Preferential habitat and spatial distribution of 3 species of sicydiine gobies (Genus *Sicydium*) based on substrate and flow rate within the Checkhall River

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Abstract

There are three species of goby from the genus *Sicydium* in the Checkhall River on the island of Dominica: *S. punctatum*, *S. plumieri*, and *S. buscki*. This genus is amphidromous meaning that these fish mature in saltwater and travel up freshwater rivers to spawn (Busson, 2017). When traveling upstream the gobies rest and feed on algae in pools between riffles. This study specifically focuses on the preferred habitat of sicydiine gobies within pools based on substrate and water velocity that these fish relate to. A total of 381 gobies were surveyed in a total of 8 pools. Each pool was divided into an upstream, middle, and downstream section where water velocity (M/S) was measured and each section contained large rocks ($S > 15$ cm), small rocks ($1 \text{ cm} < S \leq 15$ cm), and gravel ($S \leq 1$ cm). Gobies significantly preferred large rocks upstream and small rocks downstream. The data presented low numbers of individuals counted that were relating to gravel upstream and downstream. This supports that this is not a random occurrence and these gobies have a preferred habitat.

Introduction

The beautiful island of Dominica may only be 751 square kilometers but reigns as one of the most biodiverse islands of the Lesser Antilles (CIA, 2017). Situated south of Guadeloupe and north of Martinique this island displays lush rainforests, cloudy elfin forests, a boiling lake, and mountain-fed rivers. Within the rivers there are three species of algae eating gobies of the genus *Sicydium*. Particularly in the Checkhall River located on the southwest side of Dominica, gobie species present are *S. punctatum*, *S. plumieri*, and *S. buscki* (Adams, Boggs, Coe, Diaz, 2016). The Sicydiine gobies are an amphidromous (diadromous) fish meaning they spend the beginning of their lives in

saltwater to mature (Busson, 2017). After maturation, the gobies migrate up freshwater rivers to spawn. Once spawning has occurred the hatchlings float downstream to the saltwater to mature. Gobies of the genus *Sicydium* are capable of traveling up fast flowing rivers because of a ventral adhesive disc that has formed from the fusion of pelvic fins (Diaz, 2016). This disc allows the fish to stick to substrate so that it can feed on algae without being swept away by the current (Coat, Monti, Lepoint, 2008). This study was completed out of the interest of what kind of substrate gobies prefer to cling to in order to further understand where they congregate and how they move upstream. In order to understand this behavior this study examined the preferred habitat of the three species of *Sicydium* found in the Checkhall River.

Methods

This study was completed over the course of 13 days in the Checkhall River on the island of Dominica, West Indies. There were a total of 8 pools selected to complete the survey of the preferred habitat for Sicydiine (three species combined) gobies. A pool was defined as an area between two riffles that presented a greater depth and slower water velocity than the upstream and downstream riffle. A riffle was defined as an area in the river that presented a depth of less than or equal to 25 centimeters and visually had a much higher water velocity than the immediate upstream or downstream area of the river. Each pool was selected based on accessibility and likelihood to obtain quality surveys and was marked with orange flagging tape. No two pools were identical but all were measured in the most uniform way possible. Each varied in length, width, depth, benthic substrate, and water velocities (Figure 1). Mapping of each pool was completed by sketching a general outline of the water's edge from the perspective of facing upstream

towards the pool. The left side of the pool was the north side and the right side was the south side because the Checkhall River runs from east to west.

Length and width were measured using a 50-meter tape measure. Length was measured with a tape measure from the end of the upstream riffle to the beginning of the downstream riffle. Width was measured by a tape measure from the widest point on the north side of the pool to the widest point on the south side of the pool.

The most uniform way to measure depth was to stand in the north side (depth 1), middle (depth 2), and south side (depth 3) of the river when facing upstream. The deepest point was measured from the ground bottom of the pool to the surface of the water.

Water velocity was measured using a Geopacks flow meter that measured the rotations of the propeller that was fully submerged in the water. Each measurement was timed for one minute to obtain the reading of rotations per minute (RPM). Each reading was later converted to meters per second (M/S) by using the formula:

$$\text{Meters per Second} = 0.000854C + 0.05$$

where C equals RPM. A reading for each pool's water velocity was taken at the upstream third of the pool, middle third of the pool, and downstream third of the pool (Figure 1). Each water velocity reading for the upstream and downstream were measured a meter from the defined riffles and the middle third was measured in the direct center of the pool.

Benthic substrate was mapped out by roughly sketching where there were large rocks, small rocks, and gravel. A large rock was defined as being greater than 15 centimeters ($S > 15$ cm), a small rock was defined as being greater than 1 centimeter or less than or equal to 15 cm ($1 \text{ cm} < S \leq 15$ cm), and gravel was defined as being less than

or equal to 1 cm (S ≤ 1 cm). Finding the benthic substrate makeup of each pool allowed for a basic percentage chart for each type of substrate in each pool. Observations were taken via mask and snorkel at the upstream, middle, and downstream areas of each pool. Gobies were counted and categorized into three groups based on the rock size. The average numbers of gobies per pool were calculated for all three types of substrates and all three types of water velocities (Figure 1). The goal was to move as slow as possible and cause the least amount of disturbance as possible so individuals could be counted as accurately as possible.

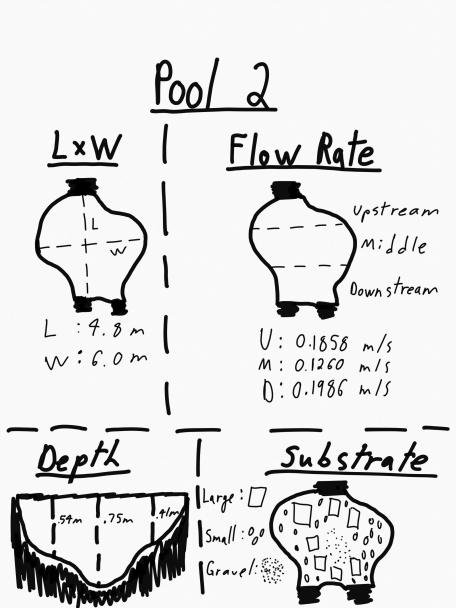

Figure 1. Examples of sketches drawn in the field where length, width, flow rate, depth, and substrate were determined.

Results

There were a total of eight pools surveyed in the Checkhall River with a total of 381 gobies counted. The data shown in Figure 2 presented a P value of less than 0.001, 4 degrees of freedom, and a Pearson Chi-Square value of 53.3. This data is significant and

shows a high contingency for gobies relating to large rocks upstream and small rocks downstream. Presence on gravel substrate upstream and downstream was significantly lower than the rest of the data providing evidence that this spatial distribution was not a random occurrence.

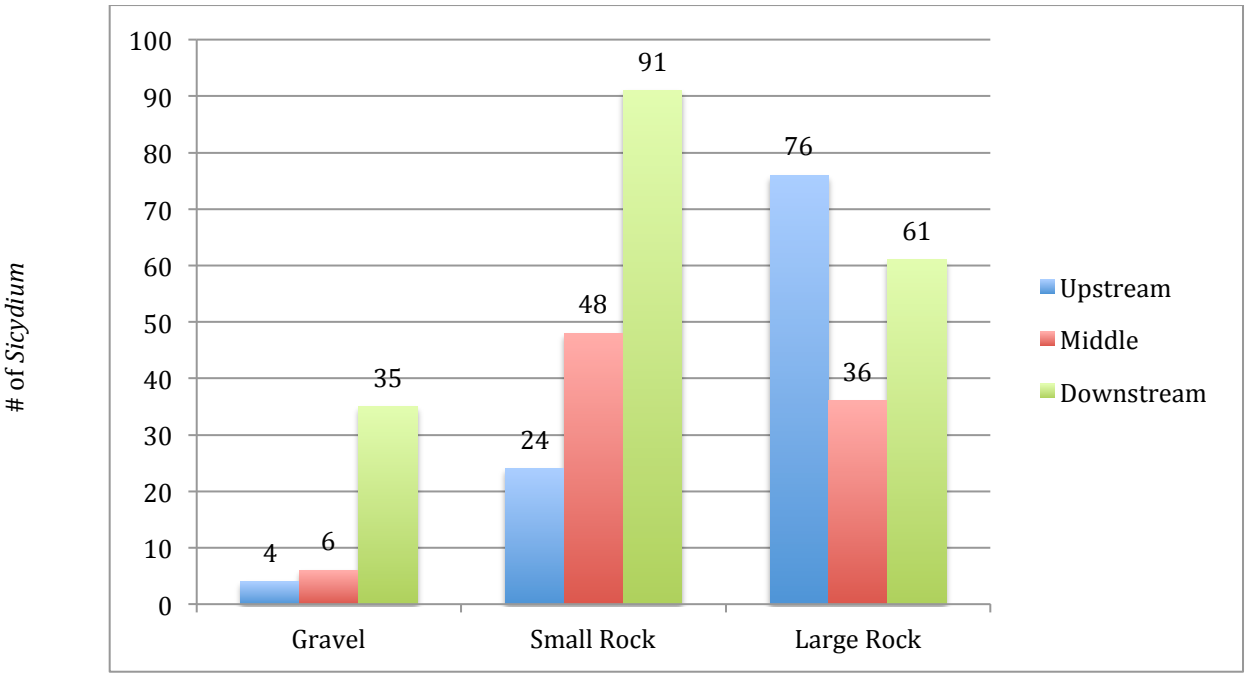

Figure 2. The number of Sicydiine gobies counted within the eight pools based on the substrate they were present on and the area of the stream they found. The P-value for this data was found to be less than .001 showing a preference for gobies relating to large rocks upstream and small rocks downstream.

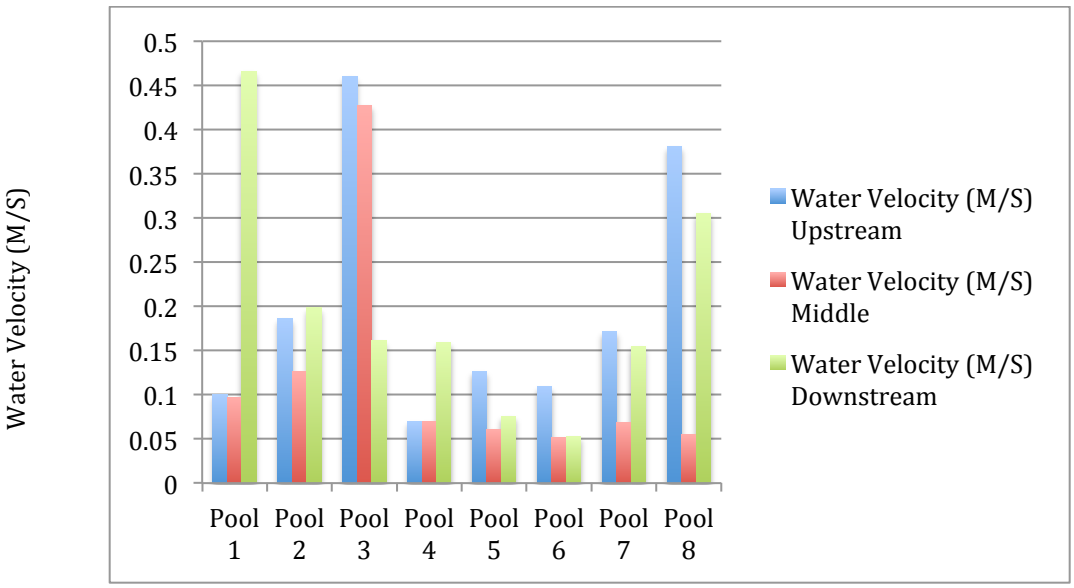

Figure 3. Water velocity was recorded in meters per second. Water Velocity in 6 of the 8 pools was highest upstream, which correlates to aggregates of gobies on large rocks upstream

Discussion

Gobies aggregate on large rocks upstream and small rocks downstream in comparison to a rare presence on gravel upstream and downstream due to the higher flow rates as seen in Figure 3. This seems to be the case because large rocks and small rocks are stationary while gravel is easily swept away. The use of ventral suction disks by Sicydiine gobies allows them to anchor to surfaces, which must cause the relation to more stationary, reliable surfaces. These reliable surfaces can also support constant feeding habits that are necessary for growth and constant energy being expended in fast flowing currents (Peters, 2015). This habitat preference seems to root from the instinctual movement upstream to breed (Bell, Pepin, Brown, 1994). When faced with high water velocities in the downstream area of the pool gobies may use the small rocks to rest. Figure 3 shows that a majority of the upstream areas have the highest water velocity in

the pools, which might push gobies to anchor on large rocks and or hide under large rocks to rest. There might also be a correlation of individuals relating to large and small rocks because of larger food sources.

Possible errors that might have occurred in this project were missing gobies because they were hiding under rocks, double counting individuals, or disturbing individuals causing movement. Surveys were completed as carefully and slowly as possible, however errors could have been made.

Data presented in Figure 2 shows a definite association of *S. punctatum*, *S. plumieri*, and *S. buscki* relating to large rocks upstream and small rocks downstream in pools. This information gives further understanding of how algae eating gobies congregate and move upstream.

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