JERÓNIMO DA GRAÇA BASTOS

SWIMMING CAPACITY OF THE POST-LARVAE OF THE LITTLE FISH OF SÃO TOMÉ

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Declaration of work authorship

SWIMMING CAPACITY OF THE POST-LARVAE OF THE LITTLE FISH OF SÃO TOMÉ

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Abstract

Little fish from São Tomé is the name attributed to a set of Gobiid post-larvae that includes the species: *Sicydium bustamantei, Sicydium brevifile* and *Awaous lateristiga*, which are caught at the mouths of the island's rivers. It represents a source of animal protein and one of the main financial resources for fishing communities. These species, during the breeding season the adults form pairs and lay their eggs in the lower parts of the rocks and crevices. After hatching in fresh water, the larvae are dragged by the currents to the ocean where they develop into planktonic post-larvae and make the migration back to the rivers. In this sense, the present study sought to identify whether there is variation in the swimming capacity of these little fish. For this purpose, tests were carried out in laboratories using the swimming chamber. The swimming capacity of the post-larvae of *A. lateristriga* ranged from 7 to 23 $cm.s^{-1}$ reaching the critical swimming speed (U_{crit}) of 5.42 minimum and 22.08 maximum. *S. brevifile* with 8 to 23 cm.s-1 and (U_{crit}) of 7.32 minimum, 22.02 maximum and *S. bustamantei* ranged from 4 to 23 $cm.s^{-1}$ and (U_{crit}) of 2.09 minimum and 22.0 maximum in the swimming chamber . It was found with this study that the variation of the critical swimming speed is not homogeneous between the species. There was a slight difference between the critical swimming speed of *A. lateristiga* in relation to other species, so the swimming capacity of the species is not influenced by their length. However, this study contributes to the understanding of the variation of the swimming capacities of the post-larvae little fish and the dynamics of their migratory flow.

keywords

Swimming chamber, Swimming capacity, Critical speed, Migratory flow.

Resumo

Peixinho de São Tomé é o nome atribuído a conjunto de pós-larvas de Gobiídeos que incluí as espécies: *Sicydium bustamantei, Sicydium brevifile* e *Awaous lateristiga*, que são apanhados na foz dos rios da ilha. Representa uma fonte de proteína animal e um dos principais recursos financeiros para as comunidades piscatórias. Essas espécies, durante a época de reprodução os adultos formam pares e depositam seus ovos nas partes inferiores das rochas e fendas. Após a eclosão em água doce, as larvas são arrastadas pelas correntes até o oceano onde se desenvolvem em pós-larvas planctónicas e fazem a migração de retorno aos rios. Neste sentido, o presente estudo buscou identificar se existem variação da capacidade natatória desses peixinhos. Para tal foram realizados testes em laboratórios utilizando a câmara de natação. A capacidade natatória das pós-larvas de *A. lateristriga* variou de 7 a 23 cm.s^{-1} atingindo a velocidade crítica de natação (U_{crit}) de 5.42 mínimo e 22.08 máximo. O *S. brevifile* com 8 a 23 cm.s^{-1} e (U_{crit}) de 7.32 mínimo, 22.02 máximo e o *S. bustamantei* variou de 4 a 23 cm.s^{-1} e (U_{crit}) de 2.09 mínimo e 22.0 máximo na câmara de natação. Constatou-se com este estudo que a variação da velocidade critica de natação não é homogénea entre as espécies. Verificou-se uma ligeira diferença entre a velocidade critica de natação do *A. lateristiga* em relação a outras espécies, pelo que, a capacidade natatória das espécies não é influenciada pelo seu comprimento. No entanto, este estudo contribui para compreensão da variação das capacidades natatórias das pós-larvas peixinho e as dinâmicas do seu fluxo migratório.

Key words

Swimming Chamber, Swimming Ability, Critical Speed, Migratory Flow.

INDEX

List of figures

Table list

1. INTRODUCTION

São Tomé and Príncipe is an archipelago located in the Gulf of Guinea on the western equatorial coast of Africa near the equator belonging to the African continent (Figure 1). It consists of the islands of São Tomé and Príncipe. These islands constitute an island state (Democratic Republic of São Tomé and Príncipe) with an area of 1001 km^2 being 859 km^2 on the island of São Tomé, 124 km^2 on the island of Príncipe and 18 km^2 on small islets (INE, 2012).

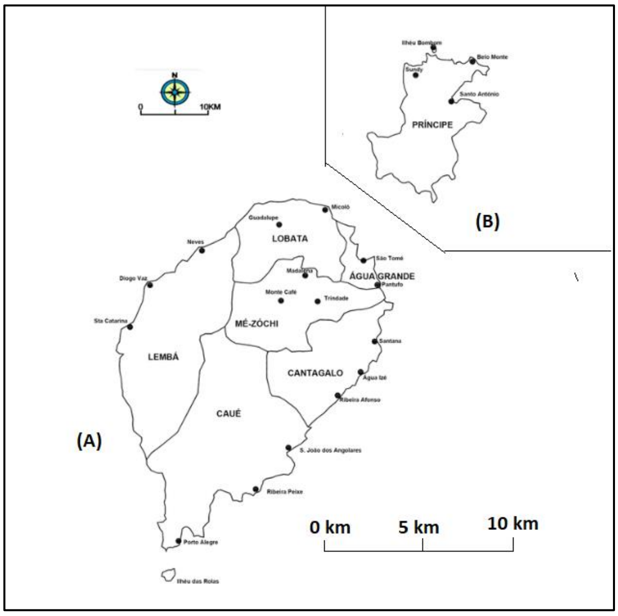


Fig.1: Map of São Tomé Island (A) and Principe Island (B)

The archipelago of São Tomé and Príncipe has only two seasons, the "rainy" (rainy season) in which the climate is warmer and wetter and covers the period from September to May with the temperature ranging between 22 to 31 °C, and the "Gravana" (dry season), the driest and coolest, covering the period from June to August with temperature ranging between 18 and 27 °C (Gomes, 2021).

The islands have a hydrographic structure, consisting of 116 hydrographic basins and 223 rivers and streams with an average length of 5 to 27 km (Figure 2). Among the rivers and streams stands out the Iô-Grande, the largest in São Tomé, and the Papagaio River on the island of Príncipe. The hydrographic structure is radial in shape on both islands, coming from the center of the mountain to the coastal areas. On the island of São Tomé, more than 60% of the runoff is located in the southwest quadrant which, in turn, represents 20% of the total area of the island (200km^2) and is the least populated (INE, 2012).

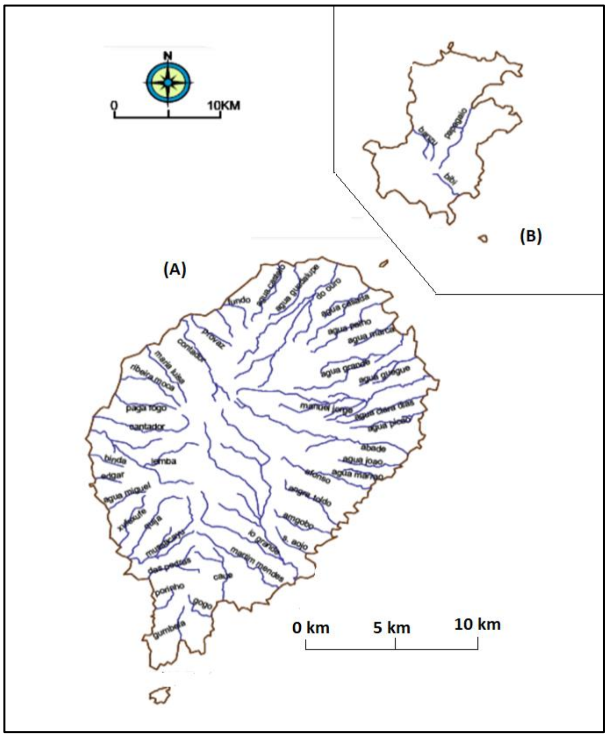


Fig. 2: Hydrographic distribution network of São Tomé (A) and Príncipe Island (B)

The rivers of São Tomé and Príncipe, constitute the habitat for several species, being colonized by amphidromic species, as is the case of the little fish that includes the species *Sicydium bustamantei* Greeff, 1884, *Sicydium brevifile* Ogilvie-Grant, 1884 (Pezold et al., 2006; Wirtz et al., 2007; Baptista, et al., 2020) and *Awaous lateristriga* (Duméril, 1861; Wirtz, 2023). The amphidromous fish of the subfamilies Sicydiinae and Gobionellinae are found in the regions of West Africa, the Pacific, Central America and the Caribbean and with the relatively high level of endemism (Moelants, 2010; Diouf, 2020; Baptista, et al., 2020).

These species are particularly associated with small oceanic islands of geologically recent volcanic origin (Figure 3). They inhabit streams and rivers of rapid flow with rocky substrates usually associated with tropical forest zones with huge cascades and slopes, often oligotrophic and exposed to extreme seasonal, hydrographic and climatic variability (Diouf, 2020; Moelants, 2010; Wirtz, 2023; Baptista, et al., 2020).

Sicydium bustamantei, S. brevifile e A. lateristriga occur in the Gulf of Guinea, on the volcanic islands of São Tomé and Príncipe. They are known locally as " little fish ", constituting one of the main sources of protein and economic income of local fishing communities. These species were also found in West Africa in Bioko and Annobón and little is known about their bioecology, particularly during the dry season and the periods of the full moon and new moon, requiring further studies to understand the biology and ecology of the species (Diouf, 2020; Moelants, 2010; Rosa, 2007; Baptista et al., 2020).

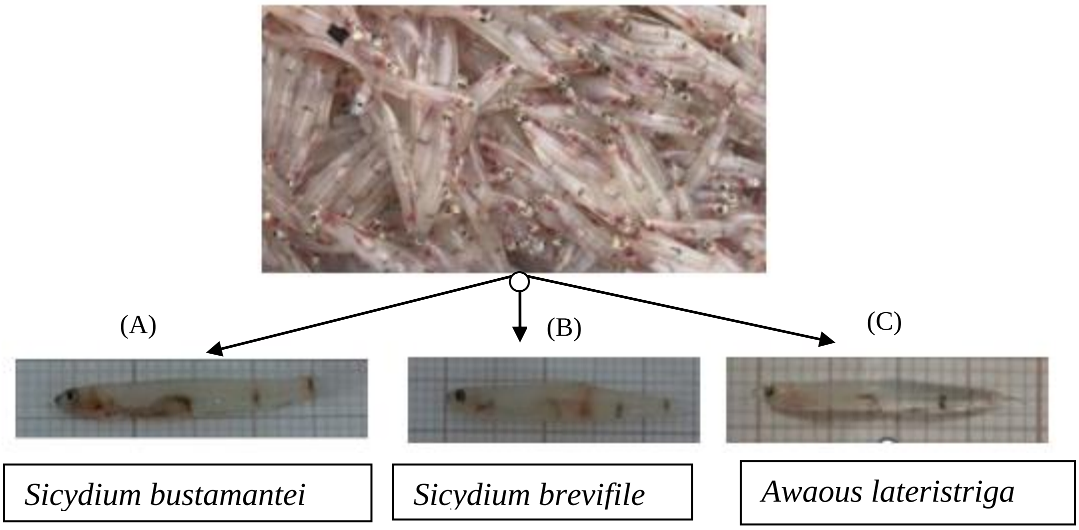


Fig.3: Species of little fish present in São Tomé: Gobiidae – subfamily Sicydiinae *Sicydium bustamantei* Greeff 1884 (A), *Sicydium brevifile* Ogilvie-Grant, 1884 (B), and subfamily Gobionellinae *Awaous lateristriga* (Duméril, 1861) (C).

1.1. Amphidromous fish

Amphidromic species use fresh and salt water to move around to seek food or shelter during their life cycle (Costa, 2017; McDowall, 2004). The term "amphidromia" dates back to the year 1949 to explain the migratory flow of species between fresh and salt water. However, these movements are not related to reproduction since it occurs in fresh water (Myers, 1949; McDwall, 1992; Orsi et al., 2016). The migratory process of these species is often marked by the gobids of the subfamilies Sicydiinae and Gobionellinae, observed in rivers on rocky islands and of volcanic origin (Keith, 2003; McDowall, 2007). Adult fish that live in fresh water usually have the herbivorous diet (an unusual feature in amphidromous fish), which guarantees them the greatest abundance of food, avoiding the food dependence on macroinvertebrates that can be scarce in these ecosystems (Benstead et al. 2009).

During the breeding season adults form pairs and lay their eggs in the lower parts of rocks and crevices, and in some gobids Sicydiinae may have limited parental care with the male protecting the eggs until hatching. However, after hatching in fresh water, the larvae are carried through the river currents to the ocean where they develop into planktonic post-larvae and make the migration back to their natural habitat (Poff & Ward, 1989; Pezold et al., 2006; Perairan, 2021).

A recent study on the diet of *S. bustamantei* by Baptista et al. (2020) revealed that zooplankton and macroalgae residues were the main sources of organic matter used by the species. However, the results also showed that the post-larvae of this species have an omnivorous diet and act as secondary consumers. The constant movements of larvae in most species is still and will continue to be the subject of study by researchers. However, it is known that in some cases the larvae can perform wider movements in the adjacent currents (Lima et al., 2015).

Depending on the use of different habitats and according to the different salinity contents, the life cycles of the species can be of two types: holobiotic or amphibiotic. However, holobiotics are characteristic of species that spend their entire lives in the sea or fresh water, while the amphibiotic life cycle is representative of species that move between environments with different salinity levels (Biender et al., 2011). These transitions of newborn larvae to the pelagic breeding environment (sea or in lakes) is particularly the most vulnerable phase of the life cycle. The larvae of amphidromous fish are very small measuring on average 1.0 mm in diameter (Orsi et al., 2016).

During the recruitment period in a pelagic environment the larvae feed on zooplankton and undergo a transformation, ceasing to be larvae and becoming juveniles (Kondo et al., 2013). At this stage it is common for the larvae of amphidromous fish to become translucent, that is, to be left with the absence of body pigments (Kondo, et al., 2013). This translucent appearance is linked to the occupation of the pelagic environment and aims to avoid predators (Biender et al., 2011).

In the terminal phase of recruitment in a pelagic environment, that is, after the larvae reach the appropriate body size and acquire some skills, they perform the return migration guided by light, salinity, temperature, stage of development or combination of factors (Keith, 2003), odor, sound and visual cues (Yanasivan & Strydom, 2023; Atema et al., 2002), guiding the larvae back to the rivers (Hale et al., 2008). These stimuli, although of great importance for the species, still remain the subject of questioning (Lima, 2011).

The migratory flow of gobids to freshwater generally begins when they reach just over 13 mm in length (Keith, 2003; Lucas et al., 2001), while other species transition to freshwater with sizes equal to or greater than 50 mm (Dunn et al., 2021). In this period of transition several physiological transformations occur, such as changes in fins, pigmentation, body shape, behavior and diet (Keith et al., 2008; Kondo et al., 2013).

1.2. Swimming ability

The migratory species present different morphological and physiological indices in their swimming capacity. These, although varying from species to species, also vary between individuals of the same species depending on size, age and environmental conditions during migration. According to Santo (2005) the swimming abilities depend on the undulations of the body and the caudal fin. On the other hand, these abilities are influenced by the temperature of the water and the muscles involved in the displacement.(Videler, 1993)(Alves, 2018)

Two types of muscles are involved in this process, white and red, which result in three types of swimming activities that correspond to different speeds: cruising swimming, explosive swimming and sustained swimming. Cruising swimming is triggered by the use of red muscle and is defined by the maximum speed that fish can move without causing physiological changes in the body, and can be maintained for hours. Explosive swimming is defined by the maximum speed at which the fish can move, and this effort can be maintained in a short time, this fact associated with the use of white muscle. Sustained swimming is the result of combining cruising swimming with explosive swimming, and can be maintained for a few minutes, but with fatigue for the fish. However, in this type of swimming, the greater the effort, the greater the anaerobic contribution. (Larinier, 2002; Saint, 2005) (Videler, 1993)(Videler, 1993; Santo, 2005) (Brett, 1964)

Although these swimming modalities correspond to the different swimming abilities, it is also determined through the critical swimming speed (U_{crit}). This speed corresponds to an approximate measure of the maximum aerobic swimming capacity of a fish, competing to an approximate measure of sustained swimming including the mixture of aerobic and anaerobic regime. These various forms of swimming allow us to understand the locomotor performance and infer the critical swimming speed of the post-larvae little fish. (Brett, 1964)

1.1. Goals

The present work has as general objective to test the swimming abilities of the gobids, S. *bustamantei, S. brevifile and A. lateristriga,* the fish of São Tomé. More specifically, the present work aims to determine the critical swimming speed of the little fish in order to understand if it has swimming abilities to swim against the coastal currents and flow of rivers.

1.2. Hypothesis

Considering the central prolemma of this study, the following hypotheses were raised:

I. The variation in critical swimming speed is not homogeneous among the three species;

II. The length of the post-larvae of little fish influences their swimming ability.

2. METHODOLOGY

2.1. Species used

For the present study, we used the post-larvae of S. *bustamantei, S. brevifile and A. lateristriga*, which are amphidromic species that use connectivity between fresh and salt water during their life cycle (Baptista et al., 2020; Diouf, 2020; Moelants, 2010).

Sicydium bustamantei is a gobiid species described by Greeff in 1884 as being a tropical and freshwater species. This species is distributed in the islands of Bioko, São Tomé, Príncipe and Annobón. The morphological characteristics (arrangement of the scales, morphology of the mandible, morphology of the lips, the number of layers of premaxillary teeth, size of the head, length of the spine of the first dorsal fin in males and pigmentation) were rewritten by Pezol et al. (2006) based on the material collected in the study in São Tomé and Príncipe. The species is considered secondary and omnivorous during its pelagic phase, feeding on zooplankton and plant/macroalgae debris. (Baptista et al., 2020).

Sicydium brevifile is a species of gobiid, endemic to western Cameroon and the islands of the Gulf of Guinea. The name comes from the Latin "short thread" referring to a small median papilla above the maxillary suture. The species was described in 1884 by Ogilvie-Grant. Adults inhabit the clear-water streams of volcanic islands and on the slopes of Mount Cameroon (Pezold et al., 2006). The description of the species was based on observations on several islands in the Gulf of Guinea (Bell, 1994) as well as its morphological characteristics (arrangement of scales, morphology of the jaw, morphology of the lips, the number of layers of premaxillary teeth, size of the head, length of the spine of the first dorsal fin in males and pigmentation). The species reaches in adult stage the 10.5 cm in length and can be found in medium and low stretches of several rivers of the Gulf of Guinea, (Pezold et al., 2006).

Awaous lateristriga is a species of gobiid belonging to the subfamily Gobionellinae described by Duméril, 1861. Its morphological characteristic, diet, biology and ecology still require scientific efforts for its identification and understanding.

During their life cycle of these species, the largest catch is concentrated in their larval stage in which they are caught at the mouth of the river, constituting the main source of income of fishing communities (Hoareau et al., 2008). They are captured in the larval stage and may be white (translucent) or black with white stripes. Individuals who manage to overcome this hard and crucial stage of their pathway cycle go to the interior of the river where they develop to reach the stage of maturation (Bell, 1994; IIda et al., 2011; Bell, 1994).

2.2. Laboratory procedures

The larvae were captured at night in Praia Pesqueira and Iô-Grande and transported to the Biology Laboratory of the Faculty of Science and Technologies of the University of São Tomé and Príncipe (FCT-USTP), where they were kept under controlled conditions and with the constant oxygenation of the water through an aerator. The experiments were conducted in a quiet, temperature-controlled room. We used 29 larvae in different stages of development (white, white with stripes and prestas) of the three species.

2.3. Swimming skills test

The swimming chamber model used for the critical swimming speed test (Ucrit, cm.s-1) was based on the work of Stobutzki and Bellwood (1997), Faria et al. (2014) and Baptista et al. (2019). The chamber was constructed with transparent material (perspex) composed of six parallel lanes (30 mm wide, 50 mm high, 180 mm long) (figure 4). Plastic flow diffusers (y- 5 mm; 40 mm long) were placed after the water inlet valve to standardize the flow on the different runways. Two mesh strips were installed at both ends of each chamber track to retain the larvae within the chamber (Stobutzki & Bellwood, 1997; Baptista et al., 2019)

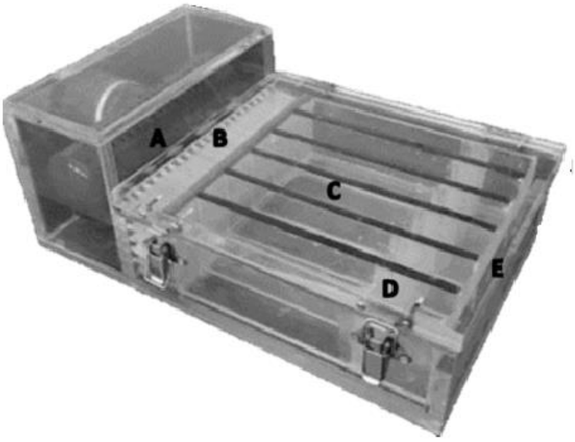


Fig. 4: Swimming chamber used in the critical swimming speed experiment performed with larvae of little fish Sicydium *bustamantei, Sicydium brevifile and* Awaous lateristriga, with different speeds [adapted from Stobutzki & Bellwood (1997), Faria et al. (2014) and Baptista et al. (2019)]. Water flows into the swimming chamber through a perforated PVC pipe (A), which then passes through two sets of plastic flow diffusers 40 mm long, to even out the flow of water entering (B) and before flowing into the six parallel swimming radii (180 × 30 × 50 mm; C × L × (C). Two mesh strips are installed at the ends of each lane to prevent larvae from entering the diffusers (B) and being carried from the chamber (D) at the end of the water outlet (E). Scheme adapted from Baptista et al. (2019).

The larvae were randomly selected from the tank and placed one at a time, totaling six individuals, one per each swimming track, at a speed of 1 cm.s-1, for 120 seconds, considering the climatization time. It should be noted that the individuals did not present symptoms of stress during the climatization period.

After the climatization period, the current velocity was increasing by approximately 1 cm.s-1 every 120 seconds until the larvae could no longer swim against the current by leaning against the net mesh in zone (D) for more than 120 seconds. At that moment the timer for this larva is stopped and the moment of its withdrawal is recorded.

2.4. Data analysis

being 19 *S. bustamantei*, 4 *S. brevifile* and 6 *A. lateristriga.* The larvae were randomly removed from the cap and placed in the swimming range at a speed of 1 cm.s^{-1} for 120 seconds considering the climatization time. After this period, the current speed was increasing by approximately 1 cm.s^{-1} every 120 seconds until they gave up swimming against the current from where the time of their withdrawal is taken. These data were grouped in an Excel sheet considering the variables: Length (mm), Maximum speed reached (cm/s), Speed increment [(cm.s$^{-1)}$ -Ui], Final increment time (second), Time interval (120 seconds) and the Critical Swimming Unit [U_{crit}= U + (t / ti - Ui)].

The calculation of the critical swimming speed (U_{crit}) was based on the equation [$U_{crit} = U + (t \times t - 1^{\times}\ Ui)$]. Where, U is the penultimate velocity increment that a larva can maintain, Ui is the velocity increment (i.e., 1 cm.s^{-1}), t is the time the larva swam in the final velocity increment, and ti is the time interval for each velocity (120 seconds). The Shapiro Wilk test and Levene Test were applied to determine the normality of the data, we also used the Spearman correlation to analyze the correlation between the critical swimming speed and the length of the larvae (mm). We also used the Kruskal Wallis test to determine the relationship between the critical velocity of each species. All statistical analyses were performed in the software R Core Team, (2023) and the length of the species was measured using the program Imagem J.

3. FINDINGS

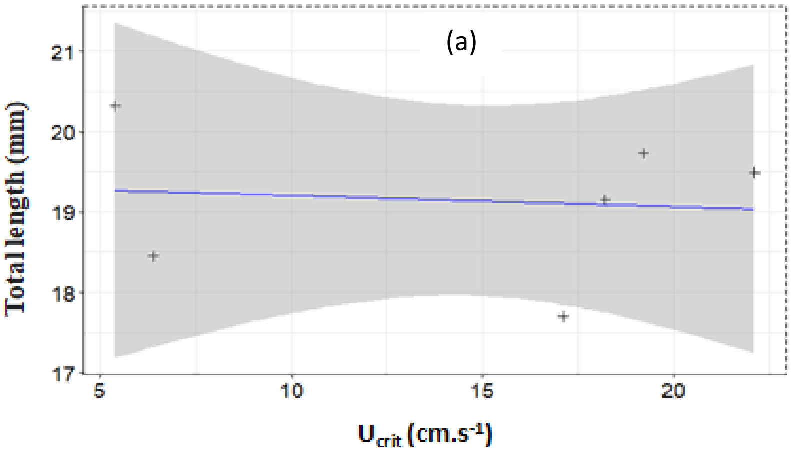
A total of 29 little fish -larvae were tested for swimming abilities. 19 are of the species of Sicydium *bustamantei*, 4 of the species of *Sicydium brevifile* and 6 of the species of *Awaous lateristriga.* All little fish-larvae were tested individually. The post-larvae of *S. bustamantei* obtained a minimum performance of 3 cm.s^{-1} and a maximum of 22 cm.s$^{-1,}$ which corresponds to a resistance of approximately 2520 seconds of swimming in a current flow of water inside the swimming chamber. The S. brevifile obtained the minimum performance of 8 cm.s^{-1} and maximum of 23 cm.s-^{1} with the resistance of 2700 seconds of the swimming chamber and likewise the A. lateristriga presents minimum values of 6 cm.s-^{1} and maximum of 23 cm.s^{-1} with the resistance of 2700 seconds. The current flow of water inside the chamber corresponds to the increase in speed 1 cm.s^{-1} every 120 seconds of testing. The water temperature was 25.8 °C during the test. *S. brevifile* and *A. lateristriga* reached the maximum speed of 23 cm.s-1 in the swimming chamber, but with a slight difference in the last speed increment *S. brevifile* (0.2 seconds) and *A. lateristriga* (0.9 seconds).

3.1. Variation of critical swimming speed

The critical swimming speed (U_{crit}) is the last speed increment of the 29 post-larvae of little fish tested. For the species *A. lateristriga* the value is 14.73 ±7.04 (mean ± standard deviation $cm.s^{-1}$), reaching the values 5.42 minimum and 22.08 maximum. On the other hand, the *S. brevifile* value is 12.78 ± 6.39 with values of 7.32 minimum, 22.02 max. Parallel to these, *S. bustamantei* obtained 11.94 ± 5.9, reaching values of 2.09 minimum and 22.01 as maximum value of critical swimming speed in the chamber (Table 1).

However, the speed increment ranged from 7.3 $cm.s^{-1}$ /24.9 mm (minimum value of Ucrit / length of species) to 22.0 $cm.s^{-1}$/24.8mm (maximum value of Ucrit / length of species) for S. brevifile, from 5.4 cm.s-1/20.3mm to 22.1 $cm.s^{-1}$/ 19.5mm for A. lateristriga and from 2.1 $cm.s^{-1}$/ 19.6mm to 21.1 $cm.s^{-1}$ / 22.0mm for *S. bustamantei* (Table 2).

Of the 29 post-larvae of the little fish *Sicydium bustamantei, S. brevifile* and *A. lateristriga.* According to the Shapiro Wilk normality test, the increment end-time variable did not follow a normal distribution (w = 0.91963, p-value = 0.02983). There is no correlation between critical swimming speed and species length ($p > 0.05$). The critical swimming speed of the species is not influenced by their length (n=29; p = 0.09885), with small dispersion in S. *brevifile* (Figure 5a), greater dispersion in the axis of the relationship length and critical swimming speed in *S. bustamantei* (Figure 5c) and slightly linear for *A. lateristiga* (Figure 5b)



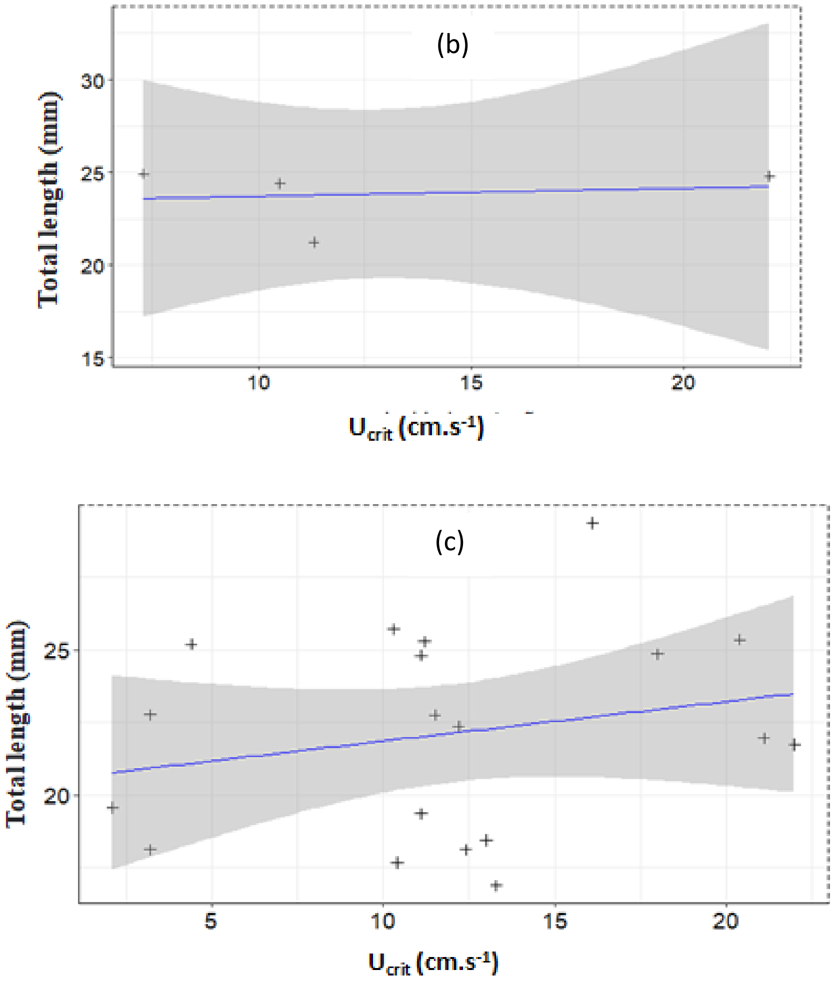


Fig. 5: Relationship between total length (mm) and critical swimming speed (Ucrit) for the post-larvae of little fish. (A) length/U_{crit} ratio of *S. brevifile*.(B) length/Ucrit ratio of *A. lateristriga* and (C) length/Ucrit ratio of *S. bustamantei*. (+ = species -- = axis of relation).

The critical swimming capacity of little fish does not vary significantly between P >0.05 species (Figure 6). However, *A. lateristiga* has the slightly higher velocity (14.73 ± 7.04).

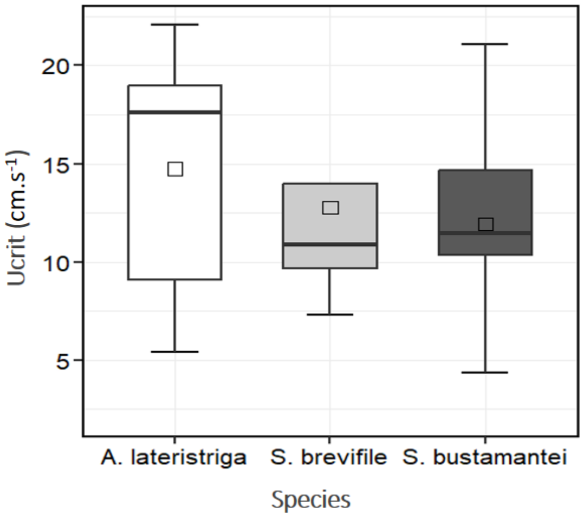


Fig. 6: Variation of critical swimming speed between species. The lines inside the squares represent the median, the smaller square represents the mean, and the tips represent the standard deviation.

The length of the goldfish larvae presents varied sizes between the minimum and maximum values: S. bustamantei between 16.88 and 29.37, S. *brevifile* between 21.92 and 24.92 and A. *lateristiga* 17.77 and 20.32 presented variation in the larvae of *S. bustamantei.*

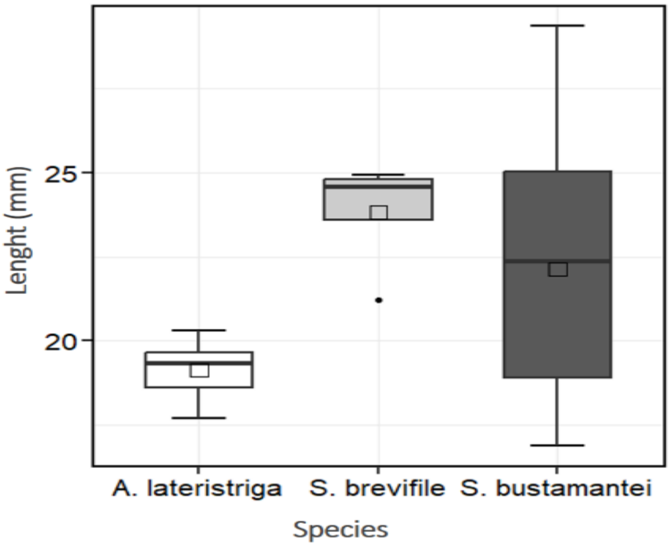


Fig. 7: Variation in the length of little fish o *S. bustamantei S. brevifile* (Greeff, 1884; Ogilvie-Grant, 1884)and *A. lateristriga* (Duméril, 1861) between the rivers of Iô-Grande and Praia Pesqueira. The lines inside the squares represent the median, the smaller square represents the mean, and the tips represent the standard deviation.

4. DISCUSSION

The behavioral characteristics and swimming abilities of little fish larvae and post-larvae influence their ability to find food, escape predators, and disperse (Stobutzki & Bellwood 1197). To determine the swimming ability of each of these species it is important to understand how it varied behavior and the various swimming skills during the test. Recent studies that include fish larvae (e.g., Fisher et al., 2000; Clarik et al. 2009) and with larvae in an advanced stage considered post-larvae (e.g., Stobutzki & Bellwood 1197; Fisher & Bellwood 2002; Fisher, 2005) did not incorporate the swimming behavior of the larvae.

Little fish from São Tomé is that includes Species *S. bustamantei*, *S. brevifile* and *A. lateristriga* studied here, they are important economic resources and protein source of fishing communities (Baptista et al., 2020). However, studies indicate that fish larvae in tropical regions feed and swim more efficiently, using more developed sensory aspects than larvae in other regions (Leis & McCormick 2002). However, the migratory flow of these species in rivers has decreased in recent decades. This can be explained by climate change, reduced river flows and pollution. Another curious fact is that they do not occur in all the rivers of São Tomé. This behavior may be closely linked to environmental cues described by (Biender et al., 2011).

We found variation in the critical swimming speed and the length of the species tested. The speed increment varied from 7.3 cm.s^{-1}/24.9mm to 22.0 cm.s^{-1}/24.8mm for the *S. brevifile,* and 5.4 cm.s^{-1}/20.3mm to 22.1 cm.s^{-1}/ 19.5mm for the *A. lateristriga* and 2.1 cm.s^{-1}/ 19.6mm to 21.1 cm.s^{-1}/ 22.0mm for the *S. bustamantei.* These velocity increments are larger compared to other literature (Clark et al 2005), which may also be related to temperature and/or morphological differences (Guan et al 2008). With this, we can affirm that the species has good swimming capacity and can resist river currents to complete its life cycle. On the other hand, the variation of the critical swimming speed is not homogeneous between species. There was a slight difference between the critical swimming speed of the *A. lateristiga* in relation to other species. However, the swimming capacity of the species is not influenced by their length and the variation of the critical swimming speed between the species can be explained by the morphological and physiological differences of each species (Guan et al 2008). The swimming capacity of each species depends on the undulation of the body and the shape of the caudal fin. These variations in the critical swimming speed can be attributed to the type of muscle in the propelling organs (Videler 1993; Santos, 2005).

5. CONCLUSION

The result of this study leads us to conclude that the post-larvae of São Tomé little fish that includes the species of *Sicydium bustamantei, S. brevifile and A. lateristriga* have good swimming ability and can resist river currents to complete their life cycle. On the other hand, the variation of the critical swimming speed is not homogeneous between species. However, *A. lateristiga* has slightly higher swimming capacity than other species. Likewise, it was found that the length of the larvae does not influence their swimming ability. This study allows us to understand the locomotor performance and infer the critical swimming speed of the post-larvae little fish. However, more scientific effort is still needed to understand particular aspects of the orientation, biology and ecology of São Tomé's little fish species.

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7. ATTACHMENT

Table 2. Database of swimming abilities and critical swimming speed of post-larvae of little fish belonging to the species of *A. lateristriga, S. brevifile* and *S. bustamantei* in the swimming chamber (n=29)

Code	Species	Maximum fleece reached(cm/s) -U	Incremente de veloc (cm/s) -Ui	Increme final time (sec)	Time interval(sec)	Ucrit = A+ (t / a - Ui)	Length (mm)
Swim_1	*Sicydium brevifile*	10	1	56	120	10,5	24,4
Swim_2	*Sicydium bustamantei*	3	1	29	120	3,2	18,1
Swim_3	*Sicydium bustamantei*	11	1	28	120	11,2	25,3
Swim_4	*Sicydium bustamantei*	12	1	48	120	12,4	18,1
Swim_5	*Sicydium bustamantei*	11	1	55	120	11,5	22,8
Swim_6	*Sicydium bustamantei*	11	1	17	120	11,1	19,4
Swim_7	*Sicydium bustamantei*	18	1	0	120	18,0	24,9
Swim_8	*Sicydium bustamantei*	12	1	18	120	12,2	22,4
Swim_10	*Sicydium bustamantei*	2	1	11	120	2,1	19,6
Swim_11	*Sicydium brevifile*	7	1	38	120	7,3	24,9
Swim_12	*Sicydium bustamantei*	13	1	30	120	13,3	16,9
Swim_13	*Sicydium bustamantei*	13	1	3	120	13,0	18,4
Swim_14	*Sicydium bustamantei*	10	1	46	120	10,4	17,7
Swim_G_1	*Awaous lateristriga*	19	1	29	120	19,2	19,7
Swim_G_2	*Awaous lateristriga*	5	1	50	120	5,4	20,3

Swim_G_3	*Awaous lateristriga*	17	1	8	120	17,1	17,7
Swim_G_4	*Awaous lateristriga*	18	1	20	120	18,2	19,2
Swim_G_5	*Awaous lateristriga*	6	1	49	120	6,4	18,5
Swim_G_6	*Awaous lateristriga*	22	1	9	120	22,1	19,5
Swim_G_7	*Sicydium bustamantei*	22	1	1	120	22,0	21,7
Swim_G_8	*Sicydium brevifile*	22	1	2	120	22,0	24,8
Swim_G_9	*Sicydium brevifile*	11	1	39	120	11,3	21,2
Swim_G_10	*Sicydium bustamantei*	21	1	9	120	21,1	22,0
Swim_G_11	*Sicydium bustamantei*	3	1	20	120	3,2	22,8
Swim_G_12	*Sicydium bustamantei*	10	1	33	120	10,3	25,7
Swim_G_13	*Sicydium bustamantei*	20	1	50	120	20,4	25,4
Swim_G_14	*Sicydium bustamantei*	4	1	46	120	4,4	25,2
Swim_G_15	*Sicydium bustamantei*	11	1	7	120	11,1	24,8
Swim_G_16	*Sicydium bustamantei*	16	1	7	120	16,1	29,4