The Abundance Parasitoid Populations of Neochrysocharis formosa and Neochrysocharis okazakii (Hymenoptera: Eulophidae) on Liriomyza spp. (Diptera: Agromyzidae) Associated with Vege...

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The Abundance Parasitoid Populations of Neochrysocharis formosa and Neochrysocharis okazakii (Hymenoptera: Eulophidae) on Liriomyza spp. (Diptera: Agromyzidae) Associated with Vegetable Crop in Bali

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Abstract
The research objective was to determine the population abundance and the level of parasitation of parasitoid of *Neochrysocharis formosa* and *Neochrysocharis okazakii* against *Liriomyza spp* on some vegetable crops in Bali (Indonesia) from March 2014 to December 2014. The method used is a survey method; the sampling of *Liriomyza spp* infected plants was conducted by purposive sampling on the low, medium and high land in Bali.The results showed that the population abundance of *N.formosa* on planting vegetables in Bali with the highest population respectively in the low, medium and high lands at 642, 409 and 162 populations. *N.okazakii* in the low, medium and high lands is 243, 99 and 10 populations. *N.formosa* parasitation highest level was found in the low, medium and highlands respectively on tomatoes, chicories, tomatoes, while *N.okazakii* on tomato plants. Both parasitoids associated with *L.sativae* in the lowlands, medium and highlands, with *L.huidobrensis* only in the medium and highlands.
Keywords: Abundance population, *N.formosa, N.okazakii, Liriomyza spp*., vegetable crops

1. INTRODUCTION

Leafminer of *Liriomyza sp*. (Diptera: Agromyzidae) is a major pest in crops of vegetables and not a native pest. These pests are expected to enter Indonesia in 1990 through the delivery of cut flowers (Rauf, 1997, 1999). *Liriomyza spp*. polifag is found attacking some plant families. *L. huidobrensis* attacked more than 70 plant species belonging to 20 families, in particular of vegetable crops and ornamental plants (Rauf *et al.*, 2000; Supartha, 1998; Supartha *et al*., 1999 ;Shepard *et al*., 1996)

Leafminer attacks on potato can reduce crop yields by 30% -70% (Rauf and Shepard, 1999). Heavy damage in the lowlands generally occurs on tomatoes, watermelon, cucumber, beans, squash, soybeans and chickpeas with the damage level of 40% -70% (Rauf *et al*., 2000; Rauf, 2001; Baliadi, 2008).

Efforts to control the leafminer are generally made by using insecticides, but such measures are often failed to reduce the level of attack, because the eggs and larvae are in the plant tissue so that they are protected from the adverse effects of insecticides (Parella, 1987). Chemical control in addition to expensive, it also pollutes the environment and threatens human health. Unwise use of insecticides can cause new problems such as resistance, resurgence and secondary pest explosion (Raman, 1988). The solution is the environmentally friendly control, namely: control by utilizing biological agents namely the natural enemies: parasitoids, predators and pathogens.

In Bali, there are 13 species parasitoids found that are associated with larvae and pupae of *L. sativae* and *L. huidobrensis*. Among the 13 species, *Hemiptarsenus. varicornis, Opius spp* and *N. formosa* are the three most dominant parasitoids found in vegetable crops with different distribution patterns. *Hemiptarsenus varicornis*was found in all types of host plants both in the highlands and lowlands, *Opius sp* is more dominant on potatoes, tomatoes, celeries, and wild plants in the highlands areas of Pancasari (Buleleng) and Baturiti (Tabanan), *N. formosa* is only found to be associated with *L. sativae* attacking on legume crops in the lowlands and midlands (Supartha, 2002; Supartha 2005).

The level of parasitation in previous years was low, but the current level of parasitation reached 47 and 43%. (Pratama *et al*., 2013), on the tomato plants by 16 and 4% (Herlianadewi *et.al*., 2013), thus it is potential as biological control of Liriomyza spp. in Bali. Until the recent time there is no information of the parasitoid potential of *N.formosa* and *N. okazakii* as biological controls of *Liriomyza spp*. in horticultural crops in Bali. Maryana (2000), examines *N. formosa* on *L.trifoli* in Japan, Swastika (2003) have examined *N.okazakii* on *L. sativae* and found that *N.okazakii* has a strong preference to instar -3 *L. sativae*. Luna *et. al*. (2011) researching *N.formosa* on tomato plants in Argentina.

The success of the use of parasitoids in the pest control of leafminer is based on the understanding of biology and ecology of the parasitoids especially the parasitoids' relationship with the host and the host plant. Based on this, a series of field research were conducted on: the abundance of population and the level of parasitation of *N.formosa* and *N. okazakii* at various altitudes and host plant species in Bali.

This research aims to determine the abundance of population and the level of parasitation of *N.formosa* and *N. okazakii* in lowland, midland and highland altitudes and host plant species in Bali.

2. MATERIALS AND METHODS

This research was conducted in the area of vegetable cultivation in the area of Bali (Indonesia) and in the laboratory of Integrated Pest Management, Faculty of Agriculture and Marine Laboratory of University of Udayana, starting from March 2014 to December 2014. The research was conducted in lowlands with an altitude of <500 m above sea level (asl), midlands ≥500-1000 m asl, and highlands> 1000 m asl, and host crops (Table 1). The materials were leaves infested by leafminer fly, 90%alcohol, altimeter, hygrothermometer, petri dishes, stationery, brushes, plastic jars, plastic bags, paper labels, binocular microscope.

Table 1. Summary of comparable attributes per altitude area

Attributes	**Lowland (< 500 m asl)**	**Midland (≥ 500 – 1000 m asl)**	**Highland (>1000 m asl)**
Location District Badung City Denpasar District Gianyar District Klungkung District Karangasem District Jembrana District Bangli District Tabanan District Buleleng	Mengwi and Buduk Sanur and Pegok Lebih and Bona Lepang and Takmung Nongan Pekutatan	Petang Apuh Sekaan and Bayung Gede Luwus, Candikuning, Batunye, Titigalar, Batusesa, Pacung	 Taman Tanda, Bedugul Pancasari
***Liriomyza* spp. Host crops**	**Family Fabaceae** Long beans (*Vigna sinensis*), Bean (*Phaseolus vulgaris* L), Red bean (*Phaseolus lunatus* L.) **FamilyCucurbitaceae** Cucumber (*Cucumis melo* L) **Famili Solanaceae** Tomato (*Solanum lycopersicum*) Eggplant (*Solanum melongena*) **Famili Convolvulaceae** Sweet potato (*Ipomoea batatas* L) **Famili Brassicaceae** Caisin (*Bransisca rapa. Var.parachinensis*)	**Famili Fabaceae** Long beans *Vigna sinensis*), Bean (*Phaseolus vulgaris* L), peas (*Pisum sativum* L.) **Famili Cucurbitaceae** Cucumber (*Cucumis melo* L) **Famili Solanaceae** Tomato (*Solanum lycopersicum*) Eggplant (*Solanum melongena*), Potato (*Solanum tuberosum*) **Famili Convolvulaceae** Sweet potato (*Ipomoea batatas* L) **Famili Brassicaceae** Mustard (*Bransisca chinensis* L) dan pokcoy (*Bransisca rapa* L.) **Famili Apiaceae** Prey (*Allium para*) **Famili Liliaceae** Lettuce (*Lactuca sativa*)	**Famili Fabaceae** Bean (*Phaseolus vulgaris* L), Peas (*Pisum sativum* L.) **Famili Solanaceae** Tomato (*Solanum lycopersicum*) Eggplant (*Solanum melongena*) **Famili Brassicaceae** Mustard (*Bransisca chinensis* L) and Pokcoy (*Bransisca rapa* L.), cabbage (*Brassica oleaceae var. capitata* L.) **Famili Liliaceae** Lettuce (*Lactuca sativa*)

2.1 Implementation of the Research

Sampling was carried out every two weeks by purposive sampling on plant leaves that showing symptoms of damage found in the vegetable production areas in Bali that often experience leafminer pest attacks. The infested leaves were then put into a plastic bag labeled according to the type of crop, altitude and date of sampling. In the laboratory, the leaves were put in a plastic cup with a diameter of 9 cm and a height of 11 cm, holes were made as ventilation on the side of the glass and covered with gauze. Observations were made every day on pupa, imago of *Liriomyza spp*. and parasitoids that appears, and then stored in a collection bottle containing 95% alcohol. Imago of *Liriomyza spp*. emerging identified based on morphology under binocular microscope according to Spencer (1973), while the imago parasitoids were identified based on morphological characteristics according to Schauff, *et. al*. (1998) and Konishi (1998).

2.2 The variables observed in the research were;
-The diversity and abundance of the population of *Liriomyza spp*. on each of the host plant
-Population abundance of parasitoids of *N.formosa* and *N.okazakii*
-The level of parasitation of parasitoids *N.formosa* and *N.okazakii*
-The level of parasitation of parasitoids was calculated by the formula:

$$\frac{\text{Number of imago parasitoids (A) that appeared}}{\text{Total number of } Liriomyza\ spp. \text{ and parasitoids (A) that appeared}} \text{ X } 100\%$$

2.3 Data analysis.
The data were tabulated, and presented in tables and images then analyzed descriptively

3. RESULTS AND DISCUSSION
The results showed that there are two *Liriomyza* species that associated with vegetable crops in Bali, namely *Liriomyza sativae* (Branchard) and *Liriomyza huidobrenssis* (Branchard). *L sativae* that have spread to all regencies in Bali, namely: Badung, Denpasar, Gianyar, Klungkung, Karangasem, Bangli, Tabanan, Buleleng and Negara, while *L.huidobrensis* spread only in the areas of Tabanan and Buleleng. The research supported the research of Setiawati (2005) and Pratama (2013) that the diversity of *Liriomyza* in Bali namely *Liriomyza sativae* (Branchard) and *Liriomyza huidobrenssis* (Branchard). *L. sativae* have been identified its spread in the lowlands, medium and highlands, while *L.huidobrensis* spread on the medium and highlands. The two species of *Liriomyza* population abundance were different in each of the host plant. In the lowlands, the highest abundance of *L.sativae* in the family of *Fabaceae* was on the plants of long beans, the family of *Curcubitaceae* was found on the cucumber plants, on the *Solanacea* family i.e. the eggplants and on the family of *Brassicaseae* i.e. the green vegetable. In the middle latitudes the population dominance was shown by *L. sativae* of *L.huidobrensis*. The highest *L.sativae* population abundance was found in long beans, cucumbers, tomatoes and cabbages. *L. huidobrensis* population abundance was found on cucumber and cabbage plants. *L. huidobrenssis* was identified to be found in the Candi Kuning, Batusesa, Pacung, Taman tanda and Pancasari areas. On highlands with an altitude of > 1000 m asl the population was dominated by *L. huidobrensis*. The highest abundance was found on the pea family of *Fabaceae*, then on tomatoes that belongs to *Solanacea*, then on the green vegetables of the *Brassicaeae* family and lettuce (family of *Liliaceae*). The abundance of *L. sativae* found on the highlands was higher in red beans, beans and tomatoes. The higher abundance of *L.sativae* in the lowlands were mainly on legumes and cucumbers because they have always been grown by farmers in the lowlands and are always available throughout the year so that it enables the imago of *L.sativae* to lay their eggs on the host plants . Likewise, in the highlands, it is because farmers plant red beans, beans and tomatoes that are the host plants.The high population of *L. huidobrensis* in the family of *Fabaceae*, especially on peas, red beans because these plants are planted consecutively in some seasons so that the host plants are always available in the field. The results of the research indicated that the population abundance of *L. sativae* on vegetable crops was higher than that of *L. huidobrensis* by 91.92% versus 8:08%. This means that *L. sativae* spread to the highlands because of the adaptation of the spread of the host plant cultivation.

The abundance of *N.formosa* and *N.okazakii* at various altitudes is presented in Figure 1. *N.formosa* abundance with the highest population respectively in the lowlands, medium and highlands was at 642, 409 and 162 populations. While *N.okazakii*found in the lowlands, medium and highlands at 243, 99 and 10 populations. The overall population abundance of *N.formosa* population was as many as 2.94 times compared with *N.okazakii*, this means that *N.formosa* is more adaptable to a wide range of altitudes than *N.okazakii.*

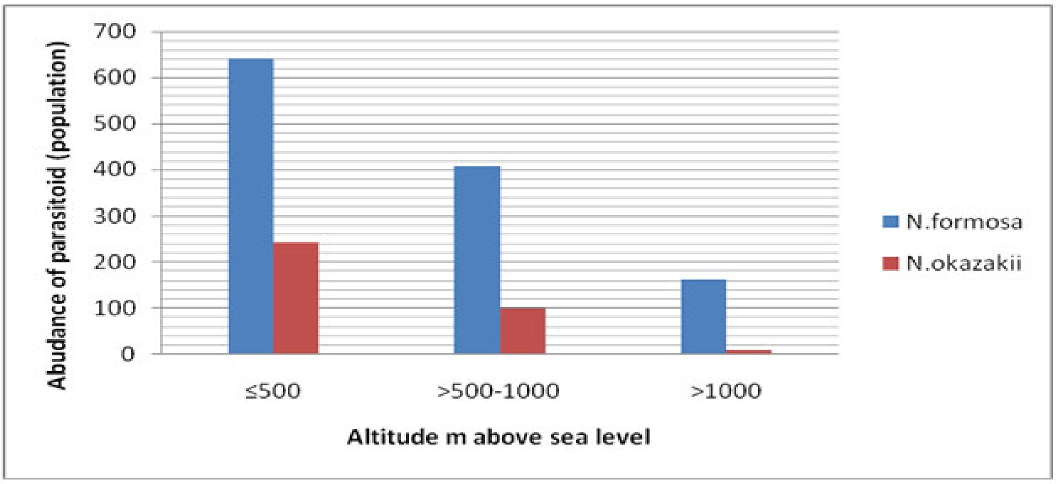

Figure 1. Population abundance of *N.formosa* and *N.okazakii* on *L.sativae* (L.s) and *L.huidobrensis* (L.h) at various altitudes on planting vegetables in Bali

The highest *N. formosa* parasitation level in the lowlands was found on tomatoes (36%) followed by red beans (28%), beans (24.47%) and the lowest was in eggplant (4.48%). The highest *N. Okazakii* parasitation was found on tomatoes and chickpeas. Thus in the lowlands, *Fabaceae* and *solanaceae* are favored by *N. formosa* and *N.okazakii* that associated with *L. sativae*. (Figure 2).

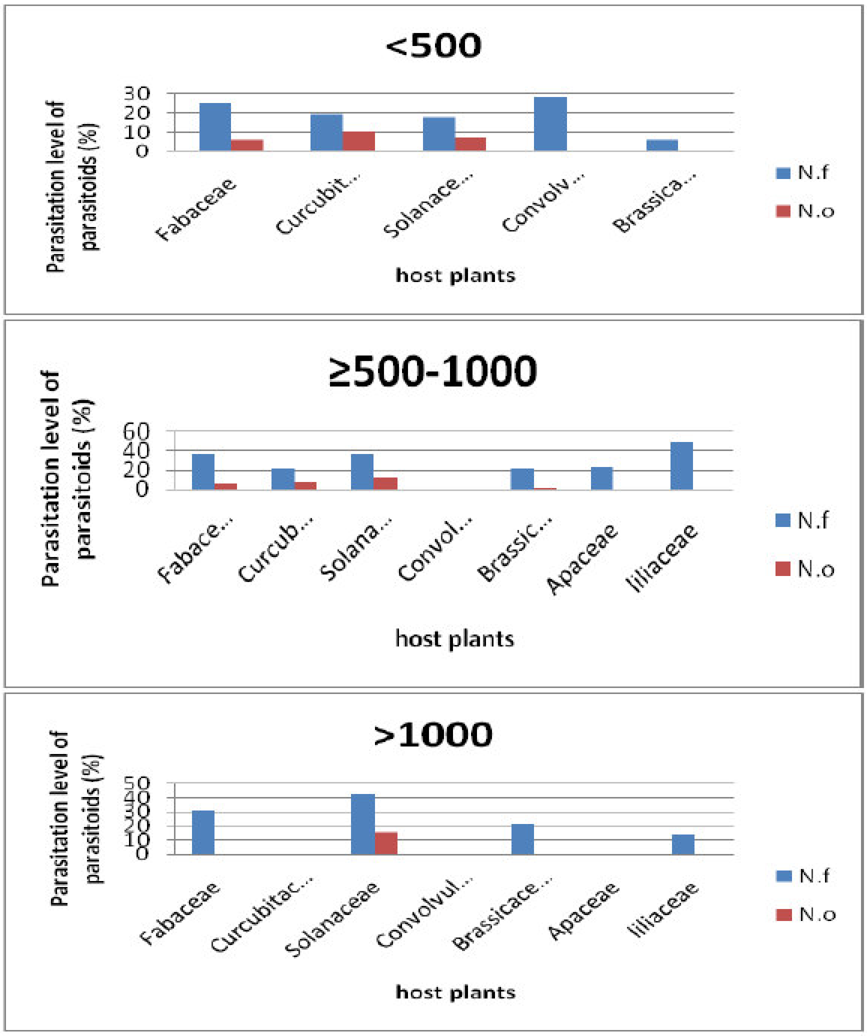

Figure 2. The level of parasitation of *N.formosa* (N.f) and *N. okazakii* (N.o) at various altitudes on vegetable crops in Bali

The highest *N. formosa* parasitation level the medium-lying lands was found on the white mustard plant

(63.63%), beans (42.63%), tomatoes and the lowest was on the lettuce. The high level of parasitation on chicory was because of the low *Liriomyza* population and it is carried out on organic farming. The highest *N .okazakii* parasitation level was found on tomato plants (Solanaceae family) and beans (Fabaceae family), whereas in the family of Asteraceae*,* Liliaceae and Apicaceae did not occur parasitation. This is consistent with the statement of Suwastika (2003) that *N.okazakii* showed a strong preference towards long beans and tomatoes.

N. formosa parasitation level on the highest plateau on tomatoes, eggplant and red beans and lowest in the cabbage. The level of parasitation of *N. okazakii* was 18:18% on tomato plants. The level of parasitation is one indicator of the effectiveness of the parasitoid in regulating the host population (Supartha, 2002).

The level of parasitation of *N.formosa* and *N.okazakii* on *L.sativae* and *L.hudobrensis* at various altitudes is presented in Figure 3. The level of parasitation of *N.formosa* at an altitude of <500 m above sea level, ≥500-1000 m asl and> 1000 m asl was found on the host plants of *L.sativae* respectively by 19.67%, 31.34% and 44.83%, while on *L.huidobrensis* was 0% 9:55% and 21.93%. The highest level of parasitation occurred on the host plants of *L.sativae* in the highlands because of the lower population abundance of *L.sativae* so that parasitoid was able to be parasitic to the host plants. In the lowlands, it was not found *L.huidobrensis* associated with *N.formosa*, because *L.huidobrensis* has not spread to the the lowlands in Bali. Supartha (2002) states that *N.formosa* spread in the lowlands and only associate with *L.sativae*.The level of parasitation of *N.okazakii* at an altitude of <500 m above sea level, ≥500-1000 m asl and> 1000 m above sea level on host of *L. sativae* are respectively 8:48%, 9.95% and 11:11% while in the host of *L.huidobrensis* was 0%, 3:39 % and 1.64%. Results of research of Herlianadewi *et.al,* 2013 found that the level of parasitation of *N.okazakii* was 4% on tomato plants in the lowlands, Pratama *et al*. 2013 found the level of parasitation was 43% on cucumbers in the middle-lying land. This suggests that this parasitoid remains on planting vegetables in Bali, as a biological agent of *Liriomyza spp*

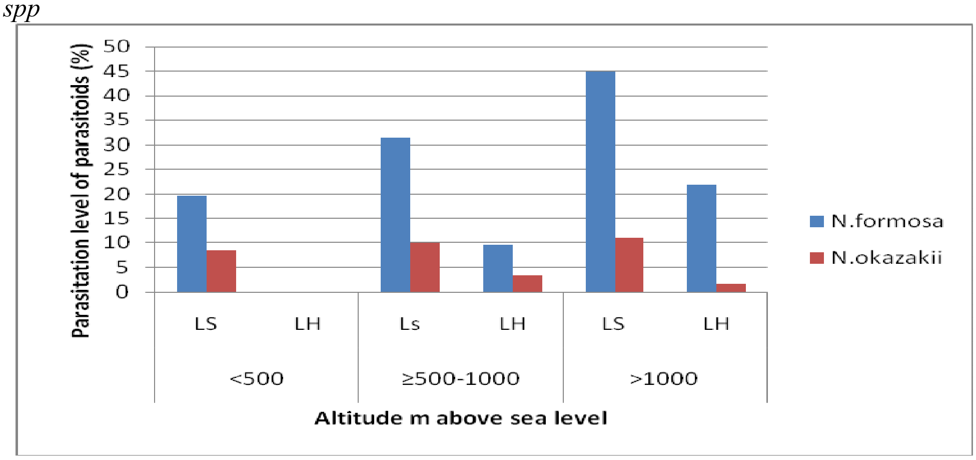

Figure 3. The level of parasitation of *N.formosa* and *N.okazakii* on *L.sativae* and *L.huidobrensis* at various altitudes on planting vegetables in Bali

CONCLUSION

Liriomyza spp associated with vegetable crops in Bali is *L sativae* (Blanchard) (Diptera: Agromyzidae) and *L.huidobrensis*. (Blanchard) (Diptera: Agromyzidae), with the population abundance of 91.92% versus 8.08%.

N.formosa population abundance in vegetable crops in Bali with the highest population respectively in the lowlands, medium lands and highlands was at 642, 409 and 162 populations. While *N.okazakii* in the lowlands, medium and highlands was respectively 243, 99 and 10 populations.

N.formosa parasitation highest level in the lowlands, medium and highlands was respectively found on tomatoes, chicory, tomatoes, while *N.okazakii* was found on tomato plants.

Both parasitoids were associated with *L.sativae* in the lowlands, medium and highlands, with *L.huidobrensis* were only found in the medium and highlands.

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