The Diversity and the Abundance ofCorn Planthopper(Hemiptera: Delphacidae)inLampung Province

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The outbreak of delphacid planthoppers has been detected across corn-growing regions in South Lampung. Survey study was conducted in three corn fields in Natar District,South Lampung Regency. In each study site, five corn plants were randomly sampled. In each sampled plant, one leaf with maximum number of planthoppers was selected for population recording. Based on the morphological identification results, there were two types of corn planthoppers attacking corn fields during sampling periods: the white bellied-planthopper, *Stenocranus pacivicus* Kirkaldy and *Peregrinus maidis* Ashmead. During sampling periods, S. *pacivicus* was most abundant species, while, the *Peregrinus* planthopper was almost undetectable. There was similar trend peak of density *S. pacificus* brachypters & nymph and macropters among the three corn fields. The maximum number of *S. pacificus* brachypters & nymph 412.38 ±23.12 individuals' leaf^{-1} was recorded at 70 days after planting (DAP). While the *S. pacificus* macropters reached the highest population number 43.81 ± 5,76 individuals leaf^{-1}. Extended feeding activity by planthoppers caused the chlorosis and necrosis of the leaf, reduced plant vigor, and stunting, resulting hopperburn symptoms. The results of this study confirm that the explosion of delphacid planthopper sand corn hopperburn are real and become a threat for corn production in Lampung Province.

keywords: *Stenocranus pacivicus*, *Peregrinus maidis*, population-outbreak, corn-hopperburn

1. Introduction

The corn planthopperoutbreak, is a new phenomenon in Indonesia, especially in Lampung Province. There are several types of delphacid-planthoppers attacking corn plants. The corn planthopper, *Peregrinus maidis* (Ashmead) (Hemiptera: Delphacidae), is one of the most common planthopper that attack corn (*Zea may*s L.) in many tropical and subtropical corn-growing regions throughout the world [1][2][3]. Nevertheless, in Indonesia, *P. maidis* planthopper attack only sporadically with low attack rate, so this pest is considered as a minor pest of maize[4][5].In addition to *P. maidis*, delphacid leafhoppers that commonly attack the corn plant is *Sogatella vibix* (Haupt) (Hemiptera: Delphacidae [6][7], Furthermore, Susilo *et al*. [8] reported that the newly-found delphacid planthoppers that attack corn plants in South Lampung the white-bellied planthopper *Stenocranus pacificus* Kirkaldy (Hemiptera: Delphacidae).

Extended feeding activity by planthoppers on corn plants can cause "hopperburn"[9],[10]. Symptoms of hopperburn are characterized byleaf chlorosis, followed by necrosis, reduced plantvigor, and stunting[11]. In addition to direct-feeding damage, this planthoppers pest also can act as a vector of plant viruses. In other words, the delphacid-planthoppers have the ability to transmit wide variety of plant viruses [1][2][3] [12][13]. According to Ammar *et al*.[14], planthopper*P.maidis* transmits two corn

viruses, maize mosaic virus (MMV, Rhabdoviridae) and maize stripe virus (MStV, Tenuivirus). Both MMV and MStV are transmitted in a persistent and propagative manner [15].

The objectives of this study were 1) to characterize the composition of the delphacid-planthoppers pattern attacking corn plants in Lampung province; and 2) to determine the population dynamics of delphacid planthoppers.

2. Materials and Methods

Study Sites. Field studies were carried out in Natar area, South Lampung, one of the main corn production area in Lampung province. The planthoppers were observed at three sites of corn fields. Site 1 was located at Agricultural College Experimental Station of Lampung University. While site two (Yono's field) and three (Jalal's field) were the corn fields own by the local farmers with minimum size of 0,5 ha at early corn vegetative-stage (± 3wk after plant emergence). The study area is mainly a flat agricultural land with an almost identical farming activity.

Leafhopper Sampling. Sampling activity was starting from on 25th March 2017 and continued at two weeks intervals for5 periods of sampling dates. The sampling activity was completed on 21th May 2017. The selection of sampling sites was done purposively among the farmers whose land was given voluntarily to be observed and, on Agricultural College Experimental Station of Lampung University. From each selected corn field, five of rows (beds) of corn plants were selected randomly. As a sampled plant, five plants were systematically chosen from each selected corn bed and were tagged at their base by using labeled plastics on which a distinct identification number was marked. In each sampled plant, one leaf with maximum number of planthoppers was selected for the counting. The number of all planthopper stages: adults (macropters and brachypters) and nymphs, number of leaves, number of egg-deposited leaves, and the percentage of egg-deposited leaf area were counted, the plant symptom of infected planthoppers. For the leafhopper-abundance recording, one leaf with maximum number of planthoppers of each sampled plant was selected for leafhopper-counting. The planthopper population abundance was recorded by direct counting using a hand-tally counter.

Insect Collection. Species composition of planthoppers infesting corn plant was determined during this study. For further identification, planthoppers were field collected using an aspirator. All collected-planthoppers in the aspirator were transferred into a glass vial containing 70% ethanol using a small brush. The vials were then transported to the Laboratory of Arthropod Pests Agricultural College, The University of Lampung for later handling, general morphology observation, and specimen identification. In the laboratory,
the adults primarily macropters were mounted on microscopy slides for identification. The specimen of each individual was cleared in 10% KOH to observe certain obscure features. Specimen identification and morphological examination were performed under a dissecting stereo-microscope. Specimens were identified using taxonomic key, provided by Wilson[6], Asche & Wilson [16], and Dupo & Barion [17].

3. Results and Discussions

The corn planthopper composition

Based on the morphological identification results, there were two types of corn planthoppers attacking corn fields during sampling periods. The first species was the white bellied-planthopper (*Stenocranus pacivicus* Kirkaldy) (Hemiptera: Delphacidae). The name of the white belly is derived from the characteristics of this insect which has a white coating on the abdomen particularly the female (Figure 1). During sampling periods, this species was more abundant compare to other planthoppers. According to Susilo et al. [8], the white coloration of female abdomen was closely related with the secretion and deposition of this white mass while they are laying their legs. The white-cottony wax trench on the corn leaves is one signs of the presence of the species on the corn plants. Based on white-

cottony substance of the female, Susilo et al. [8]propose a common name for this planthopper as *the corn white-bellied planthopper* (CWBP). Nelly et al. [18] also reported the existence of S. *pacificus* pest in West Sumatra Province. They further reported that these planthopper pests were found to attack vegetative and generative corn plants in three districts, namely Pasaman Barat, Lima puluh Kota and Tanah Datar.

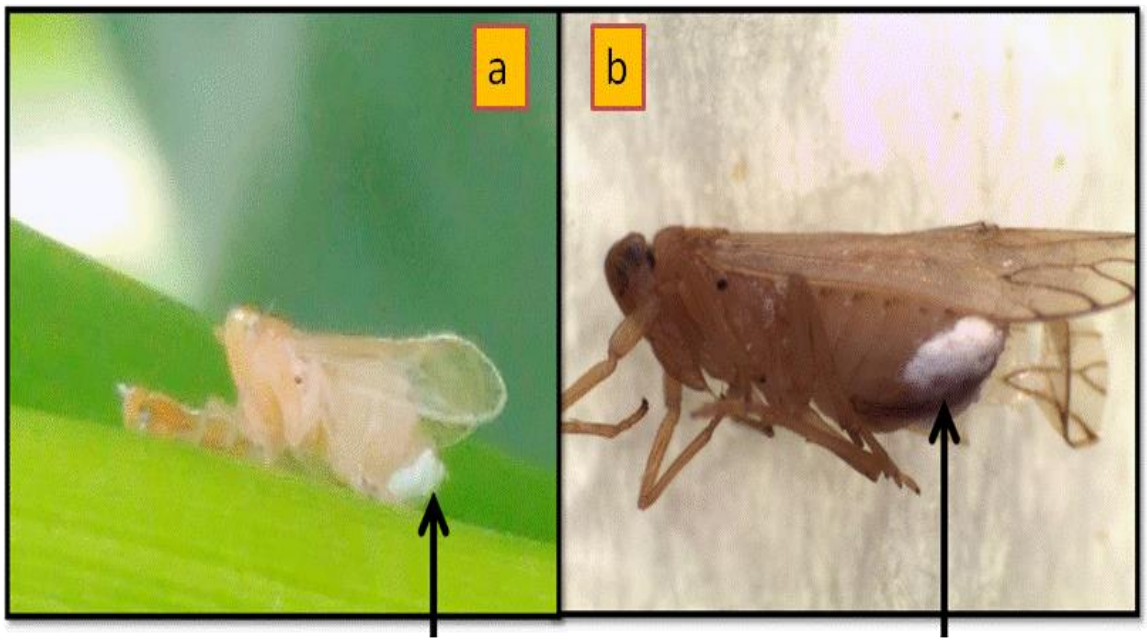

Figure 1. Female macropters of the white bellied-planthopper (*Stenocranus pacivicus Kirkaldy)* attacking corn plants. Alive macropter in the field (a) and dead specimen in the lab (b)

The scientific name *Stenocranus pacivicus* Kirkaldy was first designated in 1907 by Muir in 1916[19]. Scientific name and author year was reinforced by Fiji PHP: Taxon Details [20] as a *Stenocranus pacificus* Kirkaldy, 1907. Furthermore, this delphacid planthoppers were first reported to invade corn crops in the Philippines in 2009 and was considered to as invasive pests[21]. According to Cayabyab et al., [21], the corn planthopper was initially placed under the Sogatella genus based on genitalia features, but this insect eventually was confirmed as *S. pacificus*.[21]. Similarly, Dumayo et al. (2007) reported that *Stenocranus pacificus*, Kirkaldy (Hemiptera: Fulgoroidea: Delphacidae) was a new pest attacking many corn growing areas in the Philippines.Moreover, Dupo & Barrion [17] reported the threat of *S. pacificus* as a pest in rice plants throughout the Asia. Beside rice plants, they alsoreported that *S. pacificus* also attacked sugar cane and other grasses.

The second type of planthopper found during sampling periods was *Peregrinus maidis* Ashmead (Hemiptera: Delphacidae). In contrast to the white belly planthopper, *Peregrinus* planthopper was almost undetectable during early May to July. Only in early August, these pests were found in several corn planting locations. The *Peregrinus* leafhoppers adults are marked by dark brown body color with black spot marks on the front wingtips (Figure 2). Another characteristic of this species is the presence of a black line mark on the thorax and abdomen (Figure 2). The morphological characteristics of *Peregrinus* adult is fit with that described by Tsai and Wilson[22].

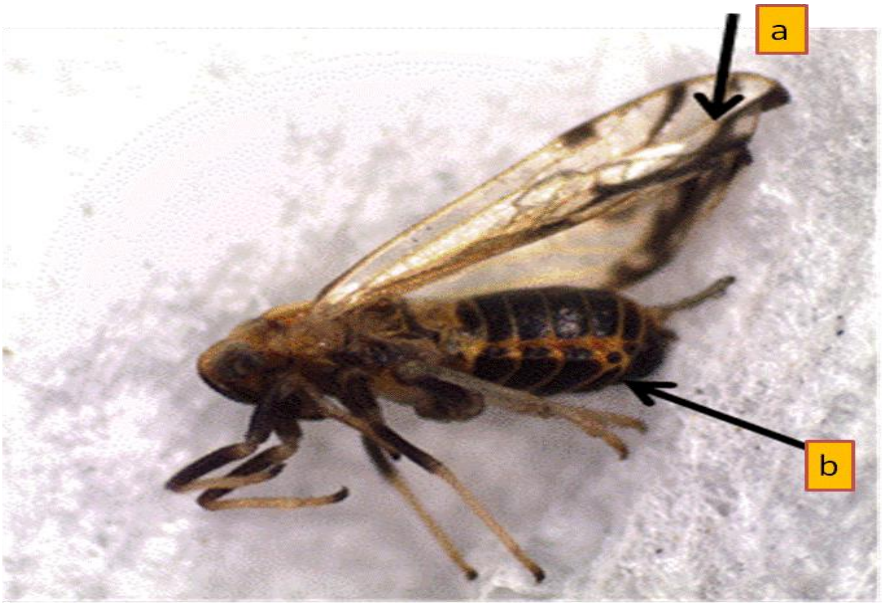

Figure 2. The corn planthopper, *Peregrinus maidis* Ashmead attacking corn plants in Lampung Province. Note the presence of black spot marks on the front wing tips (a) and also presence a black marking on abdomen (b).

The main morphological features of these two species are characterized by an enlarged tibial spur (calcar) on the hind legs (Figure 3). These characteristics are generally the main features of the genus that belong to the Delphacidae family. According to Backuset al.[11] stated that planthoppers constitute a large group of phytophagous insects in the Delphacid family and Hemiptera ordo. Moreover they found that the delphacid planthopper were distributed worldwide and all members of this group are plant-feeders and some species are considered as important pests. All planthoppers members of the Delphacidae family are mainly a group of herbivorous insects that have a mouthpart in the form of a needle-like stylet that are used for piercing and sucking plant sap. Delphacidae is one of the families commonly referred to as "delphacid stem hoppers" to distinguish it from other planthopper. According to Dupo and Barrion[17], there were 9 species of Delphacidae stem-plant hopper reported in association with corn plants in Brasilia. The nine species are *Caenodelphax taepae, Delphacidae sp-1, Delphacidae sp-2, Delphacodes saxicola, Peregrinus maidis, Pyrophagus tigrinus, Sogatella kolophon, Tagosodes cubanus, and Toya propinqua.* All these corn planthoppers were able to transmit pathogenic virus in corn plants[23],[24].Besides attacking corn plants, the delphacid planthopper of *P. maidis, S. kolophon. and T. propinqua* were also found to be associated with sugarcane and rice crops in India[18].

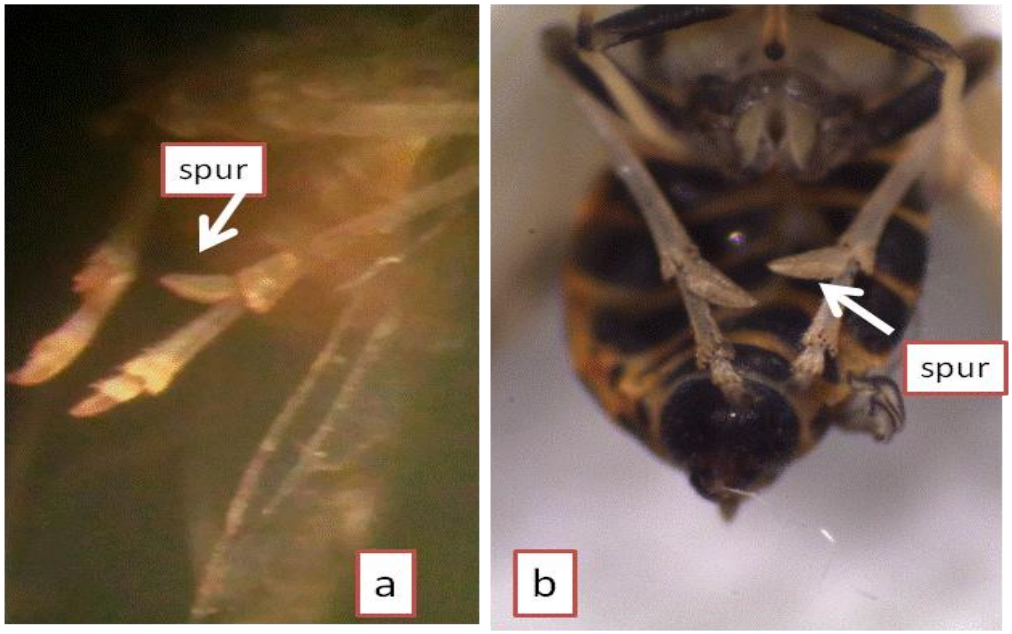

Figure3. The conspicuous tibial spurs (calcar) delphacid planthopper (a) *Stenocranus pacivicus Kirkaldy*and (b) *Peregrinus maidis* Ashmead.

***Stenocranus pacificus* Abundance**

Based on the survey study, the most abundant species of the delphacid planthoppers attacking corn plant during sampling periods (starting from 21th March 2017 and completing 21th May 2017), was *Stenocranus pacificus* Kirkaldy (Hemiptera: Delphacidae). In general, this population study indicated that the *S. pacificus* macropters and brachypters plus nymphs combined density increased as the corn plant grow (Figure 4 and 5).

At first sampling date (plant age ± at 30 DAP), only a few of this planthopper brachypters & nymphs were attacking corn plants in all study sites (Figure 4). On the site-1 (FP Unila's field) and site-2 (Yono's field) there were 1.20 ±0,25 and 28.00 ±3.37 *S. pacificus* brachypters & nymph individuals leaf^{-1},respectively. While on the site-3 (Jalal's field), there was no *S. pacificus* brachypters &nymphs found. However, as the plant age increased, the number of *S. pacificus* brachypters & nymphs were increased sharply in all corn-field surveyed. On the site-1 (FP Unila's field), the maximum number of412.38 ±23.12 planthopper individuals' leaf^{-1} was recorded on 6th May 2017 (plant age ± at 70 DAP). While, the number of *S. pacificus* brachypters & nymphs at site-2 and site-3 were peaked at 22th April 2017 (plant age ± at 60 DAP).

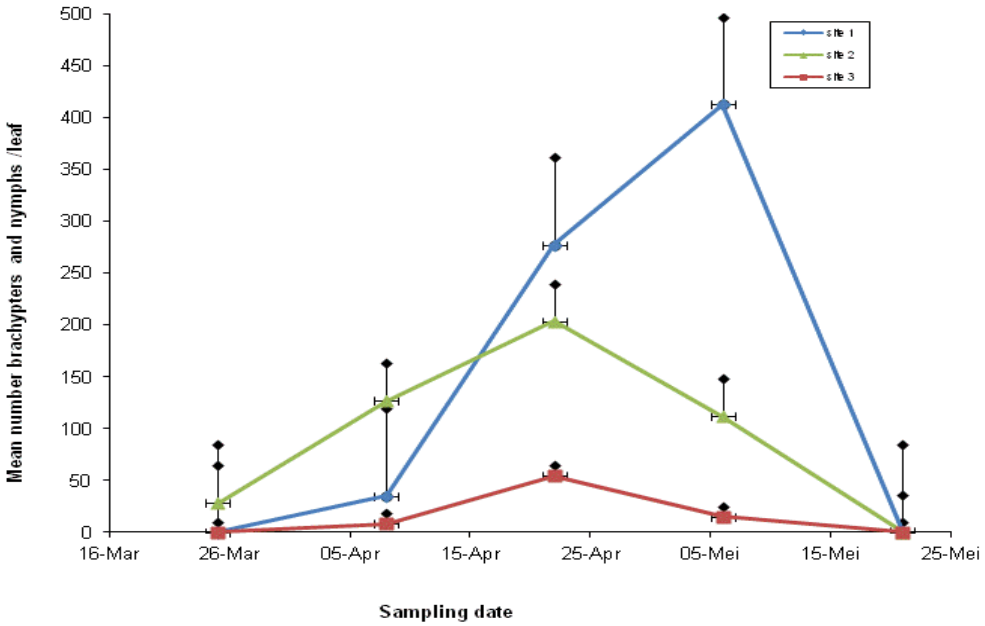

Figure4. Mean abundance of *Stenocranus pacificus*brachypters + nymphs attacking corn plants South Lampung at three study sites (Site 1 =Agricultural College Experimental Station of Lampung University; Site two =Yono's field; Site 3=Jalal's field). Noted: Bars = standard errors of the means (n = 20 plants for observation).

Similar with the population *S. pacificus* brachypters & nymph, the trend of population dynamics of S. *pacificus* macropters were resemble as that of *S. pacificus* brachypters & nymphs pattern (Figure 5). On the other hand, the population numbers of planthopper macropters in all sites were lower than that of planthopper brachypters &nymphs during sampling periods. In site-1, the highest population density of S. *pacificus* macropters, 13.81 ± 2,45individuals leaf^{-1} was achieved at 6th May 2017. While, the maximum number of S. *pacificus* macropters in in site-2 and site-3 were 43.81 ± 5,76 and 38,20 ± 8,3individuals leaf^{-1}, respectively 22th April 2017 (plant age ± at 60 DAP. It is likely that the host plant phenology may play an important role in regulating population density of S. *pacificus* in Lampung Province.

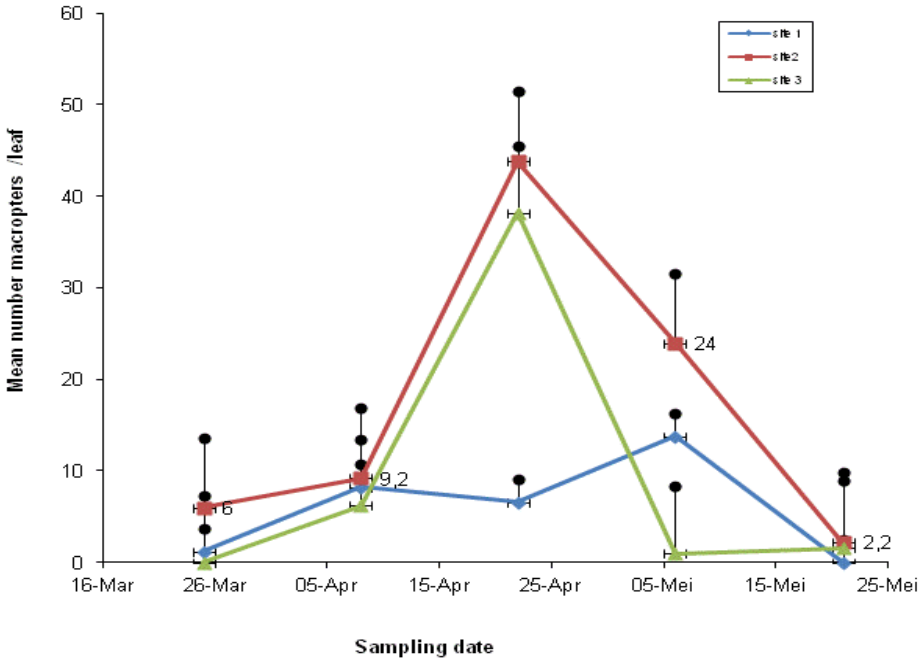

Figure 5. Mean abundance of *Stenocranus pacificus* macropters attacking corn plants South Lampung at three study sites (Site 1 =Agricultural College Experimental Station of Lampung University; Site two =Yono's field; Site 3=Jalal's field). Noted: Bars = standard errors of the means (n = 20 plants for observation).

The outbreak of *Stenocranus pacificus* in corn growing area in Lampung is a new case in which threaten the national-corn production. In general, the occurrence of insect outbreak is related to an explosive increase in abundance that occurs over a short period. Such outbreaks of corn planthoppers often have devastating economic impacts when crops are completed destroyed. According to Cheng and Zhu[26], the outbreaks of planthoppers have been triggered by misuse of insecticides, varieties with high nutrition, and other environmental factors related to cultural and climatic factors[27], [28], Cheng 1995). Furthermore, Cheng and Zhu [26]stated that the environmental factors, including cropping systems, variety, usage of chemical fertilizer and pesticide, and temperatures were found to be have impact on planthopper outbreak. On the other hand, our study indicated that one of possible explanation for outbreak *of Stenocranus pacificus* was related with *continuous* corn plantings. In 2017, Lampung Province has been assigned one as primary national corn production.

***Stenocranus pacificus* Damage**

The field study results indicated that the *S. pacificus* macropters are responsible for colonizing and laying eggs on corn plants (Figure 6.a). The *S. pacific s*female inserted its egg into the plant tissue of the mid rib leaf using its saw-like ovipositor. According to Heady and Wilson[29], the external female genitalia, in the "orthopteroid ovipositor" the fused median gonopophyses (valvula) of the 9th abdominal segment often have a serrated dorsal aspect and serve as a saw-like structure for depositing eggs, usually into plant tissues. The eggs were inserted singly its posterior and positioned near the entrance holes which was also its exit hole.

Figure 6. *Stenocranus pacivicus* macropters with white wax substance on her abdomen (a),Deposition of white-cottonywax trenches along edges of the leaf vein (b) the appearance of deposited egg inside the leaf tissue after removal of the white-cottonywax cover (c).

The appearance of *S. pacificus* eggcan be detected after removal of the white-cottony wax cover (Figure 6.c). Under stereo-microscope, it is clear that the shape of the *S. pacificus* egg is elongated (Figure 6.c). After oviposition, the female sealed its eggs using the white waxy substance in the abdomen for protection (Figure 6.b). Therefore, the early presence of corn planthopper attack can be detected by the appearance of white-cottony wax trenches or mass on the abaxial sides of the corn leaves (Figure 6.b). As a result of this oviposition behavior, someone will be difficult to locate the egg in the field. Similar ovipositional behavior also found on Dalbulus corn leafhoppers. *Dalbulus* females insert their eggs singly into corn plant tissue. The egg is positioned under the plant epidermal layer in the leaf blade or deep in the leaf midrib [30].

The field observation results indicated that the corn plants in in South Lampung, were generally heavily attacked by the *S. pacificus* of planthoppers (Figure 7a-c). After eggs hatching, planthopper nymphs' colonies emerged on the leaves. The picture of Figure7.a and 7.b that shows abundant nymphs, exuviae, and adult macropters &brachypters. The planthopper colonies stay on the lower parts of corn plants. The presence of dimorphic adults with two wing forms: macropters & brachypters were detected during sampling periods.

Early symptomatic plants harbored significantly more planthoppers at early stages of corn growth the planthopper massive attacks resulted in the loss of plant vigor and appearance of hopperburn damage (Figure 7.c). Symptoms of hopperburn are characterized by leaf chlorosis, followed by necrosis, reduced plant vigor, and stunting. According to Cheng[31],the planthopper damage on corn plants by sucking plant sap from young leaves and leaf sheaths which could lead to stunted plant growth. Moreover, Backus et al. [11]reported that feeding planthoppers move their stylets continuously or intermittently, secreting watery saliva, rupturing plant cells and then ingesting the resulting slurry yield loss.

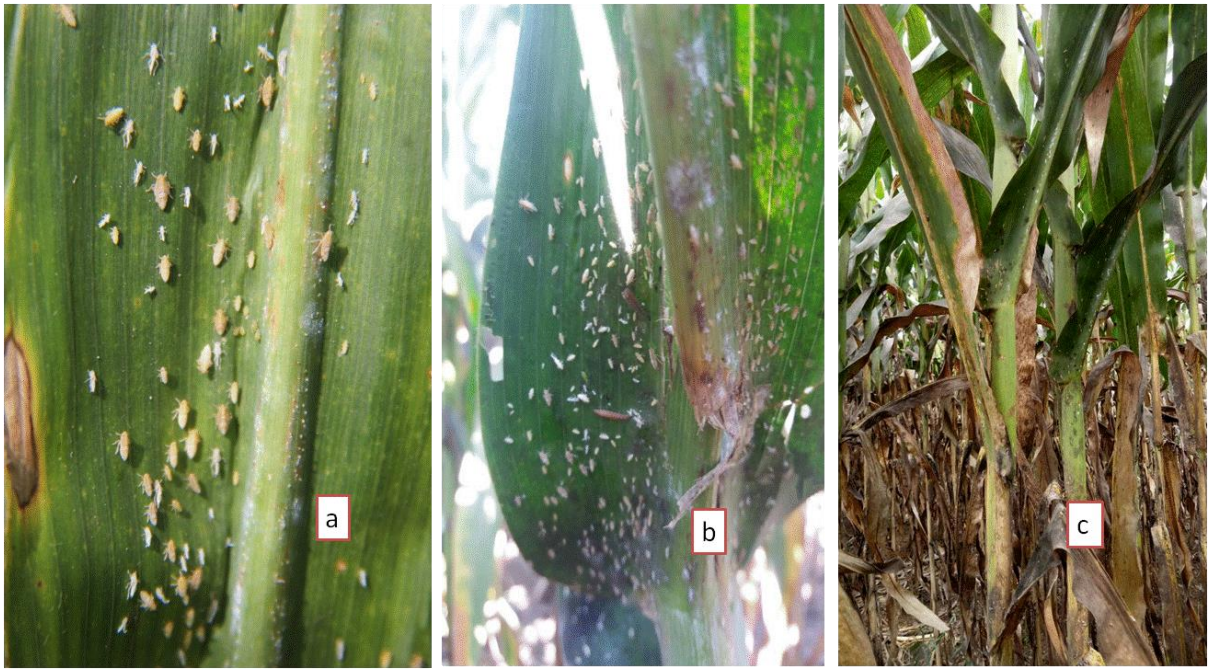

Figure 7. The *Stenocranus pacivicus* outbreak and damage: abundat number of planthopper on the midrib of the corn leaf (a), colonies on the basal of the corn leaf (b), appearance of early hopperburn symptom (c).

4. Conclusions

The corn plant in South Lampung was heavily attacked by the delphacid planthoppers. there were two types of corn planthoppers attacking corn fields during sampling periods: the white bellied-planthopper, *Stenocranus pacivicus* Kirkaldy) and *Peregrinus maidis* Ashmead. During sampling periods, S. *pacivicus* was most abundant species, while, the Peregrinusplanthopper was almost undetectable. The maximum number of S. *pacificus* macropters in site-1, site-2, and site-3 were 13.81 ± 2,45, 43.81 ± 5,76 and 38,20 ± 8,3individuals' leaf^{-1}, respectively. The extended feeding activity by planthoppers on corn plants cause the chlorosis and necrosis of the leaf, reduced plant vigor, and stunting, resulting hopperburn symptoms. The results of this study confirm that the explosion of delphacid planthoppers and corn hopperburn are real and become a threat for corn production in Lampung Province.

Acknowledgements

Appreciation is extended for Prof. Dr. Hasriadi Mat Akin (Rector of the University of Lampung) and Warsono, Ph.D (chairman of LPPM Unila) for supporting this research. We are also grateful to Prof. Irwan Sukri Banuwa (Dean of Fakultas Pertanian Universitas Lampung, FP-UNILA) for accommodation support. We thank Mr. Jalal & Mr. Yono, farmers in Natar area, South Lampung, for permitting us to observe their corn fields and for their participation in the observations. This research was funded by the Professor Research Grant of DIPA BLU UNILA Series #806/UN26.21/PP/2017. This manuscript is part of the outcome of the UNILA's Profesor Research Grant.

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