ISSN: 2456:6381
BIMS International Research Journal of Management and Commerce

HEADWAY AND USE OF PARASITOIDS FOR NATURAL APHIDS CONTROL IN CHINA

Ashish Mishra

Abstract - A brief history of Chinese biological control is presented alongside a review of aphid parasitoids in China, with a focus on their production, utilization, and conservation. In China, Aphidiidae were found in twenty genera with 99 species and Aphelinidae in two genera with 11 species. A brief description of the aphid, the host plant, research fields like taxonomy, biology, bionomics, geographic distribution, rearing, and citations to relevant literature are included for each parasitoid. For dominant aphid parasitoids like Aphidius gifuensis Ashmead, A. ervi Haliday, and Aphelinus mali Haldeman, achievements, status, issues in aphid parasitoid production, use, conservation, and future prospects are detailed. Finally, we look at the advantages and disadvantages of commercializing natural enemies in China, particularly aphid parasitoids.

Keywords: China, review, aphid parasitoids, family Aphidiidae, family Aphelinidae, biological control

1 INTRODUCTION

China has observed and utilized natural enemies for biological pest control for a long time. Over a long time back, Chinese ranchers utilized Oecophylla smaragdina Fabricius (Hymenoptera: Formicidae) to eradicate citrus blight (Chou, 1980). A few Chinese researchers conducted taxonomic and morphological studies of natural enemies in the early 20th century under the influence of an international upsurge in biological control, but only a small number of biological control techniques were utilized (Bao & Gu, 1998). These studies were carried out in response to the interests of the individual researchers, not in order to advance the science and technology of biological control.

From the 1950s to 1970s, Chinese pesticide organizations couldn't create an adequate number of pesticides for the blossoming farming utilization. As a result, numerous incentives were given to the creation and application of biological control strategies. The use of agents like Trichogramma sp. () was one of the famous cases. Hymenoptera: Anastatus sp. (Trichogrammatidae) Hymenoptera: Cryptolaemus montrouzieri Mulsant (Coleoptera: Eupelmidae), Coccinella septempunctata L., family Coccinellidae (Coleoptera: Coccinellidae) in China to eradicate a variety of agricultural pests (Li, 1984). According to Bao & Gu (1998), natural enemies and insect pathogens were used to biologically control 80 000 ha of forests and farmlands in 1972. However, by the 1980s, the country had begun using modern pesticides, the majority of which were organochlorine, organophosphates, and carbamates. Pesticides became the most common method of controlling pests in agriculture, the forest, and the sanitation industry because they could be applied quickly and easily.

In spite of the fact that pesticides have taken over as the primary method of insect control, biological control has made some progress in China. For instance, Trichogramma sp.'s application, alternative hosts, in vitro rearing, and mass release all underwent further development. This egg parasitoid was broadly used to control bug irritations, for example, Ostrinia furnacalis Hu¨bner (Lepidoptera: (Lepidoptera: Pyralidae), Heliothis armigera Hu bner Chilo infuscatella Snellen (Lepidoptera: Noctuidae), Pyralidae) and the species Dendrolimus Lepidoptera: Lasiocampidae), on 1 million acres of forest and 700,000 acres of crops (Gou 1986; Li 1986). From the mid 1990s to the mid 21st hundred years, the unfavorable impacts of compound pesticides on wellbeing, climate, biodiversity, and, surprisingly, the global exchange of horticultural items were steadily perceived by legislatures, makers and shoppers (Wei et al. 2003). At the same time, China's accession to the World Trade Organization increased the likelihood of multilateral trade in agricultural goods that must satisfy importing nations' pesticide residue requirements. In order to guarantee food safety, ecologically based IPM and alternatives like biological control and ecological management were emphasized and promoted by the public and government. In this manner, organic control gained considerably more consideration than previously (Bao and Gu 1998).

According to Stary (1970), the Aphidiidae and Aphelinidae families of hymenopteran parasitoids play a significant role in the biological control of aphids around the world. 1976 Yasnosh; Chen 1979; Liu 1989a). Stary (1970) examined the global Aphidiidae fauna in terms of integrated aphid control, including numerous international biological control efforts. Except for some information from Taiwan, there was no information on the biological control of aphids in China (Stary, 1970).

1.1 Aphid Parasitoids in China

Table I lists 20 genera and 99 species of Aphidiidae and 2 genera and 11 species of Aphelinidae. Most of these species are native parasitoids of aphids found in agriculture and forestry. The majority of aphids in the Aphidiidae family are biologically controlled by the species of Aphidius, Trioxys, Ephedrus, Praon, Pauesia, and Lysiphlebus, which together make up 80% of all known species. The majority of aphids in the family Aphelinidae are controlled biologically by Aphelinus species. They account for 91% of the parasitoids of aphids found in this family.

1.2 Aphid Parasitoid Production

Although many aphid parasitoids are capable of being produced in large quantities, only a small number of them have been thoroughly investigated in terms of their biology, bionomics, mass production, mass releases, utilization, and conservation. We report on these parasitoids as per the size of their creation, from little to huge.

2 PRODUCTION OF APHIDIIDAE

Among the 99 Aphidiidae species, only Aphidius gifuensis and A. ervi were mass-produced, while Diaeretiella rapae M'Intosh (Hymenoptera: In the laboratory, Aphidiidae) were raised. Restricted information are accessible on the field science of other significant parasitoids, for example, Aphidius avenae Haliday, Ephedrus plagiator Nees, Lysiphlebia japonica Ashmead, Trioxys indicus Subba and Sharma, and T. rietscheli Mackauer. Host aphids, host plants, field biological characteristics, parasitism, and natural limitations in the field are among these data (Tian et al.). 1981; Zhu and co. 1982; Xi & Zhu 1984; Zheng and co. 1985, 1987; Zong and co. 1986; 1989, Wang and Liu; Zhang and co. 1990; Li and co. 1991; Gao 1994; Luo, others 1994; Gu and co. 1995; Liu 1996; Liu & Li 1999).

In Yunnan Territory, A. gifuensis was considered for control of the aphid M. persicae on tobacco. Zhao and others 1980) created plant seedlings, aphids, and parasitoids in straightforward plastic nurseries. From March to August, the greenhouse in Yuxi Prefecture, Yunnan Province, had a temperature of about 27.68 degrees Celsius and a humidity of about 80 percent.

Aphids were introduced into tobacco seedlings in the greenhouses after being collected in the field from vegetables or rape (Brassica napus L.). After being warmed up and allowed to emerge as adults as mummified aphids, parasitoids were introduced into the greenhouse for the purpose of parasitizing the aphids. A large number of aphid mummies emerged after five to six days of development. They were then gathered in glass tubes and put away at 48C for future field discharges.

Wei and others Similar studies in Yunnan Province were reported in 2001 and 2003, but the techniques mentioned were more detailed, more applicable, simpler, and more systematic than the earlier studies. Using tobacco seedlings as the host plant and M. persicae as the host insect, the overall rearing procedure for A. gifuensis consisted of two parts: increasing the source of the aphid and parasitoid and mass rearing of the parasitoid (Wei et al.). 2001, 2003). They planned different mass raising nurseries as indicated by the size of creation and end clients. For instance, small businesses and academic institutions have produced natural enemies in large glass greenhouses measuring 5/10/2.5 m (Wei et al.). 2001). Glass-topped insectary greenhouses (1.7 to 5 meters) were used to produce a large quantity of seedlings, aphids, and parasitoids to meet the needs of businesses, researchers, or farmers with a high income (Wei et al.). 2003). Farmers could use the straightforward plastic greenhouses (1.7/3/3 m) (Wei et al. 2001). Black ventilated nets must be hung over the roof of every greenhouse, regardless of its size, to maintain a temperature of 22/288 degrees Celsius and a relative humidity of 50-70%. To achieve a prolonged photoperiod, three 60 Watt incandescent lights were hung from the ceiling of the greenhouses and two fluorescent lamps of 30 W each were attached to the sidewalls. D10 or L16: D8. The high proportions of parasitoids to aphids, which are 1:10 in glass-bested nurseries or in plastic nurseries and 1:100/200 in large nurseries, and short openness time to grown-up parasitoids would bring about coordinated egg affidavit and larval advancement of parasitoids. For a large plastic greenhouse, parasitoid production per generation is approximately 2.5 million mummified aphids, for a medium greenhouse, 125 000, and for a small plastic greenhouse, 45 000. These studies included in-depth data on aphids, parasitoids, greenhouse facilities, seedling care, and field collections (Wei et al.). 2001, 2003). In addition, cost analyses information was made available for the first time. As the size of the rearing operation increased, so did the cost of producing parasitoids. During the roughly 90-day rearing period, the small plastic greenhouse's daily cost per 1000 aphid mummies was US$ 0.10 (Wei et al.). 2001). In contrast to the large glass greenhouse, where the daily cost of producing parasitoids was $ 0.0021 per 1000 aphid mummies over a 90-day period and the medium greenhouse was $0.06, 2001, 2003).

3 USE OF APHID PARASITOIDS

3.1 Utilization of Aphidius Gifuensis

A lot of research has been done on the bionomics, life history, ecology, and behavior of A. gifuensis to figure out what made it successful at biologically controlling the green peach aphid (Table I). In tobacco fields, Myzus persicae has been controlled (Zhao et al.). 1980; Wu and co. 2000b; Wei and co. 2001) and on vegetables in the nursery (Xin 1986). Zhao and others 1980) suggested that for field releases, glass containers be used to collect and feed adult parasitoids. A total of 120 000 parasitoids were released in a 1.25-hectare tobacco field four times over the course of 55 days, at intervals of approximately 9 days. The subsequent field samplings revealed that within 60 days, the aphid population decreased from 34.3/plant to 0.1/plant and the parasitism rate increased from 0 to 95%. In control fields, the parasitism rate expanded from 0.1 to 38.8% and the aphid populace expanded on normal from 33.2/plant to 51.2/plant (greatest 440.5/plant) during a similar period. When pesticides were applied six times, biological control was even superior to chemical control (Zhao et al.). 1980).

Wei et al. () released A. gifuensis in large areas (2001, 2003) suggested methods for mass rearing and releasing that worked better. To release a large number of parasitoids into the field, they discovered that tobacco plants bearing mummified aphids were the most effective method. This method involves introducing small pots of tobacco seedlings (obtained from a glass-topped greenhouse) and hanging tobacco leaves (collected from large glass or simple plastic greenhouses) on plants in the field with mummified aphids. The best method for controlling M. persicae in tobacco fields was early and extensive release of A. gifuensis. In 1998, this method was used to release 109 800 parasitoids four times over a 50-day period in a 3.2 ha tobacco field; 196 000 parasitoids in 7.6 ha multiple times in a 55-day term in 1999 (Wu et al. 2000b); 780 000 parasitoids in 20 ha multiple times in a 2-month term in 2000 (Wei et al. 2001); 5 600 000 parasitoids in 200 ha in a 2-month time frame in 2001, and 50 000 000 parasitoids in 2000 ha in almost a 2.5-month duration in 2002 (Wei JN, Wang Y, unpublished information). Releases over the course of five years demonstrated that A. gifuensis established itself widely in treated fields and produced satisfying results. For instance, in 1999, the percent parasitism of aphids in fields getting arrivals of parasitoids were in right on time, mid, and late season 8.4/52.8, 64/82.3, and 93/93.5%, separately (Wu et al. 2000b).

3.2 Utilization of Aphidius Ervi

He and others 1983) came to the conclusion that multiple releases were superior to one-time releases and that releasing mummified aphids was superior to releasing adult parasitoids. It was preferable to release parasitoids earlier in the season, when aphid densities were highest, rather than later. In the primary field, the parasitism rate expanded from 0% to a normal 56% (47/66%) after 36 000 parasitoids were delivered multiple times at 10/15-day spans. After releasing 121 000 parasitoids once, the parasitism rate increased from 13.5 to 32% in the second field.

3.3 Conservation of Aphid Parsitoids

There is no question that aphid parasitoids assume a vital part in smothering aphid populaces in different networks and biological systems in horticulture and woods conditions (Stary 1970; Liu 1985, 1989a,b; Bao & Gu 1998). Numerous studies have examined the natural effects that aphid parasitoids have on Chinese wheat fields (Zhu et al. 1982; Zong and co. 1986; Zheng and co. 1987; Zhang and co. 1990; Li and co. 1991; Luo, others 1994; Shi 1980; Liu and Li 1999), cotton fields Tian et al. 1981; Xi & Zhu 1984; Zheng and co. 1985; Wang and Liu, 1989), tobacco fields 1980; Xin 1986), and soybean fields (Gao 1994). Most aphid parasitoids are native species that can possibly smother aphids in various conditions assuming their populaces are monitored (Liu 1985). In addition, in order to create a favorable habitat for natural enemies, pesticide applications must be limited through the use of appropriate timing, quantities, and intervals. Many natural enemies, including aphid parasitoids, are killed by insecticides applied to aphid host plants (Stary, 1970; Bao & Gu 1998). Bio-aphicides or selective aphicides are preferred to broad-spectrum insecticides when pesticide use is necessary. Wu and others 2000b) gave a technique for joining bug sprays and moderating A. gifuensis as indicated by the day to day musicality of this wasp. In cotton and wheat fields in Shaanxi Province, Lysiphlebus testaceipes was introduced and released in large numbers. However, the indigenous aphid parasitoids Lipolexis gracilis Forster, L. japonica, L. mirzai, T. communis, and A. gifuensis were the most frequently collected (Zheng & Tang, 1989). Recuperation of native parasitoids may have come about because of limiting pesticide use in natural control fields.

The provision of missing resources, such as alternative or supplementary foods and critical habitat required for reproduction or overwintering, can increase the number and activity of aphid parasitoids in agricultural systems (Pickett & Bugg, 1998; Landis and co. 2000). However, we must acknowledge that biological aphid control on cultivated crops alone does not completely resolve the issue. Control of aphids in the habitats around them is also important (Zhang et al. 2000). For the preservation and conservation of aphid parasitoids, additional physical and cultural methods are also essential. Management of undergrowth in orchards, shade trees, weeds, intercropping, mixed cropping, strip farming, and other practices are examples of these. Stary 1970; Bao & Gu 1998).

4 PERSPECTIVE OF APHID PARASITOID APPLICATION IN CHINA

China's aphids and parasitoids make up a significant portion of the Oriental and Palearctic fauna. Over 4,000 species of aphids are thought to exist worldwide (Liu, 1985), with 736 species found in China (Hua, 2000). Aphids' natural enemies should be included in research on them. To fully comprehend the biology and applications of aphid parasitoids, fundamental studies on the parasitoids are insufficient. For instance, despite the fact that there are approximately 80 species of Aphidiidae in Japan and nearly 400 worldwide (Liu, 1985), only slightly more than 40 species were recorded in China, and 99 natural enemies were recorded on the 54 species of aphids in this paper (Table I). We can safely assume that numerous new species and records of aphid parasitoids still need to be discovered in China. Albeit numerous aphid parasitoid species have been depicted, we have close to zero insight into their host plants and aphid has, particularly their science and nature. To support the implementation of biological control for aphids, research on the classification, bionomics, life history, and ecology of aphid parasitoids is required.

Although biological pest control has a long history in China (Chou, 1980), commercial use of natural enemies on a large scale has not yet begun. In China, the commercialization of natural enemies requires significantly more effort. Conversely, the commercialization of organic control has extended quickly during the beyond 30 years in Europe and the USA (Cranshaw et al. 1996; Van Lenteren et al. 1997). More than 80 species of natural enemies are produced in Europe by 26 companies (Van Lenteren et al.). 1997). North America has 143 organizations that sell more than 130 types of regular foes (Tracker 1997; Wan and co. 2000). China does not currently have any commercial natural enemies dealers or producers. Natural enemies' sales are bringing in money for European businesses. For instance, according to Van Lenteren et al., total sales of natural enemies in Europe totaled US$ 15 million in 1987 and US$ 60 million in 1991 (end user value). 1997). Furthermore, a lot more types of regular foes are economically accessible in Europe than in the USA, chiefly as a result of the a lot bigger nursery industry in Europe. Over the past few decades, China's greenhouse industry has experienced rapid expansion (Wei et al. 2001). In this manner, a likely interest for normal foes could invigorate their commercialization. Investing in this area and setting up biological control businesses and insectaria in China should receive more attention. Because they can be easily and cheaply raised in large numbers and released, aphid parasitoids have a great deal of potential for commercialization in China. According to Wei et al., raising A. gifuensis is less expensive in China. 2001, 2003) than raising A. ervi, Aphidius colemani, and Aphelinus abdominalis in Europe (Van Lenteren et al. 1997).

Although alternative hosts and even artificial media have been successfully utilized in the mass culture of host insects, parasitoids, and predators (Fleschner, 1959), there are only a few known instances of successful breeding of hymenopterous parasitoids using artificial diets (Stary, 1970; 1986 by Thompson). In addition to a thorough understanding of the parasitoid host interactions and their physiology and metabolism, as well as the influence of numerous innate physical and environmental factors on parasitoid growth, development, and survival, successful in vitro parasitoid development will be necessary (Thompson, 1986). Therefore, mass production of aphid parasitoids on artificial diets is unlikely in China in the near future, but this should not prevent their commercialization. Without the in vitro culture technology, Western nations have already produced and sold natural enemies. However, we believe that research on artificial diets is necessary. Due to a lack of knowledge about parasitoid nutrition and physiology, these diets are rarely used.

REFERENCES

1. Bao JZ, Gu DX. 1998. Biological control in China. Shanxi Science and Technology Publishing House. pp 1/664 [in Chinese].
2. Bi ZB, Ji ZD. 1993. Bionomics of Aphidius gifuensis Ashmead. I. Development stages and morphology of larval stage. Journal of Hebei Agricultural University 16:1/8 [in Chinese].
3. Bi ZB, Ji ZD. 1994. Bionomics of Aphidius gifuensis Ashmead adult and overwinter. Journal of Hebei Agricultural University 17(2):38/44 [in Chinese].
4. Chen JH. 1979. The fundamental knowledge of studies of Aphidiidae. Entomological Knowledge 16:265/ 268 [in Chinese].
5. Chen JH. 1980. Description of a new species of the genus Lipolexis Fo¨ rster (Hymenoptera: Aphidiidae). Entomotaxonomia 2:169/172 [in Chinese].
6. Chen YJ, Hou TY. 1997. The study on biological characteristics of Aphelinus rhopalosiphiphagus. Entomological Knowledge 34:232/235 [in Chinese].
7. Chen YJ, Li GY. 1998. The population dynamic of Aphelinus rhopalosiphiphagus in winter. Entomological Knowledge 35:154/157 [in Chinese].
8. Chen YJ, Wang LZ. 1995. The preliminary study on Aphelinus rhopalosiphiphagus population. Natural Enemies of Insects 17:172/174 [in Chinese].
9. Chen JH, Shi QX, Yang JQ. 1999. A new species of Praon Haliday from China (Hymenoptera: Aphidiidae). Journal of Fujian Agricultural University 28:167/170 [in Chinese].
10. Chou I. 1980. A history of Chinese entomology. Entomotaxonomia. pp 1/213 [in Chinese with English summary]
11. Chou I, Xiang LC. 1981. A new genera and a new species of Aphidiidae (Hymenoptera) from China. Entomotaxonomia 3:171/173 [in Chinese].
12. Chou I, Xiang LC. 1982. Seven new species of Aphidiidae (Hymenoptera) from Shannxi province, China. Entomotaxonomia 4:39/47 [in Chinese].
13. Cranshaw W, Sclar DC, Cooper D. 1996. A review of 1994 pricing and marketing by suppliers of organisms for biological control of arthropods in the United States. Biological Control 6:291/296.
14. Dong DZ, Wang YZ. 1985. A preliminary report of aphid parasitoids on the crops of Yunnan, China. Natural Enemies of Insects 7:172/180 [in Chinese].
15. Dong DZ, Wang YZ. 1996. Four new species of Aphidiidae from Yunnan, China (Hymenoptera). Acta Entomologica Sinica 39:196/202 [in Chinese].

16. Fleschner CA. 1959. Biological control of insect pests. Science 129:537/544.
17. Gao JF. 1994. Biological characteristics and control effect of Lysiphlebia japonica on Aphis glycines. Chinese Journal of Biological Control 10:91/92 [in Chinese].
18. Gou XQ. 1986. Research and application of Trichogramma in China. Natural Enemies of Insects 8:113/120 [in Chinese].
19. Gu XS, Zhao QH, Bai YC. 1995. The natural distribution centers and the eco-geography characteristics of the aphid prasitoids in Shanxi province. Acta Agriculturae Boreali Sinica 10:95/98 [in Chinese].
20. Gu XS, Zhao QH, Bai YC. 1997. A new species of the genus Trioxys Haliday from Shanxi (Hymenoptera: Aphidiidae). Acta Entomologica Sinica 40:207/209 [in Chinese].
21. HeW, Li XF, Zhao QH, Huang XY, Hou MX. 1983. Studies on the mass rearing and utilization of Aphidius ervi Haliday, a natural enemy of Acyrthosiphon pisum Harris. Acta Phytophylacica Sinica 10:167/170 [in Chinese].
22. Hua LZ. 2000. List of Chinese insects: Homoptera: Adelgoidea and Aphidoidea. Guangzhou: Zhongshan University Press. pp 110/131.
23. Huang J. 1994. Systematic studies on Aphelinidae of China (Hymenoptera: Chalcidoidea). Chongqing: Chongqing Publishing House. pp 1/348 [in Chinese].
24. Hunter CD. 1997. Suppliers of beneficial organisms in North America. Sacramento, CA: California Environmental Protection Agency Press.
25. Ji ZD, Zhang WY. 1992. A study on Parapraon Stary´, 1983 and descriptions of two new species (Hymenoptera: Aphidiidae). Acta Entomologica Sinica 35:99/104 [in Chinese].
26. Jiang N. 1986. Identification and method of survey of Encasia feavoscutellum of sugarcane woolly aphids. Natural Enemies of Insects 8:246/247 [in Chinese].
27. Kuang RP, Shan F, Tang YZ. 1989. Evaluation of natural enemies of woolly apple aphids, Eriosoma lanigerum Hausm. Natural Enemies of Insects 11:51/56, 60 [in Chinese].
28. Landis DA, Wratten SD, Gurr GM. 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. Annual Review of Entomology 45:175/201.
29. Li CD, Zhao SL. 1998. A new species of Aphelinus (Hymenoptera: Aphelinidae). Entomotaxonomia 20:150/151 [in Chinese].
30. Li LY. 1984. New progress on utilization of Trichogramma spp. Entomological Knowledge 21:237/241 [in Chinese].
31. Li LY. 1986. Mass production of natural enemies (parasitoids and predators) of insect pests. Natural Enemies of Insects 8:52/62.
32. Li WJ, Zhang BS, Yu MS, Qi ZB. 1991. A survey on Aphidius parasitoids on barley in Linqing, Shandong province. Chinese Journal of Biological Control 7:139 [in Chinese].
33. Liao DX, Li XL, Pang XF, Chen TL. 1987. Economic insect fauna of China, Fasc. 34 Hymenoptera, Chalcidoidea (I), Science Press. p 241 [in Chinese].
34. Liu AZ, Li SG. 1999. Preliminary studies on parasitizing action of Aphidius avenae and A. gifuensis on Macrosiphum avenae . Natural Enemies of Insects 21:61/64 [in Chinese].
35. Liu LJ. 1996. The preliminary report of Aphidiidae (Hymenoptera) species in Liaoning Province. Liaoning Agricutural Science 2:42/44 [in Chinese].
36. Liu SS. 1985. Biological control of aphids. Chinese Journal of Biological Control 1(3):37/40.
37. Liu SS. 1989a. A reviews of studies of the Aphidiids biology and ecological characteristics. Chinese Journal of Biological Control 5:129/133 [in Chinese].
38. Liu SS. 1989b. A reviews of studies on Aphidiids: impact on aphid populations. Chinese Journal of Biological Control 5:173/177 [in Chinese].
39. Liu SS. 1989c. The effect of temperature and host instars on the development rates of Diaeretiella rapae. Natural Enemies of Insects 11:169/173 [in Chinese].
40. Liu SS. 1990. The relationship between the age at parasitization and parasitoid impact in Myzus persicae. Acta Entomologica Sinica 33:430/435.
41. Lu H, Shi BC. 1994. Development thresholds and thermal constants of Aphidius gifuensis and Diaeretiella rapae. Acta Agriculturae Boreali-Sinica 9:72/75 [in Chinese].
42. Lu H, Shi BC, Zhang ZL. 1993. Studies on fecundity of Aphidius gifuensis Ashmead. Acta Agriculturae Boreali-Sinicae 8:76/79 [in Chinese].
43. Lu N, Ji ZD. 1992. A new record of Aphidiidae (Hymenoptera) from China. Journal of Hebei Agricultural University 15:109 [in Chinese].
44. Lu N, Ji ZD. 1993. A new species and a new record of Aphidiidae (Hymenoptera) from China. Journal of Hebei Agricultural University 16:63/65 [in Chinese].
45. Luo RW, Yang CL, Shang YF, Li CS, Zhao JH. 1994. Studies on the population dynamics and aphid control capability of Aphidius avenae . Acta Phytophylacica Sinica 21:163/168 [in Chinese].
46. Lung CT, Wang YP, Tang PG. 1955. The preliminary study on Aphelinus mali Hald., the parasitoid of the woolly apple aphids, Eriosoma lanigerum Hausm. Entomological Knowledge 1:75/77 [in Chinese].
47. Lung CT, Wang YP, Tang PG. 1960. Investigations on the biology and utilization of Aphelinus mali Hald., the specific parasitoid of the woolly apple aphids, Eriosoma lanigerum Hausm. Acta Entomologica Sinica 10:1/39 [in Chinese].
48. Pan MX. 1992. A new species of Aphelinus Dalman from Zhejiang province, China (Hymenoptera: Aphelinidae). Acta Zootaxonomica Sinica 17:75/77 [in Chinese].
49. Pickett CH, Bugg RL, editors. 1998. Enhancing biological control: habitat management to promote natural enemies of agricultural pest. Berkeley: University of California Press. p 422.