http://dx.doi.org/10.32360/acmar.v57i2.91763
ISSN 0374-5686 e-ISSN 2526-7639
ORIGINAL PAPER

Arquivos de Ciências do Mar

CHARACTERIZATION OF SEAHORSE TRADE Hippocampus spp. IN THE STATE OF CEARÁ – BRAZIL

Caracterização do comércio de cavalos-marinhos *Hippocampus spp.* no estado do Ceará – Brasil

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ABSTRACT

Seahorses have been part of human folklore since ancient times. These distinctive creatures exhibit unique morphological, behavioral, and reproductive traits, making them highly valued by aquarists globally and utilized in traditional Chinese medicine as well as Brazilian folk medicine, resulting in an annual trade involving millions of individuals. All seahorse species are classified within the family Syngnathidae and the genus *Hippocampus.* Their populations face significant threats from extensive commercial exploitation, compounded by their biological characteristics such as monogamy, low fecundity, and sedentary behavior, along with habitat degradation in reefs and mangroves. This study aims to detail the trade of dried and live seahorses in Ceará, Brazil. Fieldwork involved visits to eighteen municipalities, where interviews were conducted with 40 traders of dried seahorses and 13 collectors of live seahorses using structured questionnaires. The supply chain for dried seahorses, from catchers to final consumers, comprises three to four tiers, with initial prices ranging from R$0.50 to R$12.00 and final prices from R$1.00 to R$16.00. The trade of dried seahorses was observed in twelve municipalities, with 14 traders identified at the primary level of the commercialization chain and 35 at higher levels. These seahorses are procured for treating asthma, used in candomblé rituals, and sold as souvenirs and for their purported medicinal properties. The collection of live seahorses for the aquarium trade occurs in seven municipalities, all located in mangrove areas. The commercialization process starts with collectors, who sell to buyers exporting to other Brazilian states or abroad, or occasionally within the state. Collectors typically supply exclusively to specific buyers who provide the necessary materials for seahorse storage. The price of live seahorses varies based on color, with black, yellow, and red seahorses increasing in value

Received: 11 July 2023
Approved: 18 November 2024

respectively. Collector prices range from R$1.00 to R$5.00, while resale prices range from R$15.00 to R$18.00 in the domestic market and U$12.00 to U$18.00 internationally. Given the biological vulnerabilities of seahorses, including monogamy and low reproductive rates, stringent regulation of their collection and trade is imperative to prevent severe impacts on natural populations. This research provides the first data on the trade of live and dried seahorses in the State of Ceará, aiming to inform the development of a management plan for these species.

Keywords: Seahorses, trade, biodiversity conservation.

RESUMO

Os cavalos-marinhos habitam a fantasia da humanidade desde tempos antigos. São animais peculiares em sua forma, comportamento e reprodução, sendo apreciados por aquaristas de todo o mundo e como matéria-prima na medicina tradicional chinesa e na medicina popular brasileira, contabilizando um comércio de milhões de indivíduos por ano. Todas as espécies de cavalos-marinhos pertencem à família Syngnathidae e estão agrupados em um único gênero, Hippocampus. *Suas populações encontram-se ameaçadas pela grande exploração comercial, sendo bastante vulneráveis por apresentarem características biológicas como monogamia, baixa fecundidade e comportamento principalmente sedentário, além de terem seus habitats (recifes e manguezais) degradados. O presente trabalho tem como objetivo avaliar o comércio de cavalos-marinhos secos e vivos no Ceará. Foram visitados 18 municípios, onde se entrevistou 40 comerciantes de cavalos-marinhos secos e 13 coletores de cavalos-marinhos vivos, utilizando-se questionários dirigidos às duas modalidades de atividades. O canal de comercialização de cavalos-marinhos secos desde quem captura até o consumidor final apresenta de três a quatro níveis, sendo o preço inicial de R$0,50 a R$12,00 e o preço final de R$1,00 a R$16,00. O comércio de cavalos-marinhos secos foi observado em doze municípios, onde foram encontrados 14 comerciantes pertencentes ao primeiro nível do canal de comercialização e 35 pertencentes a níveis superiores. Estes animais são adquiridos para tratamento de crises asmáticas, rituais de candomblé e como suvenires e crendices. As coletas de cavalos-marinhos vivos para a aquariofilia ocorrem em sete municípios, todos em áreas de manguezal. O canal de comercialização se inicia com o coletor, passando para compradores que exportam estes animais para outros estados brasileiros ou para o exterior, podendo vender, também, no próprio estado. Geralmente os coletores fornecem os animais exclusivamente a um comprador que cede o material para o armazenamento dos cavalos-marinhos. O preço varia de acordo com o padrão de colorido: preto, amarelo e vermelho, em ordem crescente de valor. O preço de venda do coletor varia de R$ 1,00 a 5,00 e o preço de revenda varia de R$ 15,00 a R$ 18,00 no mercado interno e de U$ 12,00 a 18,00 quando enviados para o exterior. Dadas suas características biológicas, a atividade de coleta e comercialização de cavalos-marinhos deve ser controlada, de maneira a não impactar severamente as populações naturais destas espécies. Esta foi a primeira pesquisa a gerar dados sobre o comércio de cavalos-marinhos vivos e secos no Estado do Ceará, a fim de servir de insumo para o desenvolvimento de um plano de manejo desses animais.*

***Palavras-chave**: Cavalos-marinhos, comércio, conservação da biodiversidade.*

INTRODUCTION

Seahorses (*Hippocampus spp.*) belong to the family Syngnathidae (from Greek *syn* - fused, and *gnathus* - jaws) (Lourie *et al.*, 2004) and are notable for their unique biological and

ecological traits. These animals exhibit intense and prolonged parental care, with males possessing a brood pouch for incubating eggs and nurturing embryos until the juvenile stage. Additionally, seahorses display monogamy, low fecundity, limited mobility, and a restricted home range (Vincent, 1995a; Lourie *et al*., 2004). They inhabit shallow tropical or temperate waters and are commonly found in seagrass beds, estuaries, mangroves, and reef environments (Lourie *et al*., 2004; Rosa *et al*., 2007; Carmo *et al*., 2022; Valentim *et al*., 2023). The coastal locations of these habitats make them increasingly vulnerable to negative anthropogenic impacts. Habitat destruction is one of the primary risk factors for seahorse populations (Vincent, 1995b; Lourie *et al*., 2004).

Another significant factor contributing to the decline of seahorse populations is their intense commercial exploitation, with millions of specimens being harvested from their natural habitats annually. Seahorses are commercially utilized in various ways, including as raw materials for treating several diseases in Traditional Chinese Medicine (TCM), as aphrodisiacs, ornamental fish, and souvenirs (Vincent, 1995a; Lourie *et al*., 2004; Gurjão & Lotufo, 2018; Nottingham, 2005a, 2005b; Rosa *et al*., 2011).

Several species of seahorses are included in the 2023 IUCN Red List of Threatened Species under the vulnerable category (Pollom *et al*., 2021; IUCN, 2023). Three species are cataloged in Brazil: *Hippocampus reidi*, *H. erectus*, and *H. patagonicus* (Silveira *et al*., 2014). Studies on these species have been conducted in their natural environments within the state of Ceará (Silva, 2018; Loiola *et al*., 2022; Valentin *et al*., 2023). In the estuaries of Ceará, only *H. reidi* has been recorded (Silva, 2018; Loiola *et al*., 2022; Valentin *et al*., 2023).

At the conclusion of data collection for this research, the regulatory framework governing the collection and trade of live seahorses in Brazil was defined by IBAMA Normative Instruction No. 56, dated November 23, 2004. This instruction established annual export quotas of 250 individuals for *Hippocampus reidi* and *Hippocampus erectus* per company. In 2006, IBAMA Normative Instruction No. 140 was enacted, maintaining these quotas but introducing regulations for licensing the import, export, and re-export of specimens, products, and by-products of both Brazilian and exotic wild fauna and flora, regardless of their inclusion in the appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

According to the 2023 IUCN Red List, *H. reidi* is currently listed as Near Threatened. Additionally, according to MMA Ordinance 148/2022, all three seahorse species in Brazil are classified as Vulnerable (VU). Currently, the import and export of seahorses are regulated by IBAMA Ordinance 102/2022, and the export of wild-caught seahorses is prohibited due to their threatened status (MMA Ordinance 445/2014 and MMA Ordinance 148/2022).

This study is the first to generate data on the trade of live and dried seahorses in the state of Ceará, with the aim of informing the development of a management plan for these species.

MATERIAL AND METHODS

The coast of Ceará spans approximately 573 km, between the geographic coordinates 41° 25'W, 2° 52'S and 37° 12'W, 4° 45'S (CEARÁ, 2024). A total of 33 municipalities constitute the Coastal Zone of Ceará, covering an area of 20,635.70 km^2, with 21 of these municipalities directly facing the sea (CEARÁ, 2024). This study was conducted within the Coastal Plain geosystem of the Ceará Coastal Zone, specifically focusing on the beach strip and river plains with mangroves. Between June and December 2002, January to December 2003, and January 2004, a total of 54 locations were visited. These locations spanned 18 municipalities: 10 on the west coast, 7 on the east coast, and the city of Fortaleza.

The visits aimed to collect data on the commercial use of live and dried seahorses.

Individuals involved in these activities were identified through prior information or their related activities and were considered potential seahorse traders. Data were obtained through informal dialogues and structured interviews guided by pre-prepared questionnaires and through direct monitoring of collections.

All questionnaires were administered to individuals aged 18 years or older. The questionnaires were not submitted for analysis by the Ethics Chamber because, at that time, no such requirement existed. This requirement was established in 2011 with the creation of Plataforma Brasil (PB), a new resource developed by the Ministry of Health technicians and launched in September 2011 (Loretto, 2012). The primary mission of Plataforma Brasil is to ensure the efficiency of the CEP-CONEP system (Committee of Ethics in Research - National Commission for Ethics in Research) in protecting research subjects (Loretto, 2012).

For live seahorses, data were collected on collection practices, maintenance, commercial aspects, and the socioeconomic status of the interviewees. For dried seahorses, information was gathered on the origin of the animals, trade aspects, usage, and alternatives to using seahorses in the treatment of asthma. The questionnaires used in this study were part of the activities of the Probio Subproject research project: "Biologia, Parâmetros Populacionais e Análise do Comércio de Cavalos-marinhos (Teleostei: Syngnathidae: Hippocampus) no Brasil" and followed the data collection protocol of that project. Details on the preparation of the questionnaires, the methods for identifying and locating interviewees, the approaches, and the conduct of the interviews are described in Rosa *et al*. (2011).

The monetary values in Brazilian Real (BRL) and United States Dollar (USD) for dry and live seahorses reported in this study reflect the amounts provided by interviewees during the years 2002 to 2004. These values have not been adjusted for inflation or changes in currency value to reflect current economic conditions.

Figure 1 – Interviews and informal conversations conducted in the visited communities

Photo: Mara Nottingham

RESULTS

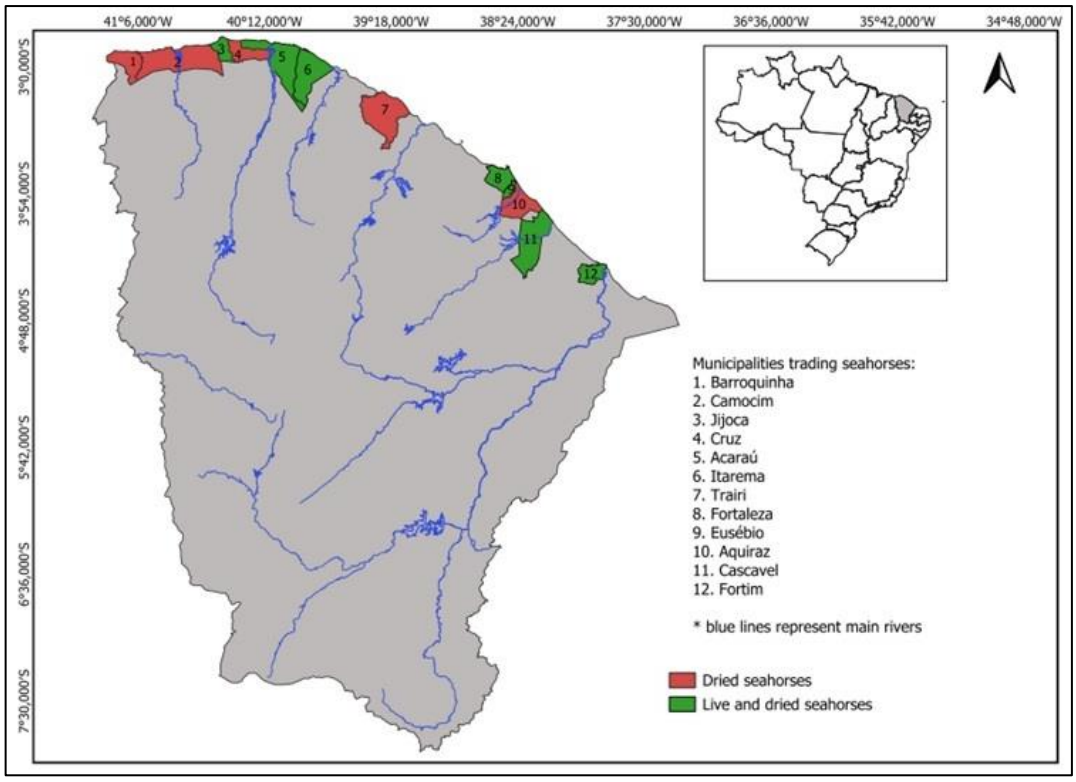
Seahorse trade was documented in 12 municipalities across Ceará. Both live and dried seahorse trade occurred concurrently in 7 of these municipalities. In all municipalities where live seahorse trade was observed, dried seahorse trade was also present. Dried seahorse trade exclusively occurred in 5 municipalities, with significant activity noted in 3 of these compared to other seahorse trade locations (Table 1).

Table 1 - Data on the number of live and dried seahorse traders in municipalities across the state of Ceará, observed during this research conducted from 2002 to 2004

Municipalities	Number of Sites Visited	Presence of Live Animal Traders	Number of Live Animal Traders	Presence of Dry Animal Traders	Number of Dry Animal Traders
Barroquinha	7	No	-	Yes	5
Camocim	3	No	-	Yes	6
Jijoca	2	Yes	1	Yes	-
Cruz	1	No	-	Yes*	1
Acaraú	4	Yes	3	Yes	2
Itarema	4	Yes	1	Yes	1
Trairi	5	No	-	Yes*	1
Fortaleza	3	Yes		Yes	25
Eusébio	2	Yes	4	Yes	2
Aquiraz	3	No	-	Yes*	1
Cascavel	3	Yes	1	Yes	3
Fortim	1	Yes	3	Yes	1
Total	38		13		48

*Incipient

Figure 2- Map of the State of Ceará indicating the municipalities involved in the seahorse trade



Trade in live seahorses

The municipalities in Ceará where the trade in live seahorses was documented include Fortaleza, Jijoca, Acarau, Itarema, Eusébio, Cascavel, and Fortim. In Fortaleza, this trade involved export warehouses (Figure 2) and retail stores. In other areas, this activity primarily took the form of collection, while in Acaraú, Itarema, and Fortim, intermediaries were identified who likely sent seahorses to Fortaleza (Tables 1 and 2).

Table 2 - Origin and destination data of live seahorses traded in Ceará, based on observations from research conducted between 2002 and 2004

Municipality	Locality (ecosystem)	The number of collectors	Destination	Quantity of Buyers
Jijoca	Guriu River Estuary (mangrove)	01	Fortaleza	01
Acarau	Gamboa de Curral-velho, Ilha dos Coqueiros River (mangrove)	03	Fortaleza	02
Itarema	Gamboa de Porto do Barcos (mangrove)	01	Gamboa de Porto do Barcos (mangrove)	01*
Eusébio	Pacoti River Estuary (mangrove)	04	Fortaleza	05
Cascavel	Choró River Estuary (mangrove)	02	Fortaleza	01
Fortim	Jaguaribe River Estuary (mangrove)	03	Fortaleza and Fortim	01

* Intermediary merchant

The majority of collectors interviewed reported supplying seahorses to buyers in Fortaleza, selling exclusively to an exporting company that provided all necessary storage materials (Figure 3, Table 3). However, some collectors utilized alternative storage methods, using "cages" made from perforated plastic bottles placed in the river (Figure 4, Table 3).

Table 3 - Seahorse maintenance practices by collectors in Ceará State, based on data collected from 2002 to 2004

Collector	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Maintenance	Tank (2000L)	Tank (40L)	Tank (500L)	Tank (2000L)	Tank (2000L)	Tank (4000L) and Aquarium (80L)	Tank (4000L) and Aquarium (80L)	Cages in the river	Cages in the river	Tank (40L)	Cages in the river (2L)	Cages in the river (2L)	Immediately passes on to the middleman
Aeration	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	_
Water exchange or filtration	Exchange and filtration	Exchange and filtration	Exchange and filtration	Exchange and filtration	Exchange and filtration	Filtration	Filtration	No	No	Exchange	No	No	_
Feed	Yes	No	Yes	No	No	Yes	Yes	No	No	No	Yes	No	_
Average number of individuals/ recipient	37,5	40	190	80	100	20	50	_	_	30	5	3	_
Maximum storage time (days)	15	6	15	30	30	5	1	_	_	15	7	3	_

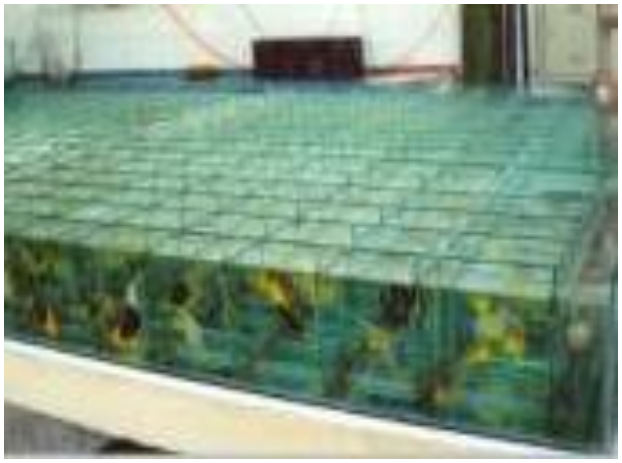


Figure 3 – Export Warehouse in Ceará (Photo: Glaura Barros)

Figure 4 – Structured used for seahorse maintenance (Photo: Mara Nottingham)

Figure 5 – Perforated PET bottle used as an alternative storage method for seahorses (Photo: Mara Nottingham)

Live seahorses were sold at low prices at the initial level of the marketing channel, with pricing determined by color pattern: black, yellow, and red in ascending order of value. Prices increased significantly when seahorses were sold by local retailers and were highest when sold by exporters (Table 4). Consequently, traders at higher levels of the trade channel benefited the most from the live seahorse trade, while collectors realized minimal profits.

Seahorses that died during storage or transport were sold or donated for various purposes, including illness treatment, souvenirs, beliefs, and religious rituals. When sold dried by collectors, these seahorses were valued between R$0.20 and R$1.00. The price of live seahorses varied among collectors and was not influenced by the size or condition of the animals.

Table 4 – Prices of seahorses sold in Ceará. All dollar values and quotations refer to the year 2002

COLOR	LIVE			DRY	
	R$ Collector	R$ Retail (Local)	U$ Wholesale (Export)	R$ Collector	R$ Retail
Black	1,00	15,00 - 18,00	*	0,50 - 12,00	1,00 - 16,00
Yellow	1,50 - 2,50	15,00 - 18,00	12,00 - 18,00	0,50 - 12,00	1,00 - 16,00
Red	1,50 - 5,00	15,00 - 18,00	12,00 - 18,00	0,50 - 12,00	1,00 - 16,00

* Black seahorses are not consumed on the international market

Collection and Maintenance Information

Thirteen seahorse collectors in Ceará were interviewed, who conducted their activities in mangroves (Figures 5 and 6, Table 2), located in gamboas (sea incursions into the continent) or estuaries. Nine of these collectors had assistants, resulting in a total of thirty-two registered seahorse collectors in Ceará. The duration of their involvement in this activity varied from one to ten years, generally performed sporadically based on orders. The average number of seahorses captured per collection day ranged from five to one hundred and ten individuals, according to the interviews. Captures were made at depths ranging from five centimeters to seven and a half meters (Tables 5 and 6).

Figure 6 – Seahorse collection in shallow areas (Photo: Mara Nottingham)

Figure 7 – Seahorse collector returning successfully from a sea dive (Photo: Mara Nottingham)

Table 5 - Fishing effort, catch quantity, and types of fishing gear used in the collection of seahorses, as reported by collectors in Ceará State. Data were collected in this study from 2002 to 2004

Collector	1	2	3	4	5	6	7	8	9	10	11	12	13
Number of assistants	6	2	--	1	1	1	1	3	--	3	--	1	0
Uptime	x	x	x	10 years	10 years	x	x	x	x	x	2years	>1year	2years
Days per month dedicated to collection (average)	14	15	Uncertain*	--	--	Uncertain*	Uncertain*	Uncertain*	Uncertain*	Uncertain*	30	Uncertain*	15
Nº of seahorse collected / day (average)	10	5	15	6	30	12,5	5,5	110	25	17,5	60	20	12,5
Capture depth (meters)	<0,5	<1	<0,5	<1	<1	1,5 - 5	--	<3	<4	<0,05	<1,5	<7,5	<0,5
Material	Bottle, Bucket	--	Bottle, Bucket and Pail	Bottle	Bottle	Bottle	Bottle, mask	Bottle, Glove	Bucket, dinghy	Bucket	Bottle	Bottle	Bottle

*Collect only when there is an order

Most collectors indicated a higher frequency of capturing females, although this information was considered unreliable due to the difficulty in distinguishing non-pregnant males from females. Concerning color patterns, collectors reported a predominance of black seahorses over other colors at the time, attributing this to intensive exploitation of yellow and red-colored specimens.

Medium and large-sized animals were reportedly the most commonly captured, whereas small individuals were often rejected by middlemen. Pregnant seahorses were also not accepted for commerce (Table 6). These practices in seahorse collection and trade were

beneficial for resource sustainability, as they involved selective harvesting to respect reproductive cycles. However, some collectors admitted that there were individuals who captured pregnant seahorses and awaited their release of offspring in aquariums before selling them.

Collectors identified the first half of the year as optimal for seahorse collection due to favorable environmental conditions, including low tide, minimal water turbidity, gentle currents, mild winds, and absence of rain. Lunar phases did not significantly influence collection preferences (Table 7).

Table 6 – Characteristics of seahorses most frequently captured and deemed dispensable by collectors in Ceará State. Data were collected in this study from 2002 to 2004

Collector	1	2	3	4	5	6	7	8	9	10	11	12	13
Color	Black	Yellow Red	Black	Black	Red	Black	Black	Black	Red	Yellow Red	Black White	Black	Red Yellow
Size	Med Lar	Med, Lar	Lar	Lar	Lar	Lar	Lar	Med	Med Lar	Lar	Med Lar	Med	Med Larg
Sex	F	_	F	M	M	_	F	M	F	F	F	_	_
Not collected	_	_	_	Preg	Med Preg	Preg	_	Preg	Preg	M	Sml Preg	Sml Preg	Sml Preg

Sml = Small; **Med** = Medium; **Lar** = Large; **F** = Female; **M** = Male; **Preg** = Pregnant

Table 7 - Preferred environmental conditions for seahorse collection, as reported by collectors in Ceará State. Data were collected in this study from 2002 to 2004

Collector	1	2	3	4	5	6	7	8	9	10	11	12	13
Months	January - June	January - June	July - December	January - June	November	January - March	January	_	December - January	August - October	January - June	January - February	January - June
Tidal Height	Low tide	Low tide	Low tide	Low tide	Low tide	Low tide	Prea-mar	_	Low tide	Low tide	Low tide	_	Low tide
Moon Phase	_	_	Full	Waning and New	No	No	No	Full and New	Crescent and waning	Crescent and waning	Full and New	_	Crescent and waning

Captures were conducted along rivers or estuaries, ranging from the mouth to several kilometers inland. During collection, seahorses were initially housed in containers exceeding five liters in volume, with regular water changes performed (Figure 7), or in perforated containers left submerged in water. Upon reaching storage facilities until sale, the seahorses were transferred to larger containers with capacities ranging approximately from forty to four thousand liters (Figure 3). These containers were equipped with aeration systems and underwent regular water changes and/or filtration. Typically, the seahorses were not fed until they were sold and were maintained in groups averaging up to one hundred and ninety individuals, for a maximum of forty-five days. Three collectors mentioned keeping seahorses confined in the river using "cages" such as perforated two-liter plastic bottles (Figure 4) or in oyster "pillows" until they were ready for sale (Table 3).

Figure 8 – A type of container used for storing seahorses during collection

Photo: Mara Nottingham

Survey of the Socio-Economic Profile of Seahorse Collectors

Seahorse collectors in the state of Ceará are predominantly male (92.3%). The majority are between 20 and 30 years old (46.15%), with 23.07% aged between 10 and 20 years, and 23.07% aged between 30 and 40 years. An older minority, comprising 7.69%, are aged between 40 and 50 years. The majority of collectors (76.92%) are heads of households, with an average family size of 5.46 individuals. Regarding education, 75% have only an incomplete primary education, 16.66% are illiterate, and 8.3% have completed high school.

The residences of these individuals are generally rustic, averaging 4.36 rooms per house. A significant majority (92.3%) are owner-occupied, while only 7.7% are rented. The construction types include masonry with tile roofs (84.6%) and mud with tile roofs (15.4%). Most floors are covered with cement (76.92%), but some are made of clay (7.7%), ceramic tiles (7.7%), or flagstone (7.7%). Electric lighting is present in 92.3% of the houses, while 7.7% use kerosene for illumination.

The primary water supply for these households is piped water (53.84%), with additional sources including cacimbas (30.76%) and wells (15.38%). Drinking water is untreated in 33.3% of the homes, treated in another 33.3%, and filtered in the remaining 33.3%. Cooking fuel primarily consists of gas only (53.84%) or a combination of gas and firewood (46.15%). A small proportion of collectors (9.1%) lack household appliances. Waste disposal methods include cesspits (76.92%), outdoor disposal (15.38%), and other methods (7.69%). Garbage collection is predominantly managed by the municipality (76.92%), while 7.69% of households bury, burn, or dispose of garbage outdoors, respectively.

Seahorse collectors are typically low-income individuals, with seahorse collection contributing minimally to family income in 75% of cases. The majority (92.3%) engage in additional economic activities such as agriculture, artisanal fishing, fishing net repair, boat watchkeeping, collection of other ornamental fish, or running small businesses like grocery

stores. Although 46.15% of the collectors possess a professional fisherman's license, 76.92% do not contribute to social security.

Trade in dried seahorses

The trade in dried seahorses is notably prevalent in municipalities such as Barroquinha, Camocim, Acaraú, Itarema, Fortaleza, Eusébio, Cascavel, and Fortim compared to others. Conversely, in Cruz and Trairi municipalities, as well as Tatajuba, Iguape, and Águas-Belas districts—Tatajuba under Camocim municipality and the latter two under Cascavel municipality—this trade remains at an incipient stage relative to other surveyed locations, characterized by smaller-scale sales of captured animals (Table 8).

Table 8 – Origin and destination of dried seahorses in Ceará State. Data collected during this study from 2002 to 2004

Municipality	Source	Buyers Origin
Barroquinha	Barroquinha - CE	Barroquinha - CE Parnaíba - PI Maranhão Belém - PA China
Camocim	Camocim - CE Chaval - CE	Camocim - CE Sobral - CE Fortaleza - CE Rio de Janeiro - RJ Brasília - DF São Paulo - SP
Jijoca	Jijoca - CE	Fortaleza - CE
Acarau	Acarau - CE	Acarau - CE Maranhão
Itarema	Itarema - CE	Itarema - CE
Fortaleza	Camocim - CE Euzèbio - CE Fortaleza - CE Cascavel - CE Fortim - CE Maranhão	Fortaleza - CE São Paulo - SP Tourists
Eusébio	Eusébio - CE	Fortaleza - CE
Aquiraz	Aquiraz - CE	Tourists
Cascavel	Cascavel - CE	Fortaleza - CE Cascavel - CE Tourists
Fortim	Fortim - CE	Fortaleza – CE

The 49 dried seahorse dealers interviewed engage in various activities: 14% are collectors of fish for the aquarium hobby (see Figures 6 and 7), 14% are artisanal fishermen who inadvertently capture seahorses (fishermen using small shrimp trawlers—see Figure 8, and those using tarrafa and caçoeira nets), 37% are traditional healers (see Figure 9), 20% are souvenir store owners, 8% are Umbanda artists, 2% are traveling merchants, 2% are itinerant craftsmen, and 2% are grocery store

owners. When combining fish collectors and artisanal fishermen as primary traders in the commercialization chain, they total fourteen individuals. Lobster fishery was cited by higher-level traders as a source of dried seahorses. Traditional healers, souvenir store owners, Umbanda artists, grocery store owners, traveling merchants, and itinerant craftsmen are grouped as secondary-level traders, totaling thirty-five individuals (see Table 9).

Table 9 – Dried seahorse dealers surveyed in Ceará State. Data collected during this study from 2002 to 2004

Modalities	Municipalities of occurrence	Points of sale	No. of merchants
Collectors of live seahorses (in rivers and in skunks)	Acarau	No fixed location	2
	Itarema	No fixed location	1
	Eusébio	No fixed location	2
	Cascavel	No fixed location	1
	Fortim	No fixed location	1
Artisanal shrimp fishermen (river and sea)	Barroquinha	No fixed location	1
	Camocim	No fixed location	1
Tarrafa and caçoeira fishermen (in river and sea)	Barroquinha	No fixed location	3
Fishermen from sailing vessels (at sea) without a determined fishing gear	Aquiraz	No fixed location	1
	Cross	No fixed location	1
Healers	Camocim	Marketplace	2
	Fortaleza	Conde D' Eu Street	7
		Castro e Silva Street	1
		General Bezerril Street	3
		Senador Pompeu Street	1
		Messejana Fair	1
		Beco da Poeira Market	2
	Cascavel	Marketplace	1
Souvenir stores	Fortaleza	Central Market	4
		Conde D' Eu Street	1
		General Bezerril Street	1
		Senador Alencar Street	1
		São José Street	1
	Cascavel	City Entrance	1
	Camocim	Edge of the Coreaú River	1
Umbanda Shops	Fortaleza	General Bezerril Street	2
		24 de Maio Street	1
		Senador Alencar Street	1
Grocery Store	Camocim	Coqueiros Neighborhood	1
Traveling Merchant	Barroquinha	No fixed location	1
Traveling craftsman	Camocim	Marketplace	1
Total			49

Figure 9 – Hand trawl for shrimp (Photo: Glaura Barros)

Figure 10 – Points of sale for traditional healers at the street market in Camocim (Photo: Glaura Barros)

The municipalities of Barroquinha, Camocim, Jijoca, Acaraú, Itarema, Eusébio, Cascavel, and Fortim represent the primary level of the commercialization channel. Seahorses from Barroquinha are collected from the Timonha, Chapada, and Remedios rivers, marketed locally to tourists or exported to Parnaíba (PI) and Belém (PA). According to a local trader, seahorses from Belém are further exported to China. In Camocim, seahorses are inadvertently collected from shrimp fisheries in the Coreaú river estuary and sold locally in souvenir stores, grocery stores, markets (raizeiros), and sent to Fortaleza, Sobral, Rio de Janeiro, and Brasília. Dried seahorses from Jijoca are sent to the commercial center of Fortaleza. In Acaraú and Itarema, seahorses are collected from rivers and gamboas to meet local demand, with some traders from Acaraú shipping them to Maranhão. In Eusébio and Fortim, seahorses from the Pacoti and Jaguaribe river estuaries are either sent to Fortaleza or consumed locally. In Cascavel, seahorses from the Choró river estuary are sold locally or in Fortaleza. Dried seahorses from Acaraú, Eusébio, Fortim, Cascavel, and Itarema are excluded from seahorse collections for aquarium hobbies. In Aquiraz, specifically in the Iguape district, a rafter occasionally sells dried seahorses to tourists (see Table 8).

Secondary levels of the seahorse marketing channel were observed in the municipalities of Barroquinha, Camocim, Fortaleza, and Cascavel. Traditional healers were present in the latter three municipalities, where they predominantly sold natural products as therapeutic resources to local residents and tourists. Souvenir shops were situated in Camocim, Cascavel, and Fortaleza, with some proprietors noting increased seahorse demand during peak tourist seasons. Stores specializing in Umbanda items were exclusively found in Fortaleza, while grocery stores, offering a variety of goods including food and fishing materials, were solely present in Camocim. The category of traveling merchants was identified solely in Barroquinha, whereas traveling artisans were identified solely in Camocim. Seahorses sold by these individuals originated from either their respective

municipalities or other locations (see Table 8). Interviews with seahorse traders confirmed the existence of dried seahorse trade in municipalities of Ceará where these animals are also collected for aquarium purposes. This trade extends between various states in Brazil and may include exports to China when sold within the state of Pará.

The peak supply times varied considerably, including months from both the first and second semesters, corresponding to winter and summer in Ceará, respectively. These periods coincide with high tourist visitation and times when small shrimp trawlers operate.

Several traders provided average monthly sales figures, while others cited specific instances of large quantities sold.

Reports of significant quantities of traded seahorses included:

- A rooter reported selling 1,000 seahorses in September 2002; in a subsequent interview, he mentioned sending 400 of them to Sobral (CE).
- A traveling merchant claimed an average annual sale of 1,200 seahorses over 15 years.
- A fisherman stated an average annual sale of 700 seahorses to Parnaíba (PI) during certain years.

Traders at the primary level may sell individual seahorses for prices ranging from fifty cents to twelve reais, with potential resale prices reaching up to sixteen reais (see Table IV). Prices generally vary among dealers irrespective of specific animal characteristics, though some differentiate based on size, valuing larger specimens more. Juvenile seahorses are also part of the dried seahorse trade, likely sourced from discarded fishing nets, as collection does not typically select for size, unlike in the case of discarded aquarium fish.

Dried seahorses are used for treating respiratory diseases, vitiligo, menstrual cramps, cancer, ornamentation, beliefs, and religiosity. Asthma treatment emerged as the primary reason for dried seahorse demand, although sixteen alternative treatments, predominantly of botanical origin, were cited by healers in Fortaleza's commercial center (see Table 10). Six of these alternatives are prepared and administered similarly to methods used with dried seahorses for asthma treatment, with comparable pricing.

Ornamental use occurs in processed forms such as keychains, panels, and necklaces, or in natural states without transformation. According to some respondents, peak demand for ornamental purposes coincides with high tourist visitation months in Fortaleza (January, February, July, and December).

In terms of beliefs, the amulet function—drawing luck and warding off envy—was frequently cited as a motivation for purchase. Some sellers also noted the use of seahorses in religious rituals.

Table 10 - Alternatives to seahorse use in asthma treatment. Information gathered from healers located in the commercial center of Fortaleza. Data collected during this study from 2002 to 2004

Alternative	Serving Price (values refer to the years 2002 to 2004)	Preparation and Administration
Holy Carnation Seed	R$ 3.00 - R$ 4.00	Roast, tread, and make tea. Oral Administration
Sesame Seed with Sunflower Seed	R$ 2,00	Roast, tread, and make tea. Oral Administration
Black Sesame Seed	R$ 2,00	Roast, tread, and make tea. Oral Administration
Okra Seed*	R$ 1.00 - R$ 5.00	Roast, tread, and make tea. Oral Administration
Sucupira Seed	—	Roast, tread, and make tea. Oral Administration
White onion	R$ 1,00	Cooking with sugar Oral administration
Almexa Bark	—	—
Nutmeg	—	—
Mandacaru Root	—	—
Seven Herbs Honey**	R$ 2.00 - R$ 5.00	Oral Administration
Termite Honey with Banana Trees	R$ 2,00	Oral Administration
Eight Herbs Syrup	R$ 8.00 - R$ 25.00	Oral Administration
Genipapo	—	Juice Oral Administration
Urucu seed with Baje de Jucá	—	—
Bee honey with Piqui Oil	—	Oral Administration
Turtle Plastron (chelonian)	R$ 10,00	Roast, tread, and make tea. Oral Administration

* Respondents cited Okra Seed and Seahorse as the most effective remedies for treating asthma.
** Seven Herbs Honey is a preparation made from bee honey combined with specific parts of seven plants.

DISCUSSION

Seahorses exhibit specific bioecological characteristics that render them particularly susceptible to overexploitation and habitat degradation. Notably, their intense and prolonged parental care involves males safeguarding fertilized eggs within a brood pouch until juveniles are released, a process that can extend for several months in certain species, thereby increasing the risk of capture while carrying their young (Rosa *et al*., 2011; Pollom *et al*., 2021). Additionally, their monogamous mating system complicates the process of finding new partners following the capture of a mate. Seahorses also have low fecundity, producing few offspring per reproductive season. Furthermore, their limited mobility and restricted home range heighten their vulnerability to capture and impede their capacity to relocate in

response to habitat degradation (Lourie *et al*., 2004; Vincent, 1995).

During data collection for this study, it was observed that seahorses had been collected for a decade in seven municipalities in the state of Ceará. Six of these municipalities supply seahorses to the state capital, Fortaleza, which has played a significant role in meeting the demand for ornamental fish in 19 countries and 13 Brazilian states. Seahorses were the third most exported species between 1995 and 2000 (Monteiro-Neto *et al*., 2002). Notably, two years before the initiation of this research, 12,586 seahorse individuals had been sold since 1995 (Monteiro-Neto *et al*., 2002). These findings underscore the substantial impact of the ornamental fish trade on seahorse populations along the coast of Ceará.

In 2004, the annual export quota for each species of seahorse native to the Brazilian coast (*Hippocampus reidi* and *Hippocampus erectus*) was set at 250 individuals per year for each ornamental fish export company (IBAMA Normative Instruction No. 56). Subsequently, captive-bred *H. reidi* seahorses began supplementing wild-caught stocks under additional quotas, significantly increasing the number of available individuals (Hora & Joyeux, 2009; Dias-Neto, 2009). Currently, imports and exports are regulated by IBAMA Ordinance No. 102/2022, which prohibits the export of wild-caught seahorses due to their threatened status (MMA Ordinance No. 445/2014 and MMA Ordinance No. 148/2022).

During this research, we observed that in the state of Ceará, there were a limited number of seahorse collectors engaged in the ornamental fish market. These collectors were typically low-income individuals, and seahorse collection represented a minor portion of their household income due to their involvement in other economic activities. This situation contrasts with other global locations where seahorse collecting constitutes a significant source of income for collectors (Vincent, 1995a; Pajaro, 1997).

In the Philippines, seahorses are intentionally collected from various habitats, including coral reefs, seagrass beds, and sargassum beds (Pajaro, 1997). In contrast, our research in the state of Ceará observed that intentional collection was primarily conducted in mangrove areas, as noted by Nottingham *et al*. 2005a, 2005b and Rosa *et al*., 2011.

In addition to the impacts of seahorse collection observed during our research on seahorse populations along the coast of Ceará, there are ongoing ecosystem impacts on their habitats. Ceará's mangroves have faced significant pressures, primarily from shrimp aquaculture and dam construction (Campos, 2003). Consequently, the species *H. reidi* remains threatened in the state of Ceará due to habitat destruction, despite the prohibition of its collection in the wild following the publication of IBAMA Ordinance No. 102/2022.

The species *H. reidi* was observed exclusively in the estuaries of the Pacoti River (Nottingham, 2004; Osório, 2008; Osório *et al*., 2011; Silva, 2018; Valentim, 2023) and the Malcozinhado River (Nottingham, 2004; Osório, 2008). This species inhabits mangroves and is particularly associated with the roots of *Rhizophora mangle* and *Avicennia* sp. (Dias, 2002; Rosa *et al*., 2002; Osório, 2008; Osório *et al*., 2011; Silva, 2018; Valentim, 2023). This observation aligns with the collection sites reported by respondents in this study, who collected seahorses in mangrove areas within estuaries or tidal creeks ("gamboas").

The results of this study indicate that significant quantities of dried seahorses were exported from Ceará to major urban centers in Brazil (e.g., São Paulo, Rio de Janeiro, Brasília, Belém, Piauí) and to China, the largest global consumer of seahorses. Individuals from Ceará likely contributed to the high demand for Traditional Chinese Medicine (TCM) (Vincent, 1995c; 1997; Rosa *et a*l., 2011).

Several traders interviewed mentioned the use of dried seahorses for asthma treatment, as souvenirs, and in cultural beliefs, consistent with previous reports in the state of Ceará (Nottingham *et al*., 2005a; Nottingham *et al*., 2005b). While similar uses of dried seahorses are observed in China, the use of dried seahorses in superstitions and religious beliefs has not been documented in that country.

In Brazil, 283 animal species are used in traditional medicine to treat various diseases, with seahorses specifically documented for the treatment of thrombosis, alcoholism, male impotence, osteoporosis, diabetes, heart diseases, bronchitis, asthma, cancer, and rheumatism (Alves *et al*., 2007). Additionally, 138 animal taxa used as medicinal resources in

fishing communities in the North and Northeast of Brazil have been recorded, of which 11 species, including seahorses, are listed as threatened (Alves and Rosa, 2007a). In the fishing communities of the Brazilian Northeast alone, 100 species are employed in therapeutic practices (Alves and Rosa, 2006). In urban areas of the North and Northeast of Brazil, 97 species are recognized as zootherapeutic animals (Alves and Rosa, 2007b). These studies highlight the inclusion of seahorses as zootherapeutic agents for the diseases documented in our research. The use of seahorses in the treatment of asthma is particularly well-documented in Brazilian zootherapy practices (Costa-Neto, 1999; 2000; Alves and Rosa, 2006; Alves *et al*., 2007; Alves and Rosa, 2007a; Alves and Rosa, 2007b).

In Taiwan, dried seahorses are sold alongside other products, primarily plants, to address a variety of patient needs (Vincent, 1995b). A similar practice was observed among dried seahorse traders in the state of Ceará, where seahorses are sold in conjunction with leaves, seeds, roots, and barks of various plants used for treating different ailments. In the Fortaleza shopping center, we found that the "Raizeiros" were familiar with 16 alternative treatments for asthma, predominantly consisting of herbal remedies accessible to the local population.

Documented cases exist of dried seahorses being used during their juvenile phase (Vincent, 1996), a practice also noted during interviews conducted in this study. In some stores that sold dried seahorses, prices varied with the size of the animals, which likely exacerbates the impact on seahorse populations by removing individuals before they have a chance to reproduce.

Therefore, both live and dried seahorses in the state of Ceará were collected to meet the demands of national and international trade. Combined with their specific bioecological characteristics, this practice poses a risk of decline to local populations. This research has provided essential information for the development of the Management Plan for the Sustainable Use of Brazilian Seahorses (IBAMA, 2011).

ACKNOWLEDGMENTS

The authors wish to express their gratitude to the Federal University of Ceará (UFC), particularly the Marine Biology Laboratory and the Tropical Marine Ichthyology Group (IMAT). We extend our thanks to Mrs. Maria and Mr. Tasso, the first seahorse collectors in the Rio Pacoti community. Special thanks are due to Dra. Daniela Pequeno for creating the map. We also acknowledge the support from CNPq for granting the scientific initiation scholarship. Special recognition is given to the Probio Subproject: "Biology, Population Parameters and Analysis of Seahorse Trade (Teleostei: Syngnathidae: Hippocampus) in Brazil," coordinated by Dra. Ierecê Lucena Rosa from the Federal University of Paraíba, for facilitating this research. Additionally, we thank the members of the EVOLVE Laboratory at the Institute of Marine Sciences (LABOMAR) for their encouragement in publishing this work.

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