

# 探索 鳥類 的達文西密碼

## 鳥類行為的分析與省思

### The Da Vinci Code of Birds

#### The Analysis and Reflection of Avian Behavior

採訪 Interview/ 賴宛靖 Wan-ching Lai、沈詠惠 Yong-hui Shen

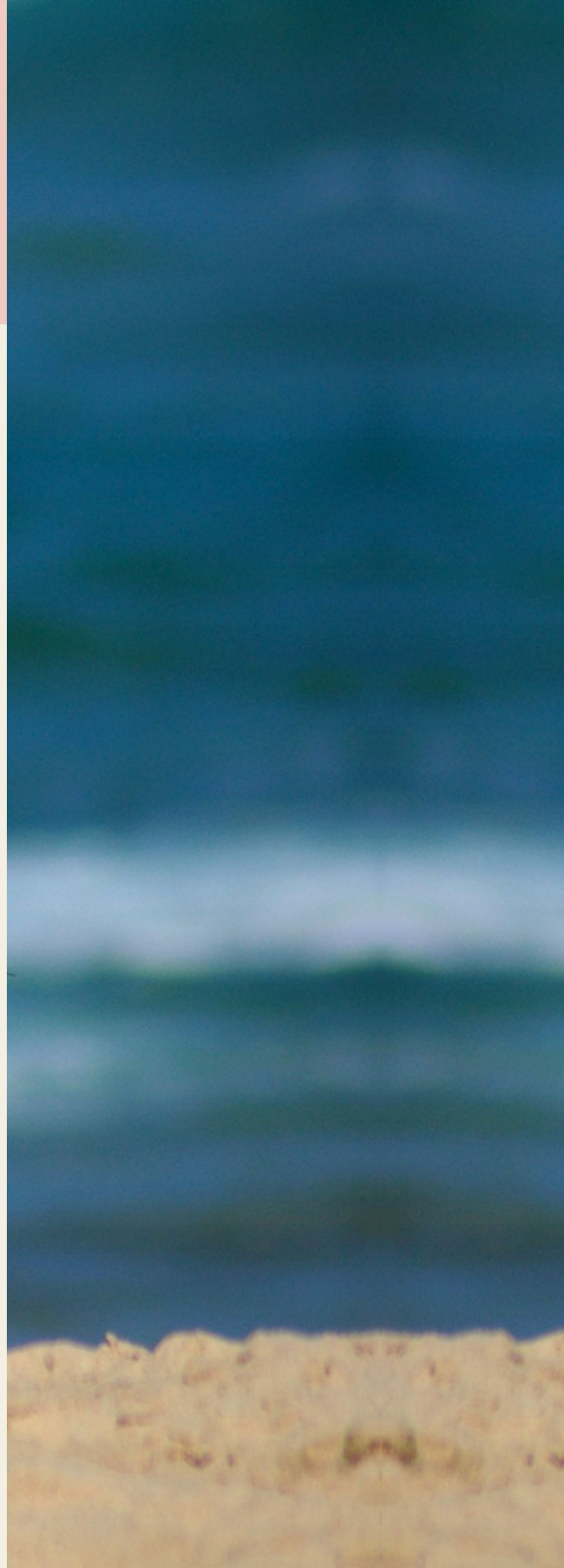
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**鳥**，一直是地球環境上諸多保育議題的指標性生物之一。不管是來自各領域的專家學者或純粹賞鳥的人士，皆期望能與鳥類產生交集，探索牠們身上神秘的行為與生存模式。或許各自的立場與需求不盡相同，然不能否認的是，這擁有著人類最奢求渴望羽翼的靈性物種，帶給人們的是數不盡的驚喜與深思。

Birds have been a biological indicator of various conservation-related issues in Earth's environment. From experts of different areas to common bird watchers, people all hope to explore the secrets and patterns of birds' behavior and survival. Whatever the purpose for humans' urge to get connected to these feathered creatures, birds have always brought people countless marvels and insights.





鳥類的分類系統比起其他生物清楚，種類鑑定容易，而且易於觀察 / 羅致平攝  
Bird's taxonomy is clearer than other species and the species identification and observation of them are easier. / by Rorem



## 觀測指標 降遷為哪般

「鳥類，可說是回答眾多生態問題的最佳素材之一，因為鳥類的分類系統比起其他生物清楚，種類鑑定容易，而且易於觀察。」台南大學生態科學與技術學系助理教授許皓捷說。

比起尚須費盡心思地進行分類，以期能透過昆蟲來研究森林樣貌；或是得滿山遍野放置鼠籠，來研究小型的哺乳動物，研究可見度高與分類完整的鳥類，在機動性、便易性與調查度上，都容易的多。

賞鳥、愛鳥的人都知道，鳥類可探討的行為習性多樣，然由於篇幅有限，此處先以鳥類的降遷作探討。

不論是鳥類或陸地上、水面下的生物，暖化的影響議題還是學者們對生物物種的關切要點之一。近幾年來有不少學者開始研究暖化對於鳥類遷徙與繁殖等行為的影響，發現在高緯度國家中，由於植物開花、昆蟲繁衍等現象之提早幅度大於候鳥提早返回繁殖地的時間，這樣可能缺少食物的環境變遷因素下，連帶影響候鳥必須加快、改變遷徙的速度與停留的時間。「耐寒、會遷徙的鳥，或許能在全球暖化的浪潮中找出生活模式，但大環境食物鏈的改變，仍舊影響了鳥的生態。」許教授說。

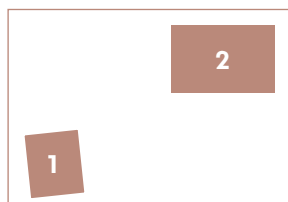
## A Perfect Indicator for Observation

“Birds are arguably one of the best bioindicators to answer numerous questions related to ecology because their taxonomy is clearer and the species identification and observation of them are easier,” explained Hau-jie Shiu, Asst. Prof. of the Dept. of Bioscience and Biotech., NUTN.

Compared to insects that require researchers' effortful classification or small mammals that necessitate capture for observation, birds are highly visible and fully classified, and thus give researchers much more mobility and ease in scientific investigations.

There are a lot to see and explore regarding birds' behavior and habits. Due to the limited pages of the Quarterly, here we use the migration of birds as an example.

As the effects of global warming on species remain a focus of concern of scientists, many have started to investigate the link between global warming and birds' migration and reproduction. It turned out that in high-latitude countries flowers blossom and insects reproduce earlier to a degree larger than migratory birds know to return to their breeding ground earlier. This threatening lack of food will put forward or change the time of birds' migration and the duration of their stay. “Cold-tolerant or migratory birds may be able to find new life patterns, but the entire ecosystem of birds has still been greatly affected in general,” said Shiu.



1. 由於氣候暖化的影響，植物開花、昆蟲繁衍等現象的提早，連帶影響候鳥必須加快改變遷徙的速度與停留的時間。  
Due to global warming, flowers blossom and insects reproduce earlier, and thus the time of birds' migration and the duration of their stay would be changed.
2. 食物的取得或許也是影響鳥類降遷行為的因素之一。圖為覓食中的黃頭鷺 / 邱銘源提供，邱盧素蘭攝  
Bird's need for food perhaps is also an important factor in affecting bird's migration. The picture shows Cattle Egret (Bubulcus ibis). / Photo provided by Ming-yuan Chiu, taken by Su-lan Chiu-Lu



除了在氣候要素上的變化，其他的因素也有可能影響鳥類的降遷。以許教授在太魯閣國家公園進行鳥類垂直遷移的研究為例，棲息在太魯閣國家公園中海拔山區的鳥類，冬天會往低海拔地區遷移，起初判定此現象為氣溫下降所致，然而進一步研究後則發現，食物的取得或許也是關鍵的因素之一。

### 分化與遺傳 人為影響最大

雖然氣候變異可能會影響鳥類的繁衍與生存，但生物體對溫度的適應力屬於天擇的一部分，除非在短時間內有劇烈改變，否則自然汰選總是需要相當時間的，相較之下，人為影響的幅度與速度，往往比自然的破壞更具威脅力。

過去的教科書上總說，地理位置的隔絕很重要，是導致分化的主因，但隨著各種研究結果顯示，地理的隔絕並非絕對，更重要的條件是，生物在兩地所承受的天擇環境是否相同？只要環境是不合適的，生物就無法順利生長，基因自然不受影響。師範大學生命科學系李壽先教授以畫眉鳥為例：「使用遺傳的方法來分析，可發現台灣與大陸的畫眉大約是350萬年前開始分隔，但中間一直持續交流，基因可以互相交換，就這樣一邊分化一邊交換，約莫到50萬年前才停下來，在這麼長的時間中牠們一直互通有無，但仍然繼續分化。」顯然，兩地環境的差異與基因適應有著最直接的關係，天擇力量的重要性在許多時候，可能遠比地域的隔絕更具關鍵性。

In addition to climatic factors, other elements also play a role in birds' migration. According to Shiu's study on the altitudinal migration of birds in Taroko National Park, the causes of birds in mid-altitude areas moving to low-altitude ones in winter are not simply a drop in temperatures as we used to believe, but also their need for food, perhaps an even more important factor in affecting bird's migration.

### Differentiation and Heredity Are Affected Most by Mankind

Climatic changes may have an impact on birds' reproduction and survival, but natural selection takes a long time since all life forms are able to adjust to variation in temperature. By contrast, threats posed by humans are often more imminent, destructive and influential.

We had been told by textbooks that geographical separation is the main cause of biological differentiation. But now research has shown that a more crucial variable is the natural selection conditions a species faces in two different places. In a hostile environment where a species has no way to live and grow, its genes will not change at all. Using the thrush, or Hwamei (*Leucodioptron canorum*) as an example, Prof. Shou-hsien Li of the Dept. of Life Science, NTNU, explained: "Taiwan Hwamei and Chinese Hwamei were geographically separated 3.5 million years ago but had since continued their differentiation and gene exchanges until half million years ago." Apparently, differences in natural selection forces of two places may often play a more direct and pivotal role than geographical separation.





「自然界本來就是進進出出的，物種的出現與滅絕，原本也就是自然的一部分。」李教授語重心長的說，「對鳥類保育最大的問題，還是在於人為因素所產生的威脅。」

李教授表示，如果從基因的觀點來看外來鳥種入侵，取決關鍵在於牠與台灣本土的鳥種會不會雜交，以及雜交之後能不能產生具有繁殖力的下一代。就好比馬和驢雖然會交配，但牠們所生下的騾並不具備繁殖力，因此對本土生物的基因組成沒有顯著影響。

而若是外來種與本土種不僅會雜交，且後代具備繁殖力，那在保育上恐怕就有點問題了，「不過這問題也要看我們怎麼思考保育的目標。」李教授接著說。「從保育角度而言，要問問我們到底想要注重、想要保護的究竟是什麼？」

不管是特有種還是特有亞種，牠們之所以珍貴，是因為牠們的形成乃是經過某一些獨特環境的長期篩選，是獨一無二的。從哲學的觀點來看，任何一種物種能夠歷經長久的演化成為牠現在的樣子，就是一件珍貴的事，應該受到尊重，更應該避免人為力量使之改變甚至遭受破壞。

“In the Nature, life forms come and go. The appearance and elimination of all species has just been part of Nature.” Li added, “So the most serious threat to bird conservation still comes from humans.”

Li argued that from a perspective of genes, the seriousness of invasion of alien bird species would depend on whether the alien bird crossbreeds with any of the indigenous birds in Taiwan, and whether their hybrid owns reproductive capacity. For instance, a mule, the hybrid of a horse and a donkey, is infertile, and thus doesn't have significant impact on the genetic makeup of local animals.

But if an alien species and an indigenous species crossbreed and their hybrid is fertile, it will cause certain problems to species conservation. “However, the solutions to these problems also involve how we think about our purposes of conservation,” Li added, suggesting that we ask ourselves what on earth we want to focus on and protect.

The reason why endemic species or subspecies are so precious is that each of them are formed and developed as a unique species through a long-term natural selection in some distinct environments. It's truly something special and respectable that a species could go through such a long process of evolution and become what it is now. They deserve to be protected against any changes or harm caused by humans.

## 科技輔助 保育更需進步

無論是環境或遺傳因子上的影響，這些分析結果，皆須靠觀察才能得知，統整出進一步的訊息。

「等待」，自然是作任何研究觀察的絕對條件之一，只是在其本身或外在因素的影響改變下，若能有科技上的輔助，在成本的控管上，會更有效率的多。

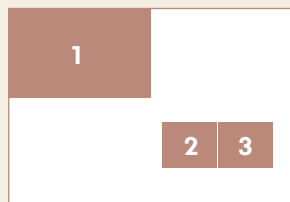
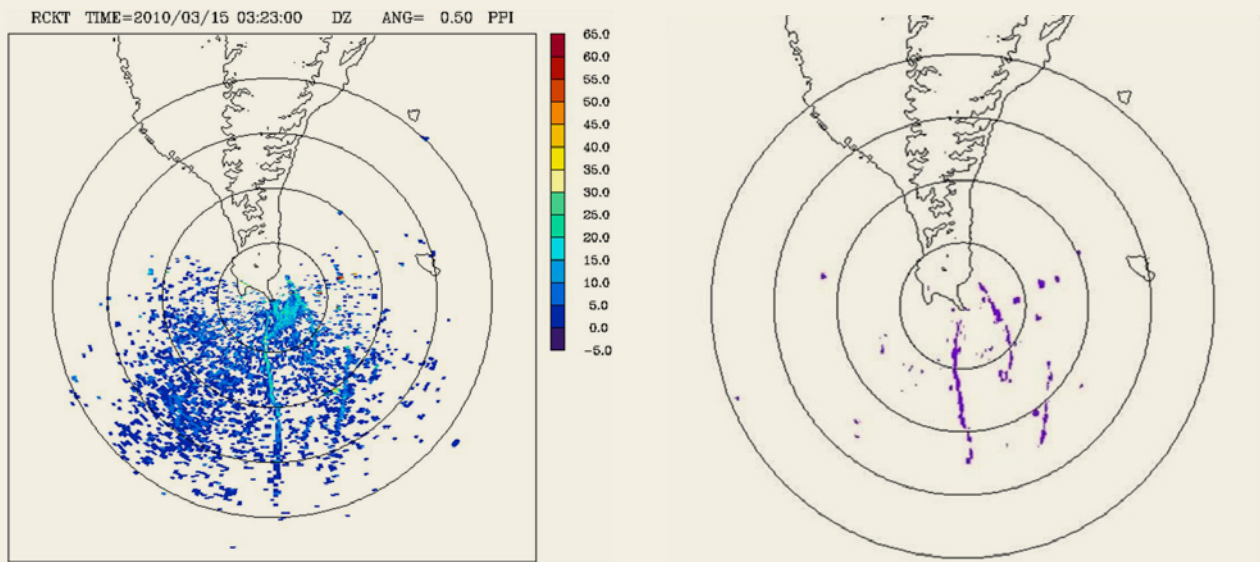
台北關渡、台南七股、墾丁社頂、關山、鵝鑾鼻……全台從北到南，不乏觀鳥、賞鳥的好地方，但研究人員與賞鳥人士最擔心的，就是少了點觀賞牠們的好運氣。以候鳥而言，雖然其遷移有固定習性，但要做到精準預測，是過去一直難以突破的困境。自2007年底起，墾丁國家公園管理處與中央大學太空所共同合作下，實行「雷達數鳥」的研究計畫，讓欣賞或觀測鳥類，將不再只能靠運氣。

## Technologies Help but Conservation Needs More

Whether the impact comes from genes or environments, it must count on observation to obtain and sort out further information on it.

As “waiting” is the basic requirement of all observations in research, other factors such as technological assistance will make observation much more cost-effective and efficient.

In every bird-watching site across Taiwan, such as Guandu, Cigu, Sheding, Guanshan, Eluanbi, etc., researchers and bird watchers always used to worry about their lack of luck to see the birds. Migratory birds, for example, had long been a difficult target for us to pinpoint the exact time of their arrival. But thanks to a joint project “Radar-assisted Bird Tracking” by Kenting National Park (KTNP) Headquarters and the Institute of Space Science, NCU, observations of birds is no longer a matter of luck.



1. 台灣與大陸的畫眉雖在350萬年前開始分隔，但其實中間一直持續交流著。圖為白耳畫眉 / 邱銘源提供，邱盧素蘭攝

Analyzing Hwamei (*Leucodioptron canorum*) by heredity, the research shows that Taiwan Hwamei and Chinese Hwamei were geographically separated 3.5 million years ago but had since continued their differentiation and gene exchanges. The picture shows Taiwan Sibia (*Heterophasia auricularis*) / Photo provided by Ming-yuan Chiu, taken by Su-lan Chin-Lu

2-3. 圖左為原始氣象雷達回波，而圖右為濾除雲雨及海浪後，看到的鷹群回波 / 潘貞杰提供

Photo (left) shows the original echoes from meteorological radars, and photo (right) shows the echoes reflected by flocks of Eagles after eliminating the information of clouds, rains and waves. / Photo provided by Chen-jeih Pan





等待，是作任何研究觀察的絕對條件之一 / 墾管處提供  
Waiting is the basic requirement of all observations  
in research. And technological assistance will make  
observation much more cost-effective and efficient. /  
Photo provided by Kenting National Park

起初，設置氣象雷達的主要目的是監測雲雨，後來發現鳥的回波也在雷達中，尤其是成群結隊的過境候鳥。於是，一直致力於候鳥保育、賞鳥文化推廣的墾管處，便有了利用雷達來偵測鳥群的想法。但實際運用後卻發現，雷達上的資料太繁雜，每回都必須利用人工判讀的方式，來過濾雲、雨，甚至是海浪的資訊，不僅費時且容易出錯，於是輾轉找到國內衛星與雷達方面的專家——中央大學太空所，並由所長潘貞杰教授親自負責本計畫。

「最早利用墾丁氣象雷達研究猛禽的是屏科大的老師，而且鳥類的研究我真的不懂，到目前為止我唯一分得清楚的是鴿子和白鷺鷥。」謙虛的潘所長一再強調自己是門外漢，但事實上，在所長與墾管處的通力合作下，雷達偵測數鳥已有很顯著的成果，不僅可以精準地濾除多餘雜訊，更可以透過雷達來監測鳥類的飛行方向，同時做到降落時間與落點的預報，無論在保育工作上或休閒賞鳥活動上，都是很重要的發展與進步。

經由多次的探測分析可得知，「大約距離目的地100公里遠的時候，牠們已經決定自己要往哪裡降落了，」潘所長娓娓道來長期參與此計畫所獲得的了解，「從雷達上不僅可以看出遷徙的習性，包括飛行高度、速度，我們都能知道。」潘所長接著表示，預報系統預計明年正式上線，只是在預報管道的選擇與保育觀念的加強宣導上，仍需要再斟酌考量，避免觀鳥的人來了，抓鳥的人也跟著來了，不僅有損雷達偵測數鳥的原始美意，更對保育造成難以平衡的傷害。

The project originated from the use of meteorological radars in monitoring the conditions of clouds and rains with the radars occasionally detecting the echoes reflected from flocks of migratory birds. That gave the bird-caring KTNP Headquarters the idea of tracking birds with radars. The first attempts failed as the data received was too complicated and required human interpretation, which was time-consuming and error-prone. Later, KTNP Headquarters managed to invite Prof. Chen-jeih Pan of Institute of Space Science to take charge of the project.

“The first scientist using the weather radar in Kenting to study raptors was a professor in Nat'l Pingtung Univ. of Science and Technology. I'm just a layman in bird research who can only tell apart pigeons and egrets.” The modest Pan has, in fact, been a great help in collaborating with KTNP in tracking birds by radars. Now not only can the noise on the radar be identified and eliminated, but the directions, routes, as well as the time and locations of landing, can be accurately monitored and forecast. This is an important advancement in both bird conservation and bird-watching activities.

According to analysis, we get to know that “at about 100 km away from their destination, these birds already decide where they are going to land,” Pan talked about his knowledge of birds' flight as he has been involved in the project for a long time. “We can tell from the radar the birds' migration habits, flight altitude, speed, etc. Even when there's a coup among a flock of birds, we 'll see it.” Pan said that the forecast system will go online starting 2011, but more care must be taken in providing the information and promoting bird conservation; otherwise, the project will help not just bird watchers but also hunters, and cause irreversible harm to the ecology.

一直以來，國家公園對於國人而言，是個郊遊踏青、親近大自然的好去處；對於鳥類來說，則是過渡、棲息、聚集之所。特殊的地理與生態環境，或許是造就這一切的根本，但人為與後天的努力亦相對重要。事實上，台灣國家公園的定位不僅是國家的公園，它更肩負環境保育的使命，希望在國人欣賞美景或休閒遊憩之餘，能獲得另一種形式的保育教育，而這些教育也需要題材，以及堅實的科學數據來佐證。在研究之下所產生的或許只是學術上的數據，但透過適當的解說，就能轉化成為民眾可接受的語言，做為認識與珍惜自然的最佳材料。🇺🇸

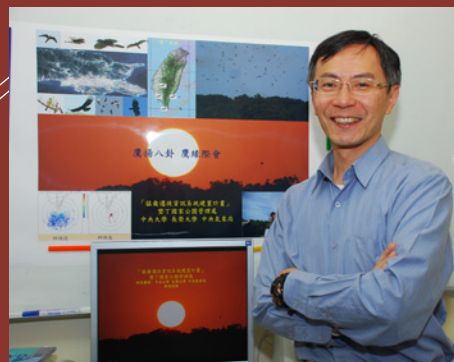
For people in Taiwan, national parks have been great places for sightseeing and hiking; for birds, these parks are where the birds pass by, rest and gather. Their importance may be mainly attributed to the distinct geographical and ecological environments they are endowed with, but also relies on human efforts. National parks are not merely parks that belong to the nation; they also bear the mission of environmental protection and conservation, offering Taiwanese people a different form of conservation education, which requires materials and scientifically proven statistics that, through interpretation, may become the best instruments to help people know about and care about the Nature. 🇺🇸

## 簡介 Profile

### 潘貞杰 Chen-jeih Pan

研究專長為雷達氣象學、電波傳播。學歷：國立中央大學大氣物理所博士。經歷：瑞典 EISCAT 科學總署博士後研究、國立中央大學太空科學研究所副研究員。目前與墾丁國家公園合作「猛禽遷徙資訊系統建置計畫」。

Dr. Pan is currently the Director of the Institute of Space Science at National Central University and collaborate Information of Bird Migration System Development Plan with KTNP. He had completed the postdoctoral research in EISCAT in Sweden. His research specialties are radar meteorology and wave propagation.



### 許皓捷 Hau-jie Shiu

專長及研究領域為聚生態學、生態方法學、生物多樣性空間分布、遙測及地理資訊系統。學歷為國立台灣大學動物學系博士，目前擔任國立臺南大學生態旅遊研究所助理教授。

Dr. Shiu is currently Assistant Prof. of the Department of Ecoscience and Ecotechnology at National University of Tainan. His research area covers community ecology, ecological Methodology and geographic information system.

### 李壽先 Shou-hsien Li

現任國立台灣師範大學生命科學系教授，擅長領域有演化生物學、演化遺傳、保育遺傳、行為生態學與鳥類學等。

Professor Li is currently Professor of the Department of Life Science at National Taiwan Normal University. He specializes in evolutionary biology, genetic evolution, behavioral ecology and ornithology.

