# Retrospective study on the casuistry of turtles (Reptilia: Testudines) in a veterinary center in Paraguay

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**Retrospective study on the casuistry of turtles (Reptilia: Testudines) in a veterinary center in Paraguay**

**Abstract**

Ten turtle species have been reported for Paraguay, and eight of them are in threatened categories. Wildlife commerce is strictly regulated, and according to the most recent data, there is no legal way of acquiring a turtle in the country. The objective of this study is to report the species of turtles that were assisted at the Wild and Exotic Animals Clinic of the Facultad de Ciencias Veterinarias, Universidad Nacional de Asunción, and the main clinical findings. Patient files from 2004 to 2023 were reviewed, and the following data were registered in a spreadsheet: file number and date, species, weight, sex, approximate age, origin, time with the person, feeding, diagnosis, and sub-classification. A total of 496 turtles were registered in individual patient files. Of these, 256 were *Chelonoidis chilensis*, 125 *C. carbonaria*, 4 unknown *Chelonoidis* spp., 8 *Acanthochelys macrocephala*, 1 *A. pallidipectoris*, 7 *Mesoclemmys vanderhaegei*, 6 *Phynops* spp. (3 *P. hilarii*, 2 *P. geoffroanus*, 1 unknown), 2 *Hydromedusa tectifera*, 14 *Kinosternon scorpioides*, and 12 unknown Pleurodira. Regarding casuistry, of the 256 *C. chilensi* brought to the practice, the main cause of consultation was trauma, representing 130 (50.78 %) of the registered files for the species. Regarding *C. carbonaria*, of the 125 cases, 26 were related to trauma, although routine control was the main cause of consultation. This constitutes the first report on turtle casuistry in Paraguay and may aid in identifying critical species to work with, while concluding that the main problem is still illegal traffic.

***Keywords***: Chelonia; *Ex-situ*; Husbandry; Testudines; Wildlife trafficking; Clinical records; Veterinary casuistry.

## Study contribution

There are ten turtle species in Paraguay, and we know most of these species are threatened. To start a conservation program for any of the species, basic information is needed on their distribution, natural habitat, feeding ecology, and main threats. Most of this information is missing in Paraguay, so this study aimed to gather casuistry data from a wildlife referral clinic to establish which species are most threatened by trafficking and have a starting point for determining which species need special attention. This study presents the first results on casuistry in Paraguay, and the results identify critical species to work on.

## Introduction

As to the latest information gathered, there are around 357 species of turtles (Order Testudines), and they are currently one of the most threatened groups worldwide, with around 51 to 56 % of species threatened, surpassed only by non-human primates.[1–3] In America, the main threat turtles face is habitat loss and degradation, followed by commercial capture for the international market.[4] Ten native turtle species have been reported in Paraguay: *Chelonoidis carbonaria*, *Chelonoidis chilensis*, *Kinosternon scorpioides*, *Acanthochelys macrocephala*, *Acanthochelys pallidipectoris*, *Mesoclemmys vanderhaegei*, *Phrynops geoffroanus*, *Phrynops hilarii*, *Phrynops williamsi* and *Hydromedusa tectifera*.[5]

Of these, three species are categorized as *Vulnerable*, four as *Endangered*, and one as *Critically Endangered*.[6] Threats identified in the country for freshwater turtles are mainly habitat loss and degradation, and for tortoises, mainly habitat loss and illegal pet

trade,[5–7] which has also been reported in Argentina and Brazil, where they comprise the most illegally traded reptiles.[8–13] The lack of quantitative information on trafficking and possession of the different species, and the lack of effective controls, make it difficult to obtain accurate information on the status of turtles in the country.

In Paraguay, since 1992, Law No. 96/92 “On Wildlife” has been in force. Article 4 declares the protection, management, and conservation of the country's wildlife to be of social interest and public utility, and mentions that all inhabitants must protect the country's wildlife. This same law, in its article 37, prohibits the hunting, transport, commercialization, export, import and re-export of all species of wild fauna that do not have the express authorization of the enforcement authority, which is the Ministry of the Environment; and regulates, in its article 50, the domestic possession of wild species.

There is, therefore, a legal framework that governs the protection, commercialization, and domestic possession of wild animals in Paraguay. However, more than 30 years after the enactment of the law, there is still no regulation for the domestic possession of wild species in the country. The aforementioned law prohibits the trade of wild animals in Paraguay that do not come from legally authorized breeders, and there is currently no legal way to obtain a wild animal for domestic possession in the country. In this sense, it can be considered that all chelonians brought to the Clinic are of illegal trade origin, beyond those brought as part of a confiscation, seizure, or rescue.

The objective of this study is to report the species of turtles that were assisted at the Wild and Exotic Animals Clinic (Consultorio de Animales Silvestres y Exóticos) of the Facultad de Ciencias Veterinarias, Universidad Nacional de Asunción, and the main clinical findings.

## Materials and methods

### *Ethical statement*

The present study was performed on already available data, and no private information was disclosed, so an Ethics Committee approval was not required. The Department of Wildlife and Natural Environment (Departamento de Recursos Faunísticos y Medio Natural), as well as the veterinarians involved, have all the required permits issued by the Ministry of Environment and Sustainable Development of Paraguay (Ministerio del Ambiente y Desarrollo Sostenible) for handling and storing data from wildlife.

### *Data*

All data analyzed was obtained from the best information from the clinical files stored in the Departamento de Recursos Faunísticos y Medio Natural, covering 2004 to 2023. All patient files are annual, and for most years, the Consultorio de Animales Silvestres y Exóticos was closed during January. For all the patient files, only the primary diagnosis was considered.

### *Data classification and analysis*

All the data was recorded in a spreadsheet, noting: date, file number, taxon, weight (if registered), sex (if registered), age (if registered), origin (if registered), time with current owner, feeding offered, diagnosis, and sub-classification (e.g., trauma caused by vehicle). Diagnosis was established from the information available and classified by affected organ or system in the following categories: routine control, dermatologic, digestive, unspecified (when a final diagnosis could not be reached), intoxication, management issue,

neoplasia, nutritional, ophthalmologic, reproductive, respiratory, trauma, or undisclosed (when left blank). Regarding the food offered, as the items varied greatly among individuals, diets were classified as “incomplete or inappropriate” or “appropriate”, according to the known feeding ecology of each species.

*Statistical analysis*

A chi-square test was performed to analyze whether the distribution of individuals among different diet groups (herbivores vs. carnivores) occurs randomly or if there are significant differences, and whether the causes of admission are evenly distributed among the individuals treated.

## Results

Between 2004 and 2023, 496 turtles were registered in the Consultorio de Animales Silvestres y Exóticos. **Table 1** presents the number of animals per taxon.

**Table 1**. Turtle taxons registered in individual patient files in the Consultorio de Animales Silvestres y Exóticos between 2004 and 2023

| **Taxon** | **Number of patients** |
|---|---|
| *Chelonoidis chilensis* | 256 |
| *Chelonoidis carbonaria* | 125 |
| *Chelonoidis* spp. | 4 |
| *Kinosternon scorpioides* | 14 |
| *Acanthochelys macrocephala* | 8 |
| *Acanthochelys pallidipectoris* | 1 |
| *Phrynops geoffroanus* | 2 |
| *Phrynops hilarii* | 3 |
| *Phrynops* spp. | 1 |
| *Hydromedusa tectifera* | 2 |
| *Mesoclemmys vanderhaegei* | 7 |
| Unidentified Pleurodira | 12 |
| *Trachemys scripta elegans* | 53 |
| *Trachemys dorbigni* | 7 |
| *Trachemys* spp. | 1 |
| Total | 496 |

The most frequent species was the Chaco tortoise (*Chelonoidis chilensis*), registered in 256 individual files. Of these, 70 were males, 109 females, and 77 did not register sex. Weight was recorded in 226 of the cases, and the mean weight registered for the species was 747.69 g. The main cause of consultation was trauma, representing 130 (50.78 %) of the registered files. Trauma was subdivided according to cause: 49 cases were vehicle-related, 44 cases were bite wounds, 5 cases burns, 2 gate-related, 2 lawnmower-related, 1 fall, and 27 unknown or undisclosed. Respiratory issues were reported in 20 animals (7.81 %), routine control was mentioned in 41 cases (16 %), and unspecific management issues were the cause of consultation in 39 cases (15.23 %). Seven files were incomplete or had undiagnosed cases (2.73 %). Vehicle-related trauma and bite wounds represent 19.14 % and 17.19 % of Chaco tortoise casuistry, respectively, being the main causes of consultation for the species in Paraguay.

Regarding the food offered to captive Chaco tortoises, feeding items varied greatly between individuals. 77.3 % (n = 198) of patient files reported incomplete or inappropriate diets, including only lettuce, only tomato, lettuce and tomato, only fruits, raw meat, commercial cat/dog food, cooked food, bread, or dairy products. 8.2 % (n = 21) of files reported appropriate diets, including varied greens, cactus, and assorted vegetables. 14.5 % (n = 37) of the files did not mention the animal's diet.

Following the Chaco tortoise, the second most common species was the red-footed tortoise (*Chelonoidis carbonarius*), registered in 125 files. Of these, 58 were male, 29 female, and 38 did not register sex. The main cause of consultation was routine control, representing 51 (40.8 %) of the registered files. Trauma was reported in 26 files (20.8 %), and trauma subcategorization reported 8 cases of bite wounds, 6 vehicle-related, 1 burn,

1 fall, and 10 unknown or undisclosed. Reproductive issues were also frequent, with 12 cases (9.6 %), of which 9 were phallus prolapse. Other causes for consultation included 9 digestive issues (7.2 %), 6 respiratory issues (4.8 %), 4 nutritional issues (e.g., pyramidism, metabolic bone disease), 3 dermatologic issues, 1 blepharitis, 1 ivermectin intoxication, 1 cutaneous sarcoma, 9 undiagnosed, and 2 incomplete files.

Although presentation in the Consultorio de Animales Silvestres y Exóticos was not homogeneous throughout the study years, both Chaco tortoise (*C. chilensis*) and red-footed tortoise (*C. carbonarius*) showed a consistent increase in number through time, with a marked impact from the COVID-19 pandemic (**Figure 1**).

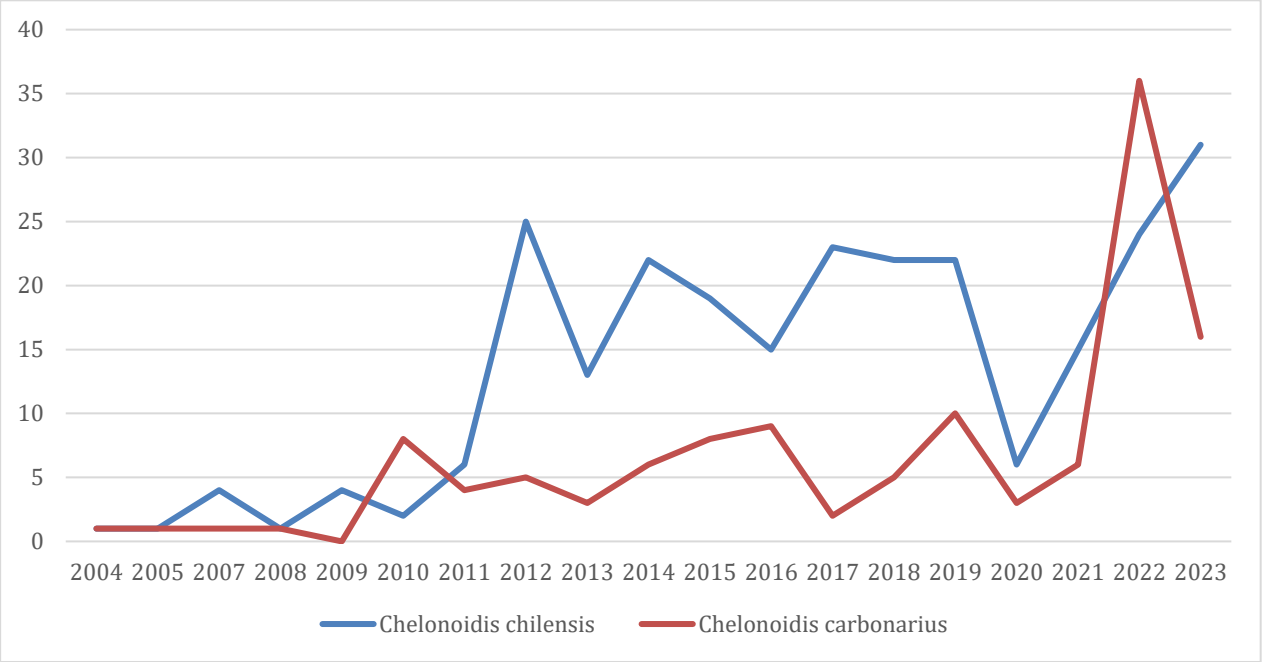


**Figure 1.** Chaco tortoise (*Chelonoidis chilensis*) and red-footed tortoise (*Chelonoidis carbonarius*) patients brought to the Consultorio de Animales Silvestres y Exóticos between the years 2004 and 2023.

Regarding native freshwater turtles, the results were grouped due to the low number of individuals per species. These included 14 scorpion mud turtles (*Kinosternon scorpioides*), 8 pantanal swamp turtles (*Acanthochelys macrocephala*), 1 Chaco side-necked turtle (*Acanthochelys pallidipectoris*), 2 Geoffroy's side-necked turtles (*Phrynops geoffroanus*), 3 Hilaire's side-necked turtle (*Phrynops hilarii*), 1 unidentified *Phrynops* sp., 2 South American snake-necked turtles (*Hydromedusa tectifera*), 7 Vanderhaege's toad-headed turtles (*Mesoclemmys vanderhaegei*), and 12 unidentified Pleurodira, totaling 50 individuals. Of the 50 individuals, 21 (42 %) were brought in for routine control, and 14 (28 %) were trauma cases: 7 due to dog bites, 3 vehicle-related, and 4 unspecified trauma. Eight cases (16 %) were related to unspecific management issues, 2 cases were recorded as nutritional problems (specifically metabolic bone disease), 1 case was filed as a respiratory problem, 1 as ophthalmologic, 1 as dermatitis, and 2 were undiagnosed or unresolved.

For scorpion mud turtles, 7 were males, 3 females, and 4 unregistered for sex. Weight was recorded for 13 individuals, with a mean of 443.69 g. Six files recorded the origin of the animal, none of which corresponded to the species' natural distribution range. Regarding Pantanal swamp turtles, 5 were males and 3 unregistered. The mean weight was 670.38 g. Origin was reported in 6 files: 4 from the Central Department (Departamento Central) (outside its natural range) and 2 from the Paraguayan Chaco (its natural distribution range). The single report of Chaco side-necked turtle corresponds to a juvenile male (380 g) found and illegally captured in Infante Rivarola, within the species' distribution range, with poor body condition. The data on *Phrynops* spp. were not analyzed

further due to the small number of individuals and variability in available data (e.g., weight, sex, origin).

For South American snake-necked turtles, one male and one female were registered, with a mean weight of 517.5 g; one originated from within the species' range, the other did not. Regarding Vanderhaege's toad-headed turtle, there was 1 male, 3 females, and 3 unregistered. Mean recorded weight was 1 081 g. Origin was recorded in 3 files and corresponded with the species' known range. As for food offered to freshwater turtles, 26 % (n = 13) of files did not mention diet. Fifty-eight percent (n = 29) reported incomplete or inappropriate diets, such as only tomato, lettuce, or raw meat. Sixteen percent (n = 8) reported appropriate diets, including varied animal organs or whole prey, commercial turtle food, and mixed vegetables and fruits.

Analysis of the chi-square test yielded a very low P-value, indicating statistically significant differences in the distribution of tortoises by dietary group. Herbivorous species were overrepresented, while carnivorous species were underrepresented, compared to what would be expected if all groups were equally represented. Regarding causes of admission, these were more frequent than would be expected by chance —especially trauma, which represented the majority. Of all cases of vehicle-related trauma, 86.5 % occurred between October and March, peaking in November and December. Dog-bite trauma was more evenly distributed throughout the year, though still 65 % occurred between October and March.

As for the origin of the animals, in 47.8 % of cases, data were unknown or undisclosed. When reported, origin information was often incomplete or unspecific (e.g., "gift", "found on the street"), with only 5.3 % of clinical files listing "Chaco." Specific cities

of origin were reported in 22.3 % of the cases, accounting for 24 different cities from various parts of the country. Notably, 5.5 % of clinical files cited an open market ("Mercado 4" in Asunción) as the source. Results referring to species belonging to the genus *Trachemys* will not be discussed further, as they are not considered native species.[5]

## Discussion

The results regarding the most frequent species match reports from Argentina, which mention Chaco tortoise as the most frequent reptile in a rescue center[14] and that all captive individuals come from illegal traffic,[15] and reports from Brazil that mention red-footed tortoise as the most trafficked reptile.[8, 9, 12, 16] Both species are classified as *Endangered* in Paraguay, according to the International Union for Conservation of Nature classification standards, and are also mentioned among the most trafficked species in Paraguay.[6, 7] Data obtained suggests that the origin of the animals is from internal trafficking, but this can only be sustained due to the lack of other information regarding national or regional traffic of turtles.

Although much research is still needed on the native species of Paraguay, the necessary data should be collected to assign research and conservation priorities, as has been done for Bolivian species.[17] The mean weight reported for Chaco tortoise, 747.69 g, doesn't match the average weight for the species, although most publications report on the southern population of the species[18–20] (former *C. donosobarrosi*) which is considerably larger than the northern population (former *C. pettersi*), for which there is not much data available, and to which the Paraguayan population appears to belong.[21] It has

to be taken into account that all patient files were annual, so patient duplicity is a possibility.

Causes of trauma can be diverse, and these can affect free-roaming as well as captive individuals. Generally, it can be defined as a physical injury caused by a violent force applied to the body.[22] The results regarding a high prevalence of trauma resemble various studies from different continents, where 62.5–86.7 % of reptiles were presented for trauma, with impact of motor vehicles and domestic animal attack being the most common subcategories.[23–28] Of all cases of vehicle-related and dog-bite trauma in the present study, 86.5 % and 65 %, respectively, occurred between October and March, the hottest months in Paraguay. This partially matches the study published by Beaudry et al.,[29] where they identify early summer as a period of elevated risk for road mortality. This, again, can be correlated with a peak in activity due to the reproductive season.[30] Although the cases of trauma represent mostly captive animals, the impact of roads on turtle populations has to be considered and studied in Paraguay.[31] We agree with Frye,[32] in that inadequate enclosure designs and husbandry issues can be associated with the majority of traumatic injuries, as these happened mostly inside the property where they were being kept.

Regarding prolapses, the results match those reported for turtles by Hedley and Eatwell,[33] having a low prevalence, and reporting mainly phallus prolapses. Other frequent reproductive issues in testudinids, particularly females, are preovulatory follicular stasis, oviductal prolapse, dystocia, ectopic eggs, and yolk celomitis.[34, 35] Digestive pathologies are usually a challenge since they appear with nonspecific clinical signs such as anorexia or altered fecal consistency, and diagnosis can be difficult as pathologies can

be caused by a wide range of agents. These agents are not necessarily infectious, and an over-interpretation of fecal microbiology and parasitology can occur, although several authors have already concluded that the presence of gastrointestinal parasites does not necessarily imply disease.[36–38]

Regarding respiratory issues, these usually don't show clinical signs until they are advanced, with most patients being lethargic. Radiography, cytology, and microbiology (from lavage) are usually very useful to guide the clinician, as causes for disease can range from obstruction to infectious (bacteria, fungi, virus, vermes), as well as not respiratory-related causes such as obesity, malnutrition, cardiomegaly and ascites.[39] Clinically relevant gastrointestinal and respiratory pathogens for turtles, such as *Cryptosporidium* spp., Herpesviruses, Adenovirus, and Ranavirus have not yet been reported in Paraguay. *Mycoplasma* spp. has been isolated from Chaco tortoise samples, but not related to clinical disease.[40]

With regard to the diet, the challenge of feeding captive turtles adds up to the fact that the diet and feeding ecology of most species are not completely understood. Many articles report on the diet of the mentioned species, but it has to be acknowledged that diet requirements for these animals can be complex and intimately related to their native habitat,[41–51] and this can be challenging for domestic owners, if they even attempt to reproduce a native diet. That being said, deficient or incomplete diets can have a lasting impact on the animals' health and can be directly involved in other pathologies.[52] For example, inappropriate or incomplete diets can lead to metabolic bone disease, which can weaken the bones in the long term, predisposing to fractures and significantly complicating the resolution of those cases.

Also, a chronically malnourished animal can suffer from kidney or liver disease, which in turn will also affect calcium and vitamin D3 metabolism, weakening the bones. Vitamin A deficiency has been associated with blepharitis, tympanic ear abscess, pneumonia and dystocia in freshwater turtles,[53] and inappropriate feeding and management can also predispose to different prolapses.[54]

Finally, it has to be highlighted that most of the patients belong to species that are out of range, if the Central Department of Paraguay is to be considered as the place where most of these individuals are being kept, as only Vanderhaege's toad-headed turtle is reported within range.[55] Extracting individuals from their natural habitat without precise data of their origin can bring other problems, if reintroduction is ever considered, as individuals of a species can be released outside of their original distribution range, leading to genetic pollution. This has been facilitated in recent years by non-conventional companion animal and food trade and increased human mobility, large-scale confiscations, and non-coordinated actions of turtle enthusiasts who release surplus or abandoned pet turtles, leading to endangered local turtle populations with genetically mismatched individuals.[2]

After more than 30 years since the enactment of Law 96/92, it is clear that the mere prohibition of wildlife trade does not work. To consider a reintroduction of individuals to the wild, the cause that brought them into captivity must be eliminated. Efforts must be focused on raising awareness among the population, avoiding the illegal purchase that finances continued extraction of individuals, and to enforce the law against offenders (whether sellers or buyers). The work of Amavet et al.[15] presents a protocol for the reintroduction of *Chelonoidis chilensis* to the wild, which could be applied to Paraguay.

## Conclusions

- Chaco tortoise (*Chelonoidis chilensis)* is the most frequent species brought to the Wild and Exotic Animal Clinic, followed by red-footed tortoise (*Chelonoidis carbonarius*), both probably being the most trafficked species in Paraguay.
- Trauma is the main cause of consultation in native turtles, representing 35.7 % of all patient files: 50.78 % in Chaco tortoise, 20.8 % in red-footed tortoise, and 28 % in freshwater species. Bite wounds were responsible for 15.52 % of turtle consultations, and 11.29 % were due to vehicle-related trauma.
- Incomplete patient files, undiagnosed patients, and unidentified species are topics to work on.
- This constitutes the first report on the casuistry of turtles in Paraguay, and may aid in identifying key species to work on, while concluding that the main problem is illegal traffic.

## Data availability

Data cannot be shared publicly because of private information regarding the address where each patient is kept. Data access can be requested from the authorities of the Facultad de Ciencias Veterinarias, Universidad Nacional de Asunción [veterin@vet.una.py].


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## Conflicts of interest

The authors have no conflict of interest to declare regarding this publication.

## Author contributions

Conceptualization: JR Vetter, SB Clay.

Data curation: JR Vetter, SB Clay.

Formal analysis: JR Vetter.

Investigation: JR Vetter.

Methodology: JR Vetter, SB Clay.

Validation: JR Vetter, SB Clay.

Writing-original draft: JR Vetter, SB Clay.

Writing-review and editing: JR Vetter, SB Clay.

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