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FATALITIES IN DROMEDARY CAMELS ACROSS THE ARABIAN PENINSULA CAUSED BY PLASTIC WASTE

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ABSTRACT

Ecological impacts of widespread, plastic pollution and subsequent ingestion of anthropogenic waste, primarily plastic bags and ropes by dromedary camels (*Camelus dromedarius*) in the United Arab Emirates (UAE) and across the Arabian Peninsula is reported here. The ingested waste is turned into a collection of tightly packed indigestible materials which can include plastics, ropes, other litter and salt deposits trapped in the stomach or digestive tract forming a large stone-like mass termed as plastic gastroliths or polybezoars. Central Veterinary Research Laboratory (CVRL), Dubai, UAE evaluated more than 30,000 camels since 2008, there have been 300 documented deaths contributed to polybezoars in the stomach. Here, we analyse a subset of five gastroliths extracted from dessicated camel skeletons found in the desert, weighing from 6.2-53.6 kg. Two random samples of anthropogenic material, primarily plastic bags and synthetic ropes, from each of these five polybezoars were analysed for polymer content, showing predominantly polyethylene and polypropylene. Gastrointestinal blockages were caused by these polybezoars, leading to sepsis from multiplying populations of gut anaerobes, and dehydration and malnutrition due to limited available space for food and water in the gut, which leads to a false sense of satiation. The frequency of these impacts result in a population-level effect of an estimated 1% mortality rate for camels living in the region. The force of high winds and the open desert environment possibly lead to escape of plastic bags and other thin, film-like packaging easily force open waste bins and landfills, travelling long distances from waste management services, therefore, alternative systems are urgently required for package and deliver goods to replace plastic bags throughout the region of Arabian peninsula.

Key words: Arabian peninsula, dromedary camel, gastroliths, plastic pollution, polybezoar, UAE

Plastic pollution poses significant environmental problems around the world. Plastic pollution of the global environment has been dominated by reports of ecological impacts on marine organisms, including evidence of entanglement and ingestion in over 637 species that interacted with plastic pollution (Gall and Thompson, 2015). Yet, emissions of plastic to the terrestrial environment may be 4-23 times higher than inputs to the marine environment (Horton *et al,* 2017).

Plastics have been observed in digestive tracts of cattle (Jebessa *et al,* 2018), sheep and goats (Tiruneh and Yesuwork, 2010), Arabian oryx (Anajariyya *et al,* 2008), camel calves (Ahmed, 2011) and adult camels (Wernery *et al,* 2014). Most of the ingested items were plastic bags and film. Plastic materials cannot be digested and may take a long time to pass through the digestive tract or be retained indefinitely when caught in complex digestive tracts. Consequences of plastic ingestion include ruminal impaction, where indigestible plastic foreign bodies accumulate in the stomach compartments, which leads to indigestion, the formation of gastroliths or polybezoars, traumas, poor body condition, immune suppression, reduced health status, and mortality (Hailat *et al,* 1997; Jebessa *et al,* 2018; Priyanka and Dey, 2018).

Grazing and scavenging animals such as ruminants, feed indiscriminately on plastic pollution in the environment. Animals ingest plastic waste due to erratic feeding behaviour, and confusing plastic with food when trying to eat leftover feed materials in plastic wrappings (Priyanka and Dey, 2018). Plastic waste accumulated in the rumen may release dioxins, phthalates, polychlorinated biphenyls (Vanitha *et al,* 2010), and heavy metals (Osuga *et al,* 2013). Ingested plastic materials in the rumen slowly release chemicals to the rumen fluid, which may enter the food chain through milk and meat products (Kunisue *et al,* 2004).

In the region surrounding the Arabian Gulf, camels are the dominant foraging ruminants, existing

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in all countries bordering the gulf. In the UAE alone, populations of camels have been estimated at over 390,000 (FAO, 2019). Camels are browsing animals with up to 37% of their time in a 24-hour period spent grazing. This feeding behaviour predisposes them to plastic pollution ingestion. Although camels have been identified as versatile animals, capable of surviving and performing in arid and semiarid regions (Iqbal and Khan, 2001), as individuals, they are not able to cope with ingested plastic pollution. Plastic pollution in the form of thin film products and packaging, like balloons and plastic bags, is increasingly abundant in deserts worldwide (Zylstra, 2013) (Fig 1).

Adverse effects on camels (*Camelus dromdarius*) due to the ingestion of anthropogenic material, consisting of primarily plastic bags, but also ropes and textiles, has been widely observed. Of 156 camels evaluated post-mortem in Jordan, foreign-body accumulation within the first and second stomach compartments was the predominant gastrointestinal disease of slaughtered adult camels (22%), including plastic (65%), rope and leather (23.5%), or all three (11.5%) (Al-Rawashdeh *et al,* 2000). A recent study of eight juvenile camels sent to a veterinary clinic in Saudi Arabia with obstructions of the oesophagus caused by plastic bags (75%) and pieces of cloth (25%) (Shawaf *et al,* 2017), and an earlier study in the same region found six juvenile camels with obstructions in the oesophagus due to plastic bags in five and cloth in one (Ahmed, 2011).

In the Central Veterinary Research Laboratory (CVRL) in Dubai, UAE, over 30,000 camels have been observed since 2008, with 300 cases of mortality due to ingesting anthropogenic waste, primarily plastic bags and ropes (Wernery *et al,* 2014). They have been observed to die for several reasons :

● Sudden death caused by complete obstruction of the intestine by a plastic bag, or incomplete obstruction accompanied by a secondary clostridial enterotoxemia, a bacterial infection, due to plastic ingestion. In the later cases, lesions are observed and toxin-producing anaerobes are abundant and isolated where the plastic mass nears the tissues.

● Death within two to three weeks due to organ failure. In these cases, the ingested plastic rubbish releases toxins into the circulatory system, which causes the liver values (glutamate oxalaetate transaminase - GOT [AST], gammaglutamyl transferase [y-GT], glutamate-pyrovatetransminase-GPT [ALT]) and kidney values (blood urea nitrogen-BUN, creatine) to increase steadily, culminating in organ failure (Wernery *et al,* 2014).

● Slow death due to starvation. Plastic bags, parts of plastic bottles and caps, plastic ropes used to hold hay bales together, and other plastic utensils accumulate, most probably over weeks, months, and years, in camels' stomach compartments. When in the stomach, they start to calcify, forming a solid plastic mass, which may fill and take the shape of the first compartment in the stomach. This plastic mass, or polybezoar, can affect feeding behaviour, resulting in camels eating less until they stop eating completely, as the camel always feels full, resulting in a false sense of satiation.

Harm to individual ruminants from plastic ingestion can be straightforward, such as mechanical obstructions, perforations of the intestinal tract, and abscessed or ulcerated intestinal linings. These impacts can lead to stomach volume displacement, false-satiation and slow malnourishment, dehydration and toxification from leached compounds from the plastics themselves or sepsis from high bacterial loads living in the folds of plastic film. This vulnerability may contribute to immuno-suppression, liver damage, and clostridium. These observations show clear harm to individual animals, but the extent of harm to entire populations has not been fully explored yet.

Therefore, the aim of this study was to document the occurrence, abundance, and composition of ingested anthropogenic matter in the stomachs of camels, introduce polybezoar as a distinct nomenclature to describe these observations, and suggest mitigations to address the problem.

Materials and Methods

Between 2008 and 2017, five bezoars of anthropogenic material (Fig 2) were recovered during post-mortem from desiccated skeletons of camels found near Dubai, UAE in a distance not more than 100 km south and 50 km east to the foothills of the Al-Hajar mountains. The polybezoars were brought to the Central Veterinary Research Laboratory (CVRL) in Dubai, whereby they were brushed and shaken to dislodge loose sediment, and were suspended outside the laboratory facility for display until gathered for this study. The five polybezoars were brought into the CVRL and weighed using a digital scale to the nearest 10 grams. Volume was ascertained by putting the bezoar inside a vacuum sealed bag, filling a large bin with water and submerging the polybeozar beneath the water surface. The volume of displaced

Fig 1. Camel (*Camelus dromdarius*) foraging on plastic waste in the UAE desert. Photo: Ulrich Wernery.

water was collected and measured to the nearest 0.1 litres. Fourier Transform Infrared Spectroscopy (FT-IR) was used for polymer identification using two instruments with different libraries. In each polybezoar, the two largest items externally visible were sampled by cutting away a small fragment of the material. Each sample, two from each of the 5 polybezoars, (n=10) was analysed on two different FT-IR instruments to get comparative results. The samples were cleaned with isopropanol to remove as much calcification and dirt as possible before analysis. First, plastic pieces were tested using an Agilent Cary 630 FT-IR spectrometer with a diamond ATR accessory followed by a Perkin Elmer Spectrum Two FT-IR with a diamond ATR accessory. Separate library searchers were performed using the Agilent Polymers ATR library. Best matches were calculated based on the library software of each instrument. Each match reported was above 90%.

Fig 2. Polybezoars collected from camel skeletons (a, b), bezoar split to expose an interior of compacted plastic film (d), polybezoars were composed of synthetic material polyethylene as per FTIR analysis (c).

Results

Plastic was clearly present in each polybezoar, with two dominated by rope fragments and the other three dominated by plastic bags, based on external evaluation.

Polybezoar was sawn in half to expose the centre, which revealed plastic film throughout the entire mass, primarily plastic bags, with no calcification internally (Fig 2). External calcification on one polybezoar was minimal, but polybezoars calcification of the rope fragments into a hardened mass was seen (Fig 2).

Discussion

Of 300 cases of mortality due to ingesting anthropogenic waste, a subset of five polybezoars, collected by the Central Veterinary Research Laboratory (CVRL) in Dubai, UAE were evaluated in this study. Using simple descriptive techniques to understand the weight and contents of each one, this study revealed the dominance of polyethylene plastic bags, with polypropylene rope second in abundance. Evidence of harm from plastic ingestion has been observed in hundreds of camels evaluated live and post-mortem by the CVRL and other veterinary clinics in the region over the past several decades. To mitigate the harm from anthropogenic plastic waste on camels, we must understand the significance of plastic waste impacts to individual animals and whether it suggests population-level harm, the exposure of animals to plastic waste in the region, and lastly the types of mitigation strategies available to reduce exposure. The literature on harm caused by plastic ingestion or entanglement is dominated by studies of marine organisms, and is largely focused on field observations of individual organisms or laboratory studies showing impact. What is missing in the literature are studies of populations of organisms at ecologically relevant concentrations of plastic waste. While field studies of population-level effects are low, the perception that population-level harm is high (Rochman *et al,* 2016). For example, in a recent risk analysis of seabird species, of 135 species between 1962 and 2012, 59% had ingested plastic waste.

By standardising the data, the authors estimated the ingestion rate would increase to 90% by 2015 (Wilcox *et al,* 2015). The authors reported "Although evidence of population level impacts from plastic pollution is still emerging, our results suggest that this threat is geographically widespread, pervasive, and rapidly increasing". Here we observe a population-level effect. The total dromedary camel population in the UAE region is estimated to be approximately 390,000 animals. The CVRL has evaluated over 30,000 camels since 2008, with over 300 documented deaths contributed to polybezoars in the stomach, representing a 1% mortality rate among camels evaluated. Similarly, 100% of the camels that contained plastic waste in their guts, and were also evaluated for toxicity, were found with elevated levels of liver and kidney enzymes, indicating toxification.

Reducing exposure to plastic waste exposure to plastic waste is abundant in the desert regions surrounding the Arabian Gulf. In the case of camels in the UAE, animals are roaming the desert in small groups that forage in acacia forests, roadsides, and in landfills. The exposure to thin film plastic bags and packaging is common in these areas, as plastics escape waste bins or dumpsters, or are littered, resulting in wind-borne macroplastics travelling long distances. FTIR analysis of 10 fragments of synthetic material, two from each of the five polybezoars make a spectrum of colours of polymer fragment image raging film blue-white-green grey-black. Profound hypophosphatemia and hypochloremia was seen in cattle with nutritional disorders known as 'Pica' where cattle and other farm animal eat unusual objects including indigestible waste like rope, cloth, polythene etc (Nikvand *et al*, 2018; Elshahawg *et al*, 2016).

Gameel *et al* (2000) surveyed 337 camel in an abattoir study and found that 40.4% investigated camel had foreign bodies, i.e. bones, trichobezoars, strings, ropes, plastics, rags, canvas and calcified bodies. In present study some similar composition foreign bodies were seen.

Desert recreation from campers, hunters, and falconers are responsible for significant loss of plastic waste. In a study of Arabian oryx in the fenced Mahazat as-Sayd Protected Area in Saudi Arabia, there is a 70km highway connecting Riyadh to Khurma City. Thirty oryx were captured and contained in the fenced protected area. Within one year, seven died of plastic waste ingestion, whereby roadside litter trapped against the fence was the primary exposure to waste that was eaten (Anajariyya *et al,* 2008). This prompted public education campaigns and waste management to recover plastic waste along the fenceline. Municipal solid waste (MSW) management is rapidly developing throughout countries surrounding the Arabian Gulf. MSW management alternatives include landfilling, incineration, and recycling. The option of landfilling is declining in most developed countries as soil, water, and air contamination, increased potential for human

health risks, and the scarcity of locations near urban developments increases (Paleologos *et al,* 2016). The MSW component of the General Waste stream in the UAE has increased from 1,523,822 tonnes in 2003 to 2,689,808 in 2011. According to the waste composition analysis conducted in 2012, 35% of the General Waste stream was organic waste, 24% paper, and 24% plastic (Saifaie and Municipality of Dubai, 2013). A recent survey of public attitudes in the UAE shows a high level of interest in rapidly addressing plastic waste (Hammami *et al,* 2017).

In recent years, as the UAE and other countries surrounding the Arabian Gulf experience a rise in GDP and population size, which correlate to increased consumption and waste generation, new models of waste management beyond landfilling have been considered. These countries are considering waste to energy as the dominant disposal option for the foreseeable future (Paleologos *et al,* 2016). In the cities of Dubai, Abu Dhabi, and Sharjah, large waste to energy facilities are currently operational or soon to become operational, meeting the goal of 75% diversion of MSW away from landfill by 2021 (United Arab Emirates, 2019). Regardless of these mitigation strategies, including common devices called "BinStraps" used to secure lids on waste bins so the force of wind cannot open them, plastic film and bags continue to escape urban developments into the environment as often people do not close the lids or they are opened by clever dromedaries. Plastic bag bans are increasing in municipalities across the globe (Xanthos and Walker, 2017). The Dubai Municipality launched the "Say No to Plastic Bags" campaign in 2013, aimed to reduce plastic bag consumption by 20% in the first year, to tackle the annual 2.9 billion plastic bag consumption rate across the UAE (Pandy, 2016). Today, efforts to eliminate plastic bags from the UAE are primarily conducted in the private sector, as shopping malls and grocery stores voluntarily eliminate plastic bags or charge a fee for bags to disincentivise their use. While these actions are noteworthy, they will not curtail the loss of plastic waste to the environment. Finally, in the absence of significant single-use plastic reduction measures, and the continued loss of plastic bags and film to the environment, it becomes the responsibility of animal husbandry and every person to reduce exposure of animals to plastic waste. Good animal husbandry, by providing adequate feed, water, shelter and mineral supplements, as well as establishing grazing centres and water facilities will deter the straying of animals to roadsides and landfills in search of sustenance (Priyanka and Dey, 2018).

Recommendations for use of plastic bags, their disposal and adverse effects on environment should be made similar to that done in Ethiopia (Adane *et al,* 2011).

Camels, while they are prized in competitive breeding, racing and are utilised in cultural events, such as weddings and political parades, they are significantly harmed by the abundance of plastic waste, especially single-use plastics and bags blowing across deserts and escaping even the most efficiently designed waste management systems. Therefore, it is essential that careful consideration be placed on the role of single-use plastics, their current use, and eventual elimination from modern societies.

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