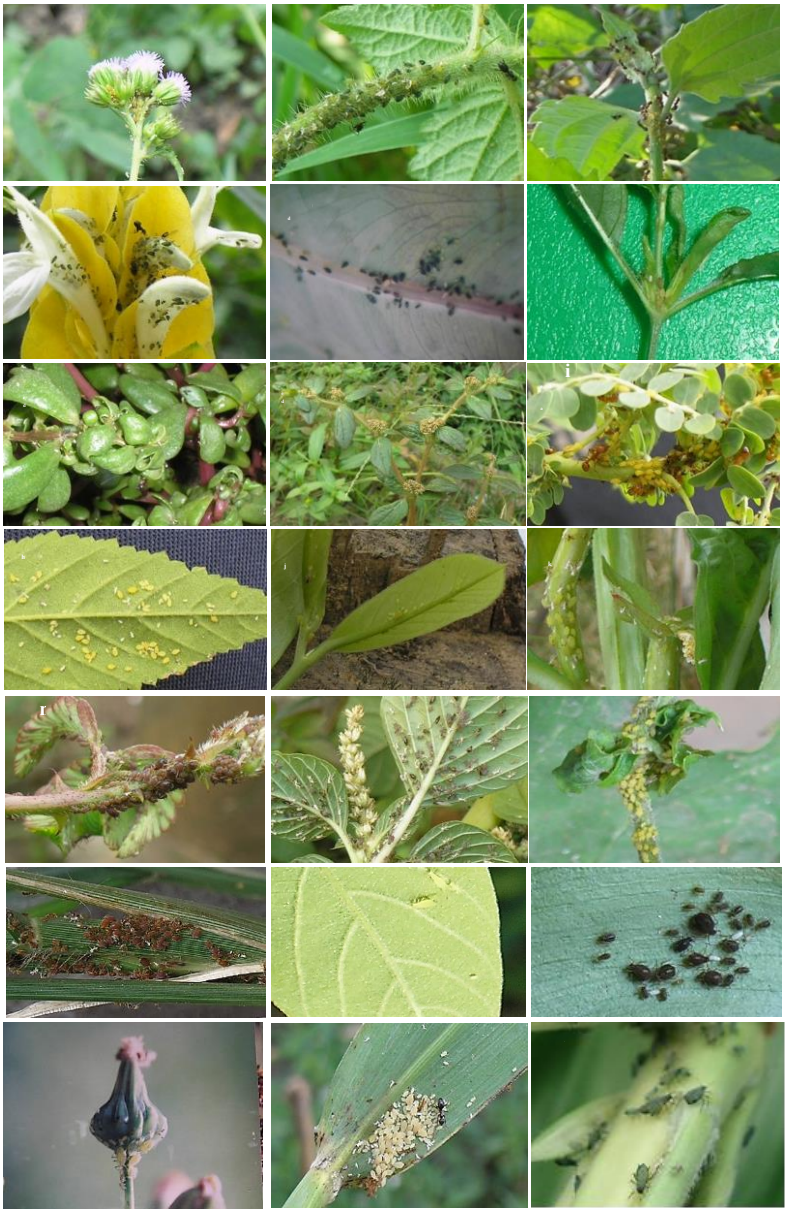

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Santiago et al., 2017). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring, 2014). *A. gossypii,* and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Alotaibi et al., 2023).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Braham et al., 2023). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens*, *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle)*, A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii,* and

they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii,* and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii,* and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants.

The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids*.* The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants.

Oxonopus compressus or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson et al., 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al., 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Yamamoto et al., 2020). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al., 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al., 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain a nutrient-rich nature and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Jakubczyk et al., 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al., 2015). Several aphids colonized herbs such as Indian mustards, *Lipaphis erysimi,* and *Myzus persicae* are the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al., 2022).

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson & Mooney, 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Zheng et al., 2022). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al., 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al., 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann & Vega, 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

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16 October 2023

Dear Editor,
Biodiversitas

As requested, this is our response to reviewers' comments and suggestions.

Thank you so much for the very kind attention and great helps provided by editorial team of Journal of Biodiversitas

"Letter on responses to reviewers' comments and suggestions from Reviewer 1"

No.	Reviewers' suggestion	Our response	Location in revised manuscript
1	The Introduction has more than 700 words	The Introduction has been revised	Line 32-83
2	The reference must be revised following Biodiversitas guidelines.	The references have been updated	Line 394

Sincerely
Corresponding author,

Chandra Irsan

COVERING LETTER

Dear **Editor-in-Chief,**

I herewith enclosed a research article,

- ☐ The submission has not been previously published, nor is it before another journal for consideration (or an explanation has been provided in Comments to the Editor).
- ☐ The submission file is in OpenOffice, Microsoft Word (DOC, not DOCX), or RTF document file format.
- ☐ The text is single-spaced; uses a 10-point font; employs italics, rather than underlining (except with URL addresses); and all illustrations, figures, and tables are placed within the text at the appropriate points, rather than at the end.
- ☐ The text adheres to the stylistic and bibliographic requirements outlined in the Author Guidelines.
- ☐ Most of the references come from current scientific journals (c. 80% published in the last 10 years), except for taxonomic papers.
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Title:

Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

Author(s) name:

Chandra Irsan[a*], Erise Anggraini[a,b], Siti Herlinda[a], Wenny Ramadhani[c], M. Umar Harun[d],

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Novelty:

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This paper described the alternative host of aphids in high land, South Sumatera. The knowledge regarding the alternative of insect pest could be beneficial resource for basic control of aphids.

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Palembang, 5 October 2023

Sincerely yours,

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Dr. Chandra Irsan

Species of Aphids Found in Ornamental and Wild Plants in Highland, Pagar Alam, South Sumatra

Abstract

Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: aphids, ornamental plants, wild plants

Running title: Aphids Found in Ornamental and Wild Plants

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020). Aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can always be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids consume young leaves sap, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, when aphids transmit viral diseases from one plant to another, this can further weaken and stunt the growth of infected plants (Jones 2022). According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Kumar 2019).

Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al. 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al. 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al. 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's

leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh and Singh 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species were found on plants that were not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo and Smilanich 2023), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin, Gwenaelle, and Armelle 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto, Hattori, and Itino 2020). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al. 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. The research on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, this study was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids were documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Aphid identification was conducted using identification keys (Blackman and Eastop 2008). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, morphology of aphids including their shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were taken.

RESULT AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagaralam, namely *Aphis gossypii*, *Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae*, *Aphis citricola*, *Aphis craccivora*, *Toxoptera aurantii*, *Pentalonia nigronervosa*,

Hystenura sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipapis erysimi.* Based on the observation, these aphids were found on various ornamental plants (Table 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1: Aphid species found in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia Kelvin*	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower
13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

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Fig 1. The location of aphid colonization on various plant parts. a) *A. gossypii* in *D. Kelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland*, h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

In addition, this study documented the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of aphid colonies also varied, namely on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Figure 2). The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).

Table 2: Species of aphids found in wild plants and their colony locations.

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii,* *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,* *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora,* *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

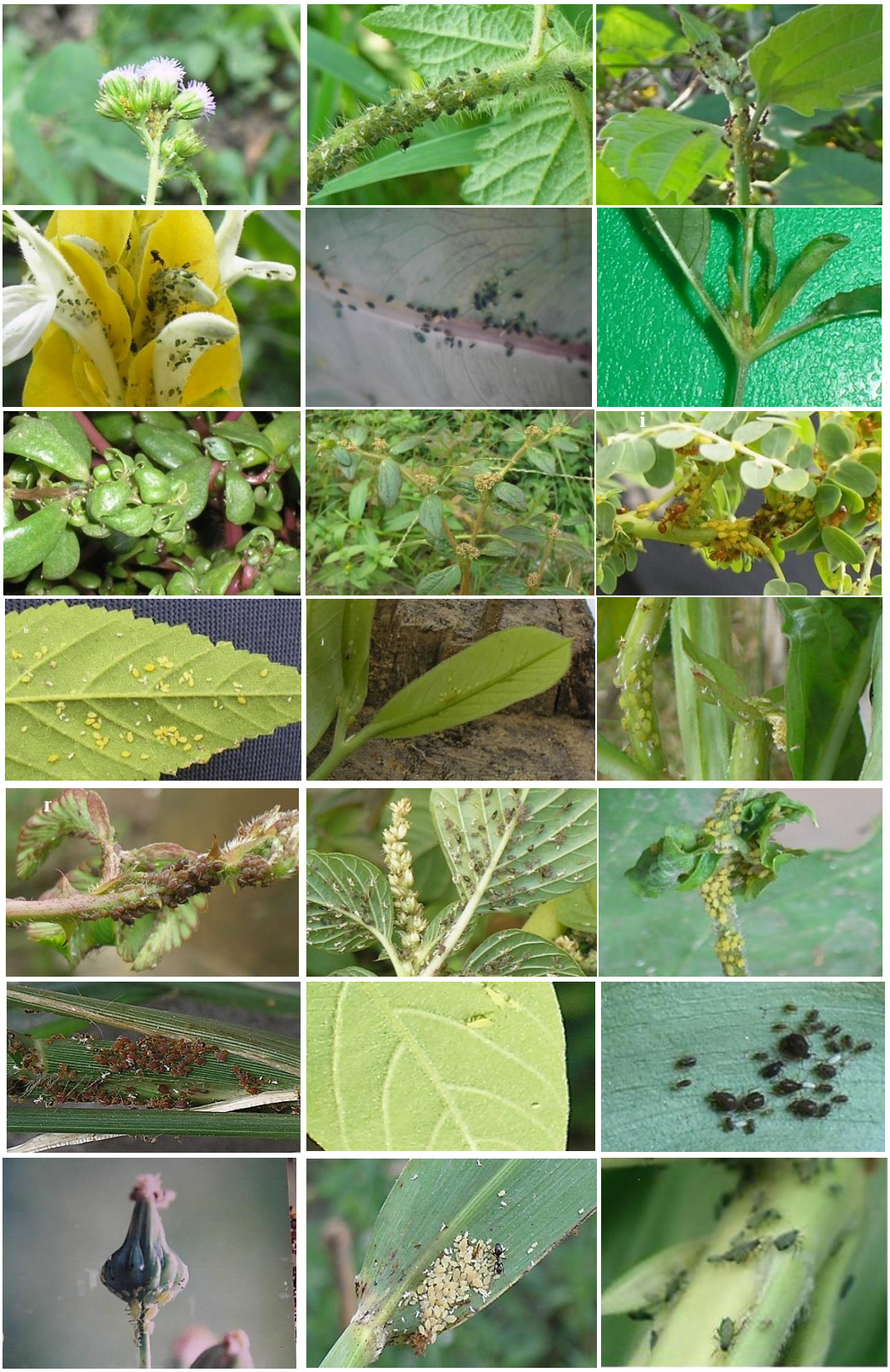

Figure 2. Aphids found on wild plants a) *A. gossypii* on the weed *Ageratum conyzoides, b) A. gossypii* on Croton weed *hirtus c) A. gossypii* on the weed *Eupatorium odoratum, d) A.gossypii* on plants *Pachystochys* sp., *e) A.gossypii* on plants *Caladium* sp., *f) A. gossypii* on the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae weeds, h) A.gossypii* on the weed *Euphorbia hirta, i) A. citricola* on the weed *Phylantus nerruri, j) A. citricola on Sida rhombifolia* weed, k) *A. citricola* on plants *Annona muricata, l) A.citricola* on the weed *Ludwigia peruviana, m) A. craccivora on Mimosa pudica* weed, n) *A.craccivora* on weeds *Amaranthus gracilis, o) A. glycine* in *Mikania micranta weed, p) Hysteneura* sp. in *Eleusin weeds, q) Greenidae* sp. in kenidai trees (shrubs) *indica, r)Hyperomyzus* sp. in *Echinocloa crusgali Weed, s) L. erysimi* on weed *sonchus arventris, t) Rhopalosiphum rice* on the weed *Oryza rufipogon, u)Rhopalosiphum Maidis* on the weed *Oryza rufipogon.*

Discussion

The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Santiago et al. 2017). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring 2014). *A. gossypii*, and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids (Alotaibi et al., 2023).

Aphids can commonly be found infesting a variety of ornamental plants. They are attracted to these plants due to the rich nutrient content in the plant sap (Braham et al. 2023). In this present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens*, *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii*. The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii*, and

they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii*. Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii*, and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii*. These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii*, and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola.* The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola.*

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants.

The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids. The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai,* was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black sifunculi and cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants.

Oxonopus compressus or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola*. The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora*. The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi*. The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi*. The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson, Tjallingii, and Hardie 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Yamamoto et al. 2020). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al. 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al. 2020). This behavior was essential for the survival and environmental adaptation of aphids.

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain a nutrient-rich nature and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *Lipaphis erysimi*, and *Myzus persicae* are the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022).

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson and Mooney 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al. 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann and Vega 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

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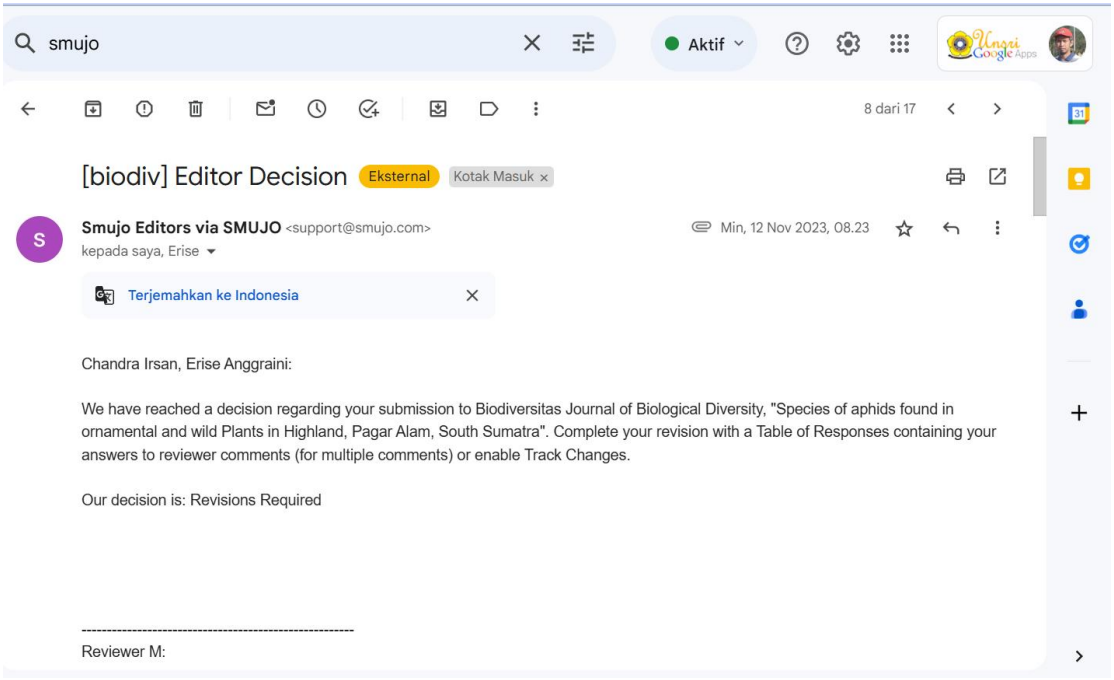
5. Bukti konfirmasi review keempat dan hasil revisi keempat

12 November 2023



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[biodiv] Editor Decision Eksternal Kotak Masuk ×

Smujo Editors via SMUJO <support@smujo.com> Min, 12 Nov 2023, 08.23

kepada saya, Erise

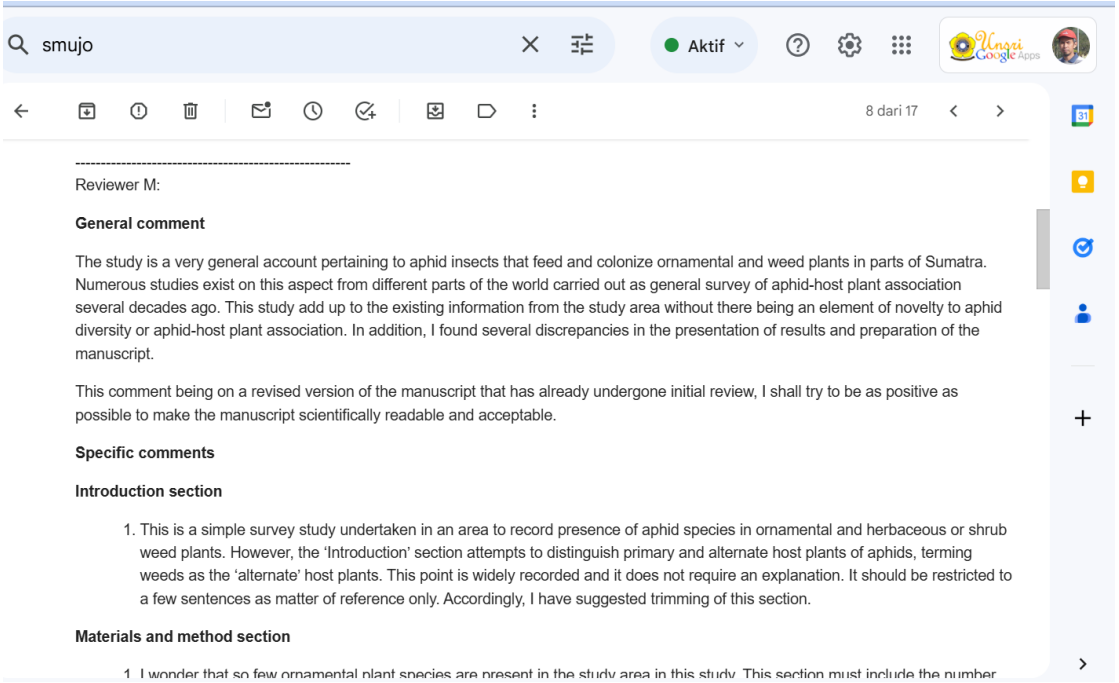
Terjemahkan ke Indonesia

Chandra Irsan, Erise Anggraini:

We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Species of aphids found in ornamental and wild Plants in Highland, Pagar Alam, South Sumatra". Complete your revision with a Table of Responses containing your answers to reviewer comments (for multiple comments) or enable Track Changes.

Our decision is: Revisions Required

Reviewer M:



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Reviewer M:

General comment

The study is a very general account pertaining to aphid insects that feed and colonize ornamental and weed plants in parts of Sumatra. Numerous studies exist on this aspect from different parts of the world carried out as general survey of aphid-host plant association several decades ago. This study add up to the existing information from the study area without there being an element of novelty to aphid diversity or aphid-host plant association. In addition, I found several discrepancies in the presentation of results and preparation of the manuscript.

This comment being on a revised version of the manuscript that has already undergone initial review, I shall try to be as positive as possible to make the manuscript scientifically readable and acceptable.

Specific comments

Introduction section

1. This is a simple survey study undertaken in an area to record presence of aphid species in ornamental and herbaceous or shrub weed plants. However, the 'Introduction' section attempts to distinguish primary and alternate host plants of aphids, terming weeds as the 'alternate' host plants. This point is widely recorded and it does not require an explanation. It should be restricted to a few sentences as matter of reference only. Accordingly, I have suggested trimming of this section.

Materials and method section

1. I wonder that so few ornamental plant species are present in the study area in this study. This section must include the number

Results

1. This section should be divided into two sub-heading:
2. Aphids infesting ornamental plants
3. Aphids infesting wild and weed plants
4. Each sub-heading should have a table providing following information:

Sr No. Aphid species* Ornamental plants Aphid Plant parts Ant

life color colonized attendance

Present(+) or absent (-)

*Aphid species names should accompany by mention of author names in the first mention only.

1. Table 1. Following discrepancies require correction/clarification:
2. Record of *Sitobion luteum* from *Aster alpinus* is unusual; this aphid normally infest crops and weed plants of Cyperaceae family; *Aster alpinus* is a plant of Asteraceae family; authors may re-check the identification of this aphid sample!
3. Record of *Pentalonia* from *Caladium* sp. require a re-check! I suggest the authors to read the paper by Bhadra P, Agarwala BK. 2010. A comparison of fitness characters of two host plant-based congeneric species of the banana aphid, *Pentalonia nigronervosa* and *P. caladii. Journal of Insect Science* 10:140 available online: insectscience.org/10.140 **and P. Bhadra and B.K. Agarwala, 2012.** On the Morphological and Genotypic Variations of Two Congeneric species of Banana Aphid *Pentalonia* (Homoptera: Aphididae) from India, Advances in Life Sciences, 2(3): 75-81, DOI: 10.5932/j.als.20120203.06, DOI: 10.5932/j.als.20120203.06. Authors can identify the aphid species based on the identification key based on morphological characters and host plant association.

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- Identification of *Pentalonia nigronervosa* from *Canna indica* require checking following the identification key provided in the above-said reference.

1. Identification of Uroleucon sp. from Cosmos caudatus mentioned in the table does not match with the figure legend “Uroleucon sp. in Chrysanthemum”. These are entirely different.

1. Similarly, *Aphis craccivora* from *Murraya paniculata* stated in the table does not match with the “ *aurantii* in the *M. paniculata* flower”

1. All the figures in the plate should be denoted by alphabets in serial order corresponding to those in the fused in the figure legend, and each of these figures should be credited to the photographer by name on the photographs.

- Table 2. Table contents be provided with similar information as suggested for the table 1. In addition, a column should include ‘Plant type’ to denote herb or shrub and weed or non-weed wild plant;

2. Other suggestions regarding improvements in the figures and figure legend made for figure 1 are to be followed for figure 2 as well.

Discussion

1. This section should be brief and to the point. Presently, it is written ad nauseous, without proper context and too elaborate. This section can divided in to three paragraphs as under:

1. First paragraph should briefly recount the results of this study.
2. Second paragraph should highlight the major features of aphid colonization of important ornamental and weed plants with respect to association of one or more aphid species association and pattern of colonization; for example, *Aphis gossypii* is found on many different plant species but their life color and colonization pattern differ in different plants;

- Third and final paragraph should be devoted to comparison of this study findings to those reported from neighboring or other parts of Indonesia or Southeast Asia.

Recommendation: Revisions Required

Species of aphids found in ornamental and wild Plants in Highland, Pagar Alam, South Sumatra

Abstract. Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: Aphids, ornamental plants, wild plants

Running title: Aphids found in ornamental and wild plants

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020). Aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can ~~always~~ be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck phloem sap of tender plant parts ~~consume young leaves sap~~, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species ~~when aphids transmit viral diseases from one plant to another, this~~ can further weaken and stunt the growth of infected plants (Jones 2022). ~~According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Kumar 2019).~~

~~Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al. 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al. 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al. 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh and Singh 2021).~~ Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are~~were~~ found on plants that are~~were~~ not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants ~~An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo and Smilanich 2023), However, they may~~ provide a means of survival when primary hosts are unavailable, during certain seasons, or

under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin, Gwenaelle, and Armelle 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto, Hattori, and Itino 2020). Weeds pose a continuous threat in both cropped and non-crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

A study of aphid species on horticultural plants has been conducted (Maharani et al. 2018), However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored. In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. The Rresearch on the diversity of aphid species in ornamental and wild plants has received little attention. Therefore, tThis study reports was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory of cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, and natural enemies where available, involved systematic searches of for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. Any plants colonized by aphids arewere documented as aphid hosts. Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.

Aphid identification was doneconducted using identification keys (Blackman and Eastop 2008). Identification of aphid species took place in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, morphology of aphids including their life shape and color, as well as any symptoms observed in the host plants were recorded, and photographs of the aphid colonies and their host plants were recorded.taken.

RESULTS AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagar Aalam, namely (Tables 1, 2).Aphis gossypii, Uroleucon sp., Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura sp., Aphis glycine, Greenidae sp., Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus sp. Lipapis erysimi. Based on the observation, Tthese aphids mostly colonised flowers of were found on various ornamental plants (Table 1, Figure 1). The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).

Table 1. Aphid species recordedfound in ornamental plants and their colony locations

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani*	flower
		Neomyzus circumflexus	
		Myzus persicae	
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii*	flower
		Neomyzus circumflexus	
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia* 'Kelvin'	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower

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13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. Photos showing colonies of different aphid species in ornamental plants: ~~The location of aphid colonization on various plant parts.~~ a) *A. gossypii* in *D. kKelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland,* h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

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In addition, this study documented ~~the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of~~ aphid colonies ~~also varied, namely~~ on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Table 2, Figure 2). ~~The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).~~

Table 2. Species of aphids found in wild or weed plants and their colony locations

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii*, *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi*, *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs, petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora*, *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

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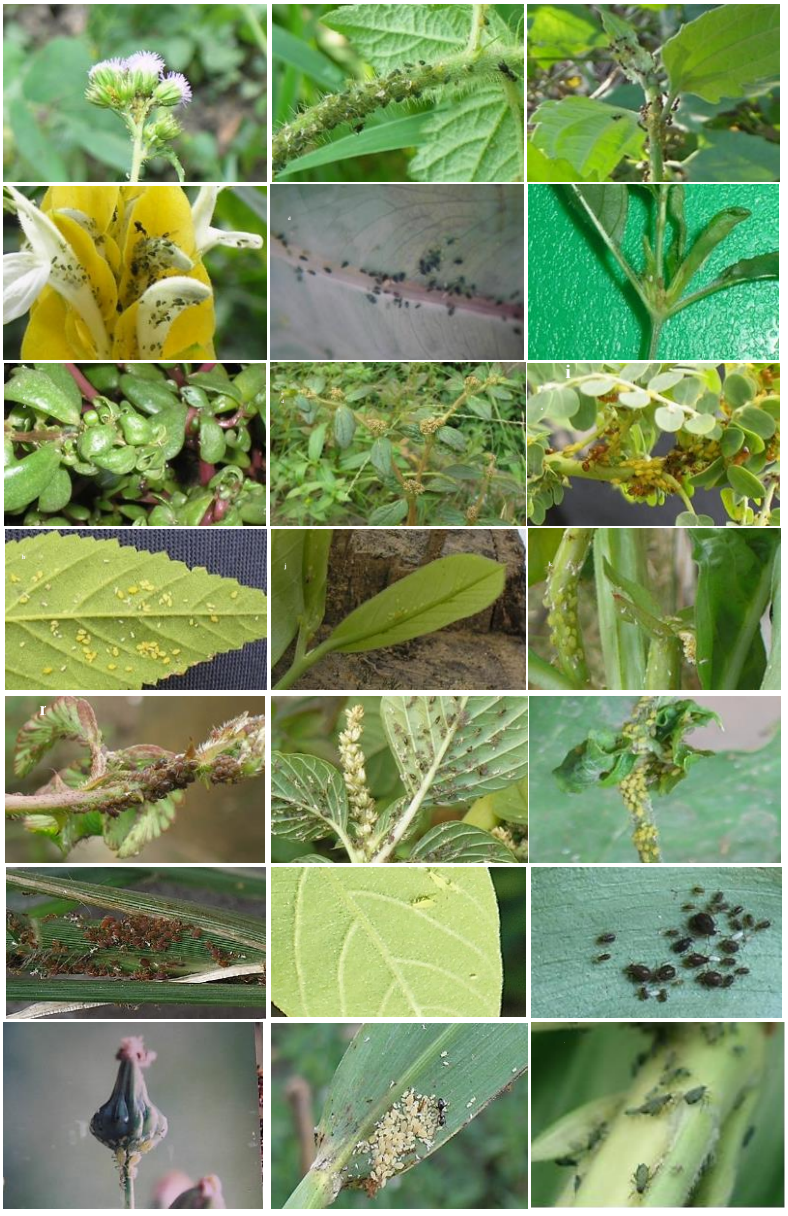

Figure 2. Aphids found infesting~~on~~ wild plants a) *A. gossypii* ~~in~~~~on the weed~~ *Ageratum conyzoides, b) A. gossypii* in~~on~~ *Croton* ~~weed~~ *hirtus c) A. gossypii* ~~in~~~~on the weed~~ *Eupatorium odoratum, d) A.gossypii* i~~o~~n ~~plants~~ *Pachystochys* sp., *e) A.gossypii* in~~o~~n ~~plants~~ *Caladium* sp., *f) A. gossypii* ~~in~~~~on the weed~~ *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae* ~~*weeds,*~~ *h) A.gossypii* in~~o~~n ~~the weed~~ *Euphorbia hirta, i) A. citricola* i~~o~~n ~~the weed~~ *Phylantus nerruri, j) A. citricola* ~~in~~~~on~~ *Sida rhombifolia* ~~weed~~, k) *A. citricola* in~~o~~n ~~plants~~ *Annona muricata, l) A.citricola* i~~o~~n ~~the weed~~ *Ludwigia peruviana, m) A. craccivora* ~~in~~~~on~~ *Mimosa pudica* ~~weed~~, n) *A.craccivora* in~~o~~n

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~~weeds~~ *Amaranthus gracilis, o) A. glycine* in *Mikania micranta* ~~*weed*~~, *p) Hysteneura* sp. in *Eleusin* ~~*weeds*~~, *q) Greenidae* sp. in kenidai trees (shrubs) *indica*, *r)Hyperomyzus* sp. in *Echinocloa crusgali* ~~*Weed*~~, *s) L. erysimi* ion ~~weed~~ *sonchus arventris, t) Rhopalosiphum rice* inon the weed ~~*Oryza rufipogon, u)Rhopalosiphum Maidis* inon the weed ~~*Oryza rufipogon.*~~

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Discussion

~~The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Santiago et al. 2017). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring 2014). *A. gossypii,* and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids [c]Alotaibi et al., 2023).~~

Many a~~A~~phid species ~~s can commonly be found~~ infest~~ing~~ a variety of ornamental plants because~~.~~ They these insects are attracted to such~~these~~ plants due to the rich nutrient content in the plant sap (Braham et al. 2023). In th~~e~~is present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

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On the *Brugmansia suaviolens*, *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle)*, A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii,* and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii,* and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were

associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii,* and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids*.* The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp.* or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black siphunculi~~sifunculi~~ and cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids*.* The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids*.* The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms

such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson, Tjallingii, and Hardie 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

~~Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Yamamoto et al. 2020). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al. 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al. 2020). This behavior was essential for the survival and environmental adaptation of aphids.~~

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain a nutrient-rich nature and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *Lipaphis erysimi,* and *Myzus persicae* are the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022).

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson and Mooney 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al. 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann and Vega 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii*, *Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae*, *Aphis citricola*, *Aphis craccivora*, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura sp., *Aphis glycine*, *Greenidae* sp., *Rhopalosiphum padi*, *Rhopalosiphum maidis*, *Hyperomyzus* sp. *Lipaphis erysimi.*

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11 December 2023

Dear Editors,
BIODIVERSITAS Journal of Biological Diversity

As requested, this is our response to reviewers' comments and suggestions.

Thank you so much for the very kind attention and great help provided by editorial team of BIODIVERSITAS Journal of Biological Diversity.

"Letter on responses to reviewers' comments and suggestions"

No.	Location in manuscript	Reviewers' suggestion	Our response
1	Introduction section	This is a simple survey study undertaken in an area to record presence of aphid species in ornamental and herbaceous or shrub weed plants. However, the 'Introduction' section attempts to distinguish primary and alternate host plants of aphids, terming weeds as the 'alternate' host plants. This point is widely recorded, and it does not require an explanation. It should be restricted to a few sentences as matter of reference only. Accordingly, I have suggested trimming of this section.	The Introduction has been rewritten as recommended
2	Materials and method section	1. I wonder that so few ornamental plant species are present in the study area in this study. This section must include the number of aphid samples collected, the area in square kilometre surveyed, frequency of sampling done from the sampling area, any seasonal survey done, and a schematic diagram of the study area be provided showing scale in sq. km and geo-coordinates. 2. Names of some plant species and aphid species mentioned in tables 1 and 2 do not match with that mentioned in the figure legends and more so in the 'Discussion' section (see below).	1. We collected samples by direct observation and did not take the location sampling sites. Therefore, we do apologize can't revise as the suggestion. 2. We already made the corrections as suggested by reviewer

3	Results	1. This section should be divided into two sub-heading: 2. Aphids infesting ornamental plants. 3. Aphids infesting wild and weed plants. 4. Each sub-heading should have a table providing following information: Sr No. Aphid species* Ornamental plants Aphid Plant parts Antlife color colonized attendance Present (+) or absent (-)	The recommended tables had been added
4	Results	*Aphid species names should accompany by mention of author names in the first mention only. 1. Table 1. Following discrepancies require correction/clarification: 2. Record of *Sitobion luteum* from *Aster alpinus* is unusual; this aphid normally infest crops and weed plants of Cyperaceae family; *Aster alpinus* is a plant of Asteraceae family; authors may re-check the identification of this aphid sample! 3. Record of *Pentalonia* from *Caladium* sp. require a re-check! I suggest the authors to read the paper by Bhadra P, Agarwala BK. 2010. A comparison of fitness characters of two host plant-based congeneric species of the banana aphid, *Pentalonia nigronervosa* and *P. caladii. Journal of Insect Science* 10:140 available online: insectscience.org/10.140 **and P. Bhadra and B.K. Agarwala, 2012.** On the Morphological and Genotypic Variations of Two Congeneric species of Banana Aphid *Pentalonia* (Homoptera: Aphididae) from India, Advances in Life Sciences, 2(3): 75-81, DOI: 10.5932/j.als.20120203.06, DOI: 10.5932/j.als.20120203.06. Authors can identify the aphid species based on the identification key based on morphological characters and host plant association.	1. We already checked and clarified. 2. We revised the species aphid; the aphid species is *Macrosiphoniella sanborni* 3. The species and the sentences have been revised

5	Results	1. Identification of *Pentalonia nigronervosa* from *Canna indica* require checking following the identification key provided in the above-said reference. 2. Identification of Uroleucon sp. from Cosmos caudatus mentioned in the table does not match with the figure legend "Uroleucon sp. in Chrysanthemum". These are entirely different. 3. Similarly, *Aphis craccivora* from *Murraya paniculata* stated in the table does not match with the " *aurantii* in the *M. paniculata* flower"	1. *Pentalonia nigronervosa* was revised to be *Rhopalosiphum nymphaeae* 2. The corrected sentences have been revised, the species of *Uroleucon* sp. In Chrysanthemum 3. The species has been corrected
6	Results	1. All the figures in the plate should be denoted by alphabets in serial order corresponding to those in the fused in the figure legend, and each of these figures should be credited to the photographer by name on the photographs. 2. Table 2. Table contents be provided with similar information as suggested for the table 1. In addition, a column should include 'Plant type' to denote herb or shrub and weed or non-weed wild plant. 3. Serial no. 19 in the table 2 mentions Lagerstroemia sp. infested by Greenidea sp. but the figure legend mentions (q) *Greenidae* in kenidai trees (shrubs) *indica*; these do not match! 4. '*t) Rhopalosiphum rice* in*Oryza rufipogon,'* mentioned in the figure legend does not match with the sr. no. 26 of the table, please check and correct. 5. Other suggestions regarding improvements in the figures and figure legend made for figure 1 are to be followed for figure 2 as well.	1. The figures have been corrected 2. The table 2 has been corrected 3. The species has been corrected 4. The species has been corrected 5. The figures have been improved
7	Discussions	This section should be brief and to the point. Presently, it is written ad nauseous, without proper context and too elaborate. This section can divided in to three paragraphs as under: 1. First paragraph should briefly recount the results of this study. 2. Second paragraph should highlight the major features of aphid colonization of important ornamental and weed plants with respect to association of one or more aphid species association and pattern of	The discussions section has been changed

		colonization; for example, *Aphis gossypii* is found on many different plant species but their life color and colonization pattern differ in different plants; 3. Third and final paragraph should be devoted to comparison of this study findings to those reported from neighboring or other parts of Indonesia or Southeast Asia.	

Sincerely,

Corresponding author,

Chandra Irsan

Species of aphids found in ornamental and wild Plants in Highland, Pagar Alam, South Sumatra

Abstract. Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that 21 species of aphids were found in Pagaralam, namely *Aphis gossypii, Aphis citricola, Aphis craccivora, Aphis glycines, Aulacorthum solani, Greenidae* sp., *Hyperomyzus* sp., *Hysteroneura setariae, Lipaphis erysimi, Macrosiphoniella sanborni, Macrosiphum rosae, Myzus persicae, Neomyzus circumflexus, Pentalonia caladii, Rhopalosiphum maidis, Rhopalosiphum nymphaeae, Rhopalosiphum padi, Sinemogoura citricola, Toxoptera aurantii, Toxoptera citricidus,Toxoptera odinae*, and *Schizaphis rotundiventris*.

Keywords: Aphids, ornamental plants, wild plants

Running title: Aphids found in ornamental and wild plants.

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020). Aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can be found throughout the year

due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck phloem sap of tender plant parts, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species can further weaken and stunt the growth of infected plants (Jones 2022).Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are found on plants that are not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. Research on the diversity of aphid species in ornamental and wild plants has received little attention. This study reports diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory of cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, and natural enemies where available, involved systematic searches of all existing plant species to find those colonized by aphids. Any plants colonized by aphids aredocumented as aphid hosts. Aphid identification was doneusing identification keys (Blackman and Eastop 2008) in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, including their life color, and photographs of the aphid colonies and their host plants were recorded.

RESULTS AND DISCUSSION

Result

Aphids infesting in ornamental plants

The results showed that 15 aphid species were found in Pagar Alam(Tables 1, 2).. These aphids mostly colonised flowers of various ornamental plants (Table 1, Figure 1).

Table 1. Aphid species recorded in ornamental plants and their colony locations.

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Macrosiphoniella sanborni*	Leaves, young twig, flower
2	*Brugmansia suaviolens*	*Aulacorthum solani*	Leaves, flower

		Neomyzus circumflexus	Leaves
		Myzus persicae	Leaves, flower
3	*Caladium* sp.	*Pentalonia caladii*	Leaves,
4	*Cananga odoratum*	*Aphis gossypii*	Leaves, flower
5	*Canna indica*	*Rhopalosiphum nymphaeae*	Leaf
6	*Catharanthus roseus*	*Aphis citricola*	Shoot, young leaves, flower
7	*Cestrum* sp.	*Aphis gossypii*	Shoot, flower
		Neomyzus circumflexus	Young leaves
8	*Clitoria ternatea*	*Aphis craccivora*	Flower
9	*Chrysanthemum* sp.	*Macrosiphoniella sanborni*	Shoot, twig
10	*Dahlia* sp.	*Aphis gossypii*	Flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	Flower
12	*Duranta* sp.	*Aphis gossypii*	Shoot, flower
13	*Helianthus giganteus*.	*Aphis glycines*	Flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	Flower
15	*Ixora paludosa*	*Aphis gossypii*,	Flower
		Toxoptera aurantii	Shoot, young leaves
16	*Ixora* sp.	*Aphis citricola*	Flower
		Aphis gossypii	Flower
		Toxoptera aurantii	Shoot, flower
17	*Murraya paniculata*	*Aphis craccivora*	Young Twig
		Toxoptera citricidus	Shoot, flower
18	*Mussaenda frondosa*	*Aphis citricola*	Shoot, flower
		Toxoptera odinae	Shoot, flower
19	*Rosa indica*	*Macrosiphum rosae*	Flower
20	*Spondias dulcis*	*Aphis citricola*	Flower

Fig 1. Photos showing colonies of different aphid species in ornamental plants: a) *Aphis gossypii* in *Dahlia* sp. flower b) *Aphis gossypii* in *Hibiscus rosasinensis* flower c) *Aphis gossypii* in *cestrum* twig and flower, d) *Aphis craccivora* in *Clitoria ternatea* flower, e) *Aphis glycines* in *Helianthusgiganteus* flower, f) *Aphis craccivora* on the *Murayya paniculata* flower, g) *Toxoptera odinae* in the *Mussaenda frondosa*, h) *Macrosiphoniella sanborni*. in *Chrysanthemum* sp. leaves i) *Macrosiphum rosae* in *Rosa indica* flower, j) *Rhopalosiphum nymphaeae* in *Canna indica* leaves. All the photos were captured by Chandra Irsan.

The relationship between aphids and ants was also recorded. Aphids produce a sweet, sticky substance called honeydew. Ants are attracted to this honey because it serves as a food source for

them. When aphids are present, they secrete honeydew, which attracts ants. This research recorded the presence of ants on plant parts colonized by aphids (Table 2).

Table 2. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized

No	Aphid Species	Ornamental plants	Aphids life colour	Plant parts colonized	Ant attendance
1	*Aphis craccivora*	*Clitoria ternatea*	black	flowers	+
		Murraya paniculata	black	flowers	+
2	*Aphis citricola*	*Catharanthus roseus*	greenish yellow	flowers	+
		Ixora sp.	greenish yellow	flowers	+
		Mussaenda frondosa	greenish yellow	shoots, flowers	+
		Spondias dulcis	greenish yellow	flowers	+
3	*Aphis glycines*	*Helianthus giganteus*	greenish yellow	flowers	+
4	*Aphis gossypii*	*Cestrum* sp.	green	shoots, flowers	+
		Cananga odoratum	light green	shoots, flowers	+
		Dahlia sp.	green dark	flowers	+
		Duranta sp.	light green	shoots, flowers	+
		Hibiscus rosasinensis	dark green	flowers	+
		Ixora paludosa	light green	flowers	+
		Ixora sp.	light green	flowers	+
5	*Aulacorthum solani*	*Brugmansia suaviolens*	greenish yellow	leaves, flowers	-
6	*Macrosiphoniella sanborni*	*Aster alpinus*	brown black	leaves, twigs, flowers	+
		Chrysantemum sp.	reddish brown	leaves, twigs	+
7	*Macrosiphum rosae*	*Rosa indica*	green	flowers	-
8	*Myzus persicae*	*Brugmansia suaviolens*	greenish yellow	leaves, flowers	-
9	*Neomyzus circumflexus*	*Cestrum* sp.	light green	young leaves, flowers	-
		Brugmansia suaviolens	light green	flowers	
10	*Pentalonia caladii*	*Caladium* sp.	brown-black	leaves	+
11	*Rhopalosiphum nymphaeae*	*Canna indica*	green black	leaves	+
12	*Sinemegoura citricola*	*Dendrobium* sp.	brown	flowers	-
13	*Toxoptera aurantii*	*Ixora paludosa*	brown black	flowers	+
		Ixora sp.	brown black	flowers	+
14	*Toxoptera citricidus*	*Murraya paniculata*	black	stems	+
15	*Toxoptera odinae*	*Mussaenda frondosa*	reddish-brown	flowers	+

(+): present, (-): absent

Aphids infesting in wild plants (weed or non-weed plants)

In addition, this study documented aphid colonies on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Table 3, Figure 2).

Table 3. Species of aphids found in wild (weed or non-weed) plants and their colony locations.

No	Host Plant	Weeds or non-weed plants	Aphid species	Colony location
1	*Ageratum conyzoides*	weed	*Aphis gossypii*	shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	weed	*Aphis gossypii*	shoots, buds
3	*Alternanthera sessilis*	weed	*Aphis gossypii*	shoots, buds
4	*Amaranthus gracilis*	weed	*Aphis craccivora*	flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	weed	*Lipaphis erysimi*	flowers, shoots, and buds
6	*Croton hirtus*	weed	*Aphis gossypii*	flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	weed	*Schizaphis rotundiventris*	flower, flower stalks
8	*Cyperus rotundus*	weed	*Schizaphis rotundiventris*	flower, flower stalks, leaf axils
9	*Cyperus compressus*	weed	*Schizaphis rotundiventris*	flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	weed	*Hystroneura setariae*	flower, flower stalks
11	*Echinocloa crussgali*	weed	*Hiperomyzus* sp.	young leaves, old leaves
12	*Ecliptica prostrata*	weed	*Aphis gossypii*	shoots, young leaves
13	*Eleusin indica*	weed	*Hysteroneura setariae*	flower, flower stalks, leaf axils
			Rhopalosiphum maidis	flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	weed	*Aphis gossypii*	flower, flower stalks, shoots
15	*Eragrostis tenella*	weed	*Hysteroneura setariae*	flower, flower stalks, seeds
16	*Euphorbia hirta*	weed	*Aphis gossypii*	young leaves, old leaves
17	*Eupotarium odoratum*	weed	*Aphis gossypii*	young leaves, old leaves,
			Aphis glycines	shoot, young twigs
18	*Hymenochera acutigluma*	Weed	*Hysteroneura setariae*	flowers, flower stalks, leaf axils
19	*Bridelia tomentosa*	Non-weed	*Greenidea* sp.	young leaves
20	*Lophatherum gracile*	Weed	*Hysteroneura setariae*	young leaves, old leaves, leaf axils
			Rhopalosiphum maidis	young leaves, old leaves, leaf axils
21	*Melastoma affine*	Non-weed	*Aphis gossypii*	shoots, young leaves
22	*Mikania mikranta*	Weed - liana	*Aphis gossypii*	shoots, young leaves, old leaves
			Aphis glycines	shoot, young twig
23	*Mimosa invisa*	weed	*Aphis craccivora*	shoots, pods
24	*Mimosa pudica*	weed	*Aphis craccivora*	shoots, pods, flowers
25	*Mimosa vigra*	Non-weed	*Aphis craccivora*	shoots, pods
26	*Oryza rufipogon*	weed	*Rhopalosiphum padi,*	old leaves, young leaves (shoot), leaf axils
		weed	*Rhopalosiphum maidis*	old leaves, young leaves (shoot), leaf axils
27	*Oxonopus compressus*	weed	*Hysteroneura setariae*	flowers, flower stalk, leaf axils
28	*Paspalum conjugatum*	weed	*Hysteroneura setariae*	flowers, flower stalk, seeds
29	*Phylanthus neruri*	weed	*Aphis citricola*	shoot, young leaves, old leaves, young twigs, petioles
30	*Portulaca oleraceae*	weed	*Aphis craccivora*	shoots, young leaves, flowers
31	*Physalis angulata*	weed	*Aphis craccivora*	shoots, young leaves, old leaves
		weed	*Aphis gossypii*	shoots, young leaves, old leaves
32	*Rorippa indica*	weed	*Lipapis erysimi*	flowers, fruits, shoots, young leaves
33	*Sida rhombifolia*	weed	*Aphis gossypii*	shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	weed	*Lipapis erysimi*	young leaves, fruit stalks, flowers, fruits

The presence of ants in aphid colonization symbolizes a mutually beneficial relationship where the ants receive food from the aphids while providing protection to the aphids. This study recorded the ant attendance in aphids colonization (Table 4).

Table 4. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized.

No	Aphid Species	Wild plants	Aphids life colour	Plant parts colonized	Ant attendance
1	*Aphis gossypii*	*Ageratum conyzoides*	Light green	shoots, young leaves, old leaves, flowers	+
		Alternanthera philoxeroides	Light green	shoots, buds	+
		Alternanthera sessilis	Light green	shoots, buds	-
		Croton hirtus	Dark green	flowers, shoots, young leaves, old leaves, young	+
		Ecliptica prostrata	green	twigs	+
		Emilia sonchifolia	green	shoots, young leaves	+
		Euphorbia hirta	light green	flower, flower stalks, shoots	+
		Eupotarium odoratum	light green	young leaves, old leaves	+

No	Aphid Species	Wild plants	Aphids life colour	Plant parts colonized	Ant attendance
		Melastoma affine	light green	young leaves, old leaves, young twigs	+
		Mikania mikranta	light green	shoots, young leaves	+
		Physalis angulata	yellowish green	shoots, young leaves, old leaves	+
		Sida rhombifolia	yellowish green	shoots, young leaves, old leaves, fruit/seeds	-
2	*Aphis craccivora*	*Amaranthus gracilis*	black	flowers, shoots, young leaves, old leaves	+
		Mimosa invisa	black	shoots, pods	+
		Mimosa pudica	black	shoots, pods, flowers	+
		Mimosa vigra	black	shoots, pods	+
		Portulaca oleraceae	black	shoots, young leaves, flowers	+
		Physalis angulata	black	shoots, young leaves, old leaves	+
3	*Aphis glycines*	*Eupotarium odoratum*	Greenish yellow	young leaves, old leaves, young twigs	+
		Mikania mikranta	Light green	shoots, young leaves, old leaves	+
4	*Aphis citricola*	*Phylanthus neruri*	Greenish Yellow	shoot, young leaves, young twigs, petioles	+
5	*Greenidea* sp.	*Bridelia Tomentosa*	Greenish Yellow	young leaves	-
6	*Hystroneura setariae*	*Digitaria ciliaris*	reddish-brown	flower, flower stalks	+
		Eleusin indica	reddish-brown	flower, flower stalks, leaf axils	+
		Eragrostis tenella	reddish-brown	flower, flower stalks, seeds	+
		Hymenochera acutigluma	reddish-brown	flowers, flower stalks, leaf axils	+
		Lophatherum gracile	reddish-brown	young leaves, old leaves, leaf axils	+
		Oxonopus compressus	reddish-brown	flower, flower stalk, leaf axils	+
		Paspalum conjugatum	reddish-brown	flower, flower stalk, seeds	+
7	*Hiperomyzus* sp.	*Echinocloa crussgali*	Black	young leaves, old leaves	-
8	*Lipaphis erysimi*	*Blumea lacera*	Whitish green	flowers, shoots, and buds	+
		Rorippa indica	Whitish green	flower, fruit, shoots, young leaves	+
		Sonchus arventris	Whitish green	young leaves, fruit stalks, flower, fruit	+
9	*Rhopalosiphum maidis*	*Eleusin indica*	green	flower, flower stalks, leaf axils	+
		Lophatherum gracile	green	young leaves, old leaves, leaf axils	+
		Oryza rufipogon	green	old leaves, young leaves (shoot), leaf axils	-
10	*Rhopalosiphum padi*	*Oryza rufipogon*	Whitish green	old leaves, young leaves (shoot), leaf axils	+
11	*Schizaphis rotundiventris*	*Cynodon dactylon*	Green	flowers, flower stalks	+
		Cyperus rotundus	green	flowers, flower stalks, leaf axils	+
		Cyperus compressus	green	flowers, flower stalks, leaf axils	+

(+): present, (-): absent

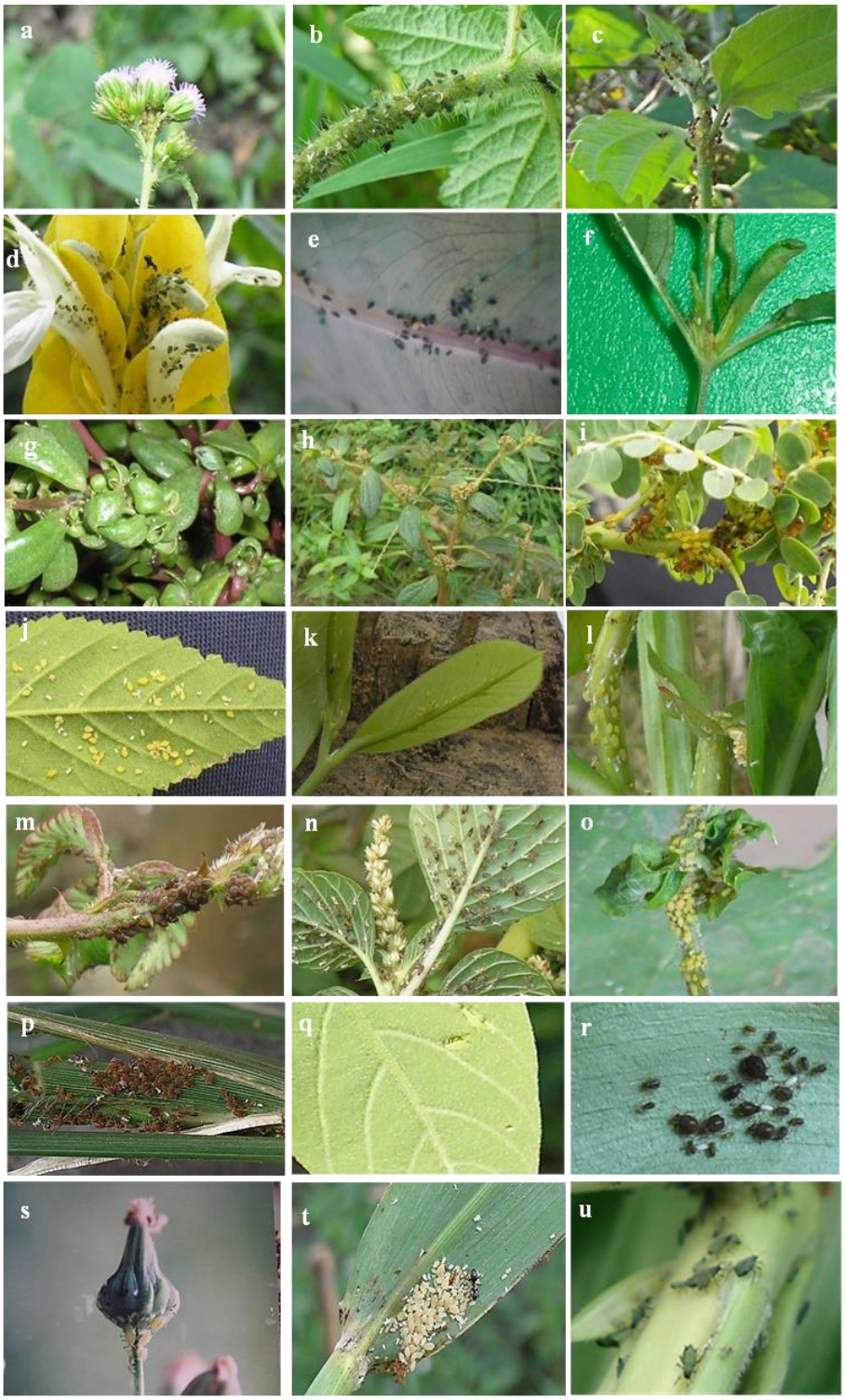

Figure 2. Aphids found infesting wild plants a) *Aphis gossypii* in *Ageratum conyzoides*, *b) Aphis gossypii* in *Croton hirtus c) A. gossypii* in *Eupatorium odoratum, d) Aphis gossypii* in *Pachystachys* sp., *e) Pentalonia caladii* in *Caladium* sp., *f) Aphis. gossypii* in *Alternanthera sessilis, g) Aphis gossypii* in *Portulaca oleraceae h) Aphis gossypii* in *Euphorbia hirta, i) Aphis citricola* in *Phylantus nerruri, j) Aphis citricola* in *Sida rhombifolia,* k) *Aphis citricola* in *Annona muricata, l) Aphis citricola* in *Ludwigia peruviana, m) A. craccivora* in *Mimosa pudica,* n) *Aphis craccivora* in *Amaranthus gracilis, o) Aphis glycine* in *Mikania micranta, p) Hysteneura* sp. in *Eleusin, q) Greenidae* sp. in *Bridelia tomentosa* young leaves., *r)Hyperomyzus* sp. in *Echinocloa*

crusgali, s) Lipaphis erysimi in *sonchus arventris, t) Rhopalosiphum padi* in *Oryza rufipogon, u)Rhopalosiphum Maidis* in *Oryza rufipogon.* All the photos were captured by Chandra Irsan.

Discussion

In the present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Macrosiphoniella sanborni*, and they were associated with ants. On the *Brugmansia suaviolens*, *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. was found one species of aphids: *P. caladii*. *P. caladii* was known and found in taro plants, the aphids formed colonies under the surface of young and older leaves (Bhadra and Agarwala 2014). According to this present study, the occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants. Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body and the identification results showed that the aphids were *Rhopalosiphum nymphaeae* (Acharya and Singh 2004). The colonies of *R. nymphaeae* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle), *A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants. Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies

were consistently associated with ants. The aphids on the *Dahlia* sp. formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* According to this present study, *Sinemegoura citricola* colonies were found on the young leaves of *Dendrobium* sp., with the color body of the *S. citricola* aphids were yellow, green to dark green, and the colonized plants did not show any disease symptoms, and they were associated with ants. On *Duranta* sp., colonies of aphids were located on the undersides of young leaves and the colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Furthermore, on the *Helianthus annuus*, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found. On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, like sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii,* and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants. Moreover, in *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of

aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellowish green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants. Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The identification results showed that the aphids were *Toxoptera odinae.* The aphids were yellow, green, and some with dark green (Blackman et al. 2011). The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*. Many aphid species infest a variety of ornamental plants because these insects are attracted to such plants due to the rich nutrient content in the plant sap (Braham et al. 2023).

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to reddish brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was

colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants. *Eleusin indica* was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves. *Eragrostis tenella* was infested by *Hysteroneura setariae* aphids. The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on *E. odoratum* plants were associated with either black or red ants. *Hymenochera acutigluma* or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*. or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile* or bamboo grass plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red

brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on *L. gracile* to mix. In addition, *Melastoma affine* was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony. *Mimosa invisa (cater*-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms. *Oryza rufipogon* was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black siphunculiand cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants. *Paspalum conjugatum* was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black. *Physalis angulata* plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The

colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations. The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson, Tjallingii, and Hardie 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies. According to this present study, ants were present in some aphids colonies from the subfamily aphidini, while the ants were absent in some aphids colonies from the macrocypini subfamily. The absent of ants in aphids colonies could be the colonies have just formed, or the population is still low (Kummel, Brown, and Bruder 2013). Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain a nutrient-rich nature and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to

penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *Lipaphis erysimi,* and *Myzus persicae* are the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022). Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson and Mooney 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al. 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann and Vega 2020).

CONCLUSION

21 species of aphids were found in Pagaralam, namely *Aphis gossypii, Aphis citricola, Aphis craccivora, Aphis glycines, Aulacorthum solani, Greenidae* sp., *Hyperomyzus* sp., *Hysteroneura setariae, Lipaphis erysimi, Macrosiphoniella sanborni, Macrosiphum rosae, Myzus persicae, Neomyzus circumflexus, Pentalonia caladii, Rhopalosiphum maidis, Rhopalosiphum nymphaeae, Rhopalosiphum padi, Sinemogoura citricola, Toxoptera aurantii, Toxoptera citricidus,Toxoptera odinae*, and *Schizaphis rotundiventris*.

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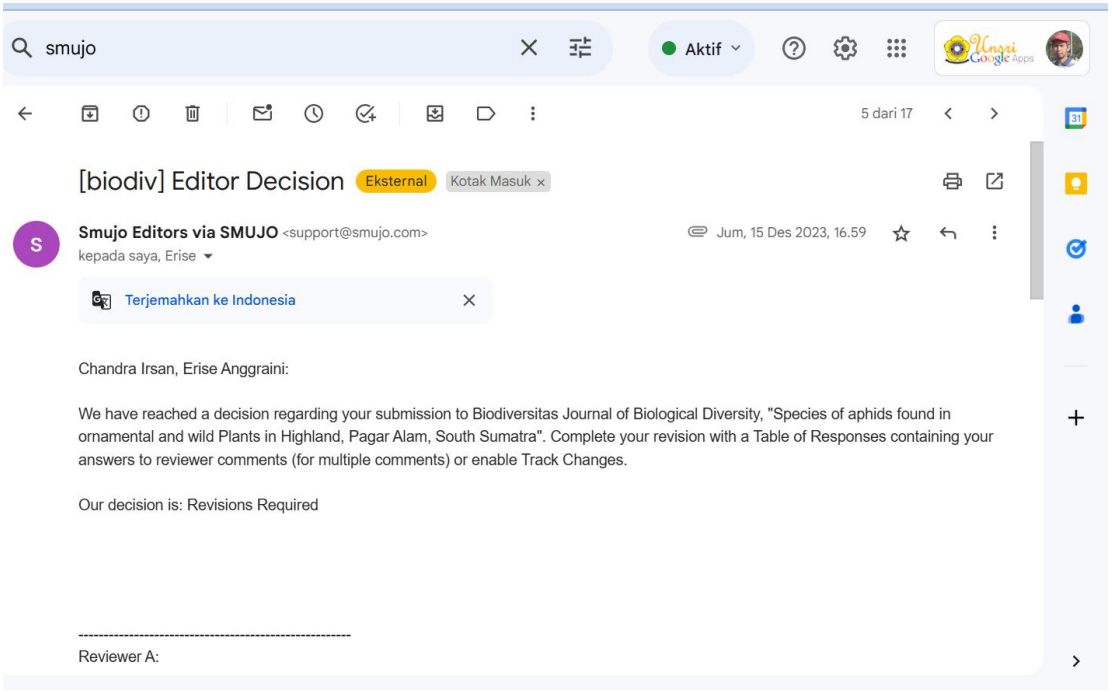
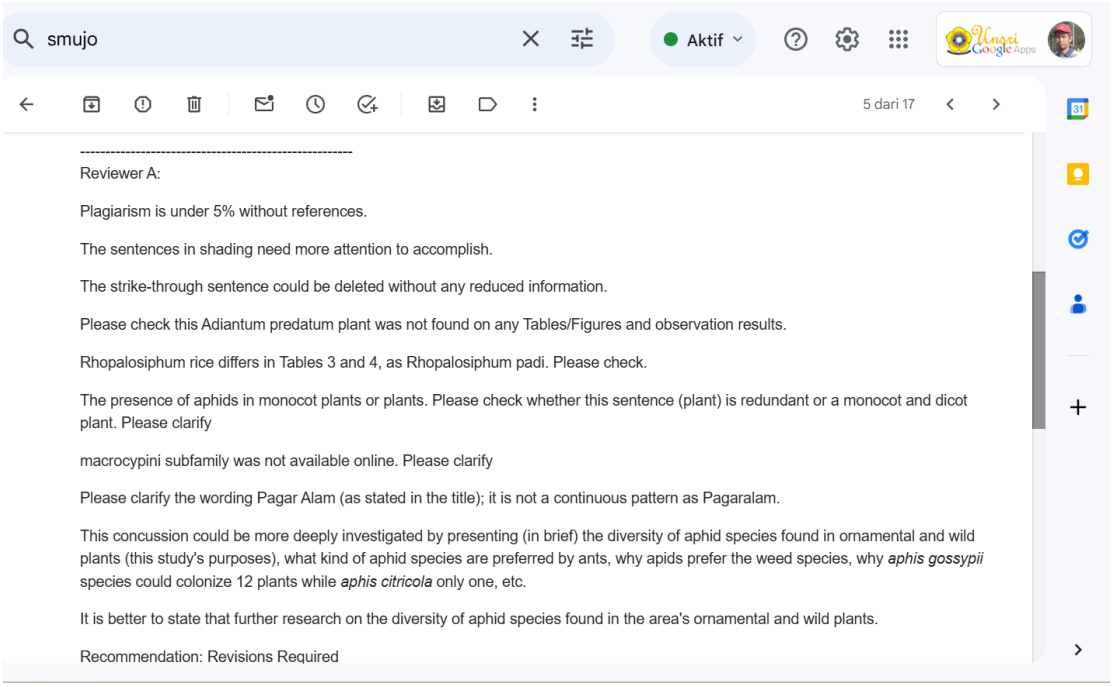
6. Bukti konfirmasi review kelima dan hasil revisi kelima

15 Desember 2023





Species of aphids found in ornamental and wild Plants in Highland, Pagar Alam, South Sumatra

Abstract. Aphids are one of the crucial pests in the tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species were found on plants that were not actually hosts such as wild plants. Therefore, this study reported the species of aphids found in ornamental plants and the wild plants. The field research employed a purposive and direct observation approach to inventory cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that 15 species of aphids were found in Pagaralam, namely *Aphis gossypii, Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura* sp., *Aphis glycine, Greenidae* sp., *Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus* sp. *Lipaphis erysimi.*

Keywords: Aphids, ornamental plants, wild plants

Running title: Aphids found in ornamental and wild plants

INTRODUCTION

Aphids are one of the crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020). Aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can ~~always~~ be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck phloem sap of tender plant parts ~~consume young leaves sap~~, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species ~~when aphids transmit viral diseases from one plant to another, this~~ can further weaken and stunt the growth of infected plants (Jones 2022). ~~According to Kinley et al. (2021), aphids cause yield losses directly (35 - 40%) by sucking the plant sap or indirectly (20 - 80%) through viral transmission. Therefore, aphid infestations can can have adverse effects on crop yields and overall plant health (Kumar 2019).~~

~~Due to their function as vectors, the presence of aphids on a plant can be highly damaging (Jaouannet et al. 2014). They feed by piercing the plant's tissues and consuming its sap, which can reduce the plant's growth and productivity, ultimately leading to weakness and possible death (Chandel et al. 2022). Additionally, as vectors, aphids can transmit a variety of plant diseases. They are as carriers for various plant viruses, and when they move from infected to healthy plants, these viruses can rapidly spread and cause extensive damage (Guo et al. 2019). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh and Singh 2021).~~ Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are~~were~~ found on plants that are~~were~~ not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or "alternative," host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants ~~An alternative host can also be a collateral host belonging to the same plant family as the primary host, helping crop pests to survive when the primary hosts are unavailable (Kumar et al., 2021). These secondary hosts may offer less adequate nutrition for insects (Mo and Smilanich 2023), However, they may~~ provide a means of survival when primary hosts are unavailable, during certain seasons, or

under certain environmental conditions (Kumar et al., 2021). ~~According to Liu et al. (2017), since hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin, Gwenaelle, and Armelle 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically a woody plant) and secondary hosts (often herbaceous plants) (Yamamoto, Hattori, and Itino 2020). Weeds pose a continuous threat in both cropped and non-crop areas, providing food, shelter and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids~~.

~~A study of aphid species on horticultural plants has been conducted (Maharani et al. 2018). However, information about aphid species on ornamental and wild plants has not received as much attention and remains largely unexplored.~~ In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. ~~The~~ R~~r~~esearch on the diversity of aphid species in ornamental and wild plants has received little attention. ~~Therefore, t~~This study reports ~~was conducted in Pagar Alam, a highland region of South Sumatra, with the aim of obtaining information on the~~ diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation approach to inventory of cultivated or wild plants hosting aphids and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. The collection and identification of host plants, and aphids, and natural enemies where available, involved systematic searches of ~~for the selected plants and subsequent examination for the presence of aphids. Observations were made to~~ all existing plant species to find those colonized by aphids. Any plants colonized by aphids are~~were~~ documented as aphid hosts. ~~Aphids, along with their natural enemies within the aphid colonies, were systematically collected. All components of the collected observations were then identified.~~

Aphid identification was done~~conducted~~ using identification keys (Blackman and Eastop 2008). ~~Identification of aphid species took place~~ in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using weed identification hand book (Kallas, 2010; Meuninck, 2023; Naidu, 2012). The location and size of aphid colonies, ~~morphology of aphids~~ including their life ~~shape and~~ color, ~~as well as any symptoms observed in the host plants were recorded,~~ and photographs of the aphid colonies and their host plants were recorded.~~taken~~.

RESULTS AND DISCUSSION

Result

The results showed that 15 aphid species were found in Pagar Aalam~~, namely (Tables 1, 2).Aphis gossypii, Uroleucon sp., Toxoptera odinae, Macrosiphum rosae, Aphis citricola, Aphis craccivora, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura sp., Aphis glycine, Greenidae sp., Rhopalosiphum padi, Rhopalosiphum maidis, Hyperomyzus sp. Lipapis erysimi~~. ~~Based on the observation, T~~these aphids mostly colonised flowers of ~~were found on~~ various ornamental plants (Table 1, Figure 1). ~~The primary colony locations were generally in flowers, and this study documented these colony locations in ornamental plants (Figure 1).~~

Table 1. Aphid species recorded~~found~~ in ornamental plants and their colony locations

No	Host Plant	Aphid Species	Colony location
1	*Aster alpinus*	*Sitobion luteum*	flower
2	*Brugmansia suaviolens*	*Aulacorthum solani* *Neomyzus circumflexus* *Myzus persicae*	flower
3	*Caladium* sp.	*Pentalonia* sp	flower
4	*Cananga odoratum*	*Aphis gossypii*	flower
5	*Canna indica*	*Pentalonia nigronervosa*	flower
6	*Catharanthus roseus*	*Aphis citricola*	flower
7	*Cestrum* sp.	*Aphis gossypii* *Neomyzus circumflexus*	flower
8	*Clitoria ternatea*	*Aphis craccivora*	flower
9	*Cosmos caudatus*	*Uroleucon* sp.	flower
10	*Dahlia* 'Kelvin'	*Aphis gossypii*	flower
11	*Dendrobium* sp.	*Sinemogoura citricola*	flower
12	*Duranta* sp.	*Aphis gossypii*	flower

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13	*Helianthus* sp.	*Aphis glycines* *Hyperomyzus* sp.	flower
14	*Hibiscus rosasinensis*	*Aphis gossypii*	flower
15	*Ixora paludosa*	*Aphis gossypii,* *Toxoptera aurantii*	flower
16	*Ixora* sp.	*Aphis citricola* *Aphis gossypii* *Toxoptera aurantii*	flower
17	*Murraya paniculata*	*Aphis craccivora* *Toxoptera citricidus*	flower
18	*Mussaenda frondosa*	*Aphis citricola* *Toxoptera odinae*	flower
19	*Rosa indica*	*Macrosiphum rosae*	flower
20	*Spondiras dulcssoland*	*Aphis citricola* *Hysteroneura setariae*	flower

Fig 1. Photos showing colonies of different aphid species in ornamental plants: ~~The location of aphid colonization on various plant parts.~~ a) *A. gossypii* in *D. kKelvin* flower b) *A. gossypii* in *H. rosasinensis* flower c) *A. gossypii* in tuberose flower, d) *A. craccivora* in *Clitoria ternatea* flower, e) *A citricola* in *Helianthus* sp., f) *A. aurantii* on the *M. paniculata* flower, g) *T. odinae* in the *S. dulcssoland,* h) *Uroleucon* sp. in chrysanthemums, i) *Macrosiphum rosae* in *R. indica* flower, j) *Pentalonia nigronervosa* in *C. indica* leaves

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In addition, this study documented ~~the presence of weeds, which might serve as alternative hosts for aphids (Table 2). The location of~~ aphid colonies ~~also varied, namely~~ on flowers, stalks, plant tops, young leaves and old leaves of wild plants (Table 2, Figure 2). ~~The presence of specific plants or host plants within a habitat influenced the types of aphids found. Many aphid species are found on a broad range of plants or host plants, while others are highly specialized and are only found on specific plants or host plants. This is closely related to the polyphagous, oligophagous or monophagous nature of aphids (Blackman & Eastop 2000).~~

Table 2. Species of aphids found in wild or weed plants and their colony locations

No	Host Plant	Aphid species	Colony location
1	*Ageratum conyzoides*	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
2	*Alternanthera philoxeroides*	*Aphis gossypii*	Shoots, buds
3	*Alternanthera sessilis*	*Aphis gossypii*	Shoots, buds
4	*Amaranthus gracilis*	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
5	*Blumea lacera*	*Lipaphis erysimi*	Flowers, shoots, and buds
6	*Croton hirtus*	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
7	*Cynodon dactylon*	*Schizaphis rotundiventris*	Flower, flower stalks
8	*Cyperus rotundus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
9	*Cyperus compressus*	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
10	*Digitaria ciliaris*	*Hystroneura setariae*	Flower, flower stalks
11	*Echinocloa crussgali*	*Hiperomyzus* sp.	Young leaves, old leaves
12	*Ecliptica prostrata*	*Aphis gossypii*	Shoots, young leaves
13	*Eleusin indica*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Flower, flower stalks, leaf axils
14	*Emilia sonchifolia*	*Aphis gossypii*	Flower, flower stalks, shoots
15	*Eragrostis tenella*	*Hysteroneura setariae*	Flower, flower stalks, seeds
16	*Euphorbia hirta*	*Aphis gossypii*	Young leaves, old leaves
17	*Eupotarium odoratum*	*Aphis gossypii*~~,~~ *Aphis glycine*	Young leaves, old leaves, young twigs
18	*Hymenochera acutigluma*	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
19	*Lagerstromea* Sp.	*Greenidea* sp.	Young leaves
20	*Lophatherum gracile*	*Hysteroneura setariae* *Rhopalosiphum maidis*	Young leaves, old leaves, leaf axils
21	*Melastoma affine*	*Aphis gossypii*	Shoots, young leaves
22	*Mikania mikranta*	*Aphis gossypii* *Aphis glycine*	Shoots, young leaves, old leaves
23	*Mimosa invisa*	*Aphis craccivora*	Shoots, pods
24	*Mimosa pudica*	*Aphis craccivora*	Shoots, pods, flowers
25	*Mimosa vigra*	*Aphis craccivora*	Shoots, pods
26	*Oryza rufipogon*	*Rhopalosiphum padi,* *Rhopalosiphum maidis*	Old leaves, young leaves (pupus), leaf axils
27	*Oxonopus compressus*	*Hysteroneura setariae*	Flower, flower stalk, leaf axils
28	*Paspalum conjugatum*	*Hysteroneura setariae*	Flower, flower stalk, seeds
29	*Phylanthus neruri*	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs, petioles
30	*Portulaca oleraceae*	*Aphis craccivora*	Shoots, young leaves, flower
31	*Physalis angulata*	*Aphis craccivora*~~,~~ *A. gossypii*	Shoots, young leaves, old leaves
32	*Rorippa indica*	*Lipapis erysimi*	Flower, fruit, shoots, young leaves
33	*Sida rhombifolia*	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
34	*Sonchus arventris*	*Lipapis erysimi*	Young leaves, fruit stalks, flower, fruit

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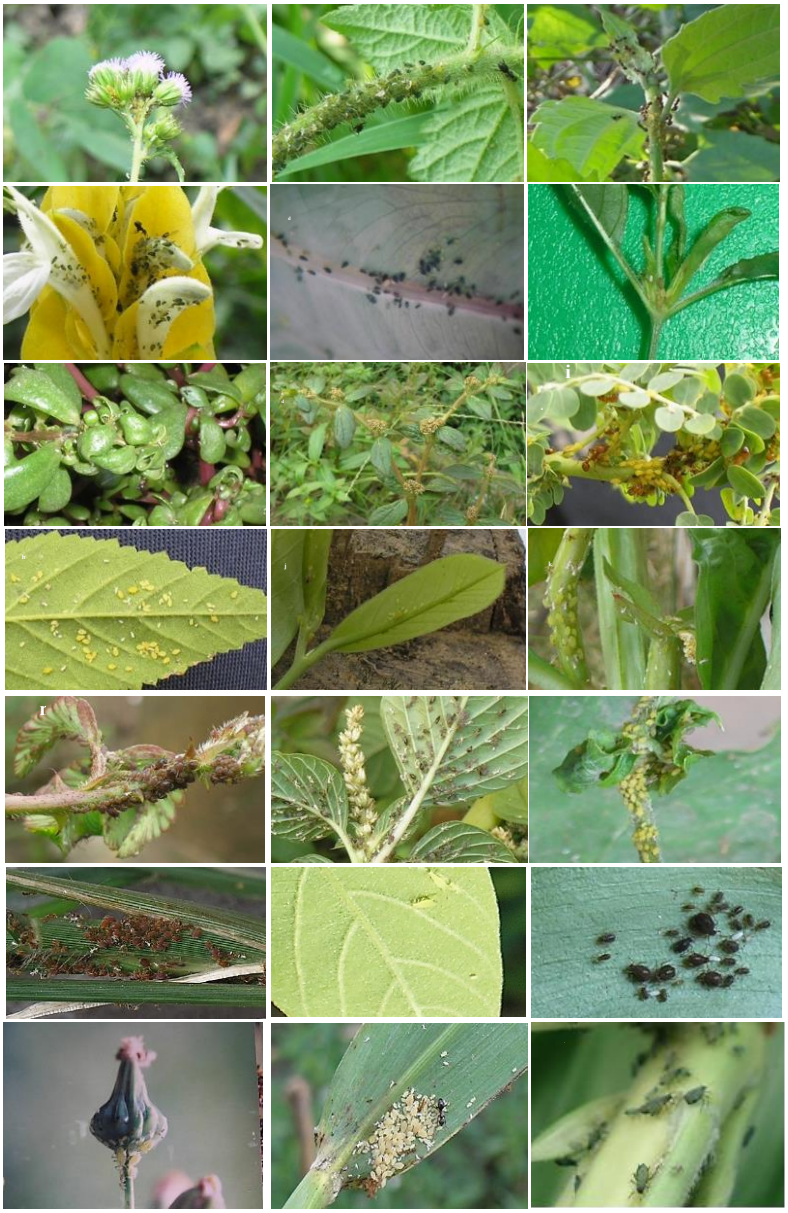

Figure 2. Aphids found infestingon wild plants a) *A. gossypii* inon the weed *Ageratum conyzoides, b) A. gossypii* inon *Croton* weed *hirtus c) A. gossypii* inon the weed *Eupatorium odoratum, d) A.gossypii* ion plants *Pachystochys* sp., *e) A.gossypii* inon plants *Caladium* sp., *f) A. gossypii* inon the weed *Alternanthera sessilis, g) A.gossypii* in *Portulaca oleraceae* *weeds, h) A.gossypii* inon the weed *Euphorbia hirta, i) A. citricola* ion the weed *Phylantus nerruri, j) A. citricola* inon *Sida rhombifolia* weed, k) *A. citricola* inon plants *Annona muricata, l) A.citricola* ion the weed *Ludwigia peruviana, m) A. craccivora* inon *Mimosa pudica* weed, n) *A.craccivora* inon

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~~weeds~~ *Amaranthus gracilis, o) A. glycine* in *Mikania micranta* ~~*weed*~~, *p) Hysteneura* sp. in *Eleusin* ~~*weeds*~~, *q) Greenidae* sp. in kenidai trees (shrubs) *indica*, *r)Hyperomyzus* sp. in *Echinocloa crusgali* ~~*Weed*~~, *s) L. erysimi* io~~n weed~~ *sonchus arventris, t) Rhopalosiphum rice* i~~non the weed~~ *Oryza rufipogon, u)Rhopalosiphum Maidis* in~~on the weed~~ *Oryza rufipogon.*

Discussion

~~The plant species or host plant influences the distribution of aphids. There are aphid species that can be found on a wide range of host plants, which is closely related to the polyphagous nature of aphids, allowing them to colonize many different species of host plants. Host plants can also affect the distribution of aphids, as evidenced by the presence of aphid species exclusively found on certain host plants (Santiago et al. 2017). But there are some species of aphids found only on one particular host and are not found on other host plants (Döring 2014). *A. gossypii,* and *Aphis aurantii* have been found on many host plants because both aphids are classified as polyphagous aphids [c]Alotaibi et al., 2023).~~

Many a~~A~~phid species ~~s can commonly be found~~ infest~~ing~~ a variety of ornamental plants because~~.~~ ~~They~~these insects are attracted to such~~these~~ plants due to the rich nutrient content in the plant sap (Braham et al. 2023). In th~~e~~is present study, some aphid species were found on some ornamental plants in Pagaralam. The location of aphid colonization on the plants varied. On *Adiantum predatum* plants, aphids formed colonies on young leaf stalks and on newly emerging leaves. The aphids displayed brown and black coloration. The aphid colonies found were small, and the colonized plant parts showed no signs of disease. The identification results showed that the aphids were *Neotoxoptera* sp., and notably, they were not associated with ants. On *Aster alpinus*, aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Uroleucon* sp., and they were associated with ants.

On the *Brugmansia suaviolens*, *M. persicae* were found on the undersides of old leaves or leaves that have started to turn yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. (taro) was found one species of aphids: *A. gossypii*. The aphids formed colonies under the surface of young and older leaves. The occupied leaf areas did not display severe symptoms. The aphids were yellow green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odoratum* (ylang-ylang), colonies of *T. aurantii* were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black in color. The colonies of *T. aurantii* were found to be associated with black ants.

Aphids on *C. indica* (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body. The identification results showed that the aphids were *P. nigronervosa.* The colonies of *P. nigronervosa* were found to be associated with ants. In the *Catharanthus roseus* (periwinkle)*, A. citricola* aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts did not show any symptoms of disease. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or flower stalks that had not fully bloomed. The colonies were quite large. The body color of aphids was green to dark green with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *A. gossypii.* The aphid colonies found were consistently associated with ants.

Aphids on *Clitoria ternatea* were found to form colonies on flower parts, flower crowns, stems and young leaves. The aphids were brown to black in color. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *A. craccivora.* These colonies were consistently associated with ants. On the plant *Cosmos caudatus*, aphids were found on the flower petals. The colonies were not very large. The body color was green and light green. The identification results showed that the aphids were *A. gossypii,* and they were also associated with ants. The aphids on the *Dahlia kelvin plant* formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* Aphids on *Datura metel* (amethyst) were found to form colonies on the undersides of old leaves. The aphids were medium sized with a green body color. The colonized plant parts did not show any symptoms of disease. The identification results showed that the aphids were *Myzus ornatus.* The aphid colonies were not associated with ants. Within *Dendrobium* sp., aphid colonies were found on the young leaves. The aphids were yellow, green to dark green. The colonized plants did not show any disease symptoms. The identification results showed that the aphids were *A. gossypii,* and they were associated with ants. On *Duranta* sp. (bonsai), colonies of aphids were located on the undersides of young leaves. The colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green in color. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants.

On the *Helianthus annuus* (sunflower) plants, aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, exhibited a tendency to fall off easily. The aphids were green and yellow in color. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were

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associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *M. ornatus.* The aphid colonies were not associated with ants. Within the colonies, mummified aphids that were parasitized by Aphidiidae were found.

On the *Hibiscus rosa-sinensis*, aphids ranging in color from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa.* First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, similar to sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii,* and they were almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants.

In *Ixora* sp. flower plants, two forms of aphids were discovered. These aphids occupied the shoots, young leaves and unopened flowers. The affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids was founded and formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce any symptoms of plant disease. The aphids were yellow or yellow green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants.

Two types of aphids were found on *Mussaenda frondos,* each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The aphids were yellow, green, and some with dark green. The identification results showed that the aphids were *A. gossypii*. The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*.

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* was infested by *Aphis gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* or alligator grass was also colonized by *Aphis gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* was colonized by *Aphis gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and they were often associated with tiny brown ants. *Amaranthus gracilis* was infested by *Aphis craccivora.* These aphids established colonies on shoots, flowers and young and old leaves. They were dark brown to black in color, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* was colonized by *Lipaphis erysimi aphids.* These aphids were bright green, and of medium size. The colonies formed on flowers, flower stalks and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus or fire* grass was infested by *Aphis gossypii.* The aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds and flowers, often forming large colonies. *Cynodon dactylon* or Bermuda grass was colonized by *Schizaphis rotundiventris.* The aphids colonized the flowers, flower stalks and sometimes in the leaf axils of the plant. Small colonies were formed. The aphids were brown to red-brown. They were associated with ants. *Cyperus rotundus* or nut grass was infested by *Schizaphis rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* or grass puzzle was colonized by *Schizaphis rotundiventris* aphids, forming colonies in the flowers, flower stalks and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* was infested by *Hysteroneura setariae* aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinocloa crussgali* or water hyacinth plants were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Ecliptica prostrata* or urang aring was colonized by *Aphis gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants.

Eleusin indica was colonized by two species of aphids: *Hysteroneura setariae* and *Rhopalosiphum maidis. H. setariae* formed colonies in flower parts, flower stalks and leaf axils resulting in quite large colonies. *H. setariae* body color ranged from red brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and on leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia,* characterized by its purple flowers, was colonized by *Aphis gossypii.* The aphids were yellow to green in colour. The colonies formed near flowers, flower stalks, and shoot leaves.

Eragrostis tenella was infested by *Hysteroneura setariae* aphids. The aphids were brown to red brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* or wart grass was colonized by Aphis *gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupotarium odoratum* was colonied by both *Aphis gossypii* and *Aphis citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves that were colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark green in body colour. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of both A. *gossypii* and A. *citricola* on E. *odoratum* plants were associated with either black or red ants.

Hymenochera acutigluma or hair axis was colonized by *Hysteroneura setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp.* or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile or bamboo grass* plants were colonized by two species of aphids: *hysteroneura setariae* and *Rhopalosiphum maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green in color, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on L. gracile to mix.

Melastoma affine was colonized by *Aphis gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and on newly emerging fruits and flowers. The body colour of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania miranta* was colonized by *Aphis gossypii* and *Aphis glycine. A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. Glycine* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony.

Mimosa invisa (cater-grass) was colonized by *Aphis craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* was observed to be colonized by *Aphis craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa vigra* was colonized by *Aphis craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms.

Oryza rufipogon was colonized by two species of aphids: *Rhopalosiphum rice* and *Rhopalosiphum maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black siphunculi~~sifunculi~~ and cauda, while *R. rice* appeared white. The colonies of *R. maidis* and *R. rice* in *O. rufipogon* plants were associated with the presence of red ants. *Oxonopus compressus* or *pait* grass was colonized by *Hysteroneura setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes in the leaf axils. The aphids were brown to dark brown in color. Small colonies were formed, and they were also consistently associated with ants.

Paspalum conjugatum was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus niruri* was colonized by *Aphis citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda, and the colonies formed were quite large. *Portulaca oleraceae* plants were colonized by *Aphis craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots and in flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black.

Physalis angulata plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show any symptoms of disease. *Rorippa indica* or mustard land was colonized by *Lipaphis erysimi.* The colonies formed on the flowers, fruits, flower stalks and the lower surface of leaves. The colonized plant parts showed symptoms

such as curling and stunting. *Sida rhombifolia* or cacabean was colonized by *Aphis gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arventris* plants were colonized by *L. erysimi.* The aphids had green to whitish green body colours, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical symptoms of damage, but some did not show any symptoms. Generally, the symptoms of the plants caused by aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition happened because the colonized parts had reached their maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. The old leaves or twigs might not show the typical symptoms associated with aphid infestations.

The part of the plant exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued to grow, resulting in some parts developing normally while others become stunted (Pettersson, Tjallingii, and Hardie 2017). This condition could lead to the bending of shoots or young stems, curling of leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants or plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the presence of aphid colonies.

~~Throughout their life cycle, aphids exhibited host alternation by switching between two distinct host plants (Yamamoto et al. 2020). They overwintered on woody plants, reproduced in the spring, and migrated to herbaceous plants during the summer before returning to their primary host in the autumn (Yamamoto et al. 2020). This allowed aphids to maximize resource utilization, avoid congestion and competition, evade predators and parasites, circumvent plant defenses, and colonize new areas. Aphids could distribute their population efficiently, thereby avoiding overcrowding, predators and parasites, and plant defenses developing over time through host switching (Yamamoto et al. 2020). This behavior was essential for the survival and environmental adaptation of aphids.~~

Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive parts of plants. Flowers contain a nutrient-rich nature and easy access to sap, therefore aphids were attractive to sap the flowers. Some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as "sap". Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *Lipaphis erysimi,* and *Myzus persicae* are the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022).

Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive as a food source (Nelson and Mooney 2022). The honeydew contained an abundance of sugars, extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often 'farm' aphids for it. In exchange for honeydew, ants provided aphids with protection from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-jamour et al. 2018). Certain species of ants would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their own progeny (Biedermann and Vega 2020).

CONCLUSION

15 species of aphids were found in ornamental and wild plants in Pagaralam, namely *Aphis gossypii*, *Uroleucon* sp., *Toxoptera odinae*, *Macrosiphum rosae*, *Aphis citricola*, *Aphis craccivora*, Toxoptera aurantii, Pentalonia nigronervosa, Hystenura sp., *Aphis glycine*, *Greenidae* sp., *Rhopalosiphum padi*, *Rhopalosiphum maidis*, *Hyperomyzus* sp. *Lipaphis erysimi.*

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Species of aphids found in ornamental and wild plants in Pagar Alam District, South Sumatra, Indonesia

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Abstract. *Irsan C, Anggraini E, Ramadhani W. 2023. Species of aphids found in ornamental and wild plants in Pagar Alam District, South Sumatra, Indonesia. Biodiversitas 24: xxxx-xxxx.* Aphids are one of the crucial pests in tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species, such as wild plants, were found on plants that were not hosts. Therefore, this study reported the species of aphids found in ornamental and wild plants. The field research employed purposive and direct observation to inventory cultivated or wild plants hosting and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants and wild plants or weeds. The collection and identification of host plants and aphids involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that the total of 15 species aphids found in Ornamental plants, *Aphis craccivora* Koch, 1854, *Aphis spiraecola* Patch, 1914, *Aphis glycines* Matsumura, 1917, *Aphis gossypii* Glover, 1877, *Aulacorthum solani* Kaltenbach, 1843, *Macrosiphoniella sanborni* Gillette, 1908, *Macrosiphum rosae* Linnaeus, 1758, *Myzus persicae* Sulzer, 1776, *Neomyzus circumflexus* Buckton, 1876, *Pentalonia caladii* van der Goot, 1917, *Rhopalosiphum nymphaeae* Linnaeus, 1761, *Sinemegoura citricola* van der Goot, 1917, *Toxoptera aurantii* Boyer de Fonscolombe, 1841, *Toxoptera citricidus* Kirkaldy, 1907, *Toxoptera odinae* van der Goot, 1917 and the total of 11 species aphids found in weeds, *A. gossypii, A. craccivora, A. glycines, A. citricola, Greenidea* sp., *Hystroneura setariae* Thomas, 1878, *Hiperomyzus* sp., *Lipaphis erysimi* Kaltenbach, 1843, *Rhopalosiphum maidis* Fitch, 1856, *Rhopalosiphum padi* Linnaeus, 1758, *Schizaphis rotundiventris* Signoret, 1860.

Keywords: Aphids, ornamental plants, wild plants

INTRODUCTION

Aphids are crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020); aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck phloem sap of tender plant parts, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species can further weaken and stunt the growth of infected plants (Jones 2022). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh and Singh 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are found on plants that are not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or alternative, host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al. 2021). These secondary hosts may offer less adequate nutrition for insects (Mo and Smilanich 2023), However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al., 2021). According to Liu et al. (2017), hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids, it is evident that host-specialized aphids

have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al. 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically woody plants) and secondary hosts (often herbaceous plants) (Yamamoto et al. 2020). Weeds pose a continuous threat in both cropped and non–crop areas, providing food, shelter, and reproductive sites for various pest organisms (Kumar et al., 2021). This indicates that weeds can serve as alternative hosts for aphids.

In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and wild plants. Research on the inventory of aphid species in ornamental and wild plants has less noticed. This study reports the diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation to inventory cultivated or wild plants hosting and collecting aphids. The plant selection included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. Where available, collecting and identifying host plants, aphids, and natural enemies involved systematic searches of all existing plant species to find those colonized by aphids. Any plants colonized by aphids are documented as aphid hosts. Aphid identification was done using identification keys (Blackman and Eastop 2008) in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using the weed identification handbook (Kallas 2010; Naidu 2012; Meuninck 2023). The location and aphid colony sizes, including their life color, and photographs of the aphid colonies and their host plants were recorded.

RESULTS AND DISCUSSION

Result

Aphids infesting in ornamental plants

The results showed that 15 aphid species were found in Pagar Alam (Tables 1 and 2). These aphids mostly colonized flowers of various ornamental plants (Table 1, Figure 1).

The relationship between aphids and ants was also recorded. Aphids produce a sweet, sticky substance called honeydew; ants are attracted to this honey because it serves as a food source. When aphids are present, they secrete honeydew, which attracts ants. This research recorded the presence of ants on plant parts colonized by aphids (Table 2).

Aphids infesting in wild plants (weed or non-weed plants)

In addition, this study documented aphid colonies on flowers, stalks, plant tops, young leaves, and old leaves of wild plants (Table 3, Figure 2).

The presence of ants in aphid colonization symbolizes a mutually beneficial relationship where the ants receive food from the aphids while protecting them. This study recorded the ant attendance in aphids colonization (Table 4).

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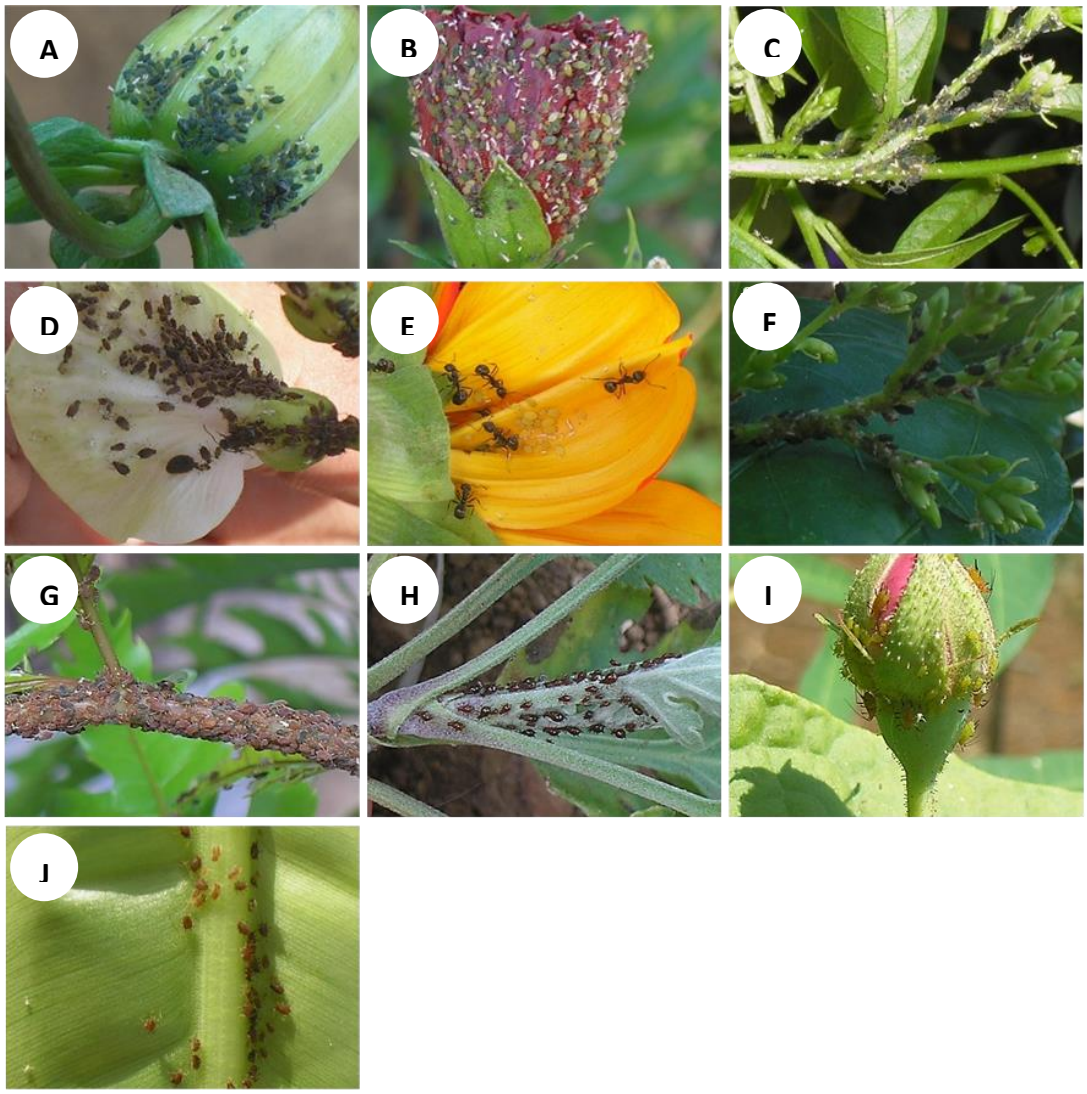

Figure 1. Photos showing colonies of different aphid species in ornamental plants: A. *Aphis gossypii* in *Dahlia* sp. flower; B. *Aphis gossypii* in *Hibiscus rosasinensis* flower; C. *Aphis gossypii* in *Cestrum* twig and flower; D. *Aphis craccivora* in *Clitoria ternatea* flower; E. *Aphis glycines* in *Helianthus giganteus* flower; F. *Aphis craccivora* on the *Murayya paniculata* flower; G. *Toxoptera odinae* in the *Mussaenda frondose;* H. *Macrosiphoniella sanborni*. in *Chrysanthemum* sp. Leaves; I. *Macrosiphum rosae* in *Rosa indica* flower; J. *Rhopalosiphum nymphaeae* in *Canna indica* leaves. Chandra Irsan captured all the photos.

Table 1. Aphid species recorded in ornamental plants and their colony locations

Host plant	Aphid species	Colony location
Aster alpinus	*Macrosiphoniella sanborni*	Leaves, young twig, flower
Brugmansia suaviolens	*Aulacorthum solani*	Leaves, flower
	Neomyzus circumflexus	Leaves
	Myzus persicae	Leaves, flower
Caladium sp.	*Pentalonia caladii*	Leaves,
Cananga odoratum	*Aphis gossypii*	Leaves, flower
Canna indica	*Rhopalosiphum nymphaeae*	Leaf
Catharanthus roseus	*Aphis spiraecola*	Shoot, young leaves, flower

Cestrum sp.	*Aphis gossypii*	Shoot, flower
	Neomyzus circumflexus	Young leaves
Clitoria ternatea	*Aphis craccivora*	Flower
Chrysanthemum sp.	*Macrosiphoniella sanborni*	Shoot, twig
Dahlia sp.	*Aphis gossypii*	Flower
Dendrobium sp.	*Sinemogoura citricola*	Flower
Duranta sp.	*Aphis gossypii*	Shoot, flower
Helianthus giganteus.	*Aphis glycines*	Flower
Hibiscus rosasinensis	*Aphis gossypii*	Flower
Ixora paludosa	*Aphis gossypii,*	Flower
	Toxoptera aurantii	Shoot, young leaves
Ixora sp.	*Aphis spiraecola*	Flower
	Aphis gossypii	Flower
	Toxoptera aurantii	Shoot, flower
Murraya paniculata	*Aphis craccivora*	Young Twig
	Toxoptera citricidus	Shoot, flower
Mussaenda frondosa	*Aphis spiraecola*	Shoot, flower
	Toxoptera odinae	Shoot, flower
Rosa indica	*Macrosiphum rosae*	Flower
Spondias dulcis	*Aphis spiraecola*	Flower

Table 2. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized

Aphid species	Ornamental plants	Aphids life color	Plant parts colonized	Ant attendance	Total individual of ant
Aphis craccivora	*Clitoria ternatea*	Black	Flowers	+	3
	Murraya paniculata	Black	Flowers	+	2
Aphis spiraecola	*Catharanthus roseus*	Greenish yellow	Flowers	+	2
	Ixora sp.	greenish yellow	Flowers	+	3
	Mussaenda frondosa	greenish yellow	Shoots, flowers	+	7
	Spondias dulcis	greenish yellow	Flowers	+	8
Aphis glycines	*Helianthus giganteus*	Greenish yellow	Flowers	+	3
Aphis gossypii	*Cestrum* sp.	Green	Shoots, flowers	+	4
	Cananga odoratum	Light green	Shoots, flowers	+	1
	Dahlia sp.	Green dark	Flowers	+	2
	Duranta sp.	Light green	Shoots, flowers	+	5
	Hibiscus rosasinensis	Dark green	Flowers	+	6
	Ixora paludosa	Light green	Flowers	+	2
	Ixora sp.	Light green	Flowers	+	7
Aulacorthum solani	*Brugmansia suaviolens*	Greenish yellow	Leaves, flowers	-	0
Macrosiphoniella sanborni	*Aster alpinus*	Brown black	Leaves, twigs, flowers	+	5
	Chrysanthemum sp.	Reddish brown	Leaves, twigs	+	5
Macrosiphum rosae	*Rosa indica*	Green	Flowers	-	0
Myzus persicae	*Brugmansia suaviolens*	Greenish yellow	Leaves, flowers	-	0
Neomyzus circumflexus	*Cestrum* sp.	Light green	Young leaves, flowers	-	0
	Brugmansia suaviolens	Light green	Flowers	-	0
Pentalonia caladii	*Caladium* sp.	Brown-black	Leaves	+	7
Rhopalosiphum nymphaeae	*Canna indica*	Green black	Leaves	+	1
Sinemegoura citricola	*Dendrobium* sp.	Brown	Flowers	-	0
Toxoptera aurantii	*Ixora paludosa*	Brown black	Flowers	+	5
	Ixora sp.	Brown black	Flowers	+	4
Toxoptera citricidus	*Murraya paniculata*	Black	Stems	+	6
Toxoptera odinae	*Mussaenda frondosa*	Reddish-brown	Flowers	+	4

Notes: (+) = present; (-) = absent

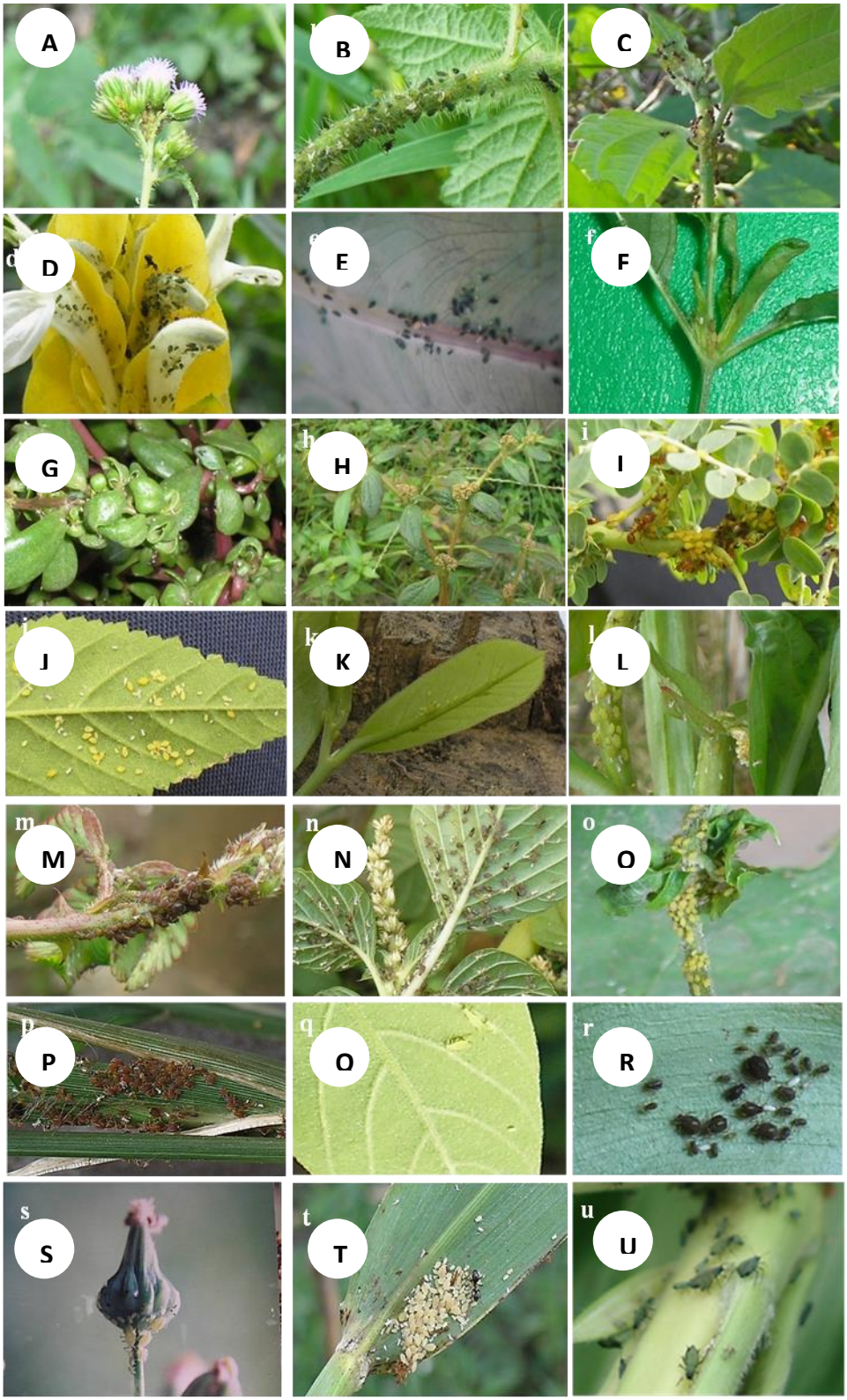

Figure 2. Aphids found infesting wild plants A. *Aphis gossypii* in *Ageratum conyzoides;* B. *Aphis gossypii* in *Croton hirtus*; C. *Aphis gossypii* in *Eupatorium odoratum*; D. *Aphis gossypii* in *Pachystochys* sp.; E. *Pentalonia caladii* in *Caladium* sp.; F. *Aphis gossypii* in *Alternanthera sessilis*; G. *Aphis gossypii* in *Portulaca oleraceae*; H. *Aphis gossypii* in *Euphorbia hirta*; I. *Aphis spiraecola* in *Phylantus nerruri*; J. *Aphis spiraecola* in *Sida rhombifolia*; K. *Aphis spiraecola* in *Bridelia tomentosa*; L. *Aphis spiraecola* in *Ludwigia peruviana*; M. *A. craccivora* in *Mimosa pudica*; N. *Aphis craccivora* in *Amaranthus viridis*; O. *Aphis glycine* in *Mikania micrantha*; P. *Hysteneura* sp. in *Eleusin* sp.; Q. *Greenidae* sp. in *Bridelia tomentosa*; R. *Hyperomyzus* sp. in *Echinocloa crusgali*; S. *Lipaphis erysimi* in *sonchus arventris*; T. *Rhopalosiphum padi* in *Oryza rufipogon*; U. *Rhopalosiphum maidis* in *Oryza rufipogon.* All the photos were captured by Chandra Irsan.

Table 3. Species of aphids found in wild (weed or non-weed) plants and their colony locations

Host plant	Weeds or non-weed plants	Aphid species	Colony location
Ageratum conyzoides	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
Alternanthera philoxeroides	Weed	*Aphis gossypii*	Shoots, buds
Alternanthera sessilis	Weed	*Aphis gossypii*	Shoots, buds
Amaranthus viridis	Weed	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
Blumea lacera	Weed	*Lipaphis erysimi*	Flowers, shoots, and buds
Bridelia tomentosa	Non-weed	*Greenidea* sp.	Young leaves
		Aphis spiraecola	Shoot, young leaves
Croton hirtus	Weed	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
Cynodon dactylon	Weed	*Schizaphis rotundiventris*	Flower, flower stalks
Cyperus rotundus	Weed	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
Cyperus compressus	Weed	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
Digitaria ciliaris	Weed	*Hystroneura setariae*	Flower, flower stalks
Echinocloa crussgali	Weed	*Hyperomyzus* sp.	Young leaves, old leaves
Ecliptica prostrata	Weed	*Aphis gossypii*	Shoots, young leaves
Eleusin indica	Weed	*Hysteroneura setariae*	Flower, flower stalks, leaf axils
		Rhopalosiphum maidis	Flower, flower stalks, leaf axils
Emilia sonchifolia	Weed	*Aphis gossypii*	Flower, flower stalks, shoots
Eragrostis tenella	Weed	*Hysteroneura setariae*	Flower, flower stalks, seeds
Euphorbia hirta	Weed	*Aphis gossypii*	Young leaves, old leaves
Eupotarium odoratum	Weed	*Aphis gossypii*	Young leaves, old leaves,
		Aphis glycines	Shoot, young twigs
Hymenochera acutigluma	Weed	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
Lophatherum gracile	Weed	*Hysteroneura setariae*	Young leaves, old leaves, leaf axils
		Rhopalosiphum maidis	Young leaves, old leaves, leaf axils
Melastoma affine	Non-weed	*Aphis gossypii*	Shoots, young leaves
Mikania micrantha	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves
		Aphis glycines	Shoot, young twig
Mimosa invisa	Weed	*Aphis craccivora*	Shoots, pods
Mimosa pudica	Weed	*Aphis craccivora*	Shoots, pods, flowers
Mimosa vigra	Non-weed	*Aphis craccivora*	Shoots, pods
Oryza rufipogon	Weed	*Rhopalosiphum padi,*	Old leaves, young leaves (shoot), leaf axils
	Weed	*Rhopalosiphum maidis*	Old leaves, young leaves (shoot), leaf axils
Oxonopus compressus	Weed	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
Paspalum conjugatum	Weed	*Hysteroneura setariae*	Flowers, flower stalks, seeds
Phylanthus neruri	Weed	*Aphis spiraecola*	Shoot, young leaves, old leaves, young twigs, petioles
Portulaca oleraceae	Weed	*Aphis craccivora*	Shoots, young leaves, flowers
Physalis angulata	Weed	*Aphis craccivora*	Shoots, young leaves, old leaves
	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves
Rorippa indica	Weed	*Lipapis erysimi*	Flowers, fruits, shoots, young leaves
Sida rhombifolia	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
Sonchus arventris	Weed	*Lipapis erysimi*	Young leaves, fruit stalks, flowers, fruits

Table 4. Aphid species were recorded in wild plants, and the presence of ants in the plant parts colonized

Aphid species	Wild plants	Aphids life color	Plant parts colonized	Ant attendance	Total individual of ant
Aphis gossypii	*Ageratum conyzoides*	Light green	Shoots, young leaves, old leaves, flowers	+	5
	Alternanthera philoxeroides	Light green	Shoots, buds	+	3
	Alternanthera sessilis	Light green	Shoots, buds	-	0
	Croton hirtus	Dark green	Flowers, shoots, young leaves, old leaves,	+	7
	Ecliptica prostrata	Green	young twigs	+	5
	Emilia sonchifolia	Green	Shoots, young leaves	+	6
	Euphorbia hirta	Light green	Flower, flower stalks, shoots	+	7
	Eupatorium odoratum	Light green	Young leaves, old leaves	+	8
	Melastoma affine	Light green	Young leaves, old leaves, young twigs	+	8
	Mikania micrantha	Light green	Shoots, young leaves	+	9
	Physalis angulata	Yellowish green	Shoots, young leaves, old leaves	+	10
	Sida rhombifolia	Yellowish green	Shoots, young leaves, old leaves, fruit/seeds	-	0
Aphis craccivora	*Amaranthus viridis*	Black	Flowers, shoots, young leaves, old leaves	+	3
	Mimosa invisa	Black	Shoots, pods	+	2
	Mimosa pudica	Black	Shoots, pods, flowers	+	3
	Mimosa vigra	Black	Shoots, pods	+	4
	Portulaca oleraceae	Black	Shoots, young leaves, flowers	+	7
	Physalis angulata	Black	Shoots, young leaves, old leaves	+	4
Aphis glycines	*Eupatorium odoratum*	Greenish yellow	Young leaves, old leaves, young twigs	+	6

	Mikania micrantha	Light green	Shoots, young leaves, old leaves	+	4
Aphis spiraecola	*Phylanthus neruri*	Greenish yellow	Shoot, young leaves, young twigs, petioles	+	5
	Bridelia Tomentosa	Greenish yellow	Shoot, young leaves	+	2
Greenidea sp.	*Bridelia Tomentosa*	Greenish yellow	Young leaves	-	0
Hystroneura setariae	*Digitaria ciliaris*	Reddish-brown	Flower, flower stalks	+	3
	Eleusin indica	Reddish-brown	Flower, flower stalks, leaf axils	+	4
	Eragrostis tenella	Reddish-brown	Flower, flower stalks, seeds	+	4
	Hymenochera acutigluma	Reddish-brown	Flowers, flower stalks, leaf axils	+	3
	Lophatherum gracile	Reddish-brown	Young leaves, old leaves, leaf axils	+	6
	Oxonopus compressus	Reddish-brown	Flower, flower stalk, leaf axils	+	3
	Paspalum conjugatum	Reddish-brown	Flower, flower stalk, seeds	+	6
Hyperomyzus sp.	*Echinocloa crussgali*	Black	Young leaves, old leaves	-	0
Lipaphis erysimi	*Blumea lacera*	Whitish green	Flowers, shoots, and buds	+	4
	Rorippa indica	Whitish green	Flower, fruit, shoots, young leaves	+	4
	Sonchus arventris	Whitish green	Young leaves, fruit stalks, flowers, fruit	+	5
Rhopalosiphum maidis	*Eleusin indica*	Green	Flower, flower stalks, leaf axils	+	3
	Lophatherum gracile	Green	Young leaves, old leaves, leaf axils	+	4
	Oryza rufipogon	Green	Old leaves, young leaves (shoot), leaf axils	-	0
Rhopalosiphum padi	*Oryza rufipogon*	Whitish green	Old leaves, young leaves (shoot), leaf axils	+	4
Schizaphis rotundiventris	*Cynodon dactylon*	Green	Flowers, flower stalks	+	6
	Cyperus compressus	Green	Flowers, flower stalks, leaf axils	+	4
	Cyperus rotundus	Green	Flowers, flower stalks, leaf axils	+	4

Notes: (+): present, (-): absent

Discussion

In the present study, some aphid species were found on several ornamental plants in Pagar Alam, the location of aphid colonization on the plants varied. On *Aster alpinus* L., aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Macrosiphoniella sanborni* Gillette, 1908 associated with ants. On the *Brugmansia suaviolens* (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl, *Myzus persicae* Sulzer, 1776 were found on the undersides of old leaves or leaves that have turned yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. was found one species of aphids: *Pentalonia caladii* van der Goot, 1917. *P. caladii* was known and found in taro plants; the aphids formed colonies under the surface of young and older leaves (Bhadra and Agarwala 2014). This study found that the occupied leaf areas did not display severe symptoms; the aphids were yellow-green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odorata* (Lam.) Hook.f. & Thomson (ylang-ylang), colonies of *Toxoptera aurantii* Boyer de Fonscolombe, 1841 were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black. The colonies of *T. aurantii* were found to be associated with black ants. Aphids on *Canna indica* L. (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body and the identification results showed that the aphids were *Rhopalosiphum nymphaeae* Linnaeus, 1761 (Ghosh and Singh 2004). The colonies of *R. nymphaeae* were found to be associated with ants. In the *Catharanthus roseus* (L.) G.Don (periwinkle), *Aphis spiraecola* Patch, 1914 aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts showed no disease symptoms. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or stalks that had not fully bloomed; the colonies were quite large. The body color of aphids was green to dark green, with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *Aphis gossypii* Glover, 1877. The aphid colonies found were consistently associated with ants. Aphids on *Clitoria ternatea* L. were found to form colonies on flower parts, flower crowns, stems, and young leaves. The aphids were brown to black. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *Aphis craccivora* Koch, 1854. These colonies were consistently associated with ants. The aphids on the *Dahlia* sp. formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* According to this present study, *Sinemegoura citricola* van der Goot, 1917 colonies were found on the young leaves of *Dendrobium* sp., with the color body of the *S. citricola* aphids were yellow, green to dark green, and the colonized plants showing no disease

symptoms, and were associated with ants. On *Duranta* sp., colonies of aphids on the undersides of young leaves, and the colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Furthermore, on the *Helianthus annuus* L., aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, tended to fall off easily. The aphids were green and yellow ~~in color~~. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *Aphis glycines* Matsumura, 1917. The aphid colonies were not associated with ants. Within the colonies, mummified aphids that Aphidiidae parasitized were found. On the *Hibiscus rosa-sinensis* L., aphids ranging from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii.* The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa* (Blume) Kurz. First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, like sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii* almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants. Moreover, two forms of aphids were discovered in Ixora sp. flower plants. These aphids occupied the shoots, young leaves, and unopened flowers; the affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes, the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce plant disease symptoms. The aphids were yellow or yellowish green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants. Two types of aphids were found on *Mussaenda frondose* L., each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The identification results showed that the aphids were *Toxoptera odinae* van der Goot, 1917. The aphids were yellow, green, and dark green (Blackman et al. 2011). The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots, and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow-green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*. Many aphid species infest various ornamental plants because these insects are attracted to such plants due to the rich nutrient content in the plant sap (Braham et al. 2023).

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* L. was infested by *A. gossypii.* These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* (Mart.) Griseb., or alligator grass, was also colonized by *A. gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* (L.) R.Br. ex DC. was colonized by *A. gossypii,* forming colonies on shoots, flowers, and fruit. The colonies were typically large, and often associated with tiny brown ants. *Amaranthus viridis* Linnaeus was infested by *A. craccivora.* These aphids established colonies on shoots, flowers, and young and old leaves. They were dark brown to black, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants.

Blumea lacera (Burm.fil.) DC. was colonized by *Lipaphis erysimi* Kaltenbach, 1843. These aphids were bright green and of medium size. The colonies formed on flowers, flower stalks, and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus* L'Hér., or fire grass, was infested by *A. gossypii;* the aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds, and flowers, often forming large colonies. *Cynodon dactylon* (L.) Pers. or Bermuda grass was colonized by *Schizaphis rotundiventris* Signoret, 1860. The aphids colonized the flowers, flower stalks, and sometimes the plant leaf axils. Small colonies were formed. The aphids were brown to reddish brown. They were associated with ants. *Cyperus rotundus* L., or nut grass, was infested by *S. rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* L., or grass puzzle, was colonized by *S. rotundiventris* aphids, forming colonies in the flowers, flower stalks, and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* (Retz.) Koeler was infested by *Hysteroneura setariae* Thomas 1878 aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinochloa crus-galli* (L.) P.Beauv., or water hyacinth plants, were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Eclipta prostrata* (L.) L., or urang-aring, was colonized by *A. gossypii,* forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants. *Eleusin indica* (L.) Gaertn. was colonized by two species of aphids: *Hysteroneura setariae* Thomas, 1878 and *Rhopalosiphum maidis* Fitch, 1856. *H. setariae* formed colonies in flower parts, flower stalks, and leaf axils, resulting in large colonies. *H. setariae's* body color ranged from red-brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia* (L.) DC. ex Wight, characterized by its purple flowers, was colonized by *A.gossypii;* the aphids were yellow to green in color. The colonies formed near flowers, flower stalks, and shoot leaves. *Eragrostis tenella* was infested by *H. setariae* aphids. The aphids were brown to red-brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* L., or wart grass, was colonized by *A. gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupatorium odoratum* L. was colonized by *A. gossypii* and *A. citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark-green body color. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of *A. gossypii* and *A. citricola* on *E. odoratum* plants were associated with either black or red ants. *Hymenachne acutigluma* (Steud.) Gilliland, or hair axis, was colonized by *H. setariae,* which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*., or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile* Brongn. or bamboo grass plants, were colonized by two species of aphids: *H. setariae* and *R. maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on *L. gracile* to mix. In addition, *Melastoma affine* D.Don was colonized by *A. gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and newly emerging fruits and flowers. The body color of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania micrantha* Kunth was colonized by *A. gossypii* and *Aphis glycines* Matsumura, 1917. *A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. glycines* aphids were light green to green in color. The colonized plant parts became distorted. The two

species of aphids could mix to form a single colony. *Mimosa invisa* Mart. ex Colla *(*cater-grass) was colonized by *A. craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* L. was observed to be colonized by *A. craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa pigra* L. was colonized by *A. craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms. *Oryza rufipogon* Griff. was colonized by two species of aphids: *Rhopalosiphum padi* and *R. maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green with black siphunculi and cauda, while *Rhopalosiphum padi* Linnaeus, 1758 appeared white. The colonies of *R. maidis* and *R. padi* in *O. rufipogon* plants were associated with the presence of red ants. *Axonopus compressus* (Sw.) P.Beauv*.,* or *pait* grass, was colonized by *H. setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes the leaf axils. The aphids were brown to dark brown. Small colonies were formed, and they were also consistently associated with ants. *Paspalum conjugatum* was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus neruri* L. was colonized by *A. citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda; the colonies formed were large. *Portulaca oleracea* L. plants were colonized by *A. craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots, and flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black. *Physalis angulata* plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show disease symptoms. *Rorippa indica* (L.) Hiern*,* or mustard land, was colonized by *L. erysimi*. The colonies formed on the flowers, fruits, flower stalks, and the lower leaf's surface. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* L.*,* or cacabean, was colonized by *A. gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks, and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arvensis* L. plants were colonized by *L. erysimi.* The aphids had green to whitish green body colors, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical damage symptoms, but some did not show any symptoms at all. Generally, the plants' symptoms due to aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition occurred because the colonized parts had reached maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. Furthermore, the old leaves or twigs might not show the typical symptoms associated with aphid infestations. The plant parts exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued growing, resulting in some parts developing ordinary while others became stunted (Pettersson et al. 2017). This condition could lead to bending shoots or young stems, curling leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the aphid colonies. According to this–study, ants were present in some aphid colonies from the subfamily Aphidinae, while the ants were absent in some aphid colonies from the macrosiphini subfamily. The bodies of aphids from the subfamily Aphidinae are relatively small and have short sifunculi. On the other hand, aphids, which

have large bodies and relatively long sifunculi, are never visited by ants. This happens because long sifunculi are reported to disturb ants, so the ants don't like to come close. Additionally, large aphids and long sifunculi generally do not produce honeydew, so ants do not want to come close.

The absence of ants in aphid colonies could be because the colonies have just formed or the population is still low (Kummel et al. 2013). Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive plant parts. Flowers contain a nutrient-rich nature and easy access to sap; therefore, aphids were attracted to flower saps. In addition, some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as sap. Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *L. erysimi,* and *M. persicae,* the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022). Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive food sources (Nelson and Mooney 2022). The honeydew contained abundant sugars extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often farm aphids for it. In exchange for honeydew, ants protected aphids from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-Jamour et al. 2018). Certain ant species would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their progeny (Biedermann and Vega 2020). Ornamental plants, and also weeds are generally grown with simple maintenance and usually free pesticides. The ecological habitat of ornamental plants and weeds is assumed to be the same. Therefore, many species of aphids found on ornamental plants were also found on weeds.

In conclusion total of 15 species aphids found in ornamental plants, *A. craccivora, A. citricola, A. glycines, A. gossypii, A. solani, M. sanborni, M. rosae, M. persicae, N. circumflexus, P. caladii, R. nymphaeae, S. citricola, T. aurantii, T. citricidus, T. odinae.* The total of 11 species aphids found in weeds, *A. gossypii, A. craccivora, A. glycines, A. citricola, Greenidea* sp., *H. setariae, Hiperomyzus* sp., *L. erysimi, R. maidis, R. padi, S. rotundiventris.*

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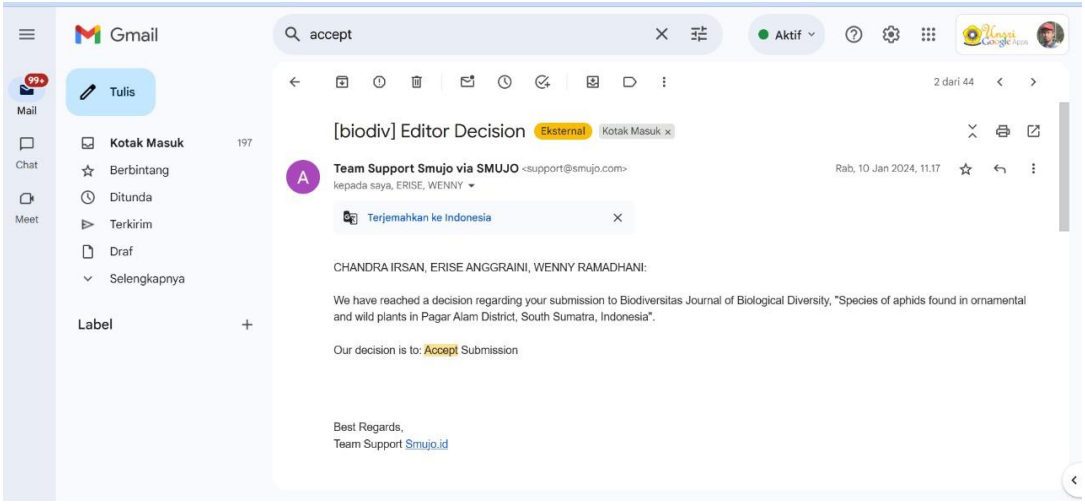

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Species of aphids found in ornamental and wild plants in Highland, Pagar Alam District, South Sumatra, Indonesia

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Abstract. *Irsan C, Anggraini E, Ramadhani W. 2023. Species of aphids found in ornamental and wild plants in Highland, Pagar Alam District, South Sumatra, Indonesia. Biodiversitas 24: xxxx-xxxx.* Aphids are one of the crucial pests in tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species, such as wild plants, were found on plants that were not hosts. Therefore, this study reported the species of aphids found in ornamental and wild plants. The field research employed purposive and direct observation to inventory cultivated or wild plants hosting and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants and wild plants or weeds. The collection and identification of host plants and aphids involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that the total of 15 species aphids found in Ornamental plants, *Aphis craccivora* Koch, 1854, *Aphis citricola* van der Goot, 1912 , *Aphis glycines* Matsumura, 1917, *Aphis gossypii* Glover, 1877 , *Aulacorthum solani* Kaltenbach, 1843, *Macrosiphoniella sanborni* Gillette, 1908, *Macrosiphum rosae* Linnaeus, 1758, *Myzus persicae* Sulzer, 1776, *Neomyzus circumflexus* Buckton, 1876, *Pentalonia caladii* van der Goot, 1917, *Rhopalosiphum nymphaeae* Linnaeus, 1761, *Sinemegoura citricola* van der Goot, 1917, *Toxoptera aurantii* Boyer de Fonscolombe, 1841, *Toxoptera citricidus* Kirkaldy, 1907, *Toxoptera odinae* van der Goot, 1917 and the total of 11 species aphids found in weeds, *A. gossypii*, *A. craccivora*, *A. glycines*, *A. citricola*, *Greenidea* sp., *Hystroneura setariae* Thomas, 1878, *Hiperomyzus* sp., *Lipaphis erysimi* Kaltenbach, 1843, *Rhopalosiphum maidis* Fitch, 1856, *Rhopalosiphum padi* Linnaeus, 1758, *Schizaphis rotundiventris* Signoret, 1860.

Keywords: Aphids, ornamental plants, wild plants

INTRODUCTION

Aphids are crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020); aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck phloem sap of tender plant parts, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species can further weaken and stunt the growth of infected plants (Jones 2022). Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are found on plants that are not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary, or alternative, host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al. 2021). In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and native plants. Research on the diversity of aphid species in ornamental and wild plants has less noticed. This study reports the diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation to inventory cultivated or wild plants hosting and collecting aphids. The plant selection included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. Where available, collecting and identifying host plants, aphids, and natural enemies involved systematic searches of all existing plant species to find those colonized by aphids. Any plants colonized by aphids are documented as aphid hosts. Aphid identification was done using identification keys (Blackman and Eastop 2008) in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on

morphological characteristics. The host plants were identified using the weed identification handbook (Kallas 2010; Naidu 2012; Meuninck 2023). The location and aphid colony sizes, including their life color, and photographs of the aphid colonies and their host plants were recorded.

RESULTS AND DISCUSSION

Result

Aphids infesting in ornamental plants

The results showed that 15 aphid species were found in Pagar Alam (Tables 1 and 2). These aphids mostly colonized flowers of various ornamental plants (Table 1, Figure 1).

The relationship between aphids and ants was also recorded. Aphids produce a sweet, sticky substance called honeydew; ants are attracted to this honey because it serves as a food source. When aphids are present, they secrete honeydew, which attracts ants. This research recorded the presence of ants on plant parts colonized by aphids (Table 2).

Aphids infesting in wild plants (weed or non-weed plants)

In addition, this study documented aphid colonies on flowers, stalks, plant tops, young leaves, and old leaves of wild plants (Table 3, Figure 2).

The presence of ants in aphid colonization symbolizes a mutually beneficial relationship where the ants receive food from the aphids while protecting them. This study recorded the ant attendance in aphids colonization (Table 4).

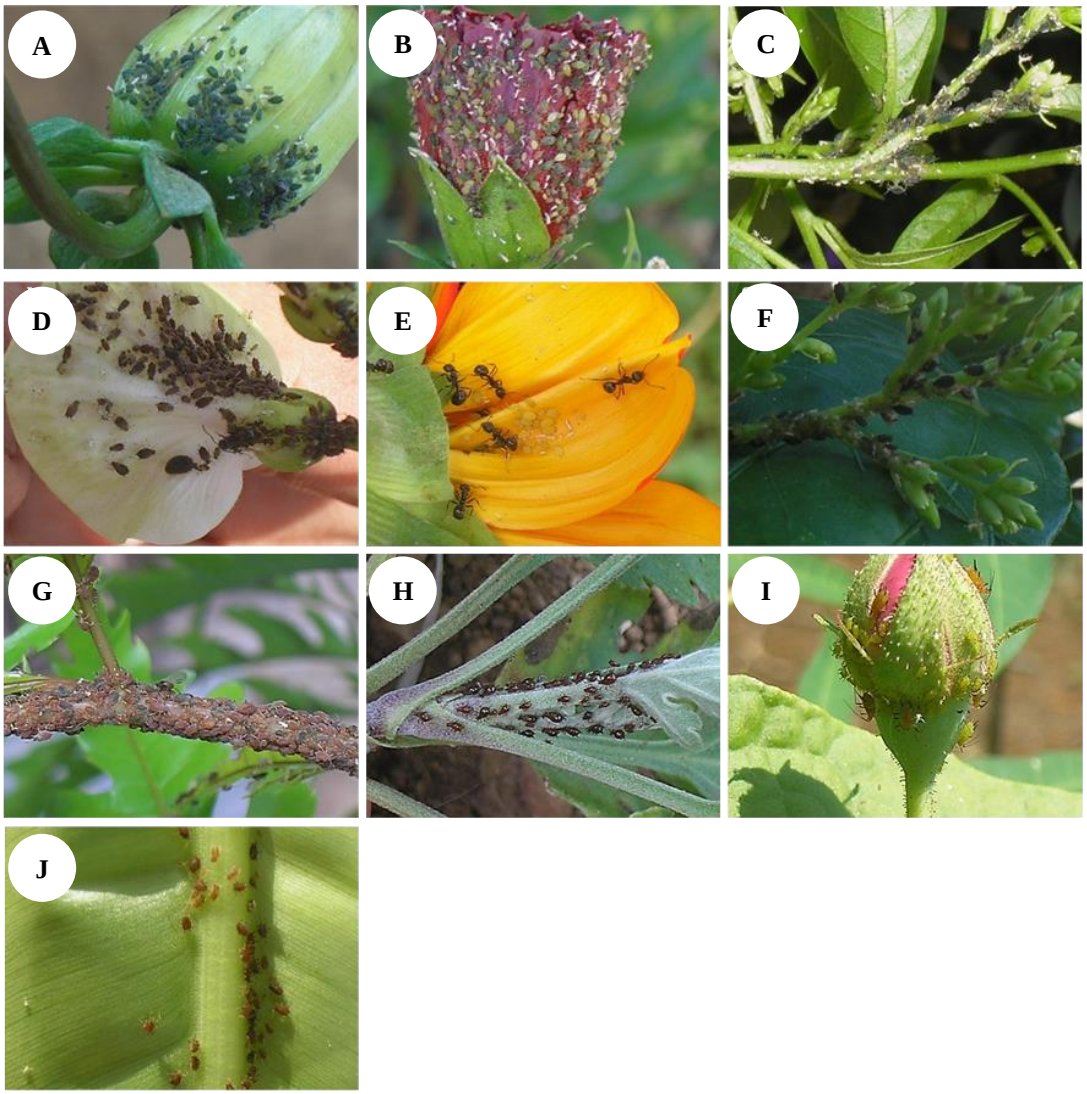

Figure 1. Photos showing colonies of different aphid species in ornamental plants: A. *Aphis gossypii* in *Dahlia* sp. flower; B. *Aphis gossypii* in *Hibiscus rosasinensis* flower; C. *Aphis gossypii* in *Cestrum* twig and flower; D. *Aphis craccivora* in *Clitoria ternatea* flower; E. *Aphis glycines* in *Helianthusgiganteus* flower; F. *Aphis craccivora* on the *Murayya paniculata* flower; G. *Toxoptera odinae* in the *Mussaenda frondose;* H. *Macrosiphoniella sanborni*. in *Chrysanthemum* sp. Leaves; I. *Macrosiphum rosae* in *Rosa indica* flower; J. *Rhopalosiphum nymphaeae* in *Canna indica* leaves. Chandra Irsan captured all the photos

Table 1. Aphid species recorded in ornamental plants and their colony locations

Host plant	Aphid species	Colony location
Aster alpinus	*Macrosiphoniella sanborni*	Leaves, young twig, flower
Brugmansia suaviolens	*Aulacorthum solani*	Leaves, flower
	Neomyzus circumflexus	Leaves
	Myzus persicae	Leaves, flower
Caladium sp.	*Pentalonia caladii*	Leaves,
Cananga odoratum	*Aphis gossypii*	Leaves, flower
Canna indica	*Rhopalosiphum nymphaeae*	Leaf
Catharanthus roseus	*Aphis citricola*	Shoot, young leaves, flower
Cestrum sp.	*Aphis gossypii*	Shoot, flower
	Neomyzus circumflexus	Young leaves
Clitoria ternatea	*Aphis craccivora*	Flower
Chrysanthemum sp.	*Macrosiphoniella sanborni*	Shoot, twig
Dahlia sp.	*Aphis gossypii*	Flower
Dendrobium sp.	*Sinemogoura citricola*	Flower
Duranta sp.	*Aphis gossypii*	Shoot, flower
Helianthus giganteus.	*Aphis glycines*	Flower
Hibiscus rosasinensis	*Aphis gossypii*	Flower
Ixora paludosa	*Aphis gossypii*,	Flower
	Toxoptera aurantii	Shoot, young leaves
Ixora sp.	*Aphis citricola*	Flower
	Aphis gossypii	Flower
	Toxoptera aurantii	Shoot, flower
Murraya paniculata	*Aphis craccivora*	Young Twig
	Toxoptera citricidus	Shoot, flower
Mussaenda frondosa	*Aphis citricola*	Shoot, flower
	Toxoptera odinae	Shoot, flower
Rosa indica	*Macrosiphum rosae*	Flower
Spondias dulcis	*Aphis citricola*	Flower

Table 2. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized

Aphid species	Ornamental plants	Aphids life color	Plant parts colonized	Ant attendance	Total individual of ant
Aphis craccivora	*Clitoria ternatea*	Black	Flowers	+	3
	Murraya paniculata	Black	Flowers	+	2
Aphis citricola	*Catharanthus roseus*	Greenish yellow	Flowers	+	2
	Ixora sp.	greenish yellow	Flowers	+	3
	Mussaenda frondosa	greenish yellow	Shoots, flowers	+	7
	Spondias dulcis	greenish yellow	Flowers	+	8
Aphis glycines	*Helianthus giganteus*	Greenish yellow	Flowers	+	3
Aphis gossypii	*Cestrum* sp.	Green	Shoots, flowers	+	4
	Cananga odoratum	Light green	Shoots, flowers	+	1
	Dahlia sp.	Green dark	Flowers	+	2
	Duranta sp.	Light green	Shoots, flowers	+	5
	Hibiscus rosasinensis	Dark green	Flowers	+	6
	Ixora paludosa	Light green	Flowers	+	2
	Ixora sp.	Light green	Flowers	+	7
Aulacorthum solani	*Brugmansia suaviolens*	Greenish yellow	Leaves, flowers	-	0
Macrosiphoniella sanborni	*Aster alpinus*	Brown black	Leaves, twigs, flowers	+	5
	Chrysanthemum sp.	Reddish brown	Leaves, twigs	+	5
Macrosiphum rosae	*Rosa indica*	Green	Flowers	-	0
Myzus persicae	*Brugmansia suaviolens*	Greenish yellow	Leaves, flowers	-	0
Neomyzus circumflexus	*Cestrum* sp.	Light green	Young leaves,	-	0
	Brugmansia suaviolens	Light green	flowers	-	0
			Flowers		
Pentalonia caladii	*Caladium* sp.	Brown-black	Leaves	+	7
Rhopalosiphum nymphaeae	*Canna indica*	Green black	Leaves	+	1
Sinemegoura citricola	*Dendrobium* sp.	Brown	Flowers	-	0
Toxoptera aurantii	*Ixora paludosa*	Brown black	Flowers	+	5
	Ixora sp.	Brown black	Flowers	+	4
Toxoptera citricidus	*Murraya paniculata*	Black	Stems	+	6
Toxoptera odinae	*Mussaenda frondosa*	Reddish-brown	Flowers	+	4

Notes: (+) = present; (-) = absent

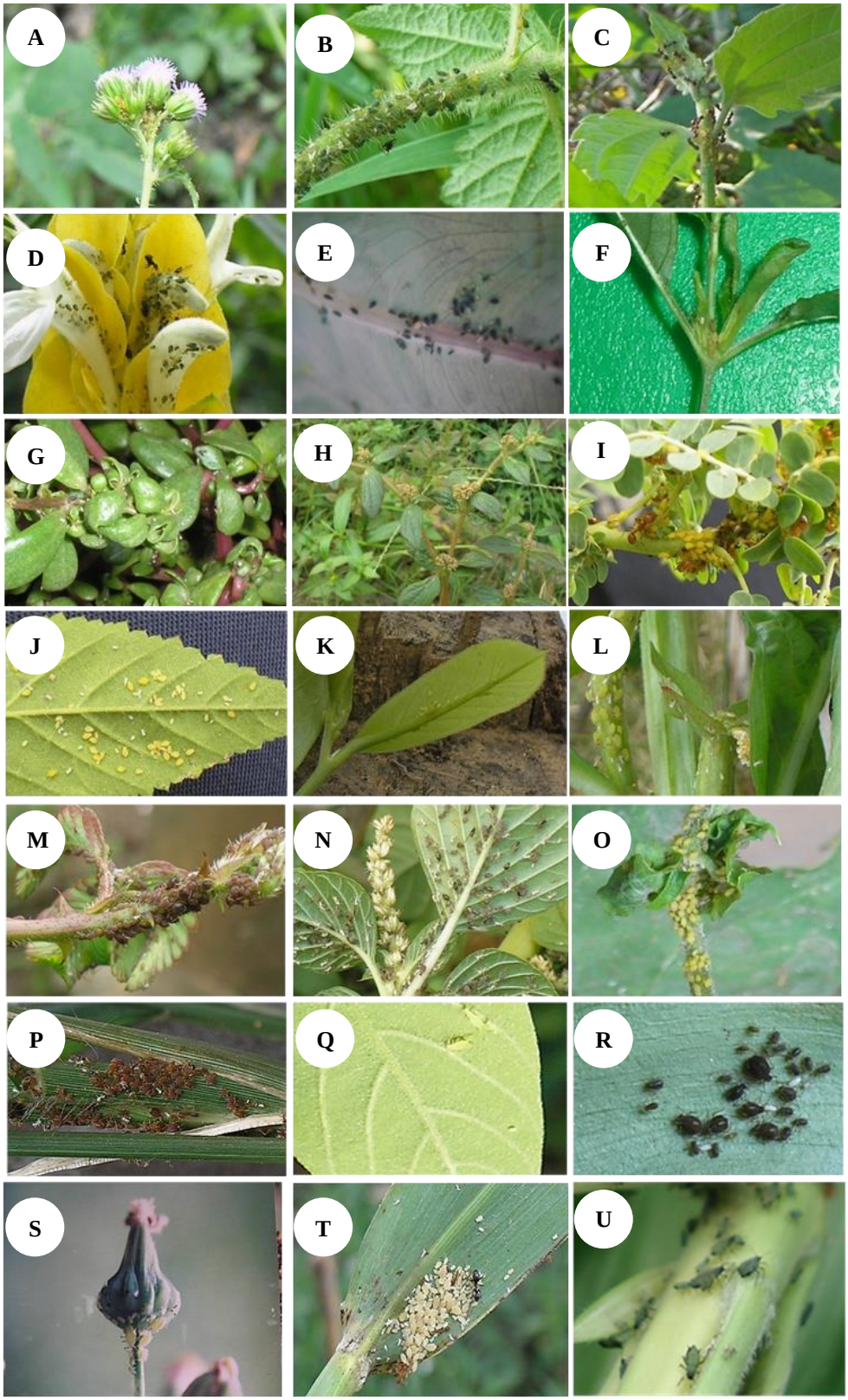

Figure 2. Aphids found infesting wild plants A. *Aphis gossypii* in *Ageratum conyzoides;* B. *Aphis gossypii* in *Croton hirtus*; C. *Aphis gossypii* in *Eupatorium odoratum*; D. *Aphis gossypii* in *Pachystochys* sp.; E. *Pentalonia caladii* in *Caladium* sp.; F. *Aphis gossypii* in *Alternanthera sessilis*; G. *Aphis gossypii* in *Portulaca oleraceae*; H. *Aphis gossypii* in *Euphorbia hirta*; I. *Aphis citricola* in *Phylantus nerruri*; J. *Aphis citricola* in *Sida rhombifolia*; K. *Aphis citricola* in *Annona muricata*; L. *Aphis citricola* in *Ludwigia peruviana*; M. *A. craccivora* in *Mimosa pudica*; N. *Aphis craccivora* in *Amaranthus gracilis*; O. *Aphis glycine* in *Mikania micrantha*; P. *Hysteneura* sp. in *Eleusin* sp.; Q. *Greenidae* sp. in *Bridelia tomentosa* young leaves.; R. *Hyperomyzus* sp. in *Echinocloa crusgali*; S. *Lipaphis erysimi* in *sonchus arventris*; T. *Rhopalosiphum padi* in *Oryza rufipogon*; U. *Rhopalosiphum maidis* in *Oryza rufipogon.* All the photos were captured by Chandra Irsan

Table 3. Species of aphids found in wild (weed or non-weed) plants and their colony locations

Host plant	Weeds or non-weed plants	Aphid species	Colony location
Ageratum conyzoides	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
Alternanthera philoxeroides	Weed	*Aphis gossypii*	Shoots, buds
Alternanthera sessilis	Weed	*Aphis gossypii*	Shoots, buds
Amaranthus gracilis	Weed	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
Blumea lacera	Weed	*Lipaphis erysimi*	Flowers, shoots, and buds
Croton hirtus	Weed	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
Cynodon dactylon	Weed	*Schizaphis rotundiventris*	Flower, flower stalks
Cyperus rotundus	Weed	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
Cyperus compressus	Weed	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
Digitaria ciliaris	Weed	*Hystroneura setariae*	Flower, flower stalks
Echinocloa crussgali	Weed	*Hyperomyzus* sp.	Young leaves, old leaves
Ecliptica prostrata	Weed	*Aphis gossypii*	Shoots, young leaves
Eleusin indica	Weed	*Hysteroneura setariae*	Flower, flower stalks, leaf axils
		Rhopalosiphum maidis	Flower, flower stalks, leaf axils
Emilia sonchifolia	Weed	*Aphis gossypii*	Flower, flower stalks, shoots
Eragrostis tenella	Weed	*Hysteroneura setariae*	Flower, flower stalks, seeds
Euphorbia hirta	Weed	*Aphis gossypii*	Young leaves, old leaves
Eupotarium odoratum	Weed	*Aphis gossypii*	Young leaves, old leaves,
		Aphis glycines	Shoot, young twigs
Hymenochera acutigluma	Weed	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
Bridelia tomentosa	Non-weed	*Greenidea* sp.	Young leaves
Lophatherum gracile	Weed	*Hysteroneura setariae*	Young leaves, old leaves, leaf axils
		Rhopalosiphum maidis	Young leaves, old leaves, leaf axils
Melastoma affine	Non-weed	*Aphis gossypii*	Shoots, young leaves
Mikania micrantha	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves
		Aphis glycines	Shoot, young twig
Mimosa invisa	Weed	*Aphis craccivora*	Shoots, pods
Mimosa pudica	Weed	*Aphis craccivora*	Shoots, pods, flowers
Mimosa vigra	Non-weed	*Aphis craccivora*	Shoots, pods
Oryza rufipogon	Weed	*Rhopalosiphum padi,*	Old leaves, young leaves (shoot), leaf axils
	Weed	*Rhopalosiphum maidis*	Old leaves, young leaves (shoot), leaf axils
Oxonopus compressus	Weed	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
Paspalum conjugatum	Weed	*Hysteroneura setariae*	Flowers, flower stalks, seeds
Phylanthus neruri	Weed	*Aphis citricola*	Shoot, young leaves, old leaves, young twigs, petioles
Portulaca oleraceae	Weed	*Aphis craccivora*	Shoots, young leaves, flowers
Physalis angulata	Weed	*Aphis craccivora*	Shoots, young leaves, old leaves
	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves
Rorippa indica	Weed	*Lipapis erysimi*	Flowers, fruits, shoots, young leaves
Sida rhombifolia	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
Sonchus arventris	Weed	*Lipapis erysimi*	Young leaves, fruit stalks, flowers, fruits

Table 4. Aphid species were recorded in wild plants, and the presence of ants in the plant parts colonized

Aphid species	Wild plants	Aphids life color	Plant parts colonized	Ant attendance	Total individual of ant
Aphis gossypii	*Ageratum conyzoides*	Light green	Shoots, young leaves, old leaves, flowers	+	5
	Alternanthera philoxeroides	Light green	Shoots, buds	+	3
	Alternanthera sessilis	Dark green	Shoots, buds	-	0
	Croton hirtus	Green	Flowers, shoots, young leaves, old leaves, young twigs	+	7
	Ecliptica prostrata	Light green	Shoots, young leaves	+	5
	Emilia sonchifolia	Light green	Flower, flower stalks, shoots	+	6
	Euphorbia hirta	Light green	Young leaves, old leaves	+	7
	Eupatorium odoratum	Light green	Young leaves, old leaves, young twigs	+	8
	Melastoma affine	Yellowish green	Shoots, young leaves	+	8
	Mikania micrantha	Yellowish	Shoots, young leaves, old leaves	+	9
	Physalis angulata	green	Shoots, young leaves, old leaves,	+	10
	Sida rhombifolia		fruit/seeds	-	0
Aphis craccivora	*Amaranthus gracilis*	Black	Flowers, shoots, young leaves, old leaves	+	3
	Mimosa invisa	Black		+	2
	Mimosa pudica	Black	Shoots, pods	+	3
	Mimosa vigra	Black	Shoots, pods, flowers	+	4
	Portulaca oleraceae	Black	Shoots, pods	+	7

	Physalis angulata	Black	Shoots, young leaves, flowers Shoots, young leaves, old leaves	+	4
Aphis glycines	*Eupatorium odoratum*	Greenish yellow	Young leaves, old leaves, young twigs	+ +	6 4
	Mikania micrantha	Light green	Shoots, young leaves, old leaves		
Aphis citricola	*Phylanthus neruri*	Greenish yellow	Shoot, young leaves, young twigs, petioles	+	5
Greenidea sp.	*Bridelia Tomentosa*	Greenish yellow	Young leaves	-	0
Hystroneura setariae	*Digitaria ciliaris*	Reddish-brown	Flower, flower stalks	+	3
	Eleusin indica	Reddish-brown	Flower, flower stalks, leaf axils	+	4
	Eragrostis tenella	Reddish-brown	Flower, flower stalks, seeds	+	4
	Hymenochera acutigluma	Reddish-brown	Flowers, flower stalks, leaf axils	+	3
	Lophatherum gracile	Reddish-brown	Young leaves, old leaves, leaf axils	+	6
	Oxonopus compressus	Reddish-brown	Flower, flower stalk, leaf axils Flower, flower stalk, seeds	+	3
	Paspalum conjugatum				6
Hyperomyzus sp.	*Echinocloa crussgali*	Black	Young leaves, old leaves	-	0
Lipaphis erysimi	*Blumea lacera*	Whitish green	Flowers, shoots, and buds	+	4
	Rorippa indica	Whitish green	Flower, fruit, shoots, young leaves	+	4
	Sonchus arventris	Whitish green	Young leaves, fruit stalks, flowers, fruit	+	5
Rhopalosiphum maidis	*Eleusin indica*	Green	Flower, flower stalks, leaf axils	+	3
	Lophatherum gracile	Green	Young leaves, old leaves, leaf axils	+	4
	Oryza rufipogon	Green	Old leaves, young leaves (shoot), leaf axils	-	0
Rhopalosiphum padi	*Oryza rufipogon*	Whitish green	Old leaves, young leaves (shoot), leaf axils	+	4
Schizaphis rotundiventris	*Cynodon dactylon*	Green	Flowers, flower stalks	+	6
	Cyperus rotundus	Green	Flowers, flower stalks, leaf axils	+	4
	Cyperus compressus	Green	Flowers, flower stalks, leaf axils	+	4

Notes: (+): present, (-): absent

Discussion

In the present study, some aphid species were found on several ornamental plants in Pagar Alam, the location of aphid colonization on the plants varied. On *Aster alpinus* L., aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Macrosiphoniella sanborni* Gillette, 1908 associated with ants. On the *Brugmansia suaviolens* (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl, *Myzus persicae* Sulzer, 1776 were found on the undersides of old leaves or leaves that have turned yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. was found one species of aphids: *Pentalonia caladii* van der Goot, 1917. *P. caladii* was known and found in taro plants; the aphids formed colonies under the surface of young and older leaves (Bhadra and Agarwala 2014). This study found that the occupied leaf areas did not display severe symptoms; the aphids were yellow-green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odorata* (Lam.) Hook.f. & Thomson (ylang-ylang), colonies of *Toxoptera aurantii* Boyer de Fonscolombe, 1841 were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black. The colonies of *T. aurantii* were found to be associated with black ants. Aphids on *Canna indica* L. (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body and the identification results showed that the aphids were *Rhopalosiphum nymphaeae* Linnaeus, 1761 (Ghosh and Singh 2004). The colonies of *R. nymphaeae* were found to be associated with ants. In the *Catharanthus roseus* (L.) G.Don (periwinkle), *Aphis citricola* van der Goot, 1912 aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts showed no disease symptoms. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or stalks that had not fully bloomed; the colonies were quite large. The body color of aphids was green to dark green, with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *Aphis gossypii* Glover, 1877. The aphid colonies found were consistently associated with ants. Aphids on *Clitoria ternatea* L. were found to form colonies on flower parts, flower crowns, stems, and young

leaves. The aphids were brown to black. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *Aphis craccivora* Koch, 1854. These colonies were consistently associated with ants. The aphids on the *Dahlia* sp. formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* According to this present study, *Sinemegoura citricola* van der Goot, 1917 colonies were found on the young leaves of *Dendrobium* sp., with the color body of the *S. citricola* aphids were yellow, green to dark green, and the colonized plants showing no disease symptoms, and were associated with ants. On *Duranta* sp., colonies of aphids on the undersides of young leaves, and the colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Furthermore, on the *Helianthus annuus* L., aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, tended to fall off easily. The aphids were green and yellow ~~in color~~. The colonies were small. The identification results showed that the aphids were *A. gossypii.* These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *Myzus ornatus* Laing, 1932. The aphid colonies were not associated with ants. Within the colonies, mummified aphids that Aphidiidae parasitized were found. On the *Hibiscus rosa-sinensis* L., aphids ranging from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa* (Blume) Kurz. First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, like sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii* almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants. Moreover, two forms of aphids were discovered in Ixora sp. flower plants. These aphids occupied the shoots, young leaves, and unopened flowers; the affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green. Sometimes, the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii.* These aphid colonies were almost always associated with ants. Another species of aphids formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce plant disease symptoms. The aphids were yellow or yellowish green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants. Two types of aphids were found on *Mussaenda frondose* L., each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The identification results showed that the aphids were *Toxoptera odinae* van der Goot, 1917. The aphids were yellow, green, and dark green (Blackman et al. 2011). The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots, and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow-green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*. Many aphid species infest various ornamental plants because these insects are attracted to such plants due to the rich nutrient content in the plant sap (Braham et al. 2023).

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* L. was infested by *A. gossypii*. These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* (Mart.) Griseb., or alligator grass, was also colonized by *A. gossypii. S*mall colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* (L.) R.Br. ex DC. was colonized by *A. gossypii*, forming colonies on shoots, flowers, and fruit. The colonies were typically large, and often associated with tiny brown ants. *Amaranthus gracilis* Desf. was infested by *A. craccivora.* These aphids established colonies on shoots, flowers, and young and old leaves. They were dark brown to black, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* (Burm.fil.) DC. was colonized by *Lipaphis erysimi* Kaltenbach, 1843. These aphids were bright green and of medium size. The colonies formed on flowers, flower

stalks, and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus* L'Hér., or fire grass, was infested by *A. gossypii;* the aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds, and flowers, often forming large colonies. *Cynodon dactylon* (L.) Pers. or Bermuda grass was colonized by *Schizaphis rotundiventris* Signoret, 1860. The aphids colonized the flowers, flower stalks, and sometimes the plant leaf axils. Small colonies were formed. The aphids were brown to reddish brown. They were associated with ants. *Cyperus rotundus* L., or nut grass, was infested by *S. rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* L., or grass puzzle, was colonized by *S. rotundiventris* aphids, forming colonies in the flowers, flower stalks, and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* (Retz.) Koeler was infested by *Hysteroneura setariae* Thomas 1878 aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinochloa crus-galli* (L.) P.Beauv., or water hyacinth plants, were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Eclipta prostrata* (L.) L., or urang-aring, was colonized by *A. gossypii*, forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants. *Eleusin indica* (L.) Gaertn. was colonized by two species of aphids: *Hysteroneura setariae* Thomas, 1878 and *Rhopalosiphum maidis* Fitch, 1856. *H. setariae* formed colonies in flower parts, flower stalks, and leaf axils, resulting in large colonies. *H. setariae's* body color ranged from red-brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *R. maidis* colonies were always associated with ants. The plant *Emilia sonchifolia* (L.) DC. ex Wight, characterized by its purple flowers, was colonized by *A.gossypii;* the aphids were yellow to green in color. The colonies formed near flowers, flower stalks, and shoot leaves. *Eragrostis tenella* was infested by *H. setariae* aphids. The aphids were brown to red-brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* L., or wart grass, was colonized by *A. gossypii.* The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *A. gossypii* colonies *on E. hirta* plants were consistently associated with ants. *Eupatorium odoratum* L. was colonized by *A. gossypii* and *A. citricola. A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves colonized by A. *gossypii* became stunted with an irregular shape. *A. gossypii* found in this plant showed yellow-green to dark-green body color. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of *A. gossypii* and *A. citricola* on *E. odoratum* plants were associated with either black or red ants. *Hymenachne acutigluma* (Steud.) Gilliland, or hair axis, was colonized by *H. setariae*, which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea sp*., or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile* Brongn. or bamboo grass plants, were colonized by two species of aphids: *H. setariae* and *R. maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *H. setariae* aphids were brown to red-brown. *R. maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *R. maidis* aphids were green to bright green, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on *L. gracile* to mix. In addition, *Melastoma affine* D.Don was colonized by *A. gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and newly emerging fruits and flowers. The body color of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania micrantha* Kunth was colonized by *A. gossypii* and *Aphis glycines* Matsumura, 1917. *A. gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *A. glycine* formed colonies on the branches. The colonies were densely populated. *A. glycines* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony. *Mimosa invisa* Mart. ex Colla *(*cater-grass) was colonized by *A. craccivora.* The aphids of *A. craccivora* on *M. invisa plants* formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* L. was observed to be colonized by *A. craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa pigra* L. was colonized by *A. craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms. *Oryza rufipogon* Griff. was colonized by two species of aphids: *Rhopalosiphum macr* and *R. maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *R. maidis* appeared green

with black siphunculi and cauda, while *Rhopalosiphum padi* Linnaeus, 1758 appeared white. The colonies of *R. maidis* and *R. padi* in *O. rufipogon* plants were associated with the presence of red ants. *Axonopus compressus* (Sw.) P.Beauv., or *pait* grass, was colonized by *H. setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes the leaf axils. The aphids were brown to dark brown. Small colonies were formed, and they were also consistently associated with ants. *Paspalum conjugatum* was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus neruri* L. was colonized by *A. citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda; the colonies formed were large. *Portulaca oleracea* L. plants were colonized by *A. craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots, and flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black. *Physalis angulata* plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *A. craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show disease symptoms. *Rorippa indica* (L.) Hiern, or mustard land, was colonized by *L. erysimi*. The colonies formed on the flowers, fruits, flower stalks, and the lower leaf's surface. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* L., or cacabean, was colonized by *A. gossypii*. The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks, and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arvensis* L. plants were colonized by *L. erysimi.* The aphids had green to whitish green body colors, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical damage symptoms, but some did not show any symptoms at all. Generally, the plants' symptoms due to aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition occurred because the colonized parts had reached maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. Furthermore, the old leaves or twigs might not show the typical symptoms associated with aphid infestations. The plant parts exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued growing, resulting in some parts developing ordinary while others became stunted (Pettersson et al. 2017). This condition could lead to bending shoots or young stems, curling leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the aphid colonies. According to this–study, ants were present in some aphid colonies from the subfamily Aphidinae, while the ants were absent in some aphid colonies from the macrosiphini subfamily. The bodies of aphids from the subfamily Aphidinae are relatively small and have short sifunculi. On the other hand, aphids, which have large bodies and relatively long sifunculi, are never visited by ants. This happens because long sifunculi are reported to disturb ants, so the ants don't like to come close. Additionally, large aphids and long sifunculi generally do not produce honeydew, so ants do not want to come close.

The absence of ants in aphid colonies could be because the colonies have just formed or the population is still low (Kummel et al. 2013). Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive plant parts. Flowers contain a nutrient-rich nature and easy access to sap; therefore, aphids were attracted to flower saps. In addition, some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as sap. Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *L. erysimi*, and *M. persicae*, the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022). Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive food sources (Nelson and Mooney 2022). The honeydew contained abundant sugars extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often farm aphids for it. In exchange for honeydew, ants protected aphids from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-Jamour et al. 2018). Certain ant species would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew

not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their progeny (Biedermann and Vega 2020). Ornamental plants, and also weeds are generally grown with simple maintenance and usually free pesticides. The ecological habitat of ornamental plants and weeds is assumed to be the same. Therefore, many species of aphids found on ornamental plants were also found on weeds.

In conclusion total of 15 species aphids found in ornamental plants, *A. craccivora, A. citricola, A. glycines, A. gossypii, A. solani, M. sanborni, M. rosae, M. persicae, N. circumflexus, P. caladii, R. nymphaeae, S. citricola, T. aurantii, T. citricidus, T. odinae.* The total of 11 species aphids found in weeds, *A. gossypii, A. craccivora, A. glycines, A. citricola, Greenidea* sp., *H. setariae, Hiperomyzus* sp., *L. erysimi, R. maidis, R. padi, S. rotundiventris.*

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Species of aphids found in ornamental and wild plants in Pagar Alam District, South Sumatra, Indonesia

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Abstract. *Irsan C, Anggraini E, Ramadhani W. 2023. Species of aphids found in ornamental and wild plants in Pagar Alam District, South Sumatra, Indonesia. Biodiversitas 24: 6602-6612.* Aphids are one of the crucial pests in tropical and sub-tropical regions. The presence of aphids in a plant can be very detrimental due to their role as vectors. Aphids exhibit species diversity, but not much information has been reported about the species diversity of aphids associated with essential crops such as ornamental plants. Furthermore, many aphid species, such as wild plants, were found on plants that were not hosts. Therefore, this study reported the species of aphids found in ornamental and wild plants. The field research employed purposive and direct observation to inventory cultivated or wild plants hosting and collecting aphids. The plant selection process included cultivated plants encompassing ornamental plants and wild plants or weeds. The collection and identification of host plants and aphids involved systematic searches for the selected plants and subsequent examination for the presence of aphids. Observations were made to all existing plant species to find those colonized by aphids. This study revealed that a total of 15 species of aphids were found in Ornamental plants, *Aphis craccivora* Koch, 1854, A*phis spiraecola* Patch, 1914, *Aphis glycines* Matsumura, 1917, *Aphis gossypii* Glover, 1877, *Aulacorthum solani* Kaltenbach, 1843, *Macrosiphoniella sanborni* Gillette, 1908, *Macrosiphum rosae* Linnaeus, 1758, *Myzus persicae* Sulzer, 1776, *Neomyzus circumflexus* Buckton, 1876, *Pentalonia caladii* van der Goot, 1917, *Rhopalosiphum nymphaeae* Linnaeus, 1761, *Sinemegoura citricola* van der Goot, 1917, *Toxoptera aurantii* Boyer de Fonscolombe, 1841, *Toxoptera citricidus* Kirkaldy, 1907, *Toxoptera odinae* van der Goot, 1917 and the total of 11 species aphids found in weeds, *A. gossypii, A. craccivora, A. glycines, A. citricola, Greenidea* sp., *Hystroneura setariae* Thomas, 1878, *Hiperomyzus* sp., *Lipaphis erysimi* Kaltenbach, 1843, *Rhopalosiphum maidis* Fitch, 1856, *Rhopalosiphum padi* Linnaeus, 1758, *Schizaphis rotundiventris* Signoret, 1860.

Keywords: Aphids, ornamental plants, wild plants

INTRODUCTION

Aphids are crucial pests in the tropics and sub-tropics, exhibiting various polyphagous, oligophagous, and monophagous characteristics (Kennedy and Stroyan 1959). One species of aphids can host more than 400 species from 40 families (Bass et al. 2014). In addition to pests, aphids can also be vectors of plant viral diseases (Gadhave et al. 2020); aphids can transmit 275 viruses (Ertunc 2020). In tropical areas, aphids can be found throughout the year due to their parthenogenetic nature of reproduction (Blackman and Eastop 2017). Aphids suck phloem sap of tender plant parts, which can deplete essential nutrients for healthy growth (Cao et al. 2018). Moreover, vector species can further weaken and stunt the growth of infected plants (Jones 2022). In addition, the honeydew that aphids secrete can lead to the growth of sooty mold, a black fungus that can prevent sunlight from reaching the plant's leaves, thereby impairing photosynthesis, the process by which plants produce food (Singh and Singh 2021). Therefore, it is crucial to control aphid populations in gardens and crops.

Many aphid species are found on plants that are not their actual hosts (Maharani et al. 2018). Aphids have one or more secondary or alternative host plants in addition to their primary host plants, which are the types of plants they feed on most frequently (Clarke et al. 2020). Alternative plants provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al. 2021). These secondary hosts may offer less adequate nutrition for insects (Mo and Smilanich 2023). However, they may provide a means of survival when primary hosts are unavailable, during certain seasons, or under certain environmental conditions (Kumar et al. 2021). According to Liu et al. (2017), hibiscus serves as an overwintering host for cotton-specialized aphids but not for cucurbit-specialized aphids; it is evident that host-specialized aphids have refuges during times of food shortage. The life cycles of numerous aphid species exhibit such complexity (Jousselin et al. 2010). They maintain a cycle of host alternation, shifting between their primary hosts (typically woody plants) and secondary hosts (often herbaceous plants) (Yamamoto et al. 2020). Weeds pose a continuous threat in both cropped and non-crop areas, providing food, shelter, and reproductive sites for various pest organisms

(Kumar et al. 2021). This indicates that weeds can serve as alternative hosts for aphids.

In South Sumatra, particularly in the highland areas like Pagar Alam, there are numerous ornamental and wild plants. Research on the inventory of aphid species in ornamental and wild plants has less noticed. This study reports the diversity of aphid species found in ornamental and wild plants found in this area. The findings from this study can serve as a valuable resource for aphid management.

MATERIALS AND METHODS

The field research employed a purposive and direct observation to inventory cultivated or wild plants hosting and collecting aphids. The plant selection included cultivated plants encompassing ornamental plants, as well as wild plants or weeds. Where available, collecting and identifying host plants, aphids, and natural enemies involved systematic searches of all existing plant species to find those colonized by aphids. Any plants colonized by aphids are documented as aphid hosts. Aphid identification was done using identification keys (Blackman and Eastop 2008) in the Laboratory of Entomology, Faculty of Agriculture, Universitas Sriwijaya. Identification relied on morphological characteristics. The host plants were identified using the weed identification handbook (Kallas 2010; Naidu 2012; Meuninck 2023). The location and aphid colony sizes, including their life color, and photographs of the aphid colonies and their host plants were recorded.

RESULTS AND DISCUSSION

Result

Aphids infesting in ornamental plants

The results showed that 15 aphid species were found in Pagar Alam (Tables 1 and 2). These aphids mostly colonized flowers of various ornamental plants (Table 1, Figure 1).

The relationship between aphids and ants was also recorded. Aphids produce a sweet, sticky substance called honeydew; ants are attracted to this honey because it serves as a food source. When aphids are present, they secrete honeydew, which attracts ants. This research recorded the presence of ants on plant parts colonized by aphids (Table 2).

Aphids infesting in wild plants (weed or non-weed plants)

In addition, this study documented aphid colonies on flowers, stalks, plant tops, young leaves, and old leaves of wild plants (Table 3, Figure 2).

The presence of ants in aphid colonization symbolizes a mutually beneficial relationship where the ants receive food from the aphids while protecting them. This study recorded the ant attendance in aphids colonization (Table 4).

Table 1. Aphid species recorded in ornamental plants and their colony locations

Host plant	Aphid species	Colony location
Aster alpinus	*Macrosiphoniella sanborni*	Leaves, young twig, flower
Brugmansia suaviolens	*Aulacorthum solani*	Leaves, flower
	Neomyzus circumflexus	Leaves
	Myzus persicae	Leaves, flower
Caladium sp.	*Pentalonia caladii*	Leaves,
Cananga odoratum	*Aphis gossypii*	Leaves, flower
Canna indica	*Rhopalosiphum nymphaeae*	Leaf
Catharanthus roseus	*Aphis spiraecola*	Shoot, young leaves, flower
Cestrum sp.	*Aphis gossypii*	Shoot, flower
	Neomyzus circumflexus	Young leaves
Clitoria ternatea	*Aphis craccivora*	Flower
Chrysanthemum sp.	*Macrosiphoniella sanborni*	Shoot, twig
Dahlia sp.	*Aphis gossypii*	Flower
Dendrobium sp.	*Sinemogoura citricola*	Flower
Duranta sp.	*Aphis gossypii*	Shoot, flower
Helianthus giganteus.	*Aphis glycines*	Flower
Hibiscus rosasinensis	*Aphis gossypii*	Flower
Ixora paludosa	*Aphis gossypii*,	Flower
	Toxoptera aurantii	Shoot, young leaves
Ixora sp.	*Aphis spiraecola*	Flower
	Aphis gossypii	Flower
	Toxoptera aurantii	Shoot, flower
Murraya paniculata	*Aphis craccivora*	Young Twig
	Toxoptera citricidus	Shoot, flower
Mussaenda frondosa	*Aphis spiraecola*	Shoot, flower
	Toxoptera odinae	Shoot, flower
Rosa indica	*Macrosiphum rosae*	Flower
Spondias dulcis	*Aphis spiraecola*	Flower

Table 2. Aphid species recorded in ornamental plants and the presence of the ants in the plant parts colonized

Aphid species	Ornamental plants	Aphids life color	Plant parts colonized	Ant attendance	Total individual of ant
Aphis craccivora	*Clitoria ternatea*	Black	Flowers	+	3
	Murraya paniculata	Black	Flowers	+	2
Aphis spiraecola	*Catharanthus roseus*	Greenish yellow	Flowers	+	2
	Ixora sp.	greenish yellow	Flowers	+	3
	Mussaenda frondosa	greenish yellow	Shoots, flowers	+	7
	Spondias dulcis	greenish yellow	Flowers	+	8
Aphis glycines	*Helianthus giganteus*	Greenish yellow	Flowers	+	3
Aphis gossypii	*Cestrum* sp.	Green	Shoots, flowers	+	4
	Cananga odoratum	Light green	Shoots, flowers	+	1
	Dahlia sp.	Green dark	Flowers	+	2
	Duranta sp.	Light green	Shoots, flowers	+	5
	Hibiscus rosasinensis	Dark green	Flowers	+	6
	Ixora paludosa	Light green	Flowers	+	2
	Ixora sp.	Light green	Flowers	+	7
Aulacorthum solani	*Brugmansia suaviolens*	Greenish yellow	Leaves, flowers	-	0
Macrosiphoniella sanborni	*Aster alpinus*	Brown black	Leaves, twigs, flowers	+	5
	Chrysanthemum sp.	Reddish brown	Leaves, twigs	+	5
Macrosiphum rosae	*Rosa indica*	Green	Flowers	-	0
Myzus persicae	*Brugmansia suaviolens*	Greenish yellow	Leaves, flowers	-	0
Neomyzus circumflexus	*Cestrum* sp.	Light green	Young leaves, flowers	-	0
	Brugmansia suaviolens	Light green	Flowers	-	0
Pentalonia caladii	*Caladium* sp.	Brown-black	Leaves	+	7
Rhopalosiphum nymphaeae	*Canna indica*	Green black	Leaves	+	1
Sinemegoura citricola	*Dendrobium* sp.	Brown	Flowers	-	0
Toxoptera aurantii	*Ixora paludosa*	Brown black	Flowers	+	5
	Ixora sp.	Brown black	Flowers	+	4
Toxoptera citricidus	*Murraya paniculata*	Black	Stems	+	6
Toxoptera odinae	*Mussaenda frondosa*	Reddish-brown	Flowers	+	4

Notes: (+) = present; (-) = absent

Discussion

In the present study, some aphid species were found on several ornamental plants in Pagar Alam, and the location of aphid colonization on the plants varied. On *Aster alpinus* L., aphids were found to form colonies on the stems or young leaf shoots, and the colonies were relatively large. The color of the aphids was dark brown to black. The colonized plant parts showed symptoms of stunting. The identification results showed that the aphids were *Macrosiphoniella sanborni* Gillette, 1908 associated with ants. On the *Brugmansia suaviolens* (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl, *Myzus persicae* Sulzer, 1776 were found on the undersides of old leaves or leaves that have turned yellow. The colonies were relatively small. The aphids found were green and large bodies. The colonized plant parts did not show any signs of disease. On *Caladium* sp. one species of aphids was found: *Pentalonia caladii* van der Goot, 1917. *Pentalonia caladii* was known and found in taro plants; the aphids formed colonies under the surface of young and older leaves (Bhadra and Agarwala 2014). This study found that the occupied leaf areas did not display severe symptoms; the aphids were yellow-green to dark green. The wingless adult aphids often had a white, flour-like appearance on their bodies. On the *Cananga odorata* (Lam.) Hook.f. & Thomson (*ylang-ylang*), colonies of *Toxoptera aurantii* Boyer de Fonscolombe, 1841 were found on the undersides of the leaves, the shoots, buds, and unopened flower petals. The *T. aurantii* colonies found were relatively large. Colonized parts, especially shoots, showed signs of stunting. The aphids found were brown to black. The colonies of *T. aurantii* were found to be associated with black ants. Aphids on *Canna indica* L. (Indian shot, African arrowroot) were found to form colonies in the leaf axils and under the leaf surface near the leaf base. The colonies were quite large. The aphids were dark brown to dark red coloring with a medium-sized body and the identification results showed that the aphids were *Rhopalosiphum nymphaeae* Linnaeus, 1761 (Ghosh and Singh 2004). The colonies of *R. nymphaeae* were found to be associated with ants. In the *Catharanthus roseus* (L.) G.Don (periwinkle), *Aphis spiraecola* Patch, 1914 aphids were found. The aphids were yellow-green, sifunculi, and black cauda. The aphids formed colonies on flowers and shoots, and the colonized plant parts showed no disease symptoms. On *Cestrum* sp. (Bastard jasmine), aphids formed colonies on the undersides of young leaves, shoots, and within flower parts, especially between petals or stalks that had not fully bloomed; the colonies were quite large. The body color of aphids was green to dark green, with small to medium-sized bodies. The colonized plant parts, especially leaves, showed stunting symptoms. The identification results showed that the aphids were *Aphis gossypii* Glover, 1877. The aphid colonies found were consistently associated with ants.

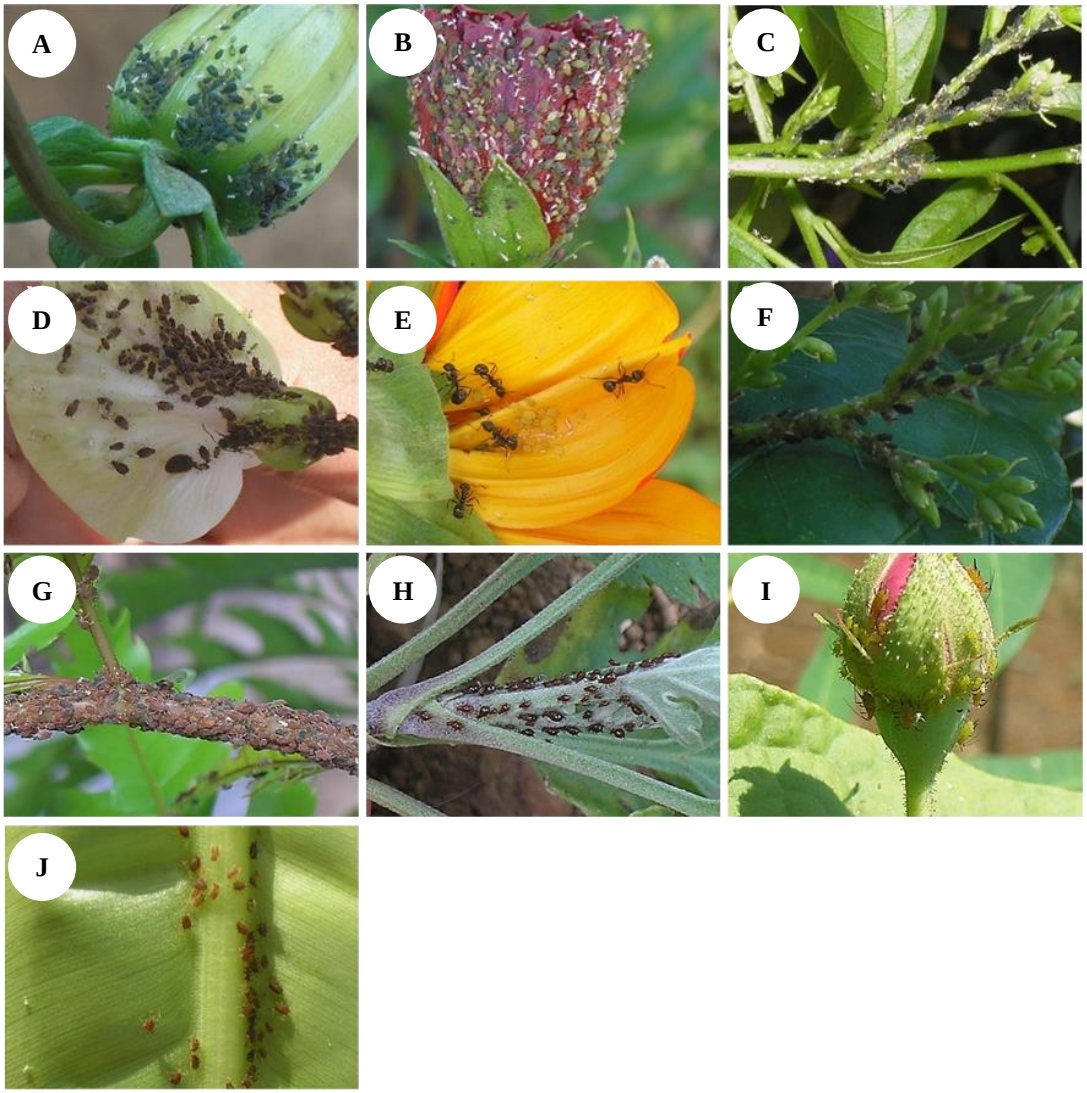

Figure 1. Photos showing colonies of different aphid species in ornamental plants: A. *Aphis gossypii* in *Dahlia* sp. flower; B. *Aphis gossypii* in *Hibiscus rosasinensis* flower; C. *Aphis gossypii* in *Cestrum* twig and flower; D. *Aphis craccivora* in *Clitoria ternatea* flower; E. *Aphis glycines* in *Helianthus giganteus* flower; F. *Aphis craccivora* on the *Murayya paniculata* flower; G. *Toxoptera odinae* in the *Mussaenda frondose;* H. *Macrosiphoniella sanborni*. in *Chrysanthemum* sp. Leaves; I. *Macrosiphum rosae* in *Rosa indica* flower; J. *Rhopalosiphum nymphaeae* in *Canna indica* leaves. Chandra Irsan captured all the photos

Aphids on *Clitoria ternatea* L. were found to form colonies on flower parts, flower crowns, stems, and young leaves. The aphids were brown to black. Colonized plant parts, especially shoots and young leaves, showed stunting symptoms. The identification results showed that the aphids were *Aphis craccivora* Koch, 1854. These colonies were consistently associated with ants. The aphids on the *Dahlia* sp. formed colonies on unopened flower buds, with a significant population among the blooming petals. The body color was green to dark green. The identification results showed that the aphids were *A. gossypii.* According to this present study, *Sinemegoura citricola* van der Goot, 1917 colonies were found on the young leaves of *Dendrobium* sp., with the color body of the *S. citricola* aphids were yellow, green to dark green, and the colonized plants showing no disease symptoms, and were associated with ants. On *Duranta* sp., colonies of aphids on the undersides of young leaves, and the colonized plant parts showed stunting symptoms. The colonies were very large. The aphids were green. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Furthermore, on the *Helianthus annuus* L., aphid colonies were found between the flower petals. The colonized flowers, especially the crowns, tended to fall off easily. The aphids were green and yellow. The colonies were small. The identification results showed that the aphids were *A. gossypii*. These aphid colonies were associated with ants. Aphid colonies on *Helianthus* sp. were found on the undersides of old leaves. These colonies were small in size. The aphids were green with a medium body size. The colonized plant parts did not show any disease symptoms. The identification results showed that the aphids were *Aphis glycines* Matsumura, 1917. The aphid colonies were not associated with ants. Within the colonies, mummified aphids that Aphidiidae parasitized were found.

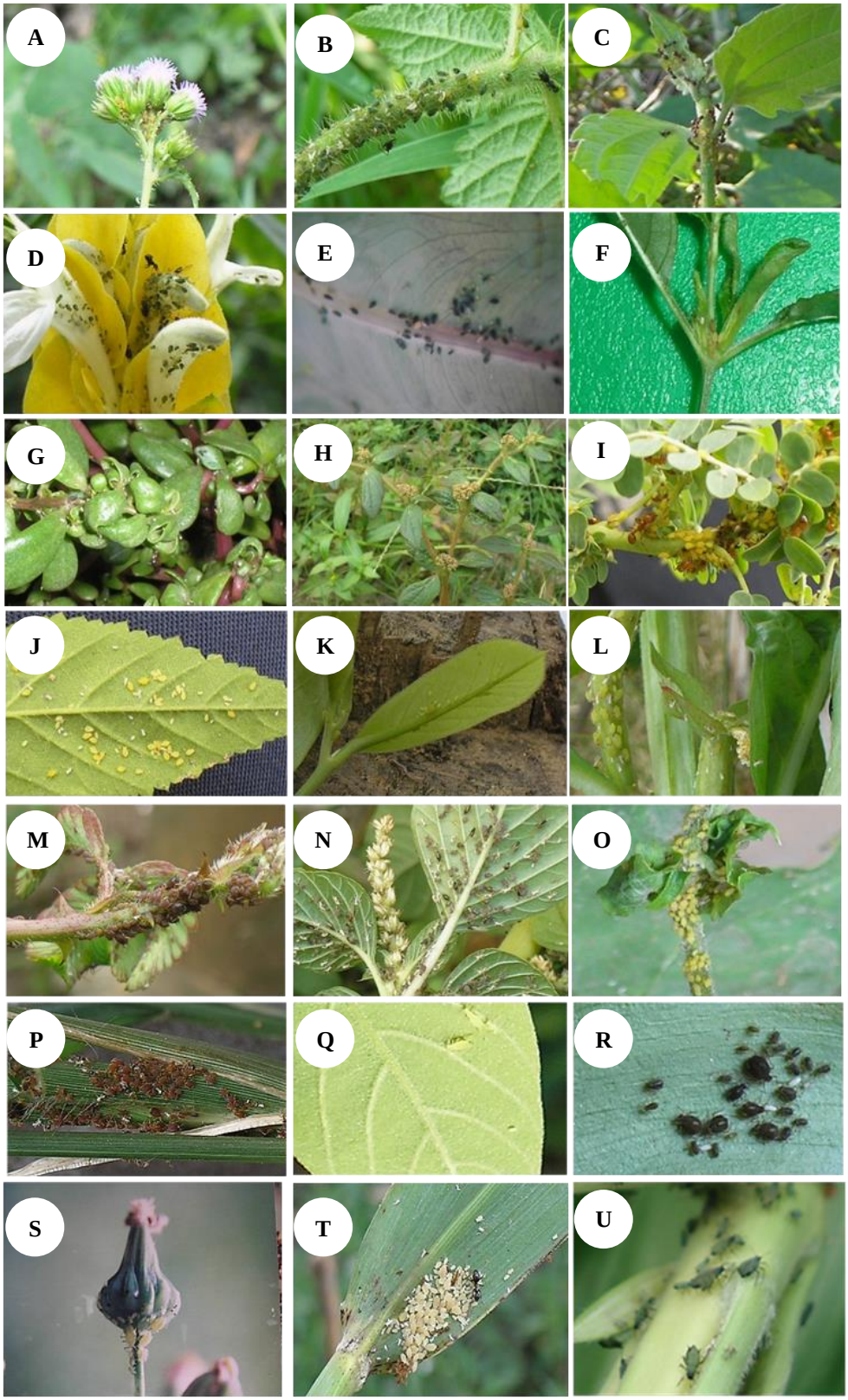

Figure 2. Aphids found infesting wild plants A. *Aphis gossypii* in *Ageratum conyzoides;* B. *Aphis gossypii* in *Croton hirtus*; C. *Aphis gossypii* in *Eupatorium odoratum*; D. *Aphis gossypii* in *Pachystochys* sp.; E. *Pentalonia caladii* in *Caladium* sp.; F. *Aphis gossypii* in *Alternanthera sessilis*; G. *Aphis gossypii* in *Portulaca oleraceae*; H. *Aphis gossypii* in *Euphorbia hirta*; I. *Aphis spiraecola* in *Phylantus nerruri*; J. *Aphis spiraecola* in *Sida rhombifolia*; K. *Aphis spiraecola* in *Bridelia tomentosa*; L. *Aphis spiraecola* in *Ludwigia peruviana*; M. *A. craccivora* in *Mimosa pudica*; N. *Aphis craccivora* in *Amaranthus viridis*; O. *Aphis glycine* in *Mikania micrantha*; P. *Hysteneura* sp. in *Eleusin* sp.; Q. *Greenidae* sp. in *Bridelia tomentosa*; R. *Hyperomyzus* sp. in *Echinocloa crusgali*; S. *Lipaphis erysimi* in *sonchus arventris*; T. *Rhopalosiphum padi* in *Oryza rufipogon*; U. *Rhopalosiphum maidis* in *Oryza rufipogon.* All the photos were captured by Chandra Irsan

Table 3. Species of aphids found in wild (weed or non-weed) plants and their colony locations

Host plant	Weeds or non-weed plants	Aphid species	Colony location
Ageratum conyzoides	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves, flowers
Alternanthera philoxeroides	Weed	*Aphis gossypii*	Shoots, buds
Alternanthera sessilis	Weed	*Aphis gossypii*	Shoots, buds
Amaranthus viridis	Weed	*Aphis craccivora*	Flowers, shoots, young leaves, old leaves
Blumea lacera	Weed	*Lipaphis erysimi*	Flowers, shoots, and buds
Bridelia tomentosa	Non-weed	*Greenidea* sp.	Young leaves
		Aphis spiraecola	Shoot, young leaves
Croton hirtus	Weed	*Aphis gossypii*	Flowers, shoots, young leaves, old leaves, young twigs
Cynodon dactylon	Weed	*Schizaphis rotundiventris*	Flower, flower stalks
Cyperus rotundus	Weed	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
Cyperus compressus	Weed	*Schizaphis rotundiventris*	Flower, flower stalks, leaf axils
Digitaria ciliaris	Weed	*Hystroneura setariae*	Flower, flower stalks
Echinocloa crussgali	Weed	*Hyperomyzus* sp.	Young leaves, old leaves
Ecliptica prostrata	Weed	*Aphis gossypii*	Shoots, young leaves
Eleusin indica	Weed	*Hysteroneura setariae*	Flower, flower stalks, leaf axils
		Rhopalosiphum maidis	Flower, flower stalks, leaf axils
Emilia sonchifolia	Weed	*Aphis gossypii*	Flower, flower stalks, shoots
Eragrostis tenella	Weed	*Hysteroneura setariae*	Flower, flower stalks, seeds
Euphorbia hirta	Weed	*Aphis gossypii*	Young leaves, old leaves
Eupotarium odoratum	Weed	*Aphis gossypii*	Young leaves, old leaves,
		Aphis glycines	Shoot, young twigs
Hymenochera acutigluma	Weed	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
Lophatherum gracile	Weed	*Hysteroneura setariae*	Young leaves, old leaves, leaf axils
		Rhopalosiphum maidis	Young leaves, old leaves, leaf axils
Melastoma affine	Non-weed	*Aphis gossypii*	Shoots, young leaves
Mikania micrantha	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves
		Aphis glycines	Shoot, young twig
Mimosa invisa	Weed	*Aphis craccivora*	Shoots, pods
Mimosa pudica	Weed	*Aphis craccivora*	Shoots, pods, flowers
Mimosa vigra	Non-weed	*Aphis craccivora*	Shoots, pods
Oryza rufipogon	Weed	*Rhopalosiphum padi*,	Old leaves, young leaves (shoot), leaf axils
	Weed	*Rhopalosiphum maidis*	Old leaves, young leaves (shoot), leaf axils
Oxonopus compressus	Weed	*Hysteroneura setariae*	Flowers, flower stalks, leaf axils
Paspalum conjugatum	Weed	*Hysteroneura setariae*	Flowers, flower stalks, seeds
Phylanthus neruri	Weed	*Aphis spiraecola*	Shoot, young leaves, old leaves, young twigs, petioles
Portulaca oleraceae	Weed	*Aphis craccivora*	Shoots, young leaves, flowers
Physalis angulata	Weed	*Aphis craccivora*	Shoots, young leaves, old leaves
	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves
Rorippa indica	Weed	*Lipapis erysimi*	Flowers, fruits, shoots, young leaves
Sida rhombifolia	Weed	*Aphis gossypii*	Shoots, young leaves, old leaves, fruit/seeds
Sonchus arventris	Weed	*Lipapis erysimi*	Young leaves, fruit stalks, flowers, fruits

On *Hibiscus rosa-sinensis* L., aphids ranging from yellow to dark green were found. The aphids formed colonies on flower buds, unopened flower crowns, and the undersides of aging leaves. The colonies grew to be very large. The identification results showed that the aphids were *A. gossypii*. The aphid colonies were consistently associated with ants. Two types of aphids were found on the flowering plant *Ixora paludosa* (Blume) Kurz. First, the aphids formed colonies on the undersides of young leaves that were still red or light green and sometimes on flower stalks that had not yet bloomed. The occupied plant parts showed symptoms such as stunted leaf growth, leaf shrinkage, necrotic spots on the leaf surface, and slightly downward-curved leaf edges. The upper leaf surface looked wet and sticky, like sugar. The aphids had yellow, green, or slightly dark green bodies, with some wingless adults having a powdery white upper surface. The identification results showed that the aphids were *A. gossypii* almost always associated with ants. The second type of aphids on *Ixora paludosa* formed colonies under the surface of young and older leaves. The colonies could also be found on newly emerging flowers and leaves. The plant parts occupied by these aphids did not show obvious signs of illness. These aphids were dark red to black, with once-branched stigma and venation in their black wings. The identification results showed that the aphids were *T. aurantii*. These aphids were also associated with ants. Moreover, two forms of aphids were discovered in Ixora sp. flower plants. These aphids occupied the shoots, young leaves, and unopened flowers; the affected plant parts did not show obvious symptoms. The aphids exhibited colors ranging from yellow and green to a slightly darker green.

Table 4. Aphid species were recorded in wild plants, and the presence of ants in the plant parts colonized

Aphid species	Wild plants	Aphids life color	Plant parts colonized	Ant attendance	Total individual of ant
Aphis gossypii	*Ageratum conyzoides*	Light green	Shoots, young leaves, old leaves, flowers	+	5
	Alternanthera philoxeroides	Light green	Shoots, buds	+	3
	Alternanthera sessilis	Light green	Shoots, buds	-	0
	Croton hirtus	Dark green	Flowers, shoots, young leaves, old leaves, young twigs	+	7
	Ecliptica prostrata	Green	Shoots, young leaves	+	5
	Emilia sonchifolia	Green	Flower, flower stalks, shoots	+	6
	Euphorbia hirta	Light green	Young leaves, old leaves	+	7
	Eupatorium odoratum	Light green	Young leaves, old leaves, young twigs	+	8
	Melastoma affine	Light green	Shoots, young leaves	+	8
	Mikania micrantha	Light green	Shoots, young leaves, old leaves	+	9
	Physalis angulata	Yellowish green	Shoots, young leaves, old leaves, fruit/seeds	+	10
	Sida rhombifolia	Yellowish green		-	0
Aphis craccivora	*Amaranthus viridis*	Black	Flowers, shoots, young leaves, old leaves	+	3
	Mimosa invisa	Black	Shoots, pods	+	2
	Mimosa pudica	Black	Shoots, pods, flowers	+	3
	Mimosa vigra	Black	Shoots, pods	+	4
	Portulaca oleraceae	Black	Shoots, young leaves, flowers	+	7
	Physalis angulata	Black	Shoots, young leaves, old leaves	+	4
Aphis glycines	*Eupatorium odoratum*	Greenish yellow	Young leaves, old leaves, young twigs	+	6
	Mikania micrantha	Light green	Shoots, young leaves, old leaves	+	4
Aphis spiraecola	*Phylanthus neruri*	Greenish yellow	Shoot, young leaves, young twigs, petioles	+	5
	Bridelia Tomentosa	Greenish yellow	Shoot, young leaves	+	2
Greenidea sp.	*Bridelia Tomentosa*	Greenish yellow	Young leaves	-	0
Hystroneura setariae	*Digitaria ciliaris*	Reddish-brown	Flower, flower stalks	+	3
	Eleusin indica	Reddish-brown	Flower, flower stalks, leaf axils	+	4
	Eragrostis tenella	Reddish-brown	Flower, flower stalks, seeds	+	4
	Hymenochera acutigluma	Reddish-brown	Flowers, flower stalks, leaf axils	+	3
	Lophatherum gracile	Reddish-brown	Young leaves, old leaves, leaf axils	+	6
	Oxonopus compressus	Reddish-brown	Flower, flower stalk, leaf axils	+	3
	Paspalum conjugatum	Reddish-brown	Flower, flower stalk, seeds	+	6
Hyperomyzus sp.	*Echinocloa crussgali*	Black	Young leaves, old leaves	-	0
Lipaphis erysimi	*Blumea lacera*	Whitish green	Flowers, shoots, and buds	+	4
	Rorippa indica	Whitish green	Flower, fruit, shoots, young leaves	+	4
	Sonchus arventris	Whitish green	Young leaves, fruit stalks, flowers, fruit	+	5
Rhopalosiphum maidis	*Eleusin indica*	Green	Flower, flower stalks, leaf axils	+	3
	Lophatherum gracile	Green	Young leaves, old leaves, leaf axils	+	4
	Oryza rufipogon	Green	Old leaves, young leaves (shoot), leaf axils	-	0
Rhopalosiphum padi	*Oryza rufipogon*	Whitish green	Old leaves, young leaves (shoot), leaf axils	+	4
Schizaphis rotundiventris	*Cynodon dactylon*	Green	Flowers, flower stalks	+	6
	Cyperus compressus	Green	Flowers, flower stalks, leaf axils	+	4
	Cyperus rotundus	Green	Flowers, flower stalks, leaf axils	+	4

Notes: (+): present, (-): absent

Sometimes, the upper surface of the wingless imago's body appeared white, resembling flour. The identification results showed that these aphids were *A. gossypii*. These aphid colonies were almost always associated with ants. Another species of aphids formed colonies on flower stalks that had not yet bloomed and on newly emerging shoots or leaves. The presence of these aphids on the plant did not induce plant disease symptoms. The aphids were yellow or yellowish green, with black cauda and siphunculi. Their bodies were very small to small. The identification results showed that the aphids were *A. citricola*. The colonies of *A. citricola* were also frequently found in association with ants. Two types of aphids were found on *Mussaenda frondose* L., each forming colonies in different locations. The first type formed colonies on young leaves, shoots, and flowers. The plant parts they occupied showed no obvious disease symptoms. The identification results showed that the aphids were *Toxoptera odinae* van der Goot, 1917. The aphids were yellow, green, and dark green (Blackman et al. 2011). The second type of aphids formed colonies on the stems or young twigs, appearing densely clustered as if piled up. The aphid colonies could also be found on young leaves, shoots, and within flower parts. The plant parts they infested showed no signs of diseases. The aphids were yellow or yellow-green, with black cauda and siphunculi. They had tiny to small bodies. The identification results showed that the aphids were *A. citricola*. Many aphid species infest various ornamental plants because these insects are attracted to such plants due to the rich nutrient content in the plant sap (Braham et al. 2023).

The results showed that 34 species of wild plants, including weeds, were growing in the yard colonized by aphids. This indicated that multiple species of aphids colonized various host plants. The aphid species colonizing these plants were generally consistent within the same taxon. *Ageratum conyzoides* L. was infested by *A. gossypii*. These aphids formed colonies on the flower sections, shoots, lower surfaces of young leaves, or leaves turning yellow. The aphids were green, yellow-green to dark green, often forming large colonies. *Alternanthera philoxeroides* (Mart.) Griseb., or alligator grass, was also colonized by *A. gossypii*. Small colonies were found on shoots or stems. These aphids had small bodies and were green, ranging from yellow-green to dark green. *Alternanthera sessilis* (L.) R.Br. ex DC. was colonized by *A. gossypii*, forming colonies on shoots, flowers, and fruit. The colonies were typically large and often associated with tiny brown ants. *Amaranthus viridis* Linnaeus was infested by *A. craccivora*. These aphids established colonies on shoots, flowers, and young and old leaves. They were dark brown to black, with shiny black wingless imagoes. Colonies of these aphids were associated with both black and red ants. *Blumea lacera* (Burm.fil.) DC. was colonized by *Lipaphis erysimi* Kaltenbach, 1843. These aphids were bright green and of medium size. The colonies formed on flowers, flower stalks, and the undersides of the leaves at the top. The aphid colonies were not associated with ants. *Croton hirtus* L'Hér., or fire grass, was infested by *A. gossypii;* the aphids were yellow-green to dark green. The colonies were found on the stems, leaves, buds, and flowers, often forming large colonies. *Cynodon dactylon* (L.) Pers. or Bermuda grass was colonized by *Schizaphis rotundiventris* Signoret, 1860. The aphids colonized the flowers, flower stalks, and sometimes the plant leaf axils. Small colonies were formed. The aphids were brown to reddish brown. They were associated with ants. *Cyperus rotundus* L., or nut grass, was infested by *S. rotundiventris* aphids. The colonies were found on flower stalks, flowers, and leaf axils. The colonies were quite large and associated with both black and red ants. The aphids were dark brown in color. *Cyperus compressus* L., or grass puzzle, was colonized by *S. rotundiventris* aphids, forming colonies in the flowers, flower stalks, and sometimes in the axils and leaves of the shoots or buds. Small colonies were observed. *Digitaria ciliaris* (Retz.) Koeler was infested by *Hysteroneura setariae* Thomas 1878 aphids, with small colonies scattered on the flowers and flower stalks. These aphids were light brown to brown in color. *Echinochloa crus-galli* (L.) P.Beauv., or water hyacinth plants, were colonized by *Hiperomyzus* sp. aphids. These aphids were dark brown to black and formed large colonies on the undersides of both young and old leaves. The aphid colonies were never found in association with ants. *Eclipta prostrata* (L.) L., or *urang-aring*, was colonized by *A. gossypii*, forming small colonies on the shoots and flowers. The aphids were bright green to blackish green. The aphid colonies were also consistently associated with ants. *Eleusin indica* (L.) Gaertn. was colonized by two species of aphids: *Hysteroneura setariae* Thomas, 1878 and *Rhopalosiphum maidis* Fitch, 1856. *Hysteroneura setariae* formed colonies in flower parts, flower stalks, and leaf axils, resulting in large colonies. *Hysteroneura setariae*'s body color ranged from red-brown to dark brown. The colonies were consistently associated with ants. The aphids of *R. maidis* formed colonies in the leaf axils and undersides of leaves and leaf shoots that had not yet opened. The colonies were not densely packed. The leaf aphids of *R. maidis* were green in color, with distinct black siphunculi and cauda. These aphids had relatively large bodies with a slightly elongated shape. *Rhopalosiphum maidis* colonies were always associated with ants. The plant *Emilia sonchifolia* (L.) DC. ex Wight, characterized by its purple flowers, was colonized by *A. gossypii;* the aphids were yellow to green in color. The colonies formed near flowers, flower stalks, and shoot leaves. *Eragrostis tenella* was infested by *H. setariae* aphids. The aphids were brown to red-brown. Small colonies formed on flowers near the seeds, with groups of aphids surrounding the plant's seeds. The aphids of *H. setariae* were consistently associated with ants. *Euphorbia hirta* L., or wart grass, was colonized by *A. gossypii*. The aphids formed colonies on the undersides of leaves, resulting in stunted growth of the leaves. The aphids were yellow to dark green in color. *Aphis gossypii* colonies on *E. hirta* plants were consistently associated with ants. *Eupatorium odoratum* L. was colonized by *A. gossypii* and *A. citricola*. *A. gossypii* formed colonies in the buds, young leaves, old leaves, and young twigs. Young leaves colonized by *A. gossypii* became stunted with an irregular shape. *Aphis gossypii* found in this plant showed yellow-green to dark-green

body color. The colonies of *A. citricola* formed on the young twigs near the shoots, with these aphids displaying yellow-green coloration and having black siphunculi and cauda. Aphid colonies of *A. gossypii* and *A. citricola* on *E. odoratum* plants were associated with either black or red ants. *Hymenachne acutigluma* (Steud.) Gilliland, or hair axis, was colonized by *H. setariae*, which formed colonies on the flower stalks and flowers. The colonized parts of the plants did not display any noticeable symptoms. *Lagerstromea* sp., or *kenidai*, was infested by *Greenidae* sp. These aphids had bright green bodies and distinctive elongated siphunculi with thorns. The aphids formed colonies on the undersides of leaves, especially on young leaves. The colonized leaves did not show any disease symptoms. *Lophatherum gracile* Brongn. or bamboo grass plants, were colonized by two species of aphids: *H. setariae* and *R. maidis.* The aphids of *H. setariae* formed colonies on the undersides of leaves, leaf shoots, and leaf axils. The colonized leaves did not show any disease symptoms. *Hystroneura setariae* aphids were brown to red-brown. *Rhopalosiphum maidis* aphids also formed colonies on the undersides of leaves, but the colonies were small. *Rhopalosiphum maidis* aphids were green to bright green, with black siphunculi and cauda. It was possible for colonies of the two species of aphids on *L. gracile* to mix. In addition, *Melastoma affine* D.Don was colonized by *A. gossypi.* The colonies formed on shoots, particularly near newly emerging shoots and newly emerging fruits and flowers. The body color of aphids ranged from yellow to green. The colonized plant parts did not show any disease symptoms. *Mikania micrantha* Kunth was colonized by *A. gossypii* and *Aphis glycines* Matsumura, 1917. *Aphis gossypii* formed colonies on the shoots, especially on the undersides of the leaves, resulting in stunted and curled leaves. *Aphis glycines* formed colonies on the branches. The colonies were densely populated. *Aphis glycines* aphids were light green to green in color. The colonized plant parts became distorted. The two species of aphids could mix to form a single colony. *Mimosa invisa* Mart. ex Colla *(*cater-grass) was colonized by *A. craccivora.* The aphids of *A. craccivora* on *M. invisa* plants formed colonies only on the shoots with small colonies. The aphids appeared dark black with wingless imagoes. *Mimosa pudica* L. was observed to be colonized by *A. craccivora.* The aphids formed colonies on shoots, especially young shoots, and occasionally on flowers and pods. The aphids were black and of medium size, resulting in stunted growth of the colonized plant parts. The colonies were quite large. *Mimosa pigra* L. was colonized by *A. craccivora.* The colonies of aphids occupied the pods and shoots with small colonies. The nymphs of aphids were black, and wingless adults were shiny black. The colonized plant parts did not show any disease symptoms. *Oryza rufipogon* Griff. was colonized by two species of aphids: *Rhopalosiphum padi* and *R. maidis.* Both aphids colonized the same plant parts, namely the unopened leaves and the leaf axils with large colonies. The two species could be distinguished by their body color. *Rhopalosiphum maidis* appeared green with black siphunculi and cauda, while *Rhopalosiphum padi* Linnaeus, 1758 appeared white. The colonies of *R. maidis* and *R. padi* in *O. rufipogon* plants were associated with the presence of red ants. *Axonopus compressus* (Sw.) P.Beauv., or *pait* grass, was colonized by *H. setariae* aphids. The colonies occupied flowers, flower stalks, seeds, and sometimes the leaf axils. The aphids were brown to dark brown. Small colonies were formed, and they were also consistently associated with ants. *Paspalum conjugatum* was colonized by *H. setariae* aphids. The colonies occupied flower parts, especially the seeds and flower stalks. Aphids had brown to dark brown bodies. *Phylanthus neruri* L. was colonized by *A. citricola.* The colonies formed on the shoots and the undersides of leaves and petioles. The colonized parts became distorted, stunted, and wrinkled. The aphids had yellow bodies with black sifunculi and cauda; the colonies formed were large. *Portulaca oleracea* L. plants were colonized by *A. craccivora.* The aphids of *A. craccivora* in *P. oleraceae plants* formed colonies on the undersides of leaves, especially young leaves, shoots, and flowers. The colonized plant parts became stunted, and leaf edges curled downward. The aphids had dark brown to black bodies, with wingless imagoes that appeared glossy black. *Physalis angulata* plants were colonized by *Aphis craccivora.* The aphids had dark green to black bodies, with glossy black wingless imagoes. *Aphis craccivora* formed colonies on the shoots or near the leaf buds. The colonized plant parts did not show disease symptoms. *Rorippa indica* (L.) Hiern, or mustard land, was colonized by *L. erysimi.* The colonies formed on the flowers, fruits, flower stalks, and the lower leaf's surface. The colonized plant parts showed symptoms such as curling and stunting. *Sida rhombifolia* L., or cacabean, was colonized by *A. gossypii.* The aphids had green-yellow to green body colors. The colonies formed on the surface of lower leaves, stalks, and flower petals. The colonized plant parts, especially the shoots, showed curling. and the leaf edges curled downward. *Sonchus arvensis* L. plants were colonized by *L. erysimi.* The aphids had green to whitish green body colors, and the colonies formed on flower stalks, under petals, and on young shoots or leaves. The colonized plant parts became stunted over time.

In general, aphids observed on ornamental and wild plants formed colonies. The colonized plant parts typically displayed typical damage symptoms, but some did not show any symptoms at all. Generally, the plants' symptoms due to aphid colonies were relatively the same, such as stunted growth, abnormal shape, and stunted or curly leaves. These characteristic symptoms serve as indicators of aphid infestations. However, some plants or plant parts did not show symptoms when colonized by aphids. This condition occurred because the colonized parts had reached maximum growth or development. It indicated that the colonized part was not currently undergoing a growth phase. The colonies that did not induce symptoms typically occurred when the colonized leaves had reached their maximum growth or when the leaves and plant parts were old. Furthermore, the old leaves or twigs might not show the typical symptoms associated with aphid infestations. The plant parts exhibiting characteristic symptoms when colonized by aphids also often experienced a cessation in

growth due to the piercing by the aphids. In contrast, the areas surrounding the puncture site continued growing, resulting in some parts developing ordinary while others became stunted (Pettersson et al. 2017). This condition could lead to bending shoots or young stems, curling leaves, downward curling of leaf edges, or stunted leaf growth. In this observation, monocot plants or groups of grasses with narrow leaves generally did not display any distinctive symptoms when colonized by aphids. This might be because the growth or development of their leaves differed from that of dicot plants. Therefore, the presence of aphids in monocot plants was often easier to recognize through the presence of ants. If a plant was found to have a significant number of ants, there was a possibility that aphids had colonized the plant (Tegelaar et al. 2012). Therefore, the presence of ants could serve as an indicator of the aphid colonies. According to this study, ants were present in some aphid colonies from the subfamily Aphidinae, while the ants were absent in some aphid colonies from the macrosiphini subfamily. The bodies of aphids from the subfamily Aphidinae are relatively small and have short sifunculi. On the other hand, aphids, which have large bodies and relatively long sifunculi, are never visited by ants. This happens because long sifunculi are reported to disturb ants, so the ants don't like to come close. Additionally, large aphids and long sifunculi generally do not produce honeydew, so ants do not want to come close.

The absence of ants in aphid colonies could be because the colonies have just formed or the population is still low (Kummel et al. 2013). Aphids colonized flowers because they may offer an accessible and rich food source, sugary plant sap found in new growth or reproductive plant parts. Flowers contain a nutrient-rich nature and easy access to sap; therefore, aphids were attracted to flower saps. In addition, some aphid species were drawn to certain colors (Jakubczyk et al. 2022). Herbs served as an alternative host for aphids in this present study. Aphids consume sugar-rich liquid in plants, known as sap. Aphids considered herbs and other green vegetation as abundant food sources. Aphids utilize needle-like mouthparts to penetrate plant tissues and access this fluid (Brożek et al. 2015). Several aphids colonized herbs such as Indian mustards, *L. erysimi*, and *M. persicae*, the most devastating insects, infesting leaves, stems, and floral parts (Jayaswal et al. 2022). Due to a symbiotic relationship, the prevalence of aphids and ants was frequently correlated. Aphids produced a delicious substance known as honeydew as a waste product, which ants found highly attractive food sources (Nelson and Mooney 2022). The honeydew contained abundant sugars extracted by aphids from the plant juice (Zheng et al. 2022). Ants were drawn to this nutrient-rich food source and would often farm aphids for it. In exchange for honeydew, ants protected aphids from other insects and predators, such as ladybugs, lacewing larvae, and parasitic wasps (Karami-Jamour et al. 2018). Certain ant species would transport aphids to new host plants for improved foraging opportunities, ensuring that aphids had a continuous food source (Giannetti et al. 2021). Honeydew not only nourished the ant colony, but its high sugar content also supported the development of their fungus farms (in certain species) and provided energy for the growth of their progeny (Biedermann and Vega 2020). Ornamental plants and also weeds are generally grown with simple maintenance and are usually pesticides-free. The ecological habitat of ornamental plants and weeds is assumed to be the same. Therefore, many species of aphids found on ornamental plants were also found on weeds.

In conclusion total of 15 species of aphids were found in ornamental plants, *A. craccivora, A. citricola, A. glycines, A. gossypii, A. solani, M. sanborni, M. rosae, M. persicae, N. circumflexus, P. caladii, R. nymphaeae, S. citricola, T. aurantii, T. citricidus, T. odinae.* A total of 11 species of aphids are found in weeds, *A. gossypii, A. craccivora, A. glycines, A. citricola, Greenidea* sp., *H. setariae, Hiperomyzus* sp., *L. erysimi, R. maidis, R. padi, S. rotundiventris.*

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