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FAUNISTIC RESOURCES USED AS MEDICINES BY ARTISANAL FISHERMEN FROM SIRIBINHA BEACH, STATE OF BAHIA, BRAZIL[1]

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ABSTRACT.– Artisanal fishermen from Siribinha Beach in the State of Bahia, Northeastern Brazil, have been using several marine/estuarine animal resources as folk medicines. We have recorded the employment of mollusks, crustaceans, echinoderms, fishes, reptiles, and cetaceans, and noted a high predominance of fishes over other aquatic animals. Asthma, bronchitis, stroke, and wounds are the most usual illnesses treated by animal-based medicines. These results corroborate Marques' zootherapeutic universality hypothesis. According to him, all human cultures that present a developed medical system do use animals as medicines. Further studies are requested in order to estimate the existence of bioactive compounds of pharmacological value in these bioresources.

Key words: Fishermen, marine resources, medicine, Bahia, Brazil

RESUMO.–Pescadores artesanais da Praia de Siribinha, estado da Bahia, Nordeste do Brasil, utilizam vários recursos animais marinhos/estuarinos como remédios populares. Registramos o emprego de moluscos, crustáceos, equinodermos, peixes, répteis e cetáceos. Observou-se uma alta predominância de peixes sobre outros animais aquáticos. Asma, bronquite, derrame e ferimentos são as afecções mais usualmente tratadas com remédios à base de animais. Estes resultados corroboram a hipótese da universalidade zooterapêutica de Marques. De acordo com ele, toda cultura humana que apresenta um sistema médico desenvolvido utiliza-se de animais como remédios. Estudos posteriores são necessários a fim de avaliar a existência de compostos bioativos de valor farmacológico nesses biorrecursos.

RÉSUMÉ.– Les pêcheurs artisanaux de la plage de Siribinha dans l'état de Bahia, au nord-est du Brésil, utilisent plusieurs ressources animales marines/estuarines en tant que médecine populaire. Nous avons enregistré l'emploi de mollusques, de crustacés, d'échinodermes, de poissons, de reptiles et de cétacés. Nous avons noté une prédominance élevée de poissons par rapport aux autres animaux aquatiques. L'asthme, la bronchite, les attaques, et les blessures sont les maux les plus habituellement traités par les remèdes à composante animale. Ces résultats corroborent l'hypothèse d'universalité zoothérapeutique de Marques. Selon lui, toute culture humaine qui présente un système médical développé utilise des animaux comme médicaments. D'autres études sont nécessaires afin d'évaluer l'existence de composés bioactifs à valeur pharmacologique dans ces resources biologiques.

INTRODUCTION

> "Naturally, fish fauna provides remedies, amulets, spurs, eyes, parts of the mandible, fins, fats, muscles, which take part in the current sea-shore folk medicine (...)".
>
> (Cascudo, 1972: 704)

Zootherapy is the healing of human diseases by using therapeutics that are obtained from animals, or ultimately are derived from them. As Marques (1994) states, "all human cultures that present a structured medical system utilize animals as medicines." Such a statement forms the basis of his 'zootherapeutic universality hypothesis.' Indeed, animals are therapeutic arsenals that have been playing significant roles in the healing processes, magic rituals, and religious practices of peoples from the five continents.

The medicinal interaction between humans and animals has been shown both in indigenous and Western societies all over the world (Gudger 1925; Conconi and Pino 1988; Antonio 1994; Marques 1995; van Huis 1996; Costa-Neto 1996, 1999a, 1999b). As some authors have pointed out, animal-based medicines have been utilized since antiquity (Weiss 1947; Angeletti et al. 1992; Rosner 1992), where popular remedies were elaborated from parts of the animal body, from products of its metabolism (corporal secretions and excrements), or from non-animal materials (nests and cocoons). An early record for animal-based medicine can be found in Tobias' Book (Catholic Bible), in which Raphael the Angel would have prescribed the use of a fish's liver content for the treatment of ophthalmic problems (Marques 1995).

The phenomenon of zootherapy has recently aroused the interest of many researchers from different branches of science, who have recorded this unusual cultural practice and sought for compounds with pharmacological action (Werner 1970; But et al. 1991; Bisset 1991; Faulkner 1992; Lazarus and Atilla 1993). This interest increases when it is considered that the annual global trade in animal-based medicinal products accounts for billions of dollars per year (Kunin and Lawton 1996). These authors have recorded that the investigation of folk medicines has proven a valuable tool in the developing art of bioprospecting for pharmaceutical compounds. Today from 252 essential chemicals that have been selected by the World Health Organization, 11.1% have plant origins, while 8.7% come from animals (Marques 1997).

In Brazil, an amazing number of about 300 animal species have been medicinally used. These resources can be easily found as commercial items sold by herbalists and curers in market places all over the country (Marques, personal communication 1996). In relation to marine/estuarine animals used as medicines, Marques (1995) has already recorded a total of 66 fish species in the folk medicines of fishing communities from 13 Brazilian states. According to him, the medicinal use of fish seems to be a very usual pattern in fishermen communities. Begossi (1992) has found that fish resources valued as medicines are usually considered taboos as food, perhaps so that they may be available as folk medicines (drugstore hypothesis).

Unfortunately, many of the zootherapeutic resources include threatened species (IBAMA 1989). In fact, the diminishing number of fauna species, especially from neotropical areas, through hunting, depauperation of their ecosystems, and their varied uses has been enormous that most of them are becoming extinct even before they have been studied by science (Huxtable 1992). Hence, studies aimed towards traditional knowledge on animal use and its significance to men should be undertaken in order to lead to better ways of exploiting the natural resources, thus, their conservation, so that future generations may know and manage them.

This paper provides an overview of the phenomenon by illustrating 39 zootherapeutic species that are prescribed by artisanal fishermen from Siribinha Beach, which is in the city of Conde, in the state of Bahia, Northeastern Brazil. Subsequent research needs to be done not only to confirm the presence of substances of medicinal value in these traditional remedies, but also to lead to a more ecologically sound exploration.

METHODOLOGY

Conde is a coastal city which is in the north region of the state of Bahia, northeastern Brazil (Figure 1). This region presents a humid/sub-humid climate, a mean temperature of 24.5°C, a mean annual rainfall of 1412 mm, and vegetation that is characteristic of tropical coastal areas (CEI 1994). Siribinha fishing community was chosen as the study area due to its localization, relative isolation, biological and ecosystem diversity, the lack of bibliographical knowledge about it, as well as the degree of both social and environmental impact to which it is submitted.

Fieldwork was performed from March 1996 to March 1998. Cultural data on zootherapy were obtained through tape-recorded, open-ended interviews carried out with 54 informants, both male and female. The informants were questioned about zootherapeutic species, the raw materials used, modes of elaboration and administration of the folk remedies, as well as the diseases for which the folk remedies are prescribed. Native words were used in order to generate a confidence relationship between interviewer and interviewees. The interviewees were asked whether recording the conversations and taking photographs were permitted.

The medicinal use-value of each animal were estimated according to the following equation:

$$UV = (\Sigma RM \times C)/ N,$$

UV represents the medicinal use value, RM refers to the total number of raw materials extracted from individual animals, C refers to the number of times which a particular animal has been cited, and N refers to the total number of informants questioned about zootherapy. Phillips and Gentry (1991, cited in Cotton 1993) developed this quantitative method in order to calculate the relative usefulness of different plant species within a given community.

Medicinal raw materials were collected and then catalogued and deposited at Feira de Santana State University (UEFS) with other ethnobiology collections. Some specimens that were sent to specialists for taxonomic identification were also in the collection. Crustaceans were identified by Dr. Tereza Calado (Alagoas Federal University), echinoderms by Dr. Winston Leahy (Alagoas Federal University), fish

specimens by Dr. Paulo Duarte (Laboratory of Ichthyology at UEFS), and the remaining animals were species known in this part of the country and were identified by the author using zoological references.

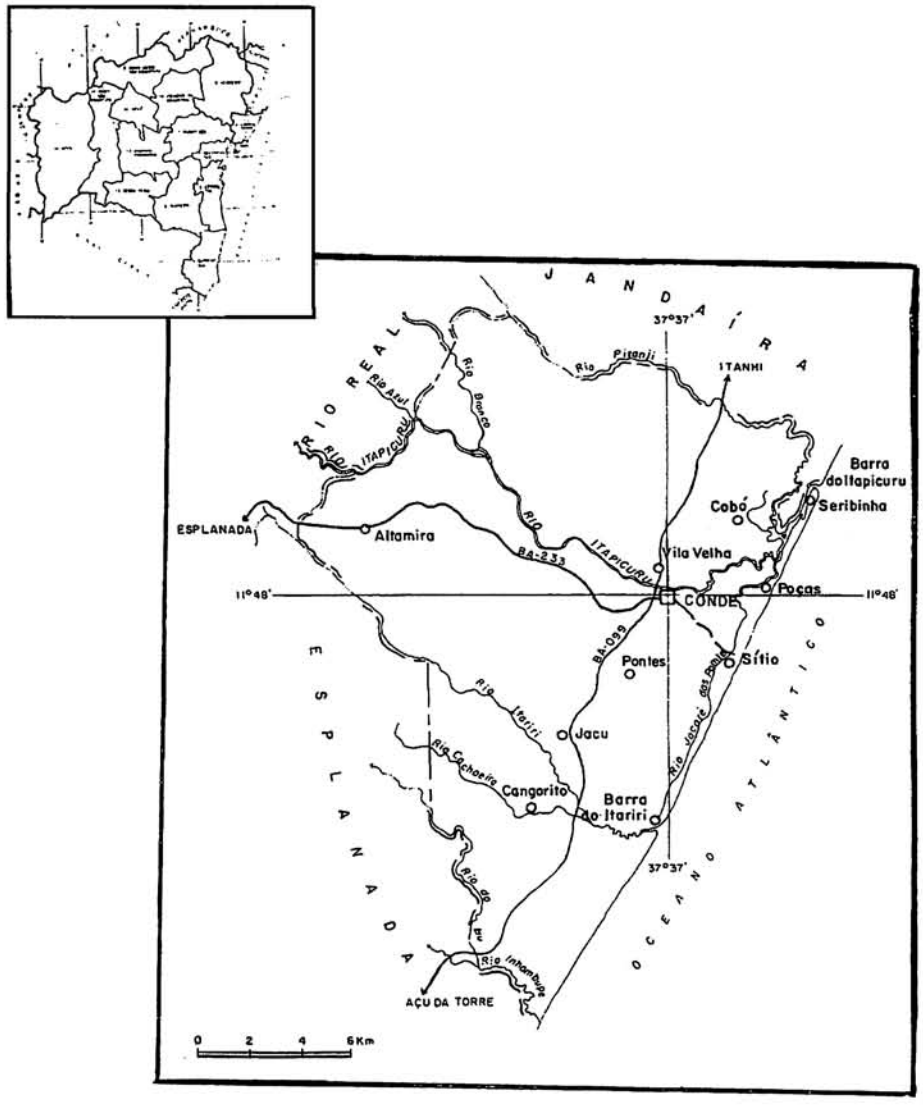

FIGURE 1. – Map showing location of the community of Siribinha where study was undertaken

RESULTS AND DISCUSSION

The medicinal use of marine/estuarine animals by the artisanal fishermen of Siribinha is one of the most consistent interactions that these fishermen perform with the local faunistic resources. Twenty-four fish species were recorded as having some therapeutic use when the fishermen were questioned about their folk medicine. Although interviews focused on fish-based medicines, fifteen other animals with medicinal properties were also cited. This makes up a total of 39 resources, which are distributed in six scientific taxonomic categories, such as fish (62%), crustaceans (13%), reptiles (10%), echinoderms (8%), mollusks (5%), and mammals (2%). Zootherapeutic species, the raw materials utilized, and diseases for which they are prescribed for are found in the Appendix.

A total of 66 raw materials including scales, spur, shell, fat, skin, globe of the eye, tentacles, otolith are used in the elaboration of remedies to treat locally diagnosed ailments. All of these resources, except the whale products, are relatively easy to obtain through hunting, fishing, or manual gathering. As can be seen in the Appendix, folk remedies are administered to the patients in the form of plasters, teas, smokes, and food. Teas, for example, are made by grinding the toasted or scraped parts of the body of the animals into powder or utilizing the whole toasted animal. Such is the case with echinoderms (starfish, sand dollar, and sea urchin) and syngnathids (seahorse). Fats, which are derived from 17 different animals, are the most usual medicinal resources and are recommended to treat a variety of diseases. As one fisherman observed, "the fat of a sea turtle sustains and heals any disease." The great majority of the animals utilized in local medicine provide only one raw material, which is prescribed for the treatment of specific diseases. This is the case with squid, whose toasted internal shell is recommended for asthma.We found that queen triggerfish (*Balistes vetula*), sea turtles (*Chelonia mydas, Eretmochelys imbricata, Caretta caretta,* and *Lepidochelys olivacea*), and toadfish (*Thalassophryne nattereri*) were the most significant zootherapeuticals, with medicinal use-values (UV) of 0.92, 0.81, and 0.72, respectively. Although some zootherapeutic species generated indices lower than 0.50, these were both medicinally and culturally significant resources since a relatively high number of interviewees cited them. Such is the case with long-snout seahorse (*Hippocampus reidi*), with a UV value of 0.44, octopus (*Octopus* cf. *variegatus*), with UV value of 0.14, squid (*Loligo* sp.), with a UV value of 0.04, Atlantic tarpon (*Tarpon atlanticus*), with a UV value of 0.25, remora (*Echeneis naucrates*), with a UV value of 0.29, sharks, with a UV value of 0.29, and catfish (*Bagre bagre, Sciadeichthys luniscutis,* and *Netuma barba*), with a UV value of 0.12. The low rank of these species results from the fact that they do not represent multiple-use medicinal species.

Fishermen also use live fish, such as swamp eel (*Synbranchus marmoratus*) and cascarudo (*Callichthys* cf. *callichthys*). The former, with a UV value of 0.04, is prescribed for bronchitis and to make an infant child walk sooner. The latter, which presented a medicinal use-value of 0.02, is recommended for asthma and umbilical hernia. By spitting into their mouth and leaving them alive in the river, it is believed that these fish take bronchitis and asthma away; a child is thought to walk sooner by rubbing the fish over its legs; and cascarudos are recommended as food for the treatment of umbilical hernia. The procedure of applying live fish to

someone's body or spitting into a fish's mouth and then freeing it is a common practice both in Brazilian and other folk medicines (Branch and Silva 1983; Begossi and Braga 1992; Marques 1995). The placement of live fish under the soles of patients suffering from jaundice or similar ailment was already cited by Shimshon Morpurgo in his book *Responsa* published in Venice in 1743 (Rosner 1992: 190).

Fishermen have a singular way to treat themselves from the injuries caused by poisonous fish, especially the toadfish (*Thalassophryne nattereri*). This fish has hollow opercular spines on its dorsal fin that are associated with bulky poison glands. Due to its bentonic habit, since it lives buried under the mud or sand in shallow waters, fishermen sometimes tread on it; the fish defends itself against the careless passer-by by injecting its poison in the person's sole. In order to avoid pain and other more serious complications, fishermen take the fish's globe of the eye ("goga do olho") immediately after contact and rub it on the injured area. Guilherme Piso, a Dutch doctor who came to Brazil in the company of Prince Maurício de Nassau in 1695, stated that "This fish is considered as having the remedy to its own poison in itself" (Piso 1957: 51). This kind of preventive medicine is performed with catfish (*Bagre bagre*, *Sciadeichthys luniscutis*, and *Netuma barba*) and the queen triggerfish (*Balistes vetula*). Another way of avoiding the pain caused by the toadfish sting is to eat the toadfish it without salt. In doing this, fishermen say they are immunized against its poison. According to the users' testimony, it can be hypothesized that analgesic substances are indeed present in the bodies of these fish species. Further studies are requested in order to test this. According to Norse (1993), the chemical identities of the toxins of poisonous fish are still being determined.

We noted some similarities between the zootherapeutic healing practices currently found in Siribinha Beach and in other fishing communities. For example, Begossi and Braga (1992) have recorded the medicinal use of ray by the fishermen from Tocantins River. Its sting is used for the treatment of asthma, cough, cold, and pneumonia. In the state of Alagoas, fishermen use the sting to treat themselves for pneumonia (Marques 1995). In the Amazon folk medicine, the oil extracted from the liver of the ray *Potomotrygon hystrix* is used for the treatment of hernia and asthma (Branch and Silva 1983). In Siribinha, stingrays (*Myliobates* sp.; UV = 0.02) are also used in the folk veterinary medicine by employing the powder of a toasted sting to heal domestic animals' wounds.

A prescription involving toasted seahorses (*Hippocampus* spp.) is also both geographically and historically well disseminated. According to Botsaris (1995), the African slaves introduced the practice of using syngnathids as medicine in Brazil. As a result, these fish have been recommended in Afro-Brazilian traditional medicine as a tonic to treat physical debility, impotence, and asthma as well as rheumatism, bronchitis, and gastritis (Lages-Filho 1934; Marques 1995). The medicinal use of seahorses in Brazil has been confirmed in at least eight states, Alagoas, Espírito Santo, São Paulo, Paraná, Bahia, Santa Catarina, Piauí, and Rio de Janeiro (Marques 1995). In Siribinha Beach, toasted seahorses have been used in cases of asthma. Clinical and pharmacological research carried out on mice, with alcoholic extracts of *Hippocampus*, led to a weight increase of the uterus and ovaries and a prolongation of the estrogen period in females, while in males it caused an in-

crease in the weight of the prostate and testicles, and a prolongation of the time of erection (Botsaris 1995).

Other fish species are used medicinally, including the cod (*Gadus* cf. *marhua*; UV = 0.04), whose skin is put on furuncles, the curimata (*Prochilodus* sp.; UV = 0.02), whose fat is used as a plaster to treat boils, the electric ray (*Narcine brasiliensis*; UV = 0.05), whose fat is used for treatment of toothache, the grunt (*Haemulon* sp.; UV = 0.02), whose liver's fat is put on swollen areas, the sheepshead porgy (*Calamus pena*?; UV = 0,02), whose toasted fin is used for curing asthma, the snook (*Centropomus undecimalis*; UV = 0.02), whose toasted fat is rubbed over swollen legs, the two-spot astyanax (*Astyanax* cf. *bimaculatus*; UV = 0.02), which is recommended for alcoholism, and the trahira (*Hoplias malabaricus*; UV = 0,10), whose fat is recommended for the treatment of asthma, bleeding, boils, wounds, snakebites, and conjunctivitis. Only one informant cited the medicinal use of the croak (*Micropogonias furnieri*; UV = 0.02), although was unable to identify the disease for which this fish is prescribed.

Siribinha fishermen use five folk species of crabs. These include the mangrove crab (*Ucides cordatus*; UV = 0.02), whose fat is recommended for treating women's hemorrhage, the giant land crab (*Cardisoma guanhumi*; UV = 0.02), whose fat is used as a plaster for the cicatrization of wounds, the ghost crab (*Ocypode quadrata*; UV = 0.04), whose toasted whole body is used for asthma, the jellyfish crab (an uncollected specimen; UV = 0.04), which is also used for asthma, and the hermit crab (a pagurid; UV = 0.02), whose toasted whole body is recommended to treat women's hemorrhage. Interestingly, the powder of crab shells in infusions has been reported in the state of Alagoas, northeastern Brazil, as an anti-asthmatic (Lages-Filho 1934). Indeed, pharmacological studies have shown the presence of anti-inflammatory, antibiotic, and anti-tumor substances in the bodies of crabs (Croft 1986).

The value of animal-based medicines.– Although zootherapy is considered by some to be a weird, even absurd practice, its pertinence should be emphasized. As many researches point out, the significance of traditional medicines cannot be denied since they have become sources of drugs within modern medical science (Launet 1993; Lazarus and Attila 1993; Ferreira 1993; Marques 1997). Worldwide, a number of pharmaceutical companies have been supporting research on marine animal-derived compounds to be used directly as medicines and as new chemical structures that could be turned into remedies (Norse 1993; Fusetani 1996).

Regarding fish, several compounds have been extracted and are employed as remedies in standardized medicines (Hamada and Nagai 1995; Salte et al. 1996). Finkl (1984), for example, refers to *Eptatretus stoutii*, *Dasyatis sabina*, and *Taricha* sp. as sources of cardiac stimulants, antitumors, and analgesic, respectively. Oily fish, like cod, herring, salmon, and turbot, have a great medicinal value to human beings due to a polyunsaturated compound known as OMEGA-3. This substance helps with the prevention of arthritis (Adeodato 1997). The presence of an anticoagulant system in the plasma of Atlantic salmon (*Salmo salar* L.) and rainbow trout (*Oncorhynchus mykiss* Walbaun) has been confirmed, which supports similarities with the protein C anticoagulant system in mammals (Salte et al. 1996). Tetrodotoxin (TTX), a water-soluble guanidinium derivative, is an example of a bioactive

compound produced by marine organisms such as puffer fish "that resembles procaine in its ability to inhibit transmission of nerve cells" (Colwell 1997). When diluted it acts as an extraordinary narcotic and analgesic (Bisset 1991). Maybe due to this property, Siribinha fishermen use the liver's content (***"fel"***) of the puffer fish (*Colomesus* sp.; UV = 0.11) for the treatment of toothache, although it has a lethal venom.

In relation to crustaceans, chemists from the Federal University of Ceará, in Brazil, have developed three products that are extracted from discarded crustacean shells (lobsters, shrimps, and crabs). The biopolymers chitin, chitosan, and glucosamin are used to combat cholesterol and obesity, and regenerate cartilage and burnt tissues (Nogueira 1999).

Echinoderms are another group of marine organisms that yield a rich source of potential chemicals. Pharmacological studies have shown important active compounds in species, such as *Actinopyga agassizi* (anti-tumor), *Acanthaster planci* (antiviral), and *Asterias forbesi* (anti-inflammatory) (Finkl 1984). According to Aliño et al. (1990), there are studies indicating that the use of sea urchins as vermifuge might have a scientific basis. Echinoids have been also used to make artificial blood veins (Russel 1978, cited in Mallmann 1996). In the folk medicine of Siribinha's fishermen, teas made with the powder of the toasted sand dollar (*Mellita* sp.), starfish (*Luidia senegalensis*), and sea urchin (*Echinometra lucunter*) are commonly recommended for the treatment of asthma. These resources are very commonly used, although their UV was only 0.16.

In 1995, scientists from the Servier Research Institute in Paris discovered the way sea turtles reduce their cerebral activity while submerged in order to save oxygen (Anonymous 1995). This physiological process was referred to as the 'turtle effect'. This study on the cerebral activity of sea turtles may lead to the development of drugs against apoplexy.

Threatened species as zootherapeuticals.– Of the 39 animals considered as sources of medicine to the Siribinha fishermen, only four are officially listed as threatened species by the Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA, 1989). These are represented by the sea turtles, which are also cited by the Convention on International Trade of Endangered Species (http://www.cites.org). Five of the world's eight known species use the Brazilian coastline as hatcheries or feeding ground (http://www.wwf.org.br/wwfeng/wwfpr35.htm). In the Bahian territory, four species used to be widely caught and killed for both food and income by the coastal peoples, indigenous and artisanal fisherman communities, who have inhabited its coastline. Sea turtles were captured specially during the reproductive season when females come up onto the beach to lay their eggs. According to the interviewees, several turtles were hung alive for a couple of days before being killed. The eggs themselves were also taken, while their shells were used to make glasses, combs, rings, necklaces, and bracelets.

Indeed, coastal peoples all over the world fish sea turtles for subsistence and commerce. For example, the Miskito Indians from the eastern coast of Nicaragua are very dependent on green turtles (*Chelonia mydas*). They catch sea turtles for their meat, leather, shell, oil, and calipee, a gelatinous substance that is the base

for turtle soup (Nietschmann 1974). Among the coastal people of northern Mindanao and the Visayan islands of Bohol, Cebu, and Negritos in central Philippines, the flesh of green turtle and hawksbill turtle (*Eretmochelys* sp.) is cooked with vinegar, soy sauce, garlic, laurel leaves, pepper corn, and salt, and then eaten for the treatment of asthma (Aliño et al. 1990).

This extractive pressure has increased in such a way that all eight species of sea turtles are now on the endangered species list. Population growth and advanced harvesting technologies made possible the enlargement of the fishing power as well as overexploitation of natural resources. Nietschmann (1974) stated that the industrial fishing nets that were introduced in the Miskito's culture helped to kill a greater number of turtles than when these Indians solely used harpoons. Siribinha fishermen have generated their own theory to explain the diminishment of sea turtles and sharks– the shrimp trawl fishery. This fishery is primarily done by outside, motorboat fishermen, who go to their fishing grounds to trawl shrimp. Vincent and Hall (1996) have already reported the negative impacts of trawling on marine organisms. In addition to this direct human persecution, sea turtles are also the victims of environmental changes and pollution.

Due to the drastic decline of wild populations, conservation measures have been taken and legislative laws now prohibit sea turtle fishing. In Brazil, the TAMAR (*Tartarugas Marinhas*) project was set up in 1980 to protect sea turtle feeding grounds and hatcheries along the Brazilian coast (about 1,000 kilometers of beaches). This is a worthwhile project since only a few tens of hawksbill turtles breed in the northeast of Brazil, specifically on the Bahian coast. At present, TAMAR has 22 bases in eight Brazilian states, at strategic nesting and feeding points along the coast.

This relatively recent intervention, however, has raised an exogenous taboo, institutionalized by rules that have been imposed on local communities by both government and conservation agents. These rules have resulted in the disconnection of a strong human/animal interaction that has a long history. Although fishermen fear being caught by IBAMA agents and taken to jail, they undertake transgressions and break the rules. Some turtles are indeed captured and eaten, or have their eggs harvested. We had the chance to document the cultural scene in which three young fishermen butchered an adult green turtle (*C. mydas*), and extracted its flesh and oil as food and remedy respectively. According to their explanation, the turtle appeared floating in the estuary and apparently died a few hours previously due to the bite of a shark on its right flipper ("***aba***"). However, this incident occurred in a very concealed way because collecting wild animal species is not considered a bailable crime in Brazil.

We would also like to call attention to the importance of seahorses. Although they are not included on the Brazilian list of endangered species, they were listed by IUCN in 1996. The alleged cause of this endangerment has been the great demand of seahorse specimens for Chinese traditional medicine, aquariums, and curios (Vincent and Hall 1996). Due to their worldwide use, seahorses are becoming rare in some regions of the globe. For example, in Indonesia the population of some species has dropped to half since 1990, with pregnant males being the most common prey.

The number of seahorses is indeed diminishing in Siribinha, as can be seen in the following informant's assertion:

> We took them to the market to be sold. People bought them for remedies. We fished a lot of them. My husband used to catch several of them, which were sun-dried and tied together in a string. He sold them at the market. But you do not see my son? Even they have disappeared that we do not find them anymore. (Mrs. Zulmira, 90 years old)

We would suggest that a biostatistical study on the wild populations of seahorses and their folk-commercial importance be carried out in order to develop reliable conservation measures that are both scientifically and culturally oriented.

Zootherapy and its sustainability.– Instead of sending the practitioners of zootherapy to prisons, or creating policies which force them to abandon such practices, decision-makers should view this human/nature interaction within its cultural dimensions. The value of animal-based medicines are very significant; they are usually the main available resources for the majority of the human population with limited access to official medicines and medical care. Since people have been using animals for a long time, suppression of their use will not save them from extinction. Considering the sea turtles, Carr (1996: 127) stated that "people have been eating turtles pretty steadily for as long as they have had the wits to get them out of their shells". In addition, millions of hatchlings are caught annually for the pet market.

A growing body of literature shows that the cultural aspects of a given human/nature interrelation should be taken into account in all debates related to sustainable development (Morin-Labatut and Akhtar 1992; Sachs 1993; Agrawal 1995; Zwahlen 1996). This cultural perspective includes the way people perceive, use, allocate, transfer, and manage their natural resources (Johannes 1993). As Alcorn (1995: 20) states, "Conservation is a social and political process." In this way, discussing the relationship between food provided by the environment, their trophic use, the physiological consequences that result from their being eating, as well as the social-economical structures that support them within the multidimensionality of the sustainable development is one of the key elements to achieve sustainability (Bahuchet 1997).

Researchers should recognize that the sustainable use of natural resources due to their medicinal value is one of the ways by which biodiversity is used (Celso 1992). According to Kangas (1997), sustainable development is tied indirectly to biodiversity through the need to maintain overall environmental values. However, the demand for natural products from marine organisms can become a serious problem if collectors overexploit the typically sessile organisms (Norse 1993). Yet, we have to realize that the negative impacts on biological diversity should not be restricted only to the traditional users, but should be extended to the use by pharmaceutical industries (Marques 1997).

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NOTES

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APPENDIX.– Folk prescriptions of zootherapeutic resources used by artisanal fishermen from Siribinha Beach, state of Bahia, Brazil.

MOLLUSKS

Octopus, "Polvo" (*Octopus* cf. *variegatus*) Cephalopoda, Octopodidae
Get the "arms" (tentacles), toast them, and then grind to make a tea that is drunk for curing asthma;
The powder of the toasted "lixa" (shell rudiment ?) is used to make a tea, which is drunk to treat "doença do vento" (stroke ?);
Get the hide (skin), burn it, and breathe the smoke to heal headache.

Squid, "Lula" (*Loligo* sp. ?) Cephalopoda, Lolliginidae
Get the "stone" (internal shell), toast it, and make a tea for curing asthma.

ECHINODERMS

Sand Dollar, "Estrela-da-costa" (*Mellita* sp.) Echinoidea, Mellitidae
The whole toasted starfish is turned into a tea to treat asthma.

Sea Urchin, "Pinaúna" (*Echinometra lucunter*) Echinoidea, Echinometridae
Idem

Starfish, "Estrela-do-mar" (*Luidia senegalensis*) Asteroidea, Luidiidae
Idem

CRUSTACEANS

Giant Land Crab, "Gaiamum" (*Cardisoma guanhumi*) Decapoda, Gecarcinidae
Get the "fel" (fat?), make a plaster, and put it on wounds to help their cicatrization.

Ghost Crab, "Grauçá" (*Ocypode quadrata*) Decapoda, Ocypodidae
Get a ghost crab, toast it, and then grind to make a tea, which is drunk to treat asthma.

Hermit Crab, "Caranguejo-ermitão" (Species not determined) Anomura, Paguridae
Get a hermit crab, take it away from the shell, toast it and grind to make a tea; then drink it to treat women's hemorrhage.

Jellyfish Crab, "Caranguejo-da-água-viva" (Specimen not collected) ?
The whole crab is turned into a tea, which is useful for asthma.

Mangrove Crab, "Uçá" (*Ucides cordatus*) Decapoda, Ocypodidae
Get the fat, filter it, mix it with white wine, and then drink it for treating women's hemorrhage.

FISHES

Atlantic Tarpon, "Cangurupim" (*Tarpon atlanticus*) Elopiformes, Elopidae
Get a scale, burn it, and breathe the smoke for curing "doença do vento" (stroke?), headache, and asthma.
Get a scale, toast it, then grind and make a tea to treat asthma.

Cascarudo, "Caboge" (*Callichthys* cf. *callichthys*) Siluriformes, Callichthyidae
Someone who has faith split into its mouth three times and then free it alive in the river to be healed from asthma;
Eat one in cases of umbilical hernia.

Coco Sea Catfish, "Bagre-fidalgo" (*Bagre bagre*) Siluriformes, Ariidae
Rub the globe of the eye over the area that was injured by its spur to alleviate pain.

Cod, "Bacalhau" (*Gadus* cf. *marhua*) Gadiformes, Gadidae
Put the hide (skin) on furuncles.

Croak, "Curvina" (*Micropogonias furnieri*) Perciformes, Scianidae
Get the otolith and make a tea.

Curimata, "Xira" (*Prochilodus* sp.) Characiformes, Prochilodontidae
Get the fat and make a plaster to treat boils.

Electric ray, "Peixe-elétrico" (*Narcine brasiliensis*) Torpediniformes, Narcinidae
Put the fat on the tooth to treat toothache.

Grunt, "Bonome" (*Haemulon* sp.) Perciformes, Haemulidae
Rub the fat of the liver over swollen areas.

Long-Snout Seahorse, "Cavalo-marinho" (*Hippocampus reidi*) Gasterosteiformes, Syngnathidae
Get one, let it to be sun-dried, then toast it and grind to make a tea, which is drunk in cases of asthma.

Marine Catfish, "Bagre-urutu" (*Sciadeichthys luniscutis*) Siluriformes, Ariidae
Rub the globe of the eye over the area that was injured by its spur to alleviate pain.

Pufferfish, "Baiacu-xaréu" (*Colomesus* sp.) Tetraodontiformes, Tetraodontidae
Put the content of the liver ("fel") in the tooth to alleviate toothache;
Get the hide (skin) and cover the wounds with it.

Queen Triggerfish, "Capado" (*Balistes vetula*) Tetraodontiformes, Balistidae
Get the scale, burn it, and breathe the smoke for curing stroke;
Get the fat of the liver, put it in a piece of cotton, and then introduce it inside the ear; it is useful for curing earache;
Get the spur, toast it, and then grind to make a tea which is drunk against its own venom;
The toasted fat is drunk against stroke;
Get the hide (skin), burn it, and breathe the smoke to treat asthma and stroke;
Rub the "goga do olho" (globe of the eye) over the area that was stung by its spur.

Remora, "Pegador" (*Echeneis naucrates*) Perciformes, Echeneidae
Get the sucking disk, let it to be sun-dried, then toast it and grind to make a tea which is drunk for curing bronchitis and asthma.

Scalloped Hammerhead (*Sphyrna lewini*) Carcharhiniformes, Carcharhinidae
Toast the liver, get the fat and drink it to treat asthma;
Massage fat on rheumatic parts of the body;
Rub the fat over wounds.

Sharpnose Shark, "Cação-rabo-seco" (*Rhizoprionodon* sp.) Carcharhiniformes, Carcharhinidae
Toast the liver, get the fat and drink it to treat asthma;
Massage fat on rheumatic parts of the body;
Rub the fat over wounds.

Sheepshead Porgy, "Peixe-pena" (*Calamus pena* ?) Perciformes, Sparidae
Toast the "pena" (fin ?) and grind it to make a tea for curing asthma.

Smalltail Shark, "Cação-gaia-preta" (*Carcharhinus porosos*) Carcharhiniformes, Carcharhinidae
Toast the liver, get the fat and drink it to treat asthma;
Massage fat on rheumatic parts of the body;
Rub the fat over wounds.

Snook, "Rubalão" (*Centropomus undecimalis*) Perciformes, Centropomidae
Get the fat, toast it, and rub it over swollen legs.

Stingray, "Arraia" (*Myliobates* sp.) Myliobatiformes, Myliobatidae
Toast the spur, grind it and make a tea for curing asthma;
Put the powder of the toasted spur in a broken tooth to alleviate the pain;
Toast the fat and drink it against asthma;
Put the fat over wounds.

Swamp eel, "Muçum" (*Synbranchus marmoratus*) Synbranchiformes, Synbranchidae
Split into its mouth and free it alive in order to treat bronchitis;
Rub a live fish over an infant child's legs to make him/her walk sooner.

Toadfish, "Niquim" (*Thalassophryne nattereri*) Batrachoidiformes, Batrachoididae
Get the globe of the eye and rub it over the area that was injured by its spur;
Rub the "miolo" (soft part of the head) over the injured area in order to take the pain away;
Eat three saltless roasted toadfish to prevent feeling pains in the next time when someone gets injured by its spur.

Trahira, "Traíra" (*Hoplias malabaricus*) Characiformes, Erythrinidae
Get the fat, toast it and use it for curing toothache, asthma, bleedings, boils, and wounds;
The raw fat is recommended as an antidote against snakebites;
Rub the fat over the eyes in order to treat conjunctivitis.

Two-spot Astyanax, "Piaba-mirim" (*Astyanax* cf. *bimaculatus*) Characiformes, Characidae

Get three live fish and grind them; then put the resulting mass in a white rum bottle and bury it for a period of five days. After this, make someone drink it in order to stop drinking.

White Sea Catfish, "Bagre-do-mangue" (*Netuma barba*) Siluriformes, Ariidae

Rub the globe of the eye over the area that was injured by its spur to alleviate pain.

REPTILES

Green Turtle, "Tartaruga-verde" (*Chelonia mydas*) Testudines, Cheloniidae

The fat is toasted and rubbed over wounds and bangs;
Put the fat in a piece of cotton and apply it on painful tooth;
Get a small piece of the shell, burn it, and breathe the smoke for curing asthma;
Get the rear foot, burn it, and breathe the smoke to treat stroke;
Toast the shell of the egg, grind it, and put the powder to be boiled; then cover it for a while and drink it to treat asthma;
A cooked egg is eaten for the treatment of diabetes;
Drink the toasted fat in cases of headache, cough, bronchitis, hoarseness, and asthma;
Mix the fat with honeybee and drink it to treat asthma and flu.

Hawksbill Turtle, "Tartaruga-de-pente" (*Eretmochelys imbricata*) Testudines, Cheloniidae

Idem

Loggerhead Turtle, "Tartaruga-cabeçuda" (*Caretta caretta*)Testudines, Cheloniidae

Idem

Olive Ridley, "Tartaruga-de-couro" (*Lepidochelys olivacea*)Testudines, Cheloniidae

Idem

MAMMALS

Whale (Specimen not determined) Cetacea

Put the fat on a teaspoon, warm it, and drink it against asthma;
Sit down on a vertebra in order to treat backaches.