Argemone ochroleuca—A newly naturalized species of *Argemone* (Papaveraceae) in Taiwan

臺灣薊罌粟屬（罌粟科）的新歸化種—淡黃薊罌粟

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Abstract

A newly naturalized species of *Argemone* L., *A. ochroleuca* Sweet, has been discovered in central, northern, and eastern Taiwan. This discovery increases the number of *Argemone* species up to two species in Taiwan. Due to its morphological similarity to *A. mexicana* L., this species has often been misidentified as *A. mexicana* in the past. This

paper provides color photographs of the external morphology, pollen, and distribution map of *A. ochroleuca* and *A. mexicana* in Taiwan. In addition, this paper also provides a key to *Argemone* in Taiwan.

Key words: Taiwan, newly naturalized plant, *Argemone ochroleuca* Sweet, pollen, key

摘要

近年於臺灣中部、北部與東部地區發現一新歸化薊罌粟屬植物 — 淡黃薊罌粟 (*Argemone ochroleuca* Sweet)，將臺灣薊罌粟屬增加至 2 種。本種與薊罌粟 (*A. mexicana* L.) 的形態相似，因此過往常被誤認為薊罌粟。本文提供淡黃薊罌粟與薊罌粟的外部形態彩色照片、花粉照片與在臺分布圖。此外，提供臺灣薊罌粟屬植物的檢索表。

關鍵詞：臺灣、新歸化植物、淡黃薊罌粟、花粉、檢索表

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Introduction

Argemone L. belongs to Papaveraceae (The Angiosperm Phylogeny Group 2016; Zuntini *et al.* 2024). Globally, *Argemone* includes approximately 30 taxa, primarily distributed across America (Schwarzbach and Kadereit 1999).

In recent years, an unidentified species of *Argemone* was discovered in central, northern, and eastern Taiwan. After reviewing relevant literature, this species was identified as *Argemone ochroleuca* Sweet. This species is newly naturalized in Taiwan, because it is a species widespread in various regions in central and eastern Taiwan. This species closely resembles *Argemone mexicana* L. (Fig. 1, 2, 3), previously recorded *Argemone* species in Taiwan (Liu 1976; Liu and Yang 1996), and their overlapping distributions have often led to misidentification. This study compares the external morphology and pollen characteristics of the two species from wild populations, and provides their distribution maps and a key to *Argemone* in Taiwan for clarifying their differences.

Materials and Methods

Sample collection and photography

The fresh samples used in this study were collected from Yunlin County in Taiwan. Externally morphological and microscopic features were recorded directly at the collection sites and subsequently processed using photographing software. After photographing, plants containing flowers or fruits were collected and brought back to the Department of Biological Resources, National Chiayi University, where they were made specimens to serve as voucher specimens. After the preparation of the voucher specimens is completed, they will be deposited in the Herbarium of Taiwan Forestry Research Institute (TAIF).

Morphology of pollen

Fresh pollen grains were collected from the field by using clean tweezers to

remove anthers, which were then temporarily stored in micro-centrifuge tubes containing 75% ethanol. Pre-photography processing was primarily based on the protocol by Halbritter (1997). The samples were put into a vial containing acidified 2,2-dimethoxypropane (1 drop of 0.2 M hydrochloric acid added to 30 mL of 2,2-dimethoxypropane). This step required 30 minutes of processing. After removing acidified 2,2-dimethoxypropane, acetone was added for preservation. Samples were gold-coated for 90 seconds and subsequently examined using a scanning electron microscope (SEM, HITACHI S-3400N). After photographing, the images were post-processed using the photographing software.

Pollen size was measured using Image J 1.50d software (Schneider *et al.* 2012). For each species, 10 pollen grains were randomly selected, followed by calculating the polar axis length (P), equatorial plane length (E), and the P/E ratio. One intact pollen grain was also selected, and 10 ornamentations were randomly measured in width. A one-way ANOVA was then performed to assess significant differences in pollen characteristics between *A. ochroleuca* and *A. mexicana*. All statistical analyses were performed using R version 4.5.1 (R Core Team 2025). Pollen terminology was primarily based on Halbritter *et al.* (2018).

Horizontal and vertical *Argemone* species distribution in Taiwan

The horizontal and vertical species distribution maps of Taiwan for *A. ochroleuca* and *A. mexicana* were generated using QGIS ver. 3.36.0. (QGIS.org. 2024). Data were obtained originally from iNaturalist (accessed 18 Mar. 2025), selecting records from 2018 to 2024 that had achieved "Research Grade" status. The downloaded data included latitude and longitude information, while elevation data were obtained using Google Earth (accessed 18 Mar. 2025). The vertical and horizontal distribution maps were

created based on this dataset, following the QGIS project template for horizontal and vertical species distribution mapping of Taiwan developed by Lin (2018).

Result and Discussion

Taxonomic treatment

Argemone L. 薊罌粟屬

Annual or perennial glaucous herbs, rarely shrubs, with yellow, foetid milkly latex. Leaves alternate, mostly pinnatifid, usually aculeate-dentate. Flowers solitary, terminal; sepals 2 or 3, coherent at apex, caducous; petals double the number of sepals, corrugate in bud; stamens numerous, short than corolla, filaments free; ovary ovoid, with 3-7 parietal placentas; style short, stigma 3-7 lobed, lobes opposite placentas; ovules numerous. Capsules 3-7 valved at apex; seed numerous, globose, reticulate-ribbed.

About 10 taxa native to America; 2 taxa naturalized in Taiwan.

Key to *Argemone* in Taiwan

Plant whitish-green; petals 6, rarely 9, pale yellow…… *A. ochroleuca*

Plant green; petals 6, light yellow……..

…….....*A. mexicana*

1.***Argemone mexicana*** L., Sp. Pl. 508. 1753; Fawcett *et al.*, Fl. Jamaica 3: 222. 1914; Liu, Fl. Taiwan 2: 654. *pl. 437*. 1976; Liu & Yang, Fl. Taiwan 2nd 2: 720. *pl. 339*. 1996; Zhang & Christopher, Fl. China 7: 262. 2008. 薊罌粟 (Fig. 1, 2)

Type: LINN 670.1 (Lectotype) (Fig. 3)

Erect annual or occasionally short-lived herb, 0.3-1 m tall, green slightly glaucous. Leaves sessile, pinnatifid, oblong-obovate or lanceolate-obovate, 7-28 cm long, 2.5-10 cm wide, spinulose-dentate, white-pruinose on both surfaces, more or less amplexicaual at base. Flower buds subspherical, prickles many, green. Flowers sessile or very short pedicelled, floral diameter 5.5-6 cm; sepals mostly 3, green, 2.7-2.9 cm long, ca. 0.7 cm wide; petals obovate, bright yellow,

2-3 cm long, ca. 1.5 cm wide; stamens many; stigma dark red, 5-lobed. Capsules oblong, 2.5-4 cm long, ca. 1.4 cm wide, 3-6 valved above, clothed with erect-patent sharp bristles. Seed spherical, deep brown, 1.5-2 mm long, 1.5-2 mm wide, obviously tessellate on surface. Flowering from December to May. Fruiting from January to May.

Naturalized in central, western, southern, and eastern Taiwan and Penghu Islands.

Voucher specimens: TAIWAN, Yunlin County, Shuilin Township, 11 Jan. 2025, *Y. Z. Lu 788* (TAIF[1]). Kaohsiung City, Tianliao District, Hsiaokunshui, 05 Jan. 2019, *Z. H. Chen 1811* (TAIF); Tashu Township, 04 Feb. 2002, *S. Z. Yang 26262* (TAIF); Shoushan, 05 Apr. 1996, *C. S. Yang 452* (TAIF). Taitung County, Taitung, 01 Mar. 1913, *Tadasaburo Soma s.n.* (TAIF). Penghu County, Penghu, 01 Sep. 1917, *Tanaka s.n.* (TAIF); Fen Kuei, Shihli Li, 22 Jun. 1994, *C. H. Chen 704* (HAST[2]); Nanliao, 22 Jul. 2015, *S. W. Chung 12248* (TAIF).

[1] This code is the herbarium of the Taiwan Forestry Research Institute, Taiwan.

[2] This code is the herbarium of Biodiversity Research Museum, Herbarium, Academia Sinica, Taiwan

2. ***Argemone ochroleuca*** Sweet, Brit. Fl. Gard. 3: 242. 1828; Chintala & Pattanaik, Zoos' Print 22(12): 2949. 2007; Patel, Phytoneuron 52: 1 2013. 淡黃薊罌粟 (Fig. 4, 5)

Type: British Flower Garden vol. 3, t. 242, 1828 (Holotype) (Fig. 6)

Argemone mexicana L. var. *ochroleuca* (Sweet) Lindley, Edwards's Bot. Reg. 16: t. 1343. 1830.

Argemone mexicana L. subsp. *ochroleuca* (Sweet) Schwarzb, Fl. Valle Tehuacán-Cuicatlán 131: 8. 2015.

Erect annual herbs, up to 1 m tall, whitish-green, densely glaucous with

reddish tinge. Leaves sessile, semi-amplexicaul, oblanceolate, 16-22 cm long, 4-8 cm wide, sinuate to pinnatifid, basal leaves deeply lobed; lobes oblong, glaucous. Flower buds oblong, prickles few, tinged red. Flower sessile or very short pedicelled, floral diameter 6-7 cm; sepals mostly 3, green, 2.5-2.6 cm long, ca. 0.7 cm wide; petals 6, rarely 9, obcuneate-obovate, pale yellow, ca. 3 cm long, 1.5-1.8 cm wide; stamens many, 8-10 mm long; filaments pale yellow; anthers oblong, recured, dark yellow; stigmas 5-lobed, deeply dissected, dark red. Capsules ovoid or lanceolate-ovoid, 3-4 cm long, 1.3-1.4 cm wide, 3-6 valved above, clothed with erect-patent sharp bristles. Seed spherical, black, 1.5-2 mm long, 1.5-2 mm wide. Flowering from December to May. Fruiting from January to May.

Naturalized in central, northern, and eastern Taiwan (Fig. 8).

Voucher specimens: TAIWAN, Changhua County, Tatsun Township, 16 Mar. 2019, *C. M. Wang 17791* (TNM[3]); Shetou Township, Shetou, 21 Mar. 2026, *Y. Z. Lu 1265* (TAIE[4]); Tienwei Township, Tienwei, 02 Apr. 2001, *C. M. Wang 04807* (TNM); Tianzhong Township, 13 Jan. 2025, *Y. Z. Lu 792* (TAIF); Hsichou Township, Hsitso Village, 31 Jul. 2016, *C. M. Wang 17029* (TNM). Yunlin County, Erhlun Township, Kanghou Village, 31 May 2022, *C. M. Wang 19391* (TNM); Taihsi Township, Provincial #155, 13 Apr. 2012, *C. H. Chen, C. M. Wang, C. Y. Li 10866* (TNM).

[3] This code is the herbarium of National Museum of Natural Science, Taiwan.

[4] This code is the herbarium of Taiwan Biodiversity Research Institute, Taiwan

Note: *A. ochroleuca* closely resembles *A. mexicana* in external morphology. However, the most notable difference between the two species lies in the color of their plant and petals. *A. ochroleuca* has

a whitish-green plant and pale yellow petals; *A. mexicana* has a green plant and bright yellow petals.

Morphology of pollen

According to SEM observation, pollen grains of *A. ochroleuca* and *A. mexicana* are very similar (Fig. 7). They are monad, subcircular in shape, and have a microrugulate surface ornamentation. Each pollen grain possesses 3-apertures, with gemmate structures on the aperture surface. However, pollen grain of *A. ochroleuca* sometimes has 4-apertures. These results are consistent with Chaturvedi *et al.* (2010).

Polar axis length (P) of *A. ochroleuca* (28.28 ± 0.52 μm, Mean ± Standrand Error) is longer than *A. mexicana* (22.86 ± 1.28 μm), and they show a significant difference. Equatorial diameter length (E) of *A. ochroleuca* (32.50 ± 1.17 μm) is longer than *A. mexicana* (30.65 ± 0.90μm), and they show a significant difference. P/E ratio of *A. ochroleuca* (0.86 ± 0.03 μm) is longer than *A. mexicana* (0.68 ± 0.06 μm), and they show a significant difference. Ornamentation width of *A. ochroleuca* (0.46 ± 0.04 μm) is longer than *A. mexicana* (0.31 ± 0.04 μm), and they show a significant difference. Hence, polar axis length, equatorial diameter length, and ornamentation width can distinguish *A. ochroleuca* and *A. mexicana*. Pollen traits of *A. ochroleuca* and *A. mexicana* are summarized in Table1.

Horizontal and vertical species distribution in Taiwan

Figure 8 is a distribution map of *A. ochroleuca* and *A. mexicana* in Taiwan. Both species are mainly found in low-altitude areas in central Taiwan. *A. mexicana* is also distributed in eastern and southern Taiwan, as well as in the Penghu Archipelago. *A. ochroleuca* has also been recorded in northern and eastern Taiwan.

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Fig. 1 Plants of *Argemone mexicana* L. in Taiwan.
圖 1 臺灣的薊罌粟植株。

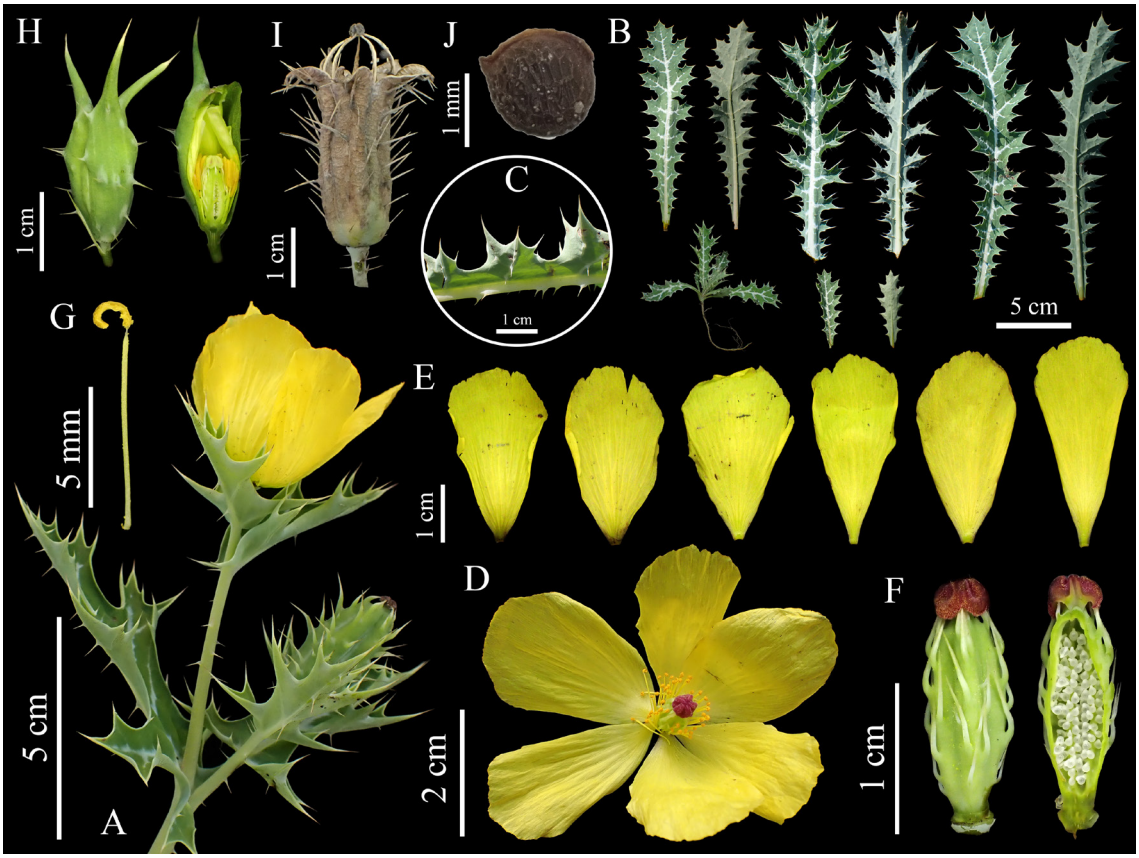

Fig. 2 *Argemone mexicana* L. (A) Habit. (B) Leaves and plantlet. (C) Side of leaf. (D) Flower. (E) Petals. (F) Pistil, outside view (left) and sectional view (right). (G) Stamen. (H) Bud, outside view (left) and sectional view (right). (I) Fruit. (J) Seed.

圖 2 薊罌粟。(A) 植株。 (B) 葉片和小苗。 (C) 葉片側面。 (D) 花。(E) 花瓣。(F) 雌蕊，外觀 (左) 與剖面 (右)。(G) 雄蕊。 (H) 花苞，外觀 (左) 與剖面 (右)。(I) 果實。 (J) 種子。

Fig. 3 Lectotype of *Argemone mexicana* L. (LINN 670.1). Image from the Linnean Collections.

圖 3 薊罌粟之選模式 (LINN 670.1)。圖片取自 the Linnean Collections (https://linnean.access.preservica.com/uncategorized/IO_48d1ed21-2176-4873-8041-f31d4b3070cd/ [retrived on 16 April 2026])。

Fig. 4 Plant of *Argemone ochroleuca* Sweet in Taiwan.
圖 4 臺灣的淡黃薊罌粟植株。

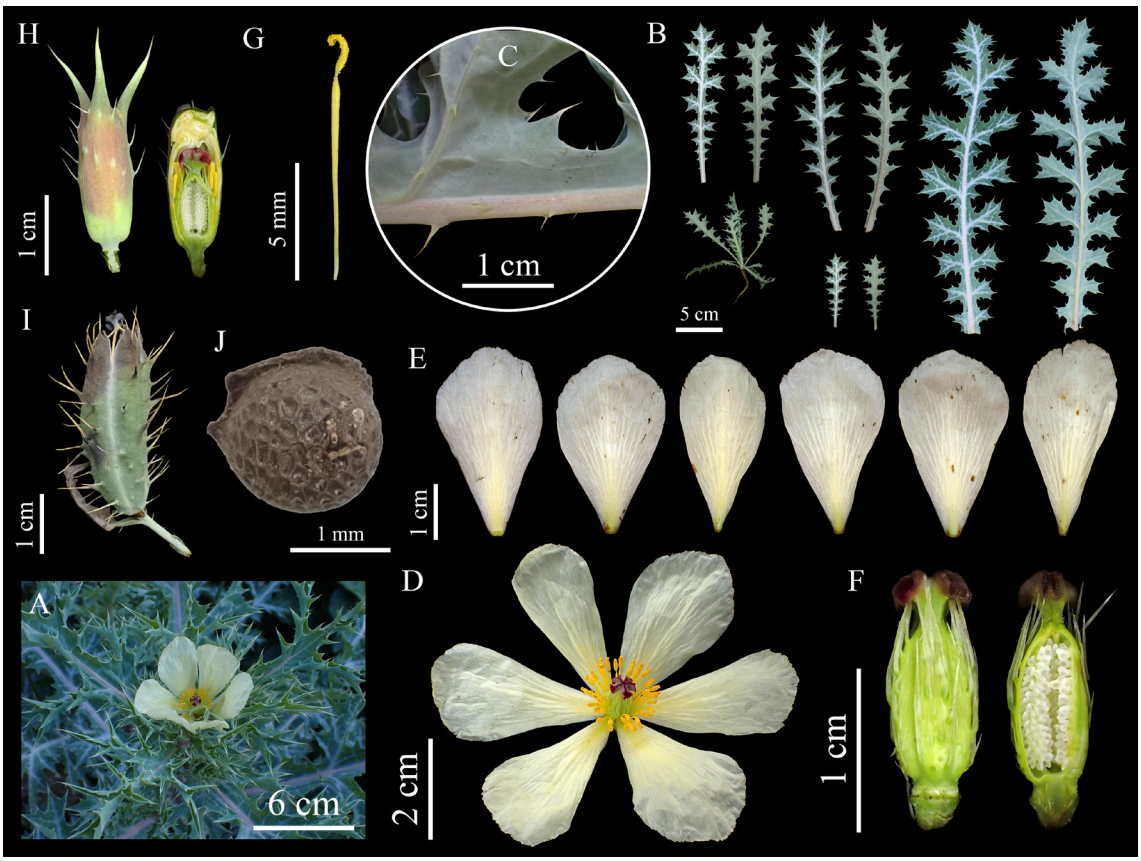

Fig. 5 *Argemone ochroleuca* Sweet. (A) Habit. (B) Leaves and plantlet. (C) Side of leaf. (D) Flower. (E) Petals. (F) Pistil, outside view (left) and sectional view (right). (G) Stamen. (H) Bud, outside view (left) and sectional view (right). (I) Fruit. (J) Seed.

圖 5 淡黃薊罌粟。(A) 植株。(B) 葉片和小苗。(C) 葉片側面。(D) 花。(E) 花瓣。(F) 雌蕊，外觀 (左) 與剖面 (右)。 (G) 雄蕊。 (H) 花苞，外觀 (左) 與剖面 (右)。 (I) 果實。 (J) 種子。

Fig. 6 Holotype of *Argemone ochroleuca* Sweet (British Flower Garden vol. 3, t. 242, 1828). Image from the Biodiversity Heritage Library.

圖 6 淡黃薊罌粟之全模式 (British Flower Garden vol. 3, t. 242, 1828)。圖片取自 Biodiversity Heritage Library (https://www.biodiversitylibrary.org/item/224660#page/178/mode/1up [retrived on 27 November 2024])。

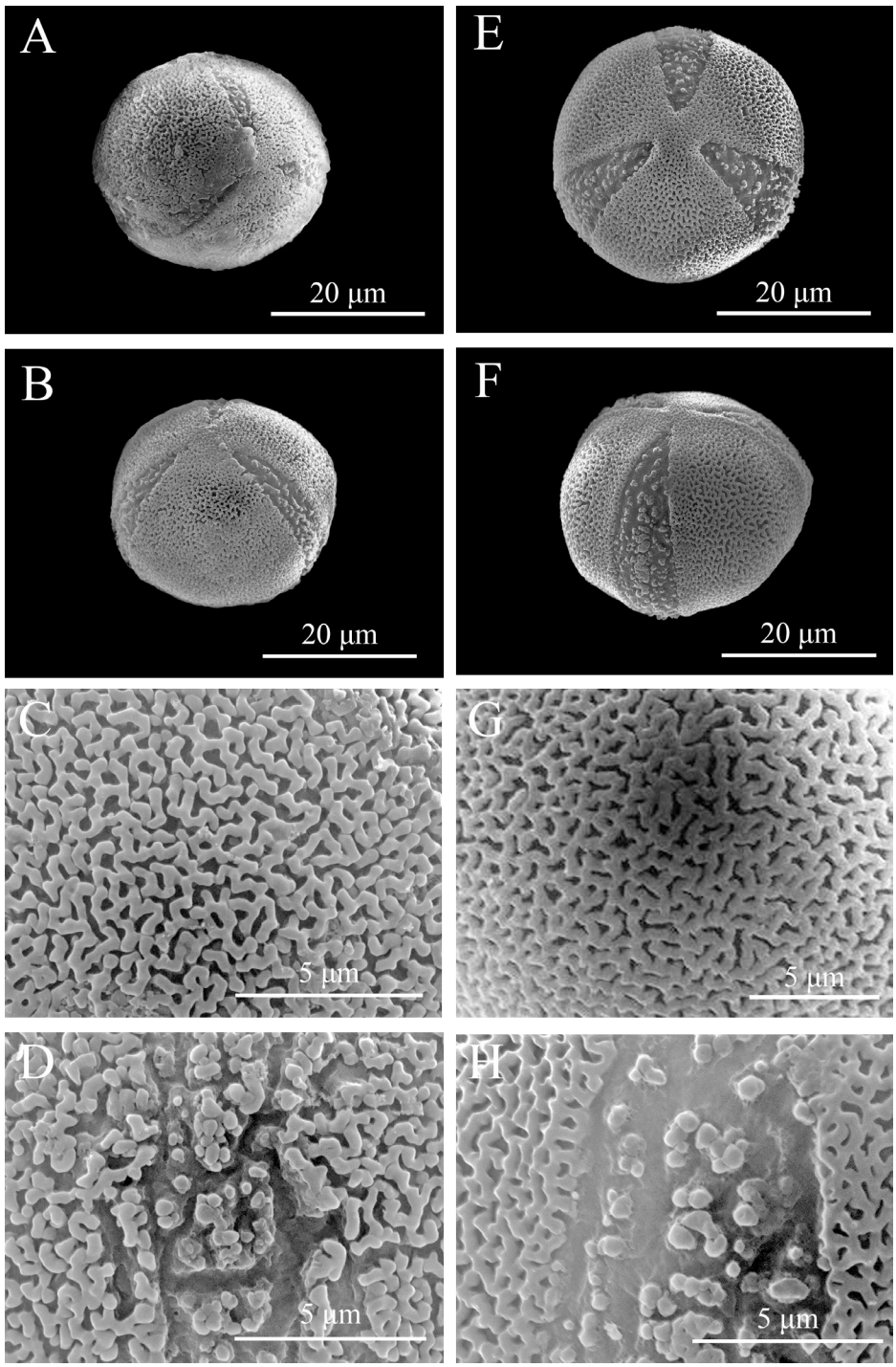

Fig. 7 Pollen morphology of *Argemone mexicana* L. (left) and *Argemone ochroleuca* Sweet (right). (A)(E) Polar view. (B)(F) Equatorial view. (C)(G) Ornamentation. (D)(H) Aperture.

圖 7 薊罌粟(左)與淡黃薊罌粟(右)的花粉外部形態。(A)(E) 極面。(B)(F) 赤道面。(C)(G) 表面紋飾。(D)(H) 萌發溝。

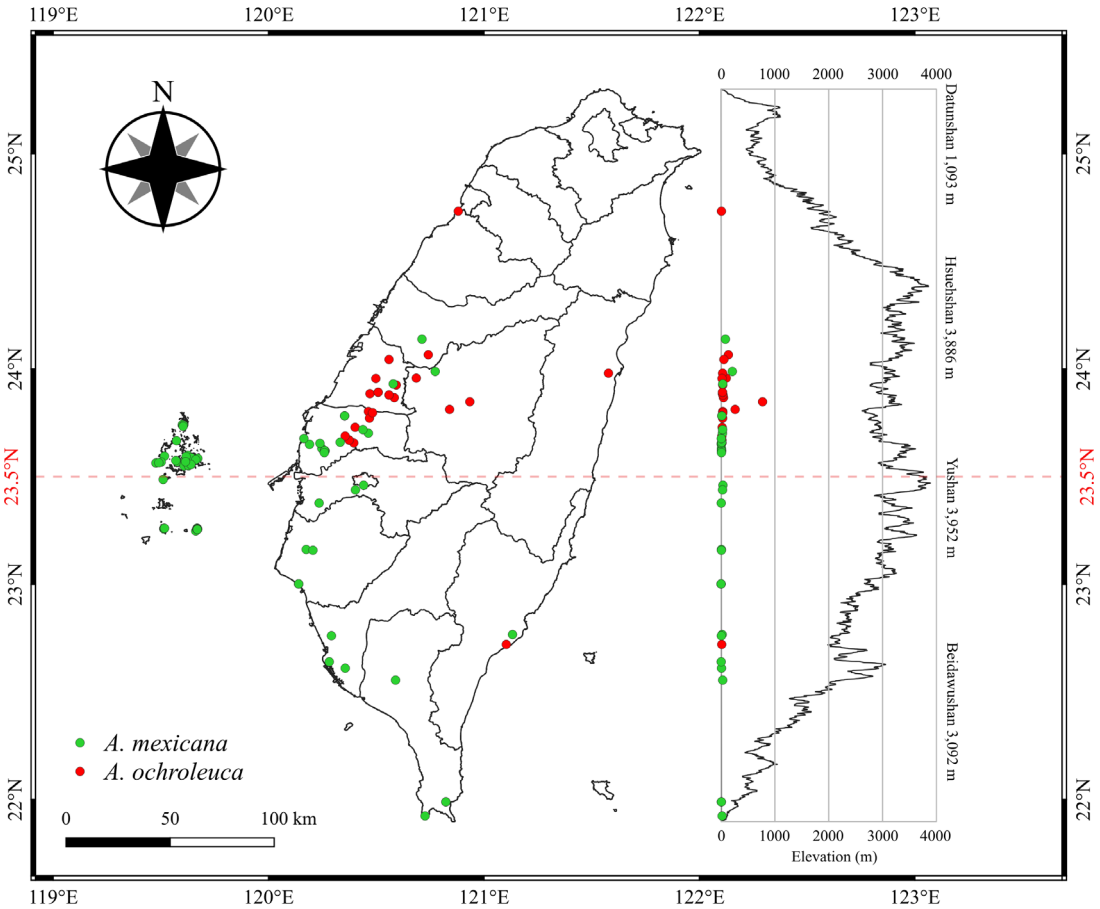

Fig. 8 Distribution of *Argemone ochroleuca* Sweet and *Argemone mexicana* L. in Taiwan.
圖 8 淡黃薊罌粟與薊罌粟在臺灣的分布。

Table 1 Pollen trait of *Argemone ochroleuca* Sweet and *Argemone mexicana* L. (* indicates a significant difference)
表 1 淡黃薊罌粟與薊罌粟的花粉特徵。(* 表示具有顯著差異)

Taxon	Shape	Ornamentation	Polar axis length (P) (μm) (*n* = 10)*	Equatorial diameter length (E) (μm) (*n* = 10)*	P/E (*n* = 10)*	Ornamentation width (μm) (*n* = 10) *
A. ochroleuca	Subcircular	Microrugulate	28.28 ± 0.52	32.50 ± 1.17	0.86 ± 0.03	0.46 ± 0.04
A. mexicana	Subcircular	Microrugulate	22.86 ± 1.28	30.65 ± 0.90	0.68 ± 0.06	0.31 ± 0.04

Note: The values in the table are Mean ± SE.
註：表中數值為平均值 ± 標準誤差。