

Occurrence of the Cookiecutter Shark *Isistius brasiliensis* in Surface Waters of the North Pacific Ocean

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The cookiecutter shark *Isistius brasiliensis* (Quoy et Gaimard) is a small shark with a maximum length of about 50 cm and inhabits the bathypelagic and epipelagic zones of tropical and subtropical oceans (Bigelow and Schroeder, 1948; King and Ikehara, 1956; Strusburg, 1963; Parin, 1964; Cadenat and Blanche, 1981; Compagno, 1984). Migrating to the surface at night, this species commonly feeds on squid, but also makes "crater wounds" on the surface of tunas, dolphin fish, billfishes, and whales (Van Utrecht, 1959; Strusburg, 1963; Jones, 1971; Baker, 1985).

Little is known about the biology and distribution of this species. On the basis of midwater trawl or plankton net catches, the cookiecutter shark has been reported to occur between 20°N and 20°S (Garman, 1899; King and Ikehara, 1956; Strusburg, 1963; Parin, 1964; Isouchi, 1970; Jones, 1971). This paper reports on the distribution and biology of cookiecutter sharks collected by three different research programs using large mesh, salmon and squid gillnets. The programs were conducted by the Japan Marine Fishery Resource Research Center (JAMARC) for Pacific pomfret research; Hokkaido University for the pelagic fish community study; and the Fishery Agency of Japan for marine mammal research. Additionally, parts of the specimen repor-

ted in this paper were used for presentation of Dr. Tokiharu Abe at the Symposium of Japanese Group for Elasmobranch Studies, held on March 17-18, 1987 in Tokyo.

Materials and methods

Catch data of the cookiecutter shark collected by the research vessels Shinyo-maru, Hokusei-maru, and Kanki-maru No. 58 were used for this study. Vessels operated 100 to 900 sets (tan) of nylon multi-filament (Shinyo-maru) and nylon mono-filament (Hokusei-maru and Kanki-maru No. 58) nets with mesh size of 19 to 250 mm at various locations of the North Pacific Ocean (Table 1). All samples were collected at the surface zone of the ocean (0-10 m) at night. All nets were set at sunset and retrieved at midnight (Shinyo-maru) or sunrise (Hokusei-maru and Kanki-maru No. 58). Cookiecutter sharks collected were frozen and brought back to our laboratory for measurements. Sea surface temperature was measured at the time of each net operation.

Results and discussion

293 net operations were made between 1980 and 1985. 43 of those operations yielded a total of 103 cookiecutter sharks as by-catch (Fig. 1). Relative abundance cannot be compared due to difference in the net set numbers of each vessel. Sharks were recorded from 23°N to 38°30'N and from 146°E to 131°W in the research area. The cookiecutter shark has been reported to inhabit the coast of California where this species causes "skin crater" wounds on northern elephant seals (Le Boeuf et al., 1987). Garman (1899) referred to the occurrence of the cookiecutter shark at 55°N, 140°W reported by F.

Table 1. Collection data for *Isistius brasiliensis* by 3 different research vessels during the period 1980-85.

Research vessel	Period	Mesh size (mm)	No. of stations sampled	No. of stations where specimens taken	No. of specimens captured
Shinyo-maru	Oct. 1980 - Feb. 1981	118-250	69	9	12
	Apr. - Jun. 1981	150-200	32	4	4
	Nov. 1981 - Feb. 1982	150-200	57	5	6
	Dec. 1982 - Feb. 1983	150-180	40	19	72
Kanki-maru	Aug. - Oct. 1984	33-179	35	3	6
Hokusei-maru	Jun. - Aug. 1982	19-233	32	1	1
	Jun. - Aug. 1985	19-233	28	2	2
Total			293	43	103

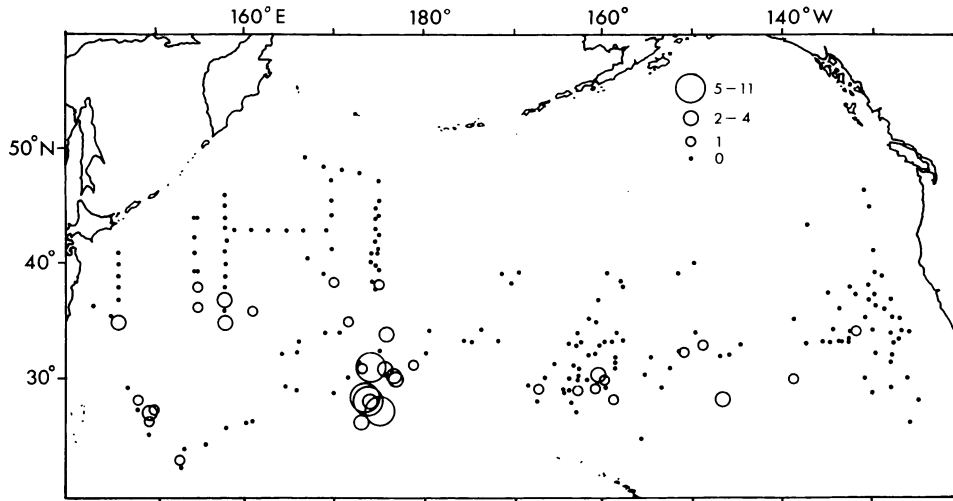


Fig. 1. Stations where the drift gill net was operated by the R/V Shinyo-maru, Hokusei-maru and Kanki-maru No. 58 during the year 1980-85. Black spots indicate the research stations and circles indicate stations where specimens of *Isistius brasiliensis* were captured. The numbers on the upper right represent those of specimens captured in each station.

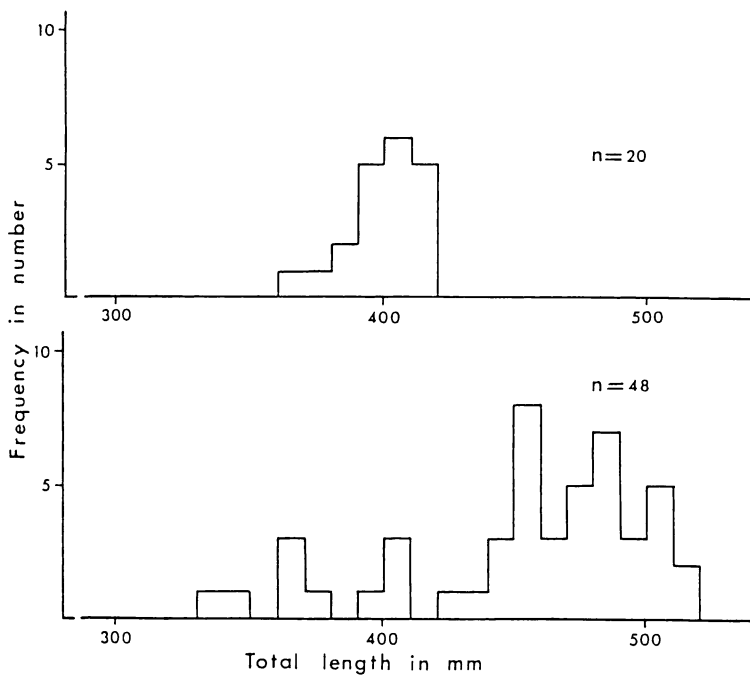


Fig. 2. Frequency distribution of the total length for females (above) and males (below) of *Isistius brasiliensis* collected in 1980-1985.

D. Benett (1840). However, Benett originally reported the position as "Lat. 55°N, Lon. 110°W" (which is inland) and Garman corrected the longitude from 110°W to 140°W. This shark is, therefore, distributed widely from tropical waters to

about 38°N, the southern limit of the subarctic region.

The Shinyo-maru collected 94 of the 103 specimens, most of which had their caudal fin entangled with the nets. The mesh size used by the Shinyo-

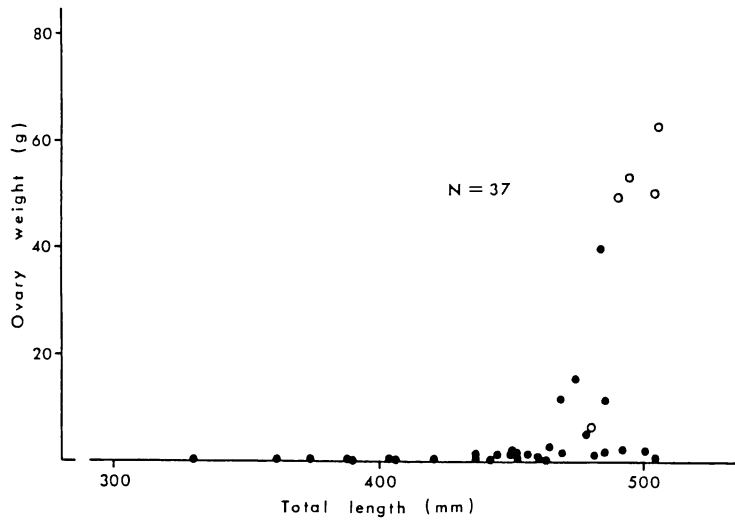


Fig. 3. Relation between total length and ovary weight of *Isistius brasiliensis*. White circles indicate weight of ovary and eggs in uteri.

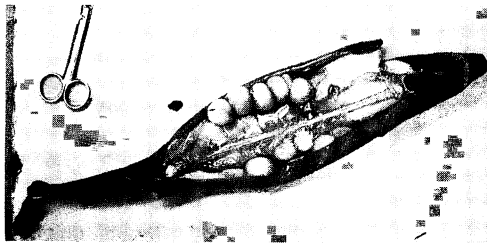


Fig. 4. Eggs in uteri of *Isistius brasiliensis*. Six and four eggs can be recognized in the left and right uteri, respectively.

maru (118–250 mm) was larger than the girth of the sharks captured. Therefore, these catches might be providential. It is suggested that the sharks were caught when they were attacking on prey captured by the gillnets.

Length composition of both sexes is shown in Fig. 2. Body size ranged from 337 to 560 mm for females and 368 to 418 mm for males. These samples included only individuals larger than 300 mm in total length. Of 36 ovaries collected, 5 were observed to possess yellow eggs in their uteri (Figs. 3, 4). The number of eggs in each uterus ranged from 2 to 8 and the total numbers in both uteri ranged from 6 to 12. Maximum egg diameter measured was 22 mm. However, no eggs showed any embryonic development and they were all yolks. Ovary weight increased rapidly in sharks larger than 460 mm total length and individuals having eggs in the uterus were larger than 480mm. Of the 15 males dissected, 9

were observed to have seminal fluid by squeezing the ductus deferens. Size at maturity of males observed in this study supports the reported size of Bigelow and Schroeder (1948), and Compagno (1984). However, size at maturity of females seems to be a little larger than previously reported.

All specimens collected were caught within 10 meters of the surface. Surface temperatures at all stations ranged from 8° to 26°C and those in the 43 stations where sharks were sampled ranged from 18° to 26°C. Water temperatures at the time of capture probably represent the range of habitat for cookie-cutter shark.

Sex ratio in 79 individuals of known sex was 56 : 23 (female : male) and was not 1 : 1 ($p < 0.005$). Sexual and growth-related segregations are generally recognized among elasmobranchs. The horizontal extension of occurrence area between males and females was observed to have no remarkable difference.

We observed that nearly all sharks captured were alive when removed from the nets. Many sharks were noted to thrust their lower jaw out of the mouth, accompanied by an audible sound. Several sharks were observed to bend along the body axis and twist. When one living cookiecutter shark was placed close to the mantle of a neon flying squid (*Ommastrephes bartrami*), a piece of its flesh was removed instantly with a combination of actions such as jaw protrusion, sound generation and body twisting. In another case, a living shark bit the skin

of a Pacific pomfret (*Brama japonica*), making a sharp hole similar to the "crater wounds" previously reported by Jones (1971).

This report expands present knowledge of the cookiecutter shark distribution where they occurred farther north than previously reported. Since they were caught by different gear as by-catch, using a more appropriate sampling equipment over a larger ocean area would be necessary to obtain much more information on this species.

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北太平洋表層域におけるダルマザメの出現

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1980年から1985年の6年間に、大目流し網、サケマス流し網、イカ流し網をそれぞれ使用した調査合計293地点のうち43地点で合計103尾のダルマザメ *Isistius brasiliensis* を採集した。これらは北緯23度から北緯38度30分、東経146度から西経131度に及ぶ広い海域で夜間に表層で採集された。この海域はこれまでダルマザメが報告されている海域よりさらに北方である。測定した雌の全長は337から520mmであり、雄は368から418mmであった。雌の卵巣重量は全長460mm以上で急激に増加し子宮内に卵を持つ個体が出現した。子宮内卵は両子宮あわせて合計6-12個で最大卵径22mmであった。雄は解剖した15個体中9個体に精液が観察された。採集地点の水温は18°から26°Cまでであった。

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