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Biology of *Aphis gossypii* Glover, on the *Solanum melongena* Aphid, and *Hibiscus rosa-sinensis* Aphid

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A B S T R A C T

Aphis gossypii Glover, a species prevalent in the Tarai regions of Bareilly, holds significant economic importance and has garnered attention from researchers across disciplines. The inherent polymorphism of this aphid species indicates its ability to manifest diverse forms or morphs within its population. Aphids are recognized for their capacity to adapt morphologically in response to environmental factors such as predation pressure or the characteristics of their host plants. In this study, conducted under semi-natural conditions on both Hibiscus Flowering Plants and egg vegetable plants, several aspects of the biology of *Aphis gossypii* were investigated experimentally. The findings revealed that the maximum average fecundity during the reproductive period on *Solanum melongena* was 144-120 hrs on *Hibiscus* plants, whereas the average reproductive period extended to 240-216 hrs on *Solanum melongena*. *Hibiscus*, belonging to the mallow family, Malvaceae, encompasses a diverse range of species resident to hot temperate (subtropical and tropical) regions, particularly prevalent in the Tarai region of Bareilly, Uttar Pradesh. Notably, *Hibiscus* species are characterized by their large, vibrant flowers and are commonly referred to as "*Hibiscus*," with alternative names including swamp mallow, hardy *hibiscus,* and *Hibiscus syriacus*.

Introduction

The black aphid, *Aphis gossypii* Glover (Homoptera: Aphididae), is a versatile. This aphid displays remarkable polyphagy, polymorphism, and continuous parthenogenetic reproduction, particularly in tropical regions worldwide. In these areas, it follows an anholocyclic life cycle. However, in cooler regions, it adopts either a heteroecious, autoecious, holocyclic. This species is widely recognized as economically important because this aphid not only damages the plant by sucking plant sap but also can transmit viruses and thus acts as a vector of many Plants' viral diseases. It may also form large occupants within a short period of seasonal plants under favorable conditions. In the United States, the economic repercussions of black aphids were ranked 6th-7th, in order of importance in 2002 - 2003, discretely. This aphid can adapt to every contingency of the environment of the host plants. Thus, *Aphis gossypii* Glover can be found in a locality throughout the year either in a particular ecological condition, or in different ecological conditions, and on the primary host or

secondary host plant species. This aphid can infest almost all kinds of habitats available on the terrestrial plain. Reveals that the maximum average fecundity on *Solanum melongena* was much higher (69.4) than on the Hibiscus plant which was only 13.4.

The average reproductive period was 180hrs – 120hrs on Hibiscus plants while the average reproductive period was 264 hrs -192 hrs on *Solanum melongena*. The average nymphal duration on the Hibiscus plant was 96 hrs to 144 hrs and in eggplant, it was between 196 hrs to 264 hrs (Kennedy, *et al.,* 1978; Zhang and Zong, 1990; Abdel-Moniem, *et al.,* 2006).

In India, the *Aphis gossypii* Glover species is predominantly observed to undergo a parthenogenetic life cycle, although instances of alatae males and apterous oviparous females have been documented. Behura (1979) researched the life cycle of this aphid species on *Solanum melongena*. Sambandam and Chelliah assessed the resistance of *Solanum* species against *Aphis gossypii* (Basu and Banerjee, 1958; Behura, *et al.,* 1979).

In temperate regions, the occurrence of sexual morphs of this aphid on *Catalpa bignonides* and *Hibiscus syriacus* during late autumn, along with the laying of overwintering eggs, is documented. Subsequently, the parthenogenetic morphs persist throughout the year, either on their primary hosts or migrating to unrelated secondary hosts, which can include shrubs, herbs, or even trees.

The widespread interest in the Hibiscus aphid, *Aphis gossypii* Glover, among researchers worldwide underscores its economic and scientific significance. This study aims to contribute to the understanding of the reproductive biology concerning two host plants, namely Hibiscus and eggplants, under semi-natural conditions.

Materials and Methods

The life history research was executed under semi-natural conditions using plastic poly bags and plastic mugs in the laboratory. *Solanum melongena* plants at the three-leaf stage were transplanted into each of the five plastic mugs, while Hibiscus seeds were sown and raised in poly bags. Uniform doses of fertilizer were applied to both the poly bags and mugs, and they were irrigated at regular intervals to prevent water stress. Each of the egg and *Hibiscus* plants was infested with one adult apterous viviparous female collected from the field on the same host species and left express for devise young one. The next morning all but a single freshly laid nymphs were disconnected from each plant and kept in 70% alcohol. Daily observations were recorded on nymphal duration, pre-reproductive, reproductive period, and fecundity per day. The study was conducted for five generations. The study During, average minimum and maximum temperature was between 18.40 -22.40 C and 28.30 – 33.10 C respectively, and the average minimum and maximum relative humidity was 60% - 69.5% and 60.32% – 82.5% respectively.

Results and Discussion

The study yielded results regarding the Curriculum vitae of *Aphis gossypii* Glover, under semi-natural conditions on Hibiscus and eggplants, encompassing provisos such as nymphal duration, propagative period, reproductive period, post-progenitive period, and total longevity. Total fecundity and fecundity per day were investigated (as shown in Tables 1 and 2). It was observed that apterous aphids reproduce nymphs parthenogenetically. Throughout their development, *A. gossypii* undergoes four nymphal instars before reaching adulthood.

Nymphal duration

Tables 1 and 2 illustrate that nymphal duration was shorter on Hibiscus plants, with an average maximum of 144 hrs and a minimum of 120-125 hrs days. In contrast, nymphal duration was relatively longer on *Solanum melongena*, with an average maximum of 168 hrs and a minimum of 144 hrs. Notably, the maximum duration of 140-144 hrs days recorded on Hibiscus plants was nearly equivalent to the minimum duration observed on *Solanum melongena* (Table 1 and 2).

Pre-reproductive period

On Hibiscus plants (Table 1), this period ranged from less than one day to a maximum of 24 hours, while on *Solanum melongena* (Table 2), it extended to two days. On average, *Aphis gossypii* Glover commenced laying its progeny slightly earlier on Hibiscus plants to *Solanum melongena*.

Reproductive period

This period sharply differed in the case of these two plants. On the *Hibiscus* plant, it was lower and the

highest average duration (190-192 hrs) was less than the lowest average duration (240-245 hrs) recorded on the *Solanum melongena*. While on the *Hibiscus* plant, this period was relatively highest in the first generation, in *Solanum melongena*, this period (240 hrs) was lowest in the first generation and highest in the 4th generation.

Post-reproductive period

The average duration of the post-reproductive period on the *Hibiscus* plant varied between 25-30 hrs, the same being recorded as the minimum duration in the first generation on *Solanum melongena*. The average post-reproductive period was recorded between 36-48 hrs, the lowest period was recorded in the first generation and the highest recorded in the 5th generation on *Solanum melongena*.

Adult longevity

The average duration of life of the adult paterae vivipara on the *Hibiscus* plant was 240 hrs in the first generation and slightly lower (220 and 230) in the second and third generations, but the minimum was 168-175 hrs in 5th generation. On eggplant, the minimum average duration of adult life was 265 hrs in the first generation. The same was gradually increased in succeeding generations (maximum in 5th generation), being 360 hrs.

Fecundity

A significant disparity was observed in total fertility between the two plant species. When *A. gossipii* was grown on Hibiscus plants the average total fecundity did not exceed 18 aphids, whereas on brinjal, the average total fecundity ranged from 24 to a maximum of 35 in the second, and third generations. Interestingly, in brinjal, the fertility increased gradually from the first to the third generation, while it was at its peak in the first generation, and in the generations of hibiscus plants, it became first low, then high, then low and then high, i.e. (The second generation became less and less after the fourth generation). Furthermore, the fecundity per hour in hibiscus plants ranged from 01 h to 240 h, whereas in brinjal, it was much higher, ranging from 1 to 5 generation.

In general, the data on life history studies bring out the fact that *A. gossypii* prefers Hibiscus plants for faster development but prefers eggplants for laying a higher number of nymphs. Higher total fecundity on eggplants suggests that eggplants perhaps provide better food quality and less plant resistance to aphids. This argument finds support from the fact that adult longevity and fecundity per day are substantially higher in eggplants.

Conversely, it may also be argued that the Hibiscus plant has a lower growth period and, therefore, faster development in aphids enables the species to utilize the host better, and this may be an advantage in having shorter nymphal duration on Hibiscus plants. Many workers have reported 95 to 120 hrs of nymphal duration on Hibiscus plants. Razmjou *et al.,* It's noted that the variation in nymphal duration may be attributed to the differing varieties of Hibiscus plants. Additionally, other studies have uncovered various resistance mechanisms, such as broad-mindedness, antixenosis, and antibiosis, which can also contribute to reducing aphid development. These mechanisms have been documented in several studies.

Behura *et al.,* (1979) conducted a study on the life history of *A. gossypii*, examining its behavior on *Solanum melongena*, *Psidium guajava*, *Hibiscus rosa-sinensis*, and Gossypium sp. in a laboratory setting using isolated leaves. They found that the aphid exhibited the highest fecundity (28)/ 1968 hours and longevity (19 days)/456 hours on *H. rosa-sinensis* while showing the least on *Psidium guajava*. On *Solanum melongena*, they recorded fecundity (27)/1728 hours and longevity (11 days) 264 hours, respectively. The significantly higher fecundity (35)/840 hours and adult longevity (15 days)/1224 observed on *S. melongena* in the current survey may be partly attributed to the fact that it was conducted in semi-natural conditions.

Nevsky (1929) noted much higher nymphal duration (2-4 days/ 48-92 hours during warm months and 3-4 days/ 36-92 hours for each instar during cooler months) in his studies in Central Asia. Although this difference seems significant when compared comparatively, it's not very large considering the variation in climatic conditions between Tropical India and Temperate Central Asia.

Table 1 shows the life history of the *Aphis gossypii*, on eggplant (*Solanum melongena*). The nymphal duration, which is the time it takes for an aphid to develop from an egg to an adult, is around 6 days for all five generations. There is some variation between generations, but the standard deviation is typically less than half a day.

Table.1 Life history of *Aphis gossypii* Glover on Eggplant (*Solanum melongena*)

Generation	Nymphal duration (In 192 Hrs)	Pre-reproductive period (In 48 Hrs)	Reproductive period (In 240 Hrs)	Post-reproductive period (In 36 Hrs)	Adult longevity (In 10-16 days)
1	6.3±0.07	1.23±0.0033	8.33±0.09	1.5±0.01	11.3±0.07
2	6.56±0.043	1.033±0.0033	8.52±0.0172	1.566±0.0033	12.1666±0.0033
3	6.5±0.13	1.1±0.01	10.4±0.07	2.5±0.07	14.3±0.19
4	6.266±0.0233	1.2±0.04	11.26±0.01333	2.5±0.01	14.3±0.13
5	6.433±0.0433	1.266±0.0433	10.4±0.04	3.133±0.0033	14.9±0.01
Total	6.41333333333333 ± 0.0583809523809524	1.16666666666667 ± 0.0223809523809528	9.784± 1.46041142857143	2.24± 0.422571428571429	13.4333333333333± 2.24238095238096

ANOVA						
Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Sample	29.52072533	4	7.380181333	167.1439	2.8E-28	2.557179
Columns	1580.963659	4	395.2409147	8951.283	1.06E-70	2.557179
Interaction	27.15730133	16	1.697331333	38.44059	1.59E-22	1.850315
Within	2.207733333	50	0.044154667			
Total	**1639.849419**	**74**				

Table.2 Life history of *Aphis gossypii* Glover on *Hibiscus rosa-sinensis*

Generation	Nymphal duration (In 192Hrs)	Pre-reproductive period (In 48 Hrs)	Reproductive period (In 240 Hrs)	Post-reproductive period (In 36 Hrs)	Adult longevity (In 7-11 days)
1	5.2±0.01	1.2333±0.0633	7.8±0.01	1.333±0.00333	10.1±0.0099
2	5.3±0.01	1.0667±0.0133	7.2667±0.0433	1.1667±0.0033	9.5±0.21
3	5.53±0.1433	1.1±0.030005	7.5333±0.0133	1.1667±0.0033	9.5667±0.0633
4	5.5±0.00993	0.7667±0.0633	6.6333±0.0433	1.5±0.01	8.333±0.1033
5	4.833± 0.0033	0.4333±0.0033	5.1667±0.0433	1.2±0.01	7.1666±0.0433
TOTAL	5.2733±0.09352	0.92±0.11314	6.88±0.96885	1.2733±0.02209	8.933±1.25380

ANOVA						
Source of Variation	***SS***	***Df***	***MS***	***F***	***P-value***	***F crit***
Sample	17.83813333	4	4.459533333	115.7318	1.24E-24	2.557179
Columns	735.3448	4	183.8362	4770.836	6.97E-64	2.557179
Interaction	14.5552	16	0.9097	23.60813	7.24E-18	1.850315
Within	1.926666667	50	0.038533333			
Total	**769.6648**	**74**				

Figure.1 Life history of *Aphis gossypii* Glover on Eggplant (*Solanum melongena)*

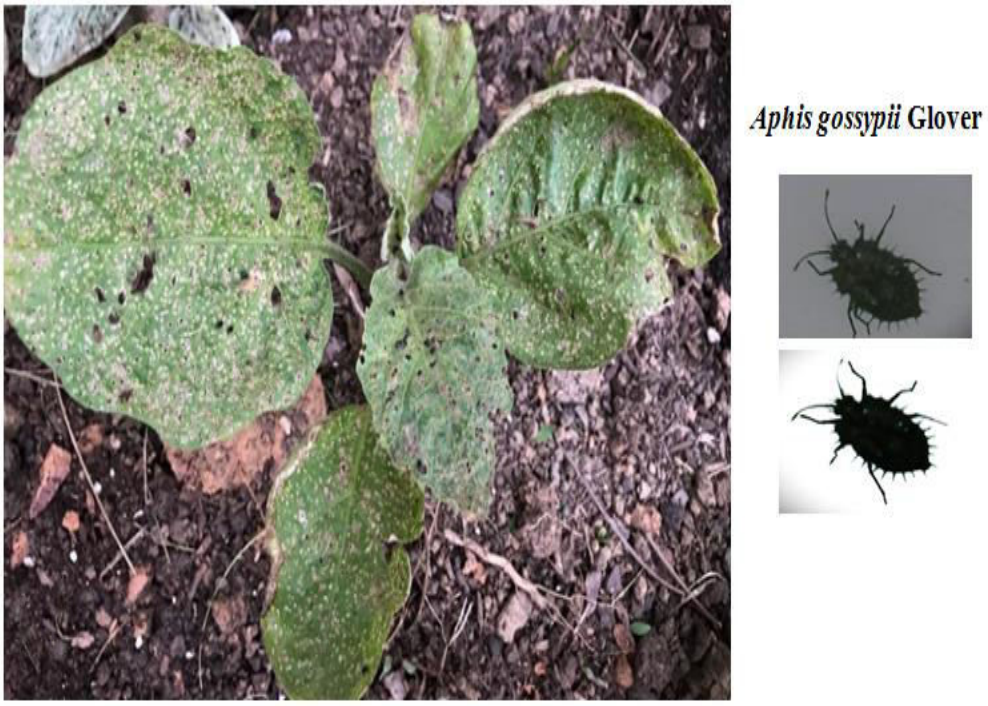

Figure.2 Life history of *Aphis gossypii* Glover on *Hibiscus rosa-sinensis*

The pre-reproductive period, which is the time between when an aphid molts into an adult and when it begins to reproduce, is around 1 day for all five generations. There is diminutive dissimilitude between generations. The reproductive period, which is the amount of time a female aphid spends reproducing, is around 8–11 days/192—264 hours.

There is more variation in this period than in the others, with a standard deviation of up to 1 day. The post-reproductive period, which is the amount of time a female aphid lives after she stops reproducing, is around 1-3 days/ 24-72 hours. There is a fair amount of variation in this period, with a standard deviation of up to 1 day. The adult longevity is around 264-336 hours.

Its idiosyncratic variability between the *Aphis gossypii* Glover Eggplant (*Solanum melongena*) generations is given in this table with an SD of less than one day (12-24 hrs). The table below shows some summary statistics as follows:

Nymphal period: This period has little variation among these genera but if we talk about the fifth generation, it is mentioned to be around 4.83 hours. Its time has been measured around 5.2 to 5.5 hours which is significantly less.
Pre-breeding period: Pre-breeding period among this generation will decrease in the population because the fifth generation has a shorter duration of 0.4333 hours.
Breeding period: The breeding cycle has decreased from generation to generation. First-generation, fifth-generation (7.8-5.1667) hours have been found.
Post-breeding period: Variation in data during this generation indicating up-down, in which no clear data has been found.

Adult longevity: First generation (242.4 hours) to fifth generation (7.1667 hours) This ANOVA table shows the differences between the 5 generations. Out of the five, statistically significant differences are seen between generations for all life history parameters excluding the nymphal period.

This shows that pre-reproductive prolongation, reproductive prolongation, post-reproductive prolongation, and adult longevity prolongation all differ outstandingly between at least a few initiations. Table 2 presents the life history parameters of *Aphis gossypii* on 5-generation *Hibiscus roseus sinenosis*. The parameters include larval period, pre-spawning period, post-spawning period, and adult longevity. The various parameters were examined using an ANOVA test to assess the relationship between two generations of different species.

The nymphal period is approximately 126.48 hours during which the differentiation of aphid's nymphs in the initiations has been attaining. In this rule, it is expected that consistent development is being shown in small differences.

The period before reproduction is 10.32 to 29.52 hours with significant differences between several generations. It is also known that many unknown factors in the starting point of reproduction may vary between generations and the average breeding period is 165.12 hours which shows the variation.

Apart from this, the potential of population growth is being fulfilled in many parameters. The post-reproductive period is 27.84 to 36 hours with some variation between generations and the average longevity is about 8.93 days. It shows many notable and clear differences.

Through this ANOVA result, if we exclude the nymph period, the parameters of its entire life history indicate highly significant differences between the generations. It also revealed that many environmental, ecosystem, biodiversity, and genetic factors are found to be involved in one another, due to which the life history of *Aphis gossypii* is seen to be moving towards another generation.

Many different interdependent factors such as the rapid development of *Aphis gossypii* in a given time and short nymph period indicate that its contribution to the population growth potential increases the reproductive period and reproductive capabilities.

Significant differences are visible between pre-reproductive generations and post-reproductive generations. The life history strategy of the *Aphis gossypii* may contribute to the successful adaptation of the changing conditions by various types of plasticity and their colonization. This study has also shown valuable insights into the life history of *Aphis gossypii* on *Hibiscus rosa-sinensis*, which indicates a very rapid development and reproductive expansion. The populations of insect kits and their adaptation to the same abandon during this period. The companionship and

predilection of insects are also shown which can indicate and contribute to the efforts of insects. Through, the survey of the given species it was concluded that the study of life history data of the eggplant plant *Aphis gossypii* shows that reproduction can last from one life to the next and its rapid growth/expansion is observed indicating a long reproductive period. This grants an opportunity for, the (IPM) importance of implementing integrated pest management strategies. Understanding the life cycle, and mapping the pest may be effective, in its productivity during the weak stage and controlling the pest during the weak stage. This enables the species to take advantage of the differences between the specific, species and weak species.

In conclusion, the life-history data of the life cycle and disease have proved that the development of (*Hibiscus roses sinenosis*) *Aphis gossypii* highlights many challenges in administration. Its measures and crop management of ornamental plants can effectively reduce the pest key negativity and improve their health. Also, entomologize feeding, life history, and gesticulation from one crop to another crop.

Author Contributions

Chanchal Shrivastav: Investigation, formal analysis, writing—original draft. Manoj Joshi: Validation, methodology, writing—reviewing. Monika Saxena:—Formal analysis, writing—review and editing. Gaurav Bhadauriya: Investigation, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

References

Abdel-Moniem, A. S. H., and T. E. Abd El-Wahab. "Insect pests and predators inhabiting roselle plants, Hibiscus sabdariffa L., a medicinal plant in Egypt." *Archives of phytopathology and plant protection* 39.1 (2006): 25-32.

Akey, D. H., and Butler Jr., G. D., 1989. Developmental rates and fecundity of apterous *Aphis gossypii* on seedlings of Gossypium hirsutum. Southwest. Entomol. 14: 295-229.

Aldryhim, Yousif N., and Amin F. Khalil. "The Aphididae of Saudi Arabia." *Fauna of Saudi Arabia* 15 (1996): 161-195.

Aldyhim, Y. N., and Khalil, A. F., 1993. Influence of temperature and day length on population development of Aphis gossypii on Cucurbita pepo. Entomologia Experimentaliset Applicata, 67(2):167-172.

Banziger, H., 1980. Aphids (Homoptera, Aphididae) collected in Thailand (1974- 1977). Mitteilungen der Schweizerischen Entomologischen Gesellschaft. Bullet in De la Societe Entomologique Suisse. 53, 143-150.

Basu, A. N., and Banerjee, S. N., 1958. Aphids of Economic Plants of West Bengal. Indian Agriculturist.2(2):89-112.

Basu, R. C., and Raychaudhuri, D. N., 1980. A study on the sexuales of aphids (Homoptera: Aphididae) in India. Records of the Z.S.I. Miscellaneous publication. Occasional papers No. 18.

Behura, B. K., Das, B. K., and Parida, P. N., 1979. On the life history of *Aphis gossypii* Glover (Homoptera: Aphidoidea). Symposium abstract, Bhubaneswar, Utkal University. P. 32.

Bohn, G. W., Kishaba, A. N., and Toba, H. H., 1972. Mechanisms of resistance to melon aphid in a muskmelon line. Hort. Science 7: 281–284.

Borner, C., 1954. Europe centralis Aphids. Die Blattlause Mitteleurope Mitt. Thuring. Bot. Ges. 4(3):1-259.

Dampc, Jan, *et al.,* "Changes in aphid—plant interactions under increased temperature." *Biology* 10.6 (2021): 480.

Dixon, A.F.G., and Welling, P.W., 1982. Seasonality and reproduction in aphids. International J. Invertebrate Reproduction. (5): 83-89.

Ebert, T. A., and Cartwright, B., 1997. Biology and ecology of *Aphis gossypii* Glover (Homoptera: Aphididae). Southwestern Entomologist. 22(1):116-153.

Ghosh, A. K., 1974. Aphids (Homoptera: Insecta) are of economic importance in India. Indian Agriculturist.18(2):81-214.

Hales, D. F., Tomiuk, J., Wohrmann, K., and Sunnucks, P., 1997. Evolutionary and genetic aspects of aphid biology: a review. Eur. J. Entomol. 94:1-55.

Jiang, Zhengxiong, *et al.,* "Effects of different host plants on the growth, development, and fecundity of Phthorimaea absoluta (Lepidoptera: Gelechiidae): an evaluation based on the age-stage two-sex life table." *Journal of Economic Entomology* 116.5 (2023): 1575-1584.

Kennedy, G. G., Mc Lean, D. L., and Kinsey, M. G., 1978. Probing behavior of *Aphis gossypii* on resistant and susceptible muskmelon. J. of Econ.Entomol. 71: 13–16.

Klingler, J., Powell, G., Thompson, G., and Isaacs, R., 1998. Phloem specific aphid resistance in Cucumis melo line AR 5: effects on feeding behavior and performance of *Aphis gossypii*. Entomologia Experimentalis et Applicata 86: 79–88.

Kocourek, F., Havelka, J., Berankova, J., and Jarosik, V., 1994. Effect of temperature on development rate and intrinsic rate of increase of Aphis gossypii reared on greenhouse cucumbers. Entomologia Experimentaliset Applicata, 71(1):59-64

Kring, J. B., 1959. The life cycle of melon aphid, *Aphis gossypii* Glover an example of facultative migration. Ann. Entomol. Soc. Amer. 52: 284-286.

Moritsu, M., 1954. Observations on the seasonal abundance of *Aphis gossypii* Glover on egg plants in Japan. Mushi. 27(9):59-68.

Nozato, K., 1987a. Population growth of the melon aphid, *Aphis gossypii* Glover (Homoptera: Aphididae) during the winter season in the warmer region of Japan and the effects of temperature on the reproduction of the aphid in the laboratory. Japanese Journal of Applied Entomology and Zoology, 31(2):162-167.

Robinson, A. G., 1972. Annotated list of Aphids (Homoptera: Aphididae) collected in Thailand with description of a new genus and species. Can. Ent. 104: 603-608.

Sambandam, C. N., and Chelliah, S., 1970. Evaluation of certain Solanum spp. for resistance of *Aphis gossypii* Glover. Ind. J. Ent. 32(3):270-271.

Setokuchi, O., 1981. Occurrence and fecundity of two color forms in *Aphis gossypii* Glover (Homoptera: Aphididae) on dasheen leaves. Applied Entomology and Zoology, 16(1):50-52.

Spira, Timothy. "Reproductive biology of Hibiscus moscheutos (Malvaceae)." *The evolutionary ecology of plants*. CRC Press, 2019. 247-255.

Steenis, M. Jvan., and El-Khawass K A M H., 1995. Life history of *Aphis gossypii* on cucumber: influence of temperature, host plant, and parasitism. Entomologia Experimentaliset Applicata. 76(2):121-131.

Takahashi, R. 1923. Aphididae of Formosa Part 2. Formosa Dept. Agric. Govt. Res. Inst. Rept. No.4:98-99.

Zhang, G. X., and Zhong, T. S., 1990. Experimental studies on some aphid life-cycle patterns and the hybridization of two sibling species. In: Campbel, R.K., and Eikenbary, R.D., eds. Aphid-Plant genotype interactions. New York, USA: Elsevier Press.

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