

The role of parasitic fish in pseudocave ecosystems of the Red Sea

Die Rolle parasitischer Fische in Pseudohöhlen-Ökosystemen des Roten Meeres

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Summary: During fish counts in pseudocaves of the Red Sea two species of cleaner wrasses and four imitators from the group of fang blennies were recorded. Two species of the latter group were parasites, which prey on skin and fins of other fish. Because these species imitate not only body shape and coloration of the model, but also the mode of swimming, a ring of mimicry exists. Whereas the cleaner wrasse *Labroides dimidiatus* was present with an abundance of 1% within the whole community of pseudocaves, the most abundant parasitic imitator, *Aspidontus taeniatus*, attained 0.2%. Therefore *L. dimidiatus* is the model in this mimicry ring, to which also the cleaner wrasse *Larabicus quadrilineatus* and the fang blennies *Plagiotremus tapeinosoma* (a parasite) and *Aspidontus dussumieri* (a plant feeder) have to be included because of their similar coloration and shape. The harmless species play a compensating role, because the relation of *L. dimidiatus* to *A. taeniatus* is by 6 : 1 relatively low in order to avoid negative consequences.

Key words: Red Sea, cleaner wrasse, fang blennies, parasites, mimicry ring

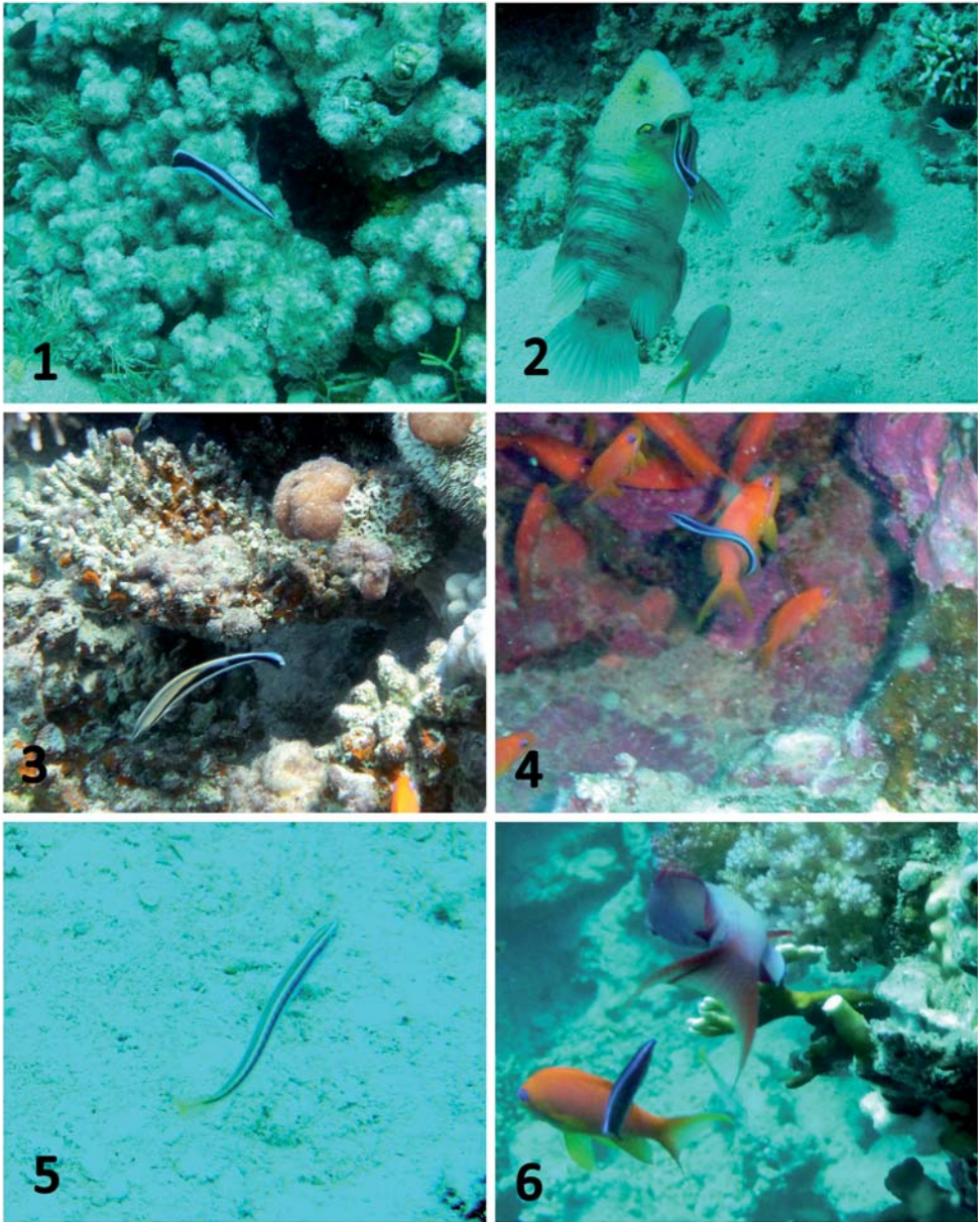
Zusammenfassung: Im Rahmen einer Zählung von Fischen in Pseudohöhlen des Roten Meeres wurden auch zwei Putzer-Lippfischarten und deren Nachahmer aus der Gruppe der Säbelzahnschleimfische erfasst. Zwei Arten unter Letzteren waren Parasiten, die anderen Fischen Haut und Flossenstücke als Nahrung herausreißen. Eine Art war Pflanzenfresser. Aufgrund der Nachahmung, die nicht nur die Gestalt und Färbung betraf, sondern auch die Art des Schwimmens, wird daher ein Mimikry-Kreis gebildet. Während der Putzerlippfisch *L. dimidiatus* mit 1 % Anteil an der gesamten Fischgemeinschaft der Pseudohöhlen vertreten war, wurde der häufigste Parasit, *Aspidontus taeniatus*, nur mit 0,2 % erfasst. Daher ist *L. dimidiatus* das Vorbild in diesem Mimikry-Kreis, zu dem auch noch der Parasit *Plagiotremus tapeinosoma* und der Putzer *Larabicus quadrilineatus* gehören, deren Färbungen aber nicht unbedingt genau dem Vorbild entsprechen. Dennoch spielen auch diese in dem System eine kompensierende Rolle, da das Verhältnis von Putzer (*L. dimidiatus*) und Parasit (*A. taeniatus*) mit etwa 6 : 1 relativ gering ist, um negative Folgen zu vermeiden.

Schlüsselworte: Rotes Meer, Putzerlippfische, Säbelzahnschleimfische, Parasiten, Mimikry-Kreis

1. Introduction

Cleaner wrasses occur in all oceans. The most abundant species in the Indo-Pacific is *Labroides dimidiatus*, which is characterized by its shape, mode of swimming and coloration: a slender body which presents a seesawing (labrid) mode of swimming and a dark blue band on the bright body side until the end of the caudal fin (figs 1, 2). The model for the cleaner is very probably the in all tropical seas present suckerfish *Echineis naucrates* with the same coloration that is, therefore, called “the international cleaner

dress”. *L. dimidiatus* is found in the Red Sea, the tropic Indian Ocean and the tropic West-Pacific. This coloration is also presented by another wrasse in the West-Indo-Pacific, *Thalassoma amblycephalum*, and the cleanerfish of the Caribbean Sea, the gobies *Gobiosoma evelynae* and *G. oceanops*. EIBL-EIBESFELDT (1955) detected as first this kind of symbiosis with the above mentioned gobies. Beside these species many other cleanerfish, mostly labrids, exist, but show different colorations, and there is also a lot of species, which only clean as juveniles. Even in the Mediterranean and North Sea labrids take



Figs 1-6: Components of a mimicry-ring of fish species from the Red Sea. **1** The cleaner wrasse *Labroides dimidiatus* (Labridae) presents a blue horizontal stripe on the bright body; this wrasse is the model for the other fish of the mimicry-ring. **2** *L. dimidiatus* cleaning the gills of a larger wrasse client, *Cheilinus fasciatus*. **3** The fang-blenny *Aspidontus taeniatus* (Blenniidae) is a parasite and the main imitator of *L. dimidiatus* and equals the model by body shape, coloration and labrid mode of swimming; it differs slightly by its yellowish front body. **4** The fang-blenny *Aspidontus dussumieri* (Blenniidae) is an herbivorous species, of same coloration, but more slender than *L. dimidiatus*. **5** The fang-blenny *Plagiotremus tapeinosoma* (Blenniidae) is a parasite of very slender body shape with similar coloration as *L. dimidiatus*, it starts its attacks on other fish from hiding places.

over this role in the ecosystem (ZANDER et al. 1999). Whereas tropic cleanerfish are professional feeders on parasitic crustaceans or monigenaens, which collect these from their hosts, in subtropical or temperate areas the labrids are rather facultative cleaner (ZANDER et al. 1999).

Like *Labroides dimidiatus* imitates the suck-erfish *Echineis naucrates* (Müller's mimicry), the wrasse itself is model for a mimikry ring in the West-Indo-Pacific. The cleaner wrasses mostly feed on parasitic crustaceans, which they collect from skin, fins and gills of hosts. The client fish visit cleaner stations, which are the territory of a cleaner wrasse. Occasionally, the cleaner wrasse bites pieces of fin and skin from its clients and, therefore, behaves like a facultative parasite. Two other *Labroides* species occur in Hawaii, which generally attack other fish (LOSEY et al. 1999). Therefore, this mode of foraging is assumed to be the origin of cleaning behavior (GRUTTER & BSCHARY, 2003).

On the other side, *L. dimidiatus* itself is model for imitators, especially of blenniids of the tribe Nemophini. These fang-blennies possess large canines in the lower jaws; some of them possess venomous glands at their basis. *Aspidontus taeniatus* (fig. 3) imitate not only the coloration with a slight yellowish body in contrast to the white body of the model, but also the characteristic mode of labrid swimming (EIBL-EIBESFELDT 1959). By this way camouflaged, it can approach

close to a larger fish and then thrust forward and bite pieces of skin or fin from its victim. It is, therefore, a real parasite presenting aggressive or Peckham's mimicry (EIBL-EIBESFELDT 1959).

A near relative, *Aspidontus dussumieri* (fig. 4), in contrast is an herbivorous species. It presents the same coloration as *L. dimidiatus*, but its body shape is more slender (Batesian mimicry).

Another fang-blenny in this mimicry ring is *Plagiotremus tapeinosoma* (fig. 5). It is of snakelike shape, the blue horizontal band looks like a chain of pearls on the bright body. *P. tapeinosoma* behaves as a parasite, which attacks passing other fish from holes in the reef.

Additionally, a second cleaning wrasse, *Larabicus quadrilineatus* (fig. 6), is included in the observed mimicry ring. This species is endemic in the Red Sea; it presents the same dark blue horizontal band as *L. dimidiatus*, but presents a bright blue basic coloration. Only young *L. quadrilineatus* are cleaner, whereas adult feed on polyps.

Material and methods

How are these five species to integrate into the ecosystem? For this aim two visual census of the fish fauna of pseudocaves in the Red Sea were performed in Marsa Alam (middle Egypt) in 2015 and in Dahab (Sinai, Egypt) in 2016 (ZANDER 2017). In these localities all fish were

6 The wrasse *Larabicus quadrilineatus* (Labridae) cleans as juveniles, but differs from *L. dimidiatus* by its bright blue basic coloration.

Abb. 1-6: Mitglieder eines Mimikry-Kreises bei Fischen des Roten Meeres. 1 Der Putzerfisch *Labroides dimidiatus* (Labridae) zeigt ein dunkelblaues Längsband auf sonst hellem Körper; dieser Lippfisch ist das Vorbild für die anderen Arten dieses Mimikry-Kreises. 2 *L. dimidiatus* befreit die Kiemen eines größeren Lippfisches, *Cheilinus fasciatus*, von Parasiten. 3 Der Säbelzahn-Schleimfisch *Aspidontus taeniatus* (Blenniidae) ist ein Parasit und der genaueste Nachahmer von *L. dimidiatus*, da er dem Vorbild nicht nur in der Körpergestalt, sondern auch in der Färbung und der labriden Schwimmweise gleicht; er unterscheidet sich von diesem leicht durch die gelbliche Färbung im Vorderkörper. 4 Der Säbelzahn-Schleimfisch *Aspidontus dussumieri* (Blenniidae) ernährt sich von Pflanzen, der Körper ist schlanker, zeigt aber die gleiche Färbung wie *L. dimidiatus*. 5 Der Säbelzahn-Schleimfisch *Plagiotremus tapeinosoma* (Blenniidae) ist ein Parasit von sehr schlanker Gestalt, aber ähnlicher Färbung wie *L. dimidiatus*; er startet seine Angriffe auf andere Fische aus Verstecken heraus. 6 Der Lippfisch *Larabicus quadrilineatus* (Labridae) ist als Jungfische ein Putzer, aber unterscheidet sich von *L. dimidiatus* durch seine hellblaue Grundfärbung.

observed 12 or 20 times, respectively, at reef habitats with decreasing light and currents on a distance of about 200 m (ZANDER 2017).

3. Results and discussion

The mentioned two labrids and three blenniids are present by about 5 % in both localities (tab. 1). *Larabicus quadrilineatus* was the most abundant species because it is thrice as abundant as *Labroides dimidiatus*. The relation of *L. dimidiatus* and the most similar imitator *Aspidontus taeniatus* is about 6:1. Therefore, *L. dimidiatus* is clearly the model of this mimicry ring. According to WICKLER (1968) the harmless model must always have a larger abundance as the dangerous imitator in order to make the mimicry advantageous for the model and to keep this kind of partnership in balance.

The calculation of the relative abundance of model to imitator can have different results. In the classical example of mimicry, butterflies of the families Danaidae and Heliconidae, the relation of distasted to harmless imitators of other families range from 19 to one up to three to one, respectively (BATES 1863). Here the relationship of model (*L. dimidiatus*) to imitator (*A. taeniatus*) seems to be an advantage for the imitator and could in consequence lead to negative experiences and avoidance of clients to the cleaner. GRUTTER & BSCHARY (2003) observed that two bites of *L. dimidiatus* in a minute are not directed to parasites but to pieces from skin or fins.

According to GRUTTER (1996, 2003) at the Great Barrier-Reef 32 fish clients were cleaned per minute. That means that two of them or 16% suffer negative experience without to change the positive effect of this partnership.

Is it, therefore, possible that a parasitic fish like *A. taeniatus* can balance this partnership? Its prey is exclusively pieces of fins and skin and mucus of other fish. The cleaner fish preys on five parasites per minute (GRUTTER 1996) and, additionally, two bites on fin or skin (GRUTTER & BSCHARY 2003); together this are seven food intakes per minute. The imitator in consequence of its similar size may also feed seven times. If the respective abundance (tab. 1) is regarded to cleaner and parasite fish the attacks to fins and skin of clients in the community result in 3.6 attacks per minute (2.2 of *L. dimidiatus* and 1.4 of *A. taeniatus*) in 2015 and in 3.4 (2.0 and 1.4) in 2016.

The other components of this mimikry ring may weaken the effect of parasitic attacks of cleaner wrasse and fang-blenny. The cleaner wrasse *L. quadrilineatus* is 3 to 4 times more abundant than *L. dimidiatus* (tab. 1). Though its coloration slightly differs, it may compensate the deficit of clients, which become distrust against the cleaner wrasse. *Aspidontus dussumieri* is a harmless imitator with identical coloration, which may disappoint potential clients, but can increase the number of not dangerous components in this mimicry ring. The parasite fang-blenny *Plagiotremus tapeinosoma*, because of

Tab. 1: Abundance (%) of mimicry fish within the fish community of pseudocaves and relationships.

Tab. 1: Häufigkeit (%) der Mimikryfische innerhalb der Fischgemeinschaft der Pseudohöhlen und ihre Beziehungen

	Marsa Alam	Dahab	Kind of prey
<i>Labroides dimidiatus</i>	1.1	1.0	Cleaner
<i>Larabicus quadrilineatus</i>	3.9	3.4	Cleaner
<i>Aspidontus taeniatus</i>	0.2	0.2	Parasite
<i>Aspidontus dussumieri</i>	0.1		Plant feeder
<i>Plagiotremus tapeinosoma</i>		0.2	Parasite
<u>Sum</u>	<u>5.3</u>	<u>4.8</u>	
<i>L. dimidiatus</i> / <i>A. taeniatus</i>	5.5	6.7	
<i>L. dimidiatus</i> / <i>A. dussumieri</i>	11.0		
<i>L. dimidiatus</i> / <i>P. tapeinosoma</i>		5.5	
<i>L. quadrilineatus</i> / <i>L. dimidiatus</i>	3.5	3.4	

its different body shape and slight different coloration, is not a real imitator of *L. dimidiatus* and has developed another chase strategy by pushing forward from its hiding places.

In 2017 counts in Dahab attained somewhat different results than in this study due to the time, which was somewhat later as in the years before. *L. dimidiatus* was as abundant as in the former two years, however, *L. quadrilineatus* was less abundant than before and equaled the values of the former species. This result may be due to growing and ripening of the latter species. The abundance of *Aspidontus* spp. and *P. tapeinosoma* in 2017 was similar as in the former years.

Another mimicry ring was detected in the Mediterranean Sea (ZANDER & NIEDER 1997). Also in this case a cleaning labrid fish (*Coris julis* juv., showing a brown horizontal band on a bright body) was the model, which was imitated by a harmless blenny (*Parablennius roulei*) and a harmless goby (*Gobius vittatus*). The fourth component in this ring are young *Serranus cabrilla*, a predator with an identical coloration, which uses its imitation to get faster near to its prey.

Investigations on relationships within symbioses are rare, therefore, the present study may be a contribution to reveal few quantitative results of mimicry. Generally, the most investigations of biocenoses regarded the dynamics of the food chain, a greater part also the function of symbioses. All these investigations can help to better understand the very complicated ecosystems with its mutual relationships between habitat and biocenosis and within biocenosis. The evolution of cleaner fish mimicry may be improved by the models, mostly wrasses, which are able to change their coloration during the course of life and give the necessary signals to clients and imitators (WICKLER 1968).

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Received: 22.01.2018

Accepted: 15.03.2018