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Short Communication

Preliminary Diet Analysis of Chinese Soft-shelled Turtle (*Pelodiscus sinensis*) in the Middle Confines of the Yellow River, Shaanxi Province, China

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FK, QJZ, FRX, JMN, HXZ and HTS designed and conducted the study. FK collected and analyzed the data. FK, QJZ and HTS wrote the manuscript.

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ABSTRACT

This present study delves into the first to quantify the diet composition of Chinese soft-shelled turtle (*Pelodiscus sinensis*) in the middle confines of the Yellow River, China. 24 stomach content samples were collected from wild-caught individuals from natural habitats, the analysis result showed that the species diet was noted to be primarily omnivorous and comprised 23 prey taxa classified into nine groups: plant (4), fish (1), frog (1), earthworm (1), insect (9), mollusk (3), shrimp (2), and other miscellaneous items.

Chinese soft-shelled turtle are widely distributed in East Asia, from the Amur and Ussuri Rivers in the Far East of Russia through Korea, Japan, and eastern, central, and southern China to southern Vietnam (TTWG, 2017). Populations of this turtles have been declining at rapid rates because of the insatiable demand for pet, food and traditional medicine markets in China (Cheung and Dudgeon, 2006). Despite its close association with human beings, very little is known of the species dietary composition analysis in the natural habitats. The lack of adequate studies seriously affected the attention accorded to the species thus severely hindering effective protection measures.

Understanding their diet, and the diets of other imperiled species, may allow conservationists to identify critical food resources, beneficial to set up nature reserves for *P. sinensis* and other freshwater turtle species. In order to develop conservation actions for *Pelodiscus sinensis*, basic ecological information is needed. This study delves into the first ever analysis of the diet composition of *P. sinensis* in the middle confines of the Yellow River, China.

Materials and methods

The study was conducted in the middle confines of Yellow River in Dali County, Shaanxi Province, China (N 34°53′33″-34°59′13″, E 110°10′23″-110°13′06″) from April 2017 to August 2018. Turtles were captured in large submerged turtle traps, and each digestive tract was cut open, and the stomachs as well as other partial gut contents were rinsed with tap water through a 0.3-mm-mesh sieve. All retained prey items were identified to the lowest taxonomic level possible using the guide to inland waters resources by Zhang and He (1990). The samples were sorted and reconstructed under a dissecting microscope (M205C; Leica Microsystems, Wetzlar, Germany) and wet volume measurements of each taxon obtained using a water displacement method in a 100-ml graduated cylinder.

Percentage number of prey individuals (%N), frequency of occurrence (%F), and volume (%V) for each identified prey taxon were calculated. Percent index of relative importance (%IRI) that incorporates %N, %F, and %V was calculated and it was used to gauge the importance of each prey taxon:

$$\%IRI = 100 \times \frac{IRI_i}{\Sigma_{i=n}^{n} IRI_i}$$

Where IRIi is (%Ni + %Vi) ×%Fi for prey type i and Σ^{n}_{i-n} IRI_i is the sum of the IRI for all prey types i (Hyslop, 1980).

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Results

A total of 24 stomachs of *P. sinensis* were collected. An analysis of the stomach contents showed 23 prey taxa classified into 9 food item groups: plant (4 prey taxa: corn, algae, sedge, duckweed), fish, frog (green pond frog), shrimp (2 prey taxa: oriental river prawn, red Swamp Crawfish), mollusk (3 prey taxa: pond snails, trumpet snails, clams), insect (9 prey taxa: butterflies, flies, mosquitoes, mantis, mayflies, water beetles, ground beetles, stink bugs, unidentified insect), earthworm, unidentified and miscellaneous. Of the 9 groups, the greatest amount for number of prey was constituted by insect, mollusk and plant (%N = 41.5, 24.8 and 14.5, respectively). The greatest amount for wet volume of prey was constituted by insect, fish, mollusk and the unidentified category (%V =25.9, 24.9, 14.8 and 12.3, respectively). The greatest prey frequency was constituted by insect, fish, mollusk and the unidentified category (%F=83.3, 76.7, 67.5 and 66.9, respectively). The greatest percent index of relative importance was constituted by insect, fish, mollusk and unidentified (%IRI = 46.3, 15.4, 13.1 and 12.7, respectively).

Discussion

P. sinensis has long been regarded as carnivorous (Mitsukuri, 1905; Pope, 1935; Ernst and Barbour, 1989). An interesting phenomena, however, was observed where plants occurred at least in 50.3% of stomach content samples of all turtles, thus accordingly, we infer its diet to be omnivorous. In spite of our great effort, majority of the food items were still difficult to identify to the species level hence a large proportion of unidentified matter. In relation to this, two propositions were put forth: (1) Since *P. sinensis* has an elaborate digestive system (Xiao *et al*., 2006), incompletely digested remains were difficult to identify. (2) Tang (2015) illustrates a scenario involving feeding on carrion. After a subsequent ingestion and re-digestion of carrion, it will be very difficult to identify the food components that first constituted it.

A novel discovery for this study, the first record ever for wild specimens, was the presence of red swamp crawfish (*Procambarus clarkii*) in the stomach contents of *P. sinensis*. Crawfish has become one of the most famous invasive species in the world and has caused lot of damage to the freshwater ecosystems in China (Huner, 1988). This study shows that crawfish are also present in middle confines of the yellow river. Thus, the diet composition of *P. sinensis* can as well be used as an indicator of the presence of the invasive red swamp crawfish. Also, we could make a rational exploitation and profit from Chinese soft-shelled turtle' biological control capability, as illustrated in Dong *et al*. (2012) where the predation capability had been applied to suppress the occurrence the invasive golden apple snail.

It is worth noting that the diets contained miscellaneous anthropogenic items including fishing wire, plastic, glass slag, and cloth debris. The prediction that plastic (and other persistent petroleum products such as nylon, polystyrene, rubber, etc.) pollution would be a major problem in the twenty-first century is now widely recognized (Ryan *et al*., 2009). Plastic ingestion often causes sub-lethal effects, such as obstruction of the gastrointestinal tract and reduction of appetite. Debris ingestion can thus be a major threat to turtle populations (Sul *et al*., 2011). If these animals continued to eat the "rubbish", this could even lead to greater conservation implications to this quite vulnerable species. Furthermore, the occurrence of a large proportion of plastics represented a major hazard for nesting female turtles.

P. sinensis is one of the fastest-declining turtle species and is listed as a vulnerable (VU) in the IUCN Redlist of threatened species (Zhang *et al*., 2018). The findings of this research are deemed to add to the greater knowledge of the species and hence give researchers and wildlife managers' insight on *P. sinensis* feeding natural history aspects that should be considered in developing management plans.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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