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Importance of visual cues of conspecifics and predators during the habitat selection of coral reef fish larvae

Importance de la reconnaissance visuelle des conspécifiques et des prédateurs par les larves de poissons coralliens lors de leur sélection de l'habitat d'installation

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ABSTRACT

The study investigated visual recognition of conspecifics and predators by settlement-stage coral reef fish larvae in a set of three experiments using a dual-choice aquarium (Moorea Island). Experiments 1 and 2 were conducted under artificial light conditions. Experiment 3 was conducted under natural light during new and full moon nights. In experiment 1, five out of six species preferred conspecifics rather than heterospecifics (*Acanthurus triostegus*, *Chromis viridis*, *Ostorhinchus angustatus*, *Stegastes fasciolatus*, *Valenciaenna strigata*). In experiment 2, three out of six species were repulsed by predators (*Mulloidichtys flavolineatus*, *O. angustatus*, *V. strigata*). In experiment 3 (conducted on one species), *A. triostegus* was attracted to conspecifics during bright nights, but did not show such behavior during dark nights. Our study raises the question of trade-off for fish larvae to settle during the night with high light intensities to favor the visual recognition of conspecifics and predators, or during darker nights to reduce reef predation.

RÉSUMÉ

La présente étude explore les capacités visuelles des larves de poissons coralliens à reconnaître les conspécifiques et les prédateurs à l'aide de trois expériences en aquarium à double choix (expériences 1 et 2 faites sous une lumière artificielle; expérience 3 faite sous la lumière naturelle de la lune). Dans l'expérience 1, cinq des six espèces testées sont attirées par les conspécifiques plutôt que par les hétérospécifiques (*Acanthurus triostegus*, *Chromis viridis*, *Ostorhinchus angustatus*, *Stegastes fasciolatus*, *Valenciaenna strigata*). Dans l'expérience 2, trois des six espèces testées sont répulsées par les prédateurs (*Mulloidichtys flavolineatus*, *O. angustatus*, *V. strigata*). Dans l'expérience 3, les larves d'*A. triostegus* sont

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attirées par les conspécifiques lors des nuits claires, mais lorsque l'intensité lumineuse diminue, cette reconnaissance disparaît. Cette étude soulève la question du *trade-off* pour les larves de poissons entre s'installer lors des nuits claires pour reconnaître les conspécifiques et les prédateurs, ou s'installer lors des nuits sombres pour éviter la prédation.

1. Introduction

On coral reefs, most fish species have stage-structured life histories, with a largely sedentary benthic stage (usually juveniles and adults), preceded by a pelagic larval stage with the capacity for long-distance dispersal [1]. After the pelagic phase, fish larvae return to reef habitat in order to continue their development into juvenile and adult stages (i.e., settlement phase) [2]. During the settlement phase, fish larvae are subjected to strong selective pressure to choose a suitable reef habitat that will promote post-settlement survival and growth of individuals [3]. Up to 90% of fish larvae may be removed by predation during the first post-settlement days if they do not select a suitable habitat [4,5]. Thus, many reef fish species show marked selectivity in habitat choice at settlement based on the presence of specific substrates and/or conspecifics, and on the absence of predators or competitors for food and space [1,3]. As it is unlikely that successful habitat selection of fish at settlement is solely a matter of chance; one of the greatest challenges facing the fish species with pelagic larval stages is how to relocate the relatively rare patches of suitable coral reef habitat on which they settle and ultimately reside as adults [6].

Recent studies on coral reef fish larvae have revealed highly developed swimming abilities and the use of sensory modalities to interpret habitat cues when settling to reef habitat [7]. Recognition of suitable settlement habitats has been hypothesized to be based on a combination of some or all of acoustic, chemical, visual, sun compass, rheotactic, magnetic, wave motion and thermal cues. However, only the visual, olfactory and auditory senses are known to be functional in coral reef fishes when they settle into their first reef habitat [1,6,7]. Sound is omnidirectional, and pervasive on coral reefs, as a result of bioactivity, and some recent studies have demonstrated its importance for several species of tropical marine fishes as they settle into their first reef habitat [8–10]. Several species of fish can use chemical cues related to the habitat, to conspecifics or to predators at settlement [11–14]. Vision may be significant over only short ranges, up to 5–10 m [6]. However, vision is especially important in environments where water transparency is high, such as on coral reefs or in non-estuarine back-reef areas [15,16]. Unfortunately, only seven studies have explored the importance of visual cues during habitat selection of coral reef fish larvae [16–22]. For example, Huijbers et al. [22] tested the response of a fish species (*Haemulon flavolineatum*) toward auditory, olfactory, and visual cues from four different reef patches (seagrass beds, mangroves, rubble, and coral reef). They showed that *H. flavolineatum* only responds to sound from coral reefs and to chemical cues from mangroves and seagrass beds, whereas conspecific visual cues overruled olfactory cues from mangrove and seagrass water.

In the present study, we aimed to increase scientific knowledge of the visual world of fish during habitat selection, focusing on the larval life history stage to better understand the settlement process. Firstly, we performed laboratory experiments to study the visual recognition of conspecifics (i.e. attraction behavior) and predators (i.e. repulsion behavior) by fish larvae. Secondly, experiments with conspecific cues were performed in outdoor aquaria under natural light in order to identify if fish larvae can visually recognize conspecifics according to lunar light intensity.

2. Materials and methods

2.1. Fish collection and experimental setup

A total of 6 larval fish species were captured with crest nets [23] on the reef crest of Moorea Island (17°31′7.38 S, 149°55′20.89 W), French Polynesia from March to June 2011: *Acanthurus triostegus* (Linnaeus, 1758 – standard length at larval stage: mean = 25 mm, SD = 4 mm), *Chromis viridis* (Cuvier, 1830 – mean = 9 mm, SD = 2 mm), *Mulloidichtys flavolineatus* (Lacepède, 1801 – mean = 78 mm, SD = 6 mm), *Ostorhinchus angustatus* (Smith and Radcliff, 1911 – mean = 16 mm, SD = 4 mm), *Stegastes fasciolatus* (Ogilby, 1889 – mean = 15 mm, SD = 3 mm) and *Valenciaenna strigata* (Broussonet, 1782 – mean = 25 mm, SD = 3 mm). Fish captured during the night were transferred and subsequently maintained in individual aquaria (0.3 × 0.3 × 0.2 m; water temperature: 26–27 °C) supplied with flow-through seawater from the adjacent lagoon, and without any added artificial or natural habitat substrate.

The conspecifics (individuals of the same species than that of the larvae tested in a dual-choice aquarium) and the heterospecifics (individuals of any fish species among the six species captured other than the species tested), used as cue transmitters (Exp. 1 and 3), were juveniles caught with crest nets and maintained in aquaria from 15 to 21 days. The fish grow in aquaria from 2 mm (*C. viridis*) to 6 mm (*M. flavolineatus*). Previous studies showed no repulsion effects by the heterospecifics on fish larvae in a dual-choice aquarium [11,20,21].

The predators, used as cue transmitters (Exp. 2), belonged to one of the three fish species captured at adult stage: *Saurida gracilis* (Quoy and Gaimard, 1824), *Neoniphon sammara* (Forsskål, 1775), *Sargocentron spiniferum* (Forsskål, 1775). These species were chosen because they