Aquatic Mammals 2001, **27.1,** 16–23

Husbandry and research training of two Florida manatees (*Trichechus manatus latirostris*)

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Abstract

Basic husbandry procedures and physiological assessment of manatees typically have been limited by the difficulty of restraining these large animals and the risk of injury to subjects and personnel. To address this problem, two male Florida manatees (*Trichechus manatus latirostris*) were trained for seven tasks: swimming onto a stretcher; stationing for body measurements; voluntary presentation of flippers for venipunctures (medial and lateral); providing urine samples; submitting to rectal measurement of core temperatures; positioning for ultrasound assessment of blubber thickness; and measuring respiration volume and flow rate. Subjects were trained to perform these tasks using standard conditioning procedures, which eliminated the need to drop water levels or to restrain subjects. The ability to meet these training objectives increased health assessment opportunities, improved the level of health care, furthered collection of baseline biological data, and facilitated physiological research.

Key words: manatee, husbandry, training, learning, behavior, physiological research.

Introduction

Assessment of health and physiological parameters of captive Florida manatees (*Trichechus manatus latirostris*) presents a substantial challenge. These large, powerful, marine mammals, averaging close to 900 kg, typically are examined while stranded in a drained tank. Multiple assistants are required to restrain the subject for basic medical procedures, such as venipunctures. Even stranded, the manatee is capable of moving, rolling, and tail-slapping, thus presenting risk and stress for both animal and humans. Other veterinary procedures, such as urine collection, often require sedation or anesthetization (Bossart & Dierauf, 1990), with their attendant risks. Alternative, safer procedures for medical examinations based on standard conditioning methods have rarely been noted for manatees (e.g., Gerstein, 1994). This is surprising since zoos and aquaria routinely use classical and operant conditioning techniques to train many of their animals for routine physical examinations. This type of conditioning, typically called husbandry training, has been used with numerous terrestrial and aquatic animals. For a review of husbandry training for other animals see Ramirez (1999).

Bossart and Dierauf (1990) noted some of the general problems of medical examinations of marine mammals, including assessment in a water environment, the large size of many species, and intractability of subjects. However, many of these difficulties have been overcome in the case of cetaceans and pinnipeds. Why have sirenians been an exception? One reason for a lack of effort with these species might be attributed to the anticipated difficulties of training an herbivore with no history of domestication (*cf.* horses, Indian elephants). A more significant reason derives from the manatee's endangered status. They are classified as endangered under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.). Most manatees in captivity are rehabilitated and technically are eligible for release. They are wild animals that have sustained injury or illness necessitating care in rehabilitation facilities with a goal of returning them to their natural environment as rapidly as possible. A special concern in captivity is habituation to humans, a condition that potentially is dangerous to manatees after release when contact with people might increase harmful or lethal encounters with boats and other human-made objects. Concerns about habituation to humans as a collateral effect of training have impeded efforts to develop safe husbandry techniques[1].

However, there are sub-groups of manatees that remain in long-term captive care where the frequent need for physical examination outweighs the concerns about habituation. Some rescued manatees have been so badly injured that they would be unable to survive without continuing human assistance. Others have communicable diseases (e.g., Papillomavirus) that might be a threat to the natural population. Another sub-group is composed of captive-born manatees, most ranging between 3 to 30 years of age. All of these long-term captives usually undergo routine physical examinations two to four times per year.

Mote Marine Laboratory houses two adult male, captive-born manatees that are low priority animals for release based on the age of the subjects (11 and 13 years at the initiation of training) and time in captivity. The United States Fish and Wildlife Service granted permission to develop a comprehensive husbandry/training program to reduce the need for stranding and restraining these subjects for medical examinations. Specific objectives included training the behaviors necessary for the collection of weights, body measurements, blood samples, urine samples, core body temperatures, ultrasound blubber depth measurements, and respiration volumes and flow rates. The broader goal was to increase health assessment opportunities, which would in turn improve the animals' health care, provide a comprehensive database of health information, and promote additional physiological research.

Materials and Methods

Subjects

Two male captive-born Florida manatees, *Trichechus manatus latirostris*, "Hugh" and "Buffett" were subjects for this study. Hugh, approximately 544 kg, was 13 years old and had no known prior training experience. Buffett, approximately 816 kg and 11 years old at the beginning of this study, was once a subject in a behavioral pilot study on auditory discrimination for a short period of time, but was eliminated from the actual study (personal communication, David Murphy, Lowry Park Zoo, March 24, 1998). Both animals were housed together in a 265,000-liter exhibit at Mote Marine Laboratory in Sarasota, Florida. The exhibit had three connected areas: the medical tank—a shallow area used for medical examinations, the shelf—another shallow water area, and the display area—a deep section.

Training

Training sessions were run between 0800 to 1000h, five to six days per week. They started in 1998 as brief episodes, about 15 min, and were gradually increased in length to include the full two hours. Husbandry training was done concurrently with discrimination training for studies of visual and tactile acuity. The manatees' daily ration of food (120–144 heads of romaine lettuce and 12 bunches of kale) was placed in the display area after each training session concluded. This food was consumed by early evening, insuring a 12 to 13 h nighttime fast before training commenced the following morning. Most training was conducted before the exhibit was open to the public, as recommended by the US Fish and Wildlife Service.

The primary reinforcers used during training included apple wedges, beet slices, and peeled baby carrots. Zupreem monkey biscuits, a preferred food, were used to reward an especially desirable behavior. Other reinforcers included scratching the animal by hand or with a wire brush on the torso and verbal praise. A specific trainer's whistle for each manatee was used as a secondary reinforcer to reward each animal's behavior independently.

Shaping by reinforcement of successive approximations was used to train all behaviors (Pepper & Defran, 1975). Each animal was trained to approach and follow a unique target throughout all areas of the tank (for more detailed training methods, see Colbert and Bauer, 1999). Time-outs (cessation of training or removal of the opportunity to receive positive reinforcement) were used to reduce undesirable behaviors (Pepper & Defran, 1975; Domjan, 1998, p. 272), such as leaving station (leaving the designated area for a specific task). Both manatees were trained simultaneously in different areas of the exhibit. For example, one manatee would be trained in the medical tank while the other was in the shelf area. No physical barrier was used to separate the manatees.

Two basic body positions, dorsal-up and ventral-up, were needed for most of the desired husbandry objectives. Both positions allowed continual breathing by the manatees (in contrast to cetaceans), facilitating extended training sessions. In both positions, the manatee was required to station at his target while remaining parallel to the side of the

[1]A careful consideration of what animals learn in a training situation strongly suggests that habituation should not be a concern anyway. The literature on context specific learning (reviewed in Gordon & Klein, 1994) and compound conditioning (Dickinson, 1980; Pearce, 1997, chap. 3) indicates that learning transfer of non-aversive training associations from captive to wild situations are likely to be weak. They would certainly be weaker than the positive associations acquired about people who reinforce the manatees with no contingencies, as occurs in non-training situations.

tank and at the surface of the water. For the ventral-up position, the manatee turned over in response to a hand signal and allowed his relaxed pectoral flipper to be held above the surface of the water by a tank-side trainer. In the early stages of shaping this behavior, it was necessary for the trainer to give the hand signal and then reach into the water and turn the manatee over into the correct position. Over the course of multiple sessions, each manatee learned to turn over in response to the hand signal alone without having to be turned manually. The criteria for reinforcement included a relaxed flipper presentation. The length of time spent in this position was extended using a fixed interval schedule of reinforcement (Pepper & Defran, 1975; Domjan, 1998, pp. 163–164). Initially, food reinforcement was provided at 15-s intervals and extended to over one minute as training progressed. In addition, informal observations suggested that subjects would remain ventral-up for longer periods (over 90 min) when the trainer maintained an ongoing monologue. Apparently, human vocalizations served to reinforce stationing.

Several changes in general procedures were necessary as training progressed. As desired behaviors became more complex, it was apparent that an in-water trainer would be necessary to assist subject positioning for several of the medical procedures. Both animals were desensitized to the in-water trainer's presence. Another change involved responses to noise. During training, it was not practical to isolate the manatees from the standard noises associated with an active aquarium site. This was initially a problem because the manatees were quite sensitive to unexpected noise. To discourage this responsiveness to potentially disturbing stimuli, on-task behavior was strongly reinforced when distracting stimuli were present.

A goal for all the procedures was to perform medical procedures without having to drain tanks or restrain the animals unnecessarily. The steps in training the husbandry objectives are briefly described for each medical procedure:

Body weights Weight measurements at Mote Marine Laboratory and many other facilities are obtained by suspending a scale from a hook on an industrial crane. The crane lifts a manatee in a stretcher from the floor of a drained tank. The training objective for this task was to station the subject over a 3.05 m × 1.8 m stretcher, fold the stretcher around the manatee, and lift it in order to weigh the manatee. Initially, the stretcher, without poles, was draped over the edge of the shelf area of the exhibit so the subjects would become accustomed to its presence. Poles were added and the stretcher was then lowered in stages into the tank. Eventually, the stretcher was laid flat on the shelf area with one handler at each corner as a precautionary measure so the animals could not become entangled. Each animal was trained to station at his target over the stretcher. The stretcher poles on each side were then raised gradually by the handlers and the two ends were closed, enveloping the stationed animal.

Several additional steps were implemented to prepare the animals. To desensitize the animals to the sounds of a crane, a generator was run by the tank during training. In addition, the stretcher straps were hung from a temporary support above the stretcher, much like they would be from the crane. When each animal stationed reliably with these modifications, an industrial crane was rented to lift the stretcher and animal for weight measurement.

Body measurements Training focussed on correct positioning of the subjects and desensitizing them to a cloth tape measure. Accurate body length measurement required that each animal station at his target in a dorsal-up position parallel to the tank wall. Straight-line body length was determined by positioning a cloth tape measure from the tip of the animal's snout to the tip of the tail. Positioning for four girth measurements corresponding to anatomical sites (peduncle, anus, umbilicus, and axilla) was also trained. Measurement of peduncle, anal, and umbilical girths were approached with the subject in the ventral-up position. Two measurements of an axillary girth were done with the animal, one in the ventral-up and the other in dorsal-up positions. A cloth tape measure was passed under the animal's body and positioned over the correct anatomical sites for measurement.

Blood samples Several behaviors were trained and linked together (chained) to obtain voluntary blood samples from the subjects' pectoral flippers. Each animal was trained to maintain the ventral-up position for a minimum of 10 min. To maintain this position over time, subjects had to be trained to breathe without rolling over to the dorsal-up posture. In addition, each was desensitized to the medical preparation of the flipper and to the insertion of a needle. It was important that each animal remained as relaxed as possible throughout the entire procedure. This was shaped by differentially providing reinforcement when tension in the flipper muscles, as determined by trainer touch, was minimal.

Both animals were initially sensitive to any type of pectoral flipper manipulation. Desensitization was done by stimulating the flipper with the trainer's hand (e.g., rubbing with the palm, scratching with fingernails) or with various scrub brushes. As the manatees became desensitized to manipulation,

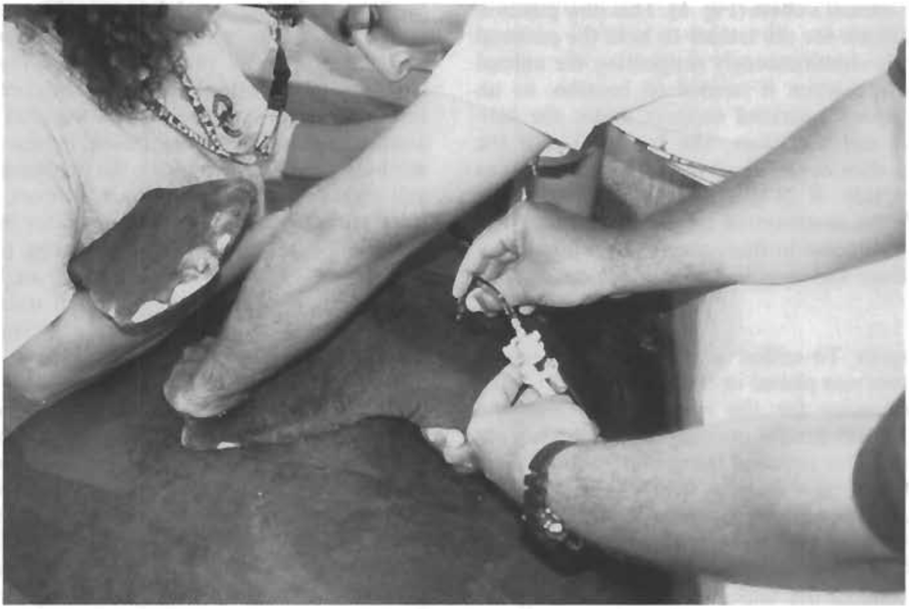

Figure 1. Lateral venipuncture showing the needle connected to a multi-sample adapter via a short plastic tube. The trainer on the left supports the subject and the trainer on the right holds the flipper in place while the veterinarian draws blood.

the procedures became more specific to those used when preparing for a blood draw including probing a specific region and bending the flipper to find the correct venipuncture site. The manatees were also desensitized to the odor and sensation of the povidone iodine and isopropyl alcohol used to cleanse the flipper in preparation for a simulated or actual venipuncture. Once this was accomplished, blunt objects, such as a pen cap, were used to approximate the sensation of a skin puncture. The instruments introduced subsequently, a paperclip and a toothpick, became progressively sharper until it was believed that the animal would remain relaxed throughout a venipuncture. The first venipuncture attempt at this stage with a 20 gauge × 3.81 cm needle resulted in the animal leaving station. Additional desensitization training was performed in response to this problem. A more gradual, step-by-step approach was taken, including shallow punctures through the skin using first a smaller, 25-gauge needle, then a 23-gauge needle. When each animal routinely stayed on task (i.e., performed the behavior desired by the trainer) throughout these progressive approximations to the final procedure, another venipuncture was attempted utilizing a 21 gauge × 3.81 cm needle. Rather than using a syringe, the needle was connected to a multi-sample adapter via a short plastic tube (17.8 cm intravenous extension set), which allowed small movements of the flipper to occur without compromising blood collection. In addition, because manatee skin is quite thick on the pectoral flipper (approximately 1 cm, personal communication, Sentiel Rommel, Florida Marine Research Institute, November 1999) insertion of the needle through the skin was done in three stages, with reinforcements delivered after each stage, rather than one long puncture. During the actual venipuncture trainers provided tactile stimulation to the face and chest areas. In conjunction with human vocalizations, these actions appeared to enhance relaxed stationing.

Initially, all voluntary blood samples were drawn from the medial side of the pectoral flippers, just as with a restrained venipuncture. Although the medial location had been used traditionally (Walsh & Bossart, 1986), some risks are involved. In manatees, the brachial nerve plexus medially overlaps part of the brachial venous plexus. This means that the insertion of the needle risked penetrating or injuring the nerves. Reports from postmortem dissections of manatee pectoral flippers suggested that drawing blood from the lateral side of the flipper would be a safer method, although it would require a longer needle (S. Rommel, personal communication, 1999). It was decided that training the manatees for this new technique would be beneficial. While remaining in a ventral-up position, both animals were trained to fold their pectoral flipper over the trainer's arm, which was positioned across the animal's chest (Fig. 1). This new position made it difficult for the trainer to hold the pectoral flipper while simultaneously supporting the animal at the surface when it needed to breathe, so an in-water trainer provided support under the subject's head and shoulders. The lateral side of the flipper was then desensitized in the same manner as the medial side. A 21-gauge × 5.08 cm needle was used, with the insertion of the needle through the skin still conducted in three stages. At a later time, the procedure was modified to a single continuous insertion.

Urine samples. To collect a urine sample, each of the manatees was placed in the ventral-up position. It was necessary for the manatee to raise and maintain his urogenital opening above the surface of the water. This required the manatees to lift their paddle off the tank floor, a behavior contrary to what they had become accustomed to when stationing for voluntary venipunctures. Due to the weight of the animal, it was difficult to shape this behavior from the side of the tank, so a handler was positioned in the water to lift the body until the urogenital area was above the water and provide support under its back. An assistant, positioned at the side of the tank, dried the genital area with a towel and positioned a collection cup cranial to the urogenital opening. Another assistant, positioned outside the tank, exerted downward ventro-dorsal pressure on the manatee's abdomen at the level of the bladder. This was done by placing one hand on top of the other and pressing on the abdomen, approximately 20–40 cm caudal to the urogenital opening. Early in training the amount of pressure varied, as trainers experimented to find an optimal technique. Later, sampling procedure included one minute of light pressure, and if unsuccessful this was followed by one minute of heavy pressure. If no sample was obtained after 2 min, the procedure was halted. Another attempt would be made later in the session.

Pressure on the abdominal area occasionally led to each subject dribbling some urine from its genital slit. Initially, each dribble was reinforced with a whistle followed immediately by a piece of food. As the dribbling became more routine, only the whistle was used for reinforcement; food was withheld. After full urination occurred, magnitude of the reward was increased by feeding several monkey biscuits.

Core temperature A flexible 70-cm piece of Tygon tubing (6.4-mm diameter) was used to simulate and desensitize the manatees to the core temperature probe, which was of the same size. Petroleum jelly was used as a lubricant. The manatees started in the ventral-up position with the in-water trainer positioned farther caudal to provide support directly under the anus. Each animal needed to remain relaxed as the veterinarian inserted the length of tubing into the rectum. The core temperature procedure took 15 min and required that each animal remains in the ventral-up position for five minutes, turn dorsal-up with the temperature probe still inserted for five additional minutes, and then turn back to the ventral-up position for the last five minutes of monitoring. The training procedures included desensitizing the subjects to anal touching and insertion of tubing. Additional training steps were directed at progressively achieving greater distances of insertion up to 70 cm.

Blubber depth A portable ultrasound device (Scanco, Scanoprobe II) was used to measure blubber depths at four specific surface locations on the manatee's body. Three anatomical locations were selected for measurement along the dorsal midline including the peduncle, anal, and umbilical sites (Ward-Geiger, 1997). One set of measurements was taken on the ventral midline at the peduncle site. The manatee was required to assume either the dorsal-up or ventral-up position while an in-water handler lifted the manatee's tail off the bottom of the tank. This position was maintained while a veterinary technician, located outside of the tank, placed the transducer on the correct anatomical sites to collect blubber depth measurements. Training consisted only of desensitizing the subjects to the touch of hands and ultrasound probe.

Respiration Volume and Flow Rate Measurement Training for these measurements started with the animal positioned perpendicular to the exhibit wall in a dorsal-up position. The subjects were desensitized to the trainer's hand placed under the lower jaw to lift the head. A standard human resuscitation mask was placed in front of the subject for visual and tactile inspection. The next step was to place the mask over the nostrils during respiration. Later the mask was connected to a spirometer (Spirometrics Flowmate LTE), which measured the volume and velocity of each inhalation and exhalation. In the first stage of this training, the manatees were reinforced for all breaths captured by the spirometer to quantify an average manatee resting breath. A goal of four, measured breaths per session was set. The goal of the second stage was the measurement of maximal volumes and flow rates. To accomplish this, each animal was reinforced only when a predetermined threshold was reached. The threshold was increased each time the subject met the previous objective reliably. If an exceptionally large respiration were obtained, the animal received a larger than normal reward and the threshold was raised to that level.

Results

Six of the seven husbandry training objectives were met by both animals: body measurement; blood samples; urine samples, core temperatures; blubber depth; and respiration assessment.

Body weights

This was the only objective not fully realized. Both subjects were desensitized to the stretcher and the four in-water handlers. Each manatee stationed reliably at its target in the stretcher while suspended by the crane in the water. However, on the first attempt to lift a subject it became highly agitated. We quickly terminated the trial and did not attempt the lift with the other subject. It should be noted that all of the trained aspects of the weighing procedure were achieved. Desensitization to the lift was never trained because of the lack of availability of a crane on a daily basis.

Body measurements (lengths and girths)

Training was completed in one session. Length and girth measurements have been obtained on all 14 occasions attempted.

Blood samples

Medial and lateral venipunctures were collected from both animals on a routine basis. Buffett successfully performed blood-sampling behavior to completion from the medial side on 30 out of 35 sessions and from the lateral side on 51 of 53 sessions. Similarly, Hugh supplied medial blood samples to completion on 27 of 32 sessions and lateral samples 55 of 56 sessions. Blood samples were sometimes collected as often as every two to three days for several weeks at a time. This high frequency of sampling was done as part of a physiological study investigating fluctuations in creatinine levels. Occasionally, an animal left station during a venipuncture attempt, but he usually returned within a few minutes for a successful collection within the session. Most of the failures occurred in the early stages of training and could be attributed to increased sensitivity of the pectoral flipper following multiple venipunctures in close succession from the same flipper. When these instances occurred, several sessions of desensitization work followed to get the animals back on task. Initial training was done only on the left flipper, but subsequent training for venipunctures from both flippers has minimized the sensitivity problem. Except for some occasional minor swelling at the puncture site, no obvious tissue trauma accompanied the blood draw procedures.

Urine Samples

Urine samples were collected from both animals on a regular basis, usually once or twice a week and occasionally as often as every two to three days. To date, Buffett has voluntarily supplied urine samples on 118 out of 159 sessions and Hugh has voluntarily supplied urine samples on 127 out of 163 sessions. The first full stream of urine occurred within four sessions for Hugh and eight sessions for Buffett. Feeding kale or romaine lettuce to the animals an hour before attempting sampling enhanced the likelihood of urination.

Core temperatures

Desensitization to core temperature measurement was completed for both animals within four sessions. At the beginning of training, several of the core temperature cues (e.g., in-water supporter, tail raised to the water's surface) were similar to urine collection procedures, and both animals attempted to provide a urine sample. This behavior was not reinforced. Over time, the insertion of the tubing itself probably became a cue that a urine sample was not being solicited. Core temperatures were obtained successfully from Buffett on four of five attempts and three of five attempts with Hugh.

Blubber depth

Desensitization to the ultrasound blubber depth measurements was completed in one session for both animals. Blubber depths were obtained on all 18 attempts.

Respiration volume and flow rate measurement

Correct body positioning and desensitization to the resuscitation mask was completed in one session. Initially, both subjects respired prematurely, often breathing as soon as they saw the mask, but this was extinguished by reinforcing only when the subject waited for the correct placement of the mask. Most successive breaths seemed to diminish in both volume and velocity if they were spaced too closely together. A delay of at least two minutes between respiration measurements resolved the problem. To date, 394 data points (measured respirations) were collected for Buffett and 331 points were collected for Hugh.

Discussion

The benefits of conditioning husbandry behaviors with long-term captive manatees are substantial. The convenience and ability to easily collect body measurements, blood and urine samples, core temperature, blubber depth and respiratory measurements has increased health assessment opportunities, improved the level of health care, furthered collection of baseline biological data, and/or facilitated physiological research. The one objective that was not completely met, weight measurements, actually was successful on all components that were trained. The lack of an on-site crane to lift the subjects prevented the step-by-step procedures necessary for shaping the actual lift. Under these circumstances, it is not surprising that this procedure was not entirely successful.

Manatees were trained using non-aversive classical and instrumental conditioning techniques. The main problem in training herbivores with positive reinforcement is that the standard food reinforcer is readily available outside of the conditioning context because of their typical prolonged grazing behavior. It is easier to gain stimulus control over a behavior when a reinforcer is absent under circumstances when the behavior is not performed, in addition to being present when it is performed (see Dickinson 1980 for a discussion of the conditions of learning). This is a condition not easily met using food reinforcers with a grazing animal. A complementary way to address the reinforcement problem is to consider manatee consumption as existing in an open economic system (Schwartz & Reisberg, 1991, pp. 192–194) in which food reward is available outside of the training context. This leads to weaker learning than in closed economic systems in which food is only available within training sessions (i.e., delivered only for performance of desired behaviors). Weaker learning is characterized by lower probabilities of desired responses, susceptibility to distraction by competing stimuli, and more rapid rates of extinction. A piscivore, such as a dolphin, can be trained using a closed system in which all of its food is contingent on trainer-desired behaviors. This is difficult to do with an animal that grazes on plants throughout the day. We addressed this problem by using preferred foods (apples, beets, carrots, and monkey biscuits), which were only available during training sessions, and by scheduling sessions for mornings, after a nighttime fast. These procedures yielded stimulus control weaker than that for the dolphin, but adequate for behavioral training.

The use of trained behaviors has reduced the numbers of handlers needed and the amount of time spent for each physical examination. These reductions in time and effort have facilitated health assessment. Furthermore, medical procedures rarely conducted with captive manatees, such as girth and blubber depth measurements at difficult-to-reach anatomical locations, urine sampling, and core temperature measurements can be achieved on a routine basis, improving the animal's level of health monitoring and care. Increases in sample collections provided more detailed baseline biological data. This is exemplified by the fact that over 80 voluntary blood samples have been obtained from Buffett and Hugh over a 21-month period in comparison to only 10 and 12 samples, respectively, collected during the 30 months prior to training. Two attempts had been made to obtain core temperatures before husbandry training was initiated, but in both instances insertion distance and measurement time were inadequate for accurate measurement. Furthermore, urine samples, axillary and umbilical girths, and ventral blubber depth measurements were never obtained from Hugh and Buffett before husbandry training was initiated.

The ease of performing voluntary medical procedures also offers a wealth of physiological knowledge. Blood samples from captive manatees, typically collected on a biannual or quarterly basis, provide insufficient data for understanding hormonal and other cyclical changes for this endangered species. The ability to collect voluntary blood and urine samples on a consistent basis will provide valuable information about these cycles. In addition, research can be designed to monitor specific physiological changes in response to manipulation of the animal's environment.

Some additional aspects of training are worth noting. Initially, training sessions were run for approximately a quarter hour per day. As the tasks became more complex, sessions often lasted more than two hours with multiple behaviors being trained. Training both manatees simultaneously in separate areas of the tank was often difficult, especially in the early stages of training. On occasion, one animal would break station and approach the other. Gate training, using a physical barrier to separate subjects, could be helpful in preventing interference between animals. Providing a substantially larger reward magnitude of monkey biscuits upon the successful completion of the chain of several behaviors needed for blood-draws and urine samples worked well. In addition, training the subjects to be resistant to extraneous disturbance was useful. Noises, observers, trainer changes, and a variety of other outside sources of disturbance have become progressively less distracting.

These two manatees were responsive to physical guidance for learning a behavior (e.g., rolling them over to train the ventral-up posture, or guiding them to a location by gently holding and pulling them to the desired area). In spite of their tremendous bulk, only minimal movements from the trainer were needed to maneuver the animals into position when they were acquiring a new task. The manatees were more responsive to hand signals that incorporated a tactile element than to visual cues only, perhaps reflecting poor visual acuity.

It was important to monitor the reactions of animals carefully and adjust procedures over time. For example, early attempts to draw blood indicated a great sensitivity to penetrating the skin. Greatest success was achieved by inserting the needle in three distinct stages. However, these stages proved to be unnecessary for later venipunctures, where a single smooth insertion proved to be the most effective technique.

Urination might not have been under complete stimulus control. Successful urine samples were obtained for Buffett on only 74% of sessions and for Hugh on 78%. Although urination frequently occurred within seconds of applying gentle pressure to the bladder area, it was not unusual to make several attempts before achieving a sample. It was clear that learning occurred as demonstrated by a steadily increasing success rate over time, however, direct pressure over the bladder might also have contributed to urination. The interpretation is made difficult by the obvious confound of length of time since last urination, i.e., the subjects might have been well trained to urinate on command but have been unable to comply because of an empty bladder.

Several collateral effects have been observed since training was initiated. Buffett, a normally lethargic animal, has become more active, an important characteristic for an overweight animal. He also became more assertive with Hugh, often pushing him away when he interfered in a training task, and showed greater persistence on-task. Hugh, a normally highly active animal became somewhat calmer. In addition, the manatees attended to multiple tasks throughout training sessions, which represented a dynamic type of environmental enrichment distinct from the more typical, static devices used for mental stimulation (see Goldblatt, 1993). Finally, preliminary data on cortisol levels comparing restrained and voluntary blood samples suggested that husbandry training might have reduced the animals' level of stress during physical examinations (unpublished data). The ancillary benefits of husbandry training remain to be more fully explored.

Acknowledgments

This research was done with the permission of the United States Fish and Wildlife Service. It was supported by a Research and Creative Scholarship Award and New College Foundation Faculty Development Grant to Gordon B. Bauer. The work could not have been accomplished without the help of many New College students and Mote staff interns and volunteers. We thank Mote's manatee trainers, Joseph Gaspard and Brandie Littlefield. We thank New College students Raquel Andres, Cristal Ange, Shelley Batts, Christy Brown, Julia Burch, Nora Collins-Mandeville, Simon Davis, Stacy Goldberg, Jenny Growden, Elizabeth Elia, Mandy Larson, Allison Long, Nick Mackin, Peter Mahoney, Nicole Morgan, Julia Orth, Carolina Pilonieta, Kate Pritchett, Sarah Rhodes, Nadia Stegeman, and Jesse Wallace. We are grateful for the assistance of Mote interns and volunteers including Eric Anderson, Lyle Aulwurm, Susan Bates, Charlotte Blair, Jesse Coe, Katie Colbert, Johanna Comer, Petra Cunningham, Samantha Deckert, Heather DeLoach, Jessica Goldstein, Michael Kress, Kristy Lindemann, Kate Robinson, Julie Schrantz, Philip Strom, Johanna Thompson, Jan Warfield, Nina Westerfrolke, Erika Zollette and Tawnia Zollinger. Butch Rommel's advice on manatee anatomy was invaluable. It was a pleasure to work with Barbara Kirkpatrick, who directed the respiratory assessments. Michelle Jeffries gave generously of her time to provide advice on training and the training history of our subjects. This manuscript was greatly improved by the helpful review of Randall Wells. Don Tremel and an anonymous reviewer also provided constructive comments.

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