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The Biology and Past Distribution of the Near-Threatened Spot-billed Pelican (*Pelecanus philippensis*) Based on Verified Historical Specimens in China

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Abstract.—The Spot-billed Pelican (*Pelecanus philippensis*) is a lesser-known pelican species that experienced a significant reduction across its geographic range during the mid-late twentieth century as the result of extirpation of many populations in Asia. Through direct examination of museum skins, we verified the species identification of four nineteenth and twentieth century Spot-billed Pelican specimens from China, including a female specimen that is the northernmost verified distribution record in China (Shanghai) collected during the typical breeding season (24 March 1931), and another individual collected just prior to the breeding season is the most recent historical specimen known from China (20 September 1963). These specimens lend support to the idea that at least some Spot-billed Pelicans were residents (and possible breeders) in China during at least part of the twentieth century. These verified specimens can supply biological material to be used in future multidisciplinary studies about the biology of the extirpated Chinese population, and they may inform future efforts toward the successful reintroduction of this species to China and elsewhere within its former geographic range. *Received 27 May 2019, accepted 14 October 2019.*

Key words.—breeding, China, distribution, extirpation, museum specimen, natural history, near threatened, Spot-Billed Pelican

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Pelicans are a globally distributed clade of birds that includes eight extant species (Kennedy *et al.* 2013). Many pelican species are well known to ornithologists, but one Asian species is less well known and suffered a significant decline during the twentieth century. The Spot-billed Pelican (*Pelecanus philippensis*) is classified as near-threatened and is likely the most threatened species of pelican (Johnsgard 1993; BirdLife International 2001), given its restricted (and significantly reduced) geographic distribution. Various researchers and conservationists are actively collecting data on some of the remaining (breeding) populations spread across India (Kannan and Manakadan 2005; Taher 2007; Gokula 2011; Kannan and Pandiyan 2013), Sri Lanka, Cambodia, and Indonesia that can be used for broader conservation planning for the species (e.g., BirdLife International 2001, 2019), but many questions remain unanswered about its past distribution, biology, and causes and pattern of decline.

There does not appear to be any currently known fossil or archeological records of the Spot-billed Pelican, and the few known pre-Pleistocene pelican fossils from across southern Asia are not supported as the closest relatives of any particular extant Old World species (e.g., Stidham *et al.* 2014). Without any prehistoric records for the species, we must rely on younger historical records alone to study its past geographic distribution. While much of the basic biological data about Spot-billed Pelican currently are unknown or unpublished including aspects of diet, foraging, and breeding, ongoing research outlining the natural history of the remaining populations is increasing (e.g., Taher 2007; Kannan and Pandiyan 2013). The effort to conserve this species will require more information on the behavior and biology of the surviving populations (e.g., Kannan and Manakadan 2005; Gokula 2011; Kannan and Pandiyan 2013), in addition to

data from across its historical distribution. In order to better conserve the remaining populations of the Spot-billed Pelican, we also need to better understand the timing, potential causation, and magnitude of its decline in the late twentieth century so that the same factors do not lead to a continued reduction.

One of the main obstacles to studying the past decline and extirpation of Spot-billed Pelican populations is the lack of knowledge about verified museum specimens that have locality and collection data. Most of the information regarding the past historical distribution of this species across Asia is based on unverified visual records of wild birds extending back over a century (extensively compiled by BirdLife International 2001), complicated further by the pelican's historically changing taxonomy through the twentieth century, creating a lack of clarity in documentation of the historical distribution of extirpated populations. While it is now considered a distinct species (monophyletic based on molecular data), the Spot-billed Pelican previously was regarded as conspecific with its currently recognized sister species, the Dalmatian Pelican (*P. crispus*) (Kennedy *et al.* 2013). In addition, the Dalmatian Pelican sometimes was allocated as a subspecies of the Spot-billed Pelican, and both species were even classified by some workers as *Pelecanus roseus*, a taxonomic name now considered to be a junior synonym of the Eastern White Pelican, *Pelecanus onocrotalus* (Johnsgard 1993). As a result, using unverified specimen (or visual) records with the known history of variable taxonomic names to examine the past distribution of the Spot-billed (and Dalmatian) Pelican is problematic because observers could have seen either species (as we recognize them today).

Another aspect facing the study of the decline of this species is that many, if not most, specimens of the Spot-billed Pelican in western museums were collected approximately a century ago (e.g., museum collection data records on VertNet) prior to the geographic decline of the species (and the foundation of the People's Republic of China in 1949), and specimen records in Asian museums are sparse. Therefore, specimens from the last half of the twentieth century just prior to, or during the extirpation of the Philippines, Chinese, and Myanmar (Burmese) populations are rare or otherwise do not appear to exist in public collections. Verified specimens are required in order to examine aspects of this pelican species beyond the date and site of collection.

The historic observational records of the Spot-billed Pelican in China are restricted to the southern and eastern coastal areas of the country (with the exception of problematic individual sightings given the taxonomic confusion discussed above, and absence of verification through photographic or specimen data). Historical observation records are from Yunnan, Anhui, Jiangsu/Shanghai, Fujian, Zhejiang, Guangxi, Guangdong, and Hainan Provinces, and the vast majority of published historical sightings in China are restricted to coastal areas (BirdLife International 2001). Published records from the interior parts of China are absent, contrasting with the distribution of this pelican extending into the interior of India, Myanmar, and other parts of Southeast Asia (BirdLife International 2001). The perceived coastal distribution in China may be an artifact of the coastal locality of many observers and their reports rather than the true former geographic range. The last known observations of Spot-billed Pelicans in China are from sometime in the 1960s and lack any firm published dates (BirdLife International 2001). Published statements supporting the resident status or potential residency (and even nesting) of the Spot-billed Pelican in China from the late 19th and early 20th centuries include observations from Yunnan, Fujian, Guangdong (Gee *et al.* 1926-1927), Anhui (Sowerby 1943), and Jiangsu Provinces (Styan 1894; La Touche 1925-1934; Caldwell and Caldwell 1931; BirdLife International 2001). However, those data seem to have been overlooked by more recent assessments of the past status of Spot-Billed Pelican with it considered solely as a non-native vagrant or non-breeding visitor in China (i.e., BirdLife International 2017; 2019).

Our objectives in this study were to verify the identity and collection location of specimens housed in the research collections of the Institute of Zoology of the Chinese Academy of Sciences in Beijing (IOZ) as individuals of the Spot-billed Pelican (*P. philippensis*), to use locality information from confirmed specimens to update current understanding of the historical distribution of the species, and to document the occurrence and preservation of these historically important specimens

METHODS

We examined all pelican specimens in the IOZ to identify them to the species level. Study skins of the Spot-billed Pelican can be differentiated from its sister species the Dalmatian Pelican readily by the presence of dark, vaguely purple, rounded to elliptical/crescentic spots on the dorsal part of the bill, that are the source of its common name (Fig. 1). Though these spots may fade a little in older museum specimens, they were visible in the specimens we examined (Fig. 1). The use of measurements (alone) for discriminating Spot-billed Pelican from Dalmatian Pelican is problematic because it appears that their (skeletal) sizes overlap (T. Stidham, unpubl. data), even though their reported body masses are quite different (Dunning 2008). All specimens discussed here are housed in the bird collection of the Institute of Zoology in the Chinese Academy of Sciences in Beijing.

RESULTS

Four specimens with locality and collection information out of the 11 pelican skins and mounted specimens in the IOZ can be verified to be of Spot-Billed Pelicans. An additional two specimens appear to have spotted bills, but their locality information appears erroneous or at least questionable. Specimen IOZ 44412 is an individual collected 20 September 1963 in Meihua, Fujian Province (Fig. 2). The original specimen label identifies the individual as a juvenile female of "*Pelecanus r. roseus*," and she may be the specimen from Fujian Province reported by BirdLife International (2001, p. 102). It is likely that this individual is the historically latest known specimen of this species from China. Specimens IOZ 21032 and 21033 are two unsexed study skins collected in 1897 (no calendar date known) from Fuzhou in Fujian Province (Fig. 2). Both specimens are labeled separately as "*P. r. roseus*" and "*P. philippensis*" originally from "E. Mus. Huede" and donated by Mr. de la

Figure 1. Dorsal view of the rostral end of the bill of the Spot-billed Pelican (*Pelecanus philippensis*), illustrating the presence of spots. Specimens are from the research collections of the Institute of Zoology (IOZ) of the Chinese Academy of Sciences in Beijing (A. IOZ 21030; B. IOZ 21033; C. IOZ 44412; Scale bar = 1 cm).

Figure 2. Map of mainland China illustrating the collecting sites of Spot-billed Pelican (*Pelecanus philippensis*) museum skins housed in the research collections of the Institute of Zoology of the Chinese Academy of Sciences in Beijing. Meihua is just North of the major city of Fuzhou in Fujian Province.

Touche. These specimens reinforce a large number of historical observational records from Fuzhou (BirdLife International 2001). Also deriving from the "E. Mus. Huede" collection is IOZ 21030, an adult female collected in Shanghai (Fig. 2) on 24 March 1931 and labeled as "*P. r. roseus*" (donated by R. P. Loiseau). This specimen is perhaps the northernmost verified record of the species within China (~31° North latitude) and close to the northernmost record within its historic range in Asia (BirdLife International 2001). It also derives from within the typical breeding season from October to April (Johsngard 1993) adding support to the idea that this species was a resident or bred in the Shanghai area (see discussion below). IOZ 37982 and 37983 also appear to have spots on the bill (though IOZ 37983 is very dirty), and are labeled as "*Pelecanus roseus roseus*." They likely represent additional material of Spot-billed Pelicans. However, their locality information inside of China does not appear correct (i.e., database information referring to the Mesozoic and Cenozoic), and they are larger sized birds (possible males). In addition, a skeleton (IVPP OV 1031) housed in the modern skeletal collection of the Institute of Vertebrate Paleontology and Paleoanthropology of the Chinese Academy of Sciences in Beijing is from a Beijing Zoo individual that died in 1960. Its original date and site of collection of that individual are unknown. However, it is one of the few known skeletons of this species in a museum collection.

DISCUSSION

These verified specimens have implications for the study of the decline and (historical) biology of the Spot-billed Pelican. Known breeding records for the Spot-billed Pelican range from October through May with major differences in timing across breeding localities (Johnsgard 1993; BirdLife International 2001). The report by BirdLife International (2001) casts doubt on the occurrence of breeding of the Spot-billed Pelican inside of China, despite several published historical reports stating the species as a resident or potential resident across southern China (including Shanghai, see above), or the reported observation of nesting in China (see references in BirdLife International 2001 for a compilation). BirdLife International (2019) reiterates that opinion with China listed as a non-breeding area. Breeding populations currently are documented only in Cambodia, Indonesia, India, and Sri Lanka (BirdLife International 2001, 2019; Kannan and Pandiyan 2013). The late September specimen (IOZ 44412) along with the late March specimen (IOZ 21030) are perhaps the Chinese specimens closest in time to the typical breeding season from October to April (Johnsgard 1993; BirdLife International 2001). If the late March date is correct, then IOZ 21030 was collected during the known breeding temporal range and could reinforce the published proposals that the Spot-billed Pelican was resident (and likely bred) in China. While suggestive, the occurrence of two twentieth century individuals in China during and adjacent to the breeding season do not definitively support past breeding in China. Those individuals also could have been visitors. However, the March specimen from Shanghai is consistent with the reports of the species being resident and breeding in Jiangsu Province (which surrounds and historically included Shanghai; Sowerby 1943). It is possible that stable isotope research could determine whether or not the specimens were residents or long distance migrants/dispersers.

The verification of these few specimens of Spot-billed Pelicans from China may catalyze new research directions on known biological material from extirpated areas. Most previous researchers have hypothesized habitat loss or other reasons as the main factor for the extirpation of the populations across Asia (summarized by BirdLife International 2001). Historically recent specimens could allow for the examination of the potential role that DDT and other environmental toxins may have played in the extirpation. The

peak usage of DDT in China for agricultural (and outdoor) purposes occurred between 1966 and 1983, with an annual output significantly less prior to 1966 (Wang *et al.* 2010). That same time period also saw a significant increase in the use of chemical fertilizers in China, which was rare prior to 1960 (Edmonds 1994).

Additional lines of future inquiry can focus on population genetics and phylogeography of the extirpated populations of this largely non-migratory bird (Johsgard 1993), assessing the degree of biodiversity loss. Furthermore, study of stable isotopes from those extirpated populations should aid resolving questions about past movements and potential residency across the geographic distribution of the species. These types of research on existing birds and historical museum tissues could help to designate populations and individuals most closely related to the lost populations in order to help inform future restoration efforts. Additionally, historical information such those presented in this study can help determine target areas for restoration efforts where birds formerly occurred. National parks, biological reserves, and a conservation ethos now exist within the former distributional boundaries of the Spot-billed Pelican (in China and the Philippines), and recent legal and enforcement changes in China related to the protection of coastal and wetland areas demonstrate this shift (Stokstad 2018). With further study, it seems plausible that someday the Spot-billed Pelican could be restored to its former geographic range, helping to shield the species from further declines given its current geographically limited populations.

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