DIFFERENT RESPONSES OF INSHORE FISHES TO THE CLEANING WRASSE, *LABROIDES DIMIDIATUS*, AS OBSERVED IN SIRAHAMA[1]

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With Text-figures 1–6 and Tables 1–4

Abstract

The inshore fishes of Sirahama were studied, particularly in relation to their responses to the cleaner *Labroides dimidiatus,* common and the only habitual and obligate cleaner at the study area, in the years from 1972 to 1975. According to their responses to the cleaner, inshore fishes can be distinguished into two categories: 'posing species' which display a pose to it and 'non-posing species' which do not exhibit any pose. It was found that most of the fishes dwelling near the cleaner are the posing species, while the fishes dwelling apart from it are mostly the non-posing. The cleaner cleaned any species, whether posing or non-posing, dwelling near to it. There is a rather extensive range in the attitude to be cleaned either among posing species or among non-posing ones, according to their modes of life. From these facts, it was suggested that posing behavior of host fishes has been developed through their daily contacts with the cleaner in their course of evolution only when cleaning has been significant for their life. Further, the importance of examining how cleaning symbiosis is prevailing among the members of the fish community within a definite area, i.e. how many posing species are found among them, was suggested.

Introduction

The cleaning symbiosis, one of the common interspecific relationship well known among terrestrial animals (MacFarland & Reeder, 1974; etc.) as well as marine organisms (Feder, 1966; etc.), is an association in which certain organisms (cleaners) remove ectoparasites, diseased or injured tissues, and other deleterious materials from cooperating organisms (hosts).

Labroides dimidiatus (Cuvier & Valenciennes), a fish of the family Labridae, is one of the most specialized cleaner in the sea, and various fishes display distinctive postures in order to be cleaned by this cleaner (Randall, 1958; Eibl-Eibesfeldt, 1959; etc.). Differences in such postures and related behaviors of host fishes to various cleaners have been studied (Abel, 1971; Hobson, 1971; Losey, 1972, 1974; Potts, 1973b). Actually, there are some fishes which display no such distinctive posture to the cleaner, though they are cleaned, and moreover some are seemingly reluctant

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to be cleaned (Randall, 1958; Potts, 1968, 1973a; Okuno, 1969a, b). Thus, there is a rather extensive range in the responses exhibited by host fishes in the cleaning association, but neither any comprehensive list of host fishes non-posing to respective cleaners nor their other responses else than posing have been yet studied sufficiently.

Since 1972, I have been studying the inshore fish community in the vicinity of Sirahama, approximately 33°42′N and 135°20′E, particularly in relation to their different responses to the cleaner *L. dimidiatus* which is the only habitual and obligate cleaner recognized and found rather commonly in the area studied. Three hundred and five species of fish were recorded from the sea of Sirahama by Araga and Tanase (1966) who also listed the tropical fishes killed by the cold and stranded on the beach in the vicinity of Seto (1968). Okuno (1956) studied the modes of life of some reef fishes in the vicinity and then later tried to compare the reef fishes in Tanabe Bay with those of the Marshall Islands (1964). Further, the distribution and abundance of rocky reef fishes in Tanabe Bay were studied by Okuno, Fuse and Harada (1958). The present paper is to show how the cleaning symbiosis is prevailing in the fish community of the vicinity and in what behavior respective fishes respond to this cleaner.

The Observation Area, Methods and the Fish

Observation Area: The town of Sirahama occupies the whole southern coast of Tanabe Bay on the west coast of Kii Peninsular, Japan (Fig. 1–A); the oceanographic

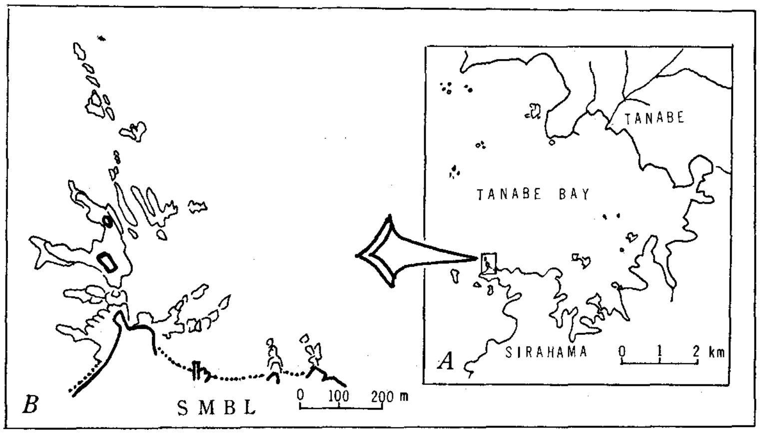

Fig. 1. Map of the study area.

conditions of the bay are given in detail by Fuse, Yamazi and Harada (1958) and Fuse (1959).

The present work was carried out mostly in the inshore waters just north of the Seto Marine Biological Laboratory which is sited on a cape projected out from the northwestern corner of the town of Sirahama (Fig. 1–B). In this area, many rocky reefs usually irregularly and complicatedly shaped, rugged with many crevices and caves, or carrying boulders on the surface, are found on the sandy flat bottom that is slanting from 5 m or less on the near shore side to 15 m or less on the off shore side. Some massive corals 10 to 50 cm across the colony are found growing separately on the rocky substratum. Algal vegetation, mostly of *Sargassum,* is conspicuous from spring to early summer. The water temperature rises up nearly to 30°C in mid-summer and falls down to about 12°C in mid-winter.

Observations were rather concentrated to the rocky reefs, as the cleaning association was rarely displayed on the sandy floor.

Methods: Observations for 500 hours or more in a total were carried out mainly by scuba diving and sometimes by snorkelling in the years from 1972 to 1975, mostly in the daytime, but sometimes at sunrise, sunset, or at night. What were noted were put on the plastic boad in pencil during the underwater observations on the following items: 1) the size, abundance, habitat and behavior of the fishes met with during respective observations and 2) the number of the fishes and their sizes and behavior for each species in cleaning association. Representatives of respective fishes were caught using dip nets and/or small gill nets to check the identification in the field.

To see the responses to the cleaner *Labroides dimidiatus* of some fishes which were never cleaned in the sea, these fishes were brought into larger, 0.3 m^3 to 250 m^3 in volume, tanks of the laboratory aquarium or into smaller, 50 to 100 *l*, tanks in the laboratory room together with the cleaner and thus their responses were confirmed by indoor observations. Such fishes were collected by myself in the area studied or obtained from the fishermen in action in Tanabe Bay, and observations were made continuously for a week or more after the host fish and the cleaner were placed together in the tank.

Cleaners: Nearly all the cleaning behaviors observed during this study concerned the cleaning wrasse *Labroides dimidiatus* which was found commonly in the area on most of the rocky reefs but rarely on the sandy floor. This fish is diurnal, hiding itself into small rock crevices around sunset and coming out of the hiding place at sunrise. They are less active in winter because of lower temperature, when some of them are hiding themselves in small rock crevices even in the daytime, though others are found engaged in cleaning. Breeding occurs in the months from May to September, and juveniles settle down from July to October at the length of about 10 mm and begin cleaning. As the cleaning wrasse swims around in its home range, it approaches and tries to clean any fishes that it encounters.

The boxer shrimp *Stenops hispidus* (Olivier), known as a part-time cleaner (Limbaugh et al, 1961; Randall, 1962), is also found commonly in rock caves or crevices in the observation area, though only two cases of cleaning fishes by this shrimp were observed during the present study.

Sub-adults of the wrasse *Thalassoma cupido* (Temminck & Schlegel) and juveniles of the surgeonfish *Prionurus microlepidotus* Lacépède, both occurring commonly in the area, have also been observed cleaning other fishes, but only twice in the former and only once in the latter.

Another cleaning wrasse, *Labroides bicolor* Fowler & Bean, has ever been recorded from the vicinity of Sirahama (Araga & Tanase, 1966), but no individual of this wrasse was observed in the area during this study.

Host Fishes: Many temperate and sub-tropical fishes are inhabiting the observation area all the year round, in addition there appear juveniles of some tropical fishes which are carried to this area by the warm Kuroshio current in summer, but mostly perished by low temperatures in winter.

I have observed more than 300 species of fish during the present study. However, the species, which are occurring only rarely in the observation area and never observed being cleaned, are left outside the consideration in the present paper. And thus, in the following are shown only 123 species that comprise all the fishes which were observed being cleaned by the cleaner *L. dimidiatus* in the sea or tanks and the fishes which were never observed being cleaned but occurred commonly in the area. Of 123 species mentioned here, 71 species were observed being cleaned by the cleaner in the sea during this study, and further the cleaning association was confirmed in the tank in 39 of these species. Other 47 species were not cleaned in the sea but observed in the tank. In five common species which were not observed being cleaned in the sea, the cleaning association were not confirmed in the tank, either.

Responses to the Cleaner and Habitats of Host Fishes

The Response Patterns in the Cleaning Association:

A series of responses involved in the cleaning association between a cleaner and a host fish have been precisely studied already by many authors (Randall, 1958; Eibl-Eibesfeldt, 1959; Youngbluth, 1968; Potts, 1968, 1973a, b; Okuno, 1969a, b; Hobson, 1971; Losey, 1971, 1972, 1974; etc.), but most of their descriptions are made on symbiotic host fishes which display an 'invitation posture' (Potts, 1968) or a 'pose' (Losey, 1972) to be cleaned during the encounter with the cleaner and may be called the 'posing species' hereafter. There are known, however, some other fishes which are cleaned but never display such a pose (Randall, 1958; Potts, 1968, 1973a; Okuno, 1969a, b) and therefore may be called the 'non-posing species'. A general outline of the succession of responses between the cleaner and its posing or non-posing host fishes is given in Fig. 2.

Posing Species: Responses of posing species have been known well. When they discern a cleaner, they approach to it and display a pose facing it, but the posture in their pose is highly specific (Randall, 1958; Potts, 1973b; etc.). On the other hand, they sometimes do not seem to be aware of the presence of a cleaner till it approaches to them and begins to clean or 'to inspect and feed' according to Youngbluth (1968), though they display a pose immediately after the start of cleaning. On certain occasions they may remain 'indifferent' to, flee from or even chase the cleaner away when it approaches to or starts to clean them, as has been already reported (Potts, 1968; Hobson, 1971; Losey, 1971; etc.). Further, fleeing or chasing responses may be observed rather in unusual situations of the host facing some dangers or being placed in a small tank.

Differences in the responses of posing fishes have been studied and expressed in the ratio 'pose to inspect' (Okuno, 1969a, b; Losey, 1972, 1974; Potts, 1973b). However, this p/i ratio can not be taken as the direct indicator of determining the difference of the responses among whole host fishes, as it involves only the posing response and is also affected by the preference of the cleaner to host fishes. It is suggested that ratios of 'posing', 'indifferent', 'fleeing' or 'chasing' to the whole responses seem to be better indicators.

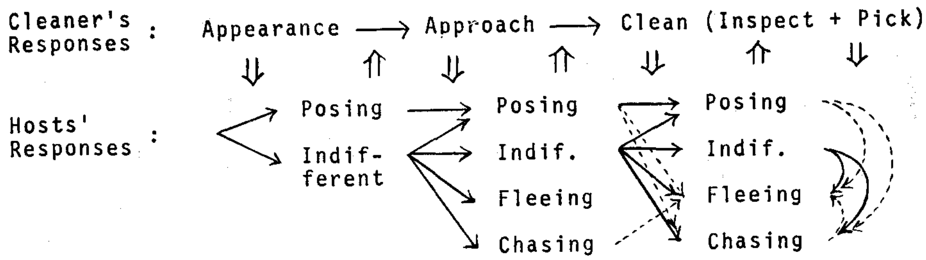

Fig. 2. The succession of responses between the cleaner and host fishes.

Non-posing Species: During the present study, many non-posing fishes were found newly in the sea of Sirahama. They were indifferent to the cleaner when they seemingly must perceive it or they remained indifferent to, fled from or chased it when the cleaner approached to them. In some cases their responses remained 'indifferent' even when the cleaner began to clean them or exhibited 'fleeing' or 'chasing' for the first time at the start of cleaning (Fig. 2). They have never displayed any poses that have been exhibited by posing species, during the whole course of the cleaning encounter. Certain responses, such as keeping a motionless state, are difficult to be judged whether they are 'indifferent' or truly 'posing'. Such undefinable responses are described as 'still' in the present paper.

As some posing fishes may display a pose only rarely, it is very difficult to judge whether such fishes as observed being cleaned only rarely and displaying no pose are regarded as posing species or non-posing species. On the other hand, the fishes occurring abundantly in the observation area but never observed displaying any pose are treated in this paper as non-posing species regardless of being never or rarely cleaned; if they were posing species, their posing behavior could have been observed with high probability.

Habitats of the Cleaner and Host Fishes:

In analysing the association between the cleaner and host fishes, it is essential to learn how frequently the cleaner and respective hosts can meet with each other, and this is dependent largely on how their habitats are overlapping. As the cleaner *L. dimidiatus* is diurnal, the daytime habitats of inshore fishes in the observation area are to be checked at present, and they are distinguished into the following ten categories:

1) intertidal habitat (IT), 2) surface-water habitat (SU), 3) mid-water habitat (MW), 4) above-sandy-floor habitat (AS), 5) sandy-bottom habitat (SB), 6) transitional-above-substratum habitat over sandy floor to rocky reef (TA), 7) transitional-bottom habitat from sandy to rocky (TB), 8) rocky-bottom habitat (RB), 9) rock-cave or crevice habitat (RC), 10) above-rocky-reef habitat (AR) (Fig. 3).

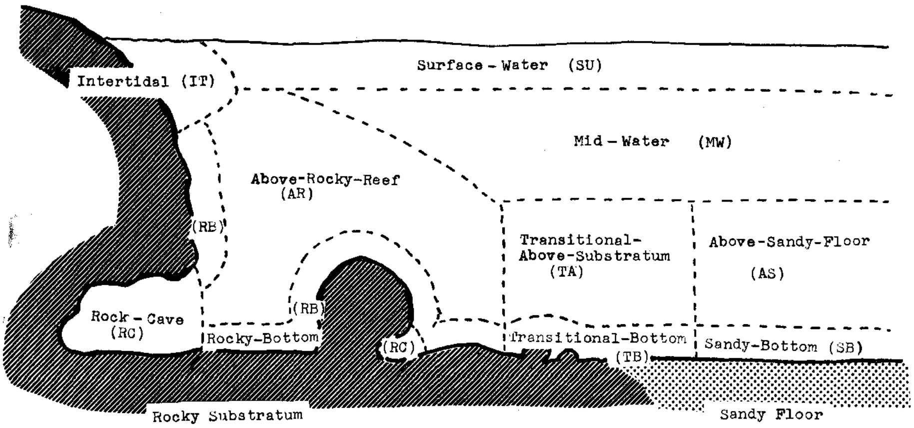

Fig. 3. A schematic representation of the inshore topography in the vicinity of Sirahama, with a proposed division of fish habitats.

As the cleaner is regarded as belonging to the AR group, it may have some chances to meet with the fishes of the groups RB, TA, TB, MW and RC, but rarely with those of the groups IT, US, AS and SB.

The Response of Each Fish in Respective Habitat:

The inshore fishes belong generally to any of the ten groups mentioned below respectively according to their habitats. However, the inhabiting range of some fishes may extend to cover habitats of more than two categories, though such species are discussed here under the group of their main habitat or arbitrarily in the group of one of the habitats when they are equally utilized. The response and other related behaviors of respective inshore fishes to the cleaner *L. dimidiatus*, observed in the sea and/or in the tank, are mentioned, and all these are shown in Table 1 in signs, together with their abundance, total length, habitat and number of cleaning bouts observed in the sea.

(1) Intertidal Group

Tripterygion etheostoma Jordan & Snyder ヘビギンポ (Tripterygiidae)
Entomacrodus stellifer (Jordan & Snyder) ホシギンポ (Blenniidae)
Istiblennius enosimae (Jordan & Snyder) カエルウオ (do.)

Three small benthic blennies mentioned above are found commonly on the reef flats in the intertidal zone in the area. They were not observed being cleaned by the cleaning wrasse, for the latter rarely swam up into the intertidal zone. *I. enosimae*

Table 1. List of the studied fishes, with their relative abundance in comparative sign, total length, habitat, number of cleaning bouts and pattern of responses to the cleaner *L. dimidiatus*.

For abundance; cc: very abundant, c: common, r: rather rare, rr: very rare. For habitats abbreviations are the same as in Fig. 4. For responses; P: posing, I: indifferent, S: still, F: fleeing, C: chasing, E: feeding, —: no contact, /: no observations made. Responses reported by other authors are given in parentheses. Numbers of cleaning bouts show those observed in the study area from Apr. 1973 to Dec. 1974. Names of fishes and their arrangement follow Masuda, Araga and Yoshino (1975).

Name of Fish	Abundance	Total length (cm)	Habitat	Cleaning bouts	Response in Field	Response in Aquarium	Posing
Class Chondrichthyes							
Subclass Elasmobranchii							
Order Rajiformes							
Family Dasyatidae							
Dasyatis akajei	rr	50–80	SB	0	—	—(P)	+
Class Osteichthyes							
Subclass Actinopterygii							
Order Clupeiformes							
Family Dussumieridae							
Spratelloides japonicus	cc	5–10	SU	0	—	/	—
Order Cypriniformes							
Family Plotosidae							
Plotosus anguillaris	c	5–20	RC	1	F	F	—
Order Anguilliformes							
Family Congridae							
Conger japonicus	r	30–70	RC	0	—	S	—
Family Muraenidae							
Gymnothorax kidako	c	20–80	RC	1	P	S	+
Order Myctophiformes							
Family Synodontidae							
Synodus variegatus	c	10–30	TB	1	S	—	—
Order Gadiformes							
Family Brotulidae							
Brotula multibarbata	r	20–30	RC	1	F	S	—
Order Mugiliformes							
Family Atherinidae							
Atherion elymus	c	5	SU	0	—	F	—
Family Mugilidae							
Mugil cephalus	r	20–30	TA	1	P	—	+
Family Sphyraenidae							
Sphyraena japonica	c	10–20	MW	0	—	/	—
Order Beryciformes							
Family Holocentridae							

Name of Fish	Abundance	Total length (cm)	Habitat	Cleaning bouts	Response in Field	Response in Aquarium	Posing
Myripristis murdjan	r	10–15	RC	0	–	C, E, P	–
Order Perciformes							
Family Pempheridae							
Parapriacanthus ransonneti	rr	5	RC	1	F	/	?
Pempheris xanthopterus	c	5–15	RC	14	P, F	/	+
Family Oplegnathidae							
Oplegnathus fasciatus	r	10–30	AR	1	S	P	+
O. punctatus	r	10–30	AR	0	–	P	+
Family Mullidae							
Upeneus tragula	r	5–20	TA	5	P	/	+
Mulloidichthys vanicolensis	rr	5–15	TA	3	P	/	+
Parupeneus spilurus	c	5–30	TA	34	P, F, C	/	+
P. barberinus	r	5–15	TA	1	P, C	/	+
P. trifasciatus	r	5–15	TA	1	P	/	+
Family Apogonidae							
Apogon taeniatus	r	10	RC	0	–	–	–
A. cyanosoma	r	5	RC	2	S, F	F	–
A. doederleini	c	5–10	RC	97	C, F, S	C	–
A. notatus	cc	5–10	RC	169	F, S, C	F	–
Family Kuhliidae							
Kuhlia mugil	r	5–15	SU	0	–	F	–
Family Pomatomidae							
Scombrops boops	r	5–10	AR	0	–	/	–
Family Serranidae							
Epinephelus fasciatus	r	10–20	RB	0	–	P	+
E. merra	r	10–15	RB	0	–	P	+
E. areolatus	r	20–30	RB	1	P	/	+
E. moara	rr	10–40	RB	0	–	P	+
E. septemfasciatus	rr	10	RB	0	–	P, E	+
Franzia squamipinnis	r	5–15	AR	1	P	/	+
Family Sillaginidae							
Sillago sihama	rr	10–20	AS	0	–	F	–
Family Girellidae							
Girella punctata	c	5–30	AR	} 67	P, F	P	+
G. melanichthys	c	5–30	AR	}	P, F	P	+
G. mezina	r	5–20	AR	0	–	P	+
Family Kyphosidae							
Kyphosus lembus	r	10–20	AR	0	–	P	+
Family Gerridae							
Gerres oyena	cc	10–30	TA	15	F, P, S, I	F	+
Family Sparidae							
Acanthopagrus latus	rr	20	TA	0	–	F	–

Name of Fish	Abundance	Total length (cm)	Habitat	Cleaning bouts	Response in Field	Response in Aquarium	Posing
Pagrus major	r	5–15	TA	0	—	P	+
Family Lethrinidae							
Lethrinus nematacanthus	r	5–15	TA	0	—	F	?
Family Lutjanidae							
Lutjanus russelli	r	10–20	TA	1	P	/	+
L. kasmira	r	5–20	TA	5	P, S	P	+
Family Pomadasyidae							
Parapristipoma trilineatum	r	10–20	AR	0	—	P	+
Plectorhynchus pictus	r	5–30	TA	2	P	P	+
Family Cheilodactylidae							
Goniistius zonatus	c	10–30	RB	82	P, I, F, C	P	+
G. zebra	r	10–30	RB	9	P	P	+
Family Labracoglossidae							
Labracoglossa argentiventris	r	5–15	AR	1	P	/	+
Family Carangidae							
Trachurus japonicus	c	10–15	TA	4	F	F, E	—
Family Mugiloididae							
Parapercis snyderi	c	5–10	TB	0	—	S, F, E	—
P. pulchella	r	5–15	SB	0	—	S, F	—
Family Callionymidae							
Callionymus punctatus	r	5–15	SB	0	—	F, —	—
Family Tripterygiidae							
Tripterygion etheostoma	c	5	IT	0	—	/	—
Family Blenniidae							
Entomacrodus stellifer	c	5–10	IT	0	—	—	—
Istiblennius enosimae	c	5–15	IT	0	—	S, F	—
Plagiotremus tapeinosoma	r	5–10	AR	1	F	/	—
Family Gobiidae							
Vireosa hanae	r	5–10	AS	0	—	F	—
Amblyeleotris japonica	cc	5–10	SB	0	—	C, —	—
Acentrogobius campbelli	c	5–10	TB	12	F, S	F, E	—
Family Pomacentridae							
Amphiprion clarkii	r	5–10	AR	0	—	P	+
Chromis isharai	rr	5	AR	0	—	P	+
C. notatus	c	5–15	AR	1	P	P	+
Dascyllus trimaculatus	r	5	AR	0	—	P	+
Eupomacentrus jenkinsi	c	5–15	AR	0	—(P)	/	+
Pomacentrus coelestis	cc	5–10	AR	147	P, F, I, C	/	+
P. nagasakiensis	r	5–10	AR	1	P	P	+
Abudefduf vaigiensis	c	5–10	AR	3	P	P	+
A. sexfasciatus	r	5–10	AR	1	P	P	+
Family Labridae							
Thalassoma lunare	r	5–15	AR	6	P, I	/	+

Name of Fish	Abundance	Total length (cm)	Habitat	Cleaning bouts	Response in Field	Response in Aquarium	Posing
T. cupido	cc	5–15	AR	8	I, P, F, C	I, F, E	+
T. lutescens	r	5–10	AR	0	—	P	+
Pteragogus flagillifera	r	10–20	AR	0	—	P	+
Pseudolabrus japonicus	c	5–25	AR	19	P	P	+
Labroides dimidiatus	c	5–10	AR	15	P	P	+
Stethojulis interrupta	c	5–15	AR	18	P, I	/	+
Halichoeres tenuispinnis	c	5–15	AR	6	P, I	/	+
H. poecilopterus	r	10–20	AS	0	—	—(P)	+
Cirrhilabrus temmincki	r	5–10	AR	9	P	/	+
Cheilinus bimaculatus	r	5–10	AR	0	—	P	+
Family Scaridae							
Calotomus japonicus	c	5–30	AR	18	P, F	/	+
Scarus ghobban	r	5–15	AR	0	—	P	+
Family Scorpididae							
Microcanthus strigatus	r	5–15	AR	6	P	/	+
Family Chaetodontidae							
Forcipiger flavissimus	rr	5–10	AR	1	P	P	+
Chaetodon auriga	r	5–10	AR	9	P, F, C	P	+
C. vagabundus	r	5	AR	1	P	/	+
C. collare	cc	5–10	AR	92	P, F, I, C	P	+
C. nippon	r	5	AR	1	P	/	+
C. citrinellus	r	5	AR	3	P	P	+
C. kleini	rr	5	AR	2	P	/	+
Heniochus acuminatus	r	5–10	AR	4	P	P	+
Family Zanclidae							
Zanclus cornutus	r	10–15	AR	3	P	/	+
Family Acanthuridae							
Acanthurus olivaceus	rr	5–15	AR	1	P	/	+
A. dussumieri	c	5–20	AR	6	P	P	+
A. nigrofuscus	r	5–10	AR	7	P, C	P	+
Prionurus microlepidotus	c	5–20	AR	29	P	/	+
Naso unicornis	r	10–20	AR	0	—	P	+
N. lituratus	rr	10–15	AR	0	—	P	+
Family Siganidae							
Siganus spinus	rr	10	AR	1	P	/	+
S. fuscescens	r	10–20	AR	0	—	P	+
Order Tetraodontiformes							
Family Balistidae							
Balistes chrysopterus	rr	5–10	AR	0	—	P	+
Family Aluteridae							
Stephanolepis cirrhifer	r	10	AR	5	P	P	+
S. japonicus	r	5–10	AR	1	P	/	+
Rudarius ercodes	r	5	AR	2	P	/	+

Name of Fish	Abundance	Total length (cm)	Habitat	Cleaning bouts	Response in Field	Response in Aquarium	Posing
Navodon modestus	r	5–15	AR	11	P	P	+
Family Ostraciontidae							
Ostracion cubicus	c	5–15	AR	8	P, S	P	+
Lactoria diaphanus	r	5–15	AR	1	F(P)	/	+
L. fornasini	c	5–15	AR	2	P, S	P	+
Family Tetraodontidae							
Canthigaster coronatus	r	5–10	AR	1	P	/	+
C. rivulatus	c	5–15	AR	12	P, F	/	+
Fugu niphobles	r	10–20	TA	0	—	P, S	+
F. vermiculare vermiculare	c	10–20	TA	4	P	P	+
F. pardale	r	10–20	TA	0	—	P	+
Tetraodon hispidus	r	10–20	AR	13	P, S, F	P, C	+
Order Cottiformes							
Family Scorpaenidae							
Sebastes inermis	r	10–15	AR	2	P	P	+
Sebastiscus marmoratus	c	10–20	RB	37	S, P, F, C	S, E	+
Scorpaenodes littoralis	r	5–10	RB	0	—	S	—
Scorpaenopsis diabolus	r	10–20	TB	0	—	E, —	—
Pterois volitans	r	10–20	RC	0	—	E, S	—
Family Synanceiidae							
Inimicus japonicus	r	15–30	TB	0	—	E, —	—
Family Congiopodidae							
Hypodytes rubripinnis	rr	5–10	TB	0	—	S	—
Family Cottidae							
Pseudoblennius percoides	r	10–15	RB	0	—	E	—
Order Gobiesociformes							
Family Gobiesocidae							
Diademichthys lineatus	r	5	RC	0	—	S, F, —	—
Order Lophiformes							
Family Antennariidae							
Antennarius nummifer	rr	15	TB	0	—	—	—

was kept in a tank together with the cleaner for three weeks, but was 'still' or 'fleeing' when cleaned, never displaying any active pose. These three species therefore seem to be non-posing species.

(2) Surface-Water Group

Spratelloides japonicus (Houttuyn) キビナゴ (Dussumieridae)
Atherion elymus Jordan & Starks ムギイワシ (Atherinidae)
Kuhlia mugil (Bloch & Schneider) ギンユゴイ (Kuhliidae)

These three species are swimming around in the surface water on and around the rocky reef, usually in school, but rarely enter the bottom layer. Thus, they have few chances of meeting with the cleaner and were not observed being cleaned by the cleaner. The latter two were respectively placed together with the cleaner in a tank for more than a week, but they always fled from the cleaner whenever the latter approached to them and began to clean. These three species are therefore regarded as non-posing.

(3) Mid-Water Group

Sphyraena japonica C. & V.	ヤマトカマス	(Sphyraenidae)

This barracuda is swimming in school in the mid-water above and around the reef. Although it must have some chances of meeting with the cleaner, the cleaning association was not observed between the two. This species seems therefore to be a non-posing species.

(4) Above-Sandy-Floor Group

Sillago sihama (Forsskål)	キス	(Sillaginidae)
Vireosa hanae Jordan & Starks	ハナハゼ	(Gobiidae)
Halichoeres poecilopterus (T. & S.)	キュウセン	(Labridae)

S. sihama, swimming around on the sandy floor, was met with only rarely and not observed being cleaned in the observation area. It was kept with the cleaner in a tank for three weeks, but it never displayed any pose and was always 'fleeing' when cleaned. Therefore, it is seemingly a non-posing species.

V. hanae is a goby floating about a meter above the bottom and hiding itself into the burrow on the sandy floor at dangers. It was neither observed being cleaned in the sea, nor displayed any pose when cleaned in the tank; in the last case its response was 'fleeing'. Therefore, this fish seems to be a non-posing species.

H. poecilopterus is a wrasse swimming around on the sandy floor. It was not observed being cleaned in the sea. Although this fish was reported by Okuno (1969a) as a posing species in the tank, it had neither contact with the cleaner, nor displayed any pose during the aquarium observation for three weeks. This wrasse therefore cannot be regarded as active to be cleaned even if it is posing.

(5) Sandy-Bottom Group

Dasyatis akajei (Müller & Henle)	アカエイ	(Dasyatidae)
Parapercis pulchella (T. & S.)	トラギス	(Mugiloididae)
Callionymus punctatus Langsdorff	ネズミゴチ	(Callionymidae)
Amblyeleotris japonica Takagi	ダテハゼ	(Gobiidae)

These four are found resting on the sandy or gravelly to pebbly floor, while the cleaner rarely swims onto the sandy floor. Thus, they were not observed being cleaned. *D. akajei* was found by Okuno (1969a) posing species during his aquarium observations. In the present study, it was observed that a relative ray of *D. akajei, D. melanospila,* displayed a pose in the tank, however *D. akajei* kept for two months in the tank never displayed any pose. The other three species were also observed in the tank, but they never displayed any pose to the cleaner and were 'still', 'fleeing' or 'chasing' when cleaned. These are therefore regarded as non-posing.

(6) Transitional-Above-Substratum Group

Upeneus tragula Richardson	ヨメヒメジ	(Mullidae)
Mulloidichthys vanicolensis (C. & V.)	アカヒメジ	(do.)

Parupeneus spilurus (Bleeker)	オキナヒメジ	(do.)
P. barberinus (Lacépède)	オオスジヒメジ	(do.)
P. trifasciatus (Lacépède)	オジサン	(do.)

These goatfishes are swimming around and forage on the sandy and rocky bottom, usually in small schools. During the present study, it was observed that they visited actively the cleaner and displayed a pose to be cleaned, especially often in *P. spilurus* that was the most abundant species of them in the observation area.

Mugil cephalus Linné	ボラ	(Mugilidae)
Gerres oyena (Forsskål)	クロサギ	(Gerridae)
Acanthopagrus latus (Houttuyn)	キヂヌ	(Sparidae)
Pagrus major (T. & S.)	マダイ	(do.)
Lethrinus nematacanthus Bleeker	イトフエフキ	(Lethrinidae)
Lutjanus russelli (Bleeker)	クロホシフエダイ	(Lutjanidae)
L. kasmira (Forsskål)	ヨスジフエダイ	(do.)
Plectorhynchus pictus (Thunberg)	コロダイ	(Pomadasyidae)

The fishes mentioned above are dwelling on and around the reef and searching after food usually on the bottom in school or solitarily. Except *A. latus* and *L. nematacanthus*, they all displayed a pose to the cleaner. Although *G. oyena* was the most abundant fish of the TA group in the area and often observed being cleaned by the cleaner, it displayed 'fleeing' rather than 'posing' when cleaned (Fig. 4–d). The 'fleeing' response was often seen when the cleaner approached to any individual of the resting school of *G. oyena*, and when the cleaner began to pick the body surface of the host, further 'fleeing' behavior was elicited more prominently. On the contrary, it was confirmed that an individual of *G. oyena* having slipped out of the school visited the cleaner, took a pose and was cleaned. Such contradictory responses of *G. oyena* suggest that the host fish may respond much differently to the cleaner according to its physiological or psychological conditions.

A. latus and *L. nematacanthus* were neither observed being cleaned nor displayed any pose in the sea, and they fled from the cleaner when cleaned in the tank. *A. latus* never learned to be cleaned by the cleaner, while it was placed together with the cleaner in a tank for more than six months, and therefore it is a non-posing species. On the other hand, intraspecific aggressions were observed among the individuals of *L. nematacanthus* in the sea, and then in the tank fish of this species were seemingly always under the strain of such an irritation. Therefore, the 'fleeing' response might have been elicited in these fishes only under unfavourable conditions, and it is hesitated to conclude that *L. nematacanthus* is a non-posing species.

Trachurus japonicus (T. & S.)	マアジ	(Carangidae)

This jack mackerel is swimming around in school and feeding on both plankton and benthos. It never displayed any pose but always 'fleeing' when cleaned either in the sea or in the tank. Therefore, this fish is regarded as a non-posing species.

Fugu niphobles (Jordan & Snyder)	クサフグ	(Tetraodontidae)
F. vermiculare vermiculare (T. & S.)	ショサイフグ	(do.)
F. pardale (T. & S.)	ヒガンフグ	(do.)

These puffers are swimming around on the sandy floor and the rocky reef, sometimes burying themselves shallowly in the bed. They were staying still when cleaned, shivering their fins mincingly. Such 'posing' behaviors are seemingly peculiar to puffers.

Seeing through the fishes of the TA group, *A. latus* and *T. japonicus* are con-

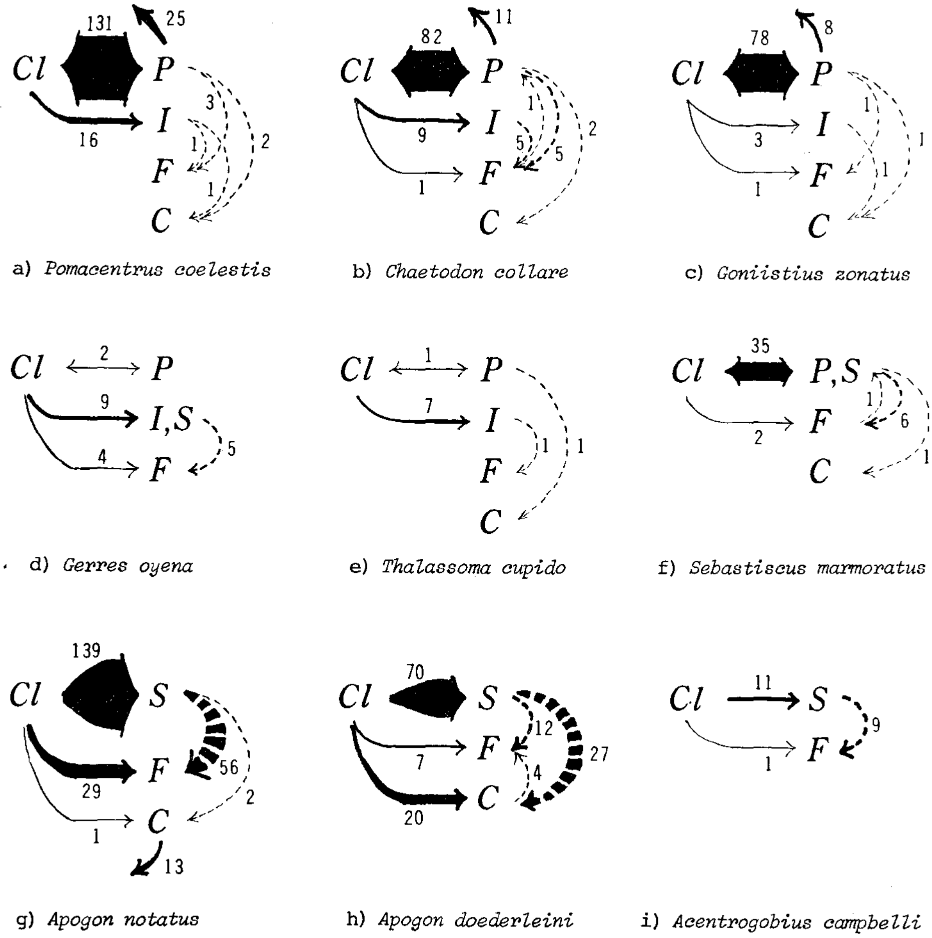

Fig. 4. Responses of 9 common fishes in the study area to the cleaner *L. dimidiatus*, observed from Apr. 1973 to Dec. 1974.

The left half in respective diagrams refers to the cleaning behavior of the cleaner (*Cl*), while the right half the responses of respective hosts; *P*: posing, *I*: indifferent, *S*: still, *F*: fleeing, *C*: chasing. Solid arrows show the correlative behaviors between the cleaner and the host, those with the heads at both ends show the behaviors elicited mutually. The upward arrows from *P* indicate posing but without cleaning and the downward arrows from *C* in *A. notatus* refers to the threatening behavior of this fish by opening its mouth against the cleaner. Arrows with broken shaft show the succession of behaviors in the host during a cleaning encounter. Figures put to respective arrows represent the numbers of respective behaviors observed in this study.

a–f: posing species, g–i: non-posing species.

sidered to be non-posing species, but other 14 species are regarded as posing, while *L. nematacanthus* remains as ambiguous.

(7) Transitional-Bottom Group

Synodus variegatus (Lacépède)	アカエソ	(Synodontidae)
Parapercis snyderi (Jordan & Starks)	コウライトラギス	(Mugiloididae)
Acentrogobius campbelli (Jordan & Snyder)	クツワハゼ	(Gobiidae)
Scorpaenopsis diabolus (C. & V.)	サツマカサゴ	(Scorpaenidae)
Inimicus japonicus (C. & V.)	オニオコゼ	(Synanceiidae)
Hypodytes rubripinnis (T. & S.)	ハオコゼ	(Congiopodidae)
Antennarius nummifer (Cuvier)	ベニイザリウオ	(Antennariidae)

These fishes are found resting on the sandy and rocky bottom and may have chances of meeting with the cleaner. *S. variegatus* and *A. campbelli* were observed once and several times respectively being cleaned by the cleaner, but the others were never so.

S. variegatus was 'still' when cleaned, without taking any particular posture. In a tank, it had no contact with the cleaner for two weeks. Thus, this fish seems to be a non-posing species.

A. campbelli was always 'fleeing' when cleaned in both the sea (Fig. 4–i) and the tank, therefore this is regarded also as a non-posing species.

The other five species did not display any pose in the tank either and were 'still', 'fleeing' or 'chasing' when cleaned; especially three of them, i.e. *P. snyderi, S. diabolus* and *I. japonicus*, exhibited even a predatory behavior against the cleaner. From these observations, all the seven species of this group are judged to be non-posing.

(8) Rocky-Bottom Group

Epinephelus fasciatus (Forsskål)	アカハタ	(Serranidae)
E. merra Bloch	カンモンハタ	(do.)
E. areolatus (Forsskål)	オオモンハタ	(do.)
E. moara (T. & S.)	クエ	(do.)
E. septemfasciatus (Thunberg)	マハタ	(do.)

These sea basses are usually resting on the rocky bottom or hiding themselves in crevices. They are not met with so frequently in the observation area, and then only *E. areolatus* was once observed being cleaned, when this fish displayed a pose. Four other species also displayed a pose in the tank. *E. septemfasciatus* once displayed a predatory behavior against the cleaner when the latter was introduced into the tank, in which the former had been kept together with some of the squirrelfish *Myripristis murdjan*, and was chased by individuals of *M. murdjan*; it seemed as if the predatory behavior of the sea bass was elicited by that of the squirrelfish. Such observations suggest evidently that these sea basses are posing species.

Goniistius zonatus (C. & V.)	タカノハダイ	(Cheilodactylidae)
G. zebra (Döderlein)	ミギマキ	(do.)

These fishes move around above the rocky bottom and rest on the floor to feed on benthic animals. They actively visited the cleaner and displayed a pose to be cleaned in both the sea (Fig. 4–c) and the tank. They are evidently posing species.

Sebastiscus marmoratus (C. & V.) カサゴ (Scorpaenidae)
Scorpaenodes littoralis (Tanaka) イソカサゴ (do.)
Pseudoblennius percoides Günther アナハゼ (Cottidae)

The two rockfishes and one sculpin mentioned above are resting on the rocky bottom or hiding themselves in crevices. *S. marmoratus* was often observed being cleaned, but seldom displayed any distinct pose and generally remained 'still' when cleaned (Fig. 4–f). Sometimes, however, it opened the gill cover to welcome the cleaner, and this made it clear that the fish was posing species. The last two were not observed being cleaned in the sea. In the tank, *S. littoralis* was 'still' or 'fleeing' when cleaned, while *P. percoides* displayed a predatory behavior against the cleaner when the latter was placed in the tank that had been occupied by the former. These two species may be regarded as non-posing.

Seeing through the fishes of the RB group, *S. littoralis* and *P. percoides* are considered to be non-posing species, but other 8 species are regarded as posing.

(9) Rock-Cave Group

This group contains both demersal and floating fishes that are usually hiding themselves in caves or crevices in the daytime.

Demersal Species:

Plotosus anguillaris (Lacépède) ゴンズイ (Plotosidae)

This sea catfish is usually hiding itself in the daytime in caves in dense school, but swims out from there at night in a diffused state. Juveniles, however, swim around in dense schools over the rocky or sandy floor even in the daytime. As this catfish always fled from the cleaner when cleaned in both the sea and the tank, it seems a non-posing species.

Conger japonicus Bleeker クロアナゴ (Congridae)

This conger eel is nocturnal and hides itself in rock holes or crevices in the daytime. It was not observed being cleaned in the sea, and it was 'still' when cleaned in the tank, never displaying any active pose. Thus, this fish is considered a non-posing species.

Gymnothorax kidako (T. & S.) ウツボ (Muraenidae)

This moray eel generally secludes in caves or crevices in the daytime and emerges from there at night, but sometimes even in the daytime. In spite of its abundant occurrences in the observation area, the cleaning association between it and the cleaner was observed only once during the present study, when the moray eel laid itself on the bottom outside the cave to be cleaned. Although many moray eels were kept alive with the cleaner in the tank for a month, none of them visited the cleaner and took any pose. This fish may be therefore a posing species, but not so active to be cleaned.

Brotula multibarbata T. & S. イタチウオ (Brotulidae)

This species is nocturnal and hiding itself in caves or crevices in the daytime. It never exhibited any particular pose when cleaned in both the sea and the tank; it was 'still' or sometimes 'fleeing'. Therefore, this fish is considered a non-posing species.

Floating Species:

Pempheris xanthopterus Tominaga ミナミハタンポ (Pempheridae)

This fish is nocturnal and usually hiding itself in caves in the daytime in schools which may sometimes come out and move around in the neighborhood even in the daytime. It was observed that this fish appeared near the entrance of refuges from their inner part to be cleaned by the cleaner and displayed a pose when cleaned. Evidently this is a posing species.

Parapriacanthus ransonneti Steindachner キンメモドキ (Pempheridae)

This species is found very rarely in the observation area, assembling in caves in the daytime. This fish was observed being cleaned only once, when it fled from the cleaner. As no more observation of this fish was made even in the aquarium, it is difficult at present to conclude whether or not it is truly a non-posing species.

Myripristis murdjan (Forsskål) アカマツカサ (Holocentridae)

This nocturnal squirrelfish is also rare in the area, hiding itself in the caves in the daytime. No cleaning association between it and the cleaner was observed in the sea. It was repeated four times to place the cleaner in a tank already occupied by some of this squirrelfish, and in every case the latter chased or tried to predate the former. However, in preparing this manuscript, I happened to observe this fish displaying distinct pose to the cleaner in the aquarium of Kushimoto Marine Park, and therefore it is a posing species.

Apogon taeniatus Cuvier	ヨコスジイシモチ	(Apogonidae)
A. cyanosoma Bleeler	キンセンイシモチ	(do.)
A. doederleini Jordan & Snyder	オオスジイシモチ	(do.)
A. notatus (Houttuyn)	クロホシイシモチ	(do.)

These cardinalfishes, nocturnal and found in assemblage in or near the cave in the daytime, did not display any pose to the cleaner. Though the most abundant *A. notatus* was cleaned most often in the observation area, the fish usually fled from the cleaner when cleaned, immediately or after a short 'still' response (Fig. 4–g). *A. doederleini*, also abundant in the area, was often cleaned and reacted usually in a 'chasing' behavior when cleaned, immediately or a more or less continuation of 'still' response (Fig. 4–h). 'Chasing' response to the cleaner was sometimes observed in coupled *A. notatus*, maintaining a territory against other fish of the same species during its reproductive season from spring to summer. *A. notatus* and *A. doederleini* have been reported by Okuno (1969b) as posing species, probably because their 'still' response was regarded by that author as truly 'posing'. According to my above mentioned observations, however, they are seemingly non-posing species, as well as the other two.

Pterois volitans (Linné) ハナミノカサゴ (Scorpaenidae)

This lionfish is motionlessly ambushing itself in caves or near the rock cliff for its prey both in the daytime and at night. It was not observed being cleaned by the cleaner in the sea. When the cleaner was introduced in the tank occupied already by this lionfish, the latter tried to predate the former, though it became indifferent to the cleaner in several days. Anyhow, as this fish never displayed any pose and was 'still' or more or less 'fleeing' when cleaned, it may safely be regarded as non-posing species.

Diademichthys lineatus (Sauvage) ハシナガウバウオ (Gobiesocidae)

This small clingfish dwells solitarily or in pair in rock cavities where the sea urchin, *Diadema*, are often aggregated. This fish was not observed being cleaned by the cleaner in the sea. During the observation for three weeks in a tank, it never took any pose to the cleaner and was still or fled when cleaned. This fish is thus judged to be a non-posing species.

Conclusively speaking, among the RC group mentioned above, *G. kidako* and *P. xanthopterus* are posing species, but *P. ransonneti* remains as ambiguous, while other 10 species are non-posing.

(10) Above-Rocky-Reef Group

Oplegnathus fasciatus (T. & S.)	イシダイ	(Oplegnathidae)
O. punctatus (T. & S.)	イシガキダイ	(do.)
Girella punctata Gray	メジナ	(Girellidae)
G. melanichthys (Richardson)	クロメジナ	(do.)
G. mezina Jordan & Starks	オキナメジナ	(do.)
Kyphosus lembus (C. & V.)	イスズミ	(Kyphosidae)
Franzia squamipinnis (Peters)	キンギョハナダイ	(Serranidae)

These fishes are swimming around above the reef in school or solitarily. *G. punctata* and *G. melanichthys*, common and abundant in the study area, were often observed being cleaned. As these two and five other species actively displayed a pose, they all belong to the posing fish.

Scombrops boops (Houttuyn) ムツ (Pomatomidae)

Only about 10 cm long youngs are found swimming around in school above the rocky reef in the observation area in summer, as the adults grown up to 50 cm are inhabiting the depths of 300 to 500 m (Katayama, 1965). These youngs are regarded as belonging to the AR group, for they are swimming nearer the bottom as compared with the members of the MW group. They were neither observed being cleaned by the cleaner nor displayed any pose to be cleaned in the sea, though there must be a lot of chance that the youngs and the cleaner meet with each other. No aquarium observations were carried out, but it seems apparent that the youngs of this species are non-posing. Naturally, no observations were made on the responses and behaviors of the adult to the cleaner in the present study.

Labracoglossa argentiventris Peters	タカベ	(Labracoglossidae)
Parapristipoma trilineatum (Thunberg)	イサキ	(Pomadasyidae)

These fishes are swimming around in school near the reef or in the mid-water layers, sometimes hiding themselves in rock caves at dangers. They displayed a pose in the sea and/or the tank, and therefore they are posing species.

Plagiotremus tapeinosoma (Bleeker) テンクロスジギンポ (Blenniidae)

This blenny stays about a meter above the rocky substratum and attacks other fishes to nibble a piece of their skin as food. This fish was observed only once being cleaned by the cleaner, when the blenny fled from the cleaner. Therefore, this is seemingly a non-posing species. The cleaner sometimes displayed an aggressive behavior to this blenny and also to the relative blenny of the latter, *P. rhinorhynchus*. It is also known that the cleaner *L. dimidiatus* attacks its mimic blenny, *Aspidontus taeniatus*, (Eibl-Eibesfeldt, 1959) which is a relative of *Plagiotremus*. Such aggressive behaviors against blennies look similar to the intraspecific aggression among the individuals of the cleaner.

Amphiprion clarkii (Bennett)	クマノミ	(Pomacentridae)
Chromis isharai (Schmidt)	アマミスズメダイ	(do.)
C. notatus (T. & S.)	スズメダイ	(do.)
Dascyllus trimaculatus (Rüppell)	ミツボシクロスズメ	(do.)
Eupomacentrus jenkinsi (Jordan & Evermann)	セダカスズメダイ	(do.)
Pomacentrus coelestis Jordan & Starks	ソラスズメダイ	(do.)
P. nagasakiensis Tanaka	ナガサキスズメダイ	(do.)
Abudefduf vaigiensis (Quoy & Gaimard)	オヤビッチャ	(do.)
A. sexfasciatus (Lacépède)	ロクセンスズメダイ	(do.)

These damselfishes float near the rocky substratum solitarily or in school. *E. jenkinsi* was neither observed being cleaned nor displayed any pose in this study, though Okamoto (1974) reported that it displayed a pose to the cleaner in the sea. The other eight species displayed a pose in the sea and/or in the tank. *P. coelestis*, the most abundant species among these, was often observed being cleaned by the cleaner (Fig. 4–a). In small tanks, however, these damselfishes were apt to become aggressive one another or between the individuals of the same species, as already reported by Okuno (1963), and in such a situation they never accepted cleaning. All the observations mentioned above show evidently that all these damselfishes are posing species.

Thalassoma lunare (Linné)	オトメベラ	(Labridae)
T. cupido (T. & S.)	ニシキベラ	(do.)
T. lutescens (Lay & Bennett)	ヤマブキベラ	(do.)
Pteragogus flagellifera (C. & V.)	オハグロベラ	(do.)
Pseudolabrus japonicus (Houttuyn)	ササノハベラ	(do.)
Labroides dimidiatus (C. & V.)	ホンソメワケベラ	(do.)
Stethojulis interrupta (Bleeker)	カミナリベラ	(do.)
Halichoeres tenuispinnis (Günther)	ホンベラ	(do.)
Cirrhilabrus temmincki Bleeker	イトヒキベラ	(do.)
Cheilinus bimaculatus C. & V.	タコベラ	(do.)
Calotomus japonicus (C. & V.)	ブダイ	(do.)
Scarus ghobban (Forsskål)	ヒブダイ	(do.)

These wrasses and parrotfishes are swimming around and forage on the rocky reef solitarily or in school. All of these fishes displayed a pose in the sea and/or in the tank. Although *T. cupido* was the most abundant species among them and therefore must have often met with the cleaner, it was not so active to be cleaned and usually was indifferent to, or even fled from or chased the cleaner when cleaned (Fig. 4–e).

Cleaning was observed between the individuals of the cleaner *L. dimidiatus* itself, in such a case the cleanee displayed a pose. According to my observations, it is suggested that such intraspecific cleaning might function as the appeasement at the intraspecific aggressive encounters.

Microcanthus strigatus (C. & V.)	カゴカキダイ	(Scorpididae)
Forcipiger flavissimus Jordan & McGregor	フエヤッコダイ	(Chaetodontidae)
Chaetodon auriga Forsskål	トゲチョウチョウウオ	(do.)
C. vagabundus Linné	フウライチョウチョウウオ	(do.)
C. collare Bloch	チョウチョウウオ	(do.)
C. nippon Steindachner & Döderlein	シラコダイ	(do.)
C. citrinellus C. & V.	ゴマチョウチョウウオ	(do.)
C. kleini Bloch	ミゾレチョウチョウウオ	(do.)
Heniochus acuminatus (Linné)	ハタタテダイ	(do.)
Zanclus cornutus (Linné)	ツノダシ	(do.)
Acanthrus olivaceus Bloch & Schneider	モンツキハギ	(do.)
A. dussumieri C. & V.	ニセカンランハギ	(do.)
A. nigrofuscus (Forsskål)	ナガニザ	(do.)
Prionurus microlepidotus Lacépède	ニザダイ	(do.)
Naso unicornis (Forsskål)	テングハギ	(do.)
N. lituratus (Bloch & Schneider)	ミヤコテング	(do.)
Siganus spinus (Linné)	アミアイゴ	(do.)
S. fuscescens (Houttuyn)	アイゴ	(do.)

These stripey, butterflyfishes, zanclid, surgeonfishes and rabbitfishes reside in or near caves and swim around above the reef usually in school. All of these fishes actively displayed a pose in the sea and/or in the tank. Particularly, the most-abundant butterflyfish in the study area, *C. collare*, was often observed visiting the cleaner to be cleaned (Fig. 4–b).

Balistes chrysopterus Bloch & Schneider	ツマジロモンガラ	(Balistidae)
Stephanolepis cirrhifer (T. & S.)	カワハギ	(Aluteridae)
S. japonicus (Tilesius)	ヨソギ	(do.)
Rudarius ercodes Jordan & Fowler	アミメハギ	(do.)
Navodon modestus (Günther)	ウマヅラハギ	(do.)
Ostracion cubicus Linné	ハコフグ	(Ostraciontidae)
Lactoria diaphanus (Bloch & Schneider)	ウミスズメ	(do.)
L. fornasini (Bianconi)	シマウミスズメ	(do.)
Canthigaster coronatus Vaillant &	ハナキンチャクフグ	(Tetraodontidae)

Sauvage

C. rivulatus (T. & S.) キタマクラ (do.)

Tetraodon hispidus Linné サザナミフグ (do.)

These triggerfish, filefishes, trunkfishes and puffers live near the rocky substratum, usually hovering around solitarily. All, but *L. diaphanus*, displayed a pose in the sea and/or in the tank. The 'pose' of puffers is to stay still with their vertical fins shaking mincingly. *L. diaphanus* was met with rarely in the observation area and observed being cleaned only once, when it fled from the cleaner. Okuno (1969b), however, observed it displaying a pose, and therefore it may be a posing species.

Sebastes inermis C. & V. メバル (Scorpaenidae)

This rockfish floats motionless near the rock cliff or rock caves. Though it was rather rare in the study area, it was observed twice being cleaned, when it displayed a pose. This fish is evidently a posing species.

Among the fishes of the AR group, *Scombrops boops* and *Plagiotremus tapeinosoma* are non-posing species, while the other 60 species are posing species.

Discussions

The numbers of posing and non-posing species and the ratio of the number of posing species to that of the total species in respective habitat groups are given in Table 2, which shows that the habitat groups AR, TA and RB hold higher percentages

Table 2. Number of posing and non-posing species in each habitat group.

Habitat group	Number of species examined	Number of posing spp. (A)	Number of non-posing spp. (B)	Number of species remaining as ambiguous	Percent of posing spp. (A/A+B×100)
IT	3	0	3		0
SU	3	0	3		0
MW	1	0	1		0
SB	4	1	3		25
AS	3	1	2		33
TB	7	0	7		0
TA	17	14	2	1*	88
RB	10	8	2		80
RC (demersal)	4	1	3		25
(floating)	9	2	6	1**	25
AR	62	60	2		97
Total	123	87	34	2	71

* *Lethrinus nematacanthus*; ** *Parapriacanthus ransonneti*

of posing species, while the groups TB, MW, SU and IT include none of posing species. It may be suggested that the fishes living in or near the habitat (AR) of the cleaner *L. dimidiatus* are mostly posing species, while the fishes dwelling apart in distance from it or, in the case of the RC group, hiden from it are mostly non-posing species (Fig. 5). There are, however, some exceptions; for example, *Dasyatis akajei* in the SB

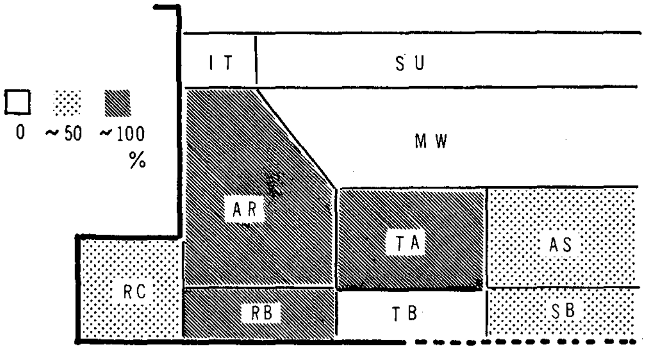

Fig. 5. Frequency of posing species in respective habitats. Actual numbers are given in Table 2.

Table 3. Numbers of cleaned species and cleaning bouts observed in the sea in each habitat group.

Figures in each column show: Total (Posing species / Non-posing species)

Habitat group	Number of total species	Number of cleaned species	Number of cleaning bouts	Percent of cleaned species
IT	3 (0/3)	0 (—/0)	0 (—/0)	0 (—/0)
SU	3 (0/3)	0 (—/0)	0 (—/0)	0 (—/0)
MW	1 (0/1)	0 (—/0)	0 (—/0)	0 (—/0)
SB	4 (1/3)	0 (0/0)	0 (0/0)	0 (0/0)
AS	3 (1/2)	0 (0/0)	0 (0/0)	0 (0/0)
TB	7 (0/7)	2 (—/2)	13 (—/13)	29 (—/29)
TA	17* (14/2)	12 (11/1)	76 (72/4)	71 (79/50)
RB	10 (8/2)	4 (4/0)	129 (129/0)	40 (50/0)
RC (demersal)	4 (1/3)	3 (1/2)	3 (1/2)	75 (100/66)
RC (floating)	9* (2/6)	5* (1/3)	283* (14/268)	56* (50/50)
AR	62 (60/2)	45 (44/1)	546 (545/1)	73 (73/50)
Total	123* (87/34)	71* (61/9)	1050* (761/288)	58* (70/26)

* Involving species undecided whether posing or non-posing (See Table 2).

group and *Halichoeres poecilopterus* in the AS group are posing species, though they dwell apart from the cleaner. On the contrary, *Plagiotremus tapeinosoma* and *Scombrops boops* both in the AR group are non-posing species, though they are living together with the cleaner.

The numbers of species cleaned and cleaning bouts observed in the sea are given for respective habitat groups in Table 3. The AR group holds the largest number of cleaned species and at the same time the highest percentage of those in the group, while none were cleaned in the groups IT, SU, MW, SB and AS. It may be natural that more numbers of species were cleaned in or near the habitat of the cleaner (Fig. 6), but Table 3 also shows that none of the two posing species dwelling far apart from

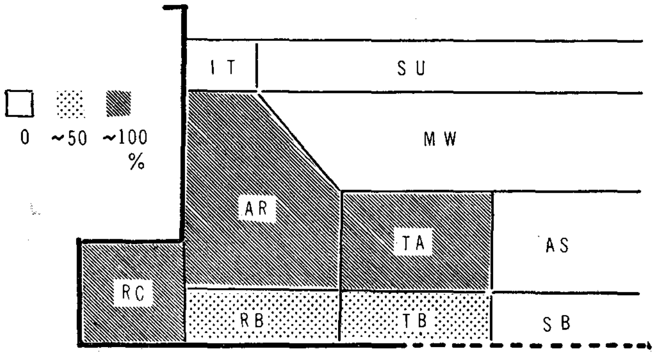

Fig. 6. Frequency of cleaned species in respective habitats. Actual numbers are given in Table 3.

the cleaner, i.e. *D. akajei* and *H. poecilopterus*, visited the cleaner from distance, although it may be probable that they were failed to be observed being cleaned because of their low density in the study area. Though posing species were cleaned in a little higher percentage than non-posing ones, about half of the non-posing species dwelling near to the cleaner were also cleaned in spite of their reluctance to be cleaned (Table 3).

The number of cleaning bouts are not always related to that of cleaned species in respective habitat groups (Table 3), probably because it may be affected by the density of each species: the cleaner may have more chances to meet with individuals of an abundant species than rare species. In fact, the most often cleaned species are abundant species (Table 1). It may be concluded that the cleaner cleans any species, whether posing or non-posing, dwelling near to it.

The fact that the habitat groups which hold many cleaned species include at the same time many posing species (Fig. 5 and 6) seems to afford further evidence to the speculation given by Okuno (1969a, b) that posing behavior of host fishes have been accomplished through their daily contacts with a cleaner in their course of evolution. However, as there are such fishes as *A. notatus* which are non-posing in spite of having many contacts with the cleaner, posing behavior may have been developed only in the fishes for whose life cleaning is significant.

Table 4. Number of species exhibited respective responses in the sea. Two species in remaining as ambiguous (*) are here placed in the columns of non-posing species for convenience' sake.

Habitat group	Number of cleaned {posing spp. / non-posing spp.	Number (percent) of species exhibited respective responses P	S	I	F	C
TB	0	—	—	—	—	—
	2	—	2 (100)	0	1 (50)	0
TA	11	11 (100)	2 (18)	1 (9)	2 (18)	2 (18)
	1	—	0	0	1 (100)	0
RB	4	4 (100)	1 (25)	0	1 (25)	1 (25)
	0	—	—	—	—	—
RC (demersal)	1	1 (100)	0	0	0	0
	2	—	0	0	2 (100)	0
RC (floating)	1	1 (100)	0	0	1 (100)	0
	4*	—	3 (75)	0	4 (100)	2 (50)
AR	44	42 (95)	4 (9)	6 (14)	10 (23)	5 (11)
	1*	—	0	0	1 (100)	0
Total	61	59 (97)	7 (11)	7 (11)	14 (23)	8 (13)
	10*	—	5 (50)	0	9 (90)	2 (20)

The numbers of species displayed respective responses in the sea are given in Table 4. Posing response were observed in 59 of 61 posing species cleaned in the sea. If the response of 'still' is regarded similar to 'indifferent', for the former was named to the response difficult to determine whether 'indifferent' or true 'posing', probably 'indifferent', every response except posing was observed both in posing and non-posing species. It is remarkable, compared with posing species, that most of the non-posing species exhibited fleeing. The frequencies of respective responses in a species are shown on nine species rather frequently observed being cleaned (Fig. 4). There is a rather extensive range in the attitude to be cleaned even among posing species; *P. coelestis, C. collare* and others are very active to be cleaned, while *G. oyena, T. cupido* and some others are not so. Among non-posing species, responses also differ much; *A. notatus* often flees from the cleaner, while *A. doederleini* often chases it (Fig. 4). Such difference of responses to the cleaner should be due to the difference of specific behavior pattern of each species which is based on its specific mode of life. Of course, these responses to the cleaner are themselves parts of specific behavior pattern of each species and therefore parts of its mode of life. Although every responses except posing are also exhibited in other cases than cleaning association, posing is a specialized behavior directed to the cleaner.

So far as I know, most of the workers on cleaning symbiosis seem to have payed special attention only to the 'symbiotic' relationship between a cleaner and its 'posing' host fish. I think, however, it is also necessary to clarify the reality of cleaning symbiosis to examine how it is prevailing among the members of the fish community within a definite area, as was shown in the present paper. Although rather many non-posing species were found in the subtropical coastal waters of Sirahama, during the present study, where only *L. dimidiatus* was a specialized cleaner, number of non-posing species may decrease in the tropical waters where many specialized cleaners are found. On the contrary, it may increase in the temperate waters where only facultative cleaners are found. There are, however, no comparable data in other waters with that of the present study in Sirahama, at present. I believe that further investigation into such difference of prevalence of cleaning symbiosis in fish communities at different localities will contribute to the inquiry into the evolutionary history of cleaning symbiosis.

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