THE SHAPE OF ENRICHMENT

A Quarterly Source of Ideas for Environmental Enrichment

Octopus Prey Puzzles

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The recent trend in captive husbandry towards combining realistic habitats with enrichment practices allows captive animals to show their "true colors," exhibiting the behaviors that make them unique (Shepherdson, Mellen, & Hutchins, 1998). Enrichment becomes even more important when the structure and design of the exhibit is limited by husbandry needs. Intelligent animals such as primates, pachyderms, or cetaceans easily fall into this category. Training can provide much stimulation, but a host of other techniques are also necessary for animal well-being. For most of the non-mammalian aquatic animals, enrichment is often limited to forms of aquascaping or the presentation of live foods, which may not be enough in some cases. Of these aquatic forms, the octopus has an obvious need for more varied forms of enrichment.

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An octopus manipulates the tube device for its contents.

The octopus in the wild is a reclusive but proficient nocturnal hunter that uses its unique physiology in various techniques of prey acquisition. It is an animal of surprising intelligence, capable of acts of amazing dexterity (Hanlon & Messenger, 1996). The wild octopus faces a multitude of challenges while hunting. Crustaceans, its primary prey, can dart into small holes and crevices to avoid capture. At times, food is captured by touch alone (Hanlon & Messenger, 1996). Unfortunately, the setting in captivity for both the octopus and its husbandry can result in a rather dim and sparse exhibit. This can cause the interesting but cryptic octopus to easily be overlooked by visitors, and the environment is also fairly devoid of stimulation for an intelligent predator.

A recent revamping of the octopus exhibit at the Cleveland Metroparks Zoo made this clear to us. Great pains were taken (figuratively and literally) to recreate an accurate image of the Northern Pacific coast for a specimen of *Octopus dolfleini*. The animal was acquired and the exhibit was officially opened. However, visitor interest in the exhibit was largely limited to feeding times and occasional glimpses of activity. Having seen that the activity levels of terrestrial animals can be increased with some kind of stimulation, enrichment seemed the logical solution to enhance our octopus exhibit. However, with the surprisingly little enrichment information available for this animal, it seemed that we would need to create our own forms. This proved challenging.

The focus of our efforts was the investigative hunting behavior of octopuses documented in the wild. Any items we used had to be durable and easy to retrieve, they had to be challenging but solvable, and expense was to be kept at a minimum. Ease of construction and ease of preparation were also strong considerations.

The result was the construction of various devices called "prey puzzles." Each had a different size, shape, and challenge in order to provide as wide a range of stimulation as possible. They were often constructed of spare filter parts, pieces of plumbing, and other assorted odds and ends that seem to congregate around aquarists. These puzzles were given names for ease of recognition on daily keeper reports. With repeated presentations, notes were

made on acceptance levels by the octopus, construction, and ease of use. The following is a compilation of those notes and other observations. The rating scale used for each item was from 1 to 5, with 1 being poor and 5 being good.

Younger/smaller octopuses tended to acquire the prey and quickly discard the device. As the octopuses grew larger, they held and inspected the puzzles for longer periods of time, even after the prey was acquired. These interactive periods would vary dramatically, sometimes lasting several hours.

THE JAR

The first item presented was a large plastic pretzel jar. The jar was introduced open and empty, and the octopus observed the new object but didn't touch it. After a 15-minute period, the jar was removed. Two hours later, the jar was reintroduced with a crab placed inside. This time the octopus investigated the jar and removed the prey, then the jar was promptly removed. Food was offered in this fashion, and accepted, for two more feedings. A lid was then added to increase the difficulty. Placed loosely at first, the lid was slowly screwed down more with every introduction, until the octopus was eventually opening a completely closed jar. The lid was later attached to the jar with monofilament for ease of recovery.

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Above: the Pretzel Jar. Right: the Hamster Ball.

Intended Challenge: Introduction of Foreign Object - Manipulation of Obstacle

Acceptance level	4
Ease of Construction	5
Cost	5
Durability	4
Ease of Retrieval	4
Ease of Preparation	5
Capable of presenting multiple sizes of food	5

Observations

The jar was the simplest of the devices. Its introduction seemed to establish that new objects could contain rewards, but that they needed to be manipulated in some way. Later, holes were drilled in the body of the jar to aid the aquarists in recovering it. This puzzle was introduced to a newly arrived specimen that was substantially larger and probably older than the previous animal, and it required no gradual introduction of the object. Approximate time for solution by this elder octopus: 20 seconds.

THE HAMSTER BALL

The "hamster ball" was a hollow plastic sphere with a locking lid that was adapted to push in with pressure. Elastic bands held the lid in place and replaced it when the puzzle was solved. Food could be accessed by locating the weak point on the surface of the sphere. Once this opening was found, the lid had to be held open while the food was obtained. For introduction, the sphere was weighted down, but later the weight was removed and the sphere was allowed to float freely in the exhibit. Food placed inside counteracted the sphere's positive buoyancy, allowing it to be neutrally buoyant or "hover" in the water column. The normal currents present carried the sphere repeatedly past the octopus's den, requiring the animal to give chase. Once the food was removed and the sphere released, it could be easily retrieved when it floated to the surface.

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Intended Challenge: Free Floating - Mobile - Manipulation of Obstacle

Acceptance level	4
Ease of Construction	4
Cost	2
Durability	3
Ease of Retrieval	5
Ease of Preparation	5
Capable of presenting multiple sizes of food	5

Observations

Initial introductions with the "twist-to-lock" lid proved to be successful for the octopus, but not as we had intended. The octopus gained access

by pulling apart the glued hemispheres of the ball, ignoring the door. Changes in the design of the door and four nylon cable ties overcame the structural flaws of the ball. The elastic bands that hold the door in place were replaced with elastic cord. Later a "Ferretball" was tried and found to be more durable (the hemispheres were held together with screws) and have a larger capacity. It came in nice colors, too.

THE BLIND BOX

The "blind box" was a clear acrylic box partially divided by a center wall. A hole at one side of the divided end provided the only access to the interior. The box was constructed from the external skimmer box of a trickle filter. The open end was covered with a scrap piece of acrylic held in place with nylon cable ties. The drain hole was left open as an access point. Closed off in this way, the box formed a "U" shaped corridor, with an end that could only be seen from the exterior. Prey items were placed in the far end and could only be gained by reaching blindly around the center-dividing wall. The food items had to be obtained by touch.

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Above: the Blind Box. Right: the Tube.

Intended Challenge: Tactile - Remote View - Variable Manipulation of Obstacles

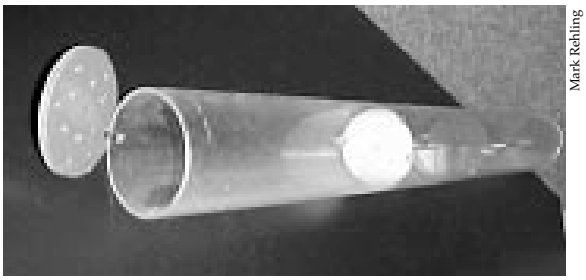
Acceptance level	2
Ease of Construction	5
Cost	5
Durability	4
Ease of Retrieval	4
Ease of Preparation	5
Capable of presenting multiple sizes of food	5

Observations

The octopuses met the blind box with limited enthusiasm. The puzzle seemed to present a limited challenge because it was readily solved. The back panel was removable, and we placed various objects in the box to provide additional obstacles. These seemed to only provide limited difficulty.

THE TUBE

The tube consisted of a 3-inch diameter acrylic cylinder salvaged from a broken protein skimmer. Left over PVC disks from hole saw cuts were used to make doors. Two smaller disks were notched at opposite ends to allow for a small piece of 3/8-inch rigid tubing. The small pieces of tubing formed a shaft that the disk could rotate on. These smaller disks were mounted inside the cylinder to form a 10-inch-long chamber with a door at each end. Additional disks were added to both ends of the tube with single cable ties to form flaps. Access to the center of "the tube" required lifting a flap on the end and rotating one of the inside doors. Pieces of rigid tubing were placed as door stops, allowing the doors to be rotated in one direction. These door stops could be added or removed on either side of the rotating doors. This proved to make the tube puzzle capable of varying degrees of difficulty.



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Intended Challenge: Tactile – Remote View – Manipulation of Obstacle

Acceptance level	4
Ease of Construction	3
Cost	3
Durability	3
Ease of Retrieval	3
Ease of Preparation	4
Capable of presenting multiple sizes of food	2

Observations

The doorstops were added after the puzzle was solved with regularity. This exposed a flaw in the design. The shafts that held the internal doors proved too weak, because the doors were removed rather than manipulated. A later model used half-inch-thick PVC disks that were tapped at either end, allowing the shafts to be glued in place. Small sections of vinyl tubing were added to the shafts of the doors. These prevented the doors from swinging freely and held the food in the center section. A larger diameter and length of tube was used, which increased the variety of

food that could be presented. This length of the tube allowed for improved visibility with larger octopuses.

THE ROTO-CYLINDER

The "roto-cylinder" was a miniature revolving door in a plastic can. It was constructed from the main cylinder of a Magnum canister filter. The filter's original design allowed for a PVC pipe to be mounted along the cylinder's axis. This formed a shaft for the revolving door. The "door" was made of a slightly larger diameter pipe, rectangles of clear acrylic, and PVC disks from hole saw cuts, put together to resemble a small paddle wheel. When placed on the shaft in the cylinder, the rectangles and the cylinder walls formed small compartments that could be rotated to an opening cut on the side of the cylinder. A top and bottom were made from the two halves of an empty wire spool held in place with nylon cable ties. The motor housing on the bottom of the Magnum cylinder was filled with gravel and capped with the wire spool. This bottom weight made the puzzle sit upright when presented.

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Above: the Roto-Cylinder. Right: the Travel Mug.

Intended Challenge: Remote View – Complex Manipulation of Obstacle

Acceptance level	3
Ease of Construction	2
Cost	4
Durability	2
Ease of Retrieval	4
Ease of Preparation	4
Capable of presenting multiple sizes of food	3

Observations

The durability of the device decreased as the octopuses grew. Larger animals were strong enough to loosen the internal panels from their settings and impair the movement of the revolving section. No design improvements have as yet been made. This device proved to be the most challenging, sometimes taking several minutes for the octopus to solve.

THE TRAVEL MUG

The "travel mug" was constructed from a 9-inch section of 3-inch clear PVC pipe. A 3 x 5-inch rectangle of 1/4-inch sheet PVC was attached to close off one end of the pipe. The handle was made from a 7 3/4-inch piece of 1/2-inch diameter PVC pipe. Two pieces of 3/8-inch PVC rod were heated and bent, then threaded through holes drilled in the handle. One rod was shaped like an omega and formed the attachment point to the rectangular base. The other rod was "Z" shaped with one end attaching to the handle and the other to a 3-inch diameter "hole saw" disk that formed a door. A slot was cut in the clear pipe to allow the rod and disk to slide up and out through the pipe. The "S" shape of the rod stopped the disk/door from being pulled clear of the pipe. Lifting up or pushing down on the handle effectively opened or closed off the open end of the clear pipe. Access to the center of the pipe could only be accomplished by pulling up on the external handle.

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Intended Challenge: Remote View – Remote Complex Manipulation

Acceptance level	4
Ease of Construction	2
Cost	4
Durability	5
Ease of Retrieval	5
Ease of Preparation	5
Capable of presenting multiple sizes of food	5

Observations

The PVC rods were heated using a small blow-torch and water-cooled. The ends of the rods that passed through the base and the disk door were later heated and flattened to prevent them from being pulled off. This design proved to be the most durable of the devices. The small size caused the manipulation to be concealed at times, but it was easy to visualize. The first

introduction was met with much interest and took an adult octopus approximately 16 seconds to solve. It took four hours to construct.

The development of the "prey puzzles" significantly improved the activity level of the octopuses. A progression of complexity seemed to be necessary as each device was made. This was mainly due to the relative ease with which the octopuses solved the puzzles. It quickly became a challenge to stump the octopus, but that was rarely accomplished for any duration of time. The solution times for the devices would vary with each presentation and between individuals. The few times noted for specific devices were exceptional solution times and recorded wtih that purpose. The solution time for each was found to be sporadic due to the varying acceptance of prey presented, external variances (e.g. camera lights), and the hunger/interest level of the individual.

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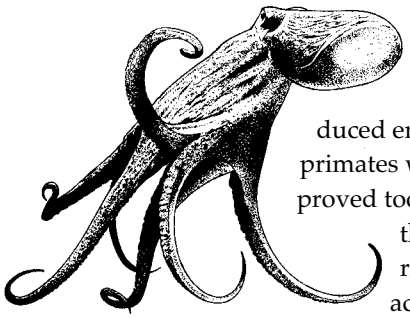
Octopus retrieving prey from the blind box.

It must also be noted that the puzzles listed are but a few of those presented. Most were of simpler design that either proved too ungainly or had failing marks on ease of use or retrieval. A few mass-produced enrichment devices designed for primates were presented as well. These proved too simplistic, as they relied on the movement limitations of a rigid skeleton. One of note, an acrylic peanut maze, was solved in less than 6 seconds. It became apparent that if the octopus was interested, the solution was quick to follow.



Behavioral trends were also observed. The readiness of the individuals to release the devices varied. Younger/smaller octopuses tended to acquire the prey and quickly discard the device. As they grew larger, the octopuses held and inspected the puzzles for longer periods of time, even after the prey was acquired. These interactive periods would vary dramatically, sometimes lasting several hours. One, an elder male, would attempt to dismantle the device and, when successful, would hold on to one or two of the pieces for more than a day. Most larger/older individuals would simply hold on to them, sometimes for several hours.

Overall, the individual's proficiency in solving a given puzzle increased with the number of presentations. However, the ease of finding the solution for each puzzle varied with each individual. Some puzzles seemed to offer little challenge to some, and great difficulty to others. The proficiency level for the more complex puzzles, specifically the roto-cylinder, would drop if the device had not been presented for several feedings. The simpler puzzles seemed to suffer little loss in proficiency if not presented to the octopus for some time.

In conclusion, the introduction of the devices had an overall positive effect. The octopuses displayed a marked increase in their investigation of the exhibit and the items found within. The public showed keen interest in this hunting, and the aquarists routinely had their egos kept in check by the animal's prowess. If any negatives could be noted, it would be that ***any*** objects introduced into the exhibit were often met with increased interest, including those regularly used in tank maintenance, which made routine cleaning more of a challenge. ✧

Author's Note

This is intended as a first installment in the compilation of an Octopus Enrichment Notebook. Ideas, suggestions, or submissions can be addressed to MLR@clevelandmetroparks.com or 216-661-6500 ext. 4485. Copies of the notebook are available upon request.

References

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