

**Agonistic and predatory behaviour of the lizardfish *Synodus saurus*
(Linnaeus, 1758) (Actinopterygii: Synodontidae) from the Azores**

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Abstract

The behaviour of the lizardfish *Synodus saurus*, a common demersal predator in Azorean waters, is described. A total of 25 hours' qualitative diurnal underwater observations were carried out between July 2000 and January 2001. Behavioural aspects are presented, illustrated with diagrams based on *in situ* observations. *S. saurus* is a cryptic predator that feeds mainly of small pelagic, gregarious fish; it is primarily associated with soft bottoms. Besides remaining camouflaged buried beneath the sand, *S. saurus* is a highly mobile predator capable of rapidly swimming more than five meters to capture its prey. *S. saurus* maintains a territory through agonistic interactions, and also interacts, non-agonistically with heterospecifics such as *Bothus podas maderensis*.

Introduction

Fish behavioural ecology is a recent, well-recognised discipline (Cury, 1998). Underwater observation to gain insight into fish behaviour is an important research tool (Longhurst, 1981; Sazima, 1986).

The lizardfish *Synodus saurus* is a common, but little known coastal predator. Golani (1993), who worked on this species in Israel, presented limited information on feeding behaviour based on the examination of stomach contents. There is no record of any qualitative or quantitative field observations of the behaviour of the species. However, the predatory behaviour of the congeneric *S. englemani* has been studied by Sweatman (1984).

Synodus saurus lives mostly on sandy bottoms in island waters (Sulak, 1986). It is abundant in Azorean waters, and commonly found at less than 20 m, although reported once at 400 m (Sulak, 1986; Santos *et al.* 1997). *Synodus saurus* has a small head, eyes of moderate size, and is effectively camouflaged by the dorsal color pattern of fine spotting and vermiculation. The pattern differs on rocky and sandy bottoms. This species exhibits no sexual dimorphism, and reaches 43 cm in total length (TL).

This study concerns aspects of the social and non-social (particularly predatory) behaviour of the lizardfish.

Material and methods

Locality

All observations were made at Terceira Island (Azores). The chosen study sites were off the south-east coast and round to the north coast of the island.

Observation sites were all shallower than 15 m, generally with sandy bottoms or mixed sand and rocks.

Behavioural observations

Observations were carried out between July 2000 and January 2001, but interrupted during December due to bad weather. A total of 25 hours of qualitative diurnal observations were made while snorkeling and scuba diving. Notes were made on a plastic slate and photographs taken. Behavioural sequence diagrams were created from *in situ* observations.

Observations were made from far enough away to avoid disturbance. Underwater visibility was good: the fish were easy to see and observe. Once located, an individual was followed for as long as possible. Any changes in position were considered moves, including changes in orientation on the same spot. Because the attacks and agonistic movements were faster, they were easy to distinguish from ordinary changes of position.

Results

Non-social behaviour

Immobile postures – on the bottom

- i. The individual remains stationary, resting on its pelvic fins, which gives it a relatively curved posture, with the head inclined upward. The head and the anterior pelvic zone are not in full contact with the bottom. Tail and dorsal fins are kept retracted. The dorsal body colour pattern mimics the bottom. In rocky environments, the dorsal bands are wider and brownish, while the dorsal area maintains a less greenish tone.

- ii. The head and ventral zone stay in close contact with the bottom. The animal rests its head on the crest of a of sand ripple (in sandy bottom) or on top of a rock.

Immobile postures – ambush

The individual remains stationary and camouflaged on the substrate. It may remain partly buried, with most of the body or just the torso visible.

Locomotion

i. Swimming

Swimming is of anguilliform type using the caudal fin and body undulations. Movement is cyclical: two to three undulations of the tail fin (extension of the caudal rays) are followed by an interruption (retraction of the caudal rays). Movement is usually in a straight line and about half a meter or less from the bottom. The pectoral fins remain extended. The dorsal rays are raised at the beginning of the swimming movement and again with every change in direction.

ii. Lift off

Before swimming, an individual lifts itself off the bottom using coordinated movements of the pelvic fins and caudal fin propulsion. The pectoral and dorsal fin rays are extended at the same time.

iii. Landing

When the fish stops swimming, it begins to sink. As it nears the bottom, the dorsal fin rays are extended, then immediately retracted. The fish settles with its rear half on the bottom, and its front half raised on the pelvic fins. The pectoral fins remain retracted.

Camouflage movements

Individuals are able to blend in with the surrounding habitat by partly burying the body. The fish opens and closes its mouth continuously, and uses the operculum to dig into the sand, while rapidly moving the pelvic and caudal fins. Lizardfish are able to stay almost completely buried.

Threat

When disturbed, the fish opens and closes its mouth frequently. The dorsal fin rays are extended and the anterior part of the body may be raised slightly. When the threat continues, the animal quickly leaves its position.

Predatory behaviour

Forty-eight predatory episodes were observed, all involving schools of small fishes. These can be classified as follows:

- a) Rapid, straight movement from a stationary position on the bottom (Figure 1);
- b) Rapid movement from a stationary position in mid-water (Figures 2 and 3);
- c) Stalking.

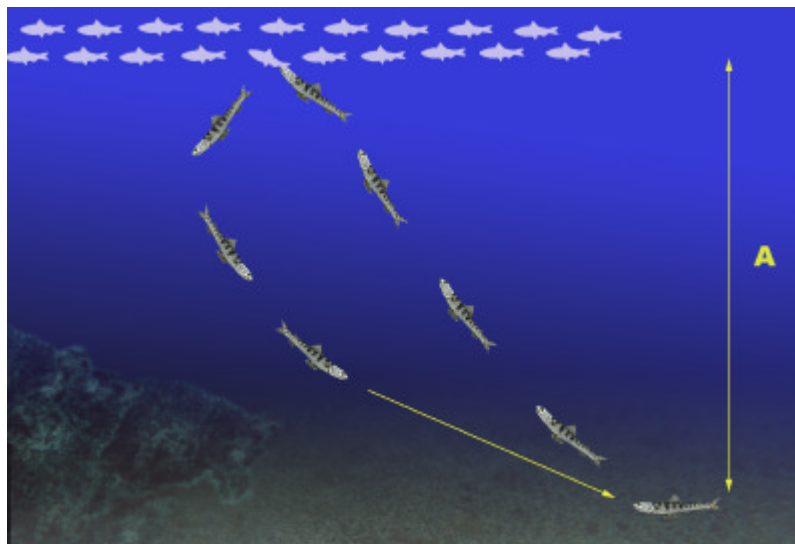


Figure 1. Predatory movement (type a).

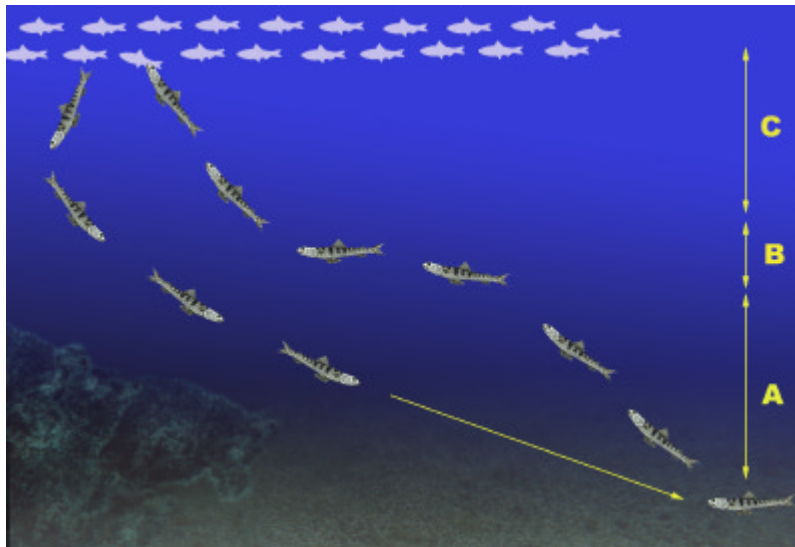


Figure 2. Predatory movement (type b) with no change of direction.

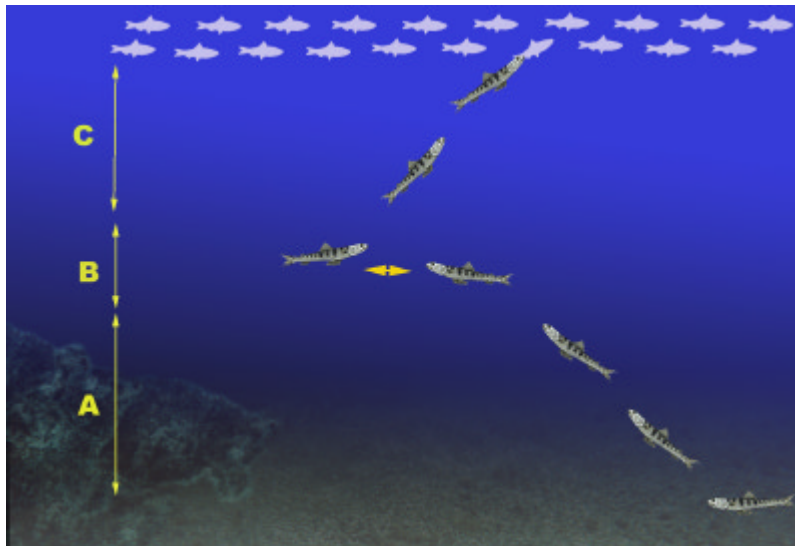


Figure 3. Predatory movement (type b) with change of direction.

Movement a) Motionless, and with its body straight, the lizardfish watches a school of fish swimming near the surface. The predator may change position or direction to keep the moving school in sight. Having focused on a specific individual or group of prey, fish, it darts swiftly from the bottom, straight at the school. This type of attack occurred during all observation periods. Several lizardfish may attack at the same time or in succession.

Movement b) begins in a similar way. In this case, however, the predator abandons its initial position on the bottom for a second position closer to its potential prey. From here, the attack may or may not proceed. If it does, the predator focuses on the school, changes direction if necessary and moves swiftly and obliquely towards the prey. These movements are very fast.

Movement c) is also aimed at several prey. The predator leaves its ambush position and, swimming slowly and stealthily, approaches and joins the school. It then strikes from a position inside the school.

Usually, the predator returns to the initial place of ambush. It seldom moves away from this original position. The failure rate of attacks is high (about 70%). The same predator may charge the same school of prey several times ($N = 1.7$ on average, for each passing school). The attacks were preceded by body movements, which made attack behaviour quite predictable.

On one occasion, we observed a simultaneous attack by two lizardfish. Both individuals swam swiftly to the school, then one of them stopped mid-water. This first fish remained stationary while the second made its strike. Both lizardfish then returned to the bottom at the same time.

Thus some targeting movements are not completed. The lizardfish moves from the bottom to mid-water, swims or even stops briefly under the school, then returns to its original position on the bottom. We observed four incomplete movements of this kind.

Some of the predators just swim under the school of prey, without attacking. The passing of the school appears to induce them to search for more suitable ambush locations while keeping in visual contact. That is, they follow the school's movement or

direction. When hunting, individuals travel as far as 5 m between the bottom and the school of prey near the surface. While on the bottom, lizardfish may make some short stalking moves. These include searching for prey, rotating, changing direction or, if motionless, maintaining a posture that enables them to scan the surroundings. Lizardfish tend to gather near the passing school of prey. At these times, few lizardfish remain buried.

Social behaviour

Agonistic behaviour - intraspecific interactions

This kind of interaction was observed 9 times. These confrontations may result in close contacts or even aggression.

i. Situation 1 (Figure 4 a, b and c)

Two individuals (A and B), separated by a few meters, remain motionless on the bottom. B whirls and changes direction to face A. They both display by erecting the dorsal fin, then charge rapidly towards each other. The “winner”, B, occupies its opponent’s previous resting place, and A swims away. A few seconds later, B moves towards its opponent’s new position. Watching carefully from a distance, A reacts instantly by swimming straight at B. They confront each other again and, as before, A is defeated. The “winner” sees its opponent off, patrols its territory energetically and finally returns to its initial position.

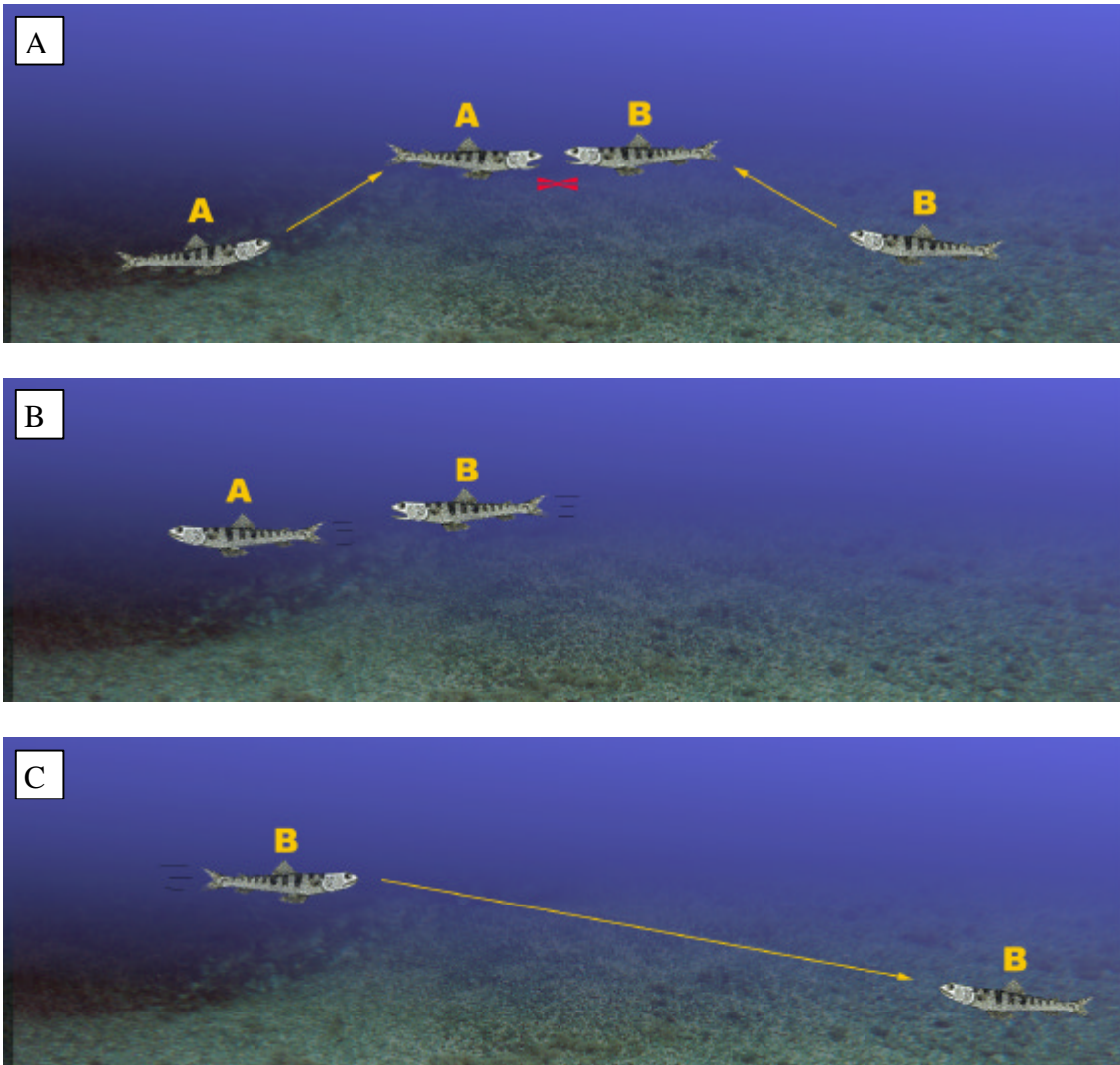


Figure 4. Intraspecific attack (Situation 1).

ii. Situation 2 (Figure 5 a, b and c)

One fish (A) swims swiftly towards another (B) that is stationary and attacks it. As they whirl about close to the sea floor, B offers some resistance but then quickly escapes. The winner, A, occupies its opponent's former position. This type of behaviour is frequent when schools of prey pass by. The predators are competing for the most suitable place to launch an attack.

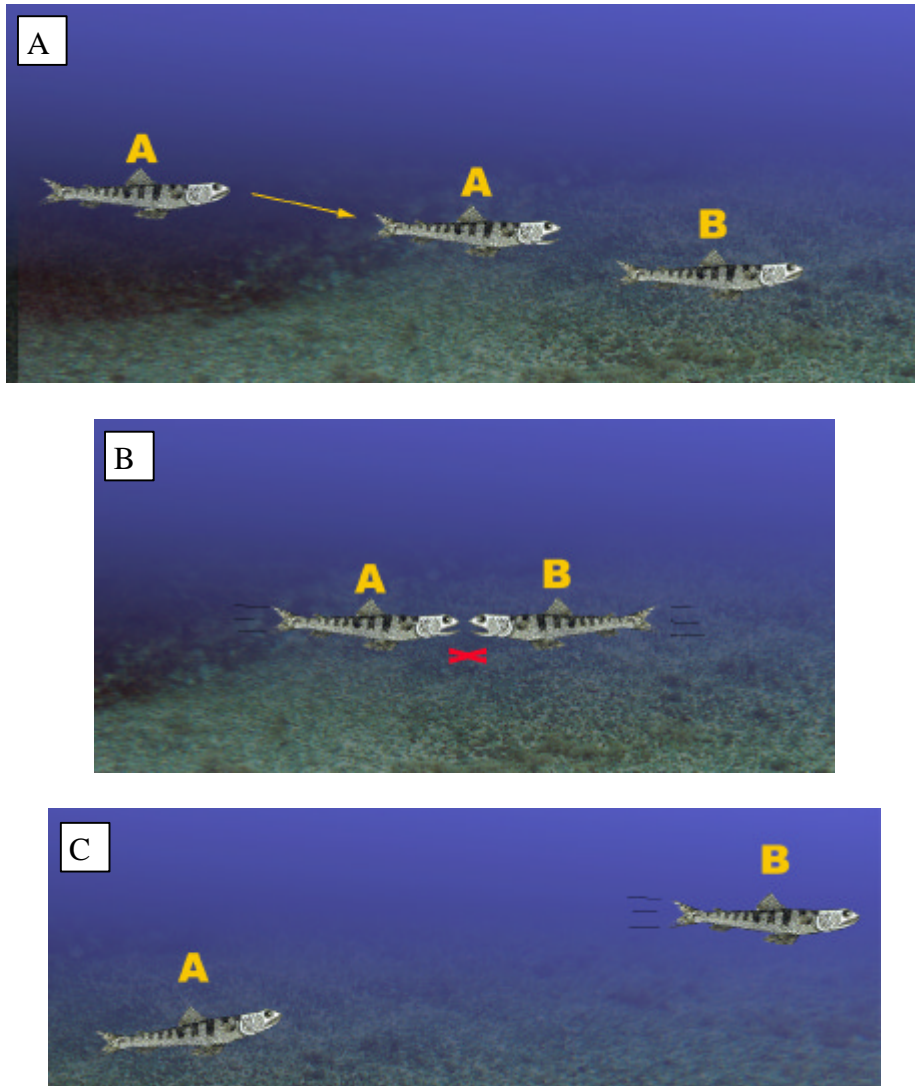


Figure 5. Intraspecific attack (Situation 2).

iii. Situation 3.

In this case, a juvenile *S. saurus*, which was stalking a school, was attacked by (as in *Movement a*) by an older and bigger conspecific.

Non-agonistic behaviour - intraspecific relations

i. Posture at the sea bottom

Pairs of individuals ($N = 15$) were observed lying close together on the bottom, parallel, head to tail and motionless, with their pectoral and caudal fins extended. This behaviour may be connected with sexual activity. However, since this species does not show

sexual dimorphism, it was impossible to determine whether such pairs were male and female. Paired postures were only seen in August.

ii. Pursuit

Also only seen in August. We recorded three instances of non-aggressive pursuit, in which one individual closely followed another (Figure 6 a, b and c).

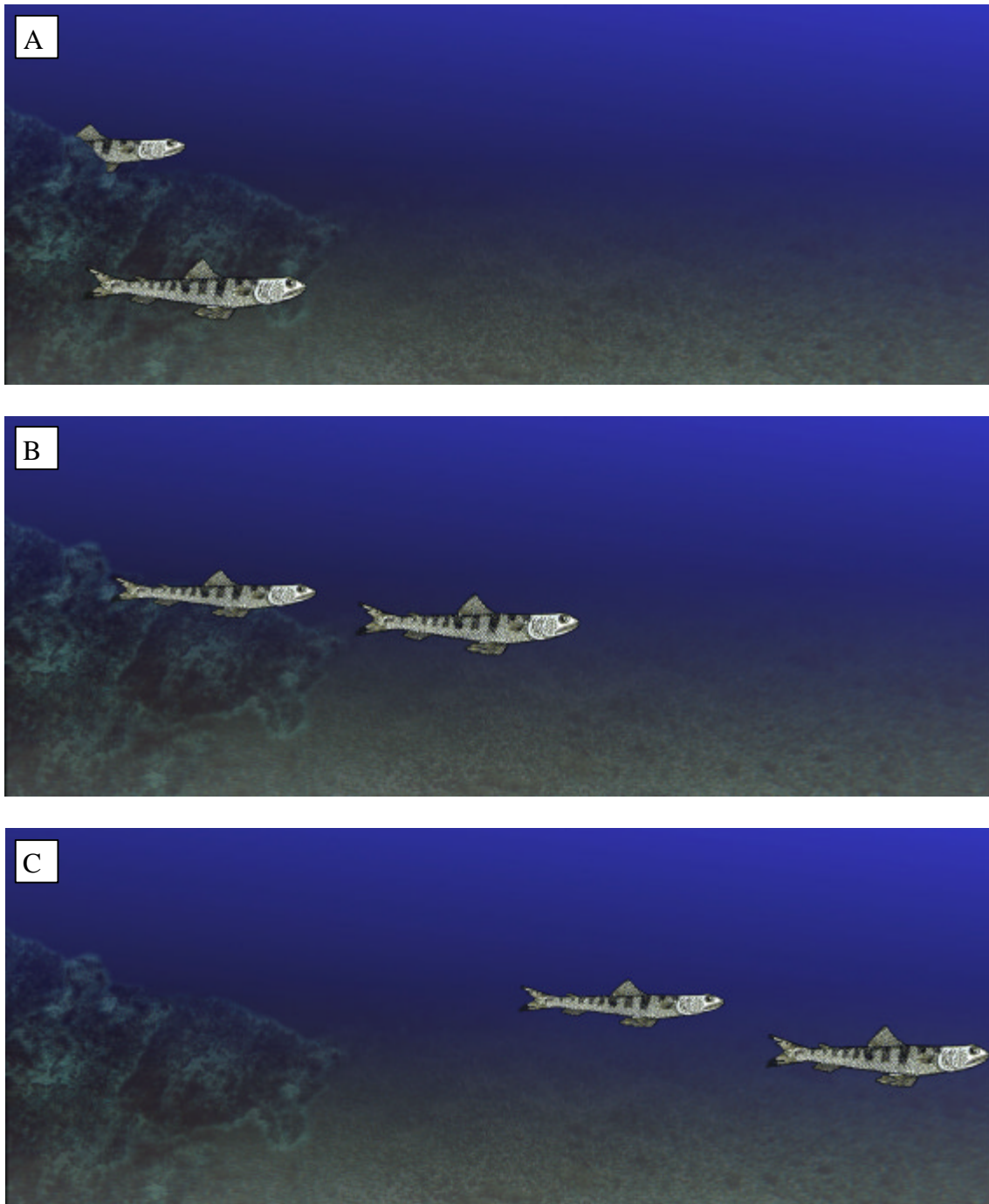


Figure 6. *S. saurus* pursues another individual of its own species.

Non-agonistic behaviour - interspecific relations

On four occasions we observed, *S. saurus* closely following a wide-eyed flounder *Bothus podas maderensis* (Pleuronectiformes: Bothidae). In three instances, the lizardfish kept 10-20 cm behind the flounder, stopping and starting with it. On one occasion there was close contact, with the lizardfish stopping directly over the flounder for a few moments (Figure 7 a and b).

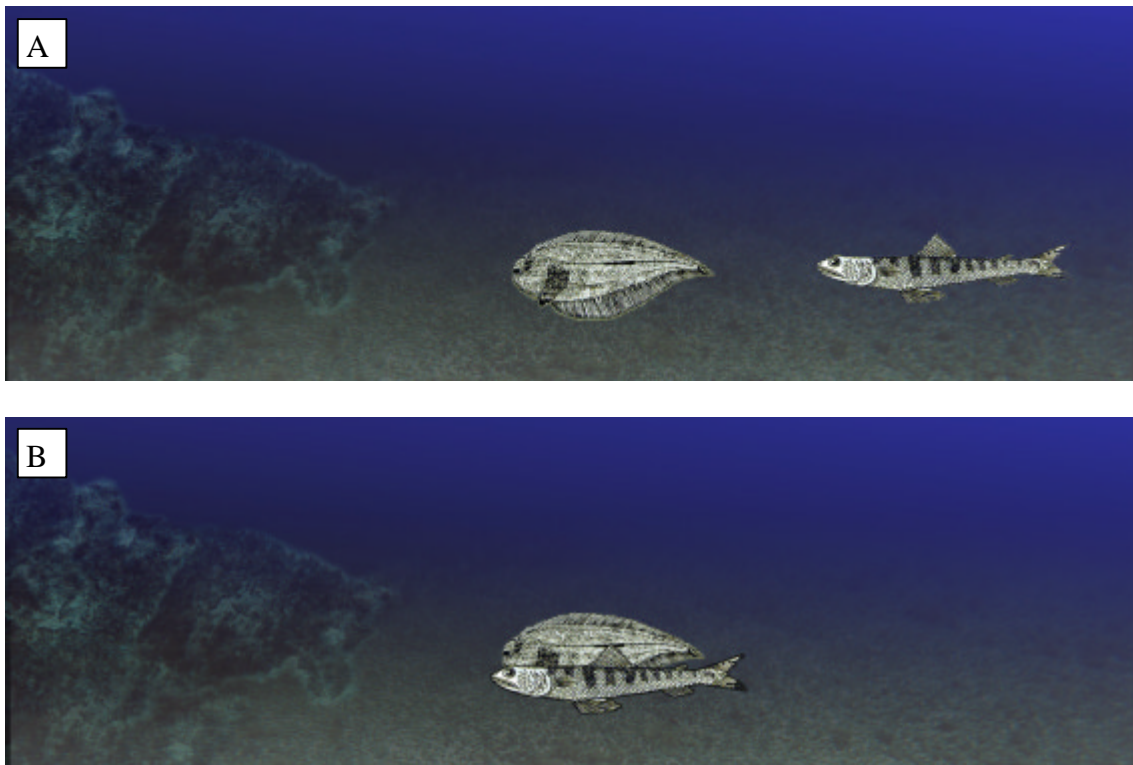


Figure 7. Straight contact between *S. saurus* and *B. p. maderensis*.

Discussion

Immobile and camouflaged postures are frequently cited as characterizing the behaviour of species of Synodontidae. Their unique ability to camouflage themselves and catch their prey has often been described in the literature (Keenleyside, 1979; Sulak, 1986; Golani, 1993; Wirtz, 1994; Saldanha, 1997; Kagiwara & Abilhôa, 2000). However,

their attack behaviour is more complex than previous reports suggest (Sweatman, 1984). Close-range ambush from a stationary position may be a lizardfish tactic, although we never saw it. None of the predatory movements we observed began from a buried ambush position, although some authors have reported such behaviour: i) An extremely rapid attack by of *S. saurus* from an immobile ambush posture, then on an *Apterichthus caecus*, biting it then slowly swallowing it head first [P. Afonso - pers. com.]. ii) A similar situation observed by M. Gonçalves [pers. com.], in which a *S. saurus* remained in an ambush position, face to face, and close to a specimen of *Scorpaena maderensis* for several minutes. There was a sudden attack, and the *S. maderensis* was ingested head-first. The fact that all attacks were directed toward schools of prey may indicate that these are more frequent, and probably more effective. These schools are very abundant in Azorean waters, and mostly composed of juvenile *Sardina pilchardus*.

Synodus saurus may stalk their prey for a long time in order to make a catch. They may also remain motionless for several minutes before striking. This suggests that the moment chosen for attack is critical. Whether targeting species of pelagic, gregarious or benthic species, the speed of strike is crucial to success. If the attack is unsuccessful, the sequence of moving and scanning begins again immediately (Sweatman, 1984). From a particular pre-strike change of posture, whether on the bottom or in mid-water, we were able to tell when an attack was about to take place.

Predation on *S. saurus* is almost unknown. Its capacity for camouflage may be an anti-predation mechanism. In the Azores, Barreiros & Santos (1998) mention *S. saurus* as a prey of *Epinephelus marginatus* (Serranidae).

Synodus saurus lives most of its life alone (Keenleyside, 1979), keeping a good distance from other lizardfish. Our observations lead us to believe that they inhabit a preferential area (possibly residential), to which they return after an attack. These preferential areas

justify their intraspecific agonistic mechanisms. Larger individuals dominate. They may change to a more promising location where there is less competition from their fellows (Farnsworth & Beecham, 1997). This may be the “distribution model” of these predators, in relation to prey and predator density or distribution. Agonistic behaviour, between members of the same species, may be a segregational mechanism targeting small individuals that venture into the preferred areas of larger and older individuals (Du Buit, 1996). Agonistic intraspecific interactions, as well as observed cannibalism (Soares, 2001), are usually referred to as regulation mechanisms to the community composition (Persson & Diehl, 1990).

The non-agonistic behaviour reported in this study, either intra- (non-aggressive pursuits) or interspecific (with *B. p. maderensis*), may represent a follower pursuit situation with feeding advantages for the follower. The lizardfish watches closely as others dig in the sand and disturb benthic organisms, then it moves in and feeds on the disturbed prey (Keenleyside, 1979).

Since this species displays no obvious sexual dimorphism (Sulak, 1986; Saldanha, 1997), the reason for posturing in pairs remains a mystery. Sousa (2001) states that the females generally attain larger size (males rarely reach more than 30 cm). In the pairs we observed, one fish (possibly a female) was always substantially larger; thus the pairing may have a sexual function.

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