內政部八十六年度研究報告

# 玉山國家公園帝雉族群動態及不同生育地生態學之研究
# Population Dynamics and Ecology of Mikado Pheasants in Two Contrasting Habitats inside Yushan National Park, Taiwan

執行單位：玉山國家公園管理處
研究機關：東海大學生物系
研究主持人：歐保羅、林良恭
研究人員：喬雅玲

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## 前言與研究回顧

對於黑長尾雉的研究，開始於西元 1975 年( Severinghaus 1997)。這個對於台灣全島的徹底調查發現黑長尾雉主要分佈在高海拔的原始和次生林的地區，並且與次生林的棲地中存在著相關係。在 1991 年，Bridgman 針對屬於次生林地區的觀高一個族群，進行無線電追蹤的研究，證實黑長尾雉可以分布於次生林地區( Bridgman 1994 )。

近年來，黑長尾雉被認為是台灣一瀕臨絕種的物種，但 McGowan & Garson ( 1995 )卻認為黑長尾雉在台灣的生息現況是屬於安全的物種 ( safe species )，而無絕種的壓力，主要原因是牠的分布範圍是包括於嚴格取締狩獵的三個國家公園內。因此黑長尾雉的實際生息狀況地位仍是疑問的。

目前對於在原始林地區黑長尾雉的了解是極少的，亦缺乏黑長尾雉利用原始與次生林棲地之比較性的研究。而於玉山國家公園內，黑長尾雉可分布於觀高( 次生林地)與對關(原生林地)地區( Severinghaus 1997,Severinghaus and Severinghaus 1987,Alexander et al. 1990, and Bridgman 1994 )。似乎兩個棲地上有明顯的差異，在這兩個研究地區，黑長尾雉的族群大小與行為值得比較（見實驗地描述部份）。本年的調查以開始收集這類研究的資料，來了解這種鳥類的生態，提供制定及施行保育的標準。

有關黑長尾雉的族群動態統計學的知識亦是缺乏的，在本年度的研究內，已收集到第一年的死亡率資料。但樣本數量還不夠大到足以在年齡效應，性別或棲地上做結論。然而，現在的確知道觀高的冬季死亡率主要是由猛禽及小型食肉目動物所捕食。不過，本年度研究在技術上得到了一個教訓；頸圈式的發報機對於黑長尾雉來說是不適當的，這種方法直接造成了少數個體進食的死亡。

另外，本年度研究亦發現知道雄黑長尾雉至少可以存活 6 年，郡大林道黑長尾雄的族群數量是比 1991 年來得少的。目前尚無法得知是什麼原因造成減少？是否而族群量減少與 1996 年 8 月的颱風所導致。

國家公園的目的之一是為未來的子孫及地球的健康保存自然的環境（植物與動物群聚）。一張包含了園區內物動的名單是不足以擔保安全的。在這些園區內的物種族群生息狀況是安全或是銳減之前，應該了解這些物種的生態習性。

就黑長尾雉而言，了解這物種的族群動態是相當重要的，假使我們現在在有適當的族群量時不研究他，以後要幫牠可能會太遲的。事實上，目前牠們的族群是穩固或是減少的尚不能肯定，因此有關未來這三年的研究，了解牠們的死亡率及生殖力之後，將可以明確評估黑長尾雉的狀態。

**實驗地區描述**

郡大林道不再有車輛出入，而觀高這個森林地區早已被砍伐過。八通關古道的對關小徑則常被登山客使用，本區是在一原始的森林內。兩個地區都在海拔約 2500 公尺，且兩者都有黑長尾雉的族群，所有的跡象指出在 1996 年 11 月之前，在郡大林道很少有或幾乎沒有人類的活動，這沒有人類的活動和影響可能已持續了幾年。

研究方法

**實驗地準備**

1996 年 7 月時，郡大林道上的雜草生長過盛，因而無法通行，在 7 月結束時，2 公里的林道被修剪得足以通行，每隔 20 公尺做標記，以木樁從 67.5 公里處到 65.26 公里處，對關小徑亦是以同樣方法從 14.38 公里到 10.16 公里處做標記。這些木樁是用來當做無線電追蹤時，從三角定位決定黑長尾雉的位置。它們對於決定觀察到的黑長尾雉與其他哺乳動物之正確位置也是有用的。

**捕捉**

從 1996 年 9 月至 1996 年 11 月以及在 1997 年 3 月在郡大林道與對關小徑設置陷阱，陷阱的設置是依照原住民傳統的設計，抓住鳥的足部，不放任何誘餌。陷阱直接放置在道路上或小徑上，陷阱在白天時都被監視，而在使用後完全部拆除。

**測量**

捕捉到的個體皆測量，測量上二個色環於腳上與一無線電發報機。在 1997 年 1 月前，發報機以頸圈的方式掛於頸部砂布之上，砂布之下如此，天線彎曲穿過肩部，朝向背部。頸圈配掛的鬆緊度不致於使發動機滑動，也不會緊到阻礙了呼吸與食物的通過。在 1997 年 1 月以後，發報機配掛在每隻捕捉到的個體的背部。在 2 個肩胛骨之間，以皮帶綁在個體的身上，翅的前後。繩帶與發報機皆隱藏於羽毛下。

發報機內藏有一個屬於探知鳥類死亡的開關，當連續 11 個小時不活動後，發報機的頻率會從慢變快，如此，直接聽發報機的聲音即可知道個體的狀態。發報機重 20 克，是一隻 500 克個體體重的 5%。發報機包含了可以維持 18 個月的電池。

**觀察**

道路與小徑用來監視黑長尾雉的活動，並記錄其他動物的活動。任何動物的死亡痕跡象皆記錄。其他哺乳動物活動的痕跡亦記錄之。

**找回死亡個體**

進行無線電追蹤，死亡的訊號發出時，則立刻尋找，試圖找到死亡個體。當找到時，拍照記錄死亡個體及地點並描述此地點與死亡原因。殘骸帶回東海大學，保存於冰箱以便日後做形態學或死亡原因的進一步研究。這些研究尚未

進行。

## 結果

從 1996 年 9 月到 1997 年 6 月，共進行了 105 的工作日，各實驗地所花時間各半。在這些日子中，44 天為捕捉日，共設了 159 個陷阱。在這期間，在林道或小徑上共觀察到 123 次的黑長尾雉，並常觀察到獼猴、山羊與山羌。共捕捉到 24 隻黑長尾雉，其中 11 隻在 1996 年 10 月到 1997 年 1 月之間死亡。在 1997 年 6 月時，只有 5 隻個體配掛了無線電發報機，另外亦捕捉到黃鼠狼、獼猴、山鷸與金翼白眉，皆立即釋放。詳見表 1 之說明。

## 黑長尾雉與哺乳動物之活動

表 2 為 1991 年秋天與 1996 年秋天捕捉與遭遇黑長尾雉及其他哺乳動物之比較。黑長尾雉的遭遇與捕捉各減少了 33%與 50%。哺乳動物則是增加了 33%至 100%。

## 人類的活動

人們在郡大林道的活動隨著這個計畫與道路的清除而重新開始。在 1996 年 11 月，玉山國家公園開始修復觀高小屋與從觀高瀑布的導水管。這些人清除了觀高到瀑布的後面，且清理了觀高地區。而 1996 年 11 月，林務局方面也派人開始開闢從八通關，經觀高坪，翻過郡大山的防火巷，這些人也做了一些清理郡大林道的工作。他們從 1996 年 11 月到 1997 年 3 月，觀高或郡大林道上，遊客的活動也漸漸增加。

## 計畫努力

從 1997 年 3 月到 6 月的資料用三角定位來定出一隻黑長尾雉的位置平均

要花 25 分鐘與步行 422 公尺，某些位置更要花上 1 小時與步行 1.5 公里遠（表 3）。

**形態**

表 4 為 1991 年秋天、1996 年秋天與 1997 年 3 月所捕獲到個體之外表特徵變異，雖是在不同的時間、實驗地，前兩者的外表特徵是相似的。即使隔了 5 年，同在郡大林道所捕捉的個體可以用來比較秋天與春天時的差異，其間體重顯著地增加，而其他特徵則相似。

**死亡情形**

1996 年秋天，11 隻配掛頸圈式發報機的個體中，有 10 隻在配掛發報機後的 3 個月內死亡（1996 年 11 月到 1997 年 1 月）（圖 1）。這其中的 2 個死亡個體確定是頸圈的配掛方式造成的－因為牠們吃了太大的殼斗，無法通過頸圈而餓死；其他的死亡則是由於盜獵、猛禽和小型哺乳動物的捕食與不明原因（圖 2）。對於 2 個不明原因的死亡個體，沒有證據證明是否由殼斗或是捕食造成，因為骨頭仍是完整的。

唯一存活的雄鳥，在 6 個月之後再捕捉到，並且改成背包式的發報機配掛方式，牠 3 公分寬的頸圈，已磨掉了頸部的羽毛。牠 3 個月再捕捉時的體重為 925 克，與其他 4 隻在同一月份捕獲的雄性個體是相似的，但是在平均之下（ 1045 克；N=5）。有另一隻雄性個體有同樣的重量。

有一死亡個體是沒有配掛發報機的，是一隻雌鳥，3 月初在郡大林道被猛禽所捕食。從 9 月到隔年 3 月，另有 4 隻死亡個體在林道與小徑上被發現（表 5）。這此死亡是由於猛禽的捕食，表 6 列出了無線電配掛的個體，牠們的配掛的地點與牠們的狀態及死亡原因。

## 壽命

2 隻於郡大林道再捕捉的個體是 1991 年到 1992 年標記的個體，這兩隻雄鳥在 1991 年 9 月 25 日與 1992 年 4 月 21 日捕捉時是幼鳥，目前已有 6 年的壽命，體重分別是 1250 克與 975 克。其他的雄性個體，除了一隻在對關小徑捕獲的個體，皆比這兩隻輕 50~250 克。

## 行為

在整個實驗的期間，只有目擊 2 次幼雛或是幼鳥，皆是在對關小徑。大部份的目擊都是單一隻個體，1997 年 3 月開始時才觀察到有成對的情形，1997 年 6 月初時並未觀察到幼雛。

在 1997 年 3 月發現雄鳥打鬥的跡象，有足夠證據暗示著這是很激烈的打鬥。一隻捕捉到的雄性個體喙上流血，另一隻的腳距上也有血跡。

## 無線電追蹤

雄性個體的活動範圍整年與雌性個體與其他雄性個體重疊（圖３－６）。1996 年秋天與 1997 年冬天的資料顯示雌性個體的活動範圍在秋天並不會重疊（圖 4 與 5），1997 年春天的資料不足但活動範圍在春天似會擴大。

在對關小徑的一隻雄性個體（＃0311）有不連續的活動範圍。牠有 2 個活動中心，相隔了 1 公里遠。大部份的無線電定位都是在南方的地點（較高海拔，且接近觀高坪）。在 1996 年 9 月，牠出現在靠北邊的地區之後，移動到南邊，從 10 月一直到 1997 年 1 月。在 1997 年 2 月，牠又回到原來靠北邊的地區，整個三月都待在此處。從 1997 年 4 月至今，牠一直在靠南邊的地區。當牠出現在靠北邊的地區時，牠的活動範圍與另一隻雄性個體（＃0369）重疊，而且牠就是在這個地區被捕捉到的。確定的是，由牠流血的腳距來看，牠在這個地區曾有打鬥，有可能是和＃0369 的雄性個體。圖 7 顯示＃0311 雄

性個體整年的活動範圍。＃0749 雄性個體也顯示了相似的不連續活動範圍，但範圍較小（圖 6）。牠主要的活動範圍集中在一隻較大且較重的雄性個體的＃0406 外圍。有 2 個時期，這兩隻雄性個體活動範圍是重疊的，且這重疊的現象只發生了幾天而已。

在 1997 年春季，只有一隻在郡大林道的雌鳥的無線電資料，牠的活動範圍主要與＃0406 雄鳥重疊，但與＃0749 雄鳥也有某些重疊（圖 6）。

## 討論

### 族群減少

1996 年秋季捕捉成功率及觀察記錄減少，與 1991 年秋天的觀察比較，顯示了自 1991 年以來黑長尾雉族群的減少。某些觀察上的減少可以由郡大林道的狀況來解釋，因林木的過度生長而很難見到黑長尾雉，然而觀察的特性仍顯示這個族群的下降。1996 年秋天，幾乎沒有幼鳥的觀察記錄，這個暗示至少在 1996 年黑長尾雉的生產力是不好的，可能是由於 1996 年 8 月初的颱風造成南投縣的大破壞，因而影響了園區內黑長尾雉的族群。不幸地，在颱風前並沒有黑長尾雉的觀察工作，這意味著不可能比較颱風前後黑長尾雉的活動與族群數量。這個減少可能不是由人們的活動造成的，因為在 1996 年 11 月之前沒有打獵的跡象。這可以更進一步地由實驗地大哺乳動物族群數量來支持，比 1991 年有更多與獼猴、山羌、野豬與山羊遭遇的記錄。

### 形態

黑長尾雉秋天時的體重可能是最低的，在這個時候，生殖季節已結束。整個冬天與早春，牠們擴張活動範圍、體重增加，這可能是為了育雛季節的開始做準備。

**發報機所導致的死亡**

兩隻雌性個體因為吃的食物太大而無法通過發報機頸圈而死亡，配掛這個形式的發報機是因為好配掛及在行為上的影響很小（Kenward, 1987）。這是對於雞形目做無線電配掛最常用的方法。然而，頸圈對黑長尾雉來說是不適合的，不只這種方式會導致死亡，亦會對個體造成某些不適，如頸部羽毛的脫落。天線亦會有卡到翅膀的傾向。這也就是為何這種方法不使用在較常飛行的鳥類身上。

到底有多少其他的死亡是由於頸圈式的發報機所造成的是具爭議性的。發報機可能造成另兩個不明原因的死亡，而且這兩個死亡是由小型食肉目動物所造成的。在台灣對於小型食肉目動物捕食技巧所知甚少，是否牠們足以捕捉到處於狀況良好的黑長尾雉個體。由於盜獵與猛禽捕食者所造成的死亡可能是自然的，因為兩個捕食者使用了差別的方式捕獵物（個人觀察記錄；Kenward,1977 ）。所有可歸因於猛禽捕食所造成黑長尾雉的死亡皆是在暴露的礦物土層之處。這些地方不是少有的陡峭山壁、矮樹、灌叢，就是草本植物層，或是郡大林道與崩坍地般暴露的地區。

一直到這個研究之前皆不知道黑長尾雉的死亡率，然而不使用發報機就不可能研究死亡率。猛禽捕食是隨機的，而小型食肉目動物會隱藏牠們的獵物。在對關小徑與郡大林道發現猛禽捕食的 5 種 12 隻鳥中，有一隻雌性是從未被捕捉與標記的（表 5）。這些全在矮樹區被發現，某些甚至沒有樹冠層的覆蓋。很少發現自然狀況下死亡的未標記雉雞。因此很難知道消失的黑長尾雉是死亡或遷移。1991 年 7 月到 11 月標記的 19 隻黑長尾雉中，有 13 隻於 1992 年 1 月後便不見蹤跡（Bridgman,1994 ）。

黑長尾雉在冬季的死亡率非常之高（64%）可歸因於自然因素。而在這些死亡的個體中，我們可分析有 43%是被猛禽所捕食，而有 29%是被小型食

肉動物所捕食。其他雉類的無線電追蹤研究同樣地發現牠們在冬天有較高的死亡率。Zheng 等（1989）在中國大陸南方的保留區的低海拔森林中研究黃腹角雉（*Tragopan aboti*），發現有 44%的冬季死亡率，其中的 75%為猛禽捕食，另外 25%是小型食肉目動物。Dumke 和 Pils（1973）研究美國威斯康新捕食者對環頸雉的影響中發現，冬季的死亡中捕食者的影響高達 78%：其中 28%是猛禽的影響，另外有 38%是小型食肉動物的影響。與其他的季節比較起來，冬季的死亡率較高，可能是由於雪的覆蓋和缺少灌木及遮蔽物，使得可見度增高（Hill & Robertson,1988 ）。對黑長尾雉來說，導致這種季節性的死亡的主要因素應是乾季時少了雲及霧的遮掩，特別是正巧遇到灌木及樹冠季節性枯死時。

**壽命**

由 2 隻 6 歲大的雄性體重來看，暗示牠們是處於一個顛峰的狀態。在此狀態下牠們能夠贏得與其他雄性的戰鬥。牠們的體重比平均體重來得重，而其中一隻在我們抓到牠的時候，他的喙上沾有血漬，我們假設牠應該歷經一場打鬥並且應該贏得那場競賽。我沒有在牠的身上找到任何打鬥中所受的傷。

**無線電追蹤**

雄性個體有重疊的活動範圍，但牠們的活動是集中在沒有與其他雄性個體重疊之處。有兩隻雄性個體的移動暗示著在育雛期間，雄鳥會到牠們平常活動以外的地區與其他雄鳥打鬥。這打鬥的原因是不明的，因為牠們離開範圍去打鬥後又回到自己的活動範圍，所以並非是為了領域而打鬥，這也不是為了得到母鳥，因為母鳥是在這些雄鳥的平常活動範圍內的。這意味著，雄鳥不用到其他活動範圍外的地方就可以獲得雌鳥，這為了打鬥而移動的行動需要更多的研究和觀察。

非常有趣的是，1996 年秋季在對關小徑的雌性個體活動範圍是沒有重疊的，是否這是整年都如此或是只因為是育雛季節時才如此，是未知的。那些小而不重疊的活動範圍的原因亦是不明的。且我們不知道是否為了維持這些活動範圍，而在有雌鳥之處有任何的打鬥。

**結論**

從這一年來的研究，有很多新的與有趣的進展，這些進展就像讀偵探小說中的其中一個章節，因為牠們使我們問比回答的還多的更多的問題。在這個計畫的未來兩年內，這些問題與行為期中有些可能可以獲得解答，或至少有詳細的描述。

以下為我們在這一年結束時間要問的一些問題：

帝雉如何在繁殖記期間長的那麼胖？是不是在牠們如飲食之中有任何特別之處？

為什麼雌性個體之間沒有重疊的領域？牠們彼此之間有打鬥的情形嗎？雄性之間又為何會打鬥？

1998 年的冬季死亡率和 1997 年的會有什麼不同，尤其是當無線電發報器現在放置於牠們的背上而不是頸子上。

由於 1996 年的低繁殖率，1997 年的會是如何？

為什麼這些帝雉會選擇在這些地方做為活動範圍？是否在這些棲地上有某些特別的特點是牠們生存所需？

這是三年計畫中的第一年的報告。由此論點而言，要對帝雉的長期照顧與共棲環境做出任何建言是不可能的，然而，就此計畫的目的來說，有二項建議。

1. 一個全職的助理以及巡山員的輔助，此計畫的範圍大到足以使 4 個人在

每個月中至少有二個禮拜忙碌於樣區中。顧及調查員的個人安全及帝雉的安全與妥善的照顧是很重要的。這個助理將接受如何使用無線電發報器的訓練。在缺乏一個受過訓練、可靠的全職助理的情況下，要研究帝雉白天活動模式的動向幾乎是不可能的，而且當帝雉的樣品數達 48 隻時，每次在做無線電標記時，就需要一個助理。而巡山員之所以必須是由於他們對調查地區的了解對於林道及道路上安全的調查是非常有用的，同時，他們不但熟練於架設陷阱，對於樣區中許多動植物的辨識也有相當可靠的認識。

2. 在研究時期的期限之內，一年二次的修剪與清理調查區內的林道與小徑是很必要的。這樣的清理提供一種可以吸引帝雉到人類曾經接近過的獨特棲地，此外，這項清理對於捕捉、放置無線電以及對於帝雉行為的直接觀察也是很重要的。然而，現在並無法斷言這樣的清理是否該在此計畫後持續下去。當這樣的修整產生一個可以吸引帝雉的棲地時，它同時也讓帝雉及其他動物暴露在獵人的威脅之下，因為修整林道致使這個地區變得容易進入。

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# Table 1 表 1
# 調查結與樣區內動物活動情形（1996/9-1997/5）
# Survey Effort and Animal Activity in Study Area
# September 1996 through May 1997

| | 9-12/1996 | | | 1-5/1997 | | |
|---|---|---|---|---|---|---|
| | Chun Ta 郡大 | Dwei Kwan 對關 | Total | Total | Dwei Kwan 對關 | Chun Ta 郡大 |
| Days in Field （調查天數） | | | 41 | 64 | 32 | 32 |
| Trap Days （捕捉天數） | 13 | 13 | 26 | 18 | 9 | 9 |
| Snares Made （陷阱製作） | 58 | 71 | 96 | 59 | 31 | 28 |
| Mikado Pheasant 帝雉: | | | | | | |
| Caught（捕捉） | 3 | 9 | 12 | 12 | 2 | 12 |
| Dead（死亡） | 2 | 4 | 6 | 5 | 3 | 2 |
| Encountered （相遇） | 27 | 44 | 71 | 52 | 17 | 35 |
| Sign（目擊） | 19 | 11 | 20 | 29 | 10 | 19 |
| Encounters 遭遇: | | | | | | |
| Muntjac （山羌） | 10 | 0 | 10 | 14 | 5 | 9 |
| Monkey（groups） （猴群） | 11 | 13 | 24 | 21 | 6 | 15 |
| Weasel （黃鼠狼） | 0 | 1 | 1 | 5 | 1 | 5 |
| Snake （蛇） | 4 | 2 | 6 | 2 | 1 | 1 |
| Mountain Goat （山羊） | 5 | 4 | 9 | 11 | 3 | 8 |
| Wild Boar （野豬） | 5 | 0 | 5 | 1 | 1 | 0 |
| Swinhoe's Pheasant （藍腹鷴） | | | 0 | 9 | 9 | 0 |

# Table 2 表 2
## 調查結果與樣區內動物活動情形（9-12/1991,1996）
## Survey Effort and Animal Activity in Study Area
## September through December 1991,1996

| | Fall 1991 | Fall 1996 | | |
|---|---|---|---|---|
| | Chun Ta 郡大 | Total | Chun Ta 郡大 | Dwei Kwan 對關 |
| Days in Field(調查天數) | 56 | 41 | | |
| Trap Days （捕捉天數） | 36 | 26 | 13 | 13 |
| Snares Made（陷阱製作） | ? | 129 | 58 | 71 |
| Mikado Pheasant 帝雉 | | | | |
| Caught （捕捉） | 23 | 12 | 3 | 9 |
| Dead（死亡） | 0 | 6 | 2 | 4 |
| Encountered （相遇） | 212 | 71 | 27 | 44 |
| Sign（目擊） | ? | 30 | 19 | 11 |
| Encounters 遭遇 | | | | |
| Muntjac （山羌） | 0 | 10 | 10 | 0 |
| Monkey(groups) （猴群） | 3 | 24 | 11 | 13 |
| Weasel （黃鼠狼） | 0 | 1 | 0 | 1 |
| Snake （蛇） | 1 | 6 | 4 | 2 |
| Mountain Goat （山羊） | 3 | 9 | 5 | 4 |
| Wild Boar （野豬） | 4 | 5 | 5 | 0 |

# Table 3 表 3
# Work Effor 3-5/1997 工作結果

| Daily Activity<br>每日活動力 | Total | per Day (range)<br>每天 |
|---|---|---|
| Hours<br>小時 | 348 | 8(6-11) |
| Kilometers<br>公里 | 427 | 10(4-21) |
| Radio-Locations<br>無線電定位點 | 156 | 3(0-9) |

| Radio-Telemetry: | Total | per Radio-Location |
|---|---|---|
| Hours | 64.1 | 25 minutes |
| Kilometers | 65.8 | 422 meters |
| Fixes | 877 | 6 |

# Table 4 表 4
## 帝雉身體特徵之比較（1991/9-11,1996/9-11,1997/3）
## Comparisons of physical characteristics of Mikado Pheasants 9-11/1996 and 3/1997

ADULT FEMALES (average measurements)
（成體） （雌鳥） （平均測量）

| | 1991 (Chun Ta) (N=4) | 1996(Dwei Kwan) (N=5) | 1997(Chun Ta) (N=3) |
|---|---|---|---|
| 體重 Weight (g) | 700 | 710 | 1066 |
| 全長 Total Length (mm) | 560 | 560 | 557 |
| 尾長 Tail Length (mm) | 252 | 193 | 200 |
| 跗徑 Tarsus Diameter (mm) | 8.7 | 7.9 | 7.7 |
| 跗寬 Tarsus Width (mm) | 6.6 | 6.2 | 6.1 |
| 跗長 Tarsus Length(mm) | 73.9 | 73.9 | 72.2 |
| 喙長 Beak Length(mm) | 27.7 | 31.5 | 30.8 |
| 距長 Spur Length(mm) | 5.8 | 2.2 | 3.2 |

ADULT MALES
（成體） （雄鳥）

| | 1991 Chun Ta (N=7) | 1996 Dwei Kwan (N=3) | 1997 Dwei Kwan (N=2) | 1997 Chun Ta (N=3) |
|---|---|---|---|---|
| 體重 Weight (g) | 905 | 767 | 1037 | 1050 |
| 全長 Total Length(mm) | 830 | 807 | 885 | 877 |
| 尾長 Tail Length(mm) | 460 | 479 | ..... | 522 |
| 跗徑 Tarsus Diameter(mm) | 9.4 | 9.7 | 10.2 | 9.3 |
| 跗寬 Tarsus Width(mm) | 7.5 | 7.1 | 7.2 | 6.8 |
| 跗長 Tarsus Length(mm) | 79.3 | 75.9 | 79.4 | 78.0 |
| 喙長 Beak Length(mm) | 28.4 | 32.2 | 32.3 | 32.3 |
| 距長 Spur Length(mm) | 17.2 | 15.5 | 16.1 | 16.4 |

Table 5 表 5

# Avian Predation 猛禽捕食

Chun Ta Logging Road and Dwei Kwan Trail.

郡大林道與對關小徑

9/96-3/97

1 Mikado Pheasant 黑長尾雉
(not among radio-tagged birds)
非無線電裝置之個體

7 Golden Mountain Thrush 虎鶇

1 Japanese Green Pigeon 綠鳩

2 Steer's Babbler 藪鳥

1 White-eared Sibia 白耳畫眉

# Table 6 表 6
## 捕捉裝置發報機個體之狀態（3/1997）
## Status of radio-tagged birds trapped 3/1997

| ID# | Sex | Loc | Capture Date | Radio Fixes | Mortality Date | Days Survived | Cause of Death |
|---|---|---|---|---|---|---|---|
| 851 | ♀ | DK | 11/13 | 6 | 11/20 | 7 | predation-avian |
| 1111 | ♀ | DK | 11/12 | 8 | 11/20 | 8 | predation-small carnivore |
| 931 | ♂ | DK | 11/14 | 12 | 12/10 | 26 | predation-avian |
| 531 | ♀ | DK | 10/09 | 13 | 12/04 | 61 | transmitter |
| 1050 | ♂ | CT | 10/19 | 0 | before11/16 | <28 | predation-avian |
| 811 | ♀ | CT | 10/14 | 5 | before11/16 | <33 | unknown |
| 384 | ♀ | DK | 10/04 | 0 | before11/15 | <42 | unknown |
| 171 | ♀ | DK | 11/14 | 13 | 1/10 | 57 | tranmitter |
| 331 | ♂ | DK | 11/13 | 16 | before1/10 | <58 | predation-small carnivore |
| 770 | ♀ | CT | 10/20 | 20 | before1/10 | <83 | predation-human |
| 406 | ♂ | CT | 3/20 | 32 | ------- | >76 | ---------- |
| 749 | ♂ | CT | 3/19 | 31 | ------- | >77 | ---------- |
| 1189 | ♀ | CT | 3/18 | 29 | ------- | >78 | ---------- |
| 368 | ♂ | DK | 3/9 | 39 | ------- | >87 | ---------- |
| 311 | ♂ | DK | 9/21 | 82 | -------- | >257 | ---------- |

| 編號 | 性別 | 地點 | 捕日捉期 | 無位線次電數定 | 死日亡期 | 存天活數 | 死原亡因 |
|---|---|---|---|---|---|---|---|

圖１： 黑長尾雉在配掛頸圈式發報機於 1996 年秋季後的存活（天數）及造成死亡的情形

Frigure 1: Survival (days) of Syrmaticus mikado after being tagged with neckloop transmitters (Fall 1996), and cause of death.

圖２： 黑長尾雉從 1996 年 9 月至 1997 年 1 月之死亡原因

Frigure 2: Sources of mortality in Syrmaticus mikado from September 1996 through January 1997.

圖３： 玉山國家公園內 1996 年秋季黑長尾雉雄鳥的活動範圍

Frigure 3: Fall 1996 range of male Syrmaticus mikado inside Yushan National Park.

♂

| ID # | Number of Locations | Range Size 95%Adaptive Kernal |
|---|---|---|
| ♂0931 | 3 | <1 ha |
| ♂0331 | 6 | 4.3 ha |
| ♂0311 | 19 | 108.9 ha |

圖４： 玉山國家公園內 1996 年秋季黑長尾雉雌鳥的活動範圍

Figure 4: Fall 1996 range of female Syrmaticus mikado inside Yushan National Park.

♀

| ID # | Number of Locations | Range Size 95%Adaptive Kernal |
|---|---|---|
| ♀0770 | 10 | 2.2 ha |
| ♀0811 | 6 | < 5 ha |
| ♀0851 | 13 | 5.0 ha |
| ♀0531 | 13 | 2.1 ha |
| ♀1111 | 10 | 2.2 ha |
| ♀0171 | 3 | < 2 ha |

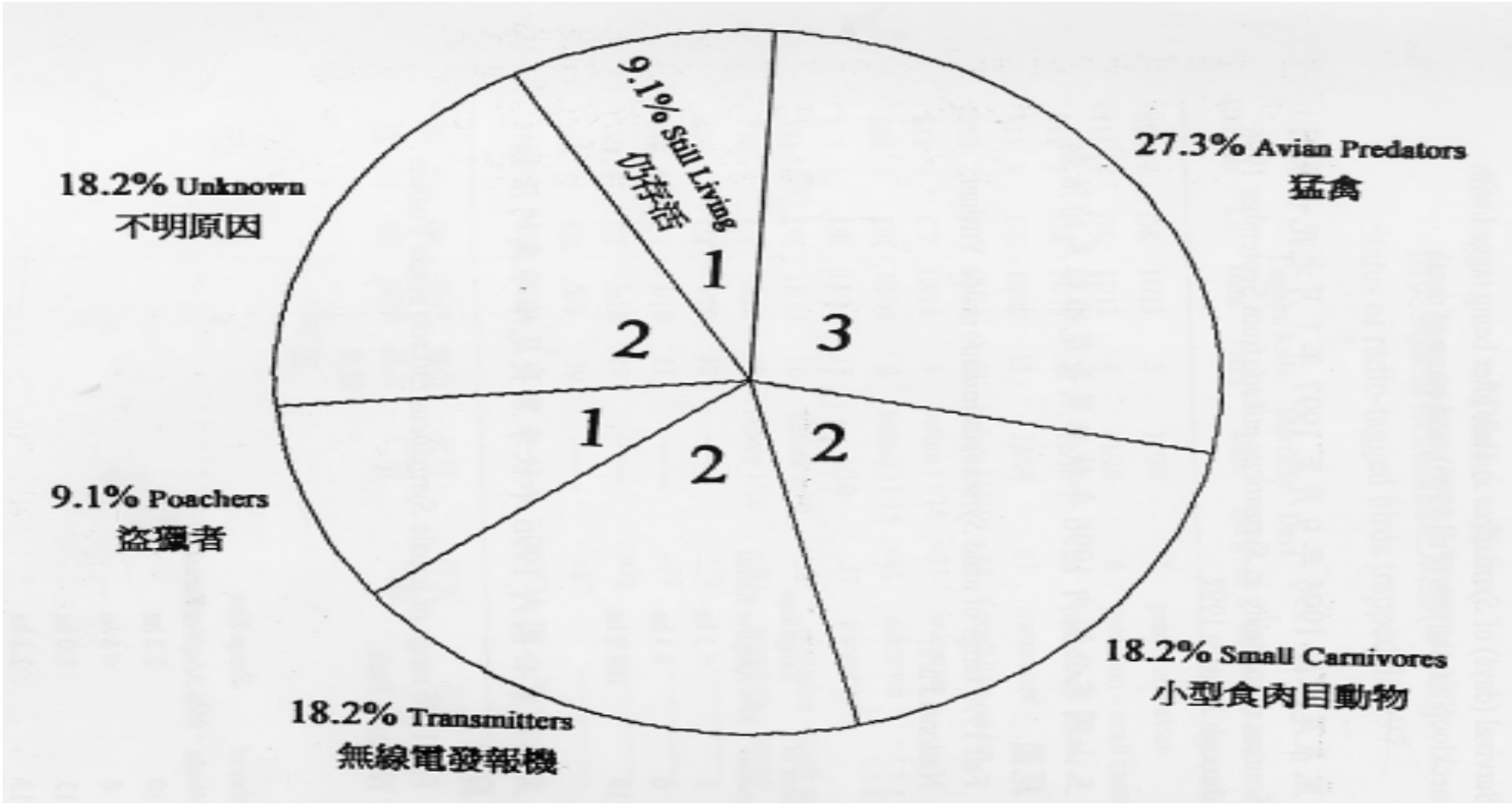



圖１： 黑長尾雉在配掛頸圈式發報機於 1996 年秋季後的
存活（天數）及造成死亡的情形

Frigure 1: Survival (days) of *Symaticus mikado* after being tagged with Neckloop transmitters (Fall 1996), and cause of death.

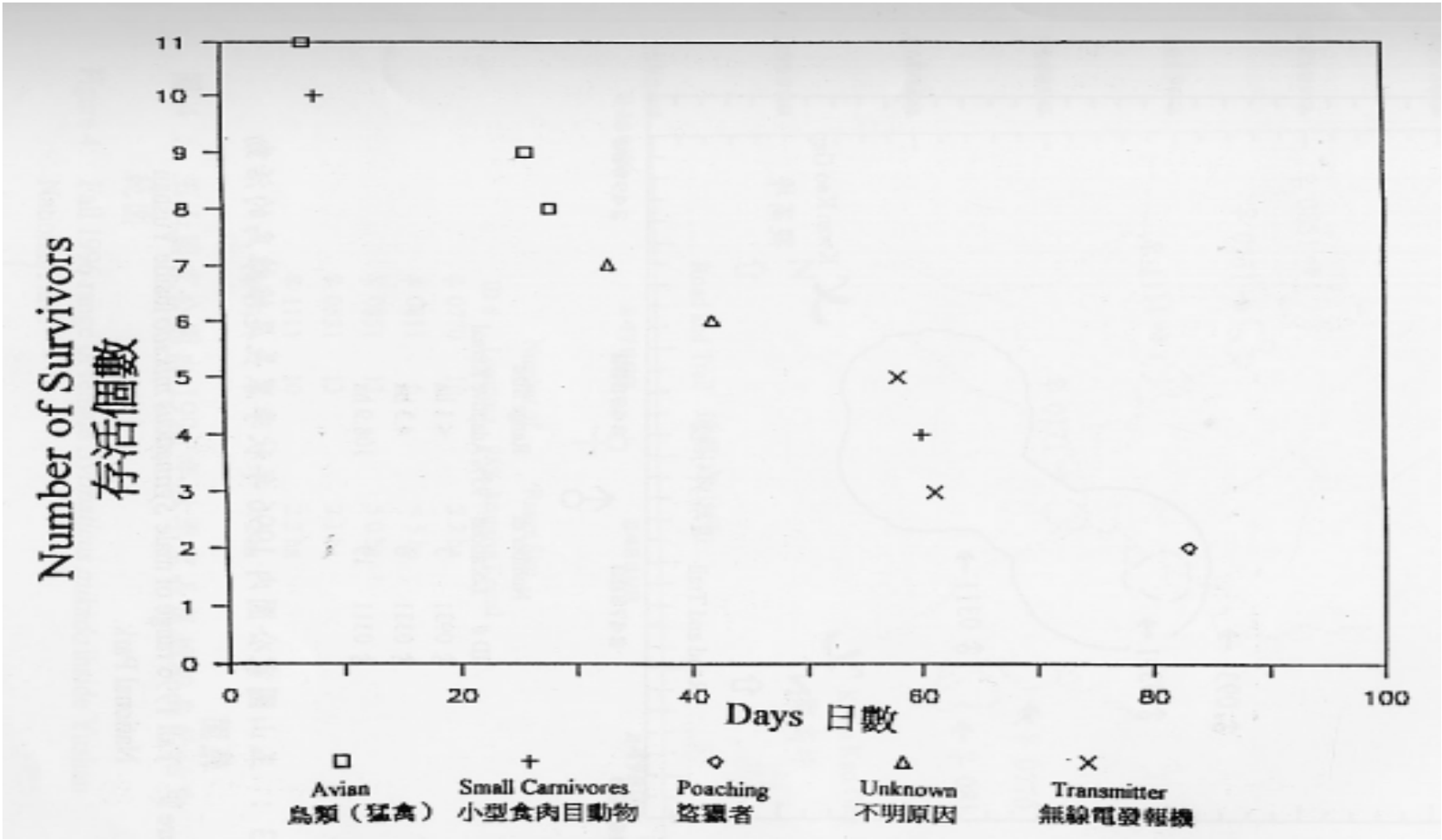
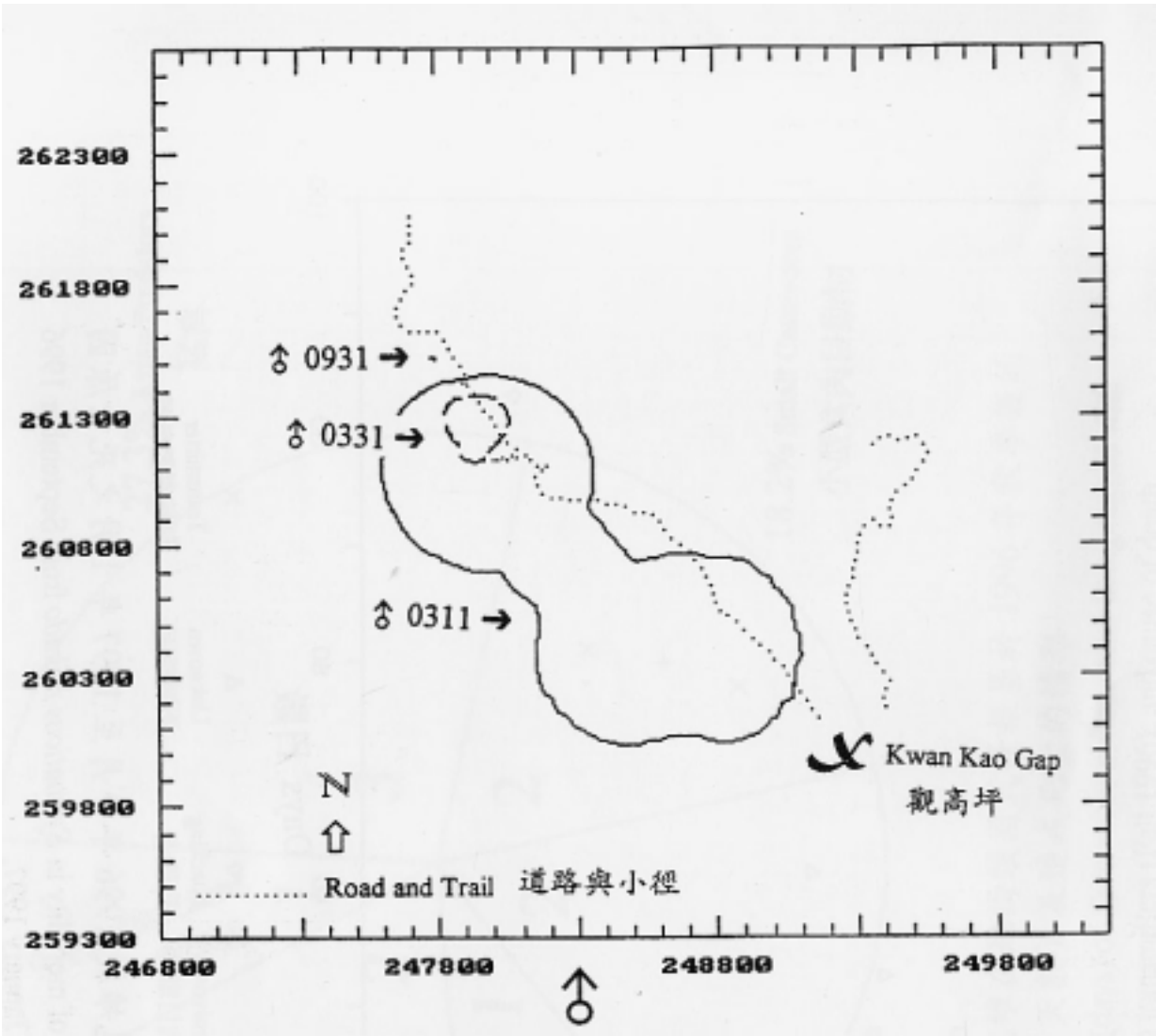



圖２： 黑長尾雉從 1996 年 9 月至 1997 年 1 月之死亡原因

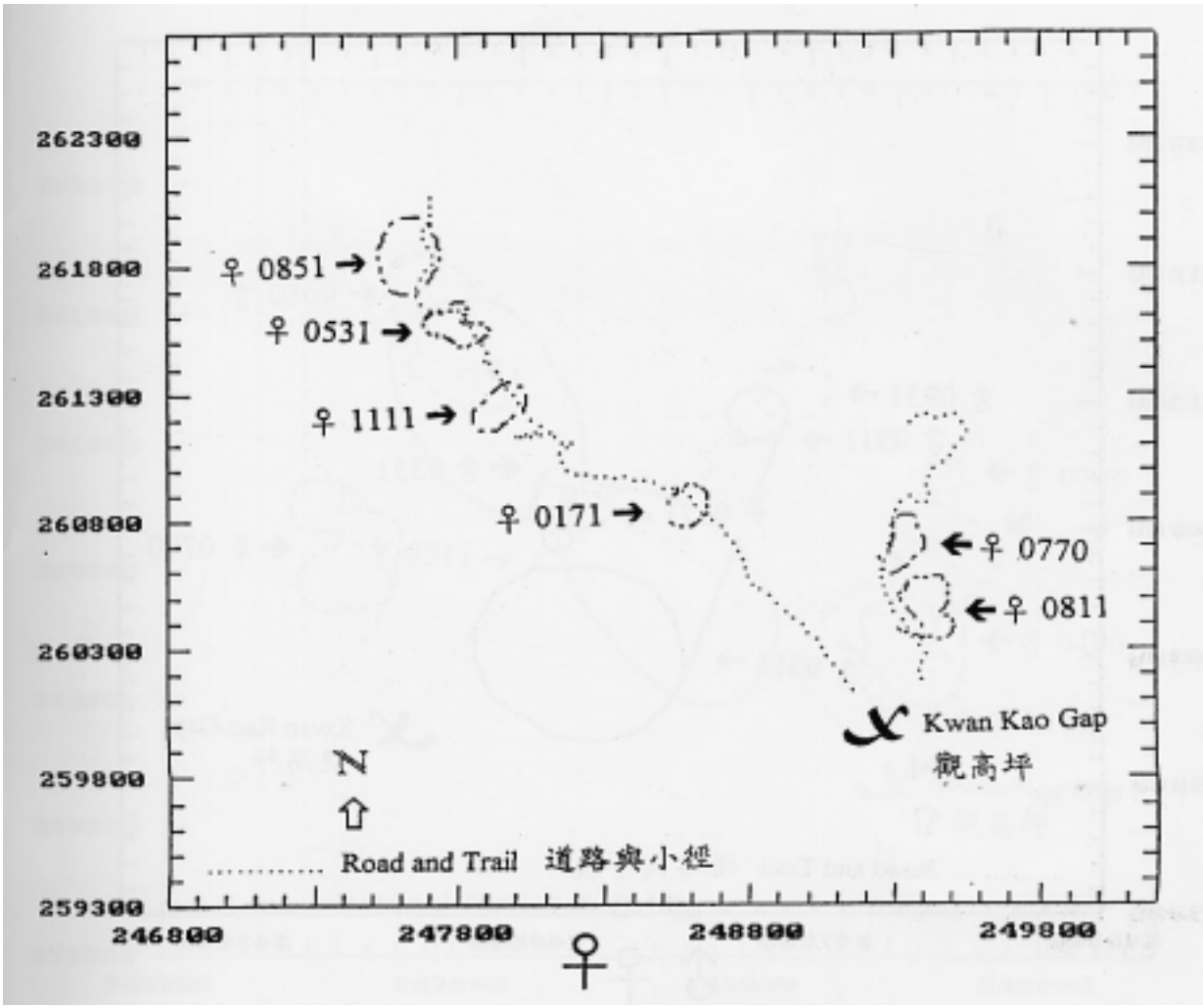
Frigue 2: Sources of mortality in *Symaticus mikado* from September 1996 through January 1997.




| ID # | Number of Locations | Range Size 95%Adaptive Kernal |
|---|---|---|
| ♂0931 | 3 | <1 ha |
| ♂0331 | 6 | 4.3 ha |
| ♂0311 | 19 | 108.9 ha |

圖 3： 玉山國家公園內 1996 年秋季黑長尾雉雄鳥的活動範圍

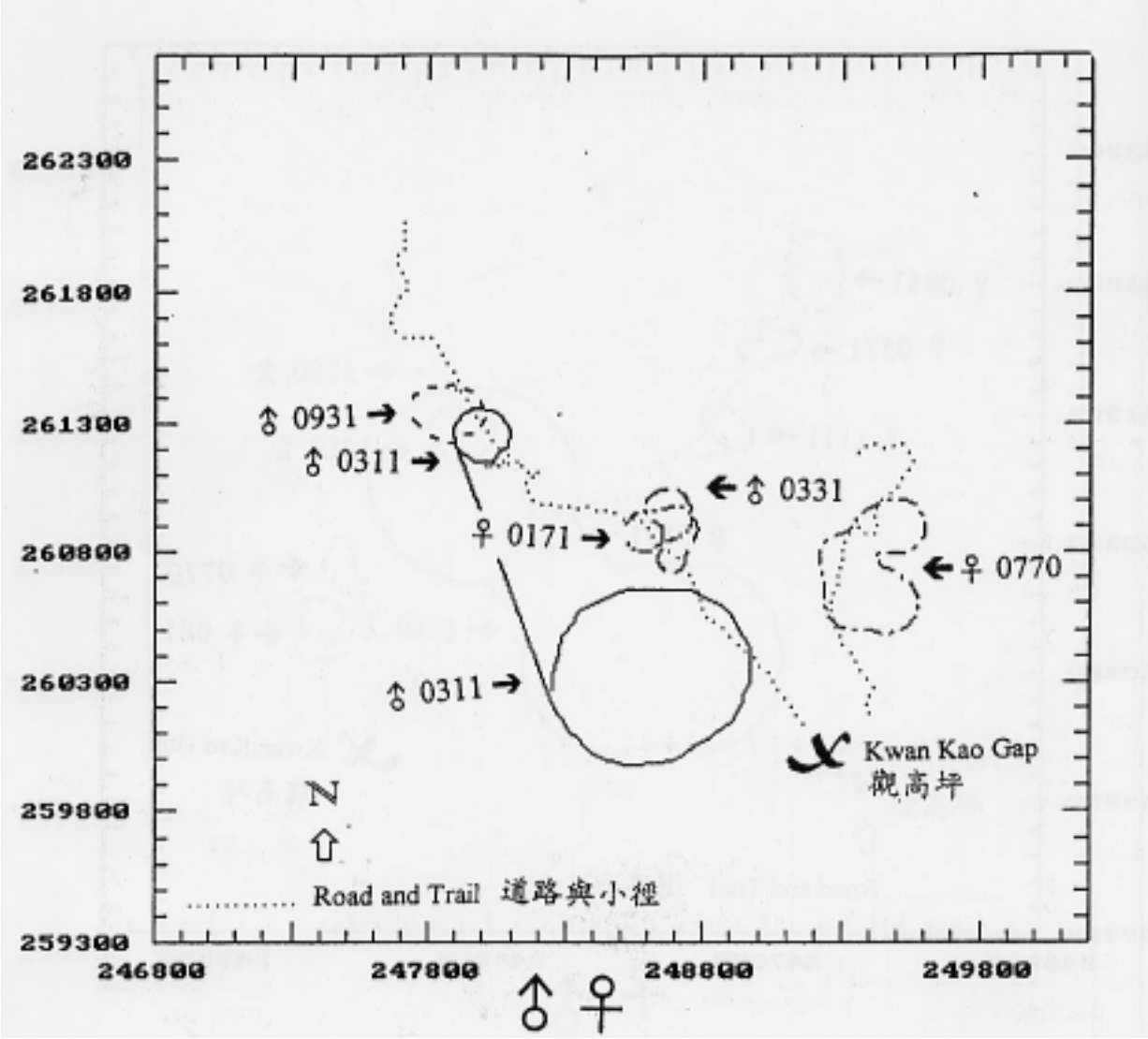
Frigure 3: Fall 1996 range of male *Symmaticus mikado* inside Yushan National Park




| ID # | Number of Locations | Range Size 95%Adaptive Kernal |
|---|---|---|
| ♀0770 | 10 | 2.2 ha |
| ♀0811 | 6 | < 5 ha |
| ♀0851 | 13 | 5.0 ha |
| ♀0531 | 13 | 2.1 ha |
| ♀1111 | 10 | 2.2 ha |
| ♀0171 | 3 | < 2 ha |

圖４： 玉山國家公園內 1996 年秋季黑長尾雉雌鳥的活動範圍

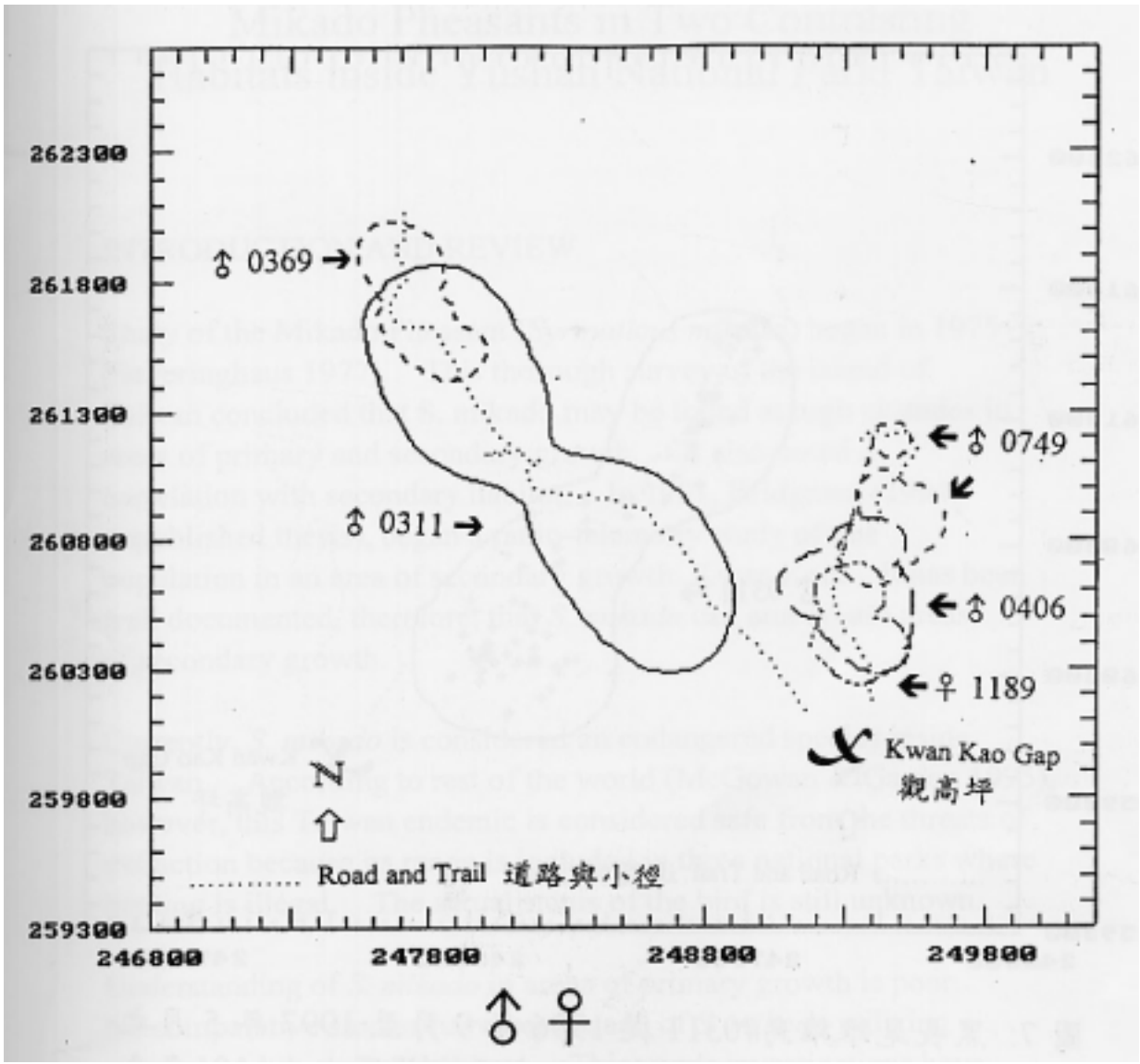
Figure 4: Fall 1996 range of female *Syrmaticus mikado* inside Yushan National Park.




| ID # | Number of Locations | Range Size 95% Adaptive Kernal |
|---|---|---|
| ♀0770 | 13 | 14.0 ha |
| ♀0171 | 11 | < 4 ha |
| ♀0931 | 9 | 4.5 ha |
| ♀0331 | 12 | 3.8 ha |
| ♀0311 | 26 | 42.1 ha |

圖５： 1997 年冬季玉山國家公園內黑長尾雉的活動範圍

Figure 5: Winter 1997 *Syrmaticus mikado* inside Yushan National Park.




| ID # | Number of Locations | Range Size 95% Adaptive Kernal |
|---|---|---|
| ♀1189 | 29 | 11.5 ha |
| ♀0311 | 37 | 86.0 ha |
| ♀0369 | 39 | 16.4 ha |
| ♀0406 | 32 | 19.5 ha |
| ♀0749 | 31 | 13.1 ha |

圖 6： 1997 年春季玉山國家公園內黑長尾雉的活動範圍

Figure 6: Spring 1997 range of *Syrmaticus mikado* inside Yushan National Park.

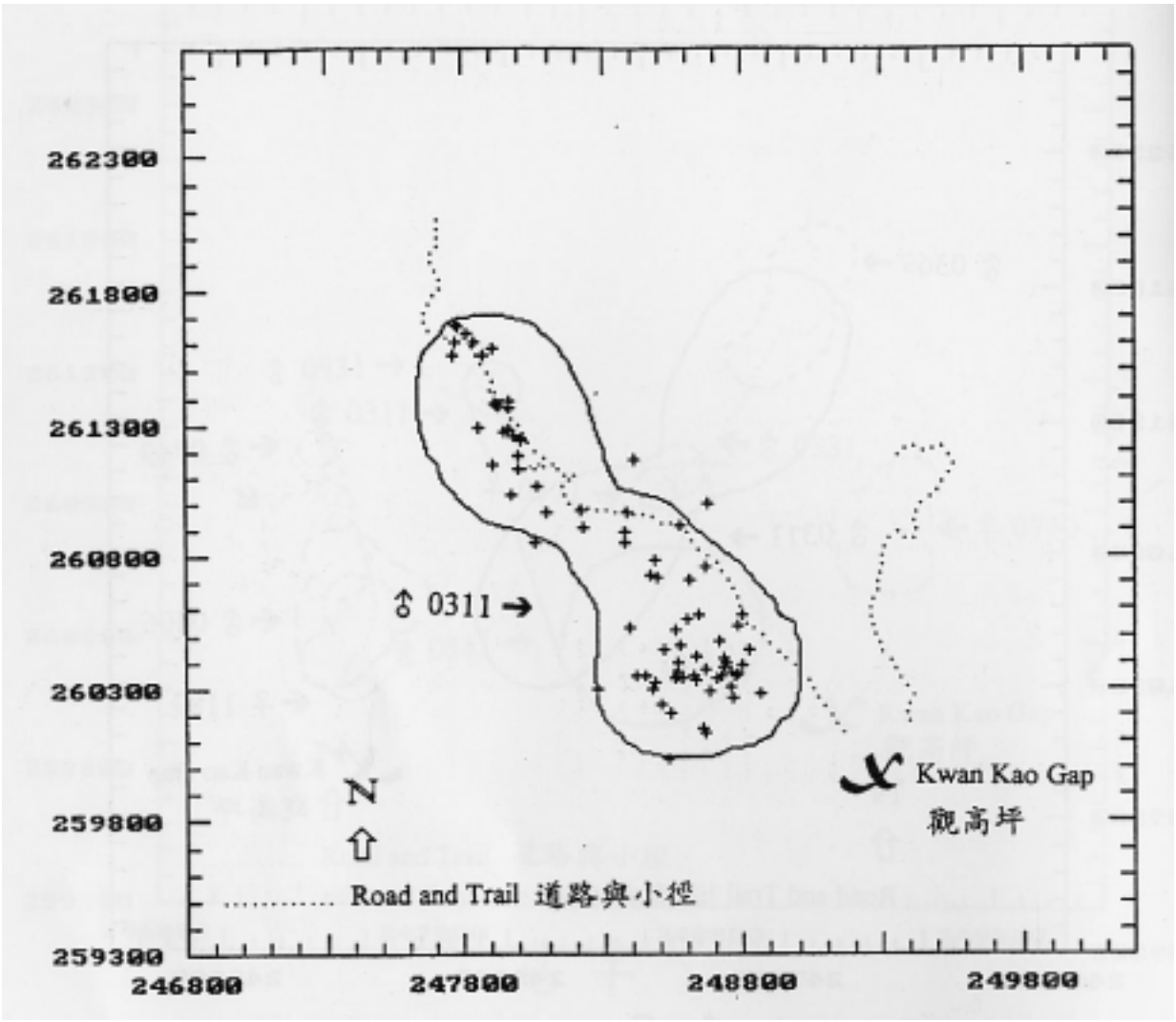



圖７： 黑長尾雉雄鳥＃0311 從 1996 年 9 月至 1997 年 5 月之活動範圍，用了 82 個定位點來決定範圍大小:101.7 公頃.

Figure 7: Range of *Syrmaticus Mikado*, male#0311, from September 1996 through May 1997. Eighty-two locations were used to determine range size:101.7 ha, 95% adaptive kernel analysis.

# Population Dynamics and Ecology of Mikado Pheasants in Two Contrasting Habitats inside Yushan National Park, Taiwan

## INTRODUCTION AND REVIEW

Study of the Mikado Pheasant (*Syrmaticus mikado*)began in 1975 (Severinghaus 1977). This thorough survey of the island of Taiwan concluded that S. mikado may be found at high altitudes in areas of primary and secondary growth. It also noted a correlation with secondary habitat. It 1991, Bridgman(1994, unpublished thesis), began a radio-telemetry study of one population in an area of secondary growth: Kwan Kao. It has been well documented, therefore, that S. *mikado* can and do use areas of secondary growth.

Currently, S. *mikado* is considered an endangered species inside Taiwan. According to rest of the world (McGowan & Garson 1995), however, this Taiwan endemic is considered safe from the threats of extinction because its range is included in three national parks were hunting is illegal. The actual status of the bird is still unknown.

Understanding of S. *mikado* in areas of primary growth is poor. No comparative studies have been made of S. *mikado* utilizing Primary and secondary habitats. This year's investigations have Begun collecting the data necessary this sort of study. Understanding of the ecology of the bird is needed to plan and Implement conservation measures.

Knowledge of S.*mikado* population demographics is also poor. In this year, the first data on mortality has been collected. The sample size is not large enough to make conclusions based on the effect of age, sex, or habitat. We do now know, however, that winter mortality is high and is primarily caused by avian and small carnivore predation. We have also learned an important lesson in technique: the necklace attachment of transmitters is

inappropriate for *S. mikado*. This method directly causes mortality. Its indirect effects are still unknown.

In this year we have learned that male *S. mikado*, at least, can live for as long as 6 years, and that they are in very good condition at this age. We also have learned that the population on the Chun Ta Logging Road has declined as compared to 1991. We do not know why, or for how long, this decline has occurred. It is possible that all or some of this decline is due to the typhoon that came to the study area in August 1996.

*Syrmaticus mikado* occur in both Kwan Kao and Dwei Kwan (Severinghaus 1997, Severinghaus and Severinghaus 1987, Alexander et al. 1990, and Bridgman 1994). Population size and behaviour appear to be similar in both study sites, regardless of obvious differences in habitat (see study site description below).

A purpose of national parks is to preserve the natural environment (plant and animal communities)for future generations and for the health of this planet. A list of species contained within a park is not enough to ensure preservation. The ecology of the organisms within the park must be understood before we can know whether their populations are doing well or declining. Right now, very little is know about the basic biology of *S. mikado*. It is important that we gain some understanding of the population dynamics and requirements of this pheasant. If we do not study *S. mikado* now,while there are reasonable sized populations in many areas, it may be too late to help them later. Right now, we cannot say whether their population is stable or declining. Hopefully at the end of this project, after three years of studying their mortality and productivity, we will be able to estimate the status of *S. mikado*.

STUDY SITE DESCRIPTION

The Chun Ta Logging Road, no longer open to vehicular traffic, Passes through secondary growth habitat. This area was completely logged about 30 years ago. The Dwei Kwan Trail,

frequently used by hikers, is in an old growth forest. Both areas are at about 2500 m in elevation, and both have populations of *S. mikado*. All signs indicate that before November 1996, there was little or no human activity on Chun Ta Logging Road.

This absence of human activity and influence may have lasted for several years.

## METHODS

### Study Site Preparation

As of July 1996, Chun Ta Logging Road was so overgrown to be impassible to humans. At then end of this month, 2 km of the road was trimmed enough to allow passage. The road was marked, every 20 m, with permanent wooden stakes from 67.5 km to 65.26 km, and Dwei Kwan Trail was marked in the same way from 14.38 km to 10.16 km. These stakes were used as telemetry bearing stations to determine pheasant location through triangulation. They were also helpful for pinpointing the exact location of observed pheasants, mammals, etc.

### Trapping

From September 1996 through November 1996, and in March 1997, snares were placed on the Chun Ta Logging Road and the Dwei Kwan Trail inside Yushan National Park. Snare construction followed traditional aboriginal design, and were set to catch each bird by the foot. No bait was used. Snares were placed directly on the road and trai. Snares were monitored throughout daylight hours and were completely dismantled at the end of each trip. Snares were set on the Chun Ta Logging Road from 67.36 km to 65.8 km and on the Dwei Kwan Trail from 13.3 km to 10.2 km.

### Measuring

Trapped birds were weighed, measured, given two plastic colored leg bands and one radio-transmitter. Before January 1997.

transmitters were placed around the neck above the gizzard and below the crop, with the antenna bent to pass over the shoulder and point down the back. Neckloops were tight, to prevent slipping, but not too tight to obstruct breathing or to prevent most food items from passing through. After January 1997, transmitters were place on the back of each trapped pheasant, between the shoulder blades, with the harness wrapping around the bird's body before and after the wing. Harness straps and transmitter were bidden under the feathers.

The transmitters contain a mortality switch which, after 11 hours of inactivity, causes the pulse rate of the transmitter to change from slow to fast. In this way, it is possible to tell the status of the pheasant just by listening to the pulse rate of the transmitter. The transmitter weigh 20 g, which is 5% of the body weight of a 500g bird. Transmitters contain batteries that are supposed to last 18 months.

Observations

The road and trail were monitored for *S. mikado* activity, and notesd were made on the activity of other animals. Signs of mortality of any animal were recorded. Signs of activity by any mammal were also recorded.

Recovery of Mortalities

When mortality signals were heard during radio-telemetry, an immediate search was made to try to locate the dead bird. Once the bird was found, we took pictures of the remains and the location, and made notes describing the location and cause of death. Remains were carried to Tunghai and preserved in a freezer there for further study of morphology or cause of death. These studies have not yet been made.

RESULTS

From September 1996 through June 1997, a total of 105 days were

spent in the study area, about half of this was in each study site. Of these days in the field, 44 days were spent trapping, and 159 traps were made. During this time, pheasants were observed on the road or trail 123 times, and there were frequent pheasants were caught, with 11 dying between October 1996 and January 1997. As of June 1997, only 5 pheasants are radio-tagged. Also caught, and immediately released, were weasel, monkey, woodcock, and golden mountain thrush. For details, please refer to Table 1.

Pheasant and Mammal Activity

Table 2 shows comparisons in the number of trapped and encountered pheasants, and encountered mammals between Fall 1991 and Fall 1996. Pheasants encountered and trapped have declined by 33% and 50% respectively. Mammal encounters have increased by 33% to 100%.

Human Activity

Human activity on Chun Ta Logging Road resumed with this project and the clearing of the road. In November 1996, workers representing Yushan National Park began restoring the houses and Kwan Kao and the water pipeline from Kwan Kao falls. These people cleared the road from Kwan Kao to the falls, and cleared and cleaned up the Kwan Kao area. Also beginning in November 1996, workers representing the Department of Forestry began clearing a firebreak from Patungkwan through Kwan Kao Gap and over Chun Ta Mountain. These people also did some work clearing Chun Ta Logging Road. They lived at Kwan Kao or on Chun Ta Logging Road from November 1996 through March 1997. Tourist activity gradually increased as the year progressed.

Project Effort

Project work effort has not been calculated for the entire year. The data from March through June 1997 indicates the sort of effort involved in this research (Table 2). Using triangulation

to determine one location of one pheasant involved an average of 25 minutes and 422 m (N = 156 locations of 5 pheasants; Table 2). Some locations may take as long as 1 hour and involve walking as much as 1.5 km.

Morphology

Table 4 shows the variation in physical characteristics between pheasants caught Fall 1991 and Fall 1996. These characteristics are similar, even though they represent different times and different study areas. This table also shows the variation in physical characteristics between Fall 1991 and 1996 and March 1997. Since most birds caught March 1997 were caught from Chun Ta Logging Road, it is possible to compare the difference between Fall and Spring body weights on Chun Ta Logging Road, even though there is a 5 year gap. Body weights are noticeably greater, although other characteristics are similar.

Mortality

Ten out of 11 necklace-tagged pheasants, trapped fall 1996, were dead within 3 months of tagging(Figure 1). This mortality occurred from November through January 1997. Two of these mortalities were definitely caused by the necklace attachments--the birds starved to death because they ate acorns which were too large to pass through the necklace. The remaining mortalities were due to poachers, avian predators, small carnivores, and unknown causes (Figure 2). For the two unknown mortalities, there was no evidence of either acorns or predation, for the skeletons were intact.

The one survivor, a male, was recaptured 6 months after being first tagged and given a backpack transmitter. He had a 3 cm wide ring around his neck where the necklace had rubbed off his feathers. His March recapture weight (925 g) was similar to that of 4 other males trapped that month, but below average (1045 g; N = 5). There was one other male with the same weight.

The remains of only one untagged *S. mikado* were found. This was

a female who was killed by an avian predator on the Chun Ta Logging Road in early March. From September through March, the remains of 4 other species of birds were found on the road and trail (Table 5). These mortalities are attributable to avian predators. See Table 6 for a list of radio-tagged individuals, their tagging location and their status and cause of death.

Longevity

Two males trapped on Chun Ta Logging Road were recaptures from The 1991-1992 study. These males were trapped as juveniles on 9/25/91 and 4/21/92, making them 6 years old. Their body weights were 1250 g and 975 g. All other males but one (on the Dwei Kwan Trail) weighed less than these two by 50 to 250 g.

Behavior

During the whole study period, there were only 2 sightings of chicks or juveniles. These sightings were on the Dwei Kwan Trail. Almost all encounters were of solitary pheasants. Beginning March 1997, some pairs were seen. As of early June 1997, no chicks were observed.

In March 1997, we found enough evidence of male fighting to suggest that these encounters are serious fights. One trapped male had blood on his beak, and another had blood on one spur.

Radio-telemetry

Male ranges throughout the year overlapped with female ranges and with other male ranges (Figures 3-6). Female ranges in the fall did not overlap in either fall 1996 or winter 1997 (Figures 4 and 5) and there is insufficient data for spring 1997. Ranges expand in the spring.

One male (#0311) on the Dwei Kwan Trail shows a disjunct range (Figures 3 and 5). He has two centers of activity which are about 1 km apart. Most radio-locations are from the more southern area (higher in elevation and close to Kwan Kao Gap).

He spent the month of September 1996 at the northem site and then moved to the southem site for October through January 1997. February 1997, he returned to the northern site where he stayed for most of March 1997. From April 1997 until present, he has been at the southern site. It is while he is at the northern site, that his range overlaps with another male (#0369), and it is at this site that he has been trapped. It is certain, based on his bloody spur, that he has been fighting in this area, possibly with male #0369. The yearly range of Male #0311 is shown in Figure 7.

Male #0749 show a similar disjunct range, but over a smaller area (Figure 6). His main area of activity is concentrated outside the range of Male #0406, who is larger and heavier. There are two occasions when the two males'ranges overlap and these overlaps occur for only a few days.

For spring 1997, there is telemetry data for only one female, who is on the Chun Ta Logging Road. Her range primarily overlaps with male #0406, but there is some overlap with male 0749 (Figure 6).

## DISCUSSION

### Population Decline

The Fall 1996 decrease in trap success and observation, as compared to Fall 1991, indicates a decline in pheasant population since 1991. Some of the decline in observation must be explained by the condition of the Chun Ta Logging Road. It is difficult to observe pheasants because the road is so overgrown. The quality of the observations, however, indicate the population has suffered a decline. Almost no juveniles were observed during fall 1996. This suggests, at the very least, that productivity was poor in 1996. It is possible that the typhoon that caused so much damage to Nantou County in early August 1996 also affected the pheasant population inside the park. Unfortunately, there are no observation of pheasants before the typhoon came. This

means it is not possible to compare pheasant activity and population size before and after the typhoon. This decline cannot be attributed to human activity, because no signs of hunting were found before November 1996. This is further supported by the large mammal populations in the study area. There are more encounters with monkeys, muntjac, wild boar, and mountain goat than in 1991.

Morphology

*Syrmaticus mikado* probably are at their lowest body weights in the fall. At this time, the breeding season is coming to a close. They expand their activity ranges and gain body weight over the winter and during early spring. This may be in preparation for the beginning of the breeding season.

Transmitter Mortality

Two female pheasants died because they ate food which was too large to pass through the neckloop of their transmitters. This form of transmitter attachment was used because it is easy to install and it is supposed to have little effect on behaviour (Kenward 1987). It is the usual method of radio-tagging galliformes. Necklaces, however, are inappropriate for use with *S. mikado*. Not only did this attachment cause mortality, it also caused some irritation to the bird, resulting in loss of feathers around the neck. The antenna also had a tendency to catch under the wing, which is why this method is not used with birds that fly frequently.

How much of the remaining mortality was due to necklace transmitters is debatable. The transmitter may have had an effect on the two unknown mortalities and the two mortalities due to small carnivores. Little is known about the hunting techniques of small carnivores in Taiwan; whether they are sufficient to capture pheasants in good condition. The mortalities due to poachers and avian predators are probably natural as both predators use methods that indiscriminately take prey (personal observation; Kenward 1977) All *S. mikado*

mortalities attributable to avian predators were in areas of with exposed mineral soil layers. These sites were either very steep hillsides with very little understory, shrub, or herb layers, or exposed areas such as the Chun Ta Logging Road and landslides.

Until this study, nothing was known about the mortality of *S. mikado*. Without the use of transmitters, it is almost impossible to study mortality. Avian predation appears to be random and small carnivores hide their kills. The remains of 12 birds representing 5 species, were found on the Dwei Kwan Trail and the Chun Ta Logging Road (Table 5). One of these birds was a female *S. mikado* who had never been trapped or banded. In all of these cases, there was an open understory, and in some cases there was no canopy cover. While it is hard to find incidences of natural mortality in untagged pheasants, *S. mikado* do disappear. It is not known, however, whether these pheasants die or disperse. In 1991, from July through November, Bridgman (1994) banded 19 *S. mikado*. Of these, 13 were never seen after January 1992.

Winter mortality attributable to natural causes is high in *S. mikado* (64%). Of this mortality, 43% is due to avian predators and 29% to small carnivores. Radio-telemetry studies of other pheasants have also found high winter mortality. Zheng et al. (1989), who studied Cabot's Tragopan (Tragopan caboti) in the lower montane forests of the Wuyanling Reserve in Southeastern China, had a 44% winter mortality: 75% to raptors and 25% to small carnivores. In a study of the effects of predation on Ring-necked Pheasants in Wisconsin, U.S.A., Dumke and Pils (1973) found predators responsible for 78% of the winter mortality:28% to raptors and 38% to small carnivores. High winter mortality, as compared to other seasons, may be because of increased visibility due to snow cover and loss of canopy or shrub cover (Hill and Robertson 1988). For *S. mikado*, the loss of cloud cover and fog during this dry season may be important, especially

when combined with decreased canopy and shrub cover due to seasonal dieback.

Longevity

The body weights of the two 6 year old males suggest that they Are in prime condition and are capable of winning combats with other males. Their weights are above average, and one male was caught with his beak covered with blood, suggesting he had been fighting, and probably winning the contest. There were no signs that he suffered any damage during the fight. There are no recaptures of females trapped in 1991 or 1992.

Radio Telemetry

Males have overlapping ranges, but their activity is concentrated in the parts of their range that do not overlap with other males. The movements of two of the males suggest that, during the breeding season, males move out of their habitual range to fight with other males. The purpose of this fighting is not clear. As they move outside their range to fight, and then move back into their range after the fight, the fighting may not be for territory. It may not be for access to females either, because females are known to be in the habitual ranges of these males. This means that the males have access to females without leaving their habitual range. This movement for fighting is a behaviour that needs more study and observation.

It is very interesting that the Fall 1996 ranges of females on the Dwei Kwan Trail do not overlap. Whether this pattern is true for the whole year or just the breeding season is not known. The reason for these small, non-overlapping ranges is also not known. And we do not know if there is any fighting on the part of the females to maintain these ranges.

CONCLUSION

There are many new and interesting developments from this year's study. These developments read like a chapter in the middle of a

mystery novel because they leave us asking more questions than we have answered. It is possible that some of these questions and behaviours may be answered, or at least described in more detail, in the next two years of this project.

These are some of the questions we are left asking at the end of this year:

How do the pheasants manage to get so fat by the beginning of the breeding season? Is there anything special in their diet?

Why do the females have non-overlapping ranges? Do they fight?

Why are the males fighting?

How different will the mortality in winter 1998 be from winter 1997, especially as the pheasants are now carrying transmitters on their backs and not around their necks?

Since productivity was poor in 1996, what will it be like in 1997?

Why do these pheasants have their ranges in the places they do? Is there some special characteristic about the habitat that they need for survival?

RECOMMENDATIONS

This is the report for the first year of a three year project. At this point it is not possible to make any recommendations for the long-term care of *S. mikado* and its environment. For the sake of the project, however, there are two important recommendations.

1. A full-time assistant and the help of park rangers. The scope of the project is such that it can keep four people busy in the field for at least two weeks each month. It is very important, for the personal safety of the investigators and for the safety and proper care of *S. mikado*, that there be a

full-time assistant. This person would be trained to use radio-telemetry. Without a trained, reliable, full-time assistant, it is not possible to study the daily activity pattern of movement of *S. mikado*. An assistant is also necessary once a full sample-size of pheasants(N = 48) have been radio-tagged. Park rangers are needed because of their knowledge of the study area, which is very useful for safe investigation of the road and trail. They are also skilled in constructing traps and have a solid understanding in the identification and behaviour of many plants and animals in the study area.

2. For the term of the study period twice yearly cutting and clearing of both the trail and trail and road(within the study site) is necessary. This clearing provides a unique habitat that attracts *S. mikado* to areas where humans have access. This clearing is important for trapping, radio-telemetry, and direct observation of *S. mikado* behaviour. It is not possible, at this time, to say whether this sort of clearing should be continued after the project, on a long-term scale. While this clearing creates a habitat that attracts *S. mikado*, it makes the area accessible to humans, exposing *S. mikado* and other animals to human hunting and interference.

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