N O T E   F R O M   T H E   E D I T O R

NOTE FROM THE EDITOR

Dear Friends, Colleagues and Otter Enthusiasts!

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We just closed the last issue 40/4 of 2023. We had another year with 4 issues and this year may see an even further increase of issues as by today we have two complete issues that we will do our best to get online soon.

It happened recently that authors asked me some months after submission about the status of their manuscript. It seems that these manuscripts got somewhere lost as they were not in my inbox and not in my spam folder. I usually send a confirmation within 3-4 days so if you do not hear from me, please contact me immediately rather than waiting so long.

In the Steering Committee we discussed a few items in relation to the Bulletin. We kindly ask all members of the OSG to state in their affiliation "OSG member". Another small change will take place in respect to the review process. I will keep sending your manuscripts to two independent reviewers. In addition the two Co-Chairs, the Continental Coordinators and the Species Coordinators will also get the manuscript for novelty and quality check but also to inform them what is going on in their area of interest.

I also welcome the guest editorial of Chris Shepherd. In case you feel like writing something like a guest editorial or letter-to-the-editor send me a mail and we see how to best address this in one of the next issues.

Lesley has done another year of excellent work for all of us as the IUCN OSG Bulletin serves really the whole community. I can assure that she always finds some last typos or missing reference in your manuscripts that slipped attention.

Lesley, thank you so much for all the time you spend on us rather than on any other of your multitude of activities. I really appreciate your support.

VIEWPOINT

Otters, charismatic carnivores of the waterways, are an essential part of every natural habitat they occupy. As key predators, they keep populations in balance. A healthy otter population is a sign of a healthy ecosystem. Unfortunately, otters are targeted for the wildlife trade in most places they occur, resulting in populations being negatively impacted and, in some cases, decimated.

Many people would easily recognize otters, perhaps from having seen them directly, or from various media sources including documentaries, traditional stories, and children's books and even art. But the plight of otters often escapes the notice of the majority – very few are aware that these gregarious mammals are in trouble.

Otters have been decimated by illegal and unsustainable exploitation in many parts of the world. While some populations are recovering, many continue to decline. Hunted for their pelts, meat, or body parts used in traditional medicines, they are also traded live to meet the demand for exotic pets, perpetuating a cycle of exploitation and decline. Despite international bans and protective legislative measures, the clandestine trade persists.

Asia is home to four otter species (excluding Sea Otters), all of which are threatened by commercial trade. Traders selling live animals as pets acquire otters from the wild to sell locally or traffic them abroad, often to countries such as Japan where demand for pet otters or otters kept in animal cafes is high. Otter cafes are dining establishments that offer the attraction for customers to interact with otters, and the chance to snap social media-worthy moments. Of the four species, Asian Small-clawed Otters, Smooth Otters and Eurasian Otters are now listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), largely banning the commercial international trade in these species. The Endangered Hairy-nosed Otter is still listed in Appendix II. Laundering of CITES I listed otters, through bogus captive breeding facilities, where animals taken from the wild are laundered into trade under the guise of being captive bred may yet prove to be a loophole that needs attention. There is much yet to be done to prevent illegal international trade in otters as traffickers continue to undermine conservation efforts by exploiting such legal loopholes.

It is therefore heartening to see actions taken by the Government of Japan to that ensure stronger and more effective legislation is in place to regulate and prevent commercial trade in otters. Japan has been identified in the past as an end destination for otters illegally sourced from other countries, especially in Southeast Asia. This new legislation will further empower the enforcement authorities to counter this trade.

Further research and monitoring of the otter trade is required to identify and address trends, to support enforcement efforts and to inform further policy changes. Ultimately, a collective awakening to reduce demand for otters is essential. Stronger national legislation and more effective use of CITES is urgently needed to tackle the illegal trade in otters and to ultimately ensure that none of these amazing species are lost.

Dr Chris R. Shepherd
Executive Director, Monitor Conservation Research Society
IUCN SSC Otter Specialist Group Member

R E P O R T

THE CURRENT STATUS OF REGULATION OF ASIAN SMALL-CLAWED OTTERS *Aonyx cinereus* TRADE IN JAPAN

Yumiko OKAMOTO[1,2,*], Chris R. SHEPHERD[2,3] and Hiroshi SASAKI[2,4]

[1]*WWF Japan, 3F. Mita Kokusai Bldg., 1-4-28 Mita, Minato-ku, Tokyo, 108-0073, Japan*
[2]*IUCN SSC Otter Specialist Group*
[3]*Monitor Conservation Research Society, Big Lake Ranch, B.C., Canada*
[4] *Chikushi Jogakuen University, 2-12-1 Ishizaka, Dazaifu, Fukuoka 818-0192, Japan*
** Corresponding author: Yumiko Okamoto - yumiko.okamoto@wwf.or.jp*

(Received 6th July 2023, accepted 14th August 2023)

Abstract: The Asian Small-clawed Otter *Aonyx cinereus* is traded internationally to supply demand for pets, both legally and illegally. In 2019, the species was elevated from being listed in Appendix II of the Convention on International trade in Endangered Species of Wild Fauna and Flora (CITES) to Appendix I, which generally prohibits international trade, as trade was deemed a threat to the conservation of this species. Although the Japanese national legislation strictly protects the CITES Appendix I-listed species, it is still possible to trade the Asian Small-clawed Otters domestically, subject to the necessary registration procedures. Here we look at current trade levels of Asian Small-clawed Otters in Japan and the impact of the CITES up-listing.
Citation: Okamoto, Y., Shepherd, C.R., and Sasaki, H. (2024). The Current Status of Regulation of Asian Small-Clawed Otters *Aonyx cinereus* Trade in Japan. *IUCN Otter Spec. Group Bull.* **41** (1): 4 - 14
Keywords: CITES, conservation, exotic pets, law enforcement, Mustelidae, wildlife trade

INTRODUCTION

Illegal and/or unsustainable trade in wildlife is a threat to the survival of an increasingly long list of species (Eaton et al., 2015; Marshall et al., 2020). Among these are the 13 extant species of otters in the world, many of which are threatened due to demand for pelts, parts for use in traditional medicines, and as pets (Duplaix and Savage, 2018). Perhaps the most heavily traded otter species to supply demand for pets is the Asian Small-clawed Otter *Aonyx cinereus* (Gomez and Bouhuys, 2018). Found throughout much of East, South and Southeast Asia (Wright et al., 2021), the Asian Small-clawed Otter is assessed as Vulnerable by the IUCN Red List of Threatened Species and is reported to be threatened by habitat loss, loss of prey and increasing trade (Wright et al., 2021). This species is frequently found in international wildlife markets, on online trade platforms and displayed in animal cafes (Aadrean, 2013; Gomez et al., 2016; Gomez and Bouhuys, 2018; Kitade and Naruse, 2018; Siriwat and Nijman, 2018, Sigaud et al., 2023). Its small size, active behaviour, and attractive appearance have made it a favourite among exotic pet keepers, and by extension, among poachers and wildlife traffickers. Due to the imminent threat to its survival from illegal and unsustainable trade, the Asian Small-clawed Otter was listed in 2019 in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which generally prohibits international trade, elevated from Appendix II. Since then, there has been one import only for scientific purposes, and no seizure records were reported in the CITES Trade Database (htpps://trade.cites.org) or

TRAFFIC's Wildlife Trade Information System (WiTIS) in Japan. The Asian Small-clawed Otter is protected as an "Internationally Rare Species of Wild Fauna and Flora" under domestic law in Japan, and since the Appendix I listing, legislation regulating the trading of Asian Small-clawed Otters has become rigid. However, Asian Small-clawed Otters obtained prior to the regulation or animals bred in captivity using individuals obtained prior to the regulation can still be traded for commercial purposes under individual otter registration with the Ministry of the Environment. This study focuses on the current status of pet otters regulation in Japan following the elevation of this species from Appendix II to Appendix I of CITES.

METHODS

To better understand the current status of otter trade in Japan, and the impact listing the species in CITES Appendix I in 2019 has had, we have carried out the following:

1. We analysed international trade data from the CITES Trade Database to determine the past and recent role of Japan in the international trade in Asian Small-clawed Otters.
2. We looked at trade levels prior to and after the up-listing of the species from CITES Appendix II to Appendix I in 2019 to determine changes in trade levels.
3. We investigated the current levels of trade in Asian Small-clawed Otters for pets in Japan.
4. We looked for recent enforcement records relating to the illegal trade in this species.
5. We looked into the current demand and use of Asian Small-clawed Otters in animal cafes in Japan.
6. We explain the new legislation in Japan to regulate and control the trade in Asian Small-clawed Otters to better understand the strengths and weaknesses of this legislation and the potential impacts it will have on the trade in this species.
7. Finally, we have made recommendations to further prevent the illegal trade in Asian Small-clawed Otters in Japan.

RESULTS

Past Pet Otter Trade and Changes in CITES Regulations

International trade of live Asian Small-clawed Otters

International trade in the Asian Small-clawed Otter is not new. In the past, many Asian Small-clawed Otters were exported from Thailand to the United States of America and the United Kingdom for pets before Thailand stopped the export in the mid-1970s (Foster-Turley, 1992). Between 1977 and 2019, a total of 1160 live individuals had been traded worldwide for all purposes as reported by importing countries in the CITES Trade Database (Table 1). Of this total, 681 otters were traded for personal use and commercial trade (Purpose codes P and T, respectively) (Table 2). During this period, Japan imported the largest number of live individuals (n = 354), while the Netherlands exported the largest number of live individuals (n= 110).

Table 1. Number of live Asian Small-clawed Otters traded for all purposes between 1977 and 2019 (by import declaration numbers on CITES Trade Database)

Importing Countries	No.	Exporting Countries	No.
Japan	382	Netherlands	148
United States of America	127	Czech Republic	115
China	124	Singapore	110
Korea	106	Indonesia	109
Uzbekistan	100	Tanzania	100
Others	327	Others	578
Total	**1160**	**Total**	**1160**

Table 2. Number of traded live Asian Small-clawed Otters for personal and commercial purposes between 1977 and 2019 (by import declaration numbers on CITES Trade Database; Purpose codes are P and T)

Importing Countries	No.	Exporting Countries	No.
Japan	354	Netherlands	110
Uzbekistan	100	Tanzania	100
United States of America	98	Indonesia	89
Singapore	45	Singapore	83
Korea	24	Czech Republic	67
Others	60	Others	232
Total	**681**	**Total**	**681**

Import of Live Asian Small-clawed Otters to Japan

There were 382 live Asian Small-clawed Otters imported into Japan between 1986 and 2019 for all purposes, but since 2020, there has been one import only for scientific purposes, and no illegal imports of this species were reported in Japan. Imports increased in the latter half of the 1980s and again in the latter half of the 2010s (Figure 1). During the first peak in the latter half of the 1980s, most were imported for commercial purposes. As it was not common to keep otters as pets in households at that time, it is likely that demand came from zoos and aquariums that used the species in exhibitions. Asian Small-clawed Otters began to be kept in zoos and aquariums in Japan in 1970. Although a total of four individuals were exhibited in two zoos at first (Japanese Association of Zoos and Aquariums, 1970), the number of individuals in zoos and aquariums increased to 22 by 1995, and there were 228 in total in 39 facilities in 2013. It has been suggested that this increase was due to the Asian Small-clawed Otters being considered attractive as exhibition animals, that they were easy to obtain, and allegedly breed throughout the year with relatively large litter sizes (Wakiguchi, 2015).

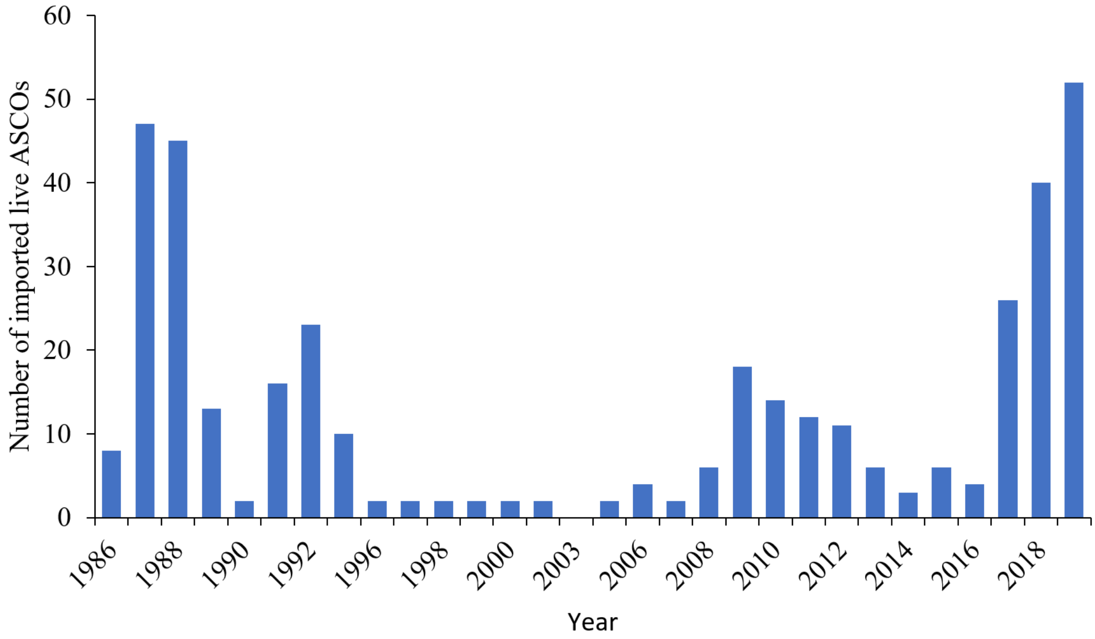

Figure 1. Changes in the number of otters imported by Japan from 1986 to 2019

Illegal Trade of Live Asian Small-clawed Otters in Asia and Japan

The high demand and increasing profits to wildlife traders has led to an increase in illegal trade in this species. In Southeast Asia, 32 live Asian Small-clawed Otters were seized between 2015 and 2017, with Thailand as the major hub of illegal trade (Gomez and Bouhuys, 2018). There was an increase in the trafficking of this species into Japan with at least 10 cases of smuggling or attempted smuggling of 62 Asian Small-clawed Otters into the country, largely from Indonesia and Thailand between 2000 to 2019 (Shepherd and Tansom, 2013; Kitade and Naruse, 2018). It is reasonable to assume that these seizures represent a mere fraction of the actual number of Asian Small-clawed Otters trafficked from a range of countries into Japan and, continued seizures and arrests indicate profitable incentives for successfully smuggling otters into Japan's market (Kitade and Naruse, 2018).

Up-Listing to CITES Appendix I in 2019

In 1977, the Asian Small-clawed Otter was listed in Appendix II of the Convention on CITES (UNEP-WCMC, 2022). However, the Parties decided to list the Asian Small-clawed Otter in Appendix I in August 2019, as excessive trade due to escalating demand for pets would increase the risk of extinction of this endangered species. As a result, international commercial transactions have been prohibited in principle since 26 November 2019.

Current Situation of Pet Otter Trade

International Trade of Live Asian Small-Clawed Otters

Since the Asian Small-clawed Otter was listed in CITES Appendix I, international trade for commercial purposes of this species has been prohibited in principle, with possible exceptions for animals bred in captivity at facilities registered with CITES. Trade for scientific purposes is still allowed with permissions issued by the government of both the exporting and importing countries. Based on the CITES trade database between 2020 to 2021, one import for commercial purposes from the

Czech Republic to South Korea was reported in 2021 (Table 3). However, as there are no breeding facilities in the world registered with CITES for this species, it is unclear how this trade was conducted.

Table 3. Record of traded live Asian Small-clawed Otters for all purposes between 2020 and 2021 (by import declaration numbers on CITES Trade Database; Purpose codes are all)

Year	Importer	Exporter	Importer Reported Quantity	Exporter Reported Quantity	Purpose	Source
2020	CH	CZ		1	Z	C
2020	MA	FR	1		B	F
2020	ZA	SG	5		B	C
2021	JP	HK	2	2	S	F
2021	KR	CZ		2	T	C
2021	KR	DK			Z	C
2021	NZ	AU			Z	C
2021	ZA	SG			B	C

AU Australia	B For breeding in captivity
CH Switzerland	C Bred in captivity (both parents captive bred)
CZ Czechia	F Born in captivity but not bred in captivity
DK Denmark	S Scientific
FR France	T Commercial
HK Hong Kong (China)	Z Zoo or Aquarium
JP Japan	
KR Republic of Korea	
MA Morocco	
NZ New Zealand	
SG Singapore	
ZA South Africa	

While the international trade of the species into Japan has declined since the CITES Appendix I listing, there are still reports of illegal trade in some range states. According to TRAFFIC's WiTIS, there were a total of 16 seizures involving 54 live Asian Small-clawed Otter reported from November 26th 2019 until December 31st 2021. There were eight seizures with a total of 34 live Asian Small-clawed Otters in Vietnam, and eight seizures with a total of 20 live Asian Small-clawed Otters in Thailand. In most of the cases, advertisements of live otters for sale as pets were posted on social media such as Facebook.

The Asian Small-clawed Otter is protected under domestic laws in all Southeast Asian countries except Cambodia and Indonesia, with the latter regulating trade on paper under a national quota system (Gomez and Bouhuys, 2018). However, as can be seen from these data, illegal trade persists in many countries despite national laws.

Law Enforcement and Market of Pet Otters in Japan

Due to elevation of the Asian Small-clawed Otter from Appendix II to I of CITES, the species has become subject to protection under domestic legislation in Japan, and regulations on management have changed significantly. Individual otter registration with the Ministry of the Environment is now required for transaction or display for sale or distribution purposes.

However, the number of animal cafes exhibiting otters whose operation is legally allowed in Japan has increased slightly since 2018. It can be seen from Google Trends that general interest in otters in Japan remains at a high level, and the "demand" for keeping otters as pets still exists. As it has been pointed out that Japanese social media posts calling for galagos to be pets are stimulating demand for pets globally (Svensson et al., 2022), the pet demand of the Asian Small-clawed otters in Japan could indirectly increase threats to the conservation of wild populations. In addition, there are concerns about animal welfare because the act of "petting" can cause physical and mental stress to animals, and animals may be placed in environments different from their natural habitats.

Legislation

Legal regulations regarding the Asian Small-clawed Otter in Japan were introduced through the Act on Conservation of Endangered Species of Wild Fauna and Flora 1992 (ACES) and the Act on Welfare and Management of Animals 1973, which are the primary laws regarding domestic trade and keeping of animals.

1. <u>Act on Conservation of Endangered Species of Wild Fauna and Flora (ACES)</u>
   The ACES is a law enacted in 1992 to conserve species that are designated as nationally endangered species as well as internationally threatened species listed in CITES Appendix I, or Conventions and Agreements for Protection of Migratory Birds. Accordingly, the Asian Small-clawed Otter was designated as an Internationally Rare Species of Wild Fauna and Flora under ACES from November 26th, 2019, onwards. In principle, the transaction referring to transfers (giving, selling, lending, receiving, buying, and borrowing) of endangered species is prohibited. Display and advertising for the purpose of sale or distribution leading to a transaction are also subject to regulation. Therefore, to transact, display or advertise for individuals that meet certain conditions such as being obtained prior to the application of ACES regulations or animals bred in captivity using individuals obtained prior to ACES regulations, each Asian Small-clawed Otter must be individually registered through the designated institution by the Ministry of the Environment of Japan. Additionally, a registration card showing the registration number, registration date, and expiration date must be provided during the transaction or display and advertising for sale or distribution.

2. <u>Act on Welfare and Management of Animals</u>
   The Act on Welfare and Management of Animals was enacted in 1973 and stipulates standards for the care and management of animals to ensure their health and safety and prevent animals from causing harm or inconvenience to humans. This law is not related to CITES implementation, and therefore, the regulation of the Asian Small-clawed Otter under this law has not changed. However, the Act on Welfare and Management of Animals stipulates various regulations regarding businesses dealing with animals, and face-to-face explanations and physical confirmation of animals are required for dealers when selling mammals, birds, and reptiles to customers, restricting the online trade in Asian Small-clawed Otters in Japan.

Market

Once a species is listed in Appendix I of CITES, international trade is prohibited in principle. In the case of the Asian Small-clawed Otter, no import record to Japan has been confirmed since 2019. Many cases of sales of otters at exotic pet fairs or online advertisements were observed in Japan before the change (Kitade and Naruse, 2018), but as of 2022, multiple dealers say on their websites that they have suspended their sale of otters because it has become difficult to import otters.

However, there are still several shops or animal cafes selling or leasing otters bred in captivity with registration numbers. In 2020, the number of Asian Small-clawed Otters registered by the Ministry of the Environment of Japan was 31, and as of July 2022, it was 95. Although it is thought that the quantity of otters on the pet market in Japan has decreased significantly due to import restrictions, this indicates that there are still some otters being traded within Japan.

Otter Cafes

From the latter half of the 2000s, the overall pet trade and posts on social media platforms of the Asian Small-clawed Otters has increased, likely encouraged by the fact that this species was featured as a cute "pet" in local TV programmes in Japan (Kitade and Naruse, 2018). Furthermore, in Japan, Asian Small-clawed Otters are not only kept as household pets but are also in demand for display at animal cafes (Kitade and Naruse, 2018; McMillan, 2018), some known as otter cafes, indicating the popularity of these animals.

Otter cafes usually offer otters on display and petting opportunities, but some facilities also legally breed and sell individuals by highlighting the "cuteness" of otters. In addition to stimulating demand, there are also concerns about animal welfare and public health related to keeping animals at these cafes. In many facilities, otters are placed in small spaces without swimming facilities and fed mainly cat food, which is not considered to be a sufficient or nutritional diet according to a nutritional study of the species (Cabana et al., 2022). There have been reports of health problems in some otters kept at these cafes that are thought to be likely caused by a lack of proper care and the stress of constant interactions with customers (Okamoto et al., 2020). Furthermore, eating and drinking by customers in direct contract with wild animals, such as otters, likely increases the risk of zoonotic diseases (Sigaud et al., 2023).

We investigated the current situation of otter cafes, which are believed to have a major impact on stimulating demand for otters as pets. As of July 2022, Asian Small-clawed Otters were exhibited at 12 otter cafes in seven cities, with the largest number of four otter cafes in Tokyo (Figure 2). This data shows the number of otter cafes has increased slightly compared to the number of ten facilities observed by TRAFFIC in 2018 (Kitade and Naruse, 2018).

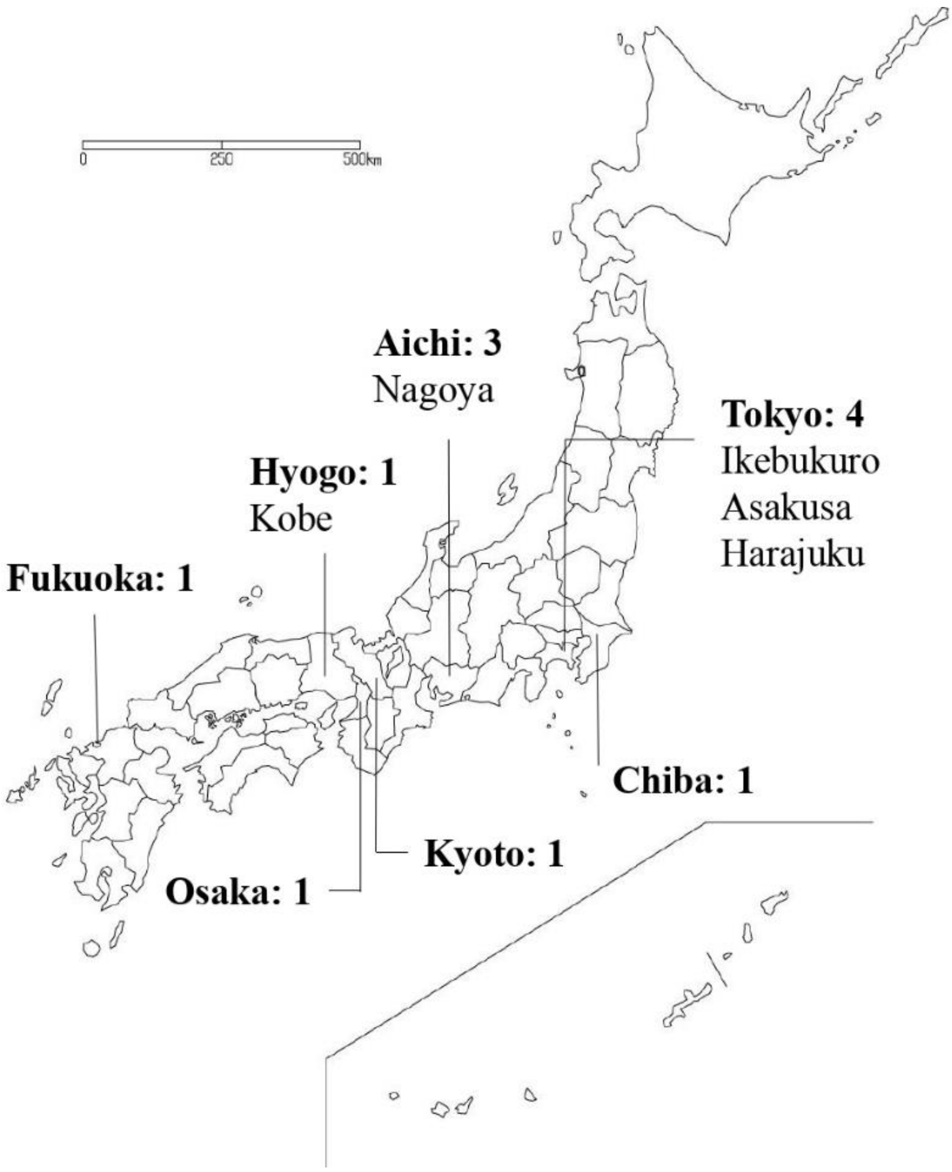

Figure 2. Locations of otter cafes in Japan confirmed in July 2022.

Demand for Pet Otters

To understand the trends in the general public's interest in otters in Japan, we searched for the word "カワウソ" (meaning "otter" in Japanese) from July 1, 2010, to July 1, 2022, using Google Trends (Figure 3). The search frequency of this word gradually increased from around 2013, peaked in August 2017, and was about half of the peak in November 2019 when the Asian Small-clawed Otter was listed in Appendix I of CITES.

Since the search trends include searches for other purposes, it is impossible to know the accurate demand for Asian Small-clawed Otters as pets. However, it is inferred that the general public in Japan still has a high interest in this species.

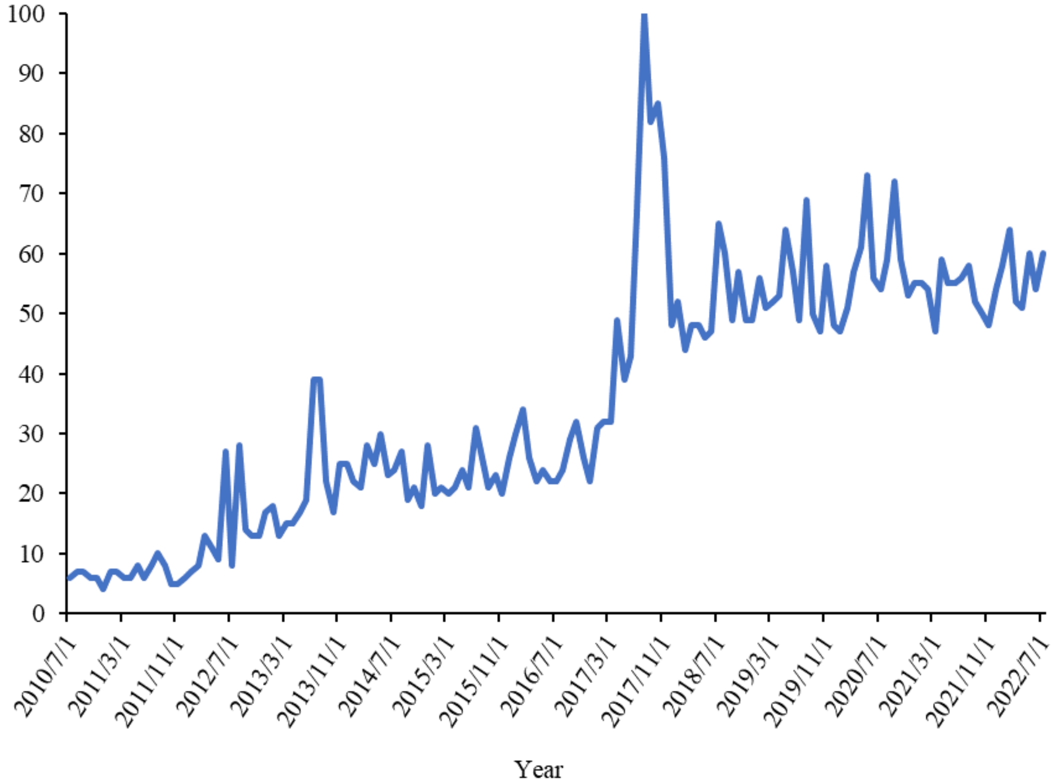

Figure 3. Google Trends for the term "カワウソ" (meaning "otter" in Japanese) from July 1, 2010 to July 1, 2022. Google Trends shows the relative popularity of the search term by setting the highest point to 100.

CONCLUSION

Since the inclusion of Asian Small-clawed Otters in Appendix I of CITES in 2019, the international trade volume of Asian Small-clawed Otters has decreased markedly. However, in many parts of the Asian region, illegal domestic trade is still conducted mainly on online platforms.

Japan, historically one of the major consuming countries for Asian Small-clawed Otters as pets, has had no new reports of imports or smuggling since it was listed in CITES Appendix I, according to CITES and WiTIS records. It became significantly difficult for dealers to trade this species due to significant decline in import volumes and tightening regulations under Japanese domestic law, and the number of advertisements of otters for sale seems to have decreased.

Individuals imported before the tightening of regulations and their offspring can still be traded if they are registered with the government. Some dealers sell captive-bred individuals, so a certain amount of pet use is expected to continue in the future. This should be closely monitored to prevent unscrupulous trade to other countries with demand for this species.

Social media and animal cafe exhibits are the main drivers creating demand for pet otters and other exotic pets. In particular, there are many concerns about animal cafes, which display wild animals such as otters, not only from the perspective of stimulating demand but also from the perspective of animal welfare and public health.

Efforts should be made to continue to reduce demand for Asian Small-clawed Otters in Japan and in all countries where this threatened species is traded. Specifically, it would be effective for the private sector to eliminate displays of this species at animal cafes, which may stimulate demand for pets. Demand is also expected to be reduced if appropriate information, including the threatened situation of Asian Small-clawed Otters and the impact of trade, is conveyed to consumers on social media or the mass media, eliminating messages that encourage them to keep this species as pets. In addition, researchers around the world will help foster social momentum to reduce demand for Asian Small-clawed Otters as pets by clarifying pet use and its adverse effects on this species.

Listing the Asian Small-Clawed Otter in Appendix I of CITES has led to a rapid reduction in legal international trade and seizure records. However, as illegal trade is still being reported in the country of origin, crackdowns should be strengthened by further clarifying and publicizing cases of illegal trade, seizures, and resulting prosecutions by the authorities of each country. Furthermore, care should be taken not to shift demand and trade of this species from countries with tighter regulations to countries with looser regulations and enforcement.

Acknowledgements - We thank Loretta Shepherd, Melissa Savage and Lalita Gomez for very helpful comments and edits on a previous draft. We also thank Naoya Ohashi for his help in finding references.

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RESUME

ÉTAT ACTUEL DE LA RÉGLEMENTATION DU COMMERCE DES LOUTRES CENDRÉES *Aonyx cinereus* AU JAPON

La loutre cendrée, *Aonyx cinereus*, est l'objet d'un commerce international en vue de répondre à la demande d'animaux de compagnie, à la fois légalement et illégalement. En 2019, l'espèce est passée de l'Annexe II de la Convention sur le commerce international des espèces de faune et de flore sauvages menacées d'extinction (CITES) à l'Annexe I, qui interdit généralement le commerce international, car son commerce est considéré comme une menace pour la conservation de l'espèce. Bien que la législation nationale japonaise protège strictement les espèces inscrites à l'Annexe I de la CITES, il est toujours possible de commercialiser la loutre cendrée au niveau national, sous réserve de procédures d'enregistrement nécessaires. Nous examinons ici les niveaux actuels du commerce des loutres cendrées au Japon et l'impact de leur inscription aux annexes de la CITES.

RESUMEN

EL ESTADO ACTUAL DE LA REGULACIÓN DEL COMERCIO DE NUTRIAS DE UÑAS PEQUEÑAS ASIÁTICAS *Aonyx cinereus* EN JAPÓN

La Nutria de Uñas Pequeñas Asiática *Aonyx cinereus* es comerciada internacionalmente para proveer a la demanda de mascotas, tanto legal como ilegalmente. En 2019, la especie fue elevada de estar listada en el Apéndice II de la Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres (CITES), al Apéndice I, que en general prohíbe el comercio internacional, ya que se estimó que el comercio es una amenaza a la conservación de ésta especie. Aunque la legislación nacional Japonesa protege estrictamente a las especies del Apéndice I de CITES, es aún posible comerciar internamente Nutrias de Uñas Pequeñas Asiáticas, sujeto a los necesarios procedimientos de registro. Aquí analizamos los niveles actuales de comercio de Nutrias de Uñas Pequeñas Asiáticas en Japón, y el impacto del cambio en el listado de CITES.

REPORT

FIRST BREEDING RECORD OF ASIAN SMALL-CLAWED OTTER *Aonyx cinereus* (ILLIGER, 1815) FROM SAHYADRI TIGER RESERVE, WESTERN GHATS, INDIA

Shantanu SHARMA[1], Uttam SAWANT[2], Shah Nawaz JELIL[1], Akash PATIL[1], Abhilasha SRIVASTAVA[1], Ramesh KRISHNAMURTHY[1]*

[1]*Wildlife Institute of India, Chandrabani, Dehradun, 248001, Uttarakhand, India*
[2]*Sahyadri Tiger Reserve, Van Vardhan building, Tarabai Chowk, Kolhapur, 416003, Maharashtra, India*
**Corresponding Author: ramesh@wii.gov.in*

(Received 29th April 2023, accepted 21st August 2023)

ABSTRACT: Sahyadri Tiger Reserve is a very understudied complex of the Western Ghats landscape of India. The presence of diverse and heterogenous habitats supports a diverse species assembly. Here, we report on the occurrence and breeding of Asian Smallclawed Otters in the tiger reserve through opportunistic camera trapping conducted from November 2021–March 2022 at sampled locations along streams. Asian Small-clawed Otters were recorded from five locations with a photographic capture rate of 0.94 (± 0.57 SE) and in group sizes of 1–5 individuals, including pups. However, extensive surveys are necessary to generate reliable abundance estimates and to clearly understand otter distribution patterns in this landscape.

CITATION: Sharma, S., Sawant, U., Jelil, S.N., Patil, A., Srivastava, A., and Krishnamurthy, R. (2024). First Breeding Record of Asian Small-Clawed Otter *Aonyx cinereus* (Illiger, 1815) from Sahyadri Tiger Reserve, Western Ghats, India. *IUCN Otter Spec. Group Bull.*, **41** (1): 15 - 23

KEYWORDS: Camera traps, Northern Western Ghats, Mustelidae, Carnivore, Sahyadri Tiger Reserve

INTRODUCTION

India is the westernmost range of the Asian Small-clawed Otter worldwide (Wright et al., 2021). This species is distributed across northeast India, the Himalayan foothills, Eastern Ghats, and Western Ghats (Hussain, 1999; Sharma et al., 2014). The Asian Small-clawed Otter occurs in freshwater and peat swamp forests, rice fields, lakes, streams, reservoirs, canals, mangroves, and along coasts (Hussain et al., 2011). In the Western Ghats, the species prefers high-altitude areas with stream pools (Perinchery et al., 2011), which was found to be contradictory by Punjabi et al. (2014) as they recorded the species' presence across an elevation gradient of 43–821 m. The species occupies narrow, fast-flowing, and rocky streams, with dense vegetation and tall grasses on both sides of the bank to provide adequate escape cover (Raha and Hussain 2016). The species is sympatric with the Smooth-coated and Eurasian otter. In India, all three species occur in the Western Ghats, Eastern coast and in northeast India (Menon, 2014; Debata et al., 2020; Wright et al., 2021).

Although there is a paucity of robust abundance estimates and population trends, it is suspected that the global population of the Asian Small-clawed Otter has declined by >30% over the past 30 years (Pacifici et al., 2013; Wright et al., 2021). It is further suspected that the future decline can be at least 30% over the next 30 years. The species is classified as Vulnerable by the IUCN Red List of Threatened Species (Wright et al., 2021) and is listed in Appendix II of CITES. It is listed in Schedule I of the Indian Wild Life (Protection) Act, 1972 (amended to date) (WPA, 2022).

The available information on the species ecology primarily comes from the southern Western Ghats. Although the river ecosystems of the northern Western Ghats have been poorly studied, certain remote stream habitats still harbor some of the rare and elusive species, such as otters. Earlier researchers remarked on the lack of species-specific surveys and an overall ecological understanding of otter species (Punjabi et al., 2014). Here, we report the first robust evidence of the occurrence and breeding of the Asian Small-clawed Otter in Sahyadri Tiger Reserve, the northern Western Ghats in Maharashtra state, India.

STUDY AREA

Sahyadri Tiger Reserve (STR), located in the northern Western Ghats of India, spans over an area of 1166 km2, jointly comprised of Chandoli National Park and Koyna Wildlife Sanctuary. The reserve has a rugged terrain with an altitudinal gradient of 350–1250 m. The tiger reserve consists of two major reservoirs: Shivsagar and Vasant Sagar. Undulating topography births numerous torrential streams from the headwater regions feeding into these reservoirs. A previous study reported high fish diversity in its stream and reservoirs. A total of fifty species of fish were recorded from the STR, of which significant species were insectivorous, omnivorous, and herbivorous in their diet preference (Johnson et al., 2019). The STR experiences a mean annual rainfall of 5000 mm from June to September (Joglekar et al., 2015). The tiger reserve represents a heterogeneous landscape covering dense forest, open forest, scrubland, barren land, agricultural land, water body, and reservoir bed (Jelil et al., 2020). The tiger reserve supports some of the few remaining undisturbed tall evergreen forests in the northern Western Ghats. It hosts large mammal species such as the common leopard Panthera pardus fusca, dhole Cuon alpinus, sloth bear Melursus ursinus, Indian gaur Bos gaurus, and sambar Rusa unicolor (Joglekar et al., 2015; Jelil et al., 2021).

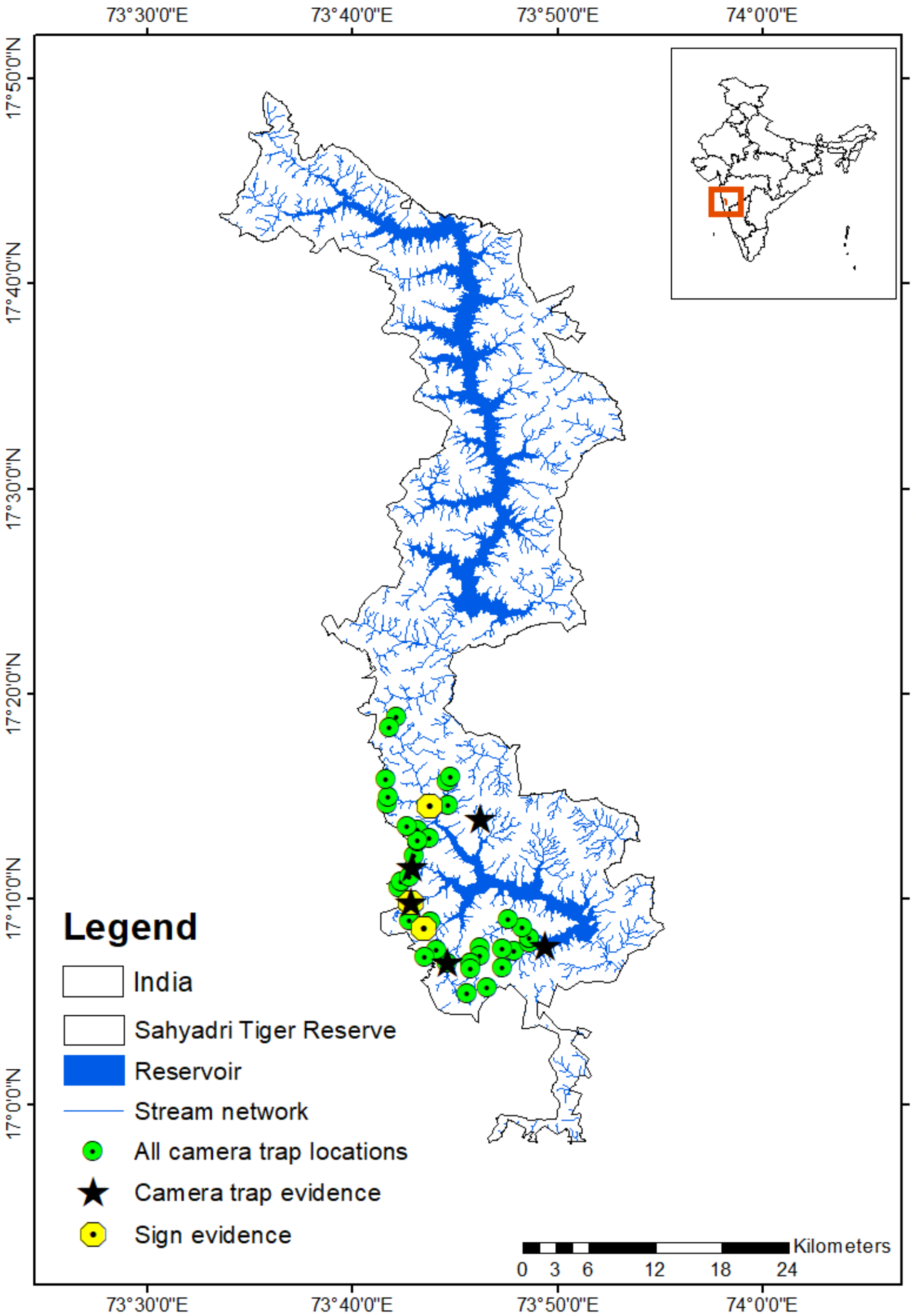

Figure 1. Map of the study area with camera trap locations, camera trap capture locations, and sign evidence locations of the Asian Small-clawed Otter photo-captures from Sahyadri Tiger Reserve.

MATERIALS AND METHODS

Thirty-eight camera traps were deployed at trails along streams in Chandoli National Park, the southern part of Sahyadri Tiger Reserve, from November 2021–April 2022 (Fig. 1). We used single-sided Cuddeback (C1 model) cameras on suitable trees at 45–50 cm height. Cameras were active 24 hours daily and set on FAP (fast as possible) mode when triggered. These cameras were monitored weekly to ensure proper functioning and data backup. The mean camera trap nights were 55.04 (± 1.09 SE).

Additionally, opportunistic sign surveys were conducted at trails along streams (Fig. 1). The Asian Small-clawed Otter signs were identified and confirmed based on Prater (1971) and Hussain et al. (2011) descriptions.
Images were considered independent when they were at least 30 minutes apart (Rovero and Zimmerman, 2016; Allen et al., 2018, 2020). We calculated the photographic capture rate by dividing the number of independent captures by the total number of camera trap nights (effort) and expressed it per 100 trap nights (Carbone et al., 2001) for each site. We then ran 999 bootstrap samples of the capture rate to estimate mean capture rates and bootstrapped standard error (SE) using the mosaic package (Prium et al., 2017).
We used the activity package (Rowcliffe, 2022) in R to analyze and visualize the temporal activity pattern of the Asian Small-clawed Otter.

RESULTS AND DISCUSSION

Twenty independent photo-captures of the Asian Small-clawed Otter were recorded from five locations in Chandoli National Park (the southern part of the tiger reserve), viz. Karde backwater, Siddheshwar stream, Ramnadi stream, Gothane stream, and stream near Vetti kuti at an elevation range of 624 m to 911 m above sea level (Table 1; Fig 1,2) with a photographic capture rate of 0.94 (± 0.57 SE). The Asian Small-clawed Otters were recorded in groups of 1–5 individuals, including pups. In addition, three other locations, viz. Ram nadi, Kandhar waterfall, and stream near Chandel kuti were confirmed with otter presence through sign surveys (spraints) (Fig. 3). We found the peak activity of the Asian Small-clawed Otter in the evening at around 1800 hours (Fig. 4).

Table 1. Details of camera trap images of the Asian small-clawed otter in Sahyadri Tiger Reserve

Date	Time (hh:mm)	Range	Site ID*
03-Nov-21	19:02	Chandoli	01
08-Nov-21	17:21	Chandoli	01
08-Nov-21	19:23	Chandoli	01
10-Nov-21	4:28	Chandoli	01
11-Nov-21	1:55	Chandoli	01
14-Nov-21	19:58	Chandoli	02
15-Nov-21	7:21	Chandoli	01
15-Nov-21	17:32	Chandoli	01
18-Nov-21	20:36	Chandoli	01
20-Nov-21	9:21	Chandoli	01
22-Nov-21	16:28	Chandoli	01
23-Nov-21	16:31	Chandoli	01
25-Nov-21	7:40	Chandoli	01
27-Nov-21	11:58	Chandoli	01
01-Dec-21	6:06	Chandoli	01
03-Dec-21	22:30	Chandoli	01
12-Dec-21	4:06	Chandoli	03
15-Feb-22	00:31	Helwak	04
22-Mar-22	3:23	Chandoli	05
26-Mar-22	17:05	Chandoli	05

***Site ID:** Gothane stream (ID-01), Stream near Vetti kuti (ID-02), Ram nadi stream (ID-03), Siddheshwar stream (ID-04), Karde Backwater (ID-05)

Figure 2. A: Camera trap image of Asian Small-clawed Otter *Aonyx cinereus* with pups along the stream; B: Camera trap image of Asian Small-clawed Otters *Aonyx cinereus*; C, D: Riparian and stream habitat used by Asian Small-clawed Otter *Aonyx cinereus* in Sahyadri Tiger Reserve

As pups were photo-captured, these images represent the first confirmed breeding record of the Asian Small-clawed Otters in the tiger reserve. However, incidental photo-captures of otters had been recorded previously from the tiger reserve (pers. obs. SNJ). This finding strengthens the species profile of the tiger reserve. This paper is a significant contribution to filling some of these knowledge gaps about the distribution of Asian Small-clawed Otter in the Sahyadri. Previously, the Asian Small-clawed Otters was first documented from the northern Western Ghats landscape and Maharashtra by Punjabi et al. (2014).

Figure 3. A, B: Indirect evidence (spraint) of Asian Small-clawed Otter *Aonyx cinereus* in Sahyadri Tiger Reserve.

The importance of riparian forests in the lives of semi-aquatic mammal species such as otters is reiterated. These forest and stream habitats provide otters with the necessary cover and food resources and are vital constituents of the terrestrial-aquatic continuum. The presence of Chandoli and Koyna reservoirs makes riparian forests a dominant forest type in the tiger reserve. Jelil et al. (2021) recorded 19 terrestrial mammals along the riparian forests of Koyna Wildlife Sanctuary, the northern part of Sahyadri. They further found that ungulates had the highest occupancy in these riparian forests. This breeding record of the Asian Small-clawed Otter proves an obligate riparian species' presence and growing population in reserve.

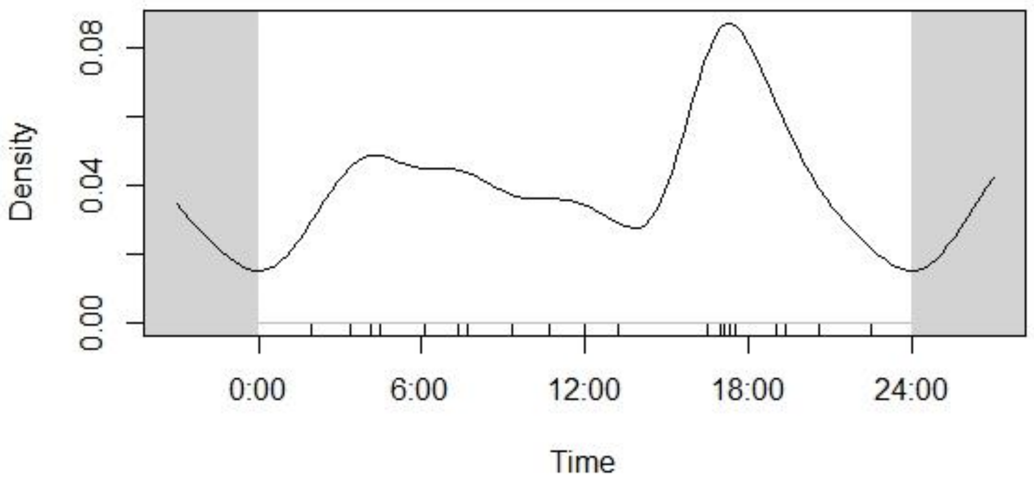

Figure 4. Activity graph of Asian Small-clawed Otter *Aonyx cinereus* in Sahyadri Tiger Reserve

Finally, this finding further demonstrates the advantages of using camera traps in wildlife studies. Camera traps in the tiger reserve have been deployed as part of regular monitoring activities and are majorly aimed at large carnivores such as tigers and leopards. However, camera traps provide data on target species and substantial data on non-target species (Edwards et al., 2018; Mazzamuto et al., 2019). Incorporating such by-catch data provides additional insights into a particular area's overall species inventory and species ecology.

ACKNOWLEDGEMENTS *- We thank the Maharashtra State Forest Department, the National Tiger Conservation Authority, and the Wildlife Institute of India for supporting the study. We thank the Sahyadri Tiger Conservation Foundation for the financial and equipment support. We thank Dr Vidyadhar Atkore (Scientist, SACON) for their review comments on the draft manuscript. We acknowledge the assistance of all the forest officials, especially the beat guards, field assistants, and forest watchmen.*

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RÉSUMÉ

PREMIERE SYNTHESE SUR LA REPRODUCTION DE LOUTRE CENDRÉE *Aonyx cinereus* (ILLIGER, 1815) DANS LA RÉSERVE DES TIGRES DE SAHYADRI, AUX GHATS OCCIDENTAUX, EN INDE

La réserve des Tigres de Sahyadri est un complexe très peu étudié du paysage des Ghâts occidentaux de l’Inde. La présence d’habitats divers et hétérogènes favorise un regroupement d’espèces diversifiées. Nous relatons ici la présence et la reproduction de loutres cendrées dans la réserve des Tigres à l’aide de pièges photographiques adaptés entre novembre 2021 et mars 2022 sur des sites sélectionnés le long des cours d’eau. Des loutres cendrées ont été observées sur cinq sites avec un taux de capture photographique de 0,94 (± 0,57 SE) et des groupes de 1 à 5 individus, y compris les loutrons. Cependant, des études approfondies sont nécessaires pour générer des estimations fiables de l’abondance et pour comprendre clairement les schémas de répartition des loutres dans ce paysage.

RESUMEN

PRIMER REGISTRO DE REPRODUCCIÓN DE NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA *Aonyx cinereus* (ILLIGER, 1815) DE LA RESERVA DE TIGRES SAHYADRI, GHATS OCCIDENTALES, INDIA

La Reserva de Tigres Sahyadri es un complejo muy poco estudiado, en el paisaje de los Ghats Occidentales de la India. La presencia de hábitats diversos y heterogéneos dá sostén a un ensamble diverso de especies. Aquí, informamos la ocurrencia y reproducción de Nutrias de Uñas Pequeñas Asiáticas en la reserva de tigres, a través de trampeo con cámaras realizado en forma oportunística, entre Noviembre 2021 y Marzo 2022, en locaciones muestreadas a lo largo de arroyos. Fueron registradas Nutrias de Uñas Pequeñas Asiáticas en cinco localizaciones, con una tasa de captura fotográfica de 0.94 (± 0.57 SE) y en tamaños de grupo de 1-5 individuos, incluyendo crías. Sin embargo, se necesitan relevamientos extensivos para generar estimaciones confiables de abundancia y comprender los patrones de distribución de las nutrias en éste paisaje.

सार : सह्याद्रि टाइगर रिज़र्व भारत के पश्चिमी घाट का काफी कम अध्ययन किया गया परिक्षेत्र है। विविध और विषम आवासों की उपस्थिति विविध प्रजातियों के संयोजन का समर्थन करती है। हमने इस टाइगर रिजर्व में नवंबर 2021 से मार्च 2022 तक कुछ नदी के किनारे के स्थानों पर कैमरा ट्रैपिंग की तथा हमने एशियाई छोटे पंजो वाले ऊदबिलाव की उपस्थिति तथा प्रजनन का वर्णन किया। एशियाई छोटे पंजे वाले ऊदबिलाव को हमने पांच जगहों पर 0.94 (± 0.57) फोटोग्राफिक कैप्चर रेट एवं 1 - 5 के समूह में बच्चों के साथ पाया। हालांकि, इनकी विश्वसनीय अनुमानित संख्या एवं ऊदबिलावो के इस परिदृश्य में विचरण के स्वरूप का पता लगाने के लिए और अधिक सर्वेक्षण की अति आवश्यकता है।

सारांश: सह्याद्री व्याघ्र प्रकल्प हा भारताच्या पश्चिम घाटाच्या प्रदेशातील अत्यंत कमी अभ्यासलेला भूभाग आहे. या ठिकाणी असलेल्या वैविध्यपूर्ण आणि विषम अधिवासांची उपस्थिती विविध

प्रजातींच्या संमेलनास साथ देते. येथे, आम्ही नोव्हेंबर २०२१ ते मार्च २०२२ या कालावधीत जंगलातील प्रवाहाच्या बाजूने प्राथमिक सर्वेक्षण केलेल्या ठिकाणी कॅमेरा ट्रॅपिंगद्वारे व्याघ्र प्रकल्पात (Asian Small-clawed Otters) आशियाई लहान-नखे असलेल्या औटर्सच्या प्रजातीची उपस्थिती आणि प्रजननाचे पुरावे नोंद केले आहेत. ०.९४ (± ०.५७ SE) च्या फोटोग्राफिक कॅप्चर रेटसह आणि १-५ पिल्लांसह पाच ठिकाणांहून एशियन स्मॉल-क्लॉड ऑटर्स चा रेकॉर्ड केले गेले आहेत. तसेच,या प्रजातीच्या विपुलतेचे विश्वसनीय अंदाज तयार करण्यासाठी आणि या प्रदेशात ओटर्सचे वितरण नमुने स्पष्टपणे समजून घेण्यासाठी विस्तृत सर्वेक्षणेची आवश्यकता आहे.

R E P O R T

DO NATURAL RIVER PITS POSE A DANGER TO OTTERS? A FIELD REPORT FROM THE MOYAR RIVER, WESTERN GHATS, INDIA

Kannadasan NARASIMMARAJAN[1]*, Himanshu Shekhar PALEI[2] and Manu Thomas MATHAI[1]

[1]*Department of Zoology, Madras Christian College, Tambaram, Chennai – 600 059, India*
[2]*Aranya Foundation, Bhubaneswar, Odisha, India*
**Corresponding author: wildlife9protect@gmail.com*

(Received 24th July 2023, accepted 6th October 2023)

ABSTRACT: This paper reports an unusual and accidental mortality event of a group of Asian small-clawed otters (*Aonyx cinereus nirnai* Illiger, 1815) trapped inside natural river pits in the Moyar River, Western Ghats, India. Otter populations are likely declining in the Western Ghats region due to various anthropogenic pressures and human-cause mortalities (poaching, roadkill, retaliate killing). Safeguarding otters from accidental mortality will help support their future survival. We discuss preventive measures to avoid such a cause of accidental mortality.

Citation: Narasimmarajan, K., Palei, H.S., and Mathai, M.T. (2024). Do Natural River Pits pose a Danger to Otters? A Field Report from the Moyar River, Western Ghats, India. *IUCN Otter Spec. Group Bull.*, **41** (1): 24 - 30

Keywords: Asian small-clawed otter; Mortality; River Pits; Hydroelectric Dam; Western Ghats

INTRODUCTION

Asian small-clawed otters (*Aonyx cinereus nirnai*) act as apex predators in aquatic ecosystems, playing a crucial role in regulating the overall health and functioning of the ecosystem. The geographic distribution of the Asian Small-clawed otter extends in South Asia from India through Southeast Asia, and on the island of Palawan (Wright et al., 2021; Kruuk, 2006). Three of the four species of Asian otters can be found in the Western Ghats region, the Smooth-coated otter (*Lutrogale perspicillata*), the Asian small-clawed otter (*Aonyx cinereus nirnai*), and the Eurasian otter (*Lutra lutra*) (Perinchery et al., 2011). Asian small-clawed otter populations in the Western Ghats are likely declining (Perinchery et al., 2011), such that preventing mortality from natural and human causes is essential for their long-term survival. Two species of otters, the Smooth-coated and Asian small-clawed otter, have been reported in the Moyar River of the Western Ghats (Narasimmarajan and Mathai, 2019). The Asian small-clawed otter is restricted to hilly regions there (> 850 m asl) in primary and secondary forest streams, where they live in small groups of 3-5 individuals (Narasimmarajan, 2020). Asian small-clawed otters often search for food in river pits in river systems, where they hunt for crustaceans and fish (Narasimmarajan, 2020).

The Moyar River is 102 km long, originates in upper Bhavani River at 2054 m asl and flows through several protected areas, the Mudumalai Tiger Reserve (Mudumalai), Sathyamangalam Tiger Reserve (Sathyamangalam), Nilgiri North & South Divisions and the Bavanisagar Dam at 254 m asl (Narasimmarajan et al. 2021) (Figure 1). The upper reaches of the river area receive ~5,000 mm of rainfall, whereas the downriver area reaches receive ~824 mm of rainfall annually (Puyravaud and Davidar, 2013). Minimum and maximum annual average temperatures vary from 14˚C - 30˚C in higher elevations, and 25˚C -38˚C in the lower elevations (Narasimmarajanet al. 2019; Puyravaud and Davidar, 2013). The elevation of the river ranges from 2,054 m asl at Pykara Dam to 250 m asl at the Bavanisagar Dam (Narasimmarajan et al. 2021).

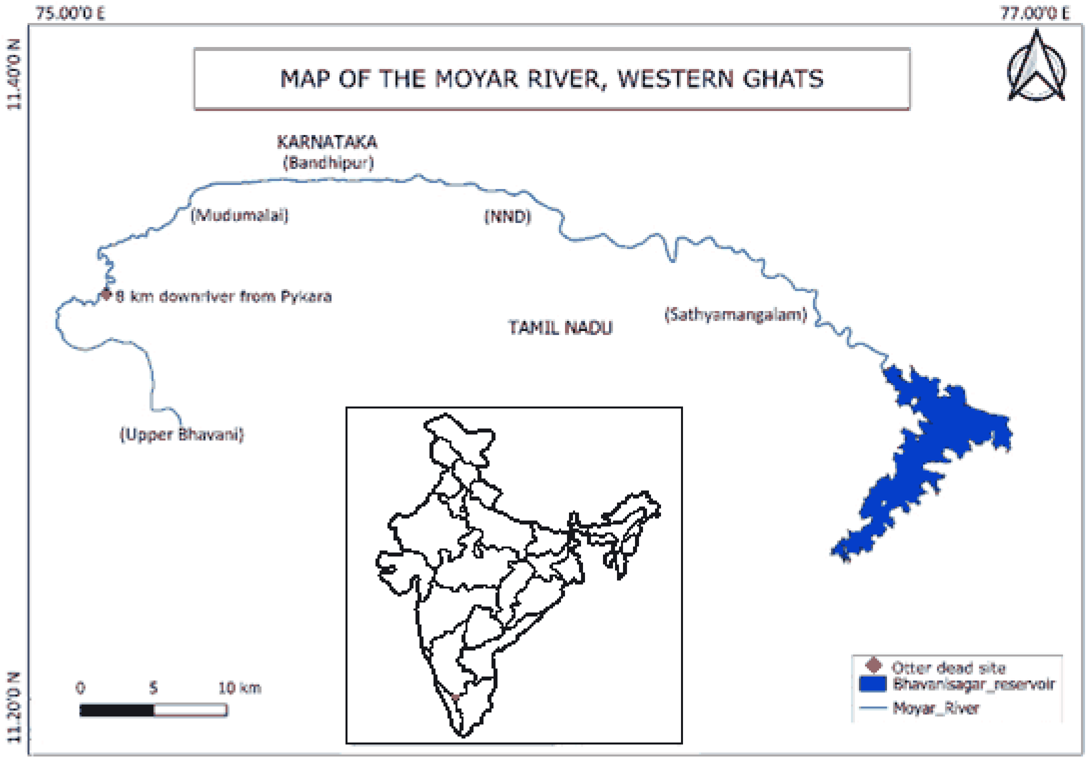

Figure 1. Map showing the Moyar River and its important landmarks in the Western Ghats – a Global Biodiversity Hotspot. Red diamond marks the location of the otter carcasses found in a river pit.

River pits are formed naturally when high water flows crack rock surfaces and creates a deep hole, or pit, in the bed of the river, about 1 to 3 meters deep (Fig. 2). These pits fill with water during a discharge from upstream hydroelectric dams, but dry up during the non-pumping time. Here we report a mortality event of Small-clawed otters in natural river pits, where they become trapped when, in search of food, they are unable to escape due to insufficient water level in a pit.

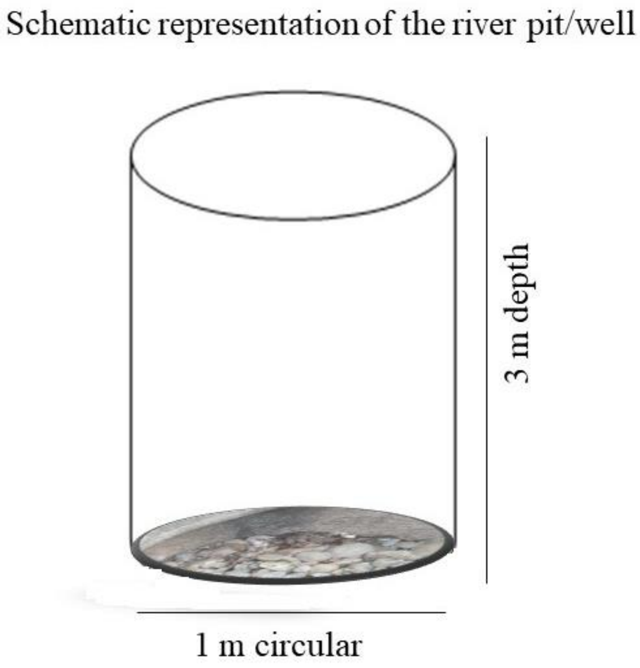

Figure 2. Schematic representation of natural river pit in the Moyar River, where otter carcasses were found at ~1860 m asl.

From 1947-54, the Tamil Nadu Electricity Board (TNEB) constructed a dam in Pykara on the Moyar River, with a hydro-electric power generation capacity of 28 MW/day. Unregulated water pumping during electricity generation controls the entire downstream river water flow, restricting the free movement of Small-clawed otters. Otters can become trapped in the deep river pits when the pumping of water is suddenly stopped. The otters cannot escape from the bottom of the pits when the water level falls too far below the surface level. Unregulated or sudden stoppage of water pumping from the dam can lead to death of a trapped otter due to starvation.

OBSERVATIONS

During an ecological survey of otters in the Moyar River on January 28, 2016, a group of otters was observed and photographed (Fig. 3A). Additionally, three Asian small-clawed otter carcasses were found in a river pit (Fig. 3B,C), along with a live Indian rat snake (*Ptyas mucosa*) (Fig. 3D). Many river pits were observed from Pykara to Thorappally River segments, but this was the only findings of otter mortality in a river pit. There may be other incidents of this kind which were unnoticed. Otters may have become trapped inside the pit when the hydroelectric dam authority stopped water discharge. Despite being skilled swimmers, Asian small-clawed otters, having small paws, might face challenges climbing slippery surfaces like deep rocky pits.

Figure 3. (A) A group of Asian small-clawed otters were photographed near the river pit where otter carcasses were seen; (B) three carcasses of Asian small-clawed otters in a natural river pit due to hunger; (C) skull and teeth of the Asian small-clawed otter collected from the natural pit; D) an Indian rat snake (*Ptyas mucosa*) found in the same river pit as the otters.

DISCUSSION

Although, natural-caused and human-caused mortalities of otters have been reported by many studies (e.g., Hussain, 1993; Weber Rosas and Ely de Mattos, 2003; Shivram et al. 2023). The accidental death of otters in their natural habitat due to unregulated water discharge by the hydroelectric dam is a novel observation. In the Moyar River, the population of Asian Small-clawed otters may be declining in the Western Ghats. Documenting natural and anthropogenic cause of death is critical for their long-term survival together with mitigating those causes. Natural river pits are a danger to small carnivores like otters when natural water flows from hydroelectric dams are stopped suddenly (Figure 4). During summer, insufficient water flow from the upstream Pykara Dam in the Moyar River can also cause a reduction in natural water flow towards downstream. The regulation of enough water flow released from dams in the region needs to be considered to prevent accidental deaths of otters and other wildlife often using the river pits in future.

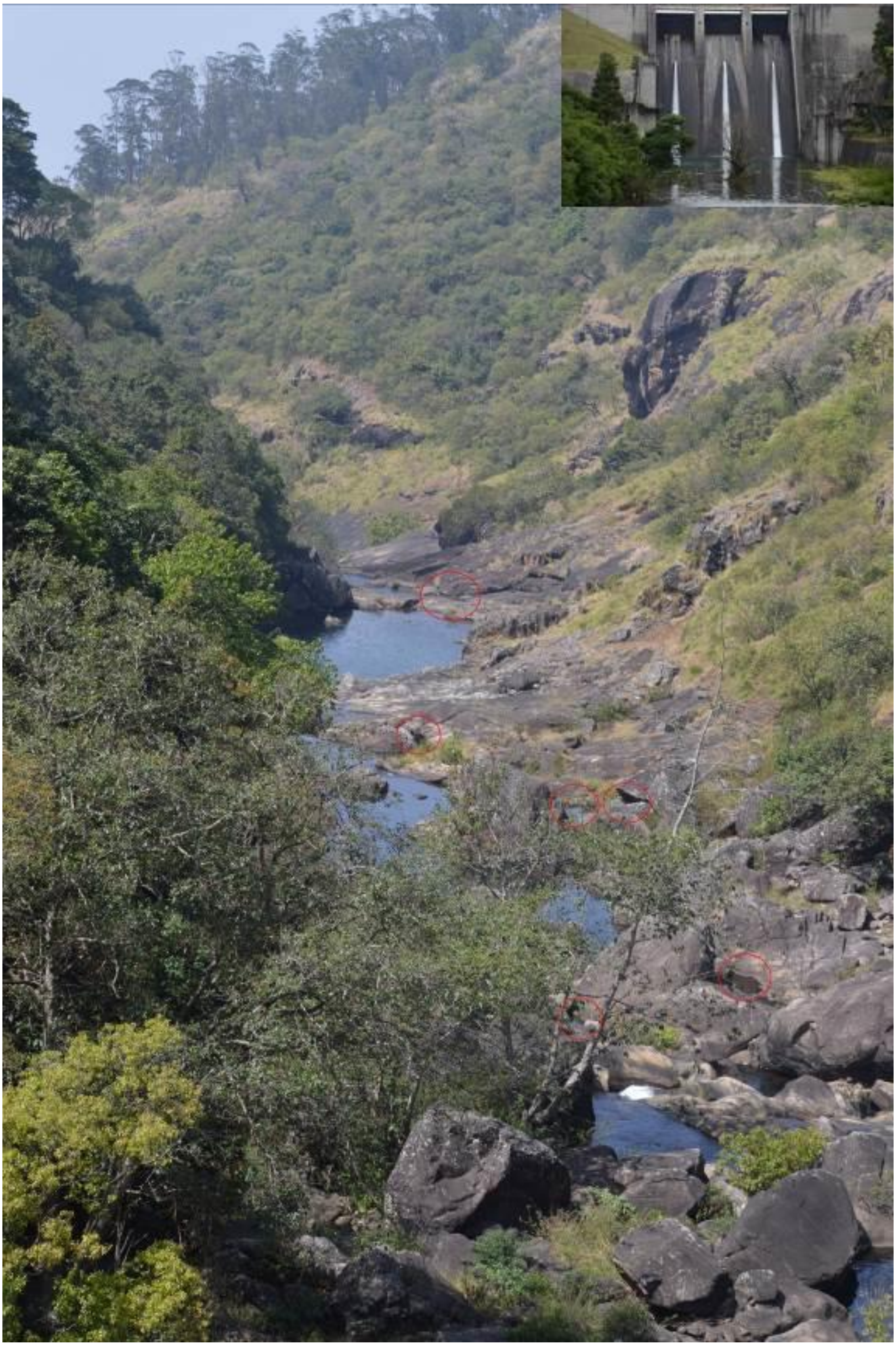

Figure 4. View of the typical Asian small-clawed otter habitat in the Moyar River, Western Ghats. Red circle indicating the narrow river width with multiple river pits and stagnant water during an event of stoppage of water pumping from the Pykara Dam (insert).

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RÉSUMÉ

LES FOSSES NATURELLES DES RIVIÈRES CONSTITUENT-ELLES UN DANGER POUR LES LOUTRES CENDRÉES ? UN RAPPORT DE TERRAIN SUR LA RIVIÈRE MOYAR, AUX GHATS OCCIDENTAUX, EN INDE

Cet article rapporte un cas de mortalité inhabituel et accidentel de loutres cendrées (*Aonyx cinereus*), piégées dans des fosses naturelles de la rivière Moyar, dans les Ghats occidentaux, en Inde. Les populations de loutres sont probablement en déclin dans la région des Ghats occidentaux en raison de diverses pressions anthropiques et de mortalités d'origine humaine (accident de la route, massacres en représailles). Protéger les loutres de la mortalité accidentelle contribuera à leur survie future. Nous discutons des mesures préventives pour éviter cette cause de mortalité accidentelle.

RESUMEN

¿LAS FOSAS NATURALES EN RÍOS SON PELIGROSAS PARA LAS NUTRIAS? UN INFORME DE CAMPO DESDE EL RÍO MOYAR, GHATS OCCIDENTALES, INDIA

Este trabajo informa de un evento inusual y accidental de mortalidad de nutrias de uñas pequeñas Asiáticas, que quedaron atrapadas dentro de fosas naturales en el Río Moyar, Ghats Occidentales, India. Las poblaciones de nutria están posiblemente declinando en la región de los Ghats Occidentales, debido a distintas presiones antropogénicas y mortalidades de origen humano (atropellamimentos, muerte por represalia). Proteger a las nutrias de las mortalidades accidentales ayudará a su supervivencia futura. Discutimos las medidas preventivas para evitar ésta causa de mortalidad accidental.

தமிழ்ச் சுருக்கம்:

இயற்கை ஆற்றுப் பள்ளங்கள் நீர்நாய்களுக்கு ஆபத்தை ஏற்படுத்துமா? இந்தியாவின் மேற்குத் தொடர்ச்சி மலையில் உள்ள மோயார் நதியிலிருந்து ஒரு கள அறிக்கை.

இந்தியாவின் மேற்குத் தொடர்ச்சி மலையில் உள்ள மோயார் ஆற்றில் உள்ள இயற்கை ஆற்றுப் பள்ளங்களுக்குள் சிக்கி, ஆசிய சிறிய நகம் கொண்ட நீர்நாய்களின் அசாதாரணமான மற்றும் தற்செயலான இறப்பு நிகழ்வை இந்தத் தாள் தெரிவிக்கிறது. பல்வேறு மானுடவியல் அழுத்தங்கள் மற்றும் மனித காரணங்களால் ஏற்படும் இறப்புகள் (வேட்டையாடுதல், சாலைக்கொலை, பழிவாங்கும் கொலை) காரணமாக மேற்குத் தொடர்ச்சி மலைப் பகுதியில் நீர்நாய்களின் எண்ணிக்கை குறைய வாய்ப்புள்ளது. தற்செயலான இறப்பிலிருந்து நீர்நாய்களைப் பாதுகாப்பது அவற்றின் எதிர்கால உயிர்வாழ்வை ஆதரிக்க உதவும். தற்செயலான இறப்புக்கான இந்த காரணத்தைத் தவிர்ப்பதற்கான தடுப்பு நடவடிக்கைகளை நாங்கள் இந்தத் தாளில் விவாதிக்கிறோம்.

A R T I C L E

FIRST REPORT OF THE ORIGIN AND DISTRIBUTION OF THE BRACHIAL PLEXUS IN THE SCAPULAR AND BRACHIAL REGIONS IN A NEOTROPICAL RIVER OTTER (*Lontra longicaudis*)

Karla Johanna RAMÍREZ ARANGO[1], Stephanie DELGADO PUENTES[1], Omar Leonardo ARISTIZÁBAL PÁEZ[1], Juan Fernando VÉLEZ GARCÍA[1,2*]

[1]Research group of Medicine and Surgery in Small Animals, Department of Animal Health, Faculty of Veterinary Medicine and Zootechnics, Universidad del Tolima, Ibagué. Colombia.
[2]Postgraduate Program in Anatomy of the Domestic and Wild Animals, Department of Surgery, School of Veterinary Medicine and Animal Science, Universidade de São Paulo, São Paulo, Brazil.
**Corresponding Author Email: jfvelezg@ut.edu.co*

   

(Received 2nd February 2023, accepted 6th October 2023)

Abstract: The neotropical river otter (*Lontra longicaudis*) is a carnivoran species belonging to the family Mustelidae. There are no reports about the brachial plexus, and its knowledge is essential to clinical diagnoses and surgical procedures of the thoracic limb. Variations in the origin and distribution of the brachial plexus may exist among carnivoran species. Thus, the present study aimed to describe the origin of the brachial plexus and the distribution of its nerves in the scapular and brachial regions of *L. longicaudis*. One formaldehyde-fixed specimen of *L. longicaudis* was dissected. The brachial plexus originated from the last three cervical spinal nerves and the first two thoracic spinal nerves (C6-T2). The brachial plexus nerves and their distribution in the scapular and brachial regions of *L. longicaudis* were similar to those described in most carnivorans. However, differences were found, including two communicating branches (*rami communicantes*) from the nervus musculocutaneus to the nervus medianus, one proximal and one distal. The ramus communicans proximalis has also been found in other mustelids, while the ramus communicans distalis has not been found in other mustelids. Thus, the brachial plexus of *L. longicaudis* may present variations compared with other carnivorans.
Citation: Ramírez Arango, K.J., Delgado Puentes, S., Aristizábal Páez, O.L., and Vélez García, J.F. (2024). First Report of the Origin and Distribution of the Brachial Plexus in the Scapular and Brachial Regions in a Neotropical River Otter (*Lontra longicaudis*). *IUCN Otter Spec. Group Bull.*, **41** (1): 31 - 45
Keywords: Anatomy, Carnivora, Mustelidae, Nerve, Neurology.

INTRODUCTION

The Neotropical river otter (*Lontra longicaudis*) belongs taxonomically to the order Carnivora and the family Mustelidae (Nyakatura and Bininda-Emonds, 2012). The species has a geographic distribution range from northwestern Mexico to Uruguay and northeastern Argentina (Nivelo-Villavicencio et al., 2020). *L. longicaudis* is mainly found in habitats close to bodies of water, such as mangrove areas, lagoons, rivers, and wetlands (González-Christen et al., 2013; Mayor-Victoria and Botero-Botero, 2010). It is a medium-large species, with an average body mass in males of 16 kg and females of 13 kg (Gallo-Reynoso et al., 2013). They are adapted to move effectively in water since their thoracic and pelvic limbs are short and robust and present interdigital membranes between their digits (Emmons and Feer, 1997; Rheingantz et al., 2017). The hands are used to grasp food when held on the chest or socialize with the young (Mosquera-Guerra et al., 2018; Trujillo and Mosquera-Guerra, 2018). It has long vibrissae that act as indicators of current and water pressure changes to locate prey. It uses its long and broad tail to paddle in the water and to direct the body when swimming (Mosquera-Guerra et al., 2018). Its diet is based on small vertebrates, mainly fishes, although it can also eat insects and fruits (Mayor-Victoria and Botero-Botero, 2010; Rheingantz et al., 2017).

The brachial plexus is a network of nerves that innervate the thoracic limb and adjacent regions, allowing sensitivity and mobility of these anatomical regions (Liebich et al., 2020; Singh, 2018). In domestic carnivorans, it is formed mainly by the rami ventrales (ventral branches) of the last three cervical spinal nerves (C6, C7 and C8) and the first thoracic spinal nerve (T1) (Singh, 2018). However, occasionally, there may be a contribution from the fifth cervical nerve (C5) and the second thoracic nerve (T2) (Hermanson et al., 2020; Singh, 2018). In most reports on wild carnivorans, the contribution of C5 and T2 is not present (Barreto-Mejía et al., 2022; Chagas et al., 2014; Demiraslan et al., 2015; Nur et al., 2020; Haligur and Ozkadif, 2021; Hermanson et al., 2020; Pinheiro et al., 2013, 2014; Souza-Junior et al., 2017, 2018; Souza et al., 2010). However, in representative species of the superfamily Musteloidea the contribution of both rami is common (Enciso-García and Vélez-García, 2022; Grzeczka and Zdun, 2022; Vélez García et al., 2023).

L. longicaudis individuals may be in zoos or wildlife care centers (Restrepo et al., 2018). Knowledge of the brachial plexus would help to perform clinical and surgical procedures. Therefore, it is essential to determine the origin and distribution of the brachial plexus since it could be applied in a neurological exam (De Lahunta et al., 2020), locoregional blocks (Ansón et al., 2013; Mencalha et al., 2014; Skelding et al., 2018) and surgical procedures. Thus, this study aimed to describe the origin of the brachial plexus and the distribution of its nerves on the scapular and brachial muscles in *L. longicaudis*.

MATERIALS AND METHODS

A male cadaver of *L. longicaudis* donated by the Corporación Autónoma Regional del Tolima (CORTOLIMA, Environmental Authority of Tolima, Colombia) to the Universidad del Tolima was used. The specimen had abdominal incisions due to the necroscopic study performed at the Wildlife Care Center of CORTOLIMA. The cadaver was conserved frozen, and after several days, it was defrosted and fixed with a solution of 10% formaldehyde and 5% glycerin via subcutaneous and intramuscular infiltrations. Subsequently, the cadaver was immersed and maintained in a container with 5% formaldehyde. The pectoral muscles were removed from their origins to review the neurovascular relations at the axillary region. Subsequently, the blood vessels, viscera (oesophagus, trachea, heart and lungs), and ventral neck muscles were removed to find the rami ventrales of the spinal nerves (Fig. 1). The anatomical description was based on the *Nomina Anatomica Veterinaria* (International Committee on Veterinary Gross Anatomical Nomenclature, 2017), and the origin of each nerve was reviewed, retracting the nerve proximally until the rami ventrales of the spinal nerves. Photographs were taken with a Canon T5i 18 MP camera associated with a Canon 60 mm macro lens and a Canon EOS 6D 20.2 MP camera associated with a Canon 100 lens. We only studied one specimen because it was a unique cadaver donated to the research project (Number 390116), which was performed between 2016 and 2022. In addition, this species is categorized as "Near threatened" by the International Union to Nature Conservation (IUCN) (Rheingantz et al., 2022). On the other hand, the nerves were only studied until the elbow because other researchers had dissected the muscles of the antebrachium. This study was approved by the Bioethics Committee of the Universidad del Tolima (Approval number: 2.3-059).

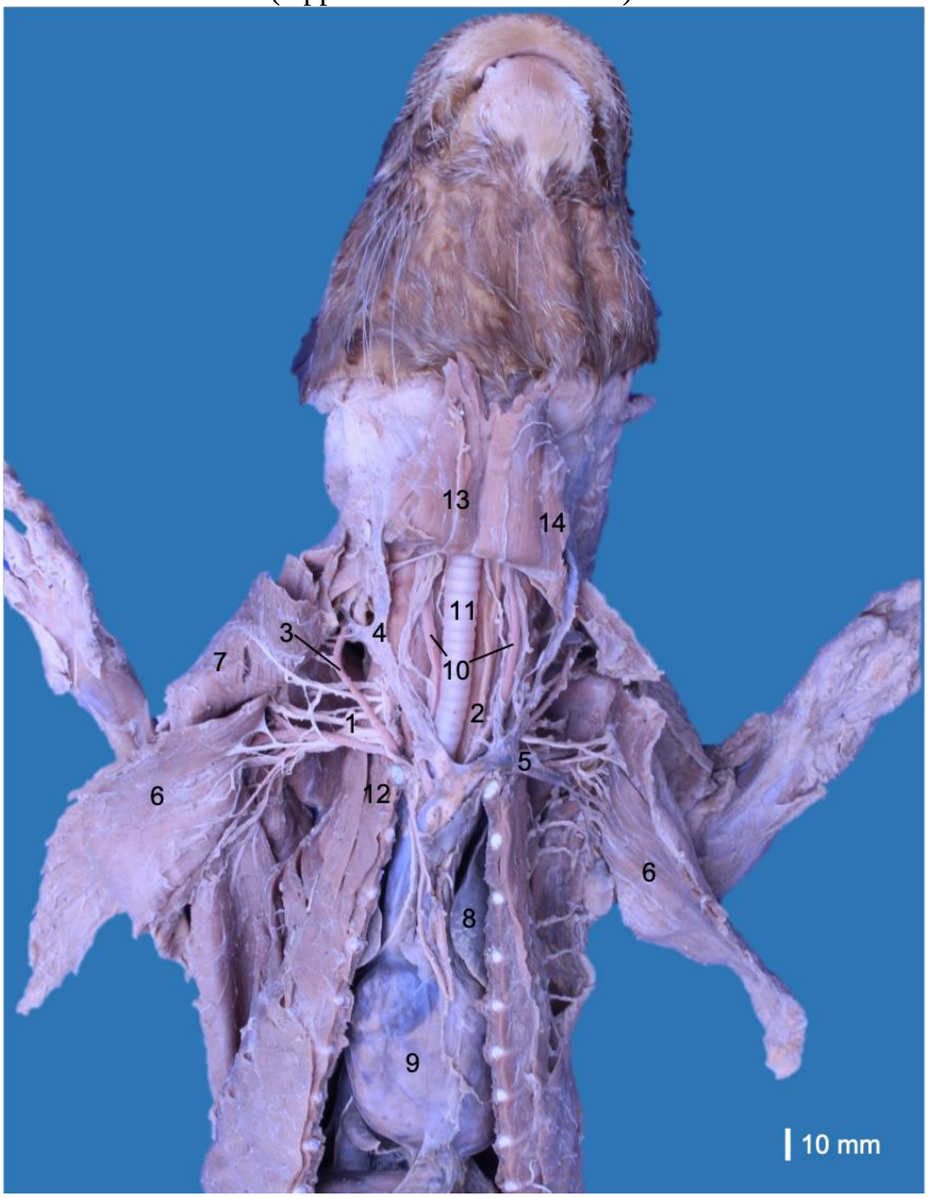

Figure 1. Ventral view of the cervical and thoracic viscera in *Lontra longicaudis* in relation to the brachial plexus. 1) brachial plexus, 2) esophagus, 3) superficial cervical artery; 4) external jugular vein; 5) subclavian vein; 6) m. pectoralis profundus, 7) mm. pectorales superficiales, 8) left lung, 9) hearth; 10) common carotid arteries, 11) trachea, 12) mm. scaleni, 13) m. sternothyroideus, 14) m. sternocephalicus.

RESULTS

The brachial plexus originated bilaterally from the rami ventrales of the last three cervical spinal nerves (C6, C7 and C8) and the first two thoracic spinal nerves (T1 and T2). These rami emerged between the musculi longus colli and scalenus ventralis toward the thoracic limb and adjacent regions. The rami ventrales of C6, C7 and C8 were related dorsally to the superficial cervical artery and phrenic nerve. The ramus ventralis of C8 was related dorsally to the axillary vein, while T1 was related ventrally to the axillary artery. C6 and C7 communicated ventral to the scalene muscles, while C8 and T1 only communicated when both had laterally overpassed the musculus scalenus ventralis. T2 was a small ramus that passed medially at the dorsal extreme of the second rib and joined to T1 before emerging into the axillary region (Fig. 2).

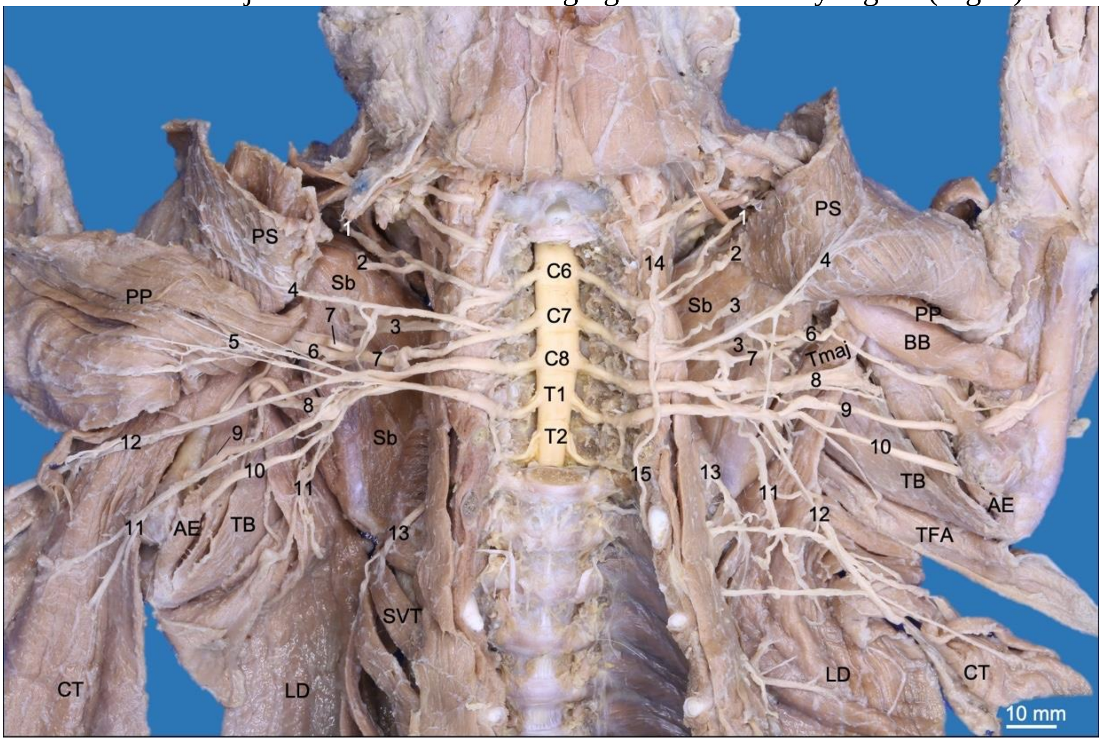

Figure 2. Ventral view of the origin and distribution of the brachial plexus from the spinal cord in *Lontra longicaudis*. C6-C8 and T1-T2) cervical and thoracic segments of the spinal cord, 1) n. brachiocephalicus, 2) n. suprascapularis, 3) nn. subscapulares, 4) nn. pectorales craniales, 5) nn. pectorales caudales, 6. n. musculocutaneus, 7) n. axillaris, 8) n. radialis, 9) n. medianus, 1). n. ulnaris, 11) n. thoracodorsalis, 12) n. thoracicus lateralis, 13) n. thoracicus longus, 14-15) n. phrenicus, AE) m. anconeus epitrochlearis, BB) m. biceps brachii, CT) m. cutaneus trunci, LD) m. latissimus dorsi, PS) mm. pectorales superficiales, PP) m. pectoralis profundus, Sb) m. subscapularis, SVT) m. serratus ventralis thoracis, TB) m. triceps brachii, TFA) m. tensor fasciae antebrachii, Tmaj). m. teres major.

The nervus brachiocephalicus (*n. brachiocephalicus*) originated from a common trunk with the nervus suprascapularis from C6 (Fig. 2). It extended into the cranial skin to the shoulder between the musculi omotransversarius and cleidocephalicus and did not innervate muscles.

The nervi pectorales craniales (*nn. pectorales craniales*) originated from a common trunk with the nervus musculocutaneus from C6 and C7. The nervi pectorales craniales passed between the anastomosis of the external jugular and subclavian veins. It first sent a ramus communicans (communicating branch) to the nervi medianus and pectorales caudales medially to the axillary artery and distally innervated the musculi pectorales superficiales (Fig. 2,3).

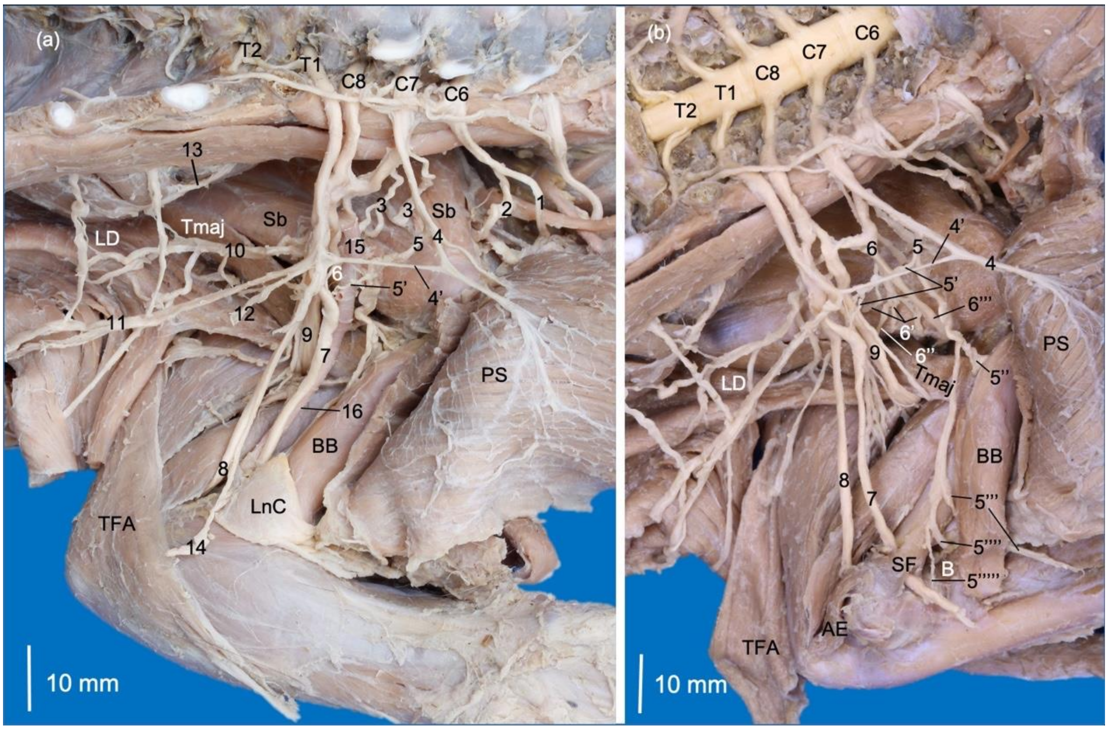

Figure 3. Medial photographic views of the left brachial plexus in *Lontra longicaudis*. (a) Brachial plexus with relation to the axillary and brachial arteries, (b) brachial plexus without relation to the axillary and brachial arteries. C6-C8) ramus ventralis of the cervical spinal nerves, T1-T2) ramus ventralis of the thoracic spinal nerves, 1) n. brachiocephalicus, 2) n. suprascapularis, 3) nn. subscapulares, 4) nn. pectorales craniales, 4') ramus communicans with 12 (Ansa pectoralis), 5) n. musculocutaneus, 5') ramus communicans proximalis cum n. mediano, 5'') ramus muscularis proximalis, 5''') n. cutaneus antebrachii medialis, 5'''') ramus muscularis distalis, 5''''') ramus communicans distalis cum n. mediano, 6) n. axillaris, 6') rami to Sb, 6'') ramus to Tmaj, 6''') ramus toward lateral aspect of the shoulder, 7) n. medianus, 8) n. ulnaris, 9) n. radialis, 10) n. thoracodorsalis, 11) n. thoracicus lateralis, 12) nn. pectorales caudales, 13) n. thoracicus longus, 14) n. cutaneus antebrachii caudalis, 15) axillary artery, 16) brachial artery, AE) m. anconeus epitrochlearis, B) m. brachialis, BB) m. biceps brachii, LD) m. latissimus dorsi, LnC) lymphonodus cubitalis, PS) mm. pectorales superficiales, Sb) m. subscapularis, SF) supracondylar foramen of the humerus, TFA) m. tensor fasciae antebrachii, Tmaj). m. teres major.

The nervi pectorales caudales (*nn. pectorales caudales*) originated from a common trunk with the nervus thoracicus lateralis, which emerged from C8 and T1. The former sent a ramus communicans to the nn. pectorales craniales and musculocutaneus medially to the axillary artery. The nn. pectorales caudales directed together with the lateral thoracic artery toward the musculus pectoralis profundus (Fig. 2,3).

The nervus thoracicus lateralis (*n. thoracicus* lateralis) extended caudally with the lateral thoracic vessels medially to the musculus latissimus dorsi. It perforated this muscle to innervate the musculus cutaneus trunci (Fig. 2).

The nervus thoracicus longus (*n. thoracicus longus*) originated from C7 and innervated the musculi serratus ventralis thoracis and scalenus medius (Fig. 2,3).

The nervus thoracodorsalis (*n. thoracodorsalis*) originated from C7 and C8 on the right side, while on the left side, it originated only from C8. It only innervated the m. latissimus dorsi (Fig. 2,3).

The nervus suprascapularis (*n. suprascapularis*) passed between the musculi subscapularis and supraspinatus together with the suprascapular vessels, reaching the scapular notch to innervate the m. supraspinatus. It continued on the lateral side of the scapular neck to innervate the m. infraspinatus (Fig. 2,3).

Two nervi subscapulares (*nn. subscapulares*) originated from C6 and C7 and only innervated the musculus subscapularis (Fig. 2,3). On the right thoracic limb, the nervus subscapularis cranialis presented two rami. On the left limb, only one ramus was present, and the nervus subscapularis caudalis presented two rami.

The nervus musculocutaneus (*n. musculocutaneus*) originated from a common trunk with nn. pectorales craniales and extended to the brachium between the brachial artery and the musculus biceps brachii. It sent a first ramus that communicated to the n. medianus at the axillary level. Distally, it sent the ramus muscularis proximalis (proximal muscular branch) at the proximal extreme of the m. biceps brachii. In the middle third, it emitted a third ramus, which perforated the belly of the m. biceps brachii and formed nervus cutaneus antebrachii medialis. This nerve passed cranially toward the antebrachium between the m. biceps brachii and the complex formed by the musculi brachialis, pectorales and latissimus dorsi. In the distal third of the m. biceps brachii, the n. musculocutaneus emitted the ramus muscularis distalis (distal proximal branch) to innervate the m. brachialis, which passed between the m. biceps brachii and the humerus. Two other rami were formed distally, one directed to the elbow joint capsule, and another one directed to the n. medianus, which corresponds to the ramus communicans distalis (*ramus communicans cum n. mediano*) (Fig. 2,3).

The nervus medianus (*n. medianus*) was initially formed by a common trunk with the n. ulnaris from C8, T1 and T2. It received a contribution from C6 and C7 through the rami communicantes (communicating branches) formed by the nervi musculocutaneus and pectorales craniales (Fig. 3). At the distal third of the brachium, it extended together with the brachial artery to pass through the supracondylar foramen of the humerus. It received another ramus communicans from the n. musculocutaneus distal to the supracondylar foramen (Fig. 3).

The nervus ulnaris (*n. ulnaris*) passed between the brachial artery and brachial vein, and in the distal half of the brachium passed between the humeral shaft and the caput mediale of the m. triceps brachii. It passed deeply to the m. anconeus epitrochlearis (m. anconeus medialis) and innervated it. It continued distally deep and caudal to the medial epicondyle of the humerus to reach the antebrachium. The nervus cutaneus antebrachii caudalis (*n. cutaneus antebrachii caudalis*) originated directly from T1 and T2 (Fig. 3).

The nervus axillaris (*n. axillaris*) originated from C6 and C7 on the right limb and from C6-C8 on the left limb. It initially emitted rami to the musculi subscapularis and teres major and continued laterally passing between both muscles (Fig. 3). Laterally, it formed rami to innervate the musculi teres minor, deltoideus (pars acromialis and pars scapularis) and cleidobrachialis (Fig. 4). In the right thoracic limb, it sent a ramus to m. infraspinatus since m. teres minor was absent (Fig. 4). The nervus cutaneus brachii lateralis cranialis passed into the cranial part of the brachium between the pars acromialis of the m. deltoideus and the caput laterale of the m. triceps brachii (Fig. 4). In the right brachium, the same nerve perforated the caput laterale of the m. triceps brachii.

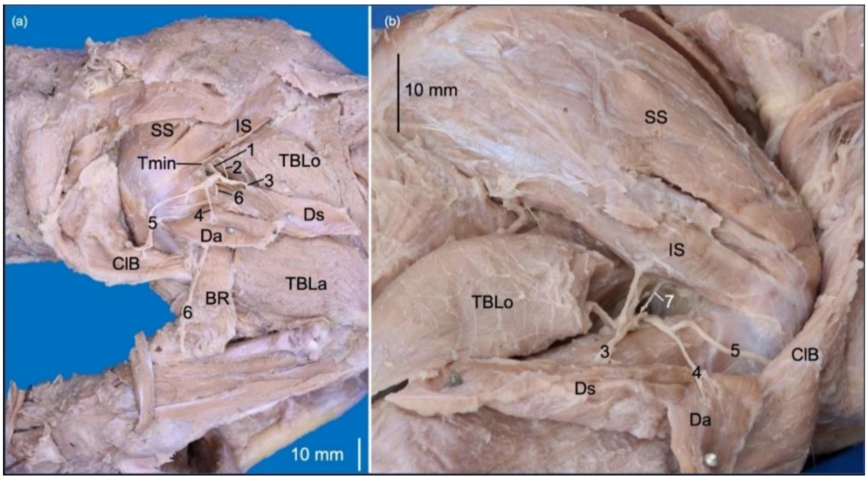

Figure 4. (a) Right lateral deep view of the axillary nerve of *Lontra longicaudis*. (b) Left lateral deep view of the axillary nerve. 1) ramus to Tmin; 2) ramus to the joint capsule of the shoulder, 3) ramus to the Da, 4) ramus to Ds, 5) ramus to ClB, 6) n. cutaneus brachii lateralis cranialis, 7) ramus to IS. ClB) m. cleidobrachialis, Da) m. deltoideus pars acromialis, Ds) m. deltoideus pars scapularis, IS) m. infraspinatus, SS) m. supraspinatus, TBLa) m. triceps brachii caput lateralis, TBLo) m. triceps brachii caput longum, Tmin) m. teres minor.

The nervus radialis (*n. radialis*) originated from C6-T2, which is directed deep to the brachial artery to emit rami musculares to the musculi tensor fasciae antebrachii and the capita mediale, accessorium and longum of the m. triceps brachii. It extended laterally between the caput longum and caput accessorium of the m. triceps brachii, where it branched to the caput laterale of the m. triceps brachii and m. anconeus. It continued distally between the m. brachialis and caput laterale of the m. triceps brachii, where it was divided into rami superficialis and profundus. The ramus superficialis is directed toward the antebrachium between the musculi brachioradialis and extensor carpi radialis. The ramus profundus innervated the craniolateral antebrachial muscles and perforated the m. supinator (Fig. 5).

Figure 5. (a) Left medial deep view of the nervus radialis of *Lontra longicaudis*. (b) Lateral deep view of the nervus radialis, 1) n. radialis, 2) ramus to m. anconeus, 3) rami to TBLa, 4) ramus to TBM, 5) rami to TBLo, 6) rami to TBA, 7) ramus to TFA, 8) ramus profundus, 8') ramus to BR, 9) ramus superficialis. An) m. anconeus, B) m. brachialis, BR) m. brachioradialis, ClB) m. cleidobrachialis, ECR) m. extensor carpi radialis, IS) m. infraspinatus, SS) m. supraspinatus, TBA) m. triceps brachii caput accessorium, TBLa) m. triceps brachii caput lateralis, TBLo) m. triceps brachii caput longum, TBM) m. triceps brachii caput mediale TFA) m. tensor fasciae antebrachii.

DISCUSSION

The origin of the brachial plexus from C6 to T2 of *L. longicaudis* has been found in other carnivorans, such as the mustelids *Neovison vison* and *Meles meles* (Grzeczka and Zdun, 2022); the procyonids *Bassariscus astutus* (Davis, 1964), *Potos flavus* (Enciso-García and Vélez-García, 2022), *Procyon cancrivorus* and *Nasua nasua* (Vélez García et al., 2023); and the canids *Vulpes vulpes, Nyctereutes procyonoides* (Grzeczka and Zdun, 2022) and *Canis lupus familiaris* (Evans and De Lahunta, 2017; Hermanson et al., 2020; Singh, 2018). T2 had a small shape in *L. longicaudis*, and it contributed to the formation of the nervi medianus, ulnaris, radialis and cutaneus antebrachii caudalis, being similar to procyonids (Enciso-García and Vélez-García, 2022; Vélez García et al., 2023), and the canid *C. lupus familiaris* (De Lahunta et al., 2020; Evans and De Lahunta, 2017; Hermanson et al., 2020; Singh, 2018).

The unique origin of the n. brachiocephalicus in *L. longicaudis* from C6 has also been reported in *Martes foina* (Demiraslan et al., 2015), *N. vison, Martes martes* (Grzeczka and Zdun, 2022), *P. flavus* (Enciso-García and Vélez-García, 2022), *P. cancrivorus, N. nasua* (Vélez García et al., 2023), *C. lupus familiaris* (Hermanson et al., 2020), *Cerdocyon thous* (Souza-Junior et al., 2014), *Lycolopex gymnocercus* (Souza-Junior et al., 2017), *V. vulpes* (Grzeczka and Zdun, 2022), *Leopardus geoffroyi* (Souza-Junior et al., 2018) and *Puma yagouaroundi* (Souza Junior et al., 2022). The absence of a ramus muscularis to m. cleidobrachialis has also been reported in procyonids (Enciso-García and Vélez-García, 2022; Vélez García et al., 2023) and some studies in *F. catus* (Hudson and Hamilton, 2010; Roos and Vollmerhaus, 2005), since its primary innervation is by the axillary nerve, such as occurred in *L. longicaudis*.

The origin of the nn. pectorales craniales in *L. longicaudis* from C6-C7 has also been found in *P. flavus* (Enciso-García and Vélez-García, 2022), *P. cancrivorus, N. nasua* (Vélez García et al., 2023), *V. vulpes* (Grzeczka and Zdun, 2022; Haligur and Ozkadif, 2021), *C. thous* (Souza-Junior et al., 2014), *L. gymnocercus* (Souza-Junior et al., 2017), *L. pardalis* (Chagas et al., 2014), *L. geoffroyi* (Souza-Junior et al., 2018) and *P. yagouaroundi* (Souza Junior et al., 2022). The ramus communicans to the nn. pectorales caudales of *L. longicaudis* has been reported in procyonids and ursids as ansa pectoralis (Davis, 1964; Vélez García et al., 2023).

The origin of the nn. pectorales caudales from C8-T1 in *L. longicaudis* may also be in *M. meles, N. procyonoides, V. vulpes* (Grzeczka and Zdun, 2022), *C. lupus familiaris* (Evans and De Lahunta, 2017; Sharp et al., 1991), *C. thous* (Souza-Junior et al., 2014), *L. gymnocercus* (Souza-Junior et al., 2017), *Atelocynus microtis* (Pinheiro et al., 2013), *Arctocephalus australis* (Souza et al., 2010), *F. catus* (Hakkı Nur et al., 2020; Sebastiani and Fishbeck, 2005), *L. geoffroyi* (Souza-Junior et al., 2018), and *P. yagouaroundi* (Souza Junior et al., 2022). It also sends rami musculares to the m. cutaneus trunci in *M. foina* (Demiraslan et al., 2015) and to the m. pectoralis transversus in procyonids (Enciso-García and Vélez-García, 2022; Vélez-García and Miglino, 2023; Vélez García et al., 2023).

The origin of the n. thoracicus lateralis from C8-T1 in *L. longicaudis* is also present in *M. martes, N. procyonoides* (Grzeczka and Zdun, 2022), *A. australis* (Souza et al., 2010), *L. gymnocercus* (Souza-Junior et al., 2017), *C. thous* (Pinheiro et al., 2014; Souza-Junior et al., 2014), *C. lupus familiaris* (Hermanson et al., 2020), *F. catus* (Hakkı Nur et al., 2020; Roos and Vollmerhaus, 2005), *L. geoffroyi* (Souza-Junior et al., 2018) and *P. yagouaroundi* (Souza Junior et al., 2022). The unique innervation to m. cutaneus trunci found in *L. longicaudis* has also been reported in *P. cancrivorus, N. nasua* (Vélez

García et al., 2023), *A. microtis* (Pinheiro et al., 2013), *P. flavus* (Enciso-García and Vélez-García, 2022) and *M. foina* (Demiraslan et al., 2015). In other species, it also innervates the m. pectoralis profundus, such as in *V. vulpes*, *M. martes* (Grzeczka and Zdun, 2022), *C. l. familiaris* (Hermanson et al., 2020), *L. gymnocercus* (Souza-Junior et al., 2017), *C. thous* (Souza-Junior et al., 2014), *F. catus* (Hakkı Nur et al., 2020), *L. geoffroyi* (Souza-Junior et al., 2018) and *P. yagouaroundi* (Souza Junior et al., 2022). In *P. cancrivorus*, *N. nasua* and *F. catus*, it also innervates the m. pectoralis abdominalis (Langworthy, 1924; Vélez-García and Miglino, 2023; Vélez-García et al., 2023; Vélez García et al., 2023).

The origin of the n. thoracicus longus in *L. longicaudis* from C7 has also been present in *M. meles* (Grzeczka and Zdun, 2022), *P. flavus* (Enciso-García and Vélez-García, 2022), *N. nasua* (Vélez García et al., 2023), *C. l. familiaris* (Hermanson et al., 2020), *L. gymnocercus* (Souza-Junior et al., 2017), *V. vulpes* (Grzeczka and Zdun, 2022), *C. thous* (Souza-Junior et al., 2014), *F. catus* (Hakkı Nur et al., 2020; Roos and Vollmerhaus, 2005; Sebastiani and Fishbeck, 2005), *L. geoffroyi* (Souza-Junior et al., 2018), *P. concolor* (Barreto-Mejía et al., 2022) and *P. yagouaroundi* (Souza Junior et al., 2022).

The origin of the thoracodorsal nerve from C7 and C8 of *L. longicaudis* has also been present in *M. foina* (Demiraslan et al., 2015), *M. martes*, *M. meles* (Grzeczka and Zdun, 2022), *P. cancrivorus*, *N. nasua* (Vélez García et al., 2023), *C. l. familiaris* (Hermanson et al., 2020), *L. gymnocerus* (Souza-Junior et al., 2017), *V. vulpes* (Grzeczka and Zdun, 2022), *F. catus* (Hakkı Nur et al., 2020; Roos and Vollmerhaus, 2005; Sebastiani and Fishbeck, 2005), *L. geoffroyi* (Souza-Junior et al., 2018), *P. concolor* (Barreto-Mejía et al., 2022) and *P. yagouaroundi* (Souza Junior et al., 2022). The single origin from C8 in *L. longicaudis* may occur in *C. l. familiaris* (Skelding et al., 2018), *C. thous* (Souza-Junior et al., 2014), *L. gymnocercus* (Souza-Junior et al., 2017), *F. catus* (Hakkı Nur et al., 2020), *L. pardalis* (Chagas et al., 2014) and *P. yagouaroundi* (Souza Junior et al., 2022).

The unique origin of the n. suprascapularis from C6 in *L. longicaudis* has been found in *M. foina* (Demiraslan et al., 2015), *N. nasua*, *P. cancrivorus* (Vélez García et al., 2023), *C. l. familiaris* (Skelding et al., 2018), *C. thous* (Souza-Junior et al., 2014), *L. gymnocercus* (Souza-Junior et al., 2017), and *Puma concolor* (Barreto-Mejía et al., 2022), *Felis catus* (Hakkı Nur et al., 2020; Sebastiani and Fishbeck, 2005), *L. geoffroyi* (Souza-Junior et al., 2018) and *P. yagouaroundi* (Souza Junior et al., 2022).

The origin of the nn. subscapularis in *L. longicaudis* from C6-C7 has also been found in *M. foina* (Demiraslan et al., 2015), *N. vison*, *M. meles* (Grzeczka and Zdun, 2022), *P. cancrivorus*, *N. nasua* (Vélez García et al., 2023), *P. flavus* (Enciso-García and Vélez-García, 2022), *C. l. familiaris* (Hermanson et al., 2020; Skelding et al., 2018), *V. vulpes* (Grzeczka and Zdun, 2022; Haligur and Ozkadif, 2021), *C. thous* (Pinheiro et al., 2014; Souza-Junior et al., 2014), *L. gymnocercus* (Souza-Junior et al., 2017), *F. catus* (König, 1992; Roos and Vollmerhaus, 2005; Sebastiani and Fishbeck, 2005), *Leopardus pardalis* (Chagas et al., 2014), *L. geoffroyi* (Souza-Junior et al., 2018) and *P. yagouaroundi* (Souza Junior et al., 2022).

The origin of the n. musculocutaneus from C6-C7 in *L. longicaudis* has been reported in *N. vison, M. martes, M. meles* (Grzeczka and Zdun, 2022), *P. cancrivorus, N. nasua* (Vélez García et al., 2023), *P. flavus* (Enciso-García and Vélez-García, 2022), *V. vulpes, N. procyonoides* (Grzeczka and Zdun, 2022), *C. thous* (Pinheiro et al., 2014; Souza-Junior et al., 2014), *A. microtis* (Pinheiro et al., 2013), *F. catus* (Hakkı Nur et al., 2020; Sánchez et al., 2013), *L. geoffroyi* (Souza-Junior et al., 2018), *L. pardalis* (Chagas et al., 2014), *Panthera onca* (Sánchez et al., 2013), *P. concolor* (Barreto-Mejía et al., 2022; Sánchez et al., 2013) and *P. yagouaroundi* (Souza Junior et al., 2022). The ramus communicans proximalis of n. musculocutaneus with n. medianus in *L. longicaudis* is similar to that described as ansa axillaris in some carnivorans (Arłamowska-Palider, 1970; Vélez García et al., 2023), which has also been described as ansa mediana in ursids (Davis, 1964) or as a communicating branch in *N. nasua* (Felipe et al., 2014), *P. flavus* (Enciso-García and Vélez-García, 2022), *N. vison, M. martes,* and *M. meles* (Grzeczka and Zdun, 2022). According to the International Committee on Veterinary Gross Anatomical Nomenclature (International Committee on Veterinary Gross Anatomical Nomenclature, 2017) and Backus et al. (2016), carnivorans do not present ansa axillaris. However, the ramus communicans proximalis could be an ansa axillaris due to its medial relationship with the axillary artery, such as was recently described in two procyonids (Vélez García et al., 2023). Therefore, the ansa axillaris may also be present in mustelids based on our findings in *L. longicaudis* and the findings of Grzeczka and Zdun (2022) in *N. vison, M. martes* and *M. meles*. On the other hand, the ramus communicans distalis at the elbow level has been reported in *P. cancrivorus* (Vélez García et al., 2023), *P. flavus* (Enciso-García and Vélez-García, 2022), *C. l. familiaris* (Hermanson et al ., 2020), *C. thous* (Souza-Junior et al., 2014; Vélez-García et al., 2018), *L. gymnocercus* (Souza-Junior et al., 2017), *V. vulpes* (Grzeczka and Zdun, 2022), *A. australis* (Souza et al., 2010), *F. catus, P. onca, P concolor* (Sánchez et al., 2013), and *P. yagouaroundi* (Souza Junior et al., 2022). However, rami communicans at the axillary and elbow levels, such as those in *L. longicaudis,* have only been reported in the procyonids *P. flavus* (Enciso-García and Vélez-García, 2022) and *P. cancrivorus* (Vélez García et al., 2023).

The origin of the n. medianus from C6-T2 of *L. longicaudis* was only reported in *P. flavus* (Enciso-García and Vélez-García, 2022), *P. cancrivorus* and *N. nasua* (Vélez García et al., 2023). Passage through the supracondylar foramen with the brachial artery also occurs in *F. catus* (Sánchez et al., 2013), while in other species, both structures also pass with the brachial vein, such as in *P. flavus* (Enciso-García and Vélez-García, 2022), *P. onca* and *P. concolor* (Sánchez et al., 2013). It passes alone in *P. cancrivorus* and *N. nasua* (Vélez García et al., 2023).

The origin of the n. ulnaris from C8-T2 of *L. longicaudis* has also been found in *N. vison, M. meles* (Grzeczka and Zdun, 2022), *P. cancrivorus* and *N. nasua* (Vélez García et al., 2023), *N. procyonoides* (Grzeczka and Zdun, 2022), *P. flavus* (Enciso-García and Vélez-García, 2022), and *C. lupus familiaris* (Evans and De Lahunta, 2017). The rami for the m. anconeus epitrochlearis in *L. longicaudis* has been reported in *P. cancrivorus* and *N. nasua* (Vélez García et al., 2023), *P. flavus* (Enciso-García and Vélez-García, 2022), *F. catus* (Barone, 2020; König, 1992), and *P. concolor* (Barreto-Mejía et al., 2022). In *C. thous,* when the m. anconeus epitrochlearis is present in a vestigial form, it is also innervated by the n. ulnaris (Vélez-García et al., 2018).

The origin of the n. axillaris from C6-C7 in the left thoracic limb of *L. longicaudis* has also been found in *P. cancrivorus*, *N. nasua* (Vélez García et al., 2023), *P. flavus* (Enciso-García and Vélez-García, 2022), *A. microtis* (Pinheiro et al., 2013), *C. thous* (Souza-Junior et al., 2014), *V. vulpes* (Grzeczka and Zdun, 2022), *F. catus* (Hakkı Nur et al., 2020; Sánchez et al., 2013), *L. geoffroyi* (Souza-Junior et al., 2018), *P. concolor* (Barreto-Mejía et al., 2022; Silva and Sánchez, 2013), *P. onca* (Silva and Sánchez, 2013) and *P. yagouaroundi* (Souza Junior et al., 2022). The C6-C8 origin in the left thoracic limb of *L. longicaudis* has been found in *P. flavus* (Enciso-García and Vélez-García, 2022), *M. martes, N. procyonoides* (Grzeczka and Zdun, 2022), *C. thous* (Souza-Junior et al., 2014), and *L. gymnocercus* (Souza-Junior et al., 2017). The innervation to the m. cleidobrachialis is similar to that of other carnivorans, such as *P.*

cancrivorus, *N. nasua* (Vélez García et al., 2023), *P. flavus* (Enciso-García and Vélez-García, 2022), *A. microtis* (Pinheiro et al., 2013), *F. catus* (König, 1992; Liebich et al., 2020; Roos and Vollmerhaus, 2005; Sebastiani and Fishbeck, 2005; Vélez-García et al., 2023) and *P. concolor* (Barreto-Mejía et al., 2022).The innervation to the m. infraspinatus in the right thoracic limb of *L. longicaudis* allows us to suggest that this innervation is due to fusion with the m. teres minor during embryonic development. In other otters (subfamily Lutrinae), it is normal to find this muscle fused to the m. infraspinatus (Howard, 1973; Macalister, 1873).

The origin of the n. radialis in *L. longicaudis* from C6-T2 has only been described in *P. cancrivorus* (Vélez García et al., 2023), *P. flav*us (Enciso-García and Vélez-García, 2022), and *C. l. familiaris* (Sharp et al., 1991). Its ramus superficialis extends cranially and distally between the brachioradialis and extensor carpi radialis muscles in *F. catus* due to the proximal origin of the m. brachioradialis (Sánchez et al., 2013), such as occurs in *L. longicaudis*.

The n. cutaneus antebrachii caudalis originated directly from T1-T2 in *L. longicaudis*, which also occurs in *P. cancrivorus*, *N. nasua* (Vélez García et al., 2023), and *P. flavus* (Enciso-García and Vélez-García, 2022). In other species, it is a ramus derived from the ulnar nerve, such as in *C. l. familiaris* (Hermanson et al., 2020; International Committee on Veterinary Gross Anatomical Nomenclature, 2017; Singh, 2018), *L. gymnocercus* (Souza-Junior et al., 2017) and *F. catus* (Hakkı Nur et al., 2020; International Committee on Veterinary Gross Anatomical Nomenclature, 2017). However, this nerve may originate independently only from T1 in *F. catus* (König, 1992; Roos and Vollmerhaus, 2005).

CONCLUSION

In conclusion, although the present study was limited to one specimen of *L. longicaudis*, some interesting differences that are not frequent in other carnivorans were found, such as the origin from T2; two rami communicantes from the n. musculocutaneus to the n. medianus; absence of a ramus to the m. coracobrachialis due to the absence of said muscle; m. cleidobrachialis only innervated by the n. axillaris; m. infraspinatus innervated by the n. axillaris due to a fusion with the m. teres minor; and the n. cutaneus antebrachii caudalis independent of the n. ulnaris. Thus, these differences should be considered in veterinary procedures on the thoracic limb of *L. longicaudis*, such as locoregional anesthesia, neurological diagnosis, and surgeries. However, further studies should be performed with more specimens to define the common pattern of the brachial plexus in this species and review which would be the anatomical variations to be considered in clinical practice (Vélez-García et al., 2018; Żytkowski et al., 2021).

Acknowledgments - Thanks to Universidad del Tolima (Colombia) for financially supporting this research, and to CORTOLIMA for donating the specimen.

Funding support - This research was funded by the Research and Scientific Development Office (Oficina de investigaciones y desarrollo científico) of the Universidad del Tolima (research project number 160130517).

Conflict of Interest Statement - The authors declare that there are no conflicts of interest.

Author contributions - JFVG, KJRA and OLAP performed the conception and design of the study. JFVG, KJRA and SDP acquired and interpreted the data. All authors drafted the article and approved the last version.

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RESUME

PREMIER RAPPORT SUR L'ORIGINE ET LA DISTRIBUTION DU PLEXUS BRACHIAL DANS LES RÉGIONS SCAPULAIRES ET BRACHIALES D'UNE LOUTRE A LONGUE QUEUE (*Lontra longicaudis*)

La loutre à longue queue (*Lontra longicaudis*) est une espèce carnivore appartenant à la famille des *Mustelidae*. Il n'existe aucun rapport sur le plexus brachial et sa connaissance est essentielle au diagnostic clinique et pour les interventions chirurgicales de la cage thoracique. Des variations dans l'origine et la répartition du plexus brachial peuvent exister selon les espèces de carnivores. Ainsi, la présente étude visait à décrire l'origine du plexus brachial et la répartition de ses nerfs dans les régions scapulaire et brachiale de *L. longicaudis*. Un spécimen de *L. longicaudis* fixé au formaldéhyde a été disséqué. Le plexus brachial provient des trois derniers nerfs spinaux cervicaux et des deux premiers nerfs spinaux thoraciques (C6-T2). Les nerfs du plexus brachial et leur répartition dans les régions scapulaire et brachiale de *L. longicaudis* étaient similaires à ceux décrits chez la plupart des carnivores. Cependant, des différences ont été trouvées, notamment deux branches communicantes (rami communicantes) du nerf musculo-cutané au nerf médian, une proximale et une distale. Le *ramus communicans proximalis* a également été trouvé chez d'autres mustélidés, tandis que le *ramus communicans distalis* n'a pas été trouvé chez d'autres mustélidés. Ainsi, le plexus brachial de *L. longicaudis* peut présenter des variations par rapport à celui des autres carnivores.

RESUMEN

PRIMER REPORTE DEL ORIGEN Y DISTRIBUCIÓN DEL PLEXO BRAQUIAL EN LAS REGIONES ESCAPULAR Y BRAQUIAL EN UNA NUTRIA DE RÍO NEOTROPICAL (*Lontra longicaudis*)

La nutria de río neotropical (*Lontra longicaudis*) es una especie del orden Carnívora perteneciente a la familia Mustelidae. No hay reportes sobre su plexo braquial, siendo su conocimiento necesario para el diagnóstico clínico y procedimientos quirúrgicos en el miembro torácico. Pueden existir variaciones en el origen y distribución del plexo braquial entre distintas especies de carnívoros. Por lo tanto, el objetivo del presente estudio es describir el origen del plexo braquial y la distribución de sus nervios en las regiones escapular y braquial de *L. longicaudis*. Fue diseccionado un espécimen fijado en formaldehído. El plexo braquial se originó de las últimos tres nervios espinales cervicales y los primeros dos nervios espinales torácicos (C6-T2). Los nervios del plexo braquial y su distribución en las regiones escapular y braquial en *L. longicaudis* fueron similares a los encontrados en la mayoría de carnívoros. Sin embargo, fueron encontradas algunas diferencias, tales como dos ramos comunicantes (*rami communicantes*) del nervio musculocutáneo con el nervio mediano, uno proximal y uno distal. El ramo comunicante proximal ha sido encontrado en otros mustélidos, mientras el ramo comunicante distal no ha sido encontrado en otros mustélidos. En conclusión, el plexo braquial de *L. longicaudis* puede presentar variaciones comparativamente con otros carnívoros.

R E P O R T

SUCCESSFUL TRACKING OF AN AFRICAN CLAWLESS OTTER (*Aonyx capensis*) VIA AN EXTERNALLY ATTACHED TELEMETRY DEVICE

Trevor McINTYRE[1*], Francois ROUX[2]

[1]*Department of Life and Consumer Sciences, College of Agriculture and Environmental Sciences, University of South Africa, South Africa.*
[2]*Mpumalanga Tourism and Parks Agency*
Scientific Services: Aquatic and Herpetofauna, South Africa
**Corresponding author:* mcintt@unisa.ac.za

(Received 18th July 2023, accepted 6th October 2023)

Abstract: Studying the behaviour and ecology of otters using biologging approaches often involves the surgical implanting of telemetry devices and, on occasion, the use of custom-made harnesses due to the difficulty of securely attaching instruments externally to otters. However, biologging instruments are continuously advancing and getting smaller, presenting opportunities for attempting simpler external attachment approaches that minimise the inherent invasiveness of such studies. Here, we present data obtained from externally attaching a small Very High Frequency (VHF) device directly to the fur of an African clawless otter (*Aonyx capensis*) using a quick-setting epoxy. We successfully tracked the locations of the otter for period of 30 days and present these data as a proof of concept that such an external attachment approach carries promise for future studies to minimise the complexity and invasiveness of instrument attachment on otters.

Citation: Mcintyre, T., and Roux, F. (2024). Successful Tracking of an African Clawless Otter (*Aonyx capensis*) via an externally attached Telemetry Device. *IUCN Otter Spec. Group Bull.*, **41** (1): 46 - 52

Keywords: spatial ecology; VHF-tracking; GPS telemetry; animal-borne devices

INTRODUCTION

Information on the movements and habitat use of animals is particularly useful, not only to better understand the ecology of species, but also for conservation planning. The application of biologging approaches to studying the behaviour and space use of otters typically takes the form of Very High Frequency (VHF) devices implanted in the abdominal cavities of otters and has been successfully used on multiple species, including North American river otters (*Lontra canadensis*) (Reid et al., 1994; Ben-David et al., 2005), sea otters (*Enhydra lutris*) (Laidre et al., 2009), Eurasian otters (*Lutra lutra*) (Ó Néill et al., 2008), Giant otters (*Pteronura brasiliensis*) (Leuchtenberger et al., 2014) and Neotropical otters (*Lontra longicaudis*) (Nakano-Oliveira et al., 2004). While this approach has been used with much success, implanting devices prevents the use of high-accuracy GPS-technology that typically requires external antennas for instruments to obtain locations and also present risks due to the invasive nature of the surgical implantation process.

These challenges can be overcome by attaching telemetry equipment externally. However, the body shape of otters (particularly their necks and heads having a similar diameter), combined with their dexterity, prevents the use of standard collars as used on other mammals. Attachment of devices on Eurasian otter has therefore also been undertaken previously using custom-made harnesses (Mitchell-Jones et al., 1984; Ó

Néill et al., 2008; Quaglietta et al., 2012). Such harnesses reportedly functioned well and only one fatality was recorded. In this case an otter got snagged with its harness by a stem of thick reeds (de Jongh, pers. comm), which was likely the result of the harness not fitting tight enough. Since then, harnesses that include a safety break-away system (de Jongh et al., 2010) have been successfully deployed on otters without any fatality in several European countries (de Jongh, pers. comm). However, the least invasive alternative to attaching biologging devices to otters is to glue instruments directly to the fur, as is commonly done in studies of other semi-aquatic mammals such as seals (McIntyre et al., 2016). This has not often been attempted on otters and as far as we are aware, there is only one published account and one unpublished account of instruments being glued directly to the fur of otters. Kruuk and de Jongh glued a transmitter to the fur of a single, large male European otter in 1983, which dislodged after one day (de Jongh, pers.comm.). Subsequently, Ó Néill et al. (2008) glued 15g devices directly to the fur of two European otters, successfully tracking these individuals for 16 and 17 days respectively. Such tracking periods were deemed too short and the authors concluded that implanting otters with tracking devices was preferable over any form of external attachment.

There are only a limited number of studies that have tracked African clawless otters (*Aonyx capensis*). Arden-Clarke (1986) tracked six individuals via internally implanted VHF devices and Somers and Nel (2004b) tracked seven otters using the same approach (see also Somers and Nel, 2004a). More recently, Majelantle et al. (2021) reported on the movement speeds of two more African clawless otters implanted with VHF-devices. Here we report on the external attachment and subsequent successful tracking of an African clawless otter and discuss this as a proof of concept for future studies into the behaviour and movement ecology African clawless otters, as well as other otter species.

ANIMALS

The instrumented otter was captured and instrumented under permit from the South African Department of Forestry, Fisheries and the Environment (Permit Number: O-52937) and the Mpumalanga Tourism and Parks Agency (Permit Number: MPB 9383).

MATERIAL AND METHODS

We opportunistically instrumented a female African clawless otter that was captured at a trout farm (hatchery) nearby Lydenburg in the Mpumalanga Province, South Africa. The otter was captured and transported using a standard carnivore cage trap to the offices of the Mpumalanga Parks and Tourism Agency (MPTA) in Lydenburg. Here, the otter was immobilised by an intramuscular injection of a pre-calculated dose of ketamine and medetomidine and basic body measures taken. The female weighed 10.6 kg with a total length of 1,250 mm and tail length of 450 mm. Based on these body size measurements, the female was considered to be an adult (Somers and Nel 2013). After degreasing the attachment site using acetone, we glued a small (length 40 mm; width 30 mm; height 22 mm; total length incl. trailing antenna 105 mm; mass 33.6 g) VHF-transmitter (Africa Wildlife Tracking) directly to the fur between the scapulae and the posterior of the head of the otter using Pratley® Quickset Epoxy (Fig. 1.).

Figure 1. Images of the immobilised African clawless otter, showing the attachment site of the VHF transmitter.

After recovery, the otter was released nearby the MPTA offices in the vicinity of suitable cover next to the Sterkspruit river. The otter was tracked on a near-daily basis post-release and locations determined using standard triangulation approaches. Locations were mapped in the R programming environment (R Core Team, 2022) and geodetic distance between sequential locations calculated using the *SoDA* package (Chambers, 2020).

RESULTS AND DISCUSSION

The otter was successfully located 22 times between 22 Nov 2022 and 22 Dec 2022 (Fig. 2). Distances between otter daily otter locations averaged 752 ± 479 m (± SD), with a maximum daily distance travelled of 1,752 m.

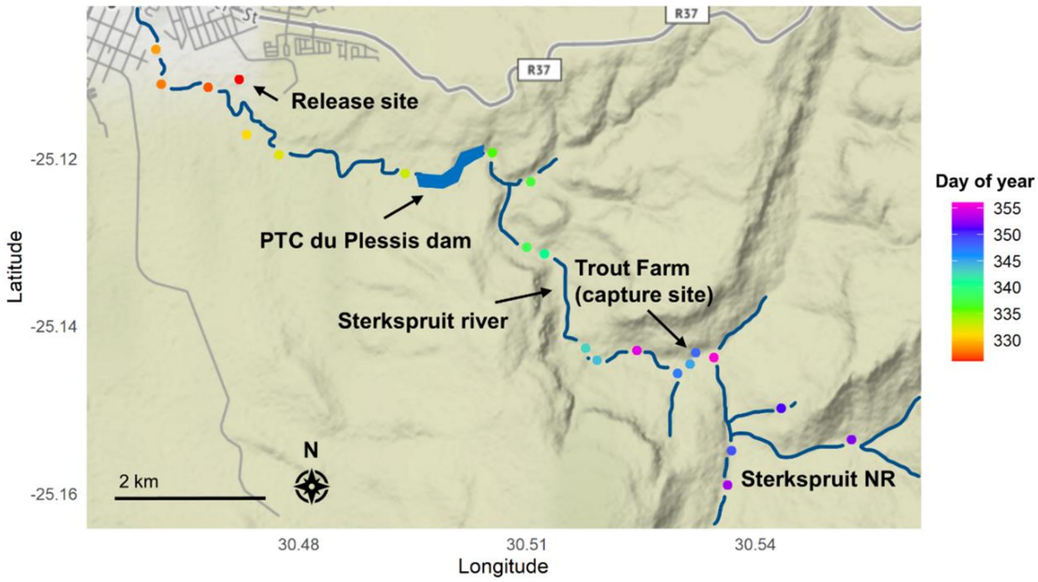

Figure 2. Track locations of the instrumented African clawless otter. Sterkspruit NR = Sterkspruit Nature Reserve. Background terrain was mapped using Terrain Map tiles by Stamen Design, under CC BY 3.0. Data by OpenStreetMap, under ODbL.

After release, the otter initially moved downstream along the Sterkspruit river closer to the town of Lydenburg (Fig. 2). From here it returned upstream past the release site and was subsequently located around the PTC du Plessis dam and a tributary to the Sterkspruit river between 29 November and 3 December. From here the otter continued to move further upstream towards the trout farm (capture site) where it was located between 11 and 13 December. The otter then moved further upstream into the Sterkspruit Nature Reserve where it was located along various tributaries of the Sterkspruit river between 15 and 19 December. After this, the otter was located again in the vicinity of the trout farm on 21 and 22 December. No attempts were made to locate the otter between 23 December and 3 January 2023. However, attempts at locating the otter on 4 and 5 January 2023 failed, and the otter was not located since.

The results above are from an initial attempt at using an approach involving comparatively negligible risk to instrumented otters (by simply gluing the instrument externally to the fur) and provide some evidence for the feasibility of using such an approach for future studies of the movement ecology of otters. We do not know the fate of the instrumented otter that we report on and can therefore only speculate on possible reasons for the otter not being relocated after 30 days of tracking. However, we consider three potential outcomes to be likely. Firstly, while the otter was never resighted without the tracking device, it is possible that she managed to ultimately dislodge the device somewhere where signal detection is unlikely (e.g. under water). Secondly, we cannot discount device failure and it is possible that any of a number of components (e.g. battery) failed, preventing the device from emitting detectable signals. Thirdly, the otter may have been trapped again and/or killed. The last recorded location of the otter indicated that she had returned to the vicinity of her original capture location (within approximately 200 metres of the capture site) and was likely foraging in the trout hatchery. Given that trout farm managers are known to use lethal means of controlling otter activity (de Vos and McIntyre, 2023), we consider this a plausible explanation. A further potential explanation that we consider to be less likely is that the otter moved out of the general area during the pause in attempts at locating her (i.e. between 23 December and 3 January). This seems unlikely though, given the overall restricted distances that the otter moved in the preceding 30 days.

Given the opportunistic nature of this study, we used a readily available epoxy (Pratley® Quickset Epoxy) for the attachment. However, the properties of specific types of epoxy glue vary substantially between specific formulations, ultimately influencing the curing times, curing temperatures, as well as texture and pliability once cured. It is therefore advisable that future attempts at gluing biologging instruments to otters make use of widely-tested formulations that are known to cure at suitable temperature to not cause cell damage, while offering suitable adherence characteristics (Field et al. 2012). The tracking protocol used in our study did not offer the opportunity to obtain visual observations of the behaviour of the otter while instrumented and we were unable to assess potential interference with normal behaviours due to the instrumenting. However, both de Jongh et al. (2010) and Quaglietta et al. (2012) reported similar movement characteristics between European otters that carried externally-attached instruments and otters implanted with tracking devices, and further noted no behavioural signs of restrictions to movement. Nonetheless, we recommend that suitable trials be carried out in controlled environments such as captivity to assess the potential for behavioural impacts associated with the external attachments of biologging instruments to otters. Such information would be very valuable to inform future field studies seeking to study the behaviours and ecology of otters using externally attached biologging instruments.

CONCLUSION

The results reported above provide information on the first external attachment of a biologging instrument to an African clawless otter. The successful relocation of the otter for a period of 30 days suggests that this method of attachment can likely be used successfully in future for medium-term tracking of otters and provide the opportunity then also for the use of tracking approaches that required external attachment such as GPS-enabled devices. Such an approach to device attachment circumvents many of the risks associated with surgical operations, as well as external attachment via harnesses (e.g. irritation and entanglement). Advances in biologging technology and in particular the continued miniaturisation of components such as sensors and batteries, promise to make biologging instruments even more amenable to simple external attachment to otters as illustrated here. We therefore foresee future studies to benefit from such approaches through the decreased handling times of otters and minimising of risk of injury or even death to otters.

Acknowledgements - The Mpumalanga Tourism and Parks Agency's (MTPA) Wildlife Management team and wildlife veterinarians based in Nelspruit are gratefully acknowledged for their assistance in the successful immobilisation of the otter and subsequent instrument deployment. Addy de Jongh is furthermore thanked for offering insights into previous trials tracking Eurasian otters.

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RESUME

SUIVI RÉUSSI D'UNE LOUTRE A JOUES BLANCHES (*Aonyx capensis*) A L'AIDE D'UN APPAREIL DE TÉLÉMÉTRIE MUNI D'UNE FIXATION EXTERNE

L'étude du comportement et de l'écologie des loutres à l'aide d'approches de bio-connexion implique souvent l'implantation chirurgicale de dispositifs de télémétrie et, parfois, l'utilisation de harnais sur mesure en raison de la difficulté de fixer solidement les instruments à l'extérieur des loutres. Cependant, les instruments de bio-connexion progressent et deviennent de plus en plus petits, offrant des opportunités pour tenter des approches de fixation externe plus simples qui minimisent le caractère invasif inhérent à de telles études. Nous présentons ici les données obtenues en fixant extérieurement un petit appareil à très haute fréquence (VHF) directement dans la fourrure d'une loutre à joues blanches (*Aonyx capensis*) à l'aide d'un époxy à prise rapide. Nous avons suivi avec succès les déplacements de la loutre pendant une période de 30 jours et présentons ces données comme une preuve du concept selon lequel une telle approche de fixation externe est prometteuse pour de futures études visant à minimiser la complexité et le caractère invasif de la fixation d'instruments sur les loutres.

RESUMEN

SEGUIMIENTO EXITOSO DE UNA NUTRIA SIN GARRAS AFRICANA (*Aonyx capensis*) UTILIZANDO UN DISPOSITIVO DE TELEMETRÍA FIJADO EXTERNAMENTE

El estudio del comportamiento y la ecología de las nutrias utilizando enfoques de bio-logging, a menudo involucra la implantación quirúrgica de dispositivos de telemetría y, a veces, el uso de arneses hechos a medida, debido a la dificultad de fijar instrumentos externamente de forma segura en las nutrias. Sin embargo, los instrumentos para bio-logging están avanzando constantemente y achicándose en tamaño, lo que ofrece oportunidades para intentar enfoques de fijación externa más simples, que minimicen la invasividad inherente de tales estudios. Aquí, presentamos datos obtenidos de fijar externamente un pequeño dispositivo VHF (Muy Alta Frecuencia) directamente a la piel de una nutria sin garras africana (*Aonys capensis*) utilizando un epoxy de fraguado rápido. Rastreamos exitosamente las localizaciones de la nutria por un período de 30 días, y presentamos éstos datos como prueba de concepto de que la fijación externa es prometedora para estudios futuros, para minimizar la complejidad e invasividad de la fijación de instrumental en nutrias.

R E P O R T

METASTATIC MAMMARY GLAND CARCINOMA IN A GIANT OTTER (*Pteronura brasiliensis*)

Estefani Segato FUJITA[1], Daniela Magalhães Drummond de MELLO[2,3*], Antony Rodrigues do NASCIMENTO FILHO[2], Carlos Eduardo FONSECA-ALVES[4], Camila TOCHETTO[5], Fernando C. Weber ROSAS[2]

[1]Instituto de Desenvolvimento Sustentável Mamirauá - IDSM. Escritório de Projetos, Tefé, Amazonas, Brazil
[2]Aquatic Mammals Laboratory, National Institute for Amazonian Research, Manaus, Amazonas, Brazil
[3]Institute of Biosciences, University of São Paulo, São Paulo, Brazil
[4]School of Veterinary Medicine and Animal Science, São Paulo State University, Botucatu, São Paulo, Brazil
[5]Ministério da Defesa, Exército Brasileiro. 13ª CIA DAM, Itaara, Rio Grande do Sul, Brazil
**Corresponding author:* danielamello@hotmail.com

(received 4th October 2023, accepted 16th October 2023)

ABSTRACT: Diagnostics of neoplasia in otters kept in captivity have been discreetly increasing over the last years, especially in older individuals. Here, we describe a case of a mammary gland carcinoma in a nulliparous 17-year-old female giant otter (*Pteronura brasiliensis*) kept at the National Institute for Amazonian Research in Brazil. It represents the first report of mammary carcinoma in a giant otter. The animal presented with lameness of the right hind limb, weight loss, dyspnea, impaired locomotion, and signs of pain. Physical examination was performed with the observation of a medium sized mass of approximately 5 cm^3 in the left mammary gland. On that occasion, samples for cytology and blood tests were collected. Results suggested the presence of mammary carcinoma and health alterations. The individual showed progressively poor health and was non-responsive to medical treatment. Euthanasia was performed and necropsy showed cachexia, a nodule in the mammary gland and an increase in the volume of mesenteric lymph nodes. Nodules from the mammary gland, pulmonary parenchyma, and mesenteric lymph node were

collected for histopathological and immunohistochemistry analyses. Histopathology results revealed a mammary carcinoma complex subtype at stage II, with confirmed results by immunohistochemistry, which yielded positive results for CK Pan, CK19 and CK7 tumoral markers in the neoplastic cells. The regular health monitoring of captive otters may aid in the understanding of the prevalence and the etiology of this type of tumor, as also to take preventive measures to avoid premature death of individuals.
Citation: Fujita, E.S., Mello, D.M.D. De, Nascimento Filho, A.R. Do, Fonseca-Alves, C.E., Tochetto, C., and Rosas, F.C.W. (2024). Metastatic Mammary Gland Carcinoma in a Giant Otter (*Pteronura brasiliensis*). *IUCN Otter Spec. Group Bull*., **41** (1): 53 - 62
Keywords: cytology, immunohistochemistry, histopathology, neoplasia, otter

INTRODUCTION

The occurrence and diagnostics of neoplasia in aquatic mammals kept in captivity have been increasing in the past few years. The reasons behind that may be related to the increasing ages of animals maintained in captivity, hence higher probability of developing neoplasia. Besides that, the increased number of pathologists and more effective diagnostic tools allowed for more numerous and precise detection of neoplasia (Colegrove, 2018). Despite of that, the identification and diagnose of neoplasia in otters remain deficient. Different types of neoplasia have been diagnosed in only seven out of 13 otter species (Reimer and Lipscomb, 1998; Nakamura et al., 2002; Bae et al., 2007; Pye et al., 2010; Stedman and Mills, 2014; Van De Velde et al., 2019; Pinto et al., 2023). In most cases, spontaneous tumors of unknown etiology were described (Bae et al., 2007; Burek-Huntington et al., 2012; Tanaka et al., 2013); while in some cases carcinogenic chemicals have been related as potential causes of neoplasia in free-ranging otters (Rodriguez-Ramos Fernandez et al., 2012). Frequently, the tumors are associated to secondary infectious viral and parasitic diseases due to debilitation and stress (Reimer and Lipscomb, 1998; Hsu and Mathura, 2018).

As top predators, aquatic and semi-aquatic mammals are considered sentinels of the environmental health as their overall health ultimately reflects the health of the ecosystems upon which they inhabit (Burek et al., 2008; Moore, 2008). The contact with carcinogenic agents may lead to the development of a variety types of neoplasia, including those related to the reproductive tract including mammary glands (Martineau et al., 2002).

Mammary cell proliferation has been extensively described in domestic dogs and cats (Rauner et al., 2018) and less frequently described in zoo canids (Munson and Moresco, 2007) and other carnivore species such as browns bears (Vashist et al., 2013) and carnivore marsupials (Canfield et al., 1990). On the other side, mammary tumors represent a major concern in wild felines representing the most frequent reproductive tumors diagnosed and commonly metastasized widely (Kloft et al., 2019). So far, one case of metastatic mammary carcinoma has been described in otter - the Asian small-clawed otter (*Aonyx cinereus*) (Muller et al., 2020). A tubular adenocarcinoma with a distinct stromal component and lymph node metastasis were diagnosed in the excised mammary tissue 9 months prior to the euthanasia of the 11 years old otter (Muller et al., 2020). Mammary carcinomas, as well as other types of tumors in otters, seems to be more frequently reported in captive adult individuals.

CASE REPORT

A 17-year-old nulliparous female giant otter (*P. brasiliensis*), maintained at the National Institute of Amazonian Research (INPA) was observed presenting asthenia, hyporexia, hypodipsia, and dyspnea in January 2016. Physical examination was performed after immobilization with Zolazepam (1.5 mg kg^{-1}) and Acepromazine (0.1 ml kg^{-1}) followed by an injection of atropine sulfate 1 % (0.09 mg kg^{-1}) (Rosas et al., 2008). Heart rate, respiratory frequency and body temperature were monitored during the anesthetic procedure in a room with controlled temperature (23 °C). All physical parameters were within normal ranges for the species (Table 1).

Table 1. Cardiac rate, respiratory frequency, and body temperature of one female giant otter under 89 min of general anesthesia.

	Pteronura brasiliensis[1]	***Pteronura brasiliensis***[2]	***Lontra longicaudis***[2]
	zolazepam + acepromazine	ketamine hydrochloride	
Cardiac rate (beats/min)	88 - 129	115	179 -186
Resp. frequency (breaths/min)	28 - 68	ND	ND
Rectal temperature (˚C)	37 - 39.5	39.4	39.3 - 40.8

[1]Present study; [2]Marsicano et al. (1986). ND = not determined

Blood was drawn from the femoral vein for hematological and serum chemistry analyses. A medium size mass was of approximately 5 cm^3 was observed in the left mammary gland during the physical examination. The mass was firm, with irregular borders, adhered to the adjacent tissue, not encapsulated, and composed by nodules of different sizes, with the largest of approximately 4-5 cm. A fine-needle aspiration cytology was performed on the mammary gland nodule to obtain a cell sample.

RESULTS

Most of the blood values showed abnormal values falling outside the normal range for the species. While the red cell series was mostly withing the normal range, the absolute and relative white blood cell counts showed values that ranged from discrete to severe alteration (Table 2).

The cytology showed predominantly epithelial cells, in groups or isolated, with cytoplasmic vacuoles, lack of pigments, and few mesenchymal cells. A large number of cells showed more than three characteristics of malignancy: Anisocytosis, anisokaryosis, multinucleate cells, irregular chromatin distribution within nuclei and evidence of mitotic figures. Results compatible with mammary carcinoma. Fine needle aspiration cytology and blood work confirmed the clinical observations.

Supportive treatment care was performed with IV fluids (Lactated Ringer's Solution) and antibiotics (Cefovecin, 8 mg kg^{-1}). Ten days after the initial treatment, the animal was non-responsive and even more debilitated. At this point, euthanasia was performed. Necropsy showed cachexia, a nodule in the mammary gland and increase of volume of mesenteric lymph nodes. The tissues were fixated by immersion in neutral buffered 10% formalin for histopathological and immunohistochemistry analyses.

Table 2. Complete blood count and serum chemistry of a giant otter (*P. brasiliensis*) with mammary gland adenocarcinoma.

Complete Blood Count	This study	Reference Range (Rosas et al., 2008)
RBC (10^6 $mm^{3\ -1}$)	5.3	5.3 - 8.6
Hematocrit (%)	42.0	41.3 - 62.6
Hemoglobin (g dL^{-1})	15.3	13.9 - 21.2
MCV (fL)	79.7	65.0 - 82.5
MCHC (g dL^{-1})	36.4	32.0 - 33.9
Platelets (10^3 $mm^{3\ -1}$)	390.0	198.0 - 619.5
White Blood Count (10^3 $mm^{3\ -1}$)	8.8	2.8 - 7.4
Neutrophils (%)	76.0	74.0 - 83.0
Eosinophils (%)	12.9	0.0 - 2.30
Lymphocytes (%)	2.0	13.7 - 22.0
Monocytes (%)	10.0	0.8 - 1.5
Basophils (%)	0.0	0.0 - 0.7
Serum chemistry		
ALT (UI L^{-1})	40.0	58.0 - 209.0
AST (UI L^{-1})	120.0	142.0 - 223.0
Total protein (g dL^{-1})	9.0	6.9 - 7.1
Creatinine (mg dL^{-1})	5.1	1.1 - 2.8
Alkaline Phosphatase (UI L^{-1})	87.8	40.0 - 77.0
Blood Urea Nitrogen (mg dL^{-1})	267.0	99.0 - 344.0

The histopathological examination revealed a solid carcinoma (Fig. 1), characterized by partially encapsulated and infiltrative neoplasm, tumor cells were arranged in solid sheets, cords, or nests. The neoplastic cells exhibited moderate pleomorphism, anisocytosis and anisokaryosis. Some binucleate cells were observed. The cytoplasmic boundaries were moderately distinct, the cytoplasm was moderate and slightly eosinophilic. Chromatin was poorly aggregated and 1-3 conspicuous nucleoli were observed. There were 2-5 mitosis figures per field of highest magnification. The stroma was characterized by fibrous connective tissue, which varies from scarce to abundant, in some places, where it is arranged in multidirectional bundles. Areas of necrosis and mineralization were also observed. There were neoplastic cells inside lymphatic and lymphatic vessels. Metastasis was observed in the mesenteric lymph nodes, whose parenchyma was replaced by neoplastic cells.

Immunohistochemistry revealed neoplastic cells negative for tumoral markers Vimentin and CK20, and positive for markers CK Pan, CK19, and CK7, supporting the metastatic mammary adenocarcinoma diagnosis.

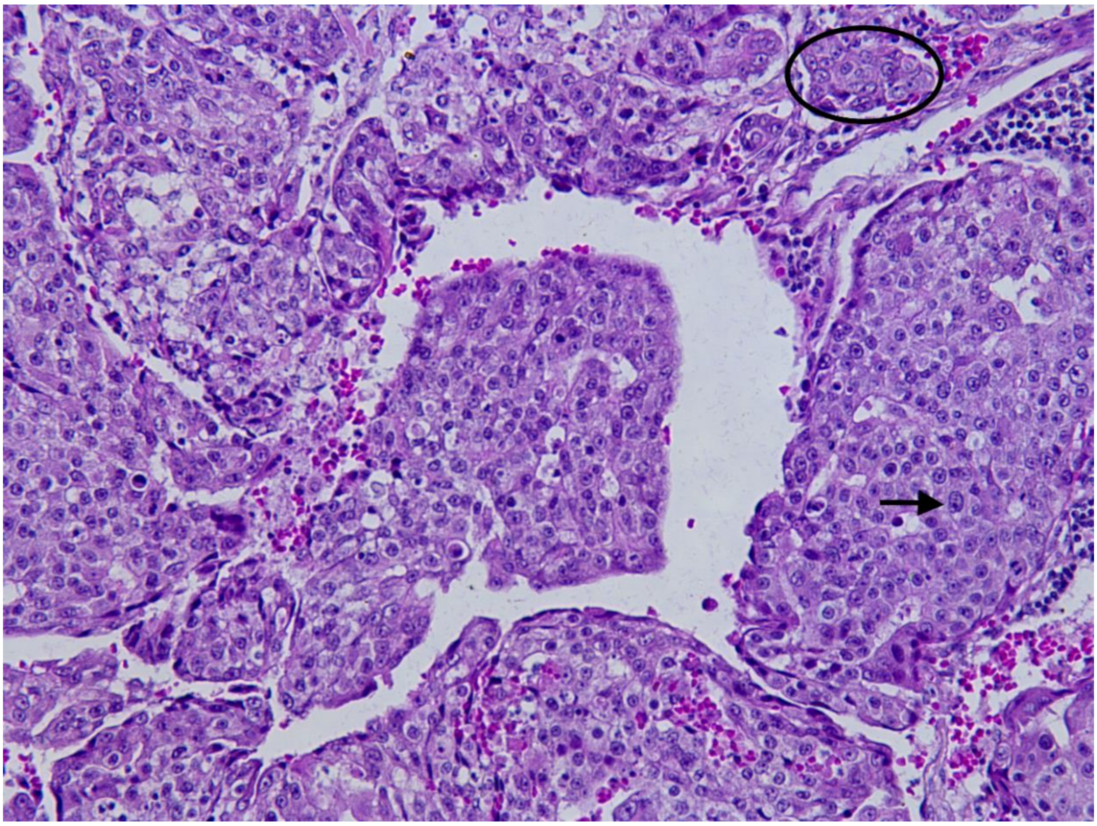

Figure 1. Histopathology of the mammary gland tumor shows tumor cells are arranged in solid sheets, and nests (black circle). The neoplastic cells exhibited moderate pleomorphism, anisocytosis and anisokaryosis (arrow). H.E, 20x, scale bar = 100 µm.

DISCUSSION

Wild animals have been considered environmental sentinels since the Roman Era due to the sensitivity of some species to environmental changes. They provide information such as type, characteristics, quantity, and prevalence of pollutants as well as their environmental effects (Fox, 2001). Therefore, human, animal and environmental health are directly connected (Zinsstag et al., 2011). A large amount of biological material from wildlife species comes from necropsies, and the information gained from postmortem examinations animals kept in rehabilitation and exhibition facilities are crucial for a better understanding of the relation between their health and the environment. Moreover, the possibility of having a compilation of the medical history from captive individuals forms the basis of understanding a certain disease and its impact at the individual, population, species, and even ecosystem level (McAloose et al., 2018).

According to Bostock (1986), the mammary carcinoma has a complex etiology with a high level of malignancy and high metastatic capacity. Animals with mammary carcinomas can show a very rapid clinical decline, as noticed in this case. The observed leukocytosis accompanied by increased values of monocytes and eosinophils have demonstrated the neoplastic and inflammatory stimulus of the mammary neoplasia. The blood alterations shown in Table 2 keep up with the clinical signs observed, together with metabolic dysfunction, alteration of organic functions and a compromised immune system. The histopathological results were similar to what was previously described in the literature for other mammals with mammary cancer (Carpenter et al., 1980; Bryant et al., 2007; Cassali et al., 2007; Munson and Moresco, 2007).

In otters, five different types of carcinomas have been reported so far. Most of them in animals kept in captivity and over eight years old. A differentiated basal cell carcinoma was found in the left submandibular region of a captive Cape clawless otter (*Aonyx capensis*) of > 8 years (Nakamura et al., 2002). Cholangiocellular adenocarcinoma was described in an adult female captive sea otter (*Enhydra lutris*) (Stetzer et al., 1981). A primary pleural squamous cell carcinoma was found in a free-ranging North American river otter (*Lontra canadensis*) (Van De Velde et al., 2019), representing the only carcinoma described in a free-ranging otter species. A thyroid gland carcinoma was diagnosed in a 20 years old captive small-clawed otter (*Aonyx cinereus*) (Hsu and Mathura, 2018). In other occasion, one case of metastatic exocrine pancreatic adenocarcinoma was described in an 18-year-old giant otter (*Pteronura brasiliensis*) in captivity with a history of inappetence and apathy (Pinto et al., 2023). All the individuals above cited were adults, reinforcing the importance of close monitoring of health from otters kept in captivity, especially when dealing with endangered species such as giant otter (Groenendijk et al., 2021).

CONCLUSION

This study is the first case report on mammary carcinoma in *P. brasiliensis*. The regular health monitoring of confined animals combined with epizootiological and pathological studies are necessary to determine the prevalence, and the etiology of this type of tumor in giant otters, as well as to take preventive measures to avoid premature death of individuals.

Acknowledgements - We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico - CNPq, Associação dos Amigos para a Proteção do Peixe-boi da Amazônia – AMPA (Projeto Mamíferos Aquáticos da Amazônia sponsored by Petrobras Socioambiental) for logistical and/or financial support, and Rodrigo Amaral for technical support.

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RESUME

COURTE COMMUNICATION SUR LE CARCINOME MÉTASTATIQUE DE LA GLANDE MAMMAIRE CHEZ UNE LOUTRE GÉANTE (*Pteronura brasiliensis*)

Les diagnostics de néoplasie chez les loutres gardées en captivité ont augmenté discrètement ces dernières années, notamment chez les individus plus âgés. Nous décrivons ici un cas de carcinome de la glande mammaire chez une loutre géante femelle nullipare de 17 ans (*Pteronura brasiliensis*) gardée à l'Institut national de recherche amazonienne au Brésil. Il s'agit du premier signalement d'un carcinome mammaire chez une loutre géante. L'animal présentait une boiterie du membre postérieur droit, une perte de poids, une dyspnée, des troubles de la locomotion et des signes de douleur. L'examen physique réalisé a permis d'observer une masse de taille moyenne d'environ 5 cm3 au niveau de la glande mammaire gauche. A cette occasion, des échantillons destinés à la cytologie et des analyses de sang ont été prélevés. Les résultats suggèrent la présence d'un carcinome mammaire et une altération de l'état de santé. L'état de santé de l'individu s'est progressivement détérioré et ne répondait plus aux traitements médicaux. L'euthanasie a été réalisée et l'autopsie a montré une cachexie, un nodule dans la glande mammaire et une augmentation du volume des ganglions lymphatiques mésentériques. Des nodules de la glande mammaire, du parenchyme pulmonaire et des ganglions lymphatiques mésentériques ont été prélevés pour des analyses histopathologiques et immunohistochimiques. Les résultats histopathologiques ont révélé un sous-type complexe de carcinome mammaire au stade II, avec des résultats positifs confirmés par immunohistochimie pour les marqueurs tumoraux CK Pan, CK19 et CK7 dans les cellules néoplasiques. La surveillance régulière de la santé des loutres en captivité peut aider à comprendre la prévalence et l'étiologie de ce type de tumeur, ainsi qu'à prendre des mesures préventives pour éviter la mort prématurée des individus.

RESUMEN

CARCINOMA METASTÁSICO DE GLÁNDULA MAMARIA EN UNA NUTRIA GIGANTE (*Pteronura brasiliensis*)

El diagnóstico de neoplasias en nutrias mantenidas en cautiverio ha venido aumentando discretamente en los últimos años, especialmente en individuos más viejos. Aquí, describimos un caso de un carcinoma de glándula mamaria en una hembra nulípara de 17 años, de nutria gigante (*Pteronura brasiliensis*) en cautiverio en el Instituto Nacional de Investigaciones Amazónicas, en Brasil. Representa el primer reporte de carcinoma mamario en una nutria gigante. El animal presentaba cojera en el miembro trasero derecho, pérdida de peso, disnea, locomoción dificultada, y signos de dolor. Se realizó un examen físico, observando una masa de tamaño mediano, de aproximadamente 5 cm^3 en la glándula mamaria izquierda. En esa ocasión, colectamos muestras para citología y pruebas sanguíneas. Los resultados sugirieron la presencia de carcinoma mamario y alteraciones en la salud. El individuo exhibió un estado de salud de deterioro progresivo, y no respondió al tratamiento médico. Se llevó a cabo eutanasia, y la necropsia mostró caquexia, un nódulo en la glándula mamaria, y un incremento en el volumen de los nodos linfáticos mesentéricos. Colectamos nódulos de la glándula mamaria, parénquima pulmonar, y nódulos linfáticos mesentéricos, para análisis histopatológicos e inmunoquímicos. Los resultados de histopatología revelaron un complejo de carcinoma mamario en estadio II, con resultados confirmados por inmunoquímica, que dieron positivos para los marcadores tumorales CK Pan, CK19 y CK7 en las células neoplásicas. El monitoreo regular de salud de las nutrias en cautiverio puede ayudar a entender la prevalencia y la etiología de éste tipo de tumor, así como a tomar medidas preventivas para evitar la muerte prematura de individuos.

RESUMO

CARCINOMA MAMÁRIO MESTASTÁTICO EM ARIRANHA (*Pteronura brasiliensis*)

O diagnóstico de neoplasias em lontras mantidas em cativeiro tem aumentado ao longo dos últimos anos, especialmente em indivíduos mais velhos. No presente relato, um caso de carcinoma mamário foi descrito pela primeira vez em ariranha (*Pteronura brasiliensis*). Tratou-se de uma fêmea nulípara, de 17 anos de idade, mantida no Instituto Nacional de Pesquisas da Amazônia, Brasil. O animal apresentou claudicação do membro posterior direito, perda de peso, dispneia, dificuldade de locomoção e apresentava sinais de dor. Durante o exame físico, observou-se uma massa de tamanho aproximado de 5 cm^3 na glândula mamária esquerda. Na ocasião, foi coletada amostra por punção aspirativa por agulha fina e sangue para citologia e testes hematológicos, respectivamente. Os resultados sugeriram a presença de um carcinoma mamário e alterações dos parâmetros sanguíneos. O animal apresentou deterioração do estado de saúde de maneira progressiva e não respondeu ao tratamento medicamentoso. Desta maneira, o indivíduo foi submetido à eunatásia e, posteriormente, à necropsia. Os achados macroscópicos demonstraram caquexia, um nódulo na glândula mamária esquerda e aumento de volume dos linfonodos mesentéricos. Amostras de tecido dos

nódulos da glândula mamária, do parênquima pulmonar e dos linfonodos mesentéricos foram coletados para exame histopatológico e imuno-histoquímico. O exame histopatológico revelou carcinoma complexo grau II. Esse resultado foi confirmado por imuno-histoquímica, que demonstrou resultado positivo para os marcadores tumorais pancitoqueratina (CK Pan), CK19 e CK7 nas células neoplásicas. O monitoramento contínuo do estado de saúde de lontras mantidas em cativeiro pode servir como uma importante ferramenta para entender a prevalência e etiologia desse tipo de tumor, bem como auxiliar na tomada de medidas preventivas para evitar a morte prematura dos indivíduos.