Moving pattern and feeding behavior of blue-spotted ribbontail ray (*Taeniura lymma*) in aquaria environment

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Abstract. The moving pattern and feeding behavior of blue-spotted ribbontail ray (*Taeniura lymma*) in aquaria environment was studied within 27 days. The moving pattern observations (e.g. movement, respond to stimulation, feeding and breathing activities) were conducted by direct observation and by recording their activities during day and night. The feeding behavior was observed by feeding them in a variety of food. The study showed that ray was active at day and becoming passive during night. The moving pattern included maneuver in vertical and horizontal directions, walk and jump on aquaria bottom, and fast reflective movements. The ray showed ability in prey hunting, more like to fed living fodder with a smooth texture, not a corpse eater, had abilities to modulate breathing rate regarding varying activities, and had skills to acclimatize in strong inflow changes of aeration and water flow.

Keywords: aquarium, coral reef fish, feeding behavior, moving pattern

1. Introduction

Behaviors study of blue-spotted ribbontail ray (*Taeniura lymma*) is interesting, because of this ray variety is a species that peoples relish it as a pet (Compagno 2005). *T. lymma* usually found at a coastal area (Allen 1996). There are many studies about *T. lymma* in common description of swimming ability, having a maneuver, and prey behavior. The ray stays in cavity, reef rift and below wreckage at daytime (Last *et al* 1999). Ray movements are dominated by elastic pectoral fin undulations (Blevins *et al* 2012). The ray performs a maneuver to stay away from predators, to prey and to attract the opposite sex (Parson *et al* 2011). The ray preys crustaceans, mollusks, polychaeta and small benthic fishes. The ray snares its prey below the body then preying in a short time (Heemstra 2004).

Ray movements are affected by the activity of pectoral, ventral, dorsal and anal fin. The main fin affecting all movements is pectoral fin. Pectoral fins help the ray in maneuvering. This function can be clearly seen because of the movements of these fins are stiffer and perpendicular to the water flow direction. Ventral fins are used by ray for walking activity at beds. This walking ability is showed that muscles of ventral fins are harder than pectoral fins. Dorsal and caudal fins are located at its tail, and they are passive because the ray hardly moves them freely. The tail can move only in vertical directions. This study aimed to investigate the moving pattern.
observations (e.g. movement, respond to stimulation, feeding and breathing activities) by direct observation and by recording their activities during day and night.

2. Materials and methods

2.1. Study species
*T. lyamma* (Blue-spotted ray) was purchased from a marine pet shop in Jakarta. The ray was transported in a container with limited dissolved oxygen. The oxygen concentration was assumed enough during transportation processes. Container temperature was estimated up to 27°C. Acclimatization after transportation was around an hour, by displacing the container to an aquarium. After an hour, the ray was released to the aquarium. Acclimatization period in the aquarium environment was four days. Aquarium temperature during the observation was 26°C-27°C.

2.2. Moving pattern observations
The observation of movement pattern was conducted every 2 hours to distinguish ray movements per time unit in 27 days. This observation aimed to see maneuvers and typical movements at bed and water column. Maneuvers and the other actions were observed by counting fin undulations frequency via video records. Responses to physically stimulus aimed to see physically response against contacting, shocking, and down-falling material to its body. These treatments were done in working and rest conditions of the ray. Observation of the breath pattern incorporating the number of inhalation and exhalation processes per time unit was recorded every 2 hours in the same condition. Responses against water and aeration inflow were also performed. This observation was conducted by testing the ray against limited and ceased inflow water and aeration for 4 hours. After that, the ray was observed in breathing, moving, feeding, preying and physically response pattern. This treatment was conducted three times during the study period.

2.3. Feeding behavior
Two feeding periods occur in a day: The first period was 7.30-10.00, and the second was 16.00-19.00. Observation on feeding and preying pattern of ray was observed in every 2 hours. The ray was treated with four kinds of feed, including fresh shrimp, living clam, living hermit crab and shrimp pellet. Weight of a piece of shrimp flesh was equal to half a piece of clam flesh and to a piece of hermit crab flesh. Weight of a piece of shrimp flesh was around 5 grams. Fresh shrimps were given in the first nine days followed by living feeds until the day of 24th and shrimp pellets until the day of 27th.

3. Results and discussion

3.1. Moving pattern
The ray moves pectoral fin from posterior to anterior to move backward. When the body was started to be forced, the ventral fins have modulated the movements, so it seems going to be slanted to the anterior side (figure 1A). Backward movements possibly happened at beds and column water. Figure 1B and 1C showed a forward movement. In order to move forward, pectoral fins were moved from anterior to posterior direction. The forward movement in figure 1B was not faster than the forward movement in figure 1C. The movement pattern of figure 1C happened when the ray shuns a physical stimulus, prepare for maneuvering and prepare for swimming to the upper water column.

Figure 1D showed the ray is going down to the beds. When going down, the fin was tending to be passive. When the fins have relaxed in a more extended period, the downward movement was going faster. Down movement velocity was not faster than upward movement. The angle of body elevation when moving downward was not higher than 35°C. Ray could not maneuver to the upper water column when in downward moving processes. Figure 1E showed how the ray is walking on beds. When walking, all fins were folded upward, except for ventral fin. Ray moves a part of ventral fin one by one,
seems like mammals walk on the grounds. Ray could not walk in an extended period. Maximum step of walking was six. Ray could walk forward and backward. Ray could also jump by using ventral fins. Standing of ventral fins also indicates the ray was ready to swim to the water column. Paddling of ventral fins can be used to amass sediments.

Figure 1F shows the ray condition when trying to catch feed on beds. The ray blows and sucks a water mass to find a feed. This behavior makes the whole of ray’s body unstable in meridian direction, therefore the ray uplifts its tail and snout to create a balance condition. Figure 1G shows how the ray turns right. When turning right, pectoral fin at the right side was less undulating than the one at the left side. Ray can turn right or left with or without using ventral fins. By using ventral fins, the ray can change swim directions faster. *T. lymma* has fin muscles along the body. All muscles are active, except in slow movements when they are not needed to swim faster or go to the upper water column (Rosenberger 1999). Undulations which are formed by pectoral fins indicate the swim speed (Blevins *et al* 2012). Faster undulation is causing the ray to swim faster. Increasing of undulation frequencies causes the length and amplitude of fin wave shorter. The highest number of undulation is 5 times per second.

Figure 1. The moving pattern of Blue-spotted ribbontail ray (*T. lymma*): (A) backward movement, (B) forward slower movement, (C) forward faster movement, (D) downward movement, (E) walking movement, (F) balancing behavior, and (G) turning movement.
Ray shun a physical stimulus in the way of moving backward when at beds and maneuvering vertically or horizontally when at the water column. Ray is not able to do downward maneuvering. The ray does not like significant material-material that is bigger than sediment particles-downfall on its body. Those materials would be flown to the water column by pectoral fins movements. This process happens until the body is clean. Ray does not give a response after the feeding period. It is maybe caused by needs of high energy in digesting processes; therefore, the ray decides to diminish releasing energy by doing movements activity.

Ray does not give a significant physical response to aeration limitation within 4 hours. When doing the activity, ray shows a change of skin color. The skin color changed to be paler. The transformation of skin color is assumed as response due to decreasing of dissolved oxygen inside the body. Skin color is essential to give warning to the other aquatic animals that the ray has extinguished poisons (John 2006).

3.2. Feeding behavior

Feeding pattern constantly fluctuates after acclimatization periods (day 1 to 4). Commonly, rest period happens after the ray preys two units of feed. The rest period is indicated by the absence of feeding activity in a day (figure 2). After the rest period, the ray preys one unit of feed for several next days (figure 3). This feeding pattern was frequently found during this study. In a particular case, there were some days where the ray did not show feeding activities, i.e. day 1st-4th, 6th, 10th, 14th, 17th-18th and day 25th-27th. Day 6th, 10th and 14th were period after high feeding activity, whilst day 25th-27th was the period of feed substitution from living clam to shrimp pellet.

Ray is favored living clams than fresh shrimps and shrimp pellets. Ray does not feed the bowel of clam and dead clam. Ray needs a longer time to devour shrimp flesh than clam flesh. Shrimp flesh is chewier and denser than clam flesh. Clam flesh is easy to be crushed even the ray does not shred it. Ray does not prey living hermit crab and clam that hide below reef. Ray waits for the clam exit from reef and opens the shells. When the shells are opened the ray come very fast. This response is electroreceptor ability to detect prey’s movements (Miller 2002). According to McEachran (2004), ray can break the shell. This study shows that not all kinds of shells can be broken down. Ray is only can break the shell with a thickness less than 1.5 mm (figure 4). Ray can prey adult clam only in open shells condition. The opening of shells can be caused by stressing of ray’s shocking movements and can also by ray’s ventral fins soft strokes.
During this study period, ray was having activity at daytime and becoming passive at nighttime. The ray can swim with maneuver in vertical and horizontal directions, can walk and jump on bed, has fast reflective movements, has smart hunting abilities, more like to feed living fodder with smooth texture, not a corpse eater, has capabilities to modulate breathing rate regarding varying activities, and to acclimatize in the significant inflow changes of aeration and water flow.

**Figure 3.** The Number of feeds by *T. lymma* (dead shrimp and living clam) during experiment period in 27 days (☐ = vannamei), (■ = living clam).

**Figure 4.** One type of feed during the experiment, Clam’s shells.

### 4. Conclusion

The ray was active during the daytime and becoming passive at the nighttime. At least 4 moving patterns were observed, i.e. vertical and horizontal directions, walk and jump on aquaria bottom, and fast reflective movements. During the experiment, the ray showed the ability in prey hunting, more like to feed living fodder with a smooth texture, not a corpse eater. Regarding respiration behavior the ray had abilities to modulate breathing rate regarding varying activities, and had abilities to acclimatize in the significant inflow changes of aeration and water flow.
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