Research Article

Trends in Medicinal Uses of Edible Wild Vertebrates in Brazil

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1. Introduction

Wildlife represents an immeasurable source of raw materials that support health systems of different human cultures that depend on nature as a source of medicines to treat and cure illnesses [1]. Plants and animals have been used as medicinal sources since ancient times, and even today animal- and plant-based pharmacopeias continue to play an essential role in health care. Although plants and plant-derived materials make up the majority of the ingredients used in most traditional medical systems globally, whole animals, animal parts, and animal-derived products also constitute important elements of the materia medica [2–6].

The use of animal species as remedies, although representing an important component of traditional medicines (sometimes in association with plant species), has been much less studied than medicinal plants [1]. However, the importance of nonbotanical remedies (those of animal and mineral origin) is emerging [7], resulting in a recent boom in publications focusing on zootherapy [8–11].

Brazil is well known for its rich social/cultural diversity, as represented by more than two hundred indigenous people and a range of local communities, which in turn have contributed to the high diversity of traditional knowledge and practices which include the use of medicinal animals. Indeed, animals have been used as a source of medicine in the country and have played a significant role in healing practices as many people have used animals as medicines or alternative or supplementary treatments [12,13].

Hence, Brazil can be considered a model to extensive zootherapeutic studies, since the use of animals and animal-derived products is widespread among the country’s human cultures, as predicted by the zootherapeutic universality hypothesis [14]. Furthermore, the concomitant use of wild animals for nutritional and medicinal purposes is also diffuse in several localities in the country, thus highlighting their important role as food medicine in well-established folk medical practices [15].

Recent research has highlighted the predominant use of vertebrates as medicinal fauna in different medical systems
worldwide [1]. As remarked by Perry [16], this is an expected trend, considering the frequent interactions between people and vertebrates—typically large-bodied animals, which may provide a wide range of medicinal products. This raises particular conservation concerns, as some of these taxa are overharvested for their medicinal uses and are now threatened [1].

In this article, we provide an assessment of the uses of wild edible vertebrate species in Brazilian Traditional Medicine. The study focused on the following questions: (1) which edible vertebrate taxa are mostly used in the Brazilian Traditional Medicine? (2) Do the conditions treated by medicinal resources vary with taxonomical group and/or animal’s habitat?

2. Methods

Data used in this research resulted from an extensive analysis of the ethnozoological database provided by the Laboratório de Etnozoologia, Universidade Estadual da Paraíba. The database comprises information from ethnozoological studies on faunal medicinal use performed in all Brazilian regions. Additional data was gathered through information available in reviews published by the laboratory researchers [17–19].

Data analysis comprised information on species of edible vertebrates used as medicines, their family classification, habitats, conservation status, and conditions to which animals were prescribed. We only considered those taxa that could be identified to species level, and the scientific nomenclature of the taxa recorded (fishes, amphibians, reptiles, and mammals) and/or habitats were in accordance with the following databases: Fishbase (Froese and Pauly, 2016; http://www.fishbase.org/), Amphibian Species of the World (http://research.amnh.org/herpetology/amphibia/index.php), The Reptile Database (http://www.reptile-database.org/), and Mammal Species of the World [20]. With regard to habitat analysis, marine and estuarine species were grouped in the same category (i.e., coastal and marine); if a marine species was also reported to freshwater environments, it habitat was categorized as coastal and marine/freshwater. Moreover, continental species which could inhabit both terrestrial and aquatic systems were considered as semi-aquatic species.

The conservation status of the analysed species follows the International Union for the Conservation of Nature [21], the Convention on International Trade in Endangered Species of Wild Fauna and Flora [22], and the Brazilian red lists (decrees 444 and 445, Brazilian Ministry of Environment, 2014). Health conditions considered in this research were categorized by the International Statistical Classification of Diseases and Related Health Problems (ICD-10 Version: 2016; http://apps.who.int/classifications/icd10/browse/2016/en).

2.1. Data Analysis. All data were verified for normal distribution (Shapiro–WilK’s test) and homogeneity of variance (Levene’s test) and nonparametric tests were performed when those assumptions were not met.

A Kruskal–Wallis test (followed by Dunn’s post hoc test) and an ANOVA were performed to determine whether the number of health conditions treated per species varied among vertebrate taxonomic groups or habitat types, respectively. Resemblance between health conditions treated (grouped into ICDs categories) and taxonomic groups or animals’ habitat types were assessed based on Jaccard’s similarity index, where resulting matrices were used to perform cluster analyses. Due to low number of species recorded (n = 3), amphibians were excluded from all statistical analysis regarding taxonomic groups.

3. Results

At least 204 edible vertebrate species have been used in Brazilian Traditional Medicine (see Table 1). Fishes were the most represented group (n = 97 species), followed by mammals (n = 48), reptiles (n = 29), birds (n = 27), and amphibians (n = 3). Most medicinal animals are aquatic (58.9%), mostly inhabiting freshwater (27.0% of total counts) and coastal/marine (26.5% of total counts) environments (Figure 1). Terrestrial and semiaquatic vertebrates corresponded to 38.7% and 2.5% of medicinal vertebrates recorded, respectively.

Edible medicinal vertebrates were reportedly used to treat 165 health conditions/diseases (see Table 2). A single illness could be treated by various animal species (e.g., 67 animal species were used in the treatment of asthma and 60 in the treatment of rheumatism), and although most species (particularly fishes, mammals, and birds) were used to treat only one (n = 85; 41.7%) or up to five illnesses (n = 156; 76.5%), several were prescribed for treating multiple illnesses (>5 conditions; n = 48, 23.5%), as shown in Figure 2. Reptiles were the most versatile group, as they were mostly used in the treatment of multiple conditions, with almost half of the species (n = 14) being used to treat more than 10 illnesses (Figure 2). Indeed, from the 10 most expressive species in the treatment of multiple conditions (see Table 1), seven are reptiles, for instance, the “teju” and the boa snake (Salvator teguixin and Boa constrictor, resp.; n = 28 health conditions prescribed, each), the Neotropical rattlesnake (Crotalus durissus; n = 27 conditions), the green sea turtle (Chelonia mydas; n = 25 conditions), and the common caiman (Caiman crocodilus; n = 24 conditions). Moreover,
Table 1: Vertebrate species (scientific and common names, when available) used as medicine food in Brazil, with remarks to habitats, conservation status, and health conditions to which each animal is prescribed. Families and species name in alphabetical order.

| Taxa             | Health conditions treated                                                                 | Habitat          |
|------------------|------------------------------------------------------------------------------------------|------------------|
| **Fishes**       |                                                                                         |                  |
| Anostomidae      |                                                                                         |                  |
| *Leporinus friderici* (Bloch, 1794), threespot leporinus | Earache            | Freshwater      |
| *Schizodon kneri* (Steindachner, 1875), “piau-branco” | Leucoma, edema     | Freshwater      |
| Arapaimidae      |                                                                                         |                  |
| *Arapaima gigas* (Schinz, 1822), “arapaima,” “pirarucu,” “pirosca” | Asthma, pneumonia | Freshwater      |
| Arhynchobatidae  |                                                                                         |                  |
| *Atlantoraja cyclophora* (Regan, 1903), eyespot skate | Haemorrhage after delivery | Marine          |
| **Ariidae**      |                                                                                         |                  |
| *Aspistor luniscutis* (Valenciennes, 1840), “bagre-amarelo” | Pain relief in injuries caused by the species’ sting | Marine/brackish |
| *Bagre bagre* (Linnaeus, 1766), coco sea catfish, “bagre-fidalgo” | Injuries caused by itself | Marine/brackish |
| *Genidens barbus* (Lacepède, 1803), white sea catfish, “bagre-do-mangue” | Pain relief in injuries caused by the species’ sting | Marine/brackish |
| *Genidens genidens* (Cuvier, 1829), sea catfish, “bagre” | Injuries caused by itself | Marine/brackish |
| Aspredinidae      |                                                                                         |                  |
| *Aspredinichthys tibicen* (Valenciennes, 1840), tenbarbed banjo, “viola” | Asthma            | Freshwater/brackish |
| *Aspredo aspedo* (Linnaeus, 1758), banjo catfish, “banjo,” “viola” | Asthma            | Freshwater/brackish |
| **Auchenipteridae** |                                                                                         |                  |
| *Trachelyopterus galeatus* (Linnaeus, 1766), “cumbá” | Umbilical hernia, asthma, sexual impotence | Freshwater      |
| **Balistidae**   |                                                                                         |                  |
| *Balistes capriscus* Gmelin, 1789, grey triggerfish, “peixe-porco” | Bronchitis        | Marine/reef     |
| *Balistes vetula* Linnaeus, 1758, queen triggerfish, “cangulo,” “capado,” “peroá” | Stroke, asthma, thrombosis, earache, pain relief in injuries caused by the species’ sting, hemorrhage, ascites, schistosomiasis, appendicitis, menstrual cramps, gastritis | Marine/reef |
| **Batrachoididae** |                                                                                         |                  |
| *Thalassophryne nattereri* Steindachner, 1876, venomous toadfish, “niquim” | Pain relief caused in injuries by the species’ sting | Marine/brackish |
| Bryconidae        |                                                                                         |                  |
| *Brycon nattereri* Günther, 1864, “pirapitinga,” “matrinchá” | Flu               | Freshwater      |
| **Callichthyidae** |                                                                                         |                  |
| *Callichthys callichthys* (Linnaeus, 1758), “cascarudo,” “caboge” | Asthma, umbilical hernia | Freshwater |
| **Lamnidae**     |                                                                                         |                  |
| *Carcharodon carcharias* (Linnaeus, 1758), great white shark | Osteoporosis       | Marine/brackish |
| *Isurus oxyrinchus* Rafinesque, 1810, shortfin mako | Osteoporosis       | Marine          |
| Taxa                        | Health conditions treated                                      | Habitat                                      |
|---------------------------|----------------------------------------------------------------|---------------------------------------------|
| Carcharhinidae            |                                                                |                                             |
| *Carcharhinus falciformis* (Müller & Henle, 1839), silky shark | Osteoporosis                                                   | Marine/reef                                  |
| *Carcharhinus leucas* (Müller & Henle, 1839), bull shark, “tubarão-cabeça-chata” | Osteoporosis                                                   | Marine/brackish/reef/freshwater              |
| *Carcharhinus limbatus* (Müller & Henle, 1839), blacktip shark, “sucuri preto” | Osteoporosis                                                   | Marine/brackish/reef                         |
| *Carcharhinus obscurus* (Lesueur, 1818), dusky shark          |                                                                |                                             |
| *Carcharhinus porosus* (Ranzani, 1839), smalltail shark, “junteiro,” “caçã-galha-preta” | Asthma, rheumatism, wounds, inflammations, osteoporosis, anemia | Marine/brackish                              |
| *Galeocerdo cuvier* (Péron & Lesueur, 1822), tiger shark, “jaguará” |                                                                |                                             |
| *Negaprion brevirostris* (Poey, 1868), lemon shark            |                                                                |                                             |
| *Rhizoprionodon lalandii* (Müller & Henle, 1839), Brazilian sharpnose shark, “caçao” | Rheumatism, osteoporosis                                   | Marine                                      |
| *Rhizoprionodon porosus* (Poey, 1861), Caribbean sharpnose shark, “caçao” | Rheumatism, osteoporosis                                   | Marine/brackish/reef/freshwater              |
| Sphyrnidae                |                                                                |                                             |
| *Sphyrna lewini* (Griffith & Smith, 1834), scalloped hammerhead, “peixe-martelo,” “caçao-paná,” “caçao-chapeu” | Asthma, wounds, rheumatism, inflammation                  | Marine/brackish/reef                         |
| *Sphyrna mokarran* (Rüppell, 1837), great hammerhead          |                                                                |                                             |
| *Sphyrna zygaena* (Linnaeus, 1758), smooth hammerhead          |                                                                |                                             |
| Squalidae                 |                                                                |                                             |
| *Squalus cubsensis* Howell Rivero, 1936, Cuban dogfish          |                                                                |                                             |
| Rhinobatidae              |                                                                |                                             |
| *Rhinobatos percellens* (Walbaum, 1792), Chola guitarfish      |                                                                |                                             |
| Centropomidae             |                                                                |                                             |
| *Centropomus parallelus* Poey, 1860, fat snook                  |                                                                |                                             |
| *Centropomus undecimalis* (Bloch, 1792), common snook, “rubalão” |                                                                |                                             |
| Characidae                |                                                                |                                             |
| *Astyanax bimaculatus* (Linnaeus, 1758), twospot astyanax, “piaba-mirim,” “machadinha,” “piaba chata” | Alcoholism, leishmaniosis, skin burns, wounds, rheumatism   | Freshwater                                   |
| Clupeidae                 |                                                                |                                             |
| *Harengula jaguana* (Poey, 1865), scaled herring, “sardinha”    |                                                                |                                             |
| *Opisthonema oglinum* (Lesueur, 1818), Atlantic thread herring, “sardinha” |                                                                |                                             |
| Cynodontidae              |                                                                |                                             |
| *Hydrolycus scomberoides* (Cuvier, 1816), Payara, “cachorra”    |                                                                |                                             |
Table 1: Continued.

| Taxa                     | Health conditions treated                                                                 | Habitat                        |
|--------------------------|-------------------------------------------------------------------------------------------|--------------------------------|
| Dasyatidae               |                                                                                            |                                |
| *Dasyatis guttata* (Bloch & Schneider, 1801), longnose stingray, “raia branca”               | Asthma, pain relief in injuries caused by the species’ sting, burns                     | Marine                         |
| *Dasyatis manieranae* Gomes, Rosa & Gadig, 2000, Brazilian large-eyed stingray, “raia mariaquita,” “raia de fogo” | Asthma, pain relief in injuries caused by the species’ sting, burns                     | Marine/reef                     |
| Diodontidae              |                                                                                            |                                |
| *Chilomycterus antillarum* Jordan & Rutter, 1897, web burrfish                               | Wounds, lump                                                                      | Marine/reef                     |
| *Chilomycterus spinosus* spinosus (Linnaeus, 1758)                                          | Wounds, lump                                                                      | Marine/brackish                 |
| Doradidae                |                                                                                            |                                |
| *Franciscodoras marmoratus* (Lütken, 1874), “Urutu”                                      | Injuries caused by itself                                                        | Freshwater                      |
| *Lithodoras dorsalis* (Valenciennes, 1840), Rock-bacu                                     | Swelling                                                                       | Freshwater                      |
| *Megalodoras uranoscopus* (Eigenmann & Eigenmann, 1888), “cuiu-cuiu”                       | Rheumatism                                                                     | Freshwater                      |
| *Oxydoras niger* (Valenciennes, 1821), ripsaw catfish, “cuiu-cuiu”                         | Rheumatism                                                                     | Freshwater                      |
| *Platydoras costatus* (Linnaeus, 1758), Raphael catfish, “cuiu-cuiu”                        | Rheumatism                                                                     | Freshwater                      |
| *Pterodoras granulosus* (Valenciennes, 1821), granulated catfish, “cuiu-cuiu”             | Rheumatism                                                                     | Freshwater                      |
| Echeneidae               |                                                                                            |                                |
| *Echeneis naucrates* Linnaeus, 1758, live shark sucker, “rêmora,” “pegador”                 | Asthma, bronchitis                                                            | Marine/brackish/reef             |
| *Remora remora* (Linnaeus, 1758), shark sucker, “rêmora”                                   | Osteoporosis                                                                  | Marine/reef                      |
| Erythrinidae             |                                                                                            |                                |
| *Erythrinus erythrinus* (Bloch & Schneider, 1801), ”Matròe”                                | Asthma                                                                        | Freshwater                      |
| *Hoplias malabaricus* (Bloch, 1794),trahira, “traíra”                                      | Ophthalmological problems, rheumatism, cataracts, wounds, snake bite, conjunctivitis, stroke, thrombosis, asthma, toothache, fever, earache, diarrhoea, deafness, boils, bleeding, alcoholism, tetanus, sore throat, itching, sprains, leucoma | Freshwater                      |
| *Hoplias aimara* (Valenciennes, 1847)                                                    | Earache                                                                       | Freshwater                      |
| Cichlidae                |                                                                                            |                                |
| *Cichla melaniæ* Kullander & Ferreira, 2006                                               | Pain relief in injuries caused by the ray sting                                 | Freshwater                      |
| Gadidae                  |                                                                                            |                                |
| *Gadus morhua* Linnaeus, 1758, Atlantic cod, “bacalhau”                                    | Boils                                                                         | Marine/brackish                 |
| Ginglymostomatidae       |                                                                                            |                                |
| *Ginglymostoma cirratum* (Bonnaterre, 1788),nurse shark, “cação-lixa”                      | Rheumatism, osteoporosis                                                     | Marine/brackish/reef             |
| Taxa                  | Health conditions treated                                                                 | Habitat                      |
|----------------------|-------------------------------------------------------------------------------------------|------------------------------|
| Gymnotidae           |                                                                                           |                              |
| *Electrophorus electricus* (Linnaeus, 1766), electric eel, “poraquê” | Sprains, bruises, insect bites, snake bite, asthma, flu, pain in general, muscle strain, rheumatism, osteoporosis, deafness, pneumonia, itching | Freshwater                   |
| Heptapteridae        |                                                                                           |                              |
| *Pimelodella brasiliensis* (Steindachner, 1876), “mandim” | Injuries caused by that fish species                                                      | Freshwater                   |
| Holocentridae        |                                                                                           |                              |
| *Holocentrus adscensionis* (Osbeck, 1765), squirrelfish, “jaguaricá” | Wounds                                                                        | Marine/reef                  |
| Megalopidae          |                                                                                           |                              |
| *Megalops atlanticus* Valenciennes, 1847, tarpon, “camurupim,” “cangurupim” | Stroke, headache, asthma, shortness of breath, thrombosis, chest pain, injuries caused by bang | Marine/brackish/reef/freshwater |
| Monacanthidae        |                                                                                           |                              |
| *Cantherhines macrocerus* (Holland, 1853), American whitespotted filefish | Asthma                                                                       | Marine/reef                  |
| *Monacanthus ciliatus* (Mitchell, 1818), fringed filefish | Asthma                                                                       | Marine/reef                  |
| Muraenidae           |                                                                                           |                              |
| *Gymnothorax funebris* Ranzani, 1839, green moray, “moréia verde” | Bleeding (wounds)                                                              | Marine/reef                  |
| *Gymnothorax moringa* (Cuvier, 1829), spotted moray, “moréia pintada” | Bleeding (wounds)                                                              | Marine/reef                  |
| *Gymnothorax vicinus* (Castelnau, 1855), purplemouth moray, “moréia” | Bleeding (wounds)                                                              | Marine/reef                  |
| Myliobatidae         |                                                                                           |                              |
| *Aetobatus narinari* (Euphrasen, 1790), spotted eagle ray, "raia-chita" | Asthma, pain relief in injuries caused by the species' sting, burns, haemorrhage | Marine/reef                  |
| Narcinidae           |                                                                                           |                              |
| *Narcine bancraffiti* (Griffith & Smith, 1834), lesser electric ray | Pain                                                                           | Marine                       |
| *Narcine brasiliensis* (Olfers, 1831), Brazilian electric ray, “raia elétrica” | Toothache                                                                     | Marine/reef                  |
| Pimelodidae          |                                                                                           |                              |
| *Practocephalus hemiolopterus* (Bloch & Schneider, 1801), redtail catfish, “Pirarara” | Asthma, wounds, hernia, burns in the skin, rheumatism, flu, cough              | Freshwater                   |
| *Pseudoplaty stigma corruscans* (Spix & Agassiz, 1829), spotted sorubim, “sorubim” | Flu, removal of wrath                                                          | Freshwater                   |
| *Pseudoplaty stigma fasciatum* (Lunnaeus, 1776), barred sorubim, “sorubim” | Cold                                                                           | Freshwater                   |
| *Sorubimichthys planiceps* (Spix & Agassiz, 1829), firewood catfish, “sorubim chicote” | Leishmaniosis, tuberculosis                                                     | Freshwater                   |
| *Zungaro zungaro* (Humboldt, 1821), gilded catfish, black manguruyu, “jaú” | Asthma, toothache, earache, wounds, athlete's foot, burns in the skin, rheumatism, flu | Freshwater                   |
| Taxa                      | Health conditions treated                                                                 | Habitat              |
|--------------------------|-------------------------------------------------------------------------------------------|----------------------|
| **Potamotrygonida**      |                                                                                           |                      |
| *Paratrygon aiereba* (Müller & Henle, 1841), discus ray, “arraia” | Asthma, hernia, flu, pneumonia, cough, earache, burns                                    | Freshwater           |
| *Plesiodyction iwamae* Rosa, Castello & Thorson, 1987, long-tailed river stingray | Pain relief in injuries caused by the species’ sting, wounds, cracks in the sole of the feet |                      |
| *Potamotrygon hystric* (Müller & Henle, 1834), porcupine river stingray, “arraia” | Asthma, hernia, flu, pneumonia, cough, earache, burns                                    | Freshwater           |
| *Potamotrygon motoro* (Müller & Henle, 1841), South American freshwater stingray, ocellate river stingray, “arraia” | Asthma, hernia, flu, pneumonia, cough, earache, burns                                    | Freshwater           |
| *Potamotrygon orbignyi* (Castelnau, 1855), smooth back river stingray, “arraia” | Pain relief in injuries caused by that species’ sting                                      | Freshwater           |
| **Pristidae**            |                                                                                           |                      |
| *Pristis pectinata* Latham, 1794, smalltooth sawfish, “espadarte,” “peixe-serra” | Asthma, rheumatism, arthritis                                                            | Marine/brackish/freshwater |
| *Pristis perotteti* Müller & Henle, 1841, largemouth sawfish, “espadarte” | Asthma, rheumatism, arthritis                                                            | Marine/brackish/freshwater |
| **Prochilodontidae**     |                                                                                           |                      |
| *Prochilodus argenteus* Spix & Agassiz, 1829, ”curimatá-pacá,” “curimatá” | To avoid swelling of the breast feeding, mycosis                                           | Freshwater           |
| *Prochilodus niger* Spix & Agassiz, 1829, black prochilodus, “curimatá” | Chilblain, skin burns, wounds, rheumatism, eye pains                                     | Freshwater           |
| **Serrasalmidae**        |                                                                                           |                      |
| *Colossoma macropomum* (Cuvier, 1818), cachama, “tambaqui”                          | Paralysis of arms and legs                                                                | Freshwater           |
| *Mylossoma duriventre* (Cuvier, 1818), pacu, “pacu-manteiga”                         | Venereal disease                                                                         | Freshwater           |
| *Serrasalmus brandtii* Lütken, 1875, white piranha, “pirambeba”                      | Inflammations, sexual impotence                                                           | Freshwater           |
| **Sciaenidae**           |                                                                                           |                      |
| *Cynoscion acoupa* (Lacepède, 1801), acoupa weakfish, “pescada amarela” | Renal failure                                                                            | Marine/brackish/freshwater |
| *Cynoscion leidreus* (Cuvier, 1830), smooth weakfish, “pescada branca”              | Renal failure                                                                            | Marine/brackish       |
| *Micropogonias furnieri* (Desmarest, 1823), whitemouth croaker, “corvina”          | Pain relief in injuries caused by the species’ sting, cough, asthma, bronchitis           | Marine/brackish       |
| *Pachyurus francisci* (Cuvier, 1830), San Francisco croaker, “crvina-de-bico”      | Asthma, urinary incontinence, backache                                                   | Freshwater           |
| *Plagioscion squamosissimus* (Heckel, 1840), South American silver croaker, “curvina” | Urinary disorders, haemorrhage, snake bites                                              | Freshwater           |
| *Plagioscion surinamensis* (Bleeker, 1873), Bashaw, “pacora,” “curvina”            | Urinary disorders, haemorrhage, snake bites                                              | Freshwater           |
| **Sparidae**             |                                                                                           |                      |
| *Calamus penna* (Valenciennes, 1830), sheephead porgy, “peixe-pena”                | Asthma                                                                                 | Marine/reef           |
### Table 1: Continued.

| Taxa                      | Health conditions treated                                                                 | Habitat                      |
|---------------------------|-------------------------------------------------------------------------------------------|------------------------------|
| Synbranchidae             |                                             |                              |
| *Synbranchus marmoratus*  | Bronchitis                                  | Freshwater/brackish          |
| Bloch, 1795, marbled swamp eel, “muçum” |                                             |                              |
| Tetraodontidae            |                                             |                              |
| *Colomesus psittacus*     | Breast cancer, backache, warts              | Marine/brackish/freshwater   |
| (Bloch & Schneider, 1801), banded puffer, “baiacu” |                                             |                              |
| *Sphoeroides testudineus* | Rheumatism                                  | Marine/brackish/reef          |
| Linnaeus, 1758, checkered puffer, “baiacu” |                                             |                              |
| Trichiuridae              |                                             |                              |
| *Trichiurus lepturus*     | Asthma                                      | Marine/brackish              |
| Linnaeus, 1758, largehead hairtail |                                             |                              |
| Urotrygonidae             |                                             |                              |
| *Urotrygon microphthalmum*| Asthma, pain relief in injuries caused by the species’ sting, burns | Marine                      |
| Delsman, 1941, small eyed round stingray, “raia” |                                             |                              |
| Amphibians                |                                             |                              |
| Bufonidae                 |                                             |                              |
| *Rhinella jimi* (Stevaux 2002) | Urinary incontinence, dental caries, cancer, wounds, boils, erysipelas acne, inducing abortion | Semiaquatic                  |
| Leptodactylidae           |                                             |                              |
| *Leptodactylus cf. labyrinthicus* (Spix, 1824), South American pepper frog, “jia-de-pelito,” “rá–pimenta” | Earache, rheumatism, joint pain, cancer, sore throat | Semiaquatic                  |
| *Leptodactylus vastus*    | Sore throat, cough, asthma, arthritis, backache, tonsillitis, hoarseness | Semiaquatic                  |
| Lutz, 1930, South American pepper frog, ra-pimenta |                                             |                              |
| Reptiles                  |                                             |                              |
| Iguanidae                 |                                             |                              |
| *Iguana iguana* (Linnaeus, 1758), Common iguana, “camaleão” | Earache, erysipelas, asthma, rheumatism, edema, abscesses, joint pain, wounds, acne, athlete’s foot, sore throat, swelling, burn, tumour, sucking a splinter out of skin or flesh, boil, injuries caused by the spines of the “arraia” and others fishes, inflammation, hernia | Terrestrial                  |
| Teiidae                   |                                             |                              |
| *Tupinambis merianae*     | Earache, deafness, rheumatism, erysipelas, skin thorns and wounds, respiratory diseases, sore throat, snake bite, asthma, tumour, swelling, infection, bronchitis | Terrestrial                  |
| (Duméril & Bibron, 1839), Lizard, “tegu,” “tejuacú” | Sexual impotence, rheumatism, erysipelas, dermatitis, snake bites, asthma, tetanus, earache, thrombosis, wounds, infection of nail, swelling, herpes zoster, irritation when milk teeth are erupting, jaundice, inflammation, tumour, sore throat, infection, bronchitis, injuries caused by the spines of the “arraia,” pain relief in injuries caused by snake bites, toothache, sucking a splinter out of skin or flesh, headache, cough, stroke, coarse throat | Terrestrial                  |
| *Tupinambis teguixin*     |                                             |                              |
| Linnaeus, 1758, Lizard, “tegu,” “tejuacú” |                                             |                              |
| Taxa                      | Health conditions treated                                                                                             | Habitat       |
|---------------------------|------------------------------------------------------------------------------------------------------------------------|---------------|
| **Boidae**                |                                                                                                                        |               |
| *Boa constrictor* (Linnaeus, 1758),*Boa, “jibóia”*                                                                   | Rheumatism, lung disease, thrombosis, boils, tuberculosis, stomach ache, edema, snake bite, cancer, ache, swelling, helping to prevent abortion, pain in the body, inflammation, athlete's foot, calluses, tumours, cracks in the sole of the feet, goitre, sore throat, arthrosis, insect sting, dog bite, erysipelas, thrombosis, asthma, neck strain, strain muscle | Terrestrial   |
| *Corallus hortulanus* (Linnaeus, 1758), snake                                                                         | Assisting in removing spines or other sharp structures from the skin, rheumatism                                       | Terrestrial   |
| *Eunectes murinus* (Linnaeus, 1758), anaconda, ”sucurujú,” ”sucuri”                                                 | Wounds, skin problems, bruises, sprains, arthrosis, rheumatism, boils, sexual impotence, headache, sore throat, thrombosis, swelling, tumour, asthma, muscle strain, numbness, syphilis, reducing pain, luxation | Semiaquatic   |
| *Epicrates cenchria* (Linnaeus, 1758), Brazilian rainbow boa, ”salamanta”                                          | Rheumatism, pain in articulations, injuries caused by itself, sore throat, earache                                     | Terrestrial   |
| **Crotalidae**            |                                                                                                                        |               |
| *Crotalus durissus* (Linnaeus, 1758), Neotropical rattlesnake, ”cascavel”                                          | Asthma, snake bite, thrombosis, wounds, luxation, rheumatism, pain in the legs, erysipelas, deafness, epilepsy, skin diseases, tuberculosis, hanseniasis, backache, tumour, boil, headache, earache, osteoporosis, sore throat, toothache, pain relief in injuries caused by sting of insects and snake bite, irritation when milk teeth are erupting, tonsillitis, impotence, fatigue |               |
| **Chelidae**              |                                                                                                                        |               |
| *Phrynops geoffroanus* (Schweigger, 1812), Geoffroy's side-necked turtle, ”cágado”                                  | Asthma, sore throat, swelling, earache, rheumatism, arthrosis, healing of umbilical cord of newborn baby, mumps       | Freshwater    |
| *Phrynops tuberosus* (Peters, 1870)                                                                                  | Diphtheria, headache, earache, pain in the breast, wounds, furuncle, gastritis, swelling, haemorrhoids, sore throat, backache, eye problems, sucking a splinter out of skin or flesh, rheumatism, deafness | Freshwater    |
| *Mesoclemmys tuberculata* (Luederwaldt, 1926), tuberculate toadhead turtle, ”cágado,” ”cágado-d’água”             | Rheumatism, discharge, thrombosis, bronchitis, diarrhoea, haemorrhage, asthma, sore throat, hoarseness, muscle aches   | Freshwater    |
| Taxa                      | Health conditions treated                                                                 | Habitat       |
|--------------------------|---------------------------------------------------------------------------------------------|---------------|
| Cheloniididae            |                                                                                             |               |
| *Caretta caretta* (Linnaeus, 1758), loggerhead turtle, “tartaruga cabecuda” | Injuries caused by bang, toothache, diabetes, headache, backache, wounds, cough, bronchitis, asthma, thrombosis, rheumatism, stroke, hoarseness, flu, backache, earache, sore throat, swelling | Marine        |
| *Chelonia mydas* (Linnaeus, 1758), green sea turtle, “tartaruga verde,” “aruana” | Injuries caused by bang, toothache, diabetes, headache, backache, wounds, cough, bronchitis, asthma, flu, thrombosis, rheumatism, toothache, stroke, hoarseness, earache, sore throat, swelling, whooping cough, arthritis, erysipelas, boil, wounds, arthrosis, inflammation | Marine        |
| *Eretmochelys imbricata* (Linnaeus, 1766), Atlantic hawksbill, “tartaruga de pente” | Injuries caused by bang, toothache, diabetes, headache, backache, wounds, cough, bronchitis, asthma, thrombosis, stroke, hoarseness, flu, rheumatism, earache, sore throat, swelling | Marine        |
| *Lepidochelys olivacea* (Eschscholtz, 1829), olive ridley | Injuries caused by bang, toothache, diabetes, headache, backache, wounds, cough, bronchitis, asthma, thrombosis, rheumatism, stroke, hoarseness | Marine        |
| Dermochelyidae           |                                                                                             |               |
| *Dermochelys coriacea* (Vandelli, 1761), leatherback turtle, “tartaruga de couro” | Rheumatism, earache, sore throat, swelling | Marine        |
| Geoemydidae              |                                                                                             |               |
| *Rhinoclemmys punctularia* (Daudin, 1802), spot-legged turtle | Wounds, tumour, erysipelas, earache, rheumatism | Semiaquatic   |
| Podocnemididae           |                                                                                             |               |
| *Podocnemis expansa* (Schweiger, 1812), Amazon river turtle, "tartaruga da amazônia" | Inflammation, acne, tumour, boil, rheumatism, pterygium, skin spots, backache, earache, arthrosis, arthritis, swelling, wrinkle | Freshwater    |
| *Podocnemis unifilis* (Troschel, 1848), yellow-spotted river turtle, "tracajá" | Wounds, tumour, erysipelas, earache, rheumatism | Freshwater    |
| *Podocnemis sextuberculata* Cornalia, 1849, six-tubercled Amazon River turtle | Blackhead, acne | Freshwater    |
| *Peltoccephalus dumeriliana* Schweigger 1812, “Cabeçuda” | Blackhead, acne | Freshwater    |
| Testudinidae              |                                                                                             |               |
| *Chelonoidis carbonaria* (Spix, 1824), red-footed tortoise, “jabuti” | Catarrh, erysipelas, bronchitis, stopping the sensation of getting thirsty, asthma | Terrestrial   |
| *Chelonoidis denticulata* (Linnaeus, 1766), yellow-footed tortoise, “jabuti” | Sore throat, rheumatism, hernia, wounds, leishmaniosis, varicocele, earache | Terrestrial   |
| Taxa            | Health conditions treated                                                                 | Habitat   |
|----------------|------------------------------------------------------------------------------------------|-----------|
| Kinosternidae  |                                                                                         |           |
| *Kinosternon acutum* (Linnaeus 1766), Tabasco Mud Turtle                                  | Muscle aches                                     | Freshwater|
| Alligatoridae  |                                                                                         |           |
| *Caiman crocodilus* (Linnaeus, 1758), common cayman, “jacaré tinga”                     | Asthma, stroke, bronchitis, backache, earache, rheumatism, thrombosis, sexual impotence, snake bites (antidote), evil eye, irritation when milk teeth are erupting, discharge, swelling, scratch, athlete’s foot, ophthalmological problems, asthma, sore throat, amulet used as a protection against snake bite, rheumatism, hernia, prostate problems | Freshwater|
|                |                                                                                         |           |
| *Caiman latirostris* (Daudin, 1801), broad-snouted cayman, “jacaré-do-papo-amarelo”       | Asthma, sore throat, amulet used as a protection against snake bite, rheumatism, irritation when milk teeth are erupting, hernia, prostate problems | Freshwater|
|                |                                                                                         |           |
| *Melanosuchus niger* (Spix, 1825), black cayman, “jacare açú”                           | Thrombosis, infection, swelling, asthma, amulet used as a protection against snake bite, injuries caused by spines of the “arraia,” pain relief in injuries caused by snake bites | Freshwater|
|                |                                                                                         |           |
| *Paleosuchus palpebrosus* (Cuvier, 1807), dwarf cayman, “jacaré coroa,” “jacaré,” “jacaré-preto,” “crocodilo” | Irritation when milk teeth are erupting, snake bite (antidote), discharge, sore throat, amulet used as a protection against snake bite, hernia, prostate problems | Freshwater|
|                |                                                                                         |           |
| *Paleosuchus trigonatus* (Schneider, 1801), smooth-fronted cayman, “Jacaré coroa”       | Rheumatism                                        | Freshwater|
| Birds          |                                                                                         |           |
| Anatidae       |                                                                                         |           |
| *Sarkidiornis sylvicola* H. Ihering & R. Ihering, 1907, American Comb Duck, “putrião”     | Bleeding (wounds)                                | Terrestrial|
|                |                                                                                         |           |
| Anhimidae      |                                                                                         |           |
| *Anhima cornuta* (Linnaeus, 1766), horned screamer, "anuhma"                            | Intoxication from poisonous animals               | Terrestrial|
| Ardeidae       |                                                                                         |           |
| *Ardea cocoi* (Linnaeus, 1766), white-necked Heron                                      | Swelling, inflammation, injuries caused by the spines of the “arraia” and others fishes, asthma, boil, tumour, inflammation, rheumatism, earache | Terrestrial|
| Caprimulgidae  |                                                                                         |           |
| *Nyctidromus albicollis* (Gmelin, 1789), pauraque, “bacurau”                           | Amulets, snake bite                               | Terrestrial|
| Taxa          | Health conditions treated                                           | Habitat  |
|--------------|---------------------------------------------------------------------|----------|
| Cracidae     |                                                                     |          |
| *Penelope jacuca* (Spix, 1825), white-browed guan, “jacu”          | Insomnia, epilepsy                                                  | Terrestrial |
| *Pauxi tuberosa* (Spix, 1825), razor-billed Curassow                 | Bleeding, snakebite, indigestion, stroke, lack of appetite in children, pneumonia | Terrestrial |
| Ciconiidae   |                                                                     |          |
| *Ciconia maguari* (Gmelin, 1789), maguari stork                      | Injuries caused by the spines of the “arraia” and others fishes, thrombosis | Terrestrial |
| Columbidae   |                                                                     |          |
| *Columbina minuta* (Linnaeus, 1766), plain-breasted ground dove     | Lack of appetite, nausea during pregnancy                           | Terrestrial |
| *Columbina picui* (Temminck, 1813), Picui Dove                       | Lack of appetite, nausea during pregnancy, deafness                 | Terrestrial |
| *Columbina talpacoti* (Temminck, 1810), Ruddy Ground Dove, “rolinha-caldo-de-feijão” | Lack of appetite, nausea during pregnancy, deafness                 | Terrestrial |
| *Leptotila rufaxilla* (Richard & Bernard, 1792), Grey-Fronted Dove, “juriti” | Lack of appetite, nausea during pregnancy, deafness, sty, thrombosis | Terrestrial |
| Corvidae     |                                                                     |          |
| *Cyanocorax cyanopogon* (Wied, 1821), white-naped jay, “can-can”    | Asthma                                            | Terrestrial |
| Cuculidae    |                                                                     |          |
| *Crotophaga ani* Linnaeus, 1758, smooth-billed ani                   | Bronchitis, thrombosis, asthma, whooping cough                     | Terrestrial |
| *Guira guira* (Gmelin, 1788), guira cuckoo, “anum branco”            | Asthma                                            | Terrestrial |
| Charadriidae |                                                                     |          |
| *Vanellus chilensis* (Molina, 1782), southern lapwing, “quero-quero” | Helping to stay awake                                               | Terrestrial |
| Emberizidae  |                                                                     |          |
| *Coereba flaveola* (Linnaeus, 1758), bananquit, “caga-sebo”          | Thrombosis                                         | Terrestrial |
| Furnariidae  |                                                                     |          |
| *Furnarius rufus* (Gmelin, 1788), rufous hornero, “maria-barreira”   | Mumps                                              | Terrestrial |
| Podicipedidae|                                                                     |          |
| *Tachybaptus dominicus* (Linnaeus, 1766), Least Grebe, “mergulhão-pequeno,” “mergulhão,” “mergulhão-preto” | Eye problems                                      | Semiaquatic |
| Rallidae     |                                                                     |          |
| *Aramides cajanea* (Statius Müller, 1776), grey-necked wood-rail, “saracura” | Evil eye                                           | Terrestrial |
| Rheidae      |                                                                     |          |
| *Rhea americana* (Linnaeus, 1758), greater rhea, “ema”               | General aches, rheumatism, thrombosis, strokes                  | Terrestrial |
Table 1: Continued.

| Taxa                      | Health conditions treated                                      | Habitat       |
|---------------------------|-----------------------------------------------------------------|---------------|
| **Tinamidae**             |                                                                  |               |
| Crypturellus noctivagus   | Thrombosis, stroke                                              | Terrestrial   |
| (Wied, 1820), yellow-legged tinamou, “zabele” |                                                                  |               |
| Crypturellus tataupa      | Assisting children who take longer than usual to start walking   | Terrestrial   |
| (Temminck, 1815), Tataupa Tinamou |                                                                  |               |
| Crypturellus parvirostris | Assisting children who take longer than usual to start walking   | Terrestrial   |
| (Wagler, 1827), small-billed Tinamou |                                                                  |               |
| Nothura boraquira         | Thrombosis, stroke, earache                                     | Terrestrial   |
| (Spix, 1825), white-bellied nothura, “codorna” |                                                                  |               |
| Nothura maculosa          | Snake bite                                                      | Terrestrial   |
| (Temminck, 1815), Spotted Nothura, “lambú espanta-boiada,” “lambú-de-capoeira” |                                                                  |               |
| Tinamus tao               | Assisting children who take longer than usual to start walking   | Terrestrial   |
| Temminck, 1815, Grey Tinamou |                                                                  |               |
| Rhynchotus rufescens      | Thrombosis, snake bites (antidote)                              | Terrestrial   |
| (Temminck, 1815), red-winged tinamou, “perdiz” |                                                                  |               |

**Mammals**

| Agoutidae                 |                                                                  |               |
| Cuniculus paca            | Wound in the breast caused by suckling, ophthalmological problems, stomach disorders, pterygium, sucking a splinter out of skin or flesh, injuries caused by the spines of “arraia,” control of cholesterol level | Terrestrial   |
| (Linnaeus, 1766), spotted paca, “paca” |                                                                  |               |

**Bovidae**

| Bubalus bubalis            | Rheumatism, osteoporosis, thrombosis                             | Terrestrial   |
| (Linnaeus, 1758), water buffalo (feral), “búfalo” |                                                                  |               |

| Bradypodidae              |                                                                  |               |
| Bradypus variegatus       | Thrombosis                                                      | Terrestrial   |
| Shinz, 1825, brown-throated three-toed sloth, “Preguiça pequena” |                                                                  |               |
| Bradypus tridactylus      | Thrombosis, insects bite, scorpions bite                        | Terrestrial   |
| Linnaeus, 1758, pale-throated three-toed sloth, “Preguiça” |                                                                  |               |

**Canidae**

| Cerdocyon thous           | Rheumatism, flu, haemorrhoids, disorders after parturition (to accelerate recovery after parturition) | Terrestrial   |
| (Linnaeus, 1766), crab-eating fox, “raposa” |                                                                  |               |
| Chrysocyon brachyurus     | Epilepsy                                                        | Terrestrial   |
| (Illiger, 1815), maned wolf, “lobo-guará” |                                                                  |               |
| Dusicyon thous            | Alcoholism, thrombosis, rheumatism, ophthalmological problems, diabetes, urinary infection | Terrestrial   |
| Linnaeus, 1766, crab-eating fox, “raposa” |                                                                  |               |

**Caviidae**

| Cavia aperea              | Inflammation                                                   | Terrestrial   |
| Erxleben, 1777, Brazilian Guinea Pig, “Preá” |                                                                  |               |
| Galea spixii              | Inflammation                                                   | Terrestrial   |
| (Wagler, 1831), Spix’s Yellow-Toothed Cavy |                                                                  |               |
| Kerodon rupestris         | Constipation                                                   | Terrestrial   |
| (Wied-Neuwied, 1820), Rock Cavy, “Mocó” |                                                                  |               |

**Cebidae**

| Alouatta belzebul         | Whooping cough, sore throat, asthma                             | Terrestrial   |
| (Linnaeus, 1766), red-handed howler monkey, “guariba,” “macaco” |                                                                  |               |
Table 1: Continued.

| Taxa | Health conditions treated | Habitat |
|------|---------------------------|---------|
| **Alouattanigerrima** Lönningberg, 1941, Black Howler Monkey | Whooping cough, inflammation | Terrestrial |
| **Alouatta macconnelli** (Linnaeus, 1766), red howler monkey, "guariba vermelho" | Whooping cough, inflammation, accelerating parturition | Terrestrial |
| **Sapajus apella** (Linnaeus, 1758), brow capuchin, “capuchin,” “macaco,” “macaco-prego” | Insect sting | Terrestrial |
| **Cervidae** | | |
| **Blastocerus dichotomus** (Illiger, 1815), marsh deer, “cervo-do-pantanal” | Diarrhoea, vomit | Terrestrial |
| **Mazama americana** (Erxleben, 1777), red brocket, “veado gaedo” | Stroke | Terrestrial |
| **Mazama simplicicornis** (Illinger, 1811) | Diarrhoea, verminosis, evil eye | Terrestrial |
| **Mazama gouazoupira** (G. Fischer, 1814), grey brocket, “veado-catingueiro” | Asthma, edema, rheumatism, snake bite, thrombosis, assisting children who take longer than usual to start walking, toothache, wounds, sprains | Terrestrial |
| **Ozotocerus bezoarticus** (Linnaeus, 1758), Pampas Deer, veado campineiro | Diarrhoea, verminosis, evil eye | Terrestrial |
| **Dasypodidae** | | |
| **Dasypus novemcinctus** (Linnaeus, 1758), nine-banded armadillo, “tatu galinha” | Thrombosis, insects bite, scorpions bite, edema, asthma, deafness, earache, evil eye | Terrestrial |
| **Euphractus sexcinctus** (Linnaeus, 1758), six-banded armadillo “tatu peba” | Wounds, earache, evil eye, asthma, sore throat, pneumonia, sinusitis, deafness, coarse throat | Terrestrial |
| ** Tolypeutes tricinctus** (Linnaeus, 1758), Brazilian three-banded armadillo, “tatu-bola” | Thrombosis, rheumatism | Terrestrial |
| **Priodontes maximus** (Kerr, 1792), giant armadillo, tatu-canastra | Snake bite | Terrestrial |
| **Dasyproctidae** | | |
| **Dasyprocta prymnolopha** Wagler, 1831, black-rumped agouti, “Cutia” | Asthma, thrombosis, earache | Terrestrial |
| **Dolphinidae** | | |
| **Sotalia fluviatilis** Gervais & Deville (1853), grey dolphin, grey river dolphin, “boto” | Asthma, headache, rheumatism, hernia, womb disorders, sore throat, injuries caused by the spines of the “arraia,” swelling, haemorrhoids inflammation, wounds, earache, erysipelas, athlete’s foot, tumour, cancer | Freshwater |
| **Sotaliaguianensis** (P. J. Van Béne dén, 1864), Guianan River Dolphin, “boto” | Asthma, headache, rheumatism, hernia, womb disorders, sore throat, injuries caused by the spines of the “arraia,” swelling, haemorrhoids inflammation, wounds, earache, erysipelas, athlete’s foot, tumour, cancer | Marine |
| **Didelphidae** | | |
| **Didelphis albiventeris** (Lund, 1840), White-Eared Opossum, “timbú” | Boils | Terrestrial |
| **Didelphis marsupialis** (Linnaeus, 1758), Black-Eared Opossum, “mucura,” “gamba,” “sarué” | Acne, wounds, bronchitis, joint pain, stomach ache, rheumatism, diarrhoea, inflammation, erysipelas, pain in gestation, asthma, headache, toothache, earache, sore throat | Terrestrial |
| Taxa               | Health conditions treated                                      | Habitat     |
|-------------------|----------------------------------------------------------------|-------------|
| **Echimyidae**    |                                                                |             |
| *Thrichomys laurentius* Thomas, 1904, “punaré”                    | Diarrhoea   | Terrestrial |
| Erethizontidae    |                                                                |             |
| *Coendou prehensilis* (Linnaeus, 1758), Brazilian porcupine, “coandú,” “porco espinho” | Bronchitis, thrombosis, epilepsy, stroke, abscesses, conjunctivitis, asthma | Terrestrial |
| Hydrochaeridae    |                                                                |             |
| *Hydrochaeris hydrochaeris* (Linnaeus, 1766), capybara, “capibara,” “capivara” | Thrombosis, conjunctivitis, venereal disease, rheumatism, earache, strengthen bones, liver pain, bronchitis, asthma, wounds, erysipelas, cough | Terrestrial |
| **Iniidae**       |                                                                |             |
| *Inia geoffrensis* (Blainville, 1817), Amazon river dolphin, “boto rosa” | Asthma, headache, rheumatism, hernia, womb disorders, sore throat, injuries caused by the spines of the “arraia,” swelling, haemorrhoids inflammation, wounds, earache, erysipelas, athlete’s foot, tumour, cancer | Freshwater |
| **Leporidae**     |                                                                |             |
| *Sylvilagus brasiliensis* (Linnaeus, 1758), forest rabbit, tapeti, “coelho,” “coelho-do-mato” | Thrombosis, conjunctivitis, boils, burns | Terrestrial |
| **Mustelidae**    |                                                                |             |
| *Conepatus semistriatus* (Boddaert, 1785), striped hog-nosed skunk, “cangambá,” “gambambá,” tacaca | Rheumatism | Terrestrial |
| *Lontra longicaudis* (Olfers, 1818), Neotropical Otter, “Lontra” | Thrombosis | Terrestrial |
| **Myrmecophagidae** |                                                            |             |
| *Myrmecophaga tridactyla* Linnaeus, 1758, giant anteater, “tamanduá-bandeira” | Thrombosis, stroke | Terrestrial |
| *Myrmecophaga tetradactyla* (Linnaeus, 1758), collared anteater, “tamanduá” | Edema, thrombosis | Terrestrial |
| **Procyonidae**   |                                                                |             |
| *Nasu nasua* (Linnaeus, 1766), South American coati, “coati,” “quati” | Sexual impotence, wounds, skin burns, snake bites, backache | Terrestrial |
| *Procyon cancrivorus* (G. [Baron] Cuvier, 1798), crab-eating raccoon, “guaxinim” | Rheumatism, epilepsy, thrombosis, snake bite | Terrestrial |
| **Tapiridae**     |                                                                |             |
| *Tapirus terrestris* (Linnaeus, 1758), Brazilian tapir, “anta” | Rheumatism, arthrosis, osteoporosis, bursitis, muscular pain, asthma, tonsillitis | Terrestrial |
| **Tayassuidae**   |                                                                |             |
| *Pecari tajacu* Linnaeus 1758, collared peccary, “porco-do-mato,” “caititu” | Thrombosis, bronchitis, stroke | Terrestrial |
Table 1: Continued.

| Taxa                              | Health conditions treated                                                                 | Habitat   |
|-----------------------------------|------------------------------------------------------------------------------------------|-----------|
| *Tayassu pecari* (Link, 1795),    | Thrombosis, stroke                                                                        | Terrestrial |
| white-lipped peccary “porco-do-mato,” | “queixada”                                                                 |           |
| Trichechidae                      | Sprains, vaginal discharge, injuries caused by bang, burns, asthma, menstrual cramps, rheumatism, sore throat, wounds, muscle strain, sucking a splinter out of skin or flesh, tumour, backache, hernia, arthrosis, luxation, menstrual cramps, insects bite | Freshwater |
| *Trichechus inunguis* (Natterer, 1883), Amazonian manatee, “peixe-boi” | Sprains, vaginal discharge, injuries caused by bang, burns, asthma, menstrual cramps, rheumatism, sore throat, wounds, muscle strain, sucking a splinter out of skin or flesh, tumour, backache hernia, arthrosis, luxation, menstrual cramps, insects bite | Marine |
| *Trichechus manatus* (Linnaeus, 1758), West Indian Manatee, “peixe-boi” | Sprains, vaginal discharge, injuries caused by bang, burns, asthma, menstrual cramps, rheumatism, sore throat, wounds, muscle strain, sucking a splinter out of skin or flesh, tumour, backache hernia, arthrosis, luxation, menstrual cramps, insects bite | Marine |
| Felidae                           |                                                                                          |           |
| *Puma concolor* (Linnaeus, 1771), mountain lion, “onça” | Wounds, leishmaniosis                                                                     | Terrestrial |
| *Panthera onca* (Linnaeus, 1758), jaguar, “onça” | Wounds, leishmaniosis                                                                     | Terrestrial |
| *Herpailurus yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803), “gatovermelho,” “gato-azul,” Jaguarundi | Wounds                                                                                   | Terrestrial |
| *Leopardus pardalis* (Linnaeus, 1758), ocelot, “gato-maracajá,” | Headache, sore throat, backache, wounds                                                   | Terrestrial |
| *Leopardus tigrinus* (Schreber, 1775), oncilla, “gato-mirim” | Wounds, urinary incontinence, injuries, sore throat, sucking a splinter out of skin or flesh | Terrestrial |

the trahira fish (*Hoplias malabaricus*; n = 23 prescriptions) and the two manatee species recorded (*Trichechus inunguis* and *T. manatus*; n = 18 prescriptions, each) also stand out for being indicated to the treatment of multiple illnesses. Each species was prescribed to treat a mean of \(4.4 \pm 0.78\) (mean ± confidence interval) health conditions. Reptiles contributed with the highest mean number of diseases treated per species, while birds and fishes comprised the groups with the lowest means (Kruskal-Wallis test: \(H = 53.209; n = 201; p < 0.01\); Dunn’s post hoc test: \(p < 0.01\); Figure 3). Nonetheless, species showed similar number of prescriptions according to habitat type (\(F_{4,199} = 1.36; p = 0.247\)).

Prescriptions of edible medicinal vertebrates were generalised in 20 disease categories, according to ICD-10. From those, “symptoms, signs, and abnormal clinical and laboratory findings” were the most recorded category in terms of therapeutic quotes recorded, followed by “infectious and parasitic diseases” and “injuries, poisoning, and other consequences of external causes” (Table 2).

With regard to the number of species associated with ICD-10 categories, most animals were prescribed for treating problems associated with the “musculoskeletal system and connective tissue” and the “respiratory system” (each: n = 80 species; 39.2%), “injuries, poisoning, and other consequences of external causes” (67 species, 32.8%), and “symptoms, signs, and abnormal clinical and laboratory findings” (58 species, 28.4%) (Table 2).

Despite most medicinal vertebrates provide raw materials for remedies, medicinal products often have magical-religious purposes, particularly for the prevention of diseases of spiritual cause (e.g., evil eye); they were also used as amulets to prevent diseases (e.g., amulet used as a protection against snake bite). It is worth noting that many animals involved in poisoning accidents, such as stingrays and snakes,
Table 2: Medicinal uses of edible fishes and game species in Brazil. Health condition categories follow the International Statistical Classification of Diseases and Related Health Problems (ICD-10 Version: 2016). \( N = \) total number of conditions treated in each category.

| ICD 10 | Indication of use and therapeutic properties | \( N \) |
|--------|---------------------------------------------|---|
| Symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified \((n = 58\) species) | Ascites; chest pain; cough; cracks in the sole of the feet; edema (also quoted as edema in the legs); fatigue; fever; headache; hoarseness; inflammation; jaundice; lack of appetite (also quoted as lack of appetite in children); numbness; pain (also quoted as pain in the body; pain in the breast; pain in the legs; to reduce pain); shortness of breath; swelling; assisting children who take longer than usual to start walking; vomiting. | 24 |
| Certain infectious and parasitic diseases \((n = 40\) species) | Abscesses; athlete’s foot; diphtheria; erysipelas; herpes zoster; infection; leishmaniosis; leprosy; mumps; mycosis; schistosomiasis; syphilis; tetanus; tuberculosis; venereal disease; verminosis; warts; whooping cough. | 18 |
| Injury, poisoning, and certain other consequences of external causes \((n = 67\) species) | Bruises; burns (also quoted as burns in the skin); chilblains; injuries caused by bang; injuries caused by the animal itself; injuries caused by the spines of fishes (also quoted as injuries caused by the spines of rays); intoxication from poisonous animals; pain relief in injuries caused by the species’ sting; pain relief in injuries caused by snake bites; pain relief in injuries caused by sting of insects; scratch; assisting in removing spines or other sharp structures from the skin (also quoted as to suck a splinter out of skin or flesh); wounds. | 16 |
| Diseases of the digestive system \((n = 40\) species) | Appendicitis; constipation; dental caries; diarrhoea; gastritis; haemorrhoids; hernia (also quoted as umbilical hernia); indigestion; irrigation when milk teeth are erupting; liver pain; stomach ache; stomach disorders; toothache. | 14 |
| Diseases of the musculoskeletal system and connective tissue \((n = 80\) species) | Arthritis; arthrosis; backache; bursitis; luxation; muscular pain; neck strain; osteoporosis; pain in joint; rheumatism; sprains; helping to strengthen bones. | 13 |
| Diseases of the respiratory system \((n = 80\) species) | Asthma; bronchitis; catarrh; coarse throat; cold; flu; lung disease; pneumonia; respiratory diseases; sinusitis; sore throat; tonsillitis. | 12 |
| Diseases of the skin and subcutaneous tissue \((n = 21\) species) | Acne; blackhead; boils; calluses; dermatitis; itching; paronychia; skin diseases; skin spots; skin thorns and wounds; wrinkles. | 11 |
| Diseases of the genitourinary system \((n = 19\) species) | Menstrual cramps; nephritis; prostate problems; renal failure; urinary disorders; urinary incontinence; urinary infection; discharge (also quoted as vaginal discharge); womb disorders. | 10 |
| Pregnancy, childbirth, and the puerperium \((n = 12\) species) | Disorders after parturition (to accelerate recovery after parturition); haemorrhage after delivery; nausea during pregnancy; pain in gestation; helping to accelerate parturition; helping to avoid swelling of the breast feeding; helping to induce abortion; helping to prevent abortion; wound in the breast caused by sucking. | 9 |
| Diseases of the eye and adnexa \((n = 13\) species) | Cataracts; conjunctivitis; eye pains; ophthalmological problems (also quoted as eye problems); leucoma; pterygium; stye. | 8 |
| External causes of morbidity and mortality \((n = 25\) species) | Dog bite; insect sting; scorpions sting; snake bite; helping to stop the sensation of getting thirsty. | 5 |
| Undefined \((n = 11\) species) | Amulet; amulet used as a protection against snake bite; evil eye; helping to remove wrath. | 4 |
| Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism \((n = 12\) species) | Anaemia; bleeding (also quoted as wounds bleeding); haemorrhage. | 4 |
| Diseases of the circulatory system \((n = 42\) species) | Stroke; thrombosis; varicocele. | 3 |
| Diseases of the nervous system \((n = 5\) species) | Epilepsy; insomnia; paralysis of arms and legs. | 3 |
| Mental and behavioural disorders \((n = 13\) species) | Alcoholism; sexual impotence; helping to stay awake. | 3 |
Table 2: Continued.

| ICD 10                                                                 | Indication of use and therapeutic properties                                      | N  |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----|
| Endocrine, nutritional, and metabolic diseases                         | Diabetes, goitre; helping to control cholesterol level.                           | 3  |
| (n = 7 species)                                                        |                                                                                   |    |
| Neoplasms                                                              | Breast cancer; cancer (also quoted as tumour).                                    | 3  |
| (n = 18 species)                                                       |                                                                                   |    |
| Diseases of the ear and mastoid process                                | Deafness; earache.                                                                | 2  |
| (n = 40 species)                                                       |                                                                                   |    |
| Certain conditions originating in the perinatal period                 | Healing of umbilical cord of newborn baby.                                        | 1  |
| (n = 1 species)                                                        |                                                                                   |    |

Figure 2: Number of health conditions treated by each taxonomic group of edible vertebrates used in traditional medicines in Brazil, according to their taxonomic group. Numbers above bars: number of animal species analysed.

are also used in folk medicine, particularly to treat injuries caused by themselves (see Table 1).

Fishes and birds appear to have most similar use according to ICD-10 categories (Jaccard index: 94.4), as well as reptiles and mammals (Jaccard index: 90.0), resulting in two distinct clusters (Figure 4(a)). When considering resemblance between the disease categories recorded and animals’ habitat types, two distinct clusters were also formed (terrestrial, freshwater, coastal, and marine; costal and marine/freshwater and semi-aquatic) (Figure 4(b)), thus reflecting highest similarities between continental habitats (terrestrial and freshwater; Jaccard index: 90.0).

With regard to species conservation status, 160 animals figure in at least one of the three red lists assessed (see Table 1). In the ICUN red list, 33 species (mainly fishes and mammals) are classified into threatened categories, mostly as vulnerable (VU; n = 27) ones. Endangered (EN) and critically endangered (CR) species comprised six fishes and reptiles, namely, *Narcine bancroftii* and *Pristis pectinata* (CR) and *Sphyrna lewini*, *S. mokarran*, *Chelonia mydas*, and *Eretmochelys imbricata* (EN). In Brazilian red lists, most threatened animals are also considered VU (n = 22); EN species (n = 9) comprise mainly fishes and mammals; and CR ones (n = 8) comprise mainly fishes and marine reptiles. In CITES, 58 species are listed, especially in its Appendix II (n = 37), mammals and reptiles being the most expressive groups.
4. Discussion

The high number of vertebrates used as medicine is not surprising given the important role played by wildlife as a source of medicines in different traditional medicine systems [8, 10, 23, 24]. The predominance of fishes and mammals in the Brazilian Traditional Medicine confirms our expectations, given that those groups comprise major targets in Brazil [25–28]. Although these two taxa have been primarily harvested for alimentary purposes, they generate a series of the inedible parts [such as bone, skin, tail, feather, liver, and bile ("fel")], rattle (from rattlesnakes), spine, scale, penis, carapace, beak, teeth, head, nails, and horn that can be used in popular medicines. According to Moura and Marques [29] the use of leftover/secondary products derived from the fauna seems to be one of the most conspicuous features on the Brazilian popular zootherapy.

Zootherapeutic products, however, do not include inedible parts solely: flesh, eggs, and viscera are among some animal products used for both medicinal and alimentary purposes [1, 12, 13, 30, 31]. This corroborates the assumption that the consumption of wild vertebrates meat is often related to the purported medicinal or cultural benefits derived from the animal parts [32–35]. In a recent review study, Alves et al. [15] pointed out that at least 354 wild animal species are used in Brazilian Traditional Medicine, of which 157 are also used as food, evidencing that a close connection between eating and healing is common in Brazilian zootherapy. This is in line with several studies in ethnobiology and ethnopharmacology that have observed how difficult the clear separation between
medicines and foods can be [36–38] and this situation includes plants and animals, essential items for the preparation of traditional medicine.

Whether for food or medicinal purposes, the consumption of wild animals can lead to the transmission of various human diseases [39]. Van Vliet et al. [40] highlighted that the consumption of bushmeat for either purpose may lead to human infection by several zoonotic pathogens. Armadillos, for example, are widely used in folk medicine and are a natural reservoir of etiological agents of several zoonotic diseases that affect humans, such as leprosy, trichinosis, coccidioidomycosis or Valley Fever, Chagas disease, and typhus [41]. Therefore, it is essential that traditional drug therapies are submitted to an appropriate benefit/risk analysis [39].

It was found that several medicinal vertebrates used in the Brazilian Traditional Medicine have multiple therapeutic indications. The possibility of using various remedies for the same ailment is popular because it allows adapting to the availability of the animals. The fact that some medicinal animals are being used for the same purpose suggests that different species can share similar medicinal properties and might indicate the pharmacological effectiveness of those zootherapeutic remedies [8].

Multiple medicinal uses become even more evident when considering reptiles, as this group comprises one of the most important animal resources related to the medicine history [42] and is widely used in the most important traditional pharmacopoeias worldwide [35]. Indeed, the use in traditional medicines is the human practice that involves the highest diversity of reptile species in Brazil [17], some of which play important roles in traditional medicines, such as the “teju” (Tupinambis teguixin) and the boa snake (Boa constrictor), which are one of the most used medicinal animals in Brazil [42, 43]. Curiously, there is a general aversion to consuming some reptile groups, such as snakes and lizards, in the country. Nonetheless, this fact does not impair the use of these animals as medicines, as it is mainly associated with popular beliefs known as "simpatias," which, in most of the cases, state that "a person receiving a given treatment cannot know what he/she is taking, otherwise the effect ceases" [18]. Hence, this fact seems to favour the high use of reptile species, despite widespread aversion to those animals.

On the other hand, despite presenting the highest diversity of medicinal species, fishes were recommended to treat a comparatively low number of health conditions. This may be related to the fact that most parts of a fish are consumed as food; thus fewer products are left to be used in medicinal practices. Similarly, when considering major hunted taxa in Brazil, that is, mammals and birds [25, 26, 44], most species are also mostly consumed as food. However, the inedible parts generate “leftovers” (e.g., skin, tail, spine, scale, teeth, nails, and horn) which are among the main products used in traditional medicine. Indeed, according to Moura and Marques [29], the zootherapeutic use of the fauna is mainly based on derived leftovers/secondary products. Those authors also emphasise that, from the ecological theory point of view, the use of leftovers could be justified as an attempt to leverage the resources obtained from ecosystems which are inappropriate for alimentary consumption due to the mechanical difficulty of ingesting these parts, such as horns, feather, and scales. Therefore, one can expect that the diversity of leftovers provided by a species may support the potential to treat multiple diseases.

Animals from continental habitats (i.e., terrestrial and freshwater) were found to treat similar disease categories; the same could be found within coastal and marine animals. This may be related to the local distribution of the diseases treated, thus leading people to use local resources in the traditional medicine of each region. For instance, in coastal areas, the occurrence of diseases classified into the category “external causes of morbidity and mortality” is very common, due to sting/poisoning accidents caused by fishes (e.g., stingrays, catfish, and toadfish), which are often treated by zootherapeutic products derived from the animals that caused the lesions [45–48].

Natural resources play an essential role in health care in traditional medical systems, as well as in bioprosppecting for new drugs [49, 50], and the interest in animal-based products has raised [49, 51, 52]. Hence, despite the available information on the chemical components and actions of some of these products, studies on fauna traditional uses still are potentially very important to shed light on several aspects of their therapeutic applications [33].

The comprehension of the multiplicity and trends in therapeutic uses of several vertebrate species is of particular interest from a conservation perspective, as threatened animals, such as those recorded in this and other studies [30] could be replaced by nonthreatened species with similar properties. However, it is important to highlight that the use of animals for both food and medicinal purposes may impose higher pressure on those species under overexploitation conditions. For instance, if the animal is solely sought for medicinal purposes, it can lead the hunter/fisher to use selective capture techniques or even release nontargeted species. On the other hand, if an animal is captured for feeding reasons and is not the main target of the hunting or fishery (e.g., due to size), it can be kept by the hunter/fisher due to some medicinal property. Hence, understanding such complex interactions and trends in the use of fauna for nutritional and medicinal purposes evidences the important role that ethnobiological and ethnopharmacological studies may play in crucial discussion on the trade-offs between animal harvesting and its sustainability towards better regulation of those practices.

5. Conclusion

Wild edible vertebrates, particularly those inhabiting aquatic environments, are used to treat a wide range of health conditions in Brazil, with reptiles consisting of the most versatile group in multiple disease prescriptions. Moreover, a trend in prescriptions was found according to animals’ habitats, as disease categories were similar within continental and within coastal and marine habitats. Several consumed species are under threat, leading to a raise in conservation concerns, particularly due to the dual function (as food and medicines) those species present.
Conflicts of Interest

The authors declare that they have no conflicts of interest.

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