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Short Note

Underwater Feeding Bottle: A New Tool in the Rehabilitation of Manatee Calves

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Two of the three extant species of manatee live in Brazil. West Indian and Amazonian manatees are classified as "Vulnerable" and "Endangered" to extinction, respectively (Self-Sullivan & Mignucci-Giannoni, 2008; Marmontel et al., 2016). The stranding of newborn calves is one of the main threats to the West Indian manatee (*Trichechus manatus*) on the Brazilian northern and northeastern coasts. The degradation of estuarine environments is considered a trigger for such calf strandings (Balensiefer et al., 2017). The primary threat to the Amazonian manatee (*Trichechus inunguis*) in Brazil is illegal hunting, after which a mother's death renders dependent calves as orphans. Additionally, an increasing proportion of dependent calves become victims of accidental entanglement in fishing nets (Calvimontes, 2009; Marmontel et al., 2016; Marmontel, 2019).

To support manatee conservation, stranded calves, orphaned or dependent, and those maintained in managed care under inadequate conditions in Brazil are rescued and transferred to official rehabilitation centers. In these facilities, calves are cared for by teams of experts until they are able to return to the wild (Instituto Chico Mendes de Conservação da Biodiversidade [ICMBio], 2011; Adimey et al., 2012). During the rehabilitation process, the calves are fed different artificial formulae, similar in composition to maternal milk, which vary according to the species, age, and physical conditions of each calf (Borges et al., 2012; Croft & Tollefson, 2014; Maduro, 2014; Walsh & de Wit, 2014). Varying degrees of stress related to captivity occur when calves arrive at specialized centers, often resulting in rejection of the feeding bottle as a source of food over many days. We developed a less invasive and more natural device that approximates nursing conditions for manatee calves in the wild. This apparatus, dubbed the "underwater feeding bottle" (UFB), is designed for the underwater-aided nursing of dependent manatee calves.

The underwater device is composed of five main parts (Figure 1): (1) a short tube with a valve in its upper part that is capable of withstanding a maximum pressure of 10 kgf/cm^2, which controls the flow of fluids; (2) a threaded connector attached to the no-return valve that supports a container in which the milk formula is stored; (3) a container featuring a structure at its base that allows the removal of air trapped inside the tubes and connectors, facilitating the flow of liquid; (4) the lower portion of the container that is composed of a reduction sleeve which is adjusted to an elbow connector attached to a cattle-feeding silicone nipple; and (5) at the midpoint of the tube, a 1.20-m long rod connecting the container to the nipple which enables handling of the UFB (see Figure 2). All tubes and connectors that comprise the UFB are made of polyvinyl chloride, a nontoxic, recyclable (Rodolfo et al., 2006), and low-cost material that is easily found away from major urban centers such as in the Amazonian countryside. Watertight connections and a one-way valve ensure that milk can be consumed even when the device is completely submerged. A patent for the UFB, under the name "Device for the artificial nursing of Sirenia™," was granted by the National Institute for Industrial Property (INPI – Instituto Nacional da Propriedade Industrial) of the Ministry of Development, Industry, and Trade on 16 April 2013.

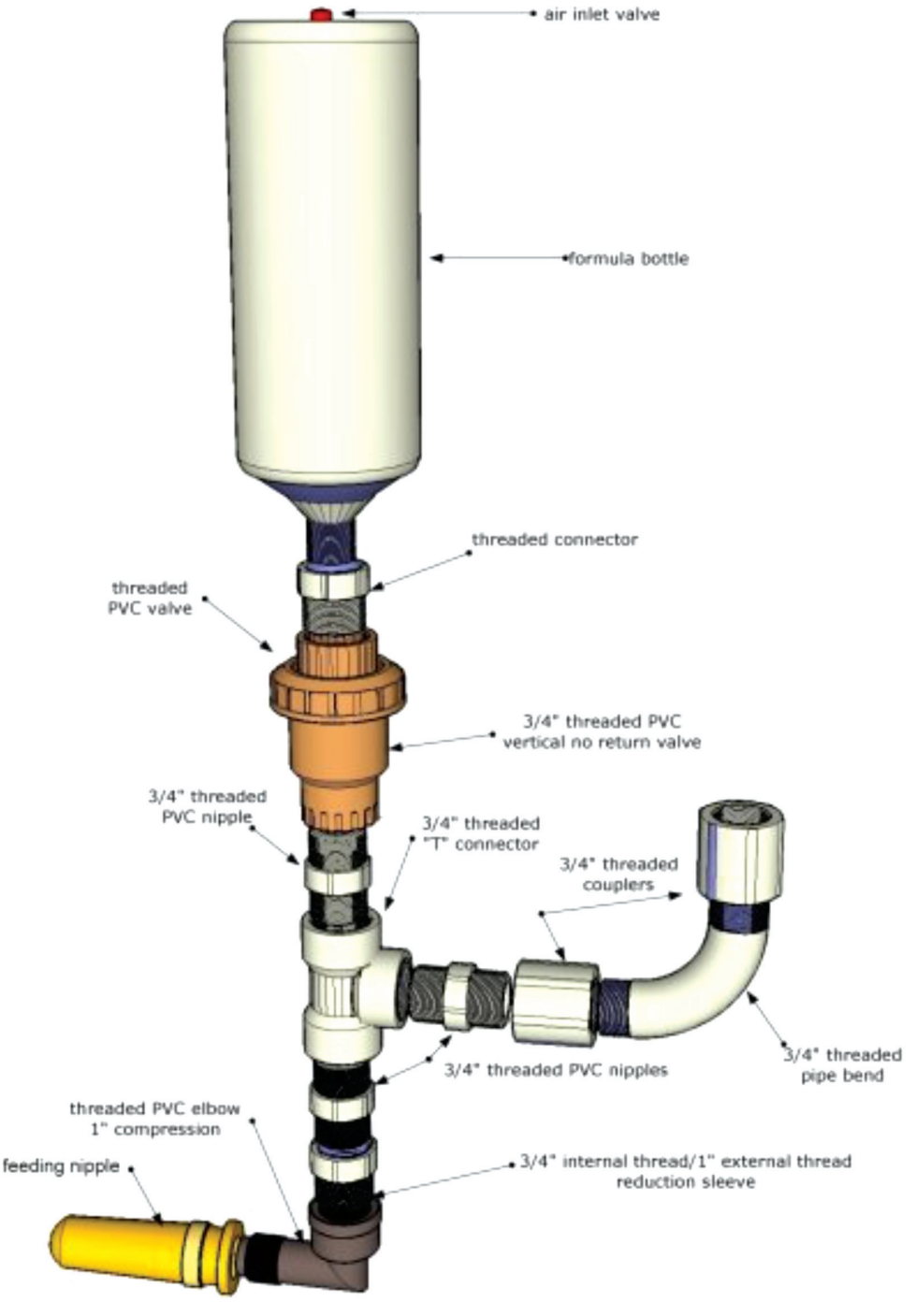

Figure 1. Diagram of the underwater feeding bottle (UFB). PVC = polyvinyl chloride. The use of the UFB results in less direct interaction between the calf and caretaker during nursing and, consequently, enables less domestication and better adaptation to the post-release natural environment (see Figure 2).

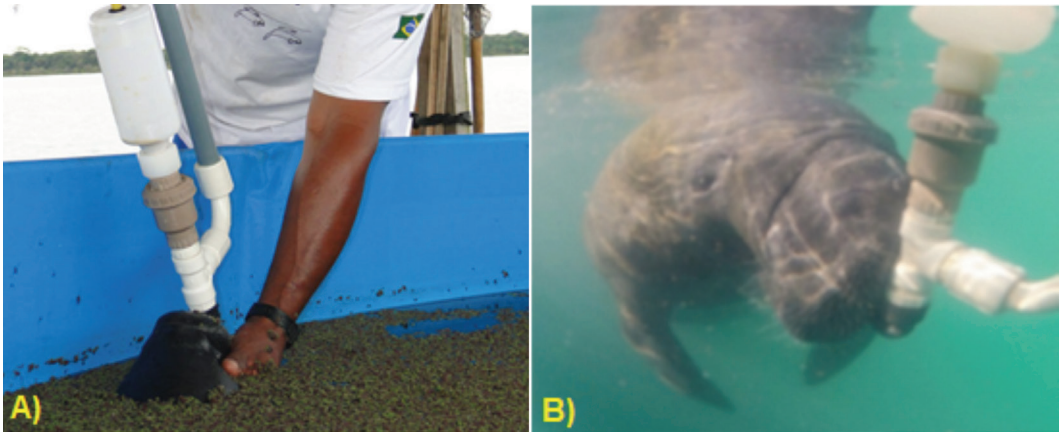

Figure 2. (A) Amazonian manatee (*Trichechus inunguis*) being propped up by a caretaker during nursing with the UFB; and (B) West Indian manatee (*Trichechus manatus*) completely submerged while nursing from the UFB.

The use of the UFB precludes the need for a caretaker to support the chin of the manatee with the head partially out of the water for feeding. Animals themselves can choose the most comfortable submersion depth when feeding.

The UFB is distinct in several ways from traditional methods for providing nutrition to manatee calves under care at rehabilitation centers. For example, according to Lima et al. (2007), the initial nursing procedures of newborns should be carried out by two people, with one person holding the animal while the other person offers the bottle. This procedure is repeated until the newborn is conditioned to nurse without the need for physical restraint and approaches the edge of the pool toward the caretaker to receive food (Gulland et al., 2018). The technique used in this nursing practice increases the likelihood that the manatees will associate food with humans (positive reinforcement) as the calves receive an average of five bottles of formula per day for approximately 2 years, the average natural nursing period, which results in approximately 3,600 occasions of direct contact.

The UFB allows calves to feed in an anatomical position similar to that of natural nursing and reduces human contact time compared with previous methods. Rehabilitation techniques that promote natural behaviors in captive animals diminish chronic stress and improve biological functionality, well-being, and rehabilitation outcomes (Appleby & Sande, 2002; Moore et al., 2007). Calves that feed in an underwater environment similar to that of free-ranging animals, without the need for direct contact with human beings, are expected to develop more normally than those that are hand-fed. The UFB may become a tool to improve the rehabilitation of sirenian calves worldwide.

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