

Short Notes

Pets and invasion risks: is the Slider turtle strictly carnivorous?

Anne-Caroline Prévot-Julliard*, Emeline Gousset, Chloé Archinard, Antoine Cadi, Marc Girondot

Abstract. According to the International Union for Conservation of Nature (IUCN), invasive species are one of the most important causes of biodiversity decline at a global scale. The impact of introduced species on local ecosystems is thus important to evaluate. Pet voluntary introductions are made by private people and usually concern only one or two individuals per occasion. However, the number of release occasions is as numerous as the number of pet owners that don't want to keep their pet anymore and then decide to "release" it. Hatchling red-eared slider turtles (*Trachemys scripta elegans*) have been massively exported from the United States to European (until 1997) and Asian countries to be sold as pets. Many owners, ignoring the potential consequences of their act, have released their grown up turtle in natural freshwater ecosystems. As a consequence, feral adult turtles have been detected all over France. In this paper, we provide information that contradicts public opinion that introduced slider turtle is strictly carnivorous. By analysing the diet of feral adult turtles, we found that adult slider turtles are omnivorous, as in their natural areas.

According to the International Union for Conservation of Nature (IUCN), invasive species are one of the most important causes of biodiversity decline at a global scale (Vitousek et al., 1997). The causes of intentional introductions are diverse, including agriculture, biological control or hunting and fishing activities (Mack et al., 2000). Voluntary introduction of pets differs from other introductions, since releases are made by private people and imply only one or two individuals per occasion. However, the number of release occasions is as numerous as the number of pet owners that do not want to keep their pet anymore and decided to "release" it.

In 1980s, an important pet trade has been developed from USA production farms of red-eared slider turtles (*Trachemys scripta elegans*) to European and Asian countries. Growing juvenile turtles, when kept in good conditions,

have led to more inconvenience that pleasure for naive owners. As a consequence, many turtles were released in natural freshwater ecosystems (e.g. Chen and Lue, 1998; Luiselli et al., 1997; Thomas and Hartnell, 2000). Although importation of the red-eared slider turtle is forbidden in European Union since 1997, many sliders are still kept as pets, and feral adult turtles have been detected all over France (Arvy and Servan, 1998).

In France, in order to deter general public from releasing turtles in the field, a lot of information has been spread out concerning damages of this species on native ecosystems. For many stakeholders (including politicians and managers), slider turtles are supposed to be ferocious carnivorous, that "could even attack small young ducks" (public information). However, there has been no study on the diet of feral slider turtles. In its natural home range, young individuals tend to be carnivorous, but adults switch to omnivorous, even vegetarian, diet when growing (McCauley and Bjorndal, 1999).

In this paper, we provide information on the diet of feral slider turtles caught near Paris

UMR 8079 Laboratoire Ecologie, Systematique and Evolution, University Paris-Sud bat. 362, F-91405 Orsay Cedex, France

*Corresponding author;
e-mail: anne-caroline.julliard@ese.u-psud.fr

(France), by dissecting digestive systems. We wanted 1) to know what kind of food slider turtles could eat, and 2) to test whether the diet composition changes with turtle age. This study is part of a more general project concerning invasion potentialities of slider turtles in France.

During summer 2003, 47 slider turtles present in two ponds within Sausset and La Courneuve parks of Seine-Saint-Denis, north-east of Paris, have been trapped, weighed and measured by the private company Espace Faune Flore (EFF) under the supervision of the Seine-Saint-Denis General Council. The measurements included the maximal length of the carapace (further named "Carapace length"). Strait-line measurements were used. Turtles were then frozen and dissected. The presence of mature ovocytes was noted when observed. For technical reasons, the digestive tract of only 25 of these turtles (18 females and 7 males) was extracted. All food fragments that were not completely digested were identified visually or under a binocular scope.

Sizes and weights have been compared using ANOVA with sex and pond origin as factor followed by Fisher Least Significant Difference test. Among females, the presence or absence of mature ovocytes has been tested by a logistic regression with size or weight as factors. The probability of presence of each group of food was tested by logistic regression depending on sex, pond origin and carapace length. All tests were done with R-software (R Development Core Team, 2005).

Biometry of captured turtles

Nine-teen turtles (3 males and 16 females) originated from Sausset pond and 28 (4 males and 24 females) from nearby La Courneuve pond were captured. The population sex ratio was significantly different from 0.5 ($\chi^2_1 = 23.1$, $P < 0.0001$) and strongly biased toward females (male frequency = 0.15).

The normality of carapace length and weights was not rejected. Carapace length did not differ between sexes ($N = 47$, $P = 0.38$) but individuals from Sausset were significantly larger than those coming from La Courneuve ($N = 47$, $P = 0.03$), without any significant interaction between origin and sex ($N = 47$, $P = 0.45$). In the same way, weights did not significantly differ between sexes ($N = 47$, $P = 0.15$) but individuals from Sausset were significantly larger than individuals from La Courneuve ($N = 47$, $P = 0.03$), without any interaction between origin and sex ($N = 47$, $P = 0.18$). However, females with ovocytes (27 individuals vs.

13 females without ovocytes) were significantly larger and heavier than females without, even after having taking into account for origin (Carapace length: $P < 10^{-4}$; Weight: $P < 10^{-4}$).

Food fragments present in digestive systems

The digestive systems of 22 individuals from the 25 analyzed were not empty. We found vegetal material in all individuals but one (seed, leaf or stem remains, table 1). These fragments belonged to aquatic species from families Junceae, Cyperaceae or Poaceae.

We found insects or insect cuticle in 14 individuals. In 4 turtles, we found many terrestrial ants, notably soldiers. Crustacean remains were observed in 7 individuals. Fish remains (scales, *branchiae*, jaws, fish bones) were observed in 10 turtles. Fish belong to two distinguishable groups based on scale morphology: Order Perciformes and Family Cyprinidae. We also found other material in 8 digestive tracts (plastic, stone, paper).

Occurrence probability of food depending on turtle size

Since vegetal material was present in all turtles but one, no test about the influence of turtle size on the probability of plant occurrence was done. The probability of occurrence of fish did not depend on the turtle size ($P = 0.79$), on sex ($P = 0.47$), nor pond ($P = 0.70$). The probability of occurrence of invertebrates was not statistically related with pond ($P = 0.60$), nor sex ($P = 0.08$). However, we found a significant relationship between the probability of occurrence of invertebrates and turtle size ($P < 0.05$). Larger turtles were less susceptible to have invertebrates in their stomachs than smaller.

Discussion

The bias toward females that we found in this study has been also denoted in a very large number of sampling designs of feral slider turtles

Table 1. Items found in the stomach of Slider turtles captured in Seine-Saint-Denis department (North of Paris). Crosses indicate presence of item. Sex: M = Male, F = Female; Origin: L.C. = "La Courneuve", S = "Sausset"; Fiches: C = Cyprinidae, P = Percormorphidae; Other: Pl = Plastic, S = Stone, Pa = Paper.

Sex	Origin	Carapace length (mm)	Plants			Invertebrates		Fishes	Others
			Unknown	<i>Juncaceae</i>	<i>Cyperaceae</i>	<i>Poaceae</i>	Insects		
F	L.C.	111.0	+				+	C	
F	L.C.	133.8	+	+	+		+	C	Pl, S, Pa
F	L.C.	138.2	+				+		
F	L.C.	141.4					+	+	
F	L.C.	143.8	+		+			+	
F	L.C.	148.8	+				+	+	
F	L.C.	160.3	+				+		S
F	L.C.	162.3	+				+		Pl
F	L.C.	162.4	+					Fishbone	
F	L.C.	172.9	+					C	
F	L.C.	174.0	+				+	C	Pl, S
F	L.C.	190.4	+						
F	L.C.	203.3	+					P, C	P
F	S.	127.3	+				+	+	P, C
F	S.	210.8	+			+			Pl, Pa
F	S.	210.8	+					C	
M	L.C.	147.2	+				+	+	
M	L.C.	162.3	+				+		
M	L.C.	179.1	+				+		C
M	L.C.	200.6	+						
M	S.	164.4	+	+	+		+	+	P, C
M	S.	170.0	+		+		+		Pl
M	S.	195.0	+				+		

in France (Delmas et al., unpublished information). It may reflect a potential strong female bias of imported juveniles (the incubation at high temperature lead to rapid hatching, but produces females in this species with Temperature dependent Sex Determination, Godfrey et al., 2003). Moreover, adult females are generally larger and heavier than adult males (Dunham and Gibbons, 1990), leading potentially to more frequent releases in nature by owners. The absence of significant difference between size and weight of both sexes in this study could reflect the presence of younger females than males, but also the lack of power of the test (only 7 available males). The larger females possess oocytes in various developmental stages indicating than egg production could be possible around Paris. Until now, the most northern latitude where successful reproduction was demonstrated and published for this species is at Montélimard, South of France (44°N) (Cadi et al., 2004). In Paris region, fertilized eggs have been detected in soil, but no emergence of young has

ever been observed (M. Girondot et al., unpublished results).

We found a rather large spectrum of food item in stomachs, suggesting that slider turtle is an omnivorous species (table 1). This result confirms diet information on slider turtles in their natural habitat (Parmenter and Avery, 1990), as well as data collected for introduced slider turtles in Taiwan (Chen and Lue, 1998). In particular, feeding on insects could increase digestive efficiency of plants, as shown in a related species *Trachemys scripta scripta* (Bjornodal, 1991). Several particularities need to be discussed further.

We found fish remains in the stomachs of half of the turtles with food items. The particularity of these remains lies in the size of fish scales we found, some scales showing a diameter of up to 12 mm, indicating a 20 cm fish (Dr. J.-Y. Sire, pers. comm.). We think it is unlikely that a slider turtle is rapid enough to catch a 20 cm fish. It seems more plausible that large fishes were found dead and than slider turtle acts

as a necrophagous species, as other species of freshwater turtles do (Spencer et al., 1998).

We found a significantly negative effect of the turtle size on the presence of invertebrates in stomach. As growth is a permanent process in turtles (Dunham and Gibbons, 1990), this finding could be interpreted as a decrease of invertebrate type of food with age. These food items are probably mostly actively captured, contrary to fishes (see above). This result could thus be interpreted as a decrease of active hunting with age. The change with age toward a diet dominated by plants has already been observed for Sliders in their native habitat (Clark and Gibbons, 1969). Our results could be interpreted in the same way.

Four individuals have ingested terrestrial ants, and one stomach was full of them. Although terrestrial activity is known for this species (Bennett et al., 1970; Gibbons, 1970), only few reports are available for terrestrial foraging (Cagle, 1944; Chen and Lue, 1998). The terrestrial activity of slider turtles is a key component for the colonization of new habitat (Parker, 1990). The observation that 16% of the captured sliders show food items from terrestrial origin calls further studies to evaluate the terrestrial home range of this species in the context of invasion.

To prevent subsequent releases in the wild, feral slider turtles have been largely diabolized in 1990s in public communication in France. One of the strong invoked arguments was that this "carnivorous" species was highly detrimental for native ecosystems. However, these arguments were not founded on any convincing result but aimed to fair and make general public guilty. Although we do not argue that they never eat fishes or other vertebrates (such as adult frogs) in the top of natural food webs, our results show that slider turtles are omnivorous, and suggest that they eat what is available in the wild. In the general context of pet's releases by private owners, we think particularly important to base education arguments on scientifically valid results. Under these prerequisites, all

stakeholders will be able to act in the same direction, i.e. environmental education to preserve potential damages to biodiversity.

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