Ingestion of foreign materials in odontocetes in the Catalan Coast, causes and consequences

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Running page head: Ingestion of foreign materials in odontocetes

ABSTRACT: Ingestion of abnormal materials by cetaceans has been reported worldwide, but few studies have investigated the causes of foreign material ingestion. We retrospectively analysed necropsies performed from 2012 to 2019 on stranded cetaceans on the coast of Catalonia (n=88) and evaluated the association of abnormal ingested materials with two risk factors, disease of the central nervous system (CNS) and maternal separation. Abnormal materials were found in the digestive tract in 19 of 88 (21.6 %) cetaceans, with 13 of them (60%) having lesions in the CNS, such as morbilliviral encephalitis, neurobrucellosis, or encephalomalacia, and 3 of them diagnosed as maternal separation. In a logistic regression model, CNS lesions and maternal separation were identified as risk factors for ingestion of foreign material, but with wide confidence intervals, probably due to the small sample size. In contrast, abnormal ingestion was not identified in any of the 25 (28 %) cetaceans with human interaction as the cause of death. Abnormal ingestion should be interpreted with caution, and efforts should be made at necropsy to exclude CNS diseases through pathologic and microbiologic investigations. If disease of the CNS is a significant risk factor for ingestion of marine debris by small odontocetes, results of monitoring programs may be biased by the prevalence of CNS disease in a specific area or population.

KEY WORDS: Foreign materials, marine debris, cetacean, ingestion, neurologic disease.

1. INTRODUCTION

Marine megafauna interactions with marine debris are of great concern (Claro et al. 2019), and the ingestion of abnormal materials by cetaceans has been reported for many years all around the world (Walker & Coe 1989, Tarpley & Marwitz 1993, Jacobsen et al. 2010, Denuncio et al. 2011, Baulch & Perry 2014, Lusher et al. 2018). Marine debris of anthropogenic origin is the most frequent abnormal material found in the digestive tract of cetaceans. Although less frequently reported, a variety of natural objects such as sand, stones, plants or other marine animals which do not belong to the normal diet of cetaceans, have also been detected at necropsies (van Franeker et al. 2018).

During lactation, a calf is highly dependent on its mother and the milk she provides, which is the only material found in the gastric compartments which can be considered normal in very young calves; it is normal for older calves to also ingest normal prey species in addition to milk, as they learn to hunt. As soon as odontocetes become juveniles, fish and cephalopods are the main components of their diet. Toothed whales use a highly sophisticated echolocation system for foraging, and various studies suggest that they can perform complex biosonar target discrimination tasks (Whitlow & Hastings 2008). It is therefore commonly accepted that they are highly selective when choosing their prey (Walker & Coe 1989, Young & Cockcroft 1994). Most studies on the interaction between marine debris and cetaceans have focused on the detection of debris and the assessment of its impact on stranded cetaceans (Baulch & Perry 2014, Baulch & Simmonds 2015), whereas very few investigations have been performed in order to determine the reasons for foreign material ingestion (Ridgway & Dailey 1972).

Based on the observation of an apparent association between some specific conditions and the ingestion of abnormal material in our necropsy cases, we hypothesized that two different factors could represent a risk for ingestion of abnormal materials: (1) central nervous system (CNS) disease, and (2) maternal separation of young nursing calves. To test this hypothesis, we retrospectively analysed all the necropsies performed from 2012 to 2019 on 88 stranded odontocetes on the coast of Catalonia (western Mediterranean) and evaluated the association of abnormal ingested materials with these two proposed risk factors.

2. MATERIALS AND METHODS

2.1. **Post-mortem investigation and laboratory analyses**.

From 2012 to 2019, 88 odontocete cetaceans stranded along the Spanish Mediterranean Coast were necropsied by the Diagnostic Service of Veterinary Pathology (SDPV) of the Universitat Autònoma de Barcelona (UAB). Stranded cetaceans selected for transport and necropsy were in a fresh or moderately autolysed condition, with a decomposition code of 2 to 3 (Kuiken 1991). Carcasses were immediately necropsied or refrigerated upon arrival and necropsied in less than 24 hours. For each cetacean, clinical history, date and place of stranding, date of necropsy, species, sex, length, weight, and state of decomposition were systematically recorded. Animals were classified into calves, juveniles and adults according to the presence of foetal folds and/or their total body length (Perrin et al. 2018). Each animal was assigned a nutritional condition score (good, poor, or emaciated) based on the convex/concave aspect of their external dorsal silhouette, as well as the thickness of the blubber behind their pectoral flipper.

A complete necropsy of each animal was performed, including brain extraction. As part of the macroscopic examination, the digestive tract (i.e. mouth, tongue, pharynx, oesophagus, stomachs, intestines) was carefully dissected and examined, and contents were documented. A complete set of organs and tissues of each animal was fixed in 10% neutral buffered formalin, processed and embedded in paraffin wax for further histological investigation. Routine surveillance for specific diseases included immunohistochemistry (IHC) and RT-PCR for Cetacean Morbillivirus (CeMV) (Soto et al. 2011a), and PCR for *Brucella* spp (Wu et al. 2014). Other specific histologic stains or bacteriological and mycologic investigations were also performed. For each necropsied cetacean, a single specific cause of death or stranding was, where possible, established.

2.2. **Case inclusion criteria and classification of foreign materials**

Necropsy reports were retrospectively reviewed to detect cases of ingestion of abnormal materials. Abnormal material was classified in two main categories: (1) anthropogenic marine debris derived from human activities, such as plastic debris, ropes from fisheries, and any other human-processed object (microplastics were not included in the study), (2) natural elements (sand, stones, plants, and invertebrates not belonging to the normal diet of these species).

2.3. **Data analyses**

Epi Info™ (Dean et al. 2011) was used for statistical analysis. The association between the diagnosis of mother-calf separation or the presence of lesions in the CNS and the ingestion of abnormal material was evaluated by means of logistic regression models, either independently or including both variables. Differences were considered statistically significant when $p<0.05$. Odds ratios and corresponding 95% confidence intervals were also calculated.

3. RESULTS

3.1. **Necropsied animals and ingestion of abnormal materials**

During the period 2012-2019 a total of 88 odontocete cetaceans were necropsied at the Catalan coast. A specific final cause of death or stranding was established for each animal (data not shown, submitted). The distribution by species and sex of the necropsied cetaceans, and the number of cases showing abnormal digestive materials is showed in **Table 1**. In 19 of 88 (21.6 %) cetaceans, abnormal materials were found in the digestive tract. Among them, 11 (57.9 %) animals were female and 8 (42.1%) were male, with 4 calves, 5 juveniles, and 10 adults. For the purpose of our analysis, necropsied cetaceans were grouped into three categories, namely cases with CNS disease, calves which had been separated from their mothers and animals with other causes of death/stranding. (Table 1).

The type of abnormal material found and the final cause of death/stranding for each of the 19 odontocetes is included in **Table 2**. The majority (15 out of 19, 79 %) of animals with abnormal digestive material had ingested natural elements, which were mostly located in the forestomach (80 %). Of these, 12 had ingested sand and 2 vegetation (Figure 1A, B). Four animals (21%) had ingested marine debris (3 plastic items and 1 fishing rope, Figure 1C,D), all found in the forestomach whilst 2 others (10%, both were calves) had ingested invertebrate marine animals, which do not normally form part of their diet. One had a seahorse lodged in the larynx, suspended by its tail at the basis of the laryngeal appendix, with the body extending into the oesophagus at the right lateral side (Figure 1E), and the other had many salps (gelatinous planktic tunicates), in the forestomach (Figure 1F). Eight individuals (42%) presented normal body condition, whereas 11 had poor body condition or were emaciated.

3.2. **Pathologic conditions in animals with ingestion of abnormal material**

Of the 19 odontocetes presenting with ingestion of foreign materials, 9 adults, 3 juveniles and 1 calf (60%) had lesions or diseases of the CNS. CeMV-associated meningoencephalitis (n=8), neurobrucellosis (mononuclear leptomeningitis) due to *Brucella ceti* (n=1), and malacia of the grey cortical matter (polioencephalomalacia) of unknown origin (n=2) were the most frequent diseases and lesions encountered. In one case, CeMV meningoencephalitis was complicated by a necrotizing encephalitis due to *Aspergillus* spp, whereas a further case presented a coinfection of CeMV and *B. ceti*. Finally, one calf had multifocal haemorrhages in the brain. *Photobacterium damselae* and *Vibrio parahaemolyticus* were isolated respectively from the brain and from other organs (lungs, liver, kidneys), suggesting that the potential cause of death was a septic shock (**Table 2**). Multifocal haemorrhages in the brain were also found in one striped dolphin concurrent with multiple muscular and dermal lesions associated with ciliated protozoa. For purposes of statistical analysis, all these cases were grouped together as CNS disease cases.

In 3 calves with foreign materials, maternal separation was established as the cause of death/stranding. This diagnosis was based on the absence of other significant lesions or infections. A Risso's dolphin calf with foetal folds, apparently in normal body condition, had recently ingested salp in abundance. Another striped dolphin calf, with normal body condition, had sand in its fore- and glandular stomachs and, lastly, an emaciated striped dolphin calf had sand and a seahorse lodged in its pharynx. This animal was emaciated, and although maternal separation was established as cause of death, it cannot be excluded that the seahorse hanging from the larynx had caused dysphagia and inability to ingest food.

Finally, in three animals (2 juveniles and 1 adult) with foreign materials in their digestive tract the cause of death/stranding remained undetermined.

3.3. **Statistical analysis**

When analysed separately, odontocetes with lesions in the CNS had a probability approximately 5 times higher to ingest abnormal materials than animals without CNS lesions. On the other hand, animals with the diagnosis of maternal separation did not have a higher probability to ingest abnormal material (Table 3). However, when both variables were included together in the logistic regression model, both animals diagnosed as maternal separation as well as those with CNS disease had a higher probability of ingesting abnormal materials (Table 4).

4. DISCUSSION

Ingestion of marine debris by marine animals is a serious threat worldwide (Kühn et al. 2015). An increasing number of reports describe the presence of anthropogenic derived marine debris and its impact on cetaceans and pinnipeds (Denuncio et al. 2011, Simmonds 2012, Bravo Rebolledo et al. 2013, Di Beneditto & Ramos 2014, Baulch & Simmonds 2015, van Franeker et al. 2018). In the case of cetaceans, interaction with marine litter is still poorly understood. This is in part due to a lack of standardisation of protocols for the collection of data and dissemination of information (ACCOBAMS 2019).

Most of the studies have focused on the prevalence of marine debris ingestion and its direct or indirect contributions to morbidity and mortality. However, very few investigations have aimed to determine risk factors for ingestion of marine debris. The present paper provides information on the occurrence of abnormal contents in the digestive tract and identifies lesions in the CNS as a relevant risk factor for ingestion of abnormal materials in small odontocetes. Abnormal plastic debris ingestion had been already described in a striped dolphin affected by chronic CeMV CNS infection (Domingo et al. 1995). In our study, maternal separation was also linked to a higher risk for ingestion of foreign material, but it was not statistically significant, probably due to the low number of cases. In contrast, abnormal ingestion was not identified in any of the 25 (28 %) cetaceans with human interaction as the cause of death in our study.

Effects of ingestion of marine debris in odontocetes are diverse, depending on species, the type of abnormal material, amount ingested, and location. From sperm whales to harbour porpoises, all odontocetes seem to be at risk of ingesting marine litter. Debris in the forestomach can cause distention, obstruction, ulceration, perforation and peritonitis, or they can functionally alter digestion, induce satiation, and cause starvation and general debilitation (Jacobsen et al. 2010, Unger et al. 2016, Puig-

Lozano et al. 2018, Terio et al. 2018, Alexiadou et al. 2019). Rope and fishing line and nets may wrap around the larynx while being ingested or while being regurgitated (Wells et al. 2008, Levy et al. 2009). In other surveys, however, foreign material ingestion could not be related to specific damage or health consequences to odontocetes (Gonzalez et al. 2000, Mazzariol et al. 2011, Lusher et al. 2018) In our study, the ingestion of foreign materials could not be specifically related to damage in the digestive system or to impairment of digestive function. In only one case, where a striped dolphin calf had a sea horse hanging by its tail in the larynx, could a disfunction of deglutition be inferred as the calf was severely emaciated. In the majority of cases of foreign material ingestion featured in our study, a detailed necropsy detected serious disease of the CNS, such as encephalitis, meningitis, or encephalomalacia of the brain cortex. These are well-documented causes of death in animals, and probably reduce foraging and feeding capacity in odontocetes. In documented cases of CNS lesions, abnormal contents in the digestive tract seem to be of secondary relevance to the stranding and death of the cetacean. This is in concordance with a review of foreign body ingestion in North America (Walker & Coe 1989), with 43 observations of abnormal digestive contents reported over a time period of 23 years (1963-1986). Necropsy information was available in only 8 of the cases, and in all of them chronic pre-existing disease was present. In seven of the cases brain lesions caused by *Nasitrema* sp. trematodes was diagnosed as the primary cause of death or stranding. As a general warning, and at least for small odontocetes, the role of abnormal ingestion as a cause of death should be interpreted with caution, and all possible efforts should be done to rule out the presence of common diseases of the CNS in those animals through a detailed pathologic and microbiologic investigation.

Frequency of ingestion of abnormal contents may vary in different parts of the world, depending on the study and on the definition of what is an abnormal content. Some surveys (Walker & Coe 1989) consider as abnormal contents not only plastic and non-plastic debris, but also sand, plant elements, and molluscs. Sand was the most common abnormal material found ingested in our study (15 out of 19 cetaceans). Inclusion of sand as an abnormal ingested material may be controversial, and it could be argued that sand could enter the oesophagus and forestomach postmortem. While this cannot be totally excluded, in our cases at least 9 out of 14 odontocetes presenting sand or plant ingestion were found alive and died shortly after stranding or were euthanised due to poor prognosis, making it improbable that there was passive entry of sand into the digestive tract. The frequency of cetaceans with abnormal ingestion in our study is similar to other recent studies. In a recent survey in the Canary Islands (Puig-Lozano et al. 2018) only anthropogenic debris, like plastics, nets and ropes were reported. These authors found ingestion of foreign bodies in 36 cetaceans (7.7 % of stranded and necropsied cetaceans) during a sixteen-year period. In a study in Ireland, 528 digestive tracts were examined, and marine debris was identified in 45 (8.5%) individuals, pertaining to 11 species. Most debris were found in the stomachs, but in a few cases, debris was found in oesophagus or intestine. Sand, plants, or other natural materials were not recorded. It is noteworthy that, parallel to our results, marine debris was not found in the animals collected from bycatch observer programmes off Ireland (Lusher et al. 2018). In contrast, 28 % of incidentally captured Franciscana dolphins (*Pontoporia blainvillei*) in Argentina (Denuncio et al. 2011) had plastic debris in their digestive tract. Ingestion of marine debris by harbour porpoises (*Phocoena phocoena*) in the North and Baltic Seas has also been reported (Unger et al. 2017, van Franeker et al. 2018), although with a very different frequency (0.4% and 7.2% respectively). However, detailed information of necropsy findings was not provided in any of these reports, and therefore, a possible relationship to specific diseases could not be established. In the present study anthropogenic debris was found in only 4 out of the 19 cases with abnormal contents (which means 4.5 % of the stranded and necropsied cetaceans). It is evident that caution is needed when comparing data, due to the different species investigated, and different habitats included in the studies. It must be noted that our sample from the Western Mediterranean Sea is mainly composed of small odontocetes, with a majority being striped dolphins, and then, caution is needed when assuming that the same risk factor may be valid for other odontocete species. Prevalence of specific diseases, like CeMV encephalitis or neurobrucellosis, which in our study are a risk factor for the ingestion of abnormal material, may also be different between ecosystems. Circulation of CeMV in the western Mediterranean striped dolphin population is recurrent (Domingo et al. 1992, Raga et al. 2008, Van_Bressem et al. 2014) and during the period of study (2012 to 2019) there was another episode of mortality with systemic CeMV infection, from 2016 to 2017, followed by several cases of CeMV CNS disease in 2018, as in previous epizootics (Soto et al. 2011b).

Maternal separation is a commonly diagnosed cause of cetacean death worldwide (Calzada et al. 1994, Bogomolni et al. 2010, Arbelo et al. 2013), as calves remain dependent on the mother even a few months after weaning (Noren & Edwards 2007, Stanton et al. 2011). Diagnosis of maternal separation at necropsy is challenging, and it needs exclusion of other causes of death, including human interaction, and any known infectious disease. Death of hypoglycaemia or hypothermia may not leave macroscopic or microscopic evidence. Some animals still show foetal folds in the skin (and are probably less than 2-3 weeks of age) and have different degree of hepatic lipidosis. At that initial age, colostrum and milk should be the only content in the gastric compartments, although in our experience we have never found clotted milk in the main stomach of very young stranded cetaceans, which probably means that they fasted for several hours or days before death. Information on abnormal material ingested by very young cetaceans is scarce, and risk factors may be different for this age class than for juveniles or adults. Ingestion of marine plants (kelp, seaweed, or seagrass) has been described in several odontocete species (Tarpley & Marwitz 1993, Baird & Hooker 2000, Mann & Sargeant 2009, Denuncio et al. 2011, Krzyszczyk et al. 2013). Calves separated from their mother may have hunger, and this, coupled with inexperience in foraging habits, curiosity, or simply as part of their foraging learning process, may lead them to ingest foreign materials. Although in our study maternal separation slightly increased the risk of ingestion of abnormal material, the wide confidence interval obtained, (probably due to the small sample size of young animals) forces us to consider this result as inconclusive. Further analysis of the ingestion of foreign materials in cetacean calves is encouraged in order to properly assess the effect of mother-calf separation on this behaviour.

Odontocetes, such as the striped dolphin, mainly feed on fish and cephalopods, and it is widely accepted that echolocation is used to target prey (Ringelstein et al. 2006). Experimental studies support that dolphins can be trained to detect small objects at long distance as well as distinguishing the composition and the thickness of different items (Kellogg 1959, Whitlow 1993, Ridgway & Au 2009). Given this, any object different from fishes, cephalopods or crustaceans should not normally be ingested by dolphins. We and others (Walker & Coe 1989) have shown that disease of the CNS is a significant risk factor for ingestion of marine debris (macroplastics, fishing nets, lines and ropes) as well as other materials not pertaining to the normal diet of odontocetes (sand, plants, invertebrates). In this scenario, ingestion of abnormal materials by small odontocetes may indirectly reflect the prevalence of CNS disease in a population, and influence results of marine debris monitoring programs.

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Table 1. Cetaceans stranded along the Catalan coast between 2012 and 2019. For each species, ingestion of foreign material, sex and disease/condition is described.

		Ingestion of Abnormal material	Sex		Disease/condition in odontocetes with ingestion of abnormal material		
	N	N (%)	Female	Male	CNS lesions	Maternal separation	Other
S. coeruleoalba	72	15 (20.8)	9	6	12	2	1
G. griseus	9	2 (22.2)	1	1	1	1	0
T. truncatus	5	1 (20.0)	1	0	0	0	1
D. delphi	1	1 (100.0)	0	1	0	0	1
Z. cavirostris	1	0 (0)	0	0	0	0	0
TOTAL	88	19 (21.6)	11 (57.9%)	8 (42.1%)	13	3	3

Table 2. Cetaceans stranded on the Catalonian Coast between 2012 and 2019, with abnormal objects in the digestive tract. For each specimen is described the necropsy ID, species, stranding condition (SC), sex, age, nutritional condition (NC), abnormal objects ingested and their location in the digestive system. D: dead, A: alive, F: female, M: male, P: pharynx, L: Larynx, O: Oesophagus, S1: forestomach, S2: glandular stomach, S3: pyloric stomach, SI: small intestine.

Necropsy ID	**Species**	**SC**	**Sex**	**Length (cm)**	**Weight (Kg)**	**Age class**	**NC**	**Abnormal objects**	**Location**	**Cause of death/stranding**
N-120-12	*S. coeruleoalba*	D	F	195	78	Adult	Poor	Sand	S1, S2	Encephalomalacia
N-225-12	*S. coeruleoalba*	D	M	208	65	Adult	Poor	Vegetation	SI	Unknown
N-355-14	*S. coeruleoalba*	D	F	107	9.5	Calf	Emaciated	Sand, sea horse	L, O	Maternal separation
N-068-15	*S. coeruleoalba*	A	F	204	83.5	Adult	Normal	Sand	F, O, S1, S2	Protozoal panniculitis and myositis, haemorrhages in CNS
N-298-16	*G. griseus*	A	M	150	34.5	Calf	Normal	Sand	S1	Septicaemia, haemorrhages in CNS
N-319-16	*S. coeruleoalba*	A	F	180	47	Juvenile	Poor	Sand	S1	CeMV systemic and neurobrucellosis
N-077-17	*S. coeruleoalba*	A	F	181	81.5	Adult	Normal	Vegetation	O, S2	CeMV systemic
N-169-17	*D. delphis*	A	M	179	72	Juvenile	Normal	Plastic	S1	Unknown
N-466-17	*S. coeruleoalba*	D	M	192	62	Adult	Poor	Sand	O, S1, S2, S3	CeMV systemic
N-488-17	*S. coeruleoalba*	A	M	198	70	Adult	Poor	Plastic	S1	CeMV systemic
N-591-17	*S. coeruleoalba*	D	F	100	9.5	Calf	Normal	Sand, Shells	O, L, Ph, S1, S2	Maternal separation
N-001-18	*S. coeruleoalba*	A	F	200	68	Adult	Poor	Rope with a knot	S1	CeMV encephalitis
N-232-18	*S. coeruleoalba*	A	F	180	51.5	Juvenile	Poor	Sand	S1	CeMV encephalitis
N-274-18	*S. coeruleoalba*	A	M	152	38	Juvenile	Poor	Sand	S1, S2, S3	Neurobrucellosis
N-292-18	*S. coeruleoalba*	D	F	194	59.5	Adult	Emaciated	Sand	S1	CeMV encephalitis
N-329-18	*S. coeruleoalba*	A	M	202	82.5	Adult	Normal	Sand	O, S1	Encephalomalacia
N-362-18	*S. coeruleoalba*	A	M	181	78	Adult	Normal	Sand	S1	CeMV encephalitis
N-521-18	*T. truncatus*	A	F	187	83.5	Juvenile	Poor	Plastic	S1	Unknown
N-312-19	*G. griseus*	A	F	173	47.5	Calf	Normal	Salps	S1	Maternal separation

Table 3. Ingestion of abnormal materials in cetaceans having lesions in the CNS or diagnosed as separated from the mother in 88 odontocetes necropsied from 2012 to 2019 in the coast of Catalonia (western Mediterranean Sea). The two variables were analysed separately by using logistic regression models.

		Ingestion of abnormal materials	
	n=88	Yes	No
CNS Lesions	Yes	13 (40.6%)	19 (59.4%)
	No	6 (10.7%)	50 (89.3%)
		OR 5.7; 95% CI 1.9 - 17.2, *p* 0.002	
	n=88		
Maternal separation	Yes	3 (33.3%)	6 (66.7%)
	No	16 (20.2%)	63 (79.7%)
		OR 1.9; 95% CI 0.4 – 8.7, *p* 0.37	

Table 4. Ingestion of abnormal materials in cetaceans having lesions in the CNS or diagnosed as separated from the mother in 88 odontocetes necropsied from 2012 to 2019 in the coast of Catalonia (western Mediterranean Sea). The two variables were analysed together in a logistic regression model.

		Ingestion of abnormal materials	
	n=79	Yes	No
CNS Lesions	Yes	13 (40.6%)	19 (59.3%)
	No	3 (6.3%)	44 (93.6%)
		OR 10.1; 95% CI 2.6 – 39.3; *p* 0.0009	
	n=56		
Maternal separation	Yes	3 (33.3%)	6 (66.7%)
	No	3 (6.4%)	44 (93.6 %)
		OR 7.3; 95% CI 1.2 – 44.9, *p* 0.031	

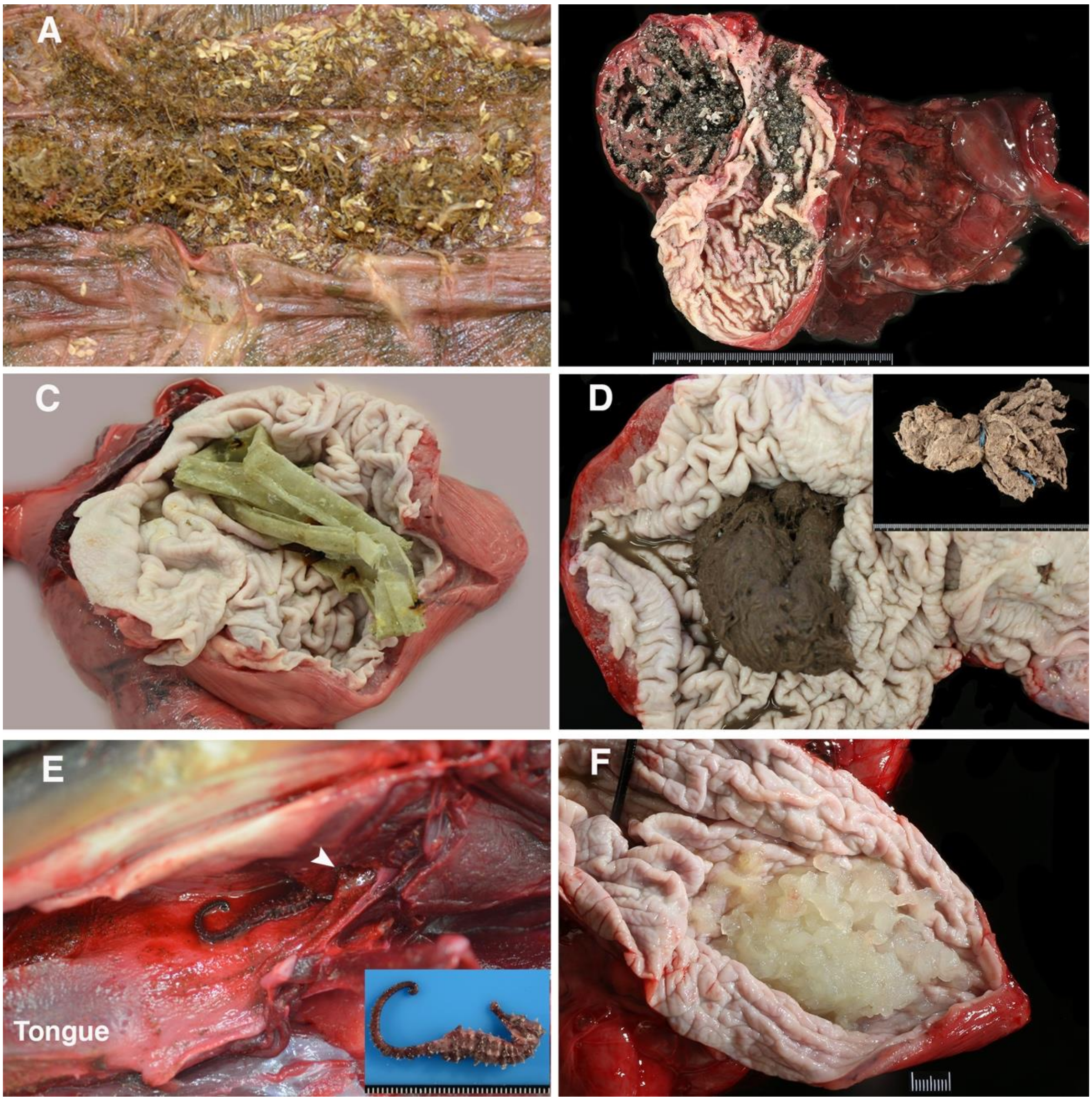


Fig.1. **A.** Proximal intestine with vegetal material, *S. coeruleoalba*, N-225-12. **B**. Sand and a few shells located in the forestomach and in the main glandular stomach, *S. coeruleoalba*, N-591-17. **C**. Plastic debris in the forestomach, *S. coeruleoalba*, N-488-17. **D.** Presence of a rope with a knot in the forestomach, *S. coeruleoalba*, N-001-18. Inlet: rope after rinsing in water. E. A sea horse (moved cranially to make it visible) was hanging from its tail from the base of the laryngeal appendix (arrowhead), still inserted in the choanae, *S. coeruleoalba*, N-355-14. F. White, gelatinous, soft, organisms, identified as salps (3-4 cm length) in the forestomach, *G. griseus*, N-312-19. The black stab is signalling the entry to the glandular stomach.

Manuscript: DAO-2020-05-001/R1 RESUBMISSION - Ingestion of foreign materials in odontocetes in the Catalan Coast, causes and consequences
Author(s): Axelle Lacombe (Co-author), Ester Pintado (Co-author), Alicia O'Byrne (Co-author), Alberto Allepuz (Co-author), Maria Dolores Perez-Rodriguez (Co-author), Mariano Domingo (Corresponding Author)

Dear Editor,
thanks for your letter, and thanks also to the reviewer for this last revision and the comments received.
All the issues raised by the reviewers have been considered, and the text has been changed accordingly.
Best regards

Reviewer 1 report:

Thank you very much for providing this revision. It is clear that you were very thorough and thoughtful in your response to the reviewer comments. With the two following minor edit recommendations (below), I am happy to support the publication of this article.

P1Line12-13: As you allude to later in the discussion, weaning is a gradual process and while very young calves will only be ingesting milk, older calves should be ingesting a combination of milk and normal prey species as they learn to hunt. Based on this, I recommend changing the wording here to "…which is the only material found in the gastric compartments which can be considered normal in very young calves; it is normal for older calves to also ingest normal prey species in addition to milk, as they learn to hunt." The latter part could be excluded, but the importance is the reference to 'very young calves' having only milk in their stomach chambers.
Changed as requested

P14 line 5: recommend inserting the words 'marine debris' before 'monitoring programs' for clarification (or something similar).
Changed as requested

Reviewer 2 report:

The authors have answered all concerns, and i have no additional revision suggestions and recommend accepting the revised manuscript.

Reviewer 3 report:

I have gone through the authors changes in response to my initial review and they have done a good job addressing all my concerns. I have reviewed the revised manuscript and only have a couple minor editorial suggestions.

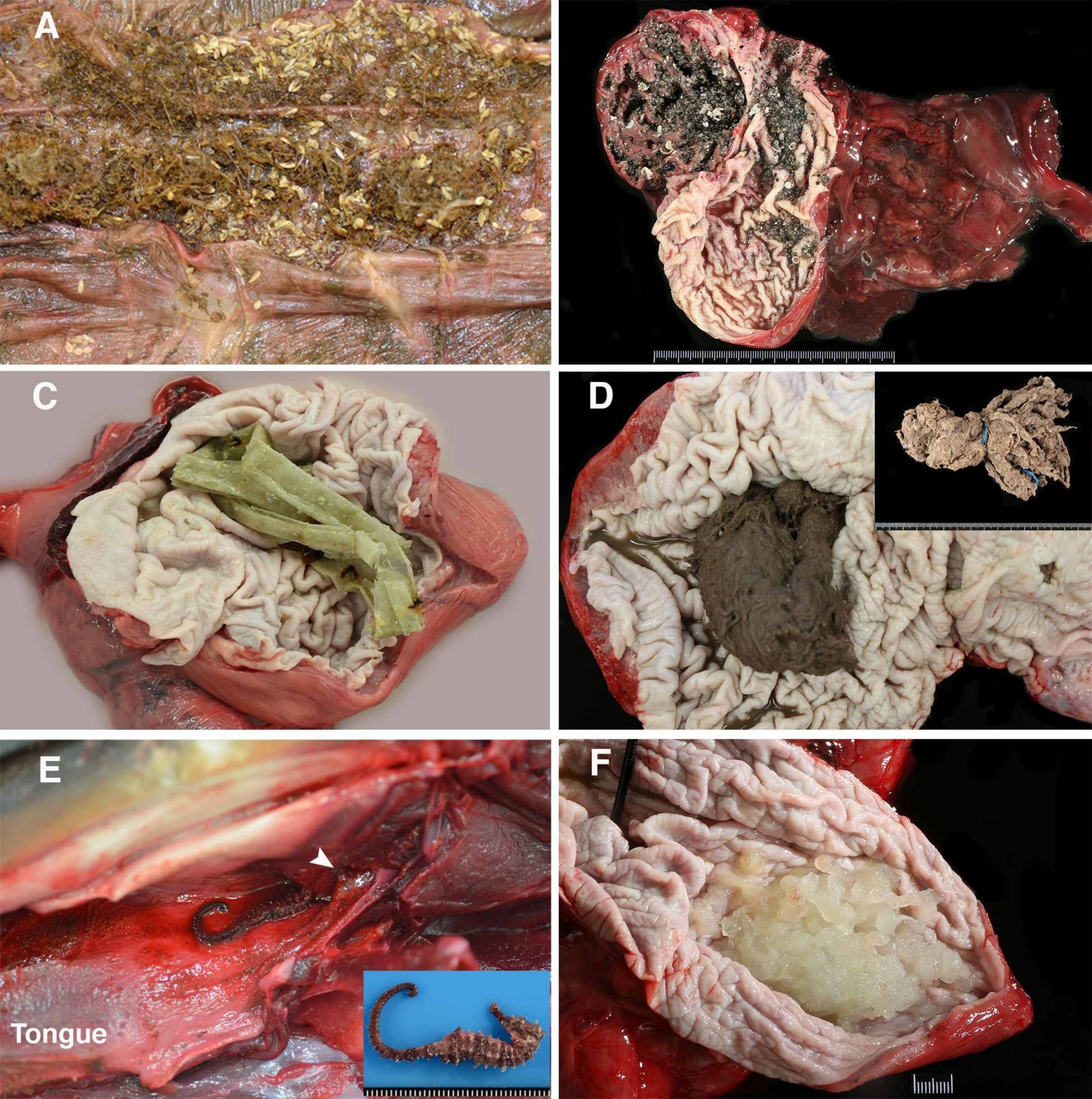
P2,L5, "done" should be "made"

Changed as requested

P4,L5. "lactating" should be replaced with "nursing"
Changed as requested

P4,L6/7. Could move the "(n=88)" to "...on 88 stranded odontocetes" to make it flow better, or remove it entirely, given that 88 is noted both in the Methods and Results.
Changed as requested

P13,L14, add "us" to read "forces us to"
Changed as requested


A
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Diseases of Aquatic Organisms

Manuscript Title: **Ingestion of foreign materials in odontocetes in the Catalan Coast, causes and consequences**

Dear Editor,
We resubmit the manuscript entitled "Ingestion of foreign materials in odontocetes in the Catalan Coast, causes and consequences" after review according to the comments and observations raised by the reviewers.
All comments have been taken into account in the revised manuscript. We hope that the manuscript can be now published.

Thanks for your interest on our work

Best regards
Mariano Domingo

Bellaterra, August 21/2020