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Short Communications

Occurrence of Cassava Lace Bug *Vatiga illudens* (Drake, 1922) (Hemiptera: Heteroptera: Tingidae) in Bali, Indonesia

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ABSTRACT
Cassava Lace Bugs (*CLB*) are native pest of cassava (*Manihot esculenta* Crantz, Euphorbiaceae) to the Neotropical Region, mainly in Brazil. On the other hand, East Java was the first region in Indonesia to record the presence of *CLB* in 2021, however, it has not been reported in other regions in Indonesia. Therefore, the very importance to recognise the occurrence of *CLB* in other regions in Indonesia. Based on this, the research has been carried out starting with a field survey, observing behaviour of insect in the field and identify morphologically in the laboratory. The survey results show that the infestation of *CLB* has been found in lowland, medium, and highland areas in Bali. Symptoms of infestation on the upper leaf surface are small yellow spots with brownish variations. Based on the identification key, *CLB* from Bali Indonesia, shows a characteristic of a head with a pair of frontal spines. Based on this evidence, the *CLB* insect can be identified as *Vatiga illudens* (Hemiptera: Heteroptera: Tingidae). It is the first report of novel distribution areas for *V. illudens* in Bali, Indonesia. The results of this research are important because *V. illudens* is one of the main pests of cassava.

Cassava Lace Bug (*CLB*) is a significant pest of cassava plants (*Manihot esculenta* Crantz, Euphorbiaceae) that are profuse on the undersides of the leaf (Fialho et al. 2009; Bellotti et al. 2012). When exposed to light, the nymphs and adults are extremely active beneath the leaf's surface. This insect damages plant leaf by sucking the liquid from cassava leaf. There are five species of *CLB* (Froeschner 1993), but only two have an economic impact on cassava, *Vatiga illudens* and *V. manihotae* (Bellon et al. 2012; dos Santos et al. 2019). Both species are indigenous to the Neotropical Region (Central America, the Caribbean, and South America), primarily Brazil (Froeschner 1993; Bellon et al. 2017). According to the report by Puspitarini et al. (2021), *CLB* was discovered for the first time in Indonesia, in the East Java region, but has not been reported in any other regions of Indonesia including Bali. Before report by Puspitarini et

al. (2021), the occurrence of the *CLB* in Indonesia has not been documented, including in "The Pests of Crops in Indonesia" (Kalshoven 1981). As well as according to the Indonesian Agency for Agricultural Research and Development, *CLB* has not been distributed in Indonesia (Saleh et al. 2013). If we look at the occurrence of *V. illudens* in Indonesia, it is very similar to *Phenacoccus manihoti*, an invasive pest from South America. *P. manihoti* first entered Africa in 1973 (Schulthess et al. 1991). Then in 2008, the pest was reported to have entered Thailand (Parsa et al. 2012). In 2010, *P. manihoti* entered Indonesia for the first time in Bogor (Muniappan et al. 2011; Muhammad et al. 2019). Likewise, *P. manihoti* entered Bali Province in 2010 (Supartha et al. 2020), and now is it the main pest in Indonesia as well Bali.

Given that *CLB* is native to the Neotropics, like the Neotropical cassava pest *P. manihoti* which entered Indonesia in 2010, the presence of *CLB* must be monitored, as a basis of future control. *Vatiga* spp. infestations was reported as main pest of cassava indicating a yield loss of 39% (Bellotti et al. 1999), and 48–55% (Fialho et al. 2009). Based on this, it is necessary to conduct research in regions other than East Java, including Bali. The research about identifying and mapping these pests is necessary to facilitate further control measures, such as policy-based controls like quarantine.

During the field survey of Cassava mosaic virus vector in January-February 2023 in low (0-400 asl), medium (400-800 asl), and high land (>800 asl) areas in Bali, we found lace bugs in cassava. Sample collection was based on the presence of cassava plants in low, medium and high land area in Bali. Mapping the distribution of the *CLB* pest in the Province of Bali, Indonesia, began with the collection of secondary data to analyse the potential locations of the *CLB* pest. Field surveys were conducted to record the coordinated location of the *CLB* pest. The coordinate point data was then converted into spatial data in a shapefile (shp) format. The spatial data were then arranged to produce a map of the *CLB* distribution in the Province of Bali. When an insect was found in the field, the insect's behaviour was observed and documented, the photo of living individuals of *CLB* in the host plant was taken with Olympus OM-D camera, E-M 1, 50 mm Macro lens. The *CLB* was transported to the laboratory by placing it in 70% alcohol (Bellon et al. 2012). At the Laboratory of Plant Pests and Diseases, Faculty of Agriculture, Udayana University, insect samples were prepared for morphological identification under the microscope Nikon smz25. The characterisation of insect morphology was matched with a key determination from a previous publication by Puspitarini et al. (2021), and validation of the identification process was conducted by Puspitarini.

Based on the survey of the distribution of *CLB* in Bali, it is discovered that *CLB* was found in the lowlands, including the Sesetan (Denpasar), Peguyangan (Denpasar), Munduk Pakel Gadungan (Tabanan), Margarana (Tabanan) areas; medium, including Sidemen (Karangasem), Baturiti (Tabanan); and highland in the Pancasari area (Buleleng). Complete location data and altitude are presented in Table 1, and the distribution map is presented in Figure 1.

CLB is a pest originating in the Neotropics (Froeschner 1993). Currently, *CLB* is already in Indonesia (East Java). In East Java *CLB* was discovered in Malang, Pasuruan, Blitar, Mojokerto, and Probolinggo, according to the findings of Puspitarini et al. (2021). In addition, the distribution of *CLB* Bali has not been reported. As with the invasive parasite *Phenacoccus manihoti* Matile-Ferrero (Hemiptera: Pseudococcidae) on cassava crops in Bali and Indonesia (Muniappan et al. 2011; Supartha et al.

Table 1. The areas of distribution of cassava lace bugs in Bali.

No.	Location	Regency	Altitude (masl)	Coordinate
1	Sesetan	Denpasar	10	8°41'42"S,115°12'50"E
2	Peguyangan	Denpasar	62	8°37'20"S, 115°13'20"E
3	Munduk Pakel Gadungan	Tabanan	264	8°27'39"S, 115°05'15"E
4	Margarana	Tabanan	289	8°27'49"S, 115°09'53"E
5	Sidemen	Karangasem	445	8°27'09"S, 115°27'45"E
6	Baturiti	Tabanan	806	8°20'23"S, 115°11'16"E
7	Pancasari	Buleleng	1200	8°15'04"S, 115°09'05"E

Figure 1. Distribution map of cassava lace bugs (*CLB*) in Bali.

2020), *CLB* must be monitored seriously, to provide the future control.

The symptoms that observed in the field, it is possible to use as a reference to determine the infestation of *CLB*. Symptoms of attack on the upper leaves surface are small yellow spots with brownish variations (Figure 2A). If the attack is heavy, the spots spread across the plant leaves (Figure 2B). Severe attack on young shoots of cassava plants is indicated by symptoms of curling with a brownish yellow colour (Figure 2C). *V. illudens* is a *CLB* species that is very detrimental to cassava plants (Bellotti et al. 1999). According to Bellotti et al. (2012), yellow spots due to *CLB* feed the cassava leaf by sucking the parenchyma cell's protoplasm. It is also reported that heavy damage could reduce cassava production. This is due to leaf damage, characterized by early leaf loss and complete defoliation in cases of severe infestation (Fialho et al. 2009; Bellotti et al. 2012). The symptoms that are caused by *CLB* have almost the same symptoms as other insect attacks such as curled leaves caused by *Phenacoccus manihoti* (Supartha et al. 2020). Therefore, attack symptoms are not an absolute measure to determine the presence of *CLB*. Further research is related to measuring the severity of pest attacks in detail to confirm the effect of *CLB* attacks on reducing yield.

Figure 2. Variation of attack symptoms from the cassava lace bugs (*CLB*) in the form of necrotic spots symptom on its leaves, **A.** Symptoms of attack on the upper leaves surface are small yellow spots with brownish variations, **B.** If the attack is heavy, the spots spread across the plant leaves, **C.** Severe attack on young shoots of cassava plants is indicated by symptoms of curling with a brownish yellow colour.

Lace bugs are generally identified by the lace-like appearance of the dorsum (Figure 3B, 4B, 5B). This is in line with the research by Cho et al. (2020). Morphological identification was carried out following the results of previous publications (Froeschner 1993; Bellon et al. 2012; Puspitarini et al. 2021). Referring to these morphological characters, the key to identification is the head with a pair of frontal spines (median spine), antennal segment I, and the costal area of the hemelytron. According to Bellon et al. (2012), *Vatiga illudens* has small thorns at the anterior angle of the head near the antennae, while *V. manihotae* has a solitary central thorn. Based on this key, the sample from Bali, Indonesia, exhibits the following characteristics: a head with a pair of frontal spines (sometimes lacking one of the pairs, but the position is not in the centre) (Figure 4E, 5E). According to Froeschner (1993) the *V. illudens* has antennal segment I (scape) not longer than head (Figure 4F, 5F). According to Puspitarini et al. (2021) costal area of hemelytron with two rows of areolae without apex throughout its length (Figure 4D, 5D). Those keys show that this species is clearly compatible with *V. illudens* (Figures 3, 4 and 5). *V. illudens* underwent several instars marked by molting (Figure 3AC). Nymphs measure ± 1.5 mm (Figure 3A), adult males measure ± 2.5 mm, and adult females measure ± 2.8 mm (Figures 4A,B,C, and Figures 3B, 5A,B,C, respectively). *V. illudens* lives in groups the lower surface of cassava leaf (Figure 3E,F), and when exposed to sunlight, it moves very quickly.

Male insects (Figure 4) and female insects (Figure 5) are difficult to distinguish based solely on their morphological characteristics. Adult male and female insects have a brownish yellow colour. The difference between the two can be seen in the ventral abdomen (Figure 6). The adult female has a single groove along the midline of the ventral side of the apical part of the abdomen. The adult male has no groove at the apical part of the abdomen (Figure 6), the morphological character was compared with previously report by Puspitarini et al. (2021). Male insects have a distinctive part like nails (claws) at the end of their abdomen (Figure 6B), while females do not have them (Figure 6A). Finally, we conclude the cassava lace bugs (*CLB*) from Bali Indonesia was identified as *Vatiga illudens* (Hemiptera: Heteroptera: Tingidae). The first report of novel distribution areas for *V. illudens* in Bali Indonesia. Information about the presence of this pest is important as an effort to prevent the spread of *CLB*. This is because *CLB* is not a native pest in Indonesia, it is feared that it will become an invasive species such as *Phenacoccus manihoti*.

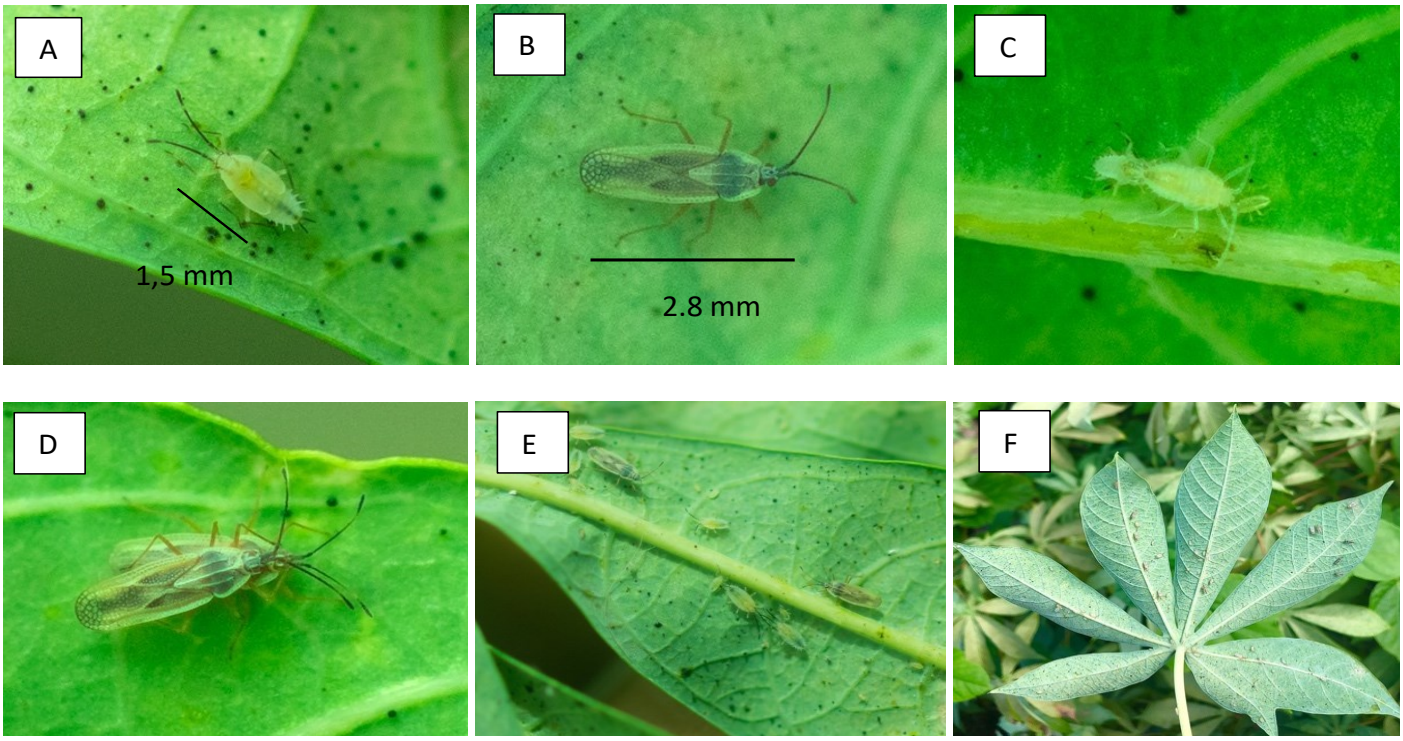

Figure 3. Living individuals of cassava lace bugs in the field, **A.** Nymph, **B.** Imago, **C.** Molting nymph, **D.** Mating pair of adults, **E-F.** a Colony of cassava lace bugs on the lower surface of cassava leaf. Photos were taken with an Olympus OM-D camera, E-M 1, 50mm Macro lens.

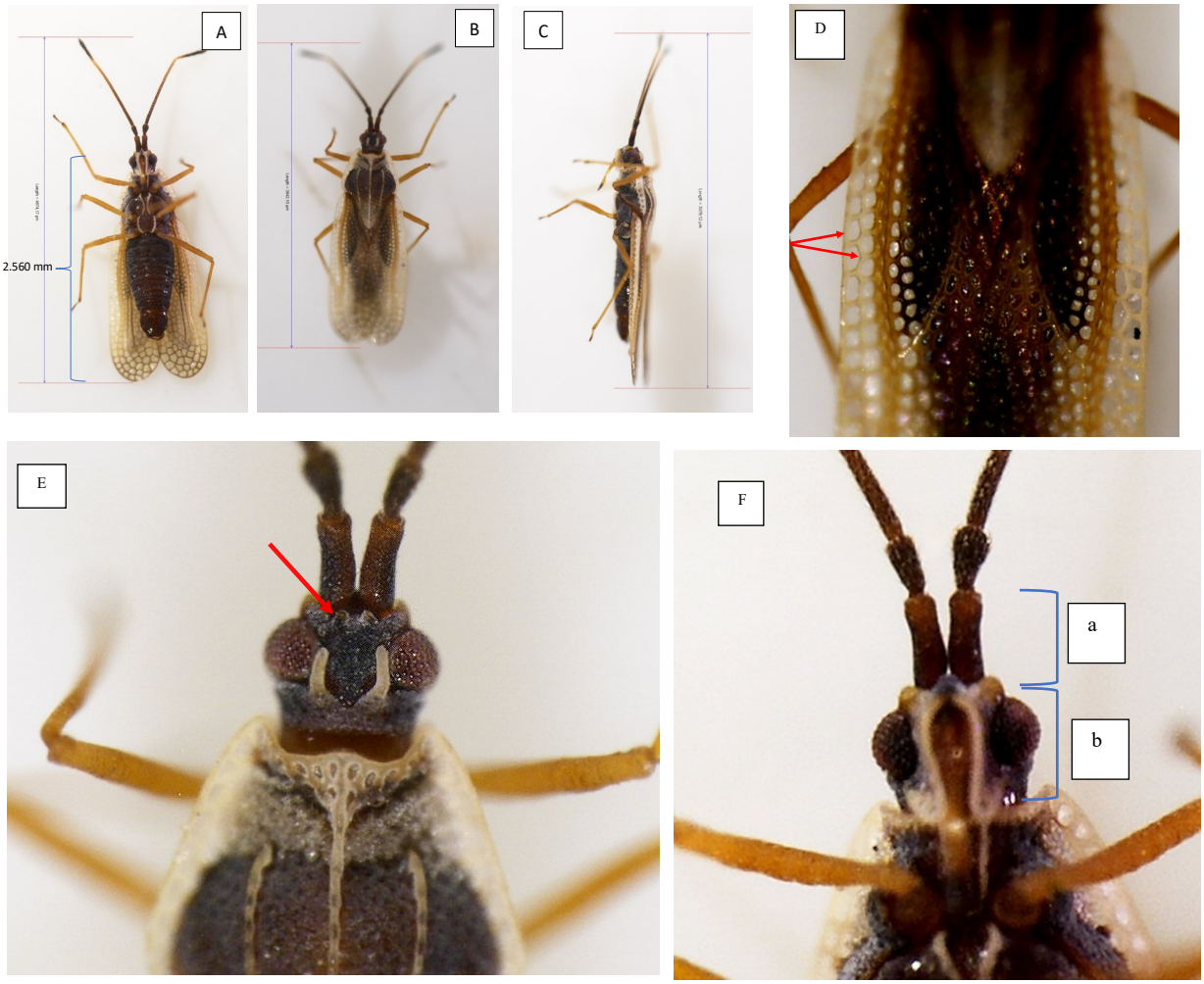

Figure 4. The male morphological characters of *Vatiga illudens* ventral, dorsal, and lateral view, head and antenna character, **A.** Ventral view, **B.** Dorsal view, **C.** Lateral view, **D.** Dorsal view of hemelytra showing the costal area, **E.** Head with a pair of frontal spines, and **F.** Antennal segment I (scape) not longer than head, a. The scape (first segment), b. head.

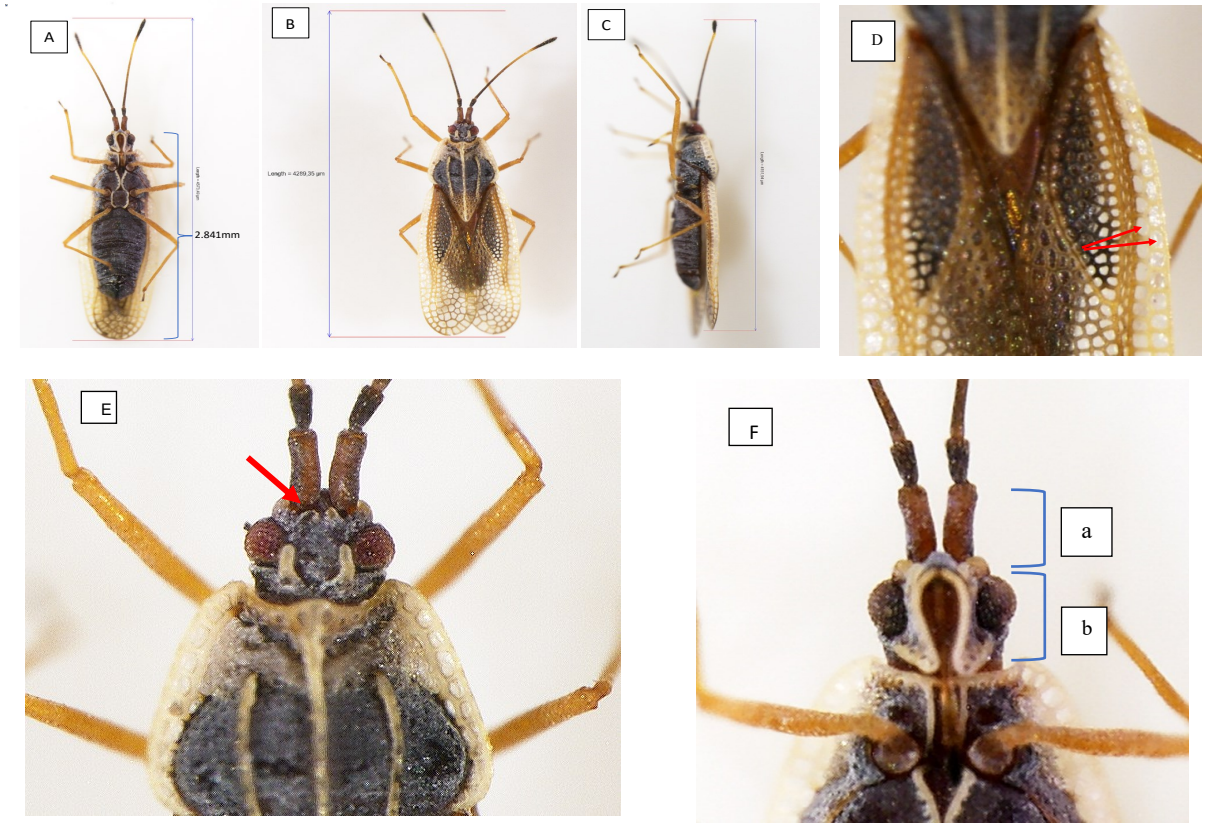

Figure 5. The female morphological characters of *Vatiga illudens* ventral, dorsal, and lateral view, head and antenna character, **A.** Ventral view, **B.** Dorsal view, **C.** Lateral view, **D.** Dorsal view of hemelytra showing the costal area, **E.** Head with a pair of frontal spines, and **F.** Antennal segment I (scape) not longer than head, a. The scape (first segment), b. head.

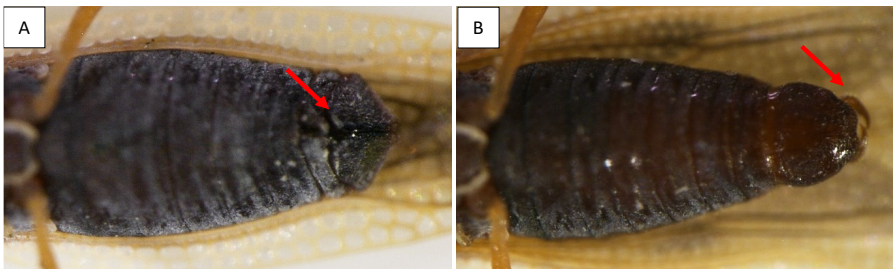

Figure 6. The differentiations of adult males and females of *Vatiga illudens* (Body ventral side), **A.** Female, **B.** Male.

AUTHORS CONTRIBUTION

IP.S., I S.M.D., K.S.D, D.S., and IP.B.A contributed to the article equally. I S.M.D., K.S.D, D.S., IP.B.A. collected the samples from the field and P.P.K.W provide the map and spatial data analysis. IP.S. and P.S.D. carried out the morphological identification. G.N.A.S.W and D.G.W.S. prepared the manuscript and final editing by IW.D.G. and K.A.Y.

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CONFLICT OF INTEREST

Authors declare that there is no competing interest regarding the publication of manuscripts.

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