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封面圖說／
盾形貓蛛（*Oxyopes sushilae*）在臺灣分布於西部中低海拔山區，棲息於草叢、灌木等棲地徘徊覓食，善於跳躍。

（羅英元 攝）

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Contents

Hypocrea cornu-damae (Hypocreales, Ascomycota), Newly Recorded Species in Taiwan

臺灣子囊菌新記錄種－火焰茸

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Abstract

A saprophytic and poisonous fungus, *Hypocrea cornu-damae* (Hypocreaceae, Ascomycota) is reported from Taiwan for the first time. The morphological description, illustration, and habitat of this species are provided in this study.

摘　要

本文描述一種臺灣子囊菌新記錄種－火焰茸 (*Hypocrea cornu-damae*)，爲腐生性有毒眞菌，文中提供形態描述、圖版、棲地及引證標本等。

Key words: Poisonous fungi, Ascomycota, Hypocreaceae

關鍵詞：毒菌、子囊菌、肉座菌科

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Introduction

Hypocrea cornu-damae is a rare species of fungus belonging to the Hypocreaceae. Its fruit body is highly toxic. Several fatal cases of poisoning by *H. cornu-damae* have been reported in Japan (Saikawa *et al*., 2001) and Korea (Ahn *et al*., 2013), however no such case has ever been reported in Taiwan. *Hypocrea cornu-damae* was first discovered in China, described and assigned under *Hypocrea* by Patouillard (1895), and later transferred to the genus *Podocrea* (Saccardo and Saccardo, 1905), before being placed under the genus *Podostroma* (Boedijn, 1934). Chamberlain *et al.* (2004) synonymized *Podostroma* with *Hypocrea*. This paper briefly describes its characteristics with illustrations and provides information on its habitats and distribution.

Taxonomic Treatment

Hypocrea cornu-damae Pat., Bull. Soc. Mycol. France 11: 198. 1895.
=*Podocrea cornu-damae* (Pat.) Sacc. & D. Sacc., Sylloge Fungorum 17: 799. 1905.
=*Podostroma cornu-damae* (Pat.) Boedijn, Bull. Jard. Bot. Buitenzorg, ser. 3, 13: 274. 1934.

Fig. 1

Stromata simple and cylindrical to narrowly clavate or branched dichotomously, 6–10 cm tall, 0.7–1 cm broad, sometimes several cylindrical stromata arising from a common base, orange, surface glabrous, smooth, perithecia elevations not visible, perithecial papilla barely protruding through stroma surface, ostiola openings appearing as minute white dots. Surface region of stroma ca. 40 μm thick in section of intertwined thin-walled hyphae, 3–4 μm wide. Perithecia subglobose, 220–250 × 120–200 μm. Tissue below perithecia composed of intertwined hyphae, 9–13 μm wide. Asci cylindrical, 65–81 × 3.5–4.5 μm, apex thickened. Ascospores hyaline, finely spinulose, distal part subglobose to slightly conical, 3.4–4.2 × 3.2–3.5 μm, proximal part ellipsoidal to subglobose, 3.5–4.4 × 3.3–3.6 μm.

Habitat: Growing on the ground, solitary to scattered under broad-leaved trees.

Distribution:

China, Japan, Korea (Patouillard, 1895; Doi, 1967; Ahn *et al*., 2013). New to Taiwan.

Specimen examined: Taitung County: Tienchih (天池), Orchid Island, ca. 450 m in elevation, 22°01'11" N, 121°30'34" E, 11 February 2011, T. C. Lin 569.

Fig.1. *Hypocrea cornu-damae* Pat. A: Clavate stromata; B. Vertical section of perithecia; C. An ascus; D. Ascospores

Remark :

Podostroma was proposed for members having stipitate, clavate, erect, fleshy and bright colored stromata in the Hypocreaceae (Karsten, 1892), Chamberlain *et al*. (2004) synonymized *Podostroma* with *Hypocrea*, mainly based on anamorphic morphology of *H. alutacea* (Pers.) Tul. & C. Tul. and *H. leucopus* (P. Karst.) H. L. Chamb. Jaklitch *et al.* (2008) based upon *rpb2* sequences showed that the type species of *Podostroma*, *P. leucopus* P. Karst., and the type species of *Podocrea*, *P. alutacea* (Pers.) Lindau, are unequivocal members of the genus *Hypocrea*. The results corroborate that the synonymization of *Podocrea* and *Podostroma* with *Hypocrea* (Chamberlain *et al*., 2004) is correct. Ten species of *Hypocrea* have been reported from Taiwan (Wang *et al*., 1999; Chang and Wang, 2008). They all have pulvinate and broadly attached stromata, while *H. cornu-damae* is the first recorded species having stipitate and clavate stromata in Taiwan, and the locality recorded on Orchid Island, Taiwan, is the southernmost locality for this species. The ascospores of this species are described as smooth by Boedijn (1934), but Patouillard (1895) described those are very finely spinulose.

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Wang, Y. Z., S. H. Wu, W. N. Chou, T. T. Chang, G. Y. Chen, S. F. Chen, J. L. Chen, S. S. Tzean, C. H. Liu, W. H. Hsieh, H. J. Hsieh, C. H. Chung and C. Y. Chien. 1999. List of the fungi in Taiwan. Agricultural Committee Administrative Government, Taipei, Taiwan. 289 pp.

Lecanorchis flavicans var. *acutiloba* (Orchidaceae), A Newly Recorded Orchid in Taiwan

白髭皿蘭(蘭科)，台灣新紀錄蘭科植物

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Abstract

Lecanorchis flavicans Fukuy. var. *acutiloba* T. Hashim. (Orchidaceae) is reported as a newly recorded species in Taiwan. It is most similar to *L. triloba* J. J. Sm. but can be distinguished by its 3–5-flowered inflorescences, longer tepals and lip without a pair of calli on the disc. In this study, we provide a description, illustration and distribution map of *L. flavicans* var. *acutiloba*.

摘　要

本文報導台灣新紀錄的蘭科植物白髭皿蘭(*Lecanorchis flavicans* Fukuy. var. *acutiloba* T. Hashim.)。此物種最接近三裂皿蘭(*L. triloba* J.J. Sm.)，但花序僅有 3 至 5 朵花，花被較長且唇盤上不具有一對胼胝體。本研究提供白髭皿蘭的描述、圖片及分布圖。

Key words: *Lecanorchis flavicans* var. *acutiloba*, new record, Orchidaceae, Taiwan, taxonomy.

關鍵詞：白髭皿蘭，新紀錄，蘭科，台灣，分類學。

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Short running title: *Lecanorchis flavicans* var. *acutiloba*, new to Taiwan

Introduction

Lecanorchis (Orchidaceae) is a genus of myco-heterotrophic orchids containing about 25 species distributed from Japan and southern China, through SE Asia to New Guinea (Cameron, 2003; Suddee and Pedersen, 2011) with about 11 species reported in Taiwan (Su, 2000; Hsu and Chung, 2009; 2010; Lin *et al*., 2011). This genus can be recognized by the presence of a cup-like calyculus that encircles the base of perianth and persists in fruit (Cameron, 2003; Suddee and Pedersen, 2011). They mainly grow in moist humus of primary forest and are often overlooked because of their leafless, dull-colored habits. Recently, a newly recorded species, *L. flavicans* Fukuy. var. *acutiloba* T. Hashim., was found in northern Taiwan during our field investigation. The morphological description, illustration and distribution map (Fig.1) of *L. flavicans* var. *acutiloba* are herein provided. Since a comprehensive taxonomic revision of the genus *Lecanorchis* in Taiwan is still in preparation, a provisional key is presented in this paper for diagnosing this new species.

Provisional key to the *Lecanorchis* species in Taiwan:

1. Inflorescence always annual and simple; scape ± soft and fleshy, dull, grayish brown or yellowish brown at anthesis; floral bracts ovate-deltoid, 3–8 mm long….....2

1a. Inflorescence often perennial and branched, occasionally annual and simple; scape ±stiff, glossy, dark brown or blackish at anthesis; floral bracts broadly ovate, 1–3 mm long..……..…….....3

2. Sepals (15–)18–28 mm long; side-lobes of lip obtuse at apices; capsule 2–3 cm long.....
.....*L. cerina* var. *cerina* and *L. thalasica*

2a. Sepals 14–19 mm long; side-lobes of lip acute at apices; capsule 1.5–2 cm long.....
.....*L. cerina* var. *albida*, *L. suginoana* and *L. virella*
3. Lip free from column.....*L. bihuensis*, *L. latens* and *L. subpelorica*
3a. Lip connate with column at base.....4
4. Lip unlobed or obscurely 3-lobed, apparently cucullate.....
.....*L. amethystea*, *L. nigricans* var. *nigricans* and *L. nigricans* var. *yakushimensis*
4a. Lip apparently 3-lobed, not cucullate..... 5
5. Inflorescence, pedicels and capsules tuberculate; sepals 16–19 mm long; lip 15–16 mm long, mid-lobe ca. 2 mm long..... .....*L. trachycaula*
5a. Inflorescence, pedicels and capsules almost glabrous; sepals 9–12 mm long; lip 10–14 mm long, mid-lobe 3–5 mm long.....6
6. Inflorescence many-flowered; sepals 9–11 mm long; lip 10–12 mm long, side-lobes rounded at apices, disc with a pair of pubescent calli..... .....*L. triloba*
6a. Inflorescence 3–5-flowered; sepals 12–14 mm long; lip 12–14 mm long, side-lobes acute at apices, disc without a pair of calli.....*L. flavicans* var. *acutiloba*

Taxonomic Treatment

Lecanorchis flavicans Fukuy. **var. *acutiloba*** T. Hashim, Ann. Tsukuba Bot. Gard. 8: 8, fig. 3. 1989. Figs. 2–3.

Type: JAPAN. Kagoshima: Yakushima, Mt. Motchomu, 24 Jul 1979, *Y. Hanei s.n.* (holotype: TNS photo!).

Morphology: Herbs, mycotrophic. Rizhomes usually branched, crooked. Roots many, brown, 1.5–2 mm in diameter. Inflorescences usually perennial and branched, occasionally annual and simple, 15–30 cm tall, slender, indurate, blackish brown, less than 1 mm in diameter. Raceme up to 5 cm, loosely 3–5-flowered, somewhat flexuose. Pedicellate ovary 15–25 mm long, with a ring-like excrescence below the calyculus; apical portion including calyculus somewhat rugose. Flower ascending or slightly nodding, not widely opened. Sepals similar, pale-yellow tinged with brownish purple, 3-veined, oblanceolate-oblong, somewhat cucullate, 11–13 × ca. 3 mm, apices obtuse. Petals pale-yellow, 3-veined, obliquely obovate-oblong, 11–13 × ca. 4 mm, apices obtuse. Lip whitish, slightly longer than other tepals, 12–14 × 8–9 mm when expanded and flattened, clawed at base, canaliculate, connate with column forming tube, 3-lobed; tube ca. 3 mm long, pubescent inside; lateral lobes erect, triangular, ca. 2 mm long, acute at apices, margins slightly irregularly denticulate; midlobe semiorbicular, slightly recurved, 3–4 × 4–5 mm, densely hairy; hairs on the disc and mid-lobe flexuous, sometimes branched, up to 2.5 mm long, smooth on surfaces. Column ca. 6 mm long, clavate, about halfway connate with the lip, with

obtuse-trapezoid lateral wings. Anther white, pubescent around the dehiscent slits. Capsules cylindrical, 18–25 mm long.

Distribution: Japan (Yakushima, Amami-oshima, Kagoshima, Okinawa) and Taiwan (New Taipei and Ilan).

Ecology: Under broadleaved forests with deep leaf litter at the elevation of 500–1000 m.

Phenology: Flowering from May to August; fruiting all year round.

Chinese name: 白髭皿蘭.

Additional specimens examined: TAIWAN. New Taipei City: Mt. Tatao (大刀山), ca. 500 m, *T. C. Hsu 6577* (TAIF); Mt. Chichouliao (紀州寮山), 500–700 m, *T. C. Hsu 6822* (TAIF). Ilan County: Songlohu trail (松羅湖步道), 800–1000 m, *T. C. Hsu 6726* (TAIF).

Note: The specimens collected in Taiwan match descriptions of *Lecanorchis flavicans* var. *acutiloba*, which differs from *L. flavicans* var. *flavicans* described from Iriomote Island of Japan, by having more connate lip and column (ca. 1/2 vs. 1/3–1/4 length of column) (Fukuyama, 1942; Hashimoto, 1989; 1990). Since *L. flavicans* var. *flavicans* is so far only known from the type collection (Hashimoto, 1990; K. Suetsugu, pers. comm. in Nov 2015) and the type specimen is not traced in any herbaria to date, further investigation in its type locality is critically necessary to clarify whether these varieties are indeed recognizable.

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We thank Dr. Kenji Suetsugu for providing valuable data and Mr. Shen-Kun Yu and Mr. Ralf Knapp for their kind assistance in field trips.

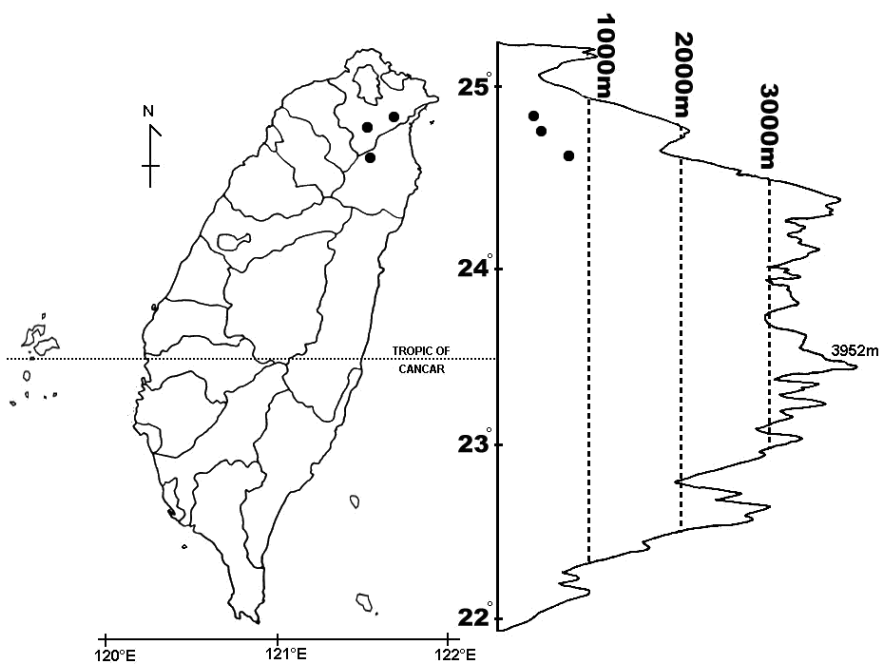

Fig 1. Distribution of *Lecanorchis flavicans* var. *acutiloba* in Taiwan.

Fig. 2. *Lecanorchis flavicans* var. *acutiloba*. A: Habit *in situ*. B: Flower, front view. C: Flower, side view. D: Capsule. Photographed by T. C. Hsu.

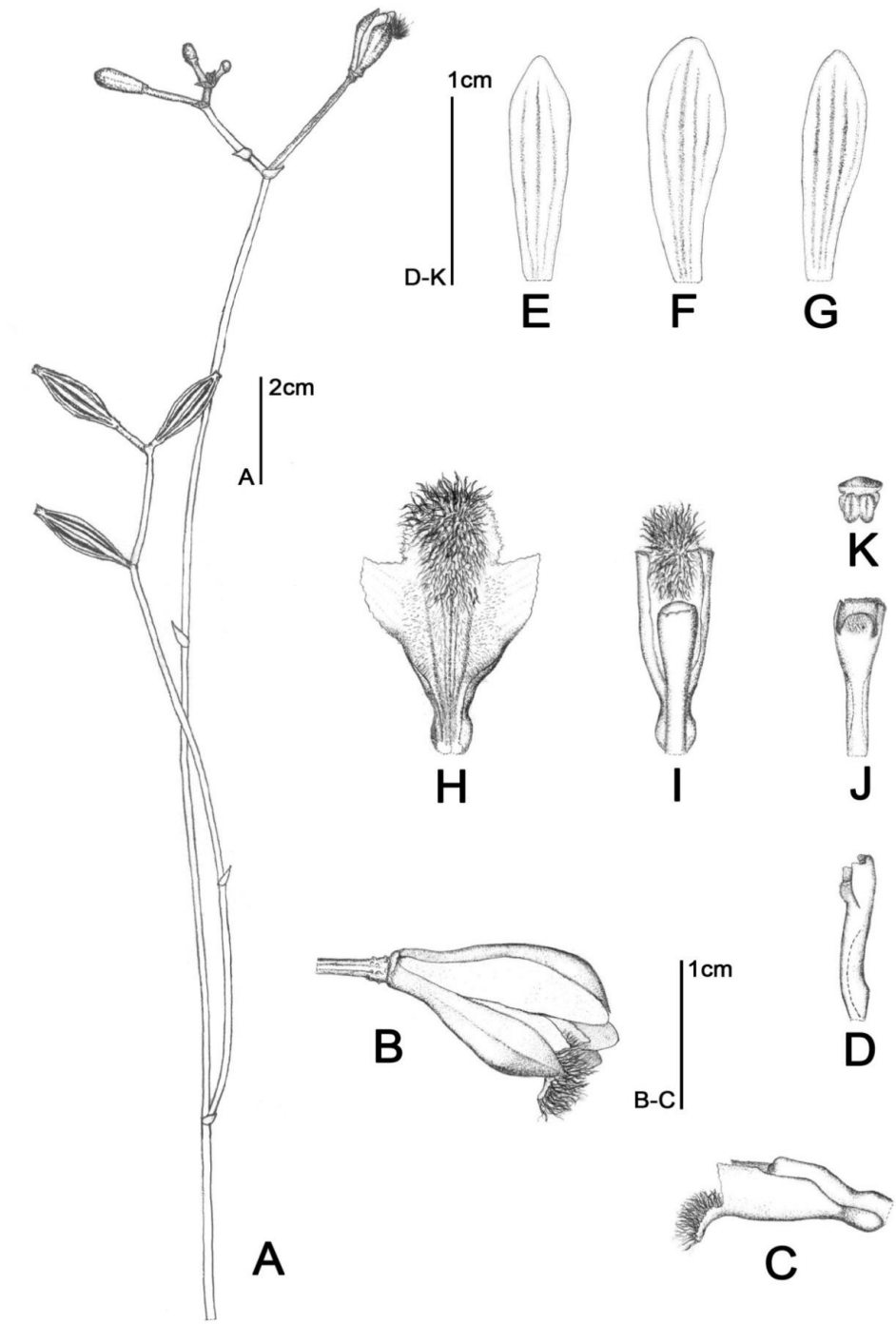

Fig. 3. *Lecanorchis flavicans* var. *acutiloba* (based on *T. C. Hsu 6577*). A: Inflorescence. B: Flower, side view. C: Lip and column, side view. D: Column, side view. E: Dorsal sepal. F: Petal. G: Lateral sepal. H: Lip, flatten. I: Lip and column, dorsal view. J: Column, ventral view. K: Anther. Illustrated by C. L. Hsieh.

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臺灣 2 種新歸化植物－蔓枝蘆莉草與小蕊珍珠草

Two Newly Naturalized Species in Taiwan, *Rnellia squarrosa* (Fenzl) Schaffnit and *Micrathemum micrathemoides* (Nutt.) Wettst.

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摘　要

蔓枝蘆莉草與小蕊珍珠草爲新歸化於臺灣中部之植物。本文描述這 2 種植物形態、解剖圖及彩色照片外並報告其分布、生態及與近似種分類上之差異。

Abstract

Ruellia squarrosa (Fenzl) Schaffnit and *Micranthemum micranthemoides* (Nutt.) Wettst. are recently naturalized in central Taiwan. This study gives morphological descriptions with photos and anatomical drawings of the species. Their distribution, notes on ecology and taxonomy are also provided.

關鍵詞：小蕊珍珠草、蔓枝蘆莉草、歸化、臺灣、分類

Key words: *Micranthemum micranthemoides*, *Ruellia squarrosa*, naturalized, Taiwan, taxonomy

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緒　言

爵床科約有 220 屬 4,000 種(Hu *et al*., 2011)；據 Hsieh & Huang (1998)紀錄臺灣有 15 屬 32 種，但遺漏了黑眼花(Ou, 1984)，加上後來學者陸續發表了 6 個種(Hsieh *et al*., 1999; Tseng and Ou 2002; Hsu and Chung 2003; Seok *et al*., 2004; Hsu *et al*., 2005; Huang and Wang, 2009)，目前已有 17 屬 39 種。雙翅爵床屬(*Dipteracanthus*)與蘆莉草屬(*Ruellia*)於臺灣植物誌第二版(Hsieh & Huang, 1998)與中國植物誌(Hu, 2002)皆將此二屬分開，但最近許多研究將它包含於廣義的蘆莉草屬內(Yang *et al*., 1999; Hu *et al*., 2011)。蘆莉草屬爲爵床科的 1 個大屬，約有 250 種，泛分布於熱帶地區(Wasshausen, 1992)，臺灣於 2003 年才有紀錄(Hsu and Chung, 2003)，連同雙翅爵床屬(*Dipteracanthus*)並入該屬，目前臺灣共紀錄 3 種，蘆莉草屬花序爲單生、穗狀或聚繖花序，花冠成 5 裂，完全雄蕊 4 枚，蒴果內具多數種子。

傳統的玄參科(Scrophulariaceae)近年來根據分子研究結果顯示並非單系群，分子系統樹上幾個主要分支已被處理爲科的階級。母草科(Linderniaceae)係近年依據分子證據與花部及種子形態將原先隸屬於玄參科的母草族獨立而來(Rahmanzadeh *et al*., 2005)，全世界約有 17屬253種(Fischer *et al*., 2013)，廣義的母草屬(*Lindernia*)，依據研究整理臺灣產6屬20種(Fischer *et al*., 2013; Liang and Wang, 2012; Liang *et al*., 2014)，本文發表1新歸化屬珍珠草屬(*Micranthemum*)植物，珍珠草屬植物約有14種(Fischer *et al*., 2013)，主要分布於中美洲地區。

分類處理

Ruellia squarrosa (Fenzl) Schaffnit, Beih. Bot. Centralbl., Abt. 1. 19(Heft 3): 455. 1906; J. Adelaide Bot. Gard. 17:139. 1996.　蔓枝蘆莉草 Fig. 1

Dipteracanthus squarrosus Fenzl, Del. Sem. Hort. Bot. Univers. Vindobon. Collect. Anno 1868: 10. 1869.

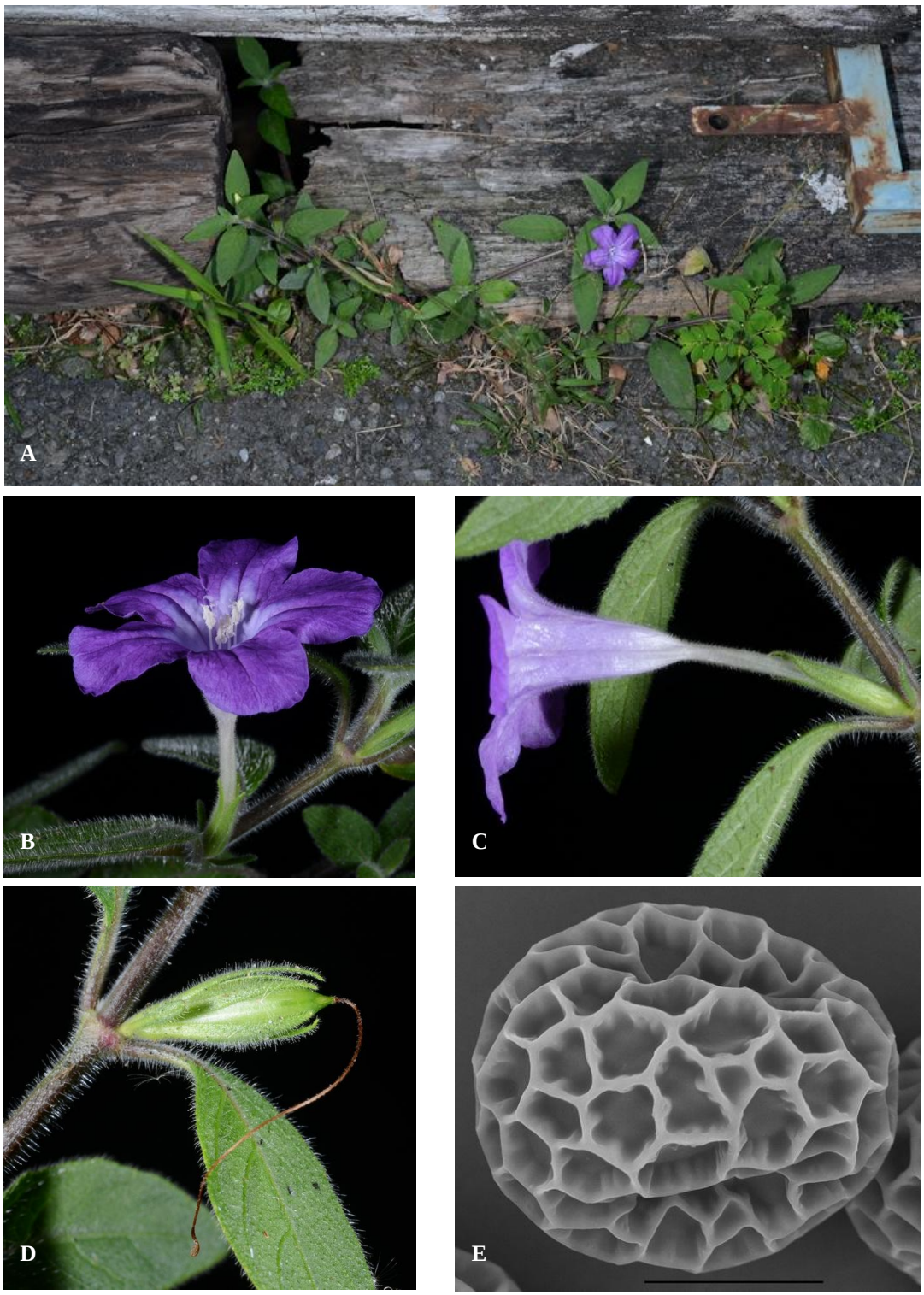

Fig. 1. *Ruellia squarrosa* (Fenzl) Schaffnit: A. habit ; B,C. flower; D. fruits; E. Pollen (scale=3 μ m).

草本，全株密被白色長柔毛，莖紫黑色，節基部膨大。單葉，對生，葉柄半圓柱形，綠色，近軸面紫色，長 5.3-8 mm，徑約 1.2 mm；葉紙質，長卵形，長 3-5 cm，寬 1.3-2 cm，葉兩面綠色，上下表面被毛，先端鈍圓，基部楔形，近全緣，側脈 5-6 對，葉脈上凹下凸。單花，腋生，花梗無，苞片 2，線形，綠色，長 6.8-7.4 mm，寬約 1.3 mm，被毛。花苞長橢圓球形，黃綠色，被毛，長 13-17 mm，徑 2.7-3.9 mm。花萼基部合生；裂片 5，披針形，綠色，長約 10 mm，寬約 1.6 mm；全長約 13 mm，被毛。花輪形，紫色，徑約 3.5 cm。花瓣基部合生成漏斗狀，白色，漸向上泛紫；裂片 5，倒卵形，紫色，長約 1.1 cm，寬約 1 cm，被毛。雄蕊 4，二強雄蕊，2 長 2 短；花絲白色，纖細，長 1-1.2 mm；花藥箭矢形，基著，2 室，縱裂，長約 2.8 mm，藥白色。子房 1，略扁長卵球形，綠色，光滑，表面略凸成長三角形；花柱纖細，長約 3 cm，被毛；柱頭 2 叉，舌狀；中軸胎座，2 室，胚珠多數。單果。果梗無。蒴果，綠色，光滑，長約 14.7 mm，徑約 3.5 mm，苞片與萼片宿存。種子多枚，扁圓形，黑褐色。

引證標本：臺灣(TAIWAN)：南投縣(Nantou County)：集集鎮(Jiji)，1 April 2015, *Hsu 19945* (TAIE); 臺南市(Tainan City): 安平區(Anping District)，5 May 2015, *Hsu 19962* (TAIE).

蔓枝蘆莉草原產於南美洲地區，普遍歸化於澳洲等地(Barker, 1996)，臺灣目前可見零星歸化於中南部鄉村排水溝兩側。南部於部分區域已可見大片小苗，可見其繁殖能力很強。

臺灣產蘆利草屬植物檢索表

A1: 根成紡錘狀，花爲聚繖花序---------- *R. tuberosa* 塊莖蘆莉草
A2: 根無紡錘狀，花單生
B1: 匍匐性草本，苞片長橢圓形---------- *R. repens* 蘆莉草
B2: 直立性草本枝條具蔓性，苞片線形---------- *R. squarrosa* 蔓枝蘆莉草

Micranthemum micranthemoides (Nutt.) Wettst., Nat. Pflanzenfam. 67(IV, 3b):77. 1891. 小蕊珍珠草 figs. 2, 3

Hemianthus micranthemoides Nutt., J. Acad. Nat. Sci. Philadelphia 1: 119. *pl.6:f.2.* 1817.

匍匐性纖細草本，節上生根，生長於水岸邊；全株光滑。單葉，對生，葉抱莖，葉微肉質，橢圓形，長約3.6 mm，寬約2 mm；先端鈍；基部楔形；葉全緣，葉背可見中肋，側脈不可見。花單生葉腋，花梗圓柱形，綠色，長約0.9 mm，徑約0.2 mm，花左右對稱，白色，2唇形，長約1.7 mm，寬約1 mm；花萼筒狀，綠色，長約1 mm，徑約0.7 mm；裂片4，裂片3角形，長約0.6 mm，寬約0.2 mm；花瓣白色，上唇弧形，較下唇短；下唇3裂，裂片先端剪裂，中裂片最大，長約1 mm，寬約0.4 mm，側裂片長約0.5 mm，寬約0.3 mm；雄蕊2，與花瓣裂片互生；不孕性雄蕊2枚，上有許多腺體；花絲短，白色；花藥黃色，2室，縱裂，離生藥；子房上位，橢圓球形，綠色，長約0.6 mm，徑約0.4 mm，花柱白色，短；柱頭二裂，舌狀；中軸胎座，胚珠多數。果單生葉腋，果梗與花梗略等長，果橢圓球形，淺褐色，長徑約0.7 mm，徑約0.5-0.6 mm，花柱與柱頭宿存。

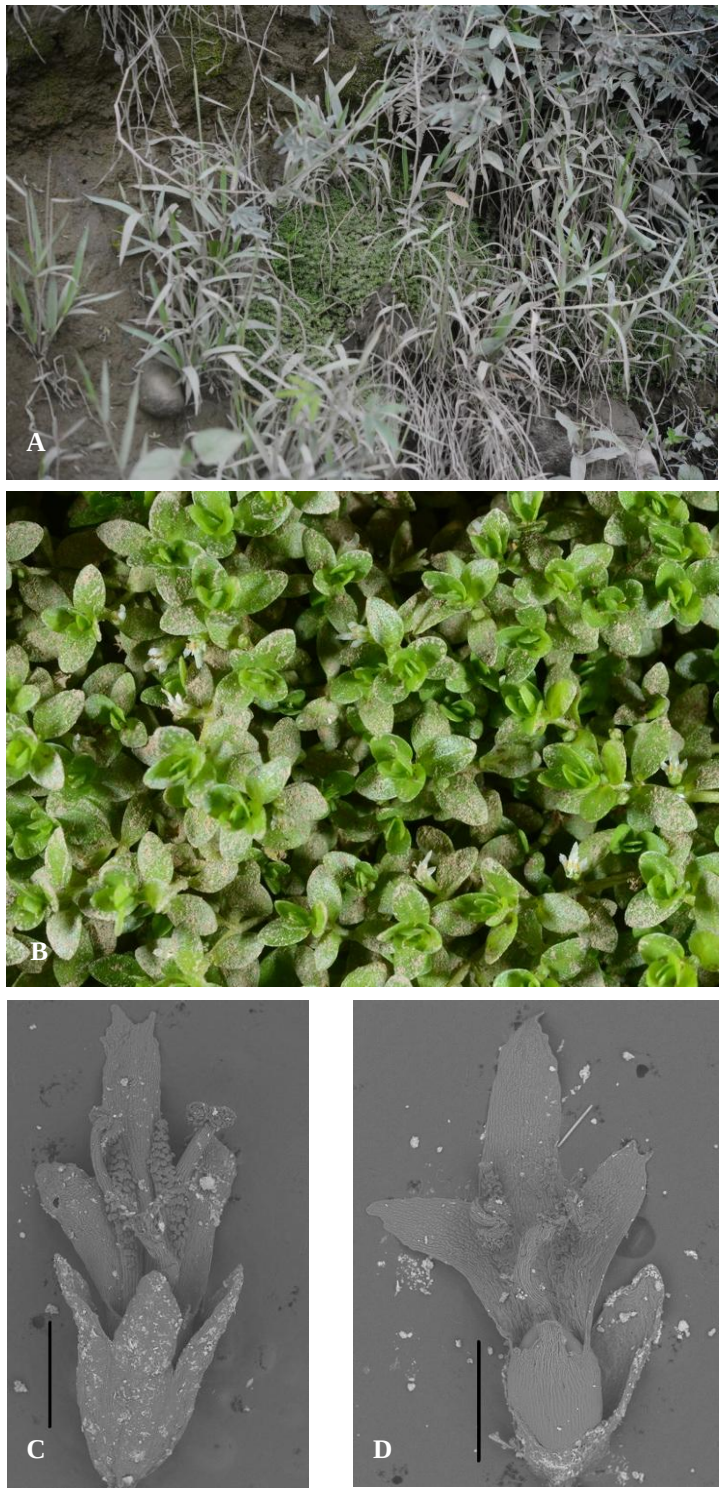

Fig. 2. *Hemianthus micranthemoides* Nutt. A,B. habit; C,D. flower (scale=0.5 mm).

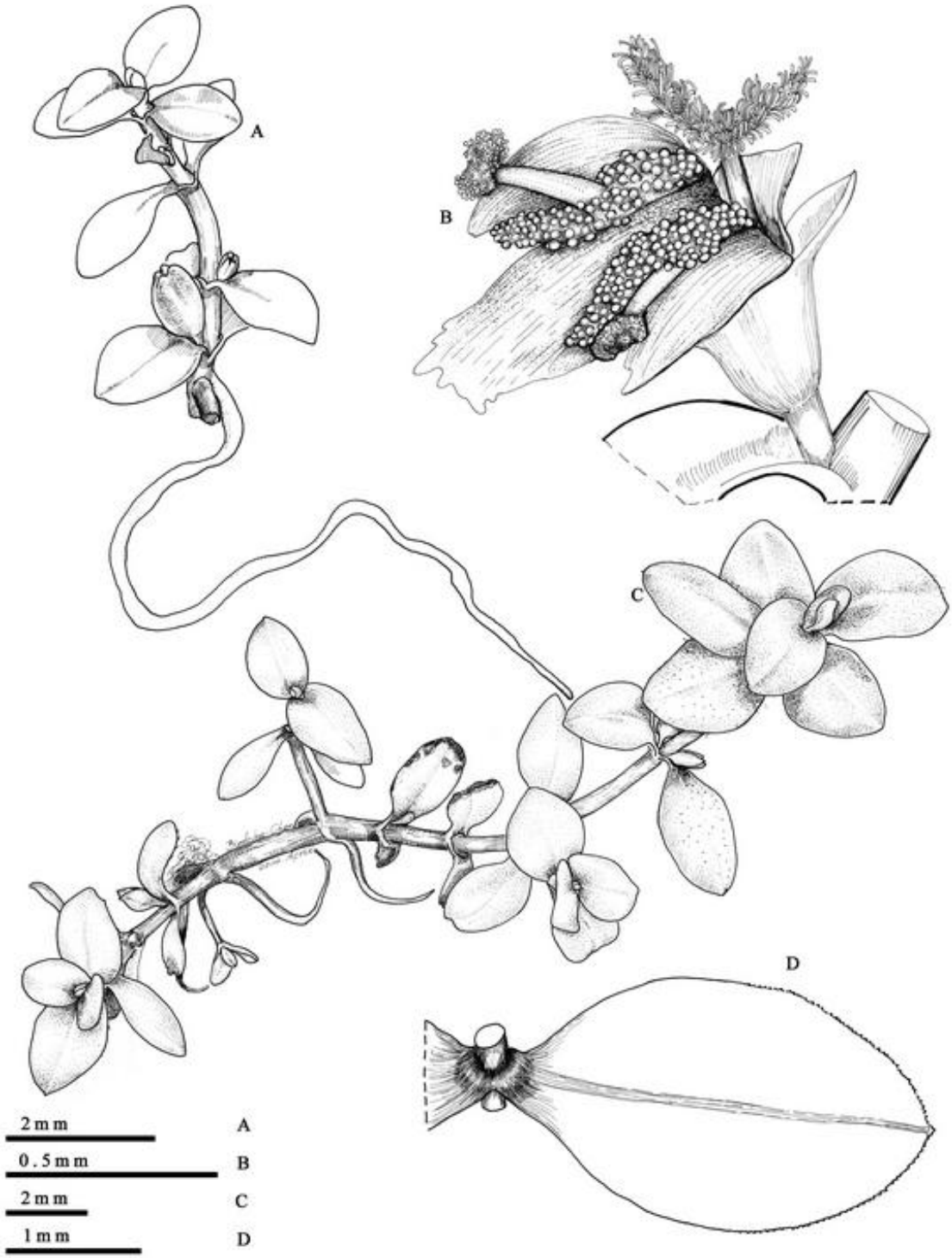

Fig. 3. *Hemianthus micranthemoides* Nutt. A,C. habit; B. flower; D. leaf.

引證標本：臺灣(TAIWAN)：南投縣(Nantou County)：水里鄉(Shueili Township)，riverside at ca. 270 m elevation, 6 Jan. 2014, *Hsu19018* (TAIE).

小蕊珍珠草原產於美國與古巴(Fischer *et al*., 2013)，臺灣應該是水族業者引進，近年來已經可以發現在溪流的兩側，溪流沙洲浮覆地或水岸淤泥高處呈現小群落生長，本種無性繁殖能力強，加上於水域傳播，應該很快會散布於各地河川。

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台灣新歸化唇形科植物－琴葉鼠尾草

Salvia lyrata L.–A Newly Naturalized Lyreleaf Sage in Taiwan

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摘 要

琴葉鼠尾草(*Salvia lyrata* L.)(新擬中名)原產美國的東部地區。本種基生葉爲蓮座狀排列、單葉羽狀分裂，葉形類似琴形等特徵與台灣的其他種類明顯不同。近年來發現歸化於新北市瑞芳區猴峒道路邊緣荒廢地。本文描述其性狀特性、生育地環境和共同伴生之植物與分布。並報導其花粉爲 6 溝花粉，表面具 2 層網狀紋飾。

Abstract

Salvia lyrata L., belonging to the mint family, is a herbaceous perennial of the Lamiaceae. It is widely distributed across eastern United States. This species is characterized by basal rosette leaves with pinnately lobed or dissected margins. In a recent plant survey, we found a wild population of *Salvia lyrata* L. in the Houdong area, New Taipei City, northern Taiwan. A detailed description with color photographs, habitat information and distribution are provided in this paper. Additionally, pollen is reported as a 6-colpate pollen grain with a reticulate tectum.

關鍵詞：琴葉鼠尾草、唇形科、分類學、台灣

Key words: *Salvia lyrata*, Lamiaceae, taxonomy, Taiwan

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緒　言

唇形科的鼠尾草屬(*Salvia* L.)為特化的一群植物，具有可孕雄蕊 2 枚和延長成線形的長條形藥隔，與花絲成丁字著生，約有 900-1,100 餘種 (Li and Hedge, 1994)。台灣植物誌中記載有 9 種 1 變種及 1 個未確定種 (Huang and Wu, 1978, 1998)。其中的未確定種田代氏鼠尾草近年來已再次被確認其產地和分布(謝等, 2010)。在歸化種方面過往報導僅有一種歸化種紅花鼠尾草(*S. coccinea* Juss. *ex* Murr.)，其花冠紅色很容易與其他種類區別，歸化於中海拔地區(Huang and Wu, 1978, 1998)。近來在高雄市半屏山地區發現一個新歸化種腺萼鼠尾草(*S. occidentalis* Sw.)(周和謝, 2015)。

本文第一作者近年來於台灣北部新北市瑞芳區猴峒採獲一種新歸化的鼠尾草屬植物（圖 1），經比對文獻後鑑定為琴葉鼠尾草(*Salvia lyrata* L.)，本種基生葉為蓮座狀排列，單葉羽狀分裂，葉形類似琴形等特徵(Thieret, 2001)，與台灣的其他種類為羽狀複葉或為單葉(Huang and Wu, 1978, 1998)，如為單葉時不會成羽狀分裂，在葉部特徵上有明顯不同，可資區別。本文根據文獻、標本和野外實地調查說明本種的分布及其相關特性。

材料與方法

花粉取自新鮮花藥，乾燥後置於離心管中，使用 Erdtman 的酸分解法（Erdtman, 1952）；酸化處理後的花粉粒使用酒精系列脫水，經自然乾燥後貼於鋁台上鍍金，置於掃描式電子顯微鏡下（SEM Desktop Microscope, Phenom）觀察和照相。

性狀描述

琴葉鼠尾草

***Salvia lyrata* L.**, Sp. Pl. 1: 23. 1753.

多年生草本。基生葉成蓮座狀排列，倒卵狀披針形，長 8-20 cm，寬可達 5 cm，先端逐漸變大，邊緣具羽狀缺刻或分裂，類似琴形，先端銳尖至鈍形，基部平截形，表面密披粗毛；葉柄 2-3 cm 長，披粗毛。開花期花莖開始抽長，四方形，表面披粗毛，高約 20-60 cm，莖生葉披針形至橢圓形，少或不存，2 cm 長，無柄。花莖每節 4-8 朵成輪繖花序，再排列成疏鬆穗狀排列；苞片卵形，小形，先端漸尖；花萼二唇形，外表面披長粗毛，上唇平截狀或明顯 3 齒裂，6-7 mm 長，下唇 2 齒裂，8 mm 長，萼齒三角形，約 4 mm

長；花冠長管狀，淡藍色或白色，二唇形，冠筒約 2.5 cm 長，上唇盔狀，稍內凹，約 1.5-2.5 mm 長，下唇 3 裂，約 5 mm 長，中裂片較大擴展，先端深凹入；雄蕊 2 枚，花藥 2 室，藥隔延長，丁字著生，花絲 2 mm 長；柱頭不等長 2 裂，胚珠 4 枚。小堅果 4 枚，卵形，1.5 mm 長，成熟時黑色，表面散生疣狀突起（圖 2C and D）。

花果期：4-6 月

分布：原產於美國東部（Thieret, 2001）。台灣目前歸化於新北市瑞芳區猴峒的荒廢地上。

觀察標本：新北市：瑞芳區猴峒，海拔約 100 m，14 Dec. 2014 , *M. J. Jung s. n.*;26 April 2014, *M. J. Jung 6057* (TAIF, 林業試驗所植物標本館); 3 May 2015, *M. J. Jung 6079* (TAIF, 林業試驗所植物標本館)。

二、花粉形態

本種花粉為球狀縱橢圓形 (prolate sphenoidal)，具 6 溝，溝細長，表面具 2 層之網狀紋飾，上層網眼之內有較小之網眼（圖 2A and B）。與 Huang 於 1972 年報導台灣產本屬其他種類之花粉在紋飾上相似（Huang, 1972），亦與田代氏鼠尾草及腺萼鼠尾草之花粉在紋飾上亦甚為相似，但在形狀上有所差別（謝宗欣等, 2010；周和謝, 2015）。

三、生態習性

本種目前歸化在新北市瑞芳區猴峒地區，生長於道路邊緣草生地及荒廢地，光照程度約 50 %，此生育地以陽性草本植物為主，本種在其間生長，並可開花結果，自行繁殖生長。其他人為植栽喬木為台灣欒樹 (*Koelreuteria henryi* Dummer)，地被常見植物有白茅(*Imperata cylindrica* (L.) Beauv. var. *major* (Nees) Hubb. *ex* Hubb. & Vaughan)、大花咸豐草(*Bidens pilosa* L. var. *radiata* Sch. Bip.)、毛車前草(*Plantago virginica* L.)、鳶尾葉庭菖蒲(*Sisyrinchium iridifolium* Kunth) 等多種陽性草本植物，且大多為外來歸化植物。

在猴峒地區估計約有 200 株，植株在春夏季 4-6 月開花，結實率極高。本種在美國部分地區被列為雜草，且因其為蓮座狀生長，不易被割草機割除，未來有近一步擴張之虞。由於本種具入侵性，未來可能會進一步擴張歸化範圍，宜加以注意。

謝　誌

感謝二位審查委員費心審閱全文並提供諸多寶貴意見，使本文更加完善，謹此至上誠摯的謝意。

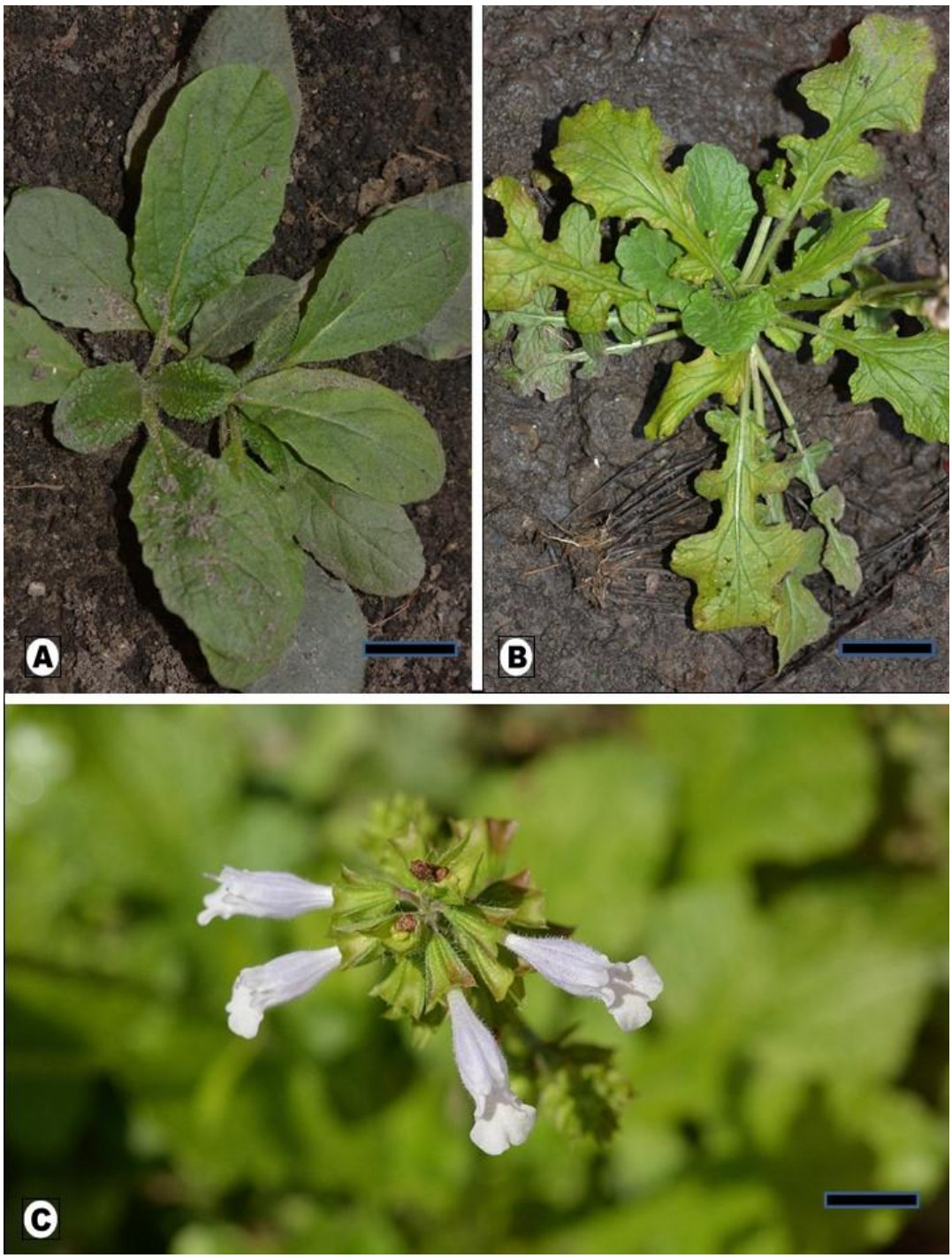

圖 1. 琴葉鼠尾草。A: 幼株形態、B: 成熟植株基生葉成羽狀分裂和 C: 花。

Fig. 1. *Salvia lyrata* L. from Taiwan. A: Young, B: adult plant and C: flowers. Scale bars = 1, 3, 0.5 cm in A, B and C respectively.

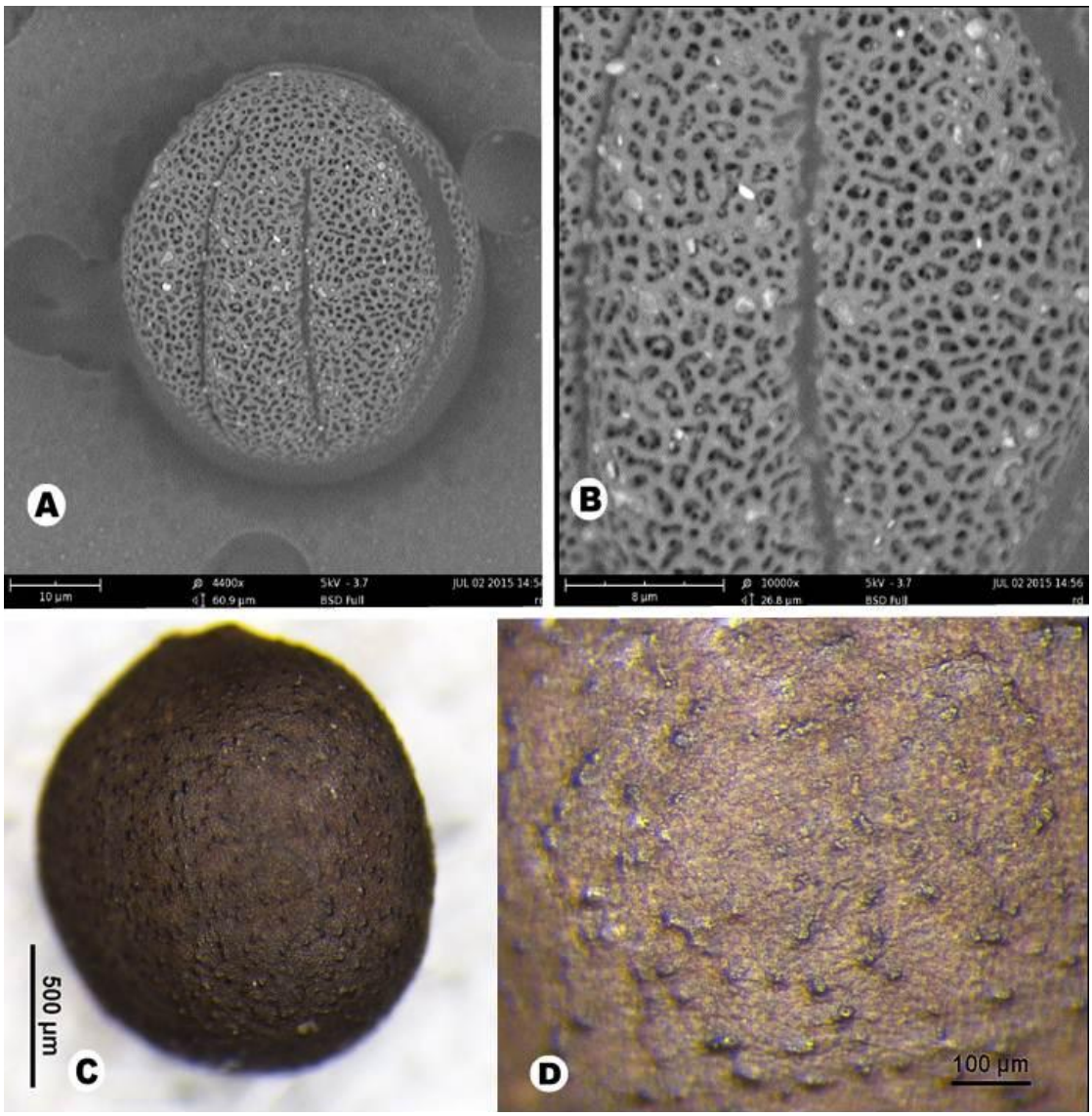

圖 2. 琴葉鼠尾草之花粉 (A-B) 和小堅果(C-D)。A：花粉赤道面形狀；B：花粉網狀的外壁紋飾(掃描式電子顯微鏡)；C：小堅果卵形，深黑色；D：小堅果表面散生疣狀突起。

Fig. 2. The pollen grain of *Salvia lyrata* L. and nutlet from Taiwan. A and B, SEM micrographs of the equatorial view of a pollen grain with reticulate tectum. C and D, black nutlet with verrucose surface.

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A New Record and Re-description of *Oxyopes sushilae* (Araneae, Oxyopidae) in Taiwan

臺灣產盾形貓蛛之新紀錄與重新描述

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Abstract

Oxyopes sushilae Tikader, 1965 is recorded in Taiwan for the first time. Both male and female of the species are re-described and illustrated here based on the specimens collected in Taoyuan, Miaoli, Nantou, Yunlin and Kaoshiung. The species can be recognized by a sclerotized and shield-like shaped epigynum, and the extension of a conspicuous basal-lateral hamulus process on cymbium of palp organ. This species is mainly distributed from low to medium altitudes of western Taiwan.

摘　要

本文報導盾形貓蛛 (*Oxyopes sushilae* Tikader, 1965) 在臺灣之首次紀錄，並對雌雄個體重新描述和繪圖。本種可由雌蛛外雌器之骨片成盾形、雄蛛觸肢器杯葉基部側面有一鉤狀突起等特徵與它種區別。盾形貓蛛主要分布於臺灣西部中低海拔山區。

Key words: Araneae, Oxyopidae, new record, Taiwan

關鍵詞：蜘蛛目、貓蛛科、新紀錄、臺灣

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Introduction

The lynx spiders of the family Oxyopidae are small to medium size spiders. They are diurnal, wandering hunters searching for prey in the shrub, lawn, tree crown, and farmland. The lynx spiders can be recognized by the high clypeus, hexagonal arranged eyes, tapered abdomen and thin legs with long, stiff and conspicuous spines (Ono and Ban, 2009; Zhu and Zhang, 2011). The anterior median eyes are small, and the remaining six eyes are spread out in a hexagonal shape on the top of the head.

The family of Oxyopidae consists of nine genera and 452 described species worldwide (World Spider Catalog, 2015). Up to present, only two genera and three species (*Peucetia formosensis* Kishida, 1930, *Oxyopes macilentus* L. Koch, 1878 and *O. sertatus* L. Koch, 1878) were recorded in Taiwan (Chu and Okuma, 1975). Recently, we collected and examined specimens of lynx spider from Taiwan, and found a species newly recorded to the Taiwanese spider fauna. The morphology of these specimens agrees with that of *Oxyopes sushilae*, in which the male was described by Tikader (1965) from India and the female was described by Hu *et al.* (1985) from China. In this article, both sexes of *O. sushilae* were re-described based on new materials from Taiwan.

Materials and Methods

Spiders were collected by a sweeping net or through visual search of their habitats. The obtained specimens were examined, measured and photographed under a stereomicroscope (Leica, MZ125). The epigynum of females was dissected and cleaned in a warm 10% KOH solution for examining its inner genital structure. All measurements are given in millimeters (mm). The measurements of the palp were shown as: total length (femur, patella, tibia, tarsus). The measurements of legs were shown as: total length (femur, patella and tibia, metatarsus, tarsus). Abbreviations used in this paper were: AER, anterior eye row; ALE, anterior lateral eye; AME, anterior median eye; MOA, median ocular area; PER, posterior eye row; PLE, posterior lateral eye; PME, posterior median eye.

Results

***Oxyopes sushilae* Tikader, 1965**

Oxyopes sushilae Tikader, 1965: 141-143, fig. 2; Hu *et al*., 1985: 28-31, figs. 1-8; Song, 1991: 175-177, fig. 7; Zhu and Zhang, 2011: 337, fig. 244; Yin *et al*., 2012: 920, fig. 466.

Specimens examined.

TAOYUAN City: DAXI, Datielaio, one male and two females (TESRI-Ar 0518–0520), 17 Apr. 2013, Ying-Yuan Lo leg.; FUXING, Sanmin, one male (TESRI-Ar 0523), 18 Apr. 2013, Ying-Yuan Lo leg. **MIAOLI County**: NANZHUANG, Shitoushan, two males (TESRI-Ar 1000, 0526), 24 Apr. 2013, Ying-Yuan Lo leg. **NANTOU County**: PULI, Taomikeng, two males and two females (TESRI-Ar 0907–0910), 10 Oct. 2014, Ying-Yuan Lo leg. **YUNLIN County**: GUKENG, Qipan village, two females (TESRI-Ar 0768–0769), 22 Apr. 2014, and two females (TESRI-Ar 0982, 1016), 2 Sep. 2014, Ying-Yuan Lo leg. **KAOHSIUNG City**: TAOYUAN, Shishan forest road, one female (TESRI-Ar 0887), 18 June 2014, Ying-Yuan Lo leg.

Diagnosis.

Oxyopes sushilae is similar to *O. macilentus* L. Koch, 1978 in body shape, coloration and shape of palp. *Oxyopes sushilae* can be distinguished from the latter by a sclerotized shield-like epigynum, in contrast to the two arc-like structures in *O. macilentus*. The male palpal cymbium bears a conspicuous dorsal hamulus process (less developed in *O. macilentus*), and there is a longitudinal ridge within the depression of palp retrolateral tibia (an oblique ridge at the infra-margin of the depression in *O. macilentus*).

Description (all measurements given in mm).

Female (TESRI-Ar 0909). Total length 8.9: cephalothorax length 3.4, width 2.7; abdomen length 5.5, width 1.7. Measurements of palp and legs: palp 3.0 (0.9, 0.3, 0.6, 1.2); leg I 17.5 (4.7, 6.0, 5.0, 1.8), leg II 16.0 (4.5, 5.4, 4.7, 1.4), leg III 12.9 (3.9, 4.1, 3.7, 1.2), leg IV 16.4 (4.8, 5.2, 5.0, 1.4). Carapace greenish-orange, pear-shaped, with two broad longitudinal dark markings on submargin, and two thin longitudinal orange markings from PME to margin of carapace; thoracic groove prominent. Eyes arranged in four rows, AER strongly recurved and PER strongly procurved. Diameters of AME 0.12, ALE 0.20, PME 0.20, PLE 0.20. MOA length 0.90, anterior width of MOA 0.38, posterior width of MOA 0.68; interval of AMEs 0.14, interval of PMEs 0.28. Clypeus 0.58, 4.8 times diameter of AME. Clypeus high, with two black streaks extending from anterior margin of AME toward anterior margin of dorsal surface of chelicera. Chelicera, sternum, endite, labium, and legs greenish-orange. Legs clothed with conspicuous long spines, longitudinal black stripes on ventral femur of all legs. Abdomen long, narrow, covered with scales; dorsum with a longitudinal deep brown central band, each side of the band with numerous deep brown stripes, bordered with two thin black lines on both sides

(Fig.1). Venter with three broad black bands, blending into one broad band and extending from epigastric fold to base spinnerets.

Epigynum yellowish, sclerotized and shield-like shape with deep lateral semicircle notch on both sides. Spermatheca large, fertilization ducts long, anterior ducts curved into semi-circular shape, elongate posteriorly beside spermatheca (Figs. 2-3, 5-6).

Male (TESRI-Ar0907). Total length 7.8: cephalothorax length 3.2, width2.7; abdomen length 4.6, width 1.5. Measurements of palp and legs: palp 4.6 (1.3, 0.5, 0.7, 2.1); leg I 17.6 (4.2, 5.8, 5.2, 2.4), leg II 15.2 (3.8, 5.0, 4.6, 1.8), leg III 12.6 (3.5, 4.3, 3.4, 1.4), leg IV 15.3 (4.2, 4.9, 4.6, 1.6). Diameters of AME 0.10, ALE 0.20, PME 0.20, PLE 0.20. MOA length 0.84, anterior width of MOA 0.34, posterior width of MOA 0.56; interval of AME 0.14, interval of PME 0.16. clypeus 0.52, 5.2 times diameter of AME. Total length slightly smaller than female, body shape and coloration are similar to female.

Palp retrolateral tibia swallow and sunken with a vertical ridge and a small flake process. Dorsal base of cymbium extends a prominent hamulus-like process (Fig. 4, 7).

Variations.

Four females and five males were measured to quantify the morphological variation. Values are mean ± SD of females (with the male in parentheses). Total length 8.8±0.5 (8.1±0.4); cephalothorax length 3.5±0.2 (3.3±0.1), width 2.6±0.1 (2.7±0.1); abdomen length 5.3±0.4 (4.8±0.3), width 1.7±0.1 (1.6±0.2). Height of clypeus 0.58±0.05 (0.49±0.10). Diameters of AME 0.1±0.02 (0.10±0.00), ALE 0.22±0.02 (0.20±0.00), PME 0.20±0.01 (0.19±0.02), PLE 0.20±0.00 (0.20±0.01). Leg I 17.1±1.7 (17.3±1.9); Leg II 15.1±1.3 (15.4±1.5); Leg III 12.4±1.1 (13.0±1.5); Leg IV 15.4±1.5 (15.7±1.7)

Distribution.

India (Maharashtra), China (Henan, Hunan, Guangdong, Zhejiang, Jiangxi, Anhui, Hainan, Fujian, Guizhou), and Taiwan.

Discussion.

The female of *O. sushilae* was first described by Tikader (1965), and the male was later reported by Hu *et al.* (1985). Although the original drawings were not in details and we were unable to examine the type specimen, both female epigynum and male palpal organ of Taiwanese specimens examined here fit the description of *O. sushilae* in Hu *et al*. (1985). The type specimen of *O. sushilae* was collected from Maharashtra of India (Tikader, 1965). Subsequently, Hu *et al.* (1985), Song (1991), Wang (2009), Zhu & Zhang (2011) and Yin *et al*. (2012) inspected additional populations collected from Henan, Hunan, Guangdong, Zhejiang, Jiangxi, Anhui, Hainan Fujian and Guizhou in China, respectively. Thus it appears that *O. sushilae* is wide spread in southern Asia. Based on the records in this study, *O. sushilae* is mainly distributed from low to medium altitudinal mountains of western Taiwan (Fig. 8). *Oxyopes shushilae* was observed to occur at the same

habitats of *O. macilentus*, which had been recorded by Chu and Okuma (1970) at Wufeng (Taichung), Meichi and Chunyang (Nantou) in the paddy field of Taiwan. Because of the similarity in body shape, coloration and shape of palpal organ of the two species, the earlier record of *O. macilentus* in Taiwan is likely to be inaccurate if genital organs did not been examined cautiously. The results suggest that the taxonomic and distributional study of lynx spiders in Taiwan are limited, thus the effort is required for extensive field collections of lynx spiders and careful examination of their genital organs.

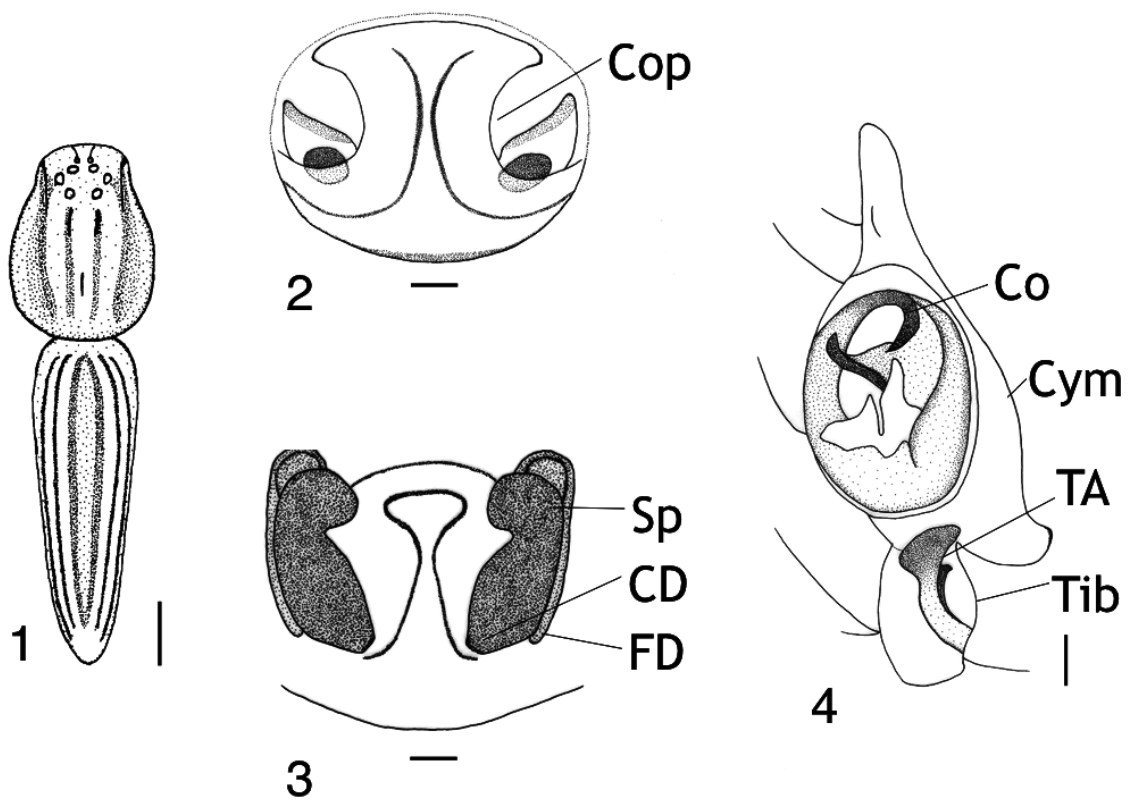

Figure 1-4. *Oxyopes sushilae*. 1, dorsal view of female cephalothorax and abdomen; 2, female epigynum, ventral view; 3, female vulva, dorsal view; 4, left male palpal organ, ventral view. 1-3, female, TESRI-Ar 0909; 4, male, TESRI-Ar 0907. CD: copulatory duct; Cop: copulatory opening; Co: conductor; Cym: cymbium; FD: fertilization duct; Sp: spermathecal; TA: tibia apophysis; Tib: tibia. Scale bars: Fig. 1 = 1 mm; Figs. 2-4 = 0.1 mm.

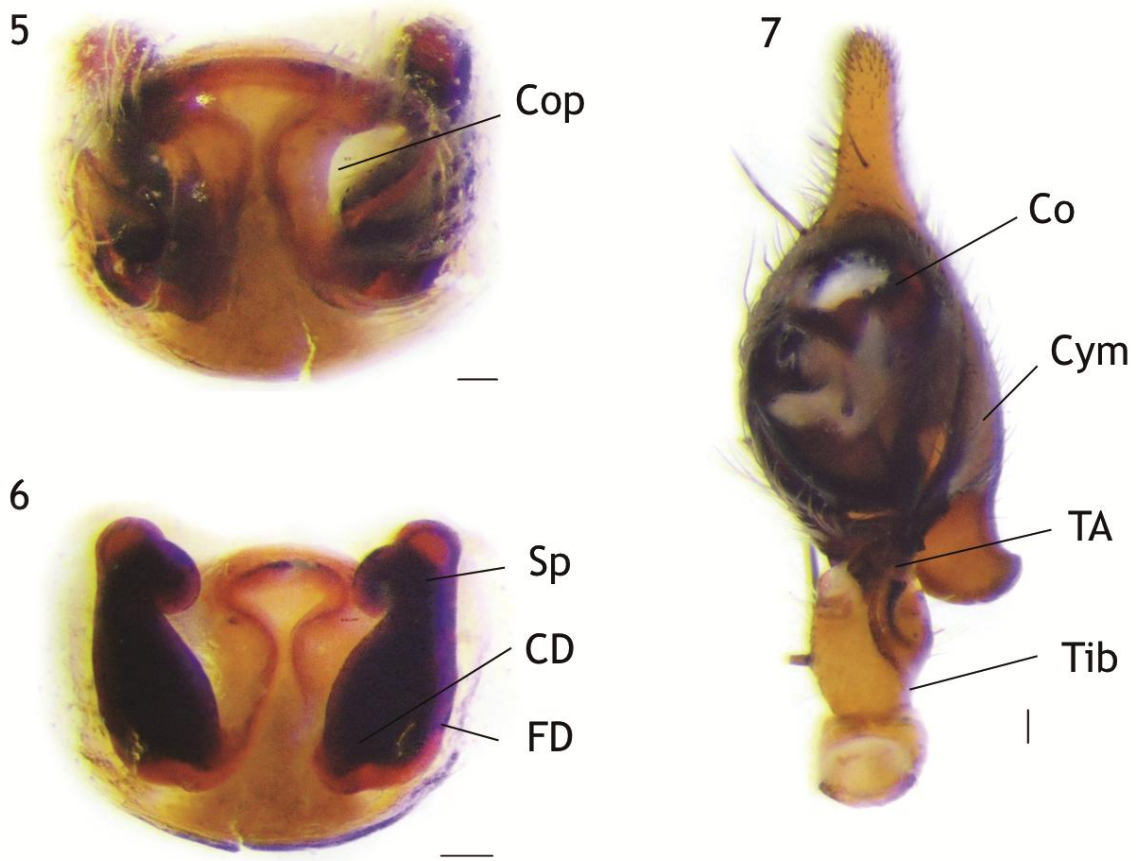

Figure 5-7. *Oxyopes sushilae*. 5, female epigynum, ventral view; 6, female vulva, dorsal view; 7, left male palpal organ, ventral view. 5-6, female, TESRI-Ar 0909; 7, male, TESRI-Ar 0907. CD: copulatory duct; Cop: copulatory opening; Co: conductor; Cym: cymbium; FD: fertilization duct; Sp: spermathecal; TA: tibia apophysis; Tib: tibia. Scale bars : 0.1 mm.

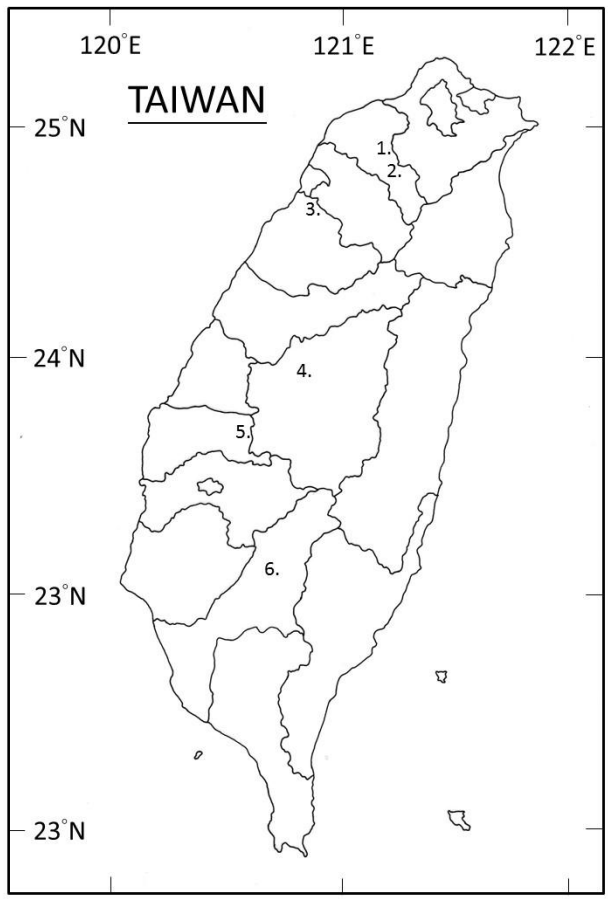

Figure 8. Sample collection of *Oxyopes sushilae* in Taiwan included in this study. The numbers indicate collecting localities (1: Datielaio, Taoyuan City; 2: Sanmin, Taoyuan City; 3: Shitoushan, Miaoli County; 4: Taomikeng, Nantou County; 5: Qipan village, Yunlin County; 6: Shishan forest road, Kaohsiung City).

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COI基因條碼在臺灣產蝮蛇科及蝙蝠蛇科蛇種辨識上的應用

Application of Species Identification via Mitochondrial COI DNA Barcoding for Viperidae and Elapidae Species in Taiwan

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摘 要

利用聚合酶連鎖反應技術，針對臺灣產之6種蝮蛇科及5種蝙蝠蛇科蛇類粒線體COI基因進行局部擴增，獲得一段658個鹼基對之基因序列片段。以Kimura-2-parameter模式計算COI基因序列在種內與種間的遺傳距離，種內遺傳距離介於0.04 ~ 2.40%，種間的遺傳距離介於1.45 ~ 25.48%。另以序列鄰接法及最大簡約法方式建構系統發育樹，兩者呈現的聚類結果並未存在衝突，同種個體皆聚集在同一分支，顯示COI序列可應用於臺灣產蝮蛇科及蝙蝠蛇科之種間鑑別。

Abstract

The PCR technique was used to amplify the partial mtDNA COI gene of 11 species of Viperidae and Elapidae snakes collected from Taiwan. The PCR products were sequenced and 658 bp of COI gene were obtained. The average Kimura-2-parameter genetic distance intra-species was 0.04 ~ 2.40%, and the inter-species was 1.45 ~ 25.48%. The phylogenetic trees estimated by neighbor-joining method and maximum-parsimony method obtained similar results. All 11 snake species showed monophyletic and

every species could be discriminated clearly. It is suggested that the COI barcoding can be used to identify Viperidae and Elapidae snakes species in Taiwan.

關鍵詞：蝮蛇科、蝙蝠蛇科、DNA 分子條碼、細胞色素氧化酶 I

Key words: Viperidae, Elapidae, DNA barcoding, Cytochrome c oxidase subunit I

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緒　言

自從Hebert *et al.* (2003a)建立以粒線體細胞色素氧化酶I（cytochrome c oxidase subunit I，縮寫成COI）基因爲遺傳標記的全球動物辨認系統以來，DNA分子條碼的應用引起很多的迴響與推廣。然而DNA分子條碼的應用不是沒有限制的，要有效運用DNA分子條碼，需先針對已確認的物種進行序列資料的建立，始可進行比對，目前並沒有針對所有物種皆能適用的DNA分子條碼。COI基因已成功應用在多類物種的鑑定，例如鱗翅目（Hebert *et al*., 2004a; Hajibabaei *et al*., 2006）、鳥類（Hebert *et al*., 2004b）、蜘蛛（Barrett and Hebert, 2005）、魚類（Ward *et al*., 2005）、雙翅目（Smith *et al*., 2006）、鼠類（Robins *et al*., 2007）及蛇類（Dubey *et al*., 2011）等等。由於部分技術性原因，導致兩棲爬蟲類的COI基因較少被定序及使用（Nagy *et al*., 2012）。但2008年後，有研究人員宣稱，兩棲類的COI基因相關技術問題已逐步克服（Smith *et al*., 2008），因此，以COI基因當做分子標記，應用在兩棲爬蟲類的物種鑑定、類緣關係及親緣地理等相關研究，未來應會逐漸增加，不過現階段比起其他分子標記仍相對較少。

臺灣本島陸域的蛇類超過40種（向等, 2012），其中蝙蝠蛇科（Elapidae）蛇類有5種，分別爲羽鳥氏帶紋赤蛇（*Sinomicrurus hatori*）、梭德氏帶紋赤蛇（*Sinomicrurus sauteri*）、雨傘節（*Bungarus multicinctus*）、環紋赤蛇（*Sinomicrurus macclellandi*）及眼鏡蛇（*Naja atra*）；蝮蛇科（Viperidae）蛇類有6種，分別爲百步蛇（*Deinagkistrodon acutus*）、龜殼花（*Protobothrops mucrosquamatus*）、鎖鍊蛇（*Daboia siamensis*）、菊池氏龜殼花（*Trimeresurus gracilis*）、瑪家山龜殼花（*Ovophis monticola*）及赤尾青竹絲（*Trimeresurus stejnegeri*），皆屬於毒蛇；在這11種蛇類當中，除赤尾青竹絲（*T. stejnegeri*）外，其餘10種皆爲政府公告之保育類野生動物（行政院農業委員會2014年7月2日農林務第1031700771號公告）。由於傳統上認爲蛇類入藥對人體具有某些特殊療效及滋補，特別是越毒的蛇效果越好的不當觀念，導致蛇類（特別是毒蛇）仍然面臨龐大的獵捕壓

力，並製成產製品違法銷售；因此，利用分子生物學的技術，能以更快速、準確的方法鑑定保育類比例逾9成的蝮蛇科及蝙蝠蛇科蛇種，在保育行政的實務上，有其必要性。然而野生蛇類活體不易發現並捕捉，因此其DNA組織樣本的蒐集相對困難，本研究利用公民科學的概念，透過參與臉書社群平台--四處爬爬走（路殺社，網址：https://www.facebook.com/groups/roadkilled/?fref=ts）的民眾，在蒐集路死蛇類資料的同時，將取得的動物屍體，製成標本保存供做其他研究外，並採取、保存其組織，進行COI基因的定序分析，除可充實臺灣本土蛇類之分子條碼系統，並評估其作爲本土蛇類蝮蛇科及蝙蝠蛇科鑑定物種的可行性。

材料與方法

一、DNA樣本蒐集

蒐集2014~2015年路殺社志工協助撿拾路死及其他管道（如自行撿拾、捕捉或本中心急救站收容個體）獲得之蛇類屍體樣本，或本中心歷年所採集之爬蟲類所製浸液標本，採集組織進行DNA萃取及純化。

二、DNA萃取、增幅及定序

取蛇類肌肉組織用Puregene DNA抽取純化試劑組（Gentra Systems, Minneapolis, MN, USA）依建議程序抽取gDNA保存於TE緩衝溶液中備用。以PCR（聚合酶連鎖反應）進行選用COI基因序列之增幅放大，選用的引子爲廣用引子Vf1d（5’-TTCTCAACCAACCACAA RGAYATYGG-3’）及Vr1d（5’-TAGACTTCTGG GTGGCCRAARAAYCA-3’）（Ivanova *et al.*, 2006）。COI的PCR擴增在25 μl的反應溶液中進行。在25 μl的反應溶液中，包含9.5 μl去離子水，1 μl的樣本基因組DNA（50-100ng extracted genomic DNA），各1 μl的10 mM正反兩股廣用引子，12.5 μl的Taq DNA Polymerase 2x Master Mix RED（Ampliqon），最後25 μl反應液總濃度各0.4 mM dNTPs，1.5 mM $MgCl_2$，0.2U Taq DNA polymerase。反應條件爲94℃預變性5 min，94℃ 30 s，45~48℃ 30 s，72℃ 1 min，35個迴圈，然後72℃延伸5 min。PCR產物會用1% agarose gel 電泳與ethidium bromide染色檢測， 使用Micro-Elute DNA Clean/Extraction Kit (GeneMark, Taiwan)將PCR產物純化並溶於10 μl去離子水。純化PCR產物用ABI Model 3100 DNA sequencer (Applied Biosystem, USA)及BigDye terminator cycle sequencing reagent (Applied Biosystem, USA)定序。將定序結果利用BioEdit v7.2.5（Hall, 1999）程式進行拼接，手工校對樣本序列，最後通過所有序列的比對和比較確定每一個體可用的公共區段。

三、序列分析

使用DnaSP v5（Librado and Rozas, 2009）軟體分析所有樣本COI基因公共區段序列鹼基組成與變異點位情況；另利用Mega 6.06（Tamura *et al.*, 2013）軟體，以Kimura-2-parameter模式計算該基因序列在臺灣產蝮蛇科及蝙蝠蛇科之種內與種間的遺傳距離，並以黃頷蛇科（Colubridae）之青蛇（*Cyclophiops major*）爲外群，以支序系統分類法中的序列鄰接（neighbor-joining method--NJ）法及最大簡約法（maximum-parsimony method--MP）建構系統發育樹，採用bootstrap檢驗（1,000 次）計算系統樹每一分支的支持度。

結果與討論

本研究總計蒐集、定序並分析臺灣地區蛇類共3科12種54個組織樣本，包括蝮蛇科6種26個組織樣本、蝙蝠蛇科5種27個組織樣本及作爲外群分析使用的青蛇（*C. major*）1個組織樣本；PCR產物定序所得之COI序列，將正反向序列進行校對、拼接後，去除引子，獲得一段長度爲658個鹼基之COI基因同源序列，該段序列未發現插入或鹼基缺失，所有序列已公布於GenBank，相關蛇種、採集地及GenBank登錄編號見表1。

分析蝮蛇科及蝙蝠蛇科53個樣本COI基因公共區段序列658鹼基之組成，發現有254個變異位點，404個保守點位；Ａ、Ｔ、Ｃ、Ｇ鹼基平均含量分別爲26.2%、28.4%、29.7%、15.7%。其中Ａ＋Ｔ 含量（54.6%）高於Ｇ＋Ｃ（45.4%）含量，表現出AT偏倚特徵。

以Kimura-2-parameter模式計算COI基因序列在臺灣產蝮蛇科及蝙蝠蛇科之種內與種間的遺傳距離（表2、表3），結果顯示，種內的遺傳距離介於0.04 ~ 2.40%，其中赤尾青竹絲（*T. stejnegeri*）爲2.40%，明顯大於其他蛇種。種間的遺傳距離，介於1.45 ~ 25.48%（蝮蛇科種間差異介於13.48 ~ 23.62%，蝙蝠蛇科種間差異從1.45 ~ 19.80%），羽鳥氏帶紋赤蛇（*S. hatori*）與梭德氏帶紋赤蛇（*S. sauteri*）種間差異僅1.45%，其餘蛇種之間差異介於13.48 ~ 25.48%。

以青蛇(*C. major*)爲外群，將包括臺灣產蝮蛇科及蝙蝠蛇科共54隻個體，分別用序列鄰接法及最大簡約法方式建構系統發育樹（圖1、圖2）。由序列鄰接系統發育樹可見，2科11種蛇類分屬於2大支系，同1科的蛇種聚在一起，分別形成蝮蛇科及蝙蝠蛇科2大支系，同一大支系下，同種聚在一起形成同一分支，且分支的支持度相當高，除羽鳥氏帶紋赤蛇(*S. hatori*)爲92%與梭德氏帶紋赤蛇(*S. sauteri*)爲93%外，其餘皆可達100%，同種個體的聚集趨勢十分顯著，即同一物種下的任一個體可以基於658個鹼基的公共重合區段序列與其他物種的個體很明顯的區分；最大簡約法系統發育樹亦呈現類似的結果。將兩個系統發育樹比對，未發現種內個體的聚類結果存在衝突，說明系統發育樹可靠。

赤尾青竹絲(*T. stejnegeri*)具有較大的種內遺傳距離，可能與赤尾青竹絲(*T. stejnegeri*)自歐亞大陸擴散分布至臺灣島的過程有關；Creer *et al.* (2001)分析臺灣的赤尾青竹絲(*T. stejnegeri*)粒線體細胞色素b (cytochrome b) 基因，將臺灣島上的族群分爲2群，分別爲北部群及其他群(兩者在東海岸有分布重疊現象)，並進行地理類緣關係的研究，認爲臺灣自上新世由歐亞大陸分離出來之後，島上的赤尾青竹絲(*T. stejnegeri*)至少經過一次自歐亞大陸拓殖至臺灣島的事件；檢視本研究赤尾青竹絲(*T. stejnegeri*)的6個樣本，亦可發現類似分群的情形，其中2個採自北部的樣本，與其他4個來自中部、南部及東部的樣本，其COI定序的結果亦呈現較大的差異，在系統發育樹呈現2個群聚分支。

Avise（2000）及Hebert *et al.*（2003b）提出COI序列的歧異度在同屬不同種間通常大於2%，在種內低於1%，此一物種鑑定的標準即爲所謂的鑑種條碼間隔（barcoding gap），不過此標準並非絕對，例如Tavares and Baker（2008）在對60對非常相近的同屬鳥類研究發現，有28.6%的姊妹種對（sister-species pairs）種間差異低於2.7%的閾值；在本研究中羽鳥氏帶紋赤蛇（*S. hatori*）與梭德氏帶紋赤蛇（*S. sauteri*）在種內的遺傳距離分別只有0.28%及0.23%，但種間的遺傳距離差異僅1.45%，然而，根據序列鄰接法及最大簡約法方式所建構系統發育樹，仍能有效的將其區分。因此，在不同的生物類群中，識別分類未知物種或近緣物種的規則或標準閾值，仍有待進一步探究。

表 1a. 本研究採用樣本之蛇種、採集地及 GenBank 登錄編號

Table1a. Sampling information and GenBank accession number of DNA sequences.

Specimen No.	Species	Locality	GenBank Accession No.
RN0035	***Sinomicrurus hatori***	Yilan	KP749803
RN0697		Taichung	KP749809
RN0743		Taichung	KP749811
RN1013		Taoyuan	KP749816
RN1270		Nantou	KP749822
RN1455		Yilan	KP772310
RN1552		Taoyuan	KR091860
RN0285	***Sinomicrurus sauteri***	Taichung	KP749804
RN0726		Kaohsiung	KP749810
RN0745		Kaohsiung	KP749812
RN1581		Taitung	KP749827
RN0296	***Bungarus multicinctus***	Kaohsiung	KP749805
RN0304		Taitung	KP749806
RN0869		Nantou	KP749814
RN0893		Nantou	KP749815
RN1073		Nantou	KP749818
RN1198		Nantou	KP749820
RN1231		Chiayi	KP749821
RN0611	***Sinomicrurus macclellandi***	Hsinchu	KP749807
RN0658		Taipei	KP749808
RN0749		Taipei	KP749813
RN1024		Taoyuan	KP749817
RN1167	***Naja atra***	Tainan	KP749819
RN1293		Taitung	KP749823
RN1294		Taitung	KP749824
RN1298		Taitung	KP749825
RN1570		Changhua	KP749826
00398	***Deinagkistrodon acutus***	Kaohsiung	KP772288
00400		Taitung	KP772289
00443		Kaohsiung	KP772290
RN1485		Taichung	KP772311

表 1b. 本研究採用樣本之蛇種、採集地及 GenBank 登錄編號

Table1b. Sampling information and GenBank accession number of DNA sequences.

Specimen No.	Species	Locality	GenBank Accession No.
RN0293	***Protobothrops***	Hsinchu	KP772291
RN0295	***mucrosquamatus***	Nantou	KP772292
RN0854		Taitung	KP772301
RN0871		Nantou	KP772302
RN0888		Taipei	KP772304
RN0302	***Daboia siamensis***	Hualien	KP772293
RN0303		Taitung	KP772294
RN1179		Taitung	KP772307
RN0413	***Trimeresurus gracilis***	Hualien	KP772295
RN0440		Nantou	KP772296
RN0471		Taichung	KP772297
RN0644		Yilan	KP772298
RN1612		Hualien	KR091862
RN0664	***Ovophis monticola***	Taoyuan	KP772299
RN1347		Nantou	KP772308
RN1371		Nantou	KP772309
RN0723	***Trimeresurus stejnegeri***	Tainan	KP772300
RN0882		Taitung	KP772303
RN0944		Hualien	KP772305
RN0959		Nantou	KP772306
RN1553		Taoyuan	KR091861
RN1758		Nantou	KR091863
RN0933	***Cyclophiops major***	Taichung	KT932596

表 2. 11 種臺灣產蝮蛇科及蝙蝠蛇科種內之 COI 基因序列的遺傳距離

Table 2. Intra-species genetic distance of COI gene fragments in 11 Viperidae and Elapidae species.

Species	**Distance**
Sinomicrurus sauteri (n=4)	0.0023
Sinomicrurus hatori (n=7)	0.0028
Bungarus multicinctus (n=7)	0.0004
Sinomicrurus macclellandi (n=4)	0.0025
Naja atra (n=5)	0.0018
Trimeresurus stejnegeri (n=6)	0.0240
Deinagkistrodon acutus (n=4)	0.0018
Protobothrops mucrosquamatus (n=5)	0.0086
Daboia siamensis (n=3)	0.0020
Trimeresurus gracilis (n=5)	0.0064
Ovophis monticola (n=3)	0.0144

註：n 爲樣本數。

表 3. 11 種臺灣產蝮蛇科及蝙蝠蛇科種間之 COI 基因序列的遺傳距離

Table 3. Inter-species genetic distance of COI gene fragments among 11 Viperidae and Elapidae species.

		1	2	3	4	5	6	7	8	9	10	11
1	***Sinomicrurus sauteri***											
2	***Sinomicrurus hatori***	0.0145										
3	***Bungarus multicinctus***	0.1858	0.1867									
4	***Sinomicrurus macclellandi***	0.1522	0.1535	0.1980								
5	***Naja atra***	0.1869	0.1820	0.1779	0.1885							
6	***Trimeresurus stejnegeri***	0.2160	0.2087	0.2232	0.2276	0.2074						
7	***Deinagkistrodon acutus***	0.2364	0.2271	0.2506	0.2483	0.2388	0.1516					
8	***Protobothrops mucrosquamatus***	0.2177	0.2138	0.2068	0.2317	0.2237	0.1619	0.1995				
9	***Daboia siamensis***	0.2407	0.2334	0.2236	0.2378	0.2548	0.2176	0.2128	0.2364			
10	***Trimeresurus gracilis***	0.2079	0.2031	0.2161	0.2249	0.2148	0.1527	0.1993	0.1688	0.2282		
11	***Ovophis monticola***	0.2010	0.1956	0.2045	0.2305	0.2026	0.1383	0.1774	0.1348	0.2362	0.1376	

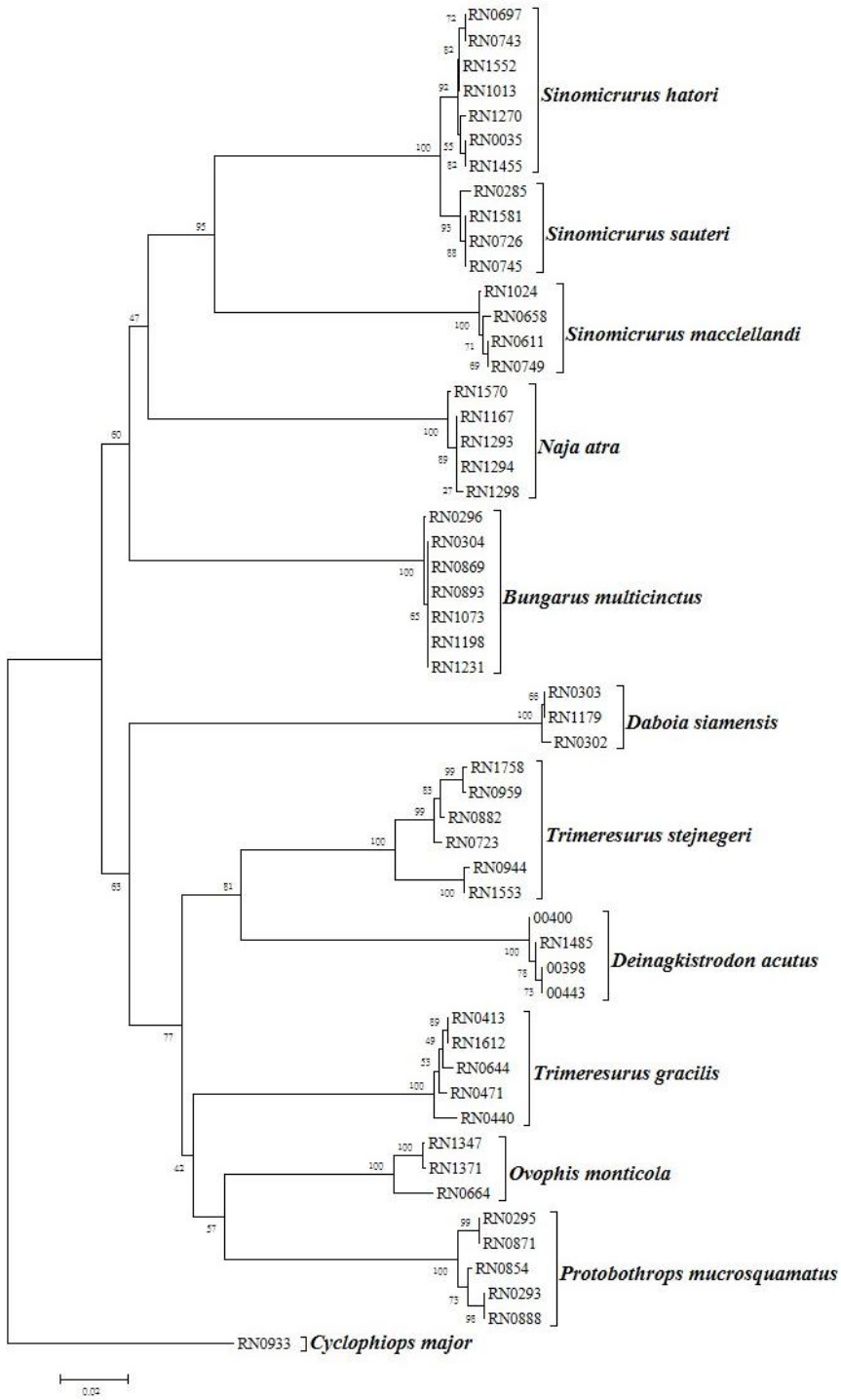

圖 1. 臺灣產蝮蛇科及蝙蝠蛇科 COI 基因序列建構的序列鄰接（NJ）系統發育樹

Fig. 1. Neighbor-joining phylogenetic tree based on COI gene sequences of 11 snake species.

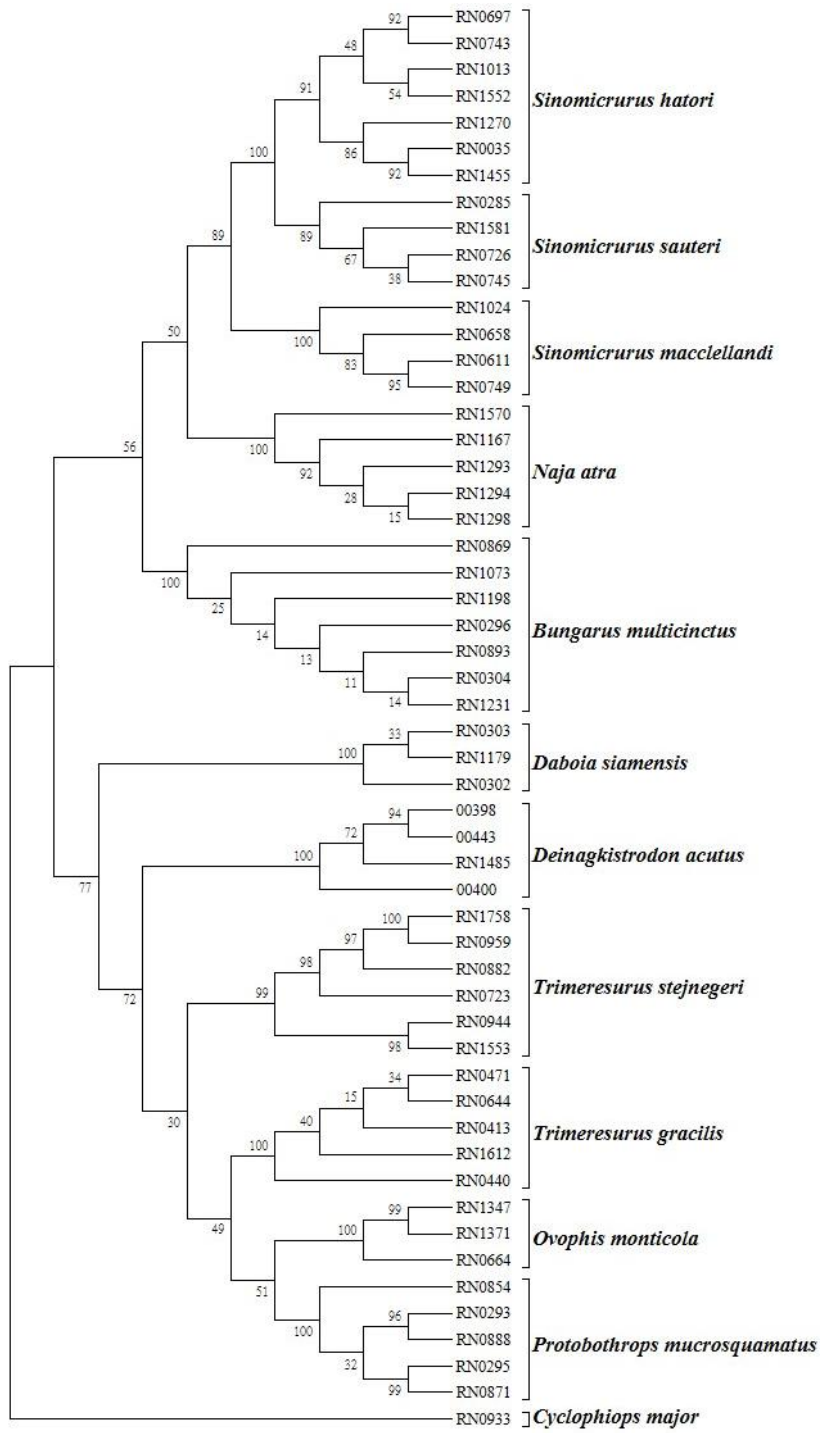

圖 2. 臺灣產蝮蛇科及蝙蝠蛇科 CO I 基因序列建構的最大簡約（MP）系統發育樹

Fig. 2. Maximum-parsimony phylogenetic tree based on COI gene sequences of 11 snake species.

結　論

2個物種間核苷酸序列的差異性，是檢驗DNA分子條碼有效與否的首要條件（Hebert *et al*., 2004a，Hebert *et al*., 2004b），本研究利用部分COI基因的658個鹼基序列進行比較分析，可明確區分臺灣產的蝮蛇科及蝙蝠蛇科等11種蛇種53個樣本，系統發育樹呈現的分支聚集結果與形態鑑定的分類結果相符，因此，本研究所採用的部分COI基因片段，應可作爲DNA分子條碼實際應用於臺灣地區蝮蛇科及蝙蝠蛇科蛇種的辨識。

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河川棲地分類方法之研究－以烏溪大旗橋河段為例

The Study of River Habitat Classification－A Case Study of Wu River

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摘 要

河川生物與棲地環境有不可分離的關係，河川棲地面積的減少會直接影響生物的生存空間。河川棲地多樣性是檢視河川棲地品質之重要指標，因此合宜的棲地分類方法顯得非常重要。現有之河川棲地分類方法大致可分爲以河川棲地特性及以河川水理特性兩種分類基礎。本研究爲探討棲地分類法與水理分類法於棲地分類結果之差異，分別以分類方法之定義類型分布及案例河段模擬結果進行比較。根據研究結果發現:棲地特性分類法與水理特性分類法於定義類型棲地分布比例並無法完全對應。例如在水深≦1 m 及流速≦1 m/s 之流況下，棲地特性分類法之理論棲地類型以深流、深潭及淺瀨爲主，水理特性分類法之理論棲地類型則以深潭、淺瀨及淺流爲主。案例河段模擬不同流量下之棲地類型分布結果顯示:於高流量時以水理特性法(如福祿數)進行棲地分類可能高估河川棲地之歧異度，建議應輔以其它水理參數(如寬深比等)進行綜合判定。

Abstract

River habitat classification can be conducted by either the habitat method or the hydraulic method. In this study the difference between two methods of habitat classification is investigated, and the theory and case simulation analysis of habitat classification are compared. According to the study results, two methods of river habitat classification did not exactly correspond. For example, under the condition of water depth≦ 1 m and velocity ≦ 1 m/s, the dominant habitat types were run, pool, and riffle when determined by the habitat method. The dominant habitat types were riffle, run and pool when determined by the hydraulic method. The case study shows that the hydraulic method of habitat classification may overestimate habitat diversity at high flows, thus it should be supplemented by other hydraulic parameters for a comprehensive judgment.

關鍵詞：河川棲地分類、福祿數、河川棲地歧異度

Keywords: River habitat classification, Froude number, River habitat diversity

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緒　言

一、前言

台灣因爲中央山脈高聳平原狹小，河川從發源地到流入海中，最長不過百餘公里，但期間的落差可高達數千公尺，在短短的河段中，形成非常複雜多變的棲地環境（陳和方，1999），也因多樣性的棲地環境才能提供台灣河川的多數特有種魚類生存。過去學者發現魚類會選擇不同的棲地(Yu *et al*., 1995)，且不同魚類在棲地的選擇上也不同，並認爲河川中環境因子會影響魚類選擇棲地(Vehanen,2003；Poff *et al*., 1997)。學者爲了解魚類與棲地之關係，而從棲地上的特性研究與魚類的相關性。賴（1996）於櫻花鉤吻鮭物理棲地特性研究中指出，棲地型態分類從國外研究及臺灣本土之研究所做之分類，大致可分爲淺瀨（riffle）、深潭（pool）、緩流（run）及梯狀潭（step-pool）。淺瀨因流速快，溶氧量高，所以有高密度的底棲生物聚集，是魚類之食物供應區。深潭則因水深遮敝性佳及流速慢的優點，提供成魚類良好的棲息場所。當乾季來臨時，此區成爲水生生物重要的避難水域。Hawkins 等（1993）指出淺流（Glide）多爲魚類進行生殖活動之棲地。魚類在河川中棲地需求包含覓食、躲藏、休憩、產卵等，多樣性棲地有助於魚類的生存，因此棲地的多樣性顯得重要。河川

生物與河川棲地有不可分離的關係，河川棲地的減少直會接影響生物多樣性。棲地多樣性是評估棲地生態品質之重要指標，因此合適之棲地分類方法也顯得非常重要。爲進行不同分類方法比較，本研究將河川棲地分類方法區分爲以「河川棲地特性」及「河川水理特性」2 種類別。水理特性分類方法是以河川水理特性（如流速、水深、底質、河床坡度等）來判定棲地類型，棲地特性分類法則依河川生物需求的角度來評估棲地類型。

二、河川棲地分類方法

2.1 棲地特性分類法

河川棲地環境與魚類有密切的關係，其環境影響魚類最密切之物理條件爲河川流速。流速較快水域可形成急流，流速較緩者形成潭區，魚類爲適應不同流速的環境其體形構造也不同。一般以生活在急流區的魚類游泳能力較強，或有特殊構造能適應其環境，而在潭區生活之魚類其游泳能力較差（王，1986）。顏（1993）研究台灣馬口魚適宜的棲地水流較緩，淤積度較低且偏好兩岸靠水草處，草叢處不僅提供躲避的地方也提供食物來源。張（1989）調查發現纓口鰍於以水深較淺及流速較快之棲地數量較多，且河川底質部分多以大型石頭爲主。魚類覓食會依照食物來源多寡及喜好來選擇覓食地區。躲藏的部分，魚類通常選擇深水的區域來躲避外敵（如鳥類等）(Matthews, 1986)，或是選擇覆蓋度高的區域。不同的魚類爲了繁衍後代，所需要的產卵場也會不一樣，有的需要水草（如菊池氏細鯽），有的需要小顆粒的石頭或是砂石，有的需要在深潭的後端或是緩流中(曾，2003) ，但水中流速過快可能會影響魚類產卵(Shen, 1994)。

汪（2000）對大甲溪做棲地改善及評估研究，將其棲地型態分爲淺瀨、淺流、深潭、深流以及岸邊緩流等五種流況(如表 1)，將淺瀨定義爲流速大於 0.3 m/s、水深小於 0.3 m 的流況，底質多爲漂石、圓石分布，容易在流水表面出現水撞擊大石頭所引起的水花；淺流定義爲流速大於 0.3 m/s、水深小於 0.3 m 的流況，底質多爲砂石、礫石、卵石且流況平緩，較少有水花出現；深潭定義爲流速小於 0.3 m/s、水深大於 0.3 m 的流況，底質多爲岩盤、漂石、圓石，分布位置於河床下切較深處；深流定義爲流速大於 0.3 m/s、水深大於 0.3 m 的流況，底質多爲漂石、圓石、卵石且常爲淺流、淺瀨與深潭間的過渡水域；岸邊緩流的定義爲流速小於 0.3 m/s、水深小於 0.1 m 的流況，底質多爲砂土、礫土常爲河道兩旁緩流的流況。溫(2005)將汪（2000）分類方法再簡化爲淺瀨(流速>0.3 m/s、水深<0.3 m)、淺流(流速<0.3 m/s、水深<0.3 m)、深潭(流速<0.3 m/s、水深 >0.3 m)及深流(流速>0.3 m/s、水深>0.3m)4 種流況。經濟部水利署(2015)參考汪（2000）及溫 (2005)等分類方法，依水面型態、流況及河床底質，將河川棲地類型分爲淺瀨、淺流、深潭及深流。分類方法中以水深 0.3 m 及流速 0.3 m/s 作爲分類基準與 Tennant 等(1976)研究認爲當河川保有 10%年平均流量，河川平均流速爲 0.3 m/s、水深約爲 0.23 m，可滿足河川中生物有基本的生活之棲地環境有其一致性。

表 1 河川棲地分類（汪，2000）

Table 1 River habitat classification (Wang, 2000)

Habitat type	Flow velocity	Flow depth	Substrate
Riffle	>0.3m/s	<0.3m	Boulder Cobble
Glide	>0.3m/s	<0.3m	Sand Gravel Pebble
Pool	<0.3m/s	>0.3m	Laccolith Boulder Cobble
Run	>0.3m/s	>0.3m	Boulder Cobble Pebble
Slack	<0.3m/s	<0.1m	Sand Gravel soil

Shen 等人 (1994)認爲合宜之河川流速應在 0.24～0.55 m/s 之間，過高的流速與偏低的流速都不利於棲地生態。當河川流速過低會導致河川中溶氧不足，流速過高可能影響重要的生物行爲（覓食與繁殖）。曾 (2003)研究認爲對大型鮭魚來說，水深是躲避天敵的最重要因素，因爲鳥類的腳長通常不會超過 30 cm，因此如果有較多深度超過 30 cm 以上的深潭可供魚類棲息，也可以獲得較多的存活機會。Yu 等(2003)研究提出紅銀小魚夏季利用 30 cm 以上水深棲地躲避。Orth(1995)爲研究棲地與河川生態的關係，將棲地型態分爲深潭(Deep pool)、中潭(Medium pool)、淺潭(Shallow pool)、急流(Run)、緩瀨(Slow riffle)及急瀨(Fast riffle)等 6 種。Azzellino 等(2001)使用 PQI(Pool Quality Index)法對所研究的河段作棲地分類，共分爲淺瀨(Tooth)、潭(Pool)、通道(Channel)、其它(Other)4 種類型。Vadas 等(2000)選擇在夏季期間對研究河段做魚類與棲地之間關係的研究，其中對多種魚類做棲地偏好分類依主要和次要棲地，而河川的棲地型態分類爲 7 種(急瀨(Fast riffle)、瀨/流(Riffle/run)、急流(Fast generalist)、淺流(Shallow rheophilic)、潭/流(Pool/run)、開闊潭(Open pool)及遮蔽潭(Pool/cover))，並探討魚類與各類型棲地環境之偏好。

2.2 水理特性分類法

水理特性分類方法是由河相學、河川棲地及景觀生態等專家於現地先以視覺辨識方法初步判定棲地類型，藉由相關儀器標記流況範圍，再選定合適之水理參數（如流速、水深及福祿數等）與對應之棲地類型進行關聯分析，並據以訂定棲地分類標準。

Jowett(1993) 提出以福祿數(Froude number，簡記 Fr) 作爲判定棲地類型之依據，當 Fr<0.18 爲深潭(Pool)，0.18<Fr<0.41 爲深流(Run)，Fr>0.41 爲淺瀨(Riflle)。Hilldale 等人(2007) 提出當 Fr<0.09 爲深潭(Pool)、0.09<Fr<0.42 爲淺流(Glide)、Fr>0.42 爲淺瀨(Riffle)。Reuter 等(2003)以流速、水深及福祿數，將河川棲地分類爲深潭(Pool)、緩流(Glide)、急流(Race)、瀨(Riffle)及邊緣流(Edge water)等 5 種棲地類型。林秉賢（2002）以福祿數將棲地類型分爲淺瀨(Riffle)、緩流(Slow water)、深潭(Pool)及急流(Rapid)四種，並加入寬深比值(b/h)等限制條件(表 2)。

表 2 河川棲地分類（林秉賢，2002）

Table 2 River habitat classification (Lin, 2002)

Habitat type	Fr range	Other restrictions
Riffle	0.255<Fr<1	R>15
Slow water	0.095<Fr<0.255	15<R<30
Pool	Fr<0.095	S=0,R<15
Rapid	Fr>1	

Note: “Fr” is Froude number

“R “ is river breadth depth ratio

“S’ is water surface slope

河川棲地之多樣性通常使用歧異度指數（Diversity Index）來表示，當歧異度指數愈高表示其多樣性愈佳，歧異度指數通常以 Simpson 歧異度指數與 Shannon 歧異度指數方法分析。本研究採用 Simpson 歧異度指數，並依其定義加以修正如下：

$$H=1-\lambda \qquad (1)$$

$$\lambda=\sum_{i=1}^{s}P_i^2=\sum_{i=1}^{s}\left(\frac{n_i}{N}\right)^2 \qquad (2)$$

式中

H：棲地歧異度指數

λ：優勢度指數

S：棲地類型數(如淺瀨、淺流、深潭及深流等)

i：棲地類型

$\boldsymbol{P}_i$：棲地類型面積比例

n_i：棲地型態之面積

$\boldsymbol{N}$：水域面積

以上式推得棲地歧異度在 0～(N −1) / N 之間，即棲地歧異度最小值可能是爲 0，最大值爲 (N −1) / N 。優勢度指數 λ 介於 0 到 1 之間，其 λ 值越高，表示此一河段的潭瀨型態越單調，棲地歧異度越低。當 λ 值等於 1 時，H 爲 0 表示此一河段的潭瀨屬於單一型態，當 λ 值接近於 0 時，H 接近於 1，表示此一河段的棲地型態趨於多樣化（溫, 2005）。

三、棲地分類方法之調整

棲地分類的種類數常由研究目的來決定，少則只有潭、瀨 2 種，多則可達十餘種型態。河川棲地型態種類基於河川的尺度、河川的特性、區域及研究者背景有多種不同定義方式。多數學者於定義深潭(Pool)及淺瀨(Riffle)並沒太大差別，但介於深潭及淺瀨間的棲地類型則有許多不同名稱。例如 Jowett(1993)將「Run」定義爲 0.18<Fr<0.41，而 Reuter(2003)則以「Race」及「Glide」取代「Run」；Hilldale(2007) 則將此之棲地類型定義爲「Glide」。本研究爲進行各分類方法進行綜合比較，將棲地分類因子限縮爲流速、水深及福祿數 3 項，並將各分類方法之棲地類型之定義與名稱作調整。棲地特性分類法選以溫 (2005)方法，水理特性分類法則以 Jowett(1993)、林(2002)及 Reuter(2003)方法，定義淺瀨(Riffle)、淺流(Glide)、深潭(Pool)及深流(Run)4 種棲地類型。(註：溫 (2005)簡稱 W 法、Jowett(1993)簡稱 J 法、林 (2002)簡稱 L 法、Reuter(2003)簡稱 R 法，如表 3)

表 3 棲地類型定義調整

Table 3 River habitat classification method adjustment

Method	Pool	Glide	Riffle	Run	Note
W	D<0.3m V>0.3m/s	D<0.3m V<0.3m/s	D>0.3m V<0.3m/s	D>0.3m V>0.3m/s	Wan (2005)
R	Fr<0.1	0.1<Fr<0.4	0.4<Fr<1	Fr>1	Reuter (2003) delete edge water
L	Fr<0.095	0.095<Fr<0.2	0.225<Fr<1	Fr>1	Lin (2002) delete Other restrictions
J	Fr<0.18	0.18<Fr<0.41	0.41<Fr<1	Fr>1	Jowett (1993) Change “Run”」to “Glide”；Set Fr>1 is “Run”

四、結果與討論

4.1 定義類型分布比較

將 W 法、J 法、L 法及 R 法於流速(0~1 m/s)及水深(0~1 m)範圍各取 100 個計算值（共計 10000 個流況組合）藉以比較各棲地分類方法之定義分布範圍之差異(如圖 1~4 及表 4)。W 法棲地類型分布圖判定爲深流(占 50%)標註爲藍色區域，淺瀨(占 21%)標註爲黃色區域，深潭(占 21%)標註爲紅色區域，淺流(占 8%)標註爲淺藍區域。當 W 法判定爲深潭區域，J 法也

判定爲深潭，R 法及 L 法則分別有 83%及 79%(相對於 W 法)判定爲深潭；當 W 法判定爲淺流，J 法僅 26%判定爲淺流，而 R 法及 L 法分別爲 55%及 49%判定爲淺流；當 W 法判定爲淺瀨，J 法及 R 法分別以 58%及 60%判定爲淺瀨，而 L 法則有 80%判定爲淺瀨；當 W 法判定爲深流區域，J 法、L 法及 R 法皆未判定爲深流。於設定之 10000 個流況中，以 J 法棲地判定深潭的數量最多。較不合於常理是:J 法與 L 法和 R 法於淺水區(水深<10 cm)卻有部分流況判定爲深潭；L 法於深水區(水深>90 cm)卻有部分流況判定爲淺瀨。

表 4 各方法相較於 W 法之理論棲地百分比

Table 4 Theory of habitat classification percentage by different methods compare with W method

W method	J method	R method	L method
Pool	**Pool** 100%	**Pool** 83% Glide 17%	**Pool** 79 % Glide 21%
Riffle	Glide 27% **Riffle** 58% Run 15%	Glide 25% **Riffle** 60% Run 15%	Glide 5% **Riffle** 80% Run 15%
Run	Pool 21% **Glide** 70% Riffle 9%	**Glide** 90% Riffle 10 %	Glide 48% **Riffle** 52%
Glide	**Pool** 67% Glide 26% Riffle 6% Run 1%	Pool 38% **Glide** 55% Riffle 6% Run 1%	Pool 36% **Glide** 49% Riffle 14% Run 1%

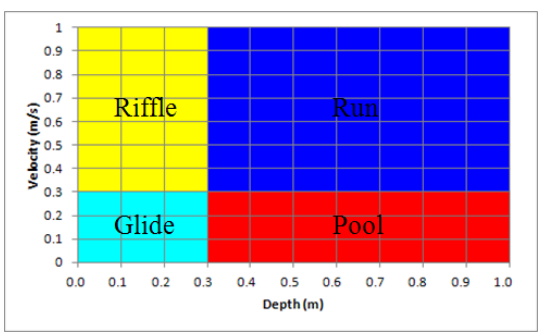

圖 1 棲地類型理論分布(W 法)

Fig. 1 Theory of habitat classification distribution (W method)

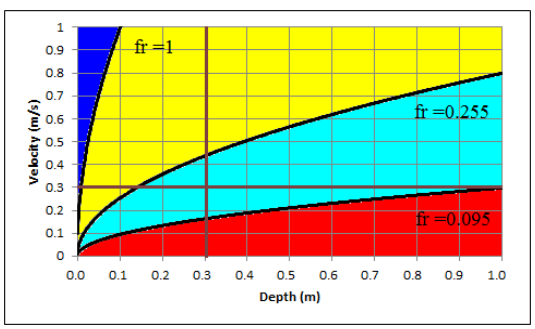

圖 3 棲地類型理論分布(L 法)

Fig. 3 Theory of habitat classification distribution (L method)

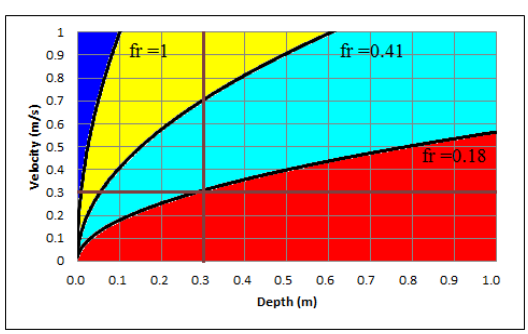

圖 2 棲地類型理論分布(J 法)

Fig. 2 Theory of habitat classification distribution (J method)

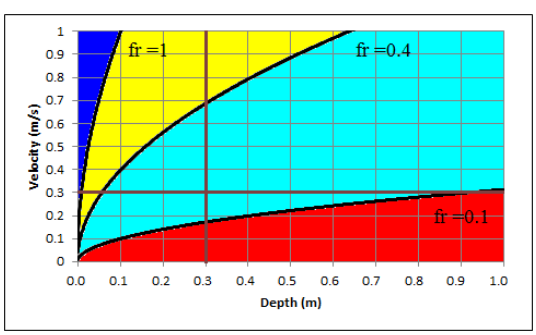

圖 4 棲地類型理論分布(R 法)

Fig. 4 Theory of habitat classification distribution (R method)

4.2 案例模擬比較

4.2.1 研究河段

本研究選取大旗橋河段上游 100 m 至 350 m 河段(共 250 m)作爲研究案例(如圖 5~6)。先以水理模式(如 River 2D)，模擬於不同流量(Q=0.46 cms、2.08 cms、50 cms 及 752 cms)下河川之流況(如圖 7~9)，再以 W 法、L 法、J 法及 R 法判定其所在位置之棲地類型。

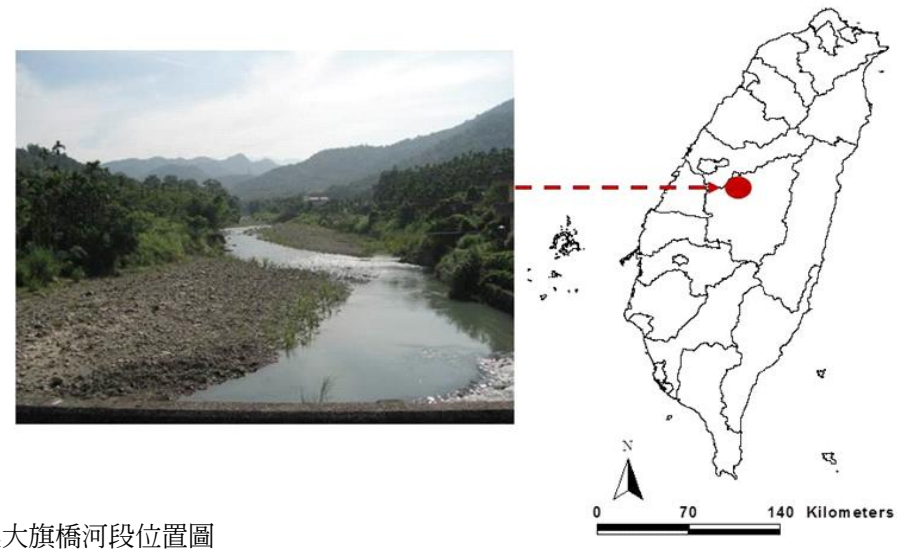

圖 5 烏溪大旗橋河段位置圖

Fig. 5 Location of the Dar-Chi Bridge section (at Wu River)

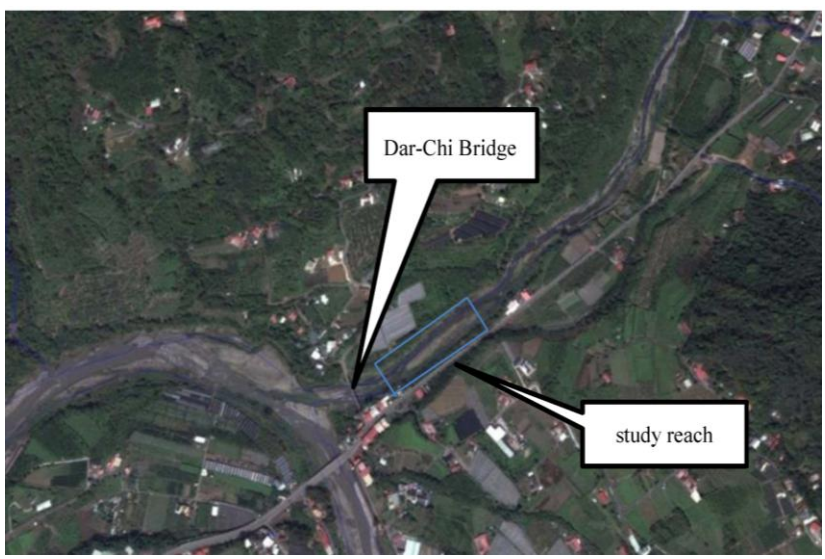

圖 6 烏溪大旗橋河段空照圖

Fig. 6 Map of the Dar-Chi Bridge section over the river (Source: Google earth)

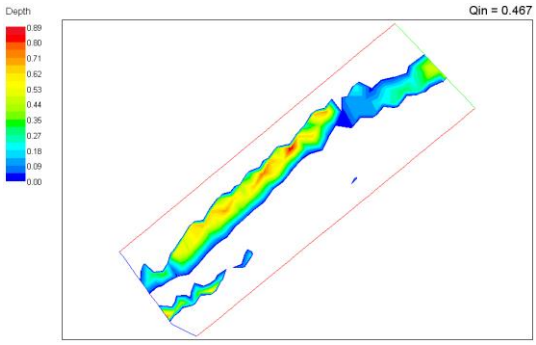

圖 7 案例河段水深分布(Q=0.46cms)

Fig.7 Case simulation: habitat result (water depth, Q=0.46cms)

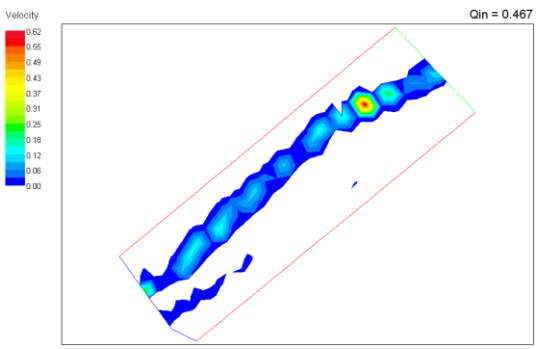

圖 8 案例河段流速分布(Q=0.46cms)

Fig.8 Case simulation: habitat result (flow velocity, Q=0.46cms)

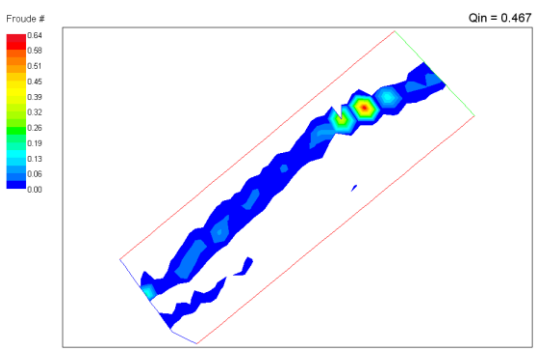

圖 9 案例河段福祿數分布(Q=0.46cms)

Fig.9 Case simulation: habitat result (Froude number, Q=0.46cms)

4.2.2、棲地分布模擬結果

(1) Q=0.46 cms 結果

Q=0.46 cms 模擬棲地結果如表 5。L 法、J 法及 R 法判定深潭比例明顯較 W 法爲高，是因 W 法於淺水區(水深<30 cm)判定爲淺流，而 L 法、J 法及 R 法則多判定爲深潭，此亦造成 L 法 J 法及 R 法之棲地岐異度指數(H=0.08~0.1)明顯低於於 W 法(H=0.51)。

表 5 以各方法判定棲地類型及棲地岐異度指數(模擬案例 Q=0.46cms)

Table 5 Case simulation of habitat classification and H index by different methods (Q=0.46cms)

0.46cms	W method	L method	J method	R method
Pool	54%	95%	96%	95%
Riffle	1%	3%	2%	2%
Run	0	0	0	0
Glide	45%	2%	2%	3%
H index	0.51	0.10	0.08	0.10

(2) Q=2.08 cms 結果

Q=2.08 cms 模擬棲地結果如表 6 及圖 10~13(深流標註爲藍色，淺瀨標註爲黃色，深潭標註爲紅色，淺流標註爲淺藍)。L 法、J 法及 R 法判定爲深潭之比例明顯較 W 法爲高；W 法與 J 法及 R 法於淺瀨數量雖相同(7%)，但發生地點卻並不一致；W 法判定深流及淺流數量均較 L 法、J 法及 R 法爲多，W 法判定爲淺瀨之位置，L 法、J 法及 R 法則可能判定爲深潭；L 法及 R 法判定結果相近，J 法之淺流較 L 法及 R 法少；W 法棲地岐異度指數(H=0.66)明顯高於 L 法、J 法及 R 法(H=0.24~0.42)，以 J 法判定之棲地岐異度指數最低(H=0.24)。

表 6 以各方法判定棲地類型及棲地岐異度指數(模擬案例 Q=2.08cms)

Table 6 Case simulation of habitat classification and H index by different methods (Q=2.08cms)

2.08cms	W method	L method	J method	R method
Pool	42%	75%	88%	76%
Riffle	7%	8%	7%	7%
Run	14%	1%	1%	1%
Glide	33%	16%	4%	16%
H index	0.66	0.42	0.24	0.41

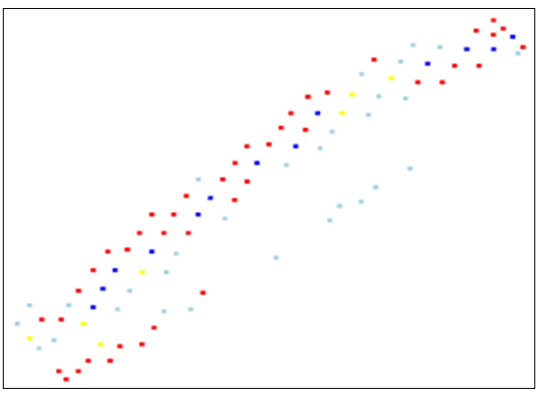

圖 10 Q=2.08cms 棲地類型分布(W 法)

Fig. 10 Case simulation habitat: classification result (W method, Q=2.08cms)

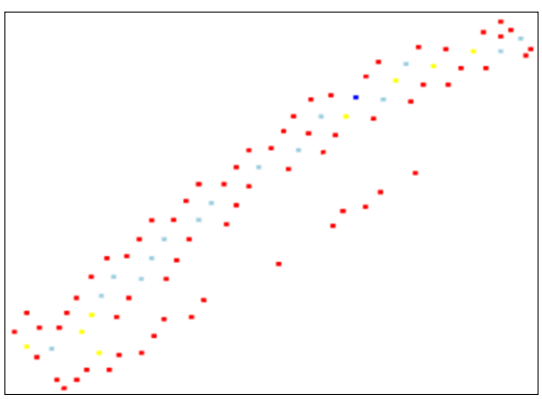

圖 11 Q=2.08cms 棲地類型分布(L 法)

Fig. 11 Case simulation: habitat classification result (L method, Q=2.08cms)

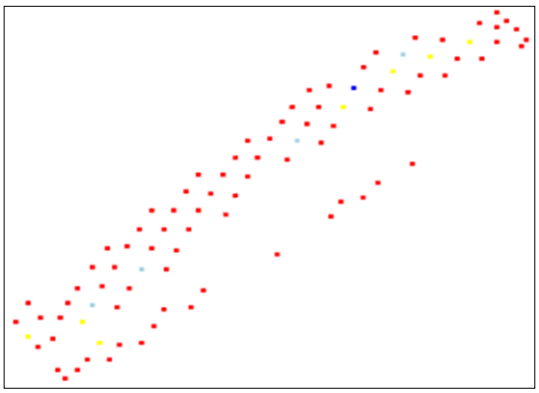

圖 12 Q=2.08cms 棲地類型分布(J 法)

Fig. 12 Case simulation: habitat classification result (J method, Q=2.08cms)

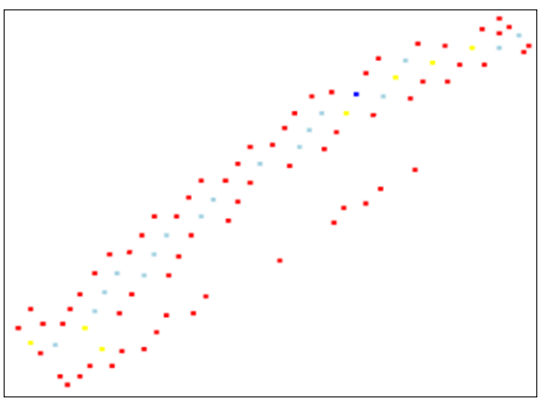

圖 13 Q=2.08cms 棲地類型分布(R 法)

Fig. 13 Case simulation: habitat classification result (R method, Q=2.08cms)

(3) Q=50 cms 結果

Q=50 cms 模擬棲地結果如表 7。L 法、J 法及 R 法判定深潭較 W 法爲多，L 法、J 法及 R 法有部分判定深潭區域，W 法則判定淺流；4 種方法之棲地岐異度指數(H=0.56~0.69)結果接近，但發現 W 法與 L 法、J 法及 R 法之棲地類型分布其實並不完全相同。

表 7 以各方法判定棲地類型及棲地岐異度指數(模擬案例 Q=50cms)

Table 7 Case simulation of habitat classification and H index by different methods (Q=50cms)

50cms	W method	L method	J method	R method
Pool	28%	38%	42%	38%
Riffle	2%	45%	36%	36%
Run	59%	7%	7%	7%
Glide	11%	10%	15%	19%
H index	0.56	0.42	0.67	0.69

(4) Q=752 cms 結果

Q=752 cms 模擬棲地結果如表 8。J 法棲地類型爲:深潭之數量較 W 法、L 法及 R 法爲多；L 法、J 法及 R 法判定深潭位置，W 法則多判定爲深流；L 法、J 法及 R 法判定淺瀨比例明顯高於 W 法；W 法判定深流比例明顯高於 L 法；W 法棲地岐異度指數(H=0.39)明顯低於 L 法、J 法及 R 法(H=0.61~0.67)。

表 8 以各方法判定棲地類型及棲地岐異度指數(模擬案例 Q=752cms)

Table 8 Case simulation of habitat classification and H index by different methods (Q=752cms)

752cms	W method	L method	J method	R method
Pool	22%	27%	34%	28%
Riffle	2%	54%	37%	39%
Run	75%	2%	2%	2%
Glide	1%	17%	27%	31%
H index	0.39	0.61	0.67	0.67

綜合而言，棲地特性法於低流量時之棲地判定類型多爲深潭及淺流，隨著模擬流量增加，棲地類型轉換爲以深潭及深流爲主；水理特性法於低流量時之棲地判定類型多爲深潭，隨著流量增加，棲地類型轉換爲以深潭、淺瀨及淺流爲主。棲地特性法之棲地岐異度隨著流量增加而增高(如 Q=2.08 cms，H=0.66)，而後又逐漸降低(如 Q=752 cms，H=0.39)；水理特性法之棲地岐異度亦隨著流量增加而增高，但於高流量時棲地岐異度並未明顯下降(如 Q=752 cms，H=0.61~0.67)，這是因水理特性法僅以福祿數作爲棲地型態判定依據，而造成棲類之不適當判定(如高流量卻有高比例之淺瀨與淺流發生)，致使高估了該流況之棲地岐異度。

五、結論

1.由各棲地分類方法的定義分布比較結果發現：棲地特性分類法(W 法)與水理特性分類法(L 法、J 法及 R 法等)無法完全對應，如 W 法在水深 1 m 及流速 1 m/s 之流況下，其棲地類型以深流、深潭及淺瀨爲主，而 L 法、J 法及 R 法棲地類型則以深潭、淺瀨及淺流爲主。

2.根據模擬案例結果顯示:水理特性分類法於低流量時(如 Q=0.46 cms)多判定爲深潭，棲地特性分類法(W 法)則判定爲及深潭及淺流；水理特性分類法於高流量(如 Q= 0.752 cms)時多判定爲深潭及淺瀨，棲地特性分類法則多判定爲深潭及深流。

六、建議

1.河川棲地岐異度爲計算棲地類型多樣性之量化指標，並無法表示河川棲地之組成情形。因此當以河川棲地岐異度作爲比較基礎

時，應同時檢視其河川棲地類型之空間分布，以免造成誤判。

2.水理特性分類法於高流量得之河川棲地歧異度(如 W 法 Q=752 cms ，H=0.39)明顯高於棲地特性分類法(如 L 法 Q=752 cms ，H=0.61)，因此僅以福祿數作爲河川棲地類型之分類依據，可能造成對河川棲地歧異度之高估，建議應輔以其它水理參數(如寬深比等)進行綜合判定。

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《台灣生物多樣性研究》稿約

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5. 英文期刊：Pimm, S. L. and J. L. Gittleman. 1992. Biodiversity : Where is it ? Science 255: 940.

6. 英文期刊：Baker, C. S., F. Cipriano and S. R. Palumbi. 1996. Molecular genetic identification for whale and dolphin products from commercial markets in Korea and Japan. Molecular Ecology 5: 671-685.

7. 英文書籍：Soule, M. E. and B. A. Wilco. 1980. Conservation biology: An evolutionary-ecological, approach. Sinauer Associates, Sunderand, Massachusetts.

8. 英文彙編書籍：Jinchu, H. and W. Fuwen. 1990. Development and progress of breeding and rearing giant pandas in captivity within China. pp. 322-325. *In*: H. Jinchu (ed.). Research and progress in biology of the giant panda. Sichuan Publishing House of Science and Technology, Sichuan, People's Republic of China.

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   Pimm, S. L. and J. L. Gittleman. 1992. Biodiversity: Where is it? Science 255: 910-940.

   Baker, C. S., F. Cipriano and S. R. Palumbi. 1996. Molecular genetic identification of whale and dolphin products from commercial markets in Korea and Japan. Molecular Ecology 5: 671-685.

   For books and symposiums:

   Soule, M. E. and B. A. Wilco. 1980. Conservation biology: An evolutionary-ecological approach. Sinauer Associates, Sunderand, Massachusetts.

   Jinchu, H. and W. Fuwen. 1990. Development and progress of breeding and rearing giant pandas in captivity within China. pp. 322-325. *In*: H. Jinchu (ed). Research and progress in biology of the giant panda. Sichuan Publishing House of Science and Technology, Sichuan, China.
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