

Status of Feral Populations of Exotic Cockatoos (Genus *Cacatua*) in Taiwan

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ABSTRACT: Based on the database of 1986-2000 provided by the Wild Bird Federation Taiwan and a field assessment survey conducted between 1998 and 2000, four exotic species of cockatoos, belonging to the genus *Cacatua* (Psittacidae), were found in Taiwan. The Goffin's Cockatoo (*C. goffini*) and the Sulphur-crested Cockatoo (*C. galerita*) are more common than the White Cockatoo (*C. alba*) and the Lesser Sulphur-crested Cockatoo (*C. sulphurea*). Most of the sightings were in single or small flocks occurring in or near metropolitan areas of western Taiwan. The birds built permanent roosting sites that were occupied by one to three species. The feral populations of the cockatoos in Taiwan have remained low but fairly stable, since they were introduced more than 20 years ago. Overall, they are not successful invaders.

KEY WORDS: Cockatoo, Exotic species, Distribution, Taiwan.

INTRODUCTION

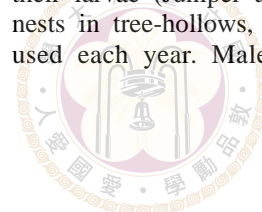
White cockatoos are composed of 12 species of medium to large parrots belonging to the genus *Cacatua* (Psittacidae) (Sibley and Monroe, 1990). They have short, squarish tails and long round-tipped wings, with predominantly white or pale salmon-pink plumage. Both sexes look alike and young birds resemble adults (Forshaw, 1989). Their native ranges are Australia and tropical islands of the Southeast Asia, including the Philippines, the eastern Indonesia, New Guinea and Solomons (Rowley, 1997). Some of them have been considered as the threatened species, causing primarily from habitat destruction and international pet trade (Beissinger and Bucher, 1992; Rowley, 1997; Juniper and Parr, 1998). On the other hand, the pet trade has resulted in successful establishment of feral populations of white cockatoos in some countries, where individual birds escaped from captivity or were deliberately released (Coates et al., 1997).

Among 12 species of white cockatoos, at least eight species have been recorded in the wild outside

their native ranges. They are Sulphur-crested Cockatoo (*C. galerita*), Lesser sulphur-crested Cockatoo (*C. sulphurea*), Salmon-crested Cockatoo (*C. moluccensis*), Goffin's Cockatoo (*C. goffini*), Major Mitchell's Cockatoo (*C. leadbeateri*), White Cockatoo (*C. alba*), Little Corella (*C. sanguinea*) and Long-billed Corella (*C. tenuirostris*) (Long, 1981; Lever, 1987; Brazil, 1991; Viney et al., 1994; Coates et al., 1997; Robson, 2000; Carey et al., 2001). Most of the successful reintroduces were found in the peripheral regions of their native ranges. For examples, the Sulphur-crested Cockatoo, a native of New Guinea and the eastern half of Australia, has successfully been introduced to New Zealand and the western Australia, while the Goffin's Cockatoo, native to the Tanimbar Islands of Indonesia, has become common in Singapore (Long, 1981; Robson, 2000). In general, these white cockatoos are not successful as introduced species (Long, 1981).

Most species of white cockatoos are social birds foraging in flocks. In their native ranges they are primarily sedentary, lowland birds, and live in wide ranges of habitat, such as woodlands, grasslands, croplands, and forests, but each species has its specific habitat preference. They are herbivorous, feeding on great varieties of seeds, grains, fruits, berries, nuts, leaf buds, blossoms, shoots, and roots of plants, but may occasionally consume insects and their larvae (Juniper and Parr, 1998). They build nests in tree-hollows, and the same nests can be used each year. Males and females establish a

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long-lasting bond, and keep in pair all the year around. Each year they return to the same nest used in previous years or nearby for breeding. Eggs take three to four weeks to hatch and the nesting period last for 7 to 14 weeks (Forshaw, 1989; Rowley, 1997; Juniper and Parr, 1998).

Because it is essential to understand relevant ecological processes and to predict ecological and economic impacts of exotic species, the study of biological invasions is an important topic of current ecological studies (Drake et al., 1989; Lodge, 1993). Severinghaus (1999) reported six species found in Taiwan from 1994 to 1999, but no detail biological information was given. The purpose of this study is to determine the status of the exotic white cockatoos in Taiwan with respect to their distribution, abundance, population fluctuation, and invasion success.

MATERIALS AND METHODS

The data on the distribution of white cockatoos in Taiwan from December 1986 to May 2000 were obtained from the observation database of the Wild Bird Federation Taiwan (WBFT). The data are consisted of species, dates, locations and numbers of birds observed. An assessment survey was conducted by the authors from September, 1998 to December, 2000 in the areas where the white cockatoos were recorded by WBFT and active bird watchers. Each site was surveyed at least once. When the birds were found, we recorded the species and their numbers.

To determine the distribution of the white cockatoos, the data with accurate records of species and locations observed were compiled. We used those data with location accuracy that can be referred to a 2 km × 2 km grid system (Lee et al., 2004) established by Lee et al. (1996). In each grid the largest number of birds recorded for a species was used to represent the relative abundance of the particular species. Distribution maps were made using ArcView GIS 3.2 (ESRI, 1999).

To illustrate the changes in abundance of the white cockatoos, the sites with data longer than five years and each year had observations longer than six months were used. The largest number of birds recorded for a species in each month was used to represent the relative abundance of that particular species in that particular month at that particular site. Based on the information, we established the population fluctuation profile of a species by plotting its relative abundance against months.

RESULTS

Based on the WBFT database, four species of cockatoos, i.e., Goffin's Cockatoo (10 locations), Lesser Sulphur-crested Cockatoo (4 locations), Sulphur-crested Cockatoo (24 locations), and White Cockatoo (2 locations), were sighted in the wild in Taiwan. Most of the locations were near the cities and towns (Table 1). In most of these sites, the maximum number was smaller than three (50-75% for each species), but small flocks in numbers between three and 25 individuals were observed in some locations for the Sulphur-crested Cockatoo (50%) and the Goffin's Cockatoo (50%). The maximum number was 12 birds for the Sulphur-crested Cockatoo and 25 birds for the Goffin's Cockatoo at Cheng-Ching-Hu, Kaohsiung County. However, in our survey, we could only find three species, while the Lesser Sulphur-crested Cockatoo was not detected. Based on occurrence records of the WBFT database, the Sulphur-crested Cockatoo and the Goffin's Cockatoo were frequently observed in the wild, but the populations for the Lesser Sulphur-crested Cockatoo and the White Cockatoo were rare.

The distribution maps for the Sulphur-crested cockatoo and Goffin's Cockatoo indicate that these two species occurred in the western coastal plain of Taiwan at elevations below 200 m in the vicinities of the major cities, including Taipei, Chiayi and Kaohsiung (Fig. 1). Some were found in the countryside. The two species shared similar habitats, such as parks, botanical gardens, school campuses, golf courses and woodlots, where there were large trees to provide food sources and holes for nesting and roosting.

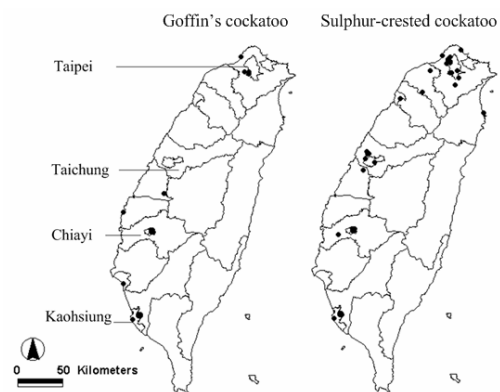


Fig. 1. Distribution maps of the Goffin's Cockatoo (*C. goffini*) and the Sulphur-crested Cockatoo (*Cacatua galerita*) in Taiwan from December 1986 to December 2000. The distribution for the the Lesser Sulphur-crested Cockatoo and the White Cockatoo were too few and thus omitted.

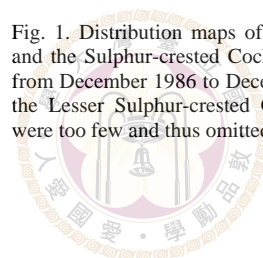


Table 1. Localities and the maximum numbers of exotic white cockatoos observed in Taiwan from 1986 to 2000 (data obtained from the Wild Bird Federation Taiwan database and a field survey between September, 1998 and December, 2000).

Species	Locality	Longitude (E)	Latitude (N)	Maximum number observed
Goffin's Cockatoo (<i>Caacatua goffini</i>)	Yu-Che-Kou, Tan-Shui, Taipei	121°25'	25°11'	2
	228 Memory Park, Taipei	121°30'25"	25°2'37"	1
	Botanical Garden, Taipei	121°30'4"	25°2'3"	12
	Nei-Wan, Tien-Chung, Changhua	120°45'	23°51'	1
	Lin-Tso, Szu-Hu, Yunlin*	120°10'	23°41'	5
	Shan-Tzu-Ting, Chiayi*	120°28'	23°29'	9
	Szu-Kun-Shen, Tainan	120°10'	23°57'	2
	Cheng-Ching-Hu, Kaohsiung*	120°20'	22°40'	25
	National Sun Yat-Sen University, Kaohsiung*	120°15'	22°38'	10
	Da-Han Bridge, Sin-Juang, Taipei	121°27'	25°2'	2
Sulphur-crested Cockatoo (<i>C. galerita</i>)	Ching-Shui, Chin-Shan, Taipei	121°37'	25°14'	4
	Yu-Che-Kou, Tan-Shui, Taipei*	121°25'	25°11'	6
	Chung-Cheng Mountain, Pei-Tou, Taipei	121°30'	25°10'	4
	Kuei-Tzu-Keng, Pei-Tou, Taipei	121°29'2"	25°9'20"	13
	Fu-Hsing-Kang, Pei-Tou, Taipei	121°29'	25°9'	1
	Chu-Hai, Pei-Tou, Taipei	121°30'	25°8'	9
	Kuan-Tu, Taipei	121°27'	25°7'	2
	Li-Nung, Pei-Tou, Taipei	121°30'	25°7'	1
	Nan-Kan, Taoyuan	121°17'	25°3'	2
	Hu-Shang-Hsi, Taipei	121°34'	25°2'	3
	Botanical Garden, Taipei	121°30'4"	25°2'3"	9
	National Taiwan University, Taipei	121°32'	25°1'	2
	Mao-Kung, Mu-Cha, Taipei	121°35'	24°58'	1
	Szu-Kan-Shui, Hsin-Tien, Taipei	121°34'	24°53'	1
	Shih-Ku-Liao, Lung-Tan, Taoyuan	121°12'	24°52'	2
	Ching-Tsao-Hu, Hsinchu	121°57'	24°46'	1
	Wu-Wei-Kang, Nan-Ao, Yilan	121°51'	24°37'	3
	Chin-Chuan-Kang, Da-Ya, Taichung	120°36'	24°16'	6
	Kan-Cheng, Taichung*	120°41'	24°8'	4
	Hu-Kang, Changhua	120°33'	24°46'	2
Shan-Tzu-Ting, Chiayi*	120°28'	23°29'	6	
Cheng-Ching-Hu, Kaohsiung*	120°20'	22°40'	12	
Lu-Tsao Farm, Chiayi	120°17'	23°25'	1	
National Sun Yat-Sen University, Kaohsiung*	120°15'	22°38'	2	
White Cockatoo (<i>C. alba</i>)	Kuei-Tzu-Keng, Pei-Tou, Taipei*	121°29'2"	25°9'20"	3
	National Sun Yat-Sen University, Kaohsiung*	120°15'	22°38'	1
Lesser Sulphur-crested Cockatoo (<i>C. sulphurea</i>)	Kuan-Yin Mountain, Taipei	121°25'	25°8'	1
	Chin-Chuan-Kang, Da-Ya, Taichung	120°36'	24°16'	1
	Tan-Shui, Taipei	NA	NA	1
	Taoyuan city	NA	NA	8

* data based on the field survey conducted from September, 1998 to December, 2000.

We identified seven permanent roosting sites that had been used by one or mixed species of Goffin's cockatoo, Sulphur-crested Cockatoo and White Cockatoo for 5 or more than 20 years (Table 2). There were one site used by three species, four sites by two species, and one site by only one species. The maximum numbers of the white cockatoos at each of the roosting sites were recorded at the time when they flew in circle around the roost area or stayed on the top of high trees prior to settling on the roosting tree. At the campus of National Sun Yat-Sen University, Kaohsiung City, the Goffin's Cockatoo were

recorded only twice in the winters of 1998 and 1999, and were not found since then.

Peitou, Taipei and Taipei Botanical Garden were the only two locations with sighting records extended at least of 5 years and each year had sightings longer than six months. Monthly relative abundance of the Sulphur-crested Cockatoo in Peitou from January, 1996 to October, 2000 (Fig. 2a), and the Goffin's Cockatoo in the Taipei Botanical Garden from November, 1994 to May, 2000 (Fig. 2b) indicated that their abundance remained fairly stable with small population size. The monthly maximum flock sizes fluctuated from one to 13 birds for both species.



Table 2. The permanent roosting sites of exotic cockatoos and the maximum number recorded at each site from late 1998 to 2000.

Locality	Goffin's Cockatoo (<i>C. goffini</i>)	Sulphur-crested Cockatoo (<i>C. galerita</i>)	White Cockatoo (<i>C. alba</i>)	Years*
Yu-Che-Kou, Tan-Shui, Taipei	2	6		> 7
Kuei-Tzu-Keng, Pei-Tou, Taipei		9	3	> 6
Botanical Garden, Taipei	7			> 9
Lin-Tso, Szu-hu, Yunlin	5			> 5
Shan-Tzu-Ting, Chiayi	9	6		> 7
Cheng-Ching-Hu, Kaohsiung	25	12		> 10
National Sun Yat-Sen University, Kaohsiung	10	2	1	> 20

*Based on the observation database of Wild Bird Federation Taiwan and personal communications with active bird watchers.

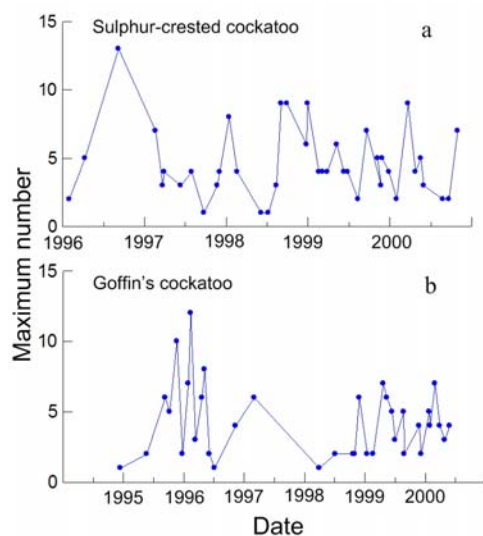


Fig. 2. Trends of relative population abundance of the Sulphur-crested Cockatoo (*Cacatua galerita*) from January, 1996 to October, 2000 at Pei-Tou (Kuei-Tzu-Keng), Taipei (a) and the Goffin's Cockatoo (*C. goffini*) from November, 1994 to May, 2000 at the Taipei Botanical Garden (b).

DISCUSSION

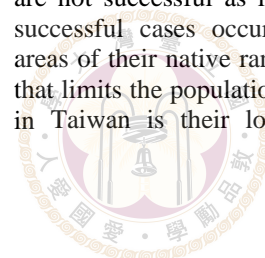
This study reported four white cockatoo species that had escaped from captivity and found in the wild in Taiwan. An analysis on the long term database maintained by WBFT indicated that the Goffin's Cockatoo and the Sulphur-crested Cockatoo were more common than the White Cockatoo and the Lesser Sulphur-crested Cockatoo. These species occurred primarily in the vicinities of metropolitan cities of western Taiwan. Despite the earliest record of the feral white cockatoos was more than 20 years ago (pers. comm., Mr. Green J. Y. Ou, former president of Kaohsiung Wild Bird Society), we found they maintained relatively small, but stable, population with nest building activities by the Goffin's Cockatoo, the Sulphur-crested Cockatoo and the White Cockatoo in the wild.

Despite the global introduction of birds has been highly non-random with respect to taxon, parrots are the one that is highly favored (Blackburn

and Duncan, 2001). Unquestionably, the source of feral populations of the white cockatoos in Taiwan is related with pet trade. In the 1994 survey for 164 bird shops in Taiwan, there were 26 species of exotic parrots, and almost all of the shops (94%) carried at least one species (Chi, 1995). Although the white cockatoos were not the most popular parrots in the bird shops, five species (included those four species reported in this study and the Salmon-crested Cockatoo) were carried by one-fifth of the shops (Chi, 1995). Except the Salmon-crested Cockatoo, the other four species had been found in the wild. Apparently, they were escaped from captivity or released deliberately by man.

Most of the exotic white cockatoos were found in or around metropolitan cities, where most of the bird shops were located (Chi, 1995). Whenever the birds escaped, they were expected to be found in or near the cities. Some illegally imported cockatoos were released by smugglers before they were inspection by the custom at harbors (pers. comm., Mr. Green J. Y. Ou). Disturbed habitats such as parks and campuses, host poor species richness (Pimm, 1989), and have less taxonomically or functionally related species (Ehrlich, 1989) and less competition (Crawley, 1986). They might be more favorable for exotic species (Smallwood, 1994; Williamson and Fitter, 1996). Although the white cockatoos in their native ranges can be found in various habitats, such as forests, farmlands, mangroves, and suburban areas (Forshaw, 1989; Rowley, 1997; Juniper and Parr, 1998), these parrots did not occur in forest of Taiwan.

White cockatoos have not invaded Taiwan successfully. One of the possible hypotheses for their performance is that the climate or environmental conditions are not comparable to their natural range (Brown, 1989; Duncan et al., 2003). Long (1981) also indicates that most parrots are not successful as introduced species and those successful cases occurred only in the peripheral areas of their native ranges. Another possible factor that limits the population growth of white cockatoos in Taiwan is their low breeding success. Exotic



species with multiple broods per season and large clutch sizes should have a higher probability of establishing their populations (Kolar and Lodge, 2001; Duncan et al., 2003). Most of white cockatoos bred between March and July in Taiwan, and their clutch size was 1-2 eggs (R. S. Lin, unpublished data). In addition, they can only raise one brood at most because they need three months to finish a complete breeding cycle (Forshaw, 1989; Rowley, 1997; Juniper and Parr, 1998). Consequently, they often lost their nests caused by bad weather which made their nesting holes as puddles and/or destroyed the trees that hold the nesting holes (R. S. Lin, unpublished data).

In Hong Kong, geographically close to Taiwan, the Sulphur-crested Cockatoo and the Goffin's Cockatoo have also established feral populations (Viney et al., 1994; Carey et al., 2001). The Sulphur-crested Cockatoo were released probably as early as in 1941, and have certainly been augmented by more recent escapes or releases. Its population remained around 60 to 100 birds in recent years (Carey et al., 2001). Although there are some confirmed breeding records in the field, it is not certain whether the population is sustainable (Viney et al., 1994). Based on the case observed in Hong Kong, the future of these white cockatoos in Taiwan might share a similar trend.

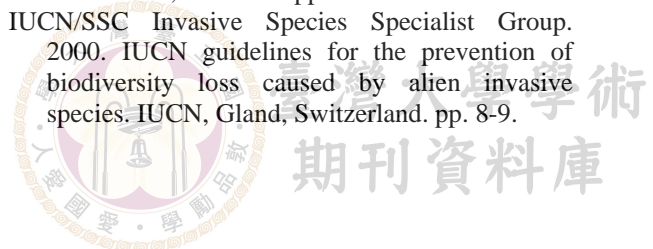
Comparing the performance of the white cockatoos to that of starlings and mynas in Taiwan (Lin, 2001), they were not very successful invaders. However, since the white cockatoos have a long life span and take two to five years to reach sexual maturity (Rowley, 1997), their populations might be able to increase if favorable conditions exist. Although there are some uncertainties for the white cockatoos populations to explode as invasive in the future, it is recommended to eradicate them at the time when their population sizes are small and localized (IUCN/SSC Invasive Species Specialist Group, 2000).

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臺灣外來鳳頭鸚鵡 (*Cacatua* 屬) 野外族群現況

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摘 要

依據中華民國野鳥學會鳥類資料庫 1986-2000 年及本研究 1998-2000 年的野外評估調查，在臺灣已有 4 種鸚鵡科 (Psittacidae) 外來鳳頭鸚鵡屬 (*Cacatua*) 鳥種的野外族群出現。其中，戈芬氏鳳頭鸚鵡 (*C. goffini*) 及葵花鳳頭鸚鵡 (*C. galerita*) 較為常見。白鳳頭鸚鵡 (*C. alba*) 及小葵花鳳頭鸚鵡 (*C. sulphurea*) 的數量則仍稀少。鳳頭鸚鵡以單獨或小群出現於臺灣西部的都會區附近，夜間棲息的地點固定並曾發現 2~3 種鳳頭鸚鵡棲息在一起。鳳頭鸚鵡的族群數量在引入後，並無明顯增加的趨勢。整體而言，外來鳳頭鸚鵡並未成功入侵臺灣。

關鍵詞：鳳頭鸚鵡、外來種、分布、臺灣。

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