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Short note/Kurze Mitteilung

Feeding associations with triggerfishes (Balistidae) in the Red Sea and in the Indian Ocean

Fressgemeinschaften mit Drückerfischen (Balistidae) im Roten Meer und im Indischen Ozean

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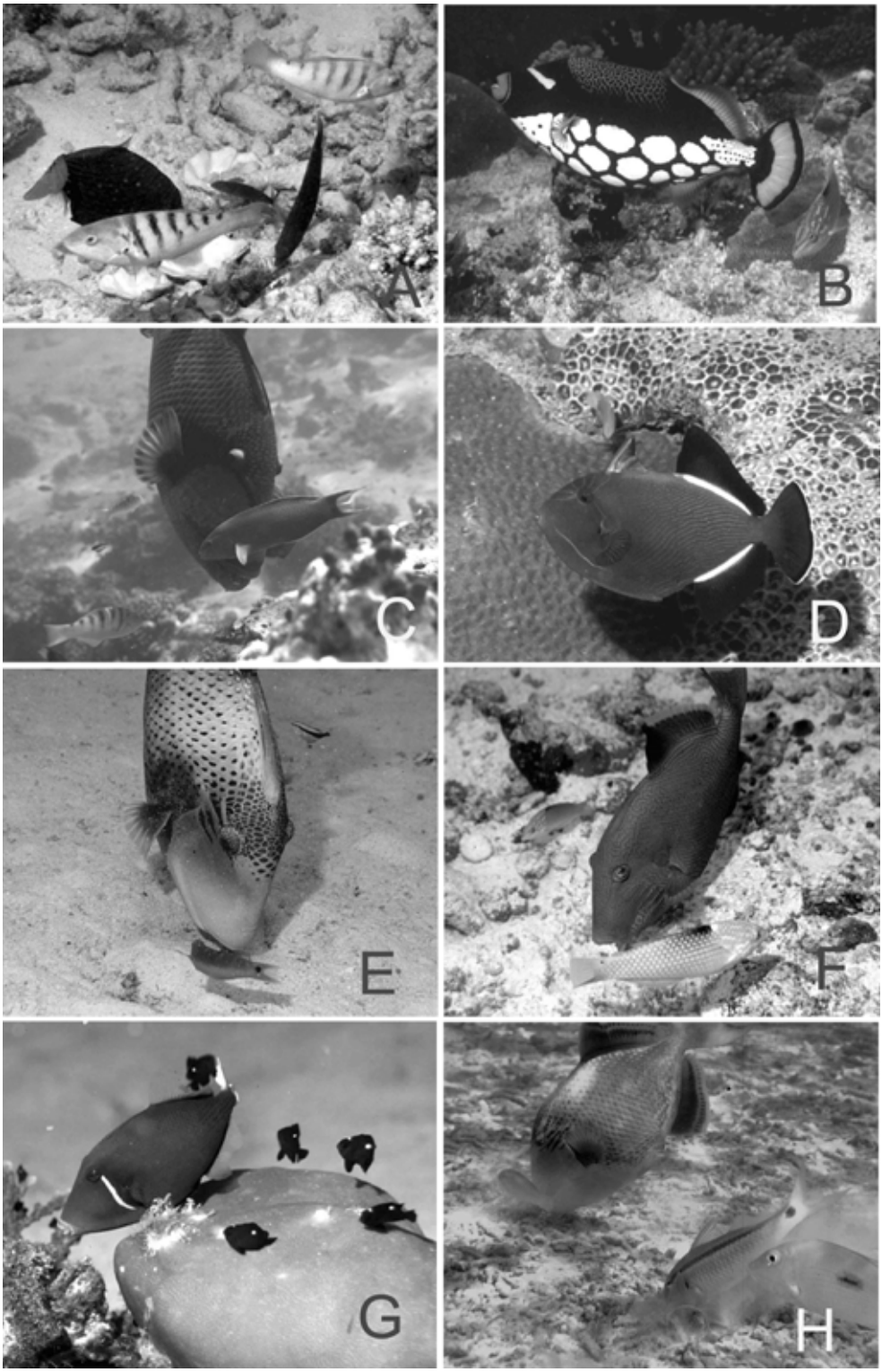
Zusammenfassung: Im nördlichen Roten Meer, im Süd-Male-Atoll (Malediven) und entlang der Westküste Sri Lankas wurden 42 Gemeinschaften mit sieben Arten von Drückerfischen (Balistidae) und 110 Kommensalen aus 35 verschiedenen Arten gezählt. Achtzehn dieser Begleiter sind aus Gemeinschaften mit Meerbarben bekannt, 15 sind neu. In jeder Gemeinschaft gab es immer nur einen Drückerfisch, der das Substrat aufwirbelte. Ein Drittel der Gemeinschaften wurde über Weichböden (Sand oder Sandeinschlüsse in Riff-Formationen), zwei Drittel auf Hartböden wie Korallen, Korallenfels oder Korallenschutt gefunden. Die Zusammensetzung der Fressgemeinschaften hing hauptsächlich von der Drückerfischart und dem Beobachtungsgebiet ab. Große Drückerfische wie *Balistoides viridescens* (besonders häufig auf den Malediven beobachtet) und *Pseudobalistes fuscus* (häufig im Roten Meer gesehen) hatten die meisten Begleiter, während z.B. *Sufflamen chrysopterum* und *Melichthys indicus* nur gelegentlich und dann nur sehr wenige Begleiter hatten.

Triggerfishes (Balistidae) are small to medium sized fishes of total lengths up to 90 cm, living mainly on shallow water coral reefs. They are characterized by a relatively deep and compressed body, a large head and a small, terminal mouth and feed on a variety of benthic animals including corals, molluscs, echinoderms, especially sea urchins, crustaceans, tunicates, and fishes, which they remove from nearly all kinds of bottoms (MYERS 1999). From hard substrates they scrape food items with their protruding close-set incisiform teeth, on sandy bottom they expose prey by emitting a strong jet of water by the mouth or they even remove substrate. These activities release other food items that are not fed by the triggerfishes, but attract other fishes resulting in so-called feeding associations (FRICKE 1975).

In the Eastern Pacific *Balistes polylepis* and *Balistes verres* act as "nuclear species" for feeding associations and were followed by fishes from eight species (STRAND 1988) . From the Fernando de Noronha Archipelago in the SW-Atlantik SAZIMA et al. (2005) reported on the triggerfish *Melichtys indicus* that was followed by the wrasse *Thalassoma noronhanum*. However, from the Indo-West-Pacific reports on feeding associations with triggerfishes as "nuclear species" are very rare. Only a few have been documented here by underwater-photographs in more popular books, but authors did not comment them sufficiently (e.g. *Balistoides viridescens*, EICHLER & LIESKE 1994, SCHÖFBERGER 1997).

In the present note I describe feeding associations with triggerfishes from the Indo-West-Pacific more detailed than before, from which most are new. The associations were counted by snorkel and scuba diving in the northern Red Sea, in the South Male Atoll (Maldives) and off western Sri Lanka on excursions from 1994 to 2009. Observations were made from the surface down to 30 m depth and noted on plastic cards by pencil. Most associations were photographed with a Mamiya RB 67 and a Nikon 601 camera in waterproof housings equipped with electronic flashlights on Kodak elite films. I recorded only associations recognized as true.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Seven species of triggerfishes have been observed in feeding associations: *Balistapus undulatus* (Mungo Park, 1797), *Balistoides conspicillum* (Bloch & Schneider, 1801), *Balistoides viridescens* (Bloch & Schneider, 1801), *Melichthys indicus* Randall & Klausewitz, 1973, *Pseudobalistes flavimarginatus* (Rüppell, 1829), *Pseudobalistes fuscus* (Bloch & Schneider, 1801) and *Sufflamen chrysopterum* (Bloch & Schneider, 1801). Each species is shown together with various commensals in figure 1 A-H. Always a single specimen acted as nuclear species. Association with specific species varied considerably. Some species could be observed only once or twice, others up to 15 times in the periods of investigation (see fig. 2). The numbers of associations with a specific triggerfish species obviously depended on its abundance and attractiveness, i.e. their activity. I did never observe triggerfishes foraging together with conspecifics. Sometimes smaller triggerfish species, e.g. *Balistapus undulatus, Sufflamen chrysopterum*, were commensals of larger triggerfish species, especially of *B. viridescens* and *P. flavimarginatus,* which both grow more than half a meter in length (see table 2). Altogether 35 species belonging to nine families were observed following triggerfishes. The largest group were species of the La-bridae, followed by species of the Poma-centridae and Chaetodontidae (tab. 1)

Tab. 1: Number of commensal fish species of different families.
Tab. 1: Anzahl der Begleitfischarten aus verschiedenen Familien.

Family	Nos. of spec.	%
Acanthuridae	1	3
Balistidae	3	9
Chaetodontidae	5	14
Serranidae	2	6
Labridae	13	36
Lethrinidae	1	3
Mullidae	3	9
Pomacentridae	6	17
Scaridae	1	3
9	35	100%

Also, the number of accompanying fish species appeared to depend largely on the triggerfish species (fig. 3). Although not statistically evaluated, the size of nuclear fishes and number of followers seem to be correlated to a certain extent. This is probably due to the fact that larger individuals and/or species, e.g. *B. viridescens, P. flavimarginatus* and *P. fuscus*, stir up more sandy substrate and/or remove larger parts of sessile invertebrates and set more particles free from hard bottoms than smaller ones (tab. 2)

Fig. 1 A-H: Interspecific feeding associations with triggerfishes as nuclear species. **A** Two *Thalassoma hardwicke* (striped) and two *T. lunare* in feeding association with *Balistapus undulatus.* Maldives. **B** *Balistoides conspicillum* accompanied by *Halichoeres hortulanus,* Maldives. **C** *Balistoides viridescens* followed by two *T. hardwicke,* a male of *T. lunare* (front) and a cleanerfish *(Labroides dimidiatus),* Maldives. **D** *Melichthys indicus* together with *Pomacentrus coelestis* (above dorsal spines). Sri Lanka. **E** *Pseudobalistes flavimarginatus* digging in the sand and followed by a *T. lunare* (bottom) and a cleanerfish (*L. dimidiatus),* Maldives. **F** *Pseudobalistes fuscus* accompanied by two *Halichoeres hortulanus,* Maldives. **G** *Sufflamen chrysopterum* followed by five *Dascyllus trimaculatus* (one at the caudal fin), Maldives. **H** A *Parupeneus barberinus* joins together with its commensal *Lethrinus harak* (lower right) to *P. flavimarginatus* accompanied by *Halichoeres scapularis*, Maldives.
Abb. 1 A-H: Interspezifische Fressgemeinschaften mit Drückerfischen. **A** Zwei *Thalassoma hardwicke* (gestreift) und zwei *T. lunare* in Fressgemeinschaft mit *Balistapus undulatus,* Malediven. **B** *Balistoides conspicillum* begleitet von *Halichoeres hortulanus,* Malediven. **C** *Balistoides viridescens* gefolgt von zwei *T. hardwicke,* einem Männchen von *T. lunare* (vorn) und einem Putzerfisch *(Labroides dimidiatus),* Malediven. **D** *Melichthys indicus* gemeinsam mit *Pomacentrus coelestis* (über den Rückenflossenstacheln), Sri Lanka. **E***Pseudobalistes flavimarginatus* begleitet von einem *T. lunare* (unten) und einem Putzerfisch (*L. dimidiatus),* Malediven. **F** *Pseudobalistes fuscus* begleitet von zwei *Halichoeres hortulanus,* Malediven. **G** *Sufflamen chrysopterum* begleitet von fünf *Dascyllus trimaculatus* (einer an der Schwanzflosse), Malediven. **H** Ein *Parupeneus barberinus* gesellt sich gemeinsam mit seinem Kommensalen *Lethrinus harak* (rechts unten) zu einem *P. flavimarginatus,* der von einem *Halichoeres scapularis* begleitet wird, Malediven.

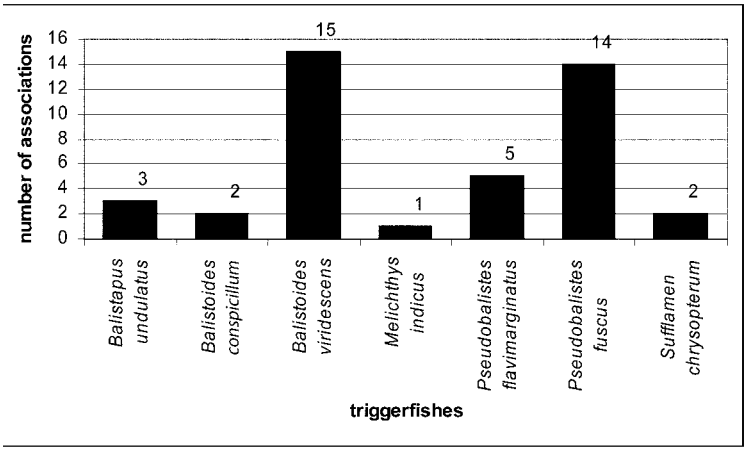

Fig. 2: Frequency distribution of various Balistidae in associations; absolute numbers (n=42).
Abb. 2: Häufigkeitsverteilung der verschiedenen Balistidae in Gemeinschaften; absolute Zahlen (n=42).

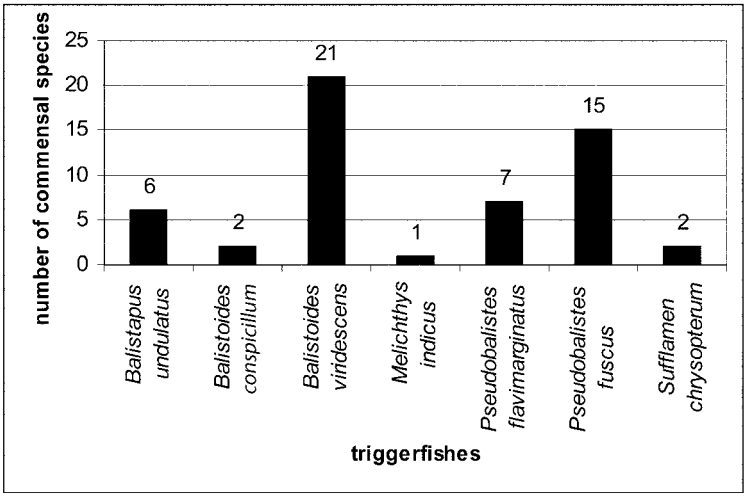

Fig. 3: Number of fish species (n = 35) accompanying triggerfish species.
Abb. 3: Anzahl von Fischarten (n = 35), die Drückerfisch-Arten begleiten.

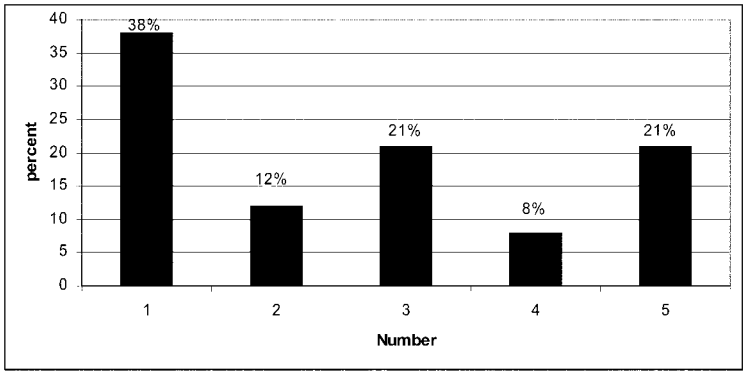

Fig. 4: Number of accompanying fish specimens per association in percent (n = 42)
Abb. 4: Anzahl von Begleitfischen pro Gemeinschaft in Prozenten (n = 42)

Tab. 2: Associations of triggerfishes and accompanying fishes in different areas of the Indian Ocean. N= Number of observations in feeding associations. * = species that were also observed in goatfish associations (MOOSLEITNER 2008). r = species found also in associations with stingrays MOOSLEITNER 2005). The remaining non-labelled species are new for feeding associations. M = Maldives, R = Red Sea, SL = Sri Lanka.
Tab. 2: Vergesellschaftung der Drückerfisch-Arten mit Begleitfischen in den verschiedenen Gebieten des Indischen Ozeans. N = Anzahl der Fressgemeinschaften in denen die betreffende Art beobachtet wurde. * = Arten, die auch in Gemeinschaft mit Meerbarben gefunden wurden (MOOSLEITNER 2008). r = Arten, die auch in Gemeinschaft mit Rochen beobachtet wurden (MOOSLEITNER 2005). Die restlichen, nicht markierten Arten sind neu für Fressgemeinschaften. M = Malediven, R = Rotes Meer, SL = Sri Lanka.

Commensals	Balistidae							n
	Balistapus undulatus.	*Balistoides conspicillum*	*Balistoides viridescens.*	*Melichthys indicus*	*Pseudobalistes flavimarginatus*	*Pseudobalistes fuscus*	*Sufflamen chrysopterum*	
Acanthuridae								
Ctenochaetus.binotatus						R		1
Balistidae								
*Balistapus undulatus** r			M					7
Odonus niger r					R			1
*Sufflamen.albicaudatum**					R			2
Chaetodontidae								
*Chaetodon auriga**						R		1
C. falcula	M		M					4
*C. fasciatus**			R			R		3
C. kleinii			M					4
C. xanthocephalus			M					1
Serranidae								
Cephalopholis argus			M					1
C. miniata			M					1
Labridae								
*Bodianus anthioides** r						R		2
Cheilinus chlorourus						M		3
*Cheilinus fasciatus**						R		2
*Coris aygula**			M					1
Coris cuvieri						R		1
*Coris caudimacula** r					R	R		4
*Halichoeres.hortulanus**r	M	M	M			M,R		10
*H. scapularis**			M		M			2
*Labroides dimidiatus** r			M		R			7
Thalassoma hardwicke	M		M					5
T. janseni			M					1
*T lunare** r	M	M	M		R	M		16
*T rueppellii** r			R					5
not identified labr.			M,R			R		4
Lethrinidae								
*Lethrinus harak** r			M					1
Mullidae								
*Parupeneus barberinus**			M		M	M		3
*P. forsskali** r						R		2
*P.macronemus**			M			M		2
Pomacentridae								
Abudefduf vaigiensis	M							1
Amblyglyphidodon indicus							M	1
Dascyllus carneus			M					1
D. trimaculatus r							M	5
Pomacentrus coelestis				SL				1
*P. trichourus** r						R		2
Scaridae								
Scarus scaber	M		M					2

As some commensals followed more than one species, the absolute numbers of followers inserted in figure 3 exceed the number of species (N=35). The number of commensals in each association ranged from one (with 16 observations most frequently) to five (fig. 4). Many commensals were noticed once or twice, while others like *Halichoeres hortulanus* and *Thalassoma lunare* were frequently seen (tab. 2). Associations with triggerfishes were seen over all kinds of substrates (fig. 5), but probably geographical differences occur concerning their frequency. For example, most associations in the Red Sea were seen with *P. fuscus*, but at the Maldives with *B. viridescens* (tab. 2).

In 13 of the associations cleaners (*Labroides dimidiatus*) were observed cleaning the nuclear fish. However, in feeding associations with goatfish (Mullidae) cleaners have been rarely seen and, if they were present, they preferred to clean the commensals and not to ingest food particles (MOOSLEITNER 2008). In other associations, wrasses (*Thalassoma noronhanum*) following parrotfishes (Scaridae) pursued both activities: they picked up raised food items and cleaned the nuclear fish (SAZIMA et al., 2005).

In some cases commensals follow nuclear triggerfishes in a limited range only. Some Pomacentridae of the genera *Amblyglyphidodon* and *Dascyllus* are coral dwelling planctivores (MYERS 1999), which join triggerfishes only if small food particles are whirled up near their home coral, whereas other *Abudefduf* and *Pomacentrus* species, which are omnivores feeding on benthic algae, small invertebrates and zooplankton (MYERS 1999), are mostly attracted by the activities of triggerfishes over mixed bottoms and reefs that may be situated farther away from their hideouts.

When comparing the above observations with data known from other feeding associations, with elasmobranchs, especially sting rays (MOOSLEITNER 2005), and Mullidae (MOOSLEITNER 2008) it becomes evident that 12 of the species (mainly of the Labridae) listed in table 2 and marked there by "r" have been also observed in association with stingrays (MOOSLEITNER 2005), and 18 species marked with "*" in associations with Mullidae (MOOSLEITNER 2008). Ten species (marked with r and *) were found in all three types of associations. Fifteen species – not labelled in table 2 – have not been observed in feeding associations before.

In brief, the increasing number of fish species of various families involved in feeding associations as commensals suggests that this phenomenon is more widespread than supposed and shows that utilization of the activities of other species acting as "nuclear fishes" is an effective energy-saving way of foraging.

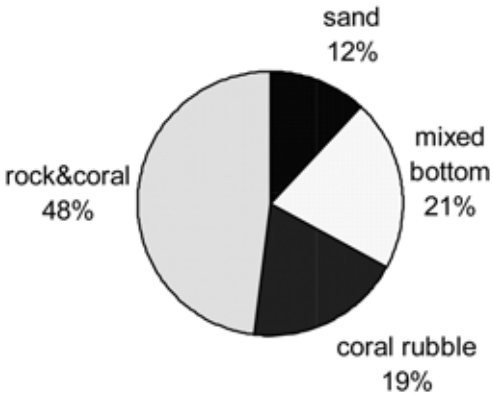

Fig. 5: Distribution of triggerfish-associations on different substrates.
Abb. 5: Verteilung der Drückerfischgemeinschaften auf verschiedenen Böden.

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