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The Distribution and Abundance of the Alien Invasive White-rumped Shama (*Copsychus malabaricus*) in Taiwan

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ABSTRACT: The White-rumped Shama (*Copsychus malabaricus*) is an alien invasive species in Taiwan. The distribution and abundance of this species was estimated based on recorded observation of active birders, the database of 1988-2007 provided by the Chinese Wild Bird Federation, literature citation, a field survey conducted from 2006 to 2008 and an eradication project conducted from 2007 to 2008. This species was found primarily in the western hilly areas of Taiwan at elevations below 400 m. Since it was first recorded in the wild in 1988, it has bred in recent years resulting in confirmed sustainable feral populations in Taiwan. The population sizes of the species in Huben Village, Linnei Township, in Yunlin County remained low originally but the rate of increase steadily increased after 2005. However, the areas where this invasive feral population has established itself are still confined to southern and central-western Taiwan. Unlike earlier avian invaders in Taiwan, the White-rumped Shama has the ability to invade lowland natural forest areas. Therefore, it is recommended that proactive control management is executed at a time when their population is still limited in number and localized.

KEY WORDS: Alien invasive species, *Copsychus malabaricus*, Distribution, Taiwan, White-rumped Shama.

INTRODUCTION

The caged bird trade has resulted in many bird species being removed from their native ranges and exported to areas well beyond their natural ranges, which has facilitated the successful establishment of feral populations in other regions of the world (Long, 1981; Lever, 2005). For example, we have witnessed the establishment of a large feral population of White-vented Myna (*Acridotheres javanicus*) in Taiwan (Lin, 2001). Biological invasion is one of the most serious threats to the conservation of native biodiversity, and an invasion of alien birds can result in very negative and even disastrous economic and ecological impacts for the region where the invasion occurs (Hunter, 1996; Williamson and Fitter, 1996; Fan et al., 2006). The White-rumped Shama (*Copsychus malabaricus*) is a member of the family Muscicapidae (Clements, 2007). Its natural distribution ranges from India, Nepal, Sri Lanka and the Andaman Islands to Burma, Thailand, Indochina, Malaysia, Borneo, Java, Sumatra, and many Indonesian islands (Lever, 2005). It is also a popular cage-bird in some European countries (Shepherd et al., 2004). Around 10,320 individuals were exported from Medan, Sumatra, Indonesia between 1997 and 2001 (Shepherd et al., 2004). While the species has failed to establish feral populations in most countries where it has been imported, it succeeded in the Hawaiian Islands where it was deliberately introduced in 1931 (Aguon and Conant, 1994; Lever, 2005). This species was imported to Taiwan as a pet and had been observed in the wild since 1988 (Chi, 1995; Shieh et al., 2006; Ren and Shieh 2007a; Fan, 2008a; pers. comm., Mr. E. H. Fang).

The White-rumped Shama is a sedentary bird. In its native range it is primarily found in lowland habitats up to 500 - 600 m but in Thailand it can be found up to 1500 m. It lives in a wide range of habitats, from the undergrowth of logged and unlogged mixed dipterocarp forest to mixed bamboo forest, secondary jungle, overgrown tree plantations, and costal vegetation. It has a preference for shady ravines. It is insectivorous and forages mainly on the ground and in low vegetation for arthropods, worms and berries (del Hoyo et al., 2005). Shamas' nests are shallow cups which are formed from rootlets, fibers, grass, and bamboo leaves, and usually placed 2-5 m up in a natural hollow in a tree trunk, stump top or at the base of a bamboo clump (Aguon and Conant, 1994; del Hoyo et al., 2005). This species is sexually dichromatic and sexually dimorphic, with females being smaller. Males and females establish monogamous pair bonds that may last two breeding seasons (Aguon and Conant, 1994; del Hoyo et al., 2005). The clutch size is 2-5 eggs. In introduced populations in Hawaii, eggs averagely take 13.6 days to hatch and the nestling period averages 12.4 days (Aguon and Conant, 1994).

Previous success at invasion is a good indicator of whether an invader will succeed in a new region (Williamson and Fitter, 1996). Additionally, unlike most invasive bird species that prefer human-modified habitats (Long, 1981), the White-rumped Shama has invaded

natural forests in the Hawaiian Islands (Aguon and Conant, 1994). Therefore, it holds high potential to penetrate deep into forests in Taiwan (Shieh et al., 2006). Thus far, there is no study of its nationwide distribution or detailed biological information in Taiwan to provide essential information for a management strategy. The aim of the present study is to determine the status of the alien White-rumped Shama in Taiwan with respect to its distribution, abundance, population fluctuation, and invasion success.

MATERIALS AND METHODS

We used six methods to collect information on the distribution and abundance of the White-rumped Shama. 1) Report back from active birders: As the appearance and song of the White-rumped Shama are very striking and loud (del Hoyo et al., 2005). Therefore, it is easy to detect its presence. We printed promotional brochures which were entitled "Wanted, White-rumped Shama – an alien invasive species in Taiwan" and included photographs of the bird. We sent these brochures to each local wild bird society, conservation organization, school, and government office in Taiwan. A digital version of the brochure was distributed through e-mails, websites, and on photography and birding forums. Additionally, we placed corresponding articles and information in newspapers and magazines ("Feather Magazine" Chinese Wild Bird Federation, CWBF; "Nanluyin" Wild Bird Society of Changhua). Responses were collected from December 2006 to July 2008. We verified each response and excluded questionable answers from the analysis. The participation of birdwatchers and also the general public clearly appears to be an important point of methodology in obtaining quick results. 2) Recorded observations in digital photography galleries: We searched for recorded photographs of this species on several digital nature photographic forums and galleries in Taiwan. We contacted the original photographers to request the location of the site where the photographs were taken. 3) The observation database of the CWBF: We obtained data on the distribution of White-rumped Shamas in Taiwan from 1988 to 2007 from the observation database of the CWBF. The data consisted of species, dates, locations and numbers of birds observed. 4) Literature citation: We referred to past reports of observations, specifically Hsu et al. (2004), Lai et al. (2006), Ren and Shieh (2007a), Ren and Shieh (2007b), and Lin (2007). 5) Field survey: We used playback to census the presence and abundance of the White-rumped Shama in the hills of the southern and central-western Taiwan where the shamas were recorded by the CWBF and active bird watchers from April, 2006 to July, 2008. This species readily responds to playback in both the breeding and non-breeding seasons (M. W. Fan, unpublished data). We recorded the existence and numbers of the species. 6) Eradication project: We started to eradicate White-rumped Shamas in Yunlin County from May, 2007 through to July, 2008 and in Changhua County, Nantou County, Tainan County and Kaohsiung City from January to July 2008. We recorded the number of independent shamas that had been detected and trapped at each of the sites we visited.

We compiled all the records with accurate identifications of this species and locations it was observed to determine its distribution. We referred the records to a 2 km x 2 km grid system established by Lee et al. (1996), and then overlaid them with an administrative map which was with administrative boundaries of 368 towns, townships or districts in Taiwan. The greatest number recorded in one recording event or the number confirmed by both the field survey and the eradication task that occurred in a specific town, township or district was used to represent the relative abundance that appeared in that administrative unit. Distribution maps were created using ArcGIS 9.0 (ESRI, 2004).

To illustrate changes in the shamas abundance, sighting records from Huben Village, Linnei Township, in Yunlin County, were used. These records from 2004 to 2008 were used to build a population fluctuation profile of the shamas. During this period, a constant point-count method was used to survey avian species composition and abundance. Additionally, the breeding biology of passerines was investigated from April to August (Chen, 2007; Fan, 2008b; Lin, 2008). When these avian research projects were conducted, the presence and abundance of White-rumped Shama were also collected. We mapped the locations and the numbers of shamas recorded by year and then overlaid them on an administrative map showing the administrative boundaries of Huben Village.

RESULTS

White-rumped Shamas have been observed in the wild in Taiwan since 1988. From 1988-2008, the shamas were recorded at 44 grids of 2 km x 2 km squares from an area of 30 administrative units in Taiwan. The majority were near cities and towns (Table 1). In 22 (73%) administrative units, the greatest number was less than four. Exceptionally high numbers of shamas, i.e., 40 and 122, have been observed in the hilly area of Gushan District, Kaohsiung City; and Linnei Township, Yunlin County, respectively. Additionally, shamas have been found breeding successfully at Ershui Township, in Changhua County; Linnei Township, Douliou City and Gukeng Township, in Yunlin County; East District, in Chiayi City; Baihe Township, in Tainan County; and Gushan District, in Kaohsiung City. These locations

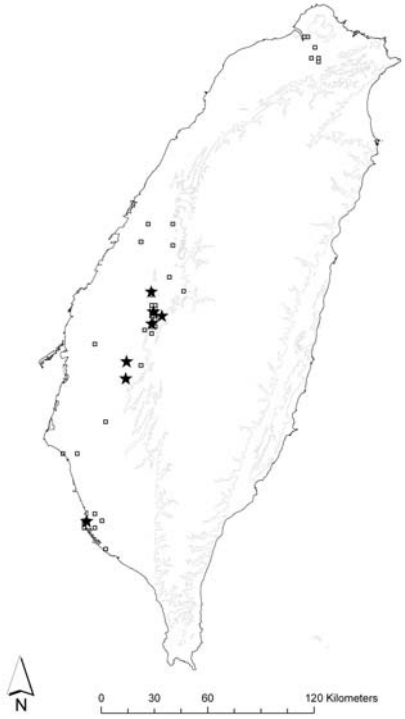

Fig. 1. Distribution map of the White-rumped Shama (*Copsychus malabaricus*) in Taiwan from 1988 to 2008. (□ grid with sighting records; ★ site with breeding records in the wild; — 400m contour).

are all situated in southern and central-western Taiwan (Fig. 1; Table 1). The results revealed that this alien species have escaped or been released to wild continuously and sporadically in western Taiwan during the past two decades. Furthermore, the shamas have probably established at least two sustainable populations very recently.

Distribution maps for the White-rumped Shama indicated that this species occurred primarily in the western hilly areas of Taiwan at elevations below 400 m (Fig. 1). The habitats in which White-rumped Shamas were observed were secondary forest, parks, botanical gardens, and on school campuses, especially when these areas had bamboo stands and large trees which provided suitable holes for nesting.

Fig. 2 shows the distribution and greatest numbers of the population in Huben Village. There were only four individuals in two locations between 2004 and 2005 but the numbers increased rapidly from four to 37 during the period 2005 to 2008. During 2007, the numbers of shamas were 30 initially and then dropped to 19 after the eradication task was executed. The population number continued increasing from 19 to 37 during 2008. Therefore, the interannual change trend of the Huben population remained low originally and then, the rate of increase increased steadily after 2005.

DISCUSSION

The present study showed that the White-rumped Shama has occurred and bred in the wild in Taiwan. This alien species occurred primarily in the western hilly areas of Taiwan at elevations below 400 m. Unlike most alien invasive bird species that prefer human-modified habitats (Moffat and Minot, 1994), the shama has successfully invaded natural forests in Taiwan. Additionally, the relative abundance of the species in the Huben Village, Linnei Township, in Yunlin County where situated in the central-western Taiwan was initially low but the rate of increase steadily increased after 2005.

The pet trade is probably responsible for the existence of the White-rumped Shama in the wilderness of Taiwan. The shama is a popular singing caged bird in many countries. Around 10,320 individuals have been exported from Medan, Sumatra, Indonesia between 1997 and 2001 (Shepherd et al., 2004). The earliest selling record for Taiwan of White-rumped Shama that we could find after a survey of 164 pet stores was in 1994 (Chi, 1995). The number of stores that sold the White-rumped Shamas have increased from one (Chi, 1995) to 21 (Ren and Shieh, 2007a) over the past 10 years. But it had been observed in the wild since 1988 in Taiwan (pers. comm., Mr. E. H. Fang). Therefore, it must have been imported into Taiwan earlier than 1994 and the feral populations in Taiwan appeared to have resulted from accidentally escaped cage birds or those deliberately released by man.

White-rumped Shamas have invaded Taiwan successfully. There are four possible hypotheses for their performance. 1) The climate or physical environmental conditions of successful establishment in Taiwan are comparable to their natural range (Williamson and Fitter, 1996; Duncan et al., 2003; Lahti, 2003). The White-rumped Shama is a tropical to subtropical species, so temperature may be a factor governing its distribution. The environments of original and introduced habitats are considered to be similar because they belong to the same temperate zone and are geographically close. These conditions may increase the chance of the species successfully establishing itself (Lahti, 2003; Kawakami and Yamaguchi, 2004). 2) This species possesses large geographic ranges which likely enhances the possibility to naturalize following introduction. Furthermore, it lives in a wide range of habitats and this characteristic corresponds to enhance establishment success (Duncan et al., 2003; Lahti, 2003). 3) Another possible factor that accelerates the population growth of White-rumped Shamas in Taiwan is their high level of breeding success. Alien species with multiple broods per season and large clutch sizes are expected to have a higher establishment ratio (Duncan et al., 2003). White-rumped Shamas breed between March and August in Taiwan, their clutch size is

Table 1. Administrative units and the greatest numbers of White-rumped Shamas (*Copsychus malabaricus*) recorded from 1988 to 2008.

Administrative units		Greatest number recorded	Year[a]
Changhua County	Changhua City	1[b]	2008
	Ershuei Township[e]	12[d]	2008
Chiayi City	East District[e]	4[b]	1997, 1999-2000, 2003-2004, 2007
Chiayi County	Fanlu Township	2[b]	2006-2008
Kaohsiung City	Gushan District[e]	40[d]	2001, 2002-2008
	Zuoying District	1[b]	2004
	Lingya District	1[b]	2000-2001
Kaohsiung County	Niaosong Township	1[b]	2002
	Linyuan Township	1[b]	2006
Nantou County	Nantou City	1[b]	1996
	Jhushan Township	15[d]	2007-2008
	Jiji Township	1[b]	2008
Taichung City	Beitun District	2[b]	2007
	Situn District	1[b]	2008
Taichung County	Tanzih Township	1[b]	2008
	Wufong Township	3[b]	2007
Tainan City	Anping District	1[b]	2000
	East District	1[b]	2006
Tainan County	Guantian Township	1[b]	2007
	Baihe Township[e]	10[c]	2007-2008
Taipei City	Jhongjheng District	1[b]	1988, 2000-2001, 2003-2004, 2008
	Shihlin District	1[b]	1998
	Da-an District	2[b]	2002–2005
	Beitou District	1[b]	1996
	Wunshan District	1[b]	2005
Taipei County	Danshuei Township	1[b]	2008
Yunlin County	Linnei Township[e]	122[d]	1997-2008
	Douliou City[e]	27[d]	2006-2008
	Gukeng Township[e]	6[d]	2008
	Beigang Township	1[d]	2008

[a] year of sighting record.
[b] data based on reports from active birders, recorded observations in digital photography galleries, the Chinese Wild Bird Federation database and literature citation. The greatest number of shamas recorded on a particular visit at each unit was adopted.
[c] data based on the field surveys conducted from April, 2006 to July, 2008. The greatest number of shamas recorded in each unit was used.
[d] data based on the White-rumped Shama Eradication Project from May, 2007 through to July, 2008 in Yunlin County and from January to July 2008 in Changhua County, Nantou County, Tainan County and Kaohsiung City. The greatest number of shamas for these areas during that period was obtained from the number of shamas trapped and detected in each site we visited.
[e] unit with breeding records in the wild.

3 -5 eggs and they can raise two broods in one breeding season (Fan, 2008a). Accordingly, this attribute of the species may enhance the possibility of successful establishment. 4) Establishment success increases with greater introduction effort (Townsend, 1996; Veit and Lewis, 1996; Duncan et al., 2003). Accession of avian flu during the winter of 2005 may have impelled bird raisers and proprietors of pet stores to release caged birds deliberately. This affair might correlate with the accelerated population growth of White-rumped Shamas in the Huben Village, Linnei Township, in Yunlin County from 2006.

The relative abundance of the species in the Huben Village, Linnei Township, in Yunlin County had been increasing since their initial occurrence and was considered to be at the cusp of an explosive increase. The rate of increase was initially low but rose rapidly after 2005 in the area. Most introduced species are considered to have an establishment period during which the population size remains low until a population boom and then rapid spread occurs (Lahti, 2003). This pattern has been reported for various introduced bird species such as the Common Starling (*Sturnus vulgaris*), House Finch (*Carpodacus mexicanus*) and Melodious Laughingthrush (*Garrulax canorus*) (Kawakami and Yamaguchi, 2004). In addition, the population growth of the alien invasive Mute Swan (*Cygnus olor*) in North America also exhibits similar trend (Ellis and Elphick, 2007). The occurrence pattern of White-rumped Shama in the Huben Village, Linnei Township, in Yunlin County was considered to coincide with this. Therefore, we need to be especially cautious about the potential of population growth and expansion of the feral shama populations in Taiwan.

Some studies have showed that introduced forest-dwelling birds are believed to be less successful in establishment (Moffat and Minot, 1994). Most introduced bird species in Taiwan became established in anthropogenic habitats (Lin, 2001; Lin and Lee, 2006). White-rumped Shama, however, has invaded indigenous forests. Thus, there is a concern that the species will have a negative

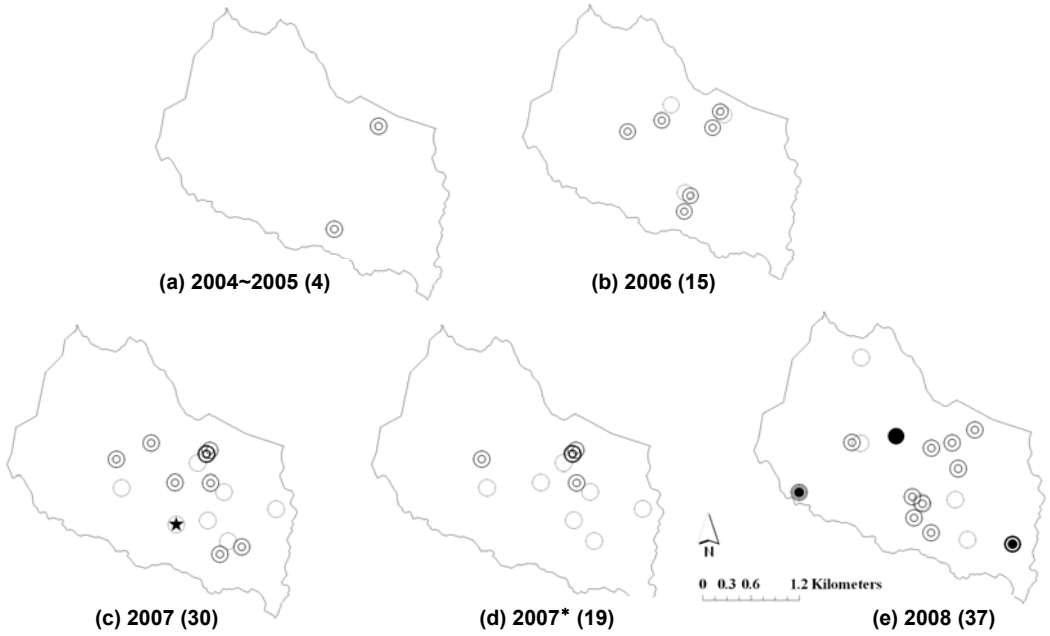

Fig. 2. The distribution and greatest numbers of the White-rumped Shama (*Copsychus malabaricus*) by year in Huben Village, Linnei Township, in Yunlin County from 2004 to 2008. (2007* After execution of the eradication task from May, 2007, the number of shamas still detected at the site; ○, ◎, ◉, ★, ◉, and ●, respectively, represents one to six individuals in order of this species in each location; The number in the parentheses means the greatest number recorded at the site for each year).

impact on native biological diversity in forest areas. This may include competition with other secondary-cavity nest birds, predatory behavior on vertebrates and arthropods (Mountainspring and Scott, 1985; Eguchi and Amano, 2004; Tojo and Nakamura, 2004). To date, there has been no study on the impact of this species in Taiwan.

Above all, White-rumped Shamas have invaded Taiwan and were in the beginning phase of establishing sustainable populations locally. Even if the impact of this species on Taiwan cannot yet be quantified, it must be assumed to be important. We know enough about problems linked to invasions and need to avoid repeating the same earlier mistakes (Williamson and Fitter, 1996; Clergeau and Mandon-Dalger, 2001; Clergeau et al., 2004). Therefore, it is advised to execute proactive control management at the time when their population sizes are small and localized (IUCN/SSC Invasive Species Specialist Group, 2000).

One basic measure against biotic introduction is the legal control of introductions (Lahti, 2003; Eguchi and Amano, 2004). Thus, we recommend that the first step be to strictly control the import of this species. Second, an eradication and regulation project of this alien bird should be executed as soon as they are recognized. Third, constant nation-wide monitoring of distribution and abundance of this species is necessary to make plans for eradication and regulation. After all, campaigns based on accurate and adequate information make it easy to obtain public approval for executing eradication and management projects (Eguchi and Amano, 2004).

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臺灣外來入侵鳥種白腰鵲鴝的野外族群分布與數量

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摘要：外來鳥－白腰鵲鴝 (*Copsychus malabaricus*) 已成功入侵臺灣。依據賞鳥者的目擊紀錄、中華民國野鳥學會鳥類資料庫 1988-2007、文獻紀錄、本研究 2006-2008 的野外調查及 2007-2008 的移除計畫等資料，探討此鳥種在臺灣野外之分布及族群數量。此鳥種主要分布在臺灣西部海拔 400 公尺以下的丘陵地帶。在 1988 年即出現在臺灣野外，但直到近年才記錄到其在野外繁殖與建立族群，且從雲林縣林內鄉湖本村之族群數量變化顯示，初期數量低但從 2005 年後急速成長。目前其成功建立族群的區域仍侷限在臺灣西岸的中南部地區，但不同於以往已入侵臺灣的外來鳥種，白腰鵲鴝能夠侵入低海拔的天然森林中。因此，建議在其野外族群數量仍低且分布侷限時，及早執行移除和管控工作，以掌握解決問題的關鍵時機。

關鍵詞：外來入侵種、白腰鵲鴝、分布、臺灣。