

Food Habits of Lancetfish *Alepisaurus ferox* (Order Myctophiformes) in Suruga Bay, Japan

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Abstract Stomach contents of 36 specimens of lancetfish stranded on the beach of Suruga Bay were analyzed and compared with those derived from surveys in the North Atlantic and the southeastern Pacific Oceans. The food consisted of organisms of such various sizes, shapes and colors, and living in such a wide variety of habitats as to indicate no selectivity. The largest proportion of food to body weight reached 74%. An example indicated that the enormous teeth serve to cut up large prey that would be impossible to swallow as a whole. The teeth seem also effective in cutting some of trunk muscles to diminish the movement of the prey. It has been reported that stomach contents of lancetfish in the North Atlantic and the southeastern Pacific are markedly similar, having in common 39% of the fish species or closely related species, and including 13–16% of young of lancetfish, but negligible amount of lanternfish. In our survey, however, stomachs contained no fish species in common with the reported food of *Alepisaurus* in the North Atlantic and southeastern Pacific, which included considerable numbers of lanternfishes, but no young of *Alepisaurus*. These facts support the idea that stomach contents of lancetfish strongly reflect the composition of animal communities to which they belong in the sea. Our data probably indicate that small lancetfish are not present in Suruga Bay, and the species may not spawn in this area.

Introduction

Lancetfish are well known among some ichthyologists for their enormous teeth and for the fact that their stomachs often contain rare deep-sea fishes. Stomach contents of *Alepisaurus* are always remarkably in good, undigested condition.

Haedrich (1964) reported on stomach contents of 40 specimens of lancetfish collected in the North Atlantic, and Haedrich and Nielsen (1966) investigated stomach contents of 140 specimens of *Alepisaurus* caught in the southeastern Pacific Ocean, and compared the results from these distant places. The results of these two surveys were surprisingly similar.

As far as we are aware, there has been no detailed report on food habit of this interesting fish in the western Pacific Ocean. On the beach of Miho Key in Suruga Bay facing the Pacific, many specimens of *Alepisaurus ferox*

Lowe are stranded between December and May. This phenomenon has been briefly reported by Kuroda (1938, 1954) and Misio (1936). Misio wrote that a sharp spine of *Triacanthus brevirostris* often pierced the body of a lancetfish. When we were completing this manuscript, we found a report on stomach contents of lancetfish written by three students of Nichidai Mishima High School (Yokoyama et al., 1968). It was reported in a publication for the student association of the high school. Since it has valuable informations, we introduce their results at the end of the result section in this report.

Since 1964, we investigated stomach contents of 36 specimens of *Alepisaurus ferox* collected on the beach of Miho Key near the Orido Campus of Tokai University. Besides analyzing stomach contents, condition of prey, especially wounds made by teeth, and some morphological characters of lancetfish were examined.

Here we present our first report on the food habits, and compare the findings with those reported for the North Atlantic and the southeastern Pacific Ocean. As to the system of fish classification in the tables, we used the same system found in the report by Haedrich and Nielsen (1966), to make comparisons easier.

Material and method

Most of the lancetfish, *Alepisaurus ferox*, used in this study were collected on the beach between the base of Miho Key and Fukiai Cape (over a distance of about 5 km). In this area the 200 m isobathic line runs close to the beach. The season in which these specimens become stranded on the beach begins in December and ends in May every year. Few of the 36 specimens were still alive when found, and most of those that had stranded during the night were dead. These specimens were brought into our laboratory on the Miho beach at Orido, Shimizu City, Shizuoka Prefecture, where various characters were measured and counted. Then the stomachs were dissected and their contents were fixed in 10% formalin solution. To facilitate comparisons, the results were tabulated (Table 2) in the similar way to that employed by Haedrich and Nielsen (1966). Jaws of cephalopods, pieces of wood, bamboo, and plastic objects were counted as one regardless of size, but were omitted from percentage calculation for each group of food organisms in Table 1. Though Misio (1936) and Tanaka and Abe (1957) stated that lancetfish often strand on the beach after stormy weather, we frequently found them just before rainy weather approached the Suruga Bay area. The basis of stranding will be reported elsewhere.

The body length of lancetfish collected is as follows (with numbers of individuals in parentheses): 590 mm (1), 725 mm (1), 801–900 mm (12), 901–1000 mm (5), 1001–1100 mm (8), 1101–1200 mm (4), 1205 mm (1).

Results

Only two of the 36 specimens had empty stomachs. Most of the stomach contents were in very good condition, enabling us to make identifications to the species level.

The food organisms were divided into following 8 groups: Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, Protochordata, Pisces, and plant or non-living objects. The total number and percentage for each group were recorded, along with the number of individuals and size range of each species and number of occurrences in each month (Table 1). Fishes, cephalopod molluscs, and crustacea dominated in quantity. Fishes exceeded all other items in volume, weight, and number of species.

Arthropoda constituted 46.0% of total individuals among stomach contents (Table 1). *Phronima sedentaria* and *Phrosina semilunata* were eaten every month. The former species appeared from 18 stomachs and the latter from 15. *Sergestes lucens*, an important commercial species of small shrimp in Suruga Bay, occurred in stomachs every month except December and May, the 237 individuals (121 males, 109 females, and 7 undetermined) constituted 54.4% of the number of all arthropods eaten. Molluscs included Heteropoda, Pteropoda, Cephalopoda, and up 12.2% of the total food organisms. The 54 individuals of *Todarodes pacificus* constituted 46.6% of the molluscs eaten.

The percentage representation of the four dominant fishes were *Gephyroberyx japonicus* 40.1%, *Lophius litulon* 9.9%, *Trichiurus lepturus* 9.1%, and *Engraulis japonica* 5.4%. All individuals of *Lophius litulon* eaten were young, 20–45 mm in body length. Many parasitic nematodes were found in lancetfish stomachs and intestines.

A lancetfish 862 mm in body length and 1020 g in weight contained in its expanded stomach two mackerels, *Scomber japonicus*, 300 mm long and the other, about 350 mm long, which had been cut off at about 250 mm

Table 1. Stomach contents of *Alepisaurus ferox* in Suruga Bay, Japan.

Month No. of specimens of <i>A. ferox</i>	No. of individuals						Size in mm	Total no. 36
	Dec. 3	Jan. 3	Feb. 5	Mar. 10	Apr. 9	May 6		
Coelenterata								2 (0.2%)
Medusae				2				
Mollusca								116 (12.2%)
Heteropoda								
<i>Pterotrachea coronata</i>	4			2	3	3		12
<i>Carinaria japonica</i>					3			3
Pteropoda								
<i>Cavolinia gibbosa</i>	2		1	1	1	1		6
<i>Eichio pyramidata</i>				1				1
Cephalopoda								
<i>Idiosius pygmaeus</i>			2				ml 9	2
<i>Onykia japonica</i>			1	2			" 26-71	3
<i>Onychoteuthis banksi</i>			2		2		" 20-82	4
<i>Calliteuthis meleagroteuthis</i>	3		1				" 10-17	4
<i>Calliteuthis</i> sp.			1				" 12	1
<i>Todarodes pacificus</i>		1	5	33	12	2	" 32-139	54
<i>Chiroteuthis imperator</i>		1	1	1	4	1	" 40-123	8
Unidentified squids			4	1	1	3	" ca. 10-39	9
<i>Argonauta</i> sp. (♂)		1	2	3	2		" 9-15	8
<i>Amphitretus pelagicus</i>			1				" 80	1
Jaws of cephalopods			4	2	5			
Annelida								5 (0.5%)
Polychaeta worms					5			5
Arthropoda								436 (46.0%)
Crustacea								
Isopoda				1	1			2
<i>Phronima sedentaria</i>	33	1	29	13	30	11		117
<i>Phrosina semilunata</i>	5	2	6	7	11	5		36
<i>Platyscelus ovoides</i>			1	3	2			6
<i>Parapronoe clausoides</i> ?			1					1
<i>Euphausia similis</i>					1		bl 20	1
<i>Sergestes lucens</i>		10	116	42	69		" 28-46	237
<i>Sergestes</i> sp.	1	1	4		1	3	" 28-61	10
Shrimp larvae	1				1	1	" ca. 18-20	3
Unidentified shrimp			1				" 21	1
Hermit crab				1				1
Crab larvae	2				3	16	" ca. 5-10	21
Echinodermata								1 (0.1%)
Sea urchin					1			1
Protochordata								145 (15.3%)
Doliolida (Cyclomyaria)					2			2
Salpida (Desmomyaria)	7			24	2	11		44
<i>Pyrosoma spinosum</i> ?	32		31	14	20	1		98
<i>Pyrosoma verticillatum</i>	1							1
Pisces								242 (25.6%)
Clupeiformes								
<i>Harengula zunasi</i>			1	5			bl 85-114	6
<i>Engraulis japonica</i>		1	1		2	9	" 33-139	13
<i>Maurolicus japonicus</i>		1			1		" 36-48	2
Myctophiformes								
<i>Myctophum asperum</i>			1				" 72	1
<i>Diaphus glandulifer</i>		1			4		" 34-43	5
<i>Diaphus latus</i>		2			1		" 30-40	3
<i>Lampanyctus festivus</i>		1					" 50	1
<i>Lampanyctus</i> spp.		1	1				" ca. 22-189	2
<i>Lestidium prolixum</i>			1	1	4		" 77-157	6
Siluriformes								
<i>Plotosus anguillaris</i>					1		tl 103	1

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Table 1. (continued).

Month No. of specimens of <i>A. ferox</i>	No. of individuals						Size in mm	Total no. 36
	Dec. 3	Jan. 3	Feb. 5	Mar. 10	Apr. 9	May 6		
Anguilliformes								
Young anguilliforms			1				" ca. 98	1
Beloniformes								
<i>Cololabis saira</i>					1		bl 125	1
Syngnathiformes								
<i>Macrorhamphosus japonicus</i>			1	1	1		" 70-91	3
Beryciformes								
<i>Gephyroberyx japonicus</i>	22	73	1		1		" 25-71	97
Lampridiformes								
<i>Trachipterus misakiensis</i>				2	2		" 82-253	4
Zeiformes								
<i>Zeus japonicus</i>					1		" 13	1
<i>Zenopsis nebulosa</i>					1	2	" 54-80	3
Perciformes								
<i>Sphyræna pinguis</i>		1					" 221	1
<i>Scomber japonicus</i>					3		" 39-350	3
<i>Nealotus tripes</i>		1					" 153	1
<i>Trichiurus lepturus</i>		1	17	2	2		tl 211-537	22
<i>Decapterus maruadsi</i>				1			bl 225	1
<i>Trachurus japonicus</i>						1	" 47	1
<i>Kaiwarinus equula</i>				1			" 45	1
<i>Leiognathus elongatus</i>					1		" 58	1
<i>Leiognathus nuchalis</i>			1	2			" 57-98	3
<i>Leiognathus rivulatus</i>				1	1		" 54-58	2
<i>Psenopsis anomala</i>					1		" 43	1
<i>Ocyrius japonicus</i>				1			" 114	1
<i>Branchiostegus argentatus</i>					1		" 75	1
<i>Lateolabrax japonicus</i>					1		" 53	1
<i>Pseudoscopelus scriptus</i>		1					" 111	1
Young uranoscopid					1		" ca. 25	1
<i>Xiphasia setifer</i>	1						tl 304	1
<i>Luciogobius guttatus</i>					1		bl 48	1
Cottiformes								
<i>Parapterois heterurus</i>			1				" 46	1
Young scorpaenid			1		2	1	" ca. 14-28	4
Tetraodontiformes								
<i>Triacanthus brevirostris</i>					2	1	" 77-96	3
<i>Ostracion tuberculatus?</i>						1	" 23	1
<i>Rhinesomus concatenatus</i>		1					" 32	1
<i>Sphoeroides vermicularis</i>					1		" 176	1
<i>Sphoeroides</i> sp.		2					" 31-53	2
Lophiiformes								
<i>Antennarius</i> sp.					1		" ca. 12	1
<i>Lophius litulon</i>					20	4	" 20-48	24
<i>Cryptopsara couesi</i>			1				" 117	1
Unidentified fish			2	2	3	2	" ca. 32-50	9
Kelp			2					2
Pieces of straw and leaf		3		1	3	1		8
Pieces of wood and bamboo				2	3	1		6
Skin of onion			1			2		3
Pieces of plastic and rubber	4	3	17	17	30	7		78

Abbreviations: bl, body length; ml, mantle length; tl, total length.

from the tip of the snout. The two mackerels weighed 752 g, 74% of the predator's weight.

Besides our data, we like to introduce here an information which contain a large amount of data by three high school students (Yokoyama et al., 1968). They examined stomach contents of 83 specimens of *Alepisaurus ferox* collected along the beach of Suruga Bay and listed 54 species of fishes. Since these students probably identified fishes by themselves (there is no acknowledgment for an adviser in the report), the degree of the accuracy of the identification is unknown. But the eight most frequently found fishes in their list are almost unmistakable groups, therefore we list them here as an additional information for our report. The number of individuals of each group are in parentheses: *Engraulis japonica* (74), *Sphoeroides* (20), *Macrorhamphosus* (19), lanternfishes (17), *Bregmaceros* (12), stomiatoids (11), *Lestidium* (9), *Champsodon* (9), and other kinds, each represented by very few specimens.

Discussion

Judging from the stomach contents, lancetfish do not appear to select food. The stomachs contained organisms that are frequent in the surface, middle, and bottom layers of the sea. This indicates that lancetfish, like many myctophiform fishes, undertake vertical migration.

In spite of the presence of many large sharp teeth in the mouth, the food organisms showed very few wounds on their bodies. Besides the ordinary food-catching role, the teeth of lancetfish seem to have at least two important functions. The one is to cut off a portion of an organism too large to swallow whole (as demonstrated by the case previously noted of a 350-mm *Scomber japonicus* and by frequent cases of the long body of a *Trichiurus lepturus* being cut off somewhere). The other function is to cut some of trunk muscles so that prey's struggling is diminished before being swallowed.

Stomach contents of lancetfish from three distant ocean areas are markedly different

Table 2. Number of specimens of fishes in stomachs of *Alepisaurus* from different ocean regions.

	<i>A. ferox</i>	<i>A. ferox</i> and <i>A. brevirostris</i>	
	N. w. Pacific	S. e. Pacific	N. Atlantic
Clupeiformes	21 (8.7%)	66 (35.5%)	80 (29.9%)
Myctophiformes			
<i>Alepisaurus</i> young	— —	25 (13.4%)	42 (15.7%)
Other alepisaurids	6 (2.5%)	49 (26.3%)	70 (26.1%)
Myctophoids	12 (5.0%)	2 (1.1%)	1 (0.4%)
Siluriformes	1 (0.4%)	— —	— —
Miripinnatiformes	— —	3 (1.6%)	— —
Anguilliformes	1 (0.4%)	2 (1.1%)	5 (1.9%)
Beloniformes	1 (0.4%)	— —	— —
Syngnathiformes	3 (1.2%)	— —	1 (0.4%)
Beryciformes	97 (40.1%)	6 (3.2%)	4 (1.5%)
Lampridiformes	4 (1.7%)	2 (1.1%)	1 (0.4%)
Zeiformes	4 (1.7%)	— —	— —
Perciformes	44 (18.2%)	23 (12.4%)	50 (18.7%)
Cottiformes	5 (2.1%)	— —	2 (0.7%)
Tetraodontiformes	8 (3.3%)	— —	1 (0.4%)
Pleuronectiformes	— —	— —	1 (0.4%)
Gadiformes	— —	8 (4.3%)	6 (2.2%)
Lophiiformes	26 (10.7%)	— —	4 (1.5%)
Unidentified fish	9 (3.7%)	— —	— —
Total	242 (100%)	186 (100%)	268 (100%)

(Table 2). Haedrich and Nielsen (1966) reported that the species of fishes in stomachs of lancetfish obtained by research vessels using tuna long lines and midwater trawls on the high sea in the North Atlantic (Haedrich, 1964) and in the southeastern Pacific Ocean were strikingly similar, including 39% of common or closely related species. Our survey, however, disclosed no species in common with those reported by Haedrich and Nielsen. In the North Atlantic and the southeastern Pacific young lancetfish constituted 13–16% of the food, but almost negligible number of lanternfish. In contrast, the lancetfish in Suruga Bay had eaten no young of its own species, but considerable numbers of lanternfish. Absence of selectivity was demonstrated by the wide variation of stomach contents: long and short, soft and hard, light and dark, large and small, and of various shapes. It seems that the stomach contents of *Alepisaurus* strongly reflect the composition of the animal communities (Haedrich and Nielsen, 1966). As far as we know no small individual lancetfish has ever been found in Suruga Bay. These data suggest that the small lancetfish were not included in the diet because the species does not spawn in this area.

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駿河湾産ミズウオの食性について

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1964年から1969年にかけて駿河湾の三保半島に打上げられた36尾のミズウオを材料として食性の調査を行った。胃内容物には食物の選択性は全くみられず、大小様々の色、形、硬軟のものが含まれていた。これらを大別すると腔腸動物、環形動物、節足動物、軟体動物、棘皮動物、原索動物、魚類、その他の8群になる。駿河湾における水産上の重要種スルメイカ、サクラエビ、カタクチイワシ、タチウオ、キアンコウ等は高い被捕食率を示している。年間に打上げられる数から察して駿河湾

のミズウオの数は決して少ないものでなく、水産上無価値であることと相まって害魚の1種とみなされる。今回の調査での摂餌率 $[(\text{胃内容物重量}/\text{体重}) \times 100]$ は最高70%に達していた。ミズウオの胃内容物には湾の表、中、底層に棲む生物が含まれていた。歯の形と食餌との間には特に関係が認められないが、大型の獲物を呑みこむ際、胃に入り切れない部分を切断するのに役立っていた。また歯は獲物の胴部の筋肉を鋭く切っており、運動を弱めるのに役立っている。Haedrich等の報告によると北大西洋と南東太平洋のミズウオの胃内容物の構成は非常に似ており、魚の共通種及び近縁種は39%にも達しているが、駿河湾の場合これらとほとんど類似性がな

い。北大西洋、南東太平洋のミズウオはハダカイワシ類をほとんど食べておらずミズウオの幼魚が13—16%に達しているが、駿河湾のものはかなりのハダカイワシ類を食しており、ミズウオの幼魚は全く食べていなかった。これらの事実からミズウオは特に食餌に対する選択性を示さず、その胃内容物はそれぞれの海域でミズウオの属する動物社会の構成を反映していると考えて良いであろう。また今回の資料はミズウオが駿河湾で産卵繁殖していないことを示唆している。

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