Japanese Journal of Ichthyology
Vol. 39, No. 4 1993

魚類学雑誌
39巻4号 1993年

Distribution and Food Habits of the Slender Smoothhound, *Gollum attenuatus*, from the Waters around New Zealand

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Abstract Three hundred and seventy-three females and 385 males of *Gollum attenuatus* were caught with bottom longlines from the Challenger Plateau, Wanganella Bank and Three Kings Ridge around New Zealand. The sharks ranged in size from 440 to 1092 mm TL for females and 442 to 1067 mm TL for males. Catch rates (number of fish per 100 hooks) were 0.41 for the Challenger Plateau, 0.14 for the Wanganella Bank, and 4.52 for the Three Kings Ridge. The sex ratio was 1 : 1. In terms of 100-m depth intervals, *G. attenuatus* was most abundant in 500 to 599 m depths. There was a marked decrease in catch rates with increased distance of the hooks from the bottom. Stomachs contained such varied items as sharks, teleost fishes, gastropods, squids, octopi, decapods, isopods, brittle stars, and human garbage. The data in this study suggest that *G. attenuatus* consumed, in order of importance, fishes and crustaceans.

The slender smoothhound, *Gollum attenuatus*, is a deep water species, endemic to New Zealand, and is characterized by its slender body and bell-shaped snout (Compagno, 1988).

Garrick (1954) described it as a new species, *Triakis attenuata*, within the family Triakidae, his generic placement being followed by Smith (1957), Kato (1968) and Springer (1968). However, Compagno (1973) placed it in the family Proscylliidae, in a new, monotypic genus, *Gollum*, which has been recognized by later authors, including Cadenat and Blache (1981), Ayling and Cox (1982), Compagno (1984, 1988), Paul (1986), Steuben and Krefft (1989), Paulin et al. (1989) and Nakaya (1990).

Biological aspects of this species are not well known, perhaps because of a lack of study material. However, recently, a unique reproductive habit of the species was reported by Yano (1993).

The objective of the present study was to increase knowledge of the biology and life history of *G. attenuatus* by analyzing data on the distribution, abundance, and food habits of the species from the waters around New Zealand and adjacent regions.

Materials and Methods

Specimens were caught with bottom longlines from the Challenger Plateau (38°00′S, 169°00′E), Wanganella Bank (32°35′S, 167°30′E), and F-Seamount of the Three Kings Ridge (28°10′S, 175°20′E) during a biological survey of the waters around New Zealand (outside the 200 miles Exclusive Economic Zone) (Fig. 1) by the R/V Fukuyoshi Maru No. 26 of the Japan Marine Fishery Resources Research Center (JAMARC). Fishing results are shown in Table 1. Previously collected specimens, deposited in the National Science Museum, Tokyo (NSMT-P) and examined in this study are as follows: NSMT-P 42802, 48°54′S, 166°46′E (off the Snares Islands); NSMT-P 42803 and 42804, 48°50′S, 167°00′E (off the Snares Islands).

The bottom longline gear used (Fig. 2) was almost the same as used by Japanese commercial vessels operating in the North Pacific Ocean for sablefish and Pacific cod (Yano, 1990). Survey method details were described in Yano (1991). The bottom longline consisted of between 90 and 360 hachis (skates) per operation (gear usually set comprised 300 hachis). Each hachi was 75 m long and included 37 hooks (total number of hooks was 3300 to 13320) that were baited with squid. Line lengths between the sinker and groundline (A in Fig. 2) were of four types (0 m, 2 m, 5 m, and 10 m). These sampled different parts of the water column, namely, on the bottom, about 1 m from the bottom [2 m − 1 m (gangion length) = 1 m], about 4 m from the bottom and about 9 m from the bottom, respectively. Each type, which comprised 30 hachis (1110 hooks) made up one set, the sets being randomly arranged in the total gear per operation. The number of each fish species

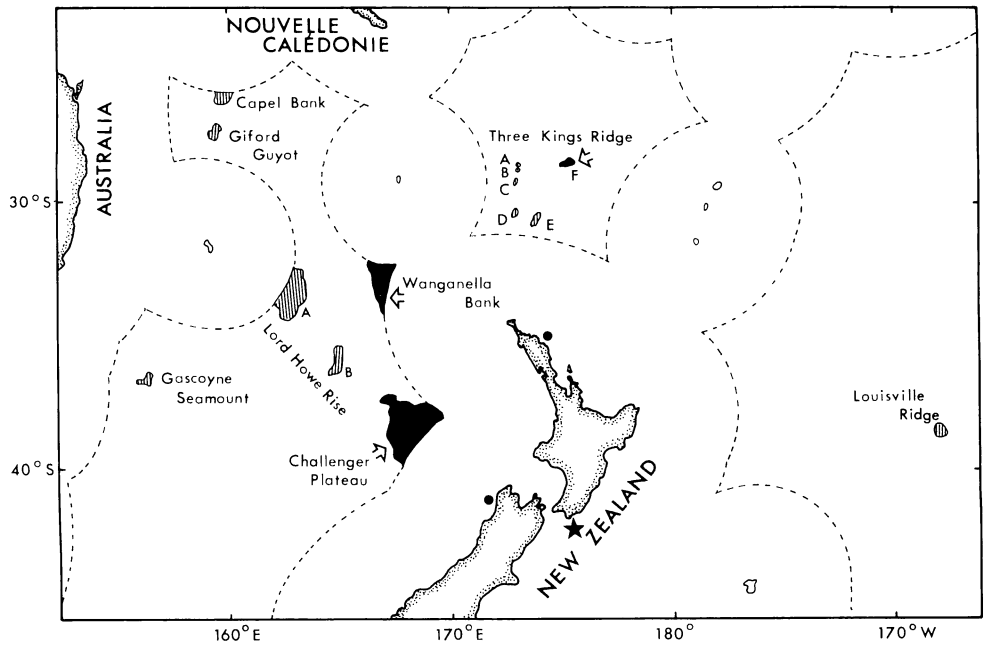

Fig. 1. Areas fished (black and striped areas) by bottom longlines around New Zealand. Black indicates areas (Challenger Plateau, Wanganella Bank, and F-Seamount of the Three Kings Ridge) where *Gollum attenuatus* was collected. Star (★) indicates type locality reported by Garrick (1954). Solid circles (●) indicate localities where *G. attenuatus* reported by Compagno (1988) were collected. Dotted lines indicate the 200 mile Exclusive Economic Zone limits.

Table 1. Bottom longline fishing data from the biological survey of the waters around New Zealand. Asterisks (*) show the areas where *Gollum attenuatus* was collected

Area	Fishing data			Number of available hooks	Number of *G. attenuatus*	
	Date (day/mo./yr.)	No. (days)	Depth (m)		Male	Female
Challenger Plateau*	19–22/12/89, 3/2/90	6	275– 965	55426	117	111
Wanganella Bank*	12–17/12/89	5	105– 930	63751	41	46
Three Kings Ridge* F	11/1/90	1	445– 880	9768	226	216
A	10/12/89	1	360–1060	10360	0	0
A–B	9/12/89, 12/1/90	2	320–1100	22200	0	0
C	13/1/90	1	930–1070	3330	0	0
D	7–8/12/89, 14/1/90	3	387– 895	33300	0	0
E	15/1/90	1	593– 912	3330	0	0
Capel Bank	15–17/2/90	3	48–1170	19980	0	0
Giford Guyot	13–14/2/90	2	295–1250	14023	0	0
Garscoyne Seamount	7–9/2/90	3	90–1140	22866	0	0
Lord Howe Rise A	11/2/90	1	650– 950	10545	0	0
B	5/2/90	1	960– 980	5550	0	0
Louisville Ridge	27/12/89–7/1/90, 24–30/1/90	19	261–1250	235690	0	0
Overall	7/12/89–17/2/90	49	48–1250	510119	384	373

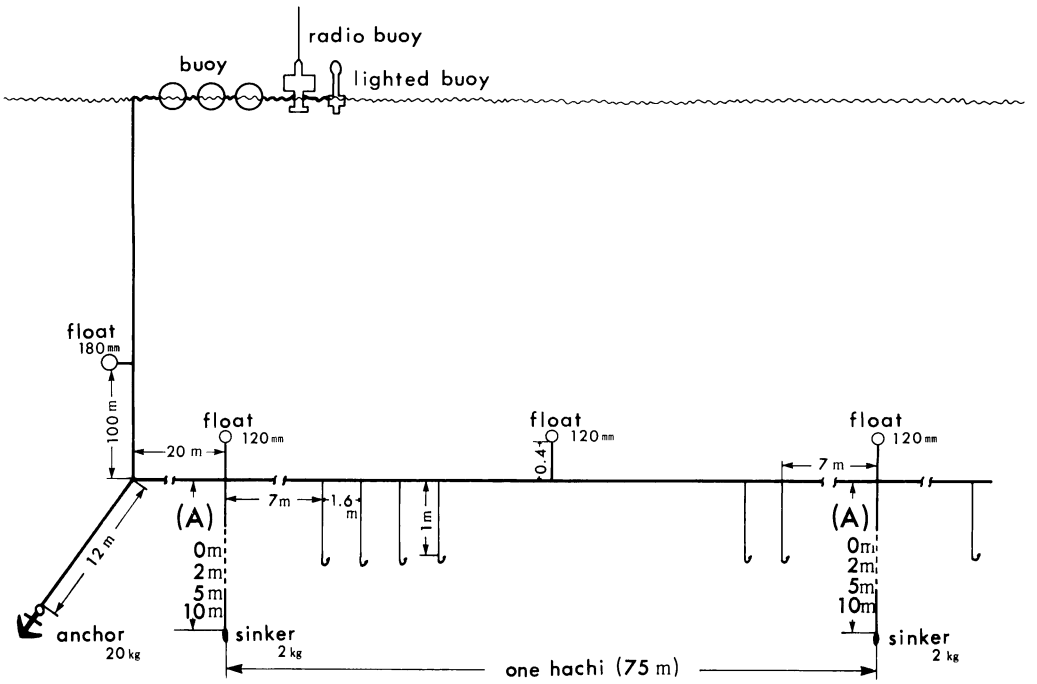

Fig. 2. Construction details of the bottom longline gear. Four types of line length (A) between sinker and groundline were used, these being 0 m, 2 m, 5 m and 10 m.

caught for each set type was counted from 30 to 60 hachis (combined total count was 120 to 240 hachis of all types) per operation. The depth at which fishes were caught was estimated by measuring the water depth under the vessel with an echo sounder at every fifth hachi. The catch rate was calculated by the number of fish caught per 100 hooks.

Water temperature and salinity were measured with a STD (model AST-1000, Alec Electronics Co., Ltd.) and the data analyzed by computer (system program, AMSTD12 for NEC PC-9801 from Alec Electronics Co., Ltd.).

Log converted length-weight equations were calculated by the least squares method. Curves for both sexes were fitted to the data by the following formula: $W=aL^b$, where W is weight in grams, L is total length in millimeters, and a and b are fitted constants (Ricker, 1973). Specimens for size frequency analysis were grouped into 20 mm length intervals.

Stomach contents were identified to the lowest possible taxon and counted. Analyses of stomach data were summarized by the Index of Relative Importance (IRI) modified from Pinkas et al. (1971): IRI=PO(PN+PW), where PO is percent frequency occurrence of prey items, PN is percent of total prey number and PW is percent of total stomach content weight (wet weight) calculated for each prey category. Specimens used for stomach contents analysis were grouped into 100 mm size intervals.

Results

Distribution and catch condition. The distribution of *G. attenuatus* around New Zealand from previous reports and from the present study is shown in Fig. 1. The large number of specimens collected were taken at only three [Challenger Plateau (5 days fishing), Wanganella Bank (6 days), and F-Seamount of the Three Kings Ridge (1 day)] of the 14 areas investigated (49 days) (Table 1, Fig. 1). The species was not caught in the remaining 11 areas (Fig. 1) despite a high fishing effort (37 days and 381 174 available hooks) (Table 1).

Of the total number of 116 fish species and 45 049 individuals caught on the longlines in all areas, *G. attenuatus* ranked 14th in abundance (catch number), and of the 38 species and 9907 individuals of chondrichthyans it ranked 5th in abundance.

The Challenger Plateau is a gentle continental slope extending from the continental shelf of New

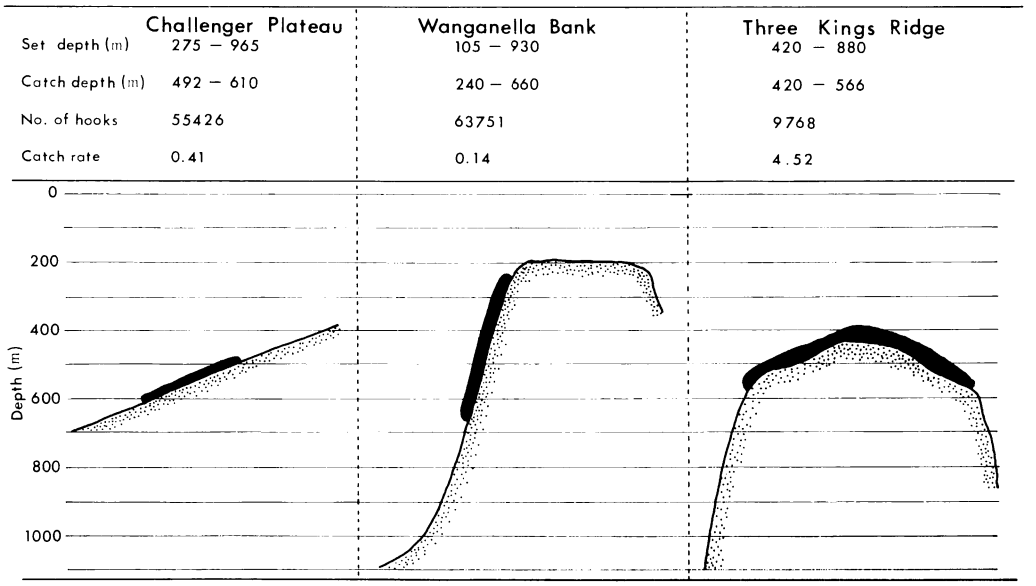

Fig. 3. Schematic illustrations of the bottom profiles of the Challenger Plateau, Wanganella Bank and Three Kings Ridge. Black indicates regions where *Gollum attenuatus* were collected. Catch rate is the number of fish caught per 100 hooks.

Zealand (Figs. 1 and 3). Specimens of *G. attenuatus* from the Challenger Plateau were caught at depths of 492–610 m on 4 of the 5 longline sets (55 426 total hooks examined). The 228 individuals collected accounted for 5.9% of all fishes caught [5.8% of catch weight (5873.1 kg)] in the area, and gave a catch rate of 0.41 (Fig. 3). Of the total of 45 fish species and 3836 individuals caught on the longlines in the area, *G. attenuatus* ranked 4th in abundance, and of the 17 species and 1597 individuals of chondrichthyans it ranked 2nd in abundance.

The Wanganella Bank is a wide platform with a depth of about 100–200 m, dropping-off to the bottom at about 1000 m or more (Figs. 1 and 3). Specimens of *G. attenuatus* from the Wanganella Bank were caught at depths of 240–660 m on the drop-off slope (Fig. 3) on 4 of the 6 longline sets (63 751 total hooks examined). The 87 individuals collected accounted for 2.1% of all fish caught [2.3% of catch weight (5802.2 kg)] in the area, and gave a catch rate of 0.14 (Fig. 3). Of the total of 40 fish species and 4192 individuals caught on the longlines in the area, *G. attenuatus* ranked 8th in abundance, and of the 17 species and 2560 individuals of chondrichthyans it ranked 5th in abundance.

The F-Seamount plateau of the Three Kings Ridge is about 420–600 m deep, its slope dropping to the bottom at about 1000 m or more (Fig. 3). The specimens of *G. attenuatus* from the Three Kings Ridge were caught in the plateau region (420–566 m) (Fig. 3) on one longline (9768 total hooks examined), the catch rate being 4.52 (Fig. 3). The 442 individuals collected accounted for 52.2% of all fish caught [41.2% of catch weight (1613.1 kg)] on the longline in this area. Among the 21 fish species and 846 individuals (8 species and 545 individuals of chondrichthyans) caught, *G. attenuatus* ranked first in abundance in the area.

The sex ratios (male/female) of *G. attenuatus* were 1.05 in the Challenger Plateau, 0.89 in the Wanganella Bank, 1.05 in the Three Kings Ridge, and 1.03 overall. Statistically, the null hypothesis that the ratio is 1 : 1 could not be rejected for any of the three areas, or overall, at the 5% significance level, according to chi-square tests.

Most *G. attenuatus* were caught at depths between 400 m and 600 m, there being no major differences in abundance between the three areas. Catch rates by depth, shown in Fig. 4, were greatest on the Three Kings Ridge, the highest catch rate, being 4.4 sharks per 100 hooks at depths of 500–599 m and the second highest 1.7 at 400–499 m. The highest catch rates in the other two areas, the Wanganella Bank (1.5) and Challenger Plateau (1.4), were also at 500–599 m

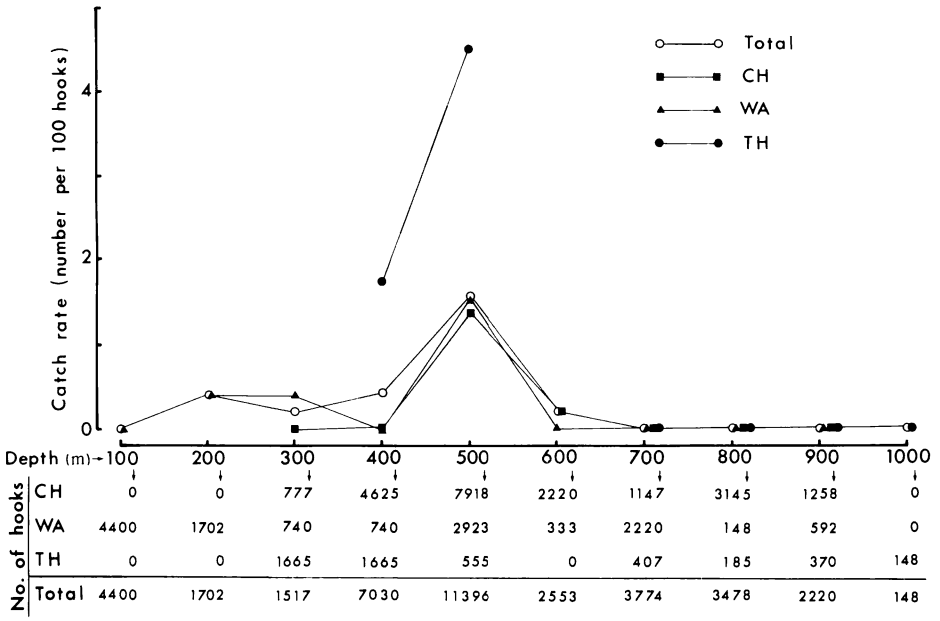

Fig. 4. Catch rates of *Gollum attenuatus* by bottom longline from various depth ranges. CH: Challenger Plateau; WA: Wanganella Bank; TH: Three Kings Ridge.

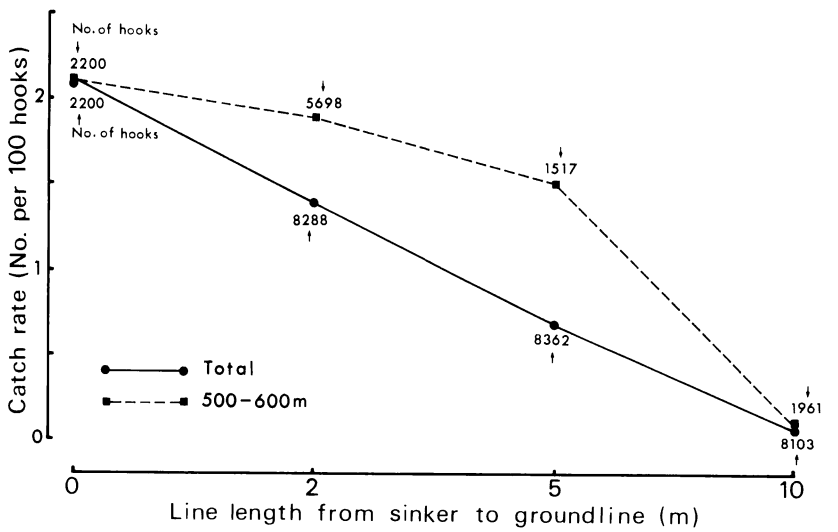

Fig. 5. Catch rates of *Gollum attenuatus* by bottom longline for the total depth range and the main catch depth, 500–599 m, in relation to different sinker-groundline distances (0 m, 2 m, 5 m and 10 m).

(Fig. 4). Although the other 11 areas surveyed were fished in the same depth ranges, no *G. attenuatus* were taken.

Comparison of catches on the four types of line length between groundline and sinker (A in Fig. 2) showed that the highest catch rate (2.1 sharks per 100 hooks) occurred on the 0 m type, i.e., when the hook and bait were on the bottom (Fig. 5). There was a marked and progressive decrease in catch rates with increased distance of the hooks from the bottom (Fig. 5), i.e., on the 2 m, 5 m and 10 m types. This relationship was the same for catches taken at all

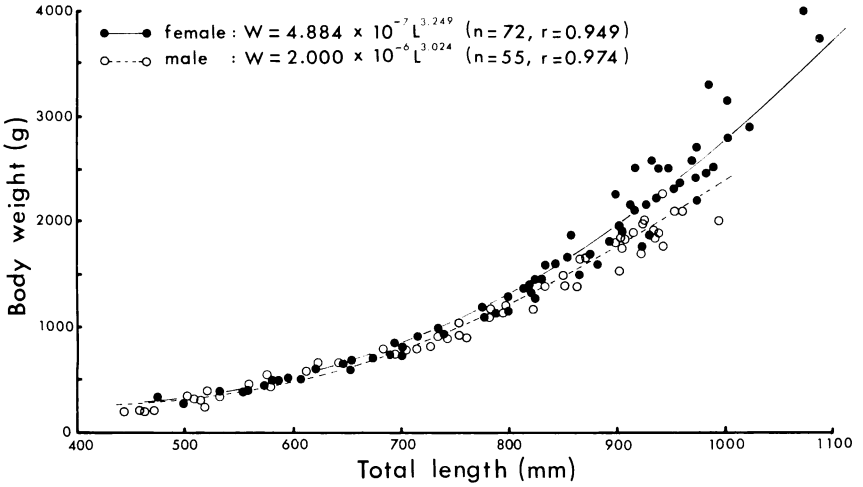

Fig. 6. Length-weight relationship, by sex, for *Gollum attenuatus*.

depths combined, and at the depth of greatest abundance (500–599 m).

Water temperature and salinity at the fishing localities and depths (400–600 m) where most *G. attenuatus* were collected were 9.3–11.4°C (10.2°C in 500 m depth) and 34.8–35.0‰ (34.9‰) for the Challenger Plateau, 8.7–11.8°C (9.7°C) and 34.7–35.1‰ (34.8‰) for the Wanganella Bank, and 8.2–11.6°C (10.0°C) and 34.6–35.0‰ (34.8‰) for the Three Kings Ridge. These data suggest that *G. attenuatus* is adapted to live in water of about 10°C and 34.8‰ salinity. In the other 11 areas, water temperature and salinity at 500 m depth were 7.5–10.7°C and 34.5–34.9‰, respectively. Therefore no major differences in temperature and salinity were found between the three areas where sharks were collected and also in the remaining areas where they were not taken.

Size. There were significant curvilinear relationships between body weight (W in g) and total length (L in mm) for both sexes of *G. attenuatus* (Fig. 6). The weight ranges were 195 g (464 mm TL) to 2260 g (942 mm TL) for males, and 225 g (440 mm TL) to 3980 g (1074 mm TL) for females. The length ranges were 442 to 1067 mm TL for males and 440 to 1092 mm TL for females.

Length frequency analysis of all specimens shows that the mode for male specimens was at 880–900 mm TL, while that for females was 920–940 mm TL (Fig. 7). Examination of specimens of more than 700 mm TL shows that 85.8% of females and 90.6% of males were mature (data on maturity size from Yano, 1993).

On the Challenger Plateau, male sharks ranged in size from 442–964 mm TL, and females from 468–1022 mm TL. The mode for males was 880–900 mm TL and for females 920–940 mm TL (Fig. 7).

On the Wanganella Bank, male sharks ranged in size from 704–1016 mm TL and females from 689–1092 mm TL. The mode for males was 860–880 mm TL and for females 820–840 mm TL (Fig. 7).

On the Three Kings Ridge, male sharks ranged in size from 449–962 mm TL and females from 440–1022 mm TL. The mode for males was 880–900 mm TL, and for females 940–960 mm TL (Fig. 7).

The modes for the females on the Challenger Plateau and Three Kings Ridge were larger than those for the males. There was no clear difference in the size composition of the sexes between the Challenger Plateau and Three Kings Ridge populations. However, the mode for females on the Wanganella Bank was smaller than that for males.

Females over 900 mm TL were much more numerous than correspondingly-sized males (53.4% of total specimens were females in this category vs. 23.6% males). Figures for the Wanganella Bank, Challenger Plateau and Three Kings Ridge were 56.5% vs. 31.7%, 50.1% vs. 30.8% and 54.2% vs. 18.1%, for females and males, respectively.

Food habits. The numbers of specimens examined for information on stomach contents and the proportion of empty stomachs by total lengths and by areas are shown in Table 2. Stomachs from 747 *G. attenuatus* were analyzed; of these, 243 stomachs (32.5%) were empty. The highest proportion of

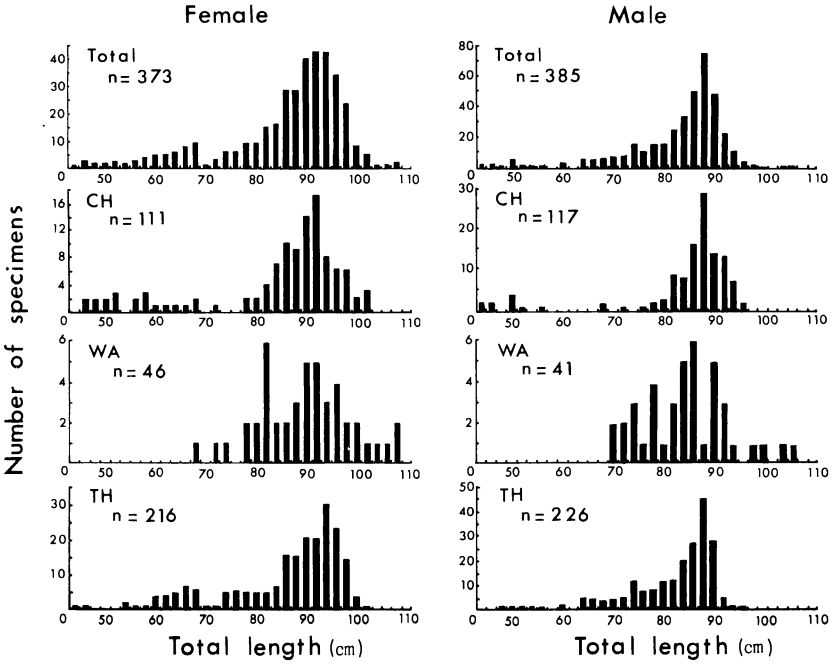

Fig. 7. Length-frequency distribution, by sex, for *Gollum attenuatus*. Specimens are grouped into 20 mm size classes. CH: Challenger Plateau; WA: Wanganella Bank; TH: Three Kings Ridge.

empty stomachs was 41.7%, in specimens of 500–599 mm TL, and the lowest was 18.2%, in specimens of 400–499 mm TL. Of the three localities, the proportion of empty stomachs in the Challenger Plateau specimens (44.9%) was higher than in those from the Wanganella Bank (27.2%) and the Three Kings Ridge (27.2%).

Stomach contents are itemized in Table 3. Stomachs contained such varied items as sharks, teleost fishes, gastropods, squids, octopi, decapods, isopods, brittle stars and human garbage (Table 3). At least 12 different species of fishes, representing 11 families, were recorded from the stomach contents. Fishes (81.1% of total Index of Relative Importance), especially family Myctophidae (12.9%), dominated the contents in terms of frequency of occurrence, number, and weight (Fig. 8). Amongst the crustaceans, at least 6 different species, representing 6

Table 2. Number of specimens of *Gollum attenuatus* examined for stomach contents, and proportions of empty stomachs by size intervals and collection areas

TL (mm) or area	Number of specimens	Number of empty stomachs	Rate of empty stomachs (%)
400– 499	11	2	18.18
500– 599	24	10	41.67
600– 699	54	10	18.52
700– 799	82	28	34.15
800– 899	293	96	32.76
900– 999	269	92	34.20
1000–1099	14	5	35.71
Challenger Plateau	225	101	44.89
Wanganella Bank	81	22	27.16
Three Kings Ridge	441	120	27.21
Total	747	243	32.53

Table 3. Composition of the diet of *Gollum attenuatus* in the waters around New Zealand in terms of the Index of Relative Importance (IRI) and its components, percent frequency occurrence (PO), percent of total prey number (PN) and percent of total contents weight (PW), and occurrence of each prey item in stomachs from three areas, Challenger Plateau (CH), Wanganella Bank (WA), and Three Kings Ridge (TH). +: present; −: absent

Prey	Composition of the diet				Occurrence of prey items		
	PO (%)	PN (%)	PW (%)	IRI	CH	WA	TH
Pisces	108.53	56.63	58.86	12 534.07			
Chondrichthyes	3.77	1.97	5.11	26.67			
Squalidae							
Centrophorus tessellatus	3.37	1.76	3.03	16.15	−	+	−
Etmopterus molleri	0.20	0.10	1.78	0.37	+	−	−
Egg capsule	0.20	0.10	0.30	0.08	−	−	+
Osteichthyes	104.76	54.66	53.76	11 357.67			
Myctophidae spp.	48.41	25.26	16.01	1998.15	+	+	+
Macrouridae sp.	0.20	0.10	0.59	0.14	−	−	+
Zenidae							
Zenion sp.	1.39	0.72	0.45	1.63	+	−	−
Macrorhamphosidae							
Macrorhamphosus scolopax	0.20	0.10	0.15	0.05	+	−	−
Scorpaenidae							
Helicolenus sp.	0.40	0.21	0.88	0.43	+	−	+
Triglidae							
Pterygotrigla pauli	0.20	0.10	0.65	0.15	+	−	−
Carangidae							
Trachurus sp.	0.20	0.10	0.74	0.17	−	+	−
Pentacerotidae							
Pentaceros decacanthus	0.20	0.10	0.20	0.06	−	+	−
Uranoscopidae							
Kathetostoma sp.	0.20	0.10	0.67	0.15	+	−	−
Gempylidae							
Rexea solandri	1.39	0.72	2.42	4.37	+	−	−
Unidentified osteichthyans	51.98	27.12	30.98	3020.44	+	+	+
Mollusca	16.27	8.49	11.81	330.23			
Gastropoda sp.	0.20	0.10	0.04	0.03	−	−	+
Cephalopoda	16.07	8.39	11.77	323.86			
Ommastrephidae sp.	7.54	3.93	9.40	100.54	−	+	+
Octopodidae sp.	4.17	2.17	1.64	15.90	−	+	+
Unidentified Cephalopoda	4.37	2.28	0.72	13.09	+	+	+
Crustacea	46.23	24.12	26.56	2343.14			
Isopoda							
Cymothoidae							
Bathynomus sp.	3.57	1.86	1.03	10.34	+	+	−
Decapoda	42.66	22.26	25.53	2038.56			
Rhynchocinetidae sp.	0.60	0.31	0.30	0.36	+	−	+
Pasiphaeidae sp.	0.20	0.10	0.06	0.03	+	−	−
Galatheidae							
Munidae gregaria	2.78	1.45	0.98	6.76	+	−	−
Unidentified shrimp	10.12	5.28	2.93	83.05	+	+	+
Paguridae sp.	1.39	0.72	0.40	1.56	+	+	+
Majidae							
Platymaia maoria	4.17	2.17	2.49	19.45	+	+	−
Portunidae							
Nectocarcinus bennetti	5.56	2.90	9.28	67.67	+	−	+
Unidentified crub	17.86	9.32	9.08	328.60	+	+	+
Echinodermata							
Ophiuroidae sp.	0.79	0.41	0.20	0.49	−	−	+
Miscellaneous	19.84	10.35	2.57	256.33			
Sea wood	0.20	0.10	0.02	0.02	−	−	+
Digested food or chyme	19.44	10.14	2.52	246.29	+	+	+
Human garbage							
Plastic bag	0.20	0.10	0.03	0.03	−	−	+

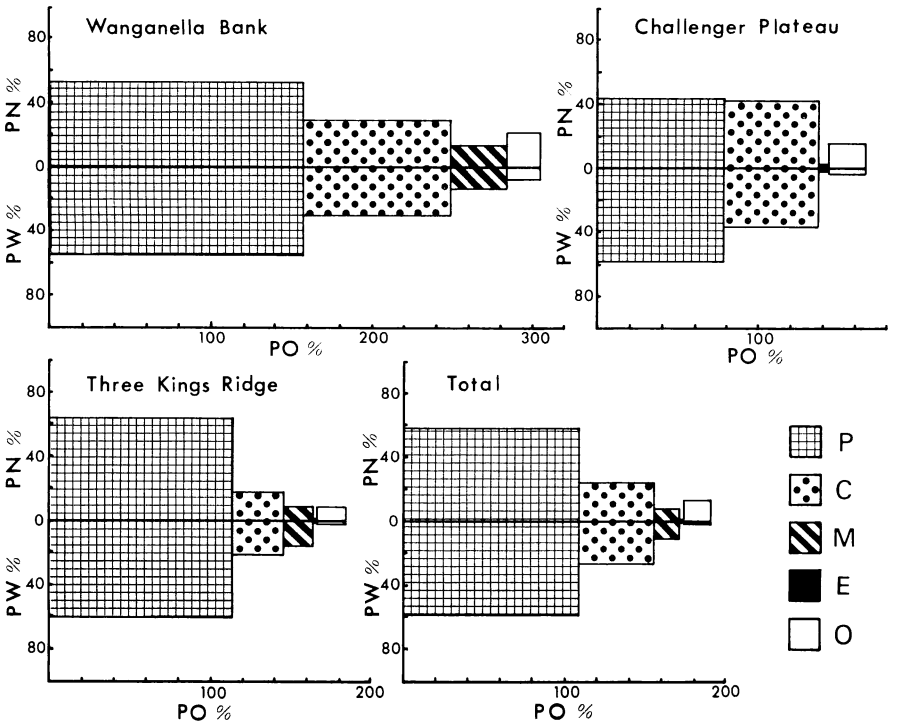

Fig. 8. Percent of frequency of occurrence (PO%), percent of prey number (PN%) and percent of stomach content weight (PW%) of major prey items in the stomach contents, by area, of *Gollum attenuatus*. P: Pisces; C: Crustacea; M: Mollusca; E: Echinodermata; O: Others.

families of Decapoda were found (Table 3). These comprised the second most important prey category (15.2%) (Fig. 8). Two families of Cephalopoda (2.1%) were consumed, mainly Ommastrephidae (0.7%), and were the third most important category. Most fish remains in the stomachs were digested and hence represented by muscle and skeletal material, including otoliths, lenses and scales (19.5%).

The importance of the various prey species or groups differs not only by areas (Challenger Plateau, Wanganella Bank and Three Kings Ridge), but also according to the size of the sharks.

On the Challenger Plateau, fishes (55.4%), especially *Zenion* sp. (0.2%), and Decapoda (41.0%), especially *Platymaia maoria* (1.8%), dominated the stomach contents (Table 3, Fig. 8). The identified contents included 8 families of fishes, one family of Isopoda, 6 families of Decapoda, and one family of Echinodermata (Table 3). For sharks 500–599 mm TL and 900–999 mm TL, fishes (33.3% and 72.2%, respectively) were the most important prey item in terms of percent of total IRI (Table 4). For the other size groups, Crustacea (27.7–94.6%) were the most important prey item of total IRI (Table 4).

On the Wanganella Bank, fishes (72.2%), especially Myctophidae spp. (2.0%), dominated the stomach contents (Table 3, Fig. 8), Decapoda being the second most important category (22.6%)(Fig. 8). The identified contents included 4 families of fishes, two families of Cephalopoda, one family of Isopoda, and two families of Decapoda (Table 3). No stomachs of sharks smaller than 600 mm TL were examined in this area. For sharks 700–799 mm TL, fishes (42.1%) and Crustacea (55.7%) dominated the contents (Table 4). For other size groups, fishes (45.0–100%) were the most important prey category (Table 4).

On the Three Kings Ridge, fishes (88.7%), especially Myctophidae spp. (27.4%), dominated the stomach contents (Table 3, Fig. 8). Identified contents included three families of fishes, two families of Cephalopoda, four families of Decapoda, and one family of Echinodermata (Table 3). For sharks 400–499 mm TL, Mollusca (63.7%) dominated the con-

tents. For other size groups, fishes (81.7–94.2%) were the most important prey category (Table 4).

The weight of the stomach contents averaged 1.09% (range of 0.03–11.11%) of the body weight in the 70 specimens for which body weights as well as stomach weights (excluding empty stomachs) were measured (Table 5). The highest and lowest average stomach contents weight: body weight ratios were 2.90% (in specimens of 1000–1099 mm TL) and 0.39% (in specimens of 500–599 mm TL) (Table 5).

Discussion

Previous accounts of *G. attenuatus* limited its geographical distribution to New Zealand (Garrick, 1954; Compagno, 1973, 1988; Ayling and Cox, 1982; Paul, 1986; Paulin et al., 1989; Nakaya, 1990), the localities reported (from only three specimens) being on the continental shelf [Garrick, 1954; Compagno, 1988 (same specimens examined as 1973)] (Fig. 1). Three further specimens, which are deposited in the

Table 4. Items of higher taxonomic groups from stomach contents of *Gollum attenuatus* indicating percent occurrence of total IRI (Index of Relative Importance) by size groups, 100 mm TL intervals, and collection areas

TL (mm)	400–499	500–599	600–699	700–799	800–899	900–999	1000–1099	Overall
Challenger Plateau								
Pisces	3.80	33.33	0.00	6.54	48.76	72.16	5.43	55.40
Mollusca	0.00	7.22	4.93	0.00	0.00	0.02	0.00	0.06
Crustacea	27.66	21.53	77.29	93.46	50.05	24.39	94.57	40.98
Echinodermata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	68.54	37.92	17.78	0.00	1.19	3.42	0.00	3.56
Wanganella Bank								
Pisces	—	—	100.00	42.07	78.58	65.20	45.02	72.16
Mollusca	—	—	0.00	0.61	4.15	8.28	0.00	4.37
Crustacea	—	—	0.00	55.67	16.91	25.33	15.14	22.57
Echinodermata	—	—	0.00	0.00	0.00	0.00	0.00	0.00
Miscellaneous	—	—	0.00	1.66	0.37	1.19	39.85	0.89
Three Kings Ridge								
Pisces	36.30	94.22	81.68	90.85	86.13	90.74	87.86	88.69
Mollusca	63.70	3.32	12.92	1.19	2.36	1.00	3.63	2.73
Crustacea	0.00	2.06	4.85	5.35	10.25	6.54	8.51	7.25
Echinodermata	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.01
Miscellaneous	0.00	0.40	0.54	2.61	1.21	1.73	0.00	1.32
Overall								
Pisces	16.26	83.57	78.78	79.80	79.36	83.58	53.96	81.05
Mollusca	11.62	4.94	13.04	1.01	1.84	1.07	0.95	2.14
Crustacea	18.93	5.47	7.19	16.94	17.84	13.24	42.38	15.15
Echinodermata	0.00	0.00	0.00	0.00	0.02	0.00	0.00	<0.01
Miscellaneous	53.19	6.02	0.98	2.25	0.94	2.10	2.72	1.66

Table 5. Stomach content weight expressed as percent of body weight (average and range) for different size intervals of *Gollum attenuatus*

TL (mm)	Number of specimens	Average (%)	Range (%)
400– 499	4	1.93	0.85– 4.90
500– 599	2	0.39	0.33– 0.45
600– 699	5	0.78	0.58– 1.08
700– 799	12	0.77	0.03– 1.89
800– 899	20	0.81	0.06– 2.02
900– 999	24	1.25	0.07–11.11
1000–1099	3	2.90	0.45– 7.59
Total	70	1.09	0.03–11.11

National Science Museum, Tokyo (NSMT), were caught with bottom trawl nets during a fisheries research survey by R/V Shinkai Maru (JAMARC) around New Zealand (Nakaya, 1990), but their localities (off the Snares Islands) were not given in Nakaya's report. Bottom trawls by commercial and research vessels may catch *G. attenuatus* around New Zealand, but if so, no information has been given of their catch numbers or localities in reports of fisheries research in the waters around New Zealand, despite the fact that these reports include information on several other species of sharks which have important commercial values (Francis, 1981; van den Broek et al., 1984; Kono and Tokusa, 1985).

The large number of records from the present study from the Challenger Plateau, Wanganella Bank and Three Kings Ridge markedly expand the known distribution of *G. attenuatus* around New Zealand. In the above areas *G. attenuatus* was a common component of the longline catch.

In the present study, juveniles, young and adults were caught in the same longline operations, although juveniles and young made up a conspicuously smaller part of the catch than did adults. This smaller catch of juveniles and young is probably due to catch selectivity of the longline gear. *G. attenuatus* probably occurs in schools, because operations in the three areas usually caught large numbers of the species. However, *G. attenuatus* was not caught in 11 other areas despite a high fishing effort. No major differences in temperature and salinity were found between the three areas where *G. attenuatus* was collected and the remaining areas where it was not taken. Its absence from the latter appears to be related to factors other than temperature and salinity. One interpretation is that the sharks may move by school around New Zealand.

Within the most commonly collected size range (i.e., greater than 900 mm TL) the proportion of large females was higher than that of males. This suggests that although the size at maturity of both sexes is the same (700 mm TL) (Yano, 1993), females grow larger than males.

Paul (1986) reported that *G. attenuatus* is present in depths below 200 m, but is nowhere very abundant. In the present study, the highest abundance of *G. attenuatus* was in 500–599 m, being the same in the three areas. Previously, *G. attenuatus* has been recorded from depths of 216 m (holotype specimen of Garrick, 1954), and 315–509 m (Nakaya, 1990). These depths are well within the depth ranges found in the present study. Although the bottom conditions in the three collection areas were different, namely, a gentle slope on the Challenger Plateau, a steep slope on the Wanganella Bank, and a plateau on the Three Kings Ridge, the sharks had the same depth preference (i.e., 500–600 m) in these areas. *G. attenuatus* appears to live in a very limited depth range (mainly 400–600 m). This is probably due to the species' reproductive habits, water temperature and salinity, and/or the presence of prey animals.

The sex ratio of collected specimens of *G. attenuatus* was 1 : 1 in each of the three collection areas. Yano (1993) reported that the sex ratio of embryos was also 1 : 1.

The largest size for both sexes of *G. attenuatus* collected (1067 mm TL for male and 1092 mm TL for female) were greater than the maximum size previously recorded (955 mm TL for male and 1015 mm TL for female; Compagno, 1988).

There are no published observations on the food habits of *G. attenuatus* (Compagno, 1984). The data here suggest that *G. attenuatus* consumed, in order of importance, fishes and crustaceans. Specific differences in prey items could be expected when comparing geographically separated collection areas; the sharks collected on the Challenger Plateau fed primarily on Crustacea, whereas those from the Wanganella Bank and Three Kings Ridge fed largely on fish. This is probably a result of prey-abundance differences between the areas rather than prey selection by the sharks. Some evidence that Crustacea are more abundant on the Challenger Plateau than on the other two areas is seen in that the same species of crab as consumed by *G. attenuatus* was found to be entangled on the bottom longline hooks only in the Challenger Plateau fishing operations.

Size-dependent prey preference by *G. attenuatus* was found on the Challenger Plateau; sharks less than 500 mm TL fed primarily on Cephalopoda whereas those greater than 500 mm TL were largely fish eaters. These data suggest that Cephalopoda may be important in the diets of juvenile sharks, at least, in this area.

There was a marked decrease in catch rates with increased distance of the hook from the bottom, suggesting that *G. attenuatus* feeds on or near the bottom. This, together with the nature of the food items in the stomach contents, suggests that *G. attenuatus* feeds mainly on bottom living animals and also scavenges. The teeth of *G. attenuatus* are small, and closely crowded so that the successional series over-

lap, as reported by Garrick (1954). This suggests that the feeding mechanism of *G. attenuatus* is of the suction-grasping type.

Acknowledgments

I wish to express my sincere thanks to Dr. J. A. F. Garrick for his valuable advice and criticism of the manuscript and the crew of the R/V Fukuyoshi Maru No. 26 for their help in collection of the specimens and cooperation during this investigation.

Literature Cited

Ayling, T. and G. J. Cox. 1982. Collins guide to the sea fishes of New Zealand. William Collins Publ. Ltd., Auckland, 343 pp.

Cadenat, J. and J. Blache. 1981. Faune Tropicale XXI. Requins de méditerranée et d'Atlantique. Office de la Recherche Scientifique et Technique outre-mer, Paris, 330 pp.

Compagno, L. J. V. 1973. *Ctenacis* and *Gollum*, two new genera of sharks (Selachii; Carcharinidae). Proc. Calif. Acad. Sci., 39: 257–272.

Compagno, L. J. V. 1984. FAO species catalogue. Sharks of the world, an annotated and illustrated catalogue of shark species known to date, part 2, Carcharhiniformes. Vol. 4. FAO Fish. Syn., (125): i–x+251–655.

Compagno, L. J. V. 1988. Sharks of the order Carcharinifomes. Princeton Univ. Press. Princeton, xxii+486 pp.

Francis, R. I. C. C. 1981. Stratified random trawl surveys of deep-water demersal fish stocks around New Zealand. Fish. Res. Div., Occ. Publ., (32): 1–28.

Garrick, J. A. F. 1954. Studies on New Zealand Elasmobranchii. Part III. A new species of *Triakis* (Selachii) from New Zealand. Trans. Roy. Soc. New Zealand, 82, part 3: 695–702.

Kato, S. 1968. *Triakis acutipinna* (Galeoidea, Triakidae), a new species of shark from Ecuador. Copeia, 1968: 319–325.

Kono, H. and K. Tokusa. 1985. Report of the Japan/New Zealand joint survey on groundfish resources in the waters south of New Zealand by Shinkai Maru, 1982. JAMARC Rep., 1981/No. 21: 1–111.

Nakaya, K. 1990. Proscylliidae. Page 62 *in* K. Amaoka, K. Matsuura, T. Inada, M. Takeda, H. Hatanaka and K. Okada, eds. Fishes collected by the R/V Shinkai Maru around New Zealand. Japan Mar. Fish. Resource Res. Cent., Tokyo.

Paul, L. J. 1986. New Zealand fishes, an identification guide. Reed Methuen Publishers, Auckland, viii+184 pp.

Paulin, C., A. Stewart, C. Roberts and P. McMillan. 1989. New Zealand fish, a complete guide. Natn. Mus. New Zeal., Misc. Ser., (19), xiv+279 pp.

Pinkas, L., M. S. Oliphant and I. L. K. Iverson. 1971. Food habits of albacore, bluefin tuna, and bonito in California waters. Calif. Dep. Fish Game, Fish Bull., (152): 1–105.

Ricker, W. E. 1973. Linear regressions in fishery research. J. Fish. Res. Bd. Can., 30: 409–434.

Smith, J. L. B. 1957. A new shark from South Africa. S. Afr. J. Sci., 53: 261–264.

Springer, S. 1968. *Triakis fehlmanni*, a new shark from the coast of Somalia. Proc. Biol. Soc. Wash., 81: 613–624.

Steuben, K. S. and G. Krefft. 1989. Die Haie der Sieben Meere. Arten, Lebensweise und sportlicher Fang. Verlag Paul Parey, Hambrug u. Berlin, 157 pp.

van den Broek, W. L. F., K. Tokusa and H. Kono. 1984. A survey of demersal fish stocks in waters south of New Zealand, March-May, 1982. Fish. Res. Div., Occ. Publ., (44): 1–51.

Yano, K. 1990. Report on sablefish and Pacific cod resource developmental survey, 1988. JAMARC Rep., S63/No. 11: 1–195. (In Japanese.)

Yano, K. 1991. Report on the new fishing ground developmental survey of bottom longline (western South Pacific Ocean). JAMARC Rep., H1/No. 10: 1–170. (In Japanese.)

Yano, K. 1993. Reproductive biology of the slender smoothhound, *Gollum attenuatus*, collected from New Zealand waters. Env. Biol. Fish. (In press.)

(Received May 19, 1992; accepted October 10, 1992)

ニュージーランド周辺海域におけるトガリドチザメの分布と食性

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ニュージーランド周辺海域のチャレンジャープラトウ，ワンガネラバンク，スリーキングズリッジで底延縄漁法により採集されたトガリドチザメの漁獲状況，水平および垂直分布，食性に関する研究を行った．採集されたトガリドチザメは，雌373個体と雄385個体であり，それらの体長範囲は，雌では440–1092 mm，雄では442–1067 mmであった．釣獲率（釣り針100本当たりの漁獲尾数）は，チャレンジャープラウトでは0.41，ワンガネラバンクでは0.14，スリーキングズリッジでは4.52であった．採集された標本の性比は1:1であった．100m間隔の水深区分による本種の釣獲率は，採集された3海域のすべてで500から599 mの間で最高であった．海底から釣り針までの位置を違えた4種類の漁具（海底のおもりから幹縄までの間の縄の長さが0m, 2 m, 5m, 10mの4タイプ）による各タイプ別の釣獲率は，海底に釣り針が接している状態のもの（0mタイプ）が最高で，釣り針が海底より離れるにしたがって釣獲率が低下していった．胃内容物は，他のサメ類，硬骨魚類，巻貝類，頭足類，十脚類，等脚類，クモヒトデ類，海中のゴミのビニール類が出現した．海底から海底付近に設置された釣り針での釣獲率が高いこと，胃内容物として出現するものの多くが底生性の種類であることから，本種の索餌層は海底か海底付近であると推定された．

（750 下関市東大和町2-5-20　水産庁西海区水産研究所下関支所）