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RICE STEM BORER DISTRIBUTIONS AND THEIR NATIVE PARASITOIDS REARING ON THE HOST EGGS, CORCYRA CEPHALONICA IN MANDALAY REGION, MYANMAR

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Abstract: Rice is the main agricultural crop and yellow stem borer, *Scirpophaga incertulas* Walker is the main destructive rice pest in Myanmar. In this research, rice stem borer eggs sampling, population estimation, occurrence of the native parasitoids and their parasitism rate were analyzed in Mandalay Region, Myanmar from 2012 to 2015. Rearing of egg parasitoids were analyzed on host eggs of rice moth, *Corcyra cephalonica*. The population estimation of rice stem borer increases year by year particularly in rainy season in both vegetable and reproductive stage of rice. Three types of the native egg parasitoids in rice stem borer such as *Trichogramma japonicum* Ashmead, *Telenomous rowani* Gahan and *Tetrastichus schoenobii* Ferriere were discovered. Among them, *T. schoenobii* is dominant on rice stem borer egg as 54%. The diet mixture of rice bran and sucrose is the suitable media with the shorter total life cycle for rearing of *C. cephalonica* showing the highest value of oviposition rate at second day. The stock culture of *T. japonicum* on *C. cephalonica* with parasitism rate as 37% was significantly higher than *T. rowani* and *T. schoenobii*. Therefore our results reveal that rice stem borer distribution increase year by year particularly in rainy season and the field dominance of egg parasitoids on rice stem borer is *T. schoenobii* in Mandalay, Myanmar. *T. japonicum* rearing on *C. cephalonica* is the effective biological approach to control rice stem borer.

Keywords: rice stem borer, eggs parasitoid, *Corcyra cephalonica*, distribution, biological control.

1. Introduction

Yellow stem borer, *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae) destroy deep water rice in both vegetable stage and reproductive stage. (Sarwar. 2012). Cutting rice leaf blade with egg-mass or cutting all larvae fed on pinnacle may effective for controlling even the resistance may found (Chen and Romena, 2006). The control analysis may feasible while the highest population density and damage level follow under the flooding (Catling and lslamt, 1995).

The implementation on the impact of arthropod natural enemies (ANEs) in both field and laboratory experiment is an effective technique and ANEs is the one of the best biological control agents for area-wide integrates pest management (AW-IPM) (Peterson et al., 2016**)**. The egg parasitoids, *Tetrastichus schoenobii* Ferriere can destroy the entire eggs of yellow stem borer egg-mass with the introduction of an exotic strain while studying the mass-rearing and releasing of egg parasitoids (Chakraborty, 2012).

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Biological control with egg parasitoids is an efficient technique on the rice stem borer towards improved integration (Manjunath, 1990). The comparactive *Telenomus* species and *Tetrastichus* species with longer studies show that the active performance together in occurrence of some pests (Kumar and Singh, 2016). The biological control of *Trichogramma* species is the one of the effective useful technique for rice Lepidoptera, sugar cane stem borer and pine defoliators (Cock, 1985).

When the species diversity and abundance in rice stem borer were studied in Tanzania, *C. partellus* is the most abundant species (48.6%) followed by *M. separatella* (35.4%) and *S. calamistis* was least abundant (16.1%) (Leonard and Rwegasira, 2015). Fipronil resistance development in rice stem borer, *Chilo suppressalis* were survey in east China from 2001 to 2004 (Jiang et al., 2005). The monitoring of N. rileyi the parasitization percentage and male-female ratio may safe to against *T. japonicum* and *T. chilonis* (Shanthakumar et al., 2010).

The aim of the research is to analyze rice stem borer distribution and their parasitoids in Mandalay Region, Myanmar for the biological control system. Three types of parasitoids such as *T. japonicum, T. rowani and T schoenobii* were discovered with the dominance percentage of *T schoenobii* as 54%. Rearing of *T. japonicum* on the host egg *C. cephalonica* is the effective approach for the biological control of rice stem borer.

2. Material and methods

2.1 Site selection

The study site of rice farm is located at 21° 45′ 0″ N, 96° 15′ 0″ E by selecting the biggest cultivation area with great commercial production at Mandalay region, Myanmar. The site was chose geographically important region under the government program with the history and logical intensive use of pesticides for controlling rice pests.

2.2 Rice stem borer population estimation and egg samplings

Samplings of rice stem borer egg were performed and brought to Department of Biotechnology, Mandalay Technological University, Mandalay, Myanmar. The sample of rice stem borer eggs were shown in Figure 1. The analysis of rice stem borer and their parasitoids populations were initiated from 1 week after transplantation rice plants to the study site with 10 days interval from 2012-2015 in both rainy and summer seasons of each year. 10 plants of Zip-Z rice were randomly chose at 4 different plots with the analysis as (a) the number of egg per plant (b) the parasitization percentage of native egg parasitoids, (c) the number of deadhearts per plant (d) the number of whitehead per plant. The stylistic data analysis were checked and graphed with Microsoft 10.

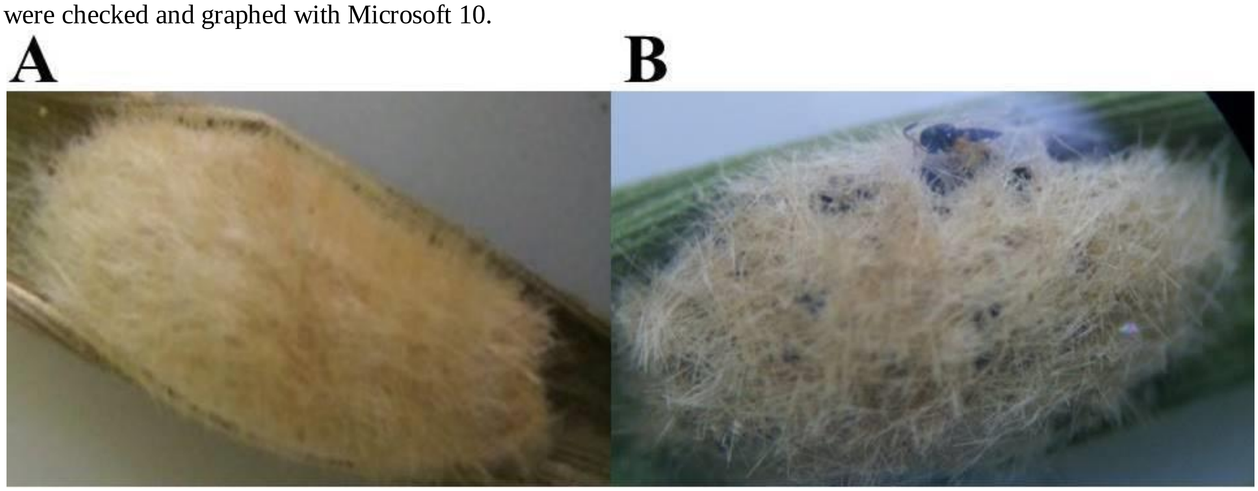

Figure 1. The rice stem borer egg mass while collection the sample in Mandalay region, Myanmar **A**. Non-parasitized egg mass B. Parasitized egg mass

2.3 Occurrence of native egg parasitoids on rice stem borer

The sampled egg mass of rice stem borers were brought to the entomological Laboratory at Mandalay Technological University and analyzed the occurrence of native egg parasitoids. The egg parasitoids were identified by the morphological characteristics under the stereo-microscope with binocular lens. The dominance percentages of egg parasitoids were checked and stylistically calculated.

2.4 Laboratory colony establishment of C. cephalonica

C. cephalonica were obtained from webbing rice brans of the local rice mills at Mandalay, Myanmar and brought to the Laboratory. Rice brans were maintained in the larval rearing cage (8 x 12 inch) covered with the cotton cloths under laboratory condition at 25±2ºC and 70±2% RH; with natural light. Newly emerging adults *C. cephalonica* were provided with 10% honey soaked cotton wool to maintain their daily activities. In this experiment, cylinder steel wire mesh was used as the oviposition cage (4 inch in diameter x 12 inch in height) and it was covered with cotton cloth for ventilation. *C. cephalonica* adults were allowed to mate in the oviposition cages for reproduction. The base of oviposition cages were provided with the aluminum foils to collect the egg. The eggs were collected from the aluminum foil for further studies.

2.5 Oviposition rate of C. cephalonica

The oviposition rates of *C. cephalonica* were performed at the laboratory condition of 25±2ºC and 70±2% RH. The 10 males and females (newly emerged) were put together for three replications and provided 10% honey solution. The fresh eggs per day were calculated by collecting the eggs from the base of oviposition cages every early morning. The statistical data were analyzed and graphed with Microsoft 10.

2.6 Life period of C. cephalonica on five different artificial diets

The life period of *C. cephalonica* were analyzed on five different of artificial diets. The ratios of five different artificial diets were formulated (Table 1). The 10 newly emerged eggs from the oviposition cages were placed to the cards. Each card was transferred to five different diets and analyzed the life period of egg, larva and pupa. The emerged adults were provided with 10 % honey sock cotton wool and analyzed life period.

Table 1. Five artificial Diet compositions for rearing of host eggs, *C. cephalonica*

Diet composition	**Rice Brans (%)**	**Wheat Brans (%)**	**Sucrose (%)**
I	100	0	0
II	0	100	0
III	97	0	3
IV	0	97	0
V	48.5	48.5	3

2.7 Parasitism rate of T. japonicum, T. rowani, T schoenobii on C. cephalonica

The parasitism rate of egg parasitoids from rice stem borer were conducted on the host egg of *C. cephalonica* at 25±2ºC and 70±2% RH. The newly emerged adult *T. japonicum, T. rowani and T schoenobii* from rice stem borers eggs were collected at a fine tube separately. The three tubes of *T. japonicum, T. rowani and T schoenobii* were provided with fresh 100 eggs of *C. cephalonica*. The total numbers of adults (each species) were counted at the base of cage after death. The parasitization percentages were calculated with the ratios of parastoids and host eggs (1:6).

3. Results

3.1 Rice stems borer population in summer season (Apr, May, Jun)

The highest value of number of eggs per plant reach at a peak in May, 2015 is 0.2 while parasitism rate of native parasitoids is very low as 1.4% which is the highest percentage in May, 2015. The deadhearts percentage is 3% which is the highest in May, 2015 and whiteheads percentage is also just 3% which is the highest in June, 2015 (Figure 2).

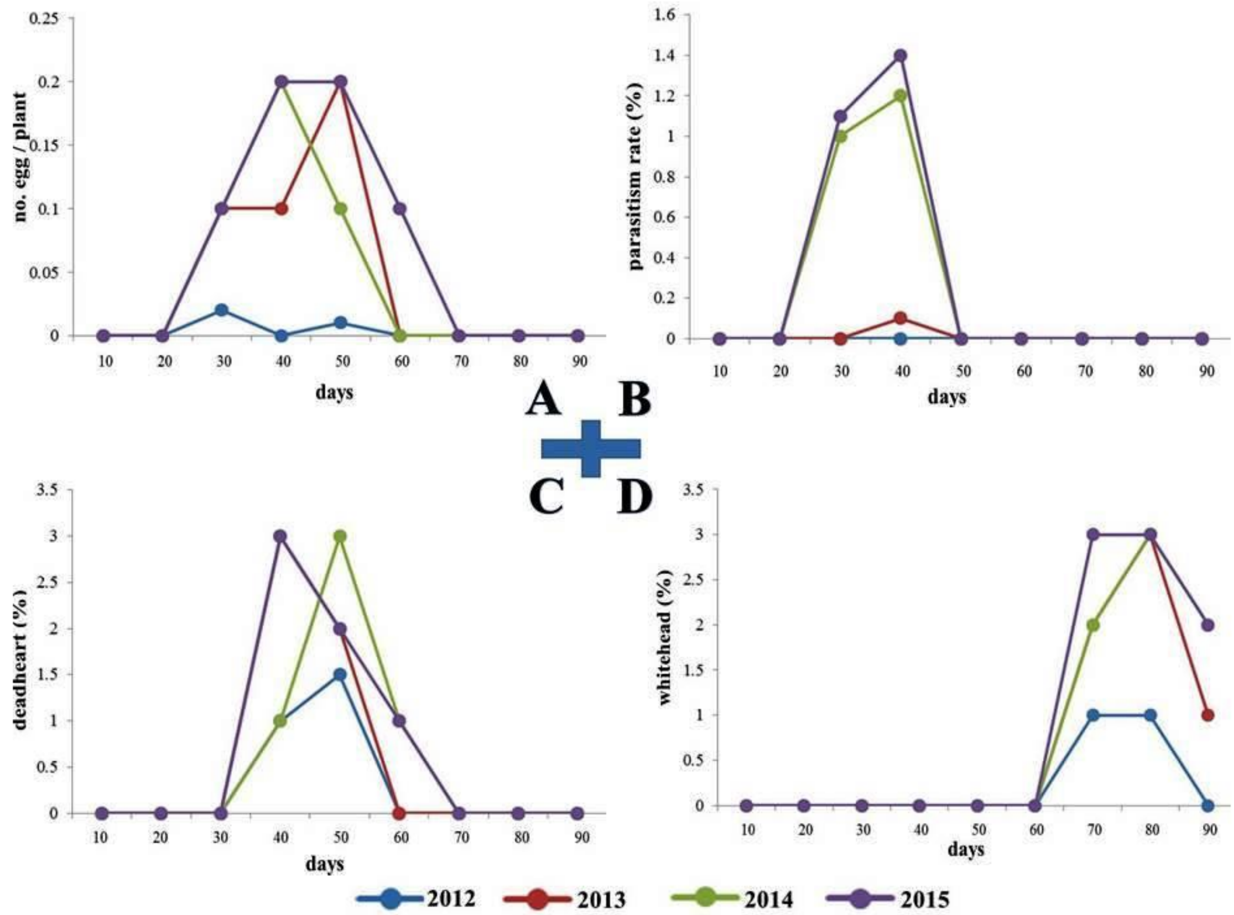

Fig 2. Population estimation of rice stem borer distribution at summer season (April, May and June) in Mandalay region, Myanmar from 2012-2015. (A) Number of egg per plant (B) Parasitization percentage of native parasitoids (C) Deadheart percentage at vegetable stage (D) Whitehead percentage at reproductive stage.

3.2 Rice stems borer population in rainy season (Sep, Oct, Nov)

The highest value of number of eggs per plant reach at a peak in September, 2015 is 4.5 while parasitism rate of native parasitoids is very high as 35% which is the highest percentage in September, 2015. The deadhearts percentage is 58 % which is the highest in October, 2015 and whiteheads percentage is 60% which is the highest in November, 2015 (Figure 3).

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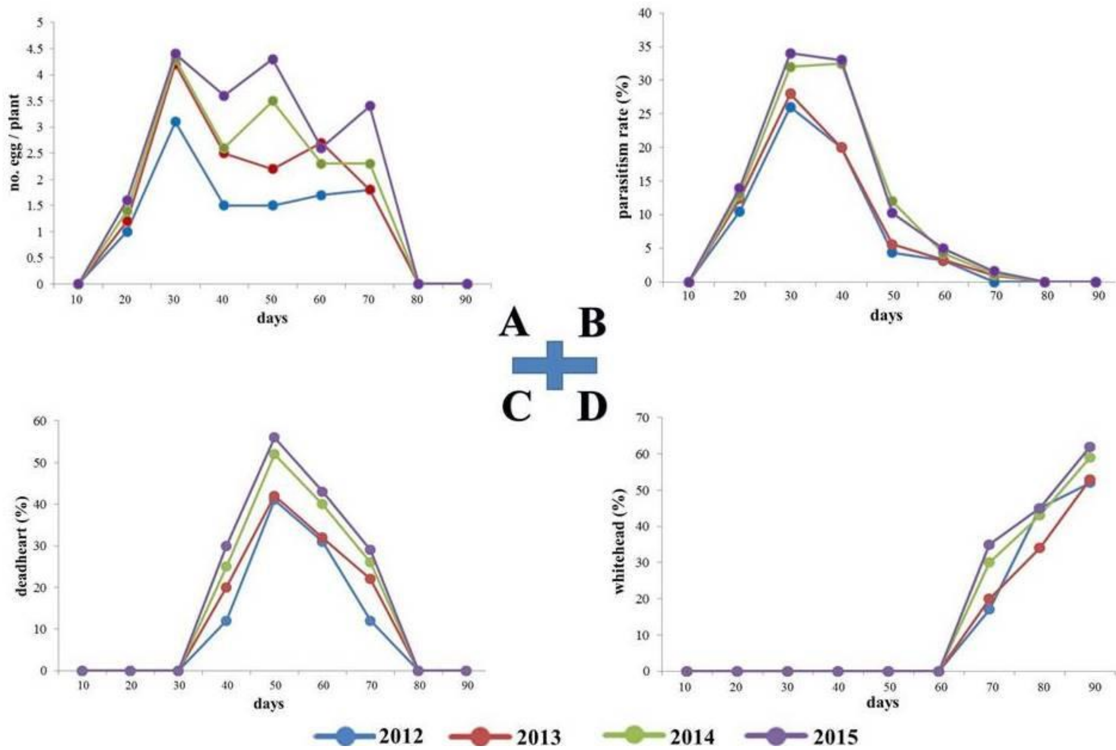

Figure 3. Population estimation of rice stem borer distribution at rainy season (September, October and November) in Mandalay region, Myanmar from 2012-2015. (A) Number of egg per plant (B) Parasitization percentage of native parasitoids (C) Deadheart percentage at vegetable stage (D) Whitehead percentage at reproductive stage.

3.3 Dominance of T. schoenobii in rice stem borers

T. japonicum, T. rowani and T schoenobii were discovered from the parasitized eggs of rice stem borer in Mandalay region, Myanmar from 2012 to 2015. Among them, 54±3.6 % of all parasitized eggs of rice stem borer were dominated by *T schoenobii* while the occurrences of *T. japonicum* and *T. rowani* from the rice stem borer's parasitized eggs were 29±2.4 % and 17±4.8% respectively (Figure 4).

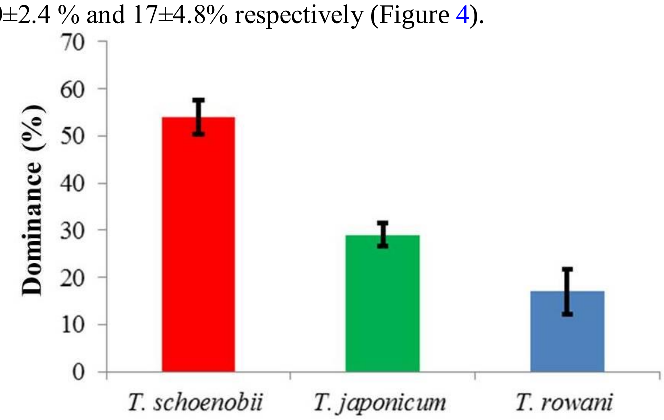

Figure 4. Occurrence of egg parasitoids in rice stem borers and their dominance percentage in Mandalay region, Myanmar from 2012-2015. The red bar represents the dominance percentage of *T. schoenobii* as 54±3.6, the green bar shows *T. japonicum* as 29±2.4 and the blue color indicates the *T. rowani* as 17±4.8.

3.4 Oviposition rate and life period of C. cephalonica

Oviposition rate of *C. cephalonica* reached at a peak as 26.7±1.5 at the second day of female adults. The total eggs laid by a female are 63.7±10.4 (Figure 5). The eggs of *C. cephalonica* hatch generally 7th days at 25±2 ˚C 70% RH

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condition while the larva and pupa life period is 18.1±1.3 days in the diets mixture of rice bran and sucrose. The total life period of *C. cephalonica* is 29.6±1.6 days in artificial which is the best for rearing (Table 2).

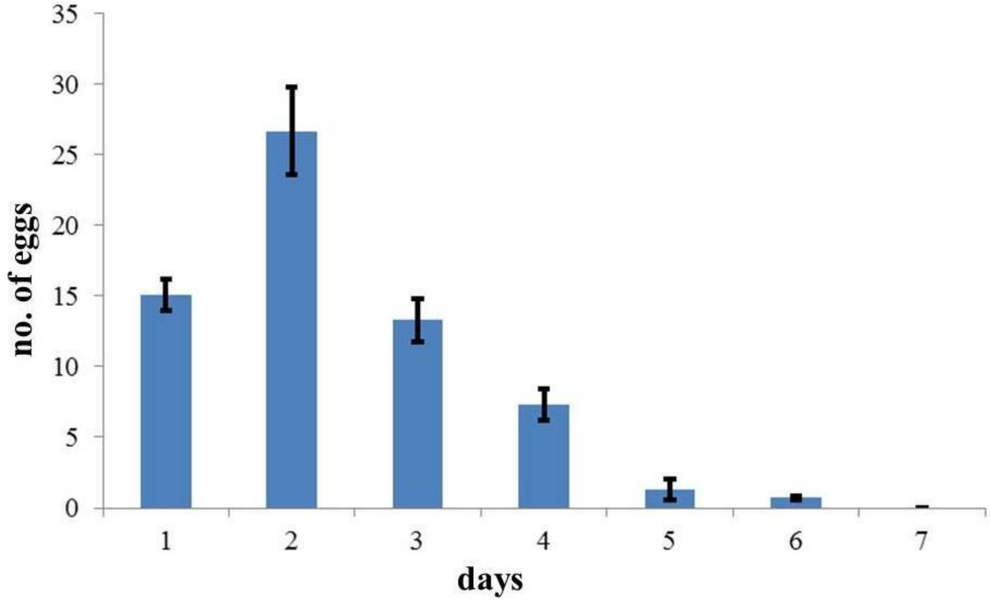

Figure 5. Oviposition rate of *C. cephalonica* (number of egg per female per day) at 25±2 ˚C 70% RH laboratory condition.

Table 2. The life period of *C. cephalonica* (egg, larva and pupa, adult) on the five different artificial diets

Artificial diets	Egg (days)	Larva and pupa (days)	Adult (days)	Total life cycle (days)
I	6±0	14.4±0.6	5.6±0.8	26±0.82
II	6±0	13.8±0.4	6±0.9	25.8±1.13
III	6.2±0.4	18.1±1.3	5.3±0.9	29.6±1.6
IV	6.1±0.3	16.9±0.9	5.2±0.9	28.2±1.4
V	6.2±0.4	17.5±1.1	5.1±0.9	28.8±1.1

3.5 Parasitism rate of T. japonicum T. rowani and T. schoenobii

Parasitism rate of *T. japonicum*, *T. rowani* and *T. schoenobii* were conducted on the host eggs of *C. cephalonica*. The parasitism rate of *T. japonicum* is 37±4.1 % while while *T. rowani* and *T. schoenobii* cannot parasitize on host eggs of *C. cephalonica* at 25±2 ˚C 70% RH laboratory condition (Figure 6).

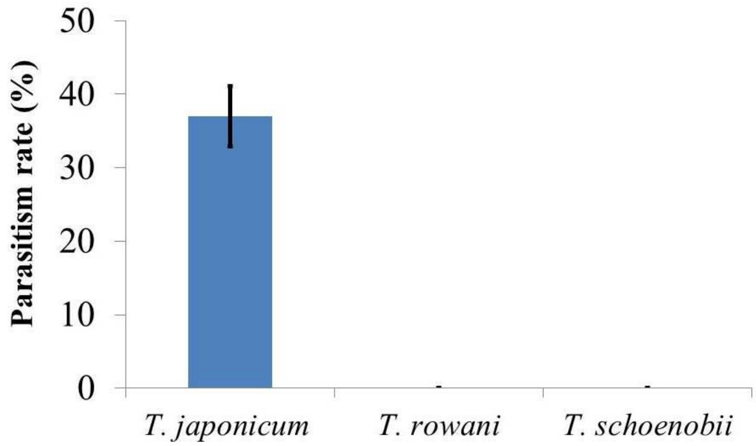

Figure 6. Parasitism rate of native egg parasitoids on the host eggs, *C. cephalonica* at 25±2 ˚C 70% RH laboratory condition. Blue color bar represents the parasitization percentage of *T. japonicum* is 37±4.1 while *T. rowani* and *T. schoenobii* cannot parasitize on host eggs of *C. cephalonica* at 25±2 ˚C 70% RH laboratory condition.

4. **Discussion**

In rice crop, the estimate population of stem borer and egg parasitoids in the middle of field is greater than edges of the field (January et al., 2018). In this research, rice stem borer distribution and native parasitism rate is higher in the middle of field than any others. The parasitization range reach a peak as 97.56% in October, while the *Telenomus* and *Tetrastichus* was more during October in Hyderabad (Varma et al., 2013). The parasitization percent on rice stem borer in Mandalay region, Myanmar reached at a peak at the end of September. In India, the highest incidence of deadhearts and whiteheads was noticed during third week of April and third week of May (Pallavi et al., 2018). In Mandalay Region, Myanmar, the highest incidences of deadhearts and whiteheads were indicated at early April and June in summer seasons while at the end of October and November in rainy seasons.

While the comparative analysis on stem borer and egg parasitoids, the population of stem borer is converse ratio with egg parasitoids (Reuolin et al., 2018). We indicated that the ratio of rice stem borer incidence and native parasitism rate is also converse. The yield increase by reducing damaging symptons of yellow stem borer as deadheart and whitehead in both vegetable and reproductive stage of rice in 2009-10, 2010-11 and 2011-12 at West Bengal (Chatterjee and Mondal, 2014). In Myanmar, deadhearts and whiteheads damage symptoms of rice stem borer is more populated in rainy seasons.

Although there are four stage of parasitoids (egg, lava, pupa, adult), egg parasitoids is predominant than any other on both developmental stage and reproductive stage of yellow stem borer in rice (Chandramohan and Chelliah, 1990). We mainly focused on the only egg parasitoids in rice stem borer in this research. Native egg parasitoid, *T. japonicum* from the field is significantly larger in body size and ovipositor length than mass rearing of *T. japonicum* and *T. chilonis* on *C. cephalonica* (Tang et al., 2017). In this research, the body size and ovipositor length between native and laboratory rearing (first generation) of *T. japonicum* on the host egg *C. cephalonica* is the same size even our target is not mass rearing. *T. rowani* and *T. schoenobii* parasitized to the rice stem borer in Indonesia and the releasing of increased dosage parasitoids increase parasitization intensity as 236% (Yunus, 2018). *T. japonicum*, *T. rowani* and *T. schoenobii* attacked to the rice stem borer with the highest 54% by *T. schoenobii* in Mandalay region, Myanmar.

Although the three species of egg parasitoids on yellow stem borer were found in Jambi Province, Indonesia, *T. japonicum* can only rear on *C.cephalonica*, host eggs (Wilyus et al., 2013). It is the same in Myanmar, although we found three types of egg parasitoids *T. japonicum*, *T. schoenobii* and *T. rowanii* in Mandalay region, Myanmar, we can rear only *T. japonicum* on the *C. cephalonica*, host eggs at 25±2˚C, 75±2RH condition. *Telenomus* species were the most common and most dominating species in some crops and become adaption among the other species of *Trichogramma spp* and *Tetrastichus spp* (Hikim, 1988). In Mandalay region, Myanmar, *T. schoenobii* is dominant as 54% among the *T. japonicum and T. rowanii*.

The impact of insecticides (deltamethrin, chlorpyrifos, Cygon) yearly high dose application is efficient against rice stem borer in Jalin province, China (Chen and Klein, 2012). In Mandalay region of Myanmar, local insecticides applications is intensive application, one plot by one plot approach which is not effective. Evaluation of *T. japonicum* performance on the rice pests in comparison to chloropyriphos and Azadirachtin against rice stem borer (*S. incertulas* and *S. innotata*) were conducted on the farmer's field in India (Upamanya et al., 2013). In this research, although we chose the farmer's field with the high production of rice, we chose by recording the history of intensive used of pesticides. Augmentation model of *T.*

japonicum for rice stem borer effect a slightly without the model in organic farm in Indonesia (Syarief and Erdiyansyah, 2010). The augmentation model is unavailable for the area wide program in Myanmar because of the high cost. The egg mass parasitization was not effected with the insecticide application among the *Trichogramma* species, *Telenomus* species and *Tetrastichus* species with the similar result of untreated control (Vennila et al., 2018). In this research, rearing of *T. japonicum* is an effective approach for the biological control of rice stem borer. A comparison with the data already published shows that the devastating power of yellow rice stem borer and *Trichogramma* species has so far been underestimated (Shazali, 1986). Here, the parasitism rate of parasitoids on the rice stem borer has direct ratio with the distribution of rice stem borer.

C. cephalonica rearing on the rice bran, sugar and yeast is the best artificial diet with the reducing total life cycle and oviposition period among the six artificial diets (Bernardi et al., 2000). We found that the best artificial diet for shorten life cycle is the mixture of rice bran and sucrose. 3% dextrose and yeast composition diet namely Italian millet was the best media for mass rearing of *C. cephalonica* among the 12 different combination of artificial diets (Chaudhuri and Senapati, 2017). The local rice bran is also suitable media in rearing of *C. cephalonica* for the biological control approach. The developmental period of larva was the fastest at 70% RH as 34.1 days and slowest at 50 % RH as 43.3 days although relative humidity did not affected the pupal duration (Mbata, 1989). We discovered that the developmental period of *C. cephalonica* larva is 18.1 days at 25±2˚C, 75±2RH condition.

5. Conclusion: In every year**,** rice were cultivated in two times such as summer season (Apr, May, Jun) and Rainy season (Sep, Oct, Nov) at Mandalay region, Myanmar. The rice stem borer incidence with number of egg per plant, parasitism rate, deadhearts and whiteheads percentage in rainy season is significantly higher than in summer season of Mandalay region, Myanmar during 2012 to 2015. Three types of parasitoids such as *T. japonicum, T. rowani and T. schebonii* were discovered in egg mass of rice stem borer with the dominance of *T. schebonii*. The oviposition rate of *C. cephalonica* reached at a peak in second day while the best artificial diet is based on rice brans. Among the *T. japonicum, T. rowani and T. schebonii,* only *T. japonicum* can be reared on the egg of *C. cephalonica*. Therefore, our results reveal that rice stem borer distribution increase year by year particularly in rainy season at Mandalay region, Myanmar and rearing of *T. japonicum* on the *C. cephalonica* is the effective biological control approach on the rice stem borer.

Conflicts of Interest: The authors declare no conflict of interest.

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