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Identification of the nettle caterpillar in smallholding oil palm plantation cultivated on peatland in Ogan Ilir, South Sumatra, Indonesia

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Abstract. *Anggraini E, Setiawati T, Herlinda S, Irsan C, Mulawarman, Gofar N, Muslim A, Lau WH. 2025. Identification of the nettle caterpillar in smallholding oil palm plantation cultivated on peatland in Ogan Ilir, South Sumatra, Indonesia. Biodiversitas 26: 36-44.* Nettle caterpillars are a major pest in oil palm plantations, posing a significant threat to the productivity and sustainability of this crop. These voracious leaf-feeding caterpillars can cause severe damage, hindering plant growth, reducing fruit production, and even leading to the mortality of oil palm trees. This study aimed to identify the species of caterpillars that inflict damage, their physical traits, population densities, and the symptoms of their attacks. This study employed direct observation and documentation of caterpillar species in the field. Observations were conducted to assess the extent of damage inflicted by caterpillars in the field. Subsequently, document using a camera, collect field samples, and identification of the nettle caterpillars found in oil palm plantation cultivated on peatland in Ogan Ilir, South Sumatera, Indonesia. This investigation identified three species of caterpillars: *Setora nitens, Birthosea bisura,* and *Parasa lepida*. These three species of caterpillars typically exhibit similar coloration but possess distinct morphological traits. The *S. nitens* species predominates among the largest number of species. Caterpillars consume both young and mature oil palm leaves, remaining only in the midrib. Additional indications of the attack include perforations in the leaves. The incidence of caterpillar assaults may attain 100% of nettle caterpillar infestation, accompanied by an attack rate of 57.75%. This study concludes that three primary species of nettle caterpillar were identified in oil palm plantations, exhibiting indications of damage classified as fairly severe. Thus, effective management of nettle caterpillars is crucial to maintaining the productivity and profitability of oil palm plantations.

Keywords: *Birthosea bisura,* morphological traits**,** *Parasa lepida,* pest attack, *Setora nitens*

INTRODUCTION

Indonesia is predominantly an agriculture-based nation, with extensive plantations that contribute to its economy. Among these, palm oil is one of the primary commodities (Jafari et al. 2017), playing a crucial role in both domestic and international markets. The cultivation and productivity of oil palm are influenced by two main factors: external factors, such as climate and soil, and internal factors, which include the genetic variety of the oil palm plant (Meijaard et al. 2020). While palm oil remains the leading agricultural export, other plantation crops like cocoa, rubber, and sugarcane are expected to become significant contributors to Indonesia's export economy in the coming years. Indonesia is the world's leading palm oil producer, surpassing other major suppliers like Malaysia and Brazil, accounting for approximately 59% (or 4.8 million tons) of the global palm oil supply (Varkkey et al. 2018; Tandra et al. 2022). This dominant position highlights the strategic importance of maintaining high productivity and addressing challenges that could threaten the industry's sustainability.

One of the major challenges confronting oil palm plantations is the prevalence of pests, which can substantially hinder productivity. Pests affecting oil palms are classified based on the specific parts of the oil palm they affect, which include leaf and shoot feeders, trunk feeders, bunch feeders, and root feeders (Setiyowati et al. 2015). Among the most leaf-eating pests are nettle caterpillars, moth caterpillars, and bagworms (Mazuan et al. 2021). Oil palm leaf-eating caterpillars, including species *Darna trima, Setothosea asigna* (van Eecke, 1929), *Setora nitens* (Walker, 1855), *Ploneta diducta* (Snellen, 1900), and *P. bradleyi* (Holloway, 1986), are known for causing extensive damage to oil palm plantations (Corley and Tinker 2015).

Nettle caterpillars intensely feed on oil palm leaves, frequently perforating them or entirely consuming the leaf blades, leaving only the midrib. This substantial loss of leaf area significantly compromises the plant's photosynthetic capacity, resulting in a notable decline in its overall health and productivity (Priwiratama et al. 2018). As the leaves are the primary site of photosynthesis, the reduction in leaf area directly impacts the plant's energy production, which in turn affects fruit development. Studies have shown that infestations by nettle caterpillars can reduce oil palm production by 70%, and if a second infestation occurs within the same year, the decline can escalate to as much as 90% (Tawakkal et al. 2019). Notably, it was reported that up to 2,000 larvae were found per frond in one outbreak, with some plants experiencing up to a 60% reduction in leaf area over several days (Kamarudin et al. 2017). Rapid and widespread damage makes nettle caterpillars one of the most destructive pests to oil palm plantations. These infestations not only impact immediate crop yields but can also lead to long-term harm to the sustainability of plantations. The implementation of effective pest management strategies is crucial to minimize the impact of nettle caterpillars on oil palm plantations.

In South Sumatra, Indonesia, oil palm farming holds a crucial position in the agricultural landscape, particularly in the Ogan Ilir district, where large-scale plantations are established on peatlands. While these plantations provide significant economic benefits, they are highly vulnerable to pest infestations, including nettle caterpillars. Effective pest management strategies are essential to ensure the long-term economic and environmental sustainability of oil palm plantations in peatland areas. Understanding the biology, behavior, and ecological impact of nettle caterpillars is essential for developing targeted and sustainable pest control methods. This study aimed to identify the nettle caterpillar species present in private oil palm plantations within South Sumatra's peatland areas. By providing a detailed analysis of the caterpillars' lifecycle, feeding habits, and ecological role, the research will offer valuable insights into pest management practices that can help reduce crop losses and improve the long-term productivity of oil palm plantations cultivated on peatland area. Ultimately, this research seeks to contribute to the sustainability of oil palm farming in South Sumatra, ensuring that the industry can thrive while preserving the integrity of peatland ecosystems.

MATERIALS AND METHODS

Study area

This research was carried out in July, August, September 2024. The research was conducted at a private oil palm plantation in Palem Raya, Ogan Ilir, South Sumatra, Indonesia (Figure 1). Identification of the species was conducted in the Entomology Laboratory, Faculty of Agriculture, Universitas Sriwijaya. The survey was conducted by direct observation of 8 years of DxP Sriwijaya 1 variety at the private oil palm plantation in Palem Raya Village. The sampling site was chosen due to the infestation of nettle caterpillars reported by the farmers. The observed area was not applied any insecticides. The observed oil palm trees received biannual fertilization with a phosphate fertilizer including two types of phosphate: one slow-release (17%) and one fast-release (14%). The nettle caterpillars found were captured and identified based on the stripes on their bodies.

Procedures

Observation and sampling method

At the time of specimen collection, the pest was in the larval stage. The larvae found on the oil palm leaves were collected and then placed in a box container to be brought to the laboratory for identification. The description of the pest and the damage observed were based on the pests attacking the oil palm crops, from the initial symptoms of infestation to the advanced symptoms caused by the nettle caterpillars. The intensity of the infestation was assessed visually based on the symptoms of the nettle caterpillar attack. One plot area of oil palm trees that reported the caterpillar infestation was observed. The sampling of infested nettle caterpillar trees used purposive sampling, the total number of the observed trees was 100 trees per observation. The observation was done per month, July 2024, August 2024, September 2024. The plants that showed symptoms of infestation were calculated.

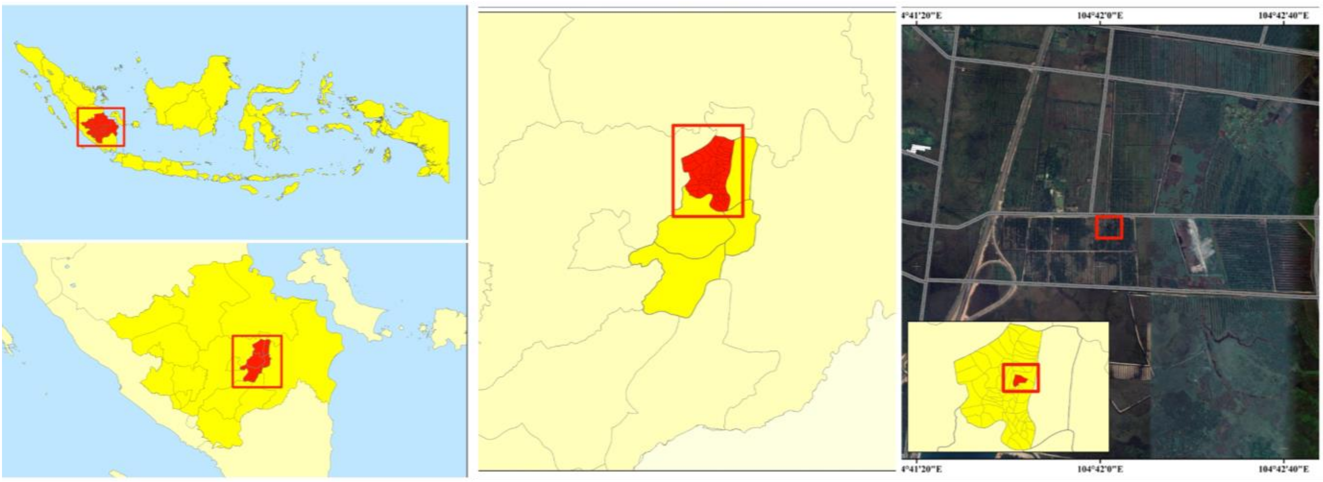

Figure 1. The sampling location is in Palem Raya, Ogan Ilir District, South Sumatra, Indonesia. The samples were taken from oil palm plantations

The intensity of pest attack (%)

The formula used to calculate the intensity of the nettle caterpillar pest infestation was applied using the following formula:

$$I = \frac{n}{N} \times 100\ \%$$

Where:

I : Intensity of attack by nettle caterpillars (%)
n : Number of plants infested by nettle caterpillars
N : Total number of plants observed

Level of attack

The level of attack refers to the level of infestation based on the number of pests found on the fronds of the observed oil palm plants (Ikhsan et al. 2023). The critical threshold for this nettle caterpillar pest is 5 individuals per plant. The levels of nettle caterpillar infestation are as follows: 1) <2 individuals/frond: light; 2) 2-4 individuals/frond: moderate; 3) 5 individuals/frond: severe (Table 1).

Data analysis

Data analysis was conducted using Microsoft Excel software to process the raw data obtained in the field, which was then presented in the form of tables. The data were analyzed using descriptive analysis. Soil samples from the cultivated oil palm were analyzed. The soil properties, including Electrical Conductivity (EC), salinity, pH, temperature, humidity (relative humidity, or Rh), and the levels of Nitrogen (N), Phosphorus (P), and Potassium (K), were monitored using a wireless Soil Moisture, Temperature, and NPK Data Logger sensor.

Table 1. Criteria for categories of nettle caterpillar attack intensity

Score	Presentation of attack intensity (%)	Category
0	0	Normal
1	0-25	Light
2	25-50	Moderate
3	50-90	Severe
4	≥ 90	Very Severe

RESULTS AND DISCUSSION

The morphology of nettle caterpillars

The oil palm plantation hosts three distinct species of nettle caterpillars: *Setora nitens*, *Birthosea bisura* (Moore, 1859), and *Parasa lepida* (Cramer, 1779). These caterpillars share a generally yellowish-green coloration, but each exhibits its unique morphological characteristics. *Setora nitens* has a yellowish-green color with two coarse spines on its head and posterior, as well as blue coloration extending from the head to the abdomen (Figure 2.A). *Birthosea bisura* is characterized by a green color with a pale dorsal line running along its body, an oval, flattened body shape, and two blue and white spots on the central part (Figure 2.B). *Parasa lepida* displays a pale green or bright yellow coloration with three green stripes running along its body and six orange spines on each end of its body (Figure 2.C).

The total number of nettle caterpillar

Three species of nettle caterpillars were identified during observations conducted on 100 oil palm trees. These observations, carried out on three separate occasions, revealed variations in the presence and abundance of the caterpillar species (Table 2). Among these, *S. nitens* was the most abundant, with population counts ranging from 143 to 218 individuals per 100 plants across the three observation periods (July, August, September 2024). *Parasa lepida* was only recorded during the second observation, with 15 individuals per 100 plants, and was absent in the first and third observations. *Birthosea bisura* was the least frequently encountered species, appearing only in the initial observation with 6 individuals per 100 plants.

The average number of nettle caterpillar species per instar

During the study, the three species were observed at different larval instar stages (Table 3). *Setora nitens* was found in instars 1 to 6, with instar 6 being the most prevalent, with an average of 78.67 individuals. *Birthosea bisura* was found only in instar stages 3 and 4 on the 100 oil palm trees, with a single individual recorded at each stage. Meanwhile, *P. lepida* was present in instar stages 1 and 5, with averages of 1.67 and 3.33 individuals, respectively.

Figure 2. Nettle caterpillar in oil palm plantation of Ogan Ilir, Indonesia. A. *Setora nitens*; B. *Birthosea bisura*; C. *Parasa lepida*

The average size of nettle caterpillar species per instar

The three species observed exhibited different sizes at each of their respective instar stages (Table 4). *Setora nitens* measured 0.60 cm at instar 1 and reached a size of 2.53 cm in instar 6 (Figure 3). *Birthosea bisura* was absent in instars 1, 2, 5, and 6. In the field, only instar 3 of *B. bisura* was found, with a size of 1.06 cm and instar 4 measuring 1.70 cm (Figure 4). Meanwhile, *P. lepida* was observed with a size of 0.50 cm at instar 1 and 2.00 cm at instar 5 (Figure 5).

Distribution map of nettle caterpillars in the field

This map illustrates the distribution of nettle caterpillars observed during three separate observations (Figure 6). According to the map legend, there are three identified species of nettle caterpillars: *Setora nitens* (represented by a green circle), *B. bisura* (represented by a red circle), and *P. lepida* (represented by a blue circle). The distribution pattern shows that *S. nitens* is the most widespread across the research location from the first to the third observation, as indicated by the prevalence of green circles. In contrast, *B. bisura* was recorded at a few points (red circles) during the first observation, with no sightings in the second and third observations. Similarly, *P. lepida* was observed at limited locations (blue circles) during the second observation, with no occurrences noted in the first and third observations.

Intensity, percentage, and symptoms of nettle caterpillar infestations

The visual observation of pest attacks revealed variations in the intensity scores of nettle caterpillar infestations across the three observation periods (Figure 7). During the first observation (July 2024), 32% of the observed plants recorded a score of 1 (indicating light intensity), followed by 29% with a score of 2 (moderate intensity), 27% with a score of 3 (severe intensity), and 12% with a score of 4 (very severe intensity). In the second observation (August 2024), the distribution shifted slightly, with 37% of plants still at score 1, 33% at score 2, 16% at score 3, and 14% at score 4. By the third observation (September 2024), scores of 1 and 2 were equal, each accounting for 38% of the plants, while 13% recorded a score of 3, and 11% recorded a score of 4.

Nettle caterpillar infestations on oil palm land have affected plant growth. Observations revealed that the percentage of nettle caterpillar attacks reached 100%, highlighting the urgent need for effective control. The severity levels of the attacks averaged 57.75 in the first observation, 51.75 in the second observation, and 49.25 in the third observation (Table 5). The severity of the nettle caterpillar attack gradually decreased from the second to the third observation, attributed to the decline in the nettle caterpillar population over the same period. If these high levels of nettle caterpillar attacks are not adequately managed, they can disrupt the fruit growth process. The caterpillars damage the leaves, impairing the plant's ability to photosynthesize and thereby hindering its overall productivity.

Table 2. Total number of nettle caterpillar species found on 100 oil palm plant

Species	Number of nettle caterpillar (individual) in the observation		
	First observation	**Second observation**	**Third observation**
Setora nitens	218	164	143
Birthosea bisura	6	0	0
Parasa lepida	0	15	0

Table 3. The average number of nettle caterpillar species per instar found per 100 trees

Spesies	Average number of nettle caterpillar					
	Instar 1	**Instar 2**	**Instar 3**	**Instar 4**	**Instar 5**	**Instar 6**
Setora nitens	0.33	4.67	16.67	41.33	33.33	78.67
Birthosea bisura	0.00	0.00	1.00	1.00	0.00	0.00
Parasa lepida	1.67	0.00	0.00	0.00	3.33	0.00

Table 4. The average size of nettle caterpillar species per instar found on 100 trees

Species	Size of nettle caterpillar at instar (cm)					
	Instar 1	**Instar 2**	**Instar 3**	**Instar 4**	**Instar 5**	**Instar 6**
Setora nitens	0.60	0.87	1.09	1.74	2.00	2.53
Birthosea bisura	0.00	0.00	1.06	1.70	0.00	0.00
Parasa lepida	0.50	0.00	0.00	0.00	2.00	0.00

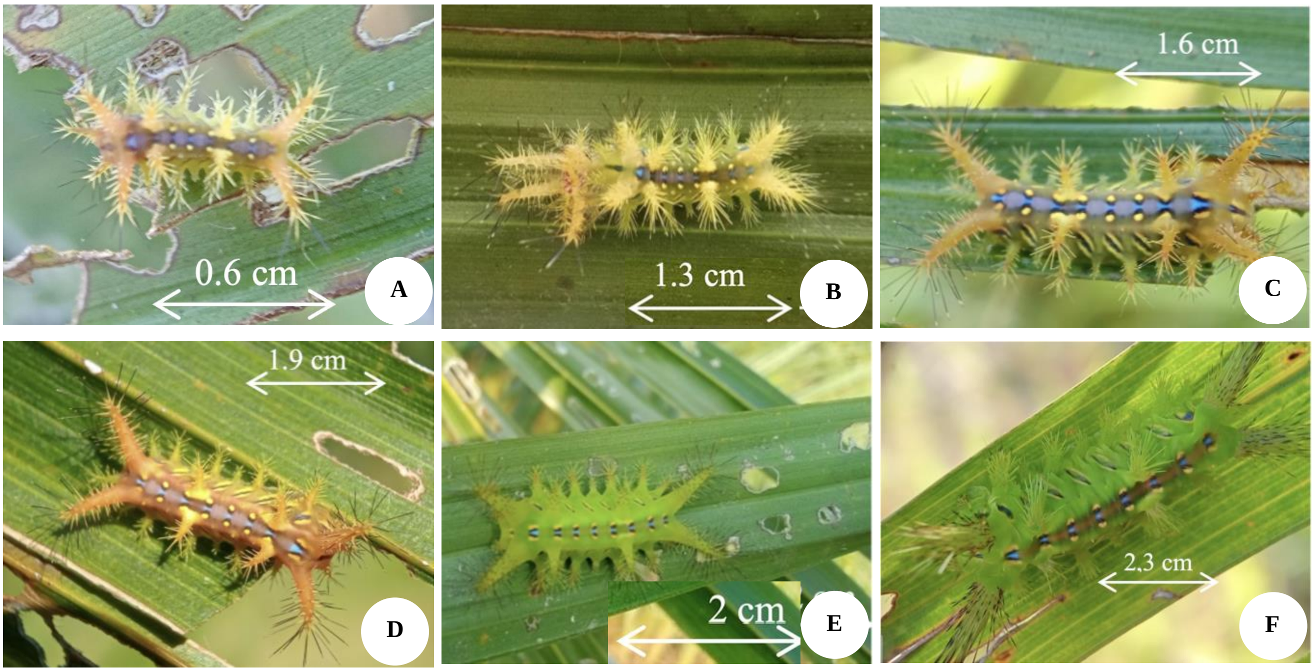

Figure 3. Larvae sizes of *Setora nitens*. A. 1st instar; B. 2nd instar; C. 3rd instar; D. 4th instar; E. 5th instar; F. 6th instar

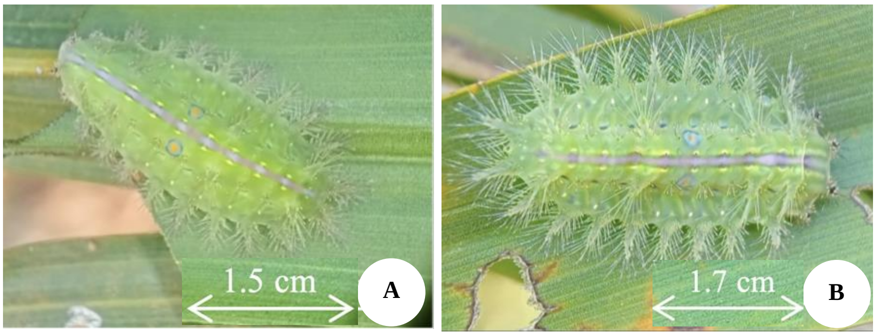

Figure 4. Larvae size of *Birthosea bisura*. A. 3rd instar; B. 4th instar

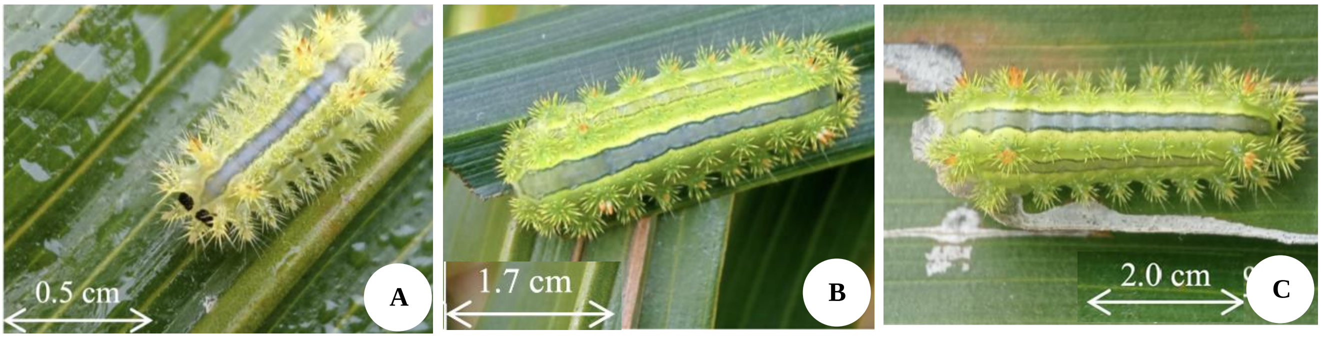

Figure 5. Larvae sizes of *Parasa lepida*. A. 1st instar; B. 4th instar; C. 5th instar

Soil characteristics

The soil sample was analyzed at the Phytopathology Laboratory of the Department of Plant Protection, Faculty of Agriculture, Universitas Sriwijaya, Indonesia. The soil analysis was conducted to assess pH, temperature, and humidity, as nettle caterpillar pupae were found in the soil of the observed oil palm plantation, which is situated in a peatland area. According to the conducted analysis, the temperature was 28°C, and humidity was 56.7% (Table 6), suggesting a favorable environment for the high population of nettle caterpillars.

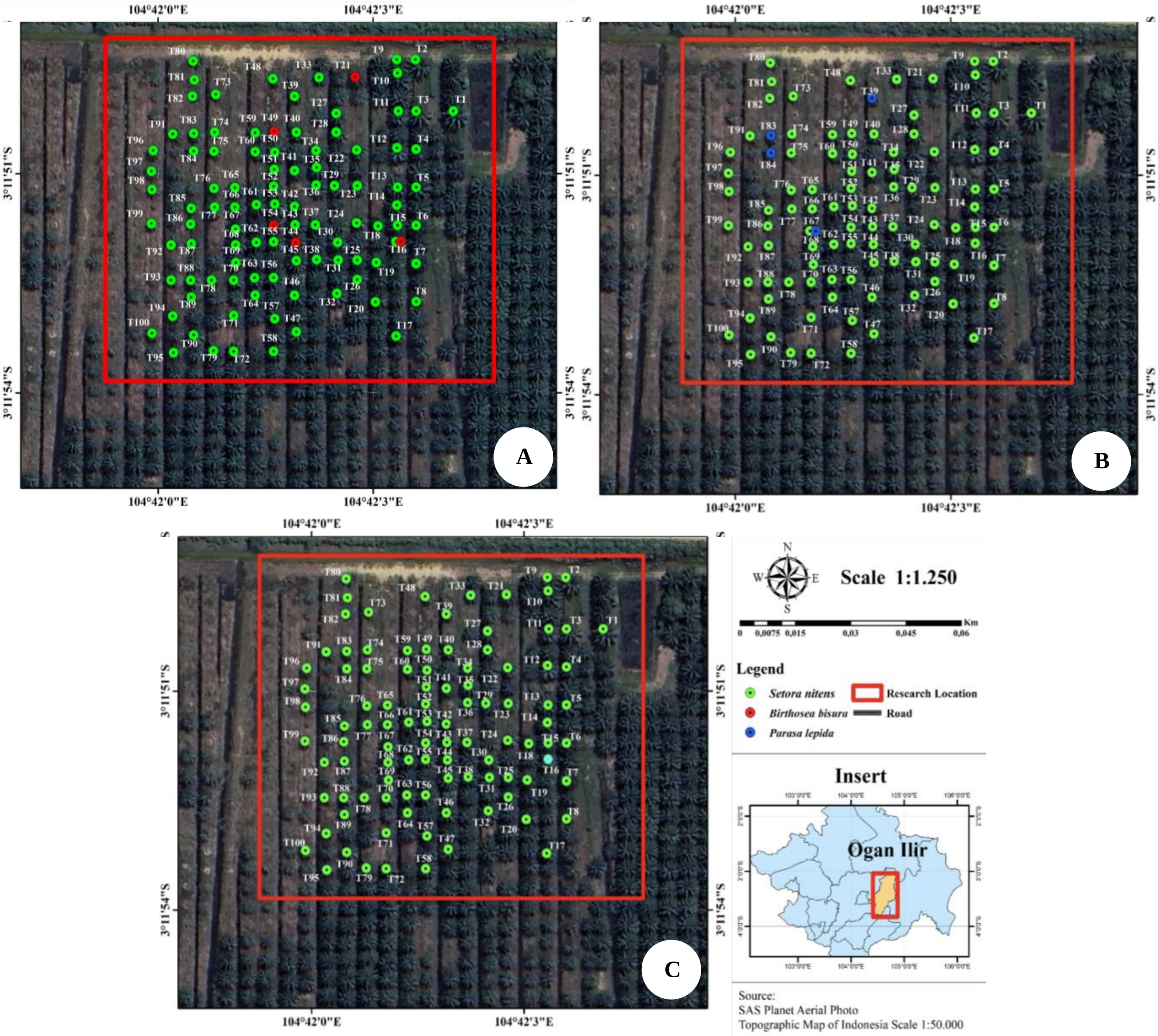

Figure 6. Distribution map of nettle caterpillars in oil palm plantation of Ogan Ilir, Indonesia. A. July 2024, B. August 2024, C. September 2024

Discussion

The study identified three species of nettle caterpillars in an oil palm plantation located in Palem Raya, Pemulutan Barat District, Ogan Ilir Regency, South Sumatra. These species were *S. nitens*, *B. bisuraa*, and *P. lepida*. Among them, *S. nitens* was the most commonly observed during the study, followed by *P. Lepida*, with *B. Bisura* being the least common. Interestingly, only the larval life stage of these caterpillars was encountered throughout the investigation. It suggests that either the timing of the observations coincided with the larval phase or that other stages, such as pupae and adults, were less conspicuous or occurred in more secluded habitats.

The larval stages of these species exhibited distinct morphological characteristics, facilitating their identification. The larvae of *S. nitens* exhibit a yellow-green coloration on their bodies that gradually transitions to reddish hues as they approach the pupal stage. These caterpillars can be distinguished by two coarse hairs on their head and two longer coarse hairs on the posterior part, with a longitudinal blue-purple line on the dorsal side. In contrast, the larvae of *B. bisura* are entirely green, featuring a distinctive pair of dark blue eye spots with a yellow-orange center. Meanwhile, *P. lepida* displays a yellowish-green coloration with small spiky setae and a green dorsolateral line during their first instar (Bhoye and Makode 2024). These distinct morphological traits not only facilitate identification but also contribute to understanding their ecological roles and vulnerabilities (Madesh et al. 2024).

In this study, three species of nettle caterpillars (Lepidoptera: Limacodidae) were found in the field with varied results. The population dynamics observed over the three-month study period reveal that *S. nitens* consistently remained the most dominant species. However, its numbers slightly decreased from 218 to 164 individuals in the second observation and further decreased to 143 individuals in the third observation. This decreasing trend could be attributed to various environmental factors or predation pressures (Cheng et al. 2020). A previous study reported that the outbreak of nettle caterpillars is often sporadic, as most of the time, the pest population is suppressed by natural enemies such as parasitoids, predators, and pathogens (Loong et al. 2017). Further research on the specific natural enemies of *S. nitens* and their influence on its population levels would provide valuable insights for devising effective pest control strategies.

In contrast, *P. lepida* exhibited intermittent appearances, with individuals only recorded during the second observation. The sporadic pattern of these caterpillars suggests that their population dynamics may be affected by factors like their life cycle, which could be synchronized with seasonal environmental conditions (Schebeck et al. 2024). This irregularity highlights the importance of sustained, long-term monitoring to better comprehend the ecological requirements and behaviors of this species.

Birthosea bisura was the least commonly found nettle caterpillar species, with only 6 individuals per 100 plants identified in the first observation, and no individuals of this species were found in the second and third observations. Its complete absence in subsequent observations suggests that this species may be particularly sensitive to environmental fluctuations or that it is seasonal. This rarity might also indicate that *B. bisura* has more specialized habitat or resource requirements, making it vulnerable to disturbances. *Birthosea bisura* was reported as a less common of nettle catterpillar in Malaysia (Firdausi and Nuraini 2016).

Analysis of the developmental stages (instars) of the three species provided further insights into their ecological dynamics. *Setora nitens* larvae found were in instars 1-6, dominated by instar 6 with an average of 78.67. It indicated that this species dominated at the later instar phases due to high survival rates and better adaptation at that stage. Conversely, *B. bisura* was found in instar phases 3 and 4 in 100 plant stems, with each having 1.00, while instars 1, 2, 5, and 6 were not found. For the *P. lepida* species, instars 1 and 5 were found in 100 plant stems, with counts of 1.67 and 3.33, respectively; instars 2, 3, 4, and 6 were not found. *Birthosea bisura* and *P. lepida* were limited to earlier instars, suggesting lower survival rates or developmental constraints in these species. This finding suggests that later instars of nettle caterpillars exhibit better adaptation to environmental stressors. Mortality rates among the early larval stages are typically very high and extremely variable (Despland 2018).

Table 5. Intensity and percentage of nettle caterpillar attacks on 100 plants

Month observation	Attack intensity (%)	Percentage of attacks (%)
July 2024	57.75	100
August 2024	51.75	100
September 2024	49.25	100

Table 6. Results of soil characteristics analysis in oil palm plantation areas

Observed variable	Result (unit)
Electrical conductivity	666 us
	0.66 ms
Salt	392 ppm
	0.39%
	0.996 S.G
pH	3.79
N	51
P	164
K	157
Temperature	28°C
RH	56.7%
	429 us/cm
pH	6.3

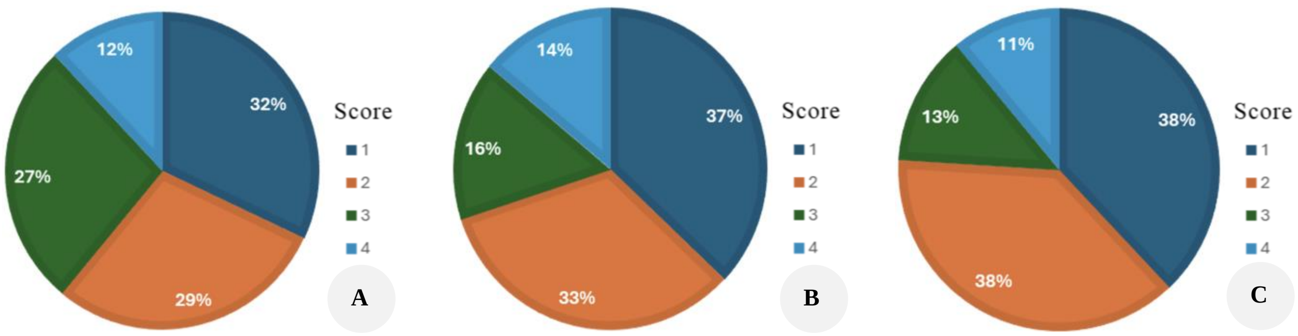

Figure 7. Intensity scores of nettle caterpillar attacks per 100 oil palm trees during A. July 2024; B. August 2024; C. September 2024

Soil analysis revealed that temperature and humidity may affect the population of nettle caterpillars in the field. An average plantation temperature of 24-35°C was found to favor rapid caterpillar development, aligning with Ruslan et al. (2019). However, extreme temperatures greatly impact insects, affecting their biology, behavior, and populations. Extreme temperature damages the nervous system, muscles, and immunity, potentially causing coma and death. It also disrupts the growth, development, reproduction, and survival of insects (Zhou et al. 2024). In addition to temperature, humidity also impacts the survival, development, and population dynamics of insect pests (Jaba et al. 2020). Nettle caterpillars, similar to several moth and butterfly species, undergo a complete metamorphosis comprising four distinct stages: egg, larva (caterpillar), pupa, and adult (Patade et al. 2022). Subsequent to feeding on their host plants, caterpillars frequently descend to soil to undergo pupation. The existence of these nettle caterpillars in oil palm trees cultivated on peatland indicates that these species may adapt to this environment. These findings underscore the importance of considering climatic factors when developing pest management strategies, as changes in temperature and humidity can alter pest population and outbreak risks.

Over the three observations, the severity index of caterpillar damage decreased from 57.75 to 49.25, coinciding with the decline in caterpillar populations. It suggests that natural processes, such as predation and environmental factors, may have contributed to the reduction in infestation levels. However, this decrease should not undermine the need for proactive management, as population resurgences could lead to renewed outbreaks and increased damage. The observed damage included leaf frond stripping, elongated holes, and epidermal consumption. The nettle caterpillar is a prevalent pest on both young and mature oil palm trees, frequently causing defoliation and leaf skeletonization (Zevika et al. 2024). It underscores the caterpillars' potential to disrupt photosynthesis. Zhang et al. (2022) reported that biotic disturbance significantly decreased the photosynthetic rate by 34.8%. It can reduce growth potential and lead to prolonged reductions in yield due to the plants' impaired ability to produce fruit bunches for multiple years (Ikhsan et al. 2023). Prolonged infestations can have devastating consequences, as affected plants may fail to produce fruit bunches for 2-3 years (Simanjuntak et al. 2020). It highlights the economic significance of these pests in oil palm cultivation and the urgency of developing effective management approaches.

The primary control strategy for nettle caterpillars in oil palm plantations relies on chemical insecticides, such as deltamethrin, lambda-cyhalothrin, cypermethrin, and others (Priwiratama et al. 2018; Rozziansha and Lubis 2023). While these methods effectively reduce caterpillar populations, they pose significant ecological risks, including unintended impacts on beneficial organisms such as parasitoids, predators, and pollinators (Sánchez-Bayo 2021). Disruptions to pollinator populations can hinder pollination and fruit formation (Brunet and Fragoso 2024). Therefore, environmentally friendly control measures are necessary. Natural enemies like *Eocanthecona furcellata* have the capability to prey on various species of caterpillars, including Lepidoptera, Coleoptera, and Heteroptera (Vanitha et al. 2018). Conserving and increasing natural enemies can reduce reliance on chemical insecticides and promote ecological balance (Yarahmadi and Rajabpour 2024). Additionally, removing infested plants, improving plantation cleanliness, and using mixed cropping systems can also help lower caterpillar numbers by limiting their habitats and food. Integrating these approaches with the careful use of selective insecticides results in more effective pest management while minimizing environmental damage. Effective management of pests like nettle caterpillars is crucial to maintaining the productivity and profitability of oil palm plantations. An Integrated Pest Management (IPM) approach that combines biological, cultural, and selective chemical control methods, along with environmental monitoring and farmer education, can bolster the resilience of oil palm plantations to pest outbreaks while mitigating potential negative impacts (Green et al. 2020).

In conclusion, this study identified three key species (*S. nitens*, *P. lepida*, and *B. bisura*), along with their population, developmental stages, and impact on oil palm productivity, providing valuable insights for pest management efforts. While chemical insecticides are commonly used, their environmental risks call for more sustainable approaches like IPM. The study also emphasizes how environmental factors like temperature and humidity affect pest populations, highlighting the need for climate-sensitive strategies. By combining scientific research and practical methods, oil palm plantations can achieve long-term sustainability. Future research should explore innovative tools to further enhance pest control and support sustainable cultivation.

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