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台灣新歸化禾本科植物－彎穗草

Dinebra retroflexa (Vahl) Panz.—A newly naturalized Poaceae in Taiwan

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摘要

禾本科（Poaceae）彎穗草（*Dinebra retroflexa* (Vahl) Panz.）原產舊大陸熱帶地區，包括非洲和亞洲的熱帶乾燥開闊地。本種為一年生草本，花序由小穗組成，呈狹長橢圓形，長 6-25cm，成熟時常下彎倒伏；每節具 2-4 個短總狀花序；小穗無柄呈兩列排列，基部具關節成熟易掉落；穎片細長成針狀，比被包覆的小花長等特徵，能與台灣已知的種類區別。本文報導彎穗草歸化於台灣北部和南部低海拔地區的農田和道路邊緣，描述其外部形態特徵、彩色照片和生態特性。

Abstract

Dinebra retroflexa (Vahl) Panz., belonging to the grass family, is native to the tropics of the Old World, including the tropical dry open lands of Africa and Asia. This small herb can be distinguished by its terminal 6-25 cm long inflorescence, two to four racemes arranged spikelets on main axis, spikelets with joints that fall off easily, and longer glumes than the flowers. In this paper, we report the naturalization of *Dinebra retroflexa* in low-altitude farmland and road edges in northern and southern Taiwan, and describe its morphological characteristics, color photo, and ecological characteristics.

關鍵詞：彎穗草、歸化種、禾本科、台灣

Key words: *Dinebra retroflexa*, naturalized, Poaceae, Taiwan

前言

禾本科（Poaceae）植物廣泛分布全球，約含有 768 屬 11,506 種（Soreng *et al.*, 2017）。彎穗草屬（*Dinebra* Jacq.）為禾本科虎尾草亞科（Chloridoideae）狗牙根族（Cynodonteae）（Soreng *et al.*, 2017），主要分布於舊熱帶地區（Sun & Philips, 2006)。近年根據分子親緣關係的研究指出彎穗草屬與千金子屬 (*Leptochloa* P. Beauv.) 的多數種類親緣關係很相近，而且千金子屬內的種類呈現多系群（polyphyly），部分種類應轉移到彎穗草屬成為單系群（monophyly），經處理後現在彎穗草屬有 23 種（Peterson et al., 2012）。台灣植物誌中千金子屬轉移到彎穗草屬內有原生的千金子（*D. chinensis* (L.) P.M. Peterson & N. Snow =*L. chinensis* (L.) Nees）和蟿子草（*D. panicea* (Retz.) P.M. Peterson & N. Snow =*L. panicea* (Retz.) Ohwi）（Chen *et al.*, 2011; Hsu *et al.*, 2000; Peterson *et al.*, 2012）。

彎穗草屬的模式種彎穗草（*Dinebra retroflexa* (Vahl) Panz.）廣

布於非洲，包括茅利塔尼亞、科麥隆、埃及、衣索比亞、南非、塞內加爾、坦尚尼亞和馬達加斯加等國家，在亞洲分布於印度、伊拉克、斯里蘭卡和巴基斯坦等國家（Clayton *et al*., 2020）。本種為一年生小草本，小穗聚合成的圓錐排列的複合花序狹長橢圓形，長 6-25 cm，成熟時常往下彎曲倒伏；每節具 2-4 個短總狀花序（圖 1A），從斜上、平展到下彎，總狀花序軸扁平具狹翼（圖 1B）；小穗在遠軸面呈兩列排列，基部具關節成熟易掉落；穎片細長成針狀，比被包覆的小花長（圖 1C），使本種容易辨識（孫和王，1990; Tanji, 2020）。本種的染色體數目被報導 n=10（Moinuddin *et al*., 1994）; 2n=20（Clayton *et al*., 2020）。

禾本科根據台灣植物誌中記載台灣有 118 屬 289 種 1 亞種 39 變種 8 型（Hsu *et al*., 2000），其中未有彎穗草分布之紀錄。禾本科與人類生活關係密切，在各地有很多歸化種，本種在中國的雲南和福建有歸化的報導（Chen and Lin, 2004），鄰近福建的金門亦發現其歸化（呂， 2011；鍾， 2019）。台灣有 695 種歸化種（Chang-Yang *et al*., 2022），尚未有彎穗草歸化之報導。

作者等近年於台灣南部烏山頭水庫的淺山區域和農耕地區及北部桃園地區，採獲一種未知的植物，經比對文獻及標本後鑑定為彎穗草。本文根據文獻、標本和野外實地調查等資料，報導本種為台灣新歸化種提供分布及其相關特性。

分類處理

Dinebra Jacq. Fragm. Bot. 77, *pl. 121, f. 1*. 1809; Sun and Philips. Fl. China 22: 470. 2006; Peterson *et al*., Ann. Bot. 109: 1326. 2012　　彎穗草屬

Dinebra retroflexa (Vahl) Panz. Ideen Revis. Gräs. 59. 1813; Sun and Philips. Fl. China 22: 470. 2006　彎穗草 (圖 1)

Cynosurus retroflexus Vahl, Symb. Bot. 2: 20. 1791

Dinebra arabica Jacq., Framg. Bot. 77. 1809; Lu. Fl. Kinmen 2: 412. 2011

圖 1. 彎穗草 (A) 頂生總狀的圓錐花序； (B) 小穗聚合排列成總狀花序，近軸面 (左) 和遠軸面 (右)； (C) 小穗，近軸面 (左) 和遠軸面 (右)。

Fig. 1. *Dinebra retroflexa* (Vahl) Panz. from Taiwan. (A) Inflorescence; (B) Spikelets aggregated into racemes; (C) Spikelets.

一年生草本，基部叢生；桿直立或斜生，高 30-60 cm，無毛。葉鞘短於節間，無毛或疏被毛；葉舌膜質，長 1-2 mm，先端撕裂狀；葉線形，扁平，長 5-30 cm，寬 0.3-1 cm，先端尖，無毛或疏被毛。花序由多數小穗聚合而成，小穗再集合成為總狀花序，長 0.5-5 cm，總狀花序再聚合成圓錐排列之複合花序，花序頂生，主軸長 6-25 cm；小穗具 1-3 朵小花，單生，長 5-6 mm，兩側壓扁。外穎遠長於小花，披針形，先端呈針狀或芒狀，長 5-6 mm，具 1 脈隆起呈脊狀；內穎與外穎等長；外稃卵形，膜質，長 1.8-1.9 mm，具 3 脈，中脈呈脊狀，無毛或基部疏被毛，先端銳尖或呈短芒狀；內稃，長 1.4-1.6 mm，具 2 脈，呈脊狀，表面無毛或疏被毛；雄蕊 3 枚，長約 0.3mm。花柱 2 枚，柱頭羽毛狀。穎果橢圓形，橫切面三角形，長約 1.1 mm。

分布：廣泛分布於非洲和亞洲的熱帶地區（Clayton *et al*., 2020）。中國（Chen and Lin, 2004 ; Sun and Philips, 2006）和日本有歸化報導（清水等 , 2001）。台灣目前歸化於北部桃園地區和南部台南六甲區，低海拔田地和道路邊緣光線充足處。

觀察標本：桃園市：大溪，Feb. 21. 2022, *H. C. Liao s. n.*（台南大學生態暨環境資源學系標本室）。台南市：六甲區，水流東，Oct. 10. 2013, *T. H. Hsieh s. n.*（台南大學生態暨環境資源學系標本室）; Jun. 15. 2021, *T. H. Hsieh s. n.*（台南大學生態暨環境資源學系標本室）；水漆林，Feb. 27. 2022, *M. C. Chiang s. n.*（台南大學生態暨環境資源學系標本室）。

花果期：2-10 月。

生態習性

彎穗草生育地環境為潮濕地區和耕作區域（Sun and Philips, 2006），在甘蔗（*Saccharum officinarum* L.）、棉　花（*Gossypium herbaceum* L.）、花生（*Arachis hypogaea* L.）、高粱（*Sorghum bicolor* (L.) Moench.）、洋蔥（*Allium cepa* L.）和水稻（*Oryza sativa* L.）田內是一種主要的雜草（Tanji, 2020）。本種為一年生草本，

種子在春天或夏天因溫度升高和白天增長而發芽、生長和開花（Tanji, 2020）。目前歸化於桃園市大溪區和台南市六甲區，在台南市六甲區水漆林區域主要種植水稻，該環境大致為農田邊緣與人為開墾環境之道路邊緣周遭潮濕處，成為農田的雜草。

2013 年在台南六甲區水流東的族群位於住家旁的菜園，在菜園旁的雜草內本種與其他草本植物混生，在 10 月份時正處於開花結果階段，但隨後住戶搬離菜園荒廢，此生育地演替成為以五節芒（*Miscanthus floridulus* (Labill) Warb. *ex* Schum. & Laut.） 優勢的高草地，本種可能因光線不足無法生存，多年未曾發現其生長。2021 年 4 月從此處挖取土壤在台南大學栽種，6 月時從土壤中長出彎穗草，可見其種子能在土壤中形成種子庫，且能存活多年。北部另一個歸化的族群位於桃園市大溪區，在新整建的親水步道旁，生長在開闊廢耕地的田埂上。該土地 2020 年整地後就未種植作物，多為大花咸豐草（*Bidens pilosa* L. var. *radiata* Sch.）、 稗（*Echinochloa crus-galli* (L.) P. Beauv.）或芒稷（*E. colona* (L.) Link），推測此族群可能是工程填充土方將種子帶進而歸化。呂（2011）指出本種在金門曾有歸化的報導，但是在調查期間皆未發現；鍾（2019）報導在金門重新採到本種植物，此類曾出現、消失又出現的情形可能與其需要光線充足的環境才能發芽生長，生育地環境不適宜時可能以種子庫的方式在土壤中存活多年有關。

彎穗草果實成熟時小穗基部的關節容易掉落。本種廣泛歸化於熱帶和亞熱帶地區。日本於 1930 年代歸化於山形縣，其後在全國各地皆可見到分布（清水等 , 2001）。中國在 1990 年新紀錄分布在雲南省，在 2004 年報導歸化於福建省（Chen and Lin, 2004 ; Sun and Philips, 2006）。台南市六甲區水流東位於烏山頭水庫集水區的丘陵地區，2022 年發現的水漆林是水庫的下方灌溉區域，間接的推測本種或許可能藉由水力進行散播。本種也

可能參雜在作物的種子中，使用機械採收或人類的衣服皆有可能助其傳播（Tanji, 2020），加上種子可在土壤中存活多年，目前已經在北部和南部有歸化族群，預測歸化後會成為農田中的雜草，未來可能會持續擴張宜事先加以防範。

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臺灣新紀錄蕨－南洋毛葉腎蕨（腎蕨科）

Nephrolepis hirsutula (G.Forst.) C.Presl (Nephrolepidaceae), a Newly Recorded Species in Taiwan

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摘 要

本文報導臺灣腎蕨科 (Nephrolepidaceae) 新紀錄蕨類植物：南洋毛葉腎蕨 (*Nephrolepis hirsutula* (G.Forst.) C.Presl)，文中附有此新紀錄物種之形態描述、同物異名、圖片、引證標本、及臺灣產腎蕨屬 (*Nephrolepis*) 之分類檢索等資訊。

ABSTRACT

This paper reports the fern *Nephrolepis hirsutula* (G.Forst.) C.Presl as a newly recorded species in the flora of Taiwan. Its morphological characters, synonyms, illustrations, voucher specimens, and a key to *Nephrolepis* in Taiwan are presented.

關鍵詞：南洋毛葉腎蕨、腎蕨屬、腎蕨科、臺灣

Key words: *Nephrolepis hirsutula, Nephrolepis*, Nephrolepidaceae, Taiwan

緒 言

文獻紀錄中，臺灣腎蕨屬 (*Nephrolepis*) 有 6 個物種 (含 3 種雜交種) (許等 2019；TPG 2019)，最近在臺東蘭嶼海拔 10~20m 步道之兩旁土坡，採集到腎蕨屬之未知物種，其形態類似毛葉腎蕨 (*Nephrolepis brownii* (Desv.) Hovenkamp & Miyam.)，但兩物種間有如下明顯不同的形態特徵 :

毛葉腎蕨 :「葉軸近軸面、遠軸面及羽片中肋密被透明或淡褐色纖維狀鱗片；羽片無論具或不具孢子囊群，其邊緣常呈較密之淺尖齒狀缺刻；葉柄基部被披針形鱗片」。

腎蕨屬之未知物種 :「葉軸近軸面、遠軸面及羽片中肋密被鐵鏽色 (或紅褐色) 纖維狀鱗片；羽片具孢子囊群，其邊緣常呈圓鈍齒狀缺刻，羽片不具孢子囊群，其邊緣常呈淺缺刻；葉柄基部線形或線狀披針形鱗片」。

經檢閱腎蕨屬分類檢索表之相關文獻 (Hovenkamp and Miyamoto 2005; Viveros & Salino 2017) 及標本 (GIBF，K，PE，TAIE，TAIF) 進行形態比對後，確認在臺東蘭嶼所採集腎蕨屬之未知物種，為臺灣新紀錄種：南洋毛葉腎蕨 (*Nephrolepis hirsutula* (G.Forst.) C.Presl)。

分類處理

南洋毛葉腎蕨 (*Nephrolepis hirsutula* (G.Forst.) C.Presl)；Tent. Pterid.: 79 (1836) . (新擬中名) 圖 1.

Nephrolepis hirsutula (G.Forst.) C.Presl, Tent. Pterid. 79. 1836; Tardieu & C.Chr. in Fl. Indo-Chine 7(2): 290. 1941; Holttum, Rev. Fl. Malaya ed. 1, 2: 382, f. 222. 1955 [‘1954’]; Ching, Fl. Reipubl. Popularis Sin. 2: 317, pl. 28, f. 3 & 4.1959; Tagawa & K.Iwats., South E. Asian Stud. 5: 78. 1967; Tagawa & K.Iwats., Fl. Thailand 3: 177. 1985; Boonkerd & Pollawatn, Pterid. Thailand: 238. 2000; Hovenkamp & Miyamoto, Blumea 50: 304. 2005.–*Polypodium hirsutulum* G.Forst., Fl. Ins. Austr.: 81. 1786.

同物異名：

Aspidium hirsutulum (G.Forst.) Sw., J. Bot. (Schrader) 1800(2): 32 (1801); *Lepidoneuron hirsutulum* (G.Forst.) Fée, Mém. Foug., 5. Gen. Filic.: 301 (1852); *Nephrolepis exaltata* var. *hirsutula* (G.Forst.) Baker, C.F.P.von Martius & auct. suc. (eds.), Fl. Bras. 1 (2): 493 (1870); *Nephrodium hirsutulum* (G.Forst.) C.Presl, Reliq. Haenk. 1: 32 (1825); *Polystichum hirsutulum* (G.Forst.) Bernh., J. Bot. (Schrader) 1801(1): 16 (1802)

引證標本：

臺灣：臺東縣：蘭嶼鄉，海拔約 15~20m，2022-09-16，M. Y. Shen 6863(TAIE)；Type：法屬波利尼西亞：Otaheite, Society Is., 1867, T. *Nightingale, K000883891* (K).

形態特徵：

根狀莖短，直立，叢生，不具特化的儲水球莖。一回羽狀複葉，葉片寬披針形或橢圓狀披針形，葉片向兩端逐漸變短，柄長 15-30cm，鱗片密集，葉柄基部密被線形或線狀披針形鱗片，貼伏，雙色，中心暗褐色，邊緣淡鐵鏽色。側羽片 35~40 對以上，互不覆蓋，互生，近無柄；中部側羽片披針形或線狀披針形，長約 8~10cm，寬約 1.5~2cm，基部上側明顯具耳形突起，下部側羽片漸細成耳狀，幾乎不具或稍有耳形突起；羽片具孢子囊群，其邊緣常呈圓鈍齒狀缺刻，羽片不具孢子囊群，其邊緣常呈淺缺刻；葉軸兩面和羽片遠軸面之中肋密被鐵鏽色 (或紅褐色) 纖維狀鱗片。葉脈游離。孢子囊群亞邊緣生，位於小脈頂端，孢膜腎形，無毛。

臺灣產新的腎蕨屬之分類檢索如下：

1a 葉軸與羽軸遠軸面光滑或僅被稀疏纖維狀鱗片……(2)

1b 葉軸與羽軸遠軸面密被纖維狀鱗片……(4)

2a 成熟葉羽片基部上側不具耳狀突起……長葉腎蕨 *N. biserrata*

2b 成熟葉羽片基部上側多少具耳狀突起……(3)


A
10cm
B
1cm
C
1cm
D

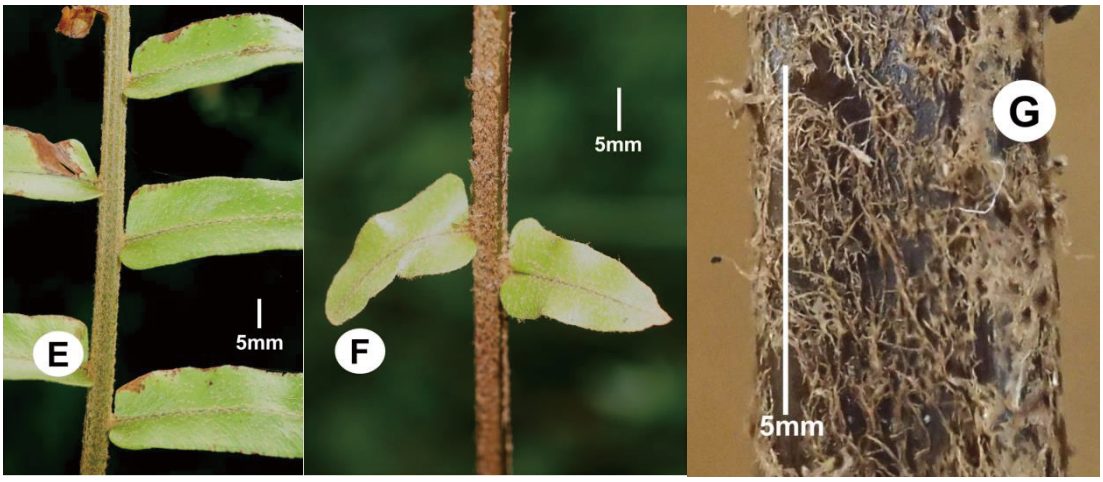


圖 1. 南洋毛葉腎蕨 (*N. hirsutula*): A, 生長環境；B, 葉片一回羽狀複；C, 葉近軸面 (基部明顯具一向上耳狀突起；密被鐵鏽色 (或紅褐色) 纖維狀鱗片)；D, 葉遠軸面 (孢子囊群亞邊緣生；葉軸遠軸面與羽片中肋密被鐵鏽色 (或紅褐色) 纖維狀鱗片)；E, 葉下半部 (基部略帶耳狀)；F, 最基部羽片 (羽片漸縮成耳狀)；G, 葉柄基部 (密被線形或線狀披針形鱗片)。

Figure 1. *N. hirsutula*: A, habit; B, lamina pinnate; C, adaxial surface (margin shallowly crenate, distinctly auricled, surface densely fibrous scales with pale ferrugineous); D, abaxial surface (sori submarginal, rachis and costae densely fibrous scales with pale ferrugineous); E, lower pinnae (hardly or slightly auricled); F, basal pinnae (tapered into auriculated); G, stipes (densely covered with linear or linear lanceolate scales).

3a 孢子囊群中生偏向葉緣；葉柄基部被淡褐色單色鱗片……馬蹄腎蕨 *N. x hipocrepicis* (= *N. cordifolia x N. biserrata*)

3b 孢子囊群亞邊緣生；葉柄基部被雙色鱗片……假長葉腎蕨 *N. x pseudobiserrata* (= *N. brownii* x *N. biserrata*)

4a 羽片長 3-4 cm; 寬約 1 cm；葉柄基部被淺褐單色鱗片……(5)

4b 羽片長 5~10 cm; 寬約 1~2 cm；葉柄基部被中間被深褐色，邊緣淡色之雙色鱗片……(6)

5a 羽片基部耳狀突起，幾乎全覆蓋葉軸；具特化儲水球莖…腎蕨 *N. cordifolia*

5b 羽片基部耳狀突起，未覆蓋或部分覆蓋葉軸；不具特化儲水球莖……科氏腎蕨 *N.* x *copelandii* (= *N. cordifolia* x *N. brownii*)

6a 葉柄被披針形鱗片 (表 1H)；葉軸兩面密被透明或淡褐色纖維狀鱗片；羽片無論具或不具孢子囊群，其邊緣常呈較密之淺尖齒狀缺刻 (表 1F 和表 1G) ……毛葉腎蕨 *N. brownii*

6b 葉柄被線狀披針形或長披針形鱗片 (表 1D)；葉軸兩面密被鐵鏽色 (或紅褐色) 纖維狀鱗片；羽片具孢子囊群，其邊緣常呈圓鈍齒狀缺刻，羽片不具孢子囊群，其邊緣常呈淺缺刻 (表 1B 和表 1C)……南洋毛葉腎蕨 *N. hirsutula*

保育等級評估：

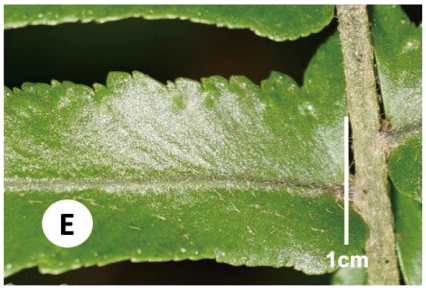
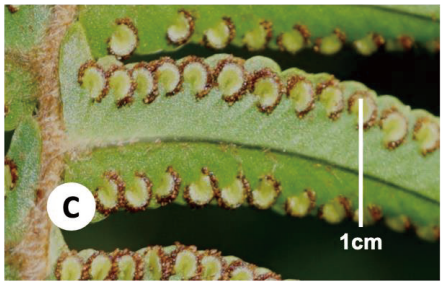
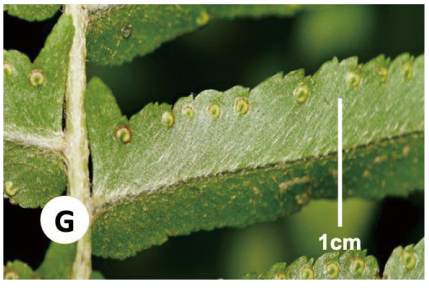
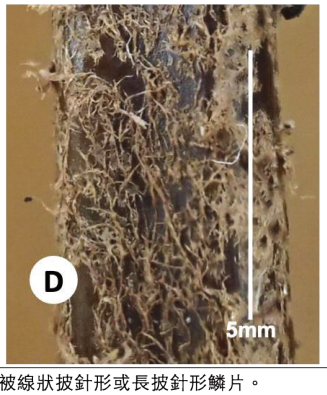
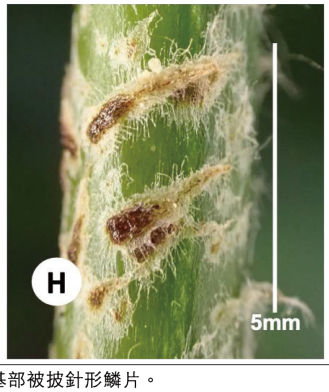
目前，我們在臺灣僅發現一個族群約 200~300 株，位於臺灣臺東蘭嶼海拔 10~20m 步道之兩旁土坡，其棲地雖很容易受到人類的威脅，但無立即滅絕之危機，未來它可能需要進一步保護，唯目前我們尚缺完整的全國分布資料，依紅皮書規範，暫將其列為數據缺乏 (DD: Data Deficient) 等級。（臺灣維管束植物紅皮書名錄 2017）。

地理分布及生態：

目前南洋毛葉腎蕨分布於中南半島 (緬甸、泰國、越南)、菲律賓、婆

表 1. 南洋毛葉腎蕨和毛葉腎蕨的形態特徵比較。

Table 1. Comparison of morphological characteristics between *N. hirsutula* and *N. brownii*.

南洋毛葉腎蕨 *N. hirsutula*	毛葉腎蕨 *N. brownii*
	
葉軸近軸面被鐵鏽色(或紅褐色)纖維狀鱗片。	葉軸近軸面被透明或淡褐色纖維狀鱗片。
	
葉軸遠軸面及羽片中肋密被鐵鏽色(或紅褐色)纖維狀鱗片；不具孢子囊群之羽片，其邊緣常呈淺缺刻。	葉軸遠軸面及羽片中肋密被透明或淡褐色纖維狀鱗片；不具孢子囊群之羽片，其邊緣常呈較密淺尖齒狀缺刻。
	
具孢子囊群之羽片，其邊緣常呈圓鈍齒狀缺刻。	具孢子囊群之羽片，其邊緣常呈淺尖齒狀缺刻。
	
葉柄基部被線狀披針形或長披針形鱗片。	葉柄基部被披針形鱗片。

羅洲、斐濟、夏威夷、爪哇島、馬來西亞、新幾內亞、小笠原島、所羅門島、蘇門答臘島、澳洲等地區 (POWO 2023)。臺灣新紀錄物種南洋毛葉腎蕨，其所在緯度為本物種北半球之南端。

分類註記：

早期臺灣部分學者把毛葉腎蕨歸屬為 *N. hirsutula* (DeVol et al. 1975)，也有部分學者把 N. hirsutula 及 *N. brownii* 歸屬為同物異名 (胡嘉穎 2020)。根據目前分子研究，認為南洋毛葉腎蕨 (*N. hirsutula*) 與毛葉腎蕨 (*N. brownii*) 的親緣關係並不密切 (Hennequin et al. 2010; Yahaya et al. 2016)，Plants of the World Online (POWO) 也認兩者為不同物種 (POWO 2023)。我們將兩個物種間主要的形態特徵做比較 (表 1)，由照片可以明顯觀察到兩個物種之間的差異。

謝 誌

作者們特別感謝蕨類專家陳正為先生的協助，提供本論文有價值的資訊與建議，同時，感謝兩位匿名審稿委員，提出本論文需改進的方向。

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A dataset of distribution of *Geothelphusa* (Decapoda: Potamidae) with their environmental parameters and stream indicators in eastern and southern Taiwan

臺灣東部及南部地區的澤蟹屬（Genus *Geothelphusa*）物種分布、溪流環境參數及指標資料集

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Abstract

This paper describes the dataset on the freshwater crab genus *Geothelphusa* (Decapoda: Potamidae), their environmental parameters, and stream indicators in eastern and southern Taiwan. This dataset is the result of 146 surveys (sampling events) of freshwater crab species and stream environment from 2013 to 2015 at 42 sampling sites throughout Taiwan, and a total of 12 species and 1,006 individuals of *Geothelphusa* were recorded. The data include presence, carapace width, carapace length, wet weight, and sex. The stream environmental data include water temperature, pH value, dissolved oxygen, conductivity, and three indicators (River Pollution Index, RPI; Water Quality

Index 7, WQI7; citizen Qualitative Habitat Evaluation Index, cQHEI).

Keywords: Sampling event, occurrence, freshwater crab, *Geothelphusa*, environmental indicator

摘要

此資料集為 2013–2015 年於臺灣 42 處樣點，合計 146 次淡水蟹澤蟹屬物種與溪流環境的調查結果，共發現 12 種 1,006 隻澤蟹。澤蟹的調查項目包括存在與否、背甲寬、背甲長、濕重及性別，溪流環境的調查項目包括水溫、pH 值、溶氧量、導電度與三項溪流環境指標（河川汙染指數 RPI、水質指數 WQI7 及定性棲地評估指數 cQHEI）。

關鍵詞：取樣事件、發現紀錄、淡水蟹、澤蟹、環境指標

Introduction

For decades, there are several indicators developed to evaluate the actual status and trends of freshwater, a vital resource for life on earth, including environmental indicators (Gupta and Gupta 2021, Rankin 1989, Plafkin *et al.* 1989, Uddin *et al.* 2021), biological indicators (Hellawell 1986, Merritt *et al.* 2008), and aggregative indicators (Singh and Saxena 2018).

Freshwater crabs live in rivers, streams, waterfalls, wetlands, karsts, and caves; many are semi-terrestrial. Almost all species require pristine water conditions to survive and are inferred to be excellent indicators of good water quality (Yeo *et al*. 2008, Cumberlidge *et al.* 2009). In addition, *Geothelphusa* species (*Geothelphusa dehaani*) is officially used as the biological indicator of good water quality in Japan (Ministry of the Environment 1985, 1992, 2006, 2022). Nevertheless, only a few studies focus on the relationships between freshwater crabs and freshwater

physicochemical parameters (Fadlaoui *et al*. 2021), and there is no study that has evaluated the relationships between the freshwater crabs and the freshwater quality.

In order to offer more data for studying the relationships between the freshwater crabs and their environments, we collected data on the freshwater crab genus *Geothelphusa* (Decapoda: Potamidae) and their environmental parameters in 42 sampling sites (Fig. 1) from June, 2013, to June, 2015, in Taiwan. We conducted 146 sampling events (Table 1) and recorded 12 *Geothelphusa* species and 1,006 crabs.

Project details

Project title: Constructing monitoring system for the freshwater ecosystem—A study on indicator species of *Geothelphusa*

Funding: Endemic Species Research Institute, Council of Agriculture, Executive Yuan, Taiwan.

Study area descriptions:

Twenty-two sites (52.4%) had been monitored in southern Taiwan in 2011 (Huang and Chen 2014), and 20 more sites were located in eastern and northeastern Taiwan.

Bounding Coordinates: South West [21.959, 120.601], North East [24.751, 121.664]

Taxonomic coverage

General taxonomic coverage description: All the crabs were identified and recorded to species level, but a few individuals labelled as "Geothelphusa" were too small to identify the species. Twelve species and 1,006 individuals of *Geothelphusa* were recorded.

Taxonomic ranks

Species:

Geothelphusa albogilva 黃灰澤蟹 ,

Geothelphusa bicolor 雙色澤蟹 ,

Geothelphusa caesia 藍灰澤蟹 ,

Geothelphusa cinerea 灰甲澤蟹 ,

Geothelphusa ferruginea 銹色澤蟹 ,

Geothelphusa ilan 宜蘭澤蟹 ,

Geothelphusa lili 力里澤蟹 ,

Geothelphusa olea 黃綠澤蟹 ,

Geothelphusa pingtung 屏東澤蟹 ,

Geothelphusa shernshan 神山澤蟹 ,

Geothelphusa tawu 大武澤蟹 ,

Geothelphusa tsayae 蔡氏澤蟹

Temporal coverage: June 14, 2013—June 11, 2015

Methods

Method step description:

The water sampling and the seven parameters required to calculate two water quality indicators, River Pollution Index and Water Quality Index, including pH value, dissolved oxygen (DO), biochemical oxygen demand (BOD5), ammonia nitrogen (NH3-N), suspended solids (SS), fecal coliform (FC), and total phosphorus (TP), were operated following the protocols published by Taiwan Environmental Protection Administration in 2013.

Study extent description:

Freshwater crabs appear in almost all clean freshwater bodies, from moist lowland forests to rugged mountains (Cumberlidge *et al*. 2009). There are 57 recognized *Geothelphusa* species, with 39 species in Taiwan (Shy *et al*. 2021). Over 20 Taiwanese *Geothelphusa* species live in stream ecosystems below 500 m above sea level (Shy and Lee 2009). In this paper, the 42 sampling sites in Taiwan (Fig. 1) were all natural habitats of streams with an elevation distribution of 2-998 m, and 33 sites (78.6%) were below 500 m altitude. The data of the 22 monitoring sites were collected quarterly from the summer of 2013 to the summer of 2015, but some surveys were abandoned due to a lack of water-related data for the drought. The other 20 sites were surveyed only once in the summer and fall of 2014.

Sampling description:

Crab investigation

A complete search of 50 meters

along the stream was conducted at each site. Then, six traps baited with dry pet food (Fig. 2) were set overnight (Chen *et al*. 2003) to collect the *Geothelphusa* crabs. After identifying species and measuring the traits of carapace breadth, carapace length, wet weight, and sex, the captured crabs were released to their native habitats except for those with doubt in species identification needed for confirmation in the laboratory.

Environmental parameters investigation

The water temperature, pH value, dissolved oxygen, and conductivity of the sampling sites were measured by a water quality meter (Horiba U-53) in situ. The water samples used to measure the values of BOD5, NH3-N, SS, FC, and TP were preserved below 4 degrees Celsius and analyzed in the laboratory within seven days from collection. In addition, the score table of cQHEI was also recorded in situ.

The data of BOD5, NH3-N, SS, FC, and TP were used to calculate two water quality indicators: River Pollution Index (Liou *et al*. 2004) and Water Quality Index 7 (Wen 2006). The data of the score table of cQHEI were used to calculate the other environmental indicator: the citizen Qualitative Habitat Evaluation Index (Hoosier Riverwatch 2019).

Datasets

Dataset description

Object name: Darwin Core Archive A dataset of distribution of *Geothelphusa* (Decapoda: Potamidae) with their environmental parameters and stream indicators in Taiwan

Character encoding: UTF-8

Format name: Darwin Core Archive format

Format version: 1.5

Distribution:

https://ipt.taibif.tw/archive.do?r=crab-indicator

https://www.gbif.org/dataset/0528b82f-

bebb-49b0-ad2e-5082ae002823
Publication date of data: 2023-02-06
Language: English
Licenses of use: Creative Commons Attribution (CC-BY) 4.0 License
Metadata language: English
Date of metadata creation: 2022-12-29
Hierarchy level: Dataset

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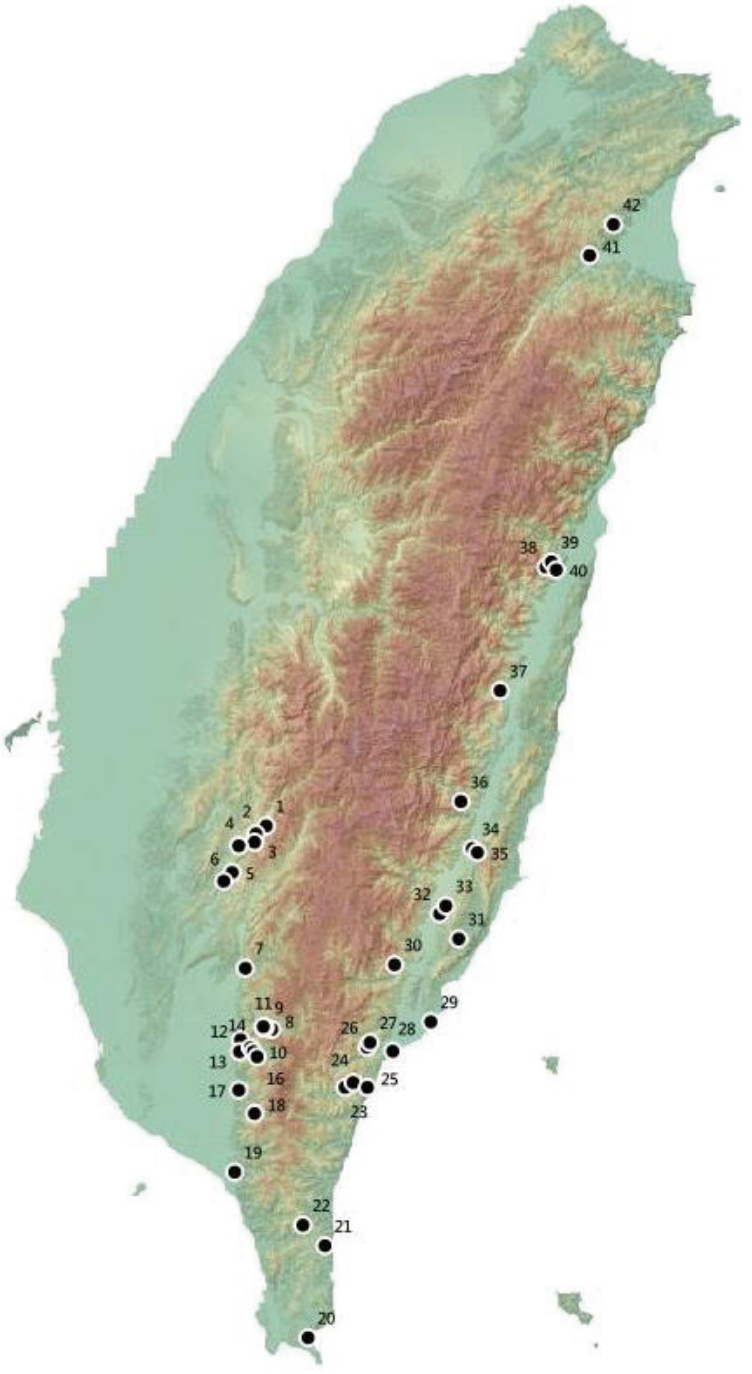

Fig. 1. The distribution of sampling sites. Data on the *Geothelphusa* species and their habitats were collected from 42 sampling sites in eastern and southern Taiwan.

圖 1. 樣點分布位置，澤蟹屬物種與其棲地資料收集自臺灣東部及南部地區 42 處樣點。

Fig. 2. The baited shrimp traps of size 30 cm (length) x 10 cm (diameter).
圖 2. 捕蟹之蝦籠，尺寸為長 30m、直徑 10m，並裝餌料誘捕。

Table 1. The time and frequencies of sampling events at the 42 sampling sites.
表 1. 42 處樣點的取樣時間與次數。

Survey Time		Sampling Sites																																							
Year	Season	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
2013	2																																									
	3																																									
	4																																									
2014	1																																									
	2																																									
	3																																									
	4																																									
2015	1																																									
	2																																									
Sampling Events		5	5	6	4	7	7	4	5	2	7	6	6	6	6	7	7	7	2	4	6	8	9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Notes on the nesting records of the Taiwan Partridge *Arborophila crudigularis*

臺灣山鷓鴣鳥巢繁殖紀錄

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Abstract

The nesting and breeding behavior of the Taiwan Partridge (*Arborophila crudigularis*), an endemic species in Taiwan, is rarely reported. However, in 2001, 2005, and 2006, three nests were discovered in Huben Village, Yunlin County. These nests were found at the base of trees or bamboo in the dry creek valley, and were constructed using fallen leaves and fine twigs. The clutch size of the Taiwan Partridge was three to four eggs. In 2006, the nesting behavior of this species was observed and recorded by video. The incubation period was 24-26 days, and the average time that the parent spent sitting on the nest was 20.8 hrs, with a range of 18.4 to 24.8 hrs. The nesting adult usually left the nest only once in the early morning, during which time it picked up dead leaves and twigs in front of the nest with its bill and threw them back over the nest. The

newly hatched chicks (Day 0-1) left the nest with their parental bird, and did not return after Day 1 or Day 2.

摘要

臺灣特有種鳥類臺灣山鷓鴣 (*Arborophila crudigularis*) 的鳥巢及繁殖行為甚少報導，為補足其基礎繁殖行為資訊，本文提供 2001、2005 及 2006 年於雲林縣湖本村發現的 3 個繁殖紀錄。發現臺灣山鷓鴣於乾溪谷的樹木基部，以落葉與細樹枝築巢，每窩蛋數為 3-4 顆蛋。2006 年發現的巢，以錄影方式記錄，發現其孵蛋期為 24-26 天，親鳥平均每日孵蛋時數 20.8 小時（18.4-24.8 小時），坐巢親鳥通常僅於清晨離開鳥巢 1 次，並在離巢前啄起巢前的枯枝落葉覆蓋鳥巢。幼鳥孵化後於 0 或 1 日齡即可隨親鳥離巢活動，1 或 2 日齡時不再回巢。

Key words: Altricial bird, breeding behavior, clutch size, incubation period
關鍵詞：早熟鳥、繁殖行為、窩卵數、孵蛋期

The Taiwan Partridge (*Arborophila crudigularis*) is an endemic bird species widespread in the mountainous regions of Taiwan at elevations below 2,300m (Severinghaus et al. 2012; Luo 2000). Its population trend was considered to be declining due to deforestation and land use conversion two decades ago (Fan 2005). However, recent monitoring data show its population stable between 2011 and 2021 (Fan et al. 2022). Therefore, its conservation status is currently cataloged as the Least Concern by the Taiwan government and IUCN (BirdLife International 2016; Lin et al. 2016).

Despite the wide distribution of the Taiwan Partridge across Taiwan Island, there is a lack of up-to-date documentation of its life history and nesting behavior in field and captivity

settings (Cheng et al. 1978; Sun 2001; Madge et al. 2002). In 2001, 2005, and 2006, we had the opportunity to observe three nests in Huben Village, located in central Taiwan. In particular, we recorded the nesting behavior of the parent bird in detail using videography for the last nest. In this paper, we aim to compile and present the gathered information to further our understanding of the life history characteristics of the Taiwan Partridge.

Huben Village is located in Linnei Township in the northeastern region of Yunlin County in west-central Taiwan (120˚37.1'E, 23˚44.5'N). The hills around the village, as well as the neighboring hills inside Linnei Township and adjacent Douliu City, have been designated as an Important Bird Area (IBA: TW-017), particularly for the Fairy Pitta (*Pitta nympha*), by the Chinese Wild Bird Federation in partnership with BirdLife International (Taiwan Wild Bird Federation 2001). The area is approximately 2,200 ha, between 50m and 500m in elevation, and covered with Taiwanese Giant Bamboo (*Dentrocalamus latiflorus*) stands mixed with natural broad-leaved trees and sparsely distributed orchards and betel nut plantations. The climate is hot and wet from April to October, with a total precipitation of 2,000mm. In contrast, the climate is cool and dry from December to February, with a precipitation of less than 500mm (Taiwan Wild Bird Federation 2001). The Taiwan Partridge is a shy and elusive bird and can be challenging to observe. However, its call can often be heard in hilly areas that are well-forested with broad-leafed trees (Luo 2000; Sun 2001).

A local bird guide named Mr. Jing-Kai Chang discovered a Taiwan Partridge nest on the morning of 6 May 2006. At the time of discovery, there was no adult bird present, but an unmarked white egg was visible. Three days later, on 9 May at 15:00, we rechecked the nest and

found an adult Taiwan Partridge inside. The basal platform nest was constructed of dead leaves and twigs, resembling a pile of twigs and leaves. It was a flattish dome with a small, nearly round-shaped opening with an inner diameter of about 7cm (Figure 1).

The nest was located against a root growing out from the base of a broad-leaf tree (*Ficus fistulosa*) near the ridge of a hill in a narrow valley at an elevation of approximately 190m. The nest was on the foot of a gentle slope beside a dried ditch with a steep bank 0.9m high and 1.8m wide (Figure 2). There was a walking track 25m below the nest. The valley was mostly covered by broad-leafed trees, while a Taiwanese Giant Bamboo plantation covered the lower sides of the track and the slope below.

To record the nesting behavior of the Taiwan Partridge, we monitored the nest (Martin et al. 1997) and utilized a digital video camera system to monitor the nest for seven days and 20.5 hrs, starting from 15:02 on 28 May 2006 to 11:29 on 5 June 2006. The system consisted of a 12mm camera set in a 56×56×76mm waterproof box on a tripod positioned 1.5m from the nest. Equipped with 24 infrared emitting diodes (950 nm), recording resolution 720×484, and a digital recorder (EDSR400H, EverFocus Electronics Corporation, Hsi-Chih, Taipei, Taiwan), the camera was connected to the recorder which was located 20m away using a 50m cable. We recorded video images five times per second, and a 250-GB hard disk was sufficient to store the recordings for 24hrs a day for 14 days. The equipment was powered by three rechargeable, 12-volt, deep-cycle batteries, and a hand-held color monitor allowed us to check the status of the nest without disturbing it. We checked and replaced the recorder's batteries every other day.

We inspected the nest on the morning of 1 June 2006 when the parent bird had left. We discovered four

unmarked white eggs in the nest (Figure 3). Three chicks hatched in the presence of the adult at 08:26 on the morning of 4 June. We presumed the female completed laying her clutch on the morning of 9 May 2006. The incubation period lasted at least 24 days up to 1 June 2006 and no more than 26 full days to the morning of 4 June 2006. During the period from 28 May until hatching, the parent bird left the nest eight times. This happened almost once a day during the morning between 06:57 and 09:24, with the exception of June 1 when the parent left twice, once at 09:24 in the morning and again at 12:55 in the afternoon. The mean duration of the parent bird sitting on the nest was 20.8 hrs with a range of 18.4 to 24.8 hrs, with the exception of the two instances on 1 June when the parent left the nest for only 1.3 hrs (Table 1).

Before leaving the nest, the parent bird heaved it a few times and then pushed itself out of the top opening in just a few seconds. It immediately used its bill to pick up dead leaves and twigs in front of the nest, throwing them back over the nest. It took the parent 4.5 ± 3.2 min (mean ±standard variation, n = 8) with a range between 0.27 min and 9.77 min to complete the above-mentioned task. Afterward, the parent left the nest in the same direction every day. Reentry to the nest was much quicker than leaving, taking less than a half minute. The parent left a small and poorly defined opening when reentering the nest.

When the three newly hatched chicks left the nest on the morning of 4 June 2006 (Day 0-1), the parental behavior remained consistent with previous days. The parents spent 2.5 minutes tending to the nest before leading the chicks out and returned to the nest at 16:51 later that day. However, on the following morning of 5 June 2006 (Day 1-2), they left the nest at 06:00 and did not return.

We also recorded the clutch sizes

and habitats of two other Taiwan Partridge nests in Huben Village before 2006. In the first nest, we observed three eggs on 15 April 2001, and three chicks hatched on 27 April 2001. The second nest had four eggs and was discovered in June 2005, but a parent was found dead near the opening of the nest. Both nests were located in habitats that were fairly similar to that described in 2006, but with certain disparities. They were found in a small valley covered by a canopy dominated by broad-leafed trees. The nest found in 2001 was located on a small platform along a steep slope about 1.5m above the base of the valley, while the nest found in 2005 was at the base of a Thorny Bamboo (*Bambusa stenostachya*) clump.

In this study, we measured the sizes of four eggs from the two nests observed in 2001 and 2006 (Table 2). We found that the size and weight of the eggs were similar to those reported in captive records (length: 38.78mm, width: 29.67mm, weight: 18.08g) (Huang et al. 2001). However, because eggs lost mass during incubation and were not weighed at the beginning of incubation, their weights are likely to be underestimated (Westerskov 1950, Drent 1973).

Cheng et al. (1978) state that the breeding season of the Taiwan Partridge is from late-February to August, nesting near the base of a tree or in crevices among boulders, with a clutch size of six to eight eggs and an incubation period of 24 days. However, we were unable to verify the source of their data. In captivity, the clutch size is two to three eggs and the incubation period is about 23 days (Huang et al. 2001). However, another captive record indicated a clutch size of four to six eggs and an incubation period of 20 to 21 days (Madge et al. 2002). Our field observations showed that the Taiwan Partridge laid three to four eggs per clutch and had an incubation period of 24-26 days, somewhat different from previous

descriptions. Our current understanding of the nesting behavior and life history traits of the Taiwan Partridge are limited to anecdotal accounts. We hope that the results of our study will serve as a starting point for future investigations into the nesting behavior of the Taiwan Partridge.

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Table 1. Nest exiting and entering times (hour:min:sec) of the adult Taiwan Partridge from 29 May to 5 June 2006

Entering	Exiting	Duration	Leaving Time
29 May, 13:57:40	30 May, 08:48:40	18:51:00	3:23:53
30 May, 12:12:33	31 May, 06:56:53	18:44:20	1:38:44
31 May, 08:35:37	1 June, 09:23:56	24:48:19	2:14:55
1 June,11:38:51	1 June, 12:55:10	01:16:19	0:05:06
1 June, 13:00:16	2 June, 07:21:32	18:21:16	3:34:41
2 June, 10:56:13	3 June, 09:00:30	22:04:17	1:49:47
3 June, 10:50:17	4 June, 08:26:39	21:36:22	8:22:47
4 June, 16:49:26	5 June, 06:00:19	13:10:53	-

Table2. Egg measurements (mean and ranges in parentheses) of the Taiwan Partridge

	N	Length (mm)	Width (mm)	Weight (g)
2001	3	40.9(39.5-41.8)	29.5(28.8-30)	19.2(18-20)
2006	1	40.4	31.1	18.8

Fig. 1. Nest of Taiwan Partridge nest in its early hatching period found in Huben Village, Taiwan, 9 May 2006.

Fig. 3. Four unmark white eggs in the Taiwan Partridge nest taken on 1 June 2006, in Huben, Taiwan.

Fig.2. Nesting environment of the Taiwan Partridge found in Huben, Taiwan, 2006. The red circle indicates the exact nest location.

「台灣生物多樣性研究」稿約

壹、一般說明

一、《台灣生物多樣性研究》為農業部生物多樣性研究所出版之學術期刊，歡迎國內外學者發表有關生物多樣性或自然保育之學術論文與有關物種出現資料之資料論文，但以未曾在其他刊物發表之原創研究及資料為限。

二、本刊為網路期刊，隨時接受投稿，並於每年 1 月、4 月、7 月及 10 月在中心網站 (https://www.tbri.gov.tw/A15_2/content/31503) 刊登發行。

三、撰稿中、英文均可，來稿以完整微軟 WORD 格式文稿電子檔傳送至「台灣生物多樣性研究」期刊編輯委員會電子信箱 (email: tjbd@tbri.gov.tw)。

四、經本刊接受刊登之稿件，投稿著作所有列名作者皆同意授權本刊單位以非專屬授權之方式再授權，並得為重製、八開傳輸、授權用戶下載、列印等行為。為符合資料庫之需求，並得進行格式之變更。

五、稿件無稿酬，但經刊登之文稿將提供 PDF 檔給作者，不另贈送抽印本。

六、來稿由本刊送請相關學者專家審查、簽註意見或修改，如需修改者再送請作者自行補充修正，作者應於收稿 2 週內完成修正，如於收稿 2 個月後仍未將修正稿件寄回者，視同放棄投稿。稿件付印前作者應負責校對。

七、通訊作者需在期刊出版前簽署文稿版權轉移同意書給期刊編輯室。

貳、文稿章節順序

一、學術論文部份

依照 1. 題目，2. 作者姓名、服務單位、地址，3. 通訊作者之 e-mail，4. 摘要，5. 關鍵詞，6. 緒言，7. 材料與方法，8. 結果與討論 (可分列)，9. 結論 (可省略)，10. 謝誌 (可省略)，11. 引用文獻等順序撰寫；其中 1 至 5 項請中英文並列，本文為中文撰寫者，依先中文後英文順序；本文為英文撰寫者，則先英文後中文。文章若屬於研究短報 (Note) 者可不分章節。

二、資料論文部份

依照 1. 題目，2. 作者姓名、服務單位、地址，3. 通訊作者之 e-mail，4. 摘要，5. 關鍵詞，6. 物種出現資料之資料集 (Dataset) 與詮釋資料 (Metadata) 連結網址，請依據國際共通之達爾文核心集 (Darwin Core, DwC) 及生態詮釋資料語言 (Ecological Metadata Language, EML) 格式，儲存於廣用並長存之網路八開空間，如全球生物多樣性資訊機構 (GBIF)。有關資料集，作者應確保其正確性及所有權，並使讀者可讀與清楚瞭解，如有任何異常值或缺少值，應特別標示；

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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.

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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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   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.

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   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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