

**OBSERVATIONS ON THE TERRITORIAL BEHAVIOUR
OF JAPANESE MAJARRA, *GERRES OYENA*
(FORSSKÅL), IN THE VICINITY OF SETO¹⁾**

HIDEAKI USUKI

4-10-36, Mukodai-Machi, Tanashi City, Tokyo

With Text-figures 1-5

Japanese majarra, *Gerres oyena*, is one of the most popular shore fishes in the coastal waters along the west coast of Kii Peninsula, Middle Japan, and found commonly on the shallow plain rocky or sandy floor of a simple topography. This is rather peculiar, because generally such monotonous environments are rarely preferred by other shore fishes as their habitat to more complicated rocky reefs. This

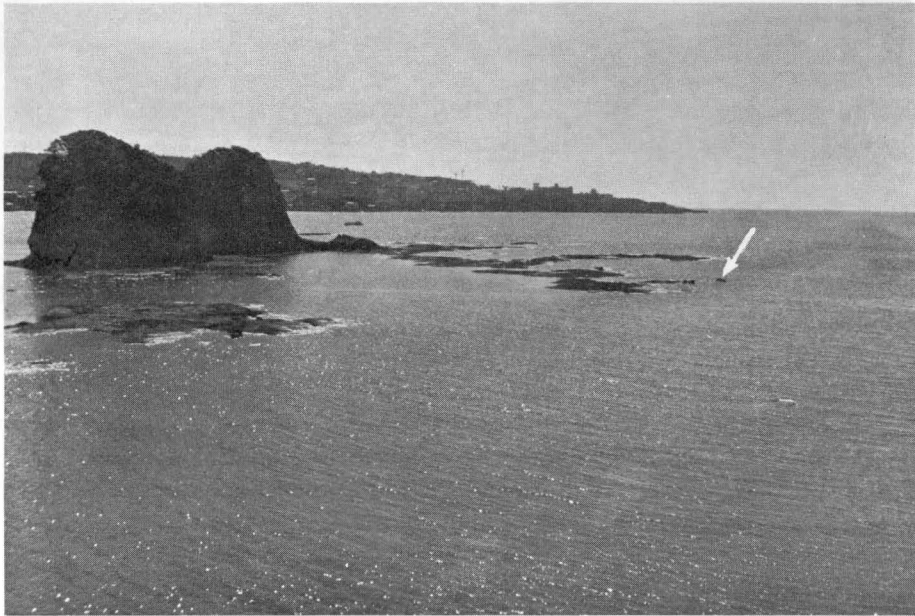


Fig. 1. The sight of the vicinity of the study area, from the north at low tide. The islet on the left is Takashima Islet. The arrow shows a rocky rising exposed in the study area at low tide; this rising is indicated as a linedated patch in respective figures of Text-figure 5.

1) Contributions from the Seto Marine Biological Laboratory, No. 616.

fish, though probably not all, has been found retaining the territory in the nature all the year round. Really many observations have been made on the fish territories (Greenberg, 1946; Braddock, 1945, 1949; Chapman, 1962; Slaney et al, 1974; Kawanabe, 1957, 1958 and others). Mori (1956) and Okuno (1956) reported and discussed the territorial and hierarchal structures in a mass of young girelloid fish imprisoned in the tide pool during the low water. However, information is little available to explain the establishment of the territorial habit of sea fishes in the nature. The present study is to learn how the territories are acquired and retained by *Gerres oyena* in the sea.

Study Area (Figs. 1 and 5a)

The observations were made in a small area on a narrow rocky reef protruded northwest and offshore from Takashima Islet, called popularly Engetsu Islet, near



Fig. 2. No. Y fish chasing an undiscriminated smaller fish that is swimming fast with the tail fin closed and bearing several darker bands in terror.

the Seto Marine Biological Laboratory. The reef surface in the area is flattened 30 cm to 1.5 m below the sea surface according to the tidal phase, swept by surf, and furnished with several elevations and covered in the winter season with *Corallina pilulifera*, *Hydroclathrus clathratus* and partly with *Gelidium japonicum*.

Method

Observations have been made extensively by snorkelling on *Gerres oyena* in the area, including all individuals from territorial owners to nomads in about two months from December 1, 1975 to January 25, 1976. The observation was usually started every day at 9:00 and continued for more than two hours, but on some very windy days when it was impossible to approach the study area. Several dives were made in the afternoon.

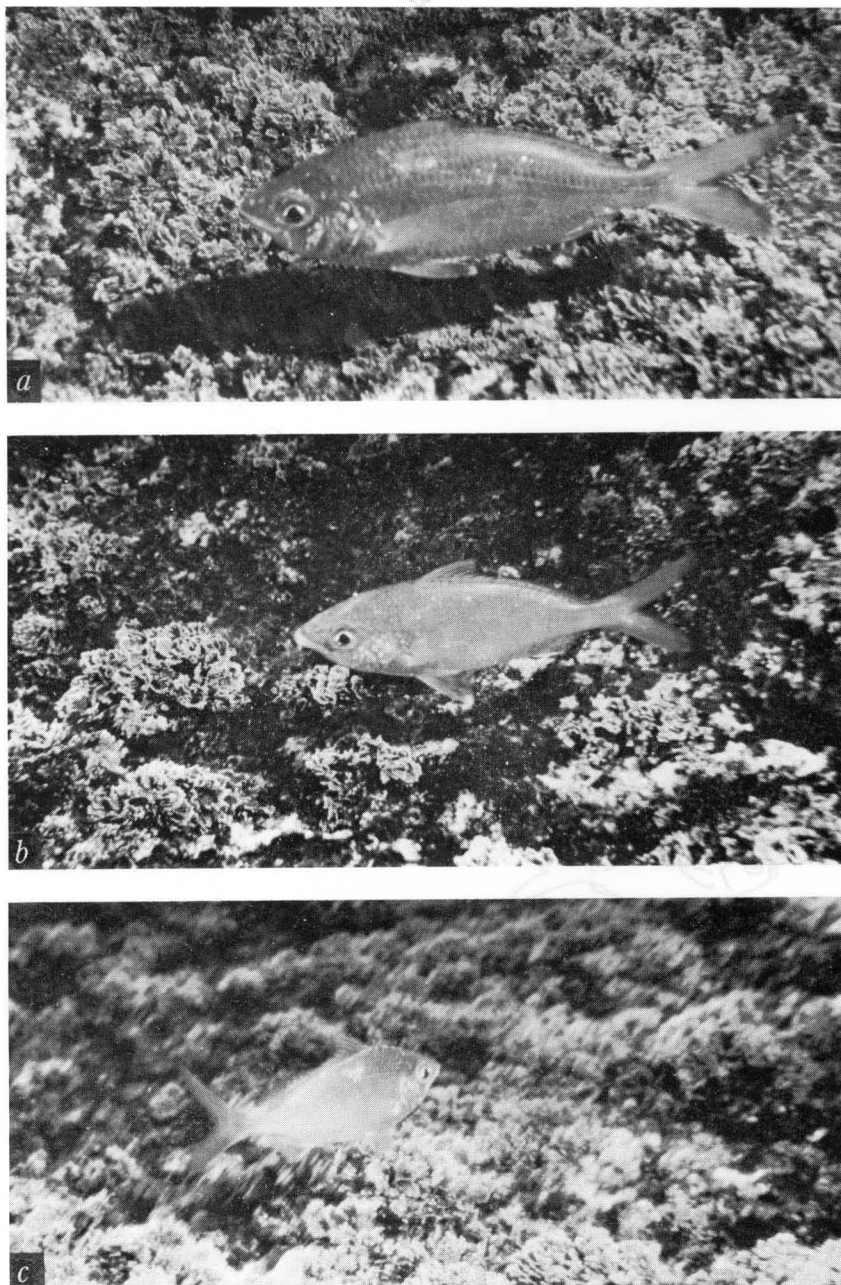


Fig. 3. a. Left side of No. Y fish, showing a scaled patch on the shoulder (refer to Fig. 4 Y).
b. Left side of No. n fish, with a linear hurt on the belly (refer to Fig. 4 n).
c. Right side of No. e fish recognized by a crescent scaled patch between the anterior part of the dorsal fin and the right lateral line (refer to Fig. 4 e).

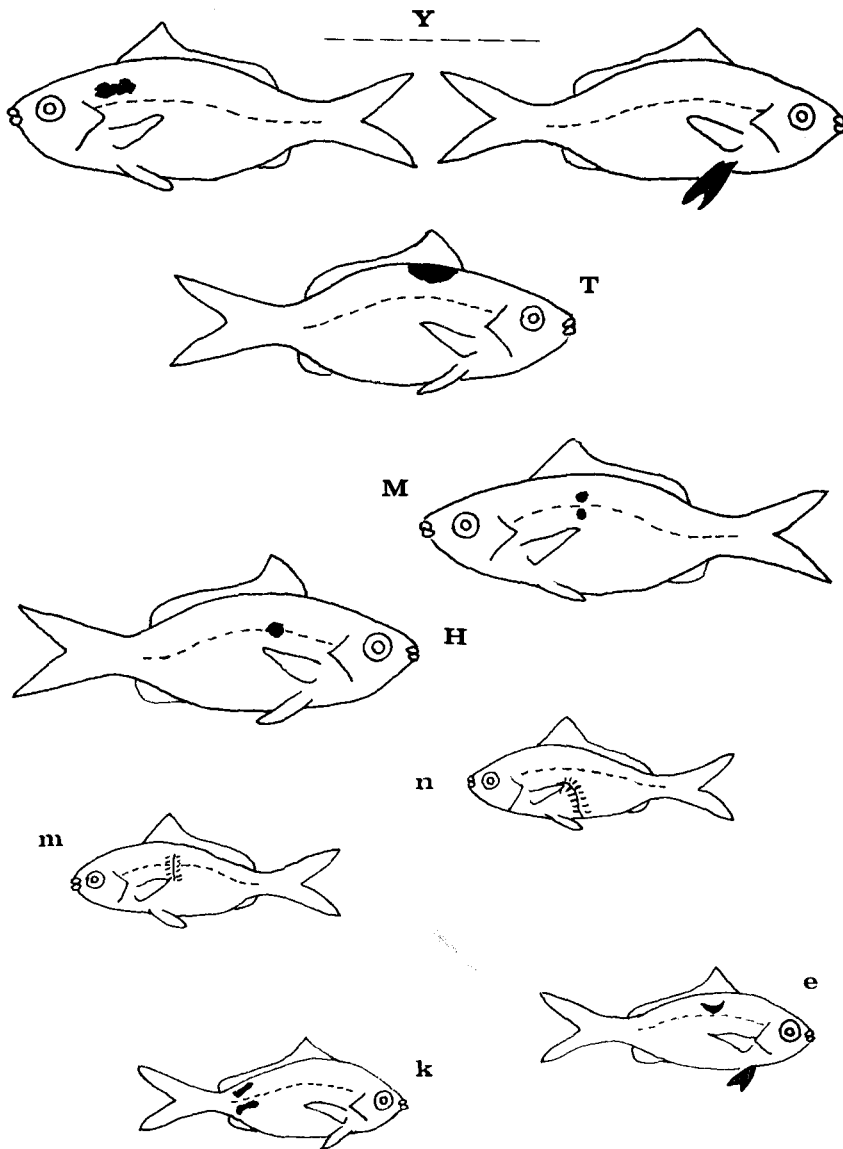


Fig. 4. Eight individuals of *Gerres oyena* discriminated by natural blemishes on their body surface. Y, T, M and H are larger and n, e, m and k are smaller fish (refer to Fig. 3).

A preliminary observation of this fish was made in July, 1975, by tagging three of four fish which had been each occupying an extraordinarily large and stable territory against the others in a tide pool, with a piece of coloured nylon line. The tagged fish, however, disappeared from the area on the 4th day after this treatment, probably because of so big stimulation at tagging. Therefore, it was planned to recognize individual fish by some blemish marked on the body surface and characteristic to respective fish. As this fish is compressed and covered with large shining deciduous scales, there are definable rather easily some scaleless parts or linear scars in addition to fin cuts. Scaleless spots look darker, brighter or whiter than intact parts according to the illuminating condition. By using such signs eight individuals of *Gerres oyena* were distinguished in the study area and named as seen in next chapter. In addition to the observations by the author himself, the behaviours of these discriminated fish were recorded and traced subsidiarily by an underwater SLR camera and an underwater 8-mm cine camera.

Record of Observations

The fish found in the area were divided into two groups of different sizes: one consisted of larger, 15–18 cm fish, while the other included smaller, 8–10 cm individuals. And larger individuals retained wider and more persistent territories than smaller ones. Between the territories of larger fish, several smaller fish remained gregariously, some of them often retaining an obvious territory. Nomads, smaller ones generally in bands and larger ones in solitude, were observed passing by the area and sometimes those invading some territories in the area were immediately chased by the residents.

Innumerable larger fish were often found moving slowly in a school along the side of the protruded reef five meters or more apart from the area or staying gregariously around the tip of the reef, two to five meters deep, where the struggles for the territorial integrity were displayed between the territorial owners and some of gregarious fish.

The discriminated eight individuals were named as follows (see Figs. 3 and 4). Larger fish are: No. Y recognized on Dec. 1, by a cut on the right abdominal fin and an obvious scaled patch between the anterior end of the dorsal fin and the left lateral line; No. T recognized on Dec. 1, by a scaled part below the right anterior base of the dorsal fin; No. M recognized on Dec. 11, by two scaled spots, one above and the other below the left lateral line near the middle; and No. H recognized on Dec. 11, by a single scaled spot near the middle of the right lateral line. Smaller fish are: No. n recognized on Dec. 15, by a linear hurt on the left side of the belly; No. e recognized on Dec. 15, by a cut of the right abdominal fin and a crescent scaled patch between the right lateral line and the dorsal fin; No. m recognized on Dec. 15, by a linear hurt across the left lateral line; and No. k recognized on Dec. 15, by two remarkable scaled spots on the right tail stalk.

Behaviours of Respective Discriminated Fish

Evidently the territorial behaviour will be explained on the observational data of respective recognized fish. To see first the outline of the territorial behaviour of this fish, the detailed records of No. n and No. e for 18 days are presented below for instance (Fig. 5). No visit was made to the study area for rough water on Dec. 16, 21–23, 26, 28 and 30–31.

December 15 (water temperature 19°C, a little wavy, cloudy but occasionally cleared): Nos. n, e, m and k, together with two other undiscriminated smaller fish, were found staying between the territories of No. Y and No. H. These six smaller fish did not go out of the area; one of them sometimes entered the territory of larger fish and was expelled by its owner. Situations of No. n and No. e were indefinite in the band of six smaller fish and exchangeable between them.

December 17 (water temperature 18°C, wave fair, fine) (Fig. 5b): No. n and No. e were found in the band of six smaller fish as on the 15th between the territories of larger fish, but their situations were definite this day and no aggression was observed among the six smaller fish in the band.

December 18 (water temperature 17°C, calm, fine to cloudy) (Fig. 5c): No. n and No. e were almost the same as on the 17th. But, No. H did not appear in the area, wherefore smaller fish were found scattered wider a little going into the vacant territory of No. H.

December 19 (water temperature 18°C, calm, fine but occasionally cloudy) (Fig. 5d): No. H appeared in the area, but the six smaller fish were not found in the former position. Only two of them, No. e and No. k, were noted in the band of 33 smaller fish staying about five meters offshore from their former position.

December 20 (water temperature 18°C, a little wavy, fine) (Fig. 5e): No smaller fish were found in the area and none of the discriminated smaller fish were noted in the neighbourhood around the area. On the other hand, all the recognized larger fish were retaining their territories stably, seldom showing aggression, because intrusions of smaller fish into their territories were made but only rarely.

December 24 (water temperature 16°C, wave fair, fine) (Fig. 5f): No. n and No. e recovered their position, together with four undiscriminated smaller fish, between the territories of No. Y and No. H. No. n manifested for the first time fighting often against No. e and at times against other smaller fish in a kissing posture, followed by biting at the flank. Such aggressive and territorial behaviours of No. n were limited only to smaller fish but never to larger ones. No. e also domiciled at its own position but showing no territorial behaviour. One of the undiscriminated

Fig. 5. The study area on the flat surface of a protruded rocky reef, together with a map showing the exact site of the study area (a), and territories in the study area observed on 9 days from December 17 to January 1 (b–j). Stippled patches: rocky elevations. Solid patch: rocky hole. Lineated patch: a rocky rising indicated by the arrow in Fig. 1.

Y, T, M and H: larger recognized fish. n, e, m and k: smaller recognized fish. L: undiscriminated larger fish. s: undiscriminated smaller fish. Parenthesized: fish displayed the territorial behaviour only against smaller comrades. Underlined: domiciliated, but not yet exhibiting the territorial behaviour. Broken line: boundaries of territories. Finer line: showing the area of bands.

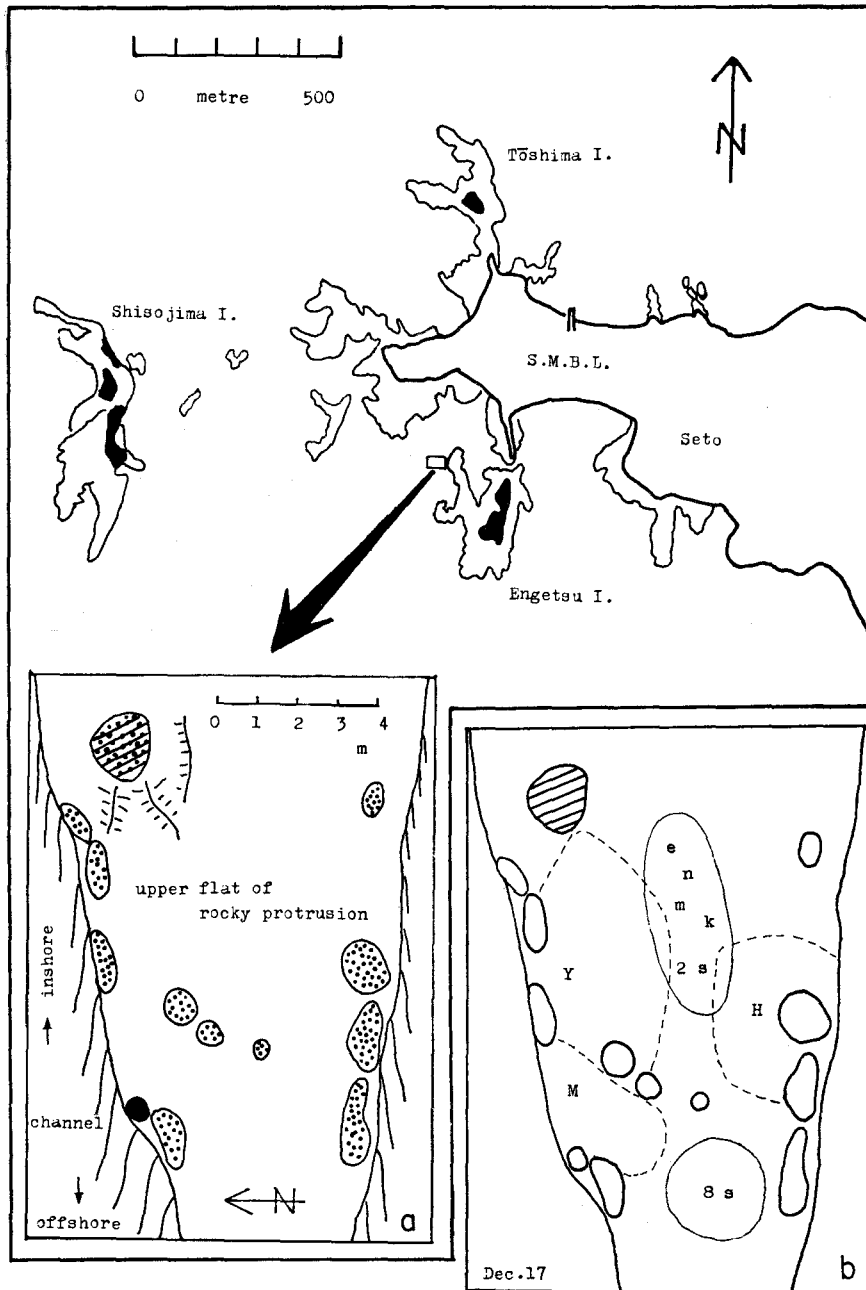


Fig. 5.

Explanation on the opposite page.

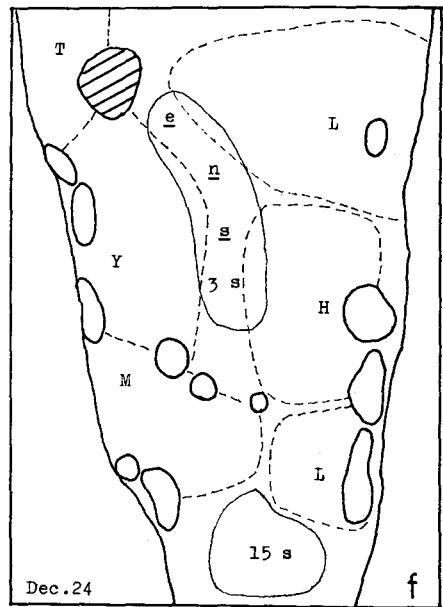
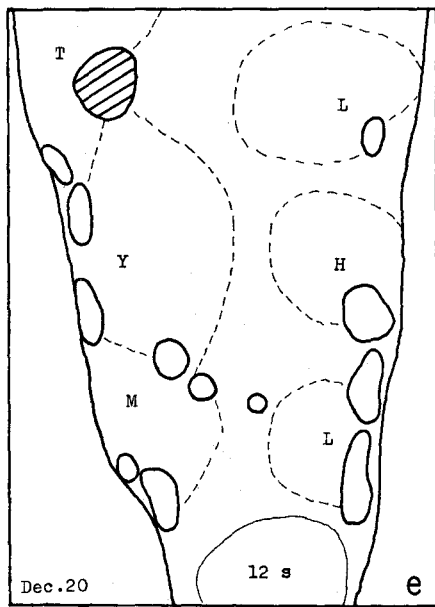
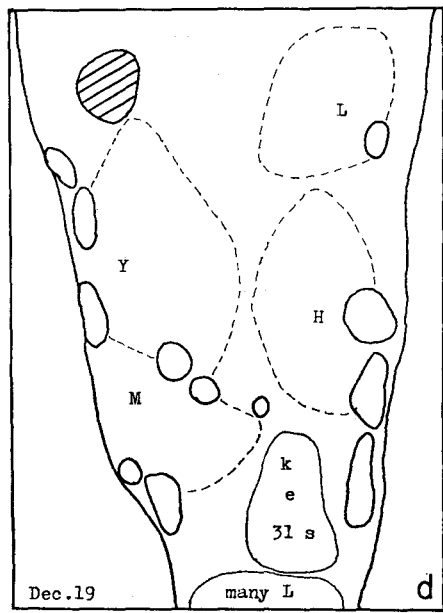
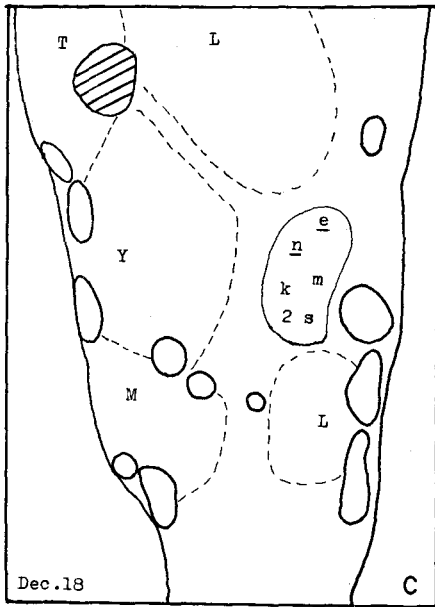


Fig. 5 (continued).

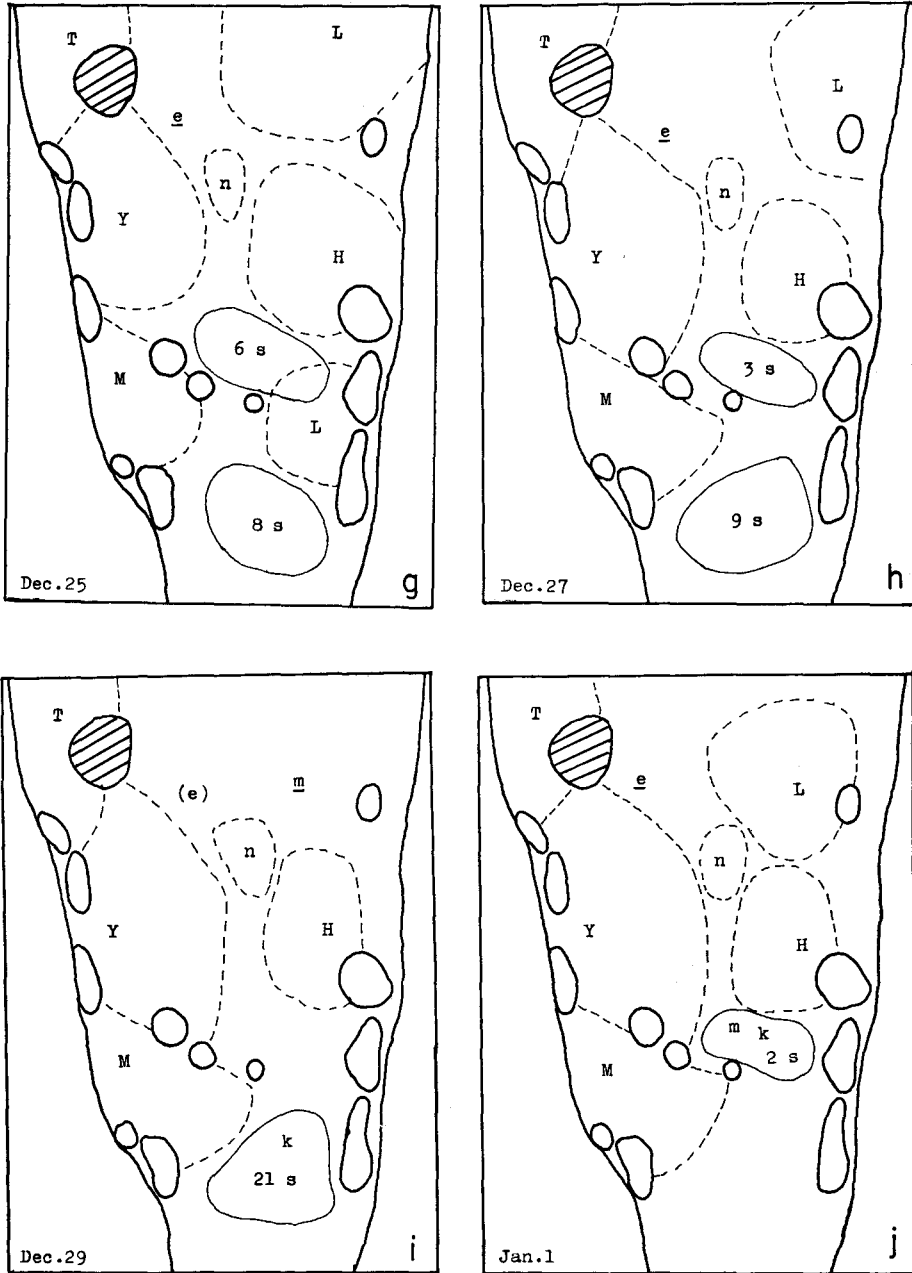


Fig. 5 (continued).

smaller fish behaved as No. e, too.

December 25 (water temperature 17°C, calm, cloudy) (Fig. 5g): No. n and No. e, together with six other undiscriminated smaller fish, were found at their former position. No. n seemed to have acquired the territory so firmly as to expel even the larger No. Y fish. No. e and another smaller fish were observed occupying their own positions in the band, but not yet showing any aggressive behaviour as on the 24th.

December 27 (water temperature 16°C, wave fair, fine) (Fig. 5h): No. n kept its territory sternly as on the 25th. No. e remained at its former position steadily, but displayed no territorial behaviour, because no fish came near it this day.

December 29 (water temperature 15.5°C, calm, cloudy) (Fig. 5i): No. n retained its territory steadily. No. e displayed an aggressive behaviour for the first time but only against a smaller fish; against larger fish No. e was non-reactive or rather exhibited an escaping movement.

January 1 (water temperature 17.5°C, calm, fine) (Fig. 5j): Between the territories of No. Y and No. H, were found Nos. n, e, m, k and three other undiscriminated smaller fish, and No. n was found retaining still its territory. On the other hand, No. e was observed often chased by No. Y, No. T and another undiscriminated larger one that was retaining the territory in the area this day. When chased, several dark vertical bands appeared on the body of No. e in terror (cit. Fig. 2), that did not, however, go out of the area and stayed at its former position quietly.

Later observations manifested that No. n retained its territory at least till January 13, but that territory was found succeeded by No. e on January 25, though it was unknown when and how the alteration took place, owing to rough water continued in the span of 12 days.

Patterns of the Territorial Behaviour in Gerres oyena

Frequently, in both the territorial owners and members of the band in the area, were observed a series of actions, started with a stop of swimming and still stay, sometimes bending slightly the posterior half of the body probably against the water current, followed by nibbles at benthos with the protrusible jaws and ending in a little advance. The series was repeated, but whenever fish intruded into any territories, they were immediately driven away by territorial owners. The manner of driving away was, however, quite different day by day probably according to the physiological conditions of the two fish, the intruder and the chaser. The territorial owner, when acted severely, chased the intruder rapidly to the boundary of the territory and nibbled at the flank of the latter if it dallied away a chance to escape. When chasing gently, the territorial owner kept often itself at the back of and almost in parallel with the intruder. Every chase was always closed by owner's displaying the lateral side of the body for a moment, with the dorsal fin erected to show the black tip of the fin, on the boundary of the territory. The kissing fight was observed

only between the individuals that had not yet retained any territory and were struggling to acquire the territory. When the owners of adjoining territories encountered each other on the boundary, sometimes a ritual of pistone movements, that one chased the other head to tail swiftly and *vice versa*, was repeated several times in a few seconds.

Territory Formation in the Morning

The present author had fortunately a chance to observe the territory formation in the morning of recognized individuals on January 13 and 25. On the 13th, no fish was found at 9:00 in the study area and in the shallow neighbourhood, too. No. n, together with four other undiscriminated smaller fish, appeared first in the area at 9:20 and settled easily at the usual position in its territory. No. Y appeared and settled in its territory at 9:25 and other recognized larger fish appeared there by 9:30. More detailed observations were made on the 25th, when several fish came in sight at 9:30 from farther and deeper space beyond the tip of the protruded reef, increasing the number gradually. They approached slowly in a loose band to the study area, busily nibbling at benthos. Ten minutes later one of them, at the head of the coming up band, was proved to be No. Y, that settled in its usual territory instantly and displayed the aggressive behaviour. In both mornings, several gregarious parties of fish were observed to come from inshore.

Territory Release in the Evening

No observations were made by the author at night. However, the observations in the twilight before sunset indicated that all the fish, including recognized No. Y, No. n and others, in the study area disappeared one after another and randomly in the time from 16:10 to 16:25 on December 29 and from 16:20 to 16:30 on January 1. They went out of the area, probably in a loose band like in the morning observations mentioned above, toward the head of the protruded reef, where a number of fish were found gregarious and some parties of them had already been moving in a school along a side of the reef toward the inshore areas; This movement was just opposite to the morning migration. There were, however, no evidences to show that any discriminated individuals migrated inshore in the evening.

Discussion and Conclusion

Three types of social organization were definable in *Gerres oyena* on the surface of a narrow rocky reef: i.e. aggregation, band and territory. Aggregations, that should be called schools when fish were swimming all in the same direction, were observed only around the head of the protruded reef in the neighbourhood of the study area; fish were often hovering around a little above the substratum, without any feeding behaviour. Therefore, those aggregations might represent a resting condition of fish. Bands, that were confined to certain places when settled, though occasionally moving, were found on the shallow rocky flat, where fish were frequently nibbling at benthos on the floor. Territories were also found on the shallow flat, covering almost all the flat surface of the protruded reef in mosaic. As the fish were feeding frequently in their territories and prevented intrusions of others into their domains,

their territory might be regarded as the food territory as in the case of *Plecoglossus altivelis* (Mizuno and Kawanabe, 1957). However, the apparent feeding attitude might not always be limited strictly to taking food but sometimes might be merely a ritual behaviour when strained by others.

Fish were alluring one another in aggregations, but almost indifferent and reserved to one another in bands, while aggressive to one another in territories.

It was interesting to find that one of the fish in a band could become aggressive to retain its territory. Through the observations of No. n and No. e, it seemed probable that the change from the indifferent attitude to the aggressive behaviour against neighbours observed in some individuals settled in a band was closely related to the existence of incessant contact with some neighbours also domiciled themselves at certain positions. It has been reported that many coastal fishes are territorial in such closed environments as tide pools or aquarium tanks (Okuno 1956, 1964; Yuyama 1952 and others). This suggests that the formation of the territory is related significantly to how the fish are situated against other conspecific individuals or the topographic features. The existence of bands in *Gerres oyena*, gregarious almost in certain definite places during certain periods and only a few individuals going out of the band, seemed to have played an important role in the formation of territory. There, the constant contact with comrades was seemingly indispensable to motivate and trigger the establishment of territories.

Daily observations of recognized fish and a series of territory maps made on the results of observations indicate the following trends.

1) Some fish retained their territory at the same position for a long time: e.g. No. Y throughout all the days of observation, No. T intermittently during the period of observation, and No. n and No. e on most days of observation.

2) The territory of larger individuals (2–6 m²) was larger than that of smaller ones (0.5–1.0 m²).

3) The establishment of the territory, at least of smaller individuals, was never achieved in a day but required a few to several days. The territories were started in the band maintained between the already established territories of larger individuals, first with the maintenance of certain positions in the area of the band by some band members that, however, never displayed any territorial behaviour in earlier stages of territorial development. Later then, some of such individuals started fighting against the nearest comrades in the band to retain its position or territory and when this was succeeded, its territory was established more persistently.

No. n and No. e were observed retaining their territories against a smaller fish on December 25 and 29 respectively, but never against larger ones. Such a behaviour was ever referred to the "partial territory" by Greenberg (1947) and regarded to be an intermediate between the hierarchy and the territory. The hierarchy is observable popularly among the fishes kept in the aquarium but seemingly not so in the nature. In the natural circumstances, the hierarchy, on the whole, refers to the ability of the animal to identify conspecific individuals, as seen in mammalian and avian species. The present author ever reported that a blenny, *Omob-*

ranchus elegans, showed a hierarchy in identifying individuals in the sea (Usuki, 1974). J. C. Braddock (1945) also presented some evidence for that the fish, *Platypoecilus maculatus*, kept in aquaria recognized one another their individuality. Nevertheless, such examples are rare or rather exceptional in fishes in the nature. Therefore, the "partial territory" in *Gerres oyena* might be accepted as a step of the territorial formation and an intermediate between the band and the territory.

The mosaic territories in *Gerres oyena* were never overlapped and territorial aggressions were always closed strictly on or within the boundary; this is pretty different from what has been observed on the fresh water fish, *Plecoglossus altivelis* (Japanese name: ayu). As the territorial boundaries were often fairly corresponding to the edge of some algal growths or rocky risings in the study area, it seemed that such topographic characters were useful to the fish to define the boundary of their territories, just like that the formation of territories in the green sunfish (*Lepomis cyanellus*), was favoured by wire-screen partitions in the aquarium tank (Greenberg, 1947).

Usability of the Natural Blemishes on the Fish Body for Identification of Individuals

On No. Y fish, the scaled part checked on December 1 remained still fairly clear on January 25 and the cut end of the fin was so, too, though somewhat transformed. Both the scaled part of No. e and the linear hurt of No. n seemed almost unchanged and were effective enough to identify those fish during the observations from December 15 to January 25. On the contrary, No. H and No. M recognized first on December 11 became undistinguishable after January 13. The usability of such signs is considered therefore to be related with the growth rate of fish that is partly subject to the water temperature. The water temperature, approximately 20°C at the beginning of the present study, dropped gradually to 13.5°C at the end of the study. Therefore, at least in the winter season with lower temperatures, the identification of individuals in *Gerres oyena* may be done better by natural blemishes than by tagging.

Summary

1. Observations on the territorial formation in *Gerres oyena* were conducted by snorkelling from December 1, 1975 to January 25, 1976 on the protruded rocky reef near the Seto Marine Biological Laboratory.
2. Eight individuals were identified by natural blemishes on their body surface and such signs were proved to be effective enough to recognize them one another for a considerably long time.
3. Three types of social organization were defined in this fish; i.e. aggregation, band and territory.
4. The territorial formation seemingly progressed in smaller individuals as: in aggregation→in band→domiciliation at certain position in band→aggressive only against smaller comrades (partial territory)→against all conspecific individuals.
5. Observations of territory formation in the morning and territory release

in the evening indicated that territorial owners went down to join the aggregation that was formed in the deeper layer and, in some cases, might migrate (inshore?) at night.

6. No hierarchy was observed in this fish, though the "nip order" between the band members, still struggling for territories, might be regarded as representing a hierarchy. Anyhow, this is far from the social organization and rather referred to the matter prior to the domiciliation.

Acknowledgements: The author's hearty thanks are due to the staff of the Seto Marine Biological Laboratory, particularly to Prof. Takasi Tokioka for reading the manuscript, to Dr. Michio Imafuku and Mr. Tetsuo Kuwamura for their advices and stimulative suggestions, and to Messrs. Torao Yamamoto and Chuichi Araga for their incessant encouragement throughout the study. The author is also debted to Prof. Toshitaka Hidaka of Kyoto University for his generosity in giving the author information on various animal behaviours.

LITERATURE CITED

- Braddock, J. C. 1945. Some aspects of the dominance-subordination relationship in the fish (*Platy-
poecilus maculatus*). *Physiol. Zool.*, 18: 176-195.
- 1949. The effects of prior residence upon dominance in the fish (*Platy-
poecilus maculatus*). *Ibid.*, 22: 161-169.
- Chapman, D. B. 1962. Aggressive behaviour in juvenile coho salmon as a cause of emigration. *J.
Fish. Res. Bd. Canada.*, 19: 1047-1080.
- Greenberg, B. 1947. Some relations between territory, social hierarchy and leadership in the green
sunfish (*Lepomis cyanellus*). *Physiol. Zool.* 20: 267-299.
- Kawanabe, H. 1957. Social behaviour and production of a salmon-like fish, *Plecoglossus altivelis*,
or Ayu with reference to its population density. *Jap. J. Ecol.*, 7: 131-137 (in Japanese with
English summary).
- 1958. On the significance of the social structure for the mode of density effect in a salmon-
like fish, "Ayu", *Plecoglossus altivelis*. *Memoirs of the College of Science, Univ. Kyoto, Series B*,
XXV, 3, Article 4: 171-180.
- Mizuno, N. & H. Kawanabe. 1957. Behaviour of salmon-like fish "ayu" in an area with closely
established territories. *Jap. J. Ecol.*, 7: 26-30 (in Japanese with English summary).
- Mori, S. 1956. Social organization of a group of young girelloid fish, *Girella punctata* Gay, confined
in a tide pool, with special reference to the relation between social hierarchy and territorial system.
Jap. J. Ecol., 5: 145-150 (in Japanese with English summary).
- Okuno, R. 1956. A schooling habit of young *Girella punctata*, a common reef fish along the Japanese
coast. *Jap. J. Ecol.*, 6: 99-102 (in Japanese with English summary).
- 1964. Schooling behaviours of the black tang, *Prionurus microlepidotus*. *Jap. J. Ecol.*, 14:
189-195 (in Japanese with English summary).
- Slaney, P. A. & T. G. Northcote. 1974. Effects of prey abundance on density and territorial be-
haviour of young rainbow trout (*Salmo gairdneri*) in laboratory stream channels. *J. Fish. Res.*
Bd. Canada, 31: 1201-1209.
- Usuki, H. 1974. The reproductive behaviour of the Nabeka (*Omobranchus elegans*). *Anima*, no.
21: 62-66, Heibonsha Co., Tokyo (in Japanese).
- Yuyama, S. 1952. Behavioural observations on *Pomacentrus coelestis* in an aquarium with reference
to territoriality. *Nanki Seibutu*, 4: 34-42 (in Japanese).