



## Composition, Distribution, and New Records of Mantises (Insecta: Mantodea) in Penghu Islands

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### ABSTRACT

The insect biodiversity in the Penghu Islands was documented rarely. Recently, surveys on insect diversity have been done sporadically on aquatic beetles, insect galls, and Orthoptera, while no records introduced mantises. This study includes field surveys, a literature review, and records of the distribution of mantis species in the Penghu Islands. Besides 1 recorded species, 4 new recorded species were found; this study demonstrates that the composition of mantids in the Penghu Islands could inspire investigations into the diversity of mantids and other insects on this offshore island of Taiwan.

**Key words:** Mantodea, Biodiversity, New Record

### Introduction

The Penghu Islands are located between Taiwan and mainland China in the central-southern section of the Taiwan Strait. It is the largest offshore island group in Taiwan. The main islands include Magong Is., Baisha Is., and Xiyu Is., which are connected by highways. Some other smaller islands include Qimei Is., Wangan Is., Dongji Is., Tongpan Is., and Jibei Is. The abovementioned islands' terrain is mostly flat, with vegetation primarily consisting of grasslands, shrubs, and artificially planted windbreak forests. The Penghu Is. are situated between Taiwan and the Asian continent, and its insect composition is related to both regions. However, the surveys for insect diversity were rarely in Penghu Is., although there have several

recent studies have been conducted on aquatic beetles (Liu *et al.*, 2020), insect galls (Hsieh *et al.*, 2021), and Orthoptera (Yang *et al.*, 2020).

Mantodea, known as praying mantises, are known for their specialized raptorial foreleg. They prey on insects and even small vertebrates such as mice, bird, snake, and fish (Wu, 2021a). As the key predators in the ecological food chain, mantises are among the highest-level insect predators and serve as the indicator species for ecological functional groups. The mantises in habitats inform the sustaining abundant insect population for survival. This study integrated the field survey and collection data of mantises in Penghu Is. from 2020 to 2023 and accompanied by the relevant literature to investigate and analyze the composition and distribution of mantises in the Penghu Is. to

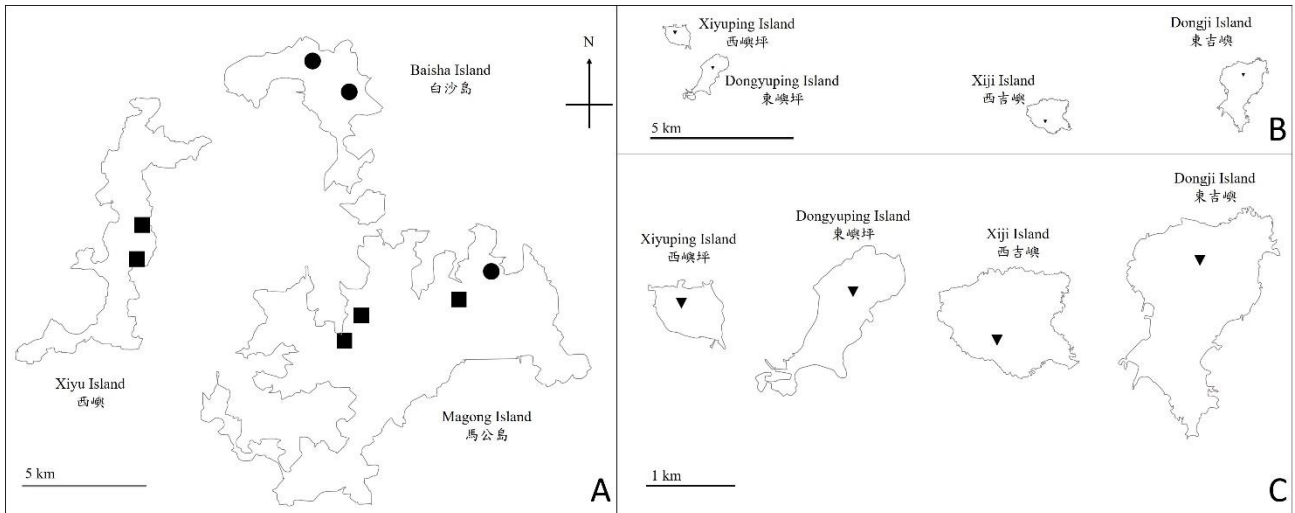


Fig. 1. Map of the Penghu Islands and South Penghu Marine National Park with collection localities in symbols. (A) The main island of Penghu includes Magong Is., Baisha Is. and Xiyu Is. (B) A scaled-down map of the actual distance of the South Penghu Marine National Park. (C) Relative location and enlarged map of the South Penghu Marine National Park. Square (■): Specimens collected during July 3-6, 2023. Circle (●): Specimens collected under the projects "Monitoring of Locust Pest Species" and "Establishing an Emergency Response Mechanism for Plant Pest Control and Talent Development for Pest Management." Inverted Triangle (▼): Specimens collected under the "Insect Resource Survey of South Penghu Islands." project.

understand the relationship of the mantis fauna between Penghu Is. and Taiwan as well as providing an identification key for mantises in Penghu Is.

## Materials and Methods

### Sample collection

Mantis specimens were collected in three surveys during 2020-2024. The collection localities included Magong City (Magong Is.), Xiyu Township (Xiyu Is.), and Baisha Township (Baisha Is.). Moreover, specimens from Wangan Township within the South Penghu Marine National Park were obtained by Liao *et al.* (2024) (Fig. 1), including Xiyuping Is., Xiji Is., Dongji Is., and Dongyuping. The collection habitats comprised tall grasslands, short grasslands, and shrublands; mantises were collected using sweep netting and hand capture. The dried, pinned specimens are preserved in the Laboratory of Molecular Systematics, Department of Entomology, National Chung Hsing University, Taichung (NCHUMSL).

### Material examination and identification

According to Chou *et al.* (2004), mantis specimens from Penghu preserved at the National Museum of Natural Science (NMNS),

Taichung, were examined, and only one individual male of *Tenodera superstitiosa* (Fabricius, 1781) was found. The mantis identification was conducted based on the descriptions by Chou *et al.* (2004), Zhu *et al.* (2012), Wu (2021a, b), and Ryuichiro (2016). Morphological terminology used in species descriptions follows Brannoch *et al.* (2017).

### Identification key for mantises in Penghu Island

Taxonomic characteristics of Mantodea species such as the pronotal shape; the shape, number, and position of spines on the inner side of the forelegs, as well as the shape and venation of the forewings and hindwings; an identification key was developed for the collections. This key would be helpful in advanced research and educational outreach.

## Results

### Mantis distribution in Penghu Islands

A total of 1 family involved 4 genera with 5 species recorded on Penghu Islands (Table 1, Fig. 2), including 4 new recorded species, i.e., *Hierodula patellifera* (Serville, 1838), *Mantis religiosa* (Linnaeus, 1758), *Statilia apicalis* (Saussure, 1871), and *Tenodera aridifolia* (Stoll,

Table 1. The mantis list in Penghu Islands

Family	Species	Chinese Name	Reference
Mantidae	<i>Hierodula patellifera</i> (Serville, 1838)	寬腹斧螳	New Record
螳科	<i>Mantis religiosa</i> (Linnaeus, 1758)	薄翅螳	New Record
	<i>Statilia apicalis</i> (Saussure, 1871)	小靜螳	New Record
	<i>Tenodera aridifolia</i> (Stoll, 1813)	枯葉大刀螳	New Record
	<i>Tenodera superstitiosa</i> (Fabricius, 1781)	細胸大刀螳	Chou <i>et al.</i> , 2004

Table 2. Distribution localities of each matis in Penghu Islands

Species\Locality	Magong	Baisha	Xiyu	Wangan islands
<i>Hierodula patellifera</i>	Y	N	N	Y
<i>Mantis religiosa</i>	Y	N	Y	Y
<i>Statilia apicalis</i>	Y	N	N	N
<i>Tenodera aridifolia</i>	Y	N	Y	Y
<i>Tenodera superstitiosa</i>	Y	Y	Y	Y

1813). In the primary islands, 5 species were recorded on Magong Is., only *Tenodera superstitiosa* was recorded on Baisha Is. (Table 2); while on South Penghu Marine National Park (Wangan), *H. patellifera.*, *M. religiosa*, *T. aridifolia*, and *T. superstitiosa* were recorded (Table 2).

## Species description of Mantodea in Penghu Islands

### *Hierodula patellifera* (Serville, 1838)

**Chinese name:** 寬腹斧螳

(Fig. 3)

**Characteristics:** body length 6-8 cm (adult), green or brown; head and gena, yellow stripe in lateral; forecoxa, 3-5 prominent yellow spines in inner; pronotum, purple-black heart shape or stripe in ventral; white stigma on forewing.

**Material examined:** PENGHU: Magong City: Anzhai (安宅里), 1♂, 03-VII-2023 Y.T.Wang (NCHUMSL); Wangan Township: Dongji Is. (東吉嶼), 1♀, 04-VIII-2024 Y.T.Wang (NCHUMSL).

**Distribution in the Penghu Islands:** One specimen recorded each on Magong Is. and Dongji Is. in the South Penghu Marine National

Park.

**Distribution:** Wide distribution in China, Japan, South Korea, India, Indonesia, alien species in Europe (Battiston *et al.*, 2020).

### *Mantis religiosa* (Linnaeus, 1758)

**Chinese name:** 薄翅螳

(Fig. 4)

**Characteristics:** body length 5-8 cm (adult), green or brown; head to pronotum to forewing, purple and white stripe in lateral; foreleg, black or white and black spot and white tiny particles in inner coxa, bright yellow spot in inner femur, avfs (anteroventral femoral spines) large and small spines are arranged alternately, large spines black.

**Material examined:** Huxi Township: 2♂, 19-V-2021 G.C.Guo (NCHUMSL); Xiyu Township: Erkan (二崁村), 1♂, 2♀, 05-VII-2023 Y.T.Wang (NCHUMSL); Wangan Township: Dongji Is. (東吉嶼), 2♂, 1♀, 16-X-2023 M.S.Chang (NCHUMSL); Wangan Township: Xiji Is. (西吉嶼), 2♂, 2♀, 4-VIII-2024 Y.T.Wang (NCHUMSL); Wangan Township: Dongyuping Is. (東嶼坪), 1♀, 15-IX-2024 Y.T.Wang (NCHUMSL); Wangan Township: Xiyuping Is. (西嶼坪), 2♂, 2♀, 15-IX-2024.

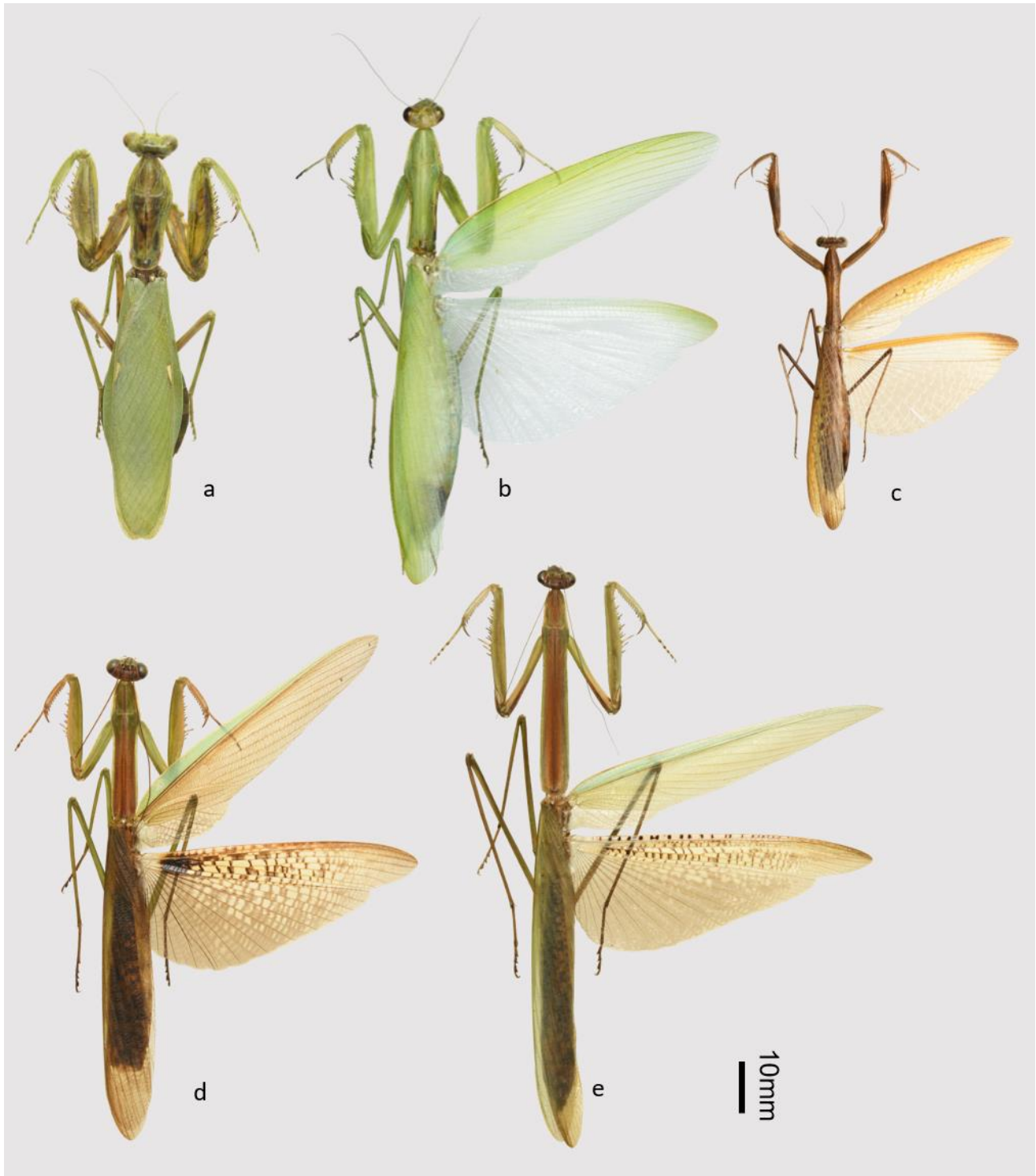


Fig. 2. Five mantises in the Penghu Islands. (a) *Hierodula patellifera*, (b) *Mantis religiosa*, (c) *Staltia apicalis*, (d) *Tenodera aridifolia*, (e) *Tenodera superstitiosa*.

Y.T.Wang (NCHUMSL).

**Distribution in the Penghu Islands:** There are records of collection on Penghu Is. and Dongji Is., Xiji Is., Dongyuping Is., and Xiyuping Is. in the South Penghu Marine National Park, with 5, 3, 4, 1, and 4 individuals respectively.

**Distribution:** Wide distribution in Europe, Africa, Australia, and Asia (Zhu *et al.*, 2012).

***Staltia apicalis* (Saussure, 1871)**

**Chinese name:** 小靜螳

(Fig. 5)

**Characteristics:** body length 4-5 cm (adult), brown; vertex, two dark brown horizontal stripes; foreleg, blue-black spot in inner coxa, blue-black and yellow spot in inner femur, black line on avfs, white stigma on forewing.





Fig. 3. Female of *Hierodula patellifera* in dorsal view (left) and ventral view (right). The scale bar is 10 mm.

**Material examined:** Mangong Ciy: Anzhai (安宅里), 1♀, 05-VII-2023 Y.T.Wang (NCHUMSL)。

**Distribution in the Penghu Islands:** One specimen recorded on Magong Is.

**Distribution:** Wide distribution in Africa, Australia, and Asia (Ryuichiro, 2016).

**Remark:** Inhabits the base of short grass.

***Tenodera aridifolia* (Stoll, 1813)**

**Chinese name:** 枯葉大刀螳

(Fig. 6)

**Characteristics:** body length 8-10 cm (adult),

green or brown; frons to clypeus to labrum, two dark brown vertical stripes; pronotum granular protrusions on prozone, yellow prominent in lateral; foreleg, black in end on avfs; hindwing, dark spot in base.

**Material examined:** Magong City: Anzhai (安宅里), 1♀, 20-VIII-2016 Y.T.Wang (NCHUMSL); PENGHU: 1♂, 19-V-2020 G.Y.Lin (NCHUMSL); Baisha Township: 1♂, 05-X-2021 G.C.Guo (NCHUMSL); Magong City: Anzhai (安宅里), 2♂, 2♀, 03-VII-2023 Y.T.Wang (NCHUMSL); Huxi Township: (湖西鄉), 1♂, 1♀, 04-VII-2023

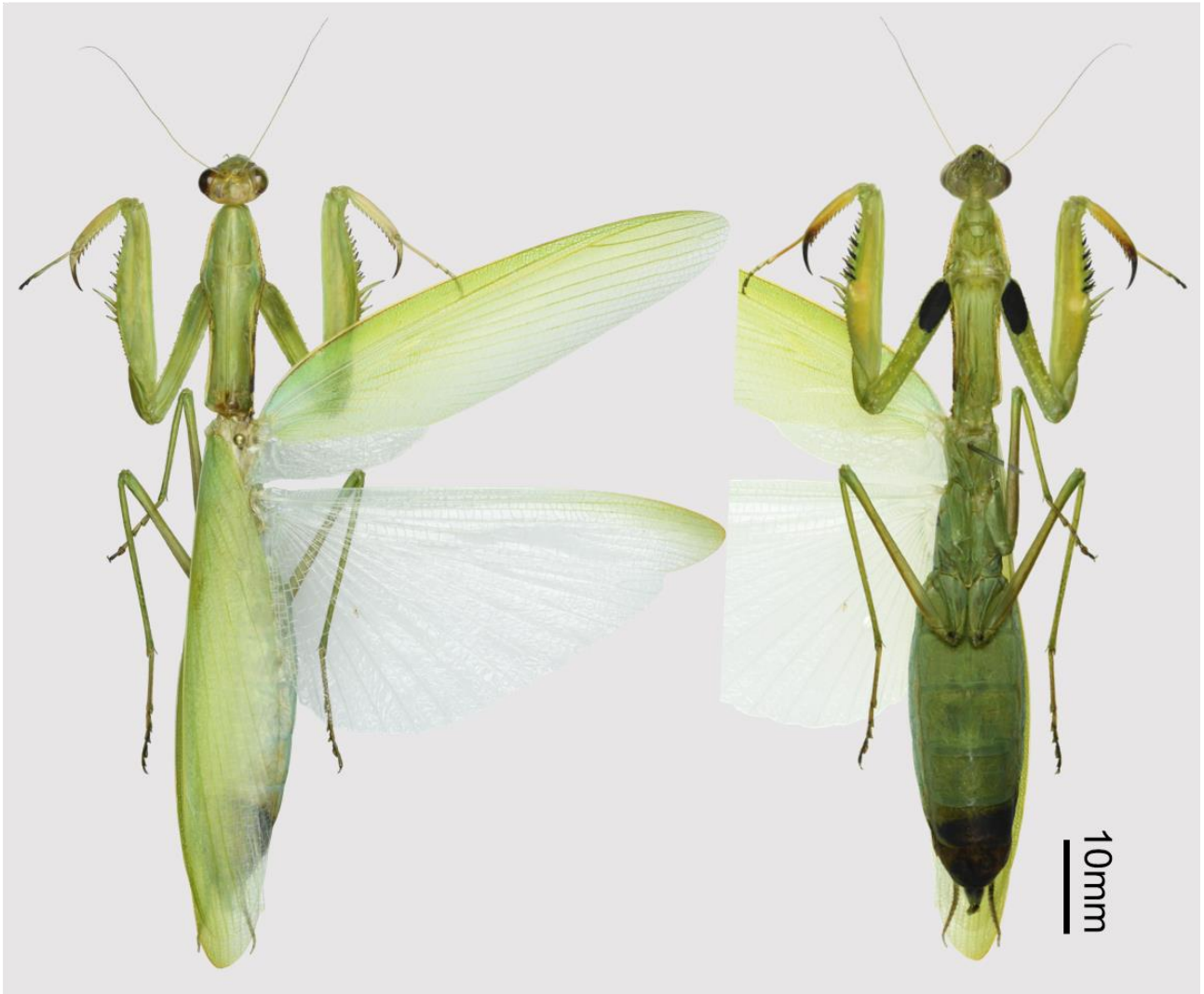


Fig. 4. Female of *Mantis religiosa* in dorsal view (left) and ventral view (right). The diagnostic character is the mark pattern in inner prolegs. The scale bar is 10 mm.

Y.T.Wang (NCHUMSL); Xiyu Township: Erkan (大菓葉), 1♀, 05-VII-2023 Y.T.Wang (NCHUMSL); Wangan Township: Xiyuping Is. (西嶼坪), 1♀, 15-IX-2024 Y.T.Wang (NCHUMSL)。

**Distribution in the Penghu Islands:** There are records of collection on Magong Is., Baisha Is., Xiyu, Dongjiyu Is., and Xiyuping Is. of the South Penghu Marine National Park, with 2, 3, 3, 1, and 1 respectively.

**Distribution:** Wide distribution in Southeast Asia (Ehrmann, 2002).

***Tenodera superstitiosa* (Fabricius, 1781)**

**Chinese name:** 細胸大刀螳

(Fig. 7)

**Characteristics:** body length 8-10 cm (adult), green or brown, slender body; pronotum, a "V" shape black stripe on junction on coxa in base in

ventral; foreleg, avfs large and small spines are arranged alternately, large spines black, small spines black in end, black on avfs1 in inner; forewing, white stripe in lateral; hindwing, translucent light brown or transparent, no dark spot in base.

**Material examined:** Taiwan Penghu Huhsi, 1♂, 22-IV-1989 sweeping net, K.W.Huang (NNMS); Magong City: Anzhai (安宅里), 1♀, 20-VIII-2016 Y.T.Wang (NCHUMSL); Magong City: Dongwei (東衛石雕公園), 1♂, 21-VIII-2016 Y.T.Wang (NCHUMSL); Baisha Township, 2♀, 19-VIII-2020 Y.C.Chu (NCHUMSL); Huxi Township, 1♂, 19-V-2021 G.C.Guo (NCHUMSL); Baisha Township, 1♂, IX-2021 G.C.Guo (NCHUMSL); Magong City: Dongwei (東衛石雕公園), 2♀, 03-VII-2023 Y.T.Wang (NCHUMSL); Magong City: Dongwei (東衛石雕公園), 1♂, 04-VII-2023

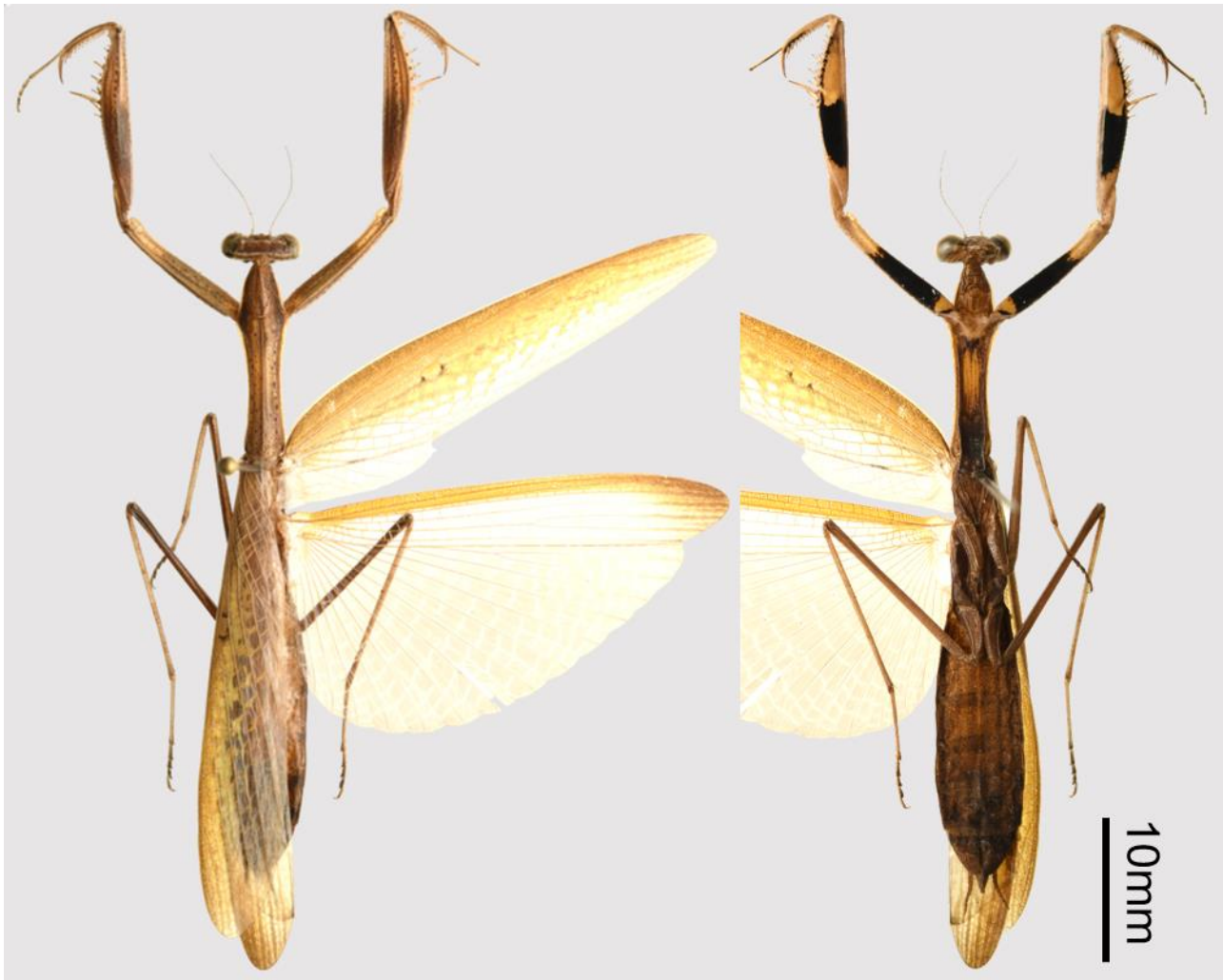


Fig. 5. Female of *Statilia apicalis* in dorsal view (left) and ventral view (right). The diagnostic character for the mark pattern in inner prolegs. The scale bar is 10 mm.

Y.T.Wang (NCHUMSL); Xiyu Township: Erkan (大菓葉), 1♂, 1♀, 05-VII-2023 Y.T.Wang (NCHUMSL); Magong City: Anzhai (安宅里), 1♂, 06-VII-2023 Y.T.Wang (NCHUMSL); Wangan Township: Dongji Is. (東吉嶼), 1♂, 16-X-2023 M.S.Chang (NCHUMSL); Wangan Township: Xiyuping Is. (西嶼坪), 2♂, 15-IX-2024 Y.T.Wang (NCHUMSL).

**Distribution in the Penghu Islands:** There are collection records in Penghu Is., Baisha Is., Xiyu Is., Dongjiyu Is., Xijiyu Is. and Xiyuping Is. of the South Penghu Marine National Park.

**Distribution:** Wide distribution in Africa, Asia, Australia, India (Kato, 1932; Chou, 2004).

**Remark:** The type locality of this species is in Africa. There is still taxonomic debate regarding this slender *Tenodera*. Identification in this study follows Chou (2004).

### Comparison with Taiwanese mantises

The vegetation of the Penghu Islands consists mainly of grass, shrubs, and a few woods, whose environment resembles the lowland and coastal habitats of western Taiwan, and their composition in mantis species is similarly comparable (Huang, 2015).

In Taiwan, Mantidae includes 6 genera, i.e., *Hierodula*, *Mantis*, *Mesopteryx*, *Statilia*, *Tenodera*, and *Titanodula*. In which, *Statilia*, *Mantis*, and *Tenodera* are commonly found in both Penghu and Taiwan grassland habitats, whereas *Hierodula* is more frequently observed in shrublands and woodlands. Meanwhile, the genera *Mesopteryx* and *Titanodula* have not been recorded in the Penghu Islands.

### Key to species of Mantodea in Penghu Islands.

1. With 3-5 prominent yellow spines on inner



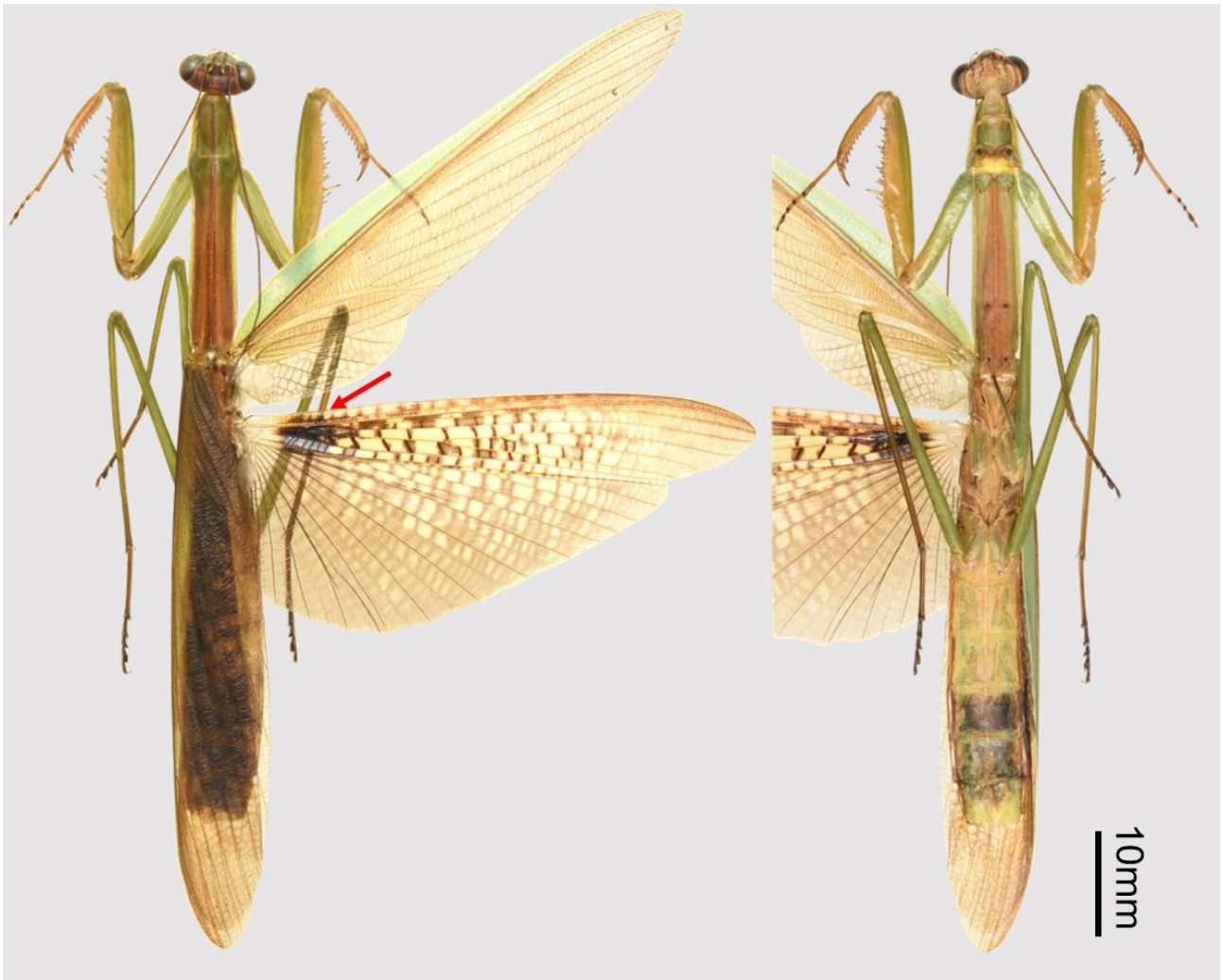


Fig. 6. Male of *Tenodera aridifolia* in dorsal view (left) and ventral view (right). The arrow indicates the diagnostic character of the dark spot in the base of the hindwing. The scale bar is 10 mm.

- forecoxa, white stigma on forewing. ....*H. patellifera* (Serville, 1838)
- 1'. Without yellow spines on inner forecoxa. ....2
2. Black or blue-black spot on inner forecoxa, over pronotum when forecoxa fold. ....3
- 2'. Without black or blue-black spot on inner forecoxa, not over pronotum when forecoxa fold, adult length over 7 cm. ....4
3. Black or white and black spot and white tiny particles on inner forecoxa, only yellow spot on inner forefemur. ....*M. religiosa* (Linnaeus, 1758)
- 3'. Only blue-black spot on inner forecoxa, blue-black and yellow spot on inner forefemur, black line on **avfs** (anteroventral femoral spines) .....*S. apicalis* (Saussure, 1871)
4. Without black spot on **avfs**, dark spot in base on hindwing. ....*T. aridifolia* (Stoll, 1813)
- 4'. Discontinuous on **avfs**, without dark spot in

base on hindwing. ....*T. superstitiosa* (Fabricius, 1781)

## Discussion

### Biodiversity of Mantodea in Penghu Islands

Field surveys and other findings indicate that the number of mantis species in the Penghu Islands is not as rare or absent as described previously. The Penghu islands have wet and dry seasons, and diverse herbaceous vegetation makes an optimal habitat for orthopterids (Yang *et al.*, 2020; Liao *et al.*, 2024). The complexity of herbaceous vegetation provides ample shelter, which ample shelter is helpful for mantis hunting (Huang, 2015; Wu, 2021a). However, among these recorded mantises, *S. apicalis* was recorded only in Magong. The recorded



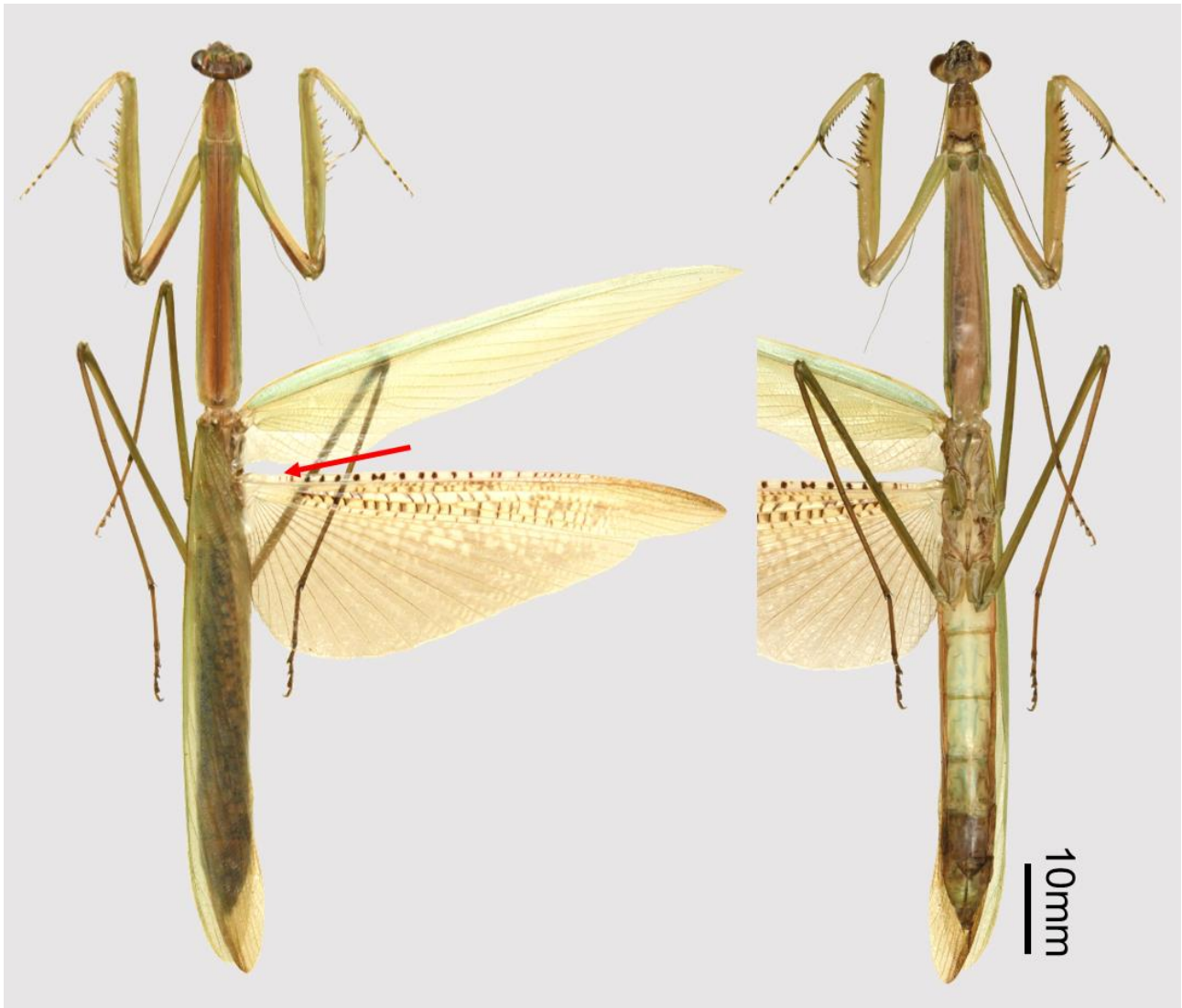


Fig. 7. Female of *Tenodera superstitiosa* in dorsal view (left) and ventral view (right). The arrow indicates the base of the hindwing without a dark spot is recognizable. The scale bar is 10 mm.

limitation might result either from its concealing behavior in its habitat or less competitive ability in small body size compared to the other four mantis species.

#### **Taxonomic debate on *Tenodera superstitiosa***

*Tenodera superstitiosa* is originally native to Africa and has been recorded as a widely distributed species. Specimens from Taiwan and surrounding islands have long been considered to be this species (Kato, 1932; Chou, 2004). However, recent studies suggest that *T. superstitiosa* is likely restricted to Africa and her neighboring islands (Ehrmann, 2002; Roy, 2018; Connors, 2023). Specimens from China, Southeast Asia, and Australia were considered as *Tenodera fasciata* (Olivier, 1792) or *Tenodera fasciata blanchardi* (Giglio-Tos, 1912) (Schwarz

and Konopik, 2014; Wu, 2021b; Connors, 2023). A comprehensive taxonomic verification based on molecular and morphological characters is necessary to validate *T. superstitiosa* and *T. fasciata*. For Taiwanese and offshore island populations, this study tentatively follows the classification by Kato (1932) and Chou (2004).

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## 澎湖群島的螳螂（昆蟲綱：螳螂目）物種組成分布及新紀錄物種

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### 摘 要

澎湖群島生物多樣性資料及相關研究鮮少提及昆蟲，近年雖有水生甲蟲、蟲癭及直翅目等昆蟲多樣性研究調查，但並無螳螂目相關調查記錄。本研究包含文獻資料，調查記錄澎湖群島的螳螂物種分布，除 1 種已知種外，新增 4 種新紀錄種；除明確了解澎湖群島螳螂物種基本組成外，亦可促進這個台灣離島的螳螂及各類昆蟲的多樣性相關調查及研究。

**關鍵詞：**螳螂目、生物多樣性、新記錄