Investigating optimal living parameters for Cannonball Jelly, *Stomolophus meleagris*, in captivity

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Abstract

The cannonball jelly, *Stomolophus meleagris*, are a part of phylum cnidarian, class Scyphozoa and order Rhizostomeae. The cannonball jellies at the UGA Aquarium display a negative response to the water circulation in the tank. A neutrally buoyant float was placed into the tank to determine whether the fixed location of the jellies was an active response to environmental stimulus. The neutrally buoyant float was also used to determine the average flow rates of the tank resulting from adjusted circulations. Three ramps varying in sizes were placed in the tank to obscure the flow rate of the tank to possibly change the location of the cannonball jellies. The ramps did not help to obscure the location of the cannonball jellies', however they did invoke an irregular response. The cannonball jellies began to approach each ramp and follow them. The larger ramps were treated as if they were the fixed location (bottom corner), but the smaller ramp caused the cannonball jellies to remain a small distance away from the ramp.

Introduction

Aquarium science generally refers to maintaining life support systems for captive aquatic plants and animals. The principles of aquarium science can be applied to public exhibitory (aquariums and zoos), aqua- or mariculture, research, and ornamental trade. Two of the main principles of aquarium science are water quality and animal husbandry. Providing and maintaining high water quality is achieved through three modes of water filtration: biological, mechanical, and chemical. Mechanical filtration refers to physical separation and extraction of suspended particles from the water column, which reduces the turbidity (Spotte, 1970). Biological filtration refers to the nitrification and denitrification processes by which bacteria neutralize organic nitrogenous compounds present in the water as a result of animal excretion and defecation (Spotte, 1970). High levels of animal excretion and defecation can result in a toxic environment. Chemical filtration removes dissolved organic compounds from the water on a microscopic scale, through absorption, fractionation, or oxidation (Spotte 1970).

Animal husbandry is accomplished through appropriate care and breeding of an organism. Husbandry includes water quality, cleaning, environmental or habitat enrichment, medical assistance, and providing food similar to the natural diet and supplemented with essential vitamins and nutrients. An additional aspect of husbandry pertains to scientific experiments that investigate optimal environmental parameters for specific species in order to maintain high quality of life.

The cannonball jelly, *Stomolophus meleagris*, belongs to the phylum Cnidarian, class Scyphozoa and order Rhizostomeae (Calder, 1982). Scyphozoa are defined as the true jellies because of the alternation in their life stages from the polyp to medusa. The anatomy of the cannonball jelly consists of a circular bell shape with a brown pigment on the border and small, short protruding tentacles used for feeding. Small round statoliths located on the brown pigment of the border of the cannonball jelly bell helps them sense gravity. They feed on zooplankton, such as bivalve veligers, copepods of all stages, fish larvae, and gastropod veligers (Larson, 1991).

The University of Georgia Aquarium currently has cannonball jellies on display in a Kreisel tank specially designed to house sea jellies. Previously the Kriesel tank contained moon jellies, *Aurelia aurita.* In a recent transition to exhibit the cannonball jellies, difficulties arose. The cannonball jellies tend to spend the majority in a bottom corner of the tank instead of in the center of the tank. The cannonball jelly is denser than the moon jelly and requires adjustments to the water circulation. The current problem that the UGA Aquarium faces is possibly a water circulation issue in the tank. The purpose of this study was to determine whether the fixed position (bottom corner) of the cannonball jellies is an active response to environmental stimulus (water circulation) or if current water circulation is forcing the jellies into the location.

Methods

The cannonball jellies were collected from Wassaw Sound located on the coast of Georgia on a 0.6 m Carolina Skiff. A dip net was used to scoop the jellies out of the water, and they were placed into a 150 L container of water for transport back to the UGA Aquarium. The cannonball jellies were placed into a 1362.75 L (360 gal) Kreisel tank specifically designed to house them. A Kreisel tank creates a gentle circular water current to keep the jellies from bumping into the walls or getting stuck in a corner like rectangular tanks. From the front (public viewing) side in Fig. 1, water enters the tank in the top right corner, water returning from the filter is in a filtration loop (creates a downward flow). A closed loop (labeled B in Fig. 1) creates a flow across the bottom towards the left side towards the open loop (labeled A in Fig. 1). A current moves upwards along the left side of the tank which creates a clockwise rotation.

Husbandry for the cannonball jellies and Kreisel tank consisted of daily water quality management, cleaning, and feeding. The Kreisel tank used has an overflow-sump system with three modes of water filtration: biological, mechanical, and chemical. An ultraviolet (UV) light is also in place as an additional filtration. Mechanical filtration happens as water from the overflow passes through three mesh filter bags upon entering the sump. Medium-sized rocks in one compartment of the sump provide surface area for bacteria carrying out the biological filtration. Chemical filtration is done with a protein skimmer that removes dissolved organic compounds through foam fractionation. Dissolved compounds adhere to the liquid/air interface of the foam bubbles that build up in the collection chamber of the skimmer where the dissolved compounds rise and become a frothy scum on the surface of the tube. The UV light helps to reduce the number of microorganisms located in the water through irradiation. Water leaving the sump passes through a UV light chamber before it returns to the main tank.

Water quality was maintained through daily cleaning of the protein skimmer and filter bags. The filter bags were cleaned using a simple garden hose. The bags were removed and placed in a bucket where they were transported to the hose located outside. Each bag was turned inside out and sprayed with the hose until it was a white/peach color. The bags were inverted and then placed back into the tank.

The cannonball jellies were fed twice a day, once in the morning and once in the evening. They were fed brine shrimp, *Artemia* sp. nauplii, which were made 24 hours before hand. The brine shrimp were prepared in a conical brine shrimp hatching jar. A liter of water was placed into the cone with 20mL of brine shrimp cysts. Twenty-four hours before a batch of brine shrimp was ready, two drops of Selcon was put into the cone. At the bottom of the cone was a valve where the hatched brine shrimp sp. nauplii were drained out.

The first experiment conducted was to determine whether the fixed position of the cannonball jellies was an active response to environmental stimulus or due to current water circulation. A neutrally buoyant float was constructed using an 82 g hamster ball and 0.5 g pebbles. A 3.8 L bin was filled half-way with salt water. A hamster ball was placed into the water without air bubbles. Pebbles were placed into the ball one at a time until the hamster ball was able to remain in the center of the water column without sinking or floating to the surface. The neutrally buoyant float was then placed into the Kreisel tank where it was allowed to fully circulate around the tank.

The second experiment consisted of manipulating the flow rate of water in the Kriesel tank and calculating the flow rates of the adjusted circulations. The neutrally buoyant float was placed into the Kreisel tank and allowed to fully circulate around the tank until it was determined that it was not resurfacing or sinking. The flow rate of the tank was determined using a stopwatch, measuring tape, and a dry erase marker to track the neutrally buoyant float. The starting point was located in the top left corner. Once the float reached or came close to the starting point the timer was started. At ten second intervals dots were drawn on the glass of the tank to document the location of the float. Once the float completed a full rotation around the tank and arrived back to the original starting point, the last point was documented. The distance between each point was measured and recorded. This process was repeated for three trials with two full rotations of rest in between each trial. The flow rate of each interval was calculated by dividing the distance between the points by ten seconds. The mean velocity of each trial for each section of the tank (Fig.1) was also calculated. The average flow rate of the tank during each adjustment was calculated to determine whether each adjustment manipulated the track of the neutrally buoyant float.

Three trials were run for each of the four adjustments to the circulation. The first consisted of unplugging or turning off the flow of the tank. The second was to plug in or turn on the flow in the tank and to close the open loop (B in Fig. 1) on the left side of the tank. The bottom loop (A in Fig. 1) located in the bottom right corner was opened all of the way. The third was the reverse of the second adjustment. The bottom loop (A in Fig. 1) was closed all the way and the open loop (B in Fig. 1) was opened all the way. The fourth adjustment was that both loops were opened all of the way. In all of the adjustments the neutral buoyant float circulated around the tank twice before each trial was commenced and was not removed from the tank.

The third experiment consisted of fabricating three triangular shaped ramps made of plexi glass and silicon glue. They were placed on the bottom of the tank in an effort to disrupt the circulation. The first ramp was 5.08 cm by 4.39 cm by 36.83 cm, the second ramp was 10.16 cm by 8.97 cm by 36.83 cm, and the third ramp was 2.54 cm by 2.54 cm by 36.83 cm to form a prism. The first two ramps were weighed down with lead weights to keep them anchored down. The third ramp did not require a weight to weigh it down. The ramps were placed into the tank in various positions at the bottom, and the response of all of the cannonball jellies to each ramp was recorded.

Results

In the first experiment the neutrally buoyant float was able to remain in the water column when placed in a specific location. When placed in the Kreisel tank the neutrally buoyant float circulated around the tank without resurfacing or sinking to the bottom of the tank. Experiment one concluded that the cannonball jellies are not physically being confined to a fixed location (bottom corner) by the circulation pattern.

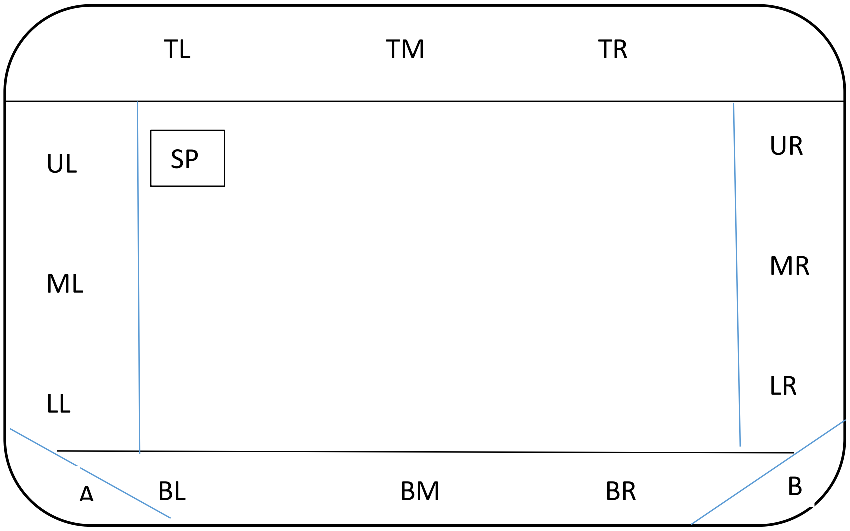

Figure 1. The SP symbolizes the starting point of each trial in each adjustment. The A in the bottom corner symbolizes the open loop in the tank. The B in the bottom corner symbolizes the closed loop. The positions reported in experiment 2: Top Left (TL_{AV}), Top Middle (TM_{AV}), Top Right (TR_{AV}), Upper Right (UR_{AV}), Middle Right (MR_{AV}), Lower Right (LR_{AV}), Bottom Right (BR_{AV}), Bottom Middle (BM_{AV}), Bottom Left (BL_{AV}), Lower Left (LL_{AV}), Middle Left (ML_{AV}), Upper Left (UL_{AV}), Center (C_{AV}), Center Middle (CM_{AV}), Center Right (CR_{AV}), Center Left (CL_{AV})

In the second experiment the average of each position for each adjustment was calculated. Adjustment two had the fastest average flow rates. The neutrally buoyant float was in each adjustment and how fast it circulated around the tank over a ten second interval (Figures 2-6). Each adjustment did not improve the fixed position of the cannonball jellies without forcefully moving them.

Table 1. Average flow rate in each adjustment and in all positions. The positions reported in experiment 2: Top Left (TL_{AV}), Top Middle (TM_{AV}), Top Right (TR_{AV}), Upper Right (UR_{AV}), Middle Right (MR_{AV}), Lower Right (LR_{AV}), Bottom Right (BR_{AV}), Bottom Middle (BM_{AV}), Bottom Left (BL_{AV}), Lower Left (LL_{AV}), Middle Left (ML_{AV}), Upper Left (UL_{AV}), Center (C_{AV}), Center Middle (CM_{AV}), Center Right (CR_{AV}), Center Left (CL_{AV})

	Adj. 1	Adj. 2	Adj. 3	Adj. 4
TL_{AV}	0.040	0.164	0.094	0
TM_{AV}	0.040	0	0	0.038
TR_{AV}	0.026	0	0.011	0
UR_{AV}	0.019	0	0.012	0
MR_{AV}	0.028	0.043	0.012	0.030
LR_{AV}	0	0.052	0.059	0
BR_{AV}	0.036	0.034	0.033	0
BM_{AV}	0.036	0.042	0.026	0.074
BL_{AV}	0.026	0	0.045	0.013
LL_{AV}	0.013	0.017	0	0.010
ML_{AV}	0.012	0	0	0
UL_{AV}	0.010	0	0.049	0.054
C_{AV}	0.004	0	0	0.009
CM_{AV}	0	0	0	0.013
CR_{AV}	0	0	0	0.008
CL_{AV}	0	0	0	0.018

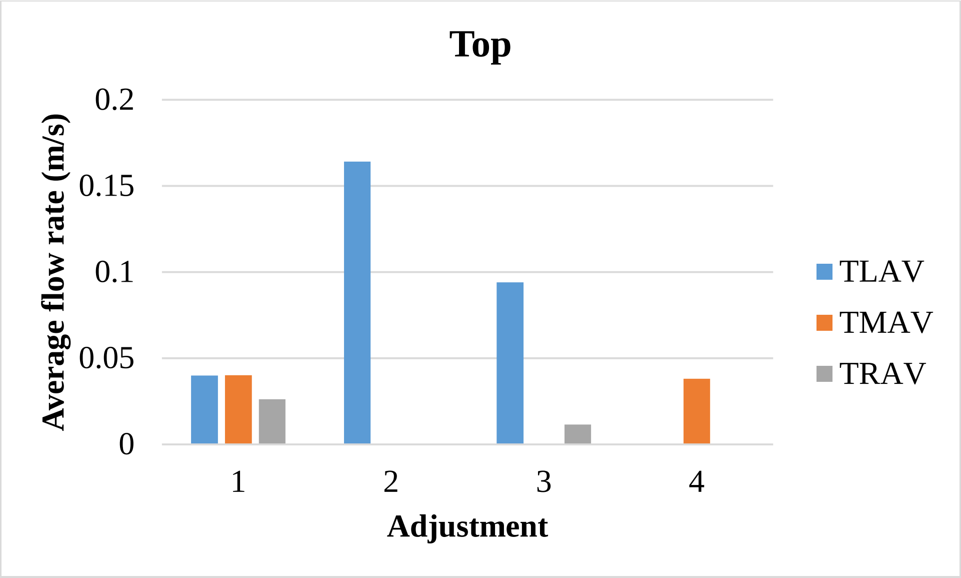

Figure 2. Average flow rate in the top positions of the tank during the four adjustments. The missing bars shows that in the ten second interval the float was not recorded in that position at the top of the tank. Adjustment 1= unplugging or turning off the flow of the tank. Adjustment 2= close the open loop (B in Fig. 1) and open the bottom loop (A in Fig. 1). Adjustment 3= open the open loop (B in Fig. 1) and close the bottom loop (A in Fig. 1). Adjustment 4= all loops were opened all of the way.

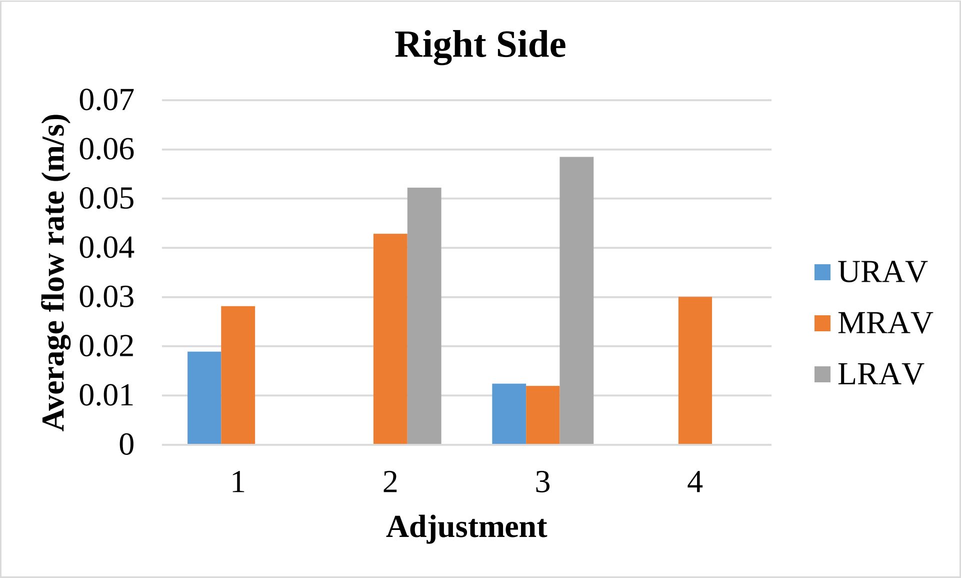

Figure 3. Average flow rate on the right side positions of the tank during the four adjustments. The missing bars shows that in the ten second interval the float was not recorded in that position on the right side of the tank. . Adjustment 1= unplugging or turning off the flow of the tank. Adjustment 2= close the open loop (B in Fig. 1) and open the bottom loop (A in Fig. 1). Adjustment 3= open the open loop (B in Fig. 1) and close the bottom loop (A in Fig. 1). Adjustment 4= all loops were opened all of the way.

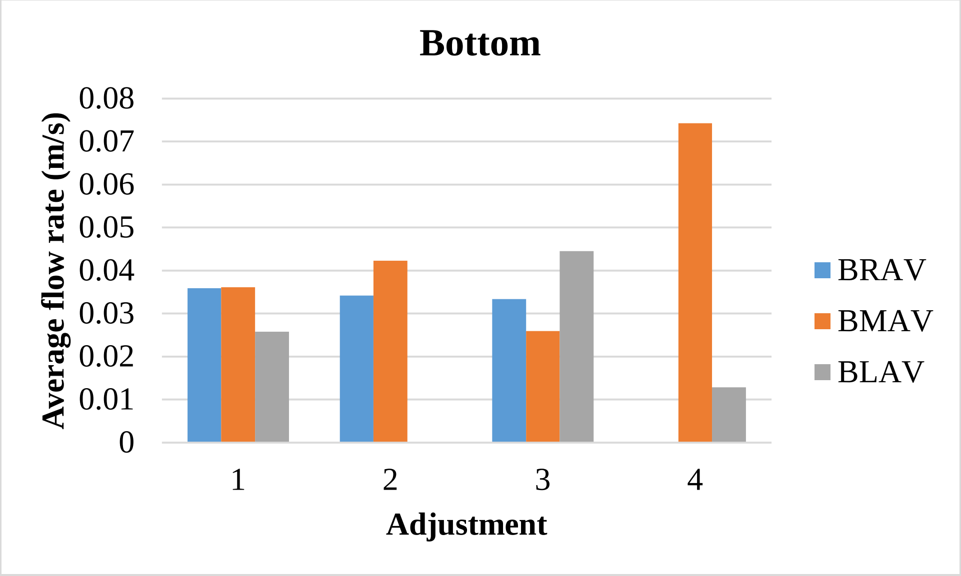

Figure 4. Average flow rate at the bottom positions of the tank during the four adjustments. The missing bars shows that in the ten second interval the float was not recorded in that position at the bottom of the tank. . Adjustment 1= unplugging or turning off the flow of the tank. Adjustment 2= close the open loop (B in Fig. 1) and open the bottom loop (A in Fig. 1). Adjustment 3= open the open loop (B in Fig. 1) and close the bottom loop (A in Fig. 1). Adjustment 4= all loops were opened all of the way.

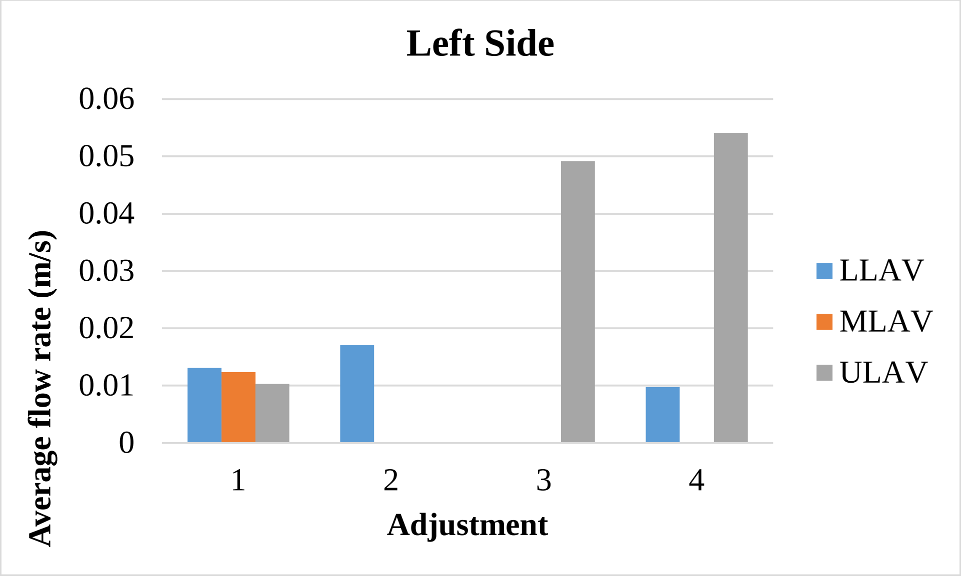

Figure 5. Average flow rate on the left side positions of the tank during the four adjustments. The missing bars shows that in the ten second interval the float was not recorded in that position on the left side of the tank. . Adjustment 1= unplugging or turning off the flow of the tank. Adjustment 2= close the open loop (B in Fig. 1) and open the bottom loop (A in Fig. 1). Adjustment 3= open the open loop (B in Fig. 1) and close the bottom loop (A in Fig. 1). Adjustment 4= all loops were opened all of the way.

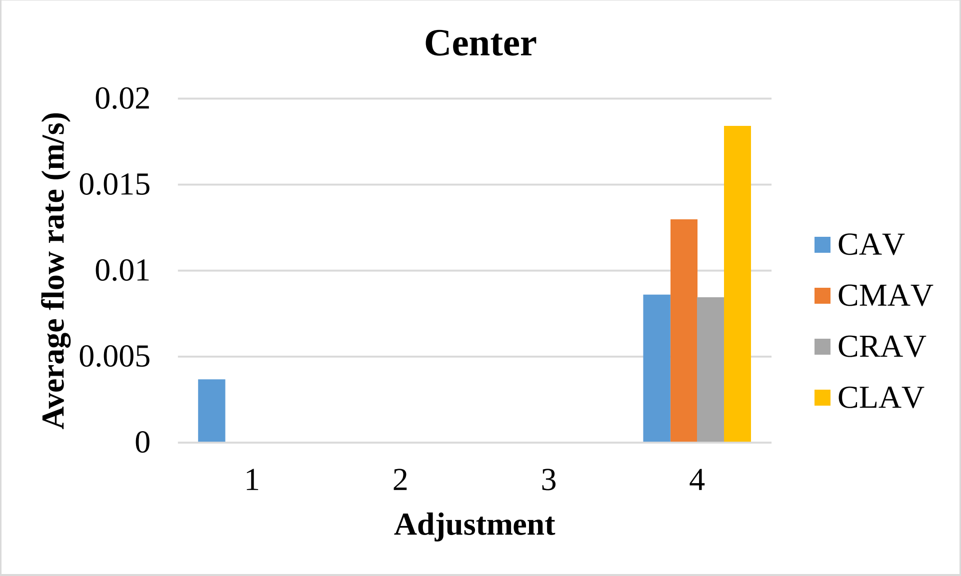

Figure 6. Average flow rate in the center positions of the tank during the four adjustments. The missing bars shows that in the ten second interval the float was not recorded in that position at the center of the tank or that the float never went to the center of the tank. . Adjustment 1= unplugging or turning off the flow of the tank. Adjustment 2= close the open loop (B in Fig. 1) and open the bottom loop (A in Fig. 1). Adjustment 3= open the open loop (B in Fig. 1) and close the bottom loop (A in Fig. 1). Adjustment 4= all loops were opened all of the way.

In experiment three the responses that the cannonball jellies displayed to each ramp was recorded. When both the 5.08 cm and the 10.16 ramp were placed in the tank the jellies approached the ramps and responded similarly as if it was the original fixed location (bottom corner) in the tank. When both ramps were placed in a new position, the jellies followed it and continued to lean against the ramp. When the 2.54 cm ramp was placed in the tank, the jellies reacted in an approached the ramp, but they remained approximately 10 cm away from the ramp without touching it. All three ramps disrupted the flow of circulation in the tank but not enough to move the jellies to the center or off the bottom of the tank.

Discussion

The cannonball jellies were not forced in to the corner of the tank because of water circulation. The fact that the neutrally buoyant float was able to fully circulate around the tank without getting stuck in a corner shows that the cannonball jellies are displaying an active response to environmental stimulus (water circulation). When the ramps were placed in the tank they did disrupt the circulation however, the different currents did not result in the intended effect of causing the jellies to suspend into the center of the tank. The ramps did effect the sea jellies in every new position they were. When the 5.08 cm and the 10.16 cm ramp and the 2.54 cm were placed in the tank the cannonball jellies did follow each ramp in every position. However, when the larger ramps were in the tank they came into contact with them.

Prior to the cannonball jellies being placed into the Kriesel tank, they were in a holding tank that had a horizontal water circulation on a different axis plane versus the vertical circulation in the Kriesel tank. The cannonball jellies moved freely in the holding tank and did not remain in a corner in the tank. The holding tank was much wider in shape compared to the Kriesel tank. The Kriesel tank may be too narrow and confining for this species of sea jelly (Dumont). With further studies there could be an analysis of whether the direction of the circulation is a variable. This study improves the knowledge of cannonball jelly care in captivity by revealing that the Kreisel tank design may not be suited well for this species. Future studies of how to keep this specific species in captivity will be needed for educational display in order to better understand why the cannonball jellies reacted negatively to the stimuli.

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