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A survey of reptiles and amphibians on Kinmen Island, Taiwan

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ABSTRACT - Little is known about the reptiles and amphibians of Kinmen Island, Taiwan. Until recently, Kinmen had been off-limits to outsiders. It was not until the mid 1990s that civilian travel was allowed to and from the island. We surveyed eight sites from 19 May through 18 July 2005, using 15 m drift fences with collapsible funnel traps on the ends. We observed 258 individuals of seven species during our survey. The herpetofauna encountered consisted of two anuran, two lizard, and three snake species. The two anuran species made up over 97% of the individuals captured in traps. Reptiles were encountered or captured less frequently. Since we sampled a limited number of sites, our study serves as a basis upon which future reptile and amphibian inventory studies, conducted on Kinmen, could be based. A more thorough inventory is needed to fully understand the natural history of herpetofauna on the island.

HISTORICALLY, Kinmen Island (also known as Greater Quemoy) has been a significant outpost during the Chinese civil uprisings (Clark & Tsai, 2002). The massive construction of ships by the late Ming patriot Cheng-Kung, who fought against the Manchu court of the succeeding Ching Dynasty, denuded the island of trees in the mid 17th Century. The deforestation lasted nearly 300 years (Lai, 2004) causing shifting sand dunes that buried entire villages on the east side of the island and erosion that shaped the modern landscape (Clark & Tsai, 2002). In more recent times, after the Chinese Civil War, the island was the site of extensive military shelling between the People's Republic of China (PRC) and the Republic of China forces (ROC) in the 1950s and 1960s (Chang & Di, 1993). A long-time military outpost, the island was returned to the civilian government in the mid-1990s and travel to and from Taiwan was allowed. Although Kinmen is administered by the ROC, it is also claimed as part of the territory of the PRC. Direct travel between mainland China and Kinmen was opened in 2002 and there has subsequently been extensive development on the island. Currently, Kinmen has a population of

approximately 50,000 people. Reforestation has taken place with the planting of *Casuarina equisetifolia*, *Acacia confusa* and *Pinus elliottii*. Wooded land now covers 50% of the island (Clark & Tsai, 2002). Many reservoirs, artificial lakes, and fish ponds have also been constructed for storing water, aquaculture, irrigation, and for recreation on the island (Hung et al., 2004).

Kinmen Island, Taiwan is approximately 134 Km², and is located ca. 11 Km east of Xiamen, Fujian Province, China, with the shortest distance from the island to the mainland at only ca. 6.9 Km. Kinmen is separated from Taiwan Island by ca. 277 Km of the Taiwan Strait (Clark & Tsai, 2002). Located at 24° 27' N, 118° 23' E, the climate of Kinmen is affected by monsoons. Approximately 80% of the island's precipitation falls between April and September with typhoons often striking the region between July and August. Kinmen's average annual rainfall is ca. 105 cm with a year-round temperature averaging ca. 21°C. The average temperature in the summer is 28.2°C and the winter average is 12.8°C. The island's geology is primarily granite with the highest point, Mt. Taiwu, peaking at 253 m above sea level.

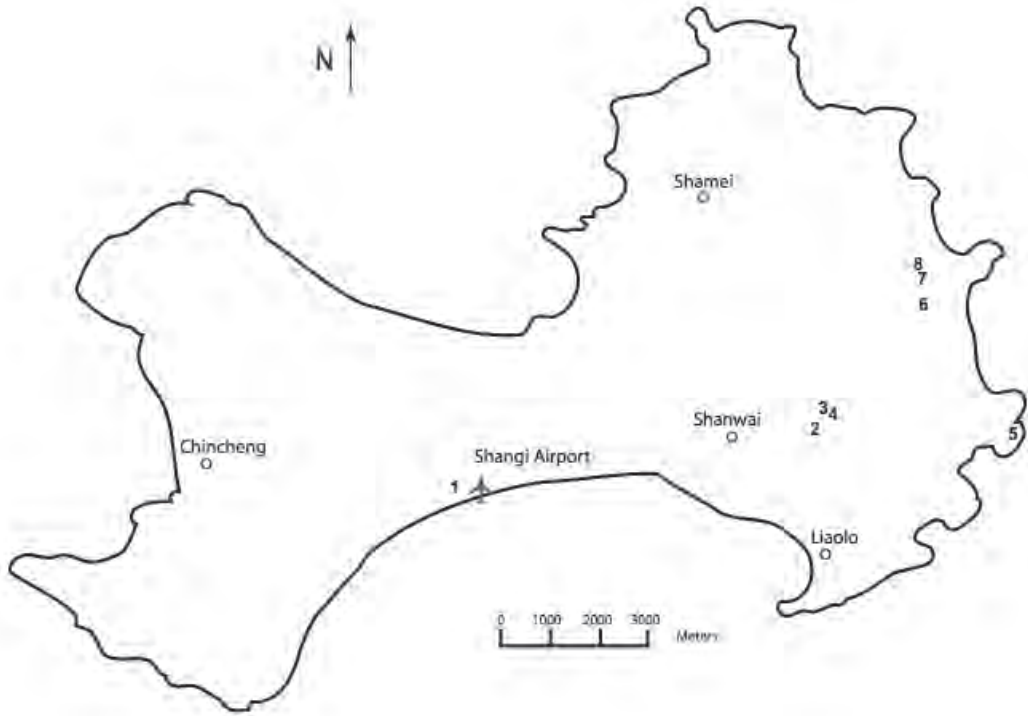


Figure 1. Map of Kinmen Island showing the locations of the eight drift fence arrays used in this study (Site 1:24° 25' 40 N, 118° 21'16 E, Site 2:24° 26' 58 N, 118° 26' 09 E, Site 3:24° 27' 05 N, 118° 26' 13 E, Site 4:24° 27' 03 N, 118° 26' 17 E, Site 5:24° 26' 37 N, 118° 28' 13 E, Site 6:24° 28' 07 N, 118° 27' 15 E, Site 7:24° 28' 21 N, 118° 27' 13 E, Site 8:24° 28' 24 N, 118° 27' 12 E).

Little is known about Kinmen island's wildlife due to its history of political isolation. Some restoration efforts to preserve the rare Asian Horseshoe Crab (*Tachypleus tridentatus*; Yang, 2004), Eurasian Otter (*Lutra lutra*; Hung, 2004), and research on nesting birds (Yuan et al., 2006) has been achieved. A single species list of herpetofauna from Kinmen Island was prepared for Kinmen National Park (Lue, 1998). We conducted a herpetofauna trapping survey to determine relative abundance of the herpetofauna of the island and the seasonal phenology of their activity. We also made inferences about the effects of soil type and proximity to water on the occurrence of herpetofauna.

METHODS AND MATERIALS

Eight drift fence arrays were built near Blue-tailed Bee-eater (*Merops philippinus*) nesting sites (Fig. 1). The focus of a related study was to

determine the abundance of large predatory snakes, using Bee-eater colonies as feeding grounds (Podlipny, 2006). The drift fences were constructed of either clear, flexible plastic, or thin, fine mesh fabric. Each fence was fifteen meters long and was positioned in front of, and as near to the center of, the colony as possible. Stakes were driven into the ground and the fence material was zip-tied to the stakes. The bottom of the fence was buried approximately 2-5 cm to prevent reptiles or amphibians from crawling underneath. Two collapsible minnow traps were placed at each end of the drift fence for a total of four traps per array in an attempt to capture reptiles or amphibians that reached the fence (Fig. 2). In theory, animals that came in contact with the fence were funneled towards and into one of the traps (Crosswhite et al., 1999). The traps were made of flexible mesh material, stretched over a wire frame, with two entry holes. The tops of the traps were covered



Figure 2. A drift fence array in front of a Blue-tailed Bee-eater colony on Kinmen Island in May 2005.

with cardboard to shield captured animals from the sun. Sand was packed up the entrance of each funnel to increase the chance of the animals entering the traps. Traps were checked twice daily; beginning at 06:30 every morning and most afternoons at 16:00. Traps were kept open for most of the bee-eater breeding season, from 19 May through 18 July 2005. In addition to reptiles and amphibians captured in our traps, we also recorded incidents of animals encountered near the trap arrays, and animals encountered en route between arrays. For this study, we considered each drift fence array as a single trap. Four of our traps were

continuously functional for the 61 day trapping period. However, the remaining four traps were not in use for some portion of the time. Traps had to be removed from one site for 17 days because of flooding. Trapping was also not commenced on another site until 20 June 2005, 32 days later than the other sites. Finally, traps at two sites were removed for a six-day period, starting at the end of June and continuing into July, because they could not be checked for logistical reasons. All of the turtle species from Kinmen Island are either sea turtles or freshwater aquatic species (Lue, 1998). Aquatic turtles are not typically captured in

Species	Nomenclature	Total Number
Spectacled Toad	<i>Bufo melanostictus</i>	197
Ornate Rice Frog	<i>Microhyla ornata</i>	44
Elegant Skink	<i>Plestiodon (Eumeces) elegans</i>	4
Bowrings Gecko	<i>Hemidactylus bowringii</i>	1
Checkered Keelback Watersnake	<i>Xenochrophis piscator</i>	1/2*
Oriental Ratsnake	<i>Ptyus muscosus</i>	2*/3**
Many-banded Krait	<i>Bungaris m. multicinctus</i>	2**

Notes: * Individuals observed near traps but not captured within the array; ** Individuals observed enroute between traps.

Table 1. Total number of reptile and amphibian species recorded from Kinmen Island from 19 May-18 July 2005.

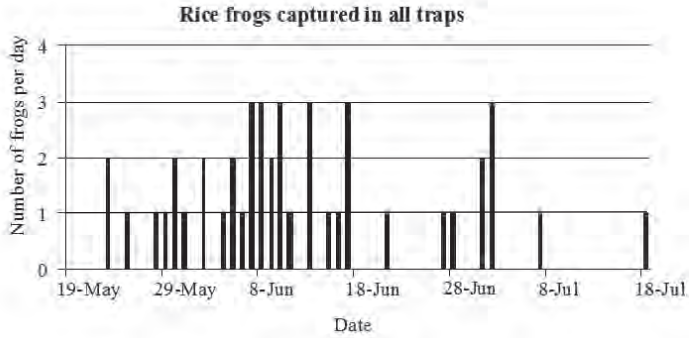


Figure 3. Number of Rice frogs (*Microhyla ornata*) captured in all traps on Kinmen Island from 19 May through 18 July 2005.

terrestrial drift fence traps like the ones we used. Therefore we excluded this group of reptiles from our study. Although we observed Red-eared Sliders (*Trachemys scripta*), and numerous individuals of at least one other aquatic turtle species in a pond at Kinmen National Park headquarters, we did not attempt to quantify their encounter.

Since our trapping efforts began in mid May, we expected that reptile and amphibian captures would decline as the summer progressed and air temperatures increased. We conducted a Cox and Stuart test for trends (Conover, 1980) to test the null hypothesis that the number of individuals per trap, of a given species captured, did not decline throughout the duration of the study. We tested this

at alpha level 0.05. We only tested for trends on species with at least 40 captures.

RESULTS

The eight sites were sampled for reptiles and amphibians for 427 trap days (the cumulative number of days all traps were opened). During our 61 day survey on Kinmen Island, we encountered seven different species of reptiles and amphibians, consisting of two species of anuran, two species of lizard, and three snake species. We captured 247 individuals in our traps, and encountered 11 additional animals (all snakes) either near the traps or en route to the traps, for a total of 258 individuals. Amphibians (the two anuran species)

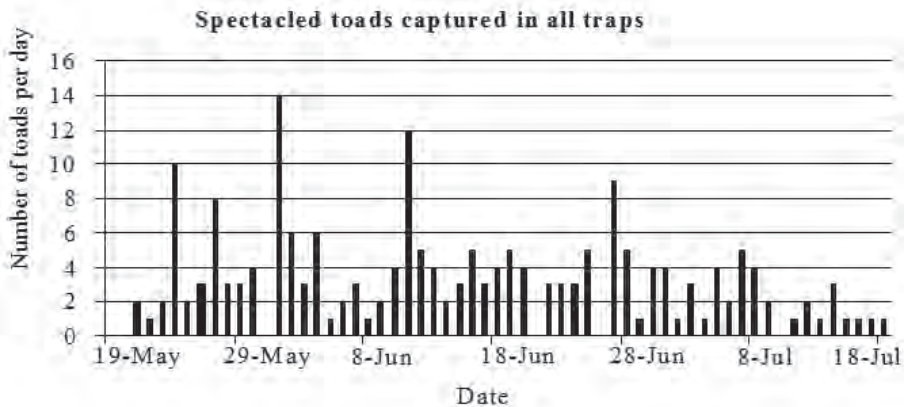


Figure 4. Number of Spectacled Toads (*Bufo melanostictus*) captured in all traps on Kinmen Island from 19 May through 18 July 2005.

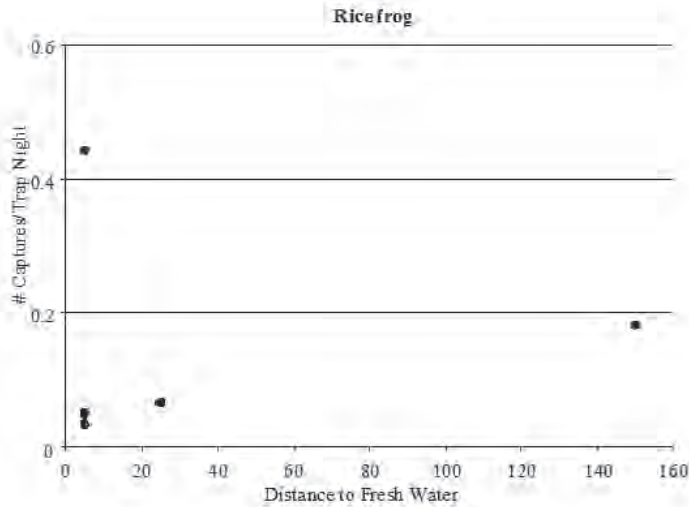


Figure 5. Points represent mean number of individual Rice frogs (*Microhyla ornata*) captured per night at each trap location and the distance of the traps to nearest permanent freshwater source.

made up over 97% of the animals captured in our traps, while the snake species were more frequently encountered near the traps or en route to the traps (Table 1). The Spectacled Toad (*Bufo melanostictus*) and Ornate Rice Frog (*Microhyla ornata*) were the only species that we captured frequently in our traps. We encountered

all other species in very low numbers; less than five individuals of any species during the survey (Table 1). Therefore we only used the most abundant anuran species for analysis. Both species of amphibian were captured throughout the sampling period. However, we found a significant trend for *M. ornata* which was captured frequently

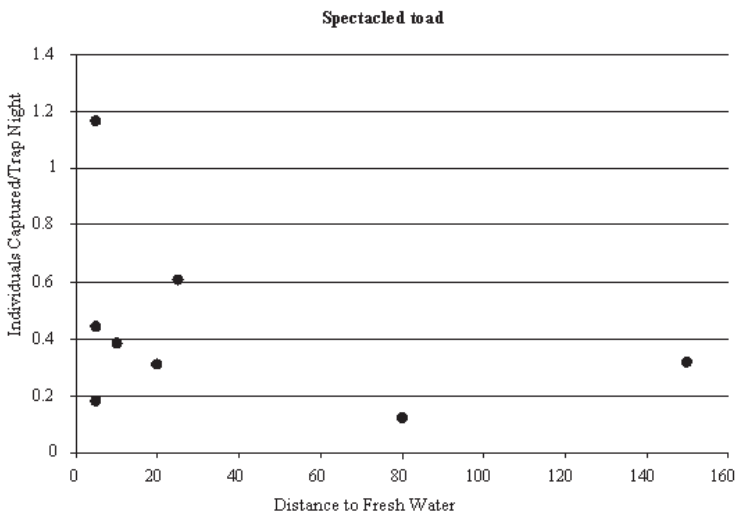


Figure 6. The mean number of individual Spectacled Toads (*Bufo melanostictus*) captured per night at each trap location, and the distance of the traps to the nearest permanent freshwater source.

in early months of early in the study but declined as the summer progressed ($T = 5$, Fig. 3). However, we could not determine a trend of decreasing captures for *Bufo melanostictus* ($T = 13$; Fig. 4). When we combined all the amphibians, we found a significant trend of more frequent captures early and fewer towards the end of summer ($T = 8$). *B. melanostictus* were captured at all eight trapping arrays at a mean rate of 0.46 individuals per trap day, while *Microhyla ornata* was captured at only five of the sites at a mean rate of 0.10 individuals per trap day. Capture rates for *B. melanostictus* and *M. ornata* might be higher at sites that were closer to permanent water sources (Figs. 5 & 6) but the data was insufficient to test for trends of this.

Only five individual lizards, of two species, were observed during the sampling period and all specimens recorded were captured in different trapping arrays. Snakes were encountered more frequently than lizards, but only one individual was captured in a trap, while 11 were observed near trap arrays or seen en route to an array.

DISCUSSION

In the 61 days we recorded data on reptiles and amphibians on Kinmen we encountered seven species comprising 70% of the species expected or known to be on the island, excluding turtles. The amphibians were the most easily trapped and greatly outnumbered the reptiles in this survey. Our traps appeared to be quite ineffective at capturing snakes, while other reptiles and amphibians seemed to enter them readily. Future studies may benefit from our experience if they were to use other sampling techniques to better sample the various groups that make up the herpetofauna of the island. Timing of the survey was also important since we found a seasonal shift in the detectability of amphibians in this study.

In addition to the reptile and amphibian species differing in relative abundance, some appeared to differ in their distribution on the island. Some species seem to be ubiquitous while others may be more selective in their choice of habitat. The Spectacled Toad was the most frequently encountered species in the study, being observed at all sampling sites. Given the ability of this toad's skin to resist desiccation, compared with other

amphibians, it was not surprising that it was more widely distributed on the island, even at sites far removed from freshwater sources. However, our study was not intended to determine the habitat use of the various reptile and amphibian species. We focused our efforts mainly in the sandier sites that are typically used by the Blue-tailed Bee-eater in the eastern half of the island (Fig. 1). A more thorough survey could include a wider variety of habitats that are available on the island (see Yuan et al., 2006).

Given the long history of isolation from outsiders the herpetofauna of Kinmen Island is poorly known. Our attempt to survey the reptiles and amphibians of Kinmen is by no means an exhaustive effort and constitutes a brief look at a subset of the species that inhabit the island. It could serve as a basis for future studies. A more thorough survey would be needed to determine the species diversity that inhabit the island. More research would also be needed to understand the relationship between habitats that exist on the island and the relative abundance of the various reptile and amphibian species.

It is important to collect such data in the near future since the island has only recently been opened to travel from the Chinese mainland and Taiwan. Increased travel between these areas and Kinmen Island could possibly lead to colonization of Kinmen Island by additional herpetofauna, or impacts from tourism. Such potential impacts could then be detected with future monitoring studies.

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