

統一編號

025034870055

台灣瀕臨絕種的綠蠔龜
——其生殖生物學及保育現況

發行人：彭作奎

出版者：行政院農業委員會

地址：台北市南海路37號

執行者：國立台灣海洋大學

地址：基隆市北寧路二號

印刷者：裕華彩藝股份有限公司

地址：台北縣新店市寶中路95號之8

電話：(02)2911-0111

版次：初版

出版日期：八十七年六月

定價：新台幣82元

**The Green Sea Turtle in Taiwan—
The Reproductive Biology and Conservation
Status of an Endangered Species**

Publisher: Peng Tso-kwei

Published by Council of Agriculture: 37 Nanhai Road, Taipei,
Taiwan, ROC.

Edited by National Taiwan Ocean University
Institute of Marine Biology

2 Pening Rd., Keelung, Taiwan, 20224, ROC.

ISBN 957-02-1416-3



9 789570 214161



台灣瀕臨絕種的

綠蠔龜

——其生殖生物學及保育現況

**The Green Sea Turtle
in Taiwan—**

**The Reproductive Biology and Conservation
Status of an Endangered Species**



行政院農業委員會 編印

國立台灣海洋大學 海洋生物研究所

程一駿 製作

Published by the Council of Agriculture

Edited by Cheng, I-Junn, Institute of Marine Biology

National Taiwan Ocean University

台灣瀕臨絕種的

綠蠔龜

——其生殖生物學及保育現況

The Green Sea Turtle in Taiwan—

The Reproductive Biology and Conservation
Status of an Endangered Species



行政院農業委員會 編印

國立台灣海洋大學 海洋生物研究所

程一駿 製作

Published by the Council of Agriculture
Edited by Cheng, I-Jiunn, Institute of Marine Biology
National Taiwan Ocean University

The Green Sea Turtle in Taiwan 1



2 台灣瀕臨絕種的綠海龜



海龜與中國民俗活動的關係十分密切，在每年的元宵節活動中，沿海的居民都會製作海龜形狀的祭品，放在廟中膜拜，以乞求平安及福氣。

Sea turtles have a deep relationship with the Chinese culture. In the annual Wen-Shau Festival, coastal residence build sea-turtle shaped offerings and worship in the temples for the peace and prosperity.

在中國人的眼中，龜和其他的爬蟲動物一樣，是長壽的表徵，代表著吉祥與福氣，因此它和中國的民俗活動，有著密不可分的關係。在許多沿海

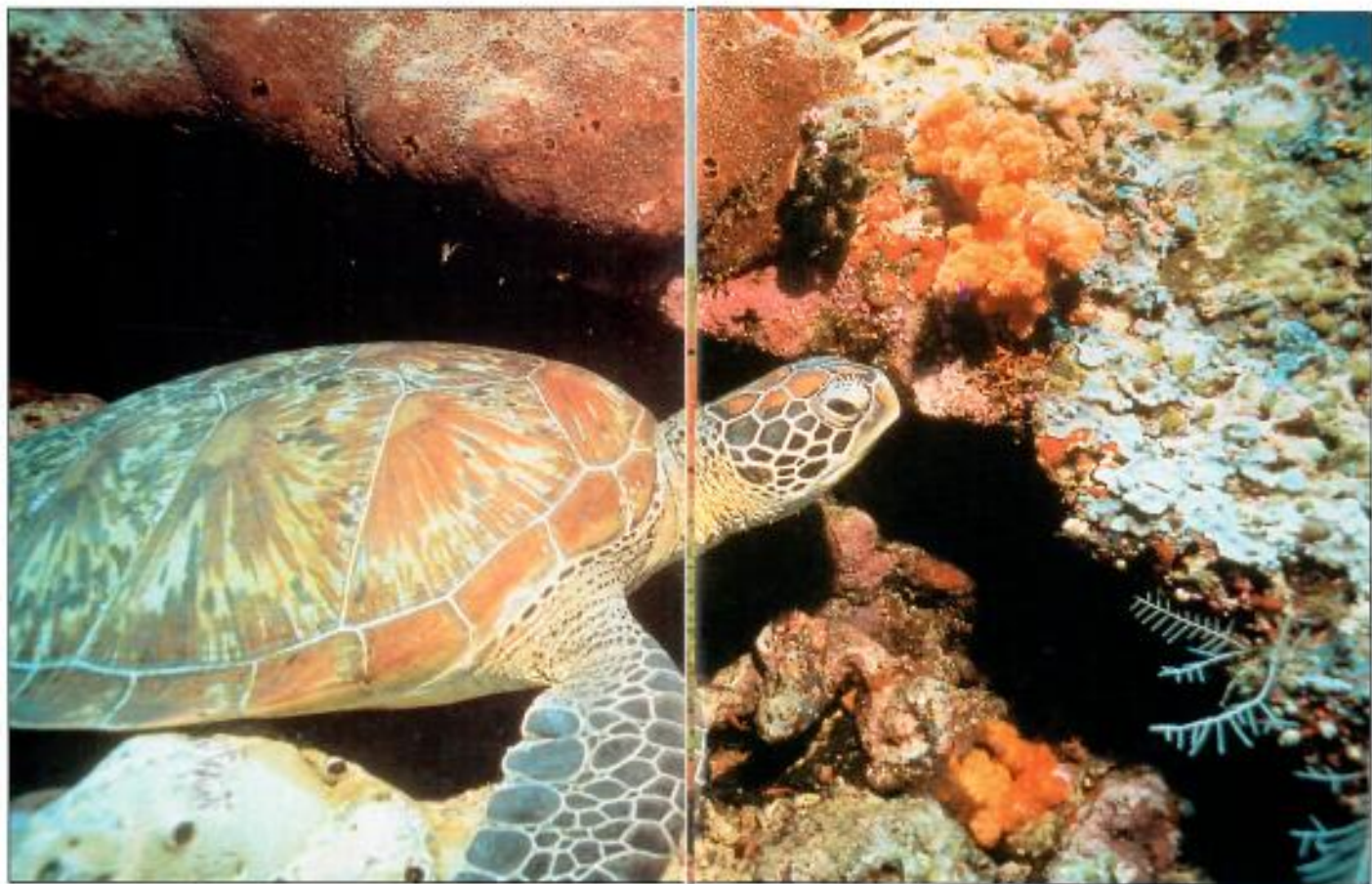
In the soul of Chinese, turtles and other reptiles are symbols of longevity; they represent luck and prosperity. Thus, these animals are deeply connected with Chinese cul-

即使在平時，許多沿海的居民也會在家中供奉海龜形狀的“金錢龜”以保平安。

Even at home, coastal residence keep sea turtle-shaped "coined turtle", in their home for religious ritual.



The Green Sea Turtle in Taiwan 3



台灣海域中常見的綠蠵龜(*Chelonia mydas*)
(台中潛水提供)

The green sea turtle (*Chelonia mydas*) in Taiwan. (courtesy of Taichung diving club)

的縣市，像澎湖群島等地，每逢元宵等重大祭典時，都會舉辦盛大的乞龜活動，用米、麵或是純金等材料打造成海龜的模型，供奉在廟中，以乞求平安與福氣。由此可見，海龜在許多中國人的心中，保有著一份崇高的地位。

同時，綠蠵龜(*Chelonia mydas*)和其他的海龜一樣，是我國名列保育類的野生動物，從1992年夏天起，行政院農委會委託國立台灣海洋大學海洋生物研究所程一駿教授，進行其生殖生物學的研究，並於1994年12月核准澎湖縣政府的申請，將其主要產卵

ture. In many coastal areas, such as PengHu County, people hold big prayer ceremonies during the Wen-Shau Festival, making sea turtle offerings from rice, wheat or gold, which they worship in the temples for good fortune. The turtle is thus a noble, respected animal in the eyes of Chinese.

Today, however, the green turtle (*Chelonia mydas*) and other sea turtles are listed as endangered species. Since the summer of 1992, the Council of Agriculture (COA) has sponsored a long-term research project to Professor Cheng I-Jiunn, Institute of Marine Biology, National Taiwan Ocean University to study the reproductive biology of the green turtle in Taiwan. Based on his work, the COA has granted permission to the PengHu County Government to establish a refuge site for nesting green turtles on Wan-An Island, to protect both the animals and their nesting environment.

Now that the refuge sites have been established, the



台灣海域中常見的赤蠵龜(*Caretta*)。
The loggerhead sea turtle (*Caretta caretta*) in Taiwan.

地之一的望安島產卵沙灘劃設為保護區，並且立法保護產卵的母龜和龜卵的孵化環境。

在保護區劃設之後，研究工作已進入了第二階段。在此階段中，除了繼續第一階段的基礎生物學研究之外，政府並展開保護區經營管理的規劃工作。由於良好的保護區經營管理需建立在確實基礎研究之上，因此每年仍然投入大量的人力與經費，來收

台灣海域中常見的蠟蟻龜(*Lepidochelys olivacea*)。
The olive ridley sea turtle (*Lepidochelys olivacea*) in Taiwan.



6 台灣瀕臨絕種的綠蠵龜



台灣海域中常見的玳瑁(*Eretmochelys imbricata*)。
The hawksbill sea turtle (*Eretmochelys imbricata*) in Taiwan.

project has moved into the second phase. In addition to continuing basic research, the government has begun to design a management strategy for the refuge sites. Because a well-designed project is based on solid data, the government is investing large amounts of manpower and money in research. Meanwhile, due to the increasing popularity of turtle-watching and other tourist activities on the island, the pressure to organize a proper ecotourism industry has also

台灣海域中常見的革龜(*Dermochelys coriacea*) (Chan and Liew提供)。
The leatherback sea turtle (*Dermochelys coriacea*) in Taiwan. (courtesy of Chan & Liew)



The Green Sea Turtle in Taiwan 7



海中游泳的母綠蠵龜（台中潛水提供）。
The female green sea turtle in the ocean. (courtesy of Taichung diving club)

集各種相關生殖生物學的資料。同時，由於近年來每逢旅遊季節時，均有大量的遊客到島上來觀賞母龜產卵及稚龜孵化，島上生態觀光的壓力有與日俱增的趨勢，因此如何規畫出一個正確的經營管理策略，將對保護區是否能發揮其應有的功能，有著決定性的影響。

澎湖縣望安島上綠蠵龜生殖生物學的資料

經過六年的調查，我們大致可以確定的是，綠蠵龜的交配期約在每年三、四月之間，而產卵季則從五月下旬或六月上旬到十月下旬，以七、八月為產卵高峰。母龜約每三年會再回到望安島來交配及產卵。上岸母龜的數量並不多，介於8到14頭之間，母龜體長大小平均為97公分背甲直線長。牠會在島上8個沙灘中的6處上岸產卵，都集中於西側及南側海岸，產卵的沙灘面積為4.02平方公里。母龜每季平均上岸9次，產下4窩卵，每窩中含112粒龜卵，和其他地區的綠蠵龜一樣，母龜對第一次產卵沙灘的忠誠度很高，約為70%，而兩次上岸產卵的間隔期約兩星期。

上岸後，母龜平均在沙灘上會爬行115公尺，由GPS(全球衛星定位儀)的研究得知，母龜在上岸後會



海中游泳的公綠蠵龜（台中潛水提供）。
The male green sea turtle in the ocean. (courtesy of Taichung diving club)

increased in recent years. To ensure that the future of the refuge site, we will have to design a management plan that takes these factors into account.

The Reproductive Biology of the Green Turtles on Wan-An Island, PengHu County

Basically, after six years of investigation it was found that the mating season of the green turtles occurs from March to April. The nesting season lasts from the last week of May or first week of June till the last week of October, and peaks in July and August. The female turtles return to Wan-An Island to mate and nest once every three years. The number of nesting female ranges from 8 to 14. The average body length is 97 cm in straight carapace length. The female turtles nest on 6 out of the 8 beaches on the island, and they are all located on the west and south sides. The total area of the nesting beaches is 4.02 km². On average, the female turtle emerges 9 times and deposits 4 nests in each season. The nest contains on average 112 eggs. Like the green turtles in other areas, the Wan-An females have a high nest site fidelity (about 70%). The interesting period is about 2 weeks.

After emerging, a nesting turtle crawls an average of 115 meters on the beach. According to our GPS (Global Positioning System) study, the turtle looks for her nest site in the vicinity of the vegetation zone. There is about a 5% chance that the turtle will not nest on Wan-An Island. The nest depth is about 70 cm, and the hatching period is about 50 days. The typical egg weights 45 g and is 23 cm in diameter. Like other



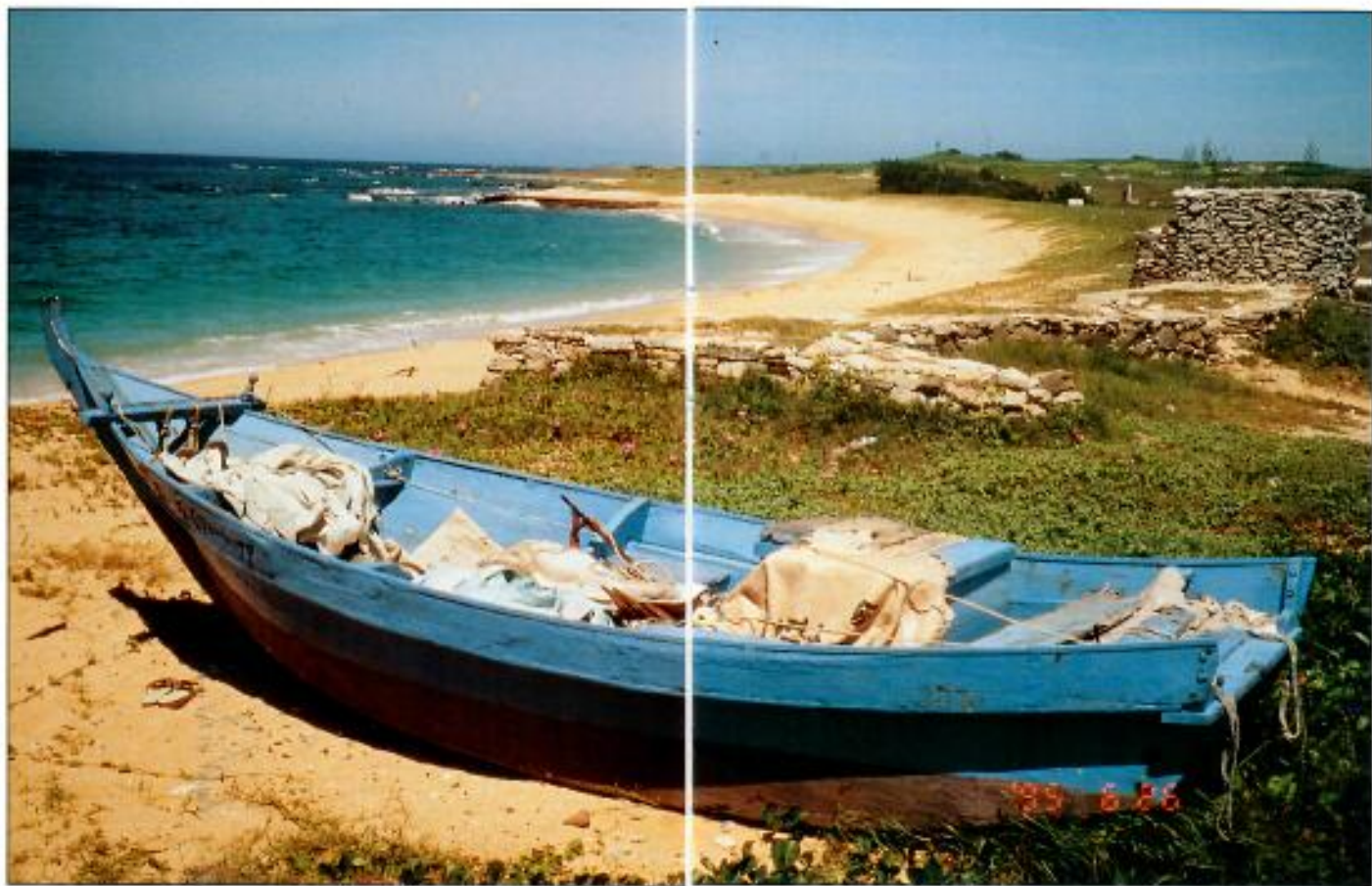
東沙島上潔白的沙灘。
The pure white sand on the Donsha Island.

在植被區附近找尋其合適的產卵地。在整個產卵季中，約有5%的母龜不會在望安島上產卵。卵窩的深度約為70公分，孵化期約為50天，龜卵大小為45克

reptiles, the sex ratio is determined by the nest temperature during the middle period of incubation. The nest produces all females if the incubation temperature is above 30°C, and all males if it is below 28°C. The nest only produces 1:1 sex ratio hatchlings when the temperature lies within this narrow temperature range. According to the records of long-term temperature loggers, the hatchlings produced in July and August are all female turtles.

位於赤道附近的熱帶雨林島——南沙群島中之太平島。
Tai-pin Island of Nansha Archipelago is a tropical rainforest island near the equator.





澎湖縣的望安島是由四個小漁村所組成。

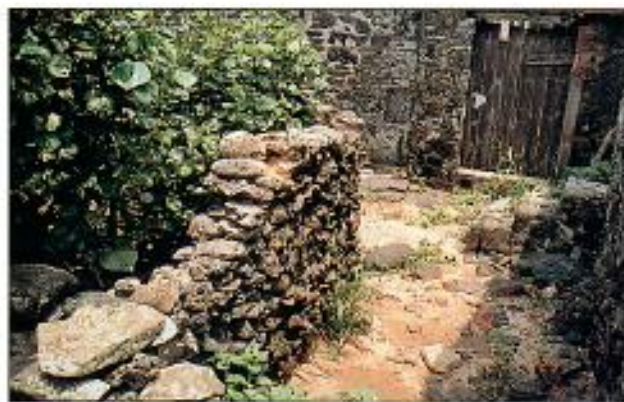
The Wan-An Island of PengHu County is composed of four small fishing villages.

重，直徑23公釐。海龜和其他的爬蟲類一樣，其性別是由孵化中期的沙溫來決定的。此期間的沙溫若高於30°C則會產生雌性稚龜，低於28°C會產生雄性稚龜；唯有介於此兩溫度之間，才會產生1:1性別的稚龜。由1996及1997年卵窩中放置長期溫度計記錄器的研究得知，在七、八月所產下的稚龜幾乎都是雌性的。

望安島上稚龜的孵化率平均為75%，影響稚龜孵化率的因子有沙溫、沙子的含水量、顆粒的大小和顏色、植被覆蓋率、卵窩深度、天敵與人為盜取和搬動等。在望安島上，孵化的沙灘主要是由細石英

The hatching success is about 75%. The factors that influence hatching success include sand temperature, pore water content, grain size and color, vegetation coverage, nest depth, natural predators, poaching and nest relocation. The beaches on Wan-An Island are composed mainly of granite, coral and shell debris. Sand grains with a diameter of 0.6-1.0 mm. And a inclusive graphic standard deviation of 0.43-0.94 ϕ , make a suitable nesting environment for the green turtle. Since the levels of natural predation on the island are low, the major factor that influenced hatching success before the establishment of the refuge sites is poaching; subsequently the biggest impact has been from fluctuations in sand temperature and pore water content caused by meteorological events such as typhoons and high summer temperatures.

In order to avoid predation, the hatchlings usually emerge after sunset, when the air temperature cools down. The



望安島上的古厝庭園。
The front yard of an ancient house on the Wan-An Island.



望安島上的產卵沙灘。
The nesting beach on the Wan-An Island.

沙和珊瑚、貝殼等碎屑所組成，其沙粒直徑在0.61-1.01釐米之間，篩選係數在0.43-0.94 ϕ 之間，係屬於綠蠵龜良好的孵化沙層結構，另外，由於該島上龜卵的天敵很少，因此影響其孵化率的因素在保護區劃設之前為人為的挖掘，劃設之後則為天氣變化(如颱風、高溫等)所引起的沙溫 and 含水量改變所致。

由於躲避天敵的特性，稚龜通常於黃昏時氣溫降低後才會爬出卵窩，稚龜大小為4.8公分背甲直線長，重23克。稚龜的天敵很多，但在望安島上，稚龜的主要天敵是大海中肉食性的魚類。下海後的稚龜要活上20到50年才會長大成熟，然而根據研究得知，每一千隻稚龜中僅有一隻能存活下來，由此來推估，望安島上每年所產下的稚龜中，僅有4到6頭會長大成熟並再回來產生下一代，因此產卵棲地的保護，對產卵母龜數量的增加，有著十分重要的意義。

為了瞭解在望安島上產卵母龜的海上行蹤，從1994年起，我們在產卵母龜的背上裝置了人造衛星發報器，並追蹤其產後的洄游路徑。到了1997年為止，一共裝置了8具電力持續二年，且會自動脫落的發報器。由這四年的研究得知，在望安產卵的母龜，其產後的海上行蹤遍佈於大陸東側的陸棚上(包括了日本、琉球及南海)，其洄游速度介於每小時1.0到

hatchlings measure 4.8 cm in straight carapace length and 23 g in weight. Although there are potentially many natural predators, the major ones on Wan-An Island are the carnivorous fishes in the ocean. After entering the sea, the hatchlings have to grow for 20 to 50 years before maturation. However, it is estimated that only one out of a thousand turtles can be expected to survive to maturity. Based on this estimate, each year only 4 to 6 hatchlings produced at Wan-An Island would be expected to reach maturity and return to mate. Therefore, protection of the nesting beaches is vital if the number of nesting adults on Wan-An Island is to be increased.

In order to understand the whereabouts of nesting females in the ocean, satellite telemetry has been conducted by deploying Argos-linked satellite transmitters (Platform Transmitter Terminal; PTT) on the female turtles since 1994. The nine PTTs deployed between 1994 and 1996 showed that the turtles that nested at Wan-An Island were distributed widely on the continental shelf east of mainland China (including the East and South China Seas and the Yellow Sea). Migration speeds range from 1.0 to 2.5 km per hr. The turtles are submerged for more than 95% of the time, and only surface to breathe for short periods. Their migration routes show that the green turtles of Wan-An Island are a resource that is shared among nations in northeast Asia.

In the summer of 1997, three years after she had left, the turtle Wan-An No. 1 returned to Wan-An Island to nest. This



台東縣的蘭嶼島為一位於太平洋上的熱帶雨林島。
The Lanyu (Orchard) Island of Taitung County is a tropical rainforest island on the Pacific.

2.5公里之間，在海上的歲月裡，95%以上的時間是在水下活動，僅於換氣時才會短暫的浮出。由其海上的棲息地可證明，在望安島產卵之綠蠵龜實應為東亞地區國家所共有的天然資產。

1997年的夏天，望安一號在牠三年前上岸產卵之後，重新返回望安島，這是我們有紀錄以來，綠蠵龜第一次返回望安島來產卵。同年8月初，我們在它的背上重新裝上了人造衛星發報器，再次追蹤其產後之洄游路徑。其結果顯示，望安一號在產後僅洄

蘭嶼島上的原住民部落。
The aboriginal tribe on the Lanyu Island.



蘭嶼島上的產卵沙灘。
The nesting beach on the Lanyu Island.

is the first record in Taiwan of a tagged green turtle that returned to the same nest site to breed. In early August 1997, this turtle was fitted with a new satellite transmitter to track her post-nesting migration. This time, instead of migrating towards Koshiki Island, Japan as in 1994, she took up residence in the nearshore waters of Ho-Lon Town, Maio-Li County, Taiwan.

Management of the Refuge Site on Wan-An Island, PengHu Archipelago

The ecological behavior of the green turtles that nest at Wan-An Island has received mass media attention since the establishment of a refuge site in December 1994. The number of turtle-watch groups has also tended to increase as has the involvement of local people in beach patrol during the summer nights. Therefore, it has now become necessary to evaluate the current management method to determine if it will meet future needs. In the summer of 1997, the researchers used questionnaire forms to interview 755 tourists (composed mainly of college graduates), 123 local residents (composed mainly of middle-school educated fishermen) and 59 Wan-An middle and primary school students.

Most interviewees agreed that all kinds of harassment of sea turtles (including riding the turtles, egg poaching, etc.) should be forbidden, as should sand mining and littering on the beaches. Most tourists agreed that riding motorcycles and collecting or removing flora from the beach should be banned, although fewer students, and only 70% of the local inhabitants with agreed with these proposals. Tourists also



正在樹下掘洞的母龜。

A female turtle is constructing her nest under the tree.

游到苗栗縣後龍鎮外海，而沒有像牠三年前一樣游到日本九州南部的下甌島外海去活動。

澎湖縣望安島保護區之經營管理

自從1994年12月保護區正式劃設公告以來，每年媒體對保護區的海龜生態行為，均有大量的報導，遊客對相關的活動如觀賞海龜產卵的行為，以及當地居民參與夜間巡邏工作等，有與日俱增的趨勢。

正在產卵的母龜。

A female turtle is depositing her eggs.



產完卵後，返回大海的母龜（行政院新聞局提供）。

After finish her nesting activities, female turtle returned to the sea. (courtesy of GIO)

agreed that campfires and ball playing should be banned and that pets should not be allowed to run free on the refuge beaches. However, only 65% of the student and local interviewees were in agreement with these suggestions. The tourists would like to prevent the construction of permanent recreational facilities on the beaches. However, only 40% of the locals agreed and 25% disagreed. Both tourists and students approved of imposing permission only limited entry to the nesting beaches during the high tide period in summer nights. However, only 50% of the locals agreed and 30% dis-

沙灘上留下的母龜爬痕。

The emerging tracks left on the beach.





沙灘上留下母龜挖過如彈坑般的體溝（行政院新聞局提供）。

The dimbed-shape body pits left on the beach. (courtesy of GIO)

因此，保護區的經營管理方式，必須加以評估，以確定過去的執行方式是否仍能因應未來的趨勢。1997年的夏天，研究單位以問卷調查的方式訪問了755位遊客（以大專畢業生為主），123位當地居民（以中學程度的漁民為主）以及59位望安國中、小學生後發現；絕大部分的受訪者同意，禁止在保護區內進行各種形式的海龜騷擾（如乘騎母龜、挖掘龜卵等）及挖沙、傾倒垃圾等行為。對於在保護區內禁行機車以及禁止採集和砍伐植物等行為，遊客十分贊成，學生次之，居民約有七成的贊成。遊客亦十分贊成禁止在保護區內生管火；進行各種球類活動及攜帶寵物，但僅有六成五的居民和學生贊成。另外，遊客皆贊成禁止在沙灘上設置遊憩設施，但僅有四成的居民贊成，兩成五反對。遊客及學生贊成在母龜產卵季中，於管制時間內，禁止民眾及遊客擅入保護區，當地居民僅有五成贊成，近三成反對。對於非經許可禁止攜帶照相機及照明設備進入保護區一事，遊客是十分贊成，然而僅有六成的當地居民和學生贊成之。在所有的調查中，約有兩成到三成的當地居民和學生表示沒有意見。

大部分遊客認為島上最需要的是海龜生態錄影帶，其次是相關的書籍、解說摺頁、新聞專題、定期



研究人員在母龜產完卵後，將龜卵取出並測量其重量與直徑。The researchers extracted eggs from the egg chamber and measured their weights and diameters.

agreed. Finally, tourists agreed that people should not be allowed to bring flash lights or other illumination devices onto the beach without permission. However, only 60% students and locals were in agreement. To every question, about 20 to 30% of the students and locals declined to express their opinion.

Tourists believed that the most needed material on the island is a video tape on the ecology of the sea turtle. Other priorities in decreasing order of importance are relevant books, brochures, media reports, periodical journals and magazines, posters and miscellaneous public awareness materials. The students, on the other hand, believed that the most needed materials were the video tape and relevant books, followed by the periodical journals and magazines, brochures, posters and public awareness materials. It is worth noting that less than 70% of the interviewees thought it necessary to build a sea turtle ecological exhibition hall on Wan-An Island.

These interviews showed that all the interviewees, tourists, local residents and students alike are well aware of the importance of sea turtle conservation in Taiwan. However, due to the variety requirements from the refuge site on the island, simply employing beach patrollers, limiting entry to the nesting beaches, and enhancing basic research apparently cannot meet the future requirements. Therefore, in addition to increasing basic research and for greater campaigning awareness through public speeches in every county, a new project which calls for tighter cooperation between re-



孵化後爬出卵窩的稚龜們。
The emerged hatchlings from the nest.

雜誌和刊物、海報及宣傳單。學生則認為島上最需要的是海龜生態錄影帶及相關的書籍，其次才是雜誌、刊物、摺頁、海報及傳單。值得注意的是，僅有七成不到的人認為島上需要蓋生態展示館。

由此次的調查得知，雖然不論是遊客、當地居民或是學生，均已對海龜的保育，有了基本的認知。然而，由於各方對於保護區之經營管理有不同程度的認知，目前單純的無人巡邏、管制保護區進出及集中研究的方式，顯然已無法應付各方面的需求。因此除了繼續加強研究與全省巡迴演講之宣導外，並將與澎湖縣政府合作，加強望安島之各項經營管理的硬、軟體設施；如製作生態錄影帶；訓練沙灘巡邏及解說人員；規劃生態及人文旅遊；設立生態展示館；以及成立一個有效的管理組織，以積極的態度來管理及維護此一保護區。同時，澎湖縣政府亦應加強與望安島居民的溝通與保育宣導，從創造生態旅遊的環境、品質與相關的就業機會，從生活及教育層面著手，以建立島民對保護區經營管理的信心，如此一來，保護區才能發揮其應有的功能。

台東縣蘭嶼島上綠蠵龜生殖生物學的資料

蘭嶼又稱為紅頭嶼，為一在太平洋上距台東49海



爬向大海的稚龜。
The hatchlings are rushing to the sea.

searchers and the PengHu County Government to be lunched in summer 1998. This project is intended to provide the necessary facilities and software programs, and its particular aims are: to produce a video tape on the ecology of the sea turtle; to organize training programs for both the beach patrols and tour guides; to organize both eco- and culture-tourism; to build a sea turtle ecology exhibition hall; and to organize community-based conservation efforts. In addition, the PengHu County Government plans to increase its public awareness education and open a dialog with the local residents, with the object of creating an environment - the relevant job opportunities - in which ecotourism could flourish on the island. In this way, the county government also aims to improve the living standard of local people and promote grassroots movements leading towards self-sufficiency. The refuge site can then operate under the proper institutional capacity.

The Reproductive Biology of the Green Turtles on Lanyu (Orchard) Island, Taitung County

Lanyu Island, also known as red-head island, is a tropical rainforest island in the Pacific 49 miles southeast of Taitung. The biodiversity on the island is very high, with many endemic fauna and flora. The nesting season of the green turtles lasts all year round, but peaks from early June till late September. According to field research in 1997 and 1998, there used to be 6 nesting beaches on the island. However, due to the long-term intensive sand mining, nesting turtles can now be found only on two beaches, Don-Chin and



稚龜的陸上天敵——赤背松柏根蛇。
The terrestrial predator of hatchlings—the Taiwan Leopard snake, *Holarchus formosanus* (Günther).

溼之熱帶雨林島，島上生物歧異度很高，特有種之動、植物種類很多。島上之綠蠵龜產卵季終年皆有，但集中於六月上旬至九月下旬之間。從1996及1997年夏季的調查中得知，島上原有六處產卵沙灘，但因大量且長時間的挖沙與海岸帶的開發，目前僅剩下東清與八代灣兩處仍有海龜上岸產卵的事實。上岸產卵母龜的數量與莒安島類似，約為11頭。母龜平均體長為101公分披甲直線長，105公分披甲曲線長。調查期間母龜共上岸68次，產下31窩卵，產卵成功率為32%，產卵間距為11天。母龜上岸後會在植被區選擇其產卵地。龜卵大小為4.16公分直徑長47.5克重，卵窩深度為73.5公分，孵化期為49.2天，孵化率為73%。稚龜大小為4.72公分披甲直線長23.8克重。為了瞭解母龜產後之洄游路徑，1997的夏天，我們在兩隻產卵的母龜背上裝置了ST-14人造衛星發報器。研究的結果發現，一隻在洄游一個月後，失去了音訊；另外一隻在洄游了近兩星期後，徘徊於澎湖海城，其洄游的距離為373公里，速度為每小時1.1公里。

雖然雅美人因傳統上認為爬蟲類動物(如海龜、蜥蜴等)為不吉祥之物而不會去騷擾牠，也不會去挖龜蛋。但因島上觀光客的干擾及挖沙的情形嚴重，造成可供產卵的沙灘大量減少。赤背松柏根蛇對龜卵



被樹根貫穿的龜卵。
The embryo that penetrated by the tree root.

Bau-Dai-Wein. As on Wan-An Island, about 11 turtles emerge on Lanyu Island during the summertime. Their average body size is 101 cm in straight carapace length. There were 68 emergence tracks and 31 nests found in the summer of 1997. The nesting success was 32%. The interesting period was 11 days. The female turtles searched for nest sites in the vegetation zone. The eggs were 4.16 cm in diameter and 47.5 g in weight. The hatching period was 49.2 days, and hatching success was 73%. The hatchlings were 4.72 cm in straight carapace length and 23.8 g in weight. To track post-nesting migration, the researchers deployed two ST-14 satellite transmitters (PTTs) in August 1997. Unfortunately, we lost contact with one PTT one month after deployment, but the other one reached the waters of PengHu County two weeks after deployment, and has stayed there ever since. The migration distance was 373 kilometers and the speed was 1.1 km per hr.

The aboriginal people of the Yamai Tribe consider all reptiles, including sea turtles and lizards, to be symbols bad luck, and thus will not disturb the nesting females, nor poach their eggs. However, the green turtles on the island still face serious problems. Firstly, the availability of suitable nesting beaches has been greatly reduced by intensive sand mining and tourist disturbance. Meanwhile, the level of natural predation on the eggs and hatchlings by the Taiwan leopard snake, *Holarchus formosanus* (Günther), has increased as the number of nesting beaches fell. In addition, a lot of nests are dug under the Kanehira tree *Pandanus odoratissimus* L.



為了解母龜在海上的行蹤，我們在母龜背上裝置了人造衛星發報器。

In order to understand the whereabouts of sea turtle in the sea, we deploy satellite transmitter on the female turtle.

與稚龜捕食的壓力也很大。另外，因不少的卵窩都產在林投樹下，若干的龜卵也遭到樹根的穿刺，因此蘭嶼島上產卵之綠蠵龜所面臨的生存壓力要比望安島大了很多，該島也應急需設立綠蠵龜產卵地保護區，來保護面臨無沙灘可產卵的海龜。

其他地區之海龜保育現況

在三、五十年前，台灣東部及南部沿海因為富含

在固定發報器之後，我們將母龜放回大海。
After deployment, the turtle was released.



26 台灣瀕臨絕種的綠蠵龜

在母龜下海後，我們開始追蹤其海上行蹤。

The whereabouts of the turtle in the ocean was tracked by the satellite telemetry.



f. var. *sinensis* (Warb.), and some eggs in these nests are penetrated by the tree roots, which obviously leads to the death of the embryos. Therefore, the green turtles on Lanyu Island are facing even more serious survival pressures than those on Wan-An Island, and refuge sites for these nesting females and hatchlings are also urgently needed.

The Conservation Status of Sea Turtles in Other Regions

There are many rocky coasts and coral reefs in the eastern and southern waters of Taiwan. The nesting and foraging possibilities of these areas attract many sea turtles. Thirty to fifty years ago, there were not only many green (*Chelonia mydas*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), hawksbill (*Eretmochelys imbricata*), and occasionally leatherback (*Dermochelys coriacea*) turtles swimming and foraging in these waters, but both green and loggerhead turtles were found nesting in these areas. In northern Taiwan, the Tamshui Estuary and the nearshore coral reef north of it are historically important foraging waters for green, loggerhead, hawksbill, and olive ridley turtles. However, apart from the illegal capture of massive numbers of turtles, coastal construction, and the development of nearshore fisheries have both greatly reduced the available nesting sites. Meanwhile, according to a field investigation in the summer of 1996, less than two nesting beaches exist in eastern Taiwan, an local environmental con-



遭到定置網意外捕獲的海龜。

The turtle captured by the setnet fishery incidentally.

宗教放生為一違法的行為（屏東普石南提供）。

The religious release of sea turtle is against the domestic wildlife protection law. (courtesy of Tseng Shih-nan, Pingtung)



海上炸魚及毒魚不僅破壞生態資源，而且危及海龜的生存。（行政院新聞局提供）

The illegal dynamic and poison fishings not only destroy the marine resources but endangered the survival of sea turtles. (courtesy of GIO)

海邊堆積的垃圾也會破壞海龜近海的棲地環境。

The dumping of the garbage by the ocean also destroy the nearshore habitat of the marine turtles.



遭到感染纖維狀乳凸瘤的綠海龜。

The green sea turtle with the fibropapilloma disease.

綠海龜的產卵沙灘遭到大量的非法挖沙，這處牌子為保護區的告示牌。

The massive sand mining on the nesting beach. The poster on the far end is the declaration of refuge beach for the green turtles.



產卵沙灘上建水泥衛浴設備，不僅污染環境而且造成大量沙石的流失。

The build of cement toilet-bathroom combinations on the nesting beach not only polluted the beach environment, but caused the massive sand loss from the nesting beach.

翻、騎母龜及挖雞蛋卵都會對海龜造成嚴重的干擾。

The riding, turning the mother turtle on her back and egg poaching can cause serious disturbance to the sea turtles.



產卵的母龜遭到無情的殺戮，僅在沙灘上留下一堆白骨。

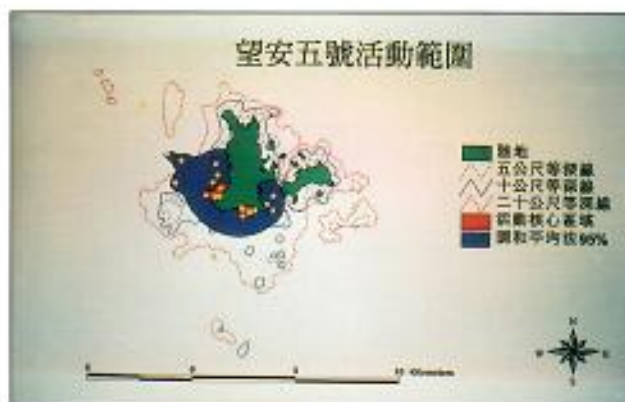
The nesting female turtle was slaughtered, left only pieces of skeleton on the beach.



要保育海龜就需先將其重要的產卵棲地劃為保護區。
The most important issue to conserve sea turtles is to establish their nesting beach as the refuge site.

海龜喜歡棲息的海域——岩石及珊瑚礁區，因此吸引許多海龜來此覓食及產卵。不但海中可以找到綠蠵龜(*Chelonia mydas*)、赤蠵龜(*Caretta caretta*)、襖蠵龜(*Lepidochelys olivacea*)、玳瑁(*Eretmochelys imbricata*)及革龜(*Dermochelys coriacea*)等海龜在此覓食及游泳，而且會發現綠蠵龜及赤蠵龜在有沙灘的地方產卵；即使是淡水河口及其北岸的淡海珊瑚礁區，也是此五種海龜重要的近岸棲息地。然而，不當的捕殺及海岸開發等因素下，產卵地急速的萎縮。在1996年夏天的調查中發現，台灣東部目前僅存不到兩處產卵地，而且產卵環境不佳，隨時有消失的可能。

據國外的資料顯示，近海漁業的發展是造成海龜在沿海遭到意外捕獲的主因，一些重要的沿岸漁業，如定置網等常常會捕獲海龜。根據1991到1995年的國內調查發現，海龜的意外捕獲量，會隨著漁獲量增加而增加。意外捕獲的海龜中以綠蠵龜為最多，赤蠵龜次之。被捕獲的海龜中，有近九成會在宗教活動中被放生；不到一成的海龜會遭到宰殺或製成標本的命運。由於宗教放生活動涉及非法買賣保育類野生動物，以及虐待動物等違法行為，所以從



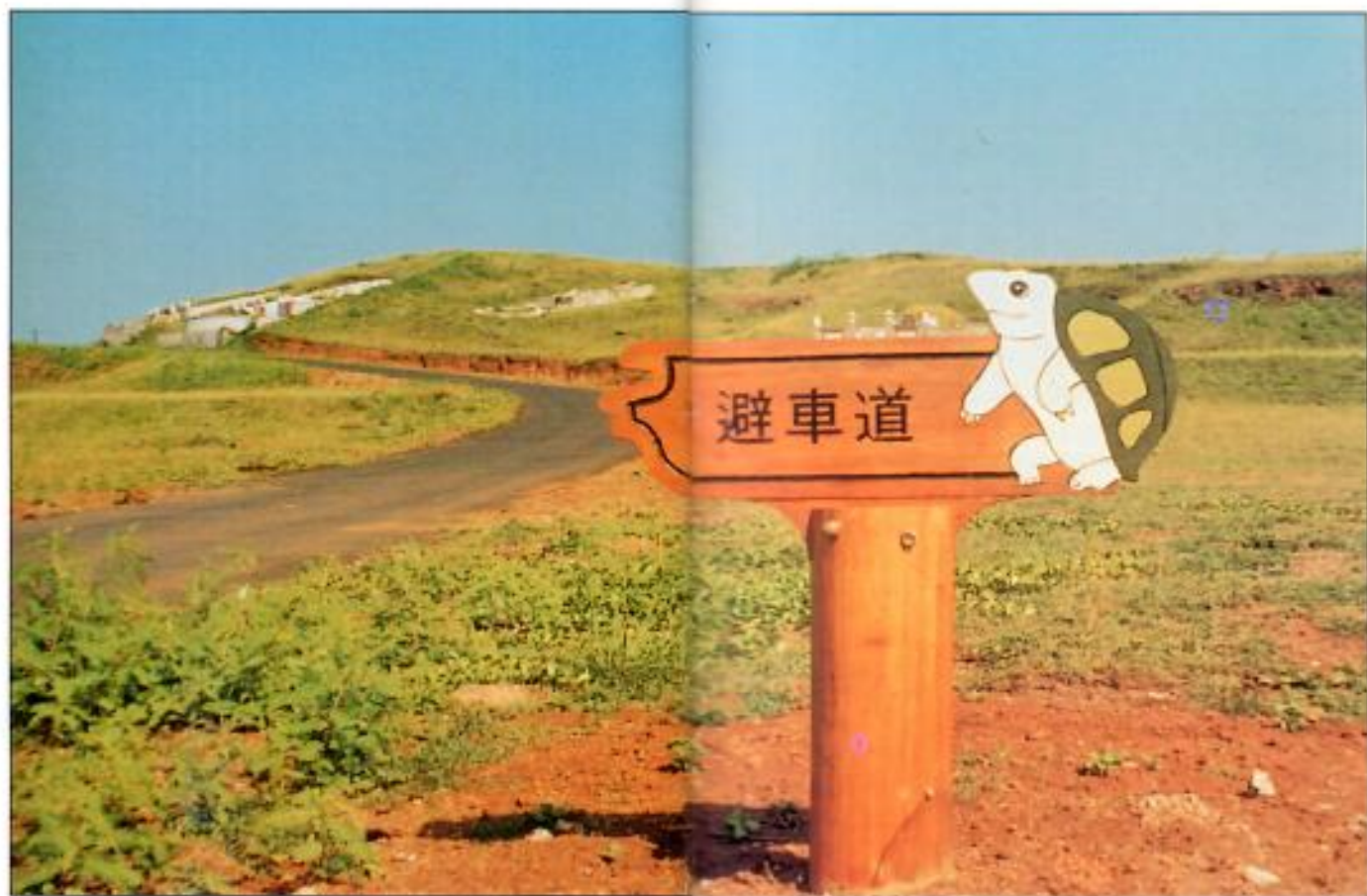
利用人造衛星資料，配合地理資訊系統軟體來決定母龜在產卵期間的海上活動範圍。

With the combination of satellite telemetry and the GIS (Geographic Information system), it is possible to determine the marine habitat of the female turtle during her interesting period.

ditions are so poor that these two may disappear forever.

Nearshore fisheries account for most of the sea turtle by-catch in Taiwan, and there are several important fisheries, including setnet fisheries, that catch sea turtles incidentally. According to a field investigation from 1991 till 1995, the by-catchment increased with the fishing yields. Green turtles were the most commonly caught species, followed by loggerhead turtles. Almost 90% of the by-caught turtles were released alive in religious ceremonies, and less than 10% were butchered or stuffed. However, because the religious release of sea turtles involve illegal trading of endangered wildlife and abuse of the captive animals, it is against the domestic wildlife protection law. The situation has improved since the implementation of the New Conservation Law in October 1994.

In the South China Sea, sea turtles are found nesting on the Xhisha island group and on Donsha and Tai-pin Island in the Nansha Archipelago. According to the literature, the Xhisha islands probably have the most important nesting sites for the hawksbill turtles. Two field investigations conducted in July 1995 (Donsha Island) and April 1995 (Tai-pin Island) found that the nesting season on Donsha Island mainly occurs in the summer. The nesting females were mainly hawksbill turtles, although green turtles were also well represented. Tai-pin Island is a tropical rainforest is-



望安島上的路標宣導牌。
The public awareness road sign on the Wan-An Island.

1988年起因野保法訂定，1994年該法修正並嚴格執行野生動物保育法後，目前販售意外捕獲海龜的情形已極為少見了。

我國南疆海域中的東沙、西沙及南沙群島的太平島也有海龜上岸產卵的記錄。據文獻記載，西沙可能是南中國海中最重要玳瑁產卵地，而根據1995年7月訪查東沙島，與1996年4月訪查太平島的記錄顯示，東沙島的產卵季主要是夏天，上岸產卵的海龜以玳瑁為主，綠蠟龜較少。太平島則因為一熱帶雨林島，終年均有海龜上岸產卵的紀錄，但以二、

land. The turtles nest here all year round, mainly in February, March and summertime, and least in April and May. The nesting females were mainly the green turtles, with some hawksbill turtles. The South China Sea famous for its coral reefs and other rich natural resources, is a particularly suitable habitat for sea turtles. However, due to improper regional management, these natural resources are facing serious threats, and the sea turtle populations have dropped to the endangered level in the region.

Conclusion

The green turtle is an endangered species in Taiwan. Both local and central government as well as researchers have worked together to establish refuge sites and have been actively involved in their management. In addition to receiving massive media coverage, these projects have been supported



藉由各種公益活動，將海龜保育的理念宣傳出去。
The release of sea turtle conservation concepts through the public awareness activities.

三月及夏季為最多，四、五月為最少。產卵的母龜以綠蠵龜為主，玳瑁次之。南中國海雖然自然資源如珊瑚礁等十分豐富，是海龜良好的棲息場所，但因其戰略地位重要和缺乏適當的經營管理，海洋資源未有效保育，海龜數量亦有減少之趨勢！

結語

綠蠵龜是我國一本土保育類野生動物，在望安島產卵保護區劃設之後，各級政府及研究單位均積極參與保護區之經營管理的各項事宜。此期間，除了媒體大量的報導外，一些重要的企業如裕隆汽車製造公司；義美食品公司；以及萊爾富超商等亦積極參與其事，並舉辦各種活動，將保育理念推廣出去。真正做到產、官、學三方面共同為綠蠵龜的保育目標而努力。人造衛星的顯示，在澎湖縣望安島產卵的綠蠵龜，因其海上的棲息地遍布中國大陸東部的陸棚上，因此除了產卵沙灘的保護外，東亞國際間之研究與保育的合作，更是牠存續與復育所不可或缺的要件。雖然目前上岸產卵的母龜數量仍少，許多海上及陸上的棲息環境仍待改善，但在持



行政院農業委員會林業處陳漢洲處長參加民間企業主辦之兒童保育活動，以落實海龜保育的理念。

Mr. Shi-Chou Chen, Director of Forestry Department, Council of Agriculture Executive Yuan joined the children conservation activity, held by a private industry, to achieve the goal of public awareness on the sea turtle.

financially by such companies as Yu-Loon Motor Co., Ltd., I-Mei Foods Co., Ltd., Hi-Life International Corporation chain Stores and Shan-Yen Culture Inc. These companies have also conducted various public awareness campaigns. With all these efforts, it is possible that government, research and industry will be able to work together for the conservation of green turtles in Taiwan. However, satellite telemetry

在望安島上試行生態觀光活動。

The preliminary trial of ecotourism on the Wan-An Island.



續不斷的宣導，及國人對生態保育的日益重視下，希望在未來的歲月裡，能更落實綠蠵龜的保育工作，使牠成為一個我們引以為傲的本土保育類野生動物。 □



台灣的綠蠵龜將有一光明的前景。(行政院新聞局提供)
The green turtle in Taiwan has a brighter future. (courtesy of GIO)

showed that the green turtles that nest at Wan-An Island are widely dispersed on the continental shelf east of mainland China. Therefore, in addition to protecting the nesting beaches in Taiwan, regional and international cooperation on research and conservation among the nations of east Asia are desperately needed to sustain and replenish the turtle population. Even though the number of nesting green turtles in Taiwan is still low and many marine and terrestrial habitats need desperately to be improved, with enhanced public awareness campaigns and stronger recognition of the importance of wildlife conservation, there is hope for the future. If we succeed in conserving the green turtle, this noble animal may one day become the most precious symbol of all the endemic protected wildlife in Taiwan. □

統一編號

025034870055

台灣瀕臨絕種的綠蠔龜

——其生殖生物學及保育現況

發行人：彭作奎

出版者：行政院農業委員會

地址：台北市南海路37號

執行者：國立台灣海洋大學

地址：基隆市北寧路二號

印刷者：裕華彩藝股份有限公司

地址：台北縣新店市寶中路95號之8

電話：(02)2911-0111

版次：初版

出版日期：八十七年六月

定價：新台幣82元

The Green Sea Turtle in Taiwan—

The Reproductive Biology and Conservation
Status of an Endangered Species

Publisher: Peng Tso-kwei

Published by Council of Agriculture: 37 Nanhai Road, Taipei,
Taiwan, ROC.

Edited by National Taiwan Ocean University

Institute of Marine Biology

2 Pening Rd., Keelung, Taiwan, 20224, ROC.

ISBN 957-02-1416-3



9 789570 214161