[研究文章 Research Article]

https://doi.org/10.5281/zenodo.10419479

Notes on Small-Scale Sleeping Aggregation in *Sallya madagascariensis* (Boisduval, 1833) (Lepidoptera : Nymphalidae)

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Abstract: Sleeping behavior is poorly documented in Lepidoptera, not to mention sleeping aggregations. In this study, I report for the first time the sleeping behavior of *Sallya madagascariensis* (Boisduval, 1833), a rare Nymphalidae species found in Madagascar. Notably, we observed that individuals of this species exhibit aggregation behavior during their nighttime resting periods. They were found resting on the undersides of leaves in a vertical position, typically at a height of three to four meters on the tree.

Key words: *Sallya*, Nymphalidae, sleeping aggregation, nighttime ecology, night roosting, Madagascar

Introduction

The aggregation of insects is a spatial arrangement unit, typically occurring when the number of individuals is greater than or equal to three (Parrish and Hamner, 1997; Mallet et al., 1987; Mallet, 1980). Many studies on butterfly aggregations have focused on overwintering behaviors, such as the overwintering clusters of *Danaus plexippus* (Linnaeus, 1758) in the Americas (James & James, 2019) and *Euploea* spp. in Taiwan (Yang et al., 2008). Although there are some records of their sleeping behaviors during the night, research on the nighttime ecology of other butterflies in relation to their overnight behavior is relatively scarce (Rau, 1916; James, 2019; Davis et al., 2012; Chao, 2008). The term 'sleep behavior' refers to the phenomenon where butterflies remain motionless in their resting positions during the night and continue to occupy their original habitats until the following day (Rau and Rau, 1916; Salcedo, 2011). *Zizina otis riukuensis* (Matsumura, 1929) and *Zizeeria maha okinawana* (Matsumura, 1929), both belonging to the family Lycaenidae, are reported to sleep aggregately (Chang et al., 2020). Some species of *Heliconius* (Nymphalidae) also exhibit similar sleeping aggregation behaviors (Mallet, 1986). In *Heliconius*, it has been observed that collective clustering facilitates anti-predator attacks (Finkbeiner, 2019). Unpalatable *Heliconius* butterflies enhance the effectiveness of their aposematic signals when in aggregations (Finkbeiner et al., 2012). The benefits provided by these aggregation behaviors include foraging advantages (Dall, 2002) and a reduction in predation risk (Merke and Mosbech, 2008).

The members of *Sallya* Hemming, 1964 (Nymphalidae) are distributed in Africa and Madagascar. The type species, *Sallya madagascariensis* (Boisduval, 1833), also known as the Malagasy Swallowtail, is primarily found in the forests of Madagascar (Lees et al., 2003). Limited information and ecological research are available on the Malagasy Swallowtail, and it was considered a rare species (Boisduval, 1833). The sleeping behavior has never been recorded in the genus *Sallya* to date. Here, I provide the first record of nocturnal sleeping behavior and aggregation in *S. madagascariensis*.

Materials and methods

This study utilized a Canon R5 digital SLR camera paired with a Canon RF100-500mm f/4.5-7.1L IS USM lens and a Yongnuo YN500EX flash for photography. Additionally, an iPhone 14 Pro was used in the study.

Results

Sallya madagascariensis (Boisduval, 1833)

Observations of *Sallya madagascariensis*: The sleeping behavior of *S. madagascariensis* was observed in the Kirindy Mitea National Park, located in the Menabe region of western Madagascar. On May 12, 2023, a group of *S. madagascariensis* butterflies was found sleeping upside-down on the undersides of leaves approximately 3 to 4 meters high on a tree at 00:12. There were a total of six individuals, with four of them perched on the same leaf, while the other two were resting on separate leaves (Fig. 1, A, B). On the following day, one of them was no longer present at the location at 7:10, but the others continued staying on the original leaf (Fig. 1, C, D). During the leaf-shedding period of the dry season, there were just a few poor leaves on the tree, making it difficult to identify the species of the perching plant (Fig. 2).

稿件收到 *Received:4 July 2023*

稿件接受 *Accepted: 9 October 2023*

稿件出版 *Published: 25 December 2023*

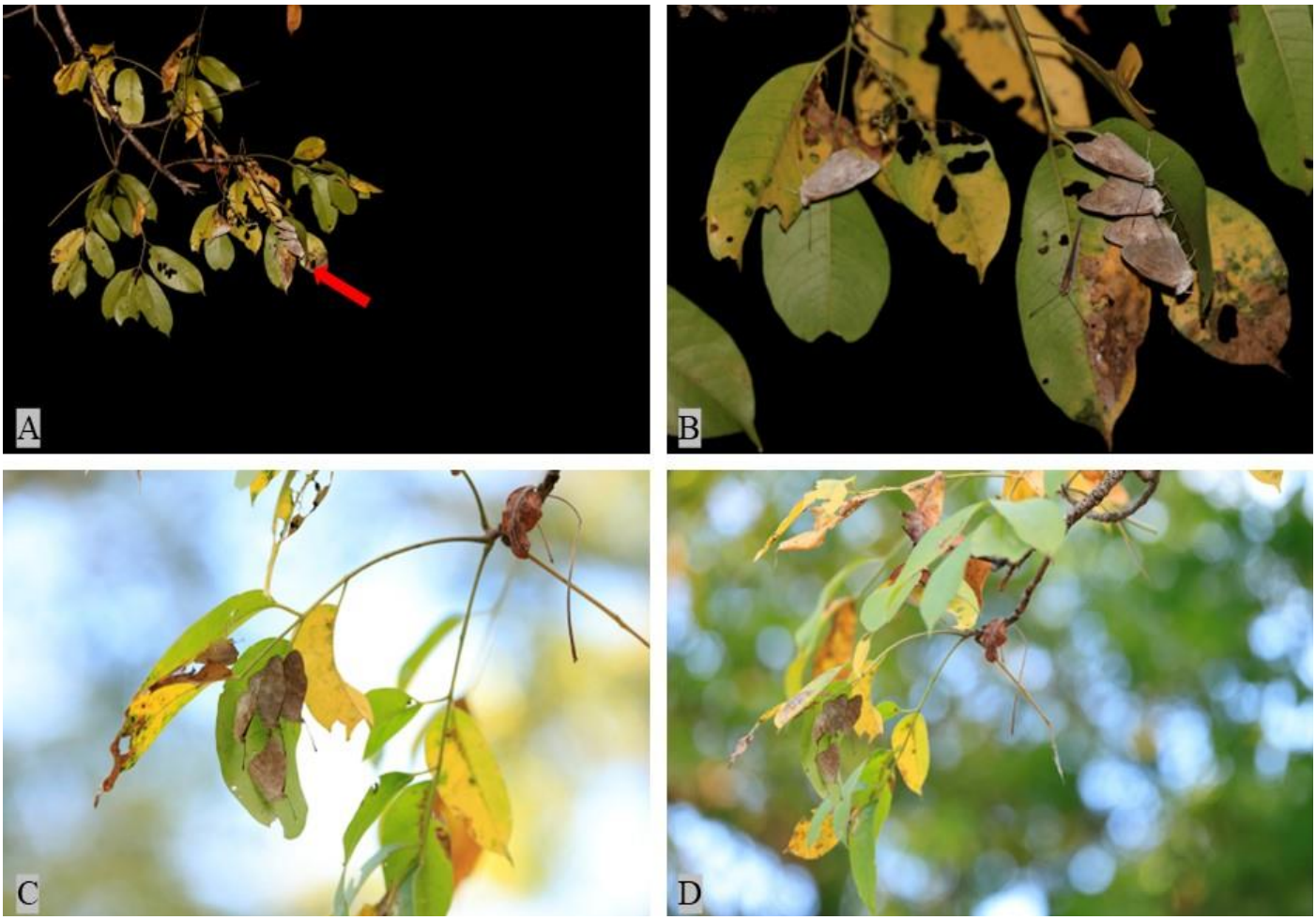

Figure 1. *Sallya madagascariensis* (Boisduval, 1833): (A) Perching locations of adult butterflies during nighttime sleeping; (B) Nocturnal aggregation of six individuals resting on the undersides of leaves; (C) Observations of five individuals the next morning; (D) Minimal variation in perching locations of adult butterflies during the daytime.

Discussion

Sleeping aggregation primarily occurs in certain unpalatable species of the subfamilies Acraeinae, Danainae, and Heliconiinae within the family Nymphalidae (Owen and Chanter 1969; Rau 1916; James 2019; Davis et al. 2012; Chao 2008; Mallet 1986). The *Acraea encedon* (Acraeinae) is found to roost aggregately at night in the same area for up to one to two months (Owen and Chanter 1969). On the other hand, *Danaus plexippus* (Danainae) is a typical case of overwintering and sleeping aggregation (Rau 1916; James 2019; Davis et al. 2012). They maintain aggregation behaviors, including sleeping aggregation, at various times, similar to the overwintering behavior of *Euploea* spp. (Danainae) in Taiwan (Chao 2008). However, it is unclear whether *S. madagascariensis* is unpalatable to predators. Among them, *Heliconius* spp. (Heliconiinae) often choose to cluster for dormancy on drooping branches. The overwintering *Arhopala paramuta horishana* (Matsumura 1910) clusters aggregate on concealed dry leaves on the tree (Lin 2020). Many butterflies typically rest individually during sleep. For example, *Pontia protodice* (Boisduval & Leconte 1830) (Pieridae) often sleeps on parts of *Eupatorium* sp. (Asteraceae) stems that still have seeds (Rau and Rau 1916). *Anthocharis cardamines* (Linnaeus 1758), on the other hand, settles on the inflorescences of *Anthriscus sylvestris* ((L.) Hoffm. 1814) (Apiaceae) and *Alliaria petiolata* (Matsumura 1910) to decrease the chances of being detected by potential predators (Courtney and Duggan 1983). I speculate that the resting appearance of *S. madagascariensis* may exhibit functional camouflage or crypsis, similar to the case of *Anthocharis cardamines*. However, *S. madagascariensis* exhibits a distinct behavior of forming sleeping aggregations, setting it apart from *A. cardamines*.

While I have not personally observed the daytime behavior of *S. madagascariensis*, it can be inferred from iNaturalist data that *S. madagascariensis* is likely to be primarily solitary in its activity (https://www.inaturalist.org/taxa/1114488-Sevenia-madagascariensis). Notably, there remains a scarcity of research in the field of nocturnal ecology, particularly regarding butterfly sleeping behavior. Therefore, this study aims to fill this research gap by documenting the nighttime sleeping and sleeping aggregation behavior of *S. madagascariensis*. The findings of this study will provide crucial biological information and contribute to the understanding of butterfly nighttime ecology.

Figure 2. Only a few leaves remain on the tree, and the resting place for adult insects is on the underside of the leaves marked in red.

Acknowledgments

I sincerely thank for Zong-Yu Shen and Chia-Lung Huang to English editor for providing comments to improve me article. I would like to extend my heartfelt appreciation to Shih-Chieh Huang and Kuo-Yuan Huang for the assistance they provided during this Madagascar trip.

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馬達加斯加星蛺蝶睡眠群聚行為之短記 (鱗翅目：蛺蝶科)

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摘要: 鱗翅目的睡眠行為較少被觀察與記錄，尤其是群聚的睡眠行為。本文首次觀察記錄到馬達加斯加星蛺蝶 (*Sallya madagascariensis* Boisduval, 1833) 在睡眠時表現出群聚行為，這是在馬達加斯加罕見的蛺蝶科物種。值得注意的是，此次觀察到該物種的個體在夜間休息期間表現出聚集行為，並發現牠們通常以垂直的姿勢停棲在葉子的底面，停棲的樹高度約為 3 至 4 公尺。

關鍵字: 星蛺蝶、蛺蝶科、睡眠群聚、夜間生態學、夜間棲息、馬達加斯加