

Review Article**Problems in the Research of *Meliboeus ohbayashii primoriensis* (Coleoptera: Biprestidae)**

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Abstract: At present, a series of researches on *Meliboeus ohbayashii primoriensis* mainly focus on the basic research of bioecology and multi-control methods, whereas, some problems still exist in the researches. In order to provide a better theoretical basis and scientific basis for comprehensive control for *M. ohbayashii primoriensis*. Based on referring to research literature of *M. ohbayashii primoriensis*, including the research status, existing problems and control technology. It has been clear about the host plants, scientific name correction and control method for *M. ohbayashii primoriensis*. It can provide guidance on the strong theoretical basis, and scientific foundation for the integrated control of walnut insect pest.**Keywords:** *Meliboeus ohbayashii primoriensis*, Research Status, Existing Problems, Control Strategies

1. Introduction

Juglans regia (L., 1753) (Juglandales: Juglandaceae), a deciduous tree, is cultivated as one of the most important economic tree species in the world. Walnut together with *Amygdalus communis*, *Anacardium occidentale* and *Corylus heterophylla*, It is known as the famous “four nuts” in the world. Walnut is widely distributed in China, north to Heilongjiang Province, south to Yunnan Province and Guizhou Province, west to Xinjiang Uygur Autonomous Region, east to Shandong Province, Liaoning Province. Not only walnut has a certain economic value, but also it has a high nutritional value and medicinal value.

Planting areas of walnuts are gradually growing year by year in China. Walnut trees have harmed by diseases and pests in Shanxi, Shaanxi, and Yunnan Provinces and other places. It will cause the death of walnut plantation in the local area, which has seriously affected the ecological construction and economic development of walnut planting area. The borer insects, such as *Meliboeus ohbayashii primoriensis* Alexeev, *Batocera horsfieldi* Hope and *Atrijuglans hetaohei* Yang, have a significant impact on the growth and development, the yield and quality of walnut trees.

In the 1920s and 1930s, *Rhagoletis completa* Cresson as walnut pest, which was belonging to the genus *Trypeta* (Diptera: Trypetidae) in North America [1]. With the development of walnut planting, the fruits, leaves, branch and roots were harmed by pests. *Carpocapsa pomonella* L. was occurred in the southwest of the United States, and damaged to the walnut fruits, resulting extensive reduction of walnut plantations in local area [2-4]. In addition, the walnut leaves were harmed by *Chromaphis juglandicola* Kaltenbach and *Lecanium pruisosum* Coquillett [5-6]. In recent years, borer insects have become increasingly serious, such as *Pityophthorus juglandis* Blackman, which has caused extensive damage to the walnut branch cadres in North America, Europe and other places [7-8]. *Zeuzera pyrina* L. and *Xyleborinus saxeseni* Ratzeburg also caused serious damage to the walnut branch cadres in Iran and Turkey [9-10]. It can be seen that the pests of walnut are not only various but also serious, which directly affects the quality and yield of walnut, and brings huge economic losses. However, there have been no reports about the damage of *M. ohbayashii primoriensis* in abroad. The reason may be due to the difference of climatic conditions in different regions, which affects the suitable distribution area of *M. ohbayashii primoriensis*. Moreover, walnut cultivars are also very different among different regions and countries, and different

varieties have different anti-insect characteristics for the same pest.

In the 1950s, *A. hetaohei* was reported that caused damage to the walnut trees in north China [11], seriously affecting the production of walnuts. In the 1970s and 1980s, a number of reports on walnut pests gradually increased. In addition to *A. hetaohei*, the main walnut pests include *M. ohbayashii primoriensis*, *Drosicha corpulenta* Kunana, walnut caterpillars and *Gastrolina depressa* Baly and so on [12-15]. Since 1990s, many reports were researched on insect species and control for walnuts, main walnut pests in our country include *A. hetaohei*, *M. ohbayashii primoriensis*, *B. horsfieldi*, *Gastrolina depressa*, *Cnidocampa flavescens* Walker, *Dictyoploca japonica* Moore, *Alcidodes juglans* Chao, *Dyscerus juglans* Chao [16-18]. The occurrence of walnut insect pests is very serious, not only the pest species large in quantity, but also the damage area is wide and the damage degree is large. Since 1970s, the first discovery for the occurrence of *M. ohbayashii primoriensis* has been reported one after another. However, there are few reports on the specific and systematic research on *M. ohbayashii primoriensis*. The damage done to the walnut tree by *M. ohbayashii primoriensis*, however, is persistent and increasingly serious. In 1974, according to the investigation in Shangluo and Baoji areas in shaanxi province, the incidence of the local walnut tree damaged reached 70%-98%, and the walnut yield was reduced by 75% in 1970 compared with 1966 [13]. In 2010, walnut trees were damaged by *M. ohbayashii primoriensis* in Yicheng County, Shanxi Province, and the rate of affected strains exceeded 70%, resulting in huge losses [19]. In recent years, *M. ohbayashii primoriensis* has been harmful to walnuts in Jinzhong, Yuncheng, Changzhi and Linfen areas, with a rate of up to 80%, and the maximum insect population density is 10-20 per plant.

Due to the continuous occurrence of walnut insect pests, not only the output and quality of walnut were seriously affected, but also brought huge losses to the local economy. In recent years, the occurrence of *M. ohbayashii primoriensis* has seriously affected the economic development and ecological construction of the walnut planting area and caused huge losses to the walnut industry in China. For this reason, the author conducted detailed research and discussion on the research status, existing problems and control technology of *M. ohbayashii primoriensis*, in order to provide a better theoretical basis and scientific basis for comprehensive control research of *M. ohbayashii primoriensis*, and provide theoretical guidance for more effective control of its hazards.

2. Current Research of *M. ohbayashii primoriensis*

2.1. *M. ohbayashii primoriensis* and Its Host

Meliboeus ohbayashii primoriensis Alexeev (Coleoptera: Buprestidae) is native to Asia and east Europe has a wide geographical distribution, including China, Japan and Russia Far-East region [20-21]. The identified hosts are *Malus* and

Crataegus sustain most damage [21]. In recent years, investigation were conducted by the author in Shanxi Province, *J. regia* was only harmed to *M. ohbayashii primoriensis*, which has a characteristic of harm specificity. Until now, other host tree species were not harmed by this pest.

2.2. Harm to *M. ohbayashii primoriensis*

In April 1973, the meeting for prevention and control of *M. ohbayashii primoriensis* was organized by Shangluo Forestry Bureau in shaanxi, which proposed *M. ohbayashii primoriensis* and carpenter moth were devastating enemies of walnut trees for the first time. After that, the morphological characteristics, biological characteristics and prevention and treatment methods of *M. ohbayashii primoriensis* were researched by domestic scholars [17, 22].

M. ohbayashii primoriensis was first reported in 1973, it has been occurring all over the country. Whereas basic research of the biological and ecological characteristics for *M. ohbayashii primoriensis* was limited, only preliminary research on the damage situation, harm symptom and morphological characteristics of *M. ohbayashii primoriensis* were conducted, systematic and detailed research were lacked [19, 23]. Therefore, it was not able to guide the actual control work, which is one of the reasons why the pest has not been effectively controlled.

Studies of the biological characteristics and life history of *M. ohbayashii primoriensis* have shown that one generation per year [16-18]. *M. ohbayashii primoriensis* overwinters as larvae in branch, and pupate in the middle of April in branch with the pupal shake lasts more-or-less 20 days, adults emerge from the beginning of early May to the end of early July mating after emergence. Female adult lays eggs on leaf scar of *J. regia*. Individuals *J. regia* overwinters as mature larvae or adults in branches. The larvae are distributed in the branches of 2- to 3-year-old plants, and cause damage mainly to branch cortex. Adults of the former feed on the leaves. Although these species immediately do not kill host plants, it can reduce water and nutrient flow, resulting in leaf loss and reduced fruit yields and contribute to tree mortality [16-18]. There have been no reports abroad about the damage of *M. ohbayashii primoriensis* to walnut trees.

2.3. Control Technology of *M. ohbayashii primoriensis*

At present, the research on the control measures of walnut harmful biological disaster were also intensive studied by experts and scholars. The main control measures for *M. ohbayashii primoriensis* include: forest management measures, physical prevention and control methods, chemical prevention and control methods, natural enemy, light trapping, and strengthening quarantine, and so on.

- (1) Forest management measures: proper trees should be planted in proper places, integrated management should be strengthened, tree development should be enhanced, walnut trees should be promoted to grow robustly, and resistance of walnut tree should be

improved. To strengthen the daily management of walnut orchard, remove weeds in time, dig deep and cover with soil and grass, improve the living environment of walnut tree, increase the tree development and enhance the ability to resist insects.

- (2) Physical prevention and control methods: the dead branches should be cut off on the walnut tree and burning. Compare the cut and uncut plants, the ratio of infested trees were decreased 77.9% [19]. The pests can be controlled by shaking tree in adult stage, eggs can be attracted through bait in egg stage, and then eggs can be destroyed timely.
- (3) Chemical prevention and control methods: chemical prevention and control method is one of the common measures with the fastest effect. Chemical spraying was carried out for different growth and development periods of insect pests, and the prevention rate of *M. ohbayashii primoriensis* of walnut was up to 79.8% [19].
- (4) Natural enemies: the natural enemies of *M. ohbayashii primoriensis* were described in the literature. The larvae of *M. ohbayashii primoriensis* could be parasitized by two kinds of parasitic wasps, with the parasitic rate reaching 16% to 56% [19, 24-25].
- (5) Light trapping: insects have a certain phototropism, and they were attracted by black-light lamp.
- (6) Strengthen quarantine: *M. ohbayashii primoriensis* was regarded as one of the important pests harming the walnut tree, the seedlings of walnuts can be transported with the artificially transported seedlings for long-distance transmission. Therefore, the plant quarantine department should carry out the plant quarantine strictly in the process of seedling cultivation, nursery and transportation to prevent the spread and spread of pests.

3. Problems in *M. ohbayashii primoriensis* Studies

3.1. Scientific Name Correction for *A. Ribbei*

At present, the Latin scientific name of *Agrilus lewisiellus* Kere was cited in the literature [18, 29-30]. However, according to literature review, *Meliboeus ohbayashii primoriensis* (Alexeev, 1979) was the Latin name [20-21]. *Agrilus lewisiellus* Kere was misdescribed in reality. It was first named and described scientifically by Alexeev, and then the Latin name was *Meliboeus ohbayashii primoriensis* (Alexeev, 1979). Later, different scholars named the new species according to the specimens collected in different places. It was found that it was the same species as *M. ohbayashii primoriensis*, and similar cases produced some homonyms, such as *Nalanda ohbayashii* (Kurosawa, 1957), there are two subspecies of *M. ohbayashii primoriensis*, *Meliboeus ohbayashii ohbayashii* (Kurosawa, 1957) and *Meliboeus ohbayashii primoriensis* (Alexeev, 1979) [21]. The code stipulates

that the effective name of a taxon is the first available name applied to it, that is, the earliest correct name [31]. When a taxon has more than two available names, the phenomenon is called synonymy, and all these names are synonyms, as in the case of *M. ohbayashii primoriensis* listed above. Among the many different names, it is necessary to determine the effective name of a classification unit according to the priority principle. To sum up, the author thought that the scientific name of *Meliboeus ohbayashii primoriensis* (Alexeev, 1979) should be *Meliboeus ohbayashii primoriensis* (Alexeev, 1979), while other scientific names should be treated as different names, and not be adopted.

3.2. Problems in Control Method for *M. ohbayashii primoriensis*

The existing control methods for walnut pests are both effective and feasible in theory [24, 29, 32-34].

- (1) At present, chemical prevention and treatment of *M. ohbayashii primoriensis* were mainly applied in many methods. However, the damage of *M. ohbayashii primoriensis* is hidden, which is difficult to be found from the surface of plants. The chemical prevention and control method using surface spraying medicine is effective, but natural enemies will also be harmed in the process, causing environmental pollution and labor. At the same time, this kind of insect damage cannot be fundamentally controlled through this method.
- (2) Although a large number of pruning and removing the damaged branches will lead to severe canopies of walnut trees, which will not only reduce the yield reduction, but also lead to weakness of trees and more vulnerable to other diseases and insects.
- (3) There are few studies on parasitic natural enemies, and it is not clear what kind of parasitic wasp is the parasitic natural enemy of *M. ohbayashii primoriensis*, as well as reports and studies on the parasitic rate of *M. ohbayashii primoriensis*. In addition, the control function of the host insect is mostly natural parasitism, there are no reports of natural enemies in artificial breeding for the control of this pest.
- (4) In practice, the effect for *M. ohbayashii primoriensis* was worse than *B. horsfieldi* using black-light lamp. The reason could be due to the compound eye structure of *M. ohbayashii primoriensis*'s own. There is no clear research results and interpretation. Therefore, it is necessary to carry out this pest trap related research work under the different wavelengths of light source, and establish a way to attractive or avoid pest using lights.
- (5) In contrast, there are no published reports on the volatile compounds of *J. regia* infested by *M. ohbayashii primoriensis* at home and abroad. It provides the theoretical basis and scientific foundation for Integrated Pest Management of pests through studies of host plant volatiles, as well as the strong

ecologically sustainable strategies for the control of pests.

4. Conclusions

At present, walnut pests are mainly belonged to Lepidoptera, Coleoptera, Hemiptera and Homoptera insect in China. Among them, defoliator insect pests were the most common, followed by insect borers, such as *M. ohbayashii primoriensis* and *B. horsfieldi*. Insect pests are the main disaster-causing factors of walnut biohazard. In addition, non-biological disasters are mainly affected by climatic factors and site conditions. Therefore, under the influence of these two kinds of factors, the potential of walnut forest will decline and reduce yield reduction, which will affect the economic and ecological benefits.

Base on the research of bio-ecology characteristics for *M. ohbayashii primoriensis* in-depth study, the field monitoring technology, effective prevention and control measures should be perfected, protection and utilization of natural resources (breeding and release), and the development of volatile compounds or housefly-repellents, sex attractant, choose low toxicity and efficient agent, insect-resistant varieties breeding work, strengthen trees tending management, combining the theory of ecosystem regulation, establish an effective disaster system of comprehensive prevention and control technology for controlling *M. ohbayashii primoriensis*.

At present, walnut cultivation is developing towards scale, commercialization and industrialization. The high biological value of walnut makes it an indispensable food and product for human beings [35]. Therefore, the safety of walnut food and products is particularly important, which is also the focus of the market and the public. Insect pheromone is an important method and method for monitoring and prevention of insect pests. It is characterized by high activity, strong specificity, no killing of natural enemies, no pollution of the environment, and easy to use. This method can not only reveal the chemical relationship between plants, insect and natural enemies, but also facilitate the biological control of natural enemies. Therefore, it is necessary to develop and utilize insect pheromones.

In addition, the degree of occurrence of *M. ohbayashii primoriensis* in walnuts is related not only to the type and forest factors, but also to the growth of trees. Through investigation, it was found that under the same site conditions, if forest and grain intercropping, deep ploughing and grass covering were adopted in the orchard, and the trees were strong, the insect pests would be less. On the other hand, if the orchard is barren and poorly managed, the trees will grow weak and insect pests will occur seriously. Therefore, it is necessary to strengthen management in the future, and in the case of conditions, take parenting measures to promote tree potential and enhance the anti-insect capacity of walnut tree, which is also an important part of the integrated control of *M. ohbayashii primoriensis*.

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