Manatees

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Sirenians are aquatic mammals that include three species of manatee (*Trichechidae*) and one species of dugong (*Dugongidae*). They are aquatic herbivorous mammals living in estuaries, swamps, rivers, marine wetlands, and coastal waters.

Keywords: manatee ; zoos ; behaviour

1. Introduction

Over recent years, manatees have become more and more popular. In the past, very little was known about these species as they were rarely observed, and ignorance was only nourished by myths about sirenians (i.e., mermaids). In Florida, for example, there was widespread aversion towards them, with claims that they consumed all the fish or attempted to bite swimmers, besides being generally regarded as a hindrance to boating activities [1]. Thankfully there has been a recent shift in human perception of these animals. Manatees are now protected, and there are conservation and education campaigns aimed at the general community. Nowadays, people perceive sirenians in a positive way, particularly the American species, *Trichechus manatus* [1]. Manatees also became attractive aquatic mammals for visitors to zoos. The study of animal behaviour is key for the development of management policies for the conservation of rare or endangered species [2][3]. Studying manatee behaviour in the wild is difficult due to their elusive nature and turbid waters; however, zoos can provide opportunities to study the behaviour of captive individuals and therefore play a crucial role in manatee conservation. Consequently, the welfare of captive manatees and their conservation in the wild are intimately linked [4][5].

Sirenians are aquatic mammals that include three species of manatee (*Trichechidae*) and one species of dugong (*Dugongidae*). They are aquatic herbivorous mammals living in estuaries, swamps, rivers, marine wetlands, and coastal waters. The sirenian order is closely related to *Elephantidae* and is part of the *Afrotheria* clade; this superorder includes many endangered mammals [6]. The dugong (*Dugong dugon*, Muller 1776) is the last living species of its genera and has a wide distribution over 40 countries throughout the Indo-West Pacific region [7]. Dugongs present several obvious differences from manatees [6][8].

The African manatee, *Trichechus senegalensis* (Link 1795), is an endangered species [9] with around 10,000 mature individuals according to the International Union for Conservation of Nature (IUCN) (https://www.iucnredlist.org/species/22104/97168578 (accessed on 4 July 2023)). Their distribution range includes the western and central coasts of Africa. Little is known about this African species, but scientific research is underway, which is vital for its conservation (see for example [10]). The remaining two species, the Amazonian manatee *T. inunguis* (Natterer 1883) and the West Indian manatee *T. manatus* (Linnaeus 1758), are found within the Americas. The former inhabits the Amazonian basin and is particularly vulnerable due to habitat fragmentation [11]. The population of this particularly cryptic species is difficult to estimate but according to the IUCN varies between 8000 and 30,000 individuals (https://www.iucnredlist.org/species/22102/43793736 (accessed on 4 July 2023)). The West Indian manatee is distributed from the Florida coast to Brazil and comprises two subspecies: *T. m. latirostris*, the Florida manatee, is present on the Florida coast and west along the Gulf of Mexico coast to Texas. The distribution range of the Antillean manatee, *T. m. manatus*, stretches from the Gulf and Caribbean coast of Mexico to the coast of north-eastern Brazil, but also around the islands of the Lesser Antilles [12]. These two subspecies are classified as vulnerable by the IUCN [13] which estimates a population of approximately 4100 and 3300 individuals for the Antillean and Florida manatee, respectively (https://www.iucnredlist.org/species/22103/9356917 (accessed on 4 July 2023)). A recent survey carried out by the Florida Fish and Wildlife Conservation Commission estimates a considerably larger figure of 5733 for the Florida subspecies (https://myfwc.com/research/manatee/research/population-monitoring/synoptic-surveys/ (accessed on 4 July 2023)). However, population numbers can fluctuate due to the difficulty of observing manatees in their natural habitats.

Currently, manatees are exhibited in several zoological parks around the world but information about their numbers, species, subspecies, and current location is often difficult to obtain. This information is essential to gain an insight into the

animals' living conditions, including their habitat design and social grouping, and to devise future actions to support institutions in promoting their welfare and effective management practices.

As previously mentioned, human perception of manatees and their behaviours have evolved over time. Initially, they were considered very passive animals but according to recent studies they appear more social with higher cognitive abilities than previously thought [14]. A biocentric approach that considers their ecological and social context [14] and research on their cognition in the wild [15] are key components needed to help zoos manage manatee groups and to contribute to their conservation. Reep and Bauer [16] report numerous anecdotes on Florida manatee behaviour that reveal that their intelligence is an important factor that requires further research. Furthermore, the presence of manatees in zoological institutions worldwide and an increase in tourism activities in their natural habitat highlight the need to consider manatee cognition to provide insights and perspectives on the welfare of these animals, whether under human care or interacting with humans in their natural habitats.

Animal welfare is an important component of conservation concerns [17]. Zoos and aquariums are important partners in scientific and conservation programs and should be more involved in animal welfare and wildlife conservation actions. For the care of manatees, zoos can rely on a wealth of veterinary scientific literature and on the EAZA best practice guidelines (https://www.eaza.net/assets/Uploads/CCC/2018-Antillean-Manatee-EAZA-Best-Practice-Guidelines-Approved.pdf, accessed on 4 July 2023) to ensure best practice in their management (see [18]. However, manatee welfare remains poorly studied and documented with a lack of knowledge on their behaviour and cognition [14] and concerns have recently been raised for sirenian welfare in both the wild and under human care in captivity; these were discussed recently, for example, see [18][19]. These issues need to be addressed through cognitive biocentric paradigms.

2. Manatee Cognition (Learning Abilities, Personality, Interactions)

Numerous anecdotes and observations indicate that manatees possess significant cognitive abilities—they display play behaviours, interact with their physical and social environment (i.e., conspecifics and other species including humans), mimic others' behaviours, and demonstrate social learning abilities [16]. For example, when human-reared manatees are reintroduced to their natural environment, they exhibit less severe responses, specifically avoidance, to anthropogenic disturbances than their wild conspecifics [20]. However, habituation of animals to people is potentially problematic as it may result in harmful encounters with them; manatees would benefit more from avoiding humans [21]. This example highlights the behavioural plasticity of manatees in changing environments and the fact that they can adapt and accommodate to human care when living in captivity.

There is little experimental research on the learning abilities of manatees, although evidence suggests that they may share cognitive abilities like those of their closest relatives, elephants [22], which show a remarkable aptitude for learning and memory [14][15][16]. In a recent study, Henaut et al. [23] show that a manatee was able to discriminate and associate geometrical forms using food rewards. Surprisingly, its scores remained high a year later, even though the animal was not subject to reinforcement.

Object manipulations and play with objects were observed in manatees during different scientific experiments [23][24] and were interpreted as play behaviours. This play activity was also observed during interactions with conspecifics or with other species including humans [16]. However, manatee temperament [24][25] may modify social interactions, play behaviours, and manipulations of social or physical objects. While some manatee individuals have been acknowledged for their curiosity and cognitive prowess, it is possible that certain individuals are more social, inquisitive, and bolder and could benefit more from social enrichment than their shier and less interactive counterparts [24]. It is essential that these factors are considered when assessing manatee welfare. A shy manatee will tend to interact less with enrichment devices provided and will show more neophobic behaviours than a bold conspecific, for instance.

A recent study showed that captive Antillean manatee calves display anticipatory vocal behaviours before regular feeding events [26]. Anticipatory behaviour can be defined as the animals' ability to use cues from the surroundings to foresee what is about to happen [27]; it has been thought to be a potential welfare indicator in bottlenose dolphins [28][29].

Manatees enjoy manipulating objects and possess excellent learning capabilities; therefore, to promote exploratory and inquisitive behaviours, the provision of appropriate stimuli is essential.

3. Manatee Behaviour and Sociality

Sociality in manatees is not easy to interpret and appears to be flexible. There are limited data available on this aspect for African and Amazonian species [30]. The two subspecies of *T. manatus* differ in their living habits (e.g., large groups for Florida manatees versus small groups for Antillean manatees) and, as observed in captivity, appear to be tolerant of each other (no aggression) and of younger animals [31].

Living in a group provides opportunities for social animals to develop and display their vocal communication abilities [32] and may increase social play behaviours and affiliative behaviours that are potential positive welfare indicators [33]. Therefore, it is essential that manatees in zoos have the opportunity to display positive social interactions with conspecifics and/or humans.

Sensorial and occupational enrichment should also be provided. Manatees possess a well-developed sense of touch (tactile sense) and demonstrate interest in a great variety of objects they spend time with and enjoy manipulating [16]. In their natural habitats, individuals are frequently observed engaging in tactile exploration or interaction with their surroundings, as well as exhibiting harassment towards other species such as alligators [16]. During experimental research, some individuals approached and interacted with new objects [23][24]. This approach and interaction behaviour, or neophilia, is largely determined by temperament. Individuals who are extroverted are more likely to engage with newly introduced objects in their surroundings as opposed to individuals who are introverted [24]. As observed by Henaut et al. [14], when new objects are introduced to a pool, manatees interacted with the objects but also increased their moving activities without displaying stereotypical circling behaviour [23]. Similarly, when one manatee associated food with various plastic geometrical shapes that were introduced to its pool, there was a noticeable increase in general activity, moving, and interactions with the shape [23]. The provision of objects and the association of an object with food appear to work as an effective occupational strategy to improve manatee activity and could then potentially increase *in fine* their welfare. Significantly, when introducing objects, particularly underwater objects, manatee vocalizations increase, and individuals tend to interact more [34]. It is, however, difficult to determine whether these behaviours are positive or negative, for example, symptomatic of a stress caused by a change in their habitat. Introduced objects seem to have a positive impact on extroverted manatees; however, it remains uncertain whether they have a favourable, neutral, or adverse impact on introverted individuals.

Manatees are sensitive to sounds; they can associate the sounds of trucks or some motorboats with unpleasant experiences and consequently swim away [16]. Wild manatees avoid areas with human activities, while manatees that were raised by humans display neutral behaviour [20]. Vocalizations are essential for intraspecific communication and new research describes how manatees interact using vocalizations, e.g., [26][32]. As observed in other species [35], noise pollution may not only induce stress in animals but also affect their communication. However, it is uncertain how noises (e.g., water pumps, music, or visitors) affect manatees in captivity. Noise pollution is a recognized stressor for numerous species, particularly aquatic mammals [36][37][38][39]. Further research is required to improve our understanding of this human-caused stressor when assessing manatee welfare in zoological institutions. It is important to establish whether manatee response to new noises is negative, neutral, or positive and further research is needed on how temperament modulates manatee responses in general, for example, when encountering new objects [24]. Research into acoustic aspects and their relationship with manatee welfare is crucial for establishing effective management strategies in zoos that aim to prevent stressful situations and modify the use of sounds according to manatee personality.

Bills et al. [40] report that male manatees use chemoreception to detect females in oestrus by identifying odours/chemicals produced by their anal glands. Barboza and Larkin [41] established that taste is used by manatees to detect toxic food, saltwater, and freshwater. Chemoreception may assist manatees in the detection of conspecifics, resources such as food and water, and their palatability; therefore, careful consideration should be given to the quality of their food and water. Manatee enrichment programs should incorporate a wider variety of feeding rations, types of food, and feeding behaviours. However, there are few studies on chemoreception in manatees and more scientific research is necessary to achieve a better understanding of this sense.

Vision in manatees is dichromatic; they distinguish blue and green from greys and discriminate brightness [42][43]. Several accounts suggest that manatees use underwater and aerial vision [16]. Manatees can also associate visual cues with food rewards and to recall this connection after one year [23]. Visual stimuli could be enriching or provoke stress; therefore, their relationship with manatee welfare also merits further study.

Manatees are close relatives of elephants, see, for example, [14], and many observations suggest that they possess remarkable memory and learning abilities [16], as is the case with their pachyderm cousins. Although these observations

lack experimental and controlled scientific contexts, they provide substantial evidence to support this claim [14]. They are also regarded as being highly trainable and possessing a strong aptitude for learning as evidenced by several observations conducted by veterinarians [14]. Manatees travel large distances searching for scattered resources in a constantly changing environment, suggesting that they require good memory and learning abilities to successfully find food, water, and conspecifics, see [14]. Further experimental research is required to gain an understanding of the role cognition plays in manatee behaviour. One potential approach to improving the welfare of manatees in human care could be cognitive enrichment. Cognitive enrichment has shown promising potential in dolphins [44][45][46] and elephants [47].

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