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Characterization and impact of planthopper (*Sanurus indecora*) infestation on kepel (*Stelechocarpus burahol*) plants

Karakterisasi dan dampak serangan wereng pohon (*Sanurus indecora*) pada tanaman kepel (*Stelechocarpus burahol*)

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ABSTRACT

Kepel (*Stelechocarpus burahol*), designated as the floral identity of the Special Region of Yogyakarta, Indonesia, faces challenges from plant pests that threaten its sustainability. Understanding the morphology and impact of pests such as planthoppers on kepel is crucial for developing effective pest management strategies. Despite its significance, there is a gap in research regarding the specific pests affecting kepel and their impact. This study aims to identify the morphological characteristics of planthopper pests and examine their infestation levels on kepel plants. Using a qualitative method with purposive sampling, samples were collected from kepel plants identified as infected by tree planthoppers. Morphological observations identified the pest species as *Sanurus indecora* from the Flatidae family. Sampling from two infected plants resulted in 81 nymphs and 16 adult *S. indecora*. Infestation analysis showed that kepel plant XII.G.D had a 7.4% infestation rate, while XIV.G.II had a 23% infestation rate. These findings highlight the presence and impact of *S. indecora* on kepel plants, providing critical information for the bioecology of this pest. This study not only fills a research gap by documenting the pests affecting kepel but also contributes to the broader knowledge required for developing targeted pest management strategies, ensuring the conservation and health of kepel plants in Yogyakarta, Indonesia.

ABSTRAK

Kepel (*Stelechocarpus burahol*), yang ditetapkan sebagai identitas flora Daerah Istimewa Yogyakarta, Indonesia, menghadapi tantangan dari hama tanaman yang mengancam keberlanjutannya. Memahami morfologi dan dampak hama seperti wereng pada kepel sangat penting untuk mengembangkan strategi pengelolaan hama yang efektif. Meskipun kepel memiliki signifikansi yang tinggi, terdapat kesenjangan penelitian mengenai hama spesifik yang mempengaruhi kepel dan dampaknya. Penelitian ini bertujuan untuk mengidentifikasi karakteristik morfologi hama wereng dan memeriksa tingkat serangan mereka pada tanaman kepel. Dengan menggunakan metode kualitatif dan *purposive sampling*, sampel diambil dari tanaman kepel yang teridentifikasi terinfeksi oleh wereng pohon. Observasi morfologi mengidentifikasi spesies hama sebagai *Sanurus indecora* dari famili Flatidae. Pengambilan sampel dari dua tanaman yang terinfeksi menghasilkan 81 nimfa dan 16 imago *S. indecora*. Analisis infestasi menunjukkan bahwa tanaman kepel XII.G.D memiliki tingkat infestasi sebesar 7.4%, sedangkan XIV.G.II sebesar 23%. Temuan ini menyoroti keberadaan dan dampak *S. indecora* pada tanaman kepel, memberikan informasi penting untuk bioekologi hama ini. Penelitian ini tidak hanya mengisi kesenjangan penelitian dengan mendokumentasikan hama yang mempengaruhi kepel, tetapi juga berkontribusi pada pengetahuan yang lebih luas yang diperlukan untuk mengembangkan strategi pengelolaan hama yang terarah, memastikan konservasi dan kesehatan tanaman kepel di Yogyakarta, Indonesia.

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INTRODUCTION

The kepel fruit (*Stelechocarpus burahol*) is a plant that holds cultural significance in the Special Region of Yogyakarta, as established by Governor Decree No. 385/KPTS/1992 on the Identification of Flora and Fauna in Yogyakarta, Indonesia. Although not yet listed among protected flora under National Government Regulation No. 7 of 1999 or the IUCN Red List, its presence is increasingly rare. Kepel trees are also found in various provinces across Indonesia under names such as kecindul, simpol, burahol, and turalok. Internationally, this plant is known as the kepel apple (Pamungkas et al., 2023).

According to Handayani et al. (2021), the kepel tree is a woody plant that begins to bear fruit at the age of six to eight years. The fruit is round, brown, and measures between 5 and 6.3 cm in diameter. Its leaves are long, shiny, and dark green. Kepel fruit contains approximately 10% water and is rich in vitamin C, making it an effective antioxidant. Pharmacologically, kepel fruit can serve as a natural deodorant by absorbing unpleasant odors and promoting the growth of Bifidobacteria. The fruits grow in clusters on the stems of the plant and maintain a brownish color (Yuanisyak et al., 2022; Rifai et al., 2022). Kepel fruit is rich in important functional compounds. Handayani et al. (2021) reported that kepel fruit exhibits high antioxidant activity, and consuming its flesh provides significant antioxidant benefits. Additionally, the leaves of the kepel plant contain saponins, alkaloids, phenolics, tannins, triterpenoids, steroids, flavonoids, and glycosides (Diniatik, 2015). Flavonoids present in kepel have antiseptic, antioxidant, and antifungal properties, highlighting the plant's potential for therapeutic applications (Angio & Firdiana, 2021).

Currently, kepel plants face serious challenges from pest infestations, particularly by the planthopper (*Sanurus indecora*). This pest infestation threatens the sustainability and productivity of kepel plants, which have various benefits in the agricultural and health sectors. Planthoppers are common pests that attack various plants, including cashew in West Nusa Tenggara Province (NTB), Indonesia (Mardiningsih et al., 2020). These pests damage plants by piercing and sucking sap from young plant parts. Planthopper nymphs have bodies covered with white wax and can jump when disturbed. The adult planthopper lacks a wax coating but still jumps to evade threats.

Sanurus sp. is a phytophagous leaf-sucking pest known to attack various agricultural crops. *S. indecora* is the primary pest of cashew plants and is commonly referred to as the cashew shoot planthopper (Anggraeni et al., 2019). Sampling techniques typically involve the use of insect nets and sweeping methods within plant canopies, with samples selected through random sampling methods (Jihadi et al., 2023). However, this study employed purposive sampling, focusing on two kepel trees infested with planthoppers. Samples were collected using insect bottles containing 70% ethanol, and identification was conducted using a Dino-Lite microscope connected to a computer.

The current knowledge gap includes limited information regarding planthopper infestations on kepel plants in Indonesia. This study aims to fill this gap by identifying the potential threats posed by planthopper infestations to kepel plants. We believe that a deep understanding of the morphology, behavior, and ecology of these planthoppers will provide a solid foundation for developing precise and effective control strategies. Identifying planthopper pests is crucial to understanding the behavior and ecology of this species, which is essential for designing effective control strategies. Consequently, the information obtained from this study will offer deeper insights into the potential threats faced by kepel plants and provide a basis for developing effective control strategies.

MATERIALS & METHODS

The study was conducted at Plant Conservation Research Center, Purwodadi Botanical Garden, under National Research and Innovation Agency (BRIN), Pasuruan, Indonesia (7°47'57.4"S 112°44'13.1"E). Sample collection was carried out using purposive sampling, a technique chosen for its suitability in qualitative research, where specific criteria are used to select samples rather than random sampling (Sugiyono, 2016). In this case, the focus was on kepel trees located in Purwodadi

Botanical Garden. Out of a total of seven kepel trees in the garden, only two trees were identified as infested with planthoppers.

The collected planthopper samples were preserved in bottles containing 70% ethanol (Onemed, Indonesia). Subsequent identification was performed using a digital microscope with a resolution of Dino Lite AM4113T Digital Microscope (USB2.0) 1.3MP Res. 10x~200x Magnification (Dino Lite, Taiwan). This process adhered to the identification criteria detailed in Melder T. 1996), involving careful examination of the insect's morphological features, including head shape, antennae, mouthparts, wings, and legs, all of which were crucial for accurate species identification.

Data analysis included the assessment of the total number of kepel trees in the garden, with specific focus on the two infested trees. The collection method involved using insect bottles filled with ethanol, followed by microscopic examination to identify the biological, ecological, and characteristic traits of the planthoppers. The damage caused by the planthopper infestation was analyzed by calculating the percentage of infested fruit. The percentage was determined using the formula:

$$P = \frac{a}{b} \times 100\% \quad (1)$$

where P represents the infestation percentage, a denotes the number of infested fruits, and b is the total number of fruits on the plant (Purba et al., 2015).

RESULTS & DISCUSSION

The study on kepel plants revealed that, out of the total 7 kepel trees observed, only 2 trees were infested by the planthopper of the genus *S. indecora* (family Flatidae), as presented in Table 1. On the first tree, a higher level of infestation was observed, with 68 nymphs and 16 adults, while the second tree had 13 nymphs and 5 adults. The infestation by *S. indecora* led to symptoms such as penetration by the planthoppers, which caused the absorption of plant sap. These infestations manifested as prominent black spots, particularly on the tips and flower stalks of the plants.

Table 1. Collection of kepel plants (*Stelechocarpus burahol*) at Purwodadi Botanical Garden

No	Species name	Vak	Coll. Number	Access No.	Age (Year)	Infested by *S. indecora*
1	*Stelechocarpus burahol*	I.A.	48	P1977040130	45	No
2	*Stelechocarpus burahol*	VII.A.	20-ab	P2019110005	3	No
3	*Stelechocarpus burahol*	XII.G.D.	4	P1965010005	57	Yes
4	*Stelechocarpus burahol*	XIV.G.II.	8	P1997110065	25	Yes
5	*Stelechocarpus burahol*	XVIII.C.	95	P2017080206	5	No
6	*Stelechocarpus burahol*	XVIII.C.	10-10a	P1977040130	45	No
7	*Stelechocarpus burahol*	XVIII.E.	68	P2015040115	7	No

The pest *Sanurus indecora* primarily attacks Arabica and Robusta coffee plants, with a preference for Arabica. Planthoppers attack leaves, branches, and stems of the plants. On leaves, they are more commonly found on the lower surface, especially during the nymph stage, where both nymphs and imagos actively feed. These pests pierce and suck plant fluids, causing stunted growth, malformed shoots, and in severe cases, the shoots may fall off or die. The damage can be exacerbated when the wax layer is covered with sooty mold, which inhibits photosynthesis. Affected plants exhibit a dirty, blackened appearance, and photosynthesis in the leaves is significantly impaired. Sooty mold represents a fungal association with this leafhopper. Adult imagos perch on plant stems and branches, often resembling thorns. When disturbed, the imagos either move away or fly off (Harahap, 2021).

Nymphs and imagos of *S. indecora* attack plants by piercing and sucking the juices from cashew shoots, stalks, and flowers. Puncture marks can reach the phloem and xylem, resulting in affected parts appearing as blackened spots, resembling scorched dots. In high populations, *S. indecora* attacks flower stalks and flowers, causing these parts to dry out, leading to flower abortion and failure in fruit formation (Soesanthy & Trisawa, 2011). Mardiningsih (2007) reports that *S. indecora* is also found on various plants such as *Citrus sp.*, *Mangifera indica*, *Eugenia aquea*, *Nephelium lappaceum*, *Crotalaria sp.*, *Jatropha curcas*, *Bougainvillea glabra*, *Artocarpus heterophyllus*, *Eugenia cumini*, *Annona squamosa*, *Gliricidia sepium*, *Achras zapota*, *Manihot utilissima*, *Psidium guajava*, and other surrounding plants, though with lower infestation intensity.

Identification of planthopper species is based on biological, ecological, and morphological characteristics. According to study by Harni et al. (2015), significant differences exist between *S. indecora* and *L. candida*. For example, *L. candida* is approximately 12 times larger than *S. indecora*. Notable differences are also observed in features such as the carina on the anterior portion of the frons, the shape of the post-clavicular suture on the tegmen, wing venation, and the number of lateral spines on the posterior tibia. Identification of *S. indecora* in kepel plants involves examining the head, tegmen, legs, and the number of lateral spines on the hind tibia, as shown in Figure 1a. *S. indecora* has a white body measuring 8-10 mm in length, as depicted in Figure 1b, with wings positioned flat against the body.

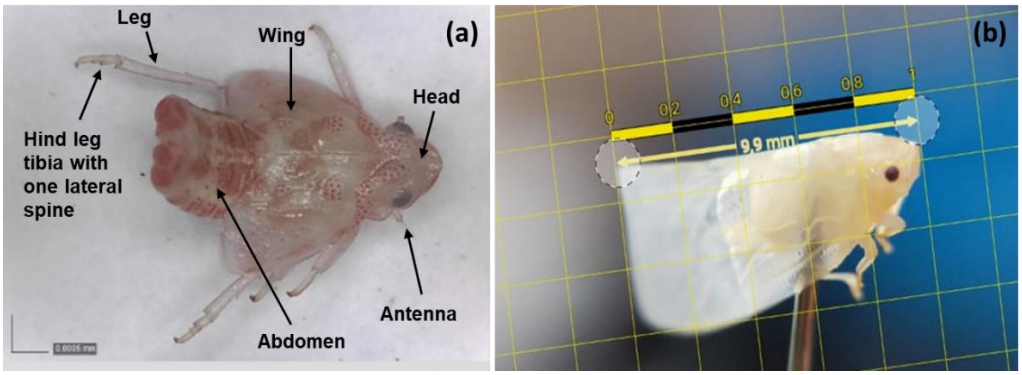

Figure 1. (a) Nymph and (b) adult of *S. indecora*

Figure 2. *S. indecora* nymph covered in a wax layer

Jihadi et al. (2023) describe green and white planthoppers in the genus *Sanurus* due to their wing and tibia characteristics, including one lateral spine. The wing venation spreads from the base, while the lower edge of the wings shows a regular venation pattern. They also note that these planthoppers are green and white, measuring 8-11 mm in length. When at rest, their wings cover their body in an upright position, forming a V-shaped structure. The tegmen widens towards the tip with the upper part forming an angle and the lower part being convex, approaching a triangular shape. The submarginal area of the wing has strong cross-venation, although its submarginal line is not very clear. Nymphs of *S. indecora* on kepel

plants are cream-colored with a sticky wax coating (Figure 2). During observation, 81 nymphs and 21 adults of *S. indecora* were found on the two kepel trees.

Figure 3. Kepel fruit stalk and kepel fruit infested by *S. indecora*

Nymphs and adults of *S. indecora* damage plants by piercing and extracting plant fluids. This feeding activity results in noticeable black spots on flower stalks and tips that resemble sores. Upon inspection, these spots reveal damage to the phloem and xylem (Mallarangen et al., 2011). To mitigate this damage, the fungus *Synnematium* sp. has been identified as an effective biological control agent, reducing the population of *S. indecora* on cashew plants. Moreover, studies have demonstrated that pest control strategies are more effective in polyculture farming systems compared to monoculture, offering a more environmentally friendly alternative for agricultural pest management (Mardiningsih et al., 2020).

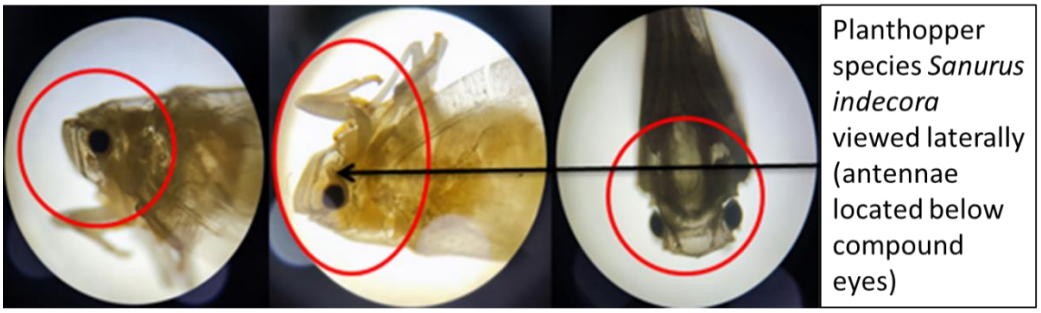

Figure 4. Head of *S. indecora*

In addition to understanding the mechanisms of plant damage and control, it is important to examine the behavior of newly hatched nymphs. Newly hatched nymphs tend to cluster in areas of young fruit, fruit stalks, and flower stalks on kepel plants, creating a distinctive behavioral pattern, as shown in Figure 3. These nymphs possess physical characteristics such as a whitish-yellow body covered with a waxy coating. *S. indecora* also features piercing-sucking mouthparts and remains active during the early developmental stages within this environment. This clustering behavior provides valuable insights into the interactions between *S. indecora* nymphs and kepel plants, as well as their interactions with the surrounding ecosystem. Adult *S. indecora* resembles a small butterfly with a pale-yellow body and legs. The head and wings of the adults show color variations, including white or reddish-white. The side tips of the head have black eyes with a brown base. The pronotum and scutellum are distinct, with the pronotum being slightly translucent white and the scutellum pale yellow, similar to the body color (Jihadi et al., 2023). The antennae are located beneath the compound eyes, as shown in Figure 4.

S. indecora pests are present in all cashew-producing villages in Buton Regency, with damage levels ranging from 8.75% to 15.64% (Awaluddin et al., 2023). Consequently, this study not only identifies the *S. indecora* pest but also assesses the extent of the damage it inflicts on kepel fruit plants, thereby providing insights into the impact of *S. indecora* attacks. During the observation period, only two kepel trees were found to be infested by *S. indecora*, specifically the kepel XII.G.D. and XIV.G.II. trees (see Table 1). The assessment focused on calculating the percentage of attacked fruits relative to the total number of fruits, as well as quantifying the losses attributable to *S. indecora*. This approach allows for a comprehensive evaluation of both the prevalence of the pest and the severity of its impact on kepel fruit production.

From the research results presented in Table 2, it is evident that the *S. indecora* pest attacks two kepel plants, namely kepel XII.G.D. with an attack percentage of 7.4% and kepel XIV.G.II. with an attack percentage of 23%. These results illustrate the vulnerability of kepel plants to *S. indecora* pest attacks. The observations show a comparison of the attack percentages between the two kepel plants. The kepel XIV.G.II. plant has a higher attack rate, reflecting a greater impact on the number of infected fruits because the kepel XIV.G.II. tree has more fruits than the kepel XII.G.D. tree. This information provides deeper insights into the impact of this pest attack on overall fruit production, which can serve as a basis for developing more effective control strategies. These research results contribute significantly to understanding the dynamics of *S. indecora* pest attacks on kepel plants and the measures that can be taken to reduce losses.

Table 2. Percentage of *S. indecora* pest infestation

Kepel Plant	Total no. of kepel fruits	No. of fruits infested by pest	Percent
XII.G.D.	391	29	7.4%
XIV.G.II.	22	5	23.0%

The *S. indecora* nymphs, which are cream-colored and coated with a sticky wax layer, tend to form groups on young fruits, fruit stalks, and flower stalks of kepel plants. The *S. indecora* adult, which is small with a yellow-pale body and legs, exhibits color variations on the head and wings. *S. indecora*, known as the cashew tip bug, is an endemic insect of Lombok Island, Indonesia, that has caused issues on cashew plants. *S. indecora* exhibits color variations including white, plain green, green with a red line along the edge of the front wings, and reddish-white or pale green (Siswanto & Rizal, 2018). *S. indecora* belongs to the Hemiptera order with simple metamorphosis, beginning from the egg, nymph, to adult stages. Eggs are laid in clusters, usually numbering 30-80, and coated with a white or cream wax layer under leaves, leaf stalks, flower stalks, and tips. The egg stage lasts about six days with almost 100% hatching rate, except for those infected by parasitoids (Siswanto & Rizal, 2018).

S. indecora attacks are generally focused on flower stalks and young fruit stalks of plants. Attacks on flower stalks can cause the flowers to dry out and hinder fruit development, while attacks on fruit stalks can cause the fruits to dry out and eventually fall off. The presence of *S. indecora* can inhibit pollinator activity, disrupting overall plant productivity (Astuti & Daniati, 2018). Newly hatched *S. indecora* nymphs remain clustered at the site, with bodies that are yellowish-white and covered with a white wax layer. Nymphs suck plant fluids around them for 2-3 weeks. Adults are relatively inactive and tend to perch on the surface of flower stalks or tips (Rismayani & Heryanto, 2020).

S. indecora is a polyphagous insect that typically attacks seasonal and perennial plants. The nymphs of *S. indecora* consist of six instars, with the duration of each instar stage ranging from 6-10 days, 6-10 days, 6-10 days, 6-10 days, 6-11 days, and 5-11 days, respectively, totaling 42-49 days for the entire nymph stage. Adults have a relatively short lifespan of 5-6 days. *Sanurus sp.* attacks leaves in the form of nymphs and adult bugs by piercing and sucking fluids, especially from young leaves or their tips. These attacks cause prominent black spots, and research shows that the punctures from this pest reach the xylem and phloem tissues, thereby disrupting the flow of nutrients within the plant. Furthermore, this pest

produces honeydew that coats the surface of the leaves, promoting the growth of sooty mold, which inhibits the process of photosynthesis (Anggraeni et al., 2019).

This study contributes to the identification of the *S. indecora* species and its characteristics on two varieties of kepel plants (kepel XII.G.D. and kepel XIV.G.II.). Biological, ecological, and morphological characteristics of the pest are detailed, including differences between nymphs and adults as well as color variations. Findings indicate that the kepel XIV.G.II. plant experiences a higher attack percentage than the kepel XII.G.D. plant, providing insights into the susceptibility levels of different kepel plant varieties to *S. indecora* attacks. These results form the basis for developing more effective control strategies to reduce the impact of this pest on fruit production. Information about the behavior of *S. indecora* nymphs and adults, including the nymphs' tendency to cluster on young fruits, fruit stalks, and flower stalks, provides insights into the pest's attack patterns. This research offers a deeper understanding of how *S. indecora* can hinder pollination activities and disrupt the productivity of kepel plants.

There are many factors influencing the sustainability of this pest in nature, and the situation is highly complex. Generally, these factors are divided into biotic and abiotic factors. If at any time the population continues to increase and there is a sudden surge in pest attacks, it indicates that one or two factors are no longer functioning due to human intervention or other factors. Findings on natural enemies, such as egg parasitoids and the fungus *Synnematium sp* (Mardiningsih, 2007), provide opportunities for developing more sustainable and environmentally friendly control strategies.

In developing natural control methods against fungal infections on *S. indecora*, understanding the environment becomes crucial (Purnama et al., 2024). Litter formed from dead organic matter, such as pruning waste and post-weeding weeds, not only affects soil structure but also alters the microclimate conditions around the plant. These changes include different levels of humidity and temperature from the optimal conditions for plant and fungal growth. In the context of natural pest control, maintaining the balance of the microclimate ecosystem around the plant becomes very important, as it can affect the effectiveness of pathogenic fungi in naturally controlling the population of *S. indecora*.

CONCLUSIONS

This study successfully identified and observed the impact of *S. indecora* infestation on two varieties of kepel trees (kepel XII.G.D. and kepel XIV.G.II.) in Purwodadi Botanical Garden. The results indicate significant damage, with an infestation rate of 7.4% in kepel XII.G.D. and 23% in kepel XIV.G.II, highlighting the vulnerability of kepel varieties and the need for effective control strategies. Additionally, the study detailed the pest's behavior, emphasizing its preference for young fruit, fruit stalks, and flower stalks, which supports the development of targeted measures to mitigate losses in kepel fruit production. However, the study's limitations include observations confined to two trees and a short time frame, which may not represent the full dynamics of *S. indecora* infestations. Further research with a larger sample size and longer observation periods is necessary to obtain more comprehensive insights.

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