圈飼台灣黑熊之繁殖性狀

Reproduction Behavior and Characters of the Formosan Black Bear in Captivity

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摘要

本試驗利用二雄二雌圈飼之台灣黑熊(*Ursus thibetanus formosanus* Swinhoe)觀察其發情、交配、攝食、體重、生產前後的狀況及行爲，並檢測類固醇性荷爾蒙的變化以探討其繁殖性狀。雌熊1號與雄熊1號在2000年交配後並未懷孕，但交配後雌熊之攝食量及體重均增加，另以酵素免疫分析法 (enzyme immunoassay，EIA) 檢測其糞孕酮 (fecal progesterone)發現於交配後約5個月明顯上昇；雌熊2號與雄熊2號在2001年交配後懷孕生產，交配後雌熊之攝食量與體重亦均增加，其糞孕酮亦於交配後約6個月明顯上昇；雌熊1號與雄熊2號在2001年亦曾合欄飼養但未有交配行爲，雌熊之攝食、體重、糞孕酮則無明顯變化。由有交配行爲才會引起攝食、體重及糞孕酮的變化，認爲台灣黑熊屬誘發排卵 (induced ovulation)，且交配後會有假懷孕 (pseudopregnancy)現象。交配懷孕者在5–6個月之後糞孕酮才上昇，在此5–6個月期間，推測是胚胎停滯發育而延遲著床 (delayed implantation)，著床同時糞孕酮昇高，並於著床後約2個月後生產，總懷孕期7個月半。假懷孕與眞懷孕的糞孕酮濃度均會明顯變化，故認爲糞孕酮無法單獨作爲診斷懷孕與否的依據。懷孕雌熊的外表特徵在產前一個月攝食量劇減、行動較緩慢、反應較遲鈍、多蜷縮於窩巢、舔自身乳房及產前一週完全拒食。產後約20多天不吃、不喝、不排糞、不排尿，與冬眠熊隻的生理性狀相似，以自身儲存的能量轉換爲乳汁育幼。

Abstract

Two male and two female Formosan black bears (*Ursus thibetanus formosanus* Swinhoe) in captivity were paired to study their reproductive behavior and characters from April 2000 to March 2002. After being paired, three reproductive conditions of the females were obtained. They were a pregnant female, a pseudopregnant female, and an unmated female. For both pregnant and pseudopregnant females, the food intake and body weight increased after mating, and its fecal progesterone contents rapidly elevated five to six months later. Also, the blood progesterone contents of the pregnant female changed with the fecal progesterone contents. For the unmated female there was no change in food intake, body weight and fecal progesterone content. The increases in food intake and body weight for both pregnant and pseudopregnant females suggested that ovulation of the female Taiwan black bear was induced by act of copulation, the so-called induced ovulation. The occurrence of rapid elevation of the progesterone contents 5-6 months later after mating suggested that there was a delayed embryo implantation. The gestation period was seven and half months. The parturition occurred two months after the elevation of progesterone. The pregnant female decreased food intake a month prior to the parturition, and was in fasting condition without intake of food, urination and defecation for about a week prior to and three weeks after the parturition. Because the elevation of fecal progesterone occurred in both pregnant and pseudopregnant females, a measurement of fecal progesterone content is useless for diagnosis of the pregnancy. About a month long fasting of the female Formosan black bear, which does not hibernate in the subtropical region in this study is fairly similar to the case reported for black bears which hibernate in the cold climatic region.

關鍵詞：台灣黑熊、繁殖行爲、假懷孕、延遲著床、糞孕酮

Key words: *Ursus thibetanus formosanus*, reproductive behavior, pseudopregnancy, delayed implantation, fecal progesterone

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緒 言

溫帶地區之美洲黑熊 (*Ursus americanus* Pallas) 具冬眠現象，其發情交配期約在 5−7月之間，都有延遲著床現象，胚胎發育期約6−10週，大多在冬天(1−2月)生產，總懷孕期6.5−8個月不等 (Wimsatt 1963; Foresman and Daniel 1983; Seager and Demorest 1986; Flowerdew 1987; Domico and Newman 1988; Hunt and León 1995)。亞洲黑熊 (*Ursus thibetanus* Cuvier) 的發情交配期與美洲黑熊大致相似，約在5−8月之間，懷孕期約5.5−8個月，於12-3月間生產 (高等 1987；楊等 1991；苟 1991；孔等 1998；Wang 1998)，唯有Domico and Newman (1988) 稱亞洲黑熊發情交配期約在3-12月之間，時間範圍較廣，另Seager and Demorest (1986) 則稱亞洲黑熊無延遲著床現象。台灣黑熊屬亞洲黑熊的亞

種，並無冬眠情形 (王及黃 1999, 2000)，其發情交配期如何、有否假懷孕、延遲著床現象及懷孕期多久等均未有懷孕生產且育成的正式報告，原因是台灣黑熊野外數量不多且分布在高山地區，地形地勢複雜，難以追蹤監測。因此，爲瞭解台灣黑熊的繁殖性狀，先由圈養的熊隻進行試驗，以期所獲得之基本資料可供保育經營管理之參考。

材料與方法

供試之黑熊4隻，截至2000年爲止，雌熊1號約8歲，體重約110 kg，右後腳截肢，於1994年3月送至台灣省特有生物研究保育中心(現爲行政院農業委員會特有生物研究保育中心，以下簡稱本中心)；雄熊1號年齡不詳，體重約145 kg，於1999年8月至2000年10月間借自壽山動物園而後送還；雄熊2號及雌熊2號年齡分別約爲13歲及9歲，體重約 120 kg及100 kg，由桃園縣大溪鎮吳俊明先生所圈養，於2001年4月及6月捐送至本中心迄今，在大溪飼養期間雄及雌分別爲13年及4年。

試驗熊隻的配對方式：(一) 雌熊1號與雄熊1號，於2000年4月間合欄飼養，發現有數次交配行爲後約一週將其分開，合欄爲期約1.5個月。(二) 雌熊2號與雄熊2號，原於大溪飼養時大多合欄飼養，於2001年3月底發現有交配行爲，之後不到二週將雄熊於次月(4月)上旬送至本中心。(三)雄熊2號與前一年交配未孕之雌熊1號於2001年4月下旬至9月間合欄約4.5個月，始終未見交配行爲。

試驗熊隻之給飼量參考楊等(2001)以雌熊1號實際攝食的經驗以乾物量1.0-1.1 kg/100 kg體重爲原則，每日記錄雌熊攝食量，並於交配後視其食慾狀況限飼性地酌增給飼量並每月至少記錄一次體重的變化。

糞孕酮的檢測，每週以非侵入法(non-invasion)採取雌熊之糞便2−3次，在生產前後未進食而無排糞時未強行侵入採取，收集後先置於-20℃待整批處理。處理時取糞材1g加入3 ml分析緩衝液，震盪混合10 min，100℃加熱10 min，再震盪混合20 min，以3,500 rpm離心30 min後抽取上清液，再參考陳(1994)的模式以酵素免疫分析法分析糞孕酮濃度，使用之抗體及酵素免疫結合體取自中興大學獸醫學系生理實驗室，標準液爲購得 (Sigma，編號P9776)，清洗微滴盤是用「anthos fluido」(version 1.3，Austria 製)，微滴盤酵素免疫分析儀是「anthos 2001」(軟體是WinRead version 2.3 for 2010，Austria 製)。

檢測所得之糞孕酮含量，每週平均繪製成散布圖，並以三週平均繪出移動趨勢線，以明瞭其變化的趨勢。

雌熊2號發現於2001年3月底有交配行爲之後，4-9月間及翌年1月每月將其麻醉後取頸靜脈血100 ml，經3,000 rpm、10 min離心採取血清置於-20℃待檢，以酵素免疫分析法檢測血清中助孕素 (serum progesterone) 的變化，其中因2001年10月接近預產期、11月初生產、12月育幼期，爲防藥物麻醉而影響到胎兒、生產或育幼，故此期間未麻醉採血分析。

觀察發情、交配、繁殖及育幼行爲，於圈養黑熊的籠舍設置監視器24小時錄影觀測，並輔以目視及監聽方式觀測發情、交配、繁殖及育幼等行爲。

結果

交配行爲：(一)雌熊1號與雄熊1號合欄約1.5個月期間，於2000年5月底由監視器的錄影帶發現總共約有5−6次交配行爲，雄熊由後面以前臂抱住雌熊腰部，並以口咬住雌熊後頸加以固定，每次5−30秒不等，其發生均在清晨或傍晚。交配後的二、三個月之間，母熊外陰部有紅腫現象，至第四個月之後逐漸

縮小恢復原狀。(二) 雄熊2號與雌熊2號於2001年3月底目睹交配3次，每次10−20 min不等，交配後雌熊外陰部等未見外觀上的變化。(三) 雌熊1號與雄熊2號，雄熊即一直不敢接近雌熊，於2001年4月下旬至9月間合欄共約4.5個月但並無交配行爲。

交配後雌熊之攝食及增重變化：(一)雌熊1號其給飼量、攝取量及體重變化情形如圖1。於2000年5月底有交配行爲之後，於8月間原來有時會剩餘少量食物情形均未再剩餘，

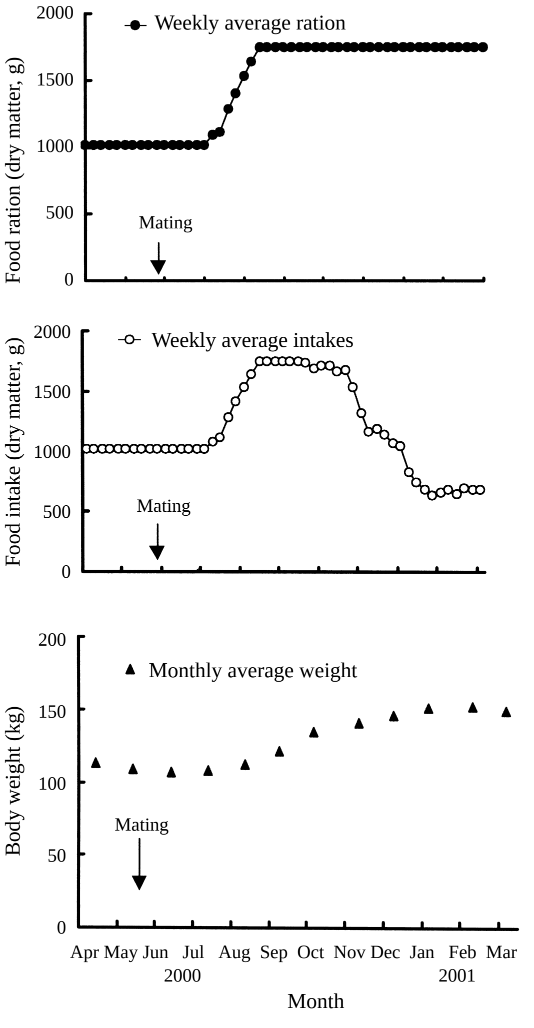

圖1. 雌熊1號於2000年5月底交配後呈現假懷孕現象，其在2000年4月至2001年3月間平均每週給飼量、攝食量及平均每月體重的變化。

Fig. 1. Changes in weekly average food rations, food intakes and monthly average body weights from April 2000 to March 2001 for the pseudopregnant female 1 mated in late May 2000.

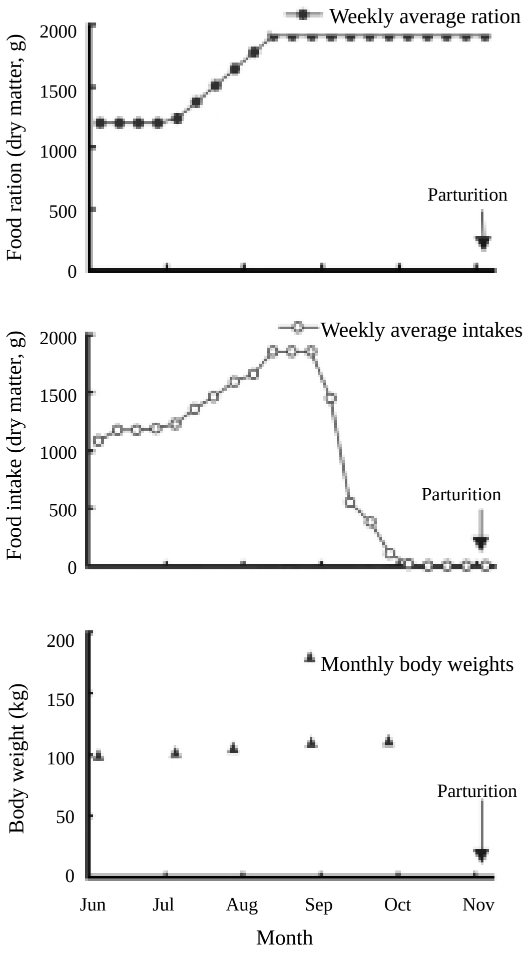

圖2. 雌熊2號於2001年3月間交配後懷孕並於11月4日生產，其每週平均給飼量、攝食量及每月平均體重的變化。

Fig. 2. Changes in weekly average food rations, food intakes and in monthly body weights from June to November 2001 for the pregnant female 2 mated in March and parturition on 4 November, 2001.

且常在欄杆旁徘徊，尤其會跟隨著人員在欄杆旁走動，似在期盼給飼而顯示食慾增加的情況，故給飼量以人爲的限飼約每隔一週分別增加原有的10%、20%、30%、40%、50%至60%，均將食物全部吃完，攝食量明顯增加，此後給飼量維持增給60%，至11月後攝食量逐漸減少，最後其攝食量維持在未交配前給飼量的70−80%之間；增重則在增加給飼量之後逐漸上升，由原來未交配前112 kg增加到146 kg，約增加30%。(二)雌熊2號其給飼、攝食及體重變化的情形如圖2，於2001年3月底有交配行爲之後，於7、8月之間亦顯示食慾增加現象，故而約每隔一週比照雌熊1號的方式逐漸增加給飼量，增給的飼料也幾乎全部吃完；增重由100 kg增至112 kg，約增加10%。(三)雌雄1號於2001年間雖與雄熊2號合欄，但未有交配行爲且無食慾增加現象，故給飼量未增加，攝食及體重均無明顯變化。

類固醇性荷爾蒙的變化：糞孕酮部分，(一)雌熊1號與雄熊1號有交配行爲，其糞孕酮濃度的變化如圖3，在2000年1−5月未交配前濃度在8.0−100.9 ng/g之間，5月底交配後，6−11月約5個月期間上下起伏略爲增加，10月底後開始明顯漸增，至12月中旬呈現高峰濃度高達 642.9 ng/g後下降，並未產仔。雌熊1號翌年另與雄熊2號無交配行爲之糞孕酮情形如圖4，結果並無明顯的變化。(二)雌熊2號與雄熊2號有交配行爲且產仔，其糞孕酮2001年4月−2002年3月間的變化如圖5，顯示在2001年3月交配後約6個月之間變化少，至10月中旬則明顯上昇，翌年1月之後又降下，其中斷線部分爲該期間未排糞而無資料可分析；血清中助孕素部分，雌熊2號血清中的助孕素含量變化如圖6，於2001年3月底交配後4−8月之5個月期間含量均在3 ng/ml以下，至接近生產(11月初)之9月則上昇至7 ng/ml，產後的2002年1月則降至微量。

產前約一個月，每天有數次短暫舔自身乳房的行爲，產前一週，舔食自身乳房的時間更長，約達10多分鐘。產後第22天才離巢喝水，之後約每隔一週才再喝水一次，第44天才開始少量進食，第47天才排尿，第55天才排糞。

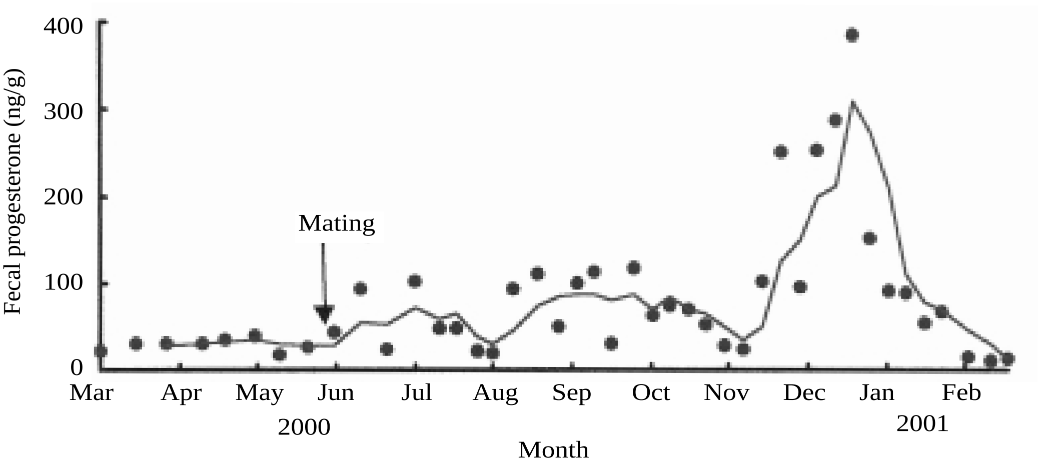

圖3. 雌熊1號假懷孕時自2000年至2001年糞孕酮每週平均濃度及三週平均移動趨勢。

Fig. 3. Changes in weekly average fecal progesterone contents (solid cicles) and 3-week moving averages (solid line) from March 2000 to February 2001 for the pseudopregnant female 1 mated on 25-26 May 2000.

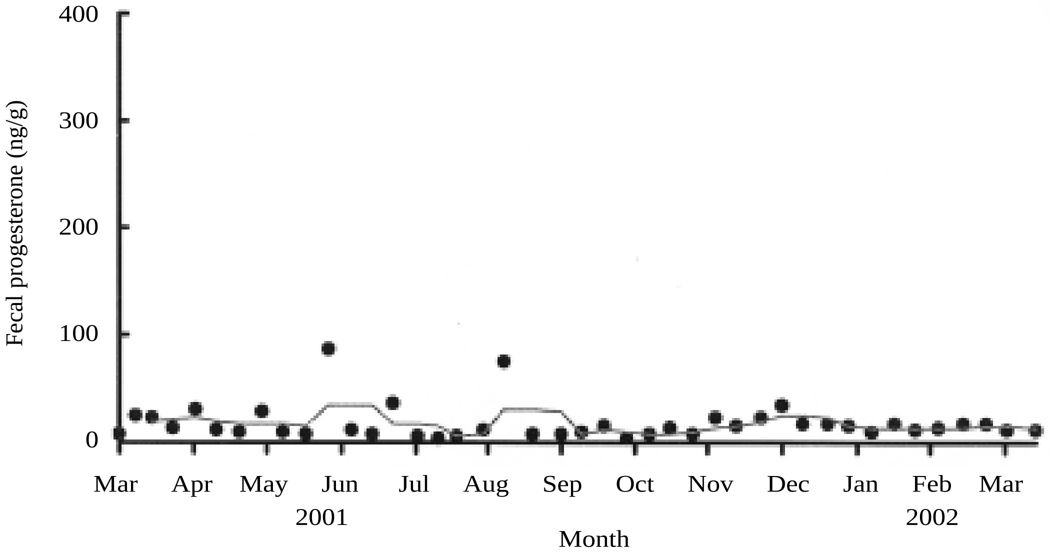

圖4. 雌熊1號未交配之糞孕酮每週平均濃度及三週平均移動趨勢。

Fig. 4. Changes in weekly average fecal progesterone contents (solid circles) and 3-week moving averages (solid line) from March 2001 to March 2002 for the female 1 failed to mate.

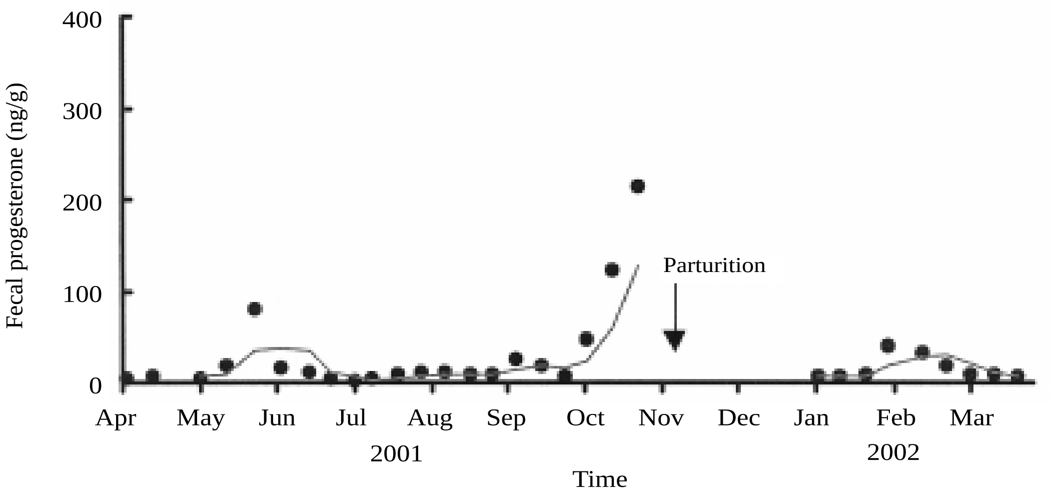

圖5. 雌熊2號懷孕生產之平均每週糞孕酮自2001年4月至2002年3月的變化。

Fig. 5. Changes in weekly average fecal progesterone contents (solid circles) from April 2001 to March 2002 for the pregnant female 2 (solid line, 20-day (3 mesurments)moving averages) .

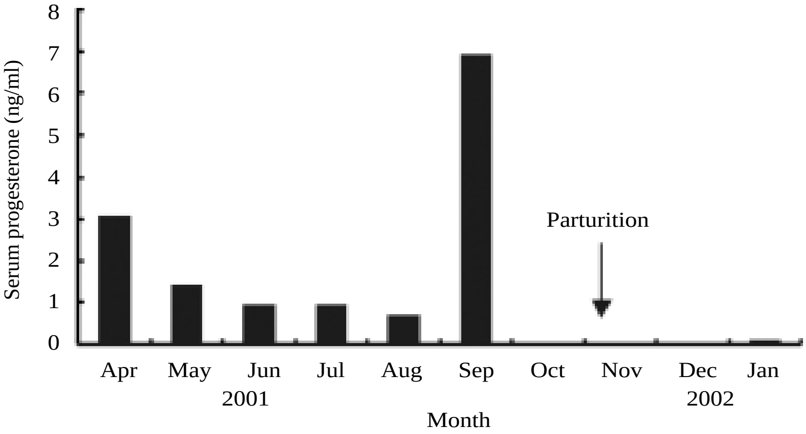

圖6. 雌熊2號交配後懷孕生產之血清中助孕素2001年4月至2002年1月的變化。

Fig. 6. Monthly concentration of serum progesterone for the pregnant female 2 from April 2001 to January 2002.

討論

雌熊1號與雄熊1號二者雖交配多次，但每次時間短僅5–30秒不等，因監視器錄影只看到架乘，推測雌熊陰道有受到刺激，此種陰道受刺激是產生假懷孕的起因 (McDonald 1980)。另Hellgren *et al*. (1991) 認爲熊隻會有假懷孕、著床失敗、胚胎重吸收現象，其中著床失敗及胚胎重吸收與環境干擾或黃體異常及營養不良有關，但本試驗的飼養管理情形尚佳，故認爲雌熊1號2000年交配後未孕是假懷孕可能性較高；雌熊2號與雄熊2號的交配在二天內目睹三次，實際總交配數未知，但交配時間比前述一對較長，多達約10–20 min，交配可能要多達類此時間以上才算成功且較有受胎的可能，因孔等 (1998) 報告稱黑熊一次交配時間約5–30 min，射精一次約1–3 min，故僅架乘數十秒可能未達射精的程度；雌熊1號與雄熊2號在2001年合欄長達4.5個月期間一直無交配行爲，未交配的原因是否爲雌熊對雄熊具選擇性並不確知。

雌熊1號在2000年與雌熊2號在2001年攝食及增重的情形大致相似，不同的是未生產雌熊1號(如圖1)的攝食量增加二個月之後，其減少的趨勢上下起伏不定且緩慢，最後亦未完全拒食，而懷孕產仔之雌熊2號(如圖2)攝食量減少的速度迅速，且至產前一週完全拒食。一般熊隻冬眠前體重約增加30–35% (Hissa 1997)，但本試驗熊隻並無冬眠現象，未懷孕生產之雌熊1號增加攝食及體重的情形，可能就是假懷孕現象。其因是假懷孕時助孕素分泌增多，其可增加攝食量、促進食物利用效率、活動降低、能量流失減少而滯留水份及蓄積脂肪 (Gelletti and Klopper 1964; Hervey and Hervey 1967; Jankowiak and Stern 1974; Cooper and Linnoila 1976; Bourne and Read 1982)或增加非脂類乾物重 (Bourne and Read 1982) 或增加瘦肉 (Hervey and Hervey 1967)。本試驗熊隻只要有交配行爲，不管眞懷孕或假懷孕，其攝食、增重及糞孕酮均有上昇現象，助孕素可能是直接影響攝食及增重的主要因素，其調整攝食及增重的機制是經由腦部下視丘(hypothalamus) 所控制 (Cooper and Linnoila 1976; Bourne and Read 1982)。

黑熊究竟是誘發排卵或自發排卵

(spontaneous ovulation) 有不同的報告，由血液中類固醇性荷爾蒙的變化 (Palmer *et al*. 1988) 及由解剖學的觀點 (Erickson *et al*. 1964) 均認爲是誘發排卵，Wimsatt (1963) 也有相同的推測。Tsubota *et al*. (1987) 則報告1隻未孕雌熊(未交配) 與4隻懷孕的圈養棕熊之血液中助孕素的變化相似，而推測於適當季節黃體會自發形成，是屬自發性排卵，後來Tsubota *et al*. (1998) 從一些研究報告所作的推測，認爲黑熊是否爲自發排卵未能十分確定。本試驗由有交配行爲之雌熊才顯示糞孕酮上昇的現象，未有交配行爲者則無此現象，推測台灣黑熊係屬誘發排卵。另以雌熊1號有交配行爲之攝食及體重增加的情形判斷，有交配未產仔者的各種變化跡象是假懷孕現象，其發生的期程與眞懷孕相似。

由圖3與圖5兩者均在交配後約5–6個月糞孕酮未見明顯上昇，這段期間認爲是交配後排卵且黃體形成，但黃體在初期功能尚未發揮，也因此推測這段期間胚胎未著床，故認爲台灣黑熊有延遲著床現象，此與Mead (1989) 稱所有熊類均會有延遲著床的看法一致。圖3與圖5不同之處是未產仔之雌熊1號在初期5–6個月之間移動平均趨勢線呈現波動狀態，而交配後產仔之雌熊2號的趨勢較爲穩定，原因可能是未眞正受孕者黃體的活動未完全靜止，而受孕者黃體幾乎呈現暫時的靜止狀態。交配5–6個月之後，糞孕酮急速昇高，Sato *et al*. (2000) 稱助孕素昇高是在胚胎著床之前，也反應了黃體復活，著床後胚胎發育期約2個月。

有多人研究糞孕酮的變化與血液中助孕素的變化一致 (Desaulniers *et al*. 1989; Hirata and Mori 1995)，或呈顯著相關 (Shideler *et al*. 1993)，相關性甚且高達0.81 (Wasser *et al*. 1996)。Wu *et al*. (1996) 回顧多人的文獻報告，由各種動物靜脈注射助孕素後可從糞便中回收約32–76.6%。但由血液採樣會影響荷爾蒙的分泌，拘捕緊迫會使助孕素升高 (Wesson *et al*. 1979)，麻醉反使之降低 (Plotka *et al*. 1983)。大部分確認熊隻懷孕的研究以檢測血液中助孕素的變化爲主，唯所得的結果不一，有認爲其濃度在懷孕與未懷孕之間不同 (Foresman and Daniel 1983; Tsubota *et al*. 1992)，亦有認爲相同者 (Tsubota *et al*. 1987)。產仔之雌熊2號血清中的助孕素含量(圖6)，變化趨勢與糞孕酮相類似(圖5)，即在產前二個月胚胎著床時 (9及10月) 急速上昇。張等 (1994) 以糞孕酮比較台灣黑熊有交配未產仔及疑似交配(未直接觀察到)者比未交配者有較高的情形，並藉此推測其誘發排卵及延遲著床的生殖現象，本試驗以糞孕酮比較熊隻交配後產仔、未產仔及未交配所產生的變化，加上血清測得助孕素的變化，更能確認台灣黑熊誘發排卵與延遲著床的可能性。本研究亦發現經交配之刺激而產生假懷孕時，糞孕酮有升高的現象，因此糞孕酮不適合單獨作爲診斷懷孕與否的依據。

懷孕產仔之雌熊2號在產前舔乳房行爲之次數少、時間短，後期次數漸多、時間增長，與糞孕酮(圖5)由少漸增的趨勢一致，因此推測舔食的行爲與黃體分泌助孕素增加，併同其他內泌素(如泌乳素)之作用，促使乳房發育而產生乳脹所引起。

本試驗產仔之雌熊2號是在3月底交配、11月初生產，總懷孕期爲7.5個月。其交配期在3月間發生的狀況，顯示位處於緯度較低之台灣，其交配期間與Domico and Newman (1988) 報告亞洲黑熊發情交配期約在3–12月之間的情形相符。Garshelis and Hellgren (1994) 由公熊睪固酮檢測結果，棲息於緯度愈低者 (36°N) 比緯度高者 (47°N) 繁殖期間較長，台灣位處緯度更低 (22-25°N)，比緯度高者 (47°N) 繁殖期間較長，故繁殖較提早於3月間即可交配，交配的適期也可能更延後。

溫帶地區黑熊產仔都在冬眠期間，熊隻

冬眠約3－5個月的時間均不吃喝、不排糞尿 (Nelson 1973; Lundberg *et al*. 1976; Nelson 1980; Nelson *et al*. 1984; Hellgren *et al*. 1990)，產仔時生理狀況與冬眠相似，同時以自己儲存的能量育幼 (Hock 1960; Nelson *et al*. 1973)。本試驗熊隻無冬眠現象，在產前及產後亦在似洞穴狀的窩巢呈類似休眠狀態，同樣有一段時間不吃、不喝、不排糞、不排尿的情況，只是時間長短不同。不排尿的原因認爲是因爲沒有蛋白質代謝產物需藉由尿排出 (Nelson *et al*. 1973)。此不吃不喝期間雌熊體內蛋白質的轉換速率增加3－5倍而有熱生成 (heat production)，而額外增熱得以維持體溫 (Lundberg *et al*. 1976)，使體中心的溫度約僅降3－5℃且保持在易醒的狀態 (Folk *et al*. 1980；Lyman 1982)，且育幼的雌熊體溫比非育幼的雌熊降得少，因爲泌乳中的雌熊大量利用體內所儲存的能量而產生熱(Maxwell *et al*. 1988; Hellgren *et al*. 1990)，故同樣類似在休眠狀態，育幼的雌熊可能比非育幼的雌熊更易清醒一些。本試驗生產之雌熊在產前及產後靜坐不動猶似在休眠狀態，有干擾時即抬頭易醒呈現警戒護仔狀態，此狀況可能就是這個原因所致。此情形與小型哺乳動物典型的冬眠 (typical deep hibernation) 狀態有所不同，典型的冬眠體溫約降至5℃或接近環境溫度，代謝只有正常的1% (Folk *et al*. 1980)，而休眠熊隻其代謝速率只約爲正常的50－60% (Hock 1960)。

熊隻冬眠時蛋白質代謝產生尿素氮 (urea N) 的速率比平常快十倍 (Wolfe *et al*. 1982)，且可在膀胱重吸收 (Nelson *et al*. 1975; Nelson 1980; Wolfe *et al*. 1982)，再與甘油 (glycerol) 結合形成氨基酸重進入蛋白質合成途徑 (Nelson *et al*. 1975)，而使熊隻得以在不進食的情況下增加維持生存的能力。冬眠後雌熊體重減輕約10－35% (Lundberg *et al*. 1976; Maxwell *et al*. 1988)，本試驗雌熊產後約二個月之體重比產前約減12%，減重未比單純的冬眠多，可能是個體的差異，但所減少之體組成推測可能包括脂肪及瘦肉(Nelson *et al*. 1973; Lundberg *et al*. 1976; Nelson 1980)。

產前及產後的雌熊可多日不喝水，推測其與冬眠熊隻膀胱可重吸收水份 (Nelson *et al*. 1975; Nelson 1980; Lyman 1982) 的功能相同。水的重要來源包括代謝水(metabolic water)，雌熊亦舔食仔熊的尿液及口腔中的唾液，雌熊流失的水主要是到仔熊 (Oftedal *et al*. 1993)。本試驗發現產後一段時間，由監視器可看清楚雌熊舔食幼熊身軀的情形，且窩巢亦無糞尿污染現象，故推測雌熊確有舔食仔熊排泄物的現象。就本試驗的各種跡象顯示，台灣熊隻雖沒有冬眠現象，但生產時的生理與冬眠的情況很類似，直接的証據值得進一步研究探討，相類似的原因可能是同源自2千多萬年前中新世 (Miocene) 時於冬天熊隻即入洞休眠 (Hunt *et al*. 1983) 所遺傳下來的機能。

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台灣長鬃山羊族群具有顯著遺傳變異之兩個分群
以粒線體DNA之D-loop序列比對

Two Distinct Phylogenetic Groups of Formosan Serow (*Naemorhedus swinhoei* Gray) Population in Taiwan:
Based on Mitochondrial D-loop Region Sequences

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摘 要

本研究的目的是利用粒線體DNA的序列了解台灣長鬃山羊族群的遺傳變異與地理分布的關係，在取得的25隻台灣長鬃山羊中，定出14隻粒線體DNA的D-loop完整DNA序列(1122 bp−1124 bp)，並比較25隻粒線體DNA的D-loop 5'端變異最大部分DNA序列(493 bp−495 bp)，分析結果顯示這25隻山羊中有14種單套型（haplotypes），各單套型之間的遺傳變異在0.24%至6.85%之間；利用親緣樹關係分析結果，得到比用cytochrome b序列所建立之台灣長鬃山羊親緣樹有更高可信度的相同兩群－花蓮太魯閣群及南投-台東群，兩分群之間平均遺傳距離約爲5.53%。從粒線體DNA的D−loop的資料顯示，台灣長鬃山羊族群至少在55萬年前的亞洲大陸可能就已分群，並於晚更新世冰河時期經由陸橋分別遷徙至台灣島，且分析兩群在台灣島的地理分布結果，可能是台灣湍急陡峭的河川加上中央山脈複雜地形造成地理條件上的阻隔。

Abstract

To investigate genetic variation of the Formosan serow (*Naemorhedus swinhoei* Gray) population , the nucleotide sequences （1122-1124 bases) of the mitochondrial DNA D-loop region was examined for 14 of 25 samples collected from Nantou, Taidong, HualienTaroko and Wulai areas of Taiwan. Fourteen haplotypes were detected from 25 samples with a pairwise comparison of the partial sequences (493-495 bases) of the D-loop region . Genetic distance divergences were estimated to be 0.24%-6.85% among the

14 haplotypes. The phylogenetic trees constructed by the sequences indicated that the Formosan serow was separated into two highly genetically variable groups: the Nantou-Taidong group and the HualienTaroko group. The separation of the two groups was estimated to have occurred over 0.55 million years ago, resulting from repeated colonization from the Asia continent to Taiwan. The rivers in the Central Mountain Range were probably a geographic barrier for allopatric differentiation of the two groups. Our result provided an insight into the understanding of the evolutionary history, phylogeny and population genetics of the Formosan serow.

關鍵詞：台灣長鬃山羊、粒線體DNA、D-loop

Key words: Formosan serow, *Naemorhedus swinhoei*, mitochondrial DNA, D-loop region

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緒 言

台灣長鬃山羊(*Naemorhedus swinhoei* Gray)是台灣列爲珍貴稀有之特有種保育類物種，也是唯一偶蹄目牛科的中大型草食性動物，由於棲息地的減少及人類的盜獵行爲，一直威脅著台灣長鬃山羊的生存，基於對台灣長鬃山羊保育，有必要了解台灣長鬃山羊的生態習性及遺傳上的變異，以作爲物種經營管理的依據。

爲了解台灣長鬃山羊的遺傳變異，先前對19隻台灣長鬃山羊粒線體DNA中cytochrome b及12S rRNA序列研究結果顯示(洪等 2001)，台灣長鬃山羊在遺傳上仍具有多樣性且有分群現象，惟由於cytochrome b在粒線體DNA內爲具有protein-coding的基因片段，在演化速率上適合應用於種間的系統演化與分類研究(Irwin *et al*. 1991；Chikuni *et al*. 1995)，前文以cytochrome b 序列建立neighbor-joining method 及UPGMA method之親緣樹關係時，在太魯閣地區的台灣長鬃山羊群顯示其經1000 replicates bootstrap test 結果，其可信度均低於50%(洪等 2001)；雖然用cytochrome b序列得到的台灣長鬃山羊個體間之遺傳變異有顯著差異(0.3%–2.0%，1–6/307 bp)，但於親緣樹分群的可信度仍嫌不足。而粒線體DNA中D-loop控制區序列是粒線體DNA變異最大的一段，它的鹼基取代速率是粒線體DNA中其它序列的五倍(Aquadro and Greenberg 1983)，故有關物種族群內的遺傳變異均是以調查粒線體DNA D-loop區序列爲主要對象 (Gravlung *et al*. 1998, Nagata *et al*. 1999, Matsuhashi *et al*. 1999)。

基於以上理由，本研究爲繼續深入探討台灣長鬃山羊族群遺傳變異及確定其分群現象，以台灣長鬃山羊的粒線體DNA演化速率快速的D-loop區序列爲研究對象，來探討其遺傳上的特性，並討論台灣長鬃山羊族群內的親緣關係及在台灣本島的演化歷史。

材料與方法

一、 樣本的收集

25隻樣本來自花蓮、台東、南投及烏來等地區(表1)。

二、DNA的抽取

取樣本的肌肉研磨後，採用proteinase K/phenol/chloroform (Kocher *et al*. 1989)抽取細胞核酸 (total DNA)，抽取的細胞DNA則以1.2%瓊脂膠體(agarose gel) 電泳檢視並用分光光度計(Beckman DU640)定量後，保存於4℃下。

表1. 在本研究中台灣長鬃山羊的樣本編號、來源及各樣本D-loop的單套型

Table 1. Sample numbers and collection localities of the Formosan serow and the haplotypes of their D-loop (495 bp)

Localities	Sample number	Haplotype
花蓮太魯閣地區	HL096	HL1
花蓮太魯閣地區	HL097	HL1
花蓮太魯閣地區	HL366	HL1
花蓮太魯閣地區	HL375	HL3
花蓮銅門地區	HL374	HL2
台東壢坵地區	TD376	TD1
台東壢坵地區	TD377	TD1
台東壢坵地區	TD378	TD1
台東延平地區	TD364	TD2
台東延平地區	TD365	TD3
台東利嘉林道	TD306	TD4
台東關山地區	TD315	TD5
南投不明地區	NT121	NT1
南投丹大地區	NT413	NT2
南投不明地區	NT134	NT3
南投信義地區	NT412	NT3
南投信義地區	NT417	NT3
南投不明地區	NT135	NT4
南投丹大地區	NT394	NT4
南投信義地區	NT416	NT4
南投信義地區	NT420	NT5
南投信義地區	NT421	NT5
烏來福山地區	WL383	WL1
烏來福山地區	WL384	WL2
烏來福山地區	WL418	WL2

三、PCR核酸引子(primers)

用來擴增(amplification)及定序(sequencing)粒線體DNA內之D-loop 基因所需的引子序列是以人類(Anderson *et al*. 1981)及牛(Anderson *et al*. 1982)的粒線體DNA內具有一致性的序列爲基礎而設計：

t-pro (5' -TCACCATCAACCCCCAAAGC-3')及
t-phe (5' -TCATCTAGGCATTTTCAGTG-3')

爲得到D-loop完整序列(complete sequence)，另外新設計三條引子：

HD1 (5' -GCTGGTTTCACGCGGCATGG-3')、
LD3 (5' -GTCAAATCCATCCTCGTCAACA-3')及
HD4 (5' -TGTTGACGAGGATGGATTTGAC-3')

四、聚合酶聯鎖反應(PCR)

對D-loop進行雙股DNA擴增與延伸的PCR反應(Kocher *et al*. 1989)所使用的試劑，採用AmpliTaq Gold reagent kit(Applied Biosystems)，並依據製造商所提供的說明書操作整個PCR反應包括5 μl 的10X PCR buffer，5 μl 的25 mM $MgCl_2$ solution ，各1 μl 的 10 mM dATP、dCTP、dGTP、dTTP，0.25 μl AmpliTaq Gold(1.25 unit / reaction)，各5 μl 的10 μm的輕重兩股引子，5 μl 的template DNA(1 μg)，20.75 μl 的ddH_2O，使反應總體積爲50 μl 。

整個PCR的反應使用Applied Biosystems Thermal Cycler 9700，其條件爲先在95℃下加熱10分鐘後，進行94℃ 1分鐘、50℃−55℃ 1分鐘、72℃ 2分鐘的循環流程，總共完成40次循環，將此PCR產物以含0.05%溴化乙錠之1.2% 瓊脂膠體電泳後在紫外光激發下觀察照相。

五、DNA定序

PCR產物的純化採用QuickStep PCR Purification Kit (EdgeBio Systems)，所得到的純PCR產物DNA利用BigDye Terminator Cycle Sequencing Ready Reaction Kit (ABI)及ABI Thermal Cycler 9700進行標定反應，反應後的產物在ABI 310 DNA自動定序儀定序。

六、DNA序列分析

經由定序完成的資料，採用Lasergene套裝軟體(Dnastar, Wisconsin 1999)分析並編輯每一樣本的DNA序列並進行排列(alignment)比對，遺傳距離(sequence genetic distance)的分析則採用MEGA電腦程式軟體2.1版(Kumar *et al*. 2001)中的Kimura's two-parameter genetic distance 方法估算，而親緣關係樹的建立同樣採用MEGA程式軟體中Neighbor-joining method(NJ)(Saitou and Nei 1987)並進行1000 bootstrap replicates, Maximum parsimonious with heuristic search(MP)用PAUP 4.0 beta10版(Swofford 2002)，其參數設定爲random addition sequence, the tree-bisection-reconnection (TBR), 經100 bootstrap replicates得到一50% majority consensus unroot的樹狀圖。

結　果

一、粒線體DNA的變異度

用PCR直接定序技術，利用三組t−pro/HD4、t−pro/HD1及 LD3/t−phe引子對已成功定出25隻中14隻台灣長鬃山羊粒線體DNA中的完整D-loop序列(HL096、HL097、HL366、HL374、HL375、NT121、NT134、NT135、TD315、TD364、TD365、TD376、TD378及WL383)，序列總長度爲1122-1124 bp，此14隻山羊之序列比對結果，共有94個位置有鹼基替換，發現在D-loop的5'端有兩段具有高度變異區(hypervariable regions)，位於第 201−300共22個位置替換及第 401−500共18個位置替換，另在3'端也有一段顯著變異，位於第851−950有15個位置替換(圖1)。

爲了解台灣長鬃山羊族群的遺傳距離，進行比對(pairwise comparison)25隻山羊粒線體DNA D-loop序列中5'端變異大的部分序列(493−495 bases)，並以日本長鬃山羊粒線體DNA D-loop序列(中山大學生物系張學文教授提供)爲外群，比較結果顯示在25隻山羊中總共得到14種單套型，其中花蓮地區3種(5隻)，台東地區4種(7隻)，南投地區5種(10隻)及烏來福山地區2種(3隻) (表1)。

14種單套型的 Kimura's two-parameter遺傳距離比對結果(刪除有gap的位置)如表2，鹼基變異範圍從最小0.24% (1/495 bases) 的台東地區 (TD1與TD2) 到最大6.85% (27/495 bases) 的花蓮太魯閣與南投地區(HL2與NT1)，與日本長鬃山羊的遺傳距離則高達19%。另495個鹼基對總共有60個位置有替換現象，其中有1−5個位置發生transversion (A-T, A-C and G-T)，其餘位置均爲transition (A-G, T-C)，其transversion替換數高於牛族群(1/60)(Loftus *et al*. 1994)及日本梅花鹿族群(1−2個)(Nagata *et al*. 1999)，而與日本長鬃山羊 transversions比較，則有8−11個替換數。

本報告內有關14隻山羊之完整序列已登錄於Genebank之序列資料庫內，其Accession numbers爲AF547433、AY139642、AY149638、AY149639、AY149640、 AY149641、AY149642、AY149643、AY149644、AY149645、AY149646，其中HL096、HL097及HL366三隻爲同一單套型，TD376及TD378兩隻爲另一單套型。

二、親緣樹的建立

爲建立此14種單套型的親緣關係，利用MEGA 2.1版的Neighbor-joining方法並對DNA序列進行1000次bootstrap test建立親緣樹如圖2及用PAUP 4.0的maximum parsimonious with heuristic search方法進行100次 bootstrap test建立其親緣樹(phylogenetic tree)(圖3)。兩親緣樹狀圖得到相同的結果，能夠很明顯的將台

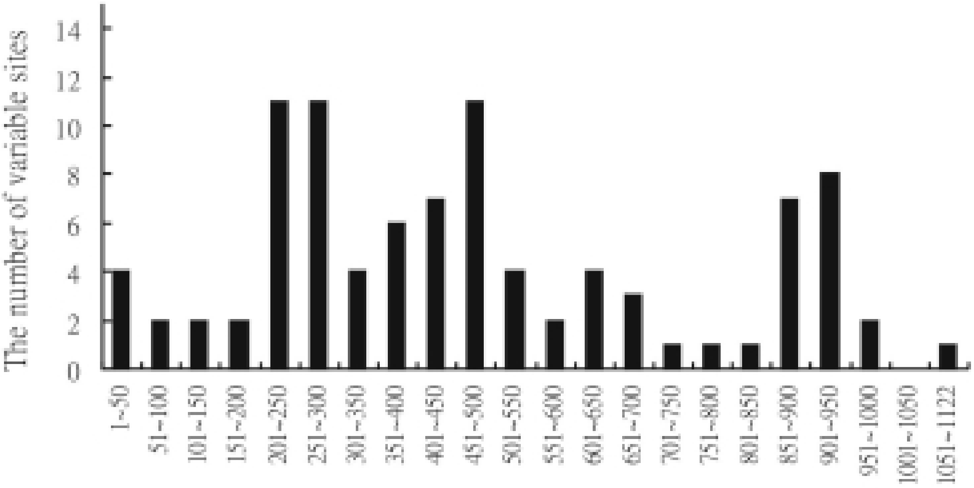

圖1. 台灣長鬃山羊粒線體DNA完整D-loop內鹼基替換的分布圖，橫軸以不重疊之每50鹼基爲單位，縱軸爲每單位中變異位置數目，圖中顯示於201-300，401-500及851-950位置有高變異。

Fig. 1. Distribution of base substitutions in the Formosan serow mtDNA D-loop region. Numbers of sequence variable sites in the data set are examined in consecutive blocks of 50 bp, and hypervariable domains are shown at nucleotide positions 201-300, 401-500 and 851-950.

表2. 台灣長鬃山羊的14種D-loop 單套型的Kimura兩參數遺傳距離(右下角部分)及Transitions/Transversions替換數(左上角部分)之比較

Table 2. Kimura's two-parameter genetic distance(%)(below diagonal) and the numbers of Transitions/Transversions (above diagonal) of the D-loop (495 bp) among 14 haplotypes of the Formosan serow and the Japanese serow (JSD)

OTUs	HL1	HL2	HL3	NT1	NT2	NT3	NT4	NT5	TD1	TD2	TD3	TD4	WL1	WL2	JSD
HL1		7/0	10/0	23/3	17/5	20/3	17/3	23/2	20/2	19/2	16/3	17/2	10/0	22/2	58/10
HL2	1.70		9/0	24/3	18/5	21/3	18/3	24/2	21/2	20/2	19/3	18/2	3/0	21/2	57/10
HL3	2.45	2.20		21/3	17/5	20/3	17/3	21/2	20/2	19/2	18/3	15/2	10/0	20/2	56/10
NT1	6.58	6.85	6.04		9/4	16/2	10/2	0/1	13/1	12/1	11/2	12/1	23/3	7/1	59/9
NT2	5.49	5.75	5.49	3.18		10/4	0/2	9/3	7/3	6/3	1/2	8/3	19/5	8/3	56/11
NT3	5.77	6.04	5.77	4.47	3.43		10/2	16/1	7/1	6/1	9/2	11/1	22/3	13/1	57/9
NT4	4.98	5.25	4.98	2.94	0.48	2.94		10/1	7/1	6/1	1/0	8/1	19/3	9/1	57/9
NT5	6.32	6.59	5.79	0.24	2.93	4.22	2.69		13/0	12/0	11/1	12/0	23/2	7/0	59/8
TD1	5.52	5.79	5.52	3.45	2.43	1.94	1.94	3.20		1/0	8/1	11/0	22/2	14/0	60/8
TD2	5.26	5.52	5.26	3.20	2.18	1.70	1.70	2.95	0.24		7/1	10/0	21/2	13/0	59/8
TD3	4.72	5.51	5.25	3.19	0.72	2.69	0.24	2.94	2.19	1.94		9/1	20/3	10/1	58/9
TD4	4.73	4.99	4.21	3.20	2.68	2.94	2.19	2.95	2.70	2.45	2.44		17/2	7/0	57/8
WL1	2.45	0.72	2.45	6.58	6.02	6.31	5.51	6.32	6.05	5.79	5.77	4.73		20/2	58/10
WL2	6.05	5.79	5.52	1.94	2.68	3.45	2.44	1.70	3.46	3.20	2.69	1.70	5.52		54/8
JSD	19.11	18.77	18.43	19.15	18.72	18.47	18.47	18.86	19.20	18.86	18.81	18.18	19.11	17.18	

灣長鬃山羊分爲兩群，再檢視兩群內取樣的分布情況又發現花蓮太魯閣成一群，而南投—台東則另成一群，比較兩群的平均遺傳距離爲5.53%(4.21%–6.85%，17–27/495)，而花蓮太魯閣群的平均遺傳距離爲1.58%(0.72%–2.45%，3–10/495)，南投–台東群爲2.45%(0.24%–4.47%，1–18/495)，若以各單套型與日本長鬃山羊的平均遺傳距離則高達18.19%(表2)。

討 論

一、台灣長鬃山羊mtDNA D-loop的特性及分歧時間

Kocher及Wilson(1991)報告有關哺乳類動物的mtDNA D-loop段具有兩個高變異區，從台灣長鬃山羊mtDNA D-loop段同樣具有兩個高變異區，此外在3'端的位置另有一段顯著變異區。且mtDNA D-loop段鹼基取代速率是粒線體DNA中其它序列的5倍(Aquadro and Greenberg 1983)，先前研究利用台灣長鬃山羊mtDNA cytochrome b與12S rRNA序列作爲族群內的親緣關係比較得到遺傳距離分別爲0.3%–2.0%與0.3%–0.8%(洪等 2001)，然而本研究用D-loop的遺傳距離爲0.24%–6.85%，顯示在台灣長鬃山羊mtDNA D-loop的替換速率大約爲cytochrome b的3.4倍之多。

在其它不同哺乳類動物用mtDNA D-loop進

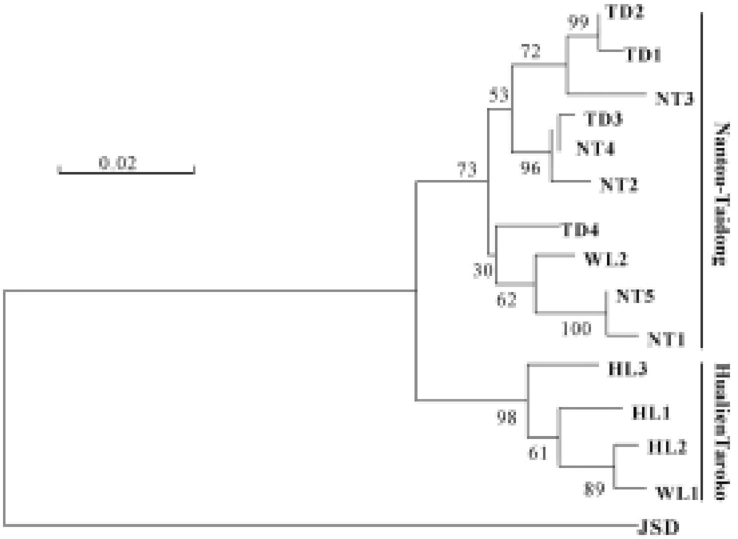

圖2. 用neighbor-joining方法建立台灣長鬃山羊 mtDNA D-loop 14種單套型親緣樹關係圖，以日本長鬃山羊(JSD)爲外群。

Fig. 2. A phylogenetic tree constructed for 14 haplotypes of mtDNA D-loop sequences (495 bp) of the Formosan serow, using the neighbor-joining method with Kimura's two-parameter genetic distance and the haplotype of the Japanese serow (JSD) as an outgroup (the bootstrap values derived from 1000 replications is indicated as a number at each node when the value is >50%).

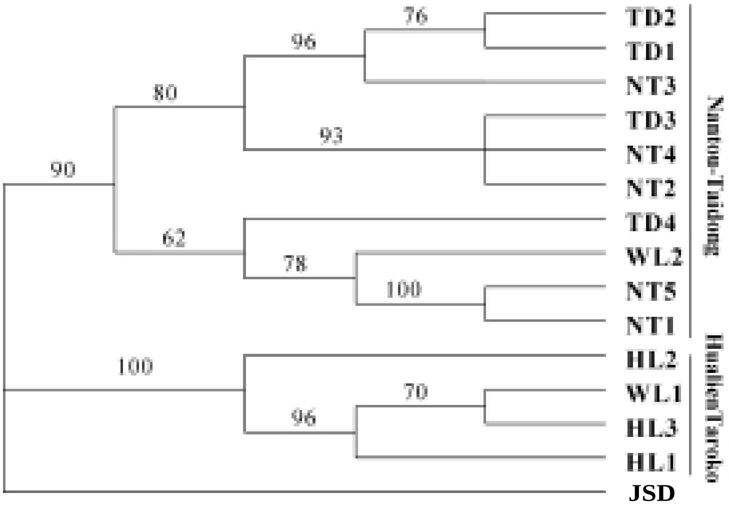

圖3. 用maximum parsimony方法建立台灣長鬃山羊 mtDNA D-loop 14種單套型親緣樹關係圖，以日本長鬃山羊(JSD)爲外群。

Fig. 3. A phylogenetic tree constructed for 14 haplotypes of mtDNA D-loop sequences (495 bp) of the Formosan serow, using the maximum parsimony method (MP) and the haplotype of the Japanese serow (JSD) as an outgroup (the bootstrap value derived from 100 replications is indicated as a number near each of the internal branches).

行族群內研究，如加拿大與瑞典的麋鹿(moose)族群D-loop遺傳距離爲3.9%(Mikko and Anderson 1995)、日本猴(Japanese monkey)D-loop遺傳距離爲0.6%−4.3%（Hayasaka *et al*. 1991）、日本灰熊(Japanese brown bear)族群爲2.0%−3.7%(Matsuhashi *et al*. 1999)及日本梅花鹿(Sika deer)爲0.2%−5.0%(Nagata *et al*. 1999)，均顯示台灣長鬃山羊mtDNA D-loop的變異(0.24%−6.85%)與這些哺乳類動物相似。

Loftus等人(1994)的報告，利用mtDNA D-loop 5' 端高度變異的375 bp探討歐亞非家牛族群的遺傳變異並比較與牛已分歧距今約一百萬年的美國野牛(American bison)，指出牛的mtDNA D-loop鹼基替換速率估計約每百萬年爲10.6%，本研究台灣長鬃山羊的花蓮太魯閣與南投−台東兩群的平均遺傳距離爲5.53%，如果以牛科的mtDNA D-loop鹼基替換速率(10.6%/Myr)來估算同爲牛科的台灣長鬃山羊兩群的分歧演化時間，則大約在至少55萬年前；與日本長鬃山羊遺傳距離比較結果(18.19%)，可能更早在一百八十萬年前即分歧演化。從台灣長鬃山羊兩群間存在高遺傳距離顯示，台灣長鬃山羊可能在前中更新世(Pleistocene)(至少55萬年前)其mtDNA遺傳結構可能在亞洲大陸已分歧演化而分群，而後隨著晚更新世冰河時期從亞洲大陸不同地點先後藉由因冰河時期形成的陸橋(land bridge)遷徙至台灣島。從表2的台灣長鬃山羊各單套型遺傳距離及圖2(NJ)、圖3(MP)親緣樹關係的結果，推測台灣長鬃山羊至少有兩次以上從亞洲大陸不同地點移入台灣，且台灣長鬃山羊的祖先可能並不是來自同一支系。

二、台灣長鬃山羊之分子親緣關係與台灣地緣關係

由圖2及圖3的D-loop親緣關係樹顯示台灣長鬃山羊具有顯著遺傳變異的兩群並有極高的bootstrap 值。從取得樣本的地點及從台灣地理的分布來看很明顯分爲南投-台東群及花蓮太魯閣群，與先前用cytochrome b與12S rRNA序列比對得到的 NJ 親緣樹的結果是一致的(洪等 2001)，且有更高的可信度(圖3 NJ方法爲98%及73%，圖4 MP方法爲100%及90%)，分析南投−台東群內的分布雖可能存在有兩個亞群，但並沒有如預期中分爲台東一亞群及南投一亞群的分布，而是南投及台東各單套型混合在一起，此現象可能是在更新世不同冰河時期先後移入台灣，在南投及台東之間混居的結果；比較令人有趣的結果是花蓮太魯閣群(木瓜溪以北、奇萊山以東及南湖大山以南區域)的台灣長鬃山羊自成一群，由於太魯閣群的遺傳距離與南投−台東的變異很大，且其群內各單套型平均遺傳距離較小(1.58%)，故推測其移入台灣的時間最晚，沒有與南投-台東群混居。

從台灣長鬃山羊的生態習性得知，台灣長鬃山羊的活動處所，都在陡峭的山坡行動，以台灣中央山脈的地形應無法阻止其遷移，基於這種生態習性的判斷，如以分子生物遺傳學角度探討，得到結果的兩群中，每群應該有各地的樣本，也就是說在南投－台東群應有太魯閣地區的樣本，反之亦然；但從本研究結果顯示兩群中的各單套型確實互不存在於對方(與中山大學生物系張學文教授完成的14個台灣長鬃山羊D-loop結果相同，私人通訊)，且兩群平均遺傳距離相差很大(5.53%以上)，此結果顯示著在此兩群中存在有某種因素的隔離。檢視本研究樣本來源南投－台東群均集中於南投縣丹大七彩湖(信義鄉)以南一直延伸至台東縣南端的壢坵，而花蓮太魯閣群之樣本來源則集中於木瓜溪以北、奇萊山以東及南湖大山以南區域，從台灣地理角度來看，其兩群交界處，在中央山脈西邊是濁水溪發源地，東邊爲木瓜溪發源

圖4. 南投–台東群與花蓮太魯閣群的位置圖(橢圓形部分)，圖中矩形部分爲可能存在的生物地理阻隔區域。

Fig. 4. The map of Taiwan showing the locations of Nantou-Taidong group and HualienTaroko group (elliptic regions) and a probably existing area of biogeographic boundaries (rectangular region).

地(圖4)，由本研究結果推測當山羊於不同冰河時期從亞洲大陸不同地點遷徙台灣(或從台灣海峽東來或沿著日本島弧南下，其確切遷徙路線尚不清楚)，隨著冰河時期結束後，因河川解凍，湍急陡峭的河川及中央山脈複雜地形，使得源於奇萊山下的濁水溪及木瓜溪對台灣長鬃山羊可能形成地理上的阻隔效應，造成兩群隔離至今。至於烏來福山取的二種單套型則呈現不同結果各分於兩群內，且從地理上雪山山脈(福山地區屬於雪山山脈)與中央山脈被大甲溪及蘭陽溪分隔，有可能是冰河時期遷入台灣的兩群山羊均先後遷入雪山山脈，但因雪山山脈樣本數太少，有必要蒐集更多樣本進行研究探討。

由本研究樣本的地點及參考中山大學張學文教授更多採得樣本地點的資料並得到同樣分群的結果並配合台灣地理的位置，台灣幾條發源於中央山脈的河川(濁水溪、大甲溪、蘭陽溪及木瓜溪等)在台灣生物地理阻隔上及生物遷徙路線可能扮演重要角色。

本研究的結果說明了利用粒線體DNA序列的遺傳距離來估算台灣長鬃山羊族群的遺傳變異並建立族群內分群及演化的關係，另嘗試從台灣長鬃山羊的分群現象討論台灣生物地理阻隔(biogeographic boundaries)，提供對台灣長鬃山羊在其演化歷史、親緣關係及族群遺傳有較深入了解。

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Roosting Behavior of the Grey-Cheeked Fulvetta *Alcippe morrisonia* Swinhoe in the Non-breeding Season

繡眼畫眉 (*Alcippe morrisonia* Swinhoe)在非繁殖季的夜棲行爲

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Abstract

Grey-cheeked fulvetta (*Alcippe morrisonia*) is a small dominant passerine bird in broad-leaved hardwood forests in Taiwan. During the non-breeding season of July 1994 and March 1995, we made 39 observations of fulvettas roosting at 18 perch sites in the Fushan Experimental Forest. Each site was located in the dense canopy of a single tree. Of them, 14 perch sites (77.8%) had two birds clumping together. One site was used for eight consecutive nights by the same two birds identified by their color band. The pair formation in night roosting may occur for both juveniles and adults.

摘　要

繡眼畫眉(*Alcippe morrisonia*)爲台灣常綠闊葉林中在數量上相當占優勢的小型燕雀目留鳥。本研究自1994年7月至1995年3月，繡眼畫眉的非生殖季節，於福山試驗林中的18個棲位，共記錄到39次繡眼畫眉的夜棲行爲。夜棲棲位都位於濃密的樹冠中，且未曾於一棵樹上同時發現兩個棲位。18個夜間棲位中有14個(77.8%)爲2隻個體緊靠在一起。更有2隻連續8晚利用同一夜間棲位，因其繫有色環被證實爲相同的個體。這種夜棲行爲的配對現象可能同時發生在第一年鳥與成鳥。

Key words: grey-cheeked fulvetta, *Alcippe morrisonia*, roosting behavior

關鍵詞 ： 繡眼畫眉、夜棲行爲

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Introduction

The grey-cheeked fulvetta *Alcippe morrisonia* Swinhoe, 1863 is a passerine bird belonging to the tribe Timaliini of the family Sylviidae (Sibley and Monroe 1990). It is only 14 to 17g in weight (Hu 1999). In Taiwan the grey-cheeked fulvetta is a resident species at elevations between the sea level and 2,800m (Yen 1990) and common in broad-leaved hardwood forests at elevations lower than 2,000 m (Ding 1993; Shiu 1995; Sun and Wang 1998). The grey-cheeked fulvetta feeds mainly on small arthropods but also plant food, of which the latter increases sharply in fall and winter (Chou *et al.* 1998; Chen and Chou 1999).

The grey-cheeked fulvetta lives in flock, often as a mixed-species feeding flock, in the non-breeding season of autumn and winter (Sun and Wang 1998; Chen and Hsieh 2002). The flock sizes differ in seasons with the largest in early non-breeding season (Lin 1996; Sun and Wang 1998). The largest flock that has been reported was 150 individuals (Chen and Hsieh 2002). The grey-cheeked fulvetta forms monogamous pairs in the breeding season of spring and summer (Lin 1996; Kuo 2000).

Many members of the tribe Timaliini have been known to roost communally in huddles in nights in the non-breeding season. The behavior has been reported for the Arabian babbler (*Turdoides squamiceps*) (Bishop and Groves 1991), the common babbler (*T. caudatus*) (Gaston 1978a), the grey-crowned babbler (*Pomatostomus temporalis*) (King 1980), the jungle babbler (*T. striatus*) (Gaston 1977), the rufous babbler (*P. isidori*) (Bell 1982), and the yellow-eyed babbler (*Chrysomma sinensis*) (Gaston 1978b). These babblers are all cooperative breeding species living in flocks in daytime in non-breeding season. At night they roost in huddles. For the grey-cheeked fulvetta, it has not been reported to roost communally, and its roosting behavior remained unknown.

Materials and Methods

This study was conducted at the Fushan Experimental Forest of the Taiwan Forestry Research Institute. It was a subtropical evergreen hardwood forest composed predominantly of Fagaceae and Lauraceae at elevations of 400 to 1,400m (Lin *et al.* 2001) in northeastern Taiwan (121°34'E, 24°46'N). From 1993 to 1997 the monthly mean temperature of the area was 18.2℃, the lowest winter temperature was -1℃ in January, and the mean annual rainfall was 3,660 mm with 221 rainy days yearly (Hsia and Hwong 1999). Observations of roosting fulvetta were made mainly in the administration area of Fushan Experimental Forest (10 ha). We also occasionally checked its botanical garden (30 ha). The elevations where we carried out the fieldwork were around 600–700m.

Fieldwork was carried out from September 1994 to January 1995. During the period, we spent three to eight nights for a month to search roosting fulvetta. We also spent one night to search roosting fulvetta in July 1994 and March 1995, respectively. During the study period, we spent totally 26 nights to search roosting fulvetta with a flashlight from 7 to 10 pm along the roadside in the forest. When roosting fulvetta was spotted, its number was counted and the color band combination of each bird if present was recorded with a pair of Leica binoculars (8 x 32 mm). We banded 221 grey-cheeked fulvettas from January 1994 to January 1995.

Results and Discussion

In the non-breeding season, the grey-cheeked fulvettas formed a feeding flock in dawn and the flock broke in dusk. At night they roosted in trees or bushes within the home range of the feeding flock. We recorded 18 roosting sites: 17 in the canopy with height estimated from 3 to 11m, while one in a bush near the trunk of a tree at about 2m up. Perch sites were usually under dense foliage. The roosting perches were small with diameters estimated to be less than 1 cm. There were no two roosting sites simultaneously present in a single tree in the same night.

We made 39 observations of roosting fulvettas at 18 roosting sites. Of them, 14 roosting sites were found to be two birds packed together. They occupied 77.8% of the total observations. The sites with a single bird and three birds had two sites each (11.1%) (Table 1). Apparently, most grey-cheeked fulvettas roosted in pair at nights during the non-breeding season.

There were five roosting sites (4, 5, 7, 10, 17) used by fulvettas more than one night, suggesting that these birds returned to the same roosting sites occupied previously (Table 1). A pair occupied Site 17 for eight consecutive nights from 16th to 23rd January 1995. They were identified as the same pair of birds by their color bands. The other four roosting sites (4, 5, 7, 10) were intermittently observed used by paired birds two to eight nights from September 1994 to January 1995.

Juveniles of the grey-cheeked fulvetta have been known to fledge before mid-August but to stay with their parents for additional 40 days or longer (Lin 1996). In this study it was observed that juvenile fulvettas and their parents of many families form a large feeding flock in daytime. The flock broke into smaller flocks again and again before roosting at dusk. At night most of the fulvettas roosted in pairs (Table 1).

During non-breeding season, many passerines form feeding flocks in daytime. However, the roosting behavior varies among species. Most members of genus *Parus* sleep singly in holes (Smith 1991), while vinous-throated parrotbill (*Paradoxornis webbianus*) roosts communally in a small specific area of 5 x 25 ㎡ to 1 x 10 ㎡ and within this small area they separated into small clusters of individuals, spreading out with one to three birds roosting side by side (Severinghaus 1987). Another type of roosting behavior is a whole flock roosting in huddle, represented by cooperative breeding babblers of the genus *Turdoides*, which live in a permanent flock and defending a territory (Gaston 1977; Gaston 1978a; Bishop and Groves 1991). Furthermore, cooperative breeding birds, such as long-tailed tit (*Aegithalos caudatus*), common bushtit (*Psaltriparus minimus*) (Smith 1972; Chaplin 1982), and yellow-eyed babbler (Gaston 1978b), also roost in huddle in cold winter, though their flocks break up before the breeding season.

Roosting behavior of the grey-cheeked fulvetta differed from the species mentioned above. It did not roost communally in a small area as a whole flock, rarely roosted individually, but roosted in pairs. Its roosting sites were widely dispersed in the forest. The nearest distance between the two roosting sites observed was about 10m. Each site was on a single tree. There was no tree that had more than one roosting site occupied simultaneously in a single night. Also, a pair of birds did not occupy a perch site of a tree for roosting permanently. They occupied the site for one night to a few consecutive nights, and then shifted to a site on another tree. It is a question what is the mechanism for paired birds select their perch sites.

The roosting perch sites of the grey-cheeked fulvetta were found to be beneath a dense canopy. It is reasonable to explain it as a protection mechanism against predators in

Table 1. Number of birds and dates of observations for the roosting grey-cheeked fulvetta at the Fushan Experimental Forest, July 1994 to March 1995

Roosting site	Dates of observation	Number of nights	Number of birds
1	21 July 1994	1	3
2	18 September 1994	1	1
3	18 September 1994	1	2
4	25 September 1994 27 November 1994	2	2
5	25-27 September 1994 16-18 January 1995	6	2
6	15 October 1994	1	1
7	15-16 October 1994	2	2
8	16 October 1994	1	2
9	16 October 1994	1	2
10	16 October 1994 27-28 November1994 10-12 and 17-18 December 1994	8	2
11	17 October 1994	1	2
12	20 November 1994	1	2
13	21 November 1994	1	2
14	28 November 1994	1	3
15	12 December 1994	1	2
16	18 December 1994	1	2
17[1/]	16-23 January 1995	8	2
18	13 March 1995	1	2

[1/] Roosting site in bush.

subtropical forests. Although the Fushan Experimental Forest is fairly cold in winter (the minimum temperature of -1℃), it is suspected that paired fulvettas have adequate feather coverage to sustain their body temperature, and/or have a proper physiological adjustment against hypothermia as found in some species of the genus *Parus* which roost individually (Smith 1991). However, seasonal mortality of the grey-cheeked fulvetta has been found to be high in winter (Lin 1996; Hu 1999). There must be a better explanation than keeping warm as a mechanism for the pair formation in night roosting in winter.

Based on the data obtained (Table 1), the pair formation in night roosting of the grey-cheeked fulvetta might start as early as late summer (September), right after the breeding season that ended in the mid-summer. It has been known that the first-year juveniles are composed of more than 40% of the winter population (Hu 1999). In this study most of the birds roosted at night were found to be paired (Table 1). Accordingly, the pair formation in night roosting might occur not only for two-year adults and older, but also for the first-year juveniles. Such pair formation in juvenile birds has been also reported in chickadees and titmice (Hogstad 1987; Smith 1991).

In this study although most grey-cheeked fulvettas roosted in pair during non-breeding season, there were some birds roosting singly or in three birds. For those roosted in three birds at late-breeding season may belong to a same family. For those roosted singly might be lost their partners. A further study is needed to answer the significance of the roosting behavior of the grey-cheeked fulvetta.

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Three Species of the Genus *Fuscoboletinus* Boletaceae Newly Recorded to Taiwan

三種褐孔小牛肝菌新紀錄種

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Abstract

This paper describes three species of newly recorded fungi belonging to the genus *Fuscoboletinus* Boletaceae of Taiwan. They are *Fuscoboletinus grisellus* (Peck) Pomerleau & Smith, *Fuscoboletinus ochraceoroseus* (Snell) Pomerleau & Smith, and *Fuscoboletinus paluster* (Peck) Pomerleau. In addition to *F. glandulosus* (Peck) Pomerleau & Smith already known in Taiwan, these three newly recorded species make the genus *Fuscoboletinus* on the island to the total of four species.

摘要

本文描述並討論在台灣首次被發現的三種褐孔小牛肝菌新紀錄種，分別是淡褐孔小牛肝菌(*Fuscoboletinus grisellus* (Peck) Pomerleau & Smith)、赭黃褐孔小牛肝菌 (*F. ochraceoroseus* (Snell) Pomerleau & Smith)及濕褐孔小牛肝菌 (*F. paluster* (Peck) Pomerleau)。加上已知的 *F. glandulosus* (Peck) Pomerleau & Smith ，台灣*Fuscoboletinus*屬共有四種。

Key words: *Fuscoboletinus grisellus*, *Fuscoboletinus ochraceoroseus*, *Fuscoboletinus paluster*, Boletaceae, Taiwan

關鍵詞：淡褐孔小牛肝菌、赭黃褐孔小牛肝菌、濕褐孔小牛肝菌、牛肝菌科、台灣

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Introduction

The genus *Fuscoboletinus* comprises the species that were once in the genera *Boletinus* and *Suillus* but were later excluded from the two genera. The species in *Boletinus* that have been transferred to *Fuscoboletinus* include those having hyphae of fruit body without clamp connections and those having viscid to glutinous pileus and separable hymenophore (Pomerleau and Smith 1962; Pomerleau 1964). The species in *Suillus* that have been transferred are those having purple, brown or chocolate-gray spore deposit, instead of cinnamon to olive print, such as *S. aeruginascens* (Secr.) Snell and *S. glandulosus* (Peck) Singer (Singer *et al*. 1963; Smith and Thiers 1971). They form mycorrhizal association with the species of the genera *Larix, Pinus*, *Abies* and *Picea* (Ying and Zang 1994).

There are a total of nine species of *Fuscoboletinus* in the world, but only the species *F. glandulosus* (Peck) Pomerleau and Smith has been reported in Taiwan (Chen and Yeh 2000). This paper describes three species of fungi belonging to the genus *Fuscoboletinus* as the new records to Taiwan. This makes a total of four known species of *Fuscoboletinus* on the island.

Specimens of fresh fruit bodies of boletes were collected and brought back to the laboratory. According to the conventional mycological methods described by Largent *et al.* (1977), the specimens were sectioned by hands, soaked in drops of the 10% NH_4OH solution, mounted in drops of 1% aqueous phloxine solution, and then examined under microscope with magnifications of 100-, 400- and 1,000-fold separately. Melzer's reagent was used in detecting amyloidity and dextrinoidity, and the ammoniac 1% Congo Red solution staining method was used for further examination (Bas 1969). After examination they were dried in warm air and deposited in the Taiwan Endemic Species Research Institute as described by Chen *et al.* (2002).

Fuscoboletinus grisellus (Peck) Pomerleau & Smith

Boletinus grisellus Peck, Mem. N. Y. State Mus. 3: 169. 1900.

Fuscoboletinus grisellus (Peck) Pomerleau & Smith, Brittonia 14: 168. 1962.

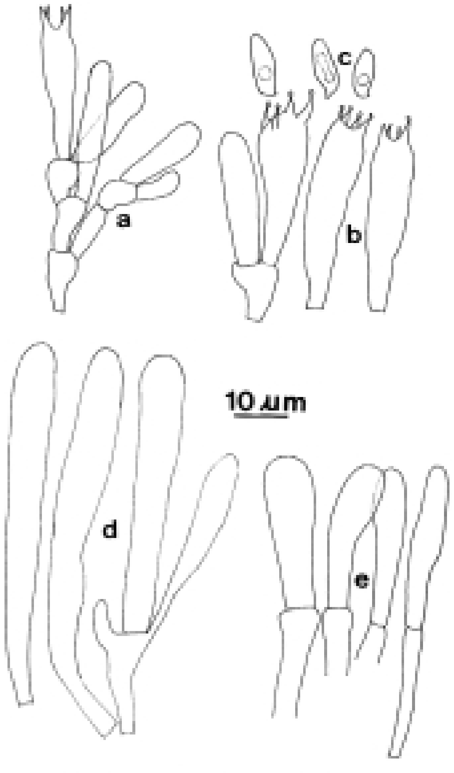

Fig. 1. *Fuscoboletinus grisellus* (a, hymenium; b, basidia; c, basidiospores; d, pleurocystidia; e, caulocystidia).

Pileus 3-6 cm broad, obtuse to broadly conic; surface glabrous to appressed-fibrillose, slightly viscid beneath fibrils when fresh; color pale dull olive, becoming pallid to grayish olivaceous or occasionally tinted with yellow, avellaneous in age, at times drying dull brown; margin inrolled when young, often decorated with remnants of submembranous grayish veil; context thick, cottony, whitish or faintly olivaceous, unchanging when cut; odor and taste not distinctive. Tubes 3-5 mm long, adnate to decurrent, scarcely separable, pallid to grayish when young, in aged yellowish, finally dull brownish; pores concolorous with tubes, round to angular, often sublamellate in radiating lines. Stipe 5-9 cm long, 0.4-0.7 cm thick, equal, straight; surface somewhat reticulate above annulus, nearly glabrous below, whitish or pallid becoming yellowish, rarely bluish when handled; context solid, whitish above annular zone, becoming yellow below; veil submemranous, well-formed annulus rare. Spore deposit gray-brown to chocolate-gray. Spores 10.5-12.5 x 4-5 μm, smooth, broadly elliptic to subovate in face view, inequilateral with shallow suprahilar depression in profile, hyaline to pale olive gray in KOH, ochre in Melzer's. Basidia 30-35 x 7-8.5 μm, mostly clavate to subcylindric, thin-walled, 4-spored, sterigmata 4.5-5.5 μm long, basidioles often subglobose in clusters on short branch hyphae, hyaline in KOH, in Melzer's mostly pale yellow. Pleurocystidia 65-85 x 7-9 μm, mostly subcylindric with rounded apices, thin-walled, sometimes with coagulated and amorphous, then brown in KOH, fasciculate, incrusted at base of fascicle with brown granular material, mostly hyaline in KOH, ochre yellow in Melzer's. Cheilocystidia 60-80 x 5-8 μm, similar to pleurocystidia. Caulocystidia 26-35 x 7-10 μm, subcylindric to clavate, apices rounded, septate, terminal cell often expanded, thin-walled, mostly hyaline in KOH, numerous, mixed with scattered caulobasidia; cuticular hyphae at base of stipe of variously inflated cells, not considered to be caulocystidia. Tube trama interwoven type, hyaline in KOH, nonamyloid. Pileal cuticle consisting of parallel, nongelationous, radial hyphae that are 7-10 μm thick, light yellowish-brown to cinnamon color in KOH. No clamp connections were observed.

Collection Locality：Taitung County, Shiang-Yang, elevation 2,300m, C. M. Chen 2929 (14. Ⅶ. 2001.).

Habitat: Cespitose on humus in rocky soil of *Pinus taiwanensis* Hayata in summer.

Distribution: Taiwan, North America, China (Sichuan, Yunnan, Tibet, Heilongjiang).

Remarks: *F. grisellus* is distinguishable from other congeneric species by having a typical conic-umbonate pileus and submemranous veil, and having a well-formed annulus. Also, it is much less viscid than *F. glandulosus*. It has no characteristic squamules on pileus like those of *F. ochraceoroseus* and *F. paluster*.

Fuscoboletinus ochraceoroseus (Snell) Pomerleau & Smith

Boletinus ochraceoroseus Snell, Mycologia 33: 35. 1941.

Fuscoboletinus ochraceoroseus (Snell) Pomerleau & Smith, Brittonia 14: 157. 1962.

Pileus 4-9 cm broad, convex to sub-umbonate, becoming plane or the margin slightly uplifted; surface dry and pitted, fibrillose to

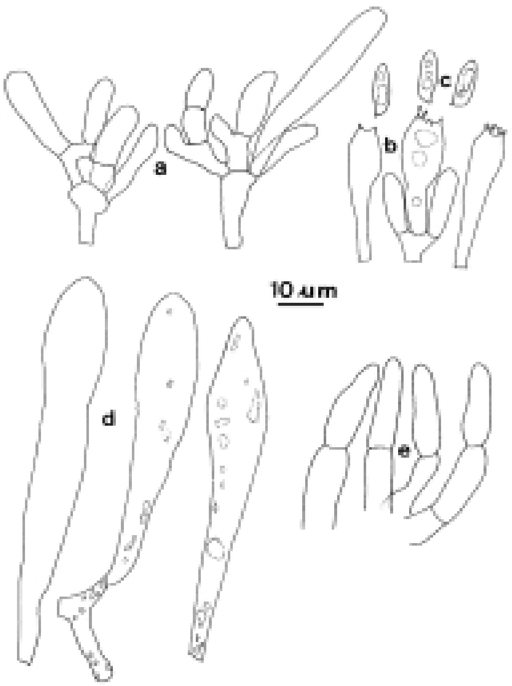

Fig. 2. *Fuscoboletinus ochraceoroseus* (a, hymenium; b, basidia; c, basidiospores; d, pleurocystidia; e, caulocystidia).

fibrillose-squamulose, the scales usually appressed toward the margin, variable in color; margin incurved and appendiculate with fragments of broken veil when young. Context thick, soft, pale bright yellow, often with a pinkish red zone under fibrils, unchanging when bruised. Hymenophore 3-5 mm thick, adnate to decurrent, boletinoid, dull olive-ocher to ding brown, pores compound, 2-4 x 1-2 mm broad, elongated to mostly angular, radiately arranged to sublamellate. Stipe 3-5 cm long, 1-1.8 cm broad, solid, subequal with subbulbous base, concolorous with tubes and reticulate at apex. Annulate, pallid to yellowish, usually adhering to margin of pileus. Spore deposit dark vinaceous-brown. Spores 9.5-12 x 4-4.5 μm, yellowish in KOH, subcylindric to slightly inequilateral, smooth, a few dextrinoids in Melzer's. Basidia 26–32 x 8–9 μm, narrowly clavate to subcylindric, 4–spored, sterigmata 2-3 μm long, subhyaline in KOH. Pleurocystidia 60–90 x 11–15 μm, scattered to abundant, subcylindric to subventricose, obtuse to abruptly acute, thin-walled, often flexuous, punctate and incrusted with brownish material when fasciculated. Cheilocystidia similar to the pleurocystidia but smaller, usually in clusters. Caulocystidia septate, terminal cell 15–25 x 5–7 μm, subcylindric to clavate, apices rounded, thin-walled, mostly hyaline in KOH, numerous, mixed with scattered caulobasidia. Tube trama parallel type, 80–90 μm thick, pallid melleous in KOH, hyphae 7–9 μm in diameter, thin-walled. No clamp connections were observed. Pileus trama of loosely interwoven hyphae 6–21 μm in diameter, hyaline in KOH, thin-walled, gelatinous. Pileus surface layer composed of compactly interwoven, cylindrical hyphae, 8–23 μm broad.

Collection Localities：Taichung County, Da-Shiu-Shan, elevation 2,350m, C. M. Chen 2884 (27. VI. 2001.); Taitung County, Shiang-Yang , elevation 2,300m, C. M. Chen 2935 (14. VII. 2001.).

Habitat: Solitary to densely gregarious under *Pinus taiwanensis* Hayata in spring to late summer.

Distribution: Taiwan, North America, China (Sichuan, Yunnan, Guizhow, Tsinghai, Tibet).

Remarks: *F. ochraceoroseus* is a common bolete in Taitung and may be found in colors ranged from dark lemon-yellow to brick-red. Its pileus is always densely tomentose to fibrillose over the surface. The stipe is short. *F. paluster* and *Suillus spraguei* (Berk. *et* Curt.) Kuntze are the other species to have densely tomentose, but differ from *F. ochraceoroseus* in other characters. *F. paluster* has a narrow stipe, and its pileus surface is deep red from the colored floccose-tomentose covering, which breaks up into fibrillose squamules on the pileus. *S. spraguei* is fairly similar in coloration to *F. ochraceoroseus*, but the former is associated with *Pinus morrisonicola* Hay. and the latter to *P. taiwanensis* Hay. Also, the spore deposit color of *S. spraguei* is olive-brown to tawny-olive, not tinted with vinicolor like that of *F. ochraceoroseus*.

Fuscoboletinus paluster (Peck) Pomerleau

Boletus paluster Peck, Ann. Rept. N. Y. State Cab. 23: 132. 1872.

Boletinus paluster (Peck) Peck, Bull. N. Y. State Mus. 298: 78. 1889.

Boletinellus paluster (Peck) Murr., Mycologia 1: 8. 1909.

Fuscoboletinus paluster (Peck) Pomerleau, Mycologia 56: 708. 1964

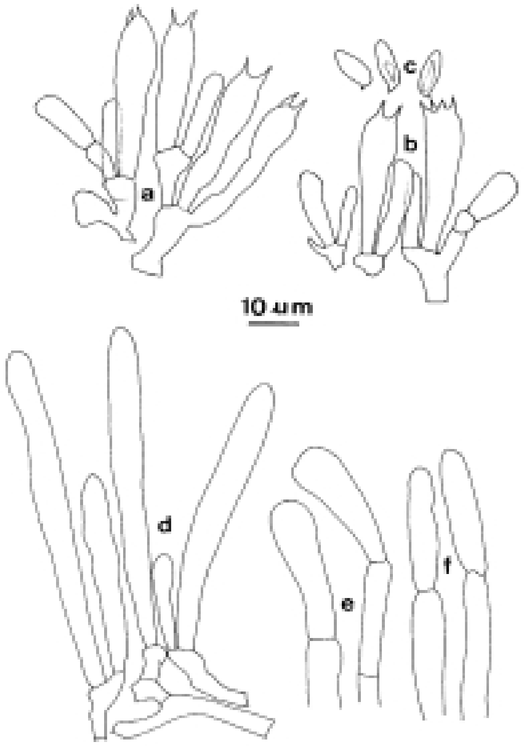

Fig. 3. *Fuscoboletinus paluster* (a, hymenium; b, basidia; c, basidiospores; d, pleurocystidia; e, caulocystidia at apex; f, caulocystidia at base).

Pileus 0.8-7 cm broad, irregularly umbonate when young, expanding to convex-umbonate or nearly plane when aged; surface floccose-tomentose covering which breaks up into fibrillose squamules; margin entire, thin, incurved; color wine red to deep red; context yellow, red under cutis, soft, unchanging when bruised; taste mildly acid, odor not distinctive. Tubes shallow (about 2 mm deep), decurrent, yellow and finally becoming dingy ochraceous, unchanging when bruised. Pores large, angular in radial arrangement or sublamellate with crossveins. Stipe 3-5 cm long, 7-10 mm thick, equal to tapering downward, solid, surface finely pruinose; concolorous with pileus, yellow band at apex covered with decurrent reticulation, base yellow mycelioid; context yellow to pallid, soft, unchanging when bruised. Spore deposit dark purplish brown when moist, pinkish brown when air-dried. Spores 9-11.5 x 3.5-4.5 μm, inequilateral, narrow, slight suprahilar depression in profile, oblong in face view, smooth, hyaline in KOH, yellow in Melzer's. Basidia 29-35 x 7-8 μm, elongate-clavate to subcylindrical, thin-walled, 2 or 4–spored,

Fig. 4. Basidiomes (a and b, *Fuscoboletinus glandulosus*; c and d, *Fuscoboletinus grisellus*; e, *Fuscoboletinus ochraceoroseus*; f, *Fuscoboletinus paluster*; scale bar = 1 cm) .

sterigmata 5–7 μm long, hyaline in KOH, pale yellow in Melzer's. Pleurocystidia 55–104 x 6.5–11 μm, subcylindric, apices rounded, thin-walled, hyaline in KOH, pale yellow in Melzer's. Cheilocystidia 20–80 x 6–11 μm, cylindric, clavate to subventricose, thin-walled, hyaline in KOH, pale yellow in Melzer's. Caulocystidia at apex of stipe 25–52 x 8-10 μm, subcylindric, clavate to clavate-mucronate, thin-walled, hyaline in KOH, at the base 25–40 x 6–9 μm, mostly clavate, septate, terminal element often obclavate, thin-walled, hyaline in KOH. Tube trama interwoven type, hyaline in KOH, nonamyloid, basal cell with clamp connections but difficult to find. Pileal cuticle a non-gelatinous trichodermium, end cells 7–12 μm thick, pale yellow in KOH, red to red-brown in Melzer's.

Collection Locality：Taitung County, Shiang-Yang, elevation 2,312m, C. M. Chen 2933 (14. Ⅶ. 2001.).

Habitat: Solitary to densely gregarious under *Pinus taiwanensis* Hayata in summer.

Distribution: Taiwan, Japan, North America, China (Sichuan).

Remarks: *F. paluster* is distinguishable from its congeneric species by having vinaceous red pileus, large and almost lamellate hymenophore, and the reaction of hyphae of its trichodermium in Melzer's. It is closely related to *Boletinus asiaticus* Sing., but the two species are distinguishable in the field. *B. asiaticus* has fistulose stipe and prominent partial veil, of which the latter covers lamellae from the stipe to the margin of pileus, whereas *F. paluster* has a solid stipe and evanescent annulus. Also, *B. asiaticus* has pileus of 4–12.5 cm in diameter, longer than 0.8–7 cm for *F. paluster*, and the former has spores of 10–12 μm in length, longer than 8–10 μm for the latter.

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Amynthas hsinpuensis (Kuo, 1995) as a Synonym of *Amynthas rockefelleri* (Chen, 1933)
(Megascolecidae: Oligochaeta)

新埔遠盲蚓*Amynthas hsinpuensis* (Kuo)定爲洛克斐勒遠盲蚓*Amynthas rockefelleri* (Chen)之同種異名

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Abstract

Characters were compared among the type specimens of *Amynthas hsinpuensis* (Kuo 1995) from Hsinchu, Taiwan and *Amynthas rockefelleri* (Chen 1933) from Chekiang, China, and specimens of *A. rockefelleri* from Taipei, Taiwan. They were undistinguishable in the characters and thus, *A. hsinpuensis* is synonymous to *A. rockefelleri*.

摘 要

新埔遠盲蚓*Amynthas hsinpuensis* (Kuo)爲1995年郭登志所發表，採集自新竹的新種蚯蚓。本文比較新埔遠盲蚓之模式標本、採自中國大陸浙江省洛克斐勒遠盲蚓之模式標本、以及採自台灣的洛克斐勒遠盲蚓三者之描述，發現新埔遠盲蚓與洛克斐勒遠盲蚓無種間之區別，故定新埔遠盲蚓爲洛克斐勒遠盲蚓的同種異名。

Key words: *Amynthas hsinpuensis*, *Amynthas rockefelleri*, synonym

關鍵詞：新埔遠盲蚓*Amynthas hsinpuensis*、洛克斐勒遠盲蚓*Amynthas rockefelleri*、同種異名

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Kuo (1995) collected six specimens of megascolecid earthworms from Hsinpu, Hsinchu County, Taiwan, and described them as a new species, *Pheretima hsinpuensis* (erroneously spelled as *Pheretima hsinpuesis*). It is a sexthecal earthworm of 110-120 mm in total length, with three setal lines on ventrum of clitellum, each with 8 setae, and paired genital papillae in VIII and XVII. It has rudimentary prostate glands and spermathecae with different stages of degeneration in size and number. According to the classification system of Sims and Easton (1972) for the genera of the *Pheretima* species complex of the family Megascolecidae, Tsai *et al*. (2000) assigned *P. hsinpuensis* to the genus *Amynthas* as *Amynthas hsinpuensis* (Kuo).

Table 1 compares the characters of *A. hsinpuensis* described by Kuo (1995) for the type specimens from Hsinchu, and *A. rockefelleri* described by Chen (1933) for the type specimens from Chekiang, China, and by Tsai (1964) for the specimens collected from Taipei, Taiwan. Both *A. hsinpuensis* and *A. rockefelleri* share the similar characters on setal number on ventrum of clitellum, number of spermathecal pores and positions, number, structure and positions of genital papillae in both preclitellar and postclitellar regions, and rudimentary prostate glands and spermathecae. However, *A. rockefelleri* from Taipei has no prostate glands (Tsai 1964), while *A. rockefelleri* from China (Chen 1933) and *A. hsinpuensis* from Hsinchu has no prostate gland on one side and a normal to rudimentary prostrate gland on the other side. Based on the characters compared, *A. hsinpuensis* is undistinguishable from *A. rockefelleri*.

Accordingly, we consider that *Amynthas hsinpuensis* (Kuo 1995) is a synonym of *Amynthas rockefelleri* (Chen 1933), which belongs to the *gracilis* (= *hawayanus*) species-group of the genus *Amynthas* (Sims and Easton 1972) in the family Megascolecidae.

Amynthas rockefelleri is a peregrine earthworm with its original home in Chekiang, China (Chen 1933). It is also found in the Yakushima Island of the Ryukyus (Kobayashi 1941), Taipei (Tsai 1964), Hsinchu (Kobayashi 1938a, b) and Ilan (Chen and Shih 1996) of the northern Taiwan, and Hong Kong (Chen 1935). In the 1999 earthworm survey in the central Taiwan, we collected two specimens around the vicinity of Wushe, Nantou County at an elevation of about 1000m.

Easton (1981) considered *A. rockefelleri* (Chen) as a synonym of *Amynthas papulosus* (Rosa 1896). However, *A. rockefelleri* has two pairs of genital papillae in VIII and XVII, each large, round with flat or convex center (Chen 1933; Tsai 1964), whereas *A. papulosus* has numerous, small presetal and postsetal papillae in horizontal rows at least in XVII, XVIII and XIX and often in VII, VIII and IX (Shen *et al*. 2002). Both species are easily distinguishable by the size, structure and position of genital papillae alone. Accordingly, we considered that *A.*

Table 1. A comparison of characters between *Amynthas hsinpuensis* (Kuo) and *Amynthas rockefelleri* (Chen)

Character	*A. hsinpuensis* (Kuo 1995)	*A. rockefelleri* (Chen 1933)	*A. rockefelleri* (Tsai 1964)
Locality	Hsinchu, Taiwan	Chekiang, China	Taipei, Taiwan
Body length (mm)	110-120	85-130	82-122
Segment number	110-117	108-142	121-135
First dorsal pore	-	11/12	11/12
Prostomium	Epilobous	Epilobous	-
Setal number			
III	-	38-54	-
VI	-	58-70	-
VIII	-	58-75	58-74
XII	-	46-68	-
XIV (clitellum)	8	6-8	6-7
XV (clitellum)	8	10-14	7-9
XVI (clitellum)	8	12-16	10-12
XX	-	-	49-59
XXV	-	52-62	-
between male pores	11-12	12-16	10-12
Spermathecal pores	3 pairs (5/6-7/8)	3 pairs (5/6-7/8)	3 pairs (5/6-7/8)
Spermathecae	Last pair bigger than anterior pairs	First pair smallest, last pair largest	-
Genital papillae			
preclitellar	One pair in VIII	One or two pairs in VIII	One or two pairs in VIII
postclitellar	Large, postsetal in XVII, paired, medial to each male pore	Large, 2-4 postsetal in XVII, paired, medial to each male pore	Large, postsetal in XVII, paired, medial to each male pore
Hearts	4 pairs (X-XIII)	4 pairs (X-XIII)	-
Intestine enlarged from	XV	XVI or XVII	XV or XVI
Caeca	XXVII-XXIV or XXVII-XXIII	XXVII-XXIV or XXVII-XXIII	XXVII-XXIV
Testis	2 pairs	Large, paired in X, XI	Large, paired in X, XI
Seminal vesicle	-	Small	Small
Prostate glands	Normal in one side or tubular, twisted	Absent in most cases, normal in one side occasionally	Absent
Accessory glands	-	Large, compact mass	Large, compact mass

rockefelleri (Chen 1933) is a valid species in the *gracilis* species-group within the genus *Amynthas* (Sims and Easton 1972).

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台灣產舖地蜈蚣屬一新紀錄種—細尖栒子

Cotoneaster apiculatus Rehd. *et* Wils.：A New Record to the Flora of Taiwan

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摘要

本文報導台灣產舖地蜈蚣屬(薔薇科)一新紀錄種—細尖栒子(*Cotoneaster apiculatus* Rehd. *et* Wils.)。本種與平枝舖地蜈蚣及高山栒子較爲相似，但本種爲直立性落葉灌木，高可達2m；而後二者爲匍匐性灌木，高0.5m以下，甚易區別。本種目前發現於南投縣與花蓮縣交界之合歡山區及高雄縣南橫公路關山地區，海拔2,300–3,200m，族群數量不多。

Abstract

This paper describes *Cotoneaster apiculatus* Rehd. *et* Wils. as a new record to the flora of Taiwan. It is an erect, deciduous shrub with the maximum height of 2m, differing from its congeneric native species *Cotoneaster subadpressus* Yü and *Cotoneaster horizontalis* Dence., which are climbers of less than 0.5m in height. The previously known distribution range of *C. apiculatus* was in southwestern China. In Taiwan it was found at Mt. Hohuan between Nantou and Hualien prefectures, and in the Kuanshan area of Kaoshong prefecture, at elevations between 2,300m and 3,200m.

關鍵詞：細尖栒子、舖地蜈蚣屬、新紀錄種、台灣

Key words: *Cotoneaster apiculatus*, new record, Taiwan

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舖地蜈蚣屬(*Cotoneaster* Medik.)(薔薇科)約有90種，廣泛分布於亞洲、歐洲和北非的溫帶地區(俞及陸 1974)。最早的研究，認爲本屬在台灣有2種，分別爲台灣舖地蜈蚣(*Cotoneaster konishii* Hayata)和玉山舖地蜈蚣(*Cotoneaster morrisonensis* Hayata)，前者爲直立型灌木，後者爲匍匐性灌木(Liu and Su 1977; Ohashi 1993)。後來Hsieh and Huang(1997)將台灣產本屬植物訂正爲4種，分別爲平枝舖地蜈蚣(*Cotoneaster horizontalis* Dence.)、台灣舖地蜈蚣、玉山舖地蜈蚣及樂山舖地蜈蚣(*Cotoneaster rokujodaisanensis* Hayata)。再加上賴及謝(2001)報導之一新紀錄種高山栒子(*Cotoneaster subadpressus* Yü)，台灣舖地蜈蚣屬之植物已知有5種。

這一、兩年，作者從南投縣與花蓮縣交界之合歡山區及高雄縣南橫公路關山地區採到本屬另一新紀錄植物──細尖栒子(*Cotoneaster apiculatus* Rehd. *et* Wils.)。本種爲落葉性直立小灌木，高可達2m，老枝常爲灰黑色；葉片革質，近圓形或寬卵圓形，先端有細短尖，成熟葉中肋及邊緣被毛，其餘光滑稀有毛。花常單生或2–3朵聚生，花瓣直立，深紅色，然末端漸白 (圖1)。本種與平枝舖地蜈蚣及高山栒子較爲相似，但本種爲直立性落葉灌木，高可達2m ；而後二者爲匍匐性灌木，高僅0.5m，可以互相區別。另外台灣產本屬植物中，台灣舖地蜈蚣亦爲直立性落葉灌木，但該種葉片較大 (2–9 cm長)，花常爲3–5朵的繖房花序，而本種的葉片小型(6–15 mm長)，花常爲單生，可以互相區別。在花粉上，本種爲3溝孔粒，表面具細穿孔(圖2)。

圖1. 細尖栒子花部及果部性狀。由上圖中可見其花瓣不展開，基部爲深紅色，先端漸白。下圖可見其果熟時近球形而略長，具短柄，艷紅色。

Fig. 1. Color photograph of *Cotoneaster apiculatus* Rehd. *et* Wils. showing upright, dark red petals with white tips of flowers (upper figure) and globose fruits (lower figure).

細尖栒子分布於中國甘肅、湖北、四川和雲南，偶見於海拔1,500–3,100m之山坡路旁或林緣等地(俞及陸 1974)。台灣於合歡山區及關山皆有分布，生於海拔2,300-3,200m之玉山箭竹草生地中或路旁、林緣處，族群數量不多。

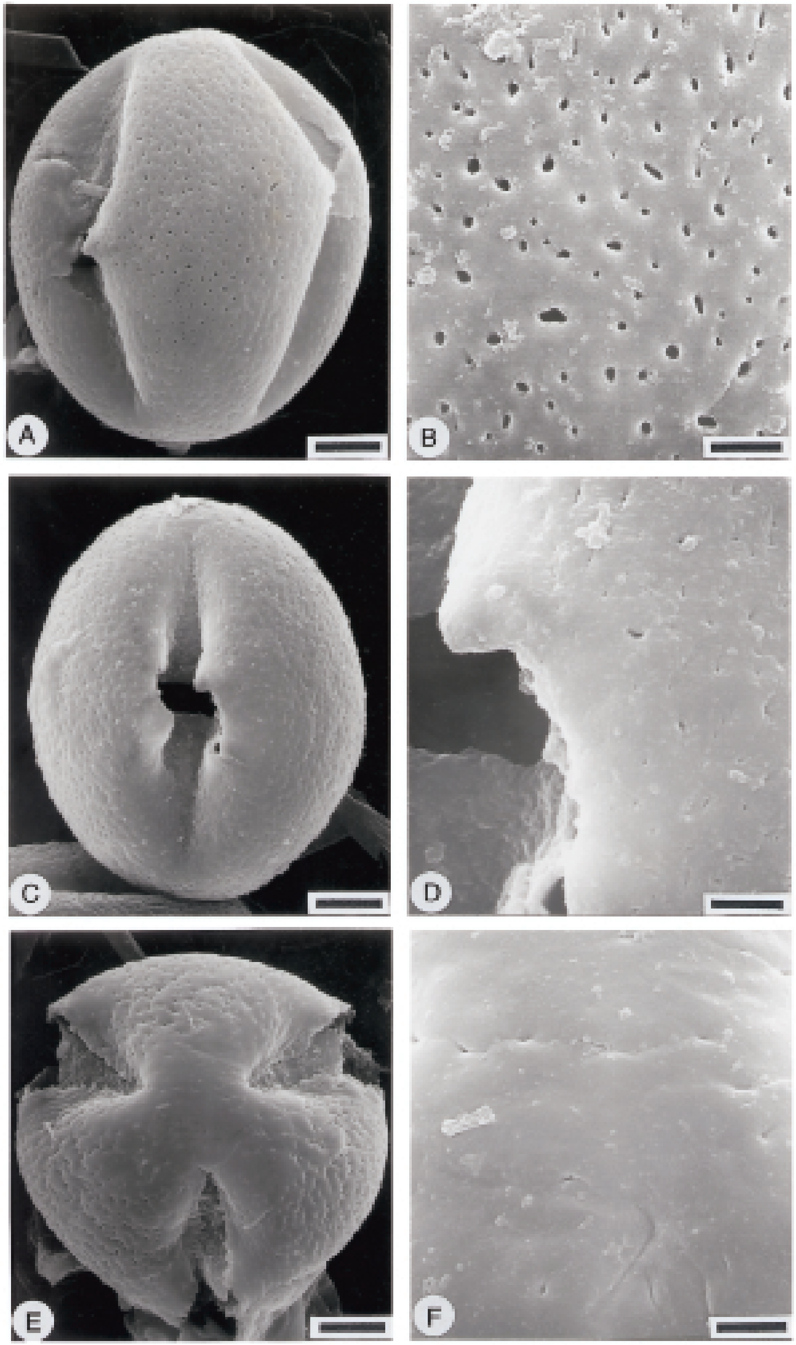

圖2. 細尖栒子花粉電子顯微鏡相片圖。表示本種爲3溝孔花粉粒，表面紋飾爲細穿孔。比例尺：A, C, E=4 μm, B, D, F=1 μm.

Fig. 2. Electron micrographs of pollen grains of *Cotoneaster apiculatus* Rehd. *et* Wils. showing 3-colporate and perforate ornamentation (scale bar=4 μm for A, C, and E; and 1 μ m for B, D and F).

細尖栒子、台灣舖地蜈蚣和玉山舖地蜈蚣在合歡山區及關山皆有分布；高山栒子目前只發現於合歡山區；平枝舖地蜈蚣則發現於合歡山區和南湖山區。從這些新分布資料來看，本屬的種類、數量及分布皆比以前知道的更多。

感謝北京植物所李振宇教授和陸玲娣教授協助鑑定標本，並提供寶貴的意見。台灣大學理學院貴重儀器中心林錦燕小姐和湯致遠先生幫忙拍攝花粉的電子顯微鏡相片。

以下描述係根據台灣的標本：

Cotoneaster apiculatus Rehd. *et* Wils., in Sarg. Pl. Wils. 1: 156. 1912; 中國高等植物圖鑑 2: 200。圖2130. 1972; Yü *et* Lu, in Fl. Reip. Popu. Sin. 36: 168. 1974.

落葉性直立小灌木，高可達2m，分枝不規則，小枝灰黑色，枝條幼時被伏毛，成熟時脫落。葉片革質，卵圓形或近圓形，長0.6–1.5 cm，寬0.5–1.0 cm，先端細短尖，基部寬楔形至圓形，上表面光亮，無毛，下表面幼時密生柔毛，成熟時僅葉脈及葉緣被較多毛，餘稀疏。葉中肋及側脈在上表面凹陷，下表面突起；葉柄短，長1–3 mm，幼時具柔毛，成熟時較稀疏；托葉線狀披針形，成熟時脫落或部分宿存。花常單生或 2–3朵聚生，具短梗；萼筒外面密生柔毛，萼片三角形；花瓣直立，深紅色，然末端漸白(圖1)，倒卵形或近圓形，長3–5 mm，寬2–3 mm，先端鈍，基部有短爪；雄蕊10–15枚；花柱常3，離生，比雄蕊短；子房密生柔毛。果實熟時近球形而略長，由橙轉艷紅色(圖1)，具短柄，直徑約5–8 mm，通常具3小核。花期爲5-6月，果期則爲10-11月，分布於南投縣與花蓮縣交界之合歡山區及高雄縣南橫公路關山地區，於海拔2,300–3,200m之玉山箭竹草生地、步道兩側、公路邊坡或林緣可見之。

觀察標本：南投縣與花蓮縣交界：合歡北峰，*賴國祥*、*曾耀德 168, 234, 236, 438* (特有生物研究保育中心高海拔試驗站標本室)；呂勝由 25291 (TAIF)；高雄縣：南部橫貫公路(關山)，*謝宗欣 2551, 2552, 2553* (NTNTC)；黃星凡、吳明洲 5387 (TAI)；*謝宗欣 4852* (NTNTC)。

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台灣新歸化的茄科有害植物—銀葉茄

Solanum elaeagnifolium Cav. (Solanaceae): A Noxious Weeds Newly Naturalized to Taiwan

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摘 要

茄屬植物爲茄科的一個大屬約共有1,200種。台灣植物誌記載了18種。本研究報導1新歸化於台灣南部及澎湖地區的有害植物—銀葉茄，本植物具刺，葉爲披針形，明顯不同於台灣野生的其他茄屬植物。本文提供此新歸化種的描述、分布及彩色照片。

Abstract

Solanum comprises about 1,200 species and is one of the largest genera in the family Solanaceae. In Taiwan 18 species of *Solanum* have been recorded. This paper describes *Solanum elaeagnifolium* Cav. as a new record to the flora of Taiwan. It is a noxious weed and found in southern Taiwan and the Penghu Islands. *S. elaeagnifolium* is easily distinguished from its congeneric species in Taiwan by having spines on branches and lanceolate leaves.

關鍵詞：茄科、茄屬、銀葉茄、歸化、台灣

Key words: Solanaceae, *Solanum, Solanum elaeagnifolium*, naturalized, Taiwan

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茄科爲被子植物的一個大科，全球約有95屬2,300種，台灣野生的約有12屬30種，其中有75%爲歸化屬。茄屬爲茄科第一大屬，全球約有1,200種，主要產於熱帶及亞熱帶地區，尤其是美洲地區更是其主要分布地，台灣植物誌第二版記載有18種，且其中超過一半爲歸化植物(D'Arcy and Peng 1998)。近年來對台灣茄科植物相關研究的有劉業經及歐辰雄(Liu and Ou 1974; Ou and Liu 1975)、郭長生等(郭及吳 1978；郭等1980)、應紹舜

Fig. 1. Color photographs of *Solanum elaeagnifolium* Cav., (A) habitat, (B) weed shape, (C) flower, and (D) fruits.

(Ying 1997)及撰寫植物誌第二版茄科植物的D'Arcy 及彭鏡毅(D'Arcy and Peng 1998; D'Arcy *et al*. 2001)。本中心近幾年進行植物資源調查，發現另一歸化於屏東縣及澎湖縣的茄屬植物，經資料比對爲原產於美洲之銀葉茄，據美洲地區資料顯示，本植物爲一有害植物並廣爲擴散，目前於澳洲、南非、埃及、希臘、以色列、西班牙及印度(Boyd *et al*. 1984)等地皆已歸化。

感謝農委會提供經費研究。中央研究院植物所、國立自然科學博物館、林業試驗所等單位標本館管理人員提供標本查詢之協助。

Solanum elaeagnifolium Cav., Icones et Descriptiones Plantarum 3: 22. *t*. 243, *p*. 115. 1795. 銀葉茄 Fig. 1.

有刺小灌木，全株密被星狀毛；葉互生，葉柄長1–2.5 cm，無刺或疏生刺，葉長披針形，長3.5–7 cm，寬1.2–2 cm，基部鈍至截形，先端鈍，兩面密被星狀毛，銀白色，葉緣爲全緣或波狀緣，側脈約7對，表面凹背凸；花序生於莖上，與葉對生或近對生，單生或3朵排成總狀花序；花梗長約1 cm，密被星狀毛，散生細刺；花萼合生，先端5裂，裂片針狀，長約2 mm；花冠合生，藍紫色，背密被星狀毛；雄蕊5枚，黃色，頂孔裂；花柱長約1.2 cm；果球形，徑約1 cm，疏被星狀毛，萼宿存。

引證標本：**TAIWAN**. PINGTUNG: Wandai, Shianan (萬丹鄉廈南村), 27 Apr 2001 *Hsu s. n.* (TESRI). PENGHU: Penghu, *Tseng 2427* (TESRI).

銀葉茄爲新近歸化於台灣南部及澎湖地區的物種，根據文獻資料記載此爲一有害的物種(Boyd *et al.* 1984)。此植物特徵爲多年生之有刺植物，高不及1m，葉爲長披針形，邊緣具波浪緣，銀白色；開藍紫色的花，明顯不同於台灣其他野生的茄屬植物。銀葉茄通常生長於平地之空曠地區，果實對家畜有毒。根據野外調查，本植物於南部地區見於牧場之草地，尚不普遍，澎湖的族群量較大，生長於開闊的草地上。

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