



## Use of fauna in the traditional medicine of native Toba (qom) from the Argentine Gran Chaco region: an ethnozoological and conservationist approach

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### Abstract

The Gran Chaco region is an area of vast cultural and biological richness that is inhabited by different American indigenous hunter-gatherer groups and has a great number of threatened wildlife species. An ethnozoological investigation was carried out to study the medicinal uses of fauna by the Toba (qom) communities of Central Chaco in the surroundings of the Bermejito River. Qualitative, quantitative and participative methods were used alternately to document and characterize the knowledge, significance and role of animals from the Chaco forest within the Toba cultural and medical context. A total of 199 uses corresponding to 72 species belonging to 52 families were documented as part of the animal pharmacopoeia employed by the natives. Information obtained by open and semistructured interviews was used to develop an Index of Local Conservation Priorities (ILCP) that allowed ordering the species according to their Relative Importance, Ecological and Cultural Value, and Conservation Status. Our results showed that of the wide range of species used in Toba zootherapy, a substantial number of reptiles, mammals and birds are included in lists of threatened species for Argentina. The ethnozoological perspective of this study provides an integral view of social and ecological elements that are useful for the protection and/or sustainable management of native species on a regional scale.

**Keywords:** *Animal remedies – Ethnozoology - Tobas - Gran Chaco*

## Introduction

The planetarian biodiversity crisis had highlighted the valuable contribution that ethnobiological studies could make to conservation biology, thus generating support for conservation efforts (Alves 2012; Anderson et al. 2011). In particular over the last decades several studies have considered that the interdisciplinary perspective of ethnozoology is appropriate for determining ecological, sociocultural and human aspects related to animal conservation and management, since it provides a better comprehension about the roles played by animals in a specific cultural context, a crucial tool with potential application to solve problems of wildlife-human conflict (Alves and Rosa 2006, 2007a,b; Alves et al. 2008, 2010; Alves and Alves 2011; Alves 2012). Most of these studies involve regions with rich biodiversity, where indigenous groups and/or peasants make a conspicuous use of the fauna as sources of food, folk medicine, or other materials, or for symbolical aspects of their lives (Alves 2012; Arenas 2003; Arenas and Porini 2009; Bourdy et al. 2004; Monroy-Vilchis et al. 2008). The study of zotherapy is particularly revealing due to the number of species and applications involved, and it is characterized by a wide geographical distribution and a remote historical origin (Alves and Alves 2011; Costa-Neto 1999).

In Latin America, many cultures still resort to animal-derived remedies as part of their traditional medicine practices, most of them deeply rooted in a long-standing tradition of wild fauna use, including many endangered species, to treat all kinds of diseases. This is evidenced, for example, by the use of about 95 animal species in folk medicine in the state of Bahia (Costa-Neto 2011), 36 species in the semiarid region of Pernambuco (Alves et al. 2009) and 51 species in the Caatinga Biome in the state of Paraíba (Alves et al. 2011), in Brazil. In México the use of 18 species in Mapimi, Durango (Jacobo-Salcedo et al. 2010), 24 species in San Luis Potosí (Alonso-Castro et al. 2011), and 74 species in the state of Chiapas (Enriquez Vazquez et al. 2006) were also reported. Finally, and just to conclude the mention of some of Latin American mostly studied, 14 species for selling were documented in the Bolivian rain forest (Apaza et al. 2003) and more than 20 species used by the Izoceño-Gurani from the South East Bolivia (Bourdy et al. 2004). Reviews including wider geographical areas estimate the use of around 42 species of insects (Costa-Neto 2002) and 250 animals (Alves 2009) in the NE Brazil, as well as 354 animal species all over Brazil (Alves et al. 2013) and at least 584 animal species in the whole Latin America (Alves and Alves 2011). Despite this, those studies underline the need for further research into zotherapeutic practices in the latter region, particularly because medicinal use of fauna represents an additional pressure for many species since many are highly promising in the search for new natural products of pharmaceutical interest (Alves and Albuquerque 2012; Dossey 2010). In this sense, recent discussion regarding the relationship between traditional medicine and biodiversity in Latin America has evidenced an increasing use, commercialization and unsustainable exploitation of animals due to new demands for natural medicine, rising the pressure on wild species, especially those endangered (Alves et al. 2007, 2008, 2009, 2011; Alves and Alves 2011).

In contrast with the broad range of studies on traditional medicinal animals in Brazil, other countries from South America such as Argentina, sharing Gran Chaco region with Brazil, have not published visible articles of medical ethnozoology. The Gran Chaco region, the second largest natural biome in South America, is an area of

great cultural and biological richness and home of several American indigenous hunter-gatherer groups who also practice incipient farming. There are currently seventeen different ethnic groups belonging to six linguistic families (Zamuco, Mataco-Mataguayo, Guaycurú, Tupí-Guaraní, Maskoy and Arawak), involving a total of 200,000 individuals (CENSO 1981; Arenas 1997). Associated with a highly diverse environmental context, Chaco people are renowned for their knowledge of nature; no aspect of their lives, from material aspects to their world view, is unconnected to living beings. Special attention has been given to the relation that different ethnic groups of Chaco have with plants, providing an important scientific contribution to ethnobotany (Arenas 1997). However, studies regarding ethnozoology and the role and significance of animals for the ethnic groups of this region are scarce. Some of the studies we can mention describe animal gathering (Vuoto 1999), food ethnography (Arenas 2003), medicinal and magical uses (Arenas 1987; Arenas and Braunstein 1981; Bourdy et al. 2004), vernacular zoological nomenclature (Martínez Crovetto 1995), and the linguistic dimension of the latter (Cúneo 2009; Cúneo and Porta 2009). Some brief critical reviews by the indigenous communities themselves can also be suggested, such as those written by the Toba Zacarías (1993), or intercultural studies like those of Medrano et al. (2011). Although not from an ethnozoological viewpoint, Altrichter's research (2006) focuses on a sustainable use of fauna, highlighting the dietary and economical importance some vertebrate species have for the mestizo populations of the semiarid Argentine Chaco.

As Arenas (2000, 2009) points out in his reviews on the vernacular medicine of the Gran Chaco ethnic groups, the specific ethnomedical studies of the regional fauna awoke the interest of different researchers. More specifically, an extensive list of animal remedies was documented for the Pilagá ethnic group, which belongs to the Guaycurú linguistic filiation (which also includes the Tobas), in an area close to our research site (Filipov 1997). Other references for members of the same linguistic family provide a detailed description of the medicinal applications of birds in a vast ethnoornithological study carried out by Arenas and Porini (2009) on the Tobas of Western Formosa. There are also studies of other Toba groups, such as the Tackshek Tobas from east Formosa, showing the role and significance of animals in their religion and view of the world (Terán 1994, 1998a,b, 2000; Terán 2006; Wilbert and Simoneau 1982; Ruiz Moras 2001). These studies also describe the myths, stories and spiritual representations of the animals and their connection with shamanism, aspects that are closely related to their traditional medicine.

Regarding the Toba (qom) communities of Central Chaco, information available is fragmented and restricted to the medicinal application of some animal species for maternal-infant health (Martínez 2007; Hecht et al. 2008), parasitic diseases and skin affections (Martínez and Barboza 2010), and odontostomatology (Martínez 2010a), as well as details associating animals with food and/or religious-medical taboos (Martínez 2010b).

Although the use of animals for medicinal purposes is becoming less frequent among the Chaco ethnic groups, many applications require exploitative activities, either gathering, hunting and/or fishing the specimens, the impact of which still remains to be determined. In this sense, the Gran Chaco area is a particularly relevant area due to the number of threatened species it has, as it is under constant pressure by environmental problems such as deforestation (associated to habitat fragmentation), advancing agricultural and farming frontiers, subsistence, commercial and sport hunting and/or fishing, wildlife trade, and others (Altrichter 2006; Bucher and Huszar 1999; Chebez 2008a,b,c, 2009; Karlin et al. 1994; Zak et al. 2004).

The aim of this study is to determine the animal species that are relevant for a community of Central Chaco Tobas (qom), from an ethnozoological approach, studying specific medicinal uses in order to develop future priorities and strategies of regional conservation. Specific objectives have been designed to:

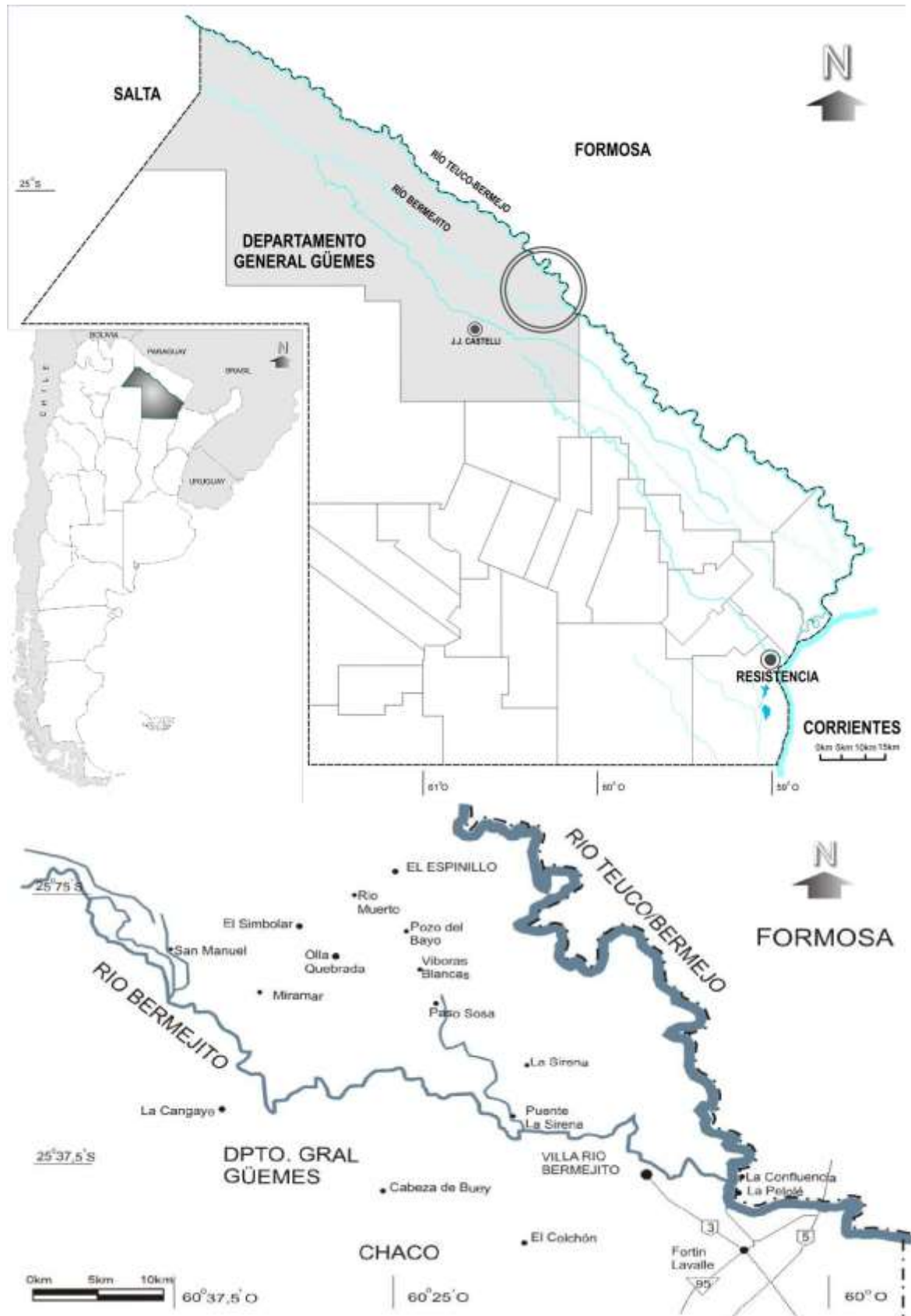
- a) qualitatively document and determine the knowledge, significance and use of invertebrates and vertebrates from the Chaco forest within a Toba (qom) cultural and medical context;
- b) quantitatively characterize the medicinal animal species used, taking into account the number, type, frequency, consensus and importance given to them by the community;
- c) identify medically relevant species and determine local conservation priorities according to the relevance and type of medicinal use given to the species, also considering other non-medicinal applications described in other studies.

## **Material and Methods**

### *Study area*

The study area is part of the Gran Chaco region, a vast sedimentary plain of 1,000,000 km<sup>2</sup> that extends north and south of the Tropic of Capricorn and includes the areas of Northern Argentina, Western Paraguay, Southeast Bolivia and part of Southeast Brazil. Involving ten provinces, 58% of the American Chaco belongs to Argentina and constitutes the vastest forest area in the world as well as one of the most endangered ecoregions of the planet (Karlin et al. 1994; Red Agroforestral Chaco 1999; Zak et al. 2004). Characterized by a great diversity of environments and species, the Chaco is not a homogenous region, varying significantly according to the amount and distribution of rainfall that decreases from East to West. Two macrounits are defined in relation to this gradient: the Humid or Oriental Chaco and the Dry or Occidental Chaco (Adámoli et al. 1990).

This area is located in the province of Chaco (Northeast Argentina) in the surroundings of the Bermejito River, the ancient river bed of the Río Bermejo (Figure 1).



**Figure 1.** Study area comprising the centre Province of Chaco, in Northeast of Argentina.

According to its phytogeographical features, corresponds to the Neotropical region of the Chaco Domain, Chaco Province, with species belonging to the Central Chaco forests, following Prado (1993), or to the transition between the Oriental or Humid Chaco and the Occidental or Dry Chaco or Semiarid Chaco, following Cabrera (1994). This is characterized by a subtropical continental climate, with a rainfall of 800-900 mm/year, an average temperature of 29°C in summer and a marked dry season in winter with an average temperature of 17°C. The landscape is defined by marked fluvial modeling (Morello and Adámoli 1974) and the vegetation consists of a xerophytic deciduous forest together with savannas, halophytic steppes, cardonales, grasslands and shrublands. Due to the presence of continuous forest blocks in a good conservation state, a great diversity of habitats and the presence of emblematic and/or threatened species, conservation organizations have declared this region (the fluvial valley of the Bermejo and the area of the Impenetrable) as a priority area for its vast biodiversity (Asta 2006).

The Chaco wildlife is not only rich in biodiversity but also in species; it plays a highly relevant ecological role in the local environment. It is also an invaluable economical resource for the subsistence of local communities providing meat, skins, feathers, hides and other supplies (Karlin et al. 1994). From a zoographic perspective, and according to Ringuélet (1970), the study area belongs to the Neotropical Region-Guayanobrasilean Subregion, within the Subtropical district-Chaco subdistrict. It is estimated to have more than 600 vertebrate species, including over 400 species of birds, almost a hundred reptiles and a slightly lower number of mammals, amphibians and fish. Bucher (1980), Karlin et al. (1994) and Arenas (2003), each presented a detailed list of species abundant/largely found in Chaco ecosystems, focusing on ecological aspects, economically and commercially productive exploitation, food resources and ethnobiological importance.

The diversity of mammals in Chaco is not very abundant and is currently decreasing; it is easy to identify species adapted to the diversity of landscapes and environments. Edentates are especially relevant as a source of food and medicine for the natives, and include the anteater (*Myrmecophaga trydactyla*) as well as armadillos such as the "tatú carreta" (*Priodontes giganteus*), the "mulita" (*Dasypus* spp.), the three-banded armadillo locally known as "mataco or quirquincho bola" (*Tolypeutes mataco*), and the "peludo" (*Euphractus* spp.). Animal food resources in the wetlands are also highly significant not only for the great number of bird species but also for the presence of mammals that, for different reasons, are fundamental to the subsistence of local communities, providing food, hides and medicine, such as the capybara or "carpincho" (*Hydrochaeris hydrochaeris*) and the river rat or "nutria" (*Myocastor coypus*).

The bird wildlife is particularly rich in this region with so many different environments, and includes a long list of species especially aquatic. In the savannas and grasslands we find, among others, small partridges (*Nothura maculosa*), tinamous (*Rhynchotus rufescens*, *Eudromia formosa*) inambues (*Crypturellus* sp.) and rheas (*Rhea americana*). There are also species of the Falconidae family and other raptors like the black vulture (*Coragyps atratus*) and species of Caprimulgidae and Strigidae.

The most popular reptiles of Chaco are the tegu, "iguana" or "lagarto overo" (*Tupinambis* spp.) and the broad-nosed caiman or "yacaré ñato" (*Caiman latirostris chacoensis*), this last being a highly threatened species living in small lakes and watercourses. There are also non-poisonous snakes like the Argentine boa constrictor or "lampalagua" (*Boa constrictor occidentalis*) and poisonous snakes like

large and small “yararas” (*Bothrops alternatus* and *B. neuwiedii*) and “coral” snakes (*Micrurus frontalis*).

The region also provides many amphibian habitats, large lakes, open grasslands prone to floods, patches of palm forests, riverside jungles and bushy low montes. The most common fish found in reservoirs and rivers are “sabalo” (*Prochilodus platensis*), “dorado” (*Salminus maxillosus*), “palometas” (*Serrasalmus* sp.), catfish or “bagres” (*Pimelodus*) and rays (*Potamotrygon* spp.).

The invertebrate fauna remains fairly unknown (Bucher 1980; Arenas 2003). The most relevant species from an ethnobiological point of view are mollusks found in wetlands (*Pomacea canaliculata*, *Anodontites trapesialis*, and others). Leaf-cutter ants of the *Atta* and *Acromyrmex* genera are also important herbivores of the Chaco ecology. In addition, termites are common in forests and a diversity of bees and wasps provides honey and other subproducts for local inhabitants.

### *The Tobas (qom) from Central Chaco (Argentina)*

The Tobas, also known as qom or qoml'ek, are an indigenous group belonging to the Guaycurú linguistic family that includes a population of allied bands with about 80.000 members. Their current habitat is mostly confined to the area of Central and Southern Chaco (in the provinces of Chaco and Formosa, Argentina), as well as other urban sites in the provinces of Santa Fe and Buenos Aires, and a small nucleus in the Northern Chaco area in Paraguay (ENDEPA 1986; Censabella 2000). As other typical Chaco ethnic groups, they were historically divided into bands of large blood-related families, which in general were hunter-gatherers (Braunstein 1983; Miller 1979). Today, this tradition has gradually evolved into a more sedentary lifestyle occupying territories. Most Tobas in this region develop some form of family subsistence economy in which products from the forest have an important role. From an economical point of view, the Tobas subsist on a combination of hunting, fishing and gathering, together with an incipient agriculture, management of goat herds, apiculture and paid handwork for cotton harvesting, selling forest resources, participation in non-governmental organizations, and aid from government help plans (Martínez 2008).

The local health system is characterized by a multiple sanitary context that includes shamanism (carried out by specialists known as pioxonac), domestic or homemade medicines and the official medicine (biomedicine) provided in health care centers run by doctors and Toba sanitary agents. Despite this pluralism, traditional Toba medicine is still not incorporated to the official medicine even though the use of natural remedies and shamanic cures are one of the main therapeutic options to which local inhabitants appeal (Martínez 2007, 2011).

### *Field work and data collection*

During the 2004-2009 period, six ethnobiological field assays were carried out. This implied staying for more than 100 days at different Toba settlements located in the surroundings of the Bermejito River, in the Río Bermejito district (Department of General Güemes, province of Chaco). Most interviews were carried out at the community of El Colchón although additional information was obtained from other sites. Before being interviewed, community members were briefed on the research project and its academic objectives. Conversations with specialists and inhabitants were based on a common objective: to improve conservation goals, increase

knowledge regarding natural remedies and develop educational materials of local interest, as suggested in the guidelines of the International Society of Ethnobiology Code of Ethics (2008).

Qualitative, quantitative and participative methods were used alternatively in different recurring instances throughout the investigation, trying to improve each new instance with previous results and following the basic scheme of an ethnobiological study: field work and laboratory work. We consider it important to highlight the epistemological difference between the cognitive systems of the human study group and that of the observer, known as the “emic” and “etic” accounts respectively, to adequately translate the local categories into occidental terms (Anderson et al. 2011; Martin 2000).

A total of 60 informers including specialists (shamans, midwives and elderly people) and community members (youngsters and adults of both sexes) were subjected to a previously designed semi-structured thematic questionnaire; open, extensive and recurring interviews were also conducted. The same were designed based on Arenas (1995) regarding topics on vernacular medicine. This information was complemented with data obtained by participative observations and in participative workshops involving members of the community.

The invertebrate zoological material was identified by specialists and is part of the author's personal collection (Museo de Antropología). Vertebrates were identified with the aid of local qualified informers using photographs and images in field guides as visual stimulus. In addition, data reported by colleagues on fieldwork with Toba communities, who systematized nomenclature of fish, birds and mammals on the basis of observations and collaborative sessions between researchers and natives (sharing hunting and fishing activities and visiting local zoos, aquariums, recordings of bird songs, among others), were considered (Cúneo 2009; Cúneo and Porta 2009; Medrano et al. 2011). This allowed us having a Toba (qom) zoonimia appropriate that was used as a reference to establish correspondence between one or more ethnospecies (on the basis of their vernacular name) and their taxonomic species. Likewise, this material was corroborated via specific ethnobiological references for the Gran Chaco region, all based on thoroughly documented information (Martínez Crovetto 1995; Arenas 2003; Arenas and Porini 2009).

### *Data analysis*

To fulfill each of the specific objectives of the study, the ethnozoologic information was analyzed considering the following methodological techniques:

- Qualitative methods: the results of open extensive interviews and participative observation data were studied to interpret and identify the role of animal pharmacopoeia in Toba ethnomedicine, trying to respect and describe the local representations, significances and viewpoints (Valles 2000), particularly regarding issues related to the native cosmology.
- Quantitative methods: Quantitative assessments were based on the number of uses reported for each species (categorized according to the frequency of mention) and the proportion they represented in the total number of reports. The data was then systematized in an Excel (Office 2000) database and a quantitative analysis was carried out using the Dynamic Tables function.



Additionally, an index catalogue was comprised including qualitative and quantitative information regarding the species and medicinal uses, and indicating the degree of consensus between the informers. The information was categorized according to the following aspects:

a) Level of taxonomic categories: we systematically analyzed the animal species involved with descriptive statistics. The number of species and documented uses were used as the basic unit of analysis.

b) Ethnopharmacological uses: we considered the number of use reports for each species and the consensus between informers regarding each specific use (Benz et al. 1994). We then determined the following indexes:

- Informant Consensus Factor (FIC): a measure of consensus between informers for each health area. This index determined whether the studied human group has specific criteria for choosing the species used. Thus, the FIC (Heinrich et al. 1998; Schlage et al. 2000) was calculated as:

$$FIC = \frac{nur - nt}{nur - 1}$$

where

nur = number of use-reports in each category;

nt = number of species used;

FIC ranges from 0 to 1. A high value (close to 1) indicates high consensus, whereby relatively few species are used by many people; a low value indicates that the informants disagree on the taxa used for treating a particular illness.

- Percentage of Uses Reported (% Ur): the ratio between the number of medicinal use reports for each species and the total number of medicinal reports.

- Relative Importance of Species (RI): it values the medicinal species according to the number of pharmacological properties (NP) attributed to the taxon (eg. analgesic, diuretic) and the number of body systems (BS) to which it is applied (eg. urology, gastroenterology), as proposed by Bennet and Prance (2000):

$$RI = ((Rel\ NP + Rel\ BS) \% 2) \times 100$$

where:

Rel NP: relative number of pharmacological properties attributed to a species (normalized to a maximum value of 1);

Rel BS: relative number of body systems or health areas treated with a determined species (normalized to a maximum value of 1).

c) Identification of relevant medicinal species and local conservation priorities. In addition to the value of RI, the following secondary sources of complementary information were also considered to assess the impact of extraction on species used for medicinal purposes compared to other applications, taking into account the local ecological characteristics.

• Ecological and cultural value of species (ECV): use as a food source (how it is obtained, hunting, fishing and/or gathering method); other uses in the different Toba

communities of the Gran Chaco that evidence some sort of sociocultural value for the species such as magical or religious uses, predictive uses, proximity or relation to shamanism, uses as a cultural material, and other uses described by Vuoto (1999), Martínez Crovetto (1995), Arenas (2003), Arenas and Porini (2009); presence and/or absence in relevant mythical stories of the Toba cosmology (Wilbert and Simoneau 1982; Terán 1994); ecological information such as taxonomic uniqueness or key ecological role of the species.

- Species Conservation Status (CS): based on references and databases for Argentina, we assigned a value to each species considering the reports of Chebez (2008a,b,c, 2009) and the Database of the Sistema de Información de Biodiversidad (Biodiversity Information System) of the Administration of National Parks (<http://www.sib.gov.ar>), which includes information from the Argentine Society of Mammal Studies (SAREM), the Argentine Herpetological Association (AHA) and comprehensive local bibliography. In the absence of local information, the conservation status follows the IUCN categories proposed in the Red List of Threatened Species (IUCN 2011: <http://www.iucnredlist.org>), and information on international trade regulation extracted from the Convention on International Trade in Endangered Species, (CITES 2011: <http://www.cites.org/eng/resources/species.html>). When there were differences in criteria regarding the category assigned by different sources, we chose the one with the highest level of protection.

Based on algorithms similar to those used in other reports regarding conservation priorities for medicinal plants (Dhar et al. 2000; Martínez et al. 2006), we determined an Index of Local Conservation Priorities (ILCP) according to the following formula:

$$ILCP = (Cat RI * Cat ECV * Cat CS) * 100 / \sum (Cat RI * Cat ECV * Cat CS)$$

This index combines the numerical values of each of the three categories, RI, ECV and CS, assigned with a value of 1 to 5 according to the indicators and/or criteria shown in Table 1, based on the aforementioned information. This index provides a numerical value that allows arranging species comparatively according to the local conservation priorities.

**Table 1.** Indicators and criteria for assigning numerical values to the categories RI, ECV and CS. (NS: National Status; IS: International Status)

Value assigned	Categories of Medicinal Relative Importance (RI) (S.D.= Standard deviation)	Categories of Ecological and Cultural Value (ECV)	Categories of Conservation Status (CS)
5	> Mean RI + 3 S.D.	<ul style="list-style-type: none"> <li>- Key ecological role and taxonomic singularity</li> <li>- Hunting, fishing and indiscriminate and illegal collection for various purposes; marketing and traffic in the present or in the past</li> <li>- Sociocultural and / or mythical-religious valorization of the specie</li> </ul>	NS: Endangered IS (UICN): CR (Critically Endangered) / EN (Endangered) Cites I
4	< Mean RI + 3 S.D. > Mean RI + 2 S.D.	<ul style="list-style-type: none"> <li>- Hunting, fishing and frequent collection for various purposes, not marketable</li> <li>- Sociocultural and / or mythical-religious valorization of the specie</li> </ul>	NS: Threatened IS (UICN): V (Vulnerable) Cites II
3	< Mean RI + 2 S.D. > Mean RI + 1 S.D.	<ul style="list-style-type: none"> <li>- Hunting, fishing and occasional collection for various purposes, not marketable</li> <li>- Sociocultural and / or mythical-religious valorization of the specie</li> </ul>	NS: Vulnerable IS (UICN): NT (Near Threatened) Cites III
2	< Mean RI + 1 S.D. > Mean RI	<ul style="list-style-type: none"> <li>- Hunting, fishing and inconspicuous or infrequent collection for various purposes, not marketable</li> <li>- With or without Sociocultural and / or mythical-religious valorization of the specie</li> </ul>	NS: Not threatened, Minor risk, IS (UICN): LC (Least Concern)
1	< Mean RI	<ul style="list-style-type: none"> <li>- Absence or insignificant hunting, fishing or collecting, or non-extractive uses (symbolic)</li> <li>- Without sociocultural and / or mythical-religious valorization of the specie</li> </ul>	NS: Indeterminate Deficient data or without information Widespread species Introduced species

## Results and Discussion

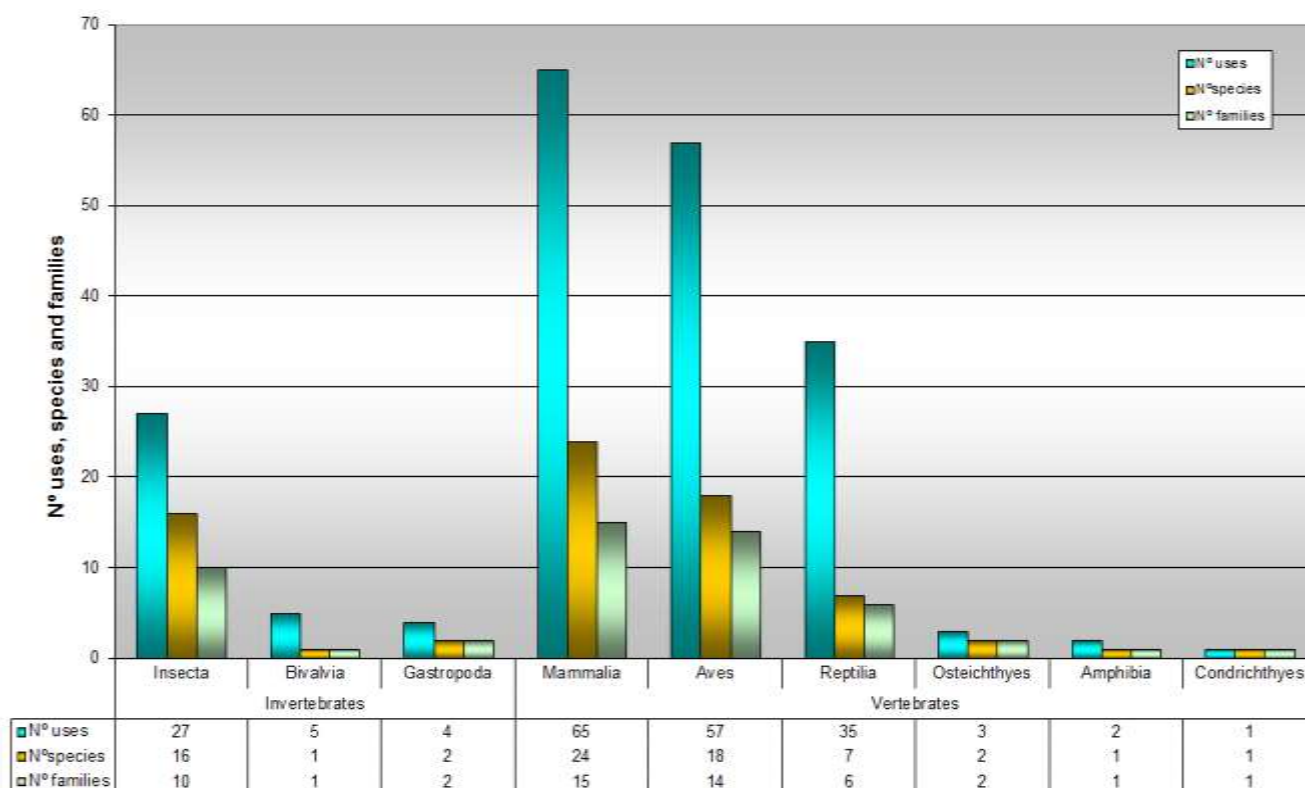
### *General characterization of the animal pharmacopoeia*

As reported by 60 informants, a total of 199 uses corresponding to 72 species from 52 families were documented as part of the animal pharmacopoeia used in the Toba (qom) traditional medicine of Central Chaco. Table 2 describes the species, applications, and quotation frequency. As can be seen, over 80% of animal species allows for 2 or 3 different medicinal uses; only 10% reaches six validated uses. On average were cited 4.74 animals per person. In addition, and considering the total amount of reports of medicinal use (n=942), a high rate of medicinal uses

documented spontaneously (in 65% of the species) are reports from up to 10 informants. This would reveal that a major part of medicinal knowledge is carried by a relatively low amount of people, which would indicate it is a specialized knowledge shared among or passed on to the various Toba households, but not with the entire ethnic group under study.

Most of the local taxa is composed of native species (87%, 62 spp.), except for introduced domestic species (*Equus* spp., *Ovis aries*, *Capra hircus*, *Sus scrofa*) and the introduced bee (*Apis mellifera*) that only make up for 13% of the total number of species used.

The analysis of species composition (Figure 2) shows that vertebrates are more relevant than invertebrates. The former includes a relevant number of Mammals, Birds and Reptiles, while the latter shows a clear predominance of Insects. Likewise, Table 3 shows a greater number of medicinal uses for vertebrates with a number of uses/number of species ratio of 3.08 compared to 1.89 for invertebrates. The same table shows high values of the number of uses/number of species ratio for Classes like Bivalves and Reptiles, which is explained by their low number of species and medicinal families and wide range of uses as in the case of *Anodontites trapesialis* and *Tupinambis meriana*, belonging to each Classes respectively. If we compared these groups with the largest number of medicinal species in the region studied, in view of those reported by Alves and Alves (2011) for Latin America, we note that 9 out of the 13 taxonomic categories mentioned are represented in Toba zootherapy; these also follow almost the same order regarding number of medicinal species (mammals followed by birds, reptiles and insects), except fish, lower in number for being from a predominantly hinterland group.



**Figure 2.** Number of uses, species and families by taxonomic category (Class and Group).

**Table 2.** Animal remedies used in the traditional medicine of the Toba (qom) community from Central Chaco (Argentina) (Origin; N: Native; I: Introduced; Quotation frequency: \* < 5 % of the informants; \*\* 5-10 % of the informants; \*\*\* 10 - 15 % of the informants, \*\*\*\* 15 -25 % of the informants, \*\*\*\*\* 25-35% , \*\*\*\*\*>35% of the informants)

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
<b>PHYLUM ARTHROPODA</b>						
<b>INSECTA</b>						
Apidae	<i>Apis mellifera</i> L.	tesaxalta, te'esaq (abeja, extranjera)	I	Honey / Food intake	Cough (expectorant): A spoon of honey, oil and lemon is prepared and eaten warm	**
					Sore throat (Antibiotic, oropharyngeal antiseptic)	***
					Fluctuations in blood pressure	*
	<i>Scaptotrigona</i> sp.	rapic, dapic (peluquera, yana)	N	Larvae/food intake	Loss of appetite, anorexia, (tonic)	**
				"Hámago" dissolved in water / Food intake	Constipation. 'Hámago' or yellow pollen of the inner of a trunk is extracted and dissolved in water, as a juice which is drunk as a laxative	*****
	Cfr. <i>Plebeia</i> spp.	piroxonac (mestizo)	N	Honey / Eye drops and bath	Eye conditions (Anti-ophthalmic)	**
	<i>Trigona</i> sp.	coilala (rubiecita)	N	"Hámago" dissolved in water / Food intake	Constipation	**
				Hypertension	**	
				Honey / Food intake	Sore throat (Antibiotic, oropharyngeal antiseptic)	**
				Honey / Eye drops and bath	Eye conditions (Anti-ophthalmic)	**
Cicadidae	Indet.	nviño' (chicharra)	N	Cuticle / Infusion or decoction in water / Beverage	Anuria: Infusion is prepared with the "pelecho" of the ratchet (nviño 'lvi'), since this insect has water every day. Also rub the bladder region of the child to urinate.	**
				Nest/ Topical	Land of the nest is used to cicatrize the navel of the newborn	**
				Animal / Symbolic action	Its abdomen is used to rub the groin and bladder, along with ash to treat bedwetting and to develop sphincter control, as it	**

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
					is considered that the excretas of this ant are never seen.	
				Animal/ Infusion or decoction/ Beverage	Drink a decoction of three ants in a kettle as a diuretic	*
Grillotalpidae	<i>Scapteriscus borelli</i> Giglio Tos	millic (grillo)	N	Animal/ Roast/ Food intake	Acquisition of speech: a child who speaks little or is stutterer is cured by feeding a roasted cricket	*****
Gryllidae	<i>Gryllus argentinus</i> Saussure	millic (grillo)	N	Animal/ Roast/ Food intake	Acquisition of speech: see recipe in S. Borelli. It is used after weaning to prevent breast bites. Drawbacks: child can bite its peers or speak a lot when he must shut up.	*****
Mantidae	<i>Coptoteryx argentina</i> Giglio-Tos, <i>Stagmatoptera hyaloptera</i> Perty	quedenaxai'chi (mamboretá)	N	Ootheca/ Body gadget	Tooth decay and toothache: hang the ootheca with eggs from a thread to relieve pain, as this insect is considered to eat the "worms" that cause toothache	*
Psychidae	<i>Oiketicus kirbyi</i> Lands Guilding	cotaxat (bicho canasta)	N	Cocoon/ Body gadget	It is used as a pendant shaped body medal or ring.	*
				Coccon/ Incineration / Topical	Ashes are applied in mouth sores and fires	*
Termitidae	<i>Nasutitermes</i> sp.	chep pilaxai (termitero)	N	Nest/ Macerated in water /washings	Musculoskeletal disorders: it is especially indicated for people with disabilities; once the bath finishes, the liquid should be discarded in west direction, thus shedding the evil	*
				Nest/ Infusion or decoction/ Beverage	Against cough	**
					Against wheezing and asthma	****
					Boil pieces of the nest and drink hot alone, or with honey and sugar. Nests that grow in 'mistoles', 'algarrobos' and 'quebrachos' are preferred. It is especially indicated for smoker's cough.	
Vespidae	<i>Polistes</i> spp.* ( <i>Polistes</i> cfr. <i>canadensis</i> and other spp.)	uotel (carán negro, carán colorado)	N	Honeycomb/ Incineration / Topical	Ashes are applied in mouth sores and fires	****
Not determined (Orden Lepidoptera)	Not determined: chrysalis state	cochel (gusano)		Cocoon/ Incineration/ Topical	Apply the ashes on the opened head of children affected by "evil-eye"	*
				Cocoon/Incineration/ Symbolic action	Tooth decay and toothache	*
<b>PHYLUM MOLLUSCA</b>						
<b>BIVALVIA</b>						
Unionidae	<i>Anodontites trapesia</i> Lam.	Coneq (concha del	N	Shell /Incineration (ash)/ External use. (topical)	Wounds and injuries	*

CLASS Family	Species	Local name ('Criollos' name) (agua)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
					Burns	*
					Bites. It is especially indicated for bites of the fish line ( <i>Potamotrygon</i> sp.)	**
					Newborn care and treatment. Ashes are used to cicatrize the navel of the newborn	****
					Ashes are applied locally to heal and relieve discomfort in the child's mouth during breast-feeding. They are also used to treat mouth sores and fires.	*****
<b>GASTROPODA</b>						
Ampullariidae	<i>Pomacea canaliculata</i> Lam.	Sapo lco'oue' (Huevo de "sapo")		Eggs / topical use	Burns	*
				Eggs /friction and massages	"Laiel" or kickstand "pata de cabra"	*
				Eggs / topical use	Mouth sores and fires	***
	<i>Strophocheilus oblongus</i> Müller	nashiyo (caracol)	N	Shell / Symbolic action	Acquisition of speech: used as a glass to drink water. More details in Martínez (2007) and Hecht et al. (2008)	*****
<b>PHYLUM CHORDATA</b>						
<b>CONDRICTHYES</b>						
Dasyatidae	<i>Potamotrygon</i> sp.	lacataic (raya)	N	Venomous stings/ Incision	Toothache and tooth decay The plectrum from the stingray tail is used to pierce the aching teeth and eliminate pain.	*
<b>OSTEICTHYES</b>						
Curimatidae	<i>Prochilodus platensis</i> Valenciennes	nñaq	N	Fat/Unprepared/External use. Fat from abdomen is preferred, especially in cases of scratches and claws	Wounds and injuries	**
				Meat/ Roasted / Food intake	Fatigue and weakness (tonic)	*

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
Serrasalmidae	<i>Serrasalmus</i> sp.	cote (palometa)	N	Teeth as a hand tool	Newborn care and treatment: sharp teeth are used to cut the umbilical cord of the newborn	**
<b>AMPHIBIA</b>						
Bufo	<i>Rhinella</i> spp. ( <i>R. arenarum</i> )	qoloxoloxo (sapo)	N	Frictions and massages. It is believed that the toad is the "owner of npoxolaxa" (itching), so the animal is rubbed on the skin to relieve discomfort. It must also be expressly request the animal to carries the disease	Itching, irritation, rash	***
				Tie a live toad in the bite until it dies in a way that allows the doctor to arrive on time	Snake bites	***
<b>REPTILIA</b>						
Alligatoridae	<i>Caiman latirostris chacoensis</i> Daudin	da'ail'oc (yacaré)	N	Fat/Unprepared/ friction and massages	Muscle pain (anti-inflammatory)	*
					As a cicatrizant for fish "palometa" bites ( <i>Serrasalmus</i> sp.)	*
					Flu (Preventive): rub on the child's arms and body	****
				Teeth/ Symbolic action	Flu / (Preventive): a necklace of alligator teeth is used to protect and strengthen the child	**
					Protection of the teeth (prevention): chew an alligator tooth to develop healthy and strong teeth	**
				Meat and fat /Unprepared / Food intake	Flu (Preventive): the meat and fat of the alligator are considered very healthy, strengthening and protecting the child	***



CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
Boidae	<i>Boa constrictor occidentalis</i> Phil.	mmi'ic, naxaraxanaaq late'e (ampalagua, lampalagua)	N	Fat/ Unprepared / Friction and massages	Eruptive diseases (chickenpox, measles, others).	*
					Earache	*
					Boils and abscesses (Maturative)	*
					Joint conditions (anti-arthritis and anti-inflammatory articular)	****
Colubridae	<i>Hydrodynastes gigas</i> (Duméril, Bibron & Duméril)	chiglogolli (ñacanina)	N	Brain/ Unprepared/Poultices	In case of a 'ñacanina' bite, this snake must be killed and its brain removed to be placed in the affected area, and covering with a poultice of the leaf of <i>Plantago major</i>	*
Teiidae	<i>Tupinambis rufescens</i> Günther	toxoxaraic qolliguesaq (iguana colorada)	N	Fat/Unprepared/ Frictions and massages.	Chagas disease (Antiinflammatory). It is applied around the inflamed eye caused by the bite of the insect vector	**
				Fat/ Unprepared/Topical use	Eye conditions	**
	<i>Tupinambis meriana</i> Duméril & Bibron	lairaxaic / naigoxonaxa qolliguesaq (iguana, lagarto overo)	N	Fat/Unprepared/ Frictions and massages.	Chagas disease (Antiinflammatory) It is applied around the inflamed eye caused by the bite of the insect vector	**
					Boils and abscesses	**
					Pimples	**
					Wounds and injuries	*
					Skin blisters	**
Warts	**					
Snakebites: chew fat iguana or pass on the bite. The brain of the iguana is also used over the injuries, since this animal tolerates them without dying	***					

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
					Sore throat (anti-inflammatory)	**
					Earache	****
					Whooping cough and cold (expectorant)	*
					Joint conditions and muscle aches (anti-arthritis and anti-inflammatory)	***
					Sprains and twists (anti-inflammatory joint)	**
				Fat/ Unprepared /Topical use	Toothache and tooth decay: the cavities of the teeth are filled with fat.	*
					Eyes conditions (ophthalmic)	*
				Bone / Unprepared / Symbolic actions	Headaches: heat to fire the bone of the neck of the Iguana to relieve headache	**
Testudinidae	<i>Chelonoidis</i> spp. ( <i>C. chilensis</i> / <i>C. carbonaria</i> Spix)	potanaxac (tortuga)	N	Shell / Infusion or decoction / Beverage	diarrhea (antidiarrheal)	*
					(Emetic)	**
					Cough ( expectorant)	**
Viperidae	<i>Crotalus durissus terrificus</i> <i>Laurenti</i>	nlonaq (vibora cascabel)	N	Rattles /Symbolic action	In case of delays in childbirth, rub the rattles on the abdomen of the pregnant women	**
<b>AVES</b>						
Cariamidae	<i>Chunga burmeisteri</i> Hartlaub	lashenec, lashinec	N	Manure/Unprepared/ Poultice	Boils and abscesses	****
Cathartidae	<i>Coragyps atratus</i> Bechstein	teguesan (cuervo)	N	Eggs/ Symbolic actions	Inguinal hernia: heat a crow's egg and place it at the site of the hernia.	*

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
				Fat /Unprepared / Friction and massages	Eye conditions (applied over the eyelids)	**
Columbidae	<i>cfr. Leptotila verreauxi Bonaparte</i>	coigueneç (yoroti, yeruti)	N	Fat/ Unprepared/ Friction and massages	Socialization and children's behavior (acquisition of gait): Apply the fat of the <i>yoroti's</i> tail and chest in the baby's waist, so that they will be able to walk with strength	*
Falconidae	<i>cfr. Polyborus plancus</i> Miller	canagayé' lapagaxai (águila, carancho)	N	Fat/ Unprepared / Friction and massages	Gangrene and severe ulcerations (anti-infectives)	*
Mimidae	<i>Mimus triurus</i> Vieillot	calanya' (calandria)	N	Animal / Roasted / Food intake	Socialization and children's behavior (acquisition of speech)	**
Phalacrocoracidae	<i>Phalacrocorax brasilianus</i> Temmink	qoyipe (biguá)	N	Feather/ Incineration / Inhalation	To treat flu	**
				Fat / Unprepared / Friction and massages	The fat of its kidney and heart is used for rubbing the chest to prevent flu	**
Phasianidae	<i>Gallus gallus</i>	olgaxa	I	Eggs /Unprepared/ Poultice	Burns	*****
				Eggs/Beverage	To ease birth (oxytocic)	**
				Fat/ Frictions and massages	Pimples	**
					Wounds and injuries	*
					Chagas' disease (antiinflammatory)	****
					Prevention of flu: rub the chest	**
					Fever (febrifuge)	**
					Sprains and twist (anti-inflammatory joint)	**
					To ease birth. Rub the abdomen to facilitate birth?	**
				Feather/Incineration/ Topic	Navel cicatrizant	*
Picidae	<i>Celeus lugubris</i> Malherbe	nacoyaxa (carpintero)	N		Harbinger of disease and shamanic spirit. When singing near the house, it announces illness or death in the family.	*
	<i>Colaptes spp. : C. melanochlorus</i> Gmelin; <i>C.</i>	chochon (carpintero)	N		The song is a harbinger of asthma in the family	*

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
	<i>melanolaimus</i>					
Psittacidae	<i>Amazona aestiva</i> L.	ele' (loro halador)	N	Feather/ Incineration/ Topic	Earache headaches	* *
Rheidae	<i>Rhea americana</i> Mohring	mañic (suri, ñandú)	N	Fat/Unprepared/ Frictions and massages	Wounds and injuries Boils and abscesses (maturative) Eruptive diseases (chickenpox, measles, others). vesicles and skin blisters Sore throat (anti-inflammatory) Earache To treat flu. Rub the body to strengthen joint conditions and muscle aches (anti-arthritis and anti-inflammatory) Sprains and twists (anti-inflammatory joint)	* * ** * ** *** *** *** *** *** *** ***
				Fat/ Unprepared/ Topic	mouth sores and fires (cicatrizant)	*
				Feather/Incineration/topic	Earache: roll a cigarette and blow the ashes into the ear canal Nosebleed (haemostatic)	** **
				Feather/ Symbolic action	Snakebites: tie a white feather wing to the bite. The ostrich is the owner of the snake, so no fears him and is his partner.	*
				Eggs/ Symbolic action	Socialization and children's behavior: A rogative that promotes the virtues of suri during adolescence and family building.	*
				Crop / Infusion or decoction/ Beveraje	Internal parasites (anthelmintic) Lunatics, demoniacs or "copchaxaic" (prevention) Flatulence ( carminative)	* * *

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
					Constipation (laxative)	*
					Stomachache (digestive)	**
					Pregnancy care and treatment. Retention of pregnancy	**
					To ease birth (oxytotoxic)	****
					Treatment of retained placenta	****
Strigidae	<i>Otus choliba</i> Vieillot	qoloxolcoq (lechuzita)	N		The song is a harbinger of disease and indicates the presence of dead spirits	*
Tinamidae	<i>Cfr. Crypturellus tataupa</i> Temminck	so'o'yon (tordillo, martineta)	N	Legs / Infusion or decoction/ Beverage	Boil two legs in a kettle and drink the infusion to treat "incurable cancer" (lesions) of purulent venereal diseases of women.	**
Trochilidae	<i>Heliomaster furcifer</i> Shaw <i>Hylocharis chrysura</i> Shaw <i>Chlorostilbon aureoventris</i> Glittering	shimixai'chi shimixai'chi late'e (picaflor, colibri)	N	Nest /Incineration (ash)/ External use (smoke)	Earache	**
			N	Nest/Incineration/Friction and massages	Evil-eye. Rub ashes on the "open" head of a child affected by "ojeadura"	**
				Symbolic actions	Eye conditions. If a parent harms a hummingbird nest or kills this bird during the pregnancy of his consort, the child develops conjunctivitis at birth. See details in Hecht et al. (2008) and Martínez (2010)	**
Tyrannidae	<i>cfr. Euscarthmus meloryphus</i>	pichaqchic	N	Nest /Incineration (ash)/ External use	Boils and abscesses	*
<b>MAMMALIA</b>						
Bovidae	<i>Bos taurus</i> L.	huaaca (vaca)	I	Manure/Incineration (ash)/ Wash	Acne and facial pimples	*
				Dissolve in 1 liter of water a tablespoon of dried cow manure; the supernatant fluid is used to wash pimples once they were cleaned with soap and water	Pimples	*

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
				Manure/Incineration (ash)/ Exposed to smoke	Insect repellent (Culicidae and Psychodidae)	**
				Bones /Unprepared/ Frictions and massages. Marrow is used as soap, in regions where spots occur	Skin spots	**
				Blood	Used to relieve pain and "fever" of the foot. Walk barefoot on fresh blood	*
	<i>Capra hircus</i> L.	ketaq (cabra)	I	Fat/ Frictions and massages	Skin blisters	*
					Hit and hematoma	*****
					Muscle pain	***
				Prepare a cream with goat fat, salt and sawdust of "palo santo" (Bulnesia sarmientoi)	Sprains and twists (anti-inflammatory joint)	*****
				Blood/Fried/Food intake. It gives the child a fried blood of a newborn animal	Intestinal parasites (pinworm)	*
	<i>Ovis aries</i> L.	qagueta (oveja)	I	Blood/Fried/Food intake. It gives the child a fried blood of a butchering animal	Intestinal parasites (pinworm)	**
				Hair/ Symbolic action	To ease birth. Wrap the abdomen of pregnant women in strips of wool	*
					Pregnancy care. If a pregnant woman wants to conceive a girl she should use a wool belt.	**
Canidae	<i>Crysocyon brachyurus</i> Illeger	qa'alac (aguará guazú)		Fat/Unprepared/Friction and massages	Arthritis and joint conditions (antiarthritic)	*
	<i>Canis lupus familiaris</i> L.	pioq (perro)		Leg/Symbolic action	Stye. Rub the leg of a puppy on the eye to heal a stye originated by seeing intercourse between dogs	*
				Hair/Symbolic action	To treat toothache arising from taboo violation during mourning	**
	<i>Cerdocyon thous</i> L.	huaxaŷaxa (zorro)	N	Fat/ Unprepared/ Friction and massages	Muscle pain, especially leg pain	*
				Bone/ Milled in water /Beverage	Scrape the bone of the fox penis and put it in the water of the kettle to prepare 'mate'.	**

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
	<i>Mazama gouazoubira</i> G. Fischer	'imshi, niemshe (guasuncho)	N	Meat and viscera/Infusion or decoction/ beverage	Blood disorders (purifier)	**
				Meat and viscera / A heart infusion or as jerky	Stop menstrual bleeding	**
Cricetidae	<i>Holochilus</i> sp.	chigoxonaxa (rata)	N	Nest/ Symbolic action	To treat enuresis. The nest of this mouse is burned and ashes are placed on the abdomen. The nest is also used as a diaper	*
Dasypodidae	<i>Dasyopus septemcinctus</i> L.	tapinec (mulita)	N	Fat/Unprepared/ Frictions and massages. External use	Skin blisters	*
					Dog bites	**
					Pimples	**
					Burns	*
					Wounds and injuries (cicatrizant)	*
					Earache	*****
				Fat/ Food intake	Asthenia / weakness	**
	<i>Euphractus sexcinctus</i> L.	napam (mulita, gualacate, tatú, pichi, peludo)	N	Fat/Unprepared/Topic and external use	Burns	***
					Wounds and injuries	**
					Earache	****
	<i>Tolypeutes mataco</i> Desmarest	mogosaxan (quirquincho bola, tatú bolita)	N	Leather / infusión or decoction / beverage	Sexually transmitted diseases. It should be drunk while seeing the planet Venus	*
					Vaginal infections (antibiotic, antivenereal)	*
Didelphidae	<i>Didelphis albiventris</i> Lund	al (comadreja)	N	Fat/ Unprepared/ Topic	Skin blisters (resolutive)	*
Equidae	<i>Equus caballus</i> L.	caaño (caballo)	I	Manure / Incineration / Symbolic action	Nosebleeds. Drip the blood on manure to stop bleeding	*

CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
	<i>Equus asinus</i> L.	ashina (burro)	I	Manure / Incineration / Symbolic action	Nosebleeds. Drip the blood on manure to stop bleeding	***
				Milk / Food intake	Cough, whooping cough, catarrh	****
Felidae	<i>Oncifelis geoffroyi</i> d'Orbigny & Gervais	copaic (gato montés)	N	Fat/Unprepared /Friction and massages	Eruptive diseases (chickenpox, measles, others)	***
	<i>Puma concolor</i> L.	saxuaxaic (león)	N	Fat/ Unprepared/Friction and massages	Sore throat	**
					Joint conditions (anti-arthritis and anti-inflammatory)	***
Hydrochoeridae	<i>Hydrochoerus hydrochaeris</i> L.	hualliquiaxai (carpincho)	N	Fat/ Unprepared/Friction and massages	Joint conditions (anti-arthritis)	**
					Hit and hematoma (anti-inflammatory)	*
				Fat/Unprepared/ Beverage or Food intake	Asthma	*
					Bronchial and pulmonary diseases	***
				Make a tea mixed with bark of <i>Geoffroea decorticans</i> and a tablespoon of fat from capybara, which is drunk twice a day. It also can be ingested in the form of crackling or drink	Tuberculosis	**
Leporidae	<i>Sylvilagus brasiliensis</i> L.	lerema (liebre)		Leather / Symbolic action	Sleeping newborn (see details in Hecth et al. 2008)	**
Mustelidae	<i>Conepatus chinga</i> Molina	coñim (zorrino)		Meat / Food intake	Prevention of flu	*
Myrmecophagidae	<i>Myrmecophaga tridactyla</i> L.	potai' (oso hormiguero)	N	Hair/Incineration (ash)/Topic use	Itching, irritation, rash	**
				Hair and fat / Topic use	Ashes and fat are applied in mouth sores and fires (cicatrizant)	***
				Hair /Symbolic action	Sleeping newborn (see details in Hecht et al.,2008)	
				Fat/Unprepared/External use	Burns	**
					Tuberculosis	**



CLASS Family	Species	Local name ('Criollos' name)	Origin	Part use, Way of preparation and administration, (Recipe)	Application (Therapeutic effect attributed)	Frequency (%)
					Severe ulcerations and gangrene. To supplement shamanic therapy	*
				bones/Milled/poultice fat/friction and massages Nail/Symbolic action	To treat broken bones (because the anteater is strong and does not break ever) (reconstituting bone, resolving) Protection from evil: cross two nails on the chest to protect against injury, disease and evil sent by a shaman ('pi'oxonaq')	*** *
Procyonidae	<i>Nasua nasua</i> (L.) Berg.	coshingo' (coati)	N	Fat/Unprepared/Friction and massages	Pimples (dermatic) Boils and abscesses (disinfectant) Mycosis Its presence is a harbinger of disease	* * * *
	<i>Procyon cancrivorus</i> Cuvier	pior'oralo' (mayoblasto)	N			*
Suidae	<i>Sus scrofa domestica</i> L.	cos (chancho)	I	Fat/ Mixed with onions in wine	To produce alcohol arrest	**
Tapiridae	<i>Tapirus terrestris</i> L.	shipegaqalo (anta, tapir)	N	Nail/Boiled /Beverage	Ease birth (oxytocic or symbolic action). It is used because the birth of this animal is very fast	**

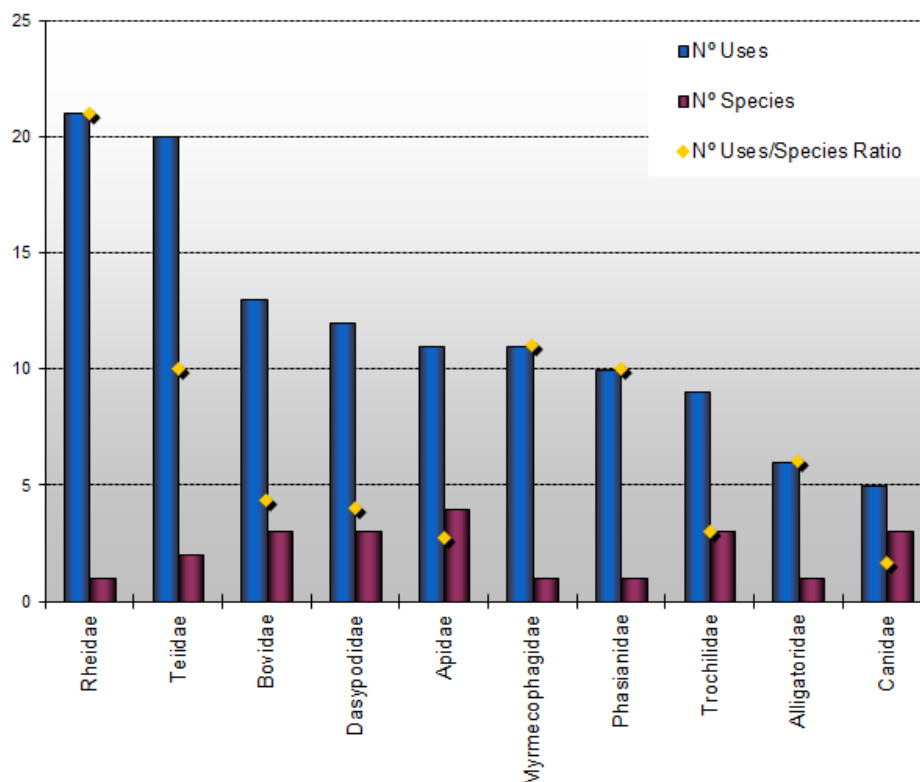
**Table 3.** Higher taxonomic categories and their N° uses / N° of species ratio

Taxonomic Categories (Group, Phylum and Class)		N° uses / N° Spp. Ratio	
		Groups	Classes
<b>(Invertebrates)</b>		<b>1.89</b>	
Phylum Arthropoda	Class Insecta		1.69
Phylum Mollusca	Class Bivalvia		5.00
	Class Gastropoda		2.00
<b>(Vertebrates)</b>		<b>3.08</b>	
Phylum Chordata	Class Mammalia		2.71
	Class Aves		3.17
	Class Reptilia		5.00
	Class Osteichthyes		1.50
	Class Amphibia		2.00
	Class Condriichthyes		1.00

Figure 3 shows that the families with the greatest number of medicinal species are Apidae for invertebrates, and Bovidae, Dasypodidae, Canidae and Trochilidae for vertebrates, all of them including 3 or 4 species each. Regarding the number of medicinal uses, the families Rheidae, Teiidae, Bovidae, Dasypodidae, Apidae, Myrmecophagidae and Phasianidae are at the top of the list, evidencing the importance of vertebrates (Birds, Mammals and Reptiles).

The importance of Hymenoptera among the insects with medicinal uses (22 species out of 42) was already noted by Costa-Neto (2002) for NE Brazil, while Canids were described among the mammal species most frequently used in zootherapy around the world (Alves et al. 2010). Likewise, the review by Alves et al. (2008) describes the fact that reptiles are among the animal species most used in traditional folk medicine and have been since ancient times.

Regarding applications, Table 4 shows the clear preference for using animal fat (42%). The number of applications for the external parts of animals, such as insect cuticles, hides and tegumentary annexes (15%), i.e. hairs, feathers, nails, shells, rattlesnake, rattles, etc., is much greater than for the internal parts (9%), meat, blood and viscera. Also relevant is the number of uses given to bird nests (9%), which in turn is the least extractive application. The preference for animal fats in domestic medicine is apparently a common phenomenon in zootherapy as shown in different previous reports (Bourdy et al. 2004; Alves et al. 2008, 2009; Costa-Neto 1999; Filipov 1997). The popularity of the use of *Tupinambis merianae* fat, a widespread natural medicine, has been the motive of one of the few studies on the clinical efficacy of animal products for medicinal purposes (Ferreira et al. 2010).



**Figure 3.** Zoological families with the highest number of species and medicinal uses.

Regarding forms of preparation (Table 5), the direct application of fats is preferred (53%) as well as the use of the ashes from tegumentary annexes, bones and nests (21%). Concerning the forms of administration, external use applications are mostly used (74%), with frictions and massages being the most common forms for fatty preparations, although topical uses and symbolic actions are also frequent (Table 6). External applications appear to be a specific dominion of the Toba animal pharmacopoeia as opposed to their phytotherapy treatments that mainly uses internal applications as infusions or decoctions (Martínez 2010c).

**Table 4.** Animal parts used in the traditional medicine practices ordered by decreasing values of frequency of use.

Animal part	Frequency of use
Fats	42.13
Cuticles, hides and skin annex (shells, bells, teeth, hair, feathers, nails)	15.23
Nests	9.14
Meat, blood and viscera (swish, brain)	8.63
Shells and bones (Endo and exoskeletons)	5.08
Eggs and milk	5.08
Whole animal	4.57
Honey and bees products	4.57
Manure	3.05
Cocoons and larvae	2.54

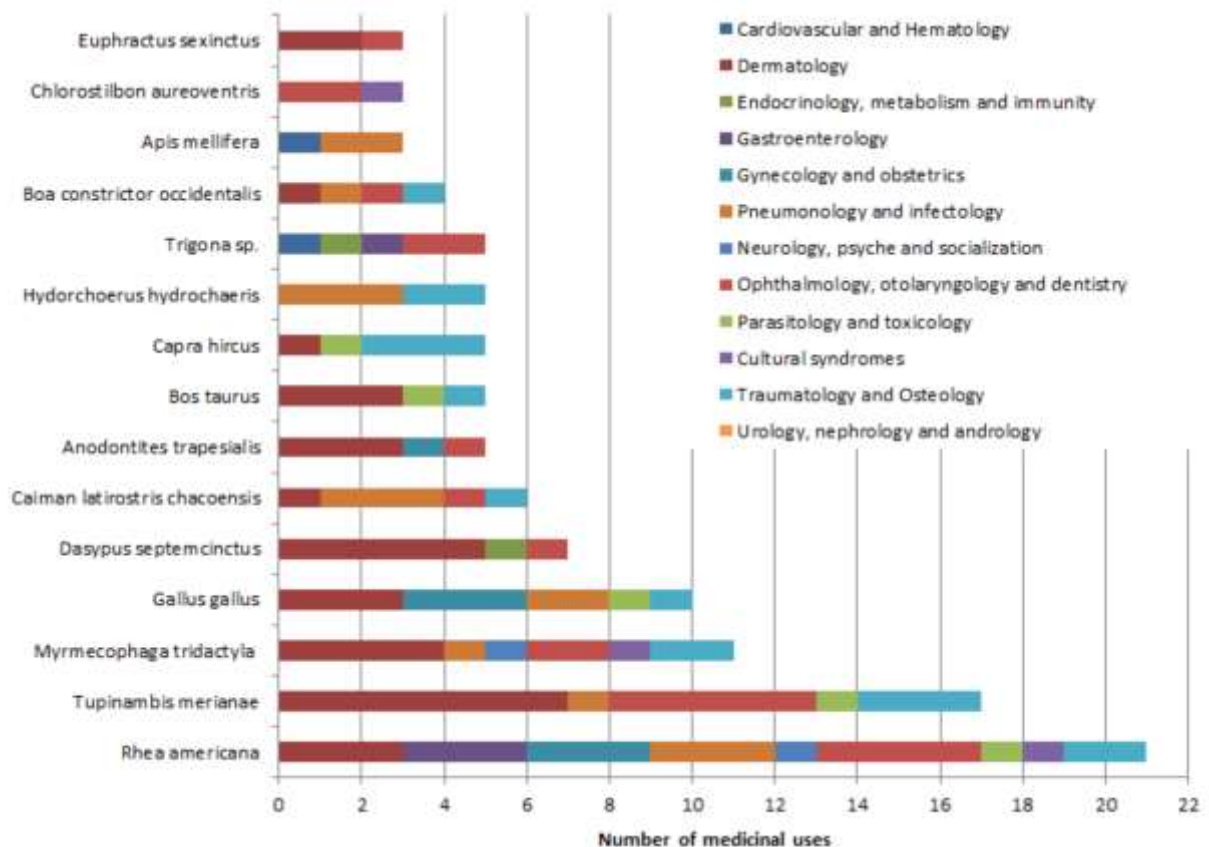
**Table 5.** Form of preparation of animal remedies ordered by decreasing values of frequency of use.

<b>Form of preparation</b>	<b>Frequency of use</b>
Unprepared	52.94
Incineration (ash, embers)	21.32
Infusion or decoction	15.44
Cocked (boiling, roasted, fried)	5.88
In solution or macerated	2.94
Milled	1.47

**Table 6.** Way of application of animal remedies ordered by decreasing values of frequency of use. (E: External; I: Internal) (E: External; I: Internal)

<b>Way of application E: External; I:Internal</b>	<b>Frequency of use</b>
(E) Friction and massages	38.38
(E) Topic	15.68
(E) Symbolic action	8.65
(E) Inhalation and exposure to smoke	2.70
(E) Body gadget	2.16
(E) Poultices and plasters	2.16
(E) Washes	2.16
(E) Eye drops or eye bath	2.16
(E) Incision	0.54
(I) Drink	14.59
(I) Food intake, chewing	11.89

Considering animals with the highest number of medicinal applications (Figure 4), the list is headed by 3 native species (*Rhea americana*, *Tupinambis merianae* and *Myrmecophaga tridactyla*). A broad range of uses is also observed for introduced domestic fauna, as in the case of *Gallus gallus*, *Bos taurus*, *Capra hircus* and *Apis mellifera* (now wild), demonstrating general agreement between their uses and applications from other Latin American zoo-therapies (Alves and Alves 2011). Likewise, the number of medicinal uses for species like *Rhea americana*, *Caiman latirostris chacoensis*, or *Tupinambis merianae* could have arisen from the interaction with neighboring Criollo communities in Formosa, Corrientes and Santiago del Estero, as evidenced in the current folklore of these groups (Di Lullo 1944).



**Figure 4.** Proportion of medicinal uses in species with the highest number of applications.

On the other hand, the connection between some of these applications and a magical-symbolical aspect cannot be disdained, particularly regarding the representation of these beings in the Toba mythology and cosmology as discussed below. Thus, the strength of the “da’ail’oc” (*Caiman latirostris*) and “mañic” (*Rhea americana*), as well as the social and reproductive behavior of the latter, makes them carriers of forces related to the health and progeny of children, evidencing the metaphorical use of these remedies in Toba infants. Similarly, we note, that, for instance, all remedies that encourage speech involve the emission of a sound as in the song of a cricket or “millic” (*Grillus argentinus*) or as in empty snail shells of “nashiyo” (*Strophocheilus oblongus*). Rats or “chigoxonaxa” (*Holochilus* sp.), of imperceptible excretas, also make up the treatment for maintaining sphincter control. Likewise, hare leather (*Sylvilagus brasiliensis*) or “ledema lo’oc” is used to help to induce newborn sleep, since hares are regarded as animals with sleepy habits.

In all these or related cases, apart from a potential pharmacological effect, their medical use also involve a sacred power, i.e., a symbolical efficiency (Le Breton 1995). The ethnomedical context within which each of the species is used has been previously described and escapes the purpose of this study. More details on the cultural significance, metaphorical value and implicit therapeutic criteria of the applications of these natural pharmacopoeia can be found in our previous contributions (Hecht et al. 2008; Martinez 2007, 2010b,c; Martínez and Barboza 2010).

Table 7 shows that animal pharmacopoeia provides a great number of uses, especially regarding skin afflictions (22%), eye, ear and mouth disorders (21%), pneumonological or infectological situations (12%) and osteo-arthro-muscular

problems (11%). It also shows that the highest consensus is regarding the choice of remedies for gastroenterological ( $F_{IC}=0.92$ ), dermatological ( $F_{IC}=0.90$ ) and pneumonological or infectological ( $F_{IC}=0.90$ ) problems, evidencing a selection of species based on very defined and precise criteria for these health areas instead of a random selection. As an example, and as described in a specific study on Toba skin affections, the use of ashes from the shell of the mollusk *Anodontites trapesialis* (Unionidae) is first on the list of animal pharmacopoeia for its popularity as a cicatrizant, followed by the use of *Gallus gallus* fat as resolutive and *Chunga burmeisteri* manure as maturative (Martínez and Barboza 2010).

On the contrary, the treatment of cultural syndromes ( $F_{IC}=0.61$ ) and urological, nephrological and andrological disorders ( $F_{IC}=0.70$ ), as well as metabolic, endocrine and immunological problems ( $F_{IC}=0.75$ ), have the lowest levels of consensus. The low consensus regarding metabolic affections and cultural syndromes associated to scarce use reports are probably due, in the former case, to a poor and imprecise knowledge of specific applications for the areas, and in the latter, to the exclusivity of certain cultural information that only a few individuals bear and do not reveal indiscreetly, and that predominantly involve symbolical applications.

The accordance of our data with the results of Alves et al. (2009) for the semiarid region of Pernambuco is noticeable regarding the high level of informant consensus on the use of specific animal remedies for skin problems and respiratory and digestive diseases, evidencing a widespread valorization of zootherapy in this sphere of folk medicine.

**Table 7.** Quantitative analysis of the categories of medicinal uses: Number and percentage of species, uses and use reports, number of species / number of uses ratio and Informant Consensus Factor (Fic) (According to decreasing values of Fic; Total species: 72; Total Uses reports: 199).

Medicinal Uses Categories	Nº species (Nt)	% species	Nº Uses	% Uses	Uses reports (Ur)	% from the total Ur	Nº Uses/ Nº Spp ratio	Fic
Gastroenterology	4	3.08	8	4.02	37	3.93	<b>2.00</b>	<b>0.92</b>
Pneumology and infectology	<b>14</b>	<b>10.77</b>	<b>24</b>	<b>12.06</b>	<b>130</b>	<b>13.80</b>	<b>1.71</b>	<b>0.90</b>
Dermatology	<b>19</b>	<b>14.62</b>	<b>44</b>	<b>22.11</b>	<b>178</b>	<b>18.90</b>	<b>2.32</b>	<b>0.90</b>
Traumatology and Osteology	<b>14</b>	<b>10.77</b>	<b>22</b>	<b>11.06</b>	<b>121</b>	<b>12.85</b>	1.57	0.89
Neurology, psyche and socialization	10	7.69	10	5.03	81	8.60	1.00	0.89
Gynecology and obstetrics	12	9.23	18	9.05	89	9.45	1.50	0.88
Ophthalmology, otolaryngology and dentistry	<b>26</b>	<b>20.00</b>	<b>42</b>	<b>21.11</b>	<b>201</b>	<b>21.34</b>	1.62	0.88
Parasitology and toxicology	9	6.92	9	4.52	46	4.88	1.00	0.82
Cardiovascular and Hematology	3	2.31	3	1.51	10	1.06	1.00	0.78
Endocrinology, metabolism and immunity	3	2.31	3	1.51	9	0.96	1.00	0.75
Urology, nephrology and andrology	4	3.08	4	2.01	11	1.17	1.00	0.70
Cultural syndromes (Non-organic illnesses)	12	9.23	12	6.03	29	3.08	1.00	0.61

## Relevant species and conservation priorities

According to the percentage of Ur shown in Table 8, the species with the highest degree of consensus and popularity for the Tobas are *Rhea americana*, *Tupinambis merianae*, *Gallus gallus*, *Capra hircus*, *Myrmecophaga tridactyla*, *Anodontites trapesialis*, *Dasypus septemcinctus* and *Caiman latirostris chacoensis*. Considering the RI, the results once again include species like *Rhea americana* (RI = 100), *Tupinambis merianae* (RI = 72.22) and *Myrmecophaga tridactyla* (RI = 61.11). Moreover, this index highlights the importance of *Trigona* sp. (RI = 36.11) and *Boa constrictor occidentalis* (RI = 33.33) and places them above the importance of other domestic species with higher values of Ur like *Capra hircus* or *Bos taurus* both widely used in Latin American pharmacopoeias.

Table 8 shows how RI, ECV and CS values are combined for each of the medicinal animal species and integrated inside ILCP. The value of ECV comprehends many aspects. For example, the provision of meat from hunted animals is still a common and relatively frequent Toba practice, as for great part of the rural population of the Gran Chaco. Arenas (2003) described that hunting is a means for supplying meat to the staple carbohydrate-based diet (flour, rice, noodles, polenta) and contributes to the subsistence of communities that generally do not have a basic or secure income. According to Altrichter (2006), small species of mammals constitute the main source of wild meat in terms of frequency and biomass for the Gran Chaco mestizo, as observed for the Toba population of the region. The species that are most appreciated for their meat are “suri” (*Rhea americana*), small deer or “corzuela” (*Mazama gouazoubira*) and “armadillos” or edentates (*Dasypus septemcinctus*, *Euphractus sexcinctus* and *Tolypeutes matacus*). The latter are particularly hunted during the cold season for their rich fatty content. Although Altrichter (2006) points out that the medicinal use of animals does not generally motivate hunting the species per se, our observations show the contrary in more than one case. This is particularly evident for species like *Hydrochoerus hydrochaeris*, *Tupinambis merianae*, *Boa constrictor occidentalis*, among others, whose fats are highly esteemed remedies for the natives. In this sense we agree with Alves et al. (2010) who consider that the medicinal use of animals generates an additional threat and must be taken into account together with other anthropogenic pressures.

On the other hand, certain felines (*Oncifelis geoffroyi*, *Puma concolor*), foxes (*Cerdocyon thous*), and reptiles (*Boa constrictor occidentalis*, *Caiman latirostris* and *Tupinambis merianae*) of the Gran Chaco were historically threatened by commercial hunting for their hides until important restrictions were made reducing the market and practically eradicating their commercialization (Arenas 2003). Furthermore, the illegal commercialization of wildlife is not a significant income for most of the natives who only occasionally sell parrots (*Amazona aestiva*) and other animals like beetles to animal collectors or as pets.

Regarding the ecological importance, species like *Rhea americana*, *Hydrochoerus hydrochaeris*, and *Euphractus sexcinctus* are important for their taxonomic singularity because they are monotypic genera and/or families. In other cases, they play a key role in local ecosystems and their reduction or disappearance would cause important environmental alterations as in the case of *Puma concolor*, *Crotalus durissus terrificus*, and others.

Another aspect to be considered for any species conservation plan is its sociocultural and mythical-religious significance. The use of animals in native medicine transcends mere zootherapy, and involves, for example, the use of magical

amulets (Vuoto 1999), performing symbolical healing actions, or using animals as shamanistic auxiliaries that send and/or heal diseases by the transgression of taboos (Martínez 2010a,b). Toba cosmology and religion is filled with sacrality and power, as well as by a series of interdictions and fears regarding the use and exploitation of species. Thus, it is common for animals to be subdued or associated to a theophany, powerful entity, master or guardian, who are the custodians of these non-human beings (Miller 1979; Terán 2000; Ruiz Moras 2001). The most common reference is their belief in the power of “No’ouet”, hierophany or a paradigm of the powerful that is responsible for terrestrial species and the forest in general, and is also the initiator of shamans (Cordeu 1969/70; Tola 2001; Wright 1984, 2005). Other deities or mythological animals in their cosmology have different degrees of relevance and influence (Terán 1994, 1998a,b, 2000; Terán 2006). Hence, animism and anthropomorphism are an inherent feature of the Toba cosmovision of the animal world, as expressed by their stories and myths that evidence their significance in everyday life. A brief analysis on the profuse mythographical collection and narrations provided by Wilbert and Simoneau (1982) and Terán (1994) for Tobas shows the diversity of motives for which some of the species in this study are frequently mentioned. Some of these topics are: hierarchies and power relations, kinds of kings (the giant, speaking father of ostrich “mañic”, the father and mother of owl “qoloxolcoq”, the father of iguanas “qolliguesaq”, the father of coati “coshingo”); animals representing a culture hero or trickster (fox “huaxaŷaxa”, armadillos “napam” and “tapinec”, chuña “lashenec” and lizards); transformation of animals to persons or vice versa (anteater “potai”, capybara “hualliquiaxai”, chuña “lashenec”, armadillos “napam” and “tapinec”, deers “ñi’imshi”, caiman “da’ail’oc”); stories about animal parts or products that cure diseases (iguanas “qolliguesaq” and rabbit fat); acquisition of magic and shamanic powers (iguana “qolliguesaq”); animal magicians, establishment of animal haunt (coati “coshingo”); friendship, enmity and marriage among animals (black vulture “canagaye” and bigua “qoyipe”); origin of constellations and stars from animals and other notions of ethnoastronomy (ostrich “mañic”); origination of cosmogonies and other cataclysms (fox “huaxaŷaxa”, armadillos “napam” and “tapinec”; rainbow boa “qemoxonalo”).

Regarding the CS, two of the species used in Toba zootherapy, *Myrmecophaga tridactyla* and *Boa constrictor occidentalis*, have been nationally reported as “endangered species” and the second is also included in the CITES I list. These species are also among the first in RI based on the local medicinal applications attributed by the natives. Other species heading the list of priorities for local conservation that are threatened and or listed in CITES II are *Rhea americana*, *Tupinambis rufescens*, *Chelonoidis* spp., *Caiman latirostris chacoensis*, *Oncifelis geoffroyi*, *Cerdocyon thous*, and *Tapirus terrestris*. Although the medicinal use of species like *Hydrochoerus hydrochaeris*, *Oncifelis geoffroyi*, *Cerdocyon thous*, *Tapirus terrestris*, *Tolypeutes mataco* and *Puma concolor* are very restricted with low values of RI, their ecological and cultural relevance and their conservation status places them among the first fifteen species of the local conservation priority ranking.

On the other hand, some species of invertebrates - as *Trigona* sp., *Pomacea* sp., *Nasutitermes* sp., and *Anodontites trapesialis* - that are relevant from an ethnomedical point of view (RI), but to a lesser degree in the ecological cultural aspect, present values of ILCP that are lower than the mean of all the species because they lack references regarding their CS. Despite this, and as discussed below, their importance and role in the fauna resources of the area must not be undermined.



**Table 8.** Uses reported (Ur), Relative importance (RI), and Conservation priorities of animal species ordered by decreasing values of ILCP. Criterion for assigning numerical categories according to Table 1) (w/d: without document)

SPECIES	Ur	RI	Category of Relative Importance (RI)	Category of Ecological and Cultural Value (ECV)	Category of Conservation Status (CS)	Index of Local Priority (ILCP)
<i>Rhea americana</i>	<b>9.98</b>	<b>100.00</b>	5	5	4	12.67
<i>Myrmecophaga tridactyla</i>	<b>4.88</b>	<b>61.11</b>	4	4	5	10.14
<i>Tupinambis meriana</i>	<b>8.92</b>	<b>72.22</b>	5	5	3	9.51
<i>Boa constrictor occidentalis</i>	1.70	<b>33.33</b>	3	4	5	7.60
<i>Tupinambis rufescens</i>	1.17	19.44	2	5	4	5.07
<i>Chelonoidis</i> spp. ( <i>C. chilensis</i> / <i>C. carbonaria</i> )	1.06	19.44	2	4	4	4.06
<i>Caiman latirostris chacoensis</i>	<b>3.50</b>	<b>30.56</b>	2	4	4	4.06
<i>Hydrochoerus hydrochaeris</i>	2.12	25.00	2	5	3	3.80
<i>Oncifelis geoffroyi</i>	0.64	8.33	1	5	4	2.53
<i>Cerdocyon thous</i>	0.53	16.67	1	5	4	2.53
<i>Tapirus terrestris</i>	0.32	8.33	1	4	4	2.03
<i>Tolypeutes mataco</i>	0.42	16.67	1	5	3	1.90
<i>Puma concolor</i>	1.38	16.67	1	5	3	1.90
<i>Gallus gallus</i>	<b>7.11</b>	<b>47.22</b>	3	2	2	1.52
<i>Euphractus sexcinctus</i>	1.80	19.44	2	3	2	1.52
<i>Dasypus septemcinctus</i>	<b>4.46</b>	<b>30.56</b>	2	3	2	1.52
<i>Amazona aestiva</i>	0.42	11.11	1	3	4	1.52
<i>Conepatus chinga</i>			1	3	3	1.14
<i>Phalacrocorax brasilianus</i>	0.64	11.11	1	4	2	1.01
<i>Otus choliba</i>	0.21	8.33	1	2	4	1.01
<i>Mazama gouazoubira</i>	0.64	16.67	1	4	2	1.01
<i>Hylocharis chrysura</i>	0.96	19.44	2	2	2	1.01
<i>Heliomaster furcifer</i>	0.96	19.44	2	2	2	1.01
<i>Crysocyon brachyurus</i>	0.21	8.33	1	2	4	1.01
<i>Chlorostilbon aureoventris</i>	0.96	19.44	2	1	4	1.01
<i>Procyon cancrivorus</i>	0.21	8.33	1	2	3	0.76
<i>Nasua nasua</i>	0.64	13.89	1	2	3	0.76
<i>Mimus triurus</i>	0.32	8.33	1	3	2	0.76
<i>Mimus saturninus</i>	0.32	8.33	1	3	2	0.76
<i>Hydrodynastes gigas</i>	0.21	8.33	1	3	2	0.76
<i>Crotalus durissus terrificus</i>	0.32	8.33	1	2	3	0.76
<i>Coragyps atratus</i>	0.64	16.67	1	3	2	0.76
<i>Chunga burmeisteri</i>	1.17	8.33	1	3	2	0.76
cfr. <i>Leptotila verreauxi</i>	0.21	8.33	1	3	2	0.76
<i>Apis mellifera</i>	1.59	19.44	2	3	1	0.76
<i>Sylvilagus brasiliensis</i>	0.32	8.33	1	2	2	0.51
<i>Scaptotrigona</i> sp.	2.02	11.11	1	4	1	0.51
<i>Colaptes melanolaemus</i>	0.21	8.33	1	2	2	0.51

<i>Colaptes melanochlorus</i>	0.21	8.33	1	2	2	0.51
cfr. <i>Polyborus plancus</i>	0.21	8.33	1	2	2	0.51
cfr. <i>Crypturellus tataupa</i>	0.32	8.33	1	2	2	0.51
<i>Celeus lugubris</i>	0.21	8.33	1	2	2	0.51
<i>Rhinella</i> spp.	1.38	11.11	1	2	2	0.51
<i>Trigona</i> sp.	2.02	<b>36.11</b>	3	1	1	0.38
w/d <i>Plebeia</i> spp.?	0.32	8.33	1	3	1	0.38
<i>Serrasalmus</i> sp.	0.42	8.33	1	3	1	0.38
<i>Prochilodus platensis</i>	0.74	16.67	1	3	1	0.38
<i>Polistes</i> spp. ( <i>Polistes</i> cfr. <i>canadensis</i> and others)	0.96	5.56	1	3	1	0.38
<i>Pomacea canaliculata</i>	1.06	22.22	2	1	1	0.25
<i>Nasutitermes</i> sp.	1.91	19.44	2	1	1	0.25
<i>Holochilus</i> sp.	0.21	8.33	1	1	2	0.25
<i>Gryllus argentinus</i>	2.02	8.33	1	2	1	0.25
<i>Equus caballus</i>	0.21	8.33	1	1	2	0.25
<i>Didelphis albiventris</i>	0.21	8.33	1	1	2	0.25
cfr. <i>Euscarthmus meloryphus</i>	0.32	8.33	1	1	2	0.25
<i>Capra hircus</i>	<b>5.10</b>	<b>30.56</b>	2	1	1	0.25
<i>Bos taurus</i>	1.91	25.00	2	1	1	0.25
<i>Anodontites trapesialis</i>	<b>4.67</b>	19.44	2	1	1	0.25
<i>Sus scrofa domestica</i>	0.32	8.33	1	1	1	0.13
<i>Strophocheilus oblongus</i>	2.66	8.33	1	1	1	0.13
<i>Scapteriscus borelli</i>	2.02	8.33	1	1	1	0.13
<i>Potamotrygon</i> sp.	0.21	8.33	1	1	1	0.13
<i>Ovis aries</i>	0.93	16.67	1	1	1	0.13
<i>Oiketicus kirbyi</i>	0.42	8.33	1	1	1	0.13
<i>Equus asinus</i>	2.44	16.67	1	1	1	0.13
Not determined ( <i>Lepidoptera</i> chrysalis)	0.42	13.89	1	1	1	0.13
<i>Coptoteryx argentina</i> , <i>Stigmatoptera hyaloptera</i>	0.21	8.33	1	1	1	0.13
<i>Canis lupus familiaris</i>	0.53	11.11	1	1	1	0.13
<i>Atta vollenweideri</i>	0.64	8.33	1	1	1	0.13
w/d <i>Dorymyrmex exsanguis</i> ?			1	1	1	0.13
Not determined (Cicadidae)	0.42	8.33	1	1	1	0.13

In all, 30% of the species used for zootherapy were categorized with levels 3, 4 and 5, whether vulnerable, threatened or in danger, or in categories I and II of CITES. Similar values of threatened animals were found in other studies, including 30% of the animal pharmacopoeia of NE Brazil (Costa-Neto 1999), 25% for canids (Alves et al. 2010) and 53% for reptiles (Alves et al 2008), both worldwide estimations. However, it is only fair to point out that contrary to studies in other regions of Latin America, we did not observe the commercialization of animal medicinal products among the Tobas, indicating that their recollection is merely restricted to a domestic use and in many cases subordinated to other needs and practices such as food.

Taking the above into account, and according to the perception and uses of the Tobas from the Gran Chaco region, the following ten local species must be prioritized: one bird (*Rhea americana*), five reptiles (*Boa constrictor occidentalis*,

*Tupinambis merianae*, *Tupinambis rufescens*, *Chelonoidis* spp., *Caiman latirostris chacoensis*) and four mammals (*Myrmecophaga tridactyla*, *Hydrochoerus hydrochaeris*, *Oncifelis geoffroyi* and *Cerdocyon thous*).

A simple comparison of the Toba indigenous pharmacopoeia with that of other ethnic groups from the Gran Chaco and other regions of Latin America evidences the recurrence of the use of certain species and noticeable coincidences in some of their applications. Thus, the use of *Boa constrictor occidentalis*, *Tupinambis rufescens*, *Tupinambis merianae*, *Caiman latirostris chacoensis*, *Oncifelis geoffroyi*, *Hydrochoerus hydrochaeris*, *Mirmecophaga tridactyla* and *Rhea americana* is similar to that of the Pilagá and Toba-Pilagá of Formosa (Filipov 1997; Arenas 2000), evidencing a regional pattern of use and a fluid interethnic exchange of knowledge. Particularly, species like *Tupinambis merianae* and *Rhea americana* would seem to adopt a panacean status among the different Chaco groups given the wide range of ailments for which they are used and the variety of their forms of use.

Similarities are also observed in even more geographically and linguistically distant ethnic groups. More than 50% of the species and great part of the applications used in zootherapy by the Tsimane' Amerindian of the Bolivian rain forest and by the Izoceño-Guaraníes or Chiriguanos of the Bolivian Chaco are also found in the Toba animal pharmacopoeia (Apaza et al. 2003; Bourdy et al. 2004). Another example is the relevance of products originated from *Tupinambis merianae* and *Tupinambis teguixin*, indicated for the treatment of 8 and 18 conditions respectively, whereas caiman fat (*Caiman latirostirs*) is still used in Brazilian rural and urban communities for treating rheumatism Alves et al. (2008, 2009). Likewise, Alves and Alves (2011) report, within the framework of Latin America zootherapy, that the products obtained from *Tupinambis merianae* and *Boa constrictor* were prescribed to treat near 30 conditions, each one, revealing the amplitude of this pattern of use, probably related to ancient or colonial times. Furthermore, in a review on the use of 14 canids in traditional medicine, Alves et al. (2010) describe a great diversity of uses for Brazil and Bolivia, some of which coincide with applications described by the Tobas.

On the other hand, and despite the lack of information regarding the CS of invertebrates and their inferior ECV compared to vertebrates, these resources are not to be disdained from a symbolical and ethnopharmacological point of view, particularly in species that present widely used applications in different ethnic groups. For example, insects of the *Atta*, *Apis*, *Plebeia*, *Trigona*, *Gryllus* and *Nasutitermes* genera are part of the 42 insects used in folk remedies in Northeast Brazil (Costa-Neto 2002), with noticeable coincidences in their medicinal applications as in the case of *Gryllus domesticus* for children with difficulties or delays in speech development, or the ophthalmological, bucopharyngeal and/or pectoral use of hymenopteran honey and other products. This shows the need to further the studies on the medicinal use of insects and insect-derived products that apparently present a very specific pattern of applications, many of which could become potential sources of drugs due to their promising results on/implications for human health, as in the antibiotic activity of the natural products of a species of *Nasutitermes* genus (Coutinho et al. 2009; Dossey 2010). The study of products related to hymenopteran apiculture and meliponiculture deserves special attention due to the current use of these activities for the subsistence of Tobas and other ethnic groups and farmers of Argentina (Arenas 2003; Zamudio et al. 2010).

To summarize, we can mention the fact that medicinal fauna in Gran Chaco region is based on wild animals, including endangered species, demonstrating remarkable coincidences with ethnomedicines from other Latin American countries.

## Conclusions

The great wealth of genetic resources and the complex cultural diversity of the Gran Chaco region here presented involve an adaptation process of its ethnic groups, generating an invaluable local knowledge and a medical system that include extensive information on animal uses. Despite the difficulties found in the access to modern biomedical services, the zootherapy “qom” acquires an intrinsic value because of the multiple ways and criteria of uses of the remedies, revealing the existence of a consistent and structured ethnomedicine. A deep understanding of the cultural context of the traditional use of Toba animal therapies seems to be central for elucidating their potential impact not only in public health, but also in local conservation.

Our results show that of the wide range of species used in Toba zootherapy, an important number of reptiles, mammals and birds appreciated for their medicinal applications, cultural significance and other uses, are included in lists of threatened or endangered species for Argentina. Even though the Gran Chaco is particularly affected by structural environmental issues (deforestation and fragmentation of natural environments, expansion of the agricultural frontier, non-sustainable hunting and wildlife trade), the knowledge, use, significance and cultural value of the local fauna for this ethnical group is relevant, as it is a valuable tool for developing conservation strategies. The implementation of wildlife conservation actions that have no negative effects on the lifestyle of local communities, but instead consider and include them, are one of the challenges that must be taken into account when planning them.

The present study on Toba zootherapy not only evidences the actual use of animals in their medical practices, but also the way these natives see and consider themselves regarding their alterity, in this case with animals. Tobas believe that animals have their own spiritual principles enabling them to have interpersonal relations, which undoubtedly influences everyday hunting, fishing and/or gathering practices and in turn affects animal conservation. Without necessarily agreeing with the romantic concept that the Toba indigenous practices are fundamentally ecological as proposed by Miller (1979), it is fair to point out that animistic representations and the anthropomorphization of the animal world are valuable aspects for carrying out sustainable wildlife management with these communities. We agree with Chan (2012) that encouraging anthropomorphism (attributing human characteristics to non-human animals) can help conservation biologists develop more empathy towards target species. We do not pretend, as warned by Arenas (2003), to idealize the relationship between natives and their environment. Moreover, natives are not exempt from making extractive and exploitive use of natural resources nor are they oblivious to the installation of a capitalist form of life, which in more than one case requires monitoring the use of medicines, meat or other animal products, especially for threatened or endangered species as the ones mentioned in this study. Likewise, we must point out that specialists with knowledge on the specificity of these ethnomedical practices are becoming less frequent, and obtaining them is becoming more difficult due to environmental and cultural changes. Therefore, the implementation of inadequate use and management norms would imply the risk of reducing their cultural value, fomenting the lack of intergenerational transmission of traditional uses and hence extinguishing experience by disuse. This situation is observed among Toba communities that have migrated to large cities far away from their native forest, where the new generations have no idea of the species and

applications used and only the memory of the older people, who at some point were hunters, survives.

Therefore, the ethnozoological perspective of this study provides an integral view of social and ecological elements for the protection of species on a regional scale, which is also methodologically viable for studies in other regions and ethnic groups. The local conservation priorities presented orient the task of zoologists and ecologists towards a sustainable regulation and/or management of species. Finally, they allow choosing premises that can be focused on by sensibilization, interpretation, intercultural and environmental educational tasks in order to mitigate the harmful effects of extractive activities, overexploitation and reduction of the animal and cultural diversity of the Argentine Chaco.

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