ORIGINAL ARTICLE

TRACES OF POLLUTION OBSERVED IN BLUE SHARKS (*Prionace glauca*) IN MOROCCAN WATERS

| Habiba Hamdi *[1] | Aziza Lakhnigue [2] | Abdellatif Boumaaz [3] | and | Souad El Amrani [4] |

[1.2.3.] Institut National de Recherche Halieutique | INRH |
[4.] Faculté des sciences Ben Msik | Université Hassan II |

| Received April 18, 2023 | | Accepted May 23, 2023 | | Published June 07, 2023 | | ID Article | Habiba–Ref7-5-16ajiras180523 |

RESUME

Introduction : Le requin bleu (Prionace glauca) fait face à de multiples menaces, notamment la surpêche, le lent renouvellement de la population et la pollution anthropique. Des recherches antérieures se sont concentrées sur l'étude de la présence de plastique dans l'estomac des requins bleus. Cependant, d'autres études sont nécessaires pour évaluer l'étendue de la pollution, son impact sur la santé humaine et les caractéristiques spécifiques des déchets plastiques observés**. Objectif** : L'objectif de cette étude était d'examiner la présence de déchets plastiques dans l'estomac de requins bleus prélevés à la criée du marché de gros à Casablanca. L'étude visait à déterminer la prévalence de l'ingestion de plastique, à identifier les caractéristiques des déchets plastiques et à évaluer les implications de cette pollution pour la santé humaine. **Méthodes** : Des séances d'échantillonnage ont été menées au marché de gros aux poissons de Casablanca, où un nombre important de requins bleus étaient disponibles. Les estomacs ont été disséqués et la présence de déchets plastiques a été examinée visuellement. Les caractéristiques des déchets plastiques, telles que la taille, le type et la quantité, ont été enregistrées. De plus, la taille et le stade de maturité de chaque individu ont été documentés. **Résultats :** Les résultats de cette étude ont révélé la présence de déchets plastiques dans l'estomac d'un requin bleu immature mâle mesurant 105 cm, qui a été capturé dans la région de Boujdour. Cette découverte confirme l'existence de déchets solides dans la région et met en évidence le potentiel de pollution du milieu marin. **Conclusion** : L'observation de déchets plastiques dans l'estomac d'un requin peau bleue souligne la nécessité de nouvelles études approfondies pour évaluer le niveau et le taux de pollution dans la région. De plus, l'impact de cette pollution sur la santé humaine doit être étudié de manière approfondie. Cette étude contribue à sensibiliser à la présence de polluants dans les écosystèmes marins et souligne la nécessité de mettre en place des mesures pour atténuer la pollution et protéger la population de requin bleu.
***Mots clés** : pollution, plastiques, requin bleu.*

ABSTRACT

Background: The blue shark (Prionace glauca) faces multiple threats, including overfishing, slow population renewal, and anthropogenic pollution. Previous research has focused on investigating the presence of plastic in the stomach of blue sharks. However, further studies are needed to assess the extent of pollution, its impact on human health, and the specific characteristics of the observed plastic waste. **Objective**: The objective of this study was to examine the presence of plastic waste in the stomach of blue sharks sampled at the wholesale fish market in Casablanca. The study aimed to determine the prevalence of plastic ingestion, identify the characteristics of the plastic waste, and assess the implications of this pollution for human health. **Methods**: Sampling sessions were conducted at the wholesale fish market in Casablanca, where a significant number of blue sharks were available. Stomachs were dissected, and the presence of plastic waste was visually examined. The characteristics of the plastic waste, such as size, type, and quantity, were recorded. Additionally, the size and maturity stage of each individual were documented. **Results**: The results of this study revealed the presence of plastic waste in the stomach of a male, immature blue shark measuring 105 cm, which was caught in the Boujdour region. This finding confirmed the existence of solid waste in the region and highlights the potential for pollution in the marine environment. **Conclusion**: The observation of plastic waste in the stomach of a blue shark underscores the need for further comprehensive studies to evaluate the level and rate of pollution in the region. Additionally, the impact of this pollution on human health needs to be thoroughly investigated. This study contributes to raising awareness about the presence of pollutants in marine ecosystems and emphasizes the necessity of implementing measures to mitigate pollution and protect the blue shark population.
***Keywords**: pollution, plastics, blue shark.*

1. INTRODUCTION

Numerous studies have highlighted the alarming threat faced by blue sharks, along with other pelagic shark species, due to excessive exploitation in recent decades. The global catch of blue sharks has tripled over the past fifty years, escalating from approximately 50 tonnes to around 112,000 tonnes [1]. Furthermore, the Food and Agriculture Organization (FAO) study emphasizes the intensification of fishing activities targeting sharks, driven by the demand for shark fins, meat, and cartilage [2]. This mounting pressure on shark populations is exacerbated by their slow reproductive rates [3]. With late sexual maturity (exceeding ten years for some species), long gestation periods (up to 22 months), intervals of 2 to 4 years between litters, and a relatively low number of offspring per litter, the scale of fishing is disproportionately large in relation to the reproductive capacities of these animals [4].

Anthropogenic pollution represents another significant factor posing a threat to pelagic sharks, including the blue shark. Marine ecosystems are constantly under threat from contaminants produced by human activities. As apex predators

*Corresponding author Author & Copyright Author © 2023: | Habiba Hamdi * |

occupying the top of the food chain, sharks are particularly vulnerable to bioaccumulation, making them potential sentinel species for assessing marine contamination levels. In light of these concerns, a macroscopic investigation was conducted with the primary objective of examining pollution traces in the stomachs of blue sharks to assess the impact of pollution on this species.

2. MATERIALS AND METHODS

The methodology employed in this study consisted of two main steps. First, the total length of each individual blue shark was measured using a measuring tape. Second, the animals were dissected to extract their stomachs. For larger stomachs weighing over 10 kg, the analysis was conducted on-site. Conversely, smaller stomachs were preserved in 70% alcohol and transported to the laboratory for further analysis. In the laboratory, the stomachs were first weighed, then dissected to assess their level of digestion. The contents were examined using a binocular magnifier (10x to 40x) equipped with a light source, enabling a detailed analysis of the stomach contents.

It should be noted that blue sharks generally undergo evisceration in the ports of origin before being transited to the Casablanca wholesale market to maintain their freshness and only a few individuals escape evisceration. As a result, only a few uneviscerated individuals were available for our sampling process. To increase the number of samples, discarded viscera from fishermen were also collected and analyzed. The size of each individual was estimated based on the relationship provided by Hamdi et al., (2018) [5]. In total, 94 blue shark stomachs, representing both sexes and varying in size, were sampled. The stomachs have been classified according to three main phases:

- Phase I: Beginning of digestion, generally the prey no longer has a head but the item is still identifiable.
- Phase II: Advanced digestion; the item begins to lose its appearance and shape. Generally, it is no longer identifiable, but it can be classified by family.
- Phase III: Very advanced digestion: the item is well digested, and the stomach contents are in the form of a viscous liquid.

3. RESULTS AND DISCUSSION

The individuals included in the sample range in size from 80 to 300 cm (TL). This indicates that the biological sampling encompassed nearly all size categories that were captured [6]. The sizes observed in the sample exhibited a multimodal distribution, with a prominent peak at 200 cm.

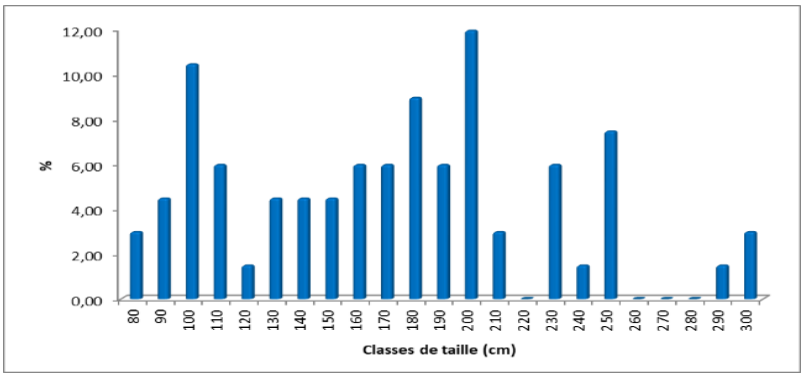

Figure 1: The figure presents the frequency distribution of sampled sizes.

Referring to the size of first maturity reported by Hamdi and al., (2017) [6], which is 188.53 cm for males and 156.79 cm for females, our samples were categorized into two groups. The "immature" category consisted of juveniles and sub-adults ranging from 80 to 190 cm, representing approximately 60% of the sampled population. The "mature" category included individuals over 190 cm. The first group exhibited a modal class of 100 cm, while the second group showed a modal class of 200 cm.

During the analysis, the stomachs were observed in two main states: full and empty. Out of the stomachs analyzed, 42 units (45%) were found to be empty. This empty state could be attributed to factors such as gastric eversion, a probable method of purging indigestible objects [7], as well as reproductive reasons. Springer (2060) [8] concluded that pregnant sharks cease feeding upon entering the nursery area. The remaining stomachs were full and exhibited four levels of digestion: intact prey, beginning digestion, advanced digestion, and very advanced digestion. Stomach analysis revealed a variety of prey items consumed by the blue sharks (Table 1), with a significant preference for small pelagic species, particularly common sardines (Sardina pilchardus) accounting for 40% (F=40%). Cephalopods ranked second with a frequency of 16.27% (F=16.27%) [5].

Table 1: The table presents the classification of prey found in the stomachs of blue sharks.

Prey category	Family/species	F0%
Pelagic teleosts	European pilchard (Sardina pilchardus)	39,53
	Mackerel (scomber sp)	2,32
	Belonidae	2,32
	Horse mackerel (trachurus sp)	4,65
	Small tuna	2,32
	Xiphidae	2,32
Demersal teleosts	Lophiidae (Lophius sp)	2,32
	Sparidea	2,32
Unidentifiable teleosts	Unidentifiable	9,30
Elasmobranchs	Centrophoridae birdbeak dogfish	4,65
	ray	9,30
Cephalopods	Cephalopods	16,27
Crustaceans	Unidentifiable shrimps	2,32
Viscos liquids	Unidentifiable	20,93
Anthropogenic materials	Plastic	2,32

In addition, the macroscopic analysis of the full stomachs allowed us to identify an individual that exhibited plastic fragments in the gastric juice, along with the presence of 6 sardines. This individual is a juvenile male measuring 105 cm, captured in the Boujdour region in southern Morocco.

Figure 2: The figure presents the plastic fragment found in the stomach of an individual blue shark.

Based on this preliminary analysis, several hypotheses can be proposed:

The presence of plastic fragments along with other prey suggests that blue sharks may unintentionally ingest plastic while consuming their prey, rather than intentionally swallowing it due to a lack of prey availability. This behavior is observed in various marine species, highlighting the susceptibility of blue sharks to accidentally consuming plastic.

The individual that ingested the plastic fragments is immature, indicating that juvenile blue sharks are more prone to ingesting marine litter compared to adults. A study conducted by Bernardini et al., (2018) [9] found a higher incidence of plastic ingestion in the stomachs of juvenile blue sharks.

The control individual was captured in the Boujdour region of southern Morocco, which indicates the presence of pollution in Moroccan marine waters. Indeed, Loulad conducted a study on pollution in southern Moroccan waters, based on data collected during a trawling campaign in October 2014, and identified various types of marine debris, including plastic, metal, rubber, glass, and textile. Plastic debris accounted for the majority of the collected debris, comprising 54% of the trawling operations, with items such as plastic bags, bottles, boots, gloves, and octopus-catching pots [10].

Furthermore, it is possible that in addition to the visible plastic fragments found in the stomachs of the sampled individuals, microplastics may have gone unnoticed during macroscopic examination. The anthropogenic pollution rate within the sampled population was estimated at 1.06%. It is likely that this rate would have been higher if a more detailed investigation, such as microscopic examination of gastric juice, had been conducted to detect microplastics. Other studies conducted by different authors have also reported the presence of plastic materials in the stomachs of marine organisms [11, 12]. These findings highlight the pervasive level of pollution in the oceans, which, combined with global warming, is expected to impact marine biodiversity, as observed in the Mediterranean Sea [3]. Additionally, some livers observed during this study exhibited signs of degradation, including brownish spots, indicating a potential accumulation of toxic substances. These results warrant further chemical analysis to assess the levels of heavy metals accumulating in the livers of blue sharks.

Indeed, previous studies conducted by other authors [13, 14] have consistently demonstrated elevated levels of mercury exceeding the permissible limit (>1 ppm wet weight) for human consumption as established by numerous international agencies.

These findings underscore the extent of liquid and solid pollution in the marine environment, with blue sharks, like other elasmobranch species, serving as significant bioaccumulators of pollutants. Adult sharks, in particular, accumulate such high levels of mercury that certain Australian fisheries have implemented restrictions on the size of sharks that can be commercially harvested for human consumption. For instance, the sale of sharks weighing over 18 kg is prohibited in Western Australia, while southern fisheries also impose limitations on the landing of large sharks [15]. Furthermore, Alves et al. (insert year of publication) [16] observed concentrations of specific contaminants in shark tissues that surpassed legally authorized limits for human consumption. Consequently, the consumption of blue shark meat and liver-derived products poses risks to human health.

4. CONCLUSION

This experiment has successfully revealed the presence of plastic fragments in the stomach of the sampled blue shark, confirming the pollution of Moroccan marine waters. It is crucial to conduct further in-depth studies to determine the extent of pollution, assess its impact on human health, and subsequently identify appropriate solutions to combat this contamination. This is particularly significant as Morocco recently demonstrated its commitment to preserving the oceans during its participation in the One Ocean summit held in Brest, France, two months ago. The summit aims to provide strong political momentum to the European and international agenda on maritime issues.

Acknowledgements: I thank all the people who helped me to bring this work to life. It was with their help, understanding and collaboration that his hard work has become possible.

5. REFERENCES

1. FAO. [Internet]. Fishery species. Rome: Food and Agriculture Organization of the United Nations; 2018 [cited 2023 May 30]. Available from: http://www.fao.org/fishery/species/2018/en
2. FAO. [Internet]. La FAO appelle à une interdiction internationale de la pêche destructive [FAO calls for international ban on destructive fishing]. Rome: Food and Agriculture Organization of the United Nations; 2013 [cited 2023 May 30]. French. Available from: https://www.fao.org/news/story/fr/item/171977/icode/
3. Bradai MN, Saidi B, Enajjar S. Elasmobranchs of the Mediterranean and Black Sea: status, ecology, and biology. Bibliographic analysis. Studies and Reviews. General Fisheries Commission for the Mediterranean. No. 91. Rome: Food and Agriculture Organization of the United Nations; 2012. 103 p.
4. Perez N. Requins une espèce en voie de disparition [Sharks, an endangered species]. 2008 [cited 2023 May 30]. Available from: https://www.mediation-animale.org/requins_une-espece_en_voie_de_disparition/
5. Hamdi H. Etude de la biologie et de l'exploitation des requins dans les eaux marocaines : cas du requin peau bleue (Prionace glauca, L. 1758) [Study on the biology and exploitation of sharks in Moroccan waters: the case of the blue shark (Prionace glauca, L. 1758)]. [Doctoral thesis]. Casablanca: Ben M'Sik Faculty of Sciences; 2018. French.
6. Hamdi H, El Amrani S, Charouki N. Contribution to the biological study of the blue shark "prionace glauca" in Moroccan waters. *J Wat Env Sci.* 2017;1(1):29-38.
7. Brunnschweiler JM, Andrews PLR, Southall EJ, Pickering M, Sims DW. Rapid voluntary stomach eversion in a free-living shark. *J Mar Biol Assoc UK*. 2005;85:1141-1144.
8. Springer S. Natural history of the sandbar shark. *Fish Bull*. 1960;61(178):1-38.
9. Bernardini I, Garibaldi F, Canesi L, Fossi MC, Baini M. First data on plastic ingestion by blue sharks (Prionace glauca) from the Ligurian Sea (North-Western Mediterranean Sea). *Mar Pollut Bull*. 2018;135:303-310.
10. Loulad S, Houssa R, Rhinane H, Boumaaz A, Benazzouz A. Spatial distribution of marine debris on the seafloor of Moroccan waters. *Mar Pollut Bull*. 2017;124(1):303-313.
11. Vaske JT, Lessa RP, Gadig OBF. Feeding habits of the blue shark (Prionace glauca) off the coast of Brazil. *Biota Neotrop*. 2009;9:55-60.
12. Cord MEM, Campana SE. A quantitative assessment of the diet of the blue shark (Prionace glauca) off Nova Scotia, Canada. *Can J Fish Aquat Sci*. 2003;32:57-63.
13. Neves M, Branco V, Vale C. Mercury and selenium in blue shark (Prionace glauca, L. 1758) and swordfish (Xiphias gladius, L. 1758) from two areas of the Atlantic Ocean. *Environ Pollut*. 2007;150(3):373-380. doi: 10.1016/j.envpol.2007.01.040
14. Barrera-García A, O'Hara T, Galván-Magaña F, Méndez-Rodríguez LC, Castellini JM, Zenteno-Savín T. Oxidative stress indicators and trace elements in the blue shark (Prionace glauca) off the east coast of the Mexican Pacific Ocean. *Comp Biochem Physiol C Toxicol Pharmacol*. 2012;156:59-66.
15. Camhi M, Fowler S, Musick J, Bräutigam A, Fordham S. Les requins et autres poissons cartilagineux: écologie et conservation [Sharks and other cartilaginous fishes: ecology and conservation]. Groupe de spécialistes des requins de la CSE de l'UICN. UICN, Gland, Suisse et Cambridge, Royaume-Uni. 1998; iv + 44pp.
16. Alves LM, Nunes M, Marchand P, Le Bizec B, Mendes S, Correia JP, Lemos MF, Novais SC. Blue sharks (Prionace glauca) as bioindicators of pollution and health in the Atlantic Ocean: Contamination levels and biochemical stress responses. *Sci Total Environ*. 2016 Sep 1;563-564:282-92. doi: 10.1016/j.scitotenv.2016.04.085.

How to Cite This Article: Habiba Hamdi, Aziza Lakhnigue, Abdellatif Boumaaz, and Souad El Amrani. Traces of Pollution Observed in Blue Sharks (*Prionace glauca*) in Moroccan Waters. *Am. J. innov. res. appl. sci.* 2023; 16(6): 322-325.