

# 動物行為研究於再引入上所扮演的角色

在面臨全球性物種及自然棲地消失的衝擊下,動物行為生態研究如何有效地回饋 保育生物學,最近成為一些行為學家大聲疾呼的議題。

行為研究可協助我們瞭解動物內部生理環境條件的變化,以及外在生態環境變化 對於個體生存及繁殖等行為表現的影響。一般常見的行為表徵包括:畫夜活動模式、 覓食、群居或社會行為、繁殖及配對、親代育幼、通訊、領域及活動範圍、禦敵和遊 戲等。動物行為時常也是左右族群數量、性別及年齡結構或遺傳多樣性的主因。因此 這些物種特定的行為模式遂為族群經營管理或擬定保育策略的必要資訊。

在過去,棄養、捐贈、查緝沒收、救傷的大型食肉動物,通常會以動物園或收容中心為最終歸途。但現今對於野外資料缺乏或種群處境受威脅的物種,例如大貓熊(Ailuropoda melanoleuca)及亞洲黑熊(Ursus thibetanus),如何善用現有圈養的或是圈養繁殖的個體,增益保育或研究的潛能,近年漸受到重視。以熊科動物而言,野放圈養個體的潛在理由很多,除了藉由移置同種個體以增加原生棲地內的現存族群數量(再引入)外,尚包括試驗野化訓練(rehabilitation)的技術,以及提供可近距離觀察研究的個體。



# The Role of Animal Behavior Research in Reintroduction

Under the impacts of the loss of species and natural habitats taking place world wide, how the study of animal behavior can effectively provide contributions to conservation biology in return has become an issue that some behavioral scientists are advocating.

Behavior studies help us understand more about the changes of animals' internal physical conditions and the influence of external environmental changes on the survival and reproduction of individuals. The commonly seen behavioral characteristics are daytime and nighttime activity patterns, feeding, collective living or social behaviors, reproduction and mating, nursing young, communications, territories and extent of activities, defense, and play. Animal behavior is often the primary factor that determines the number of population, gender and age structures, or genetic diversity. Therefore, the specific behavior patterns of certain species become the necessary information for the operation and management of population or development of conservation approaches.

In the past, large carnivores that were abandoned, donated, confiscated and rescued were often destined to zoos or other animal sanctuaries. However, for species that there is a lack of information for regarding life in the wild or are threatened in current status, such as giant pandas (Ailuropoda melanoleuca) and Asian black bears (Ursus thibetanus), the issue of how to benefit from individuals kept or bred in captivity and discover the potential for conservation and research works is now a center of scientific attention. For ursine animals, there are a lot of potential reasons for releasing captivated individuals to the wild. In addition to relocating individuals of the same species to increase its wild population in the original habitats (reintroduction), there are reasons such as testing the rehabilitation skills, and providing individuals that can be closely observed for research purposes.

In comparison to other species, ursine animals are more difficult to be recovered successfully. In general, it



相較於其他動物,熊類的成功復 育更加困難。一般而言,有經適應期個 體的釋放比沒有適應期個體的釋放容易 成功,而有經野化訓練的比沒有野化訓 練個體容易成功。以臺灣黑熊為例,牠 們的數量稀少,動物習性機警且隱蔽, 而且臺灣山林植相複雜、 遮蔽度高, 地形崎嶇和交通不便,相較於其他活動 於開闊地區或容易觀察的物種,如黑 面琵鷺(Platalea minor)、櫻花鉤吻鮭 (Oncorhynchus masou),野外研究黑熊 族群及其相關生態習性的作業便顯得十分 困難,資料收集費時且耗資。此時,在圈 養或半自然的環境下的個體,則提供了研 究者可詳細觀察動物行為的簡便途徑。雖 然圈養與野生個體所處的環境不同,但此 資訊仍有助於拼湊出動物的生活史,並且 助益整體保育效能。

# 臺灣黑熊野放行為訓練

#### 臺灣黑熊

臺灣黑熊(Ursus thibetanus formosanus)是臺灣唯一原產的熊類,屬 亞洲黑熊的種群之一。近幾十年來自然環 境過度開發及人為活動頻繁,使得早期分 布廣泛的黑熊如今僅侷限於地形較崎嶇陡 峭、高海拔或人為活動較少的山區,其族 群也處於受瀕臨滅絕的狀態。臺灣黑熊體 型龐大,活動範圍廣泛,無線電追蹤資料 顯示其活動範圍可超過100平方公里,而 且涵蓋了各種不同的生態環境梯度,是保 育學上的庇護物種(umbrella species)或地景 物種(landscape species)。

### 遛熊計畫(Walking with bears)

2005年11月,位於臺灣中部山區的特 有生物研究保育中心低海拔試驗站繁殖了

刻板行為 stereotypic behaviour

野生動物在圈養環境下容易發生的一種行為,推測原因來自動物為了克服不良 的環境壓力,而引發的一種抗緊迫行為,其中又以熊科和貓科的來回踱步、自殘或 搖擺;大型靈長目的重複嘔吐或食糞;大象的左右搖晃;以及鳥類功能性失調的拔 羽行為等較為嚴重。

以臺灣黑熊野放訓練為例

is easier to release an individual that has gone through a period of adaptation than those without, as well as the rehabilitated ones than those that are not. Take Formosan black bears as an example. They are scarce in number, always on alert and secretive. On top of that, the floristic forests in Taiwan are complicated and dense. Rugged terrain and uneasy access have also made the field study of Formosan black bear populations and associated habitual behavior to be seemingly more difficult than black-faced spoonbills (Platalea minor) and Formosan landlocked salmons (Oncorhynchus masou) that live in open areas or are easy to observe, not to mention the cost and time consumed for collecting data. At this moment, the individuals that are kept in captivity or semi-natural environment provide a convenient way for researchers to closely observe the behaviors of these animals. Despite of the difference in the environments in which the wild and captive animals live, the information collected from those captive animals still helps to piece together the life cycle of its species, as well as to improve the overall effectiveness of conservation.

## Behavior Training for Releasing Formosan Black Bears

#### Formosan black bears

Formosan black bears (Ursus thibetanus formosanus) are the only bears that are originated in Taiwan and belong to one of the Asian black bear families. Since decades ago, the over-development of natural environments and frequent human activities have driven the black bears that used to roam freely in the wild to high altitude mountainous areas where have rugged terrains or less human activities. Thus, the species is close to extinction. Formosan black bears have large bodies, as well as a large extent of activities. The radio tracking data shows that a bear's territory can cover over 100km2, which included many gradients of ecological environments. It is what is called the umbrella species or landscape species in conservation biology.

#### Walking with Bears Project

Nov 2005, the low-altitude testing station of the Endemic Species Research Institute located in the mountains of Central Taiwan successfully bred 2 female cubs. The research team decided to carry out an experimental release study, so that the cubs can be returned to its natural habitat in the future while the researchers closely observe their habitual behaviors as well as the behavioral developments that change as they grow to develop more understandings of the behavioral development patterns of black bears and their adaptability to the life in the wild.

Due to the constant contact with people, animals that are kept in captivity and fed by humans tend to lose their basic ability to survive in the wild, including finding food, hunting, avoiding predators and looking for shelters. Indeed, they even develop behaviors that normally will not occur in the wild, such as habituation, domestication or stereotypic behaviors, and become passive, dependant, hence no longer to be fit for independent living in the wild. Therefore, for captive animals to be released, a training process that can put them on the right track and better prepare them for life in the wild is rehabilitation.

To help the cubs adapt to the natural environment, increasing diversity of food and providing less artificial



# Stereotypic behavior

This concept refers to behavior that is bound to happen to wild animals kept in captivity. The reason for this is speculated to be that the animals develop a stress resisting counter behavior to overcome environmental stresses. Some of the extreme cases can be seen in ursine and feline animals walking back and forth, large primates vomiting repetitively or eating their own excrement, elephants swinging from left to right and the functional disorder of birds plucking feathers.

1. 台灣黑熊

he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July

2. 台灣黑熊 he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July 行動保育 Conservation in Action

2隻雌性幼熊。研究團隊決定進行試驗性 野放研究,以期日後牠們可以在野外釋放 並生活,並且藉由研究人員跟隨和追蹤, 近距離的直接觀察牠們的自然生態習性, 以及隨成長變化的行為發展,增加對於黑 熊行為發展模式以及野外行為適應的瞭 解。

人為圈養的動物由於長期與人接 觸,並接受飼育,基本的野外生存如覓 食、獵食、避敵及掩蔽等能力會變弱, 並發展出一些在野外不會出現的行為, 如習慣化、馴化或刻板行為(stereotypic behaviour),變得被動及依賴,而不適合 在野外獨立生活。因此對於擬野放的圈 養動物,需要一個導正和訓練的過程, 以加強其野外適應能力,即為野化訓練 (rehabilitation)。

本計畫為增加幼熊對天然環境的適 應性,藉由提高食物多樣性和野外食物的 供應量,並逐漸減少人為食物的供應,增 進擬野放幼熊對野外食物的探索,於天然 環境中獲得成長和生存所需營養來源的覓 食能力。研究者也隨時對圈養環境進行綠 化及豐富化,避免幼熊因習慣圈養欄舍而 出現刻板行為。同時針對幼熊進行不同階 段性的野化訓練,包括食物的多樣性、覓 食技能、獵食能力和社會學習等。了解成 長期的黑熊對食物上的偏好、需求及學習 過程,期以提供未來黑熊圈養管理和域外 (ex situ)復育的必要參考基礎。

### 野化試驗三階段

- (1)第一期(幼熊4月齡之前):透過監 視器錄影或由研究人員現場觀察親 子行為,母熊和幼熊皆不受到人為 操弄打擾。
- (2)第二期(5-8月齡):建立小熊與研究者間之關連,以讓研究者能直接觀察幼熊在成長過程中的行為發展,漸進式地將幼熊與母熊隔離,並與1-3名特定研究人員接觸。隔離時間從每天幾小時,到每週隔離3-4天。希望藉由親子之間的互動,學習成長過程中所需的生存技能。幼熊活動於11X20平方公尺的欄舍,管理人員持續地豐富及布置圈養的環境,並開始提供採集自附近森林和市場的各式食物讓熊嘗試。
- (3)第三期(9-15月齡):2006年7月以後,幼熊完全與母熊隔離,8月移置於半開放型40x60平方公尺的森林 圍場。圍場內為原始闊葉林,幼熊可於內自由活動及探索。此時提供 大量自野外採集的食物餵食,減少

# 庇護物種 Umbrella Species

庇護物種的概念是近來常常用在保育計劃的一個方法,因為保育某個目標必須 連同與它的食物、棲息地、活動空間有關的共存生物一起保育,否則這個目標一樣 會消失。在有限的經費、知識、與時間的限制下,保育經常要以最有效率的方式維 持生態多樣性,例如專注於一些關鍵或焦點物種,一般是考慮以大型哺乳類或鳥類 為主,如臺灣黑熊。當給予該物種足夠的保護空間,其他看不見或是尚不知道的物 種就可能受到良好的保護,這個頂端的物種就稱為「庇護物種」。評估何者適合做 為護庇護物種,必須對物種有多年的調查研究,以評估保護何物種能最有效率的保 護其他物種。



- 研究者與熊同行的「遛熊計畫 (walking-with-bears)」 he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July
- 台灣山區環境多變且崎嶇,研究大型野生動物困難度高 he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July
- 第一次上樹:剛會走路就會爬樹(3 月齡)
   he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July
- 副滿月的幼熊,眼耳已張開,但尚 無法站立
- he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July 5. 66日齡的小黑熊,已能站立,踏出
- 人生的第一步 he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July
- 數掛發報器警圈的幼熊,已逐漸熟 恣森林的環境 he 2008 Cultural Taiwan Exhibition will
  - be held from mid-April to mid-July



food are used in the project to encourage the cubs to explore the potential food source in the wild in the attempt to train the cubs to develop the skill in finding food in the wild to receive vital nutrients for their survival and growth.

The researchers also make various arrangements with plantations in their captive environment in order to keep the cubs from developing stereotypic behaviors. The cubs are also given rehabilitation trainings at different stages, including food diversity, food searching skills, hunting skills, socialization and so forth. By understanding the preference for food and the needs and learning process of black bear cubs during their growth stage, it is hoped to provide the necessary basis of reference for future captivity management and ex-situ recovery of Formosan black bears in the future.

#### 3 Stages of Rehabilitation Experiment

- (1) Stage 1 (cubs under 4 months old): Research staff observed the interactions between mother and cubs on site or through surveillance camera and made no human disturbance.
- (2) Stage 2 (cubs between 5-8 months old): The connection between cubs and researchers was established to allow research staff directly observe the cubs' behavioral development as they grew up. The cubs were gradually separated from their

mother and remained contacts with 1-3 designated researchers. The separation period ranged from a few hours per day at the beginning to 3-4 days per week in the end. The idea is to help the cubs learn the survival skills they need in the growing stage through interactions between the parent and cubs. The cubs were allowed to move around in an 11m X 20m enclosure where keepers constantly rearranged the environment and provided a variety of food gathered from neighboring forests and market for them to try.

(3) Stage 3 (cubs between 9-15 months): Began from July, 2006, the cubs were separated from their mother and relocated in a semi-open 40m x 60m forest enclosure in August.. The enclosure was located in a primitive broadleaf forest, and the cubs were allowed to move around and explore freely. Large quantity of food gathered from the wild was provided to the cubs, and artificial feeding was deliberately reduced. Also, the cubs were given the opportunities to try to hunt live prays, such as chicks and piglets.

#### Food Selection Experiment

During the research, a variety of food was provided to the cubs. In total of 255 species from 88 families of plants provided (71% of which were collected

# Umbrella Species

This idea is now a method commonly used in conservation projects, as the conservation of the targeted species will not succeed if any other species that are in correlation with its food source, habitat, and living space cannot be protected. Under the constrains of funding, knowledge and time, conservation usually requires the most effective way to maintain ecologic diversity, for example, concentrating on some critical or focused species. In general, large mammals or birds are the first to be considered, such as Formosan black bears. By providing sufficient space and protection to one species, the other species that are not found or known yet may as well be provided with good protection. Thus, the species at the top is called the "umbrella species." It is necessary to have years of investigation and studies on a specific species in order to evaluate whether it is the umbrella species and thus other species will also be protected in a most effective manner.

行動保育 Conservation in Action



人為食物,同時製造機會讓幼熊去 獵捕活體動物,比如雞和小豬等。

### 擇食試驗

研究期間我們提供幼熊各式各樣的 食物,植物總計88科255種(71%採集自 野外),幼熊曾取食73科154種,種類取 食率為60%。幼熊選食以果實居多,尤其 是甜度較高或多汁的漿果或梨果,也會優 先取食較為熟悉的食物,然當該項食物減 量或不再提供時,嘗試新食物或在展場中 自行覓食的頻度則有增加的趨勢。對於未 曾接觸過的植物,常以嗅聞方式探索,試 探性含入口中或更進一步直接取食,如糙 莖菝契的嫩芽、山黃麻的葉、禾本科小草 等。

我們也發現幼熊對有些未曾接觸過食物起初表現沒有興趣,但隨後當幼熊與母 熊同處時,再次提供此時物,母熊先食用 此食物,幼熊驅前嗅聞母熊口中正在進食 的食物,隨即從母熊口中擷取部分食物食 入,或直接取食附近可及的該食物。後續 再提供此類食物時,沒有母熊伴隨的幼熊 便會主動取食該食物。這類食物包括花椰 菜、百香果、板栗、絲瓜、大葉山欖、蘭 嶼肉荳蔻、百香果、欖仁和水麻等30種。 幼熊曾取食我們採集自野外的10類 動物性食物。在籠舍中,幼熊亦曾自 行捕食10類,包括斑頸鳩(Streptopelia chinensis)、刺鼠(Niviventer coxingi), 以及大部分的昆蟲類,對於兩棲及爬蟲類 則興趣缺缺。幼熊在欄舍裡也不時展現其 覓食本能,主動嗅聞找尋朽木,以爪刨挖 內含的鞘翅目幼蟲及取食蟻窩。

隨幼熊年齡增長,處理食物之技能亦 隨之建立,獵捕的能力也是如此。例如雞 或兔等小型脊椎動物可獨立迅速捕獲,而 對豬、羊等較大的獵物,則在兩隻合作下 方捕殺成功。同時我們也觀察到幼熊會自 行探掘天然的食物,將吃剩的食物掩埋起 來和做窩巢,就如同野生的熊一般。

### 行為發展及活動模式

由於熊類生長發育為晚熟型的特性, 獨立前的親子關係對於幼獸行為發展或生 存具有重要的影響。在親代育幼的階段, 幼熊學習有關獵食者、食性選擇和覓食地 點的資訊,因此學習在熊類長期的親子關 連中扮演重要的角色。

利用無線電追蹤及現場觀察記錄幼 熊的24小時活動模式發現,2隻一歲半的 幼熊活動同步且程度相近。活動高峰出現

7. 台灣黑雄樹上活動

- he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July 8. 嗅聞媽媽口中的食物,幼熊跟著學習接受新的食物。
  - he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July
- 9. 專注一眼前的台東火刺木果實。 he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-July
- 10. 台灣黑熊是目前唯一紀錄會築窩的熊,森林展場下的熊無師自通 he 2008 Cultural Taiwan Exhibition will be held from mid-April to mid-Julymid-April to mid-July

in the wild), the cubs ate 154 species from 73 families of them, accounting for 60% of the percentage of species chosen. The cubs chose to feed on fruits the most, especially the sweeter or juicy berries or pomes. They also preferred to choose the food they were familiar with. However, when the quantity of that food was reduced or no longer available, the frequency for the cups to start trying new food or search inside the enclosure increased. For plants they had never encountered, they would sniff them, take a testing bite, or further devour them; for instance, tender shoots of Smilax bracteata var. verruculosa, leaves of Trema orientalis, Gramineae grass, and so forth.

It was also found that the food that cubs showed no interest at the beginning such as cauliflower, passion fruit, chestnut, sponge cucumber, Palaquium formosanum, Myristica cagayanensis, Terminalia catappa, Debregeasia orientalis, and others, in total of 30 kinds, would draw the cubs attention later even if their mother was not around. When their mother took the first bite, the cubs would approach and sniff her mouth and begin to taste the food from her mouth or nearby places.

The cubs had eatten10 types of animal we collected in the wild. Inside the enclosure, they had also captured 10 types of animal, including spotted doves (Streptopelia chinensis), Niviventer coxingi, and large portion of insects; however, they seemed less interested in amphibians and reptiles. In addition, the cubs constantly displayed their instinct of finding food as they would sniff and search for rotten wood to dig for larvas of coleoptera with their claws as well as fed on termite lairs.

As they grew up, the cubs started mastering their food processing and hunting skills. For example, they were very agile in catching small vertebrates, such as chicken and hares. For larger preys like boar or goat, they had successes by working together. Also, it was observed that the cubs were just like wild bears as they also digged for natural food, buried their leftovers, and made nests,.

#### Behavior Development and Activity Patterns

As bears mature very late in their growing stage, the parent-children relation before independence is very important to the behavior development or survival of the cubs. During the nursing stage, cubs learn about the information associated with being a hunter, food choices, and feeding grounds. Therefore, learning plays a very important role for ursine animals in their long-term parent-children relation.

The cubs' activities were recorded 24 hours a day with radio tracking and on-site observation and the 2 18-month-old cubs seemed to behave in the same way and with the same frequency. The peak of their activity took place between 6:00~16:00, and they were less active at night. Their least active period was between 01:00~04:00. The primary daytime activities of captive cubs were similar to those in the wild. However, the average time for these captive cubs' activity was 1/3 of a day, far less than the 54-57% of a day of matured wild Formosan black bear.

#### Expelling and Avoiding Strangers Experiment

For the bear cubs' behavior development, hiding from enemies is one of the self-protection approaches. To prevent the captive cubs being used to people other than the researchers, a negative condition training with strangers was conducted. Different strangers were invited into the enclosure at Stage 3 of experiment. They would scare off the cubs by bluffing, making loud noises (shouting, making big sounds, firing firecrackers, or banging on metal pots), or using pepper spray if the cups got too close to them. At first, the cubs would try to approach the strangers closely to observe and sniff them. As the frequency and intensity of the training increased, the cubs changed tactics by observing from a far distance. At the 7th or 8th experiment, the cubs would seek coverage (e.g. in the woods or up on a tree) to hide themselves from the strangers and would not approach them actively.





 11.

 親子互動是熊類社會行為發展及求生技

 能養成之關鍵

 he 2008 Cultural Taiwan Exhibition will be

 held from mid-April to mid-July

 12.

 在陌生人訓練中,14月大的小熊趕緊爬

 到樹上

 he 2008 Cultural Taiwan Exhibition will be

 held from mid-April to mid-July

 13.

 寬食技能影響個體的適應度(fitness),

 關鍵野放個體的成敗

 he 2008 Cultural Taiwan Exhibition will be

 held from mid-April to mid-July

於日間06:00~16:00,入夜後活動量逐漸 減緩,直到清晨 01:00~04:00,活動量最 低。圈養幼熊主要日間活動,與野外的情 況相同,然其平均活動時間佔一天的三分 之一,低於野外的臺灣黑熊成體活動時間 的54-57%。

### 驅避陌生人試驗

在幼熊的行為發展上,藏匿避敵是 自我保護的行為之一。為了避免圈養環境 下的幼熊對於非研究者的人類的接受度過 高,遂採取陌生人負面制約訓練。在試驗 第三期時邀請不同的陌生人進入圈養場 內,如果幼熊靠近人,陌生人就會裝腔作 勢、喧鬧及製造各種聲響(吼叫、製造噪 音、放鞭炮或敲打金屬鍋蓋)或噴灑胡椒 粉,將幼熊驅退。起初幼熊對於陌生人會 接近觀察、嗅聞,但隨著訓練次數及強度 增加,幼熊改成在遠距離觀察陌生人。至 了第7、8次試驗時,陌生人進入展場後, 幼熊會往有遮蔽處(如林中或樹上)遠離 陌生人,不再主動接近陌生人。

## 瀕危物種之保育教育宣導

因為在各種人為發展如棲地喪失和過 度狩獵等活動的影響下,許多種類的數目 和分布皆大為減少,熊類的再引入計畫近 年漸受重視,也同時提高公眾保育意識。 藉由本研究資料收集工作,除了累積了野 化過程上有關操作流程,以及圈養黑熊的 照養管理的寶貴參考資訊和經驗之外,相 關網站(臺灣黑熊教育網 HYPERLINK "http://www.tesri.gov.tw/content/animal/ black\_bear/index.html" http://www.tesri.gov. tw/content/animal/black bear/index.html ) 及生態紀錄片的製作(搶救臺灣黑熊以及 兩隻小熊的成長故事),更有效地促進社 會大眾關心此議題。因此在體認保育瀕危 物種是一門危機科學之餘,如何以符合科 學的嚴謹去規劃野放黑熊計畫,同時多元 地以教育去創造保育的契機應該值得我們 進一步深思及努力。

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## Promotion of Conservation Education of Endangered Species

Under the impacts of human developments such as the loss of habitats and over-hunting, a lot of species are reduced in number and distribution. The bear reintroduction project has been the center of people's attention in recent years and at the same time increased the public awareness towards conservation. The data collected in this research has not only helped accumulate the precious information and experience for the development of operation procedures of rehabilitation, but also the management and raising of captive black bears. The establishment of associated websites (Taiwan Black Bear Education Website HYPERLINK "http://www. tesri.gov.tw/content/animal/black\_bear/index.html" http://www.tesri.gov.tw/content/animal/black\_bear/ index.html ) and the making of ecologic documentaries (Saving Taiwan Black Bears and the Story of Two Growing Cubs) has effectively made the public aware of the seriously treat facing Formosan black bears. Therefore, in addition to knowing that the conservation of endangered species is a science of crisis, it is worth more of our deep consideration and effort to plan bear release project in a more scientific manner as well as to dynamically use education to create potential for conservation.



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