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GILLNET SELECTIVITY FOR MULTI-SPECIES COASTAL FISHERIES IN PALAU

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Introduction

Fishes were sampled with gillnets in a coastal water in Palau in order to study applicability of selectivity of gillnets in multi-species fisheries in tropical shallow waters. Development of selective fishing is emphasized in the FAO Code of Conduct for Responsible Fisheries, while studies on multi-species fishery management are encouraged in the Kyoto Declaration and Plan of Actions (MATSUOKA 1996). However, selectivity of fishing gear has been studied mainly for mono-species fisheries in high-latitude waters. The basis for implication of selectivity in multi-species fishing in most tropical coastal waters has not been established. This study aimed at clarification of the basic factors and conditions to be taken into methodology to deal with selectivity of fishing gear in coastal waters of tropical countries such as Palau. Authors are deeply indebted to Mr. S. ISHIZUKA, a post graduate student of Kagoshima University who assisted in preparation of the figures.

Materials and Methods

A series of gillnet trial fishing was carried out in a shallow water in the vicinity of Ollei Village on the northern end of Babeldaob Island, Palau in October, 1995. The applied experimental gillnet was designed for sampling in coastal waters. One net was composed of six panels of webbing of different mesh sizes, *i.e.* 60.4 mm, 66.9 mm, 75.5 mm, 81.3 mm, 89.6 mm, and 99.4 mm of the same twine material, PA monofilament #4, rigged with a constant hanging ratio, 0.50. A complete net was 72 m long and 3.5 m high (Fig. 1). In the experiments, four nets were joined with two each of commercial gillnets of PA monofilament, 91.4 mm in mesh size on each end of the series of the nets. This method intended to enable random sampling by different meshes in shallow waters where a patch of different environmental components are merged in a small area.

Caught specimens were identified at the species level. The four body-form parameters, *i.e.* the anterior girths, G_1 around the preoperculum and operculum, the maximum body girth, G_2 and the standard body length, L_b were measured. A net mark was examined to identify capture status for each fish. The girth at the net mark, either G_{n1} or G_{n2} depending on its position was also measured.

Selectivity of the tested meshes for the major species, *Gerres acinaces* was calculated according to the fish body form parameters measured as above.

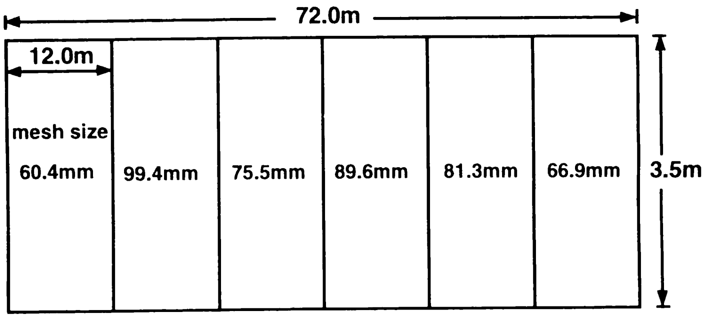

Fig. 1. Arrangement of six mesh panels in experimental gillnet.

Results

Species variation A total of 291 specimens of 18 species were sampled through six times of fishing in the trial ground of approximately 3 m in depth at high tide. A total of 155 specimens of *G. acinaces* which was the most popular species comprised of 53.3% of the specimens. This was followed by 35 specimens of *Upeneus vittatus* and 20 of *Liza vaigiensis*, which comprised of 12.0% and 6.9% of the specimens. The top three species comprised of 62.2% of the specimens and 95% of the specimens were composed of ten species (Table 1). Major species were sampled by the six meshes fairly at random.

Table 1. Fish species and number of specimens sampled by different meshes

		Mesh size (mm)						
Scientific name	Common name	60.4	66.9	75.3	81.3	89.6	99.4	Total
Tylosurus acus melanotu	Blackfin longtom	0	0	0	0	6	0	6
Liza macrolepis	Borneo mullet	0	0	3	0	0	0	3
Liza vaigiensis	Diamond-scaled mullet	8	6	4	0	1	1	20
Valamugil seheli	Mullet	1	1	0	0	0	0	2
Sphyraena barracuda	Great barracuda	1	0	1	0	0	0	2
Scomberoides lysan	Oriental leatherskin	0	0	0	0	1	0	1
Caranx melampygus	Trevally	0	1	1	0	0	0	2
Caranx ignobilis	Lowly trevally	5	6	1	0	0	1	13
Carangoides orthogrammu	Yellow-spotted trevally	0	2	1	2	2	3	10
Gnathanodon speciosus	Banded trevally	4	1	3	2	1	4	15
Gerres oblongus	Silver-belly	4	0	0	0	0	0	4
Gerres acinaces	Silver-belly	6	10	22	17	64	36	155
Upeneus viltatus	Yellowstriped goatfish	11	3	10	5	3	3	35
Terapon jarbua	Threestripe tigerfish	0	1	0	0	0	0	1
Lethrinus harak	Blackspot emperor	0	2	2	2	0	2	8
Acanthurus triostegus	Fiveband surgeonfish	1	0	0	0	0	0	1
Siganus canaliculatus	Whitespotted spinefoot	2	1	0	4	0	0	7
Siganus guttatus	Deepbody spinefoot	1	0	2	1	2	0	6
Total		44	34	50	33	80	50	291

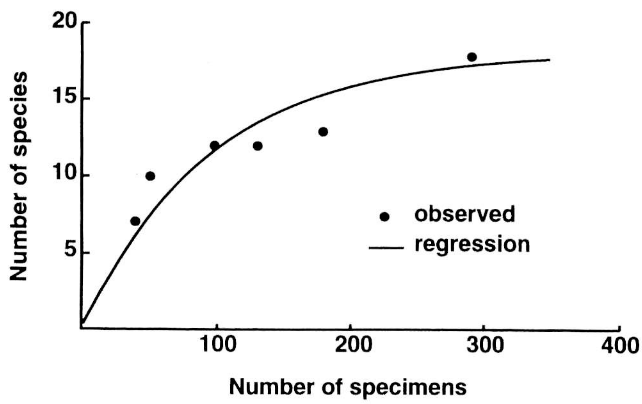

Fig. 2. Regression relationship between accumulated numbers of sampled specimens and occurred species.

According to the time-series catch record, the relationship between the accumulated numbers of specimens, n and occurred species, $N(n)$ was represented by an equation as (Fig. 2);

$$N(n) = 18.2\{1-\exp(-0.0104 \cdot n)\} \quad \cdots\cdots\cdots\cdots (1)$$

This was calculated by iteration under the confined condition where $N(n)$ is no less than 18, because a total of 18 species occurred *in situ*.

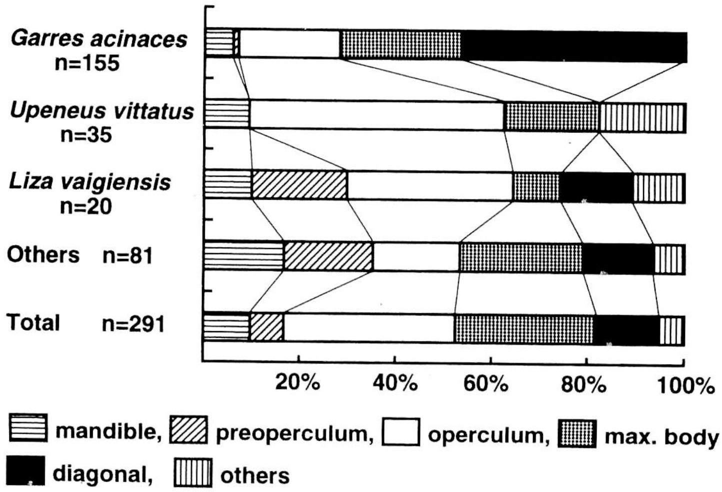

Fig. 3. Ratios among capture status for three major species: The listed status indicates; (1) entangled on mandible, wedged at right angle to the body's axis around (2) preoperculum, (3) operculum and (4) the maximum body section, (5) diagonally wedged between preoperculum and the maximum body section, and (6) various entanglement.

Capture status The capture status for all the specimens were categorized into; (1) entangled on mandible, wedged at right angle to the body's axis around (2) preoperculum, (3) operculum and (4) the maximum body section, (5) diagonally wedged between preoperculum and the maximum body section, and (6) various entanglement (Fig. 3). The ratios among the six categories of capture status for three major species revealed that the capture mechanisms are quite different from species to species. Only 47% of *G. acinaces* were wedged at right angle, while 45% were wedged diagonally with a few entanglement. On the other hand, 74% of *U. vittatus* were wedged at right angle, however, 26% were entangled. *L. vaigiensis* were mainly wedged at right angle (65%), however, 15% were diagonally wedged and 20% were entangled. In total, the capture status for all samples varied greatly, where only 56% were right-angle-wedged, while others were either diagonally wedged (29%) or entangled on mandible or other parts of bodies (15%).

Selectivity curve Selectivity of the tested meshes was availed only for *G. acinaces* because of the insufficient numbers of samples for other species. Selectivity curves were calculated on the basis of the observed catch status and measured body-form parameters according to KAWAMURA (1972) and MATSUOKA *et al.* (1995).

The linear regressions of the opercular and the maximum body girths, G_1 and G_2 to length, L_b were obtained as;

$$G_1 = 0.818\, L_b - 8.50 \cdots\cdots\cdots (2)$$

$$G_2 = 0.852\, L_b + 0.336 \cdots\cdots\cdots (3).$$

The girths were converted to dimensionless values by dividing by lengths. The standard deviations, U_{g1}' and U_{g2}' of the relative girths derived above were represented as;

$$U_{g1}' = 0.00000867\, L_b + 0.0356 \cdots\cdots\cdots (4)$$

$$U_{g2}' = -0.0000280\, L_b + 0.0441 \cdots\cdots\cdots (5).$$

The mesh size calibration coefficients, k_1 and k_2 were found to be 1.23 and 1.13 on the basis of the net mark girths, G_n measured around either opercular or the maximum body section divided by the mesh sizes which caught them.

In comparison of the calculated selectivity curves of the tested meshes to the length distributions of the fish sampled by respective meshes revealed that 93% of the right-angle-wedged samples occurred within the 5% selective ranges for the respective meshes (Fig. 4). Large portions of samples caught in the other categories of capture status appeared out of the selective ranges.

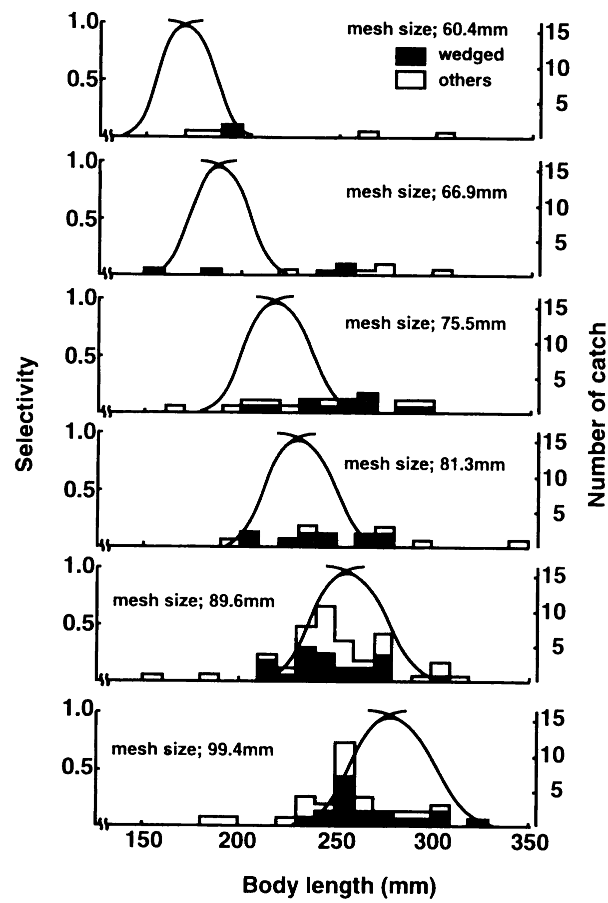

Fig. 4. Calculated selectivity curves of six meshes of experimental gillnet for *G. acinaces* and length distribution of specimens caught by respective meshes.

Discussions

Given a certain fishing gear, the constant in the specimen-species regression equation, for example 18.2 in the Equation (1) in the present case, indicates the number of species to occur in a fishing ground when a water is infinitely fished. The value reflects, therefore, the magnitude of specific variation in the fished ground and less selectivity of the applied gear.

There are only a few data to be compared to the present constant, 18.2. Matsuoka (1992) reported the values of 51.2 and 25.8 for bottom longline and handline in a lagoon water within the barrier reef on the southern coast of Papua New Guinea. The present value is apparently less than the above, however, it is unknown what is the responsible factor, either the selectivity of gillnets in comparison to hook and line gear or less specific variation in the studied ground. The obtained value appeared almost the same to the number of species actually sampled, which seems slightly odd. This is attributable to that a large number of species occurred in the final trial and a small number of trials were carried out.

In the studies case, 95% of specimens were composed of ten species. According to Equation (1), the tenth major species occurs in theory when the 77th fish is sampled. In other words, the equation indicates that if at least a certain number, S of samples are required for all the major species, 77 x S specimens are to be sampled. This means that, for example, a total of 23,000 specimens must be caught if 300 specimens each, which is approximately the usual minimum number of specimen needed to calculate selectivity, are required for all the ten species.

Selectivity curves obtained for *G. acinaces* indicates difficulties to achieve reliable selectivity curves for fishes irregularly enmeshed. Together with the another finding that a large portion of individuals of sampled species were diagonally wedged or entangled in the studied ground, estimation of selectivity for tropical shallow waters is assessed to be uneasy. Despite recent encourage of selective fishing and multi-species management, those on the basis of application of the conventional selectivity curve theory is thought difficult even for a gillnet on which researches on selectivity have been conducted most commonly among fishing gears. This is attributed to; (1) a large variation in caught species, consequently (2) a greatly large number of specimens required to estimate selectivity curves for all the major species, and further (3) irregular enmesh of a large portion of tropical shallow species, which is the negative factor against accurate estimation of selectivity curves. These may indicate that it is impractical and unrealistic to manage tropical fisheries on the basis of size-selectivity researches for all the fishes. A different concept of fishing gear management may have to be established for multi-species fisheries.

References

KAWAMURA, G. 1972. Nippon Suisan Gakkaishi, 38(10): 1119-1127.

MATSUOKA, T., MANA, R., & NAGALETA, H. 1992. Application of bottom longline fishing in tropical shallow water, Fisheries Section Technical Report 1/92, 25 pp. University of Papua New Guinea, Port Moresby.

MATSUOKA, T., MORI, K., & SAITO, Y. 1995. Nippon Suisan Gakkaishi, 61 (6) : 880-888. (in Japanese)

MATSUOKA, T. 1996. *Fisheries Research*, 15(3): 29-33. (in Japanese)